Appendix E1 – Restoration Plans and TMDLs (Watershed Assessments)

C O N T E N T S

Map - Large Watershed Assessments Completed through FY2019
Map - Small Watershed Assessments FY2019

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Report - Little Gunpowder River Watershed Assessment
Report - Broad Creek and Lower Susquehanna North Watershed Assessment
Report - Swan Creek and Lower Susquehanna North Watershed Assessment
Report - Lower Bynum Run Watershed Assessment

Appendix E1

Harford County, MD Department of Public Works
Watershed Protection and Restoration

Large Watershed Assessments Completed through FY2019

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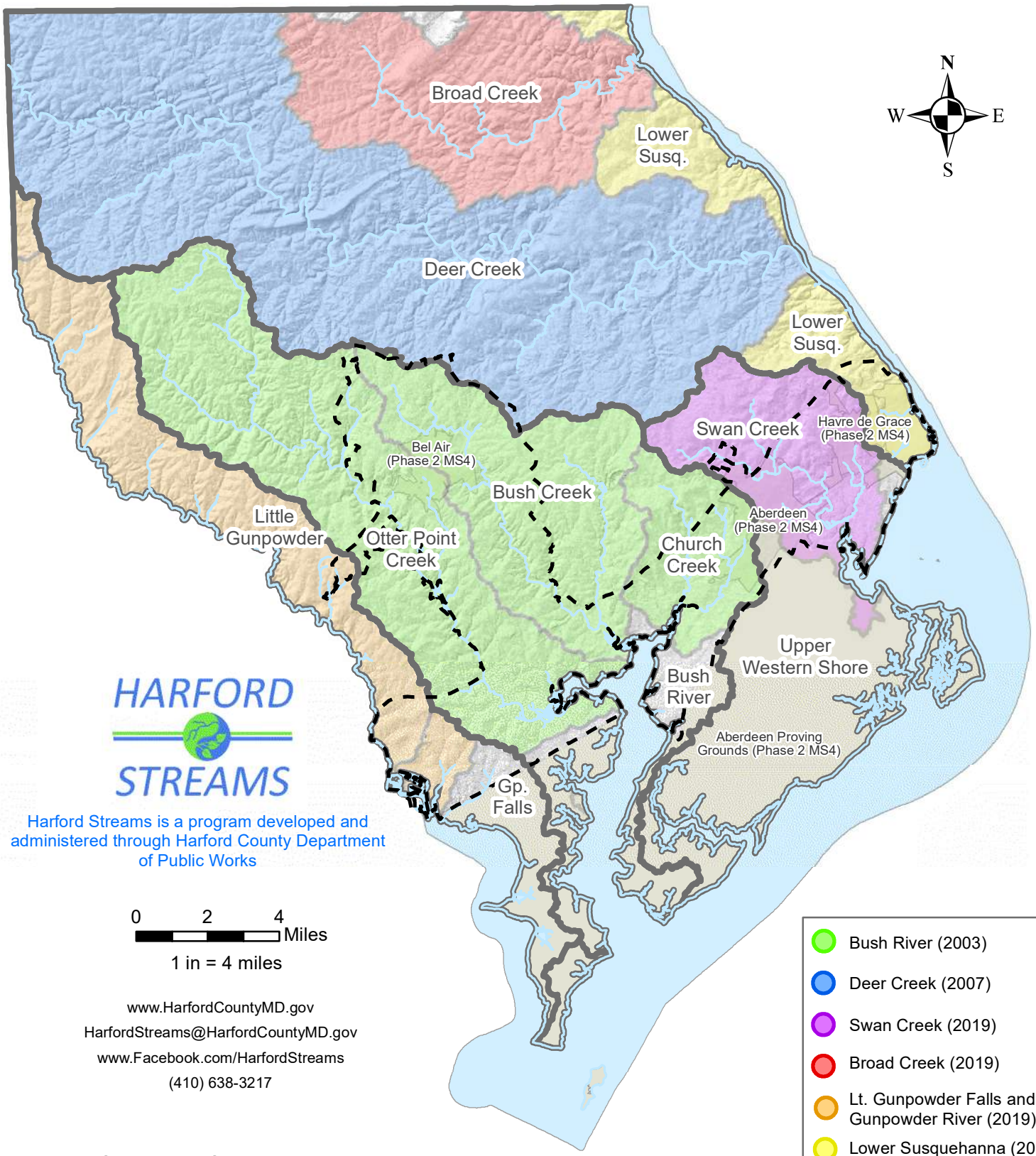
County Executive



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Appendix E1

Harford County, MD Department of Public Works
Watershed Protection and Restoration

Small Watershed Assessments FY2019

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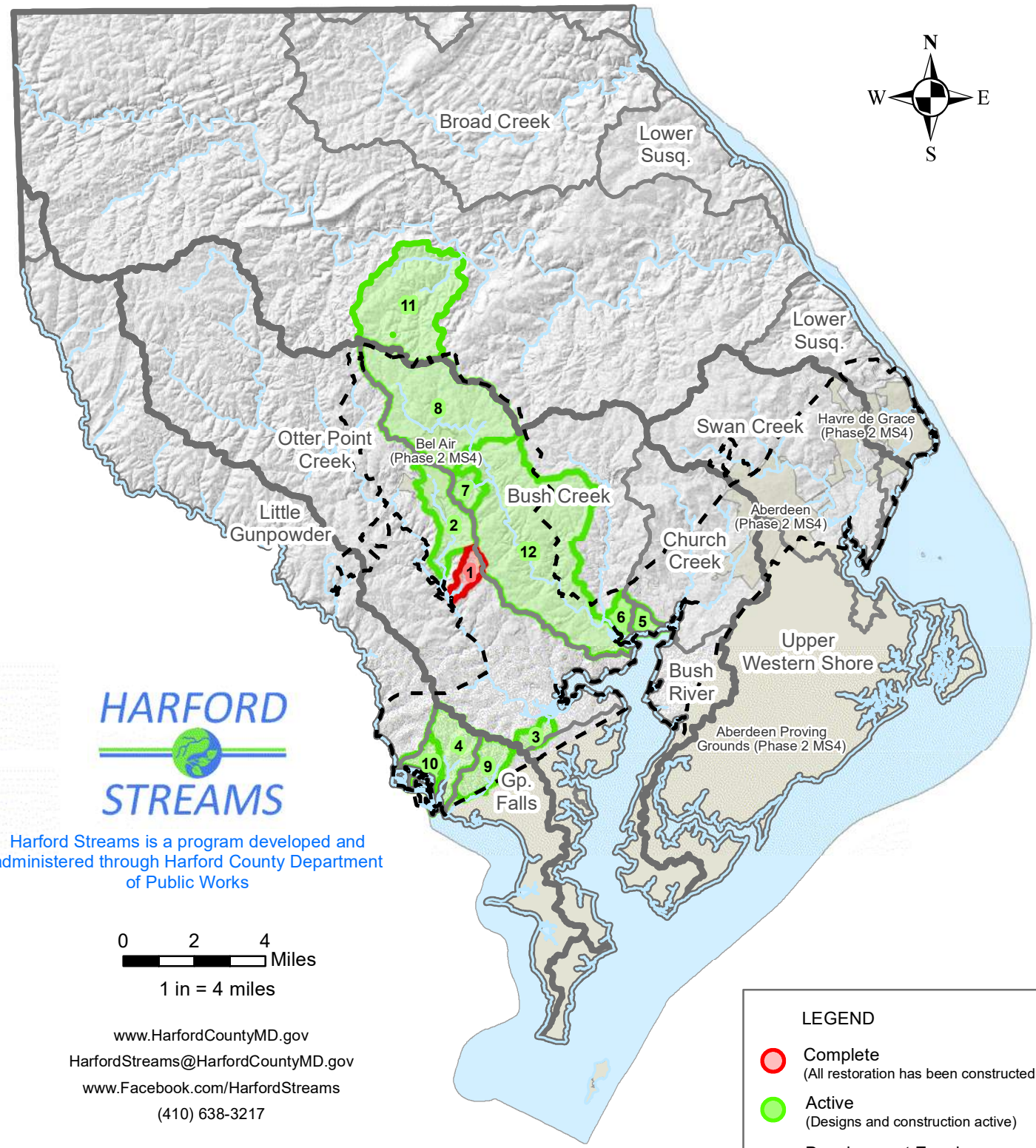
County Executive



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LEGEND

Complete
(All restoration has been constructed)

Active
(Designs and construction active)

---- Development Envelope

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Summary of Restoration Projects by Watershed Assessment

Harford County, MD Department of Public Works
Watershed Protection and Restoration
Small Watershed Assessments

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	Watershed	Completed	Drainge (ac)	Impervious (ac)	
1	Wheel Creek	2008	440	120	27%
2	Plumtree Run	2011	1,650	480	29%
3	Sams Branch	2012	370	90	24%
4	Foster Branch	2012	1,420	250	18%
5	Riverside Area	2014	300	110	37%
6	Declaration Run	2014	430	110	26%
7	Upper Farnandis Branch	2017	490	100	20%
8	Upper Bynum Run	2018	5,350	1,500	28%
9	Upper Emmord Branch	2018	1,010	190	19%
10	Taylors Creek	2018	670	200	30%
11	Stout Bottle Branch	2018	4,670	290	6%
12	Lower Bynum Run	2019	9,260	1,320	14%
		Totals	26,060	4,760	18%

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Watershed Protection and Restoration
Wheel Creek Stream Improvement Projects

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Wheel Creek Watershed Assessment (2008)
(440 acres / 120 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000030	Wheel Creek at Calvert Walks Stream Restoration	2013	1	21.75	$324,682	$204,951	$14,928
WP000022	Wheel Creek at Gardens of Bel Air SWM Retrofit	2013	1	4.79	$322,120	$178,804	$67,248
WP000026	Wheel Creek at Festival at Bel Air SWM Retrofit	2016	1	12.00	$385,601	$195,436	$32,133
WP000024	Wheel Creek at Country Walk 1A SWM Retrofit	2016	2	8.66	$576,532	$324,119	$66,574
WP000025	Wheel Creek at Country Walk 1B SWM Retrofit	2017	1	3.66	$292,152	$118,614	$79,823
WP000027	Lower Wheel Creek SWM Retrofit & Stream Restoration	2017	6	139.52	$2,103,964	$1,420,177	$15,080
			Totals	190.38	$4,005,051	$2,442,103	$21,037

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Watershed Protection and Restoration
Plumtree Run Stream Improvement Projects

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Plumtree Run Watershed Assessment (2011)
(1650 acres / 480 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000087	Tributary to Plumtree Run at Wakefield Manor Stream Restor	Active	1	9.00	$97,159	$0	$10,795
WP000039	Plumtree Run at Barrington Stream Restoration	Active	6	73.60	$3,063,462	$0	$41,623
WP000040	Pumphrey Property Demolition	2009	3	0.51			
WP000013	Plumtree Run at Tollgate Stream Restoration	2011	1	50.40	$428,877	$215,000	$8,509
WP000035	Ring Factory ES SWM Retrofit & Stream Restoration	2018	3	41.33	$1,490,585	$660,132	$36,065
WP000088	Stormwater Retrofit at Homestead Elementary	2019	1	1.57	$131,374	$0	$83,678
			Totals	176.41	$5,211,458	$875,132	$29,542

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Watershed Protection and Restoration
Sams Branch Stream Improvement Projects

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Sams Branch Watershed Assessment (2012)
(370 acres / 90 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000033	Willoughby Beach SWM Retrofit & Stream Restoration	Active	6	51.25	$1,667,567	$1,100,000	$32,538
WP000042	Washington Court Demolition	2011	1	2.11			
			Totals	53.36	$1,667,567	$1,100,000	$31,251

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Watershed Protection and Restoration
Foster Branch Stream Improvement Projects

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Foster Branch Watershed Assessment (2012)
(1420 acres / 250 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000037	Foster Branch at Stillmeadow Stream Restoration	Active	3	31.44	$1,757,580	$0	$55,903
WP000019	Woodbridge SWM Retrofit	2013	1	3.80	$256,467	$0	$67,491
WP000032	Foster Branch at Trimble Road Stream Restoration	2014	1	24.26	$570,051	$275,000	$23,498
WP000020	Woodbridge Stream Restoration	2015	1	24.60	$553,083	$258,832	$22,483
WP000036	Foster Branch at Dembytown Stream Restoration	2017	2	42.10	$902,662	$500,000	$21,441
			Totals	126.20	$4,039,843	$1,033,832	$32,011

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Watershed Protection and Restoration
Declaration Run Stream Improvement Projects

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Declaration Run Watershed Assessment (2014)
(430 acres / 110 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000043	Northwest Branch Declaration Run Stream Restoration	Active	1	38.80	$1,306,252	$0	$33,666
WP000034	Church Creek ES SWM Retrofit & Stream Restoration	Active	3	45.92	$1,671,160	$980,000	$36,393
			Totals	84.72	$2,977,413	$980,000	$35,144

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Watershed Protection and Restoration
Upper Farnandis Branch Stream Improvement Projects

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Upper Farnandis Branch Watershed Assessment (2017)
(490 acres / 100 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000097	Woodland Run Stream Restoration	Active	1	54.00	$1,124,996	$0	$20,833
			Totals	54.00	$1,124,996	$0	$20,833

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Watershed Protection and Restoration
Upper Bynum Run Stream Improvement Projects

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Upper Bynum Run Watershed Assessment (2018)
(5350 acres / 1500 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000110	Spenceola Retrofit	Active	1	2.50	$807,449	$0	$322,980
WP000109	Hickory Vet Retrofit	Active	1	0.80	$500,565	$0	$625,707
WP000108	Gavigans Retrofit	Active	1	1.00	$478,790	$0	$478,790
WP000104	Courthouse Bioretention	Active	1	0.40	$165,000	$0	$412,500
WP000091	C Milton Wright Stormwater Retrofit and Stream Restoration	Active	1	35.00	$2,627,767	$0	$75,079
WP000012	Bynum Ridge Stream Stablization	2011	1	13.95	$225,212	$0	$16,144
WP000018	Friends Pond SWM Retrofit	2011	1	11.70	$109,761	$0	$9,381

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Watershed Protection and Restoration
Upper Bynum Run Stream Improvement Projects

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Upper Bynum Run Watershed Assessment (2018)
(5350 acres / 1500 acres impervious)

Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
		Totals	65.35	$4,914,544	$0	$75,203

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Watershed Protection and Restoration
Upper Emmord Branch Stream Improvement Projects

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Upper Emmord Branch Watershed Assessment (2018)
(1010 acres / 190 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000085	Emmord Stream Restoration	Active	1	60.00	$768,478	$0	$12,808
WP000056	Magnolia Middle School Tree Planting	2014	1	0.23	$5,295	$5,295	$23,022
WP000094	Magnolia Middle School Tree Planting II	2015	2	0.47	$12,267	$12,267	$26,101
			Totals	60.70	$786,040	$17,562	$12,950

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Watershed Protection and Restoration
Taylors Creek Stream Improvement Projects

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Taylors Creek Watershed Assessment (2018)
(670 acres / 200 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000105	Mariner Point Tree Planting	Active	1	0.20	$8,000	$0	$40,000
			Totals	0.20	$8,000	$0	$40,000

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Watershed Protection and Restoration
Lower Bynum Run Stream Improvement Projects

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Lower Bynum Run Watershed Assessment (2017)
(490 acres / 100 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000021	Sunnyview Drive Stream Restoration	Active	1	90.00	$1,509,789	$0	$16,775
WP000057	Patterson Mill High School Tree Planting	2013	1	0.82	$23,688	$23,688	$28,888
WP000029	Bynum at St Andrews Way Stream Restoration	2019	1	92.52	$2,083,589	$1,600,000	$22,520
			Totals	183.34	$3,617,066	$1,623,688	$19,729

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Little Gunpowder River Watershed Assessment

Prepared for:

Harford County
Department of Public Works

Little Gunpowder River Large Watershed Action Plan

November 2019

Prepared by

BayLand Consultants & Designers, Inc.

"Integrating Engineering and Environment"

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Website: www.baylandinc.com

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1. INTRODUCTION

1.1. Overview & Background

The Harford County (the County) Department of Public Works (DPW) has contracted BayLand Consultants & Designers, Inc. (BayLand) to provide a detailed watershed assessment referred to as a Large Watershed Action Plan (LWAP) for the Little Gunpowder River Watershed.

The LWAP is intended to satisfy the requirements of the County's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit (11-DP-3310 MD0068268). It is also intended to:

- Determine current water quality conditions;
- Include the results of the visual watershed inspection;
- Identify and rank water quality problems;
- Prioritize all structural and nonstructural water quality improvements;
- Specify pollutant load reduction benchmarks that demonstrate progress toward meeting all applicable stormwater wasteload allocations (WLA).

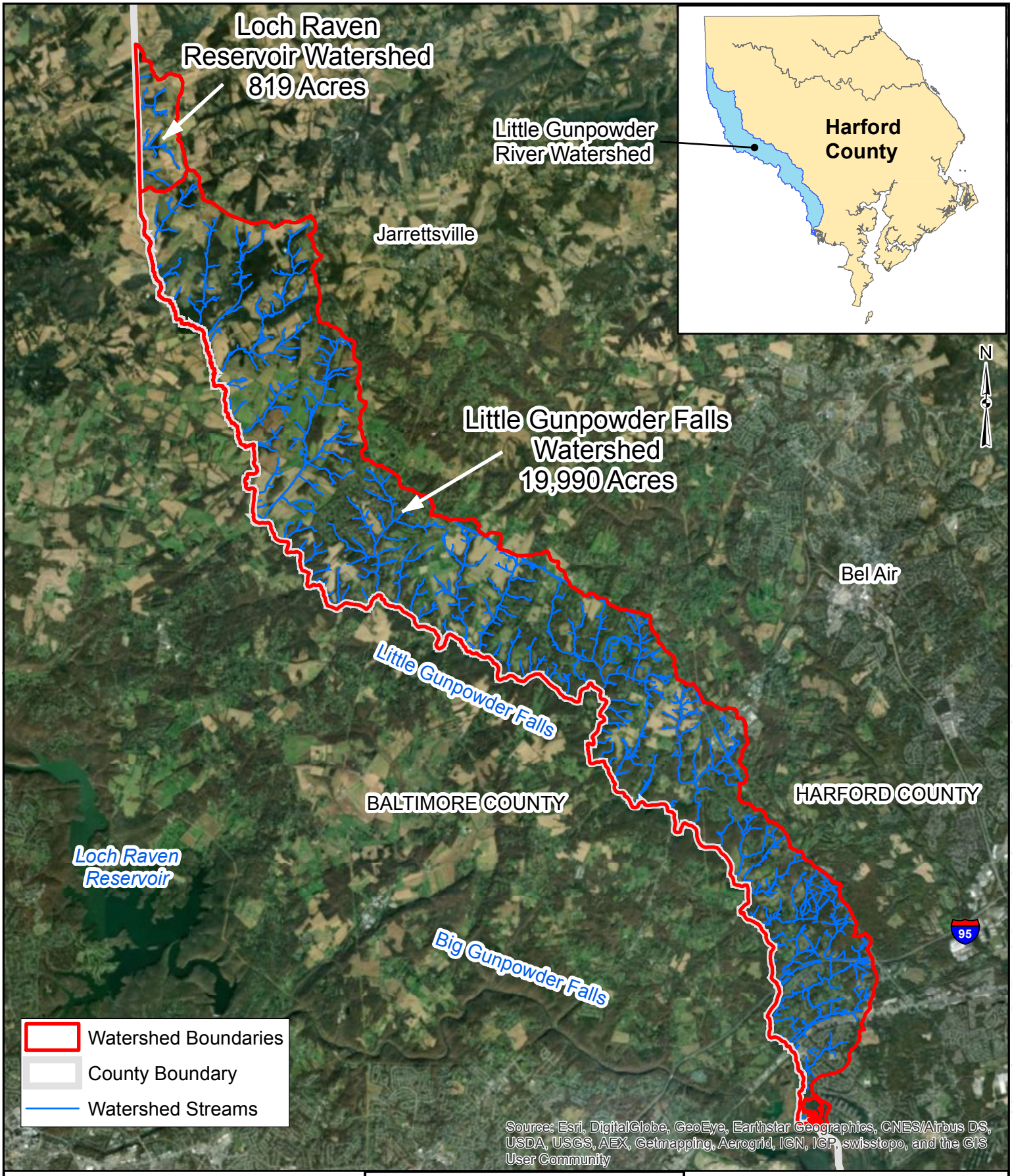
The Little Gunpowder River Watershed is located on the eastern boundary of the County. A watershed map is included as Figure 1.

The Little Gunpowder River Watershed totals approximately 20,809 acres (32.5 square miles) and is comprised of the Harford County portion of the Little Gunpowder Falls Watershed (MDE 8-Digit 02130804) and the Harford County portion of the Loch Raven Reservoir Watershed (MDE 8-Digit 02130805). Both the Little Gunpowder Falls and Loch Raven Reservoir Watersheds flow into the Gunpowder River Watershed (MDE 6-Digit 021308).

Historical land use changes throughout the watershed, including urbanization, deforestation, afforestation and agricultural intensification has resulted in degraded water quality, accelerated stream bank erosion due to increased stormwater runoff and altered basin hydrology, reduced flood storage capacity, and increased risk to public and private infrastructure and property along the County's stream corridors.

As a result, the watershed has been targeted for assessment to locate and quantify areas of instability and degradation, identify potential causes of water quality impairments, and recommend structural and non-structural methods to reduce pollutant loads in the watershed.

This LWAP will focus on the developed areas of the Little Gunpowder River Watershed where residential and commercial development, as well as unmanaged stormwater runoff, are a primary concern.



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Watershed Features from 2013 Harford County GIS.

0 0.5 1 2 3 4 Miles

1" = 2 mi

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FIGURE 1
LITTLE GUNPOWDER
RIVER
WATERSHED
(IN HARFORD COUNTY)

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 1 - Little Gunpowder Study Area.mxd

1.2. Scope of Study

Existing conditions for the Little Gunpowder River Watershed were evaluated through desktop analysis, field reconnaissance, review of existing as-built information, and modeling of pollutant loads. The data was utilized to characterize the current conditions of the watershed and to identify sub-watersheds with the highest pollutant loads. Ultimately, results were used to develop and prioritize restoration opportunities in highly impacted sub-watersheds. Cost and pollutant load reduction estimates were developed for each restoration opportunity including best management practices (BMP) and stream restoration projects. Sub-watershed pollutant loads were then recalculated to demonstrate anticipated pollutant reductions associated with the proposed projects.

Ultimately, potential projects were evaluated and prioritized according to the following criteria:

- Location within the Watershed
- Estimated Pollutant Load Reductions
- Impervious Acre Credits
- Property Ownership
- Site Access
- Existing Utility Conflicts
- Cost

2. WATERSHED CHARACTERIZATION

2.1. Watershed

The Little Gunpowder River Watershed totals approximately 20,809 acres (32.5 square miles) and is comprised of a mix of agricultural, forested and urban land uses. The Loch Raven Reservoir Watershed comprises approximately 819 acres (1.3 square miles) and the Little Gunpowder Falls Watershed comprises approximately 19,990 acres (31.2 square miles).

Section 303(d) of the Clean Water Act (CWA) requires states to develop lists of impaired watersheds, which are commonly referred to as “303(d) Lists” (EPA, 2019).

The Little Gunpowder Falls Watershed was first identified on the 1996 303(d) List submitted by the Maryland Department of the Environment (MDE) to the United States Environmental Protection Agency (EPA) as impaired by nutrients and heavy metals (MDE, 1996). The Little Gunpowder Falls Watershed was removed from the list between 2008 and 2012 according to Maryland Integrated Reports of Surface Water Quality (MDE, 2008, 2012). In 2014, the watershed was again added to the 303(d) List for excessively high temperatures. According to the 2014 Maryland Integrated Report of Surface Water Quality for Little Gunpowder Falls, “temperature measurements exceed criteria and no coldwater taxa were found” (MDE, 2014). As of the 2018 Maryland Integrated Report of Surface Water Quality, the Little Gunpowder Falls Watershed remains on the 303(d) List for high temperatures (MDE, 2018).

The Loch Raven Reservoir Watershed was first identified on the 2014 303(d) List submitted by MDE to the EPA as impaired by chloride, sulfate and phosphorus (MDE, 2014).

2.2. Physiography

The Little Gunpowder River Watershed falls within the Atlantic Coastal Plain Province and Piedmont Plateau Province including the Hampstead Upland District (422300), Chattolanee Upland District (425100), Timonium Valley District (425200), Bel Air Upland District (422100), Perry Hall Upland District (426100), and Middle River Lowland District (511200) (MGS, 2008).

Most of the watershed lies within the Hampstead Upland District (422300), which features rolling to hilly uplands interrupted by steep-walled gorges. This landform features differential weathering of a variety of rock types that results in ridges, hills, barrens, and valleys. Streams may have short segments of narrow and steep-sided valleys (MGS, 2008).

The Chattolannee Upland District (425100) consists of gently rolling to subdued hilly dome-like uplands underlain mainly by Baltimore Gneiss, each surrounded by steep (greater than 15 degree) slopes underlain by quartzite and schist (MGS, 2008).

The Timonium Valley District (425200) consists of a broad flat-bottomed valley underlain by Cockeysville Marble. Where the marble outcrop becomes narrow, the valley disappears. Chemical weathering of the marble produces a distinctive dolomite sand and numerous pinnacles and residual boulders (MGS, 2008).

The Bel Air Upland District (422100) is an upland characterized by gently rolling to flat surfaces (MGS, 2008).

The Perry Hall Upland District (426100) is a transition between crystalline Piedmont and unconsolidated Coastal Plain; many hilltops are capped by cretaceous gravels and sediments and rivers flow across the region in steep-walled valleys incised into crystalline rock (MGS, 2008).

The Middle River Lowland District (511200) features gently rolling to a nearly flat transition between the Fall Zone Region and the Aberdeen Lowlands District. The District is segmented by the drowned mouths and associated estuarine deposits of the Gunpowder River (MGS, 2008).

2.3. Climate

The climate in the County is largely influenced by its location in the warm temperate zone of the eastern United States. The County typically experiences mild winters and hot, humid summers.

As shown in Table 1, the mean annual temperature is 55.4 degrees Fahrenheit (F) with an average summer temperature of 76.1 degrees F and an average winter temperature of 34.4 degrees F. Mean monthly high and low temperatures range from 22.0 degrees F to 41.8 degrees F for January, and 66.7 degrees F to 89.6 degrees F in July (NCEI, 2019).

Precipitation is uniformly distributed during the year. Winter rainfall primarily results from low-pressure storms moving through the area and is less variable than summer rainfall. Mean annual precipitation is 47.5 inches, with mean monthly precipitation varying from a low of 2.9 inches in February to a high of 5.0 inches in September (NCEI, 2019).

Table 1 – Average Daily and Annual Values for Temperature and Precipitation at Conowingo Dam in Maryland*

Average Monthly and Annual Values													
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean Annual**
Average Temperature (°F)	31.9	34.7	42.8	53.5	63.8	73.7	78.2	76.5	69.0	56.9	46.2	36.6	55.4
Precipitation (inches)	3.4	2.9	4.3	3.9	4.0	4.2	4.3	3.9	5.0	4.1	3.5	4.0	47.5

*Information obtained from NOAA.gov (http://www.ncdc.noaa.gov/cdo-web/datatools/normals)

2.4. Geology

According to the Maryland Geological Survey, the upland region of the watershed is underlain by schist, gneiss, gabbro and marble. The lower part of the watershed is dominated by gravel and sand upland deposits, and gravel, sand, silt, and clay of the Potomac Group and lowland deposits (MGS, 1968). The geologic characteristics influence the chemical composition of surface water and groundwater, as well as groundwater recharge rates. The properties of soil can also influence the rate and total amount of pollutants entering water bodies in developed areas (Baltimore County Department of Environmental Protection and Sustainability (BC-DEPS), 2014).

2.5. Soils

Soils within the Little Gunpowder River Watershed were determined using the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Web Soil Survey (2019). The hydrologic soil groups are listed in Table 2. Detailed soils maps, reports of drainage class and hydrologic soil groups are included in Appendix B.

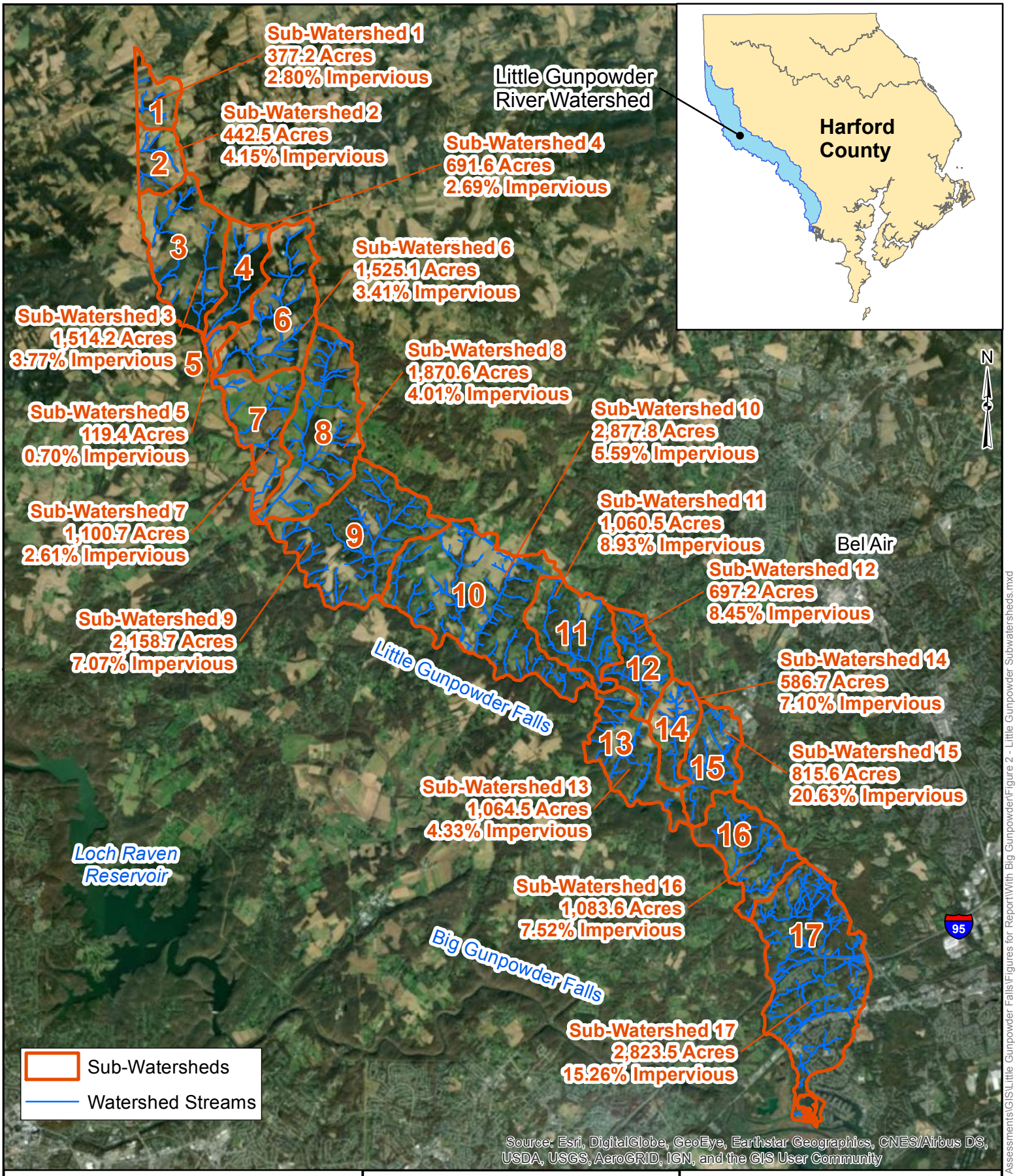
Table 2 – USDA-NRCS Soils

Hydrologic Soil Group	Acres in Watershed (acres)	Percentage of Watershed (%)
Little Gunpowder River Watershed		
A	187.8	0.9
B	14,204.2	68.3
B/D	693.3	3.3
C	3,367.8	16.2
C/D	1,674.2	8.0
D	485.3	2.3
Cut/ Fill Land	96.7	0.5
Water	100.1	0.5
Little Gunpowder River Total	**20,809.4**	**100.0**

According to the survey, the dominant soil in the watershed is Glenelg loam with slopes ranging from three to eight percent which comprises 11 percent of the watershed (Soil Survey Staff, USDA-NRCS, 2019). Glenelg loam consists of very deep, well drained soils on uplands of the Blue Ridge and the Northern Piedmont (Soil Survey Staff, USDA-NRCS, 2019). These soils formed in residuum weathered from micaceous schist. Soil color is generally brown but can range from yellowish brown to strong brown, as well as yellowish red. Most areas of Glenelg soils are in crops including corn, soybeans, small grains, hay and pasture. The native vegetation for this type of soil is typically red oak, white oak, tulip poplar and hickory.

2.6. Sub-Watersheds

The Little Gunpowder River Watershed was delineated into 17 sub-watersheds at hydrologically significant locations such as stream confluences, pipe outfalls and culverts using Harford County Geographic Information Systems (GIS) data. The sub-watersheds range from 119.4 acres to 2,877.8 acres (0.2 to 4.5 square miles) with impervious cover ranging from 0.7 to 20.6 percent. The Little Gunpowder River Sub-Watersheds are shown in Figure 2.



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Watershed Features from 2013 Harford County GIS.
3. Impervious Land use Data from 2014 Harford County GIS

0 0.5 1 2 3 4 Miles

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FIGURE 2
LITTLE GUNPOWDER RIVER SUB-WATERSHEDS

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 2 - Little Gunpowder Subwatersheds.mxd

2.7. Historical Land Use

Land use changes in a watershed can have large impacts on watershed hydrology (Bierman, 2005; Miller et al., 1993; Costa, 1975; Knox, 1977; Wolman and Schick, 1967). In order to develop a broader understanding of former land use influences on the Little Gunpowder River Watershed, a brief investigation of land use history was conducted.

Historical aerial imagery obtained from Harford County GIS data depicts the Little Gunpowder River Watershed from 1938 to 2004 (Appendix A). The historic aerials show that by 1938 the watershed was dominated by agricultural fields and some urban development. Two major roads are also evident in the 1938 aerial, including Pulaski Highway (Route 40) and Belair Road (Route 1). By 1964, Interstate 95 is visible on the aerials. The aerials indicate that most commercial and residential development in the watershed occurred prior to the implementation of Maryland's Stormwater Management (SWM) Regulations in 1983. Since this development predates current SWM design standards, runoff in these regions is either unmanaged or under-managed. Increasing impervious surface in a watershed has been shown to reduce infiltration and evapotranspiration, and increase runoff into stream networks (MDE, 2000). Watersheds with higher levels of imperviousness generally have lower levels of water quality and biological health.

2.8. Existing Land Use

The Little Gunpowder River Watershed is approximately 20,809 acres (32.5 square miles) with approximately seven percent impervious area.

Existing land use was originally developed using a combination of various data sources per guidance from MDE (Table 3). Water, wetlands, tree canopy over turf, forest, turf and mixed open land use categories were derived from 2016 Chesapeake Conservancy (CC) GIS data edited by MDE. It should be noted that MDE edited the CC land use categories to account for hydrologic differences between managed and unmanaged vegetative communities within urbanizing areas. Impervious surface was derived from 2014 Harford County Impervious Area GIS data, and agriculture was derived from the United States Geological Survey (USGS)'s Chesapeake Bay Phase 6 Land Use data.

Each existing land use category was assigned an equivalent land use designation compatible with the Chesapeake Bay Program (CBP) Phase 6 Watershed Model. The equivalent Phase 6 existing land use categories are summarized in Table 3.

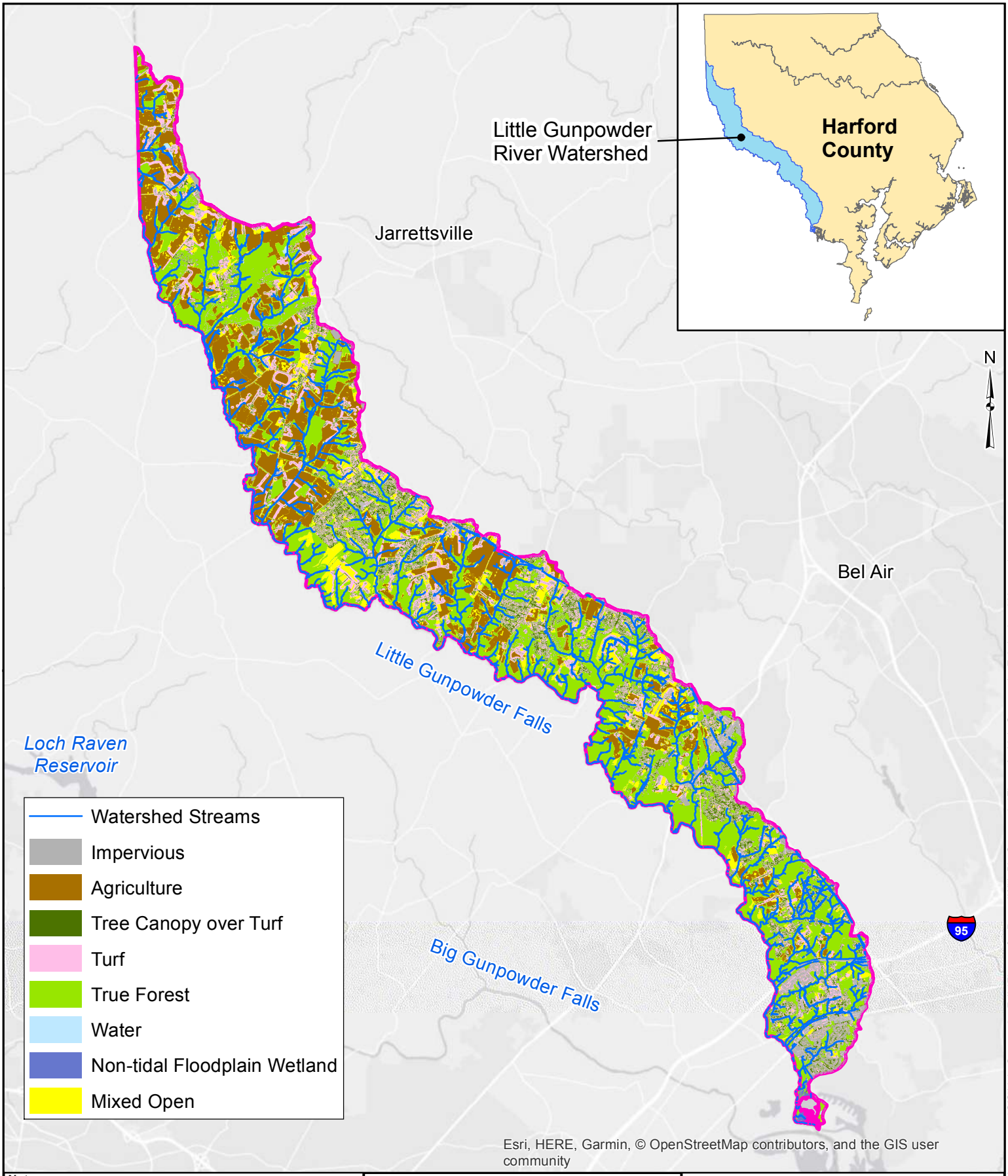
Table 3 – Harford County Existing Land Use	
Existing Land Use	**Equivalent Phase 6 Existing Land Use**
Water	Water
Wetlands	Non-tidal Floodplain Wetland
Tree Canopy Over Turf	Tree Canopy over Turf
Forest	True Forest
Turf	Turf
Mixed Open	Mixed Open
Agriculture	Agriculture
Impervious Surfaces	Impervious

The Phase 6 existing land use categories for the Little Gunpowder River Watershed are depicted in Table 4 and Figure 3. The existing land use analysis shows that the watershed is primarily forest, agriculture and turf.

Table 4 – Little Gunpowder River Watershed Phase 6 Existing Land Use		
Parameter	**Acres**	**Percentage of Drainage Area (%)**
True Forest	8,699.1	41.8
Agriculture	5,154.1	24.8
Turf	2,873.7	13.8
Impervious	1,496.6	7.2
Tree Canopy over Turf	1,269.7	6.1
Mixed Open	1,216.6	5.8
Water	56.8	0.3
Non-tidal Floodplain Wetland	42.8	0.2
Little Gunpowder River Total	**20,809.4**	**100.0**

Existing land use was also determined for each sub-watershed (Table 5). Sub-Watershed 17 has the largest amount of impervious area (430.8 acres) while Sub-Watershed 8 has the largest amount of agricultural area (857.2 acres). Sub-Watershed 5 has the smallest amount of impervious area (0.8 acres) as it is primarily agricultural (68%).

Table 5 – Little Gunpowder River Sub-Watersheds Phase 6 Existing Land Use								
Sub-Watershed	**Impervious (ac.)**	**Water (ac.)**	**Non-tidal Floodplain Wetland (ac.)**	**True Forest (ac.)**	**Agriculture (ac.)**	**Mixed Open (ac.)**	**Turf (ac.)**	**Tree Canopy over Turf (ac.)**
1	10.6	0.1	0.0	71.5	211.8	14.6	60.3	8.3
2	18.3	8.5	0.0	60.4	249.0	16.7	82.0	7.6
3	57.0	0.6	0.0	620.8	552.0	72.0	178.1	33.7
4	18.6	1.1	0.0	414.6	160.1	31.2	53.2	12.8
5	0.8	0.0	0.0	16.6	81.7	15.3	4.0	1.0
6	52.1	8.2	0.0	568.6	579.4	92.3	175.0	49.5
7	28.7	1.0	0.0	221.3	658.7	31.2	127.3	32.5
8	75.0	5.8	0.0	583.6	857.2	38.6	246.7	63.7
9	152.7	3.8	0.0	921.1	214.5	275.7	358.8	232.1
10	160.8	5.9	0.0	1170.6	812.0	152.3	411.0	165.2
11	94.7	3.2	0.0	447.6	120.6	110.1	191.0	93.2
12	58.9	1.3	0.0	303.6	71.0	75.5	123.8	63.1
13	46.1	1.2	0.0	708.9	144.5	31.5	87.7	44.6
14	41.7	1.3	0.0	215.2	182.0	53.4	70.1	23.0
15	168.3	0.0	0.0	383.0	41.7	31.6	114.2	76.8
16	81.5	2.5	0.0	625.7	114.0	34.5	117.8	107.6
17	430.8	12.3	42.8	1,365.9	103.9	140.1	472.7	255.0
Total	**1,496.6**	**56.8**	**42.8**	**8,699.1**	**5,154.1**	**1,216.6**	**2,873.7**	**1,269.7**



Notes:
1. Streams Data from 2013 Harford County GIS
2. Agriculture Land Use Data from 2017 USGS Phase 6 Land Use Viewer
3. Impervious Land Use Data from 2014 Harford County GIS
4. All other Land Use Data from 2017 Chesapeake Bay Conservancy modified by MDE

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FIGURE 3
LITTLE GUNPOWDER RIVER
EXISTING LAND USE

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 3 - Little Gunpowder Existing Land Use.mxd

2.9. Aquatic Resources

The Maryland Biological Stream Survey (MBSS) is a stream sampling program intended to assess the current condition of ecological resources in Maryland's 1st through 4th order non-tidal streams (DNR, 2019). Biological, physical, and chemical parameters are measured, and site catchment data is also reported. MBSS sampling is conducted at the six-digit river basin and eight-digit watershed levels while a volunteer component of MBSS, Stream Waders, collects samples at the 12-digit sub-watershed level. For the Little Gunpowder River watershed, MBSS and Stream Waders sampling data was available including Benthic Index of Biotic Integrity (BIBI) and Fish Index of Biotic Integrity (FIBI) scores. A total of 24 sites were sampled through the MBSS program from 1996 to 2017 for fish and benthic macroinvertebrates. Additionally, 42 sites were sampled through the Stream Waders program from 2001 to 2013 for benthic macroinvertebrates. It should be noted that BIBI and FIBI scores are classified as either poor, fair or good. A score of less than 3.0 is poor, 3.0 to 3.9 is fair, and 4.0 to 5.0 is good. The scores are shown in Table 6. Streams that scored poor or fair were evaluated for potential stream restoration projects.

Table 6 – MBSS and Stream Waders Data

Type	Sample Source	Number of Sites Sampled	Good	Fair	Poor
BIBI	MBSS	24	12 (50.0%)	9 (37.5%)	3 (12.5%)
BIBI	Stream Waders	42	7 (16.7%)	26 (61.9%)	9 (21.4%)
FIBI	MBSS	22	12 (54.6%)	5 (22.7%)	5 (22.7%)

Two of the tributaries that received poor BIBI scores are Overshot Branch and Wildcat Branch. Overshot Branch (MBSS site LIGU-110-R-2001), located along Laurel Branch Road, received a BIBI rating of 2.67. Historical aerial imagery shows that an upstream neighborhood was developed in the 1960's. These residential developments, built before current stormwater management standards, could potentially contribute to the poor BIBI rating.

Wildcat Branch (MBSS site LIGU-104-R-2001) also received a BIBI rating of 2.67. Wildcat Branch runs along Belair Road. Historical aerial imagery shows commercial development along Belair Road during the 1950's and 60's. As with Overshot Branch, this development occurred prior to current stormwater management standards, which may have contributed to the poor BIBI rating.

In contrast, Yellow Branch (MBSS site LIGU-103-R-2008), located in the northern part of the Little Gunpowder Falls Watershed, received a good BIBI rating of 5.00. Based on historical aerial imagery, very little development has occurred in the Yellow Branch watershed since 1952. Forested area has increased since 1952, replacing formerly agricultural land.

3. POLLUTANT LOAD DETERMINATION & MODELING

3.1. Modeling Methodology

The Chesapeake Assessment Scenario Tool (CAST) is a web-based modeling tool used to simulate the impact that the implementation of various BMP technologies has on watershed pollutant loads (CBP, 2017). It is utilized by multiple states and jurisdictions to support the development of Watershed Implementation Plans (WIP) and local Total Maximum Daily Loads (TMDL).

It should be noted that there are several limitations associated with the CAST modeling tool. CAST was developed to model large-scale watersheds, such as the Chesapeake Bay watershed, and in Maryland is limited to modeling watersheds averaging 9,000 acres or larger. Additionally, CAST only runs pollutant loading scenarios for watersheds pre-established by MDE and does not permit the input of unique drainage areas. Since the Little Gunpowder River Sub-Watersheds range from approximately 377 to 2,878 acres in size and are not pre-established drainage areas within the CAST model, full application of the CAST model was precluded for use in this analysis. Therefore, after consulting with MDE, it was determined that the CAST model would only be used to determine unit pollutant loading rates for land uses not included within the Maryland Phase III WIP Unit Load Summary Tables. The Maryland Phase III WIP Unit Loads Summary Tables were applied where possible to ensure the most current information was used to develop the loading rates for the Little Gunpowder River Watershed. The pollutant loading rate source for each land use is provided in Table 7 in Section 3.2, below.

The CAST model can be run under a variety of scenarios, including the “Progress” scenario which determines pollutant loading rates while accounting for existing BMPs within the landscape and the “No Action” scenario which determines pollutant loading rates without existing BMPs. For this analysis, the “2017 Progress” scenario was utilized so pollutant loading rates were determined while accounting for all BMPs constructed and documented within the sub-watersheds up to and including the year 2017.

The results of the CAST output for the Little Gunpowder River Watershed is provided in Appendix C.

3.2. Pollutant Loading Rates

Table 7 depicts the pollutant loading rates associated with the Little Gunpowder River Watershed derived from the Maryland Phase III WIP Unit Load Summary Tables and the CAST model. Predictably, impervious and agricultural land uses produce higher pollutant loads than areas covered by water, wetlands or forests. Impervious land use has a significantly higher total suspended sediment (TSS) loading rate while agriculture has a significantly higher total nitrogen (TN) loading rate. Turf land use has the highest total phosphorus (TP) loading rate.

Table 7 – Unit Loading Rates				
Land Use	**Source of Unit Loading Rates**	**2017 Progress Scenarios EOS Unit Loading Rates**		
		TN (lb/ac/yr)	**TP (lb/ac/yr)**	**TSS (lb/ac/yr)**
Water	Maryland Phase III WIP EOS Unit Loads for Harford County	8.41	0.61	0.00
Non-Tidal Floodplain Wetland	Maryland Phase III WIP EOS Unit Loads for Harford County	1.32	0.03	14.68
True Forest	Maryland Phase III WIP EOS Unit Loads for Harford County	1.41	0.03	21.46
Mixed Open	Maryland Phase III WIP EOS Unit Loads for Harford County	1.92	0.17	815.37
Agriculture	CAST Model	21.20	0.33	845.14
Impervious	Maryland Phase III WIP EOS Unit Loads for Harford County	14.04	0.77	1,927.82
Turf	Maryland Phase III WIP EOS Unit Loads for Harford County	8.95	0.99	758.46
Tree Canopy over Turf	Maryland Phase III WIP EOS Unit Loads for Harford County	6.80	0.74	528.77

Once the Phase 6 existing land use and unit loading rates for the Little Gunpowder River Watershed were finalized, annual pollutant loads were calculated for each sub-watershed according to the following formula:

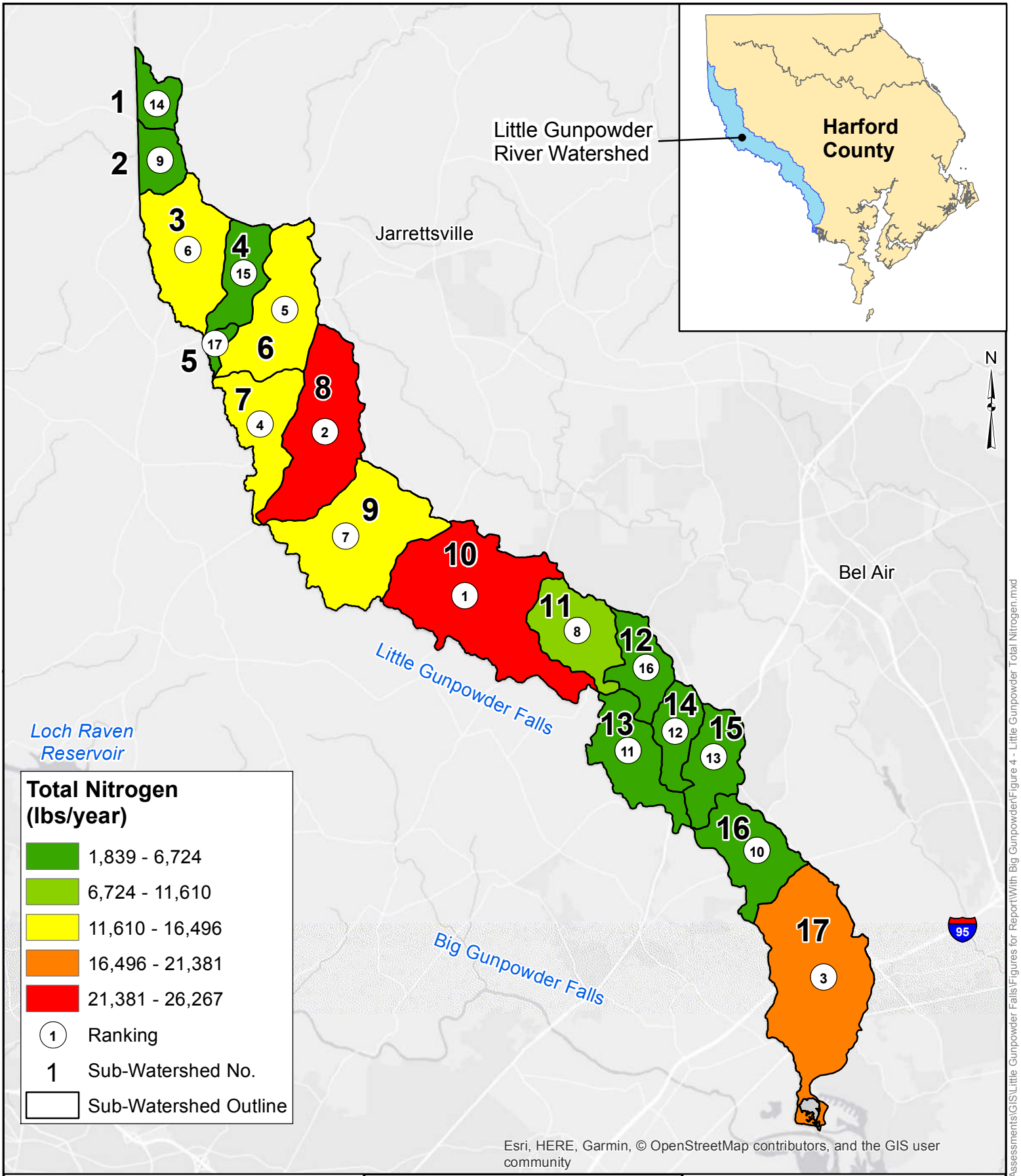
$$Annual\ Pollutant\ Load\ \left(\frac{lb}{yr}\right) = Land\ Use\ (ac) * Unit\ Loading\ Rate\ \left(\frac{lb}{ac * yr}\right)$$

3.3. Modeling Results

The annual pollutant loads for each sub-watershed are provided in Appendix D, Table 8, and Figures 4 to 6. Table 8 depicts the sub-watersheds ranked from highest to lowest total annual pollutant loads.

Table 8 – Little Gunpowder River Sub-Watershed Annual Pollutant Loads					
Rank	**Sub-Watershed**	**Area (acres)**	**2017 Progress Scenario**		
			Total Nitrogen (lb/yr)	**Total Phosphorus (lb/yr)**	**Total Suspended Sediment (ton/yr)**
1	17	2,823.5	16,571.0	1,096.8	778.0
2	10	2,877.8	26,264.5	989.3	772.3
3	8	1,870.6	22,809.7	663.5	566.9
4	9	2,158.7	13,340.6	793.1	557.5
5	6	1,525.1	15,963.0	481.6	418.2
6	3	1,514.2	15,343.0	461.1	400.7
7	7	1,100.7	16,106.3	405.1	378.0
8	11	1,060.5	7,098.4	405.4	289.0
9	15	815.6	5,391.1	330.3	260.4
10	16	1,083.6	6,316.6	323.3	220.6
11	12	697.2	4,452.1	261.0	184.4
12	14	586.7	5,641.8	195.6	173.8
13	13	1,064.5	5,867.4	231.0	171.0
14	2	442.5	6,509.9	194.0	163.5
15	1	377.2	5,363.1	149.5	131.4
16	4	691.6	4,873.0	148.4	126.3
17	5	119.4	1,838.9	35.8	43.5
Little Gunpowder River Total		**20,809.4**	**179,750.4**	**7,164.8**	**5,635.5**

In the Little Gunpowder River Watershed, Sub-Watershed 17 has the highest total annual pollutant loads likely due to the high percentage of impervious area (15%). Sub-Watershed 5, a more rural watershed with a low percentage of impervious area (<1%), has the lowest total annual pollutant loads.



Notes:
1. Watershed Features from 2013 Harford County GIS.

0 0.5 1 2 3 4 Miles

1" = 2 mi

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FIGURE 4
LITTLE GUNPOWDER RIVER TOTAL NITROGEN LOADS

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 4 - Little Gunpowder Total Nitrogen.mxd

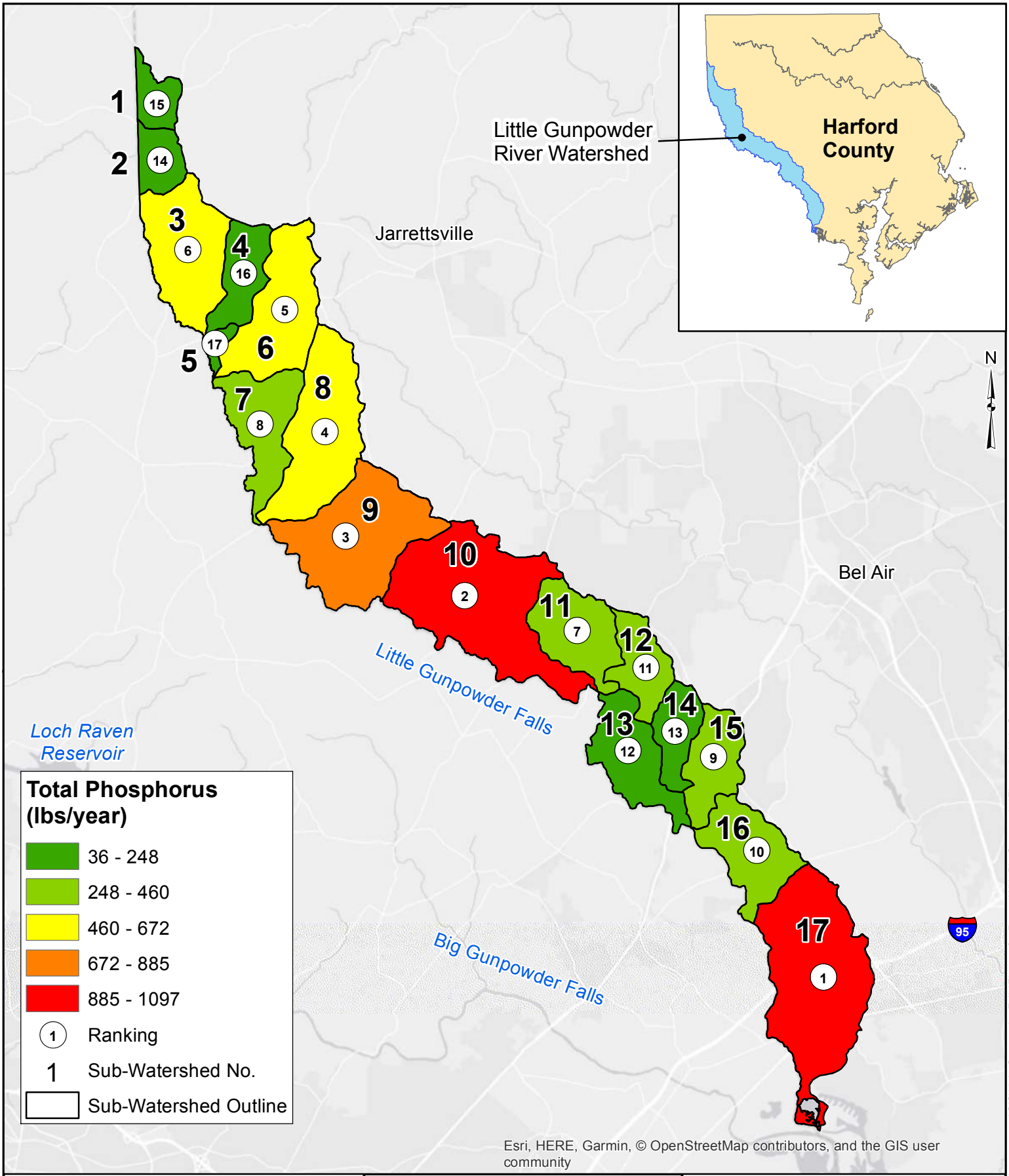

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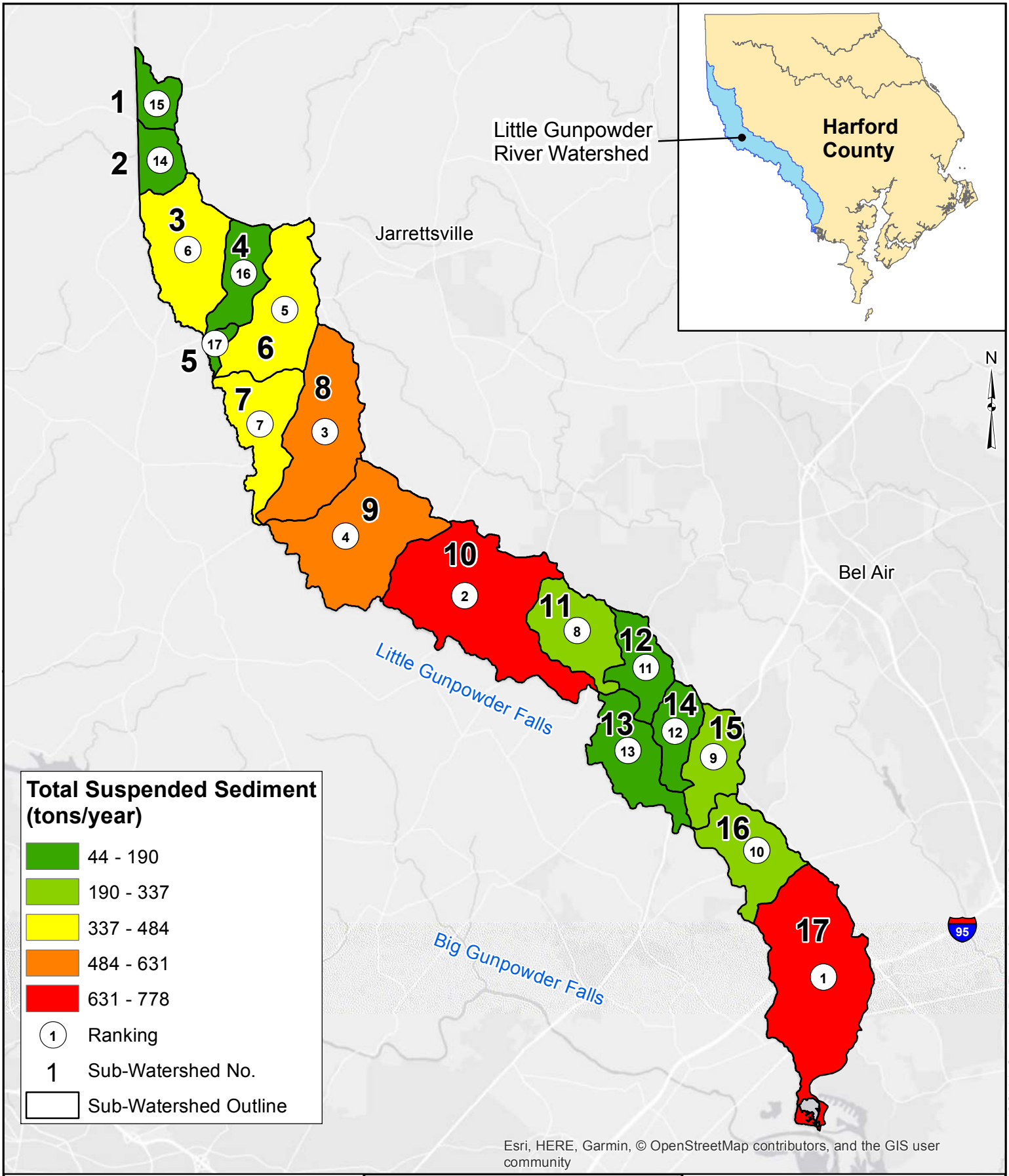
FIGURE 5
LITTLE GUNPOWDER RIVER TOTAL PHOSPHORUS LOADS

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 5 - Little Gunpowder Total Phosphorous.mxd



Notes:
1. Watershed Features from 2013 Harford County GIS.

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FIGURE 6
LITTLE GUNPOWDER RIVER SUB-WATERSHED TOTAL SUSPENDED SEDIMENT LOADS

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 6 - Little Gunpowder Total Suspended Sediment.mxd

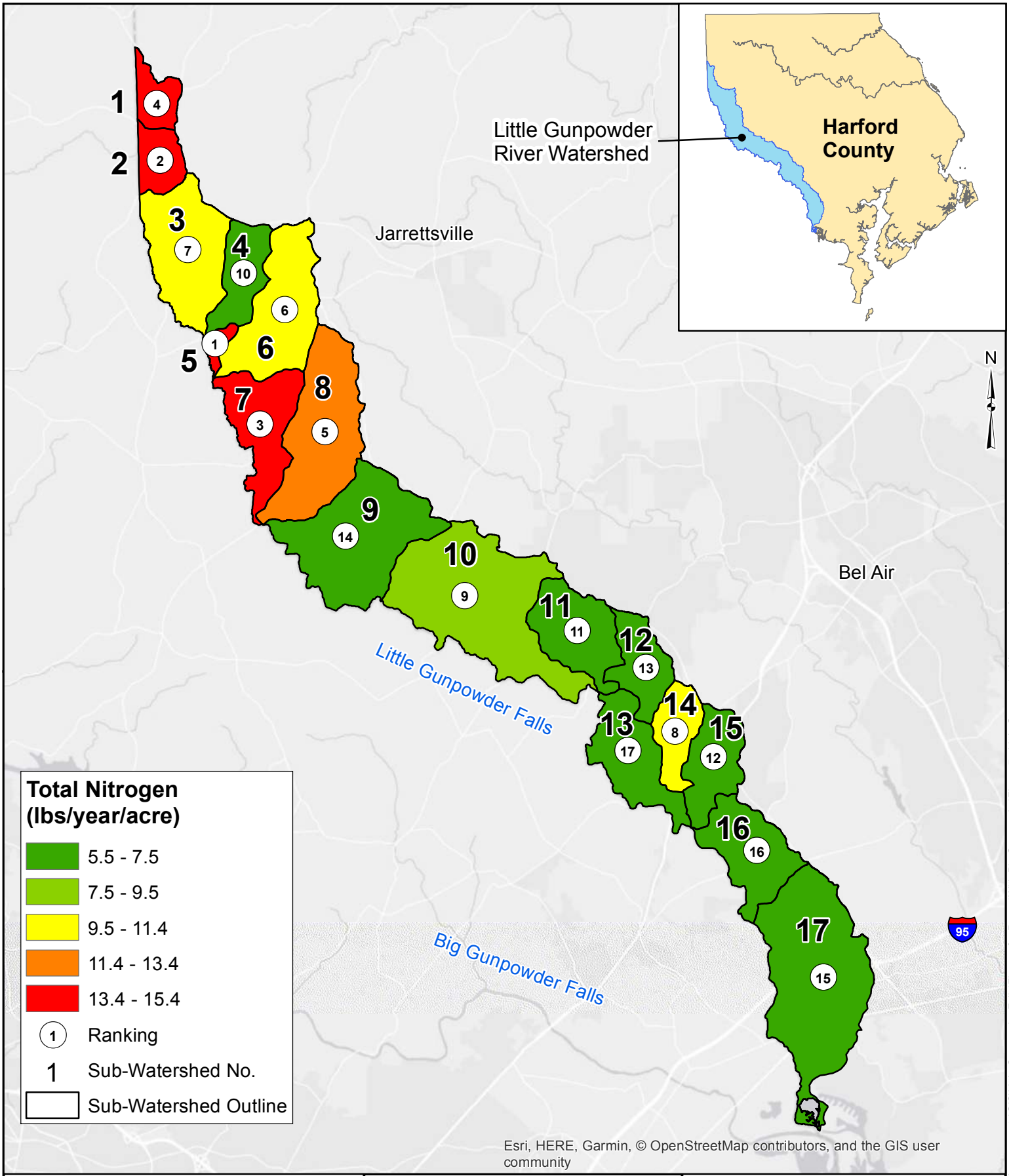
In an effort to normalize sub-watersheds based on their areas, the annual pollutant loads per acre were calculated for each sub-watershed, as shown in Appendix D, Table 9, and Figures 7 to 9. Table 9 shows the total annual pollutant load per acre ranked from highest to lowest.

Table 9 – Little Gunpowder River Sub-Watershed Annual Pollutant Loads per Acre

Rank	Sub-Watershed	Area (acres)	2017 Progress Scenario		
			TN (lb/yr/acre)	TP (lb/yr/acre)	TSS (ton/yr/acre)
1	2	442.5	14.7	0.4	0.4
2	5	119.4	15.4	0.3	0.4
3	1	377.2	14.2	0.4	0.4
4	7	1,100.7	14.6	0.4	0.3
5	15	815.6	6.6	0.4	0.3
6	8	1,870.6	12.2	0.4	0.3
7	14	586.7	9.6	0.3	0.3
8	17	2,823.5	5.9	0.4	0.3
9	6	1,525.1	10.5	0.3	0.3
10	11	1,060.5	6.7	0.4	0.3
11	10	2,877.8	9.1	0.3	0.3
12	3	1,514.2	10.1	0.3	0.3
13	12	697.2	6.4	0.4	0.3
14	9	2,158.7	6.2	0.4	0.3
15	16	1,083.6	5.8	0.3	0.2
16	4	691.6	7.1	0.2	0.2
17	13	1,064.5	5.5	0.2	0.2
Little Gunpowder River Total		**20,809.4**	**8.6**	**0.3**	**0.3**

Sub-watershed 2 has the highest total annual pollutant loads per acre due to the large percentage of agricultural area (56%). Sub-watershed 13 has the lowest pollutant loads per acre due to the high percentage of forest area (67%).

Ultimately it was determined that the total annual pollutant loads are more representative in ranking the sub-watersheds with the most water quality impairments.



Notes:
1. Watershed Features from 2013 Harford County GIS.

0 0.5 1 2 3 4 Miles

1" = 2 mi

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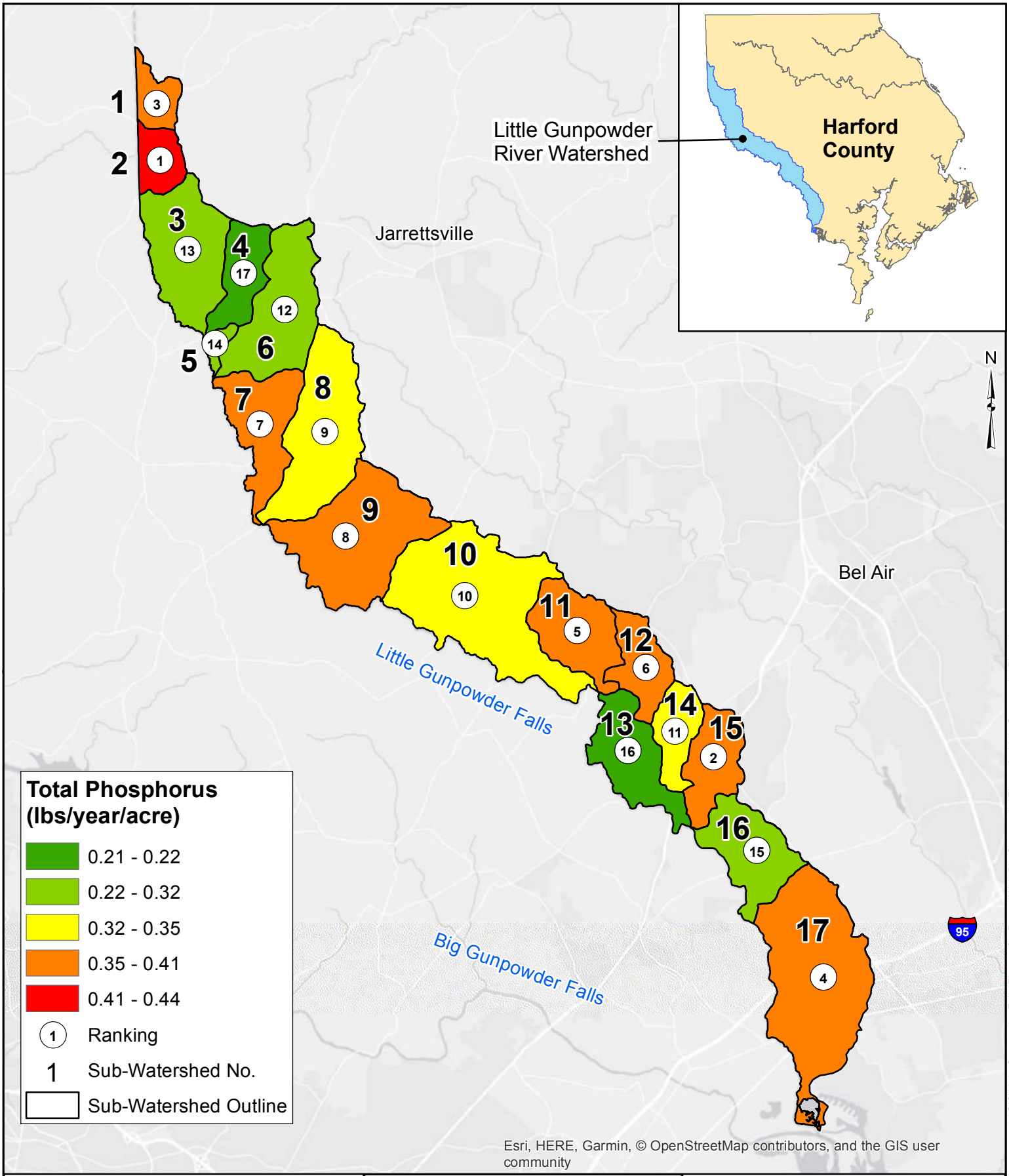
FIGURE 7
LITTLE GUNPOWDER RIVER SUB-WATERSHED NITROGEN LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 7 - Little Gunpowder Nitrogen per Acre.mxd



Notes:
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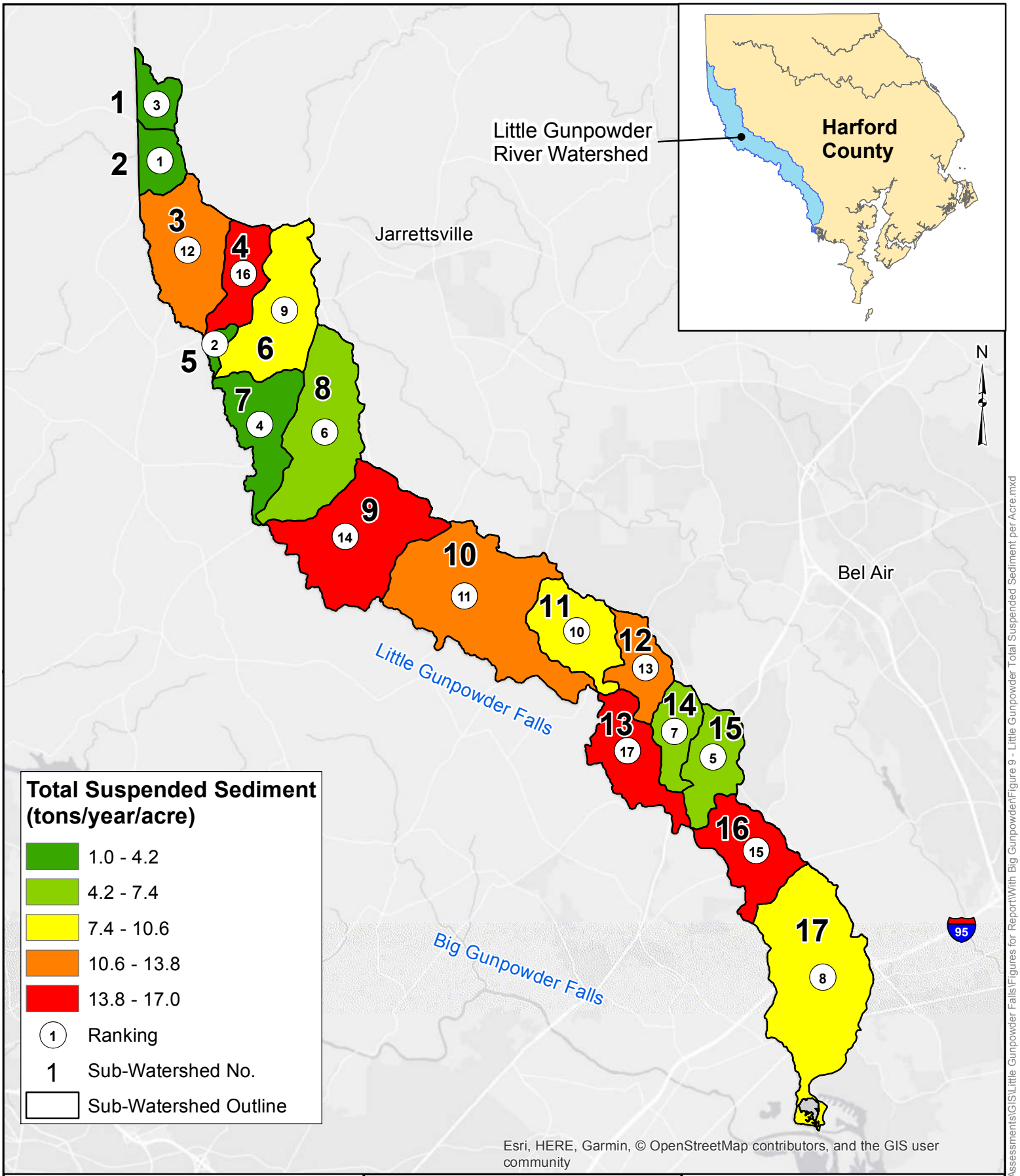
FIGURE 8
LITTLE GUNPOWDER RIVER SUB-WATERSHED PHOSPHORUS LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 8 - Little Gunpowder Phosphorous per Acre.mxd



Notes:
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FIGURE 9
LITTLE GUNPOWDER RIVER SUB-WATERSHED TOTAL SUSPENDED SEDIMENT LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 9 - Little Gunpowder Total Suspended Sediment per Acre.mxd

To assess the impact of existing BMPs within the sub-watersheds, the “No Action” and “2017 Progress” scenarios were compared. Table 10 shows the annual pollutant loads for each sub-watershed under both scenarios and the difference between the two scenarios. The same methodology described in Sections 3.1 and 3.2 that was used to derive the “2017 Progress” scenario annual pollutant loads was used to derive the “No Action” scenario annual pollutant loads.

Table 10 – Little Gunpowder River Sub-Watershed "No Action" Versus "2017 Progress" Scenario Annual Pollutant Loads										
		No Action Scenario			**2017 Progress Scenario**			**Change from No Action to 2017 Progress Scenario**		
Sub-Watershed	**Area (acres)**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (ton/yr)**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (ton/yr)**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (ton/yr)**
1	377.2	5,409.6	156.4	132.4	5,363.1	149.5	131.4	46.5 (0.9%)	6.9 (4.4%)	1.0 (0.8%)
2	442.5	6,572.6	203.3	165.0	6,509.9	194.0	163.5	62.7 (1.0%)	9.3 (4.6%)	1.5 (0.9%)
3	1514.2	15,493.8	483.0	404.8	15,343.0	461.1	400.7	150.8 (1.0%)	21.9 (4.5%)	4.1 (1.0%)
4	691.6	4,920.0	155.2	127.7	4,873.0	148.4	126.3	47.0 (1.0%)	6.8 (4.4%)	1.4 (1.1%)
5	119.4	1,842.3	36.3	43.6	1,838.9	35.8	43.5	3.4 (0.2%)	0.5 (1.4%)	0.1 (0.2%)
6	1525.1	16,118.0	504.1	422.2	15,963.0	481.6	418.2	155.0 (1.0%)	22.5 (4.5%)	4.0 (1.0%)
7	1100.7	16,214.0	421.0	380.5	16,106.3	405.1	378.0	107.7 (0.7%)	15.9 (3.8%)	2.5 (0.7%)
8	1870.6	23,025.7	694.9	572.6	22,809.7	663.5	566.9	216.0 (0.9%)	31.4 (4.5%)	5.7 (1.0%)
9	2158.7	13,739.7	849.9	568.7	13,340.6	793.1	557.5	399.1 (2.9%)	56.8 (6.7%)	11.2 (2.0%)
10	2877.8	26,666.4	1,046.7	783.8	26,264.5	989.3	772.3	401.9 (1.5%)	57.4 (5.5%)	11.5 (1.5%)
11	1060.5	7,300.4	433.9	295.3	7,098.4	405.4	289.0	202.0 (2.8%)	28.5 (6.6%)	6.3 (2.1%)
12	697.2	4,583.4	279.6	188.4	4,452.1	261.0	184.4	131.3 (2.9%)	18.6 (6.7%)	4.0 (2.1%)
13	1064.5	5,962.0	244.2	174.0	5,867.4	231.0	171.0	94.6 (1.6%)	13.2 (5.4%)	3.0 (1.7%)
14	586.7	5,712.7	205.5	176.3	5,641.8	195.6	173.8	70.9 (1.2%)	9.9 (4.8%)	2.5 (1.4%)
15	815.6	5,561.5	352.2	269.0	5,391.1	330.3	260.4	170.4 (3.1%)	21.9 (6.2%)	8.6 (3.2%)
16	1083.6	6,474.3	345.1	225.8	6,316.6	323.3	220.6	157.7 (2.4%)	21.8 (6.3%)	5.2 (2.3%)
17	2823.5	17,151.9	1,174.8	802.0	16,571.0	1,096.8	778.0	580.9 (3.4%)	78.0 (6.6%)	24.0 (3.0%)
Total	**20,809.4**	**182,748.3**	**7,586.1**	**5,732.1**	**179,750.4**	**7,164.8**	**5,635.5**	**2,997.9 (1.7%)**	**421.3 (5.6%)**	**96.6 (1.7%)**

For the Little Gunpowder River Watershed, TN, TP and TSS were reduced by 1.7, 5.6, and 1.7 percent respectively from the “No Action” to “2017 Progress” scenario. This indicates that the existing BMPs are reducing the overall pollutant loads within the watershed.

4. WATERSHED ACTION PLAN

4.1. Project Evaluation Criteria

Projects were evaluated and prioritized according to the criteria listed in Table 11.

Table 11 – Project Prioritization Criteria	
Criteria	**Description**
Location within the watershed	Is the project located in the most degraded sub-watersheds?
Pollutant Load Reduction	Does the project result in high pollutant loading reductions?
Impervious Acre Credits	Does the project result in high amounts of impervious area treatment credit?
Property Ownership	Is the project on public property? On one private property? On multiple private properties?
Site Access	Are there access constraints? Are there natural resources impacts such as mature trees, wetlands and wetland buffers? Are there infrastructure constraints? Steep slopes?
Existing Utility Conflicts	Are there existing utilities that conflict with the design?
Cost	What is the total cost and what is the cost per impervious acre treated?

As part of project prioritization, sub-watersheds with the highest pollutant loads due to untreated impervious area and degraded stream channels were prioritized over sub-watersheds with minimal impervious area and pollutant loadings.

The amount of eligible impervious acre and pollutant reduction credits was another key factor in project prioritization. For the Little Gunpowder River Watershed, stream restoration projects typically resulted in higher impervious acre and pollutant reduction credits than BMP projects.

Property ownership and site access were also considered. Project locations were considered easily accessible if they were adjacent to public roads, contained an existing access easement, or could be accessed through County property. Projects on County property were prioritized over projects located on private property.

Existing utility conflicts were also noted in the desktop and field investigations, including but not limited to light poles, sanitary sewer infrastructure, and overhead power lines. Projects with existing utility constraints were considered less favorable.

Project costs included design, permitting, construction and construction management. To account for varying project sizes and costs, cost efficiency was evaluated on a cost per impervious acre treated. Typically, larger projects treating extensive amounts of

impervious area are more cost efficient than smaller projects, even though they can be significantly more expensive.

4.2. Stream Restoration

4.2.1. Methodology

An in-depth desktop analysis and field assessment were performed within the Little Gunpowder River Watershed to identify eroded and degraded stream restoration projects that would improve the stability and function of the system, as well as provide the County with TMDL and MS4 credits. The desktop analysis consisted of review of aerial photography and a detailed GIS query that included drainage and impervious area calculations, land use, property ownership, storm drain networks, utilities and site access. Ultimately, nine stream sites were identified for field assessment in order to document existing stream channel and riparian conditions, map potential sources of sediment, identify causes of instability, and record unstable stream and riparian conditions. Field data sheets are included in Appendix E.

After the field and desktop assessments were completed, three sites were chosen as potential stream restoration projects. A detailed description of these projects is provided in Section 4.2.4.

4.2.2. Pollutant Removal and Impervious Area Accounting Measures

Pollutant reduction and impervious area credit was calculated for the potential stream restoration projects within the Little Gunpowder River Watershed. Pollutant load removal and efficiency was estimated using planning rates for stream restoration from *Final Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (Schueler, T., Stack, B., 2014). Impervious area MS4 credit was calculated using methodologies described in MDE's *Accounting for Stormwater Wasteload Allocation and Impervious Acres Treated* (MDE, 2014) as well as a recent MDE memorandum, *Stream Restoration Crediting Clarification for MS4 Permitting Purposes* (April 30, 2019). The 2019 MDE memorandum indicates that stream restoration projects in the coastal plain physiographic region may take credit toward impervious area treatment at a rate of two acres for every 100 linear feet of channel restoration and projects in the non-coastal plain physiographic region may take credit toward impervious area treatment at a rate of three acres for every 100 linear feet of channel restoration.

The pollutant load reduction planning rates for stream restoration and impervious acre equivalents are shown in Table 12.

Table 12 – Planning Rates for Stream Restoration and Impervious Acre Equivalents				
Geography	**TN[1] (lbs/ft)**	**TP[1] (lbs/ft)**	**TSS[1] (lbs/ft)**	**Equivalent Impervious Acres[2] (acres/ft)**
Coastal Plain	0.075	0.068	15	0.02
Non-Coastal Plain	0.075	0.068	45	0.03

[1] *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects, Schueler and Stack, 2014*
[2] *Stream Restoration Crediting for MS4 Permitting Purposes, (Memorandum), April 30, 2019*

4.2.3. Proposed Stream Restoration Approaches

Typical stream restoration approaches used to restore function in highly degraded stream systems that were considered for each proposed stream restoration project are described below.

Riffle-Pool Systems/Floodplain Connectivity

Connecting a channel to an abandoned floodplain is essential to restoring the hydrological, morphological and biological functions of a stream. Incised channels with limited floodplain connectivity during large, less frequent storm events experience high shear stresses and velocities within the channel, resulting in increased rates of erosion and nutrient loading downstream. Floodplain connectivity can be achieved either through raising the bed of the existing stream channel to connect with a previously abandoned floodplain or by creating a new floodplain at the existing channel bed elevation. Raising the existing stream to re-connect with the original floodplain or creating a new floodplain within the over-widened channel is often referred to as Stream and Valley Restoration. Restoring floodplain connectivity increases pollutant removal efficiencies and biological habitat, decreases channel shear stresses and erosion, and reduces nutrient loadings downstream. An example of a stream reach with restored floodplain connectivity, designed by BayLand located in Frederick County, Maryland is shown in Photo 1.

Photo 1 – Restored floodplain connectivity.

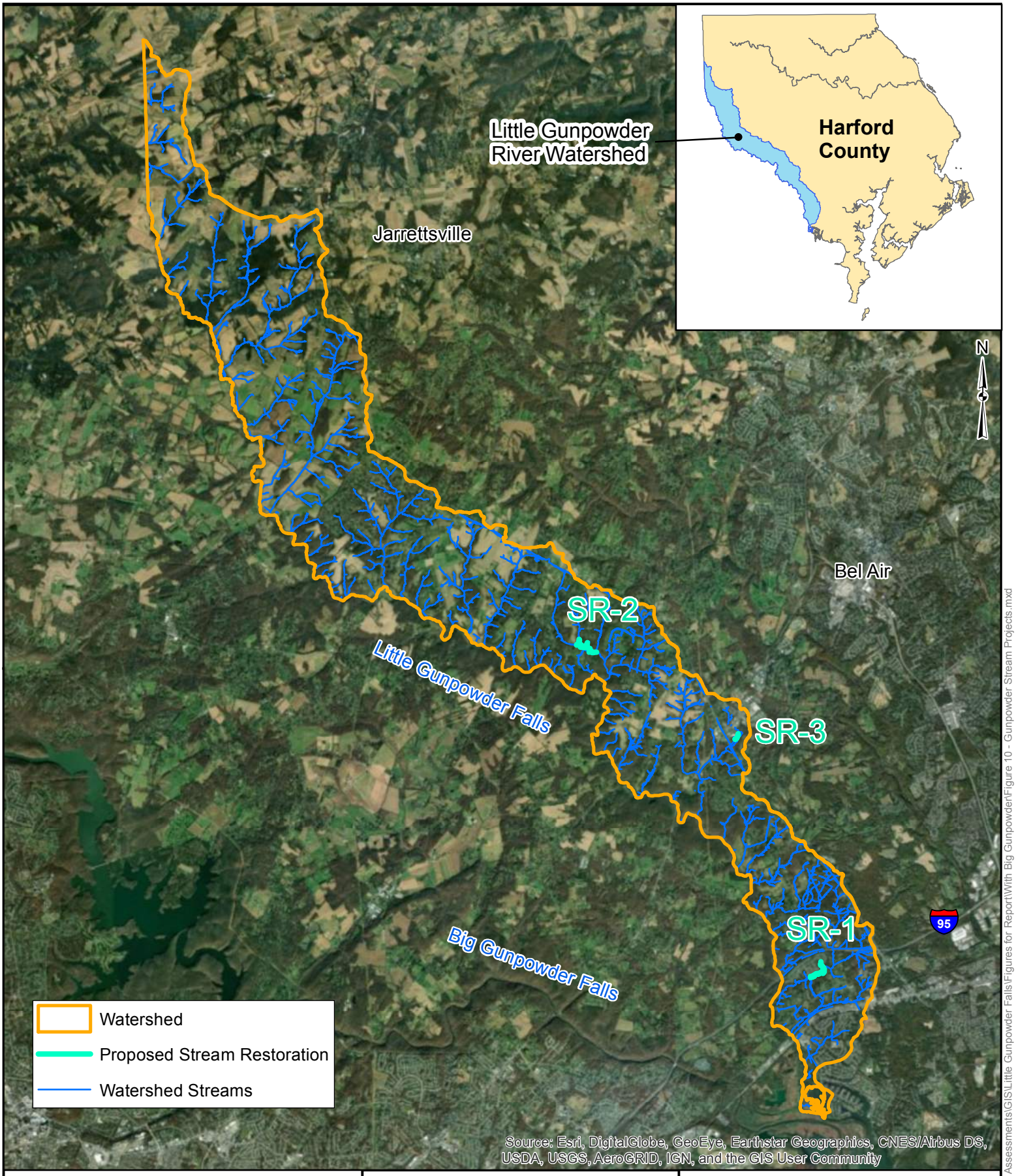
Step Pool Weir Systems

Step pool weir systems consist of a series of one or more instream riffle weirs strategically placed in confined intermittent or perennial channels to provide lateral and vertical stability. Step pool weir systems are typically utilized in confined, high-gradient valleys where floodplain connectivity is limited or where site constraints prohibit flooding increases. An example of a step pool weir system designed by BayLand is shown in Photo 2.

Photo 2 – Step Pool Weir System

4.2.4. Potential Stream Restoration Projects

Three locations were identified as a potential stream restoration projects (Figure 10). The projects were carefully selected based on criteria described in Section 4.1. A description of each project is provided in Tables 13 to 15, and pollutant reduction and impervious acre credit information is provided in Appendix E. Locations of individual projects are shown in Figures 11 to 13. A summary of the potential stream restoration projects is provided in Table 16.



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Watershed Features from 2013 Harford County GIS.

0 0.5 1 2 3 4 Miles

1 " = 2 mi

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FIGURE 10
LITTLE GUNPOWDER
PROPOSED STREAM
RESTORATION
PROJECTS

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 10 - Gunpowder Stream Projects.mxd

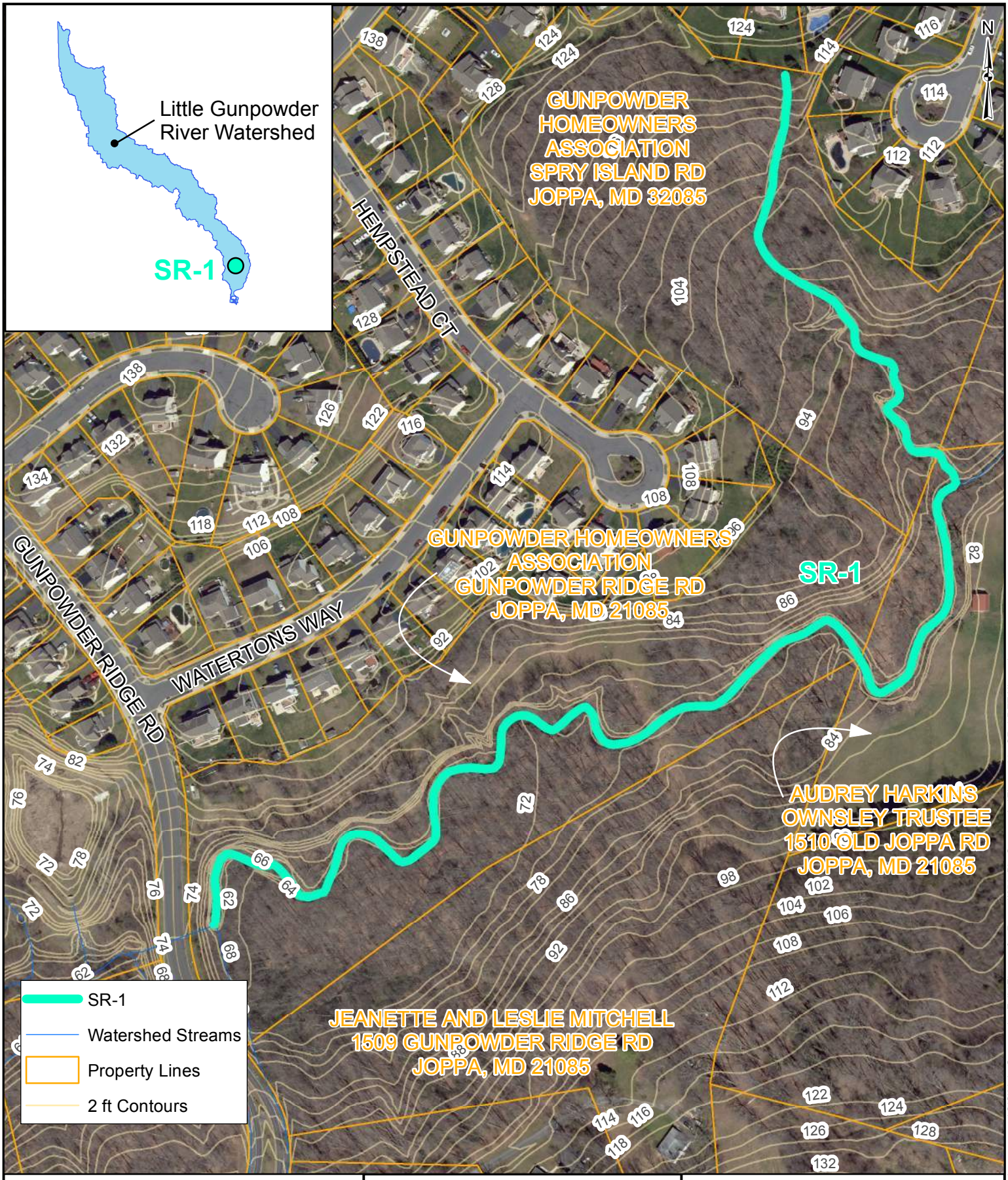
Table 13 – SR-1			
Site Name	Gunpowder Ridge Stream		
Linear Feet of Restoration	2,850		
Proposed Approach	Stream Restoration – Step Pool Weir System		
Sub-Watershed Location	17		
TN/TP/TSS Pollutant Removal	213.5 lbs/yr	193.6 lb/yr	64.1 ton/yr
Impervious Acre Credit	85.4		
Property Owner	Gunpowder Homeowners Association and Audrey Townsley Harkins		
Site Access	Access via Gunpowder Ridge Road		
Existing Utility Conflicts	Multiple utility boxes and a fire hydrant were noted at Gunpowder Ridge Road		
Total Project Cost	$2,335,000		
Description SR-1 is a single-thread, perennial channel characterized by bank erosion (Photo 3), irregular point bar formation (Photo 4) and tortuous meander bends. The reach originates behind the houses at the end of Bridewells Court and continues approximately 2,850 linear feet downstream to a culvert crossing under Gunpowder Ridge Road. Upstream of the Gunpowder Ridge Road culvert, the right bank is lined with approximately gabion baskets approximately 15 feet high (Photo 5). Upstream of the gabion baskets there is evidence of bank erosion and slumping (Photo 6). Bank heights range from three to 15 feet high and are predominately composed of silt and sand. Since SR-1 is characterized by a narrow, steep gradient valley, a step pool weir system is the recommended restoration approach.			

Photo 3 – Active bank erosion at SR-1

Photo 4 – Irregular point bar formation at SR-1

Photo 5 – Gabion baskets on right bank, upstream of Gunpowder Ridge Road culvert crossing

Photo 6 – Bank slumping at SR-1



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 55 110 220 330 440 Feet

1 " = 200 feet

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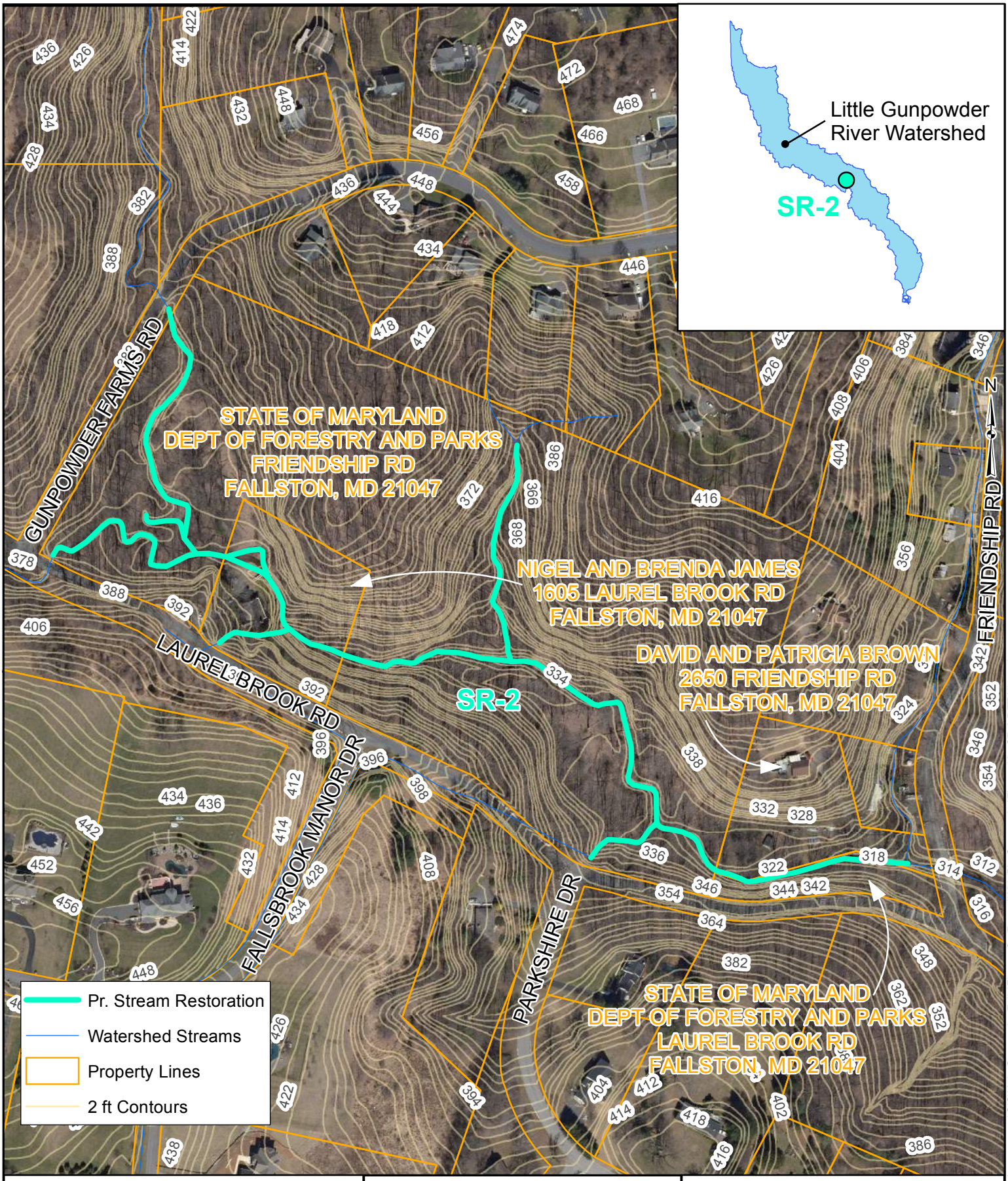
FIGURE 11
SR-1
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 11 - SR-1 DETAIL.mxd

Table 14 – SR-2			
Site Name	Overshot Branch		
Linear Feet of Restoration	3,800		
Proposed Approach	Stream Restoration – Step Pool Weir System		
Sub-Watershed Location	11		
TN/TP/TSS Pollutant Removal	285.7 lb/yr	259.0 lb/yr	85.7 ton/yr
Impervious Acre Credit	114.3		
Property Owner	State of Maryland, Nigel and Brenda James, and David and Patricia Brown		
Site Access	Access via Gunpowder Farms Road or Laurel Brook Road		
Existing Utility Conflicts	Utility pedestal noted at the intersection of Gunpowder Farms Road and Laurel Brook Road		
Total Project Cost	$3,123,000		
Description SR-2 is a perennial channel that originates at Gunpowder Farms Road and continues approximately 2,400 linear feet downstream to Friendship Road. It also includes five tributaries that outfall along the left and right banks and ranges in length from 110 to 450 linear feet. The reach is characterized by bank erosion and tortuous meander bends (Photo 7) as well as downed trees and debris jams (Photo 8). Bank heights average four feet high and are predominately composed of sand and silt. It should be noted that SR-2 is biologically impaired; Overshot Branch received a a “Poor” BIBI rating in 2001 when sampled by MBSS. Since SR-2 is characterized by a narrow, steep gradient valley, a step pool weir system is the recommended restoration approach.			

Photo 7 – Bank erosion and tortuous meander bends at SR-2

Photo 8 – Downed trees and debris jams at SR-2



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 65 130 260 390 520 Feet

1 " = 250 feet

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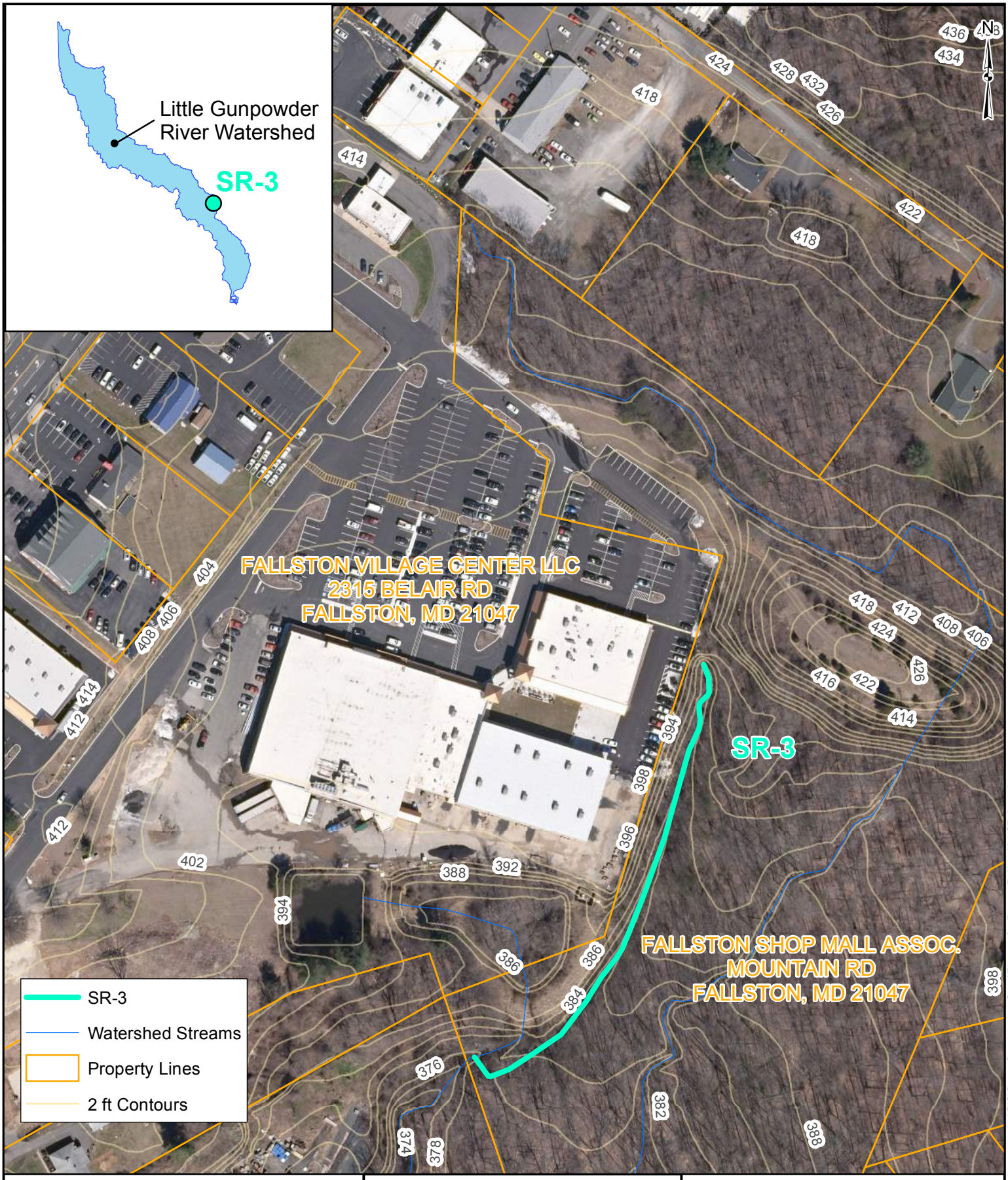
FIGURE 12
SR-2
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 12 - SR-2 DETAIL.mxd

Table 15 – SR-3			
Site Name	Fallston Village Outfall		
Linear Feet of Restoration	615		
Proposed Approach	Stream Restoration – Step Pool Weir System		
Sub-Watershed Location	15		
TN/TP/TSS Pollutant Removal	46.1 lb/yr	41.8 lb/yr	13.8 ton/yr
Property Owner	Fallston Shop Mall Association		
Property Location	2315 Belair Rd Fallston, MD 21047		
Site Access	Access is via the Fallston Village parking lot near the Maryland Quartermaster store.		
Existing Utility Conflicts	None noted		
Total Project Cost	$504,000		
Description SR-3 is a single-thread channel that originates at an elliptical CMP outfall with concrete wingwalls (Photo 9) and continues downstream approximately 615 linear feet. Field investigation revealed large boulders lining the channel bed and left bank immediately downstream of the outfall. The reach is characterized by bank erosion and low sinuosity (Photo 10). Bank heights average three feet high and are predominately composed of silt and sand. Since SR-3 is characterized by a narrow, steep gradient valley, a step pool weir system is the recommended restoration approach.			

Photo 9 – Outfall at upstream end of SR-3

Photo 10 – Representative photo of SR-3



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 40 80 160 240 320 Feet

1 " = 150 feet

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FIGURE 13
SR-3
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 13 - SR-3.mxd

Table 16 – Proposed Stream Restoration Projects										
Project ID	**Name**	**Sub-watershed**	**Length (ft)**	**Property Owner**	**Pollutant Reduction**			**Project Cost**	**Impervious Acre Credits***	**Cost/Imp. Acre**
					TN (lbs/yr)	**TP (lbs/yr)**	**TSS (tons/yr)**			
SR-1	Gunpowder Ridge Stream	17	2,850	Gunpowder Homeowners Association and Audrey Townsley Harkins	213.5	193.6	64.1	$2,335,000	85.4	$27,000
SR-2	Overshot Branch	11	3,800	State of Maryland and Nigel James	285.7	259.0	85.7	$3,123,000	114.3	$27,000
SR-3	Fallston Village Outfall	15	615	Fallston Shop Mall Association	46.1	41.8	13.8	$504,000	18.5	$27,000
Little Gunpowder River Total			**7,265**		**545.3**	**494.4**	**163.6**	**$5,962,000**	**218.2**	**$27,000**

**See Section 4.2.2 for a description of the methods used in calculating impervious acre credits.*

4.3. Best Management Practices

4.3.1. Methodology

An in-depth desktop analysis and field assessment was conducted within the Little Gunpowder River Watershed to identify BMP projects that would improve water quality treatment, enhance functionality and aesthetics, as well as assist the County in meeting its TMDL and MS4 permit requirements.

In addition to the criteria listed in Section 4.1, additional criteria were utilized to narrow the list of potential BMP projects. Specifically, existing SWM facilities were targeted since they typically yield the greatest potential increase in impervious acre and pollutant removal credits.

During the desktop analysis, as-built records for existing SWM facilities were obtained as available and reviewed to determine the year the facility was constructed, the volume of water quality treatment provided, existing hydraulic controls and potential for retrofit. Typically, facilities built prior to 1985 were designed to provide quantity control, as opposed to water quality treatment. Facilities built after 1985 and prior to 2002 were typically designed to capture and treat one half inch of rainfall runoff. Current SWM regulation in Maryland requires treatment of at least one inch of rainfall runoff. Therefore, existing SWM facilities not meeting current design standards were targeted for retrofit to provide additional water quality treatment.

Ultimately, 31 potential BMP projects were identified for field assessment, 25 of which were SWM retrofit opportunities and six of which were new BMP opportunities. Facilities with small amounts of impervious area, difficult access, confined facility footprints and negligible retrofit potential were removed from consideration.

In August 2019, BayLand field investigated the 31 potential BMP sites. At the existing SWM facilities of interest, key parameters were documented including existing structures (headwall, riser, outfall pipe, etc.), hydraulic controls (presence/location of a low flow orifice, shape and sizes of openings, condition and size of outfall pipes), stability of the outfall pipe, the condition of the embankment, the size of the existing footprint and site access.

After the field assessments were completed, six existing facilities were identified as potential BMP retrofit projects and one site was identified for new BMP construction. Field data sheets are provided in Appendix E.

4.3.2. Pollutant Load Reduction and Impervious Area Accounting Measures

Pollutant load reduction and impervious acre credits were calculated according to MDE WLA accounting measures (MDE, 2014). Pollutant removal efficiencies were determined by the depth of rainfall runoff that the proposed BMP will capture and treat.

A series of pollutant removal adjustor curves (Schueler and Lane, 2012) were used to determine nutrient and sediment load reductions for BMP implementation. BMPs are classified as either environmental site design (ESD) or stormwater treatment (ST) practices and there are separate pollutant removal curves for each type.

Impervious acre credits are calculated based on the fraction of water quality volume (WQv) (one inch of rainfall runoff) that a facility can treat. If a facility stores the entire WQv, then credit can be achieved for all the impervious area draining to the facility. If only half of the target WQv is treated, then the facility is eligible to receive credit for half of the impervious area within its drainage area. The accounting measures also permit additional impervious acre credits if a BMP stores more than the required one inch of WQv runoff. A 0.1 impervious acre credit is allocated for every 0.4 inches of additional rainfall depth treated above the initial one inch of runoff (MDE, 2014), up to a maximum of 2.6 inches.

4.3.3. Proposed BMP Approaches

Design approaches that were considered for each proposed BMP project are described below.

Wet Stormwater Management (SWM) Ponds

Wet SWM ponds maintain a permanent pool with a storage volume equivalent to the WQv. They are intended to control excess stormwater runoff and improve water quality by removing pollutants through sediment settling and biological uptake. It is illegal to construct stormwater ponds in jurisdictional waters, which include wetlands, interstate waters, and navigable waters, without both a Clean Water Act Section 404 permit and a State of Maryland wetlands and waterway permit. They have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats. An example of a stormwater pond with a fountain, retrofitted by BayLand, located in Anne Arundel County, Maryland is shown in Photo 11.

Photo 11 - Stormwater pond with fountain

Stormwater Management (SWM) Wetlands

SWM wetlands are areas that are saturated with water either permanently or seasonally and are designed to remove pollutants through settling and biological uptake. They have variable micro-topography including above-pool vegetation, shallow pools and deep pools to promote dense and diverse vegetative cover. They can treat large impervious areas, are aesthetically pleasing, enhance faunal and floral habitat, and have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats.

SWM wetlands require a large facility footprint and require a water balance to be performed to ensure hydric soil conditions. An example of a stormwater wetland, designed by BayLand, located in Anne Arundel County, Maryland is shown in Photo 12.

Photo 12 – Stormwater Wetland

Infiltration Basins

Infiltration basins provide nutrient and sediment reduction through attenuation and infiltration of storm flow runoff. Runoff is temporarily stored within the basin, removing sediments and nutrients from the water column through settling and percolation into the underlying soil media. Excess storm flows are conveyed downstream or returned to the main conveyance system (storm drain) through a riser structure, diversion or overflow spillway.

Infiltration basins have various design requirements to ensure the anticipated sediment and nutrient reduction efficiencies and credits are achieved. Infiltration basins must be underlain by Hydrologic Soil Groups (HSG) A, B or C soils with an infiltration rate of 0.52 inch per hour or greater. The bottom of the facility must be at least four feet vertically from the seasonally high water table or bedrock layer and they are prohibited from areas of karst topography. Typically, pretreatment of at least 25 percent of the WQv is required prior to entering the facility via sedimentation basins, plunge pools, stilling basins or other acceptable measures.

Infiltration basins have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats. An example of an infiltration basin, designed by BayLand, located in Howard County, Maryland is shown in Photo 13.

Photo 13 – Infiltration Basin

Bioretention Basins

Bioretention basins capture and treat runoff from impervious surfaces by passing the water through a filter bed mixture of sand, soil and organic matter. Filtered stormwater partially infiltrates into the ground or is returned to a conveyance system.

Bioretention basins are versatile and can be implemented as parking lot islands, median filters, terraced slope facilities, cul-de-sac islands, or planter boxes to provide WQv. If

designed to meet ESD criteria, the contributing drainage area is limited to half an acre and the slopes must be mild (less than or equal to five percent). The pollutant removal efficiencies are 57 percent TN, 66 percent TP and 70 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats.

An example of a bioretention basin, designed by BayLand, located in Anne Arundel County, Maryland is shown in Photo 14.

Photo 14 – Bioretention basin in a parking lot median.

Step Pool Storm Conveyance Systems

A Step Pool Storm Conveyance System (SPSC) is a series of open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow. These systems safely convey, attenuate, and treat the quality of storm flow. SPSC systems utilize a series of constructed shallow aquatic pools, riffle grade control, native vegetation, and an underlying sand/woodchip mix filter bed media. For steeper slopes, boulder cascades can be used to transverse grade. The pollutant removal efficiencies are 57 percent TN, 66 percent TP and 70 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats.

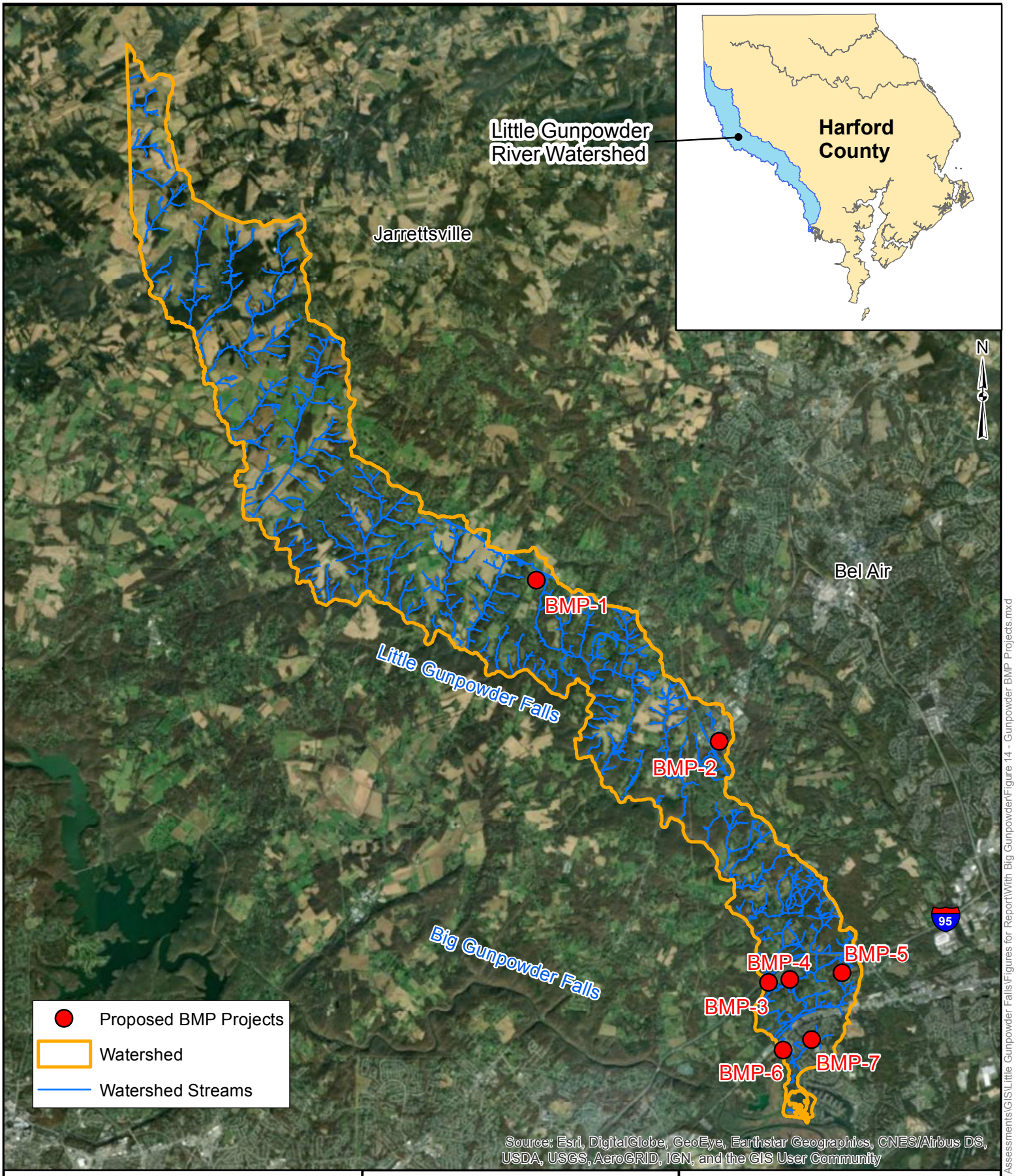
An example of a SPSC system designed by BayLand located in Anne Arundel County, Maryland is shown in Photo 15.

Photo 15 -– Step Pool Storm Conveyance (SPSC)

4.3.4. Potential BMP Projects

Six sites were identified as potential BMP retrofit projects and one site was identified where a new BMP facility could be built (Figure 14).

The BMP projects were selected to maximize pollutant removal efficiency and impervious acre credits, provide WQv storage to the current State standard, and minimize the total cost per impervious acre treated. The BMP pollutant removal rates were calculated assuming full WQv treatment and follow the stormwater WLA accounting measures described in Section 4.3.2. Design and construction costs were estimated by comparing the magnitude of proposed retrofits to recently designed and constructed projects. The total cost includes design, permitting, construction and construction oversight. Table 24 provides an overview of the selected BMP projects, while Figure 14 shows their locations within the Little Gunpowder River Watershed. A description of each project is provided in Tables 17 to 23. Locations of individual projects are shown in Figures 15 to 21. Pollutant loading information is provided in Appendix D, and impervious acre credit information is provided in Appendix F.



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Watershed Features from 2013 Harford County GIS.

0 0.5 1 2 3 4 Miles

1 " = 2 mi

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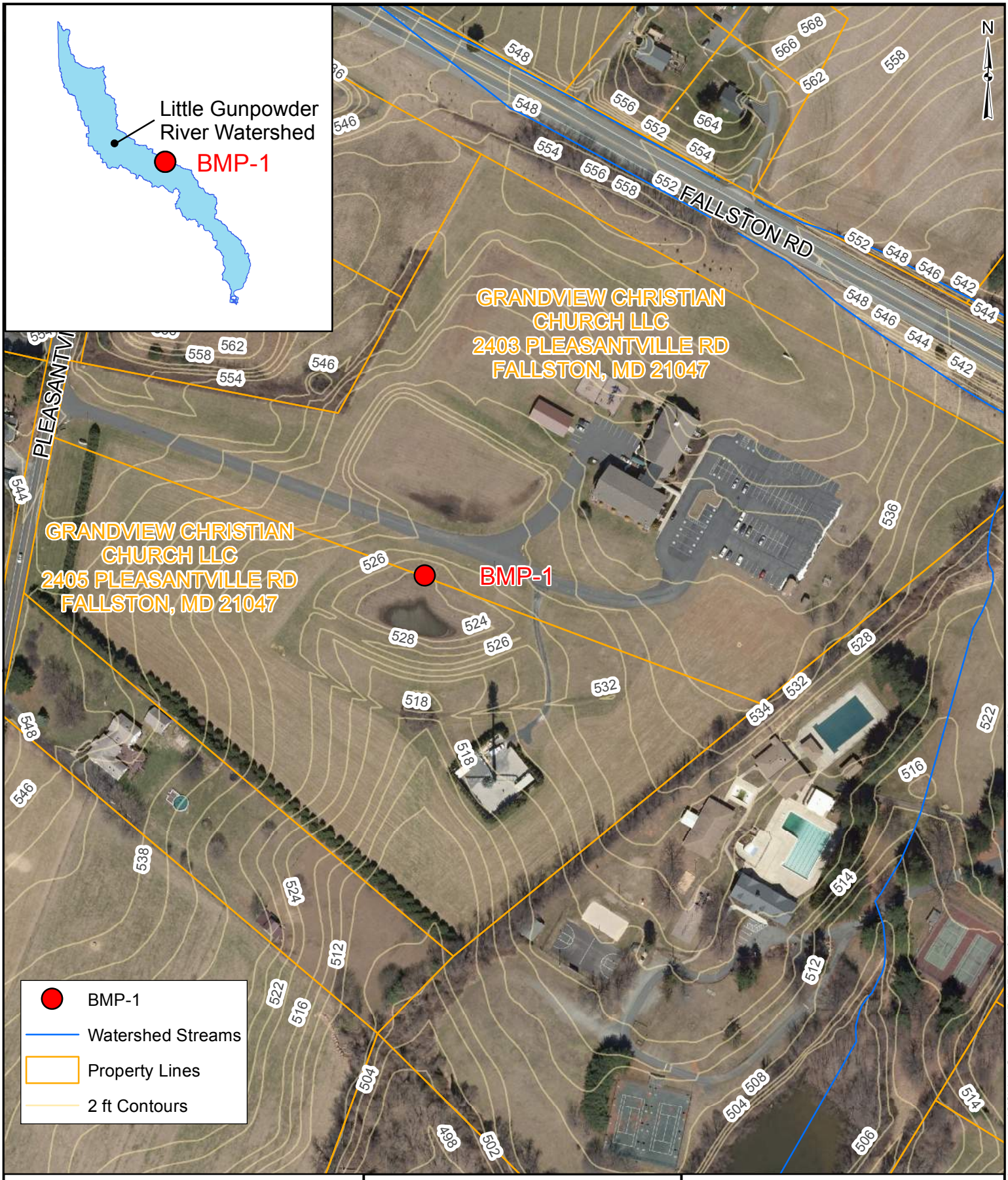
FIGURE 14
LITTLE GUNPOWDER
PROPOSED
BMP PROJECT
LOCATIONS

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 14 - Gunpowder BMP Projects.mxd

Table 17 – BMP-1			
Name	Grandview Christian Church		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	11		
TN/TP/TSS Pollutant Removal	7.3 lb/yr	1.0 lb/yr	1.0 ton/yr
Property Owner	Grandview Christian Church Inc.		
Property Location	2202 Fallston Rd Fallston, MD 21047		
Site Access	Access is via the private church access road		
Existing Utility Conflicts	Nearby cell phone tower		
Total Project Cost	$115,000		
Drainage Area (acres)	14.6		
Impervious Area (acres)	2.3 (15.8%)		
Required WQv (ac-ft)	0.24		
Anticipated Proposed WQv (ac-ft)	0.24		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	1.1		
Description BMP-1 is an existing dry SWM facility located south of the Grandview Christian Church driveway (Photo 16). Although as-built plans for the facility were not available, field investigation revealed that the facility is grass-lined with a small amount of ponded water and receives runoff from the adjacent church, driveway and parking lot (Photo 17). It should be noted that a control structure for the facility was not visible during field assessment. The facility is assumed to currently treat 0.5 inches of rainfall runoff. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.24 ac-ft). Due to the presence of ponded water indicating low subsoil infiltration rates and the ability to expand the existing facility footprint, the facility could potentially be converted into a SWM wetland.			

Photo 16 – Existing SWM Facility

Photo 17 – Existing SWM Facility with ponded water



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 55 110 220 330 440 Feet

1 " = 200 feet

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FIGURE 15
BMP-1
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 15 - BMP-01.mxd

Table 18 – BMP-2			
Name	Fallston Village Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	15		
TN/TP/TSS Pollutant Removal	11.8 lb/yr	1.2 lb/yr	1.4 ton/yr
Property Owner	Fallston Village Center LLC		
Property Location	2315 Belair Rd Fallston, MD 21047		
Site Access	Access is via the Fallston Village parking lot behind Horizon Cinemas		
Existing Utility Conflicts	None noted		
Total Project Cost	$339,000		
Drainage Area (acres)	15.8		
Impervious Area (acres)	10.9 (69.0%)		
Required WQv (ac-ft)	0.71		
Anticipated Proposed WQv (ac-ft)	0.71		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	4.3		
Description BMP-2 (SWM-0150 per County GIS data) is an existing SWM facility located south of the Fallston Village Center. Although as-built plans for the facility were not available, field investigation revealed that the facility receives runoff from the adjacent buildings and parking lot via a 24-inch corrugated metal outfall with a concrete headwall (Photo 18). The basin is inundated (Photo 19) and outfalls into a single-thread perennial channel. It should be noted that a control structure for the facility could not be field located. The facility is assumed to currently treat 0.5 inches of rainfall runoff. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.71 ac-ft). Due to the elevated groundwater table, the facility could potentially be converted into a wet pond or a SWM wetland.			

Photo 18 – Inlet into BMP-2

Photo 19 – Existing facility footprint

Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 40 80 160 240 320 Feet

1 " = 150 feet

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FIGURE 16
BMP-2
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 16 - BMP-02.mxd

Table 19 – BMP-3			
Name	Spry Island Road Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	17		
TN/TP/TSS Pollutant Removal	16.0 lb/yr	1.9 lb/yr	1.8 ton/yr
Property Owner	Gunpowder Homeowners Association		
Property Location	104 Spry Island Road Joppa, MD 21085		
Site Access	Access via HOA land between lots at 104 and 106 Spry Island Road.		
Existing Utility Conflicts	Nearby Verizon utility vault		
Total Project Cost	$329,000		
Drainage Area (acres)	21.31		
Impervious Area (acres)	8.2 (38.5%)		
Required WQv (ac-ft)	0.70		
Anticipated Proposed WQv (ac-ft)	0.70		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	4.1		
Description BMP-3 (SWM-0474 per County GIS Data) is a MD-378 Class “A” detention pond located west of the intersection of Powdersby Road with Spry Island Road (Photo 20). According to as-built plans (No. 041001 to 041007) the facility was constructed in 2001 and certified as-built in 2004. The pond consists of a concrete riser structure (Photo 21) with an 18-inch RCCP principle spillway that outfalls into an open channel. According to the as-built plans, a 36-inch HDPE storm drain pipe conveys runoff from the adjacent development into the facility. The facility is assumed to currently treat 0.5 inches of rainfall runoff. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.70 ac-ft). If modifications are made to the riser structure, the facility could potentially be converted into a wet pond or infiltration basin depending on subsoil infiltration rates.			

Photo 20 – Existing SWM Facility

Photo 21 – Existing riser structure with trash rack

Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 201 Harford County GIS.

0 25 50 100 150 200 Feet

1 " = 100 feet

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FIGURE 17
BMP-3
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 17 - BMP-03.mxd

Table 20 – BMP-4			
Name	Gunpowder Ridge Road Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	17		
TN/TP/TSS Pollutant Removal	28.1 lb/yr	3.5 lb/yr	3.3 ton/yr
Property Owner	Gunpowder Homeowners Association		
Property Location	1600 Gunpowder Ridge Rd Joppa, MD 21085		
Site Access	Access via Gunpowder Ridge Road		
Existing Utility Conflicts	Utility boxes on the other side of Gunpowder Ridge Road		
Total Project Cost	$469,000		
Drainage Area (acres)	39.1		
Impervious Area (acres)	15.8 (40.4%)		
Required WQv (ac-ft)	1.34		
Anticipated Proposed WQv (ac-ft)	1.34		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	7.87		
Description BMP-4 (SWM-0473 per County GIS data) is an existing detention pond located west of the intersection of Gunpowder Ridge Road with Waterton's Way. According to as-built plans (No. 040955 to 040960) the facility was designed in 1998 and certified as-built in 2004. The facility consists of a concrete riser structure with a 48-inch RCCP principle spillway that outfalls into an open channel (Photo 22). The pond receives drainage from an inflow channel (Photo 23), as well as a 42-inch RCCP that conveys runoff from the adjacent development. The facility is assumed to currently treat 0.5 inches of rainfall runoff. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (1.34 ac-ft). The facility could potentially be converted into a wet pond or SWM wetland if modifications are made to the existing riser structure.			

Photo 22 – Existing SWM Facility

Photo 23 – Existing riser structure with trash rack

Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 25 50 100 150 200 Feet

1 " = 100 feet

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FIGURE 18
BMP-4
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 18 - BMP-04.mxd

Table 21 – BMP-5			
Name	JB Hunt Transport Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	17		
TN/TP/TSS Pollutant Removal	3.6 lb/yr	0.4 lb/yr	0.5 ton/yr
Property Owner	Philadelphia Road 706 LLC		
Property Location	706 Philadelphia Rd Joppa, MD 21085		
Site Access	Access is via a narrow steep dirt path from the JB Hunt Transport parking lot		
Existing Utility Conflicts	None noted		
Total Project Cost	$150,000		
Drainage Area (acres)	4.5		
Impervious Area (acres)	3.1 (68.9%)		
Required WQv (ac-ft)	0.25		
Anticipated Proposed WQv (ac-ft)	0.25		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	1.5		
Description BMP-5 (SWM-0179 per County GIS data) is an existing SWM facility located north of the JB Hunt transport facility (Photo 24). According to as-built plans (No. 941434 to 941435) the facility was designed in 1989, redlined in 1992, certified as-built in 1994 and again in 2002. The basin receives runoff from the adjacent building and parking lot via an 18-inch BCCMP inflow pipe. Outflow from the basin is controlled by a 15-inch BCCMP that outfalls into a riprap lined channel (Photo 25). The facility is assumed to currently treat 0.5 inches of rainfall runoff. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.25 ac-ft). The facility could potentially be converted into a wet pond by installing a riser structure and increasing facility depth to increase storage volume.			

Photo 24 – Existing SWM facility

Photo 25 – Outfall from BMP-6

Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 40 80 160 240 320 Feet

1 " = 150 feet

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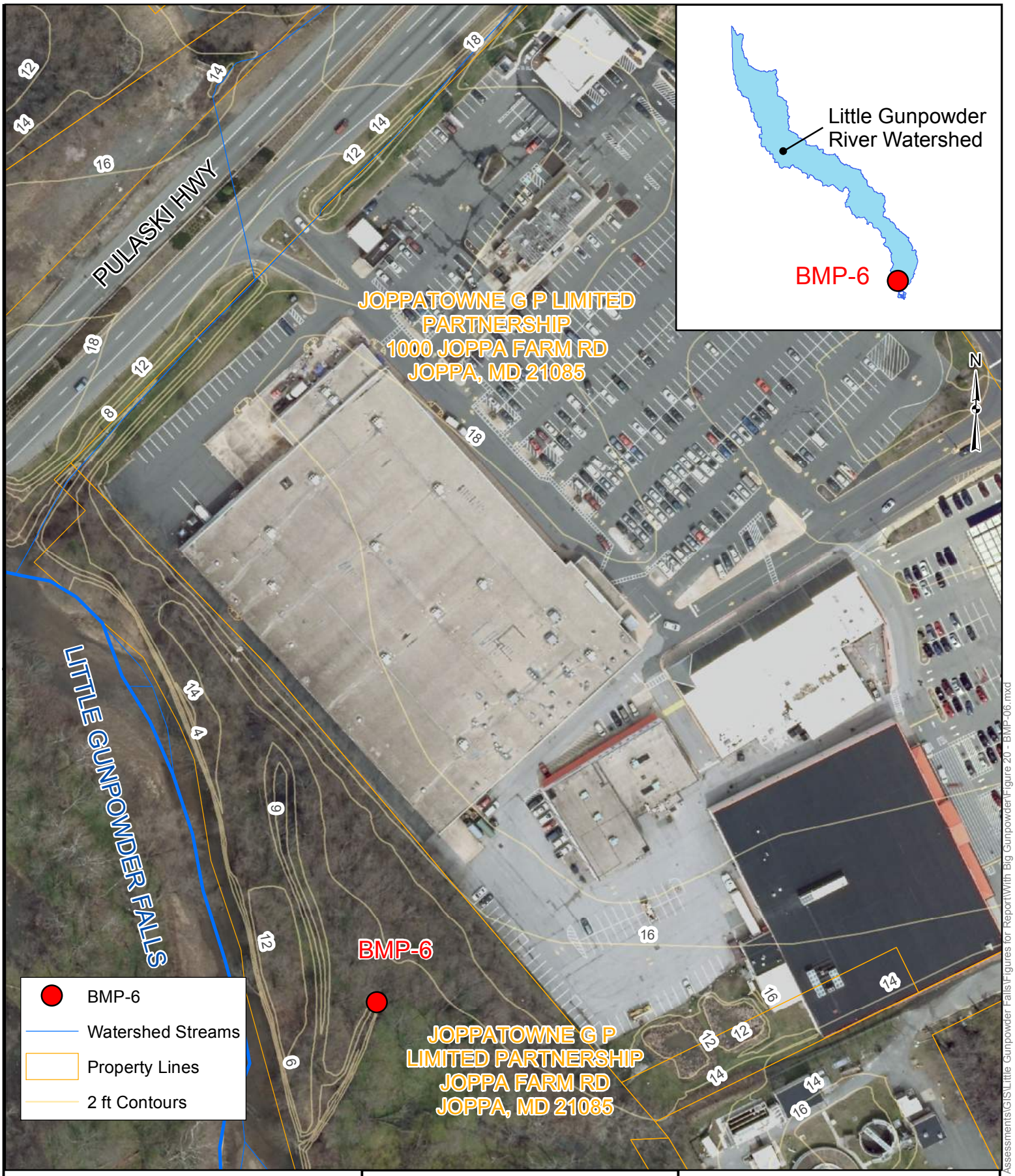
FIGURE 19
BMP-5
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 19 - BMP-05.mxd

Table 22 – BMP-6			
Name	Joppatowne Plaza Outfall		
Proposed Approach	New BMP (SWM Wetland)		
Sub-Watershed Location	17		
TN/TP/TSS Pollutant Removal	81.1 lb/yr	8.1 lb/yr	10.4 ton/yr
Property Owner	Joppatowne GP Limited Partnership		
Property Location	1000 Joppa Farm Rd Joppa, MD 21085		
Site Access	Access is via the parking lot of the Joppatowne Plaza shopping center. Paved lot available for staging and stockpile.		
Existing Utility Conflicts	None noted		
Total Project Cost	$535,000		
Drainage Area (acres)	17.4		
Impervious Area (acres)	11.4 (65.5%)		
Required WQv (ac-ft)	0.93		
Anticipated Proposed WQv (ac-ft)	2.41		
EX. Rainfall Depth Treated (inches)	0.0		
PR. Rainfall Depth Treated (inches)	2.6		
Impervious Acre Credits	15.9		
Description BMP-6 involves construction of a new BMP downstream of an existing outfall southwest of the Joppatowne Plaza. The proposed BMP would entail construction of a curb and gutter system around the perimeter of the parking lot to collect overland flow and flow from roof drains (Photo 26) and convey it into the facility. The BMP would be installed in a wooded area (Photo 27) and would be designed to treat 2.6 inches of rainfall runoff (2.41 ac-ft) before discharging to the nearby Little Gunpowder Falls River. The new BMP could potentially be a SWM wetland.			

Photo 26 – Adjacent impervious area

Photo 27 – Potential facility location



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 30 60 120 180 240 Feet

1 " = 125 feet

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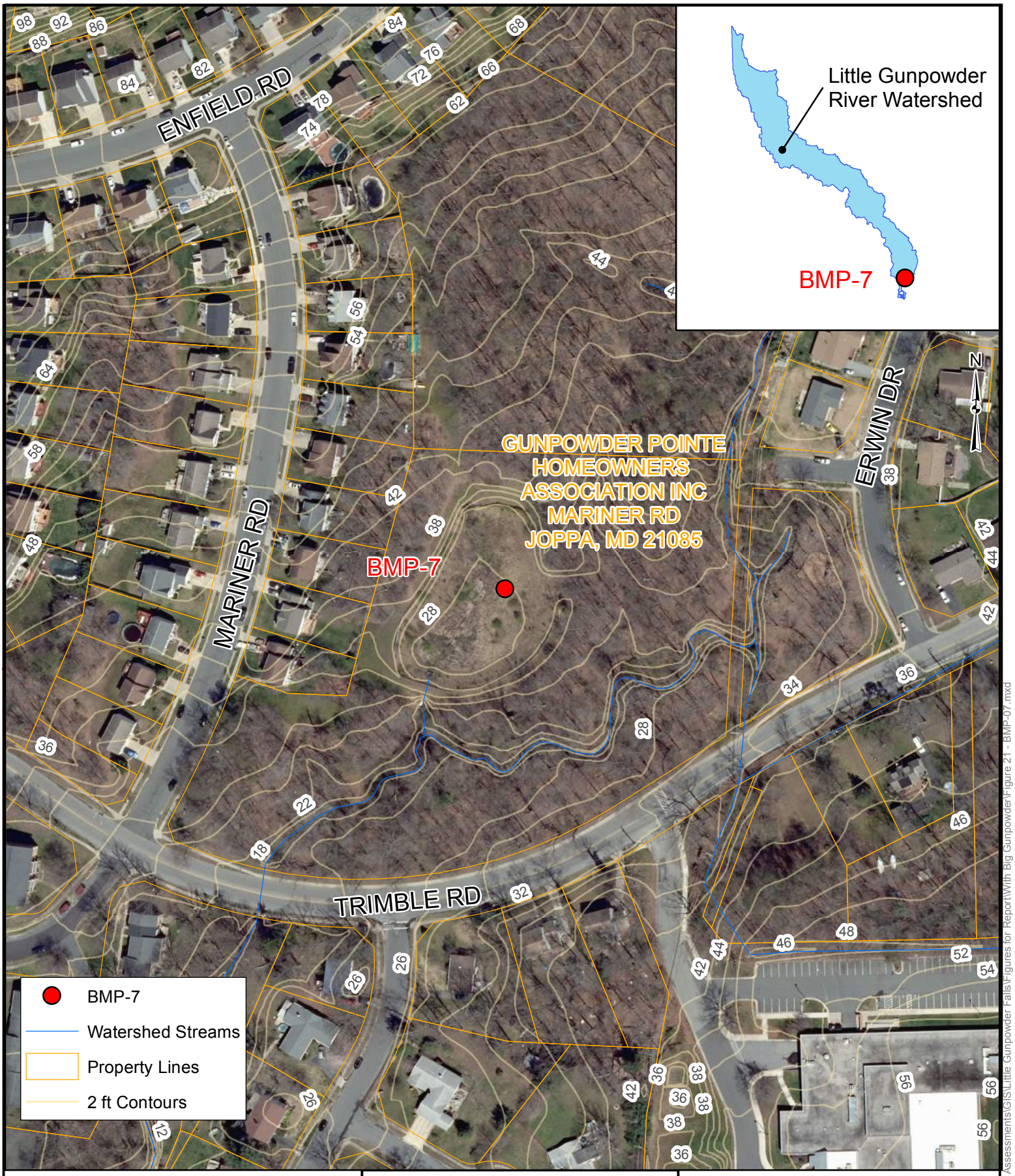
FIGURE 20
BMP-6
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 20 - BMP-06.mxd

Table 23 – BMP-7			
Name	Joppa Crossing Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	17		
TN/TP/TSS Pollutant Removal	21.6 lb/yr	2.6 lb/yr	2.6 ton/yr
Property Owner	Gunpowder Pointe Homeowners		
Property Location	1001 Mariner Rd Joppa, MD 21085		
Site Access	Access is via mown HOA property off Mariner Road near its intersection with Trimble Road.		
Existing Utility Conflicts	Utility boxes near Mariner Road access		
Total Project Cost	$420,000		
Drainage Area (acres)	31.6		
Impervious Area (acres)	12.3 (38.9%)		
Required WQv (ac-ft)	1.05		
Anticipated Proposed WQv (ac-ft)	1.05		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	6.1		
Description BMP-7 is an existing SWM facility located east of the intersection of Mariner Road with Trimble Road. Although as-built plans for the facility were not available, field investigation revealed that the facility receives runoff from the adjacent development via a storm drain pipe. The facility consists of a concrete riser with a metal trash rack (Photo 28) and a 24-inch principle spillway pipe with a metal end section that discharges into a stream (Photo 29). The facility is assumed to currently treat 0.5 inches of rainfall runoff. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (1.05 ac-ft). The facility could potentially be converted into a SWM wetland through excavation and modification of the riser structure.			

Photo 28 – Existing SWM facility

Photo 29 – Outfall from BMP-7



Notes:
1. Streams Data from 2013 Harford County GIS.
2. Property Lines Data from 2018 Harford County GIS.
3. 2 ft Contours from 2018 Harford County GIS.

0 40 80 160 240 320 Feet

1 " = 150 feet

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FIGURE 21
BMP-7
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Figure 21 - BMP-07.mxd

Table 24 – Proposed BMP Projects											
Project ID	**Name**	**Sub-watershed**	**BMP Type**	**Drainage Area (ac.)**	**Property Owner**	**Pollutant Reduction**			**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
						TN (lbs/yr)	**TP (lbs/yr)**	**TSS (tons/yr)**			
BMP-1	Grandview Christian Church	11	New BMP	14.6	Grandview Christian Church Inc.	7.3	1.0	1.0	$115,000	1.1	$100,000
BMP-2	Fallston Village Pond	15	Existing BMP Retrofit	15.8	Fallston Village Center LLC	11.8	1.2	1.4	$339,000	4.3	$79,000
BMP-3	Spry Island Road Pond	17	Existing BMP Retrofit	21.3	Gunpowder Homeowners Association	16.0	1.9	1.8	$329,000	4.1	$80,000
BMP-4	Gunpowder Ridge Road Pond	17	Existing BMP Retrofit	39.1	Gunpowder Homeowners Association	28.1	3.5	3.3	$469,000	7.9	$60,000
BMP-5	JB Hunt Transport Pond	17	Existing BMP Retrofit	4.5	Philadelphia Road 706 LLC	3.6	0.4	0.5	$150,000	1.5	$98,000
BMP-6	Joppatowne Plaza Outfall	17	New BMP	17.4	Joppatowne GP Limited Partnership	81.1	8.1	10.4	$535,000	15.9	$34,000
BMP-7	Joppa Crossing Pond	17	Existing BMP Retrofit	31.6	Gunpowder Pointe Homeowners	21.6	2.6	2.6	$420,000	6.1	$68,000
Little Gunpowder River Total						**169.5**	**18.7**	**21.0**	**$2,357,000**	**40.9**	**$58,000**

4.4. Revised Watershed Pollutant Loading Rates

A summary of the revised pollutant loading rates for each sub-watershed (Table 25) and the Little Gunpowder River Watershed (Table 27) are provided below. Pollutant and sediment reductions occurred in Sub-Watersheds 11, 15 and 17. Sub-watersheds 1 to 10, 12 to 14, and 16 do not have any proposed projects.

It should be noted that the pollutant and sediment load reductions listed in Tables 25 and 26 do not fully reflect the realized benefit the proposed restoration projects will have on the Little Gunpowder River Watershed. Current TMDL accounting guidelines (Schueler and Stack, 2014) limit the amount of pollutant and sediment reduction credits for stream restoration projects to one half of the total annual pollutant and sediment loadings to account for project inefficiencies and naturally occurring erosional processes. The proposed stream restoration methodologies; however, are highly efficient at reducing in-channel bank erosion and capturing sediment from unstable upland sources, resulting in increased sediment reduction efficiencies and decreased annual sediment loads within the sub-watersheds.

Table 25 – Summary of Sub-Watershed Pollutant Reduction & Efficiency

Sub-Watershed	Annual Pollutant Loads			Annual Pollutant Reduction from Restoration Projects			Percent Reduction of Annual Pollutant Loads		
	TN (lbs/yr)	TP (lbs/yr)	TSS (tons/yr)	TN (lbs/yr)	TP (lbs/yr)	TSS (tons/yr)	TN (%)	TP (%)	TSS (%)
1	5,363.1	149.5	131.4	0.0	0.0	0.0	0.0	0.0	0.0
2	6,509.9	194.0	163.5	0.0	0.0	0.0	0.0	0.0	0.0
3	15,343.0	461.1	400.7	0.0	0.0	0.0	0.0	0.0	0.0
4	4,873.0	148.4	126.3	0.0	0.0	0.0	0.0	0.0	0.0
5	1,838.9	35.8	43.5	0.0	0.0	0.0	0.0	0.0	0.0
6	15,963.0	481.6	418.2	0.0	0.0	0.0	0.0	0.0	0.0
7	16,106.3	405.1	378.0	0.0	0.0	0.0	0.0	0.0	0.0
8	22,809.7	663.5	566.9	0.0	0.0	0.0	0.0	0.0	0.0
9	13,340.6	793.1	557.5	0.0	0.0	0.0	0.0	0.0	0.0
10	26,264.50	989.3	772.3	0.0	0.0	0.0	0.0	0.0	0.0
11	7,098.4	405.4	289.0	293.0	260.0	86.7	4.1	64.1	30.0
12	4,452.1	261.0	184.4	0.0	0.0	0.0	0.0	0.0	0.0
13	5,867.4	231.0	171.0	0.0	0.0	0.0	0.0	0.0	0.0
14	5,641.8	195.6	173.8	0.0	0.0	0.0	0.0	0.0	0.0
15	5391.1	330.3	260.4	57.9	43.0	15.3	1.1	13.0	5.9
16	6,316.6	323.3	220.6	0.0	0.0	0.0	0.0	0.0	0.0
17	16,571.0	1,096.8	780.0	363.8	210.1	82.7	2.2	19.2	10.6
Little Gunpowder River Total	**179,750.4**	**7,164.8**	**5,635.5**	**714.7**	**513.0**	**184.6**	**0.4**	**7.1**	**3.3**

Table 26 – Watershed Pollutant Removal & Impervious Acre Summary			
Pollutant/Impervious Area	**Total Watershed Pollutant Loading**	**Total Pollutant Load Removal for Completed Projects**	**Removal Efficiency (%)**
Total Nitrogen (lbs/yr)	179,750.4	714.7	0.4
Total Phosphorus (lbs/yr)	7,164.8	513.0	7.1
Total Suspended Sediment (tons/yr)	5,635.5	184.6	3.3
Impervious Area (Acres)	1,496.6	259.1	17.3

The proposed projects for the Little Gunpowder River Watershed would reduce nitrogen by 714.7 pounds per year or 0.4 percent, phosphorus by 513.0 pounds per year or 7.1 percent, and sediment by 184.6 tons per year or 3.3 percent. The total impervious area treated is 259.1 acres or 17.3 percent of the total impervious area within the Little Gunpowder River Watershed. Sub-Watershed 11 has the highest pollutant reductions, due to the proposed stream restoration project at Overshot Branch (SR-2) and the BMP retrofit at Grandview Christian Church (BMP-1).

4.5. Project Prioritization

As mentioned in Section 4.1, prioritization of stream and BMP projects was based on several factors including location within the watershed, pollutant reduction and impervious acre credits, property ownership, site access, existing utility conflicts and design and construction costs. High priority projects are located within severely degraded systems and sub-watersheds, have favorable site access and property ownership, are eligible for pollutant reduction and impervious acre credits, and are cost efficient. Proposed projects in order of prioritization are listed in Table 27.

Within the Little Gunpowder River Watershed, Sub-Watershed SR-2, Overshot Branch, is the highest ranked project. It has the highest number of available impervious acre credits (114.3) at a relatively low cost per acre treated at $27,000 per acre, and most of the stream is located on property owned by the State of Maryland. SR-1, Gunpowder Ridge Stream is ranked second. It has the second highest number of available impervious acre credits (85.4) at $27,000 per acre and is located primarily on homeowners association property. SR-1 is also located within Sub-watershed 17, which had the highest pollutant loadings.

SR-3, the Fallston Village Outfall, is the third highest priority project due to the large number of available impervious acre credits and large potential for sediment reduction as well as the low cost per acre treated at $27,000 per acre treated.

Table 27 – Project Prioritization										
Project Ranking	**Project ID**	**Sub-Watershed**	**Type**	**Owner**	**TN (lbs/yr)**	**TP (lbs/yr)**	**TSS (tons/yr)**	**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
1	SR-2	11	Stream Restoration	State of Maryland and Nigel James	285.7	259.0	85.7	$3,123,000	114.3	$27,000
2	SR-1	17	Stream Restoration	Gunpowder Homeowners Association and Audrey Townsley Harkins	213.5	193.6	64.1	$2,335,000	85.4	$27,000
3	SR-3	15	Stream Restoration	Fallston Shop Mall Association	46.1	41.8	13.8	$504,000	18.5	$27,000
4	BMP-6	17	New BMP	Joppatowne GP Limited Partnership	81.1	8.1	10.4	$535,000	15.9	$34,000
5	BMP-4	17	Existing BMP Retrofit	Gunpowder Homeowners Association	28.1	3.5	3.3	$469,000	7.9	$60,000
6	BMP-7	17	Existing BMP Retrofit	Gunpowder Pointe Homeowners	21.6	2.6	2.6	$420,000	6.1	$68,000
7	BMP-2	15	Existing BMP Retrofit	Fallston Village Center LLC	11.8	1.2	1.4	$339,000	4.3	$79,000
8	BMP-3	17	Existing BMP Retrofit	Gunpowder Homeowners Association	16.0	1.9	1.8	$329,000	4.1	$80,000
9	BMP-5	17	Existing BMP Retrofit	Philadelphia Road 706 LLC	3.6	0.4	0.5	$150,000	1.5	$98,000
10	BMP-1	11	Existing BMP Retrofit	Grandview Christian Church Inc.	7.3	1.0	1.0	$115,000	1.1	$100,000
Little Gunpowder River Total					**714.8**	**513.1**	**184.6**	**$8,319,000**	**259.1**	**$32,000**

5. IMPLEMENTATION SCHEDULE

Projects shall be implemented according to the prioritization rankings established in Section 4.5. The number of projects in the different phases of design, construction, and post-construction monitoring may vary from year to year and will depend on available County resources. Although design and construction timelines for BMP and stream restoration projects are highly variable due to site specific factors such as access, property ownership, environmental impacts, permitting, utilities, and design methodology, typical timelines for design, permitting and construction for BMP projects is one and a half to two years. Typical timelines for design, permitting, utilities for stream restoration projects is two and a half to three years. Each project will be monitored, and the efficacy of design techniques and methodologies will be evaluated. This on-going analysis will allow future projects and techniques to be adapted to changing conditions and allow for better allocation of resources to areas and projects with the highest probability of success.

6. CONCLUSION

The LWAP for the Little Gunpowder River Watershed has identified potential projects to assist the County in meeting TMDL and MS4 permit requirements. The recommendations in this plan are based on the results of desktop analysis and field assessment which targeted the developed areas of the watersheds where the effects of unmanaged stormwater runoff are a primary concern. Prioritization of stream and BMP projects was based on several factors including location within the watershed, pollutant reduction and impervious acre credits, site access, property ownership, and design and construction costs.

Proposed projects include implementing one new BMP, three step pool systems, and six stormwater pond retrofits. Full implementation of these projects would reduce nitrogen by 714.7 pounds per year or 0.4 percent, phosphorus by 513.0 pounds per year or 7.1 percent, and suspended sediment by 184.6 tons per year or 3.3 percent. The total impervious area treated by all 11 projects is 259.1 acres or 17.3 percent of the total impervious area within the Little Gunpowder River Watershed. The total cost for all proposed projects is estimated to be $8,319,000, with a cost per acre treated of $32,000. This cost includes design, permitting and construction.

Since this LWAP represents the current understanding of the overall condition and impairments to the watersheds, it should be reevaluated at regular intervals to assess its progress towards meeting TMDL and MS4 permit requirements. In addition, lessons learned from the implementation of projects in surrounding watersheds may be incorporated in this assessment.

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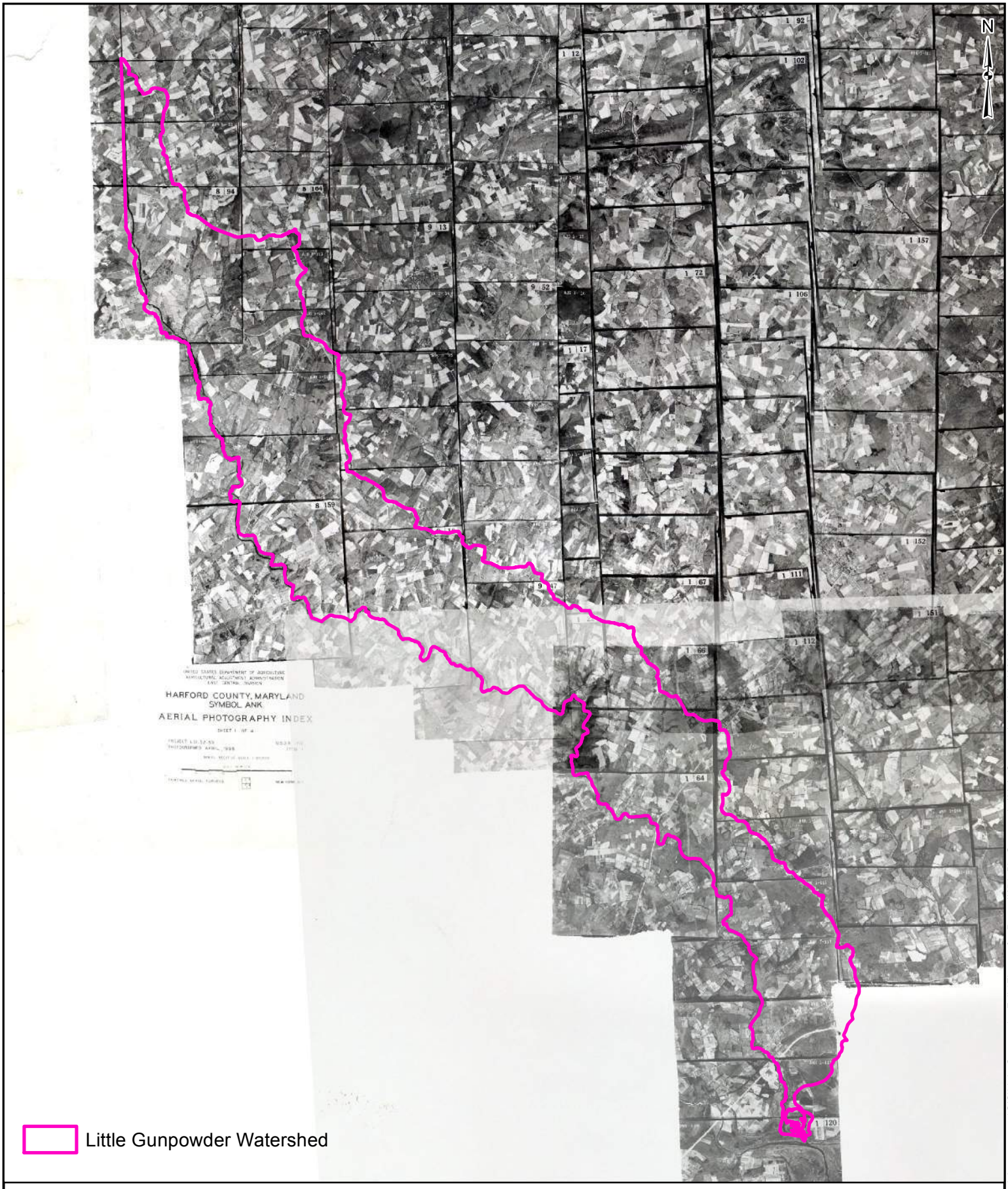
APPENDIX A

Historic Aerial Imagery



Notes:
1. 1938 Historical Aerial from 1938 U.S. Agriculture Stabilization and Conservation Service (ASCS)

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1 in = 2 miles

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APPENDIX A LITTLE GUNPOWDER RIVER, 1938

P:\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\With Big Gunpowder\Little Gunpowder Aerials 1938.mxd

Notes:
1, 1952 Historic Aerial Photography from 2015 Harford County GIS

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1 in = 2 miles

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APPENDIX A LITTLE GUNPOWDER RIVER, 1952

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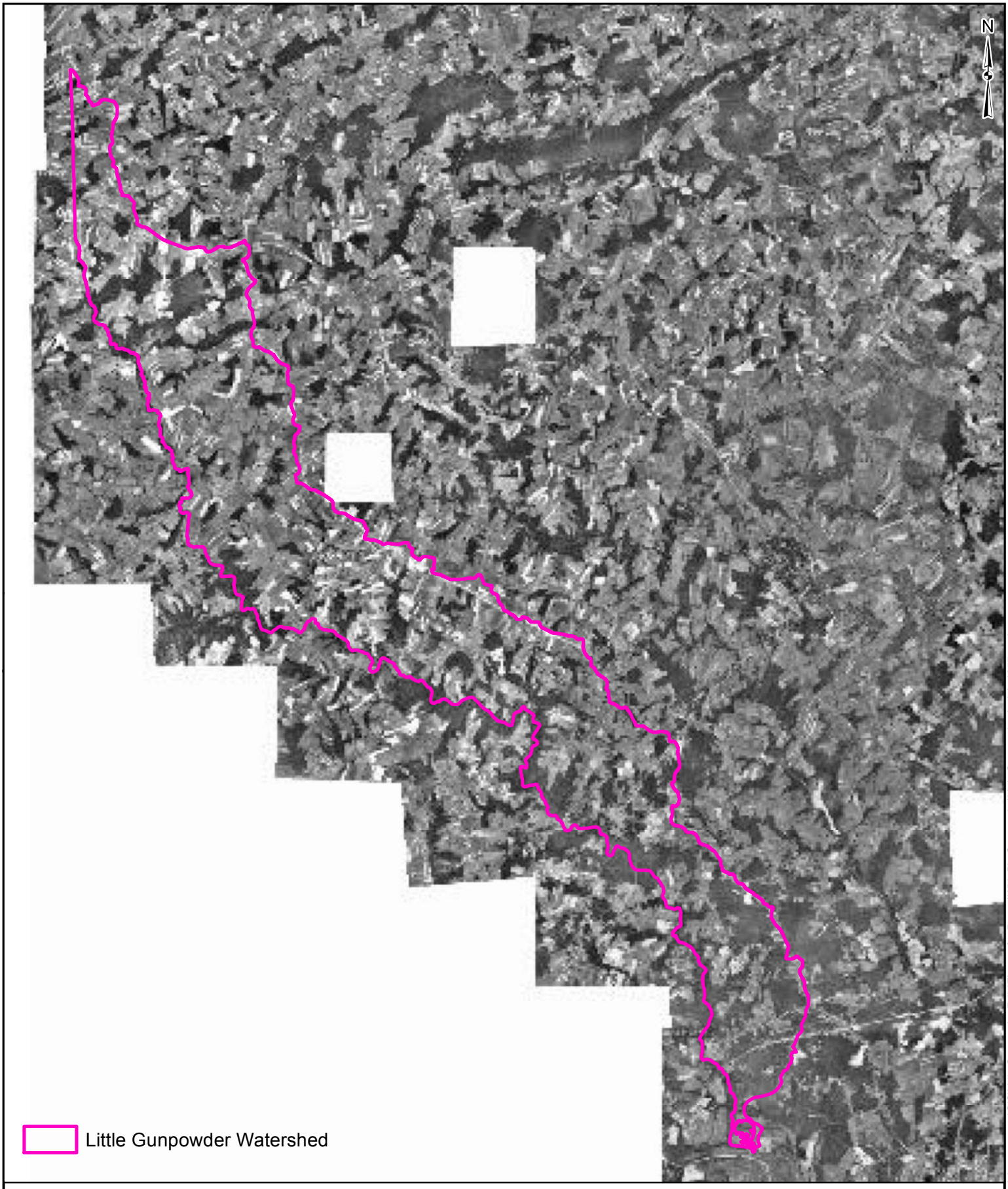

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APPENDIX A LITTLE GUNPOWDER RIVER, 1957

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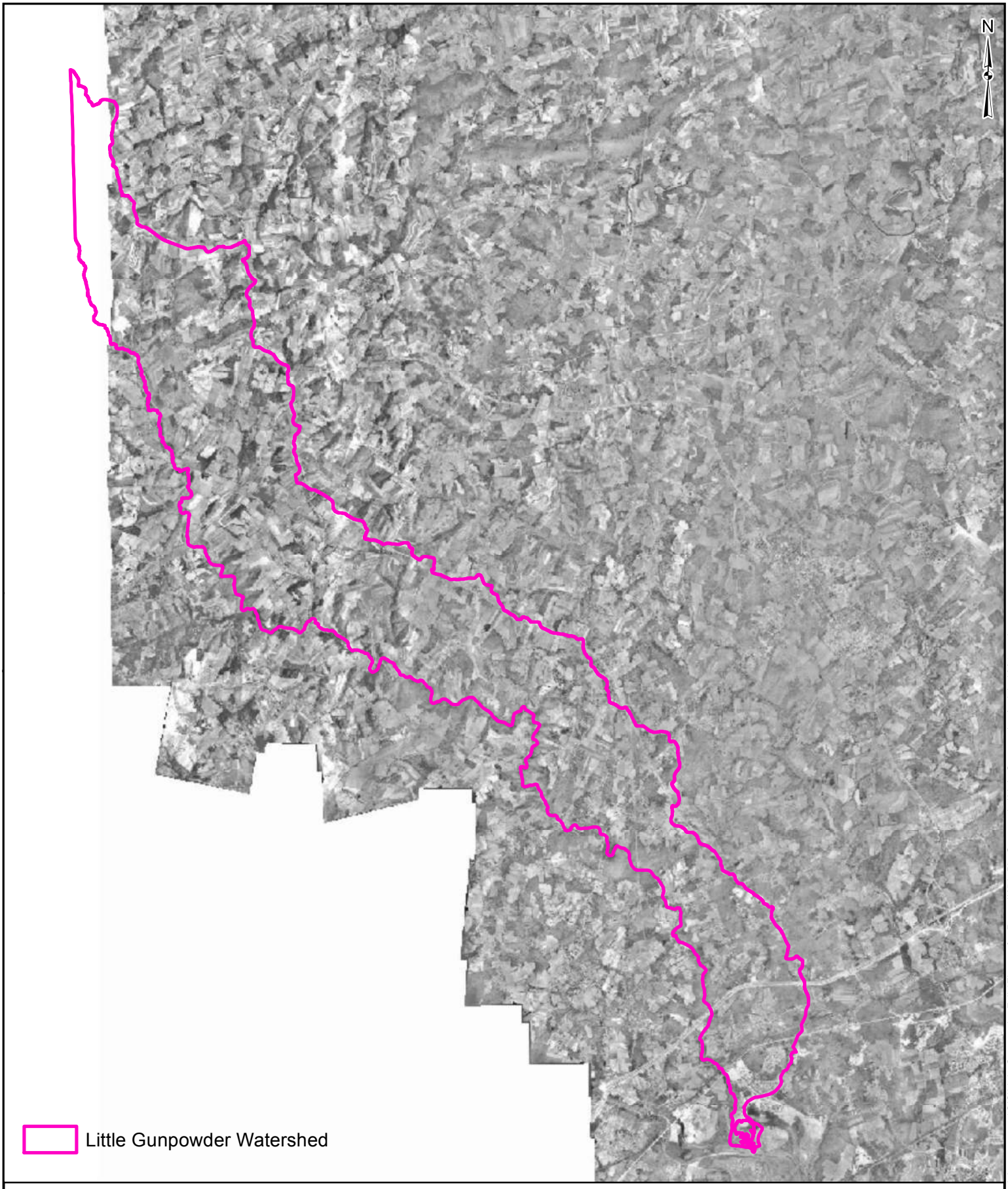

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1 in = 2 miles

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APPENDIX A LITTLE GUNPOWDER RIVER, 1964

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1. 1967 Historical Aerial Photography from 2015 Harford County GIS

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1 in = 2 miles

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APPENDIX A LITTLE GUNPOWDER RIVER, 1967

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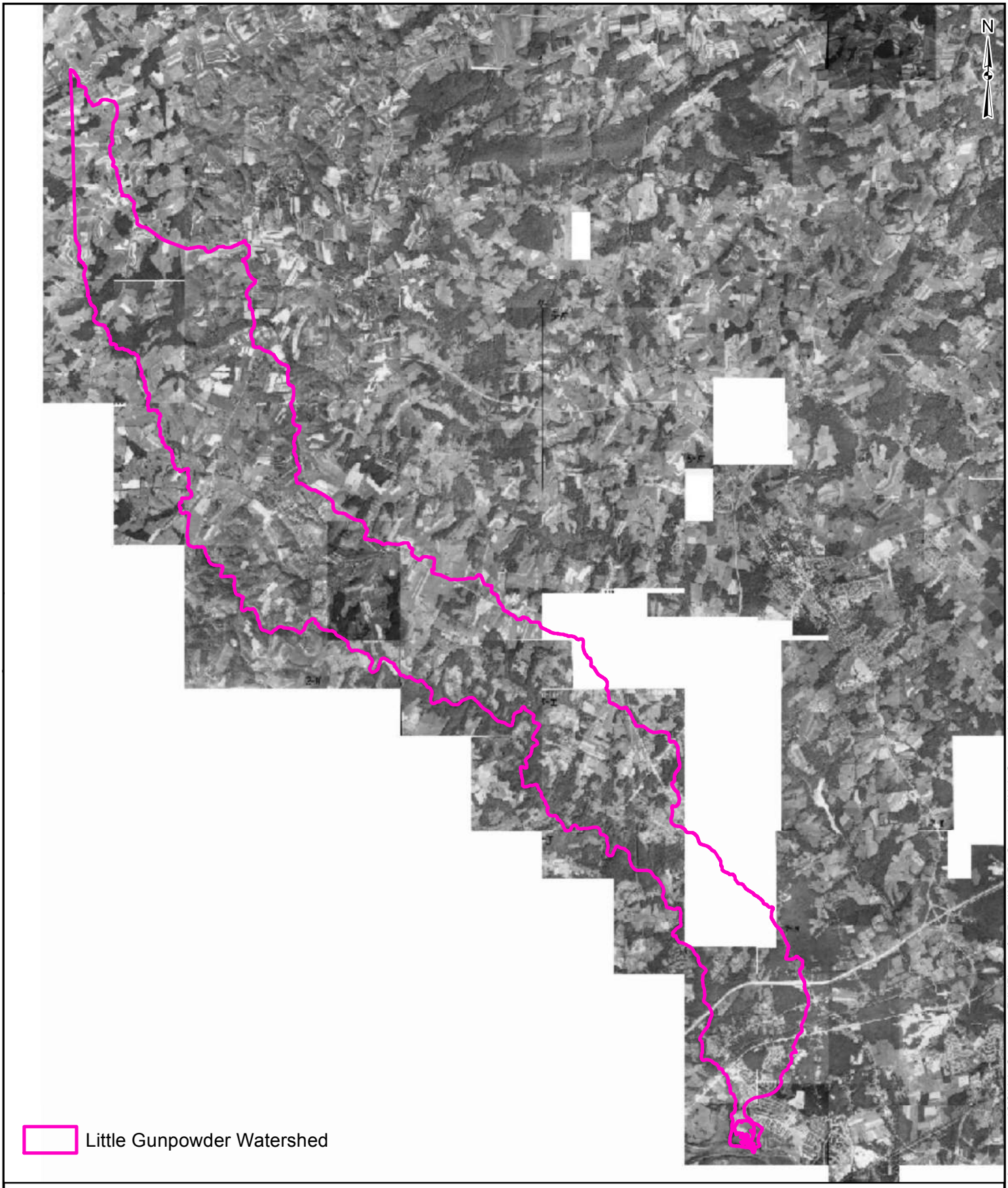

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1 in = 2 miles

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APPENDIX A LITTLE GUNPOWDER RIVER, 1971

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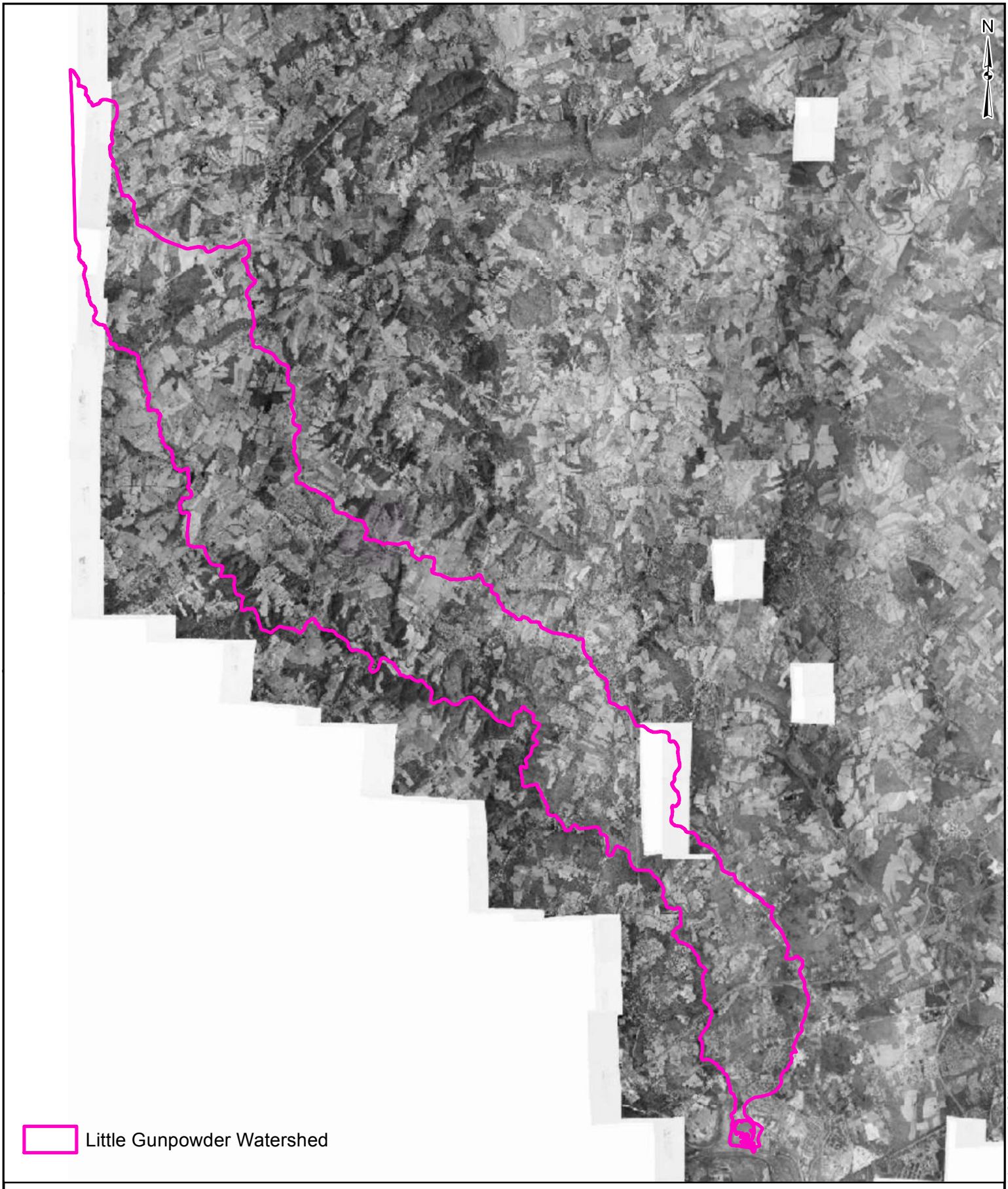

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1 in = 2 miles

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APPENDIX A LITTLE GUNPOWDER RIVER, 1977

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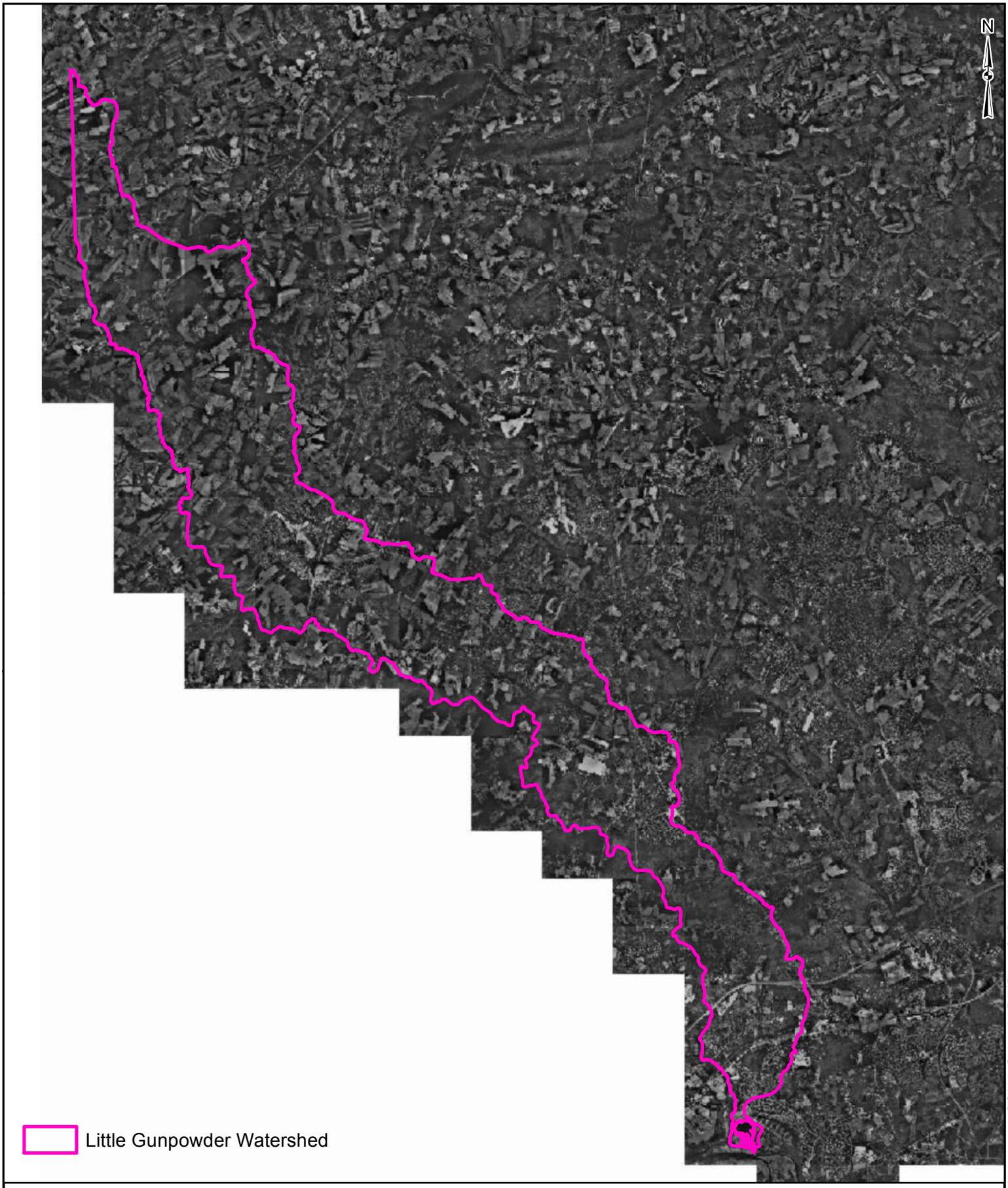

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APPENDIX A LITTLE GUNPOWDER RIVER, 1990

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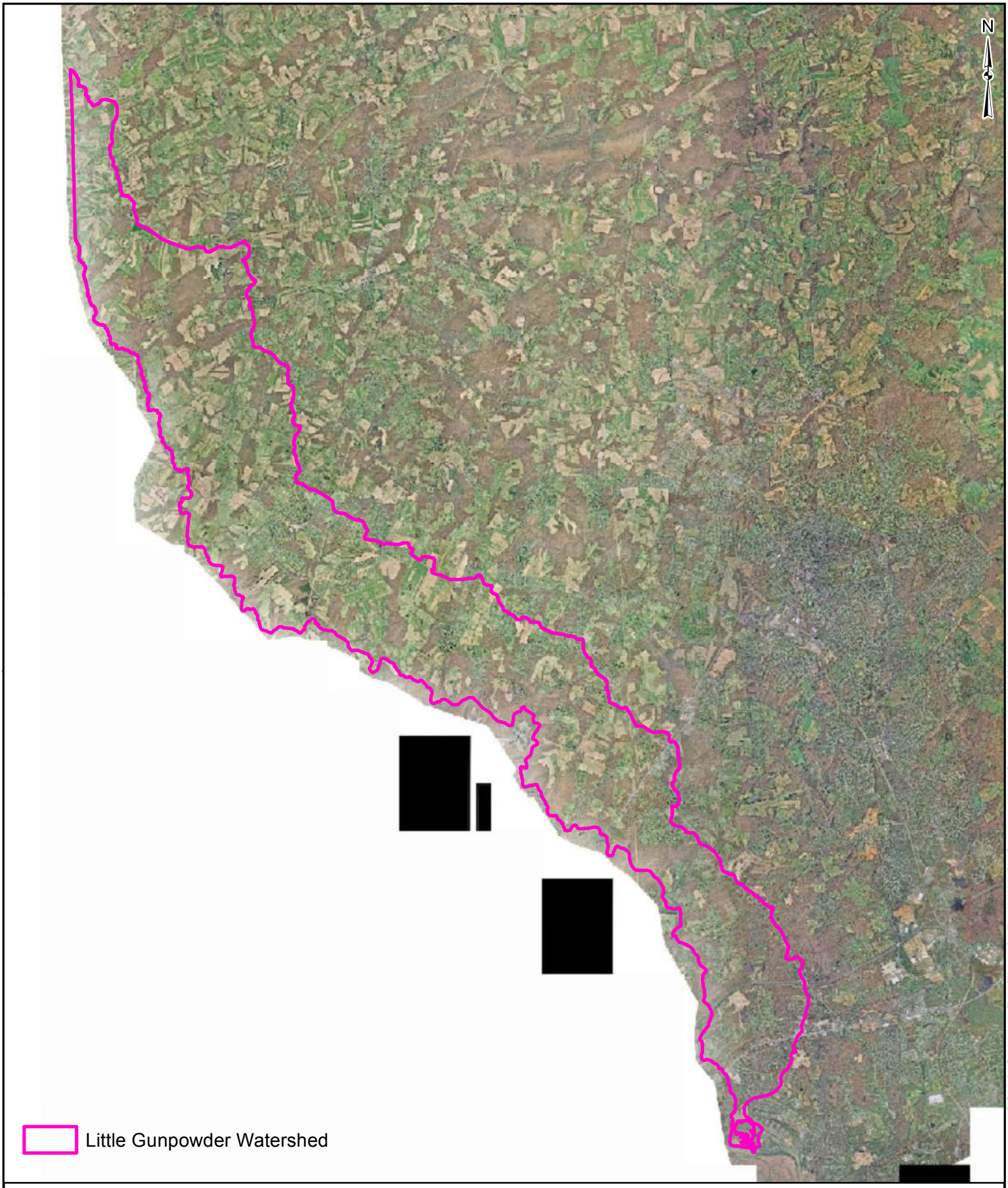

Notes:
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1 in = 2 miles

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APPENDIX A LITTLE GUNPOWDER RIVER, 2000

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Notes:
1. 2004 Historic Aerial Photography from 2015 Harford County GIS

0 0.5 1 2 3 4 Miles

1 in = 2 miles

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APPENDIX A LITTLE GUNPOWDER RIVER, 2004

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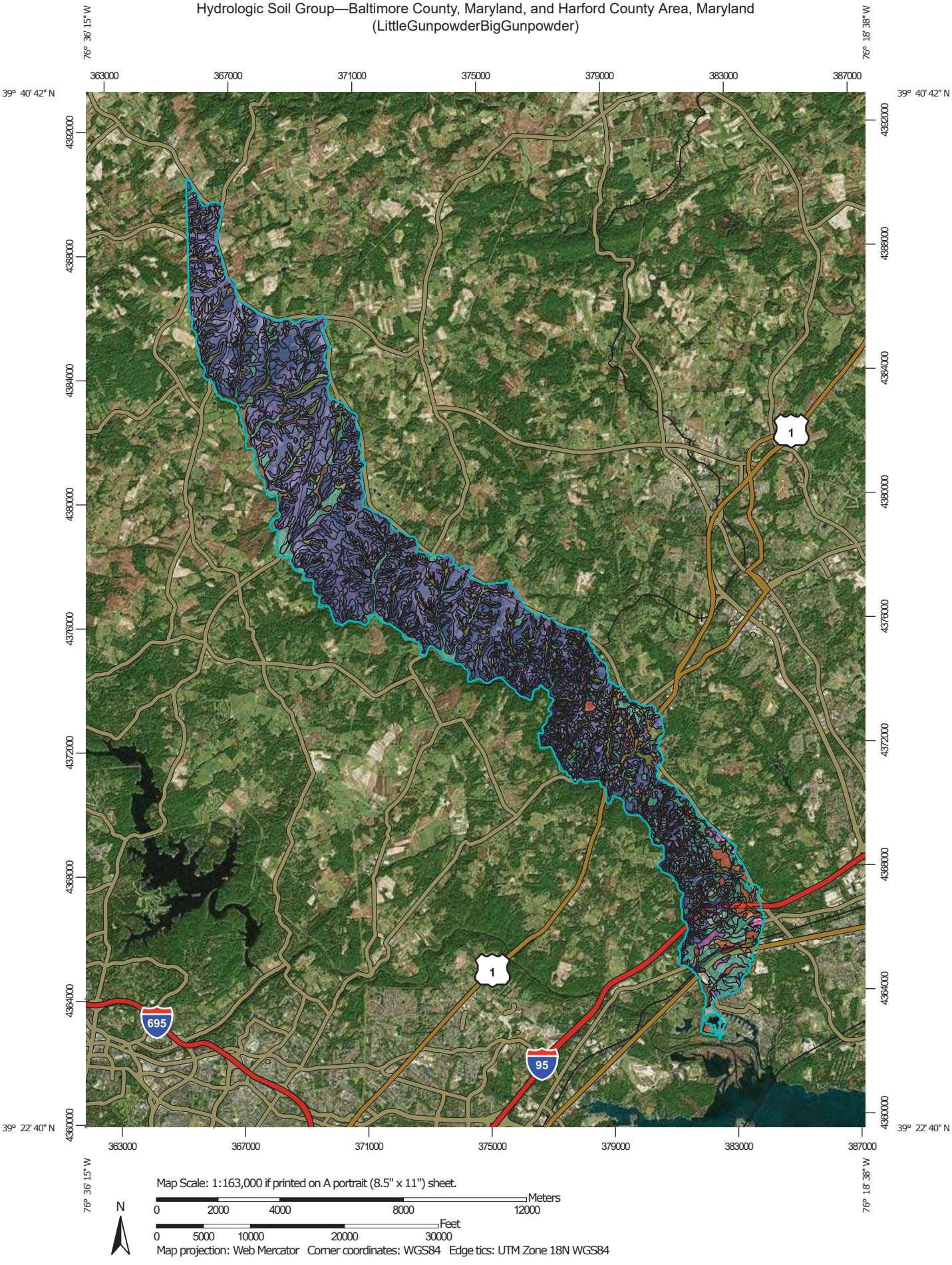
APPENDIX B

Soils

Hydrologic Soil Group—Baltimore County, Maryland, and Harford County Area, Maryland
(LittleGunpowderBigGunpowder)



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 scales ranging from 1:12,000 to 1:15,800.

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

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

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

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

Soil Survey Area: Baltimore County, Maryland
Survey Area Data: Version 14, Sep 13, 2019

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 13, Sep 13, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BaA	Baile silt loam, 0 to 3 percent slopes	C/D	0.2	0.0%
CfA	Codorus silt loams, 0 to 3 percent slopes	C	1.5	0.0%
GhC	Glenville silt loam, 8 to 15 percent slopes	C	0.1	0.0%
HbA	Hatboro silt loams, 0 to 3 percent slopes	B/D	1.6	0.0%
MaC	Manor loam, 8 to 15 percent slopes	B	0.0	0.0%
McF	Manor-Bannertown sandy loams, 45 to 65 percent slopes, rocky	B	0.0	0.0%
MdE	Manor-Brinklow complex, 25 to 45 percent slopes, very rocky	B	0.0	0.0%
QS	Quarries, schist/gneiss		0.0	0.0%
W	Water		12.0	0.1%
Subtotals for Soil Survey Area			**15.4**	**0.1%**
Totals for Area of Interest			**20,808.8**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Aldino silt loam, 0 to 3 percent slopes	C	20.3	0.1%
AdB	Aldino silt loam, 3 to 8 percent slopes	C	139.7	0.7%
AdC	Aldino silt loam, 8 to 15 percent slopes	C	8.6	0.0%
AsB	Aldino very stony silt loam, 0 to 8 percent slopes	C	48.9	0.2%
BaA	Baile silt loam, 0 to 3 percent slopes	C/D	110.3	0.5%
BaB	Baile silt loam, 3 to 8 percent slopes	C/D	132.6	0.6%
BeA	Beltsville silt loam, 0 to 2 percent slopes	C	27.1	0.1%
BeB	Beltsville silt loam, 2 to 5 percent slopes	C	167.4	0.8%
BeC	Beltsville silt loam, 5 to 10 percent slopes	C	44.7	0.2%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BrC2	Brandywine gravelly loam, 8 to 15 percent slopes, moderately eroded	A	1.5	0.0%
BrD3	Brandywine gravelly loam, 15 to 25 percent slopes, severely eroded	A	1.8	0.0%
CcA	Chester silt loam, 0 to 3 percent slopes	B	21.5	0.1%
CcB2	Chester silt loam, 3 to 8 percent slopes	B	1,918.9	9.2%
CcC2	Chester silt loam, 8 to 15 percent slopes	B	348.4	1.7%
CgB2	Chester gravelly silt loam, 3 to 8 percent slopes, moderately eroded	B	47.8	0.2%
CgC2	Chester gravelly silt loam, 8 to 15 percent slopes, moderately eroded	B	41.8	0.2%
CgD2	Chester gravelly silt loam, 15 to 25 percent slopes, moderately eroded	B	2.2	0.0%
ChB2	Chillum silt loam, 2 to 5 percent slopes, moderately eroded	C	126.5	0.6%
CkC2	Chillum-Neshaminy silt loams, 5 to 10 percent slopes, moderately eroded	B	75.5	0.4%
CrE	Chrome channery silty clay loam, 15 to 45 percent slopes	C	5.9	0.0%
Cu	Codorus silt loam	C	918.1	4.4%
Cv	Comus silt loam	B	42.7	0.2%
Cx	Cut and fill land		96.7	0.5%
DcA	Delanco silt loam, 0 to 3 percent slopes	C	35.8	0.2%
DcB	Delanco silt loam, 3 to 8 percent slopes	C	394.9	1.9%
EhB2	Elioak silt loam, 3 to 8 percent slopes, moderately eroded	C	130.2	0.6%
EhC2	Elioak silt loam, 8 to 15 percent slopes, moderately eroded	C	32.6	0.2%
En	Elkton silt loam	C/D	85.8	0.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
EsA	Elsinboro loam, 0 to 2 percent slopes	B	24.6	0.1%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	B	250.5	1.2%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	B	129.1	0.6%
EvC	Evesboro loamy sand, 5 to 15 percent slopes	A	6.0	0.0%
FgaA	Fallsington loams, 0 to 2 percent slopes, Northern Coastal Plain	C/D	4.7	0.0%
GcB2	Glenelg loam, 3 to 8 percent slopes	B	2,303.3	11.1%
GcC	Glenelg loam, 8 to 15 percent slopes	B	1,161.0	5.6%
GcC3	Glenelg loam, 8 to 15 percent slopes, severely eroded	B	171.4	0.8%
GcD	Glenelg loam, 15 to 25 percent slopes	B	128.3	0.6%
GcD3	Glenelg loam, 15 to 25 percent slopes, severely eroded	B	89.7	0.4%
GgB2	Glenelg channery loam, 3 to 8 percent slopes	B	198.5	1.0%
GgC2	Glenelg gravelly loam, 8 to 15 percent slopes, moderately eroded	B	146.1	0.7%
GgC3	Glenelg gravelly loam, 8 to 15 percent slopes, severely eroded	B	56.5	0.3%
GgD2	Glenelg gravelly loam, 15 to 25 percent slopes, moderately eroded	B	80.6	0.4%
GgD3	Glenelg gravelly loam, 15 to 25 percent slopes, severely eroded	B	26.7	0.1%
GnA	Glenville silt loam, 0 to 3 percent slopes	C	145.9	0.7%
GnB	Glenville silt loam, 3 to 8 percent slopes	C/D	939.0	4.5%
Hb	Hatboro silt loam	B/D	397.5	1.9%
HcA	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	B/D	294.3	1.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
JpB	Joppa gravelly sandy loam, 2 to 5 percent slopes	A	74.7	0.4%
JpC	Joppa gravelly sandy loam, 5 to 10 percent slopes	A	69.2	0.3%
KeB	Kelly silt loam, 3 to 8 percent slopes	D	90.3	0.4%
KeC2	Kelly silt loam, 8 to 15 percent slopes, moderately eroded	D	20.7	0.1%
KfD	Kelly very stony silt loam, 3 to 25 percent slopes	B	40.7	0.2%
KpA	Keyport silt loam, 0 to 2 percent slopes	D	25.2	0.1%
KpB	Keyport silt loam, 2 to 5 percent slopes	D	313.5	1.5%
KrA	Kinkora silt loam, 0 to 3 percent slopes	C/D	10.7	0.1%
KrB	Kinkora silt loam, 3 to 8 percent slopes	C/D	68.3	0.3%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	C	43.9	0.2%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	C	55.9	0.3%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	B	10.2	0.0%
LeE	Legore silt loam, 25 to 45 percent slopes	B	28.3	0.1%
LfC	Legore very stony silt loam, 0 to 15 percent slopes	B	44.0	0.2%
LfD	Legore very stony silt loam, 15 to 25 percent slopes	B	48.5	0.2%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	B	92.8	0.4%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	B	101.9	0.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	B	58.6	0.3%
Lr	Leonardtown silt loam	D	24.3	0.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
MbB2	Manor loam, 3 to 8 percent slopes, moderately eroded	B	618.8	3.0%
MbC	Manor loam, 8 to 15 percent slopes	B	1,453.4	7.0%
MbD	Manor loam, 15 to 25 percent slopes	B	779.3	3.7%
McB2	Manor channery loam, 3 to 8 percent slopes, moderately eroded	B	115.5	0.6%
McC2	Manor channery loam, 8 to 15 percent slopes, moderately eroded	B	493.8	2.4%
McC3	Manor channery loam, 8 to 15 percent slopes, severely eroded	B	163.4	0.8%
McD2	Manor channery loam, 15 to 25 percent slopes, moderately eroded	B	376.8	1.8%
McD3	Manor channery loam, 15 to 25 percent slopes, severely eroded	B	421.7	2.0%
MdE	Manor very stony loam, 25 to 45 percent slopes	B	173.6	0.8%
MfE	Manor soils, 25 to 45 percent slopes	B	715.1	3.4%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	B	11.7	0.1%
MgD	Manor and Glenelg very stony loams, 15 to 25 percent slopes	B	30.6	0.1%
MkA	Matapeake silt loam, 0 to 2 percent slopes	C	2.9	0.0%
MkB	Matapeake silt loam, 2 to 5 percent slopes	C	5.7	0.0%
MlaA	Mattapex silt loam, 0 to 2 percent slopes, northern coastal plain	C	6.8	0.0%
MlaB	Mattapex silt loam, 2 to 5 percent slopes, northern coastal plain	C	31.5	0.2%
MsA	Montalto silt loam, 0 to 3 percent slopes	B	24.2	0.1%
MsB2	Montalto silt loam, 3 to 8 percent slopes, moderately eroded	B	354.2	1.7%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	B	72.0	0.3%
NeA	Neshaminy silt loam, 0 to 3 percent slopes	B	51.8	0.2%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	B	354.7	1.7%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	B	64.8	0.3%
NsC	Neshaminy and Montalto very stony silt loams 0 to 15 percent slopes	C	198.1	1.0%
NsD	Neshaminy and Montalto very stony silt loams, 15 to 25 percent slopes	C	71.1	0.3%
NsE	Neshaminy and Montalto very stony silt loams, 25 to 45 percent slopes	B	100.5	0.5%
RuB	Russett fine sandy loam, 0 to 5 percent slopes	C	150.2	0.7%
RuD	Russett fine sandy loam, 5 to 15 percent slopes	C	520.3	2.5%
RuE	Russett fine sandy loam, 15 to 30 percent slopes	C	5.1	0.0%
Sa	Sand and gravel pits	A	34.6	0.2%
ShaB	Sassafras sandy loam, 2 to 5 percent slopes, Northern Coastal Plain	B	3.7	0.0%
ShaC	Sassafras sandy loam, 5 to 10 percent slopes, Northern Coastal Plain	B	1.1	0.0%
SlB2	Sassafras loam, 2 to 5 percent slopes	B	22.1	0.1%
SlC2	Sassafras loam, 5 to 10 percent slopes, moderately eroded	B	7.1	0.0%
SsD	Sassafras and Joppa soils, 10 to 15 percent slopes	B	11.2	0.1%
SsE	Sassafras and Joppa soils, 15 to 30 percent slopes	B	16.3	0.1%
St	Stony land, steep	B	76.5	0.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Sw	Swamp	D	4.7	0.0%
Tm	Tidal marsh	D	27.2	0.1%
W	Water		87.4	0.4%
WaA	Watchung silt loam, 0 to 3 percent slopes	C/D	57.5	0.3%
WaB	Watchung silt loam, 3 to 8 percent slopes	C/D	90.5	0.4%
WcB	Watchung very stony silt loam, 0 to 8 percent slopes	C/D	154.0	0.7%
WoaB	Woodstown loam, 2 to 5 percent slopes, Northern Coastal Plain	C	28.0	0.1%
Subtotals for Soil Survey Area			**20,793.4**	**99.9%**
Totals for Area of Interest			**20,808.8**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX C

CAST

Geography	Sector	LoadSource	Allocation	Agency	Unit	Little Gunpowder _Amount	Little Gunpowder_ NLoadRateE OS	Little Gunpowder _PLoadRate EOS	Little Gunpowder _SLoadRate EOS	Little Gunpowder_ NLoadRateE OT	Little Gunpowder_ PLoadRateE OT	Little Gunpowder _SLoadRate EOT
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Agriculture	Agriculture	Load Allocation	All Agencies	acres	8986.194	21.198	0.335	845.142	14.926	0.181	286.252
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Agriculture	Regulated Agriculture	Waste Load Allocation	All Agencies	acres	0.022	522.724	38.903	5824.973	366.412	19.821	2052.956
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Developed	Non-Regulated Developed	Load Allocation	All Agencies	acres	433.773	9.387	0.975	969.076	6.607	0.530	323.826
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Developed	Regulated Developed	Waste Load Allocation	All Agencies	acres	9775.129	10.302	0.854	1326.275	7.245	0.461	441.042
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Natural	Natural	Load Allocation	All Agencies	acres	17528.237	3.187	0.470	1568.573	2.248	0.256	525.291
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Natural	Non-Tidal Water Deposition	Load Allocation	All Agencies	acres	425.950	8.747	0.606	0.000	6.792	0.471	0.000
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Septic	Septic	Load Allocation	All Agencies	systems	6196.566	12.831	0.000	0.000	9.024	0.000	0.000
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Wastewater	Wastewater	Waste Load Allocation	All Agencies	acres	0.000						
020600030501 - Little Gunpowder Falls (CBWS Portion Only)	Wastewater	Wastewater-CSO	Waste Load Allocation	All Agencies	acres	0.000						

Notes:
Loadings Rates in pounds per year
EOS - Edge of Stream
EOT - Edge of Tide
N - Total Nitrogen
P - Total Phosphorous
S - Total Suspended Solids

APPENDIX D

Land Use and
Stream Pollutant Loadings

Sub-Watershed 1 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	14.59334	28.01920704	2.480867	11898.97
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	71.49166	100.8032462	2.14475	1534.211
Water	0.147506	1.24052546	0.089979	0
Impervious without Tree Canopy	10.55699	148.2200975	8.12888	20351.97
Turf with Tree Canopy	8.270006	56.2360408	6.119804	4372.931
Turf without Tree Canopy	60.29581	539.6475264	59.69285	45731.96
Agriculture	211.7673	4488.966308	70.85665	178973.5

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	377.12	5363.13	149.51	262863.55

Sub-Watershed 2 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	16.70443	32.07250368	2.839753	13620.29
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	60.41817	85.18962393	1.812545	1296.574
Water	8.525326	71.69799166	5.200449	0
Impervious without Tree Canopy	18.34536	257.5689106	14.12593	35366.56
Turf with Tree Canopy	7.586139	51.5857452	5.613743	4011.323
Turf without Tree Canopy	81.96144	733.5549149	81.14183	62164.48
Agriculture	249.0005	5278.220494	83.31473	210440.8

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	442.54	6509.89	194.05	326900.01

Sub-Watershed 3 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	72.02058	138.279504	12.2435	58723.42
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	620.7626	875.2752477	18.62288	13321.57
Water	0.628856	5.28867896	0.383602	0
Impervious without Tree Canopy	57.01563	800.4994452	43.90204	109915.9
Turf with Tree Canopy	33.67296	228.9761416	24.91799	17805.25
Turf without Tree Canopy	178.1198	1594.171959	176.3386	135096.7
Agriculture	551.9732	11700.52539	184.6884	466495.8

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1514.19	15343.02	461.10	801358.65

Sub-Watershed 4 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	31.19651	59.89729728	5.303407	25436.7
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	414.5996	584.585467	12.43799	8897.308
Water	1.12464	9.4582224	0.68603	0
Impervious without Tree Canopy	18.61128	261.3023712	14.33069	35879.2
Turf with Tree Canopy	12.78732	86.9537624	9.462615	6761.55
Turf without Tree Canopy	53.15548	475.741546	52.62393	40316.31
Agriculture	160.164	3395.097832	53.59035	135361.4

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	691.64	4873.04	148.43	252652.41

Sub-Watershed 5 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	15.30185	29.37955776	2.601315	12476.67
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	16.59033	23.3923653	0.49771	356.0285
Water	0.023704	0.19935064	0.014459	0
Impervious without Tree Canopy	0.833653	11.70448812	0.641913	1607.133
Turf with Tree Canopy	1.040918	7.0782424	0.770279	550.4062
Turf without Tree Canopy	4.001261	35.81128595	3.961248	3034.796
Agriculture	81.67575	1731.332495	27.32844	69027.62

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	119.47	1838.90	35.82	87052.65

Sub-Watershed 6 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	92.3204	177.2551699	15.69447	75275.29
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	568.5791	801.6965691	17.05737	12201.71
Water	8.190834	68.88491394	4.996409	0
Impervious without Tree Canopy	52.07932	731.1936107	40.10107	100399.5
Turf with Tree Canopy	49.49111	336.5395548	36.62342	26169.41
Turf without Tree Canopy	175.0276	1566.497244	173.2773	132751.5
Agriculture	579.355	12280.95571	193.8503	489637.4

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1525.04	15963.02	481.60	836434.78

Sub-Watershed 7 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	31.16928	59.84502336	5.298778	25414.5
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	221.3022	312.0360809	6.639066	4749.145
Water	0.973354	8.18590714	0.593746	0
Impervious without Tree Canopy	28.68812	402.7812329	22.08985	55305.54
Turf with Tree Canopy	32.54503	221.3061972	24.08332	17208.83
Turf without Tree Canopy	127.2897	1139.242502	126.0168	96544.12
Agriculture	658.6987	13962.85407	220.3984	556694.1

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1100.67	16106.25	405.12	755916.20

Sub-Watershed 8 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	38.62314	74.15643648	6.565934	31492.15
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	583.647	822.9422432	17.50941	12525.06
Water	5.817608	48.92608328	3.548741	0
Impervious without Tree Canopy	74.97396	1052.634455	57.72995	144536.3
Turf with Tree Canopy	63.73681	433.4103352	47.16524	33702.12
Turf without Tree Canopy	246.6758	2207.748285	244.209	187093.7
Agriculture	857.1665	18169.90168	286.8051	724427.6

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1870.64	22809.72	663.53	#########

Sub-Watershed 9 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	275.662	529.2710957	46.86254	224766.5
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	921.054	1298.686095	27.63162	19765.82
Water	3.767785	31.68707185	2.298349	0
Impervious without Tree Canopy	152.7028	2143.946961	117.5811	294383.5
Turf with Tree Canopy	232.0769	1578.123185	171.7369	122715.3
Turf without Tree Canopy	358.846	3211.671288	355.2575	272170.3
Agriculture	214.5146	4547.202693	71.77589	181295.4

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	2158.62	13340.59	793.14	#########

Sub-Watershed 10 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	152.3197	292.4538989	25.89436	124196.9
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	1168.428	1647.483312	35.05284	25074.46
Water	5.778696	48.59883336	3.525005	0
Impervious without Tree Canopy	160.9545	2259.801152	123.935	310291.3
Turf with Tree Canopy	165.2916	1123.982669	122.3158	87401.22
Turf without Tree Canopy	410.9984	3678.436029	406.8885	311725.9
Agriculture	812.1733	17216.15199	271.7505	686401.9

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	2875.94	26266.91	989.36	#########

Sub-Watershed 11 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	110.0732	211.3404614	18.71244	89750.35
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	447.6346	631.1648466	13.42904	9606.239
Water	3.21851	27.0676691	1.963291	0
Impervious without Tree Canopy	94.67733	1329.269741	72.90155	182520.9
Turf with Tree Canopy	93.18358	633.64831	68.95585	49272.68
Turf without Tree Canopy	191.0165	1709.597424	189.1063	144878.4
Agriculture	120.5961	2556.352006	40.35106	101920.9

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1060.40	7098.44	405.42	577949.33

Sub-Watershed 12 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	75.50126	144.9624173	12.83521	61561.46
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	303.5654	428.027159	9.106961	6514.513
Water	1.285046	10.80723686	0.783878	0
Impervious without Tree Canopy	58.87994	826.6743295	45.33755	113509.9
Turf with Tree Canopy	63.0982	429.0677464	46.69267	33364.43
Turf without Tree Canopy	123.7733	1107.771465	122.5356	93877.13
Agriculture	70.98753	1504.767593	23.75219	59994.55

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	697.09	4452.08	261.04	368822.02

Sub-Watershed 13 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	31.50941	60.49807104	5.3566	25691.83
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	708.9186	999.5752641	21.26756	15213.39
Water	1.167385	9.81770785	0.712105	0
Impervious without Tree Canopy	46.10454	647.3077276	35.5005	88881.25
Turf with Tree Canopy	44.59699	303.2595388	33.00177	23581.55
Turf without Tree Canopy	87.6533	784.497044	86.77677	66481.52
Agriculture	144.4727	3062.478564	48.34008	122099.9

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1064.42	5867.43	230.96	341949.49

Sub-Watershed 14 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	53.39218	102.5129933	9.076671	43534.39
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	215.1978	303.428922	6.455935	4618.145
Water	1.296512	10.90366592	0.790872	0
Impervious without Tree Canopy	41.652	584.7941221	32.07204	80297.56
Turf with Tree Canopy	22.95613	156.101684	16.98754	12138.51
Turf without Tree Canopy	70.05942	627.0317911	69.35882	53137.27
Agriculture	181.9577	3857.073006	60.88245	153780.1

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	586.51	5641.85	195.62	347506.01

Sub-Watershed 15 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	31.57247	60.61914816	5.36732	25743.25
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	383.0067	540.0394823	11.4902	8219.324
Water	0.014211	0.11951451	0.008669	0
Impervious without Tree Canopy	168.2642	2362.429663	129.5635	324383.1
Turf with Tree Canopy	76.80723	522.28913	56.83735	40613.36
Turf without Tree Canopy	114.2474	1022.514328	113.1049	86652.09
Agriculture	41.66098	883.1141042	13.93963	35209.45

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	815.57	5391.13	330.31	520820.60

Sub-Watershed 16 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	34.53274	66.30285312	5.870565	28156.96
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	625.6736	882.1998028	18.77021	13426.96
Water	2.548389	21.43195149	1.554517	0
Impervious without Tree Canopy	81.46207	1143.727435	62.72579	157044.2
Turf with Tree Canopy	107.5591	731.4018936	79.59374	56874.03
Turf without Tree Canopy	117.8217	1054.504296	116.6435	89363.05
Agriculture	114.0223	2417.00184	38.15147	96365.01

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1083.62	6316.57	323.31	441230.21

Sub-Watershed 17 **2017 Progress Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	140.0701	268.934592	23.81192	114208.96
Non-tidal Floodplain Wetland	42.78352	56.47424508	1.283506	628.06206
True Forest	1365.939	1925.973738	40.97816	29313.047
Water	12.25863	103.0950867	7.477765	0
Impervious without Tree Canopy	430.8455	6049.07089	331.751	830592.58
Turf with Tree Canopy	255.0337	1734.229017	188.7249	134854.16
Turf without Tree Canopy	472.7371	4230.996866	468.0097	358552.17
Agriculture	103.8908	2202.23802	34.7615	87802.454

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	2823.56	16571.01	1096.80	1555951.43

Sub-Watershed 1 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	14.59334	28.01920704	2.480867	11898.97
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	71.49166	100.8032462	2.14475	1534.926
Water	0.147506	1.24052546	0.089979	0
Impervious without Tree Canopy	10.55699	151.9150429	8.44559	21243.93
Turf with Tree Canopy	8.270006	60.3710438	6.698705	4494.583
Turf without Tree Canopy	60.29581	578.2368467	65.72244	46737.09
Agriculture	211.7673	4488.966308	70.85665	178973.5

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	377.12	5409.55	156.44	264883.01
				132.44
				(tons/yr)

Sub-Watershed 2 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	16.70443	32.07250368	2.839753	13620.29
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	60.41817	85.18962393	1.812545	1297.178
Water	8.525326	71.69799166	5.200449	0
Impervious without Tree Canopy	18.34536	263.989788	14.67629	36916.56
Turf with Tree Canopy	7.586139	55.3788147	6.144773	4122.915
Turf without Tree Canopy	81.96144	786.0102384	89.33797	63530.77
Agriculture	249.0005	5278.220494	83.31473	210440.8

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	442.54	6572.56	203.33	329928.51
				164.96
				(tons/yr)

Sub-Watershed 3 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	72.02058	138.279504	12.2435	58723.42
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	620.7626	875.2752477	18.62288	13327.77
Water	0.628856	5.28867896	0.383602	0
Impervious without Tree Canopy	57.01563	820.4549157	45.6125	114733.1
Turf with Tree Canopy	33.67296	245.8126226	27.2751	18300.58
Turf without Tree Canopy	178.1198	1708.168613	194.1506	138066
Agriculture	551.9732	11700.52539	184.6884	466495.8

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1514.19	15493.80	482.98	809646.69
				404.82
				(tons/yr)

Sub-Watershed 4 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	31.19651	59.89729728	5.303407	25436.7
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	414.5996	584.585467	12.43799	8901.454
Water	1.12464	9.4582224	0.68603	0
Impervious without Tree Canopy	18.61128	267.8163192	14.88902	37451.66
Turf with Tree Canopy	12.78732	93.3474214	10.35773	6949.652
Turf without Tree Canopy	53.15548	509.7610532	57.93947	41202.41
Agriculture	160.164	3395.097832	53.59035	135361.4

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	691.64	4919.96	155.20	255303.23
				127.65 (tons/yr)

Sub-Watershed 5 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	15.30185	29.37955776	2.601315	12476.67
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	16.59033	23.3923653	0.49771	356.1944
Water	0.023704	0.19935064	0.014459	0
Impervious without Tree Canopy	0.833653	11.99626667	0.666922	1677.568
Turf with Tree Canopy	1.040918	7.5987014	0.843144	565.7181
Turf without Tree Canopy	4.001261	38.37209299	4.361374	3101.497
Agriculture	81.67575	1731.332495	27.32844	69027.62

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	119.47	1842.27	36.31	87205.27
				43.60
				(tons/yr)

Sub-Watershed 6 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	92.3204	177.2551699	15.69447	75275.29
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	568.5791	801.6965691	17.05737	12207.39
Water	8.190834	68.88491394	4.996409	0
Impervious without Tree Canopy	52.07932	749.4213716	41.66345	104799.7
Turf with Tree Canopy	49.49111	361.2851103	40.0878	26897.43
Turf without Tree Canopy	175.0276	1678.514924	190.7801	135669.2
Agriculture	579.355	12280.95571	193.8503	489637.4

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1525.04	16118.01	504.13	844486.38
				422.24
				(tons/yr)

Sub-Watershed 7 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	31.16928	59.84502336	5.298778	25414.5
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	221.3022	312.0360809	6.639066	4751.358
Water	0.973354	8.18590714	0.593746	0
Impervious without Tree Canopy	28.68812	412.8220756	22.9505	57729.39
Turf with Tree Canopy	32.54503	237.5787117	26.36147	17687.57
Turf without Tree Canopy	127.2897	1220.707887	138.7457	98666.04
Agriculture	658.6987	13962.85407	220.3984	556694.1

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1100.67	16214.03	420.99	760942.93
				380.47 (tons/yr)

Sub-Watershed 8 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	38.62314	74.15643648	6.565934	31492.15292
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	583.647	822.9422432	17.50941	12530.90068
Water	5.817608	48.92608328	3.548741	0
Impervious without Tree Canopy	74.97396	1078.875342	59.97917	150870.8575
Turf with Tree Canopy	63.73681	465.2787422	51.62682	34639.68367
Turf without Tree Canopy	246.6758	2365.620788	268.8766	191205.802
Agriculture	857.1665	18169.90168	286.8051	724427.5751

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1870.64	23025.70	694.91	1145166.97
				572.58 (tons/yr)

Sub-Watershed 9 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	275.662	529.2710957	46.86254	224766.5486
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	921.054	1298.686095	27.63162	19775.02869
Water	3.767785	31.68707185	2.298349	0
Impervious without Tree Canopy	152.7028	2197.392932	122.1622	307285.3212
Turf with Tree Canopy	232.0769	1694.161655	187.9823	126129.1748
Turf without Tree Canopy	358.846	3441.332699	391.1421	278152.2643
Agriculture	214.5146	4547.202693	71.77589	181295.3685

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	2158.62	13739.73	849.86	1137403.71
				568.70
				(tons/yr)

Sub-Watershed 10 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	152.3197	292.4538989	25.89436	124196.9456
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	1168.428	1647.483312	35.05284	25086.14661
Water	5.778696	48.59883336	3.525005	0
Impervious without Tree Canopy	160.9545	2316.135226	128.7636	323890.3459
Turf with Tree Canopy	165.2916	1206.628454	133.8862	89832.66192
Turf without Tree Canopy	410.9984	3941.47503	447.9883	318577.22
Agriculture	812.1733	17216.15199	271.7505	686401.9114

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	2875.94	26668.93	1046.86	1567985.23
				783.99
				(tons/yr)

Sub-Watershed 11 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	110.0732	211.3404614	18.71244	89750.35
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	447.6346	631.1648466	13.42904	9610.716
Water	3.21851	27.0676691	1.963291	0
Impervious without Tree Canopy	94.67733	1362.406807	75.74187	190520.1
Turf with Tree Canopy	93.18358	680.2400975	75.4787	50643.41
Turf without Tree Canopy	191.0165	1831.847966	208.208	148062.6
Agriculture	120.5961	2556.352006	40.35106	101920.9

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1060.40	7300.42	433.88	590508.07
				295.25
				(tons/yr)

Sub-Watershed 12 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	75.50126	144.9624173	12.83521	61561.46
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	303.5654	428.027159	9.106961	6517.548
Water	1.285046	10.80723686	0.783878	0
Impervious without Tree Canopy	58.87994	847.2823078	47.10395	118484.7
Turf with Tree Canopy	63.0982	460.6168454	51.10954	34292.61
Turf without Tree Canopy	123.7733	1186.986407	134.9129	95940.44
Agriculture	70.98753	1504.767593	23.75219	59994.55

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	697.09	4583.45	279.60	376791.30
				188.40 (tons/yr)

Sub-Watershed 13 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	31.50941	60.49807104	5.3566	25691.83
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	708.9186	999.5752641	21.26756	15220.48
Water	1.167385	9.81770785	0.712105	0
Impervious without Tree Canopy	46.10454	663.4443162	36.88363	92776.62
Turf with Tree Canopy	44.59699	325.5580343	36.12356	24237.57
Turf without Tree Canopy	87.6533	840.5951566	95.5421	67942.7
Agriculture	144.4727	3062.478564	48.34008	122099.9

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1064.42	5961.97	244.23	347969.15
				173.98
				(tons/yr)

Sub-Watershed 14 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	53.39218	102.5129933	9.076671	43534.39
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	215.1978	303.428922	6.455935	4620.297
Water	1.296512	10.90366592	0.790872	0
Impervious without Tree Canopy	41.652	599.3723232	33.3216	83816.74
Turf with Tree Canopy	22.95613	167.579749	18.59447	12476.2
Turf without Tree Canopy	70.05942	671.8698186	76.36477	54305.16
Agriculture	181.9577	3857.073006	60.88245	153780.1

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	586.51	5712.74	205.49	352532.92
				176.27
				(tons/yr)

Sub-Watershed 15 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	31.57247	60.61914816	5.36732	25743.25
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	383.0067	540.0394823	11.4902	8223.154
Water	0.014211	0.11951451	0.008669	0
Impervious without Tree Canopy	168.2642	2421.32214	134.6114	338599.8
Turf with Tree Canopy	76.80723	560.6927425	62.21385	41743.19
Turf without Tree Canopy	114.2474	1095.632671	124.5297	88556.6
Agriculture	41.66098	883.1141042	13.93963	35209.45

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	815.57	5561.54	352.16	538075.41
				269.04
				(tons/yr)

Sub-Watershed 16 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	34.53274	66.30285312	5.870565	28156.96
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	625.6736	882.1998028	18.77021	13433.21
Water	2.548389	21.43195149	1.554517	0
Impervious without Tree Canopy	81.46207	1172.239159	65.16965	163926.9
Turf with Tree Canopy	107.5591	785.1814446	87.12287	58456.22
Turf without Tree Canopy	117.8217	1129.910189	128.4257	91327.14
Agriculture	114.0223	2417.00184	38.15147	96365.01

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1083.62	6474.27	345.06	451665.48
				225.83
				(tons/yr)

Sub-Watershed 17 **No Action Scenario**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	140.0701	268.934592	23.81192	114208.96
Non-tidal Floodplain Wetland	42.78352	56.47424508	1.283506	628.06206
True Forest	1365.939	1925.973738	40.97816	29326.706
Water	12.25863	103.0950867	7.477765	0
Impervious without Tree Canopy	430.8455	6199.866817	344.6764	866994.72
Turf with Tree Canopy	255.0337	1861.745857	206.5773	138605.7
Turf without Tree Canopy	472.7371	4533.548597	515.2834	366432.69
Agriculture	103.8908	2202.23802	34.7615	87802.454

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	2823.56	17151.88	1174.85	1603999.29
				802.00
				(tons/yr)

BMP-01 **Wallgreens Fallston**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	1.22625	2.3544	0.208463	999.8475
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.033092	0.04665972	0.000993	0.710154
Water	0	0	0	0
Impervious without Tree Canopy	1.039249	14.59105596	0.800222	2003.485
Turf with Tree Canopy	0.016655	0.113254	0.012325	8.806664
Turf without Tree Canopy	1.271153	11.37681935	1.258441	964.1187
Agriculture	0.113291	2.401501049	0.037907	95.747

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	3.70	30.88	2.32	4072.71
				2.04 (tons/yr)

BMP-02 **Grandview Christian Church**

2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	5.651141	10.85019072	0.960694	4607.771
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.056144	0.07916304	0.001684	1.20485
Water	0	0	0	0
Impervious without Tree Canopy	2.279419	32.00304276	1.755153	4394.31
Turf with Tree Canopy	0.030403	0.2067404	0.022498	16.07619
Turf without Tree Canopy	6.336099	56.70808605	6.272738	4805.678
Agriculture	0.210894	4.470453631	0.070564	178.2354

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	14.56	104.32	9.08	14003.27
				7.00
				(tons/yr)

BMP-03 Contributing **Celebree School Fallston**

2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	1.276167	2.45024064	0.216948	1040.548
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.338278	0.47697198	0.010148	7.259446
Water	0	0	0	0
Impervious without Tree Canopy	2.582996	36.26526384	1.988907	4979.551
Turf with Tree Canopy	0.822618	5.5938024	0.608737	434.9757
Turf without Tree Canopy	0.888262	7.9499449	0.879379	673.7112
Agriculture	0.268989	5.701930125	0.090003	227.3339

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	6.18	58.44	3.79	7363.38
				3.68
				(tons/yr)

BMP-03 Contributing **Fallston Crossing North**

2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	2.174512	4.17506304	0.369667	1773.032
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	9.860093	13.90273113	0.295803	211.5976
Water	0	0	0	0
Impervious without Tree Canopy	6.03761	84.7680444	4.64896	11639.43
Turf with Tree Canopy	1.668436	11.3453648	1.234643	882.2189
Turf without Tree Canopy	5.028919	45.00882505	4.97863	3814.234
Agriculture	0.00123	0.026073089	0.000412	1.039525

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	24.77	159.23	11.53	18321.55
				9.16
				(tons/yr)

BMP-03 Contributing **Fallston Crossing South**

2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	1.704704	3.27303168	0.2898	1389.965
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	1.488151	2.09829291	0.044645	31.93572
Water	0	0	0	0
Impervious without Tree Canopy	4.885008	68.58551232	3.761456	9417.416
Turf with Tree Canopy	0.442495	3.008966	0.327446	233.9781
Turf without Tree Canopy	2.726542	24.4025509	2.699277	2067.973
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	11.25	101.37	7.12	13141.27
				6.57
				(tons/yr)

BMP-03 Contributing **Royal Farms**

Land Use	Acres	2017 Progress Scenario TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	0.057523	0.11044416	0.009779	46.90253
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.245703	0.34644123	0.007371	5.272786
Water	0	0	0	0
Impervious without Tree Canopy	1.896807	26.63117028	1.460541	3656.702
Turf with Tree Canopy	0.669895	4.555286	0.495722	354.2204
Turf without Tree Canopy	0.835302	7.4759529	0.826949	633.5432
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	3.71	39.12	2.80	4696.64
				2.35 (tons/yr)

BMP-03 **Fallston Village Outfall**

Land Use	Acres	2017 Progress Scenario TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	8.75317	16.8060864	1.488039	7137.072
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	43.97216	62.00074842	1.319165	943.6426
Water	0	0	0	0
Impervious without Tree Canopy	43.66364	613.0374635	33.621	84175.63
Turf with Tree Canopy	12.75288	86.7195772	9.43713	6743.34
Turf without Tree Canopy	20.63662	184.6977043	20.43025	15652.05
Agriculture	0.398537	8.448041095	0.133349	336.8204

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	130.18	971.71	66.43	114988.55
				57.49 (tons/yr)

BMP-04 Contributing **Burger King**

Land Use	Acres	2017 Progress Scenario TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	0.065416	0.12559872	0.011121	53.33824
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.007883	0.01111503	0.000236	0.169169
Water	0	0	0	0
Impervious without Tree Canopy	0.594662	8.34905448	0.45789	1146.401
Turf with Tree Canopy	0.021169	0.1439492	0.015665	11.19353
Turf without Tree Canopy	0.197704	1.7694508	0.195727	149.9506
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	0.89	10.40	0.68	1361.05
				0.68
				(tons/yr)

BMP-04 **Nephrology Center of MD**

2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	0.008405	0.0161376	0.001429	6.853185
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.000741	0.00104481	2.22E-05	0.015902
Water	0	0	0	0
Impervious without Tree Canopy	0.614586	8.62878744	0.473231	1184.811
Turf with Tree Canopy	0.003402	0.0231336	0.002517	1.798876
Turf without Tree Canopy	0.014663	0.13123385	0.014516	11.1213
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	0.64	8.80	0.49	1204.60
				0.60
				(tons/yr)

BMP-04 Contributing **Smitty's Fine Wine and Spirits**

2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	0.066395	0.1274784	0.011287	54.13649
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.006166	0.00869406	0.000185	0.132322
Water	0	0	0	0
Impervious without Tree Canopy	1.11797	15.6962988	0.860837	2155.245
Turf with Tree Canopy	0.013575	0.09231	0.010046	7.178053
Turf without Tree Canopy	0.410494	3.6739213	0.406389	311.3433
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1.61	19.60	1.29	2528.04
				1.26
				(tons/yr)

BMP-04 **Fallston Village Pond**

2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	0.598146	1.14844032	0.101685	487.7103
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.640783	0.90350403	0.019223	13.7512
Water	0.014211	0.11951451	0.008669	0
Impervious without Tree Canopy	10.88092	152.7681589	8.378311	20976.46
Turf with Tree Canopy	0.886036	6.0250448	0.655667	468.5093
Turf without Tree Canopy	2.737601	24.50152895	2.710225	2076.361
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	15.76	185.47	11.87	24022.79
				12.01
				(tons/yr)

BMP-05 **Spry Island Road Pond**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	1.554658	2.98494336	0.264292	1267.621
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.289073	0.40759293	0.008672	6.203507
Water	0	0	0	0
Impervious without Tree Canopy	8.184295	114.9075018	6.301907	15777.85
Turf with Tree Canopy	0.223177	1.5176036	0.165151	118.0093
Turf without Tree Canopy	10.2766	91.9755342	10.17383	7794.387
Agriculture	0.781301	16.56173192	0.261421	660.3104

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	21.31	228.35	17.18	25624.38
				12.81
				(tons/yr)

BMP-06 **Gunpowder Ridge Road Pond**

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	3.395362	6.51909504	0.577212	2768.476
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.428265	0.60385365	0.012848	9.190567
Water	0.71009	5.9718569	0.433155	0
Impervious without Tree Canopy	15.74519	221.0624114	12.12379	30353.88
Turf with Tree Canopy	0.593331	4.0346508	0.439065	313.7356
Turf without Tree Canopy	18.18977	162.7984057	18.00787	13796.21
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	39.06	400.99	31.59	47241.50
				23.62
				(tons/yr)

BMP-07 **JB Hunt Tranport Pond**

2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	0.41757	0.8017344	0.070987	340.4741
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	0.122975	0.17339475	0.003689	2.639044
Water	0	0	0	0
Impervious without Tree Canopy	3.072892	43.14340368	2.366127	5923.983
Turf with Tree Canopy	0.164863	1.1210684	0.121999	87.17461
Turf without Tree Canopy	0.67881	6.0753495	0.672022	514.8502
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	4.46	51.31	3.23	6869.12
				3.43
				(tons/yr)

BMP-08 **Joppatowne Plaza Outfall**

Land Use	Acres	2017 Progress Scenario TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	0.533941	1.02516672	0.09077	435.3595
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	1.654266	2.33251506	0.049628	35.50055
Water	0	0	0	0
Impervious without Tree Canopy	11.36495	159.5639261	8.751013	21909.58
Turf with Tree Canopy	2.079597	14.1412596	1.538902	1099.629
Turf without Tree Canopy	1.786444	15.9886738	1.76858	1354.946
Agriculture	0	0	0	0

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	17.42	193.05	12.20	24835.02
				12.42 (tons/yr)

BMP-09 **Joppa Crossing Pond**

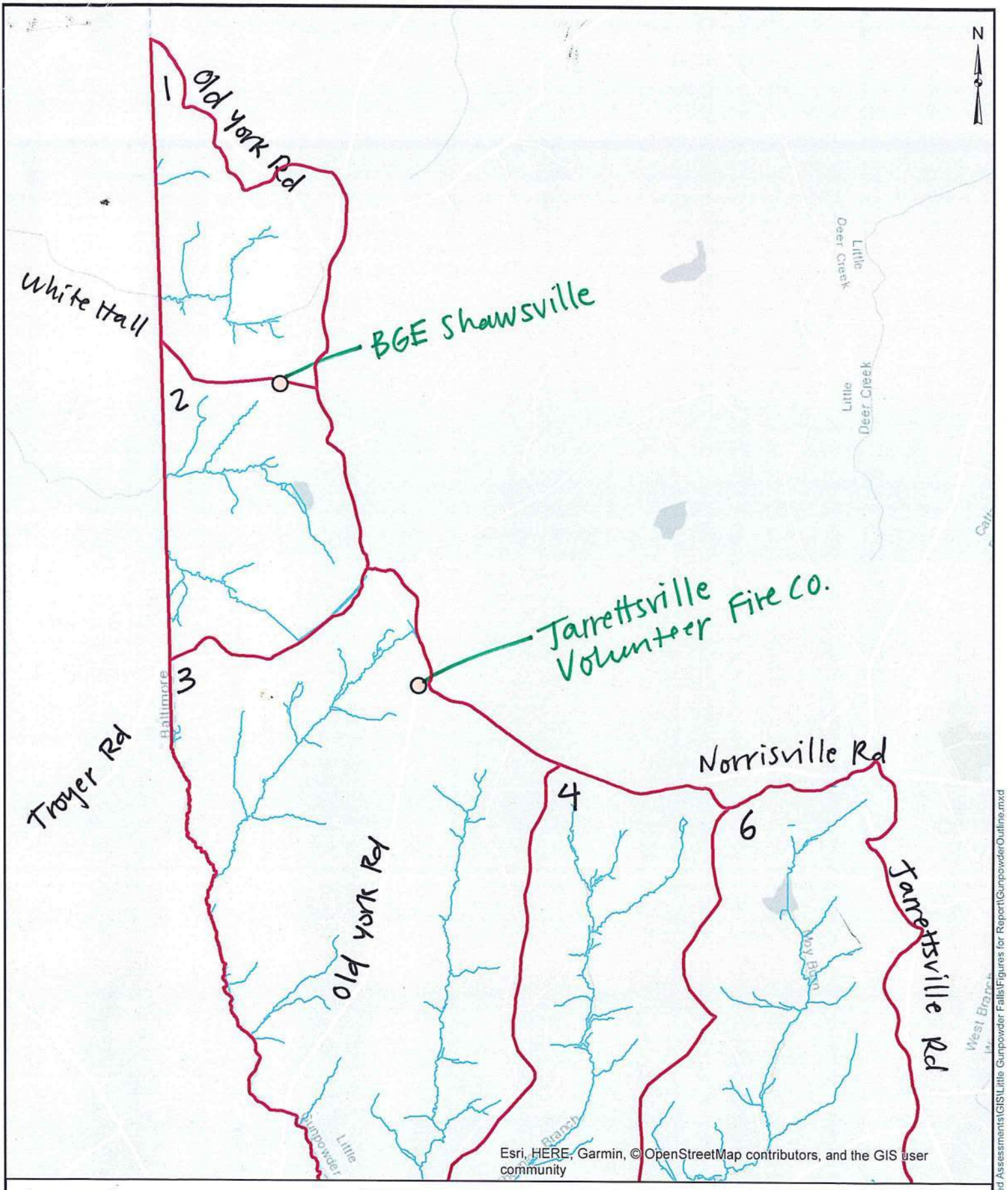
2017 Progress Scenario

Land Use	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Mixed Open	2.892214	5.55305088	0.491676	2358.225
Non-tidal Floodplain Wetland	0	0	0	0
True Forest	1.336751	1.88481891	0.040103	28.68668
Water	0	0	0	0
Impervious without Tree Canopy	12.26471	172.1965565	9.443828	23644.16
Turf with Tree Canopy	3.68625	25.0665	2.727825	1949.178
Turf without Tree Canopy	11.3049	101.1788192	11.19185	8574.311
Agriculture	0.121977	2.58562369	0.040813	103.0879

	Acres	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	31.61	308.47	23.94	36657.65
				18.33
				(tons/yr)

APPENDIX E

Field Sheets



Legend

- SWM to Visit
- Streams to Visit
- Prop. BMP from HarCo

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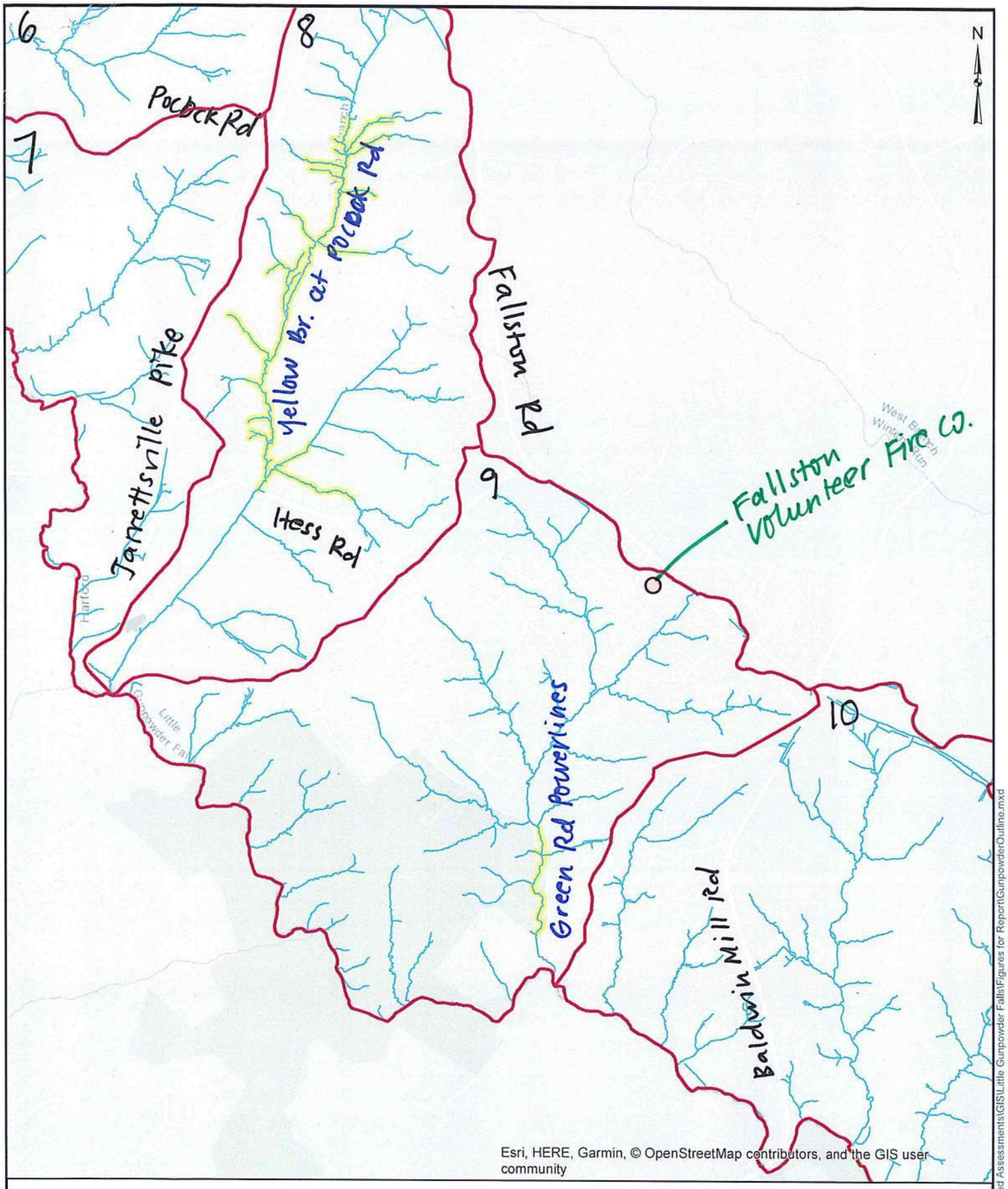
LITTLE GUNPOWDER SUBWATERSHEDS 1-6

04_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\GunpowderOutline.mxd



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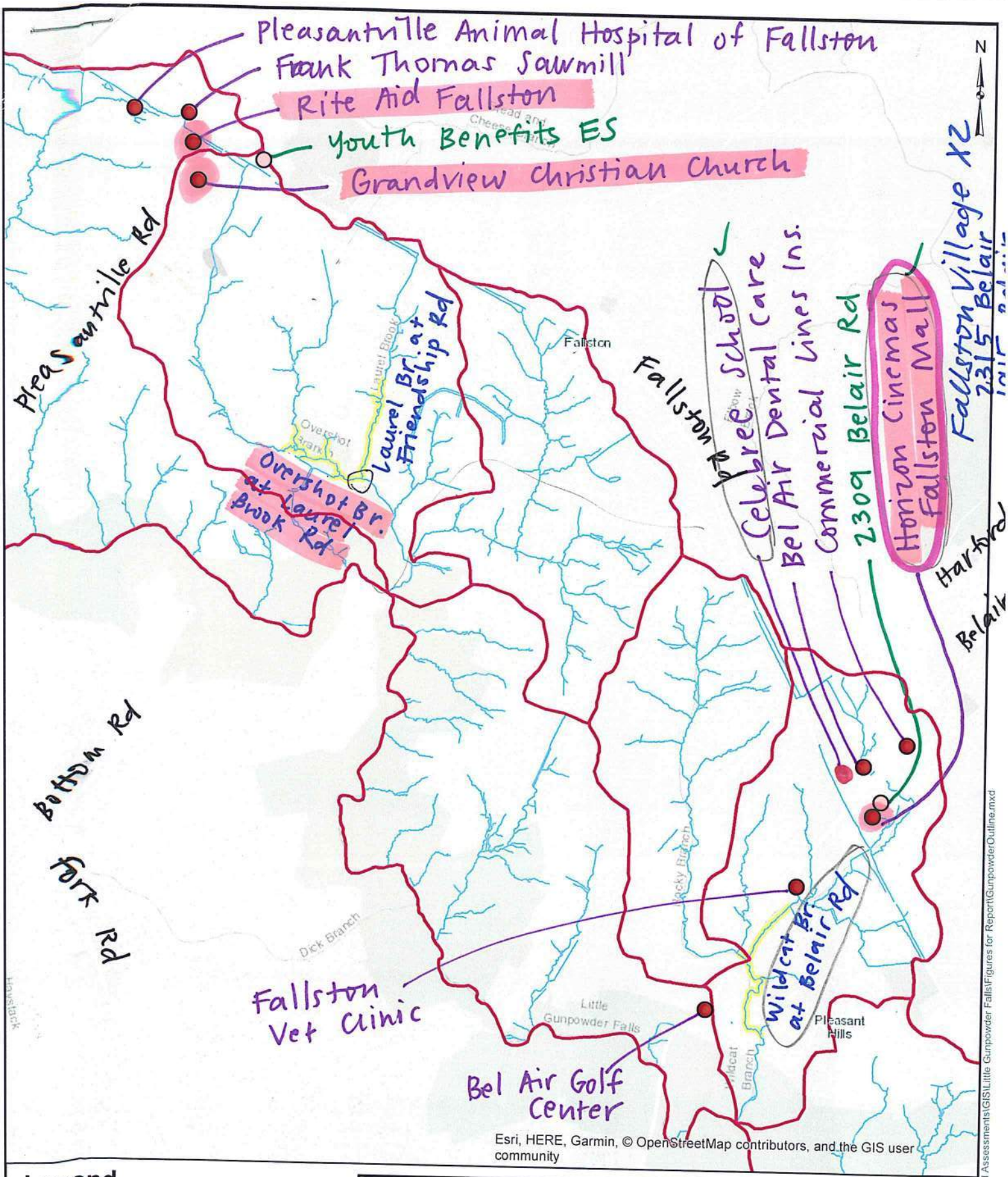
LITTLE GUNPOWDER SUBWATERSHEDS 6-10

214_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\GunpowderOutline.mxd



Legend

- SWM to Visit
- Prop. BMP from HarCo
- Streams to Visit

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LITTLE GUNPOWDER SUBWATERSHEDS 10-16

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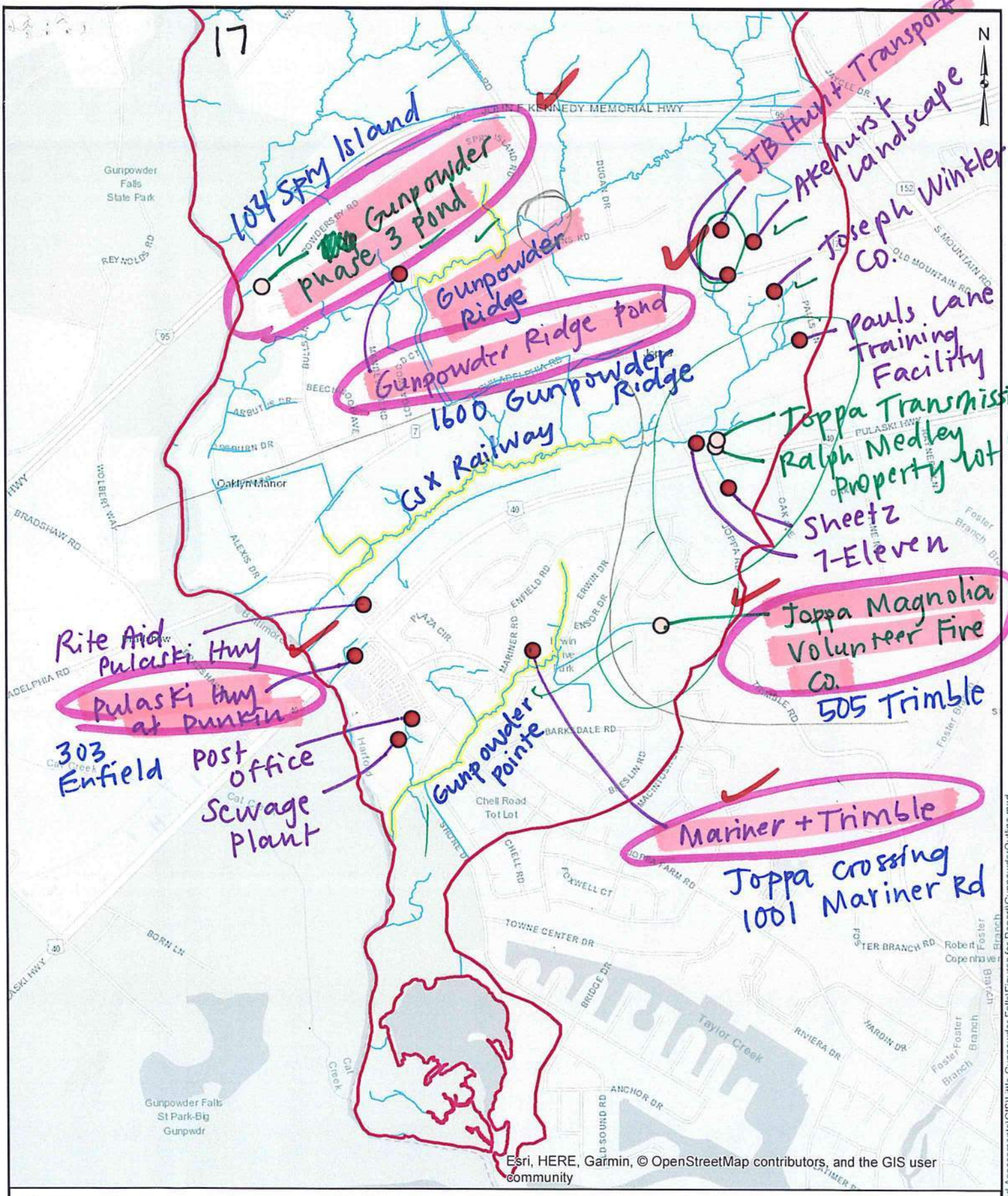

Legend

- SWM to Visit
- Streams to Visit
- Prop. BMP from HarCo

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LITTLE GUNPOWDER SUBWATERSHED 17

4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\GunpowderOutline.mxd

944

Project Name: Yellow Br. at Pocock Rd		**CEW:** X	**HarCo:**
Site No. 1	**Address:** 2700 Pocock Rd		
Linear Feet	**Property Owners:** Harford Holding Co, Nancy Waylett, 3311 Jarrettsville Pike LLC, William Smith III		

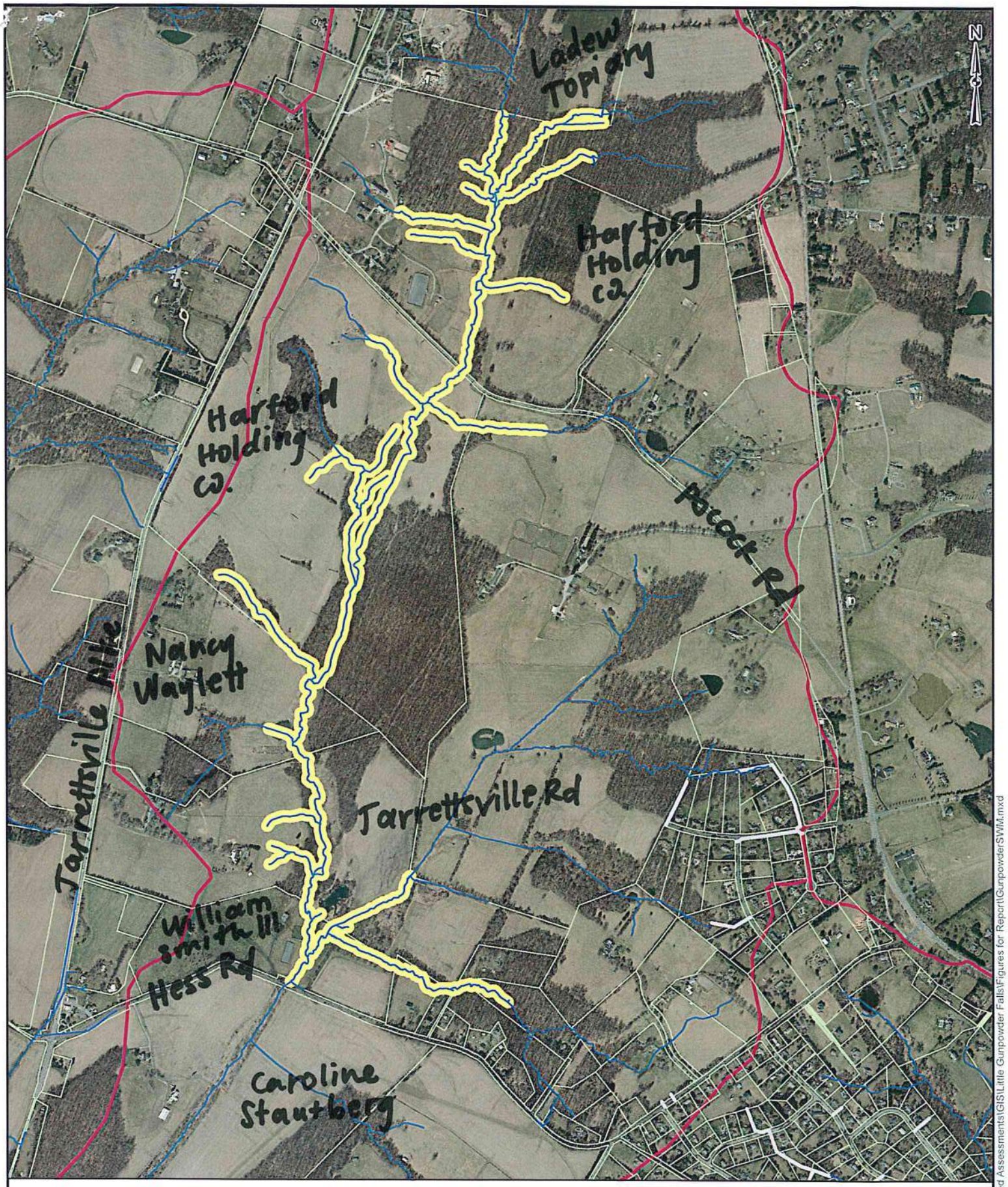
Description:

Access (including staging/stockpiling):

Utilities: telephone poles along Pocock
none along Hess

Constructability:

Other Notes:
- ~~facility not visible~~ At Pocock Rd
2-3' banks Hound hunting grounds
"Horse and Hound Crossing
Private property Hess Rd
sandy low banks



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YELLOW BR.

014_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\GunpowderSWM.mxd

10:23

Project Name: Greene Rd Powerlines		**CEW:** X **HarCo:**
Site No. 2	**Address:** 2801 Green Rd	
Linear Feet	**Property Owners:** State of MD, BGE	

Description:

Access (including staging/stockpiling):

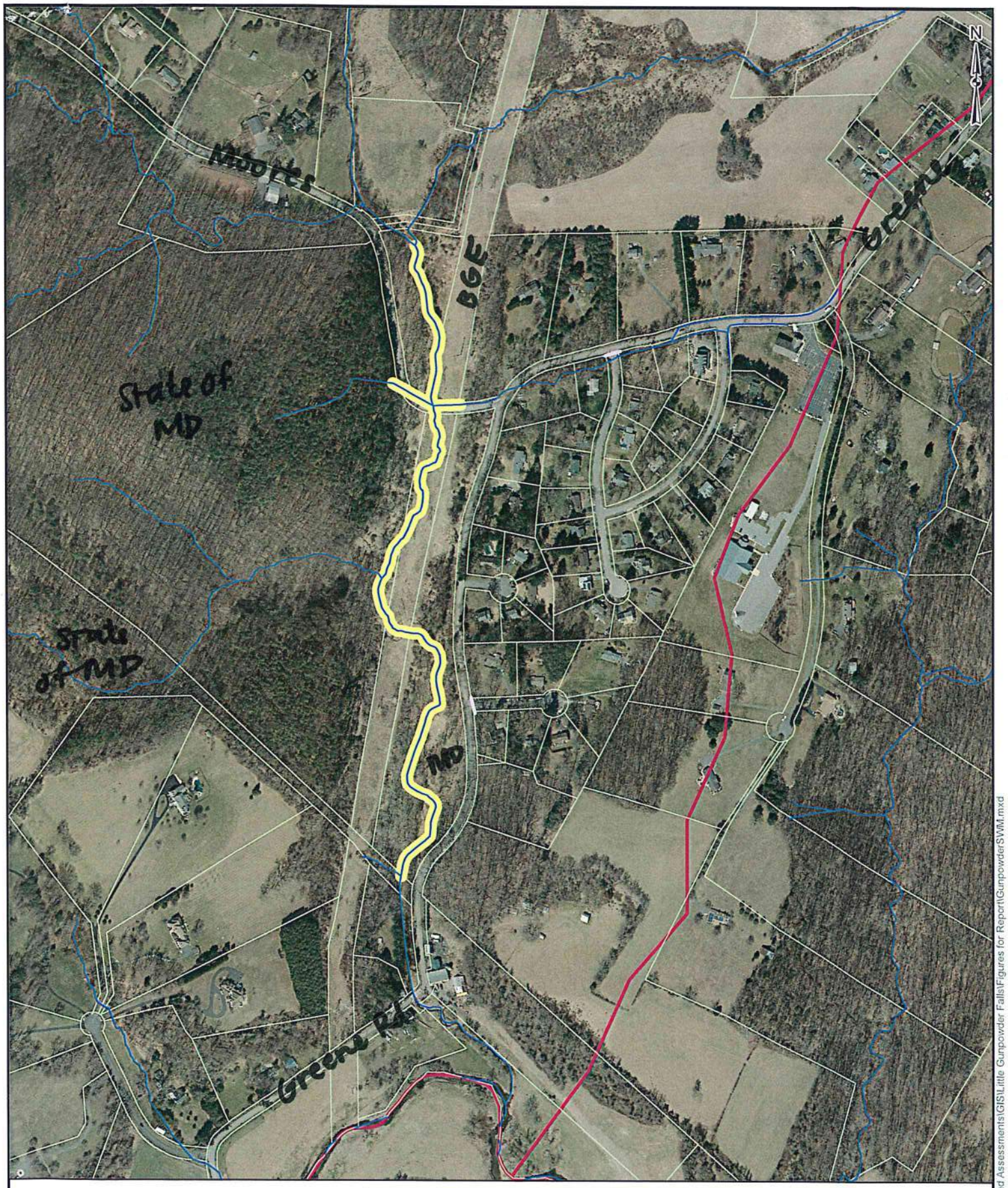
Utilities:

Transmission lines galore
petroleum pipeline

Constructability:

Other Notes:

5-6' banks



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GREENE RD POWERLINES

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11:31 11:40

Project Name: Overshot Br. at Laurel Brook Rd		**CEW:** X **HarCo:**
Site No. 3	**Address:** 2645 Gunpowder Farms Rd	
Linear Feet	**Property Owners:** State of MD, Nigel James	

Description: Overshot Br. between Gunpowder Farms Rd and Friendship Rd

Access (including staging/stockpiling):
would need to clear forest for staging

Utilities:
none seen

Constructability:

Other Notes:
~3' eroded banks on both sides of GF Rd.
check properties on other side of road
outfall at Park Shire Ct eroded
boulder black matting coming up.
12:01 ~~continues to be eroded~~ DS of
big washout ~~erosion~~ goes over Laurel Brook Rd
Friendship Rd

11:31

Project Name: Laurel Br. at Friendship Rd		**CEW:** X **HarCo:**
Site No. 4	**Address:**	
Linear Feet	**Property Owners:** multiple private homeowners	
Description: stream along friendship Rd		
Access (including staging/stockpiling): Wasn't much area		
Utilities: none seen		
Constructability:		
Other Notes: some erosion concrete channel walls along properties some parts looked fine.		

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LAUREL BR. AND OVERSHOT BR.

check owner

14_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\GunpowderSWM.mxd

Project Name: Wildcat Br. at Belair Rd		**CEW:** X **HarCo:**
Site No. 5	**Address:** 2705 Belair Rd	
Linear Feet	**Property Owners:** multiple commercial properties, one private at Reckord	

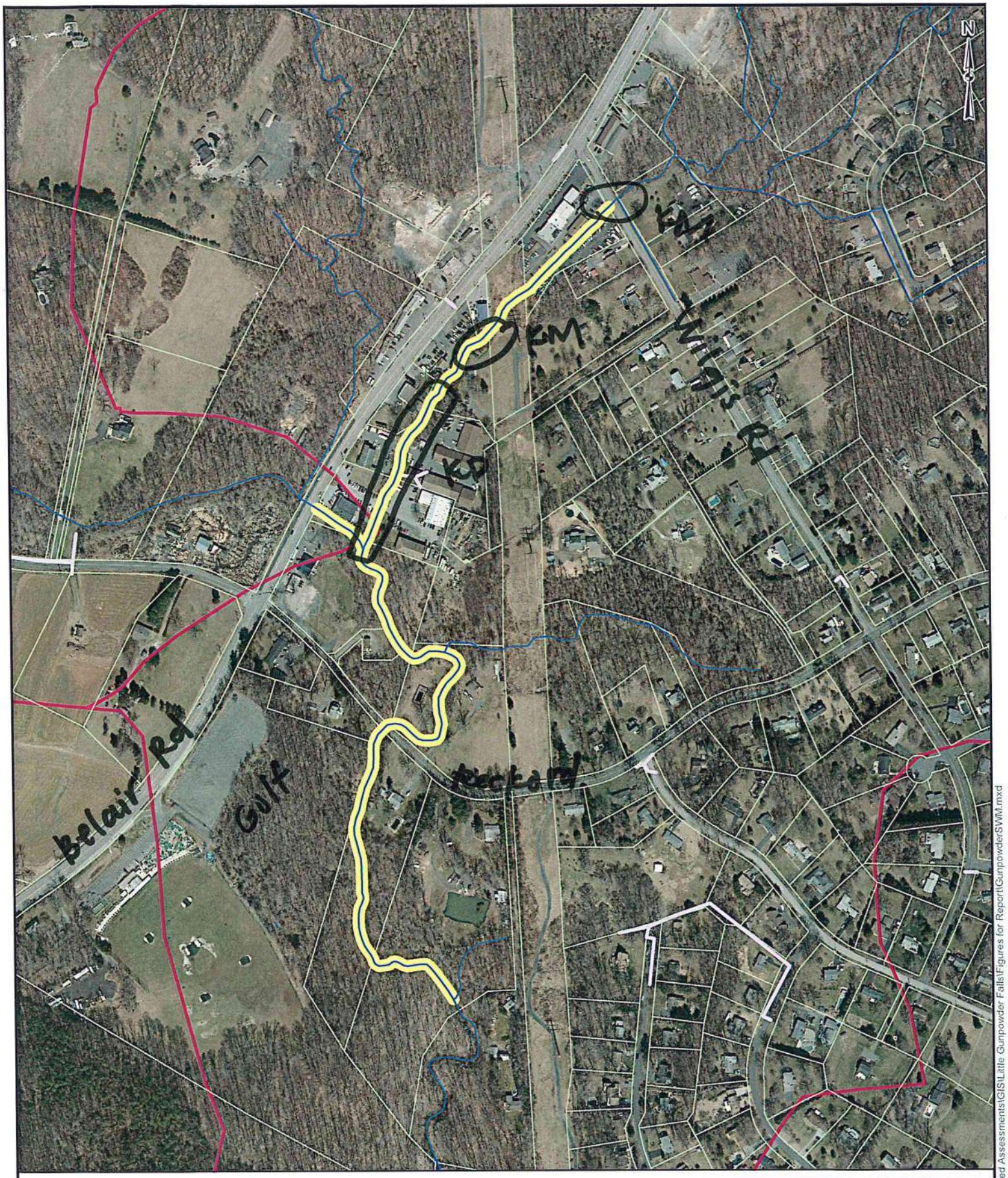
Description: Along Belair Rd between Wilgis and Reckord

Access (including staging/stockpiling):
lots of parking lots

Utilities:
BGE transmission

Constructability:

Other Notes:
eroded behind businesses
property owner Woody complained of flooding last year
DS neighbor very excited about idea of restoration



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WILDCAT BR.

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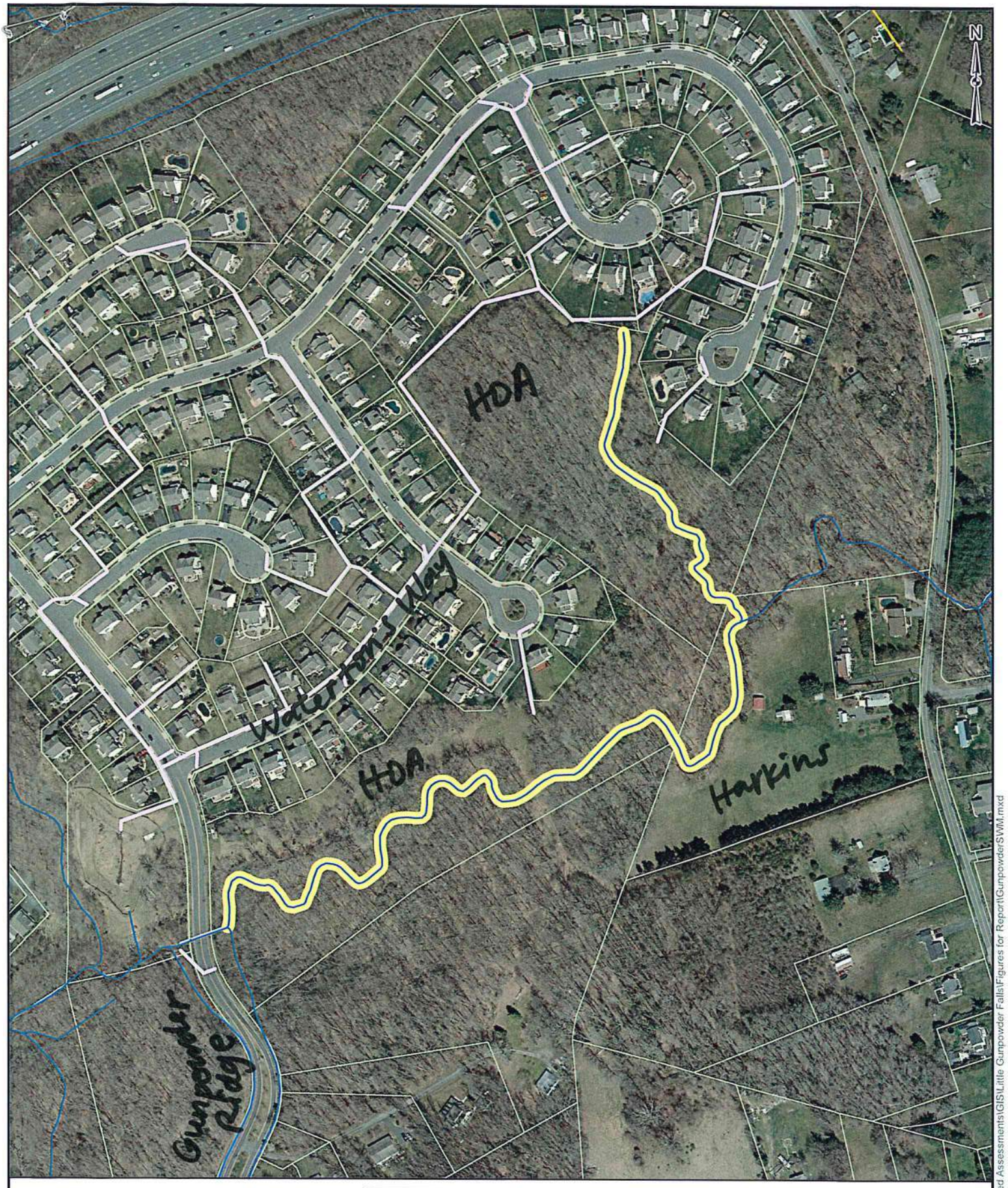
Project Name: Gunpowder Ridge		CEW: X	HarCo:
Site No. 6	Address: DS: 1600 Gunpowder Ridge Rd		
Linear Feet	Property Owners: Gunpowder Homeowners, Audrey Tomsky Harkins, Gunpowder Homeowners		
Description: Gunpowder Ridge HOA land			
Access (including staging/stockpiling): only access from Gunpowder Ridge			
Utilities: ~~[illegible]~~ some boxes at start			
Constructability: Already lots of gabion baskets stacked ~15' high at GR Rd. banks upstream up to ~15' high lots of deposition			
Other Notes: Wow! Pick this!			



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GUNPOWDER RIDGE

t_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\GunpowderSWM.mxd

Project Name: CSX Railway	CEW: X	HarCo:

Site No.	Address:
7	~~US: 1203 Toppa Farm Rd~~ US: 1203 Toppa Rd Middle: Community Baptist 303 Philadelphia Rd DS: 1258 Toppa Farm Rd
Linear Feet	Property Owners: BGE

Description: Along CSX railway and BGE powerlines between Toppa Rd and Toppa Farm Rd

Access (including staging/stockpiling):
off Toppa Rd
parking lot (stockpile?)
down BGE access
near 1 lane underpass

Utilities:
M: far enough from utilities ~40' clearance
DS: closer to utilities

Constructability:

Other Notes:
US: by 7-Eleven Pond
1' eroded banks
~~access of~~
M: ~5' banks ~~far enough from~~
DS: wasn't bad. All concrete "Waterfall" coming off road
~~closer~~

Project Name: Gunpowder Pointe		**CEW:** X **HarCo:**
Site No. 8	**Address:** 385 Enfield Rd 372 Thimble Rd 920 Rumsey Pl 900 Toppa Farm 101 Shore Dr	
Linear Feet	**Property Owners:** Gunpowder Pointe Homeowners, Weiss Brothers, The Pointe at County Crossing, Samuel Epstein, Toppatowne GP Ltd Partnership	
Description: Gunpowder Pointe Neighborhood to Mainstem ~~Re~~ Enfield access between 385 and 377		
Access (including staging/stockpiling): Access at these addresses		
Utilities: Verizon utilities near access to pond ~~Upstream cafe~~		
Constructability:		
Other Notes: Upstream of pond: ~~[illegible]~~ healthy At pond: minimal erosion gullies ripped geotech fabric At apartments: new bridge crossing some eroded banks ~2' Shore Dr: sandy deposition some eroded banks ~~[illegible]~~ could not access stream veg. made it hard to see how downstream erosion went.		

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CSX RAILWAY AND GUNPOWDER POINTE

\4_4101_HCo Large Watershed Assessments\GIS\Little Gunpowder Falls\Figures for Report\GunpowderSWM.mxd

Project Name: Fallston Mall Day 2			CEW: HarCo:
Site No. 9	Address:		
DA:	Imp Credits:	Property Owners:	

Description: check outfall behind Uncle's Hawaiian

Access (including staging/stockpiling):
big parking lots

Utilities:
none noted

Constructability:
need as-builts.

Other Notes: OUTFALL
outfall ellipse CMP ~3' high ~4' wide
bench forming
lots of trash
Boulder lined 2' Boulders
maintained cross memorial?
" SWM "
swampy, fire hydrant
CMP 2' maybe.
some matting fabric not much erosion
lots of trash

Project Name: BGE Shawsville			CEW:	HarCo: X
Site No. 1	Address: 3111 White Hall Rd			
DA: 0.56	Imp Credits: 0.11	Property Owners:		

Description: Bioretention retrofit to dry pond

Access (including staging/stockpiling):

very spacious

Utilities:

Constructability:

plant

Other Notes:

Not visible from road
Could not find

Project Name: Jarrettsville Volunteer Fire Co.			CEW:	HarCo: X
Site No. 2	Address: 4352 Norrisville Rd			
DA: 0.73	Imp Credits: 0.21	Property Owners:		

Description: Prop. new BMP

Access (including staging/stockpiling):
parking lot
very easy access

Utilities:
"Jarrettsville excavation"
powerlines along ~~Norrisville Rd~~ Rd

Constructability:
~~deep~~ maybe alongside

Other Notes:
property slopes down to main road
culvert under main road
depression on neighboring property

10:12

Project Name: Fallston Volunteer Fire Co.		CEW:	HarCo: X
Site No. 3	Address: 3108 Hunt Rd (access Fallston Rd)		
DA: 2.97	Imp Credits: 0.57	Property Owners:	

Description: Infiltration basin retrofit
culvert under firehouse driveway

Access (including staging/stockpiling):
field for stockpile easy access off Fallston Rd

Utilities:
telephone lines

Constructability:

Other Notes:
Looks like new trees have been planted recently

10:38

Project Name: Pleasantville Animal Hospital		CEW: X HarCo: X
Site No. 4	Address: 2128 Fallston Rd	
DA: 3	Imp Credits: 0.58	Property Owners:

Description: veg. swale along road, near degraded outfall, pond (?) in field
"Bioretention Retrofit to Dry pond"

Access (including staging/stockpiling):
grassy area for staging

Utilities:
telephone lines

~~**Constructability:**~~
Vet looks great
PVC pipes near building swale

Other Notes:
swale along road, plants, cattails
couldn't see pipe under driveway
~~grassy area~~
swale from vet sign to pond
pond lets out 20' away
neighboring property had erosion along rd
No trespassing
6' pipe under Fallston

good project

Project Name: Frank Thomas Sawmill			CEW: X	HarCo:
Site No. 5	Address: 2019 Fallston Rd			
DA:	Imp Credits:	Property Owners:		
Description: pond along Pleasantville Rd				
Access (including staging/stockpiling):				
Utilities: none seen chain link fence around pond				
Constructability: Not much room for expansion wet pond already relatively steep slopes				
Other Notes: concrete / brick "riser" couldn't find where it let out				

11:07

Project Name: Rite Aid Fallston Walgreens now			CEW: X	HarCo: X
Site No. 6	Address: 2101 Fallston Rd			
DA: 5.73	Imp Credits: 1.11	Property Owners:		

Description:
dry mown pond
"Sand Filter Retrofit to ED Dry Pond"

Access (including staging/stockpiling):
via Walgreens parking lot

Utilities:

Constructability:

Other Notes:
parking lot drains to pond
no water seen
gravel filter in pond

11:22

Project Name: Youths Benefit ES			CEW:	HarCo: X
Site No. 7	Address: ~~New bioretention - possible curb~~ 1901 Fallston Rd			
DA: ~~[illegible]~~ 1.21	Imp Credits: 0.9	Property Owners:		
Description: New bioretention - possible curb cut to bioretention in grass area at center of the driveway				
Access (including staging/stockpiling):				
Utilities:				
Constructability:				
Other Notes: - many stormwater features here already - not really room for any more				

Project Name: Grandview Christian Church			CEW: X	HarCo:
Site No. 8	Address: 2022 Fallston Rd (access along Pleasantville)			
DA:	Imp Credits:	Property Owners:		

Description: dry-ish pond (?) along road to church

Access (including staging/stockpiling): parking lot and grassy areas

Utilities: cell phone tower

Constructability: make wet ponds

Other Notes: TIME: before Walgreens after sawmill

12:38

Project Name: Bel Air Dental Care			CEW: X	HarCo:
Site No. 9	Address: 2300 Belair Rd			
DA:	Imp Credits:	Property Owners:		

Description: grassy area behind practice

Access (including staging/stockpiling):

Utilities:
out front: telephone poles
BGE gas
sign " underground facilities.

Constructability:
grassy space / parkinglot

Other Notes:
grassy landscaped depression out back
~~ridge~~ berm between depression and building
concrete channel out front

Project Name: Commercial Lines Insurance			**CEW:** X **HarCo:**
Site No. 10	**Address:** 2401 Belair Rd		
DA:	**Imp Credits:**	**Property Owners:**	
Description: space for SWM behind building			
Access (including staging/stockpiling): parking lot			
Utilities: none observed			
Constructability: green depressed area could be space for pond?			
Other Notes: Now Art to Soul galleria			

After Dental Care 12:45

Project Name: 2309 Belair Rd - Nephrology Center of MD		**CEW:**	**HarCo:** X
Site No. 11	**Address:** 2309 Belair Rd		
DA: 0.64	**Imp Credits:** 0.12	**Property Owners:**	

Description: Bioretention retrofit to dry pond

Access (including staging/stockpiling):
lots of grassy area
tight access from Belair Rd
you'd have to come from mall
and could stockpile there

Utilities:
none.

Constructability: Make a bigger pond

Other Notes: riser and 4 concrete blocks
very small 8'x8' approx.

12:50

Project Name: Horizon Cinemas Fallston Mall			**CEW:** X **HarCo:** X
Site No. 12	**Address:** 2315 Belair Rd		
DA: 16.2	**Imp Credits:** 3.13	**Property Owners:**	

Description: check behind movie theater
"MS4 Retrofit to Dry pond"

Access (including staging/stockpiling):
lots of un-used old parking lot.

Utilities: Behind Uncle's ~~Julio's~~ Hawaiian (1:05) some sort of elec. box? Wetland-y back there

Constructability:
you could just remove impervious area here looks like there's active construction

Other Notes: stream looks stagnant, dirty
bricks and other construction debris
smells like sewage

Project Name: Celebree School Fallston			CEW:	HarCo:
Site No.	Address: 2312 Belair Rd			
DA:	Imp Credits:	Property Owners:		
Description:				
Access (including staging/stockpiling): good access through Auto Showcase short chainlink fence around veg. made it hard to see				
Utilities: ~~[illegible]~~ fire hydrant no overhead				
Constructability: couldn't see riser				
Other Notes: wetland plants shallow DS barely a channel				

before 1:30

Project Name: Fallston Veterinary Clinic			CEW: X HarCo: X
Site No. 13	Address: 2615 Belair Rd		
DA: 0.95	Imp Credits: .18	Property Owners:	

Description: pond behind parking lot
"MS4 Retrofit to Wet pond"

Access (including staging/stockpiling):
parking lot, small grassy area at vet

Utilities:
sewer, BGE

Constructability:
not much room to expand, but could dig deeper?
Marshy plants in pond (cattails, e.g.)

Other Notes:
Empty lot next door w/ lots of impervious

1:57 dep.

Project Name: Bel Air Golf Center			CEW: X	HarCo: X
Site No. 14	Address: 3103 Belair Rd			
DA: 1	Imp Credits: 0.19	Property Owners:		

Description: veg. pond out front
"Bioretention Retrofit to ED Dry Pond"

Access (including staging/stockpiling): parking lot

Utilities: telephone poles

Constructability: bioretention - no riser structure

Other Notes: only saw road runoff going into it.
parking lot storm drain is downstream of facility.

Project Name: Gunpowder Phase 3 Pond			CEW:	HarCo: X
Site No. 15	Address: 104 Spry Island Rd (access between 104 and 106)			
DA: 61.2	Imp Credits: 11.81	Property Owners:		

Description: MS4 Retrofit to ED dry pond

Access (including staging/stockpiling):

Through ~~[illegible]~~ court
not sure where staging could go

Utilities:

Verizon utilities

Constructability:

very steep
couldn't deepen or expand, but ~~[illegible]~~
could modify riser/remove lower ~~pipe~~
outfall pipe

Other Notes:

outfall lower elev. than riser
inflow from pipe

Project Name: Gunpowder Ridge Rd			CEW: X HarCo: X
Site No. 16	Address: 1600 Gunpowder Ridge Rd		
DA: 114.4	Imp Credits: 22.1	Property Owners:	
Description: vegetated pond ED "MS4 Retrofit to Dry Pond"			
Access (including staging/stockpiling): not much stockpile room			
Utilities: boxes across road			
Constructability: steep, could modify riser, couldn't deepen or expand			
Other Notes: well vegetated			

Project Name:	JB Hunt Transport - Ramsey	CEW: X	HarCo: X
Site No. 17	Address: 706 Philadelphia Rd		
DA: 5.35	Imp Credits: 1.03	Property Owners:	

Description:
dry pond behind? swales in front
"Sand Filter Retrofit to Dry Pond"

Access (including staging/stockpiling):
narrow steep dirt access road
stockpile would have to be in Hunt lot

Utilities:
none seen

Constructability:
couldn't find riser
mostly dry
couldn't expand, but could add riser/
modify riser or deepen
stream rest. DS.

Other Notes:
eroded DS

note that JB Hunt employee said
county had been to pond recently

Project Name: Akehurst Landscape Services			CEW: X	HarCo: X
Site No. 18	Address: 712 Philadelphia Rd			
DA: 1.95	Imp Credits: 0.38	Property Owners:		

Description: veg. pond out back
"Bioretention retrofit to Dry Pond"

Access (including staging/stockpiling):
lots of room, barbed wire gate

Utilities: no utilities seen

Constructability:
modify riser
dig deep

Other Notes:
vegetated w/ swampy plants
not room to expand
metal riser

Project Name: Joseph Winkler Co. - CAC Prop.			CEW: X	HarCo: X
Site No. 19	Address: 709 Philadelphia Rd			
DA: 2.35	Imp Credits: 0.45	Property Owners:		
Description: veg. pond out back "Bioretention retrofit to Dry Pond"				
Access (including staging/stockpiling): through construction area				
Utilities: none				
Constructability: convert riser, dig deeper couldn't make any deeper.				
Other Notes: dry mown "pond" metal riser				

3:47

Project Name: Paul's Lane Training Facility			CEW: X	HarCo:
Site No. 20	Address: 1200 Pauls Ln			
DA:	Imp Credits:	Property Owners:		
Description: dry pond next to athletic field				
Access (including staging/stockpiling): could not access fence all around				
Utilities:				
Constructability:				
Other Notes:				

4:00

Project Name: Toppa Transmission		**CEW:**	**HarCo:** X
Site No. 21	**Address:** 604 Pulaski Hwy		
DA: 5.95	**Imp Credits:** 1.15	**Property Owners:**	
Description: Infiltration basin retrofit			
Access (including staging/stockpiling): good Toppa trans. parking lot			
Utilities: ~~none~~ electrical			
Constructability:			
Other Notes: not much to be done			

Project Name: Ralph Medley Property Lot 1		CEW:	HarCo: X
Site No. 22	Address: Rt 40 and Joppa Rd		
DA: 5.79	Imp Credits: 1.12	Property Owners:	

Description: Sand filter retrofit to ED dry pond

Access (including staging/stockpiling):
- Joppa transmission parking lot
- grassy ~~[illegible]~~ area under transmission lines

Utilities:
- transmission lines

Constructability:

Other Notes:
- ~~difficult to~~ could not find outfall / ~~access~~ difficult to access
- no pond structures visible
- lots of vegetation

Project Name: Sheetz Joppa			CEW: X	HarCo: X
Site No. 23	Address: 601 Pulaski Hwy			
DA: 4.24	Imp Credits: 0.8	Property Owners:		
Description: dry pond behind parking lot "Bioretention retrofit to dry pond"				
Access (including staging/stockpiling): - sheetz parking lot - fence around pond w/ gate				
Utilities:				
Constructability:				
Other Notes: -no riser ~~stri~~ structure				

3:54

Project Name: 7-Eleven Toppa			CEW: X	HarCo:
Site No. 24	Address: 602 Pulaski Hwy			
DA:	Imp Credits:	Property Owners:		

Description: veg. pond N of 7-Eleven

Access (including staging/stockpiling):
7-11 parking lot access

Utilities:
powerlines
transmission lines

Constructability:
modify metal riser
no room to expand but could deepen

Other Notes:
stream looks fine

Project Name: Rite Aid Joppatowne			CEW: X HarCo: X
Site No. 25	Address: 300 Pulaski Hwy		
DA: 1.93	Imp Credits: 0.37	Property Owners:	

Description: dry pond behind building
"Bioretention retrofit to ED dry pond"

Access (including staging/stockpiling):
from Rite Aid/Wallgreens

Utilities:
nearby light poles

Constructability:

Other Notes:
marsh plants at one end
chain link fence
riser
couldn't see water it was holding
cuts in curb that led to pond

Project Name: Pulaski Hwy at Dunkin Donuts			CEW: X	HarCo:
Site No. 26	Address: 998 Joppa Farm Rd			
DA:	Imp Credits:	Property Owners: SHA?		
Description: swales along Pulaski Hwy				
Access (including staging/stockpiling): Joppatowne Plaza parking lot				
Utilities: telephone poles in swale Utility pedl. sanitary sewer electrical vault gas pipeline				
Constructability: not much room to expand wouldn't want to cause flooding on roadway. Too many utilities				
Other Notes: concrete lined looks like it drains a large amount of impervious area				

Project Name: Post Office Toppa			CEW: X	HarCo:
Site No. 27	Address: 906 Toppa Farm Rd			
DA:	Imp Credits:	Property Owners:		
Description: SWM facilities all around the property				
Access (including staging/stockpiling): at Redners or back parking lot				
Utilities: some underground				
Constructability: Fed. land?				
Other Notes: one SWM pond couldn't find outfall wooden fence around it marsh plants in and downstream of expected outfall				

Project Name: Harford County Sewage Plant			CEW: X	HarCo:
Site No. 28	Address: 101 Shore Dr			
DA:	Imp Credits:	Property Owners:		

Description: possible ex. bioretention site

Access (including staging/stockpiling):

Utilities:
water sewage treatment facility

Constructability: facility surrounded by barbed wire

Other Notes:
garden swale
well maintained

Project Name: Mariner + Trimble - Toppa Cross.			CEW: X	HarCo: X
Site No. 29	Address: 1001 Mariner Rd			
DA: 36.85	Imp Credits: 7.11	Property Owners: ~~1004 Mariner Rd~~ HOA		

Description: pond in HOA area accessible from Mariner or Trimble. Check out outfall at intersection "MS4 Retrofit to Dry Pond"

Access (including staging/stockpiling):
From Mariner

Utilities: verizon, telephone utilities

Constructability:

Other Notes:
moved 3/4 around
riser, emergency spillway
plastic outfall reinforced concrete ~3'
marshy plants

Project Name: Toppa Magnolia Volunteer Fire Co.			CEW:	HarCo: X
Site No. 30	Address: 505 Trimble Rd			
DA: 0.47	Imp Credits: 0.47	Property Owners:		

Description: New bioretention - treat impervious runoff near inlet

Access (including staging/stockpiling):
staging on the grass because you'd block fire trucks otherwise

Utilities:
waterlines, manhole HMAN

Constructability:

Other Notes:
culvert under road
depressed area in front of fire house
evidence of path of water from depressed area to culvert

9/18/19

Project Name: Amish Market Outfall SWM-0003		**CEW:** X	**HarCo:**
Site No. 31	**Address:** 1000 Joppa Farm Rd Joppa, MD 21085		
DA:	**Imp Credits:**	**Property Owners:** Joppatowne GP Limited Partnership	

Description:
behind Joppatowne Plaza where SD network joins LG River

Access (including staging/stockpiling):
plenty of staging space
access is right off large parking lot behind Chinese Boys Restaurant.

Utilities:
none noted

Constructability:
BMP in woods next to parking lot.

Other Notes:
could not find single outfall.
14+ gutters spouts evenly spaced along the back of the building
couldn't find outfall pipe
couldn't identify single drainage pt.

APPENDIX F

Pollutant Removal and Impervious Area Computation

SR-1 **Gunpowder Ridge Stream**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Pr. Treatment	SR-NCP	2847.00			#DIV/0!				0.075	0.068	0.0225	#DIV/0!			213.53	193.60	64.06	85.41

SR-2 **Overshot Branch**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Pr. Treatment	SR-NCP	3809.00			#DIV/0!				0.075	0.068	0.0225	#DIV/0!			285.68	259.01	85.70	114.27

BMP-01 **Walgreens Fallston**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. Treatment	ST		3.70	1.04	28.1%	30.9	2.3	2.0	26	41	52	0.093	0.047	0.50	8.0	1.0	1.1	0.52
Pr. Treatment	ST		3.70	1.04	28.1%	30.9	2.3	2.0	33	52	66	0.093	0.093	1.00	10.2	1.2	1.3	1.04
Additional Treatment and Credit	**ST**		**3.70**	**1.04**	**28.1%**	**30.9**	**2.3**	**2.0**	**26**	**41**	**52**	**0.093**	**0.047**	**0.50**	**2.2**	**0.3**	**0.3**	**0.52**

BMP-02 **Grandview Christian Church**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. Treatment	ST		14.56	2.28	15.7%	104.3	9.1	7.0	26	41	52	0.243	0.121	0.50	27.1	3.7	3.6	1.14
Pr. Treatment	ST		14.56	2.28	15.7%	104.3	9.1	7.0	33	52	66	0.243	0.243	1.00	34.4	4.7	4.6	2.28
Additional Treatment and Credit	**ST**		**14.56**	**2.28**	**15.7%**	**104.3**	**9.1**	**7.0**	**26**	**41**	**52**	**0.243**	**0.121**	**0.50**	**7.3**	**1.0**	**1.0**	**1.14**

BMP-03 **Fallston Village Outfall**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Fallston Crossing North	ST		24.77	6.04	24.4%	159.2	11.5	9.2	33	52	66	0.556	0.556	1.00	52.5	6.0	6.0	6.04
Fallston Crossing South	ST		11.25	4.89	43.4%	101.4	7.1	6.6	33	52	66	0.413	0.413	1.00	33.5	3.7	4.3	4.89
Celebree School Fallston	ST		6.18	2.58	41.7%	58.4	3.8	3.7	33	52	66	0.219	0.219	1.00	19.3	2.0	2.4	2.58
Royal Farms	ST		3.71	1.90	51.2%	39.1	2.8	2.3	32.5	51	65	0.158	0.158	1.00	12.7	1.4	1.5	1.90
Fallston Village Outfall	**ST**		**130.18**	**28.26**	**21.7%**	**853.7**	**53.3**	**43.2**	**33**	**52**	**66**	**2.662**	**2.662**	**1.00**	**281.7**	**27.7**	**28.5**	**28.26**
						971.7	66.4	57.5										

Total Fallston Village Outfall Drainage Area

BMP-04 **Fallston Village Pond**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Burger King UGS	ST		0.89	0.59	67.1%	10.4	0.7	0.7	33	52	66	0.048	0.048	1.00	3.4	0.4	0.4	0.59
Smitty's Fine Wine and Spirits SF	ESD		1.61	1.12	69.2%	19.6	1.3	1.3	57	66	70	0.091	0.091	1.00	11.2	0.9	0.9	1.12
Nephrology Center of MD UGS	ST		0.64	0.61	95.8%	8.8	0.5	0.6	32.5	51	65	0.049	0.049	1.00	2.9	0.3	0.4	0.61
Fallston Village Pond	ST		15.76	8.55	54.3%	168.0	10.4	10.3	26	41	52	0.707	0.354	0.50	43.7	4.3	5.3	4.28
Pr. Treatment	ST		15.76	8.55	54.3%	168.0	10.4	10.3	33	52	66	0.707	0.707	1.00	55.4	5.4	6.8	8.55
Additional Treatment and Credit	**ST**		**15.76**	**8.55**	**54.3%**	**168.0**	**10.4**	**10.3**	**26**	**41**	**52**	**0.707**	**0.707**	**0.50**	**11.8**	**1.1**	**1.4**	**4.28**
						185.5	11.9	12.0										

Total Fallston Village Pond Drainage Area

BMP-05 **Spry Island Road Pond**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. Treatment	ST		21.31	8.18	38.4%	228.4	17.2	12.8	26	41	52	0.703	0.351	0.50	59.4	7.0	6.7	4.09
Pr. Treatment	ST		21.31	8.18	38.4%	228.4	17.2	12.8	33	52	66	0.703	0.703	1.00	75.4	8.9	8.5	8.18
Additional Treatment and Credit	**ST**		**21.31**	**8.18**	**38.4%**	**228.4**	**17.2**	**12.8**	**26**	**41**	**52**	**0.703**	**0.351**	**0.50**	**16.0**	**1.9**	**1.8**	**4.09**

BMP-06 **Gunpowder Ridge Road Pond**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. Treatment	ST		39.06	15.75	40.3%	401.0	31.6	23.6	26	41	52	1.344	0.672	0.50	104.3	13.0	12.3	7.87
Pr. Treatment	ST		39.06	15.75	40.3%	401.0	31.6	23.6	33	52	66	1.344	1.344	1.00	132.3	16.4	15.6	15.75
Additional Treatment and Credit	**ST**		**39.06**	**15.75**	**40.3%**	**401.0**	**31.6**	**23.6**	**26**	**41**	**52**	**1.344**	**0.672**	**0.50**	**28.1**	**3.5**	**3.3**	**7.87**

BMP-07 **JB Hunt Transport Pond**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. Treatment	ST		4.46	3.07	68.9%	51.3	3.2	3.4	26	41	52	0.249	0.125	0.50	13.3	1.3	1.8	1.54
Pr. Treatment	ST		4.46	3.07	68.9%	51.3	3.2	3.4	33	52	66	0.249	0.249	1.00	16.9	1.7	2.3	3.07
Additional Treatment and Credit	**ST**		**4.46**	**3.07**	**68.9%**	**51.3**	**3.2**	**3.4**	**26**	**41**	**52**	**0.249**	**0.125**	**0.50**	**3.6**	**0.4**	**0.5**	**1.54**

BMP-08 **Joppatowne Plaza Outfall**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Pr. Treatment	ST		17.42	11.36	65.2%	193.1	12.2	12.4	33	52	66	0.925	0.925	1.00	63.7	6.3	8.2	11.36

BMP-09 **Joppa Crossing Pond**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. Treatment	ST		31.61	12.26	38.8%	308.5	23.9	18.3	26	41	52	1.052	0.526	0.50	80.2	9.8	9.5	6.13
Pr. Treatment	ST		31.61	12.26	38.8%	308.5	23.9	18.3	33	52	66	1.052	1.052	1.00	101.8	12.4	12.1	12.26
Additional Treatment and Credit	**ST**		**31.61**	**12.26**	**38.8%**	**308.5**	**23.9**	**18.3**	**26**	**41**	**52**	**1.052**	**0.526**	**0.50**	**21.6**	**2.6**	**2.6**	**6.13**

Swan Creek and Lower Susquehanna River South Watershed Assessment

Prepared for:

Harford County
Department of Public Works

Swan Creek & Lower Susquehanna South Large Watershed Action Plan

November 2019

Prepared by

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1. INTRODUCTION

1.1. Overview & Background

The Harford County (the County) Department of Public Works (DPW) has contracted BayLand Consultants & Designers, Inc. (BayLand) to provide a detailed watershed assessment referred to as a Large Watershed Action Plan (LWAP) for Swan Creek and a smaller watershed that drains directly to the Susquehanna River (hereafter referred to as the Lower Susquehanna South Watershed).

The LWAP is intended to satisfy the requirements of the County's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit (11-DP-3310 MD0068268). It is also intended to:

- Determine current water quality conditions;
- Include the results of the visual watershed inspection;
- Identify and rank water quality problems;
- Prioritize all structural and nonstructural water quality improvements;
- Specify pollutant load reduction benchmarks that demonstrate progress toward meeting all applicable stormwater wasteload allocations (WLA).

The Swan Creek and Lower Susquehanna South Watersheds are located in the southeast portion of the County. A watershed map is included as Figure 1.

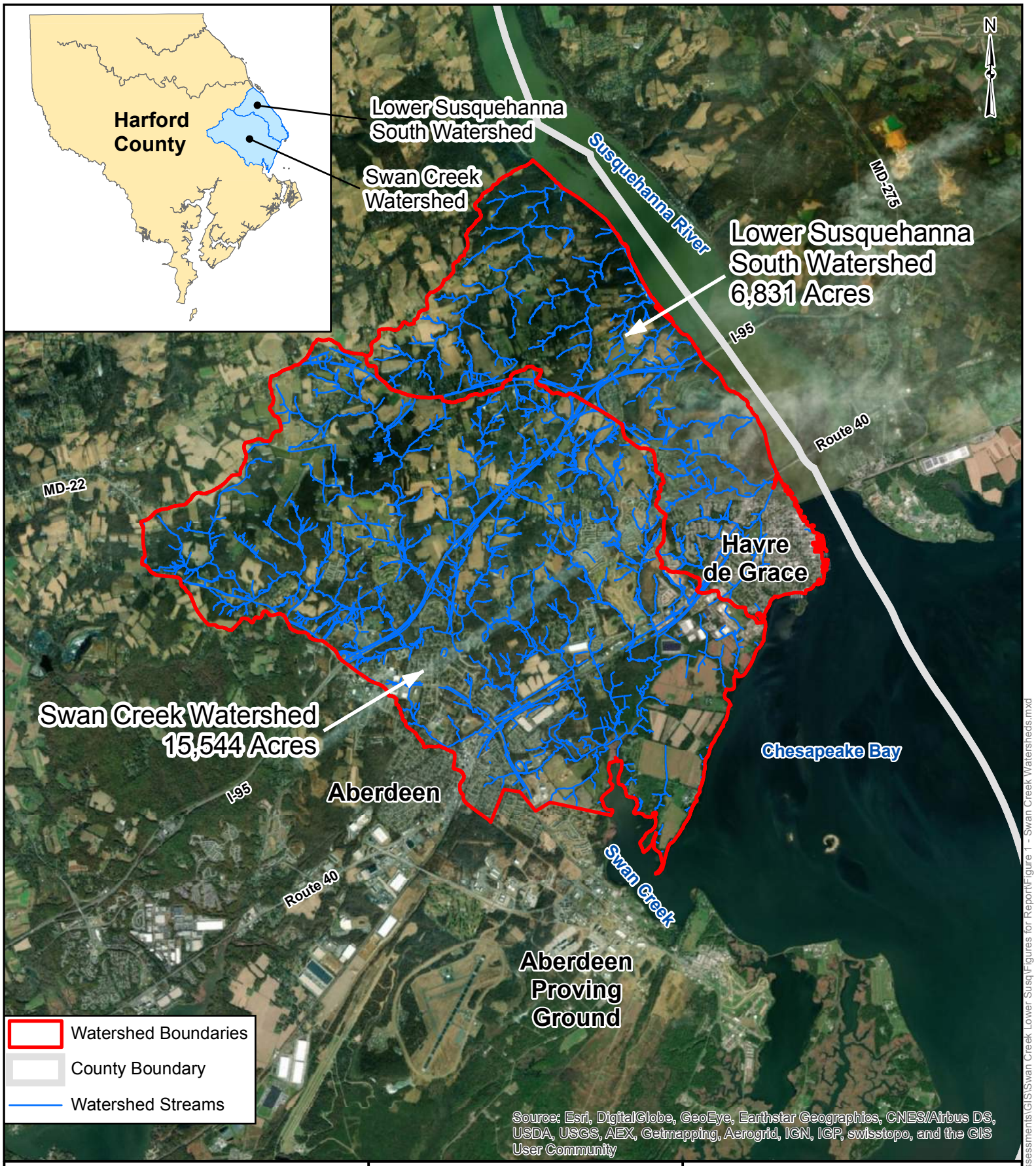
The Swan Creek Watershed is comprised of the Harford County portion of the Swan Creek Watershed (MDE 8-Digit 02120205) with the exclusion of Aberdeen Proving Grounds which falls under the jurisdiction of the federal government. The Swan Creek Watershed is approximately 15,544 acres (24.3 square miles) and drains into Swan Creek.

The Lower Susquehanna South Watershed is comprised of the southern Harford County portion of the Lower Susquehanna River Watershed (MDE 8-Digit 02120201). The Lower Susquehanna South Watershed is approximately 6,831 acres (10.7 square miles) and drains into the Susquehanna River.

Historical land use changes throughout the watersheds, including urbanization, deforestation, afforestation, and agricultural intensification has resulted in degraded water quality, accelerated stream bank erosion due to increased stormwater runoff and altered basin hydrology, reduced flood storage capacity, and increased risk to public and private infrastructure and property along the County's stream corridors.

As a result, the watersheds have been targeted for assessment to locate and quantify areas of instability and degradation, identify potential causes of water quality impairments and recommend structural and non-structural methods to reduce pollutant loads in the watersheds.

This LWAP will focus on the developed areas of the Swan Creek and Lower Susquehanna South Watersheds where residential and commercial development, as well as unmanaged stormwater runoff, are a primary concern.



Notes:
1. Watershed Features from 2013 Harford County GIS.

0 0.75 1.5 3 Miles
1 inch = 1.5 miles

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FIGURE 1
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH WATERSHEDS (IN HARFORD COUNTY)

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 1 - Swan Creek Watersheds.mxd

1.1.1. Previous Watershed Assessments

In the 1996 study, *Engineering Study of the Swan Creek Watershed*, the County evaluated potential water quality retrofit and stream stabilization areas in the Swan Creek Watershed. The study included field visits of existing sites, selection of proposed projects, conceptual designs, cost estimates and a feasibility analysis. The proposed sites from this study were taken into consideration; however, the Swan Creek Watershed has undergone significant development since 1996 and most of the proposed areas are no longer applicable.

In the 2017 report, *Swan Creek Watershed Total Maximum Daily Load Restoration Plan for Sediment*, a guideline was established to reduce sediment in the Swan Creek Watershed. The plan identified two locations as ideal stream restoration areas based on several factors such as minimal riparian buffer, Maryland Biological Stream Survey (MBSS) sites with failing parameters, and Harford County property. An implementation schedule and cost were also provided as part of the restoration plan. While these sites were taken into consideration when choosing projects, more degraded stream reaches were chosen for this LWAP.

1.2. Scope of Study

Existing conditions for the Swan Creek and Lower Susquehanna South Watersheds were evaluated through desktop analysis, field reconnaissance, and modeling of pollutant loads. The data was utilized to characterize the current conditions of watersheds and identify sub-watersheds with the highest pollutant loads. Ultimately, results were used to develop and prioritize restoration opportunities in highly impacted sub-watersheds. Cost and pollutant load reduction estimates were developed for each restoration opportunity including best management practices (BMP) and stream restoration projects. Sub-watershed pollutant loads were then recalculated to demonstrate anticipated pollutant reductions associated with the proposed projects.

Ultimately, potential projects were evaluated and prioritized according to the following criteria:

- Location within the Watershed
- Estimated Pollutant Load Reductions
- Impervious Acre Credits
- Property Ownership
- Site Access
- Existing Utility Conflicts
- Cost

2. WATERSHED CHARACTERIZATION

2.1. Watershed

The Swan Creek Watershed is approximately 15,544 acres (24.3 square miles) and the Lower Susquehanna South Watershed is approximately 6,831 acres (10.7 square miles). Both watersheds are comprised of a mix of residential, agricultural and forested land uses.

Section 303(d) of the Clean Water Act (CWA) requires states to develop lists of impaired watersheds, which are commonly referred to as “303(d) Lists” (EPA, 2019). Swan Creek was first identified on the 2014 303(d) List submitted to the Environmental Protection Agency (EPA) by Maryland Department of the Environment (MDE) as impaired by sediment (MDE, 2014). MDE concluded that biological communities within the non-tidal portions of the watershed were impacted by low dissolved oxygen saturation and high pH from altered flow/sediment and instream habitat stressors.

The Lower Susquehanna River Watershed was first identified on the 2018 303(d) List submitted to the EPA by the MDE as impaired by Total Phosphorus (TP) (MDE, 2018). Listings of polychlorinated biphenyls (PCB) in fish tissue were added in 2008 (MDE, 2008).

2.2. Physiography

The Swan Creek and Lower Susquehanna South Watersheds fall within the Piedmont Plateau Province and the Atlantic Coastal Plain Province including the Bel Air Upland District (422100), the Perry Hall Upland District (426100), the Aberdeen Estuaries and Lowlands District (512100), and the Susquehanna Gorge District (421200) (MGS, 2008).

The Bel Air Upload District (422100) features an upland characterized by gently rolling to flat surfaces (MGS, 2008).

The Perry Hall Upland District (426100) is a transition between crystalline Piedmont and unconsolidated Coastal Plain; many hilltops are capped by cretaceous gravels and sediments and rivers flow across the region in steep-walled valleys incised into crystalline rock (MGS, 2008).

The Aberdeen Estuaries and Lowlands District (512100) is a relatively featureless lowland characterized by an irregular coastline that is indented by the mouths of several rivers (MGS, 2008).

The Susquehanna Gorge District (421200) is a gorge marked by rapids, bedrock islands, and very steep (greater than 25 degrees) to vertical valley walls (MGS, 2008).

2.3. Climate

The climate in the County is largely influenced by its location in the warm temperate zone of the eastern United States. The County typically experiences mild winters and hot, humid summers.

As shown in Table 1, the mean annual temperature is 55.4 degrees Fahrenheit (F) with an average summer temperature of 76.1 degrees F and an average winter temperature of 34.4 degrees F. Mean monthly high and low temperatures range from 22.0 degrees F to 41.8 degrees F for January, and 66.7 degrees F to 89.6 degrees F in July (NCEI, 2019.)

Precipitation is uniformly distributed during the year. Winter rainfall primarily results from low-pressure storms moving through the area and is less variable than summer rainfall. Mean annual precipitation is 47.5 inches, with mean monthly precipitation varying from a low of 2.9 inches in February to a high of 5.0 inches in September.

Table 1 – Average Daily and Annual Values for Temperature and Precipitation at Conowingo Dam in Maryland*

Average Daily and Annual Values													
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean Annual**
Average Temperature (°F)	31.9	34.7	42.8	53.5	63.8	73.7	78.2	76.5	69.0	56.9	46.2	36.6	55.4
Precipitation (inches)	3.4	2.9	4.3	3.9	4.0	4.2	4.3	3.9	5.0	4.1	3.5	4.0	47.5

*Information obtained from NOAA.gov (http://www.ncdc.noaa.gov/cdo-web/datatools/normals)

2.4. Geology

According to the Maryland Geological Survey, this region of the County is underlain by unconsolidated (cretaceous) sands, gravels, silts and clays over crystalline bedrock (MGS, 1968). The geologic characteristics influence the chemical composition of surface water and groundwater, as well as groundwater recharge rates. The properties of soil can also influence the rate and total amount of pollutants entering water bodies in developed areas (Baltimore County Department of Environmental Protection and Sustainability (BC-DEPS), 2014).

2.5. Soils

Soils within the Swan Creek and Lower Susquehanna South Watersheds were determined using the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Web Soil Survey (2019). The hydrologic soil groups are listed in Table 2. Detailed soils maps, reports of drainage class and hydrologic soil groups are included in Appendix B.

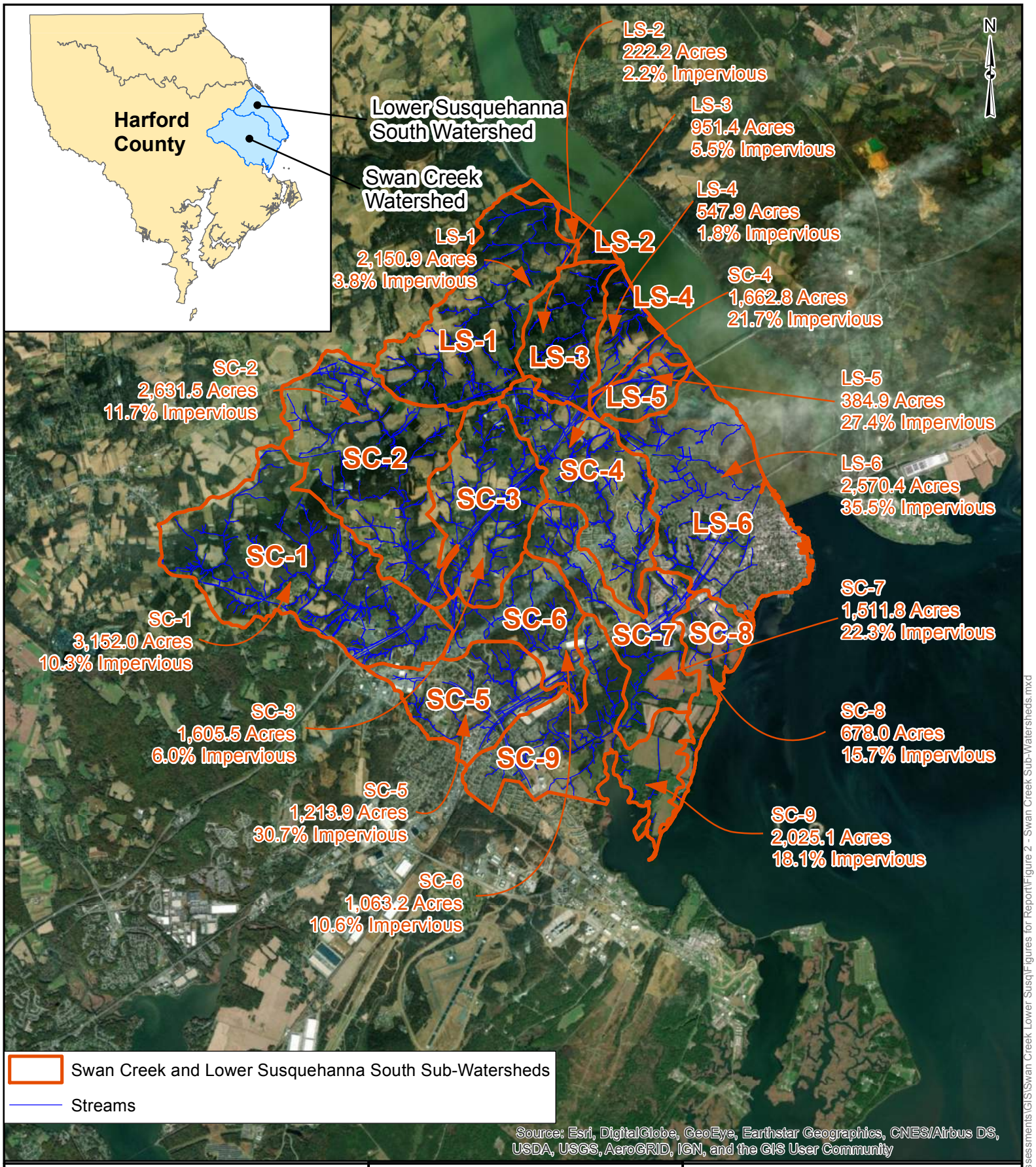
Table 2 – USDA-NRCS Soils		
Hydrologic Soil Group	**Acres in Watershed (acres)**	**Percent of Watershed (%)**
Swan Creek Watershed		
A	421.2	2.6
B	5,688.4	35.1
C	8,653.0	56.8
D	637.7	0.6
Cut/Fill Land	101.6	4.5
Water	41.8	0.4
Swan Creek Total	**15,543.7**	**100.0**
Lower Susquehanna South Watershed		
A	301.2	4.4
B	3741.7	54.8
C	2524.7	37.0
D	122.1	1.9
Cut/Fill Land	130.7	1.8
Water	10.2	0.1
Lower Susquehanna South Total	**6,830.6**	**100.0**

According to the survey, the dominant soil in the Swan Creek Watershed is Aldino silt loam with slopes ranging three to eight percent which comprises seven percent of the watershed. The Aldino series consists of deep, moderately well drained, slowly permeable soils on uplands. They formed in materials weathered from serpentine and an overlying silt mantle (Soil Survey Staff, USDA-NRCS, 2019).

The dominant soil in the Lower Susquehanna South Watershed is Neshaminy silt loam with slopes ranging from three to eight percent which comprises eight percent of the watershed. Neshaminy silt loam consists of very deep, well drained soils on uplands (Soil Survey Staff, USDA-NRCS, 2019). These soils formed in materials weathered from diabase and other dark colored basic rocks. The soil color is generally brown but can range from very dark grayish brown to yellowish-red and red. Stony and steep areas are mostly in woodland, dominated by oaks and hickories. Some less steep or non-stony areas are used for cropland, hay and pasture, as well as developed for urban or suburban communities.

2.6. Sub-Watersheds

The Swan Creek Watershed was delineated into nine sub-watersheds and the Lower Susquehanna South Watershed was delineated into six sub-watersheds at hydrologically significant locations such as stream confluences, pipe outfalls and culverts using Harford County Geographic Information Systems (GIS) data. The sub-watersheds range from approximately 222.2 to 3,152.0 acres (0.3 to 4.9 square miles), with impervious cover ranging from 1.8 to 35.5 percent. The Swan Creek and Lower Susquehanna South Sub-Watersheds are shown in Figure 2.



Notes:
1. Streams Data from 2013 Harford County GIS
2. Watershed Features from 2013 Harford County GIS
3. Impervious Land Use Data from 2014 Harford County GIS

0 0.75 1.5 3 Miles

1 inch = 1.5 miles

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FIGURE 2
SWAN CREEK AND
LOWER SUSQUEHANNA
SOUTH SUB-WATERSHEDS

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 2 - Swan Creek Sub-Watersheds.mxd

2.7. Historical Land Use

Land use changes in a watershed can have large impacts on watershed hydrology (Bierman, 2005; Miller et al., 1993; Costa, 1975; Knox, 1977; Wolman and Schick, 1967). In order to develop a broader understanding of former land use influences on the Swan Creek and Lower Susquehanna South Watersheds, a brief investigation of land use history was conducted.

Historical aerial imagery obtained from Harford County GIS data depicts the Swan Creek and Lower Susquehanna South Watersheds from 1952 to 2004 (Appendix A). The historic aerials show that by 1952 the watersheds were dominated by agricultural fields and some urban development. Pulaski Highway (Route 40) is visible in the 1952 aerial, and records indicate the highway was constructed in 1926. By 1964, Interstate 95 is visible on the aerials. Two of the largest municipalities in Harford County are located in the Swan Creek and Lower Susquehanna South Watersheds, including the City of Havre de Grace and the City of Aberdeen. According to the U.S. Decennial Census, from 1940 to 1970, the City of Havre de Grace nearly doubled in population and from 1940 to 1970, the population in the City of Aberdeen increased eight-fold. This indicates development within these areas occurred largely prior to the implementation of Maryland's Stormwater Management (SWM) Regulations in 1983. Since this development predates current SWM design standards, runoff in these regions is either unmanaged or under-managed. Increasing impervious surface in a watershed has been shown to reduce infiltration and evapotranspiration, and increase runoff into stream networks (MDE, 2000). Watersheds with higher levels of imperviousness generally have lower levels of water quality and biological health.

2.8. Existing Land Use

The Swan Creek Watershed is approximately 15,544 acres (24.3 square miles) with approximately 15 percent impervious area. The Lower Susquehanna South Watershed is approximately 6,831 acres (10.7 square miles) with approximately 17 percent impervious area.

Existing land use was originally developed using a combination of various data sources per guidance from MDE (Table 3). Water, wetlands, tree canopy over turf, forest, turf, and mixed open land use categories were derived from 2016 Chesapeake Conservancy (CC) GIS data edited by MDE. It should be noted that MDE edited the CC land use categories to account for hydrologic differences between managed and unmanaged vegetative communities within urbanizing areas. Impervious surface was derived from 2014 Harford County Impervious Area GIS data, and agriculture was derived from the United States Geological Survey (USGS)'s Chesapeake Bay Phase 6 Land Use data.

Each existing land use category was assigned an equivalent land use designation compatible with the Chesapeake Bay Program (CBP) Phase 6 Watershed Model. The equivalent Phase 6 existing land use categories are summarized in Table 3.

Table 3 – Harford County Existing Land Use	
Existing Land Use	**Equivalent Phase 6 Existing Land Use**
Water	Water
Wetlands	Non-tidal Floodplain Wetland
Tree Canopy Over Turf	Tree Canopy over Turf
Forest	True Forest
Turf	Turf
Mixed Open	Mixed Open
Agriculture	Agriculture
Impervious Surfaces	Impervious

The Phase 6 existing land use categories for the Swan Creek and Lower Susquehanna South Watersheds are depicted in Table 4 and Figure 3. The existing land use analysis shows that both the Swan Creek and Lower Susquehanna South Watersheds are primarily forest, impervious area and agriculture.

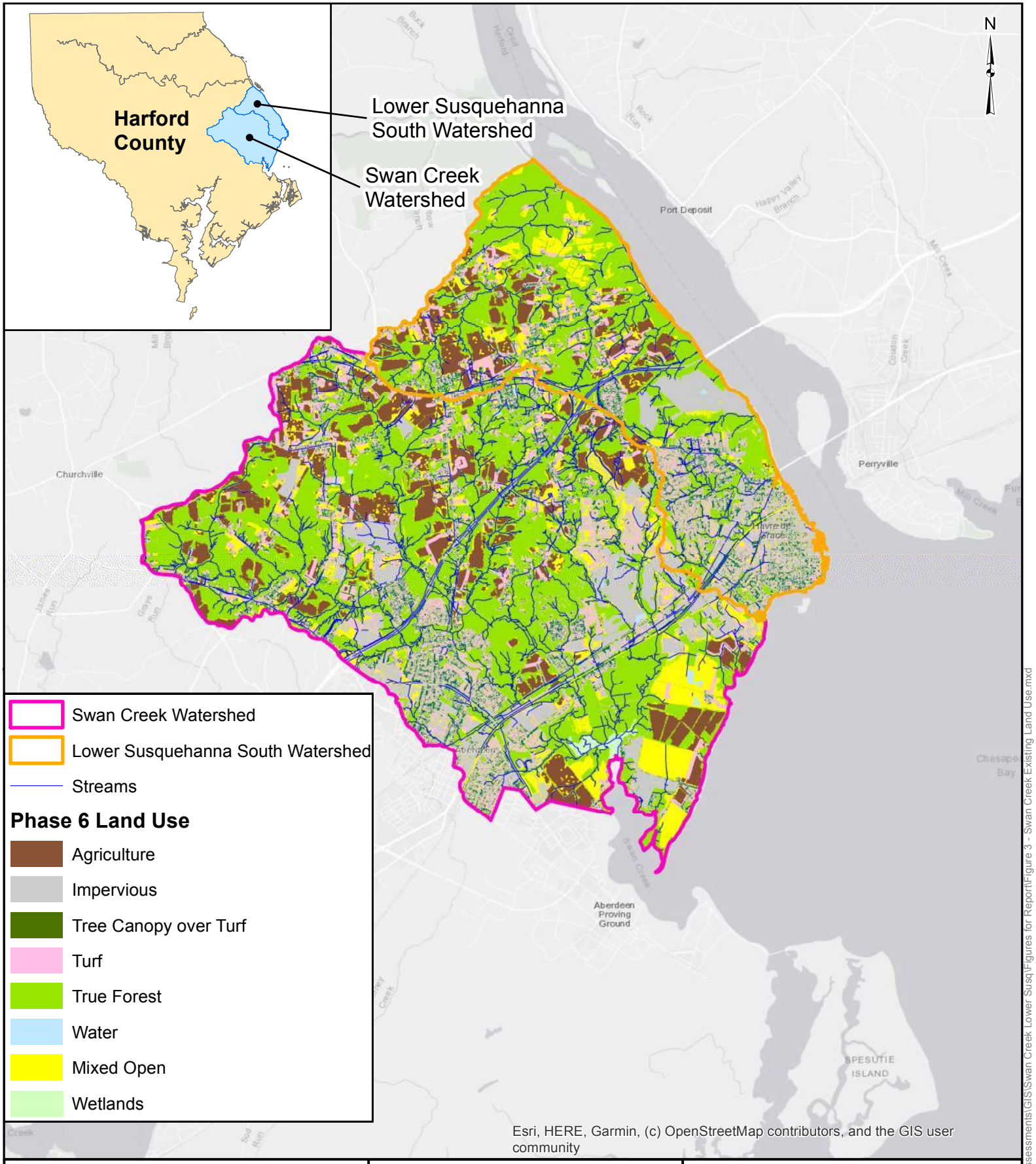
Table 4 – Swan Creek and Lower Susquehanna South Watersheds Phase 6 Existing Land Use		
Parameter	**Acres**	**Percentage of Drainage Area (%)**
Swan Creek Watershed		
True Forest	6,660.7	42.9
Impervious	2,383.2	15.3
Agriculture	2,297.0	14.8
Turf	2,172.3	14.0
Mixed Open	1,028.6	6.6
Tree Canopy over Turf	820.8	5.3
Water	127.0	0.8
Non-Tidal Floodplain Wetland	54.0	0.3
Swan Creek Total	**15,543.7**	**100.0**
Lower Susquehanna South Watershed		
True Forest	3,028.2	44.3
Impervious	1,165.2	17.1
Agriculture	990.1	14.5
Turf	881.4	12.9
Tree Canopy over Turf	429.7	6.3
Mixed Open	319.6	4.7
Water	16.4	0.2
Lower Susquehanna South Total	**6,830.6**	**100.0**

Existing land use was also determined for each sub-watershed (Table 5). Within the Swan Creek Watershed, Sub-Watershed SC-5 has the largest amount of impervious area (372.0 acres) and Sub-Watershed SC-2 has the largest amount of agricultural area (679.2 acres). Sub-Watershed SC-3 has the smallest amount of impervious area (96.6 acres) as it is primarily forested (55 percent).

Within the Lower Susquehanna South Watershed, Sub-Watershed LS-6 has the largest amount of impervious area (912.2 acres) while Sub-Watershed LS-1 has the largest amount of agricultural area (576.4 acres). Sub-watershed LS-2 has the smallest amount of impervious area (5.0 acres) as it is primarily forested (76 percent).

Table 5 – Swan Creek and Lower Susquehanna South Sub-Watersheds Phase 6 Existing Land Use								
Sub-Watershed	**Water (ac.)**	**Non-tidal Floodplain Wetland (ac.)**	**True Forest (ac.)**	**Mixed Open (ac.)**	**Agriculture (ac.)**	**Impervious (ac.)**	**Turf (ac.)**	**Tree Canopy over Turf (ac.)**
Swan Creek Sub-Watersheds								
SC-1	4.8	0.0	1,694.7	138.0	477.3	324.5	363.8	148.8
SC-2	11.1	0.0	1,016.1	74.0	679.2	307.0	427.4	116.7
SC-3	4.9	0.0	889.8	74.6	315.5	96.6	162.0	62.1
SC-4	10.7	0.0	598.7	86.3	226.3	360.9	296.5	83.3
SC-5	10.5	0.0	347.8	64.9	48.4	372.0	230.1	140.2
SC-6	3.2	0.0	643.6	31.7	63.6	112.4	130.5	78.3
SC-7	29.4	8.0	632.3	144.5	111.3	337.5	200.4	48.4
SC-8	5.1	0.8	182.1	131.8	126.0	106.6	98.6	27.0

SC-9	47.3	45.2	655.6	282.8	249.4	365.7	263.1	116.0
Swan Creek Total	**127.0**	**54.0**	**6,660.7**	**1,028.6**	**2,297.0**	**2,383.2**	**2,172.3**	**820.8**
Lower Susquehanna South Sub-Watersheds								
LS-1	1.7	0.0	1,061.6	119.1	576.4	81.1	236.1	72.8
LS-2	0.0	0.0	167.8	0	37.9	5.0	6.2	3.1
LS-3	1.4	0.0	511.1	71.5	127.2	51.8	133.9	55.3
LS-4	2.3	0.0	343.6	10.9	126.8	9.6	46.7	6.0
LS-5	0.9	0.0	170.9	0	72.8	105.5	17.2	17.6
LS-6	10.1	0.0	773.2	107.6	48.9	912.2	441.3	274.9
Lower Susquehanna South Total	**16.4**	**0.0**	**3,028.2**	**319.6**	**990.1**	**1,165.2**	**881.4**	**429.7**



Notes:
1. Streams Data from 2013 Harford County GIS
2. Agriculture Land Use Data from 2017 USGS Phase 6 Land Use Viewer
3. Impervious Land Use Data from 2014 Harford County GIS
4. All other Land Use Data from 2017 Chesapeake Bay Conservancy modified by MDE

1.5 0.75 0 1.5 Miles

1 inch = 1.5 miles

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FIGURE 3
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH EXISTING LAND USE

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 3 - Swan Creek Existing Land Use.mxd

2.9. Aquatic Resources

The MBSS is a stream sampling program intended to assess the current condition of ecological resources in Maryland's 1st through 4th order non-tidal streams (DNR, 2019). Biological, physical, and chemical parameters are measured, and site catchment data is also reported. MBSS sampling is conducted at the six-digit river basin and eight-digit watershed levels while a volunteer component of MBSS, Stream Waders, collects samples at the 12-digit sub-watershed level. For the Swan Creek and Lower Susquehanna South Watersheds, MBSS and Stream Waders sampling data was available, including Benthic Index of Biotic Integrity (BIBI) and Fish Index of Biotic Integrity (FIBI) scores. A total of 17 sites were sampled in the watersheds through the MBSS program from 1997 to 2017 for fish and benthic macroinvertebrates. Additionally, 32 sites were sampled in the watersheds through the Stream Waders program from 2004 to 2017 for benthic macroinvertebrates. It should be noted that BIBI and FIBI scores are classified as either poor, fair or good. A score of less than 3.0 is poor, 3.0 to 3.9 is fair and 4.0 to 5.0 is good. Streams that scored poor or fair were evaluated for potential stream restoration projects (Table 6).

An unnamed tributary flowing to Gasheys Creek received the lowest BIBI score in the Swan Creek Watershed of 1.57 (Site ID 1135-06-2008).

Fountain Run received a poor BIBI score of 1.86 (Site ID 0318-01-2008). This is a highly urbanized area in Havre de Grace, which could contribute to the low BIBI score.

Table 6 – MBSS and Stream Waders Data

Type	Sample Source	Number of Sites Sampled	Good	Fair	Poor
Swan Creek Watershed					
BIBI	MBSS	16	2 (12.5%)	5 (31.2%)	9 (56.3%)
BIBI	Stream Waders	16	0 (0.0%)	10 (62.5%)	6 (37.5%)
FIBI	MBSS	16	6 (37.5%)	6 (37.5%)	4 (25.0%)
Lower Susquehanna South Watershed					
BIBI	MBSS	1	1 (100.0%)	0 (0.0%)	0 (0.0%)
BIBI	Stream Waders	16	5 (31.2%)	7 (43.8%)	4 (25.0%)
FIBI	MBSS	1	0 (0.0%)	0 (0.0%)	1 (100.0%)

3. POLLUTANT LOAD DETERMINATION & MODELING

3.1. Modeling Methodology

The Chesapeake Assessment Scenario Tool (CAST) is a web-based modeling tool used to simulate the impact that the implementation of various BMP technologies has on watershed pollutant loads (CBP, 2017). It is utilized by multiple states and jurisdictions to support the development of Watershed Implementation Plans (WIP) and local Total Maximum Daily Loads (TMDL).

It should be noted that there are several limitations associated with the CAST modeling tool. CAST was developed to model large-scale watersheds, such as the Chesapeake Bay watershed, and in Maryland is limited to modeling watersheds averaging 9,000 acres or larger. Additionally, CAST only runs pollutant loading scenarios for watersheds pre-established by MDE and does not permit the input of unique drainage areas. Since the Swan Creek and Lower Susquehanna South Sub-Watersheds range from approximately 222 to 3,152 acres in size and are not pre-established drainage areas within the CAST model, full application of the CAST model was precluded for use in this analysis. Therefore, after consulting with MDE, it was determined that the CAST model would only be used to determine unit pollutant loading rates for land uses not included within the Maryland Phase III WIP Unit Load Summary Tables. The Maryland Phase III WIP Unit Loads Summary Tables were applied where possible to ensure the most current information was used to develop the loading rates for the Swan Creek and Lower Susquehanna South Watersheds. The pollutant loading rate source for each land use is provided in Table 7 in Section 3.2, below.

The CAST model can be run under a variety of scenarios, including the “Progress” scenario which determines pollutant loading rates while accounting for existing BMPs within the landscape and the “No Action” scenario which determines pollutant loading rates without existing BMPs. For this analysis, the “2017 Progress” scenario was utilized so pollutant loading rates were determined while accounting for all BMPs constructed and documented within the sub-watersheds up to and including the year 2017.

The results of the CAST output for the Swan Creek and Lower Susquehanna South Watersheds are provided in Appendix C.

3.2. Pollutant Loading Rates

Table 7 depicts the pollutant unit loading rates associated with the Swan Creek and Lower Susquehanna South Watersheds derived from the Maryland Phase III WIP Unit Load Summary Tables and the CAST model. Predictably, impervious and agricultural land uses produce higher pollutant loads than areas covered by water, wetlands or forests. Impervious land use has a significantly higher total suspended sediment (TSS) loading rate while agriculture has a significantly higher total nitrogen (TN) loading rate. Turf land use has the highest total phosphorus (TP) loading rate.

Table 7 – Unit Loading Rates				
Land Use	**Source of Unit Loading Rates**	**2017 Progress Scenarios EOS Unit Loading Rates**		
		TN (lb/ac/yr)	**TP (lb/ac/yr)**	**TSS (lb/ac/yr)**
Water	Maryland Phase III WIP EOS Unit Loads for Harford County	8.41	0.61	0.00
Non-Tidal Floodplain Wetland	Maryland Phase III WIP EOS Unit Loads for Harford County	1.32	0.03	14.68
True Forest	Maryland Phase III WIP EOS Unit Loads for Harford County	1.41	0.03	21.46
Mixed Open	Maryland Phase III WIP EOS Unit Loads for Harford County	1.92	0.17	815.37
Agriculture (Swan Creek Watershed)	CAST Model	18.32	0.42	310.55
Agriculture (Lower Susquehanna South Watershed)	CAST Model	19.81	0.36	822.44
Impervious	Maryland Phase III WIP EOS Unit Loads for Harford County	14.04	0.77	1,927.82
Turf	Maryland Phase III WIP EOS Unit Loads for Harford County	8.95	0.99	758.46
Tree Canopy over Turf	Maryland Phase III WIP EOS Unit Loads for Harford County	6.80	0.74	528.77

Once the Phase 6 existing land use and unit loading rates for the Swan Creek Watershed and Lower Susquehanna South Watershed were finalized, annual pollutant loads were calculated for each sub-watershed according to the following formula:

$$Annual\ Pollutant\ Load\ \left(\frac{lb}{yr}\right) = Land\ Use\ (ac) * Unit\ Loading\ Rate\ \left(\frac{lb}{ac * yr}\right)$$

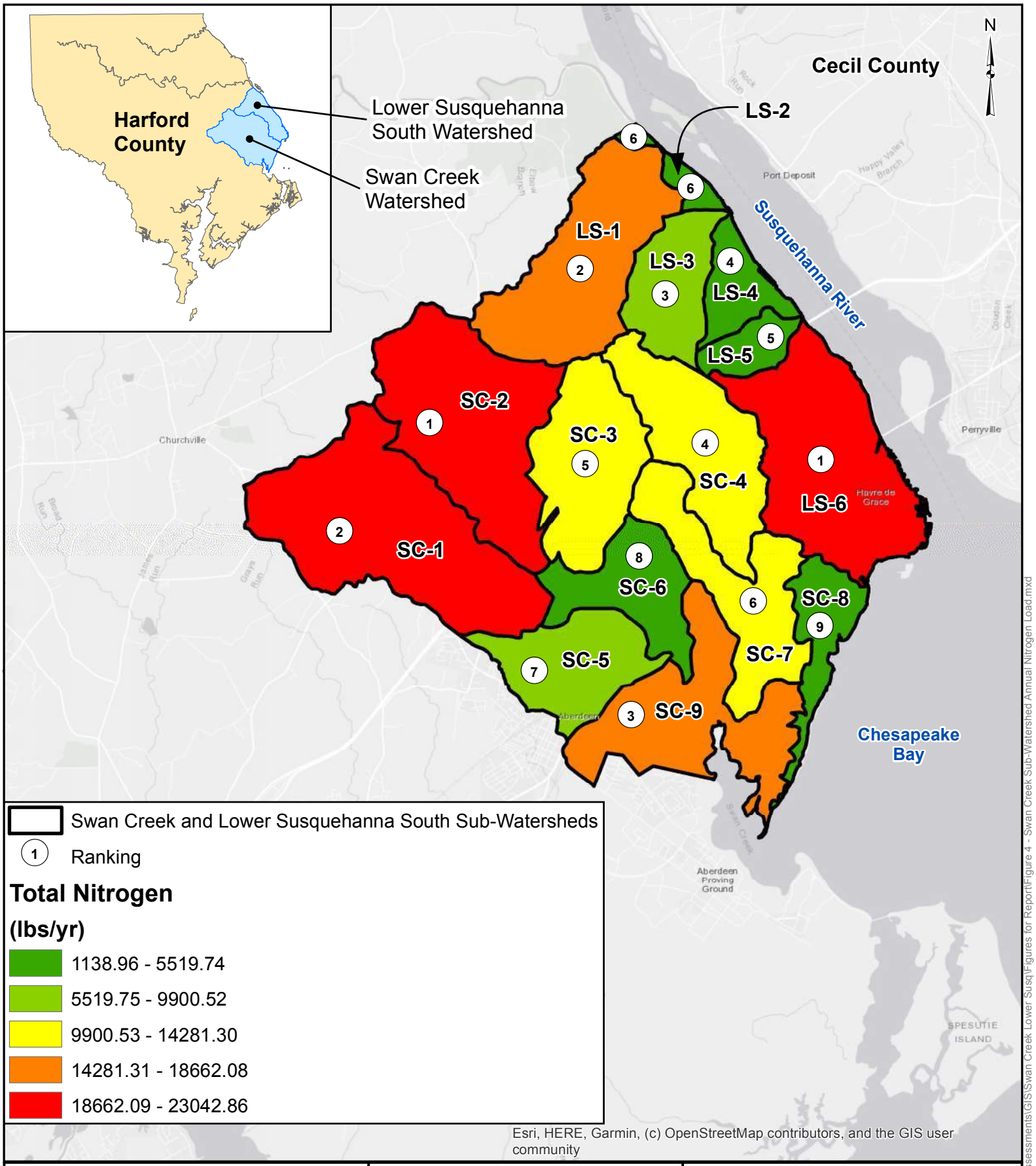
3.3. Modeling Results

The annual pollutant loads for each sub-watershed are provided in Appendix D, Table 8 and Figures 4 to 6. Table 8 depicts the sub-watersheds ranked from highest to lowest total annual pollutant loads.

Table 8 – Swan Creek and Lower Susquehanna South Sub-Watershed Annual Pollutant Loads					
Rank	**Sub-Watershed**	**Area (acres)**	**2017 Progress Scenario**		
			TN (lb/yr)	**TP (lb/yr)**	**TSS (ton/yr)**
Swan Creek Watershed					
1	SC-9	2,025.1	14,771.7	830.3	644.3
2	SC-1	3,152.0	20,264.9	997.4	638.6
3	SC-2	2,631.5	23,042.9	1,080.3	635.4
4	SC-4	1,662.8	13,534.7	767.1	559.1
5	SC-5	1,213.9	9,825.3	666.1	520.6
6	SC-7	1,511.8	10,328.0	602.5	497.2
7	SC-3	1,605.5	10,448.8	455.3	259.9
8	SC-8	678.0	5,427.0	283.6	222.7
9	SC-6	1,063.1	5,436.9	326.8	208.1
Swan Creek Total		**15,543.7**	**113,080.1**	**6,009.3**	**4,185.9**
Lower Susquehanna South Watershed					
1	LS-6	2,570.3	20,982.1	1,408.4	1,192.5
2	LS-1	2,150.9	16,911.3	612.2	484.8
3	LS-3	954.4	5,696.5	288.2	203.2
4	LS-5	384.9	3,446.1	143.3	144.6
5	LS-4	547.9	3,634.9	117.9	89.7
6	LS-2	222.2	1,139.0	31.5	26.3
Lower Susquehanna South Total		**6,830.6**	**51,809.9**	**2,601.5**	**2,141.0**

In the Swan Creek Watershed, Sub-Watershed SC-9 has the highest total annual pollutant loads due to its large size and relatively high percentage of impervious area (18 percent) and agricultural area (12 percent). Sub-Watershed SC-6 has the lowest total annual pollutant loads due to its small size and a high percentage of forested area (61 percent).

In the Lower Susquehanna South Watershed, Sub-Watershed LS-6 has the highest total annual pollutant loads due to the large amount of impervious area (35 percent). Sub-Watershed LS-2 has the lowest total annual pollutant loads primarily due to the small size, minimal amount of impervious area (two percent) and a high percentage of forested area (76 percent).



Notes:
1. Watershed Features from 2013 Harford County GIS.

0 0.75 1.5 3 Miles
1 inch = 1.5 miles

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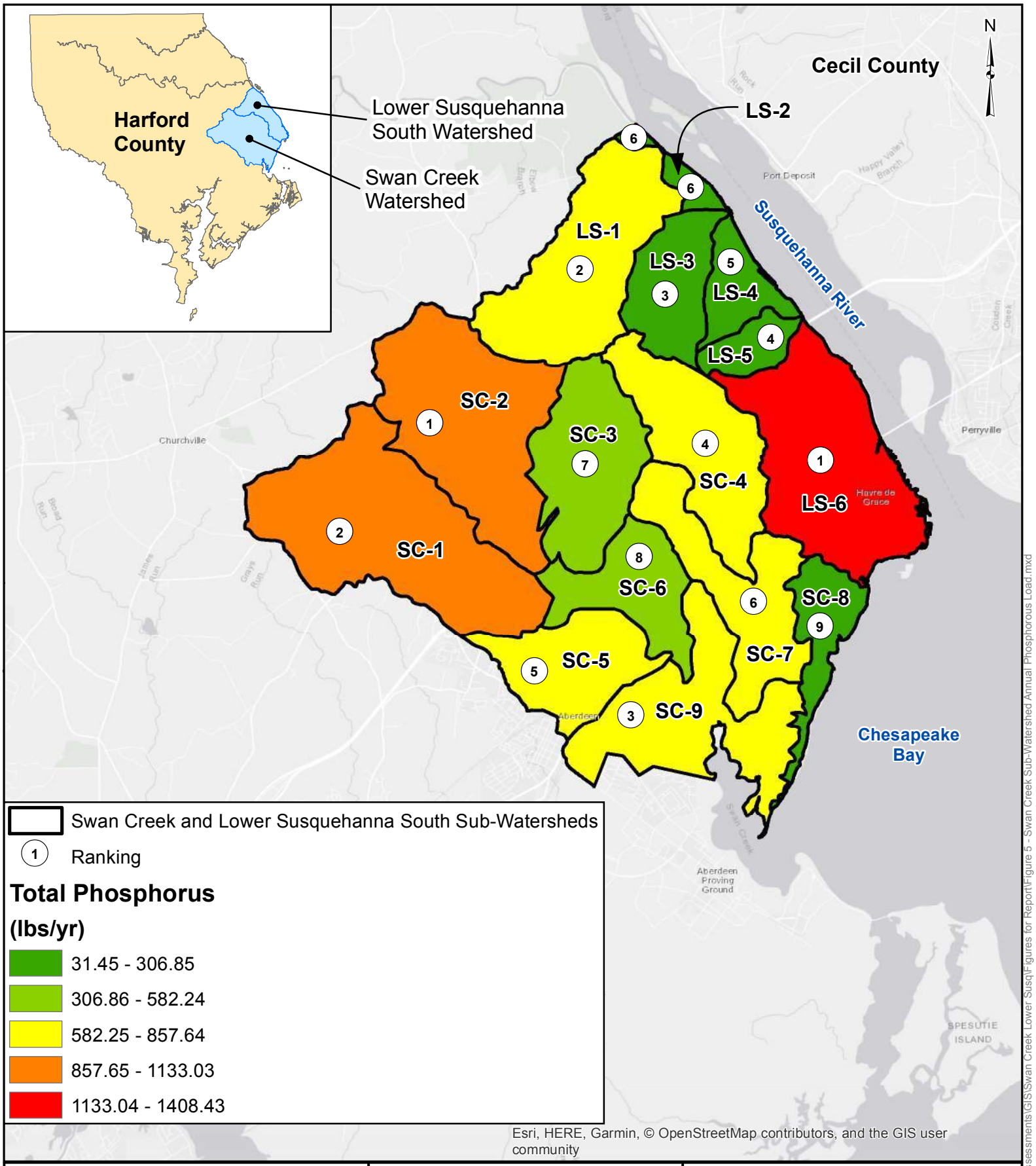
FIGURE 4
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH SUB-WATERSHED ANNUAL NITROGEN LOAD

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 4 - Swan Creek Sub-Watershed Annual Nitrogen Load.mxd



Notes:
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0 0.75 1.5 3 Miles
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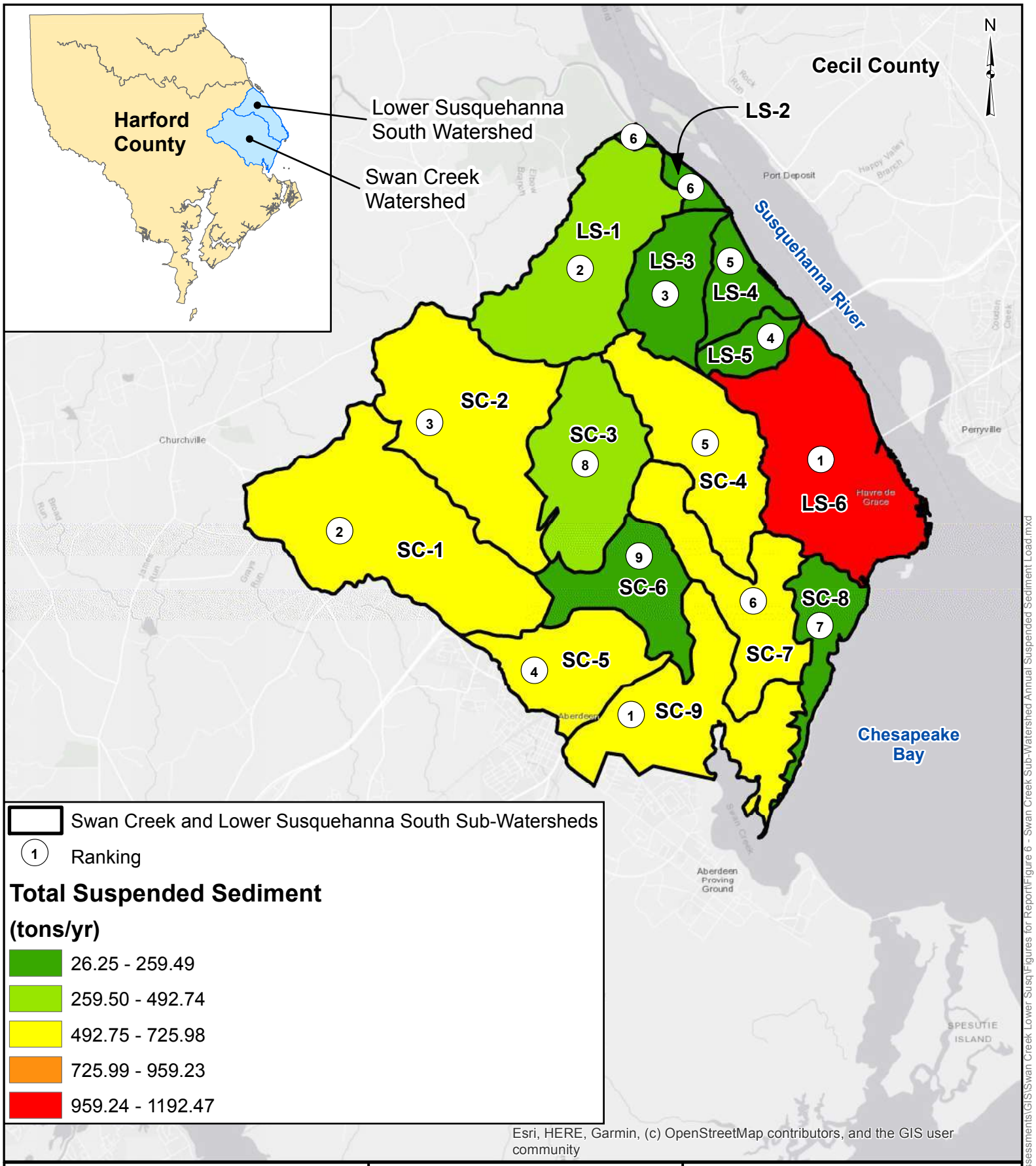
FIGURE 5
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH SUB-WATERSHED ANNUAL PHOSPHORUS LOAD

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 5 - Swan Creek Sub-Watershed Annual Phosphorous Load.mxd



Notes:
1. Watershed Features from 2013 Harford County GIS.

0 0.75 1.5 3 Miles
1 inch = 1.5 miles

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FIGURE 6
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH SUB-WATERSHED ANNUAL SUSPENDED SEDIMENT LOAD

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 6 - Swan Creek Sub-Watershed Annual Suspended Sediment Load.mxd

In an effort to normalize sub-watersheds based on their areas, the annual pollutant loads per acre were calculated for each sub-watershed, as shown in Appendix D, Table 9, and Figures 7 to 9. Table 9 shows the total annual pollutant load per acre ranked from highest to lowest.

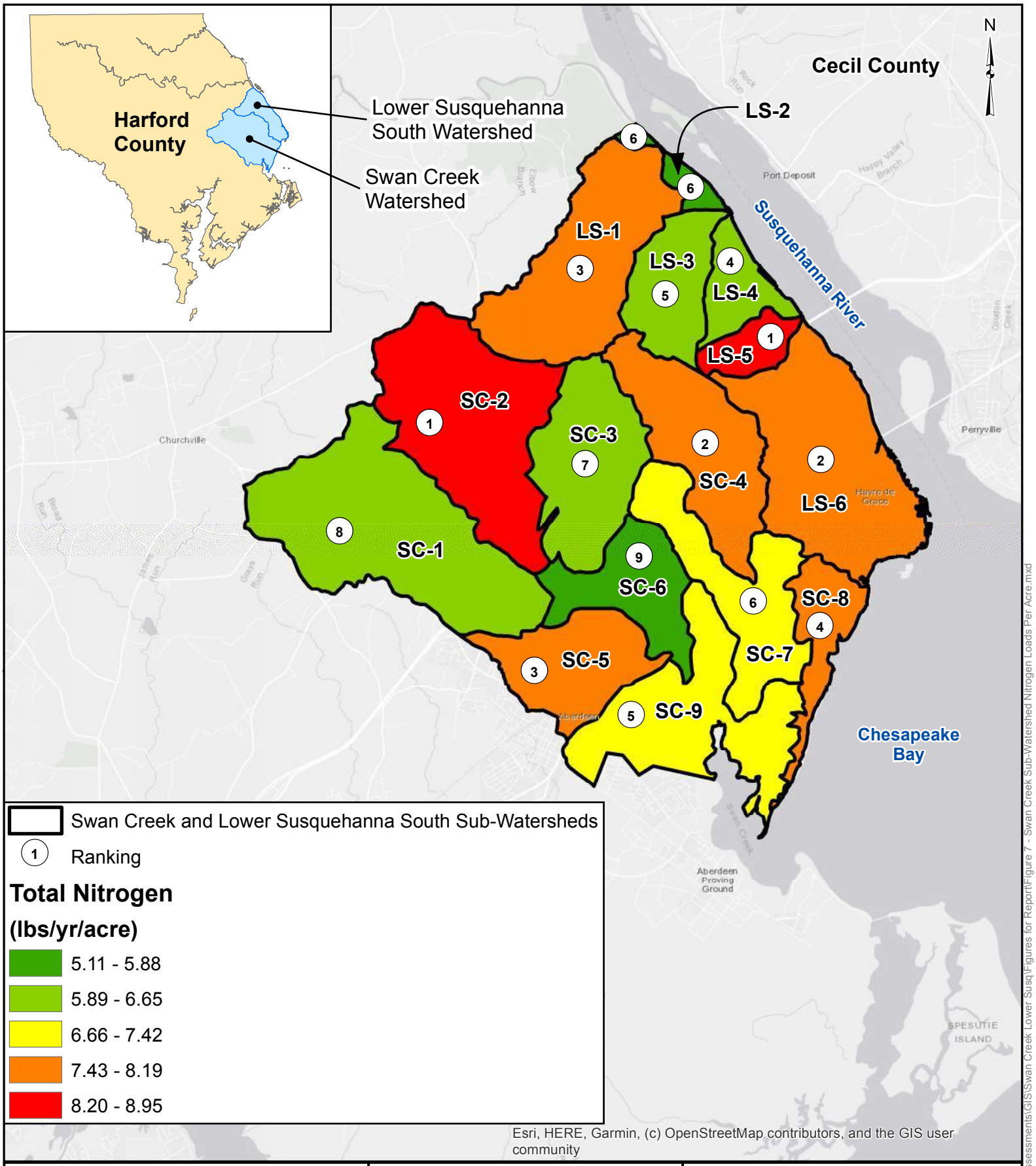
Table 9 – Swan Creek and Lower Susquehanna South Watersheds Annual Pollutant Loads Per Acre

Rank	Sub-Watershed	Area (acres)	2017 Progress Scenario		
			TN (lb/yr/acre)	TP (lb/yr/acre)	TSS (ton/yr/acre)
Swan Creek Watershed					
1	SC-5	1,213.9	8.09	0.55	0.43
2	SC-4	1,662.8	8.14	0.46	0.34
3	SC-7	1,511.8	6.83	0.40	0.33
4	SC-8	678.0	8.00	0.42	0.33
5	SC-9	2,025.1	7.29	0.41	0.32
6	SC-2	2,631.5	8.76	0.41	0.24
7	SC-1	3,152.0	6.43	0.32	0.20
8	SC-6	1,063.1	5.11	0.31	0.20
9	SC-3	1,605.5	6.51	0.28	0.16
Swan Creek Total		**15,543.7**	**7.28**	**0.39**	**0.27**
Lower Susquehanna South Watershed					
1	LS-6	2,570.3	8.16	0.55	0.46
2	LS-5	384.9	8.95	0.37	0.38
4	LS-1	2,150.9	7.86	0.28	0.23
5	LS-3	954.4	5.98	0.30	0.21
5	LS-4	547.9	6.63	0.22	0.16
6	LS-2	222.2	5.13	0.14	0.12
Lower Susquehanna South Total		**6,830.6**	**7.58**	**0.38**	**0.31**

Sub-Watershed SC-5 has the highest total annual pollutant loads per acre due to the large percentage of impervious cover (31 percent) and SC-3 has the lowest pollutant loads per acre due to the low amount of impervious area (six percent).

The Lower Susquehanna South Watershed has the same results that were presented in Table 8; the Lower Susquehanna South Sub-Watershed LS-6 has the highest total pollutant loads per acre and LS-2 has the lowest total pollutant loads per acre.

Through the desktop analysis and field investigation, it was determined that the total pollutant loads per acre would be used as the primary ranking method for the Swan Creek and Lower Susquehanna South Watersheds. Normalizing the rankings based on area allowed for prioritization of projects in highly urbanized sub-watersheds.



Notes:
1. Watershed Features from 2013 Harford County GIS.

0 0.75 1.5 3 Miles
1 inch = 1.5 miles

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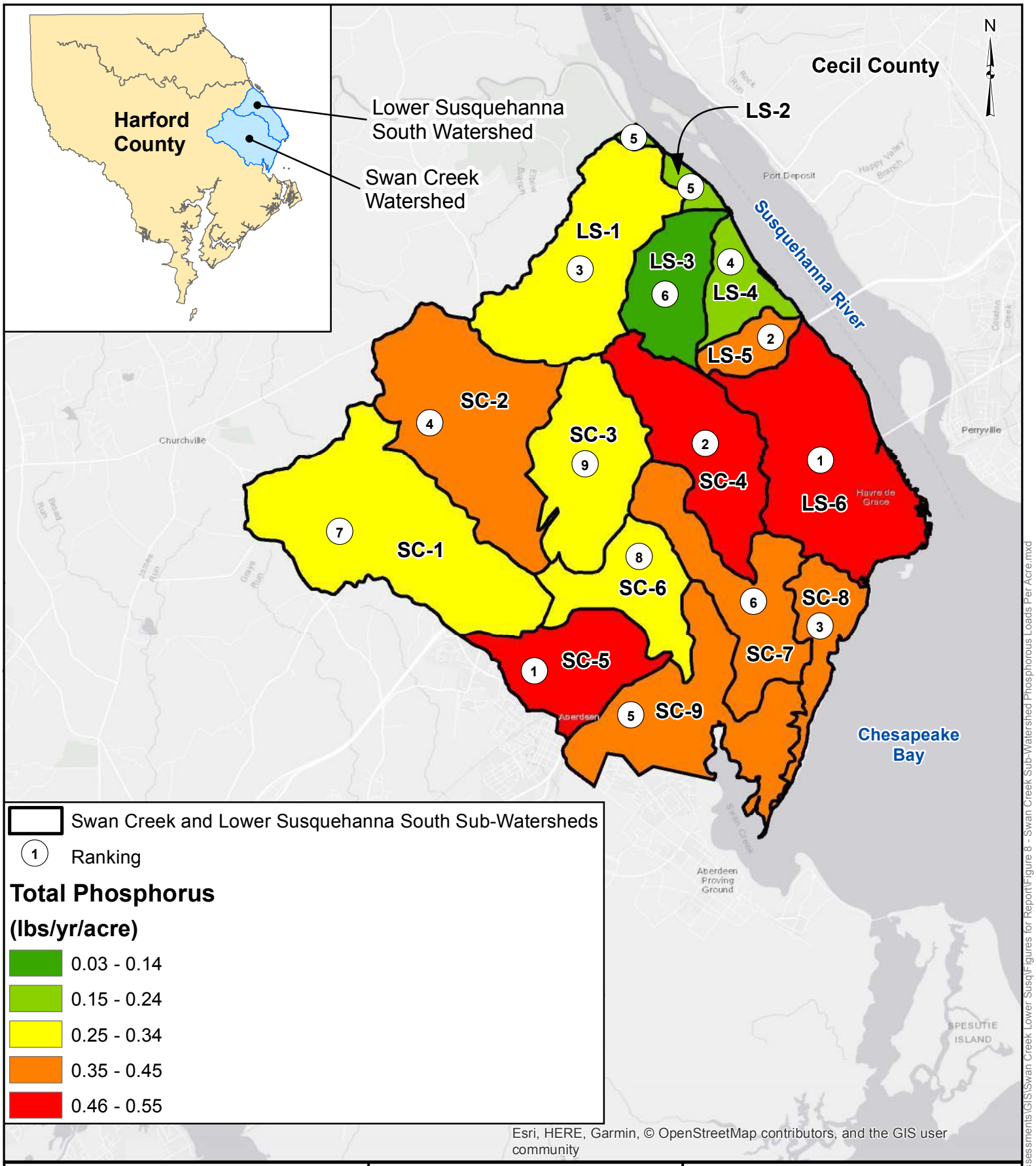
FIGURE 7
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH SUB-WATERSHED NITROGEN LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 7 - Swan Creek Sub-Watershed Nitrogen Loads Per Acre.mxd



Notes:
1. Watershed Features from 2013 Harford County GIS.

0 0.75 1.5 3 Miles
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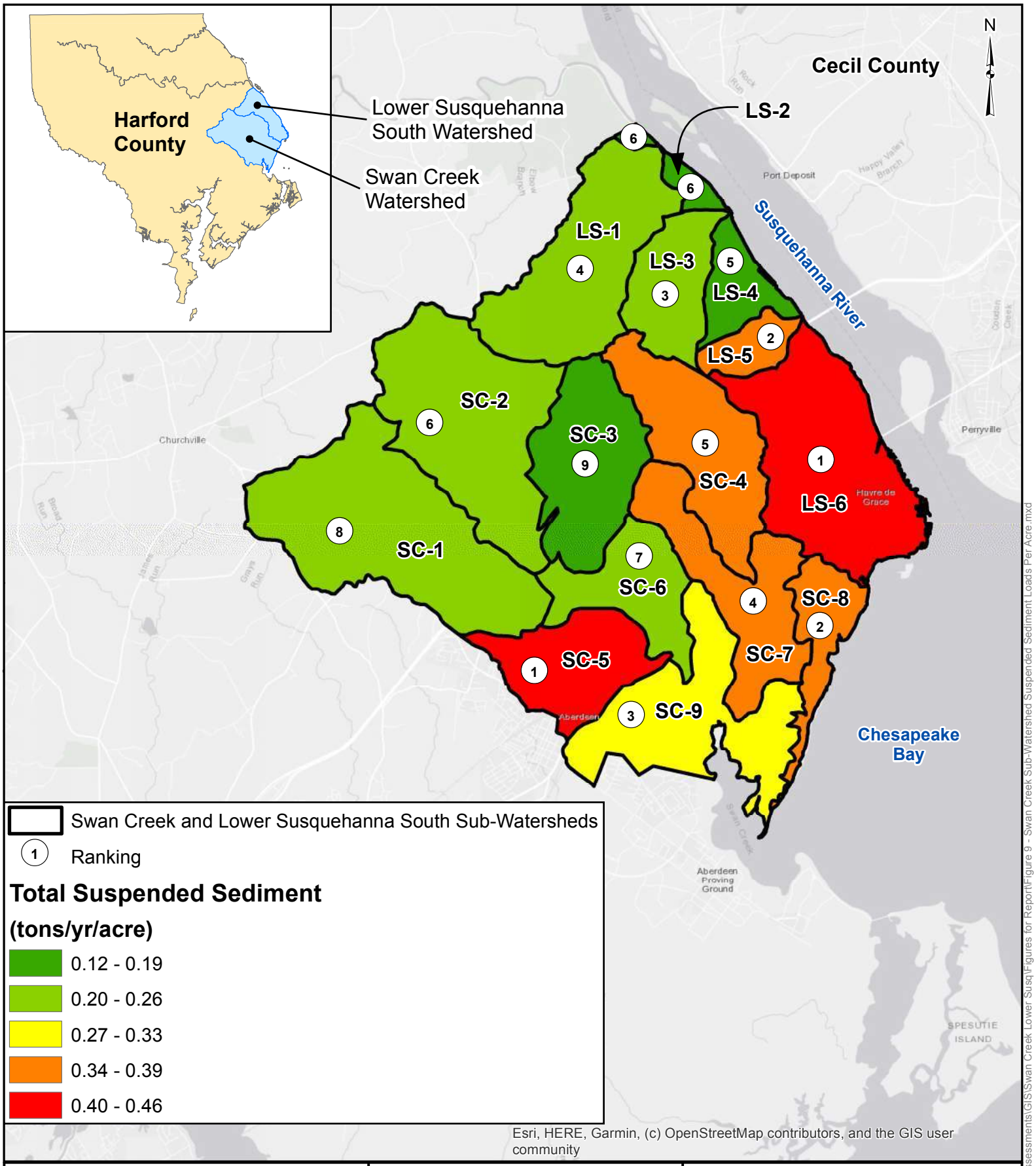
FIGURE 8
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH SUB-WATERSHED PHOSPHORUS LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 8 - Swan Creek Sub-Watershed Phosphorous Loads Per Acre.mxd



Notes:
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FIGURE 9
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH SUB-WATERSHED SUSPENDED SEDIMENT LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 9 - Swan Creek Sub-Watershed Suspended Sediment Loads Per Acre.mxd

To assess the impact of existing BMPs within the sub-watersheds, the “No Action” and “2017 Progress” scenarios were compared. Table 10 shows the annual pollutant loads for each sub-watershed under both scenarios and the difference between the two scenarios. The same methodology described in Sections 3.1 and 3.2 that was used to derive the “2017 Progress” scenario annual pollutant loads was used to derive the “No Action” scenario annual pollutant loads.

Table 10 – Swan Creek and Lower Susquehanna South Sub-Watershed "No Action" Versus "2017 Progress" Scenario Annual Pollutant Loads										
Sub-Watershed	**Area (acres)**	**No Action Scenario**			**2017 Progress Scenario**			**Change from No Action to 2017 Progress Scenario**		
		TN (lb/yr)	**TP (lb/yr)**	**TSS (ton/yr)**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (ton/yr)**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (ton/yr)**
Swan Creek Watershed										
SC-1	3,152.0	20,685.7	1,053.9	656.5	20,264.9	997.4	638.6	420.8 (2.0%)	56.5 (5.4%)	17.8 (2.7%)
SC-2	2,631.5	23,482.2	1,140.5	652.8	23,042.9	1,080.3	635.4	439.4 (1.9%)	60.1 (5.3%)	17.4 (2.7%)
SC-3	1,605.5	10,617.3	478.7	265.8	10,448.8	455.3	259.9	168.6 (1.6%)	23.4 (4.9%)	5.9 (2.2%)
SC-4	1,662.8	13,892.4	813.4	577.4	13,534.7	767.1	559.1	357.7 (2.6%)	46.3 (5.7%)	18.3 (3.2%)
SC-5	1,213.9	10,172.9	710.1	539.3	9,825.3	666.1	520.6	347.5 (3.4%)	44 (6.2%)	18.7 (3.5%)
SC-6	1,063.1	5,598.8	348.7	214.5	5,436.9	326.8	208.1	161.9 (2.9%)	21.9 (6.3%)	6.4 (3.0%)
SC-7	1,511.8	10,598.6	636.1	513.4	10,328.0	602.5	497.2	270.6 (2.6%)	33.6 (5.3%)	16.3 (3.2%)
SC-8	678.0	5,541.0	298.5	228.2	5,427.0	283.6	222.7	114 (2.1%)	15 (5.0%)	5.5 (2.4%)
SC-9	2,025.1	15,126.0	875.7	662.8	14,771.7	830.3	644.3	354.4 (2.3%)	45.4 (5.2%)	18.5 (2.8%)
Swan Creek Total	**15,543.7**	**115,714.9**	**6,355.5**	**4,310.7**	**113,080.1**	**6,009.3**	**4,185.9**	**2,634.8 (2.3%)**	**346.2 (5.4%)**	**124.9 (2.9%)**
Lower Susquehanna South Watershed										
LS-1	2,150.9	17,127.2	643.3	490.7	16,911.3	612.2	484.8	215.9 (1.3%)	31.1 (4.8%)	5.9 (1.2%)
LS-2	222.2	1,146.3	32.4	26.5	1,139.0	31.5	26.3	7.3 (0.6%)	1.0 (3.1%)	0.2 (0.8%)
LS-3	954.4	5,828.0	307.0	206.9	5,696.5	288.2	203.2	131.5 (2.3%)	18.8 (6.1%)	3.7 (1.8%)
LS-4	547.9	3,671.1	123.3	90.5	3,634.9	117.9	89.7	36.2 (1.0%)	5.4 (4.4%)	0.8 (0.9%)
LS-5	384.9	3,502.9	149.4	149.4	3,446.1	143.3	144.6	56.7 (1.6%)	6.1 (4.1%)	4.8 (3.2%)
LS-6	2,570.3	21,721.3	1,499.2	1,236.7	20,982.1	1,408.4	1,192.5	739.2 (3.4%)	90.7 (6.1%)	44.2 (3.6%)
Lower Susquehanna South Total	**6,830.6**	**52,996.7**	**2,754.6**	**2,200.7**	**51,809.9**	**2,601.4**	**2,141.0**	**1,186.8 (2.2%)**	**153.2 (5.6%)**	**59.7 (2.7%)**

For the Swan Creek Watershed, TN, TP and TSS were reduced by 2.3, 5.4 and 2.9 percent respectively from the “No Action” to the “2017 Progress” scenario. For the Lower Susquehanna South Watershed, TN, TP and TSS were reduced by 2.2, 5.6 and 2.7 percent respectively from the “No Action” to the “2017 Progress” scenario. The results indicate that existing BMPs are reducing the overall pollutant loads within the watersheds.

4. WATERSHED ACTION PLAN

4.1. Project Evaluation Criteria

Projects were evaluated and prioritized according to the criteria listed in Table 11.

Table 11 – Project Prioritization Criteria

Criteria	Description
Location within the watershed	Is the project located in the most degraded sub-watersheds?
Pollutant Load Reduction	Does the project result in high pollutant loading reductions?
Impervious Acre Credits	Does the project result in high amounts of impervious area treatment credit?
Property Ownership	Is the project on public property? On one private property? On multiple private properties?
Site Access	Are there access constraints? Are there natural resources impacts such as mature trees, wetlands and wetland buffers? Are there infrastructure constraints? Steep slopes?
Existing Utility Conflicts	Are there existing utilities that conflict with the design?
Cost	What is the total cost and what is the cost per impervious acre treated?

As part of project prioritization, sub-watersheds with the highest pollutant loads due to untreated impervious area and degraded stream channels were prioritized over sub-watersheds with minimal impervious area and pollutant loadings.

The amount of eligible impervious acre and pollutant load reduction credits was another major component in project prioritization. For the Swan Creek and Lower Susquehanna South Watersheds, stream restoration projects typically resulted in higher impervious acre and pollutant reduction credits than BMP projects.

Property ownership and site access were also considered. Project locations were considered easily accessible if they were adjacent to public roads, contained an existing access easement, or could be accessed through County property. Projects on County property were prioritized over projects located on private property.

Existing utility conflicts were also noted in the desktop and field investigations, including but not limited to light poles, sanitary sewer infrastructure, and overhead power lines. Projects with existing utility constraints were considered less favorable.

Project costs included design, permitting, construction and construction management. To account for varying project sizes and costs, cost efficiency was evaluated on a cost per impervious acre treated. Typically, larger projects treating extensive amounts of impervious area are more cost efficient than smaller projects, even though they can be significantly more expensive.

4.2. Stream Restoration

4.2.1. Methodology

An in-depth desktop analysis and field assessment were performed within the Swan Creek and Lower Susquehanna South Watersheds to identify eroded and degraded stream restoration projects that would improve the stability and function of the system, as well as provide the County with TMDL and MS4 credits. The desktop analysis consisted of review of past watershed assessments and reports, review of aerial photography and a detailed GIS query that included drainage and impervious area calculations, land use, property ownership, storm drain networks, utilities and site access. Ultimately, 13 stream sites were identified for field assessment in order to document existing stream channel and riparian conditions, map potential sources of sediment, identify causes of instability, and record unstable stream and riparian conditions. Field data sheets are included in Appendix E.

After the field and desktop assessments were completed, five sites were chosen as potential stream restoration projects. A detailed description of these projects is provided in Section 4.2.4.

4.2.2. Pollutant Removal and Impervious Area Accounting Measures

Pollutant reduction and impervious area credit was calculated for the potential stream restoration projects within the Swan Creek and Lower Susquehanna South Watersheds. Pollutant load removal and efficiency was estimated using planning rates for stream restoration from *Final Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (Schueler, T., Stack, B., 2014). Impervious area MS4 credit was calculated using methodologies described in MDE's *Accounting for Stormwater Wasteload Allocation and Impervious Acres Treated* (MDE, 2014) as well as a recent MDE memorandum, *Stream Restoration Crediting Clarification for MS4 Permitting Purposes* (April 30, 2019). The 2019 MDE memorandum indicates that stream restoration projects in the coastal plain physiographic region may take credit toward impervious area treatment at a rate of two acres for every 100 linear feet of channel restoration and projects in the non-coastal plain physiographic region may take credit toward impervious area treatment at a rate of three acres for every 100 linear feet of channel restoration.

The pollutant load reduction planning rates for stream restoration and impervious acre equivalents are shown in Table 12.

Table 12 – Planning Rates for Stream Restoration and Impervious Acre Equivalents				
Geography	**TN[1] (lbs/ft)**	**TP[1] (lbs/ft)**	**TSS[1] (lbs/ft)**	**Equivalent Impervious Acres[2] (acres/ft)**
Coastal Plain	0.075	0.068	15	0.02
Non-Coastal Plain	0.075	0.068	45	0.03

[1] *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects, Schueler and Stack, 2014*
[2] *Stream Restoration Crediting for MS4 Permitting Purposes, (Memorandum), April 30, 2019*

4.2.3. Proposed Stream Restoration Approaches

Typical stream restoration approaches used to restore function in highly degraded stream systems that were considered for each proposed stream restoration project are described below.

Riffle-Pool Systems/Floodplain Connectivity

Connecting a channel to an abandoned floodplain is essential to restoring the hydrological, morphological and biological functions of a stream. Incised channels with limited floodplain connectivity during large, less frequent storm events experience high shear stresses and velocities within the channel, resulting in increased rates of erosion and nutrient loading downstream. Floodplain connectivity can be achieved either through raising the bed of the existing stream channel to connect with a previously abandoned floodplain or by creating floodplain benches within the existing channel. Raising the existing stream to re-connect with the original floodplain or creating floodplain benches and/or a new floodplain within the over-widened channel is often referred to as Stream and Valley Restoration. Restoring floodplain connectivity increases pollutant removal efficiencies and biological habitat, decreases channel shear stresses and erosion, and reduces nutrient loadings downstream. An example of a stream reach with restored floodplain connectivity, designed by BayLand located in Frederick County, Maryland is shown in Photo 1.

Photo 1 – Restored floodplain connectivity

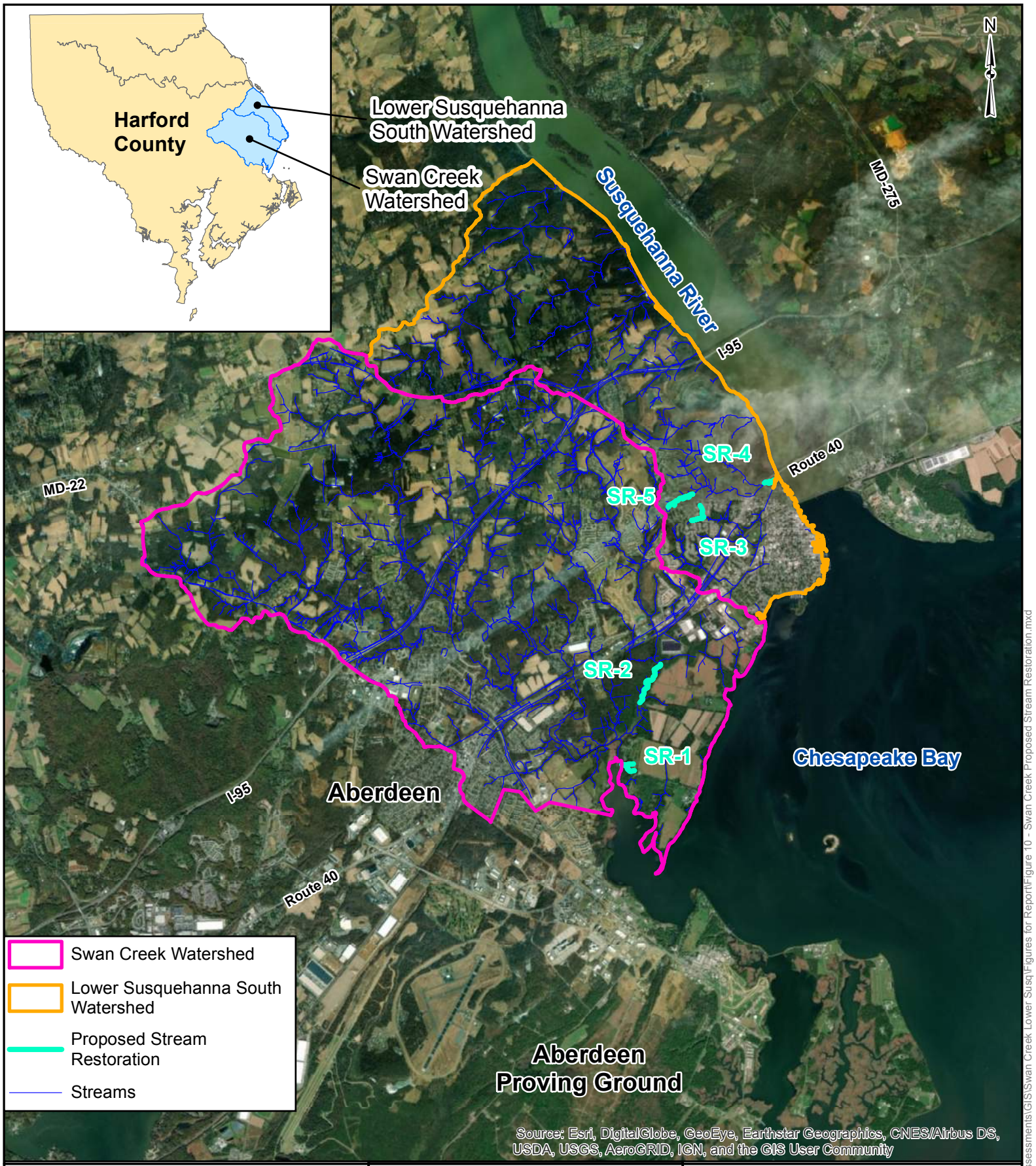
Step Pool Weir Systems

Step pool weir systems consist of a series of one or more instream riffle weirs strategically placed in confined intermittent or perennial channels to provide lateral and vertical stability. Step pool weir systems are typically utilized in confined, high-gradient valleys where floodplain connectivity is limited or where site constraints prohibit flooding increases. An example of a step pool weir system designed by BayLand is shown in Photo 2.

Photo 2 – Step Pool Weir System

4.2.4. Potential Stream Restoration Projects

Five locations were identified as potential stream restoration projects (Figure 10). The projects were carefully selected based on criteria described in Section 4.1. A description of each project is provided in Tables 13 to 17, and pollutant reduction and impervious acre credit information is provided in Appendix E. Locations of individual projects are shown in Figures 11 to 15. A summary of the potential stream restoration projects is provided in Table 18.



Notes:
1. Streams Data from 2013 Harford County GIS
2. Watershed Features from 2013 Harford County GIS

0 0.75 1.5 3 Miles

1 inch = 1.5 miles

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FIGURE 10
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH PROPOSED STREAM RESTORATION

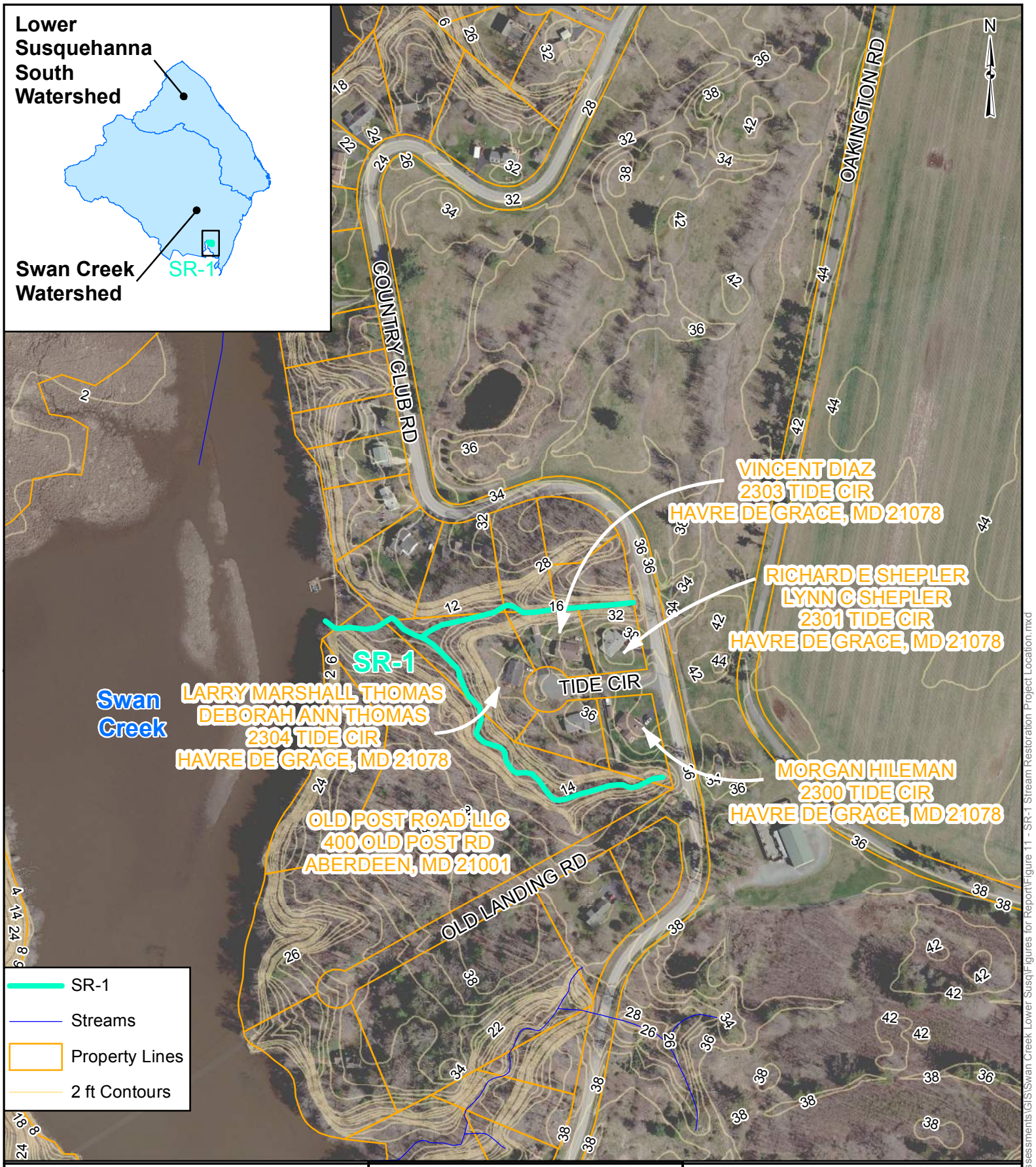
P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 10 - Swan Creek Proposed Stream Restoration.mxd

Table 13 – SR-1			
Name	Tide Circle Outfalls		
Linear Feet of Restoration	1,610		
Proposed Approach	Stream Restoration – Step Pool Weir System		
Sub-Watershed Location	SC-9		
TN/TP/TSS Pollutant Removal	120.8 lbs/yr	109.5 lbs/yr	12.1 tons/yr
Impervious Acre Credit	32.2		
Property Owner	Ward Management, Inc.; Morgan L Hileman; Larry Marshall Thomas and Deborah Ann Thomas; Vincent Diaz; Richard E Shepler and Lynn C Shepler		
Site Access	Via Country Club Rd		
Existing Utility Conflicts	Overhead electric along Country Club Rd		
Total Project Cost	$1,320,000		
Description SR-1 consists of a single thread channel that originates at an outfall off of Country Club Road, south of Tide Circle (Photo 3) and continues downstream approximately 1,080 linear feet to Swan Creek. It also includes 530 LF of a tributary that originates at an exposed, undercut outfall north of Tide Circle (Photo 4) and discharges into the main stem from the right bank. SR-1 is characterized by channel incision and near-vertical, eroding banks (Photo 5). Bank heights at SR-1 range from three to ten feet high and are predominately composed of silt, sand and gravel. SR-1 is characterized by a step gradient valley so the installation of a step-pool weir system is the recommended restoration approach.			

Photo 3 – Outfall on south side of Tide Circle

Photo 4 – Outfall on north side of Tide Circle

Photo 5 – Bank erosion at SR-1



Notes:
1. Strams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 150 300 600 Feet
1 inch = 300 feet

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FIGURE 11
SR-1
STREAM RESTORATION
PROJECT LOCATION

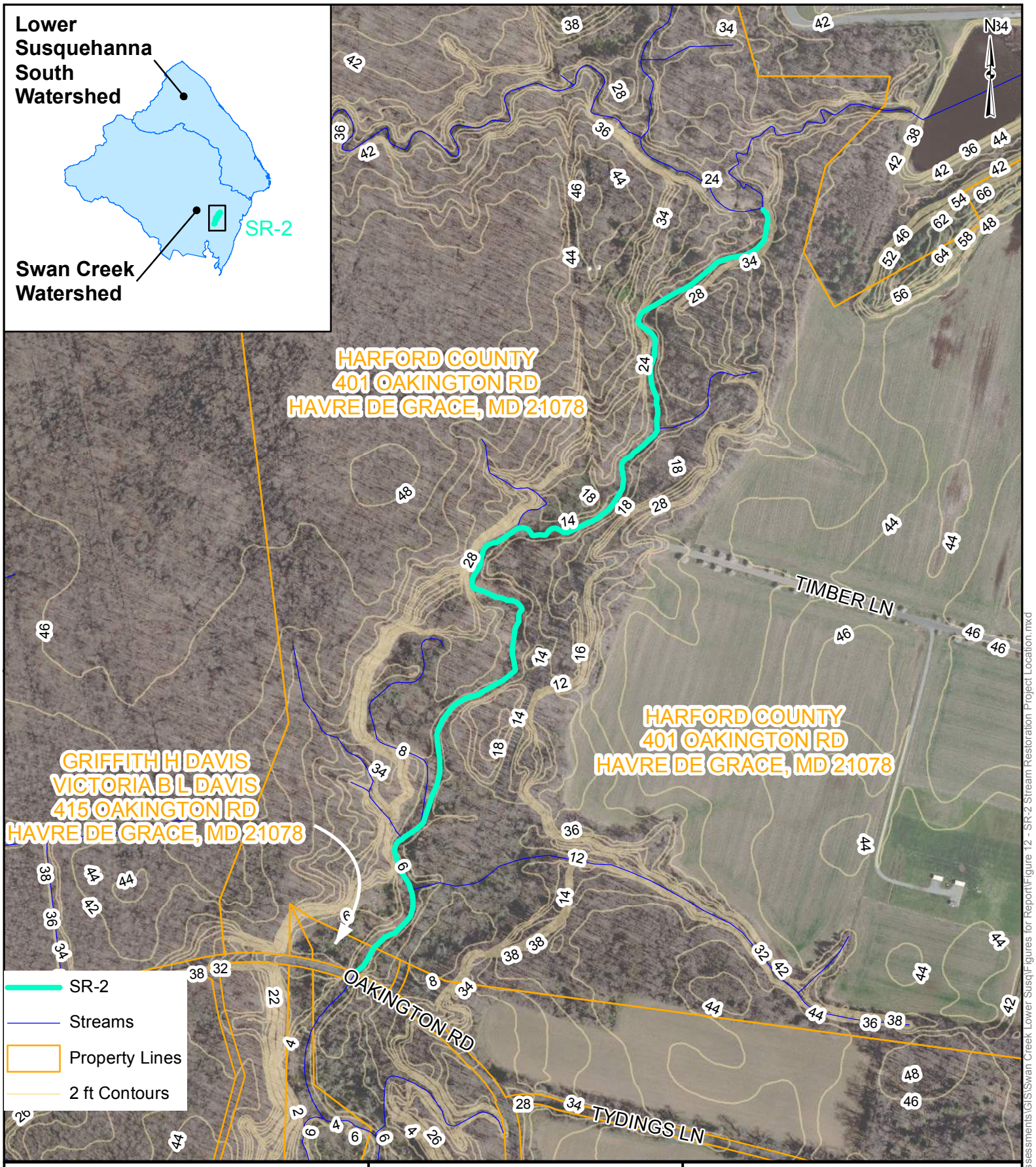
P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 11 - SR-1 Stream Restoration Project Location.mxd

Table 14 – SR-2			
Name	Gasheys Creek		
Linear Feet of Restoration	3,500		
Proposed Approach	Stream Restoration – Riffle Pool System		
Sub-Watershed Location	SC-7		
TN/TP/TSS Pollutant Removal	262.5 lbs/yr	238.0 lbs/yr	26.3 tons/yr
Impervious Acre Credit	70.00		
Property Owner	Harford County; Griffith H Davis and Deborah B L Davis		
Site Access	Via Timber Lane		
Existing Utility Conflicts	None		
Total Project Cost	$2,275,000		
Description SR-2 is a single-thread perennial channel that originates at the confluence of Gasheys Creek with an unnamed tributary, approximately 1,000 LF north of Timber Lane, and continues downstream to Oakington Road. SR-2 is characterized by channel incision, excessive bank erosion (Photo 6), fallen trees (Photo 7), and debris jams (Photo 8). Bank heights range from four to 20 feet high and are predominately composed of silt and sand. It should be noted that SR-2 is biologically impaired; Gasheys Creek received a “Fair” BIBI rating when sampled by MBSS in 2007 and a “Poor” BIBI rating in 2008 when sampled by Stream Waders. Since SR-2 has a flatter gradient valley there are no infrastructure/flooding constraints restricting floodplain reconnection, the installation of a riffle pool system is the recommended restoration approach.			

Photo 6 – Bank erosion SR-2

Photo 7 – Fallen trees at SR-2

Photo 8 – Debris jam characteristic of SR-2



Notes:
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0 200 400 800 Feet
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FIGURE 12
SR-2
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 12 - SR-2 Stream Restoration Project Location.mxd

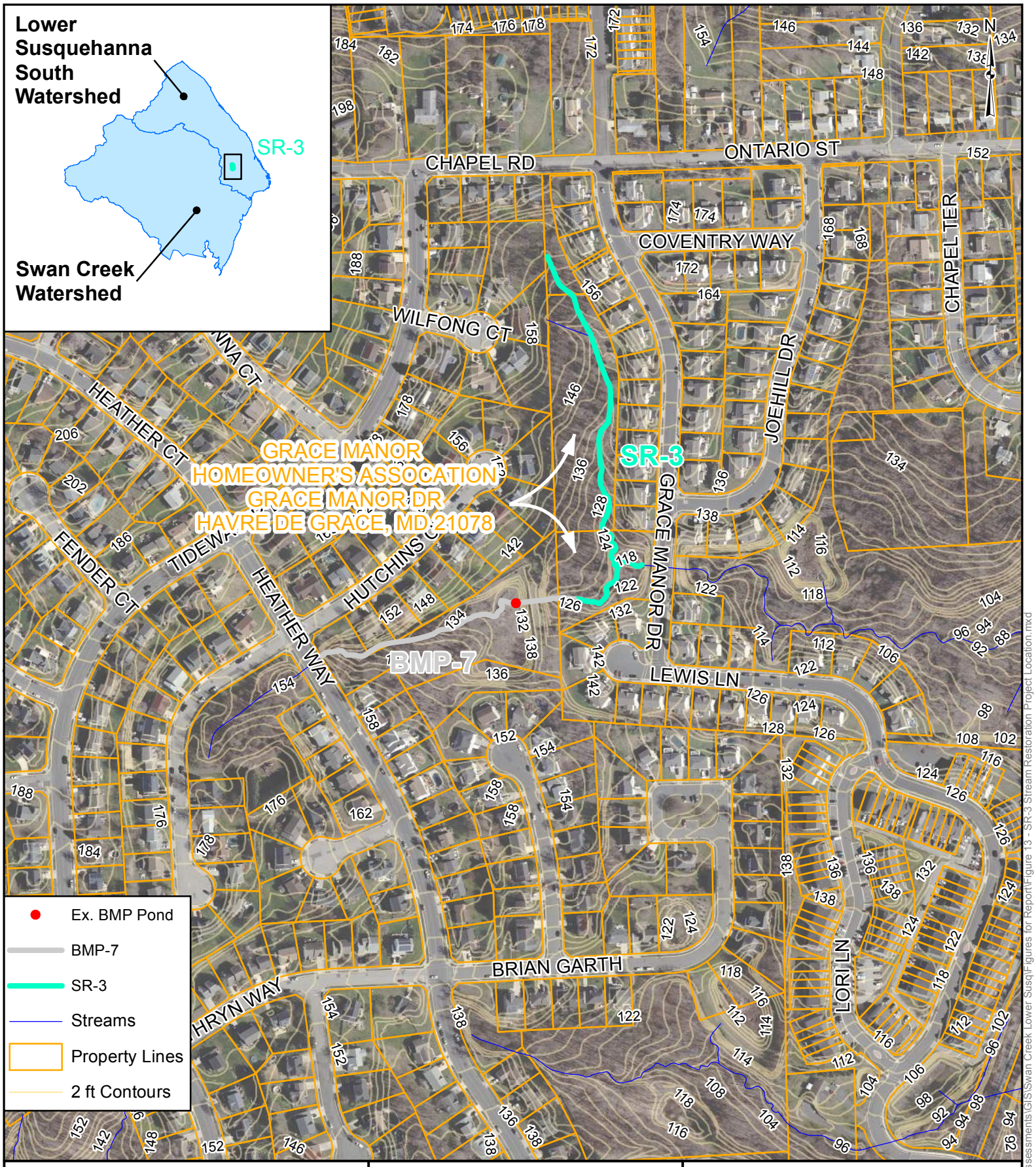
Table 15 – SR-3			
Name	Grace Manor HOA Stream Restoration		
Linear Feet of Restoration	1,060		
Proposed Approach	Stream Restoration – Step Pool Weir System		
Sub-Watershed Location	LS-6		
TN/TP/TSS Pollutant Removal	79.5 lbs/yr	72.1 lbs/yr	23.9 tons/yr
Impervious Acre Credit	31.80		
Property Owner	Grace Manor HOA, Inc.		
Site Access	Via Grace Manor Drive and Lewis Lane		
Existing Utility Conflicts	Sewer and Water along Hutchins Ct, Grace Manor Drive, Lewis Lane, Heather Way		
Total Project Cost	$875,000		
Description SR-3 is a single-thread channel that originates downstream of Chapel Road and continues downstream approximately 885 LF to a culvert crossing under Grace Manor Drive. The project also includes 175 LF of a tributary that originates downstream of an existing SWM facility (BMP-7). SR-3 is characterized by excessive bed and bank erosion (Photos 9 & 10), bank slumping (Photo 11), and debris jams (Photo 12). Bank heights range from three to eight feet and are predominately composed of sand and silt. SR-3 is characterized by a step gradient valley so the installation of a step-pool weir system is the recommended restoration approach.			

Photo 9 – Erosion at SR-3

Photo 10 – Bank erosion adjacent to private property

Photo 11 – Bank slumping at SR-3

Photo 12 – Debris jam



Notes:
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0 150 300 600 Feet
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FIGURE 13
SR-3
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 13 - SR-3 Stream Restoration Project Location.mxd

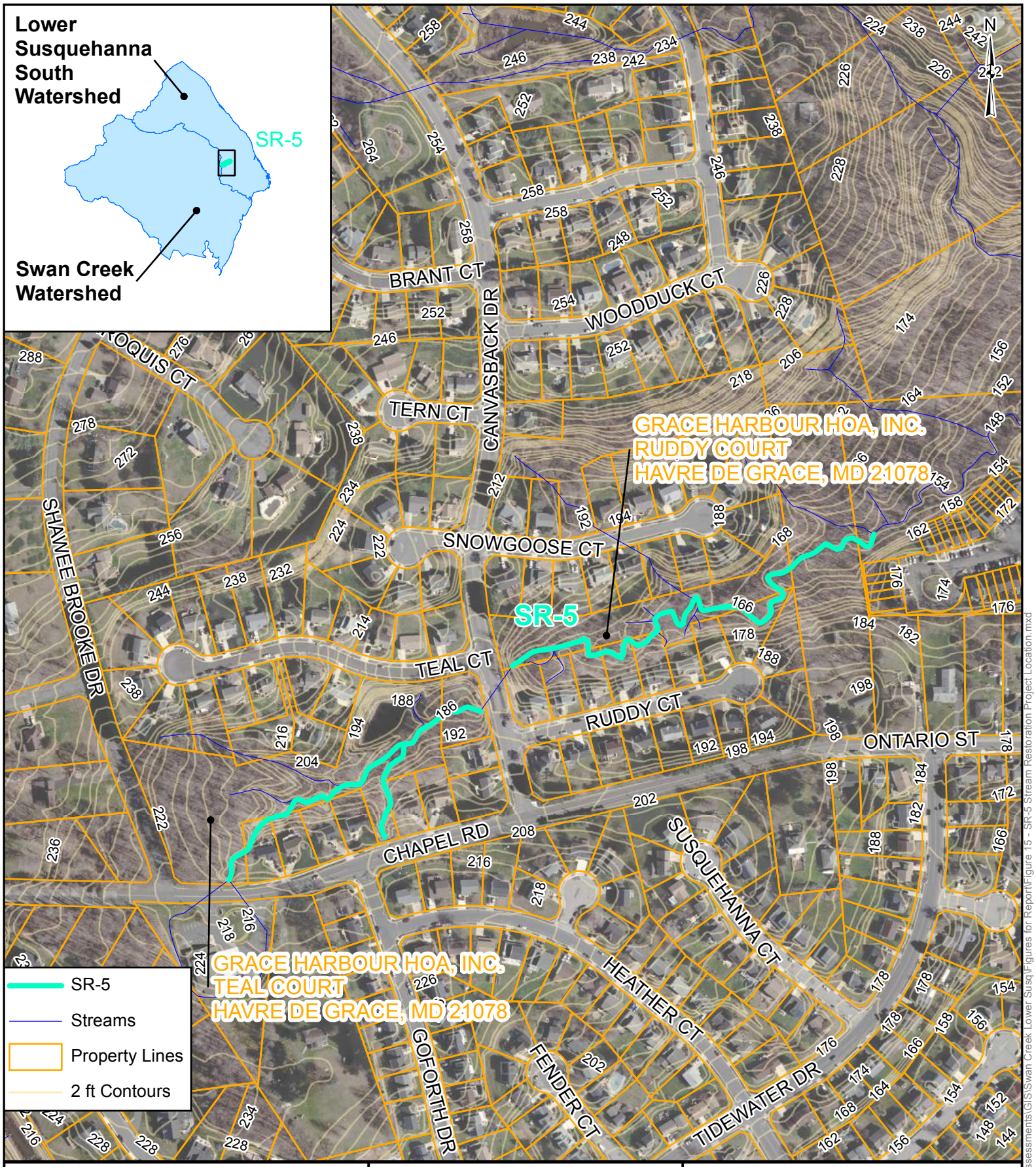
Table 16 – SR-4			
Name	McLhinney Park Stream Restoration		
Linear Feet of Restoration	1,810		
Proposed Approach	Stream Restoration – Riffle Pool System		
Sub-Watershed Location	LS-6		
TN/TP/TSS Pollutant Removal	135.8 lbs/yr	123.1 lbs/yr	13.6 tons/yr
Impervious Acre Credit	36.20		
Property Owner	Mayor and City Council, Havre de Grace; A&M Properties; PECO Energy and Power Company		
Site Access	Via Superior Street		
Existing Utility Conflicts	Sanitary Sewer along Superior St.		
Total Project Cost	$1,177,000		
Description SR-4 is a single-thread channel that originates at Superior Street and continues downstream approximately 1,810 LF. The reach is characterized by eroding banks (Photo 13) and tortuous meander bends (Photo 14). The majority of SR-4 is surrounded by North park property and has an inadequate riparian buffer (Photos 15 & 16). Bank heights average three to four feet and are predominately composed of silt and sand. It should be noted that the stream is biologically impaired, as evidenced by a “Poor” BIBI rating from Stream Waders sampling conducted in 2008. Since SR-4 has a flatter gradient valley and some floodplain connectivity could be achieved with the installation of a floodplain bench, the installation of a riffle pool system is the recommended restoration approach.			

Photo 13 – Eroding left bank along SR-4

Photo 14 – Eroding left bank and tight meander bend along SR-4

Photo 15 – Inadequate riparian buffer at SR-4

Photo 16 – Inadequate riparian buffer at SR-4



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0 150 300 600 Feet
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FIGURE 15
SR-5
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 15 - SR-5 Stream Restoration Project Location.mxd

Table 17 – SR-5			
Name	Grace Harbour HOA		
Linear Feet of Restoration	2,380		
Proposed Approach	Stream Restoration – Step Pool Weir System		
Sub-Watershed Location	LS-6		
TN/TP/TSS Pollutant Removal	178.5 lbs/yr	161.8 lbs/yr	53.6 tons/yr
Impervious Acre Credit	71.40		
Property Owner	Grace Harbour HOA, Inc.; Laura L Druyor and Douglas D Druyor JR; William N Le Brun and Barbara Le Brun; Michael Lee Zellman and Beth Hamilton; Augusto D Barretto; Wilfredo J Cruz; Timothy Brammer JR; Raymond Caldwell; Donald Kinsey		
Site Access	Via Canvasback Dr		
Existing Utility Conflicts	Sewer along Canvasback Dr., Ruddy Ct., Teal Ct. Overhead Electric on Chapel Rd.		
Total Project Cost	$1,964,000		
Description SR-5 originates at an outfall off of Chapel Road and flows downstream approximately 810 LF to a culvert crossing under Canvasback Drive (Photo 17). Downstream of the culvert crossing the project limits extend an additional 1,315 LF. The project limits also include 255 LF of a tributary that originates at an outfall off of Chapel Road and discharges into the mainstem on the right bank. There is an existing SWM pond on the left bank of the mainstem, near the confluence with the tributary (Photo 18). Upstream of Canvasback Drive, SR-5 is characterized by eroded banks averaging four feet high as well as exposed roots and log jams (Photo 19). Downstream of Canvasback Drive, SR-5 is characterized by tortuous meander bends and severely eroded banks ranging from eight to ten feet high (Photo 20). Since SR-5 is characterized by a step gradient valley and flooding is a concern due to private property on the left and right banks, the installation of a step-pool weir system is the recommended restoration approach.			

Photo 17 – Canvasback Drive Culvert Crossing

Photo 18 – Ex. SWM pond

Photo 19 – Bank erosion at the upstream end of SR-5

Photo 20 – Bank erosion at the downstream end of SR-5

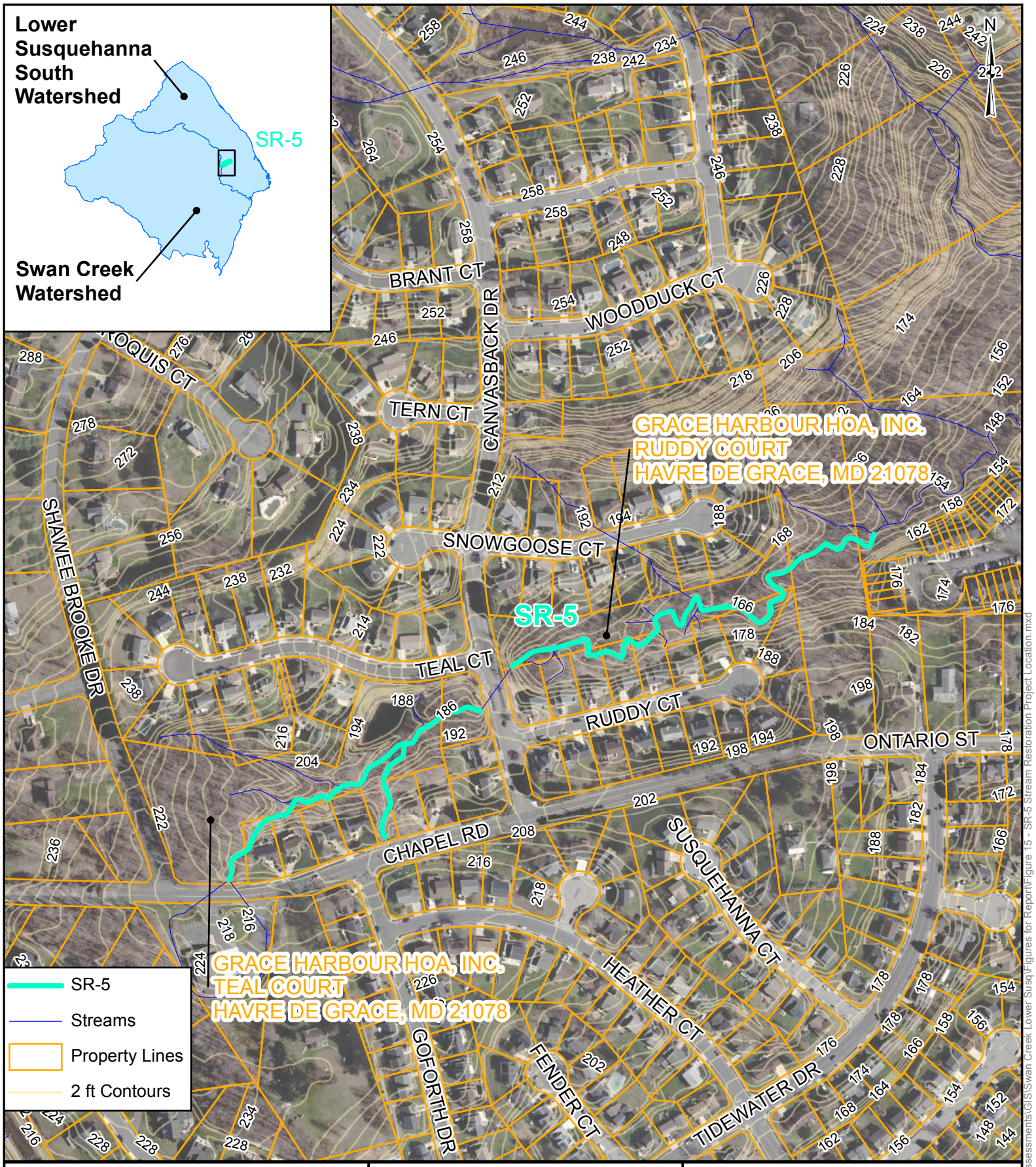

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FIGURE 15
SR-5
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 15 - SR-5 Stream Restoration Project Location.mxd

Table 18 – Proposed Stream Restoration Projects										
Project ID	**Name**	**Sub-Watershed**	**Length (ft)**	**Property Owner**	**Pollutant Reduction**			**Project Cost**	**Impervious Acre Credits***	**Cost/Imp. Acre**
					TN (lbs/yr)	**TP (lbs/yr)**	**TSS (tons/yr)**			
Swan Creek Watershed										
SR-1	Tide Circle	SC-9	1,610	Ward Management, Inc.; Morgan L Hileman; Larry Marshall Thomas and Deborah Ann Thomas; Vincent Diaz; Richard E Shepler and Lynn C Shepler	120.8	109.5	12.1	$1,320,000	32.2	$41,000
SR-2	Gasheys Creek	SC-7	3,500	Harford County; Griffith H Davis and Deborah B L Davis	262.5	238.0	26.3	$2,275,000	70.0	$33,000
Swan Creek Total			**5,110**	**N/A**	**383.3**	**347.5**	**38.4**	**$3,595,000**	**102.2**	**$35,000**
Lower Susquehanna South Watershed										
SR-3	Grace Manor HOA	LS-6	1,060	Grace Manor HOA, Inc.	79.5	72.1	23.9	$875,000	31.8	$28,000
SR-4	McLhinney Park	LS-6	1,810	Mayor and City Council, Havre de Grace; A&M Properties; PECO Energy and Power Company	135.8	123.1	13.6	$1,177,000	36.2	$33,000

Table 18 – Proposed Stream Restoration Projects										
Project ID	**Name**	**Sub-Watershed**	**Length (ft)**	**Property Owner**	**Pollutant Reduction**			**Project Cost**	**Impervious Acre Credits***	**Cost/Imp. Acre**
					TN (lbs/yr)	**TP (lbs/yr)**	**TSS (tons/yr)**			
SR-5	Grace Harbour HOA	LS-6	2,380	Grace Harbour HOA, Inc.; Laura L Druyor and Douglas D Druyor JR; William N Le Brun and Barbara Le Brun; Michael Lee Zellman and Beth Hamilton; Augusto D Barretto; Wilfredo J Cruz; Timothy Brammer JR; Raymond Caldwell; Donald Kinsey	178.5	161.8	53.6	$1,964,000	71.4	$28,000
Lower Susquehanna South Total			**5,250**	**N/A**	**393.8**	**357.0**	**91.1**	**$4,016,000**	**139.4**	**$29,000**

**See Section 4.2.2 for a description of the methods used in calculating impervious acre credits.*

4.3. Best Management Practices

4.3.1. Methodology

An in-depth desktop analysis and field assessment was conducted within the Swan Creek and Lower Susquehanna South Watersheds to identify BMP projects that would improve water quality treatment, enhance functionality and aesthetics, as well as assist the County in meeting TMDL and MS4 permit requirements.

In addition to the criteria listed in Section 4.1, additional criteria were utilized to narrow the list of potential BMP projects. Specifically, existing SWM facilities were targeted since they typically yield the greatest potential increase in impervious acre and pollutant removal credits.

During the desktop analysis, as-built records for existing SWM facilities were obtained as available and reviewed to determine the year the facility was constructed, the volume of water quality treatment provided, existing hydraulic controls and potential for retrofit. Typically, facilities built prior to 1985 were designed to provide quantity control, as opposed to water quality treatment. Facilities built after 1985 and prior to 2002 were typically designed to capture and treat one half inch of rainfall runoff. Current SWM regulation in Maryland requires treatment of at least one inch of rainfall runoff. Therefore, existing SWM facilities not meeting current design standards were targeted for retrofit to provide additional water quality treatment.

Ultimately, 20 potential BMP projects were identified for field assessment, 11 of which were BMP retrofit opportunities and nine of which were new BMP opportunities. Facilities with small amounts of impervious area, difficult access, confined facility footprints and negligible retrofit potential were removed from consideration.

In August and September 2019, BayLand field investigated the 20 potential BMP sites. At the existing SWM facilities of interest, key parameters were documented including existing structures (headwall, riser, outfall pipe, etc.), hydraulic controls (presence/location of a low flow orifice, shape and sizes of openings, condition and size of outfall pipes), stability of the outfall pipe, the condition of the embankment, the size of the existing footprint, and site access.

After the field assessments were completed, three existing facilities were identified as potential SWM retrofit projects, and four sites were identified for new BMP construction. Field data sheets are provided in Appendix E.

4.3.2. Pollutant Load Reduction and Impervious Area Accounting Measures

Pollutant load reduction and impervious acre credits were calculated according to MDE WLA accounting measures (MDE, 2014). Pollutant removal efficiencies were determined by the depth of rainfall runoff that the proposed BMP will capture and treat. A series of pollutant removal adjustor curves (Schueler and Lane, 2012) were used to

determine nutrient and sediment load reductions for BMP implementation. BMPs are classified as either environmental site design (ESD) or stormwater treatment (ST) practices and there are separate pollutant removal curves for each type.

Impervious acre credits are calculated based on the fraction of water quality volume WQv (one inch of rainfall runoff) that a facility can treat. If a facility stores the entire WQv, then credit can be achieved for all the impervious area draining to the facility. If only half of the target WQv is treated, then the facility is eligible to receive credit for half of the impervious area within its drainage area. The accounting measures also permit additional impervious acre credits if a BMP stores more than the required one inch of WQv runoff. A 0.1 impervious acre credit is allocated for every 0.4 inches of additional rainfall depth treated above the initial one inch of runoff (MDE, 2014), up to a maximum of 2.6 inches.

4.3.3. Proposed BMP Approaches

Summaries of typical water quality SWM BMPs frequently used to control runoff and mitigate water quality degradation are provided below.

Wet Stormwater Management (SWM) Ponds

Wet SWM ponds maintain a permanent pool with a storage volume equivalent to the WQv. They are intended to control excess stormwater runoff and improve water quality by removing pollutants through sediment settling and biological uptake. It is illegal to construct stormwater ponds in jurisdictional waters, which include wetlands, interstate waters, and navigable waters, without both a Clean Water Act Section 404 permit and a State of Maryland wetlands and waterway permit. They have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats. An example of a stormwater pond with a fountain, retrofitted by BayLand, located in Anne Arundel County, Maryland is shown in Photo 21.

Photo 21 – Stormwater pond with fountain

Stormwater Management (SWM) Wetlands

SWM wetlands are areas that are saturated with water either permanently or seasonally and are designed to remove pollutants through settling and biological uptake. They have variable micro-topography including above-pool vegetation, shallow pools and deep pools to promote dense and diverse vegetative cover. They can treat large impervious areas, are aesthetically pleasing, enhance faunal and floral habitat, and have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats.

SWM wetlands require a large facility footprint and require a water balance to be performed to ensure hydric soil conditions. An example of a stormwater wetland, designed by BayLand, located in Anne Arundel County, Maryland is shown in Photo 22.

Photo 22 – Stormwater Wetland

Infiltration Basins

Infiltration basins provide nutrient and sediment reduction through attenuation and infiltration of storm flow runoff. Runoff is temporarily stored within the basin, removing sediments and nutrients from the water column through settling and percolation into the underlying soil media. Excess storm flows are conveyed downstream or returned to the main conveyance system (storm drain) through a riser structure, diversion or overflow spillway.

Infiltration basins have various design requirements to ensure the anticipated sediment and nutrient reduction efficiencies and credits are achieved. Infiltration basins must be underlain by Hydrologic Soil Groups (HSG) A, B or C soils with an infiltration rate of 0.52 inch per hour or greater. The bottom of the facility must be at least four feet vertically from the seasonally high-water table or bedrock layer and they are prohibited from areas of karst topography. Typically, pretreatment of at least 25 percent of the

WQv is required prior to entering the facility via sedimentation basins, plunge pools, stilling basins or other acceptable measures.

Infiltration basins have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats. An example of an infiltration basin, designed by BayLand, located in Howard County, Maryland is shown in Photo 23.

Photo 23 – Infiltration Basin

Bioretention Basins

Bioretention basins capture and treat runoff from impervious surfaces by passing the water through a filter bed mixture of sand, soil, and organic matter. Filtered stormwater partially infiltrates into the ground or is returned to a conveyance system.

Bioretention basins are versatile and can be implemented as parking lot islands, median filters, terraced slope facilities, cul-de-sac islands or planter boxes to provide WQv. If designed to meet ESD criteria, the contributing drainage area is limited to half an acre and the slopes must be mild (less than or equal to five percent). The pollutant removal efficiencies are 57 percent TN, 66 percent TP and 70 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats. An example of a bioretention basin, designed by BayLand, located in Anne Arundel County, Maryland is shown in Photo 24.

Photo 24 – Bioretention basin in a parking lot median

Step Pool Storm Conveyance Systems

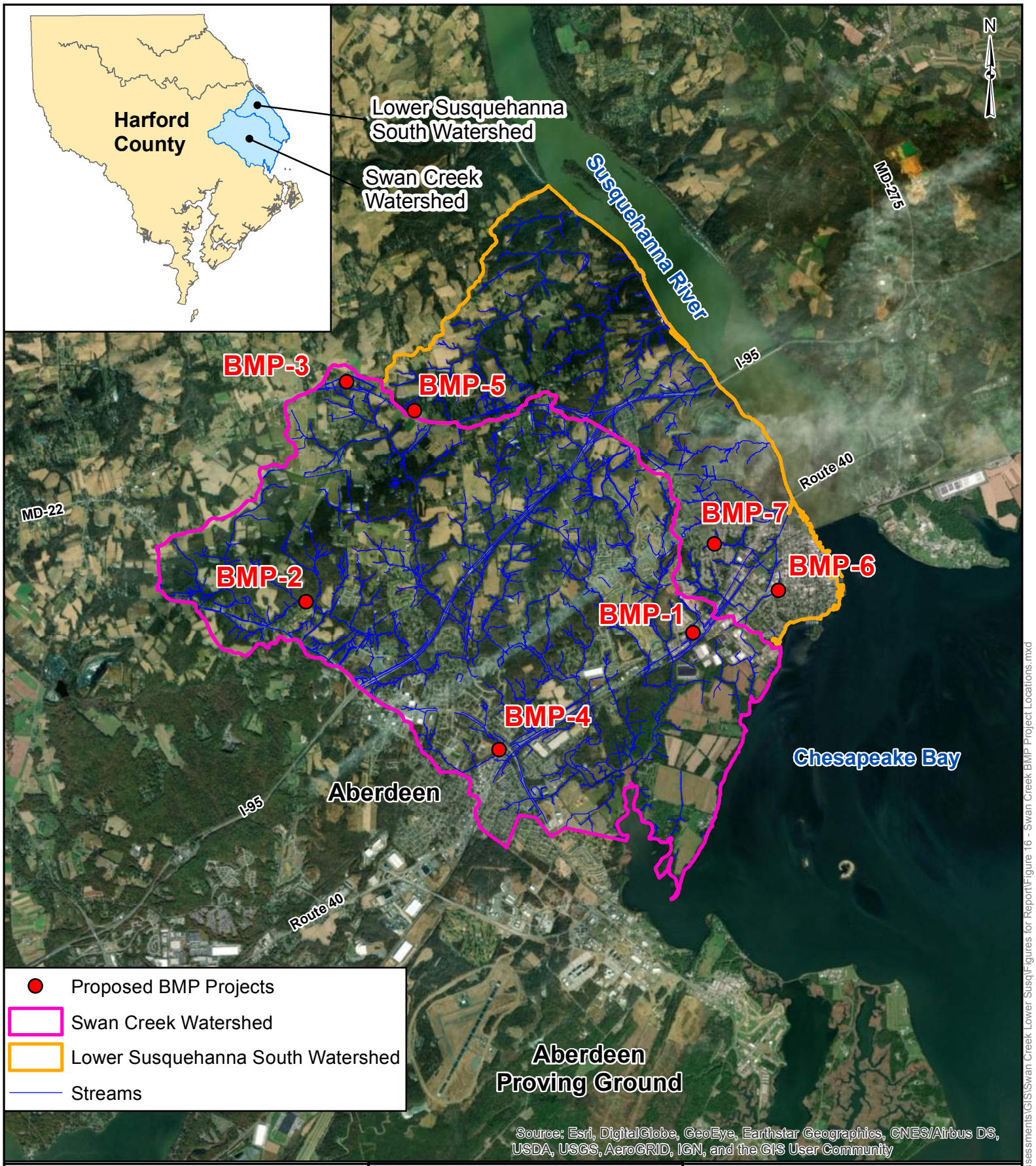
A Step Pool Storm Conveyance System (SPSC) is a series of open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow. These systems safely convey, attenuate, and treat the quality of storm flow. SPSC systems utilize a series of constructed shallow aquatic pools, riffle grade control, native vegetation, and an underlying sand/woodchip mix filter bed media. For steeper slopes, boulder cascades can be used to transverse grade. The pollutant removal efficiencies are 57 percent TN, 66 percent TP and 70 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats. An example of a SPSC system designed by BayLand located in Anne Arundel County, Maryland is shown in Photo 25.

Photo 25 –– Step Pool Storm Conveyance (SPSC)

4.3.4. Potential BMP Projects

Three sites were identified as potential SWM retrofit projects and four sites were identified where new BMP facilities could be built (Figure 16).

The BMP projects were selected to maximize pollutant removal efficiency and impervious acre credits, provide WQv storage to the current State standard, and minimize the total cost per impervious acre treated. The BMP pollutant removal rates were calculated assuming full WQv treatment and follow the stormwater WLA accounting measures described in Section 4.3.2. Design and construction costs were estimated by comparing the magnitude of proposed retrofits to recently designed and constructed projects. The total cost includes design, permitting, construction and construction oversight. Table 26 provides an overview of the selected BMP projects, while Figure 16 shows their locations within the Swan Creek and Lower Susquehanna South Watersheds. A description of each project is provided in Tables 19 to 25. Locations of individual projects are shown in Figures 17 to 23. Pollutant loading information is provided in Appendix D, and impervious acre credit information is provided in Appendix F.



Notes:
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2. Watershed Features from 2013 Harford County GIS

0 0.75 1.5 3 Miles

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FIGURE 16
BROAD CREEK AND LOWER SUSQUEHANNA SOUTH BMP PROJECT LOCATIONS

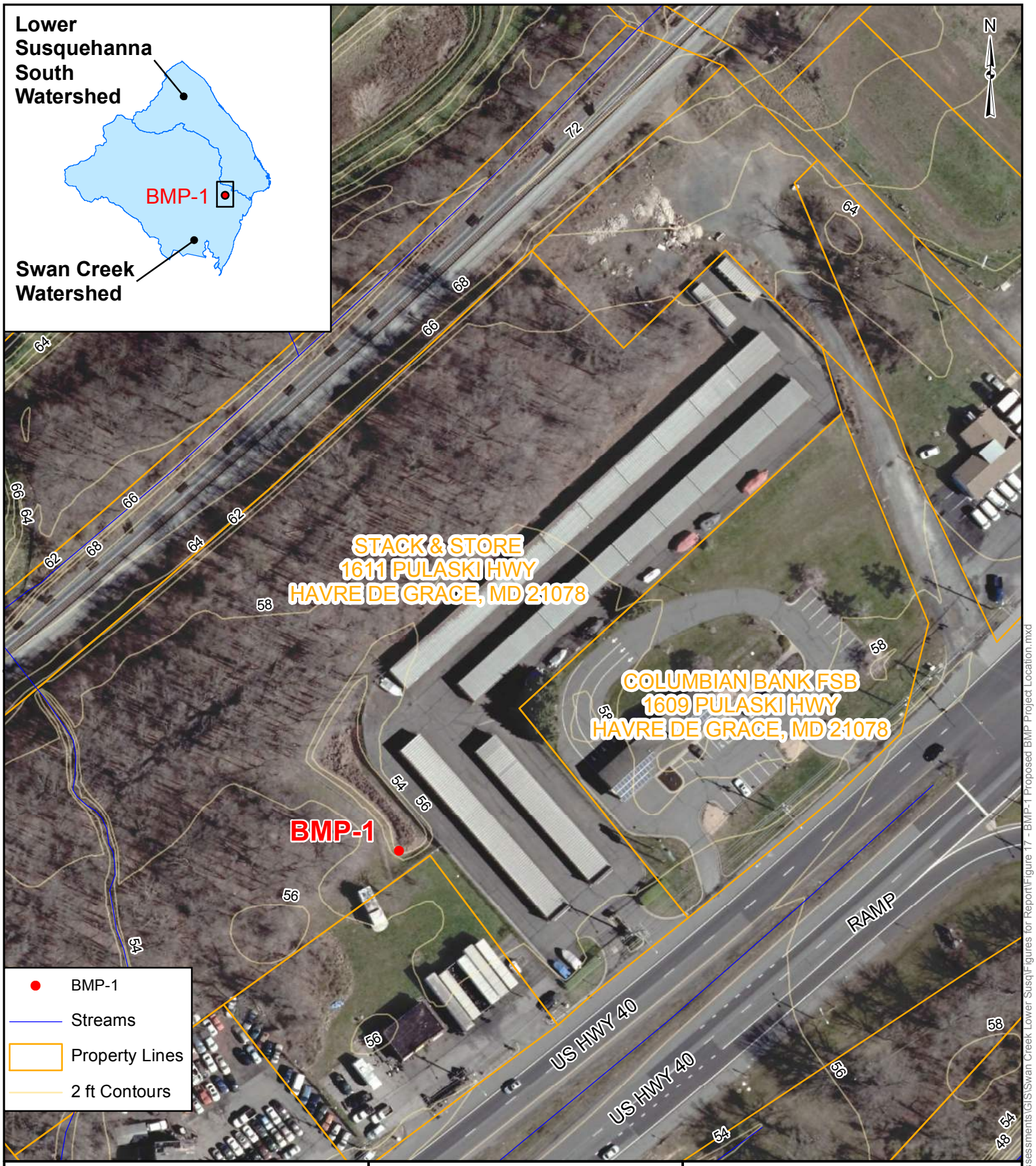
P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 16 - Swan Creek BMP Project Locations.mxd

Table 19 – BMP-1			
Name	Stack & Store Pond Retrofit		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	SC-7		
TN/TP/TSS Pollutant Removal	3.6 lbs/yr	0.4 lbs/yr	0.5 tons/yr
Property Owner	HDG Realty, LLC		
Site Access	Via Pulaski Hwy		
Existing Utility Conflicts	Overhead Electric along US Route 40		
Total Project Cost	$125,000		
Drainage Area (ac.)	5.9		
Impervious Area (ac.)	2.5 (42.4%)		
Required WQv (ac-ft)	0.21		
Anticipated Proposed WQv (ac-ft)	0.21		
EX. Rainfall Depth Treated (in.)	0.5		
PR. Rainfall Depth Treated (in.)	1.0		
Impervious Acre Credits	1.3		
Description BMP-1 (SWM-0255 per County GIS data) is an existing SWM facility built prior to 2002 that is located behind the Stack & Store storage facility along US Highway 40. The existing SWM pond treats runoff from the storage facility and adjacent parking lot. As-built plans for the facility could not be obtained, however, field investigation revealed inflow into the facility via a curb cut in the parking lot (Photo 28). The facility consists of a corrugated metal riser (Photo 29) and is densely vegetated (Photo 30). The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.21 ac-ft). The facility could potentially be converted into a wet pond or wetland through expansion of the existing facility footprint and installation of a new riser structure.			

Photo 28 – Curb cut in parking lot

Photo 29 – BMP-1 Riser

Photo 30 – Vegetation within BMP-1



Notes:
1. Streams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 50 100 200 Feet
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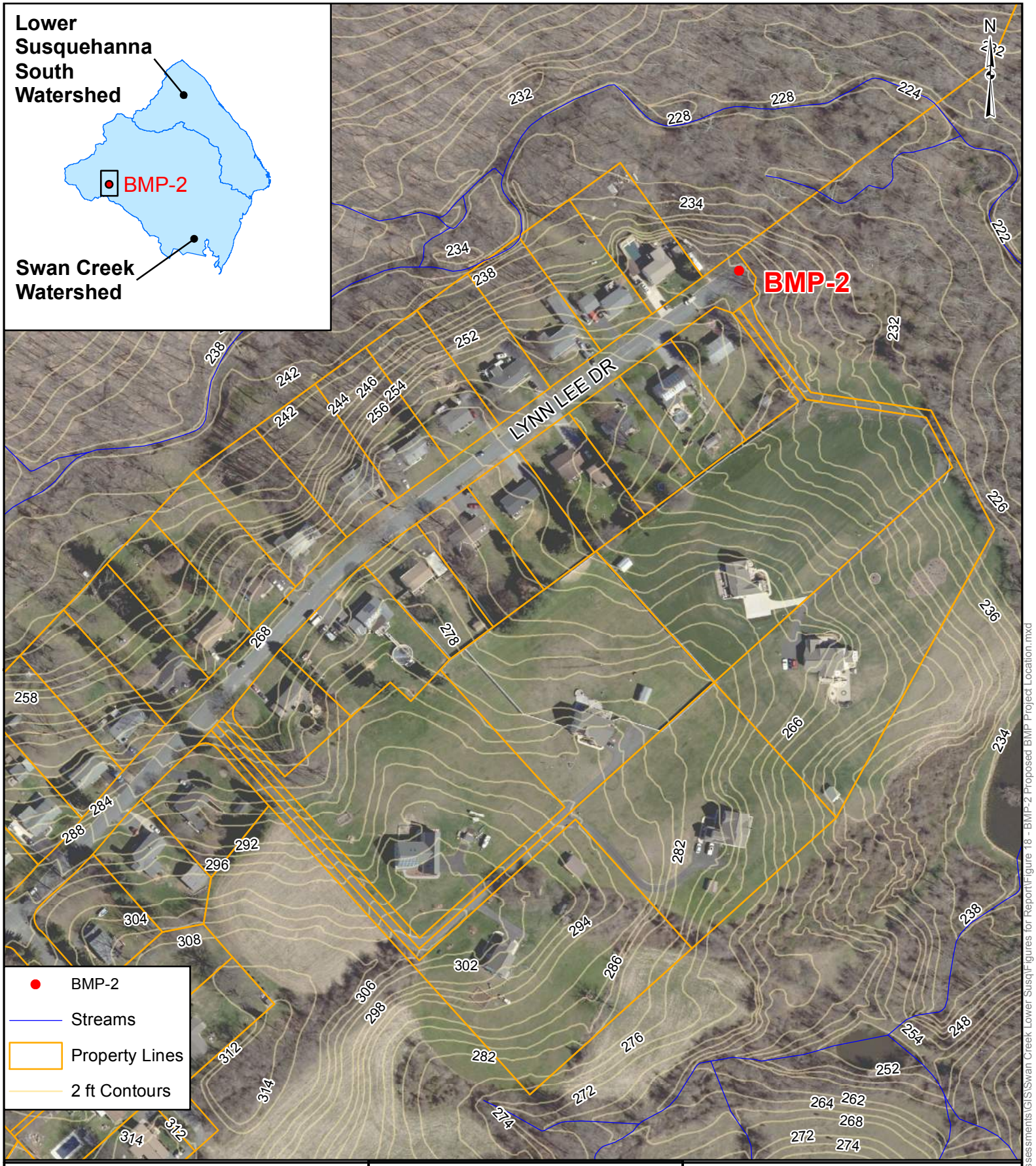
FIGURE 17
BMP-1
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 17 - BMP-1 Proposed BMP Project Location.mxd

Table 20 – BMP-2			
Name	Lynn Lee Drive Pond		
Proposed Approach	New BMP (Bioretention Basin)		
Sub-Watershed Location	SC-1		
TN/TP/TSS Pollutant Removal	18.3 lbs/yr	1.6 lbs/yr	1.4 tons/yr
Property Owner	Jackie Davis L		
Site Access	Via Lynn Lee Drive		
Existing Utility Conflicts	Sanitary Sewer on Lynn Lee Drive		
Total Project Cost	$149,000		
Drainage Area (ac.)	2.7		
Impervious Area (ac.)	1.1 (40.5%)		
Required WQv (ac-ft)	0.09		
Anticipated Proposed WQv (ac-ft)	0.24		
EX. Rainfall Depth Treated (in.)	0.0		
PR. Rainfall Depth Treated (in.)	2.6		
Impervious Acre Credits	1.5		
Description BMP-2 involves the construction of a new BMP downstream of a reinforced concrete outfall at the end of Lynn Lee Drive in Aberdeen, MD (Photo 31). The proposed BMP would be designed to treat 2.6 inches of rainfall runoff (0.24 ac-ft) from the adjacent development and road. The facility would outfall into an existing stream (Photo 32). Construction of the BMP would require extensive tree impacts. Considering the small contributing drainage area, the facility could potentially be converted into a bioretention facility.			

Photo 31 – Erosion at outfall

Photo 32 – Existing stream



Notes:
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3. 2 ft Contours from 2018 Harford County GIS

0 100 200 400 Feet
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FIGURE 18
BMP-2
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 18 - BMP-2 Proposed BMP Project Location.mxd

Table 21 – BMP-3			
Name	Level Volunteer Fire Department Pond		
Proposed Approach	New BMP (Bioretention Basin)		
Sub-Watershed Location	SC-4		
TN/TP/TSS Pollutant Removal	18.0 lbs/yr	1.2 lbs/yr	1.5 tons/yr
Property Owner	Level Volunteer Fire Company, Inc.		
Site Access	Via Level Rd		
Existing Utility Conflicts	Overhead Electrical, light poles near proposed pond. Electrical sub-station downstream of proposed pond.		
Total Project Cost	$213,000		
Drainage Area (ac.)	1.9		
Impervious Area (ac.)	1.7 (86.6%)		
Required WQv (ac-ft)	0.13		
Anticipated Proposed WQv (ac-ft)	0.34		
EX. Rainfall Depth Treated (in.)	0.0		
PR. Rainfall Depth Treated (in.)	2.6		
Impervious Acre Credits	2.3		
Description BMP-3 involves the construction of a new BMP south of the Level Volunteer Fire Company parking lot (Photo 33). The proposed BMP would entail construction of a curb and gutter system around the perimeter of the parking lot to collect overland flow and convey it into the facility. The BMP would be installed in a grass, open space area (Photo 34) and would be designed to treat 2.6 inches of rainfall runoff (0.34 ac-ft). Due to the small footprint of the proposed facility, the new BMP could potentially be an ESD facility such as a bioretention basin.			

Photo 33 – Fire Dept. parking lot

Photo 34 – Area for proposed bioretention facility

Notes:
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2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 50 100 200 Feet
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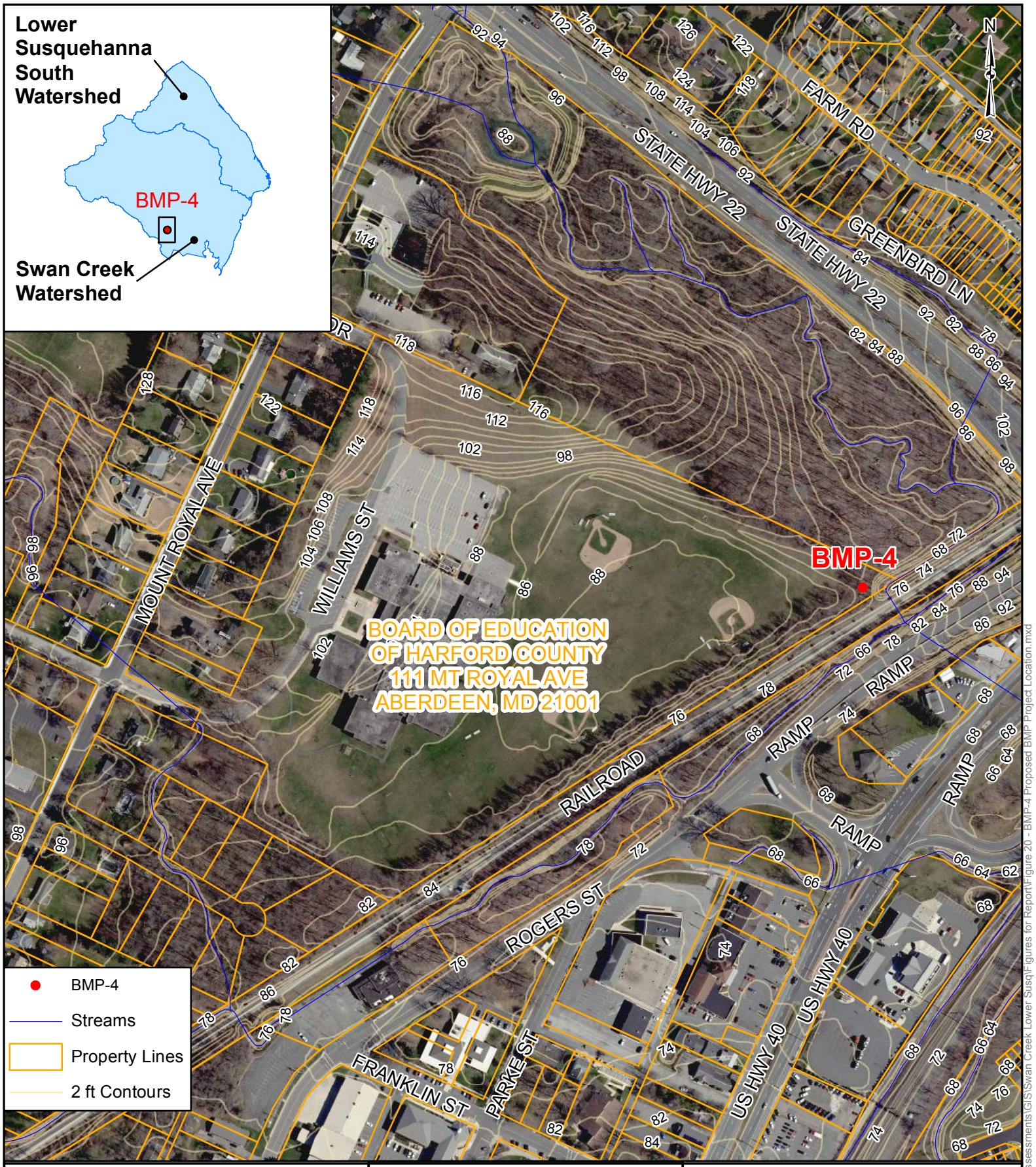
FIGURE 19
BMP-3
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 19 - BMP-3 Proposed BMP Project Location.mxd

Table 22 – BMP-4			
Name	Aberdeen Middle School Pond		
Proposed Approach	New BMP (Wet Pond)		
Sub-Watershed Location	SC-2		
TN/TP/TSS Pollutant Removal	86.5 lbs/yr	9.9 lbs/yr	11.0 tons/yr
Property Owner	Harford County Board of Education		
Site Access	Via Mount Royal Ave		
Existing Utility Conflicts	Sewer line adjacent to proposed pond		
Total Project Cost	$521,000		
Drainage Area (ac.)	20.9		
Impervious Area (ac.)	9.3 (44.4%)		
Required WQv (ac-ft)	0.78		
Anticipated Proposed WQv (ac-ft)	2.04		
EX. Rainfall Depth Treated (in.)	0.0		
PR. Rainfall Depth Treated (in.)	2.6		
Impervious Acre Credits	13.0		
Description BMP-4 involves the construction of a new BMP southeast of the Aberdeen Middle School baseball fields (Photo 35). Currently an existing storm drain network collects runoff from the school and adjacent fields and outfalls into a conveyance channel that parallels the railroad tracks. The proposed project would involve daylighting the existing storm drain network and constructing a new BMP to intercept and treat 2.6 inches of rainfall runoff (2.04 ac-ft). The facility would be installed in a grass and wooded area so some tree impacts would be required (Photo 36). It should be noted that there is a sanitary sewer network near the proposed SWM facility. The facility could potentially be constructed as a wet pond.			

Photo 35 – Aberdeen Middle School field

Photo 36 – Proposed location of BMP-4



Notes:
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3. 2 ft Contours from 2018 Harford County GIS

0 150 300 600 Feet
1 inch = 300 feet

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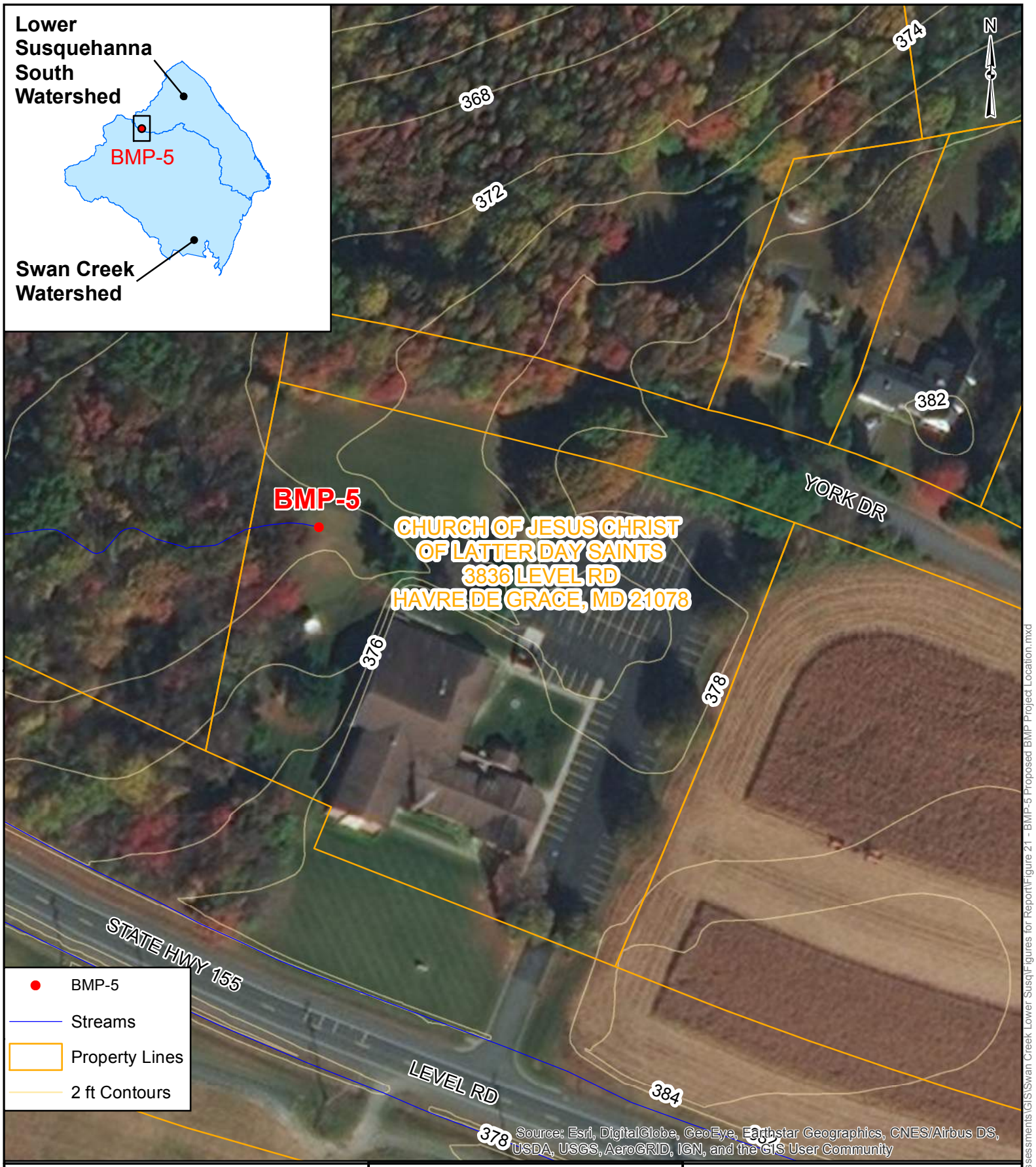
FIGURE 20
BMP-4
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 20 - BMP-4 Proposed BMP Project Location.mxd

Table 23 – BMP-5			
Name	LDS Church Pond Retrofit		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	LS-1		
TN/TP/TSS Pollutant Removal	14.1 lbs/yr	1.4 lbs/yr	1.4 tons/yr
Property Owner	Church of Jesus Christ of Latter Day Saints		
Site Access	Via Level Road		
Existing Utility Conflicts	Satellite dish adjacent to existing pond.		
Total Project Cost	$138,000		
Drainage Area (ac.)	3.9		
Impervious Area (ac.)	1.4 (35.9 %)		
Required WQv (ac-ft)	0.12		
Anticipated Proposed WQv (ac-ft)	0.12		
EX. Rainfall Depth Treated (in.)	0.0		
PR. Rainfall Depth Treated (in.)	1.0		
Impervious Acre Credits	1.4		
Description BMP-5 (SWM-0174 per County GIS data) is an existing detention basin located west of the Church of Jesus Christ Latter Day Saints off of Level Road. The facility receives runoff from the church and parking lot, as well as some of an adjacent farm. According to design plans (No. 820469 to 820473) the facility was constructed in 1982 to provide quantity control and does not appear to provide any water quality treatment. The facility was designed with a riprap pilot channel through the basin that outfalls into a concrete weir with gabion wing walls (Photos 37 & 38). The proposed design involves retrofitting the facility to provide 1.0 inch of rainfall runoff (0.12 ac-ft). The facility could potentially be converted into a wet pond if modifications are made to the riser structure.			

Photo 37 – Existing facility looking towards outlet

Photo 38 – BMP-5 outlet structure



Notes:
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0 50 100 200 Feet

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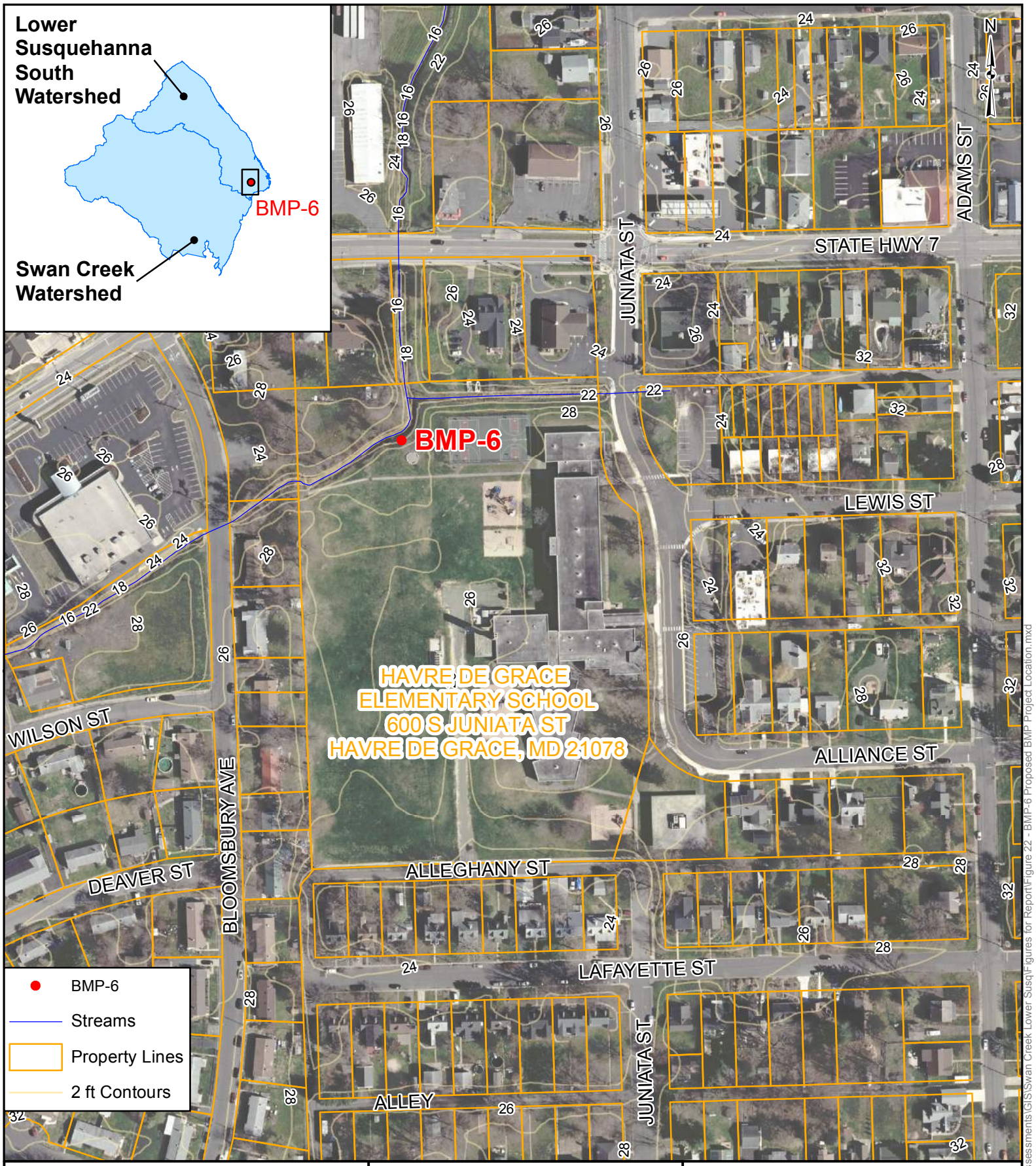
FIGURE 21
BMP-5
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 21 - BMP-5 Proposed BMP Project Location.mxd

Table 24 – BMP-6			
Name	Havre de Grace Elementary Pond		
Proposed Approach	New BMP (Bioretention Basin)		
Sub-Watershed Location	LS-6		
TN/TP/TSS Pollutant Removal	67.8 lbs/yr	8.6 lbs/yr	7.8 tons/yr
Property Owner	Harford County Board of Education		
Site Access	Via S. Juniata Street		
Existing Utility Conflicts	None		
Total Project Cost	$474,000		
Drainage Area (ac.)	17.0		
Impervious Area (ac.)	5.8 (34.2%)		
Required WQv (ac-ft)	0.51		
Anticipated Proposed WQv (ac-ft)	1.32		
EX. Rainfall Depth Treated (in.)	0.0		
PR. Rainfall Depth Treated (in.)	2.6		
Impervious Acre Credits	8.1		
Description BMP-6 involves the construction of a new BMP west of the Havre de Grace Elementary School basketball courts. Currently, an existing storm drain network collects runoff from the school and neighboring field and outfalls into a stream (Photo 39). The proposed project would involve daylighting the existing storm drain network and constructing a new BMP to intercept and treat the runoff. The facility would be installed in a grass, open space area (Photo 40) and would be designed to treat 2.6 inches of rainfall runoff (1.32 ac-ft). Due to the small footprint of the proposed facility, the new BMP could potentially be an ESD facility such as a bioretention basin.			

Photo 39 – Outfall to stream

Photo 40 – Proposed location of new SWM facility



Notes:
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0 90 180 360 Feet
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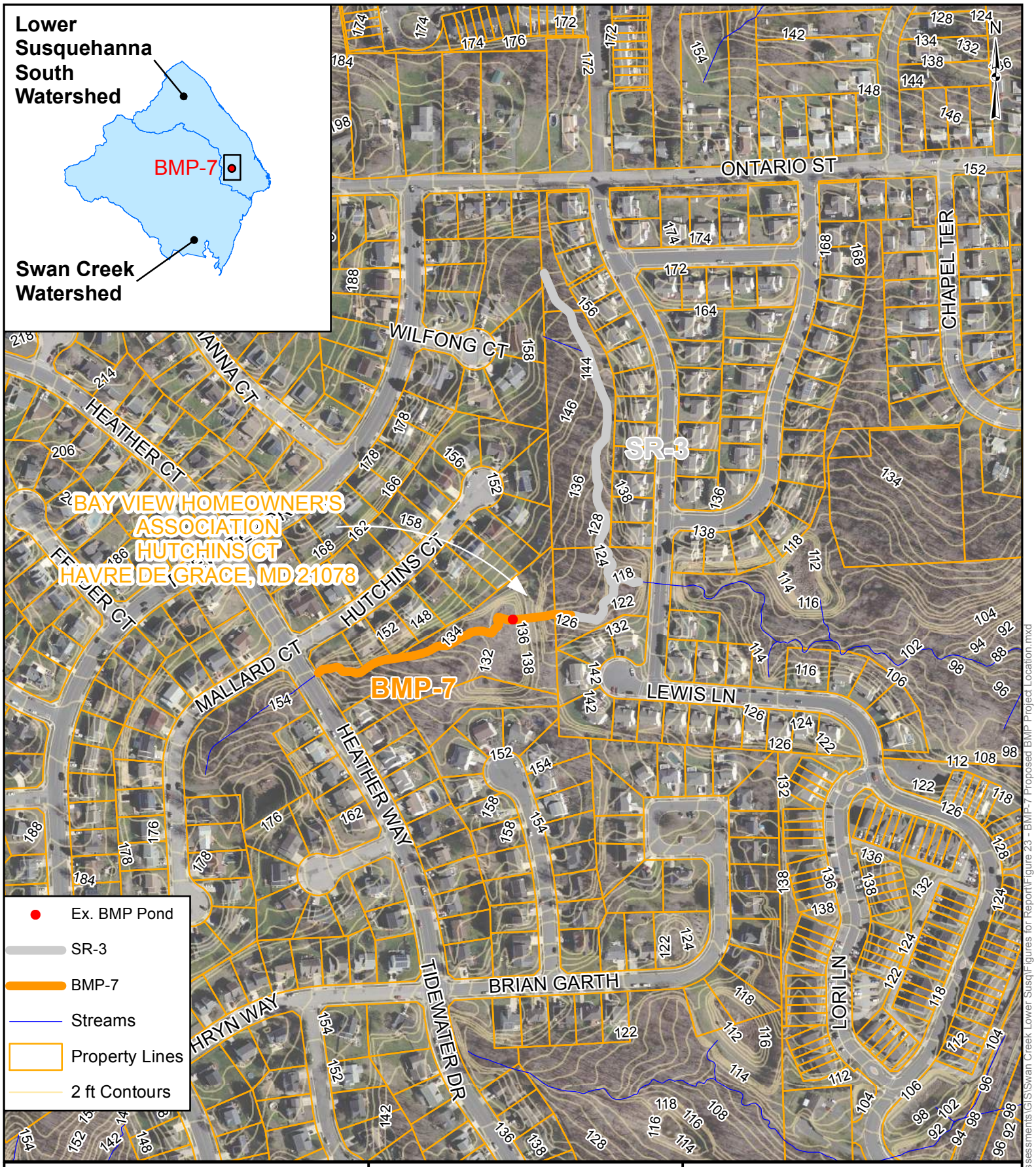
FIGURE 22
BMP-6
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 22 - BMP-6 Proposed BMP Project Location.mxd

Table 25 – BMP-7			
Name	Bay View HOA SPSC		
Proposed Approach	Decommission Existing Facility - SPSC		
Sub-Watershed Location	LS-6		
TN/TP/TSS Pollutant Removal	145.3 lbs/yr	17.7 lbs/yr	17.3 tons/yr
Property Owner	Bay View HOA, Inc.		
Site Access	Via Heather Way		
Existing Utility Conflicts	Sewer and Water along Hutchins Ct, Grace Manor Drive, Lewis Lane, Heather Way		
Total Project Cost	$574,000		
Drainage Area (ac.)	37.3		
Impervious Area (ac.)	13.5 (36.2%)		
Required WQv (ac-ft)	1.17		
Anticipated Proposed WQv (ac-ft)	3.04		
EX. Rainfall Depth Treated (in.)	0.0		
PR. Rainfall Depth Treated (in.)	2.6		
Impervious Acre Credits	18.9		
Description BMP-7 is an existing SWM facility built prior to 1995 per aerial imagery that is located south of Hutchins Court. The pond is an in-line facility that receives runoff from the Bay View Estates neighborhood and an outfall along Heather Way (Photo 41). As-built plans for the facility could not be obtained, however, field investigation revealed that the facility is vegetated with a corrugated metal riser (Photo 42). The proposed design approach involves breaching the existing embankment and installing a SPSC system to safely convey large storm events and treat 2.6 inches of rainfall runoff (3.04 ac-ft). It should be noted that this project is adjacent to proposed stream restoration site SR-3 (Section 4.2.4) and both sites could be designed, permitted and constructed as one project.			

Photo 41 – Outfall from Heather Way

Photo 42 – Existing SWM facility and riser



Notes:
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3. 2 ft Contours from 2018 Harford County GIS

0 150 300 600 Feet
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FIGURE 23
BMP-7
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Figure 23 - BMP-7 Proposed BMP Project Location.mxd

Table 26 – Proposed BMP Projects											
Project ID	**Name**	**Sub-Watershed**	**BMP Type**	**Drainage Area (ac.)**	**Property Owner**	**Pollutant Reduction**			**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
						TN (lbs/yr)	**TP (lbs/yr)**	**TSS (tons/yr)**			
Swan Creek Watershed											
BMP-1	Stack & Store Pond Retrofit	SC-7	Existing SWM Retrofit	5.9	HDG Realty, LLC	3.6	0.4	0.5	$125,000	1.3	$100,000
BMP-2	Lynn Lee Drive Pond	SC-1	New BMP	2.7	Jackie L Davis	18.3	1.6	1.4	$149,000	1.5	$98,000
BMP-3	Level Volunteer Fire Department Pond	SC-4	New BMP	1.9	Level Volunteer Fire Company, Inc.	18.0	1.2	1.5	$213,000	2.3	$92,000
BMP-4	Aberdeen Middle School Pond	SC-2	New BMP	20.9	Harford Co. Board of Ed.	86.5	9.9	11.0	$521,000	13.0	$40,000
Swan Creek Total						**126.5**	**13.2**	**14.4**	**$1,008,000**	**18.09**	**$56,000**
Lower Susquehanna South Watershed											
BMP-5	LDS Church Pond Retrofit	LS-1	Existing SWM Retrofit	3.9	Church of Jesus Christ of Latter Day Saints	14.1	1.4	1.4	$138,000	1.4	$99,000
BMP-6	Havre de Grace Elementary Pond	LS-6	New BMP	17.0	Harford Co. Board of Ed.	67.8	8.6	7.8	$474,000	8.1	$58,000
BMP-7	Bay View HOA SPSC	LS-6	SPSC System	37.3	Bay View HOA, Inc.	145.3	17.7	17.3	$574,000	18.9	$30,000
Lower Susquehanna South Total						**227.2**	**27.7**	**26.5**	**$1,186,000**	**28.4**	**$42,000**

4.4. Revised Watershed Pollutant Loading Rates

A summary of the revised pollutant loading rates for each sub-watershed (Table 27), and for the Swan Creek and Lower Susquehanna South Watersheds (Table 28) are provided below. The greatest pollutant and sediment reductions in the Swan Creek Watershed occurred in Sub-Watersheds SC-5, SC-7 and SC-9 due to the presence of degraded channels and existing SWM facilities with potential for retrofit. Sub-Watershed SC-1 has one of the highest total annual pollutant loading rates within the watershed; however, because of its large size and low impervious area, there are limited opportunities for structural and non-structural BMP implementation. The greatest pollutant and sediment reductions in the Lower Susquehanna South Watershed occurred in Sub-Watershed LS-6 due to the high impervious area and a large amount of existing stormwater controls with potential for retrofit. The remainder of the Lower Susquehanna South Sub-Watersheds have a low amount of impervious area and therefore limited opportunities were identified.

It should be noted that the pollutant and sediment load reductions listed in Tables 27 and 28 do not fully reflect the realized benefit the proposed restoration projects will have on the Swan Creek and Lower Susquehanna South Watersheds. Current TMDL accounting guidelines (Schueler and Stack, 2014) limit the amount of pollutant and sediment reduction credits for stream restoration projects to one half of the total annual pollutant and sediment loadings to account for project inefficiencies and naturally occurring erosional processes. The proposed stream restoration methodologies; however, are highly efficient at reducing in-channel bank erosion and capturing sediment from unstable upland sources, resulting in increased sediment reduction efficiencies and decreased annual sediment loads within the sub-watersheds.

Table 27 – Summary of Sub-Watershed Pollutant Reduction & Efficiency									
Sub-Watershed	**Annual Pollutant Loads**			**Annual Pollutant Reduction from Restoration Projects**			**Percent Reduction of Annual Pollutant Loads**		
	TN	**TP**	**TSS**	**TN**	**TP**	**TSS**	**TN**	**TP**	**TSS**
	(lbs/yr)	**(lbs/yr)**	**(tons/yr)**	**(lbs/yr)**	**(lbs/yr)**	**(tons/yr)**	**(%)**	**(%)**	**(%)**
Swan Creek Watershed									
SC-1	20,264.9	997.4	638.6	18.3	1.6	1.4	0.1	0.2	0.2
SC-2	23,042.9	1,080.3	635.4	18.0	1.2	1.5	0.1	0.1	0.2
SC-3	10,448.8	455.3	259.9	0.0	0.0	0.0	0.0	0.0	0.0
SC-4	13,534.6	767.1	559.1	0.0	0.0	0.0	0.0	0.0	0.0
SC-5	9,825.3	666.1	520.6	86.5	9.9	11.0	0.9	1.5	2.1
SC-6	5,436.9	326.8	208.1	0.0	0.0	0.0	0.0	0.0	0.0
SC-7	10,328.0	602.5	497.1	266.1	238.4	26.7	2.6	39.6	5.4
SC-8	5,427.0	283.6	222.7	0.0	0.0	0.0	0.0	0.0	0.0
SC-9	14,771.6	830.3	644.3	120.8	109.5	12.1	0.8	13.2	1.9
Swan Creek Total	**113,080.0**	**6,009.4**	**4,185.8**	**509.7**	**360.7**	**52.7**	**0.5**	**6.0**	**1.3**
Lower Susquehanna South Watershed									
LS-1	16,911.3	612.2	484.8	14.1	1.4	1.4	0.1	0.2	0.3
LS-2	1,139.0	31.5	26.3	0.0	0.0	0.0	0.0	0.0	0.0
LS-3	5,696.5	288.2	203.2	0.0	0.0	0.0	0.0	0.0	0.0
LS-4	3,634.9	117.9	89.7	0.0	0.0	0.0	0.0	0.0	0.0
LS-5	3,446.1	143.3	144.6	0.0	0.0	0.0	0.0	0.0	0.0
LS-6	20,982.1	1408.4	1,192.5	606.9	383.3	116.2	2.9	27.2	9.7
Lower Susquehanna South Total	**51,809.9**	**2,601.4**	**2,141.0**	**621.0**	**384.7**	**117.6**	**1.2**	**14.8**	**5.5**

Table 28 – Watershed Pollutant Removal & Impervious Acre Summary			
Pollutant/ Impervious Area	**Total Watershed Pollutant Loading**	**Total Pollutant Load Removal for Completed Projects**	**Removal Efficiency (%)**
Swan Creek Watershed			
TN (lbs/yr)	113,080.1	509.7	0.5
TP (lbs/yr)	6,009.3	360.7	6.0
TSS (tons/yr)	4,185.9	52.7	1.3
Impervious Area (Acres)	2,383.2	118.8	5.0
Lower Susquehanna South Watershed			
TN (lbs/yr)	51,809.9	621.0	1.2
TP (lbs/yr)	2,601.4	384.7	14.8
TSS (tons/yr)	2,141.0	117.6	5.5
Impervious Area (Acres)	1,165.2	167.8	14.4

The proposed projects for the Swan Creek Watershed would reduce TN by 509.7 pounds per year or 0.5 percent, TP by 360.7 pounds per year or 6.0 percent, and TSS by 52.7 tons per year or 1.3 percent. The total impervious area treated is 118.8 acres or 5.0 percent of the total impervious area within the Swan Creek Watershed.

The proposed projects for the Lower Susquehanna South Watershed would reduce TN by 620.9 pounds per year or 1.2 percent, TP by 384.7 pounds per year or 14.8 percent, TSS by 117.4 tons per year or 5.5 percent. The total impervious area treated is 167.8 acres or 14.4 percent of the total impervious area within the Lower Susquehanna South Watershed.

4.5. Project Prioritization

As mentioned in Section 4.1, prioritization of stream and BMP projects was based on several factors including location within the watershed, pollutant reduction and impervious acre credits, property ownership, site access, existing utility conflicts and design and construction costs. High priority projects are located within severely degraded systems and sub-watersheds, have favorable site access and property ownership, are eligible for pollutant reduction and impervious acre credits, and are cost efficient. Proposed projects in order of prioritization are listed in Table 30.

Within the Swan Creek Watershed, stream restoration project SR-2 and SWM project BMP-4 are the highest priorities due to their large amount of impervious acre credits, the low cost per acre treated, and their location on Harford County property.
Within the Lower Susquehanna South Watershed, stream restoration project SR-4 and SR-3 are the highest priorities. SR-4 includes the restoration of the stream running

through McLhinney Park in Havre de Grace. The location on Harford County property and the high amount of impervious credits available make this a high priority project. SR-3 includes the restoration of the stream running through property owned by the Grace Manor Homeowner's Association. The project is a high priority project since there is only one property owner and a low cost per impervious area treated. As noted previously in Section 4.3.4, BMP-7 and SR-3 in the Bay View and Grace Manor HOA properties could be designed, permitted and constructed as one project.

Table 29 – Project Prioritization										
Project Ranking	**Project ID**	**Sub-Watershed**	**Type**	**Owner**	**TN (lbs/yr)**	**TP (lbs/yr)**	**TSS (tons/yr)**	**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
Swan Creek Watershed										
1	SR-2	SC-7	Stream Restoration – Riffle Pool System	Harford County; Griffith H Davis and Deborah B L Davis	262.5	238.0	26.3	$2,275,000	70.0	$33,000
2	BMP-4	SC-5	New SWM BMP	Harford County Board of Education	86.5	9.9	11.0	$521,000	13.0	$40,000
3	SR-1	SC-9	Stream Restoration – Step Pool Weir System	Ward Management, Inc.; Morgan L Hileman; Larry Marshall Thomas and Deborah Ann Thomas; Vincent Diaz; Richard E Shepler and Lynn C Shepler	120.8	109.5	12.1	$1,320,000	32.2	$41,000
4	BMP-3	SC-2	New SWM BMP	Level Volunteer Fire Dept., Inc.	18.0	1.2	1.5	$213,000	2.3	$92,000
5	BMP-1	SC-7	Existing BMP Retrofit	HDG Realty, Inc.	3.6	0.4	0.5	$125,000	1.3	$100,000
6	BMP-2	SC-1	New SWM BMP	Jackie Davis L	18.3	1.6	1.4	$149,000	1.5	$98,000
				Swan Creek Total	**509.7**	**360.7**	**52.7**	**$4,603,000**	**120.3**	**$38,000**

Table 29 – Project Prioritization										
Project Ranking	**Project ID**	**Sub-Watershed**	**Type**	**Owner**	**TN (lbs/yr)**	**TP (lbs/yr)**	**TSS (tons/yr)**	**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
Lower Susquehanna South Watershed										
1	SR-4	LS-6	Stream Restoration – Riffle Pool System	Mayor and City Council, Havre de Grace; A&M Properties; PECO Energy and Power Company	135.8	123.1	13.6	$1,177,000	36.2	$33,000
2	SR-3	LS-6	Stream Restoration – Step Pool Weir System	Grace Manor HOA, Inc.	79.5	72.1	23.9	$875,000	31.8	$28,000
3	SR-5	LS-6	Stream Restoration – Step Pool Weir System	Grace Harbour HOA, Inc.; Laura L Druyor and Douglas D Druyor JR; William N Le Brun and Barbara Le Brun; Michael Lee Zellman and Beth Hamilton; Augusto D Barretto; Wilfredo J Cruz;	178.5	161.8	53.6	$1,964,000	71.4	$28,000

Table 29 – Project Prioritization										
Project Ranking	**Project ID**	**Sub-Watershed**	**Type**	**Owner**	**TN (lbs/yr)**	**TP (lbs/yr)**	**TSS (tons/yr)**	**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
				Timothy Brammer JR; Raymond Caldwell; Donald Kinsey						
4	BMP-7	LS-6	SPSC System	Bay View HOA, Inc.	145.3	17.7	17.3	$574,000	18.9	$30,000
5	BMP-6	LS-6	New SWM BMP	Harford County Board of Education	67.8	8.6	7.8	$474,000	8.1	$58,000
6	BMP-5	LS-1	Existing BMP Retrofit	Church of Jesus Christ of LDS	14.1	1.4	1.4	$138,000	1.4	$99,000
Lower Susquehanna South Total					**621.0**	**384.7**	**117.6**	**$5,200,000**	**167.8**	**$31,000**

5. IMPLEMENTATION SCHEDULE

Projects shall be implemented according to the prioritization rankings established in Section 4.5. The number of projects in the different phases of design, construction, and post-construction monitoring may vary from year to year and will depend on available County resources. Although design and construction timelines for BMP and stream restoration projects are highly variable due to site specific factors such as access, property ownership, environmental impacts, permitting, utilities, and design methodology, typical timelines for design, permitting and construction for BMP projects is one and a half to two years. Typical timelines for design, permitting, utilities for stream restoration projects is two and a half to three years. Each project will be monitored, and the efficacy of design techniques and methodologies will be evaluated. This on-going analysis will allow future projects and techniques to be adapted to changing conditions and allow for better allocation of resources to areas and projects with the highest probability of success.

6. CONCLUSION

The LWAP for the Swan Creek and Lower Susquehanna South Watersheds has identified potential projects to assist the County in meeting its TMDL and MS4 permit requirements. The recommendations in this plan are based on the results of previous watershed studies, desktop analysis and field assessment which targeted the developed areas of the watersheds where the effects of unmanaged stormwater runoff are a primary concern. Prioritization of stream and BMP projects was based on several factors including location within the watershed, pollutant reduction and impervious acre credits, site access, property ownership, and design and construction costs.

In the Swan Creek Watershed, two stream restoration projects, three new stormwater BMPs, and one stormwater retrofit are proposed. Implementation of all proposed projects in the Swan Creek Watershed would reduce TN by 509.7 pounds per year or 0.5 percent, TP by 360.7 pounds per year or 6.0 percent, TSS by 52.7 tons per year or 1.3 percent. The total impervious area treated by all of the projects is 118.8 acres or 5.0 percent of the total impervious area within the Swan Creek Watershed. The total cost for all proposed projects is estimated to be $4,603,000 with a cost per acre treated of $38,000. This cost includes design, permitting, and construction.

In the Lower Susquehanna South Watershed, three stream restoration projects, one new stormwater BMP, and two existing BMP retrofits are proposed. Implementation of all proposed projects in the Lower Susquehanna South Watershed would reduce TN by 620.9 pounds per year or 1.2 percent, TP by 384.7 pounds per year or 14.8 percent, TSS by 117.4 tons per year or 5.5 percent. The total impervious area treated by all of the projects is 167.8 acres or 14.4 percent of the total impervious area within the Lower Susquehanna South Watershed. The total cost for all proposed projects is estimated to be $5,202,000 with a cost per acre treated of $31,000. This cost includes design, permitting and construction.

Since this LWAP represents the current understanding of the overall condition and impairments to the watersheds, it should be reevaluated at regular intervals to assess its progress towards meeting TMDL and MS4 permit requirements. In addition, lessons learned from the implementation of projects in surrounding watersheds may be incorporated in this assessment.

7. REFERENCES

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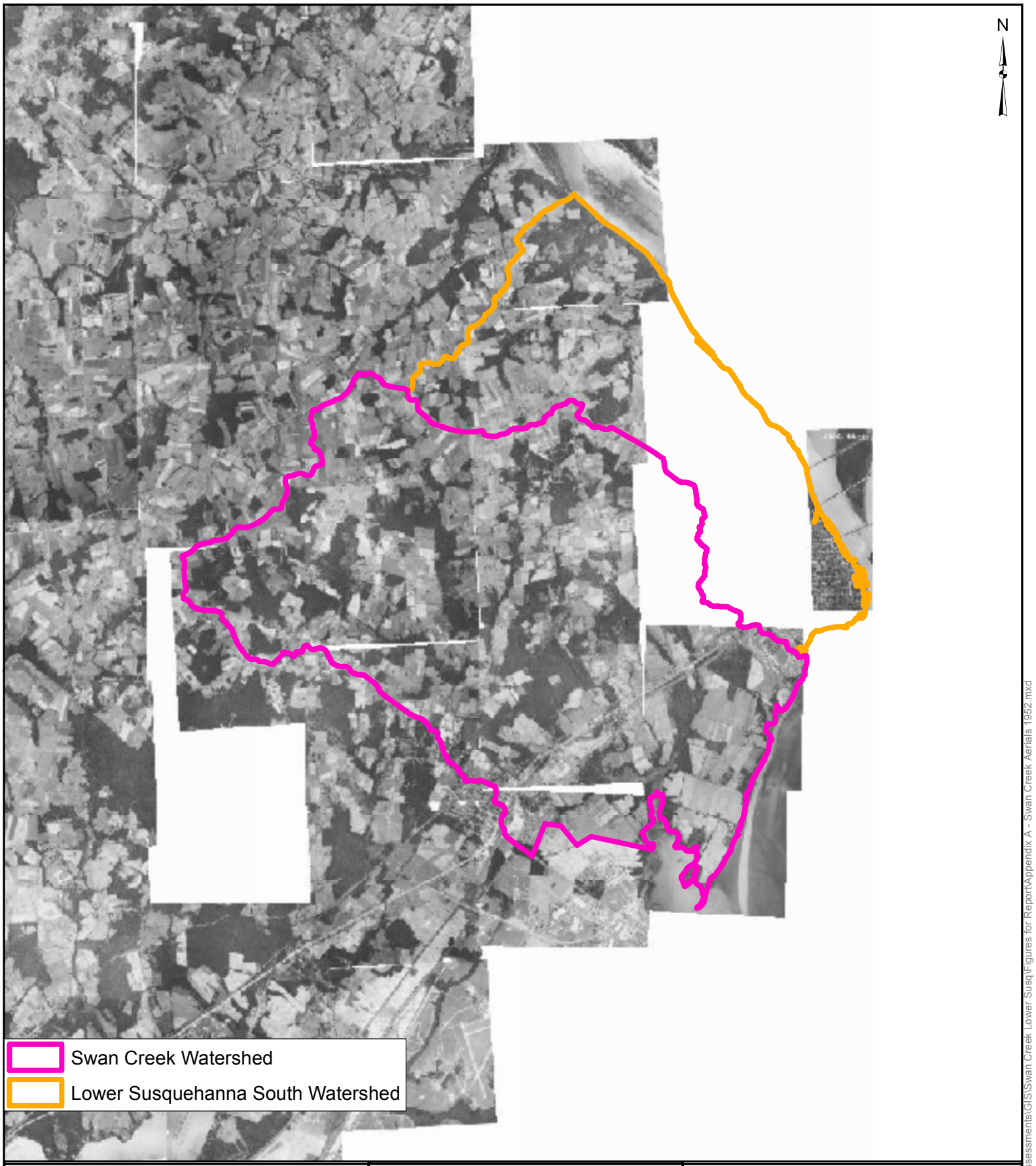
APPENDIX A

Historic Aerial Imagery



Notes:
1. 1952 Historic Aerial Photography from 2015 Harford County GIS

0 0.75 1.5 3 Miles
1 inch = 1.5 miles

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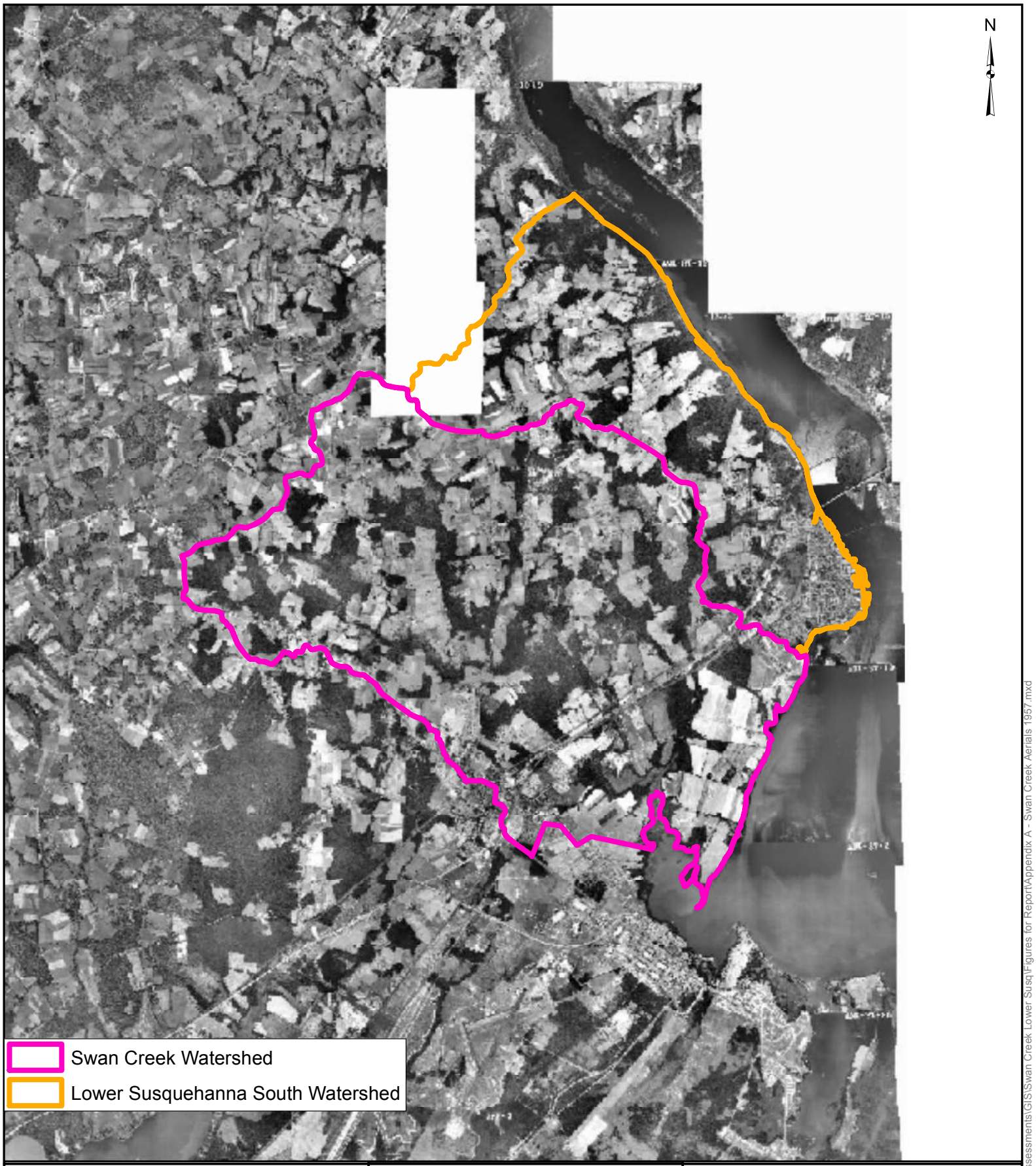
APPENDIX A
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH, 1952

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Appendix A - Swan Creek Aerials 1952.mxd



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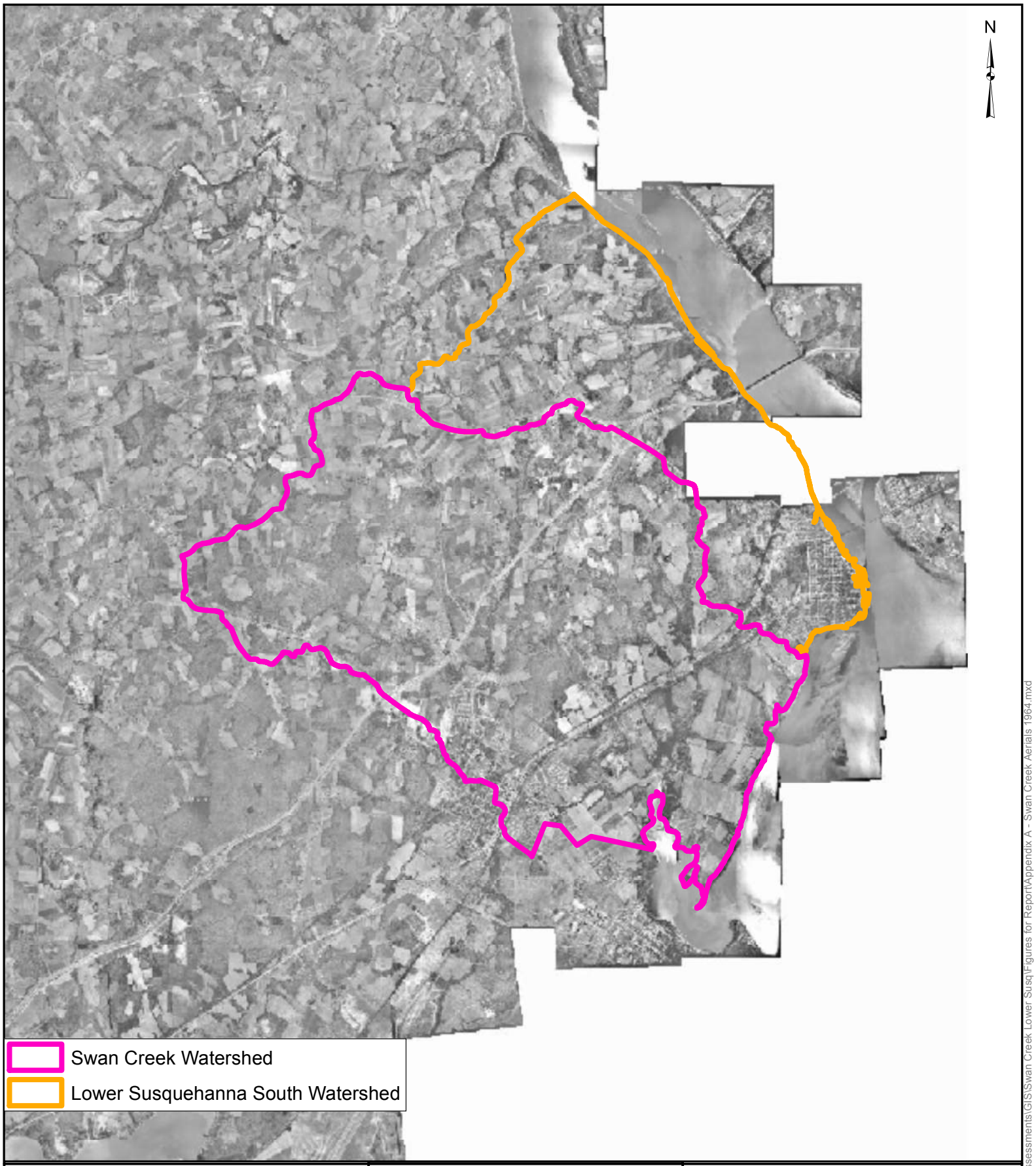

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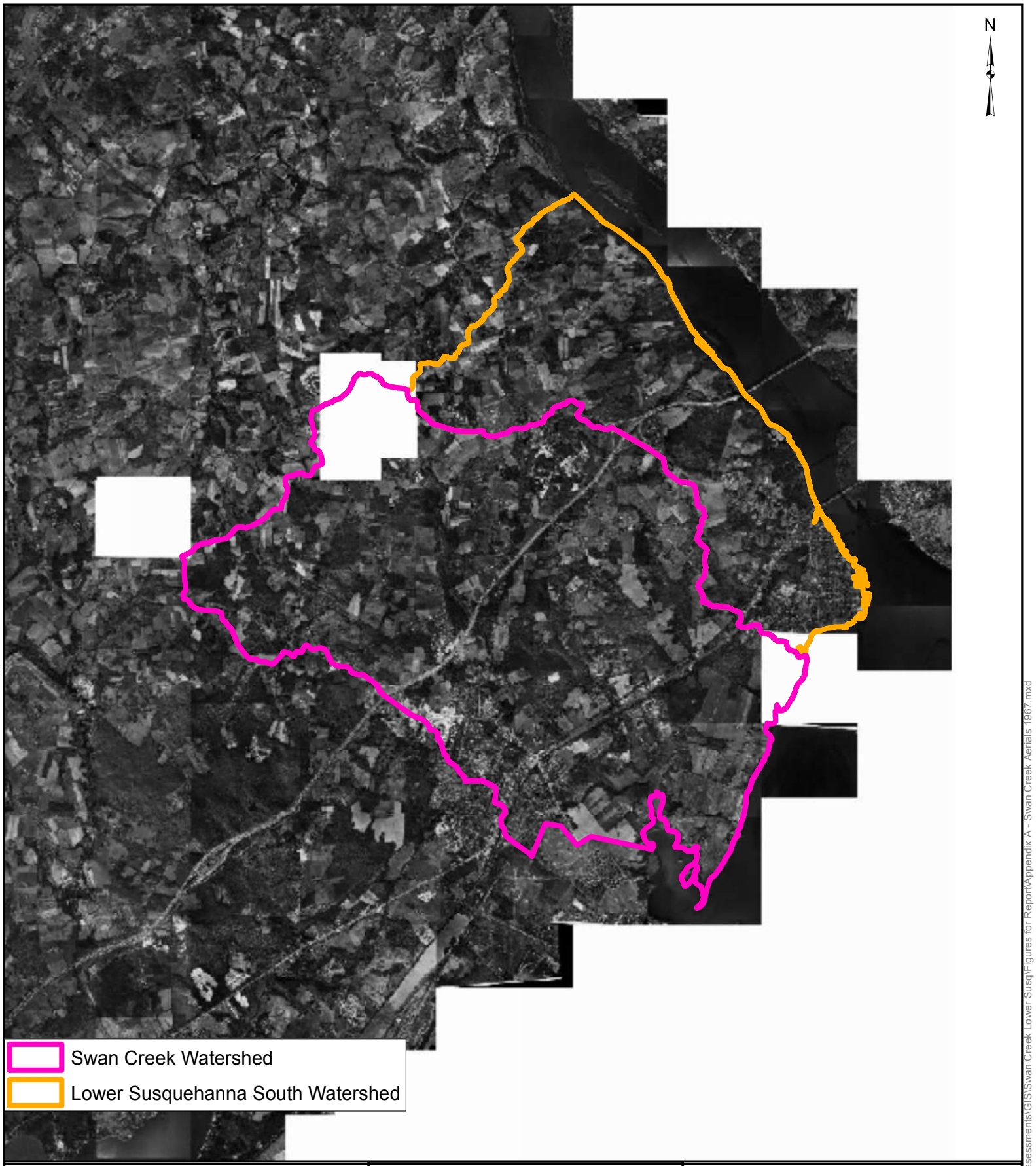

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SWAN CREEK AND
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SOUTH, 1967

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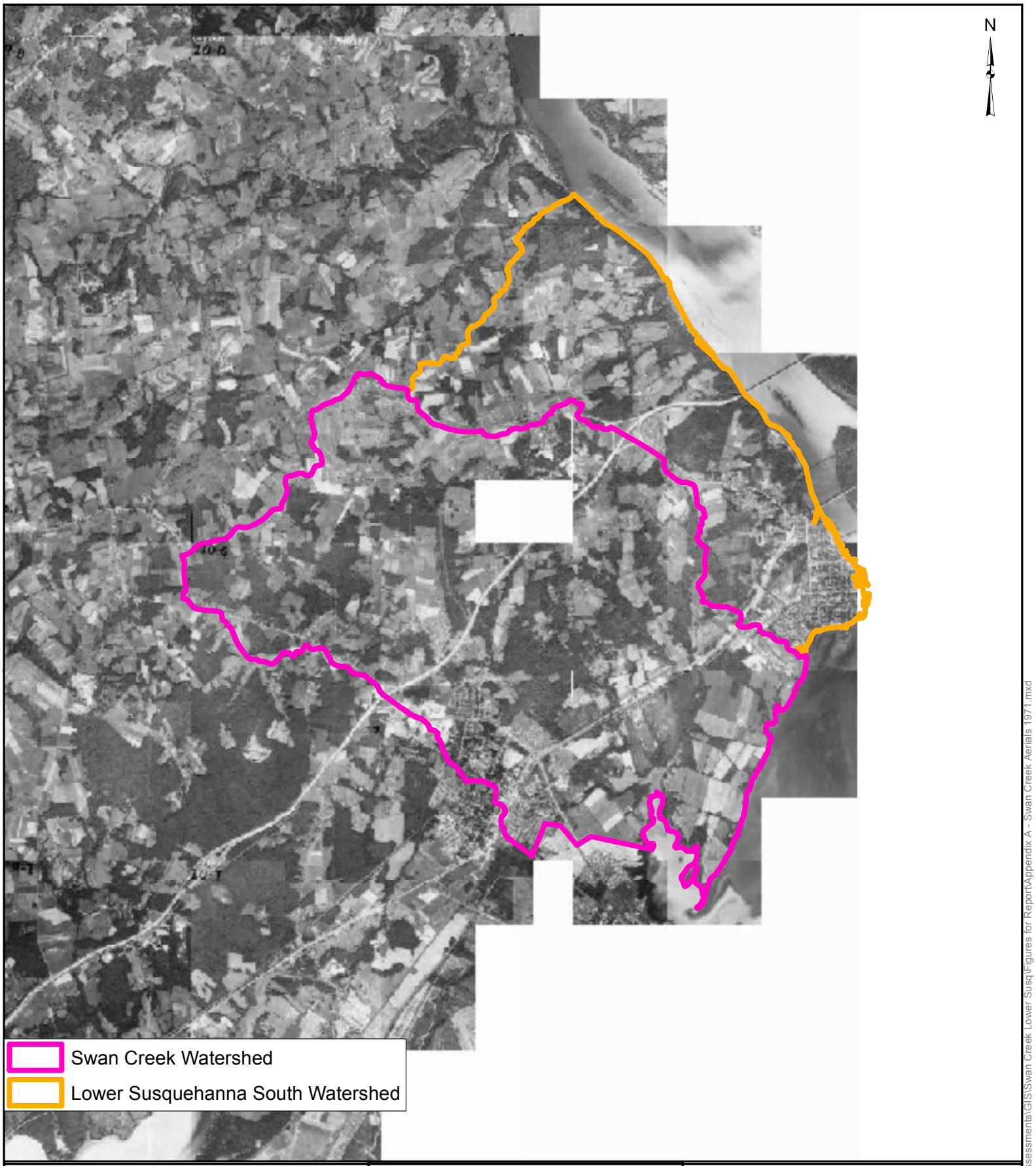

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SOUTH, 1971

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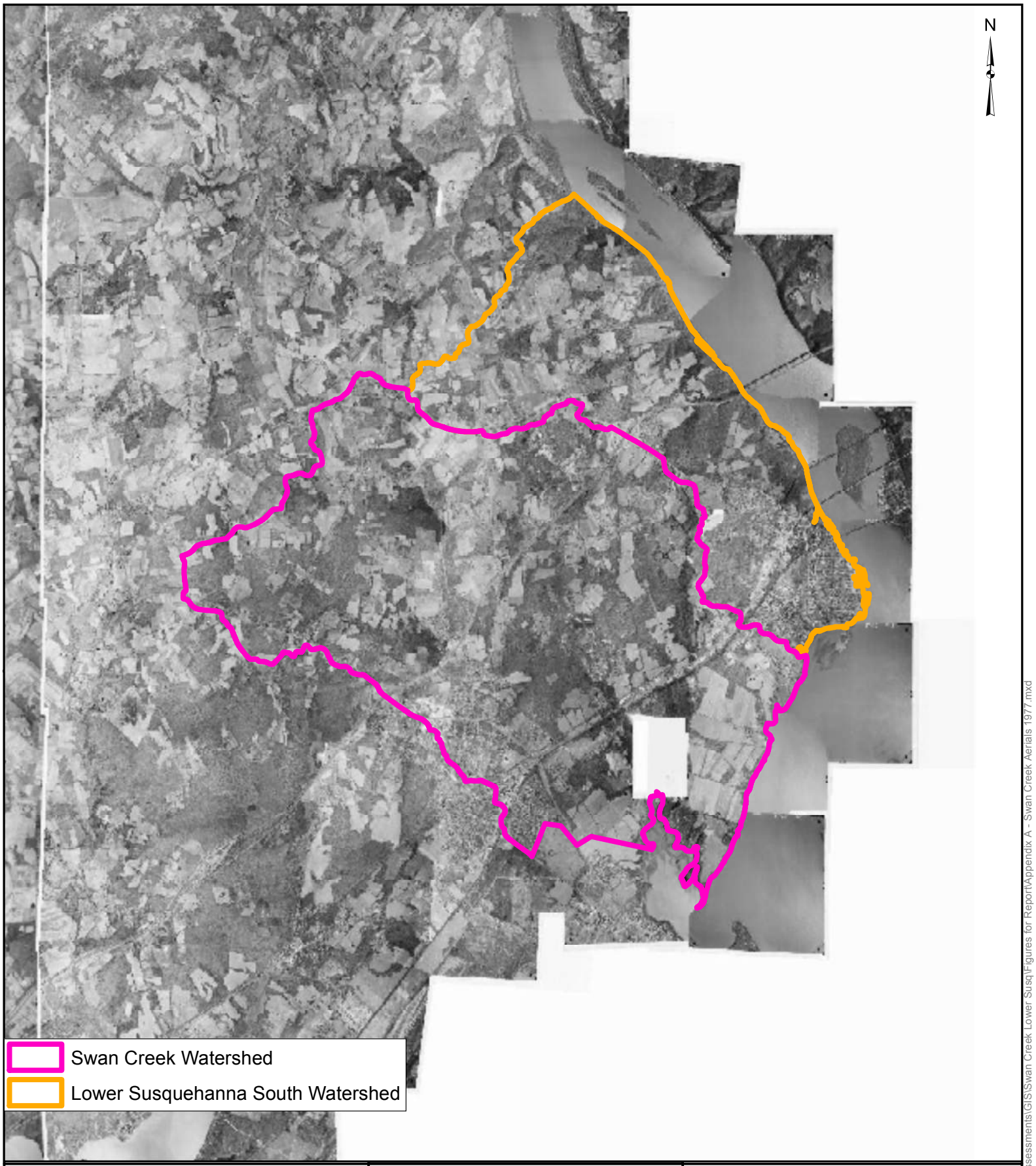

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SOUTH, 1977

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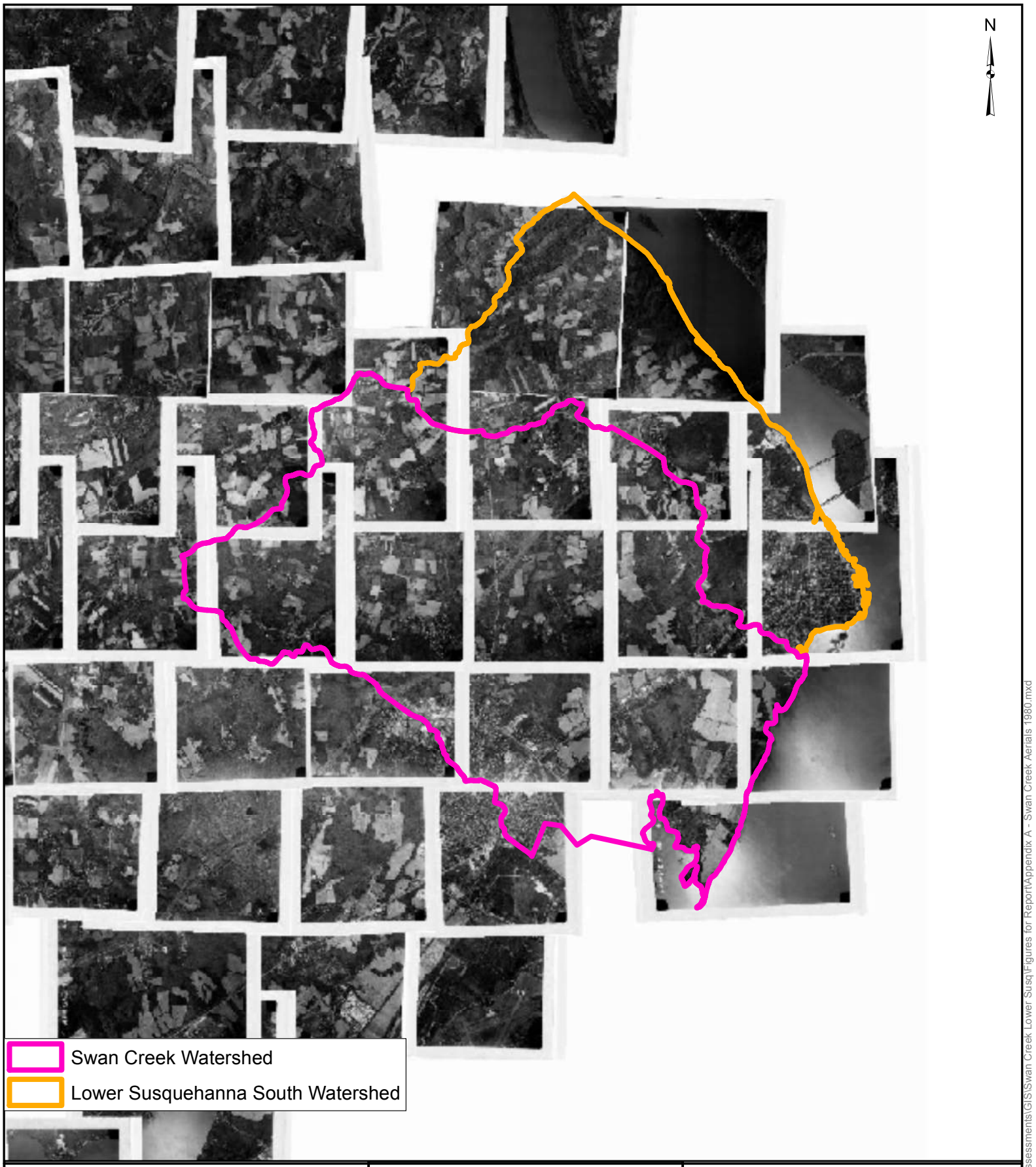

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SOUTH, 1980

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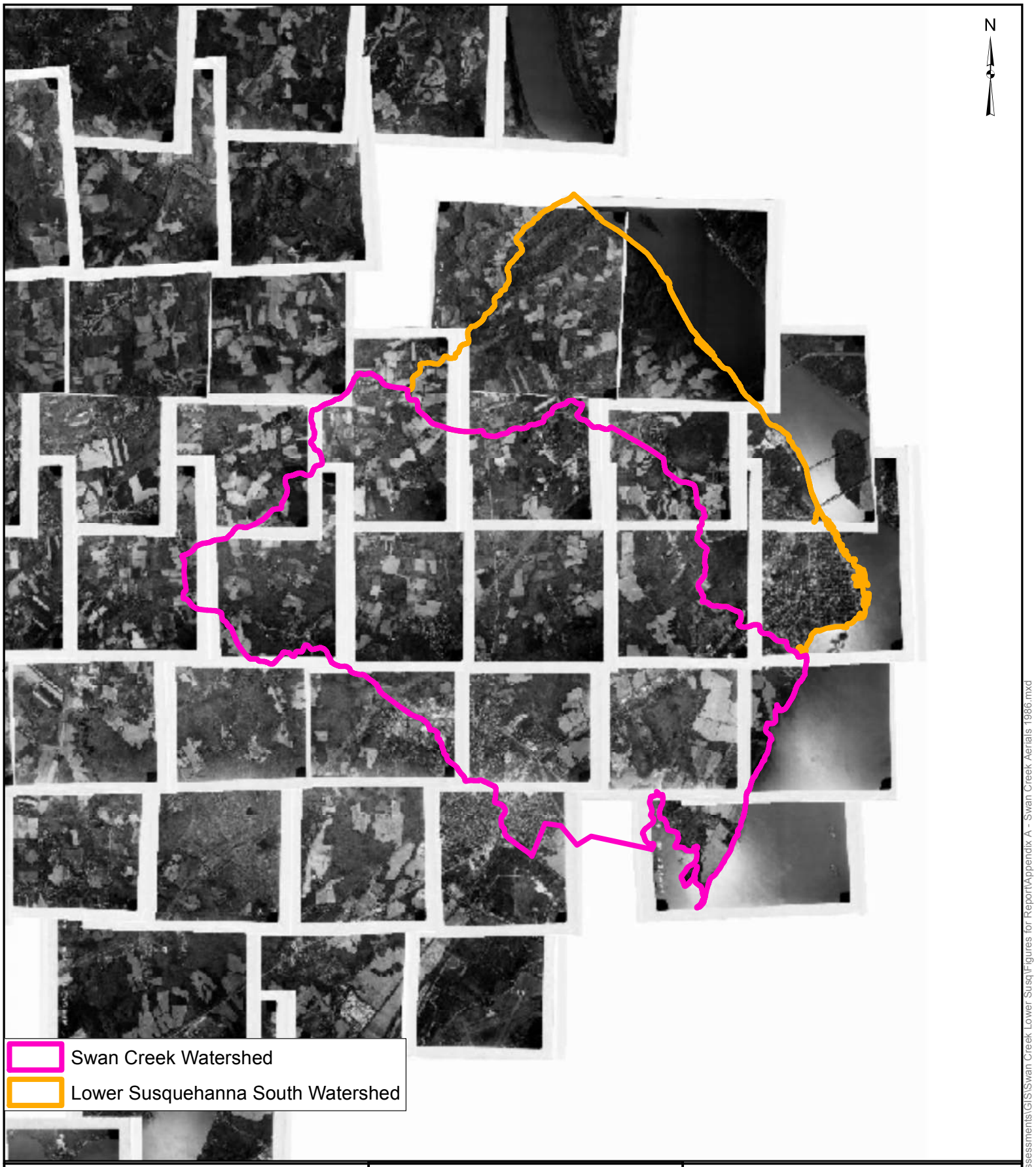

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SOUTH, 1986

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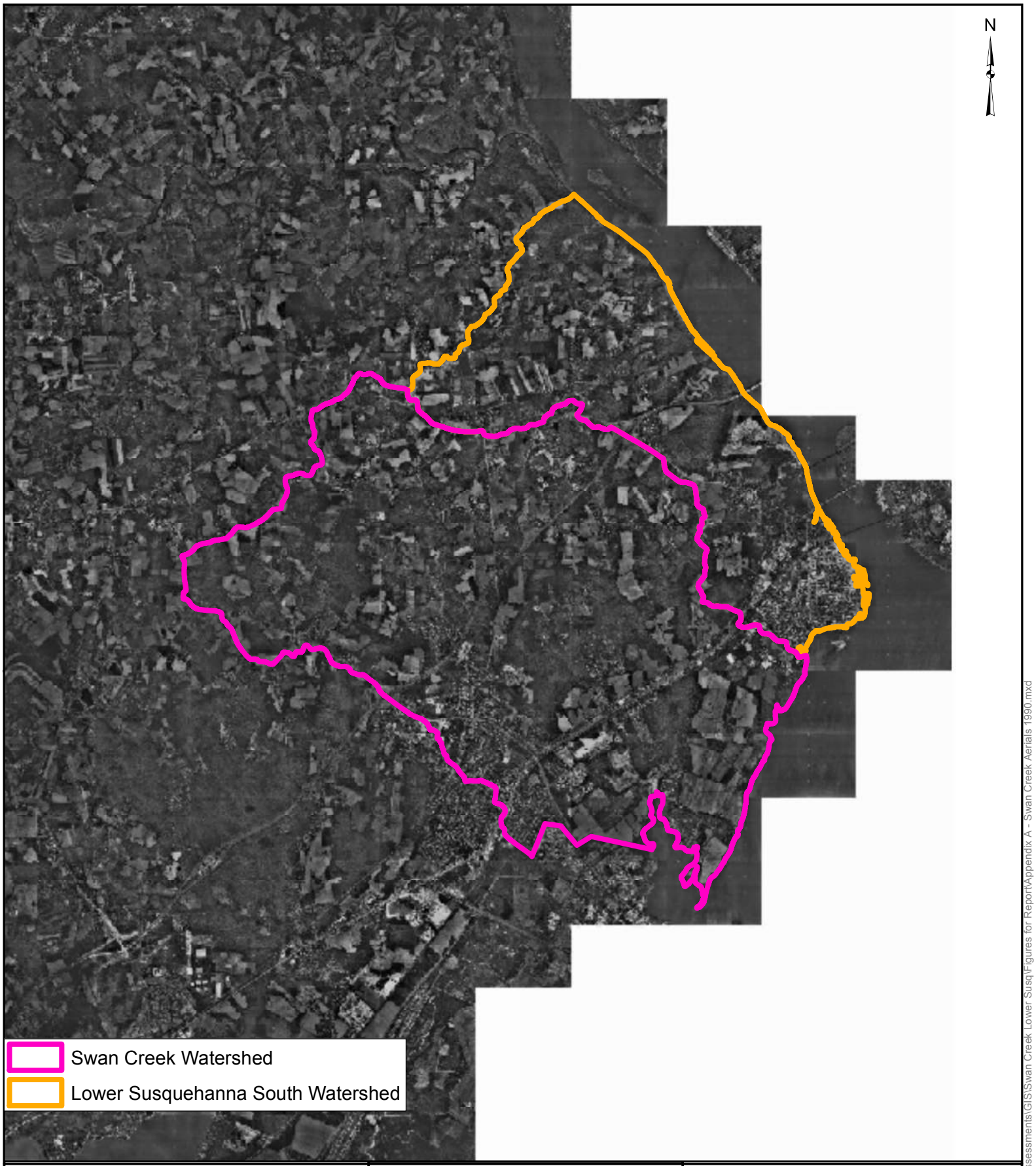

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1 inch = 1.5 miles

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APPENDIX A
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH, 1990

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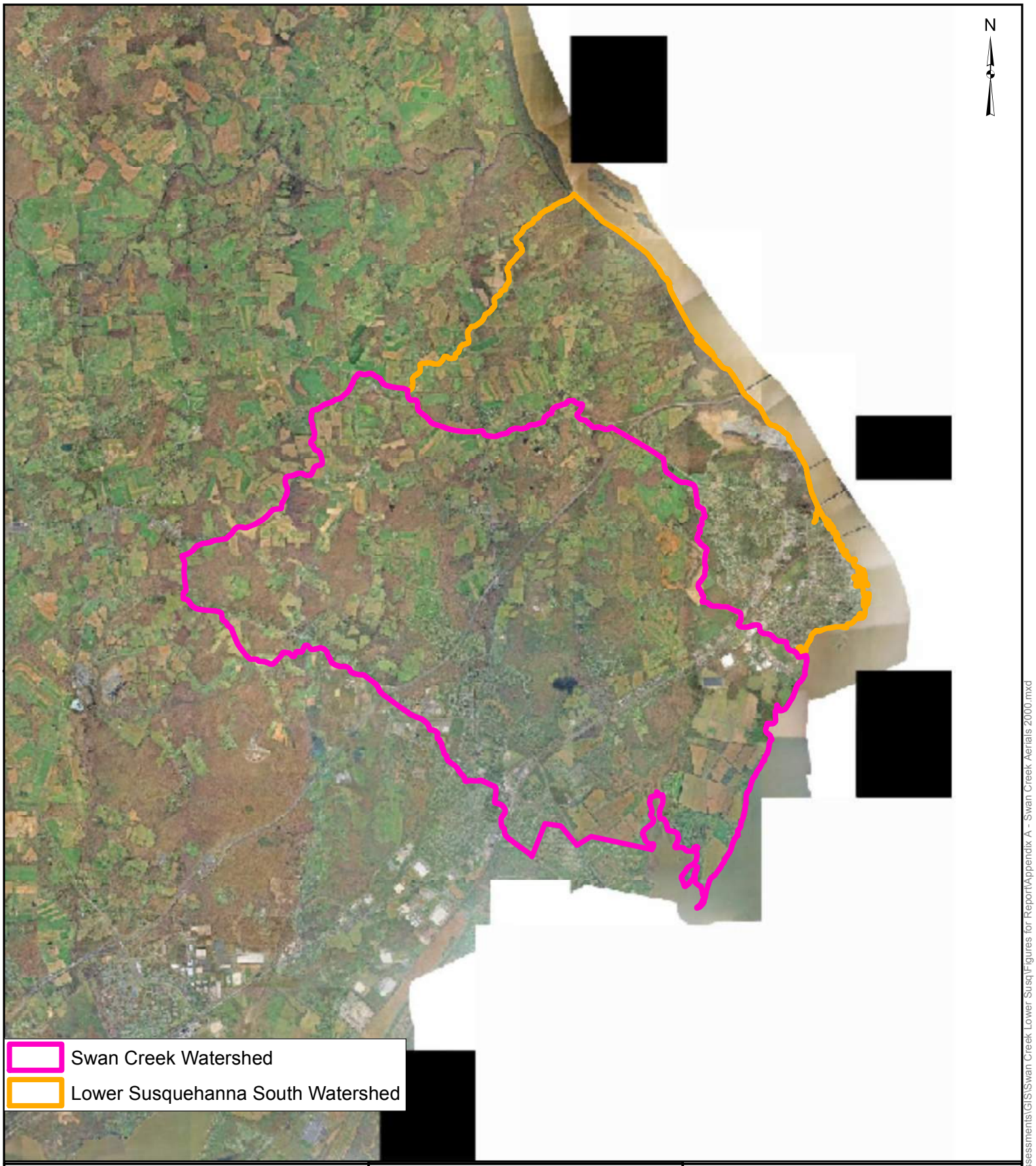

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1 inch = 1.5 miles

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SWAN CREEK AND
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SOUTH, 2000

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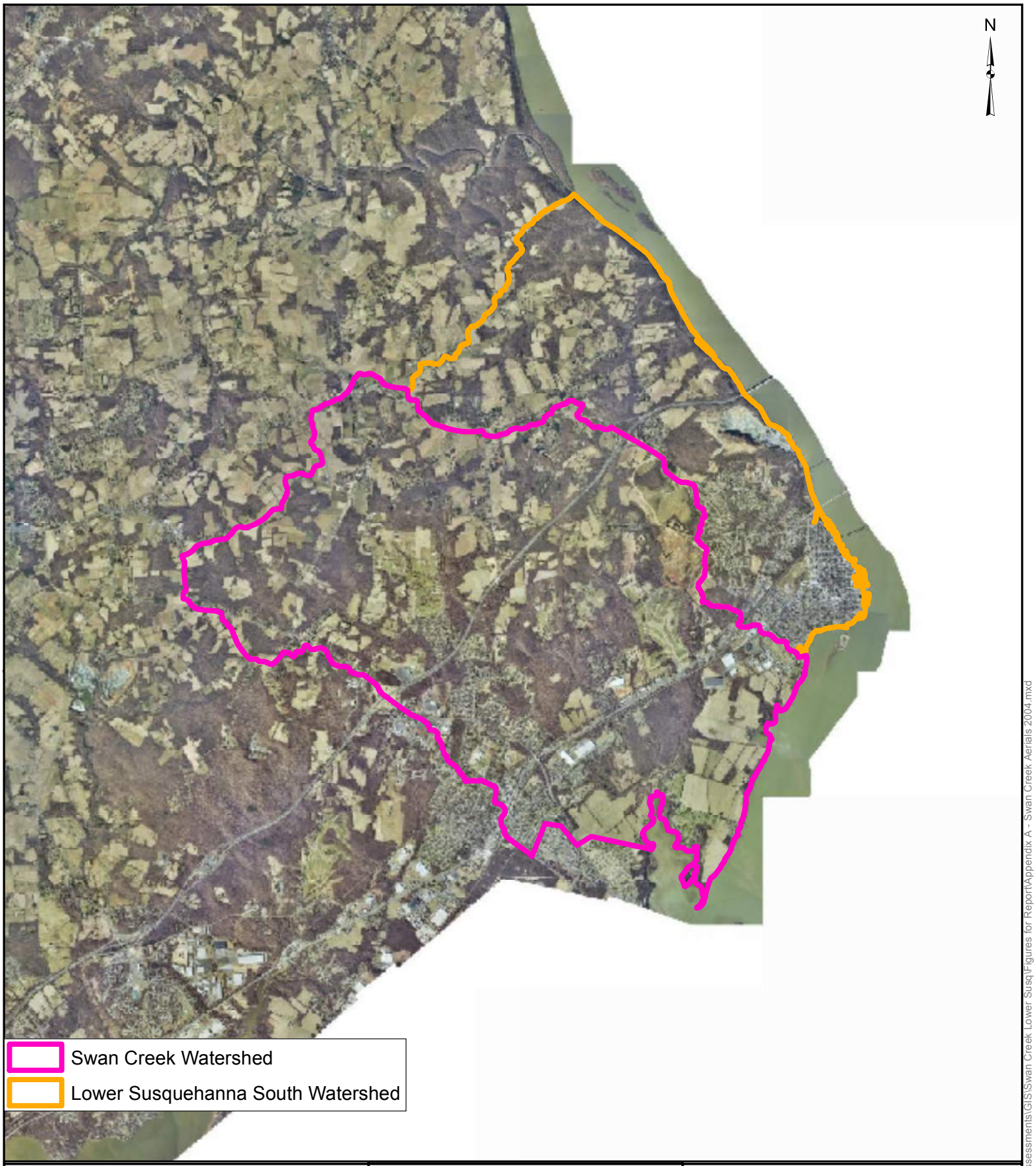

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APPENDIX A
SWAN CREEK AND LOWER SUSQUEHANNA SOUTH, 2004

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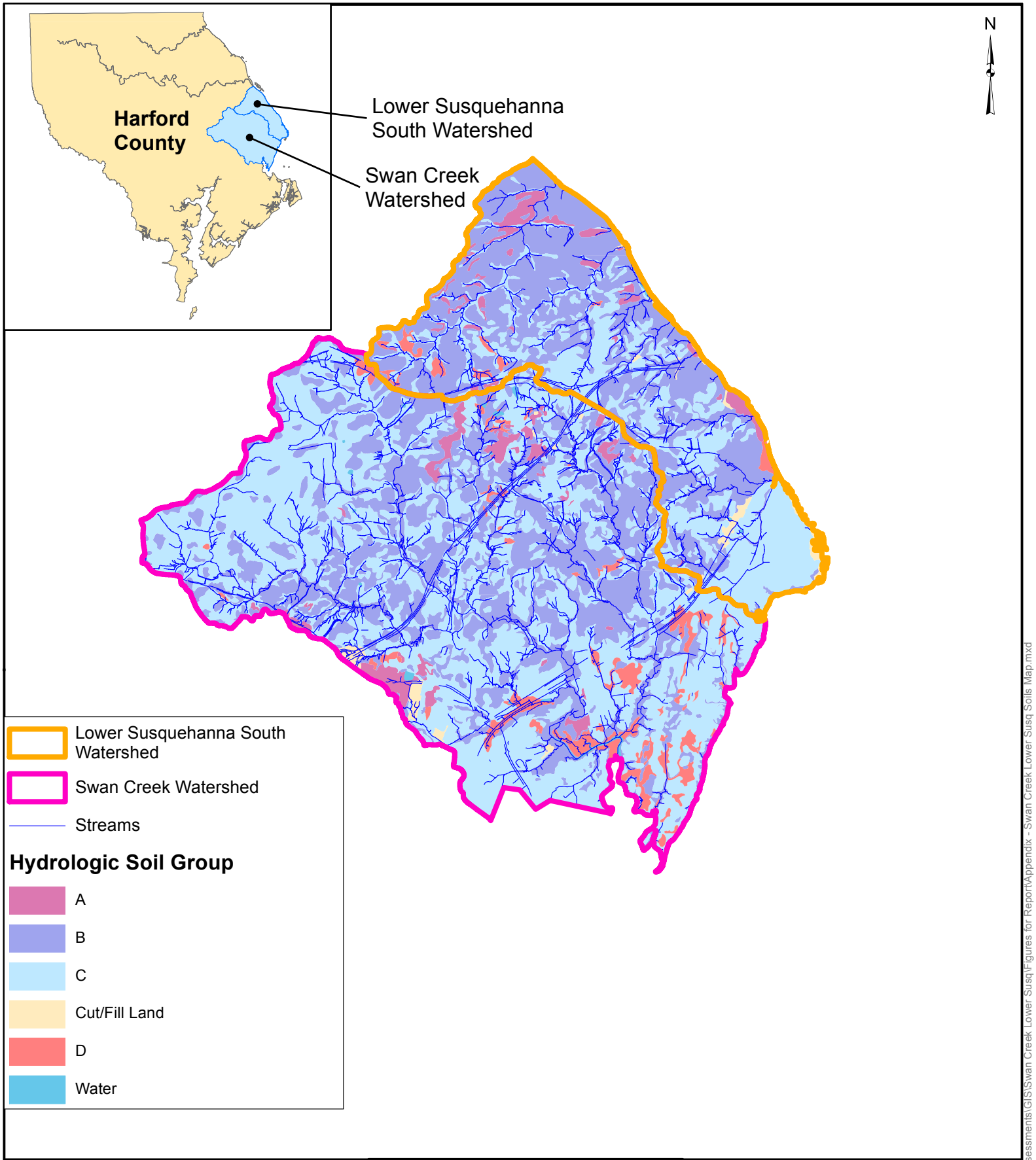
APPENDIX B

Soils



Notes:
1. Watershed Features from 2013 Harford County GIS
2. Soils Data from NRCS Web Soil Survey

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1 in = 1.5 miles

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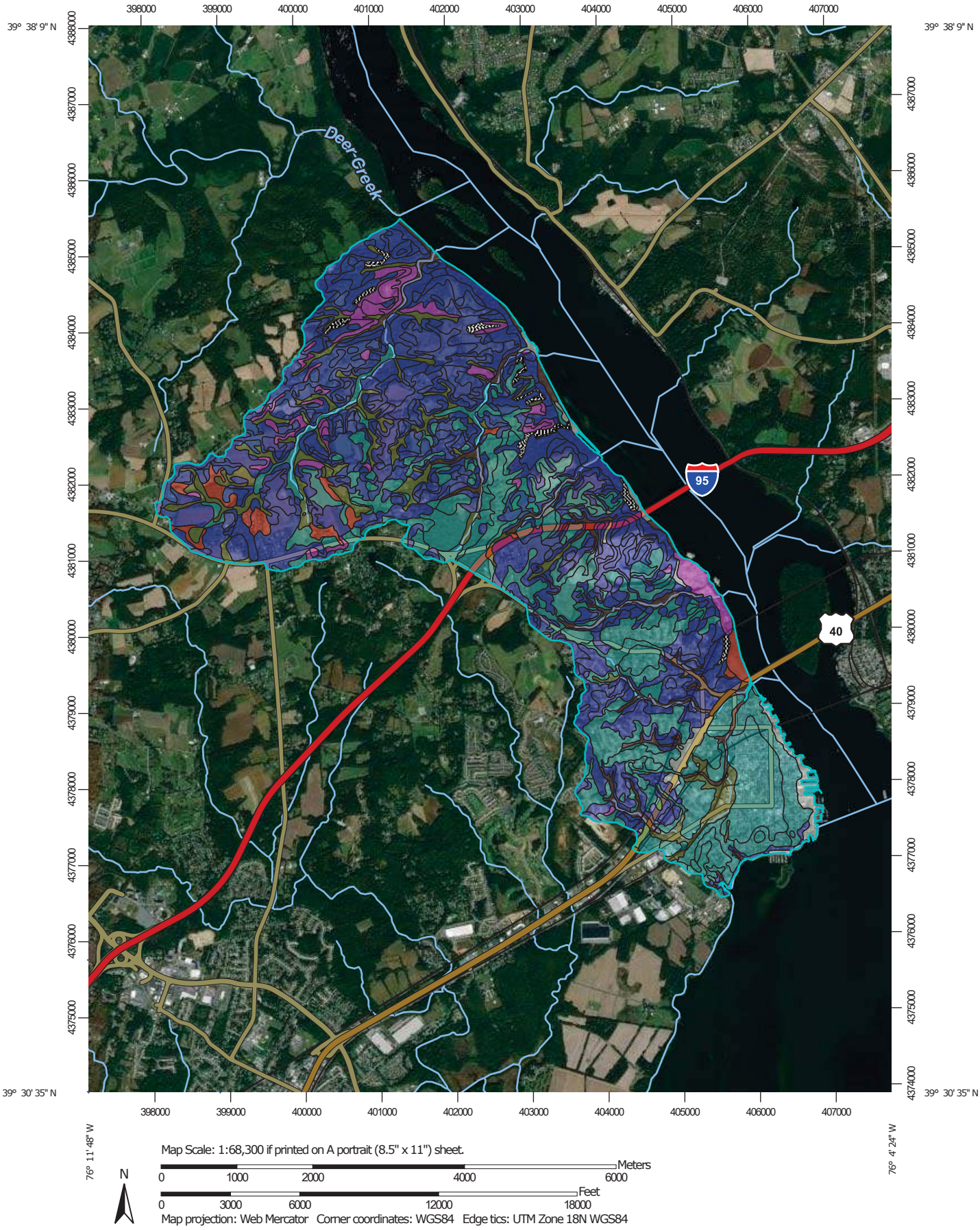
APPENDIX B
SWAN CREEK AND
LOWER SUSQUEHANNA
SOUTH SOILS

P:\4_4101_HCo Large Watershed Assessments\GIS\Swan Creek Lower Susq\Figures for Report\Appendix - Swan Creek Lower Susq Soils Map.mxd

Hydrologic Soil Group—Harford County Area, Maryland
(LowerSusSouthDA)



Map Scale: 1:68,300 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 1000 2000 4000 6000

Feet: 0 3000 6000 12000 18000

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 1:15,800.

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

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

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

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

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 13, Sep 13, 2019

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

Date(s) aerial images were photographed: Jun 16, 2014—Oct 20, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Aldino silt loam, 0 to 3 percent slopes	C	11.9	0.2%
AdB	Aldino silt loam, 3 to 8 percent slopes	C	194.2	2.8%
AdC	Aldino silt loam, 8 to 15 percent slopes	C	69.3	1.0%
AsB	Aldino very stony silt loam, 0 to 8 percent slopes	C	13.1	0.2%
BaB	Baile silt loam, 3 to 8 percent slopes	C/D	31.1	0.5%
BeA	Beltsville silt loam, 0 to 2 percent slopes	C	26.2	0.4%
BeB	Beltsville silt loam, 2 to 5 percent slopes	C	50.1	0.7%
BeC	Beltsville silt loam, 5 to 10 percent slopes	C	18.9	0.3%
BrC2	Brandywine gravelly loam, 8 to 15 percent slopes, moderately eroded	A	52.8	0.8%
BrD3	Brandywine gravelly loam, 15 to 25 percent slopes, severely eroded	A	99.8	1.5%
BrE3	Brandywine gravelly loam, 25 to 45 percent slopes, severely eroded	A	65.0	1.0%
CcB2	Chester silt loam, 3 to 8 percent slopes	B	103.0	1.5%
CcC2	Chester silt loam, 8 to 15 percent slopes	B	3.2	0.0%
ChB2	Chillum silt loam, 2 to 5 percent slopes, moderately eroded	C	347.2	5.1%
CkC2	Chillum-Neshaminy silt loams, 5 to 10 percent slopes, moderately eroded	B	194.7	2.9%
CrE	Chrome channery silty clay loam, 15 to 45 percent slopes	C	10.1	0.1%
Cu	Codorus silt loam	C	81.7	1.2%
Cx	Cut and fill land		130.8	1.9%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
DcA	Delanco silt loam, 0 to 3 percent slopes	C	6.4	0.1%
DcB	Delanco silt loam, 3 to 8 percent slopes	C	132.9	1.9%
En	Elkton silt loam	C/D	6.5	0.1%
EsA	Elsinboro loam, 0 to 2 percent slopes	B	17.6	0.3%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	B	83.1	1.2%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	B	30.3	0.4%
GcB2	Glenelg loam, 3 to 8 percent slopes	B	345.8	5.1%
GcC	Glenelg loam, 8 to 15 percent slopes	B	454.8	6.7%
GcC3	Glenelg loam, 8 to 15 percent slopes, severely eroded	B	15.7	0.2%
GcD	Glenelg loam, 15 to 25 percent slopes	B	91.9	1.3%
GcD3	Glenelg loam, 15 to 25 percent slopes, severely eroded	B	55.6	0.8%
GgB2	Glenelg channery loam, 3 to 8 percent slopes	B	19.0	0.3%
GgC2	Glenelg gravelly loam, 8 to 15 percent slopes, moderately eroded	B	13.8	0.2%
GgC3	Glenelg gravelly loam, 8 to 15 percent slopes, severely eroded	B	8.3	0.1%
GgD2	Glenelg gravelly loam, 15 to 25 percent slopes, moderately eroded	B	2.8	0.0%
GgD3	Glenelg gravelly loam, 15 to 25 percent slopes, severely eroded	B	21.7	0.3%
GnB	Glenville silt loam, 3 to 8 percent slopes	C/D	223.5	3.3%
Hb	Hatboro silt loam	B/D	20.5	0.3%
HcA	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	B/D	246.0	3.6%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
JpB	Joppa gravelly sandy loam, 2 to 5 percent slopes	A	0.8	0.0%
JpC	Joppa gravelly sandy loam, 5 to 10 percent slopes	A	7.5	0.1%
KeB	Kelly silt loam, 3 to 8 percent slopes	D	93.2	1.4%
KeC2	Kelly silt loam, 8 to 15 percent slopes, moderately eroded	D	5.9	0.1%
KfD	Kelly very stony silt loam, 3 to 25 percent slopes	B	19.3	0.3%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	C	288.1	4.2%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	C	222.8	3.3%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	B	73.4	1.1%
LeE	Legore silt loam, 25 to 45 percent slopes	B	60.7	0.9%
LfC	Legore very stony silt loam, 0 to 15 percent slopes	B	85.3	1.2%
LfD	Legore very stony silt loam, 15 to 25 percent slopes	B	59.9	0.9%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	B	115.8	1.7%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	B	172.2	2.5%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	B	119.6	1.8%
MbB2	Manor loam, 3 to 8 percent slopes, moderately eroded	B	3.5	0.1%
MbC	Manor loam, 8 to 15 percent slopes	B	18.3	0.3%
MbD	Manor loam, 15 to 25 percent slopes	B	40.5	0.6%
McB2	Manor channery loam, 3 to 8 percent slopes, moderately eroded	B	4.4	0.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
McC2	Manor channery loam, 8 to 15 percent slopes, moderately eroded	B	1.9	0.0%
McC3	Manor channery loam, 8 to 15 percent slopes, severely eroded	B	2.3	0.0%
McD2	Manor channery loam, 15 to 25 percent slopes, moderately eroded	B	1.5	0.0%
McD3	Manor channery loam, 15 to 25 percent slopes, severely eroded	B	5.2	0.1%
MdE	Manor very stony loam, 25 to 45 percent slopes	B	92.8	1.4%
MfE	Manor soils, 25 to 45 percent slopes	B	42.5	0.6%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	B	22.5	0.3%
MgD	Manor and Glenelg very stony loams, 15 to 25 percent slopes	B	56.3	0.8%
MkA	Matapeake silt loam, 0 to 2 percent slopes	C	47.0	0.7%
MkB	Matapeake silt loam, 2 to 5 percent slopes	C	169.3	2.5%
MlaA	Mattapex silt loam, 0 to 2 percent slopes, northern coastal plain	C	264.1	3.9%
MlaB	Mattapex silt loam, 2 to 5 percent slopes, northern coastal plain	C	110.4	1.6%
MsA	Montalto silt loam, 0 to 3 percent slopes	B	5.2	0.1%
MsB2	Montalto silt loam, 3 to 8 percent slopes, moderately eroded	B	87.5	1.3%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	B	49.3	0.7%
NeA	Neshaminy silt loam, 0 to 3 percent slopes	B	12.2	0.2%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	B	535.2	7.8%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	B	161.9	2.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NsC	Neshaminy and Montalto very stony silt loams 0 to 15 percent slopes	C	21.1	0.3%
NsD	Neshaminy and Montalto very stony silt loams, 15 to 25 percent slopes	C	7.6	0.1%
NsE	Neshaminy and Montalto very stony silt loams, 25 to 45 percent slopes	B	6.1	0.1%
Ot	Othello silt loams, 0 to 2 percent slopes, northern coastal plain	C/D	78.5	1.1%
Sa	Sand and gravel pits	A	75.3	1.1%
SlB2	Sassafras loam, 2 to 5 percent slopes	B	3.7	0.1%
SlC2	Sassafras loam, 5 to 10 percent slopes, moderately eroded	B	17.8	0.3%
SsD	Sassafras and Joppa soils, 10 to 15 percent slopes	B	2.0	0.0%
SsE	Sassafras and Joppa soils, 15 to 30 percent slopes	B	18.9	0.3%
St	Stony land, steep	B	115.9	1.7%
Sw	Swamp	D	3.1	0.0%
Tm	Tidal marsh	D	25.8	0.4%
W	Water		10.2	0.1%
WaA	Watchung silt loam, 0 to 3 percent slopes	C/D	24.8	0.4%
WaB	Watchung silt loam, 3 to 8 percent slopes	C/D	42.3	0.6%
WcB	Watchung very stony silt loam, 0 to 8 percent slopes	C/D	19.3	0.3%
Totals for Area of Interest			**6,830.3**	**100.0%**

Description

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

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

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

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

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

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

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

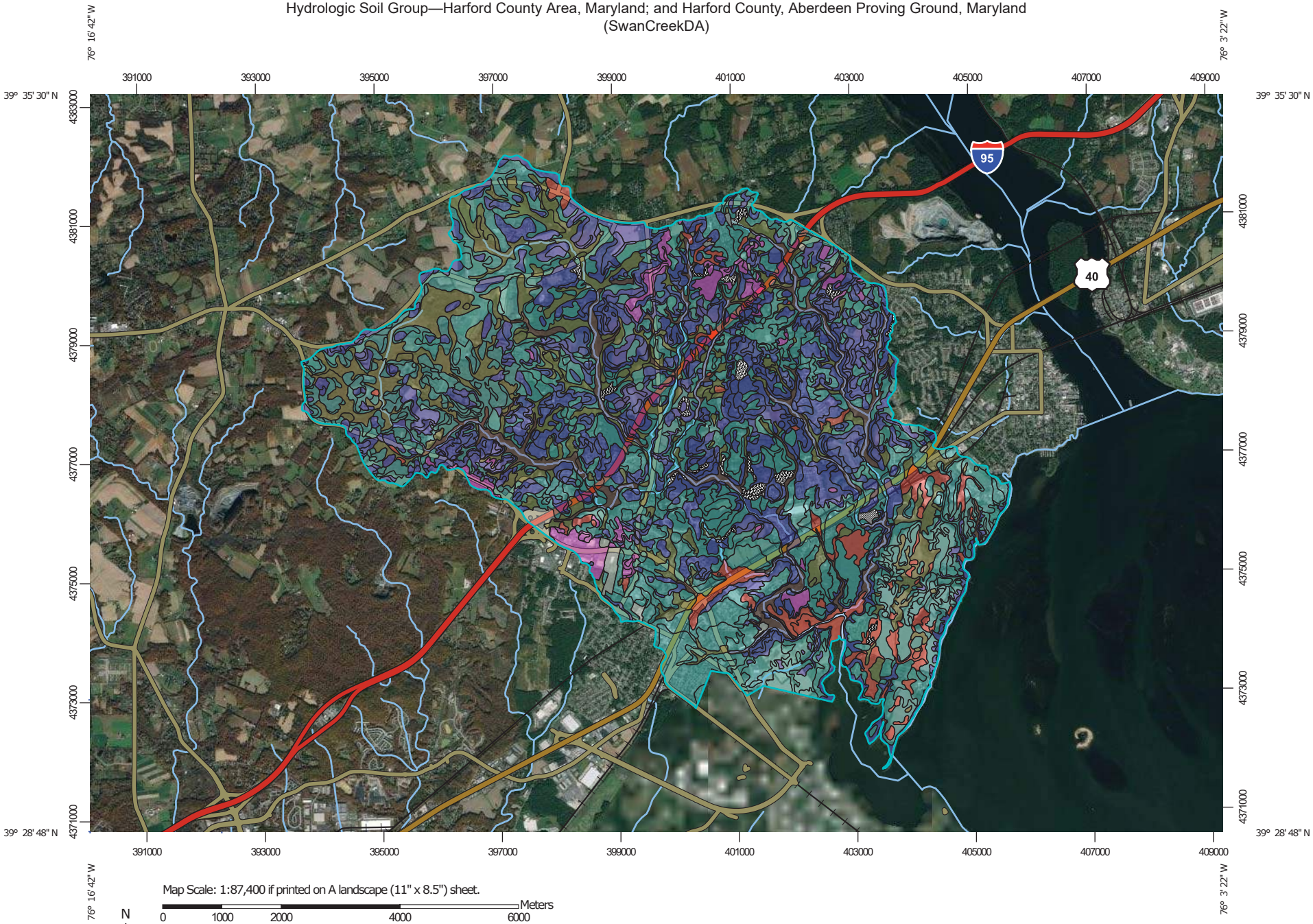
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Hydrologic Soil Group—Harford County Area, Maryland; and Harford County, Aberdeen Proving Ground, Maryland
(SwanCreekDA)



Map Scale: 1:87,400 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 1000 2000 4000 6000

Feet: 0 4000 8000 16000 24000

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 scales ranging from 1:12,000 to 1:15,800.

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

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

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

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

Soil Survey Area: Harford County Area, Maryland
Survey Area Data: Version 13, Sep 13, 2019

Soil Survey Area: Harford County, Aberdeen Proving Ground, Maryland
Survey Area Data: Version 14, Sep 13, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jun 16, 2014—Oct 20, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Aldino silt loam, 0 to 3 percent slopes	C	411.5	2.6%
AdB	Aldino silt loam, 3 to 8 percent slopes	C	1,145.8	7.4%
AdC	Aldino silt loam, 8 to 15 percent slopes	C	69.6	0.4%
AsB	Aldino very stony silt loam, 0 to 8 percent slopes	C	300.5	1.9%
BeA	Beltsville silt loam, 0 to 2 percent slopes	C	567.1	3.6%
BeB	Beltsville silt loam, 2 to 5 percent slopes	C	487.0	3.1%
BeC	Beltsville silt loam, 5 to 10 percent slopes	C	122.0	0.8%
BrC2	Brandywine gravelly loam, 8 to 15 percent slopes, moderately eroded	A	3.8	0.0%
BrD3	Brandywine gravelly loam, 15 to 25 percent slopes, severely eroded	A	3.3	0.0%
CcA	Chester silt loam, 0 to 3 percent slopes	B	7.9	0.1%
CcB2	Chester silt loam, 3 to 8 percent slopes	B	53.4	0.3%
ChB2	Chillum silt loam, 2 to 5 percent slopes, moderately eroded	C	652.9	4.2%
CkC2	Chillum-Neshaminy silt loams, 5 to 10 percent slopes, moderately eroded	B	159.7	1.0%
Cu	Codorus silt loam	C	132.8	0.9%
Cv	Comus silt loam	B	70.6	0.5%
Cx	Cut and fill land		101.2	0.7%
DcA	Delanco silt loam, 0 to 3 percent slopes	C	67.6	0.4%
DcB	Delanco silt loam, 3 to 8 percent slopes	C	719.8	4.6%
En	Elkton silt loam	C/D	235.2	1.5%
EsA	Elsinboro loam, 0 to 2 percent slopes	B	131.1	0.8%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	B	471.8	3.0%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	B	173.9	1.1%
EvC	Evesboro loamy sand, 5 to 15 percent slopes	A	6.8	0.0%
GcB2	Glenelg loam, 3 to 8 percent slopes	B	98.7	0.6%
GcC	Glenelg loam, 8 to 15 percent slopes	B	17.4	0.1%
GcC3	Glenelg loam, 8 to 15 percent slopes, severely eroded	B	20.2	0.1%
GcD	Glenelg loam, 15 to 25 percent slopes	B	1.4	0.0%
GcD3	Glenelg loam, 15 to 25 percent slopes, severely eroded	B	11.8	0.1%
GnA	Glenville silt loam, 0 to 3 percent slopes	C	4.4	0.0%
GnB	Glenville silt loam, 3 to 8 percent slopes	C/D	47.2	0.3%
Hb	Hatboro silt loam	B/D	101.8	0.7%
HcA	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	B/D	638.8	4.1%
JpB	Joppa gravelly sandy loam, 2 to 5 percent slopes	A	118.7	0.8%
JpC	Joppa gravelly sandy loam, 5 to 10 percent slopes	A	106.4	0.7%
KeB	Kelly silt loam, 3 to 8 percent slopes	D	71.3	0.5%
KeC2	Kelly silt loam, 8 to 15 percent slopes, moderately eroded	D	2.0	0.0%
KpA	Keyport silt loam, 0 to 2 percent slopes	D	149.1	1.0%
KpB	Keyport silt loam, 2 to 5 percent slopes	D	52.9	0.3%
KrA	Kinkora silt loam, 0 to 3 percent slopes	C/D	53.2	0.3%
KrB	Kinkora silt loam, 3 to 8 percent slopes	C/D	83.6	0.5%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	C	173.5	1.1%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	C	92.6	0.6%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	B	68.6	0.4%
LeE	Legore silt loam, 25 to 45 percent slopes	B	31.9	0.2%
LfC	Legore very stony silt loam, 0 to 15 percent slopes	B	209.1	1.3%
LfD	Legore very stony silt loam, 15 to 25 percent slopes	B	116.8	0.8%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	B	92.6	0.6%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	B	110.7	0.7%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	B	69.2	0.4%
Lr	Leonardtown silt loam	D	261.3	1.7%
MbB2	Manor loam, 3 to 8 percent slopes, moderately eroded	B	34.6	0.2%
MbC	Manor loam, 8 to 15 percent slopes	B	43.5	0.3%
MbD	Manor loam, 15 to 25 percent slopes	B	17.5	0.1%
McB2	Manor channery loam, 3 to 8 percent slopes, moderately eroded	B	7.5	0.0%
McC2	Manor channery loam, 8 to 15 percent slopes, moderately eroded	B	3.3	0.0%
McC3	Manor channery loam, 8 to 15 percent slopes, severely eroded	B	9.1	0.1%
MfE	Manor soils, 25 to 45 percent slopes	B	3.3	0.0%
MkA	Matapeake silt loam, 0 to 2 percent slopes	C	138.8	0.9%
MkB	Matapeake silt loam, 2 to 5 percent slopes	C	411.9	2.6%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
MlaA	Mattapex silt loam, 0 to 2 percent slopes, northern coastal plain	C	420.1	2.7%
MlaB	Mattapex silt loam, 2 to 5 percent slopes, northern coastal plain	C	474.0	3.0%
MsA	Montalto silt loam, 0 to 3 percent slopes	B	53.3	0.3%
MsB2	Montalto silt loam, 3 to 8 percent slopes, moderately eroded	B	585.1	3.8%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	B	130.5	0.8%
NeA	Neshaminy silt loam, 0 to 3 percent slopes	B	146.3	0.9%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	B	1,042.9	6.7%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	B	196.9	1.3%
NsC	Neshaminy and Montalto very stony silt loams 0 to 15 percent slopes	C	374.5	2.4%
NsD	Neshaminy and Montalto very stony silt loams, 15 to 25 percent slopes	C	85.0	0.5%
NsE	Neshaminy and Montalto very stony silt loams, 25 to 45 percent slopes	B	26.2	0.2%
Ot	Othello silt loams, 0 to 2 percent slopes, northern coastal plain	C/D	136.4	0.9%
RuB	Russett fine sandy loam, 0 to 5 percent slopes	C	14.2	0.1%
RuD	Russett fine sandy loam, 5 to 15 percent slopes	C	14.1	0.1%
RuE	Russett fine sandy loam, 15 to 30 percent slopes	C	9.2	0.1%
Sa	Sand and gravel pits	A	181.9	1.2%
ShaB	Sassafras sandy loam, 2 to 5 percent slopes, Northern Coastal Plain	B	13.8	0.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
ShaC	Sassafras sandy loam, 5 to 10 percent slopes, Northern Coastal Plain	B	5.0	0.0%
SlB2	Sassafras loam, 2 to 5 percent slopes	B	65.3	0.4%
SlC2	Sassafras loam, 5 to 10 percent slopes, moderately eroded	B	82.3	0.5%
SsD	Sassafras and Joppa soils, 10 to 15 percent slopes	B	70.9	0.5%
SsE	Sassafras and Joppa soils, 15 to 30 percent slopes	B	246.5	1.6%
St	Stony land, steep	B	12.6	0.1%
Sw	Swamp	D	27.5	0.2%
Tm	Tidal marsh	D	75.3	0.5%
W	Water		41.4	0.3%
WaA	Watchung silt loam, 0 to 3 percent slopes	C/D	641.2	4.1%
WaB	Watchung silt loam, 3 to 8 percent slopes	C/D	367.3	2.4%
WcB	Watchung very stony silt loam, 0 to 8 percent slopes	C/D	413.2	2.7%
WoaB	Woodstown loam, 2 to 5 percent slopes, Northern Coastal Plain	C	19.6	0.1%
Subtotals for Soil Survey Area			**15,542.3**	**100.0%**
Totals for Area of Interest			**15,543.1**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Le	Lenape mucky peat	C/D	0.0	0.0%
MpaA	Mattapex silt loam, 0 to 2 percent slopes, northern coastal plain	C	0.0	0.0%
MpaB	Mattapex silt loam, 2 to 5 percent slopes, northern coastal plain	C	0.0	0.0%
NnA	Nassawango silt loam, 0 to 2 percent slopes	C	0.8	0.0%
Ur	Urban land-Udorthents complex, 0 to 10 percent slopes	D	0.0	0.0%
Subtotals for Soil Survey Area			**0.9**	**0.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Totals for Area of Interest			**15,543.1**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX C

CAST

Swan Creek CAST Output - Major Source - All Agencies

Geography	Sector	LoadSource	Allocation	Agency	Unit	Swan Creek_Amount	Swan Creek_NLoadRateEOS	Swan Creek_PLoadRateEOS	Swan Creek_SLoadRateEOS
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Agriculture	Agriculture	Load Allocation	All Agencies	acres	2430.942	18.324	0.419	310.550
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Agriculture	Regulated Agriculture	Waste Load Allocation	All Agencies	acres	0.000			
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Developed	Non-Regulated Developed	Load Allocation	All Agencies	acres	319.515	8.412	0.868	383.442
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Developed	Regulated Developed	Waste Load Allocation	All Agencies	acres	5377.911	10.667	1.063	720.895
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Natural	Natural	Load Allocation	All Agencies	acres	7653.366	4.426	2.005	1509.855
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Natural	Non-Tidal Water Deposition	Load Allocation	All Agencies	acres	212.538	8.414	0.610	0.000
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Septic	Septic	Load Allocation	All Agencies	systems	1479.045	10.953	0.000	0.000
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Wastewater	Wastewater	Waste Load Allocation	All Agencies	acres	0.000			
020600030201 - Swan Creek-Chesapeake Bay (CBWS Portion Only)	Wastewater	Wastewater-CSO	Waste Load Allocation	All Agencies	acres	0.000			

Lower Susquehanna CAST Output - Major Source - All Agencies

Geography	Sector	LoadSource	Allocation	Agency	Unit	2017 Progress V9_Amount	2017 Progress V9_NLoadRateEOS	2017 Progress V9_PLoadRateEOS	2017 Progress V9_SLoadRateEOS
MD-02050306 - Lower Susquehanna	Agriculture	Agriculture	Load Allocation	All Agencies	acres	51686.981	19.814	0.362	822.438
MD-02050306 - Lower Susquehanna	Agriculture	Regulated Agriculture	Waste Load Allocation	All Agencies	acres	3.897	889.227	134.154	3258.023
MD-02050306 - Lower Susquehanna	Developed	Non-Regulated Developed	Load Allocation	All Agencies	acres	963.569	10.177	0.942	1026.152
MD-02050306 - Lower Susquehanna	Developed	Regulated Developed	Waste Load Allocation	All Agencies	acres	34527.639	10.957	0.813	1315.420
MD-02050306 - Lower Susquehanna	Natural	Natural	Load Allocation	All Agencies	acres	83552.872	2.732	0.265	1114.752
MD-02050306 - Lower Susquehanna	Natural	Non-Tidal Water Deposition	Load Allocation	All Agencies	acres	6476.194	8.860	0.608	0.000
MD-02050306 - Lower Susquehanna	Septic	Septic	Load Allocation	All Agencies	systems	17485.129	13.209	0.000	0.000
MD-02050306 - Lower Susquehanna	Wastewater	Wastewater	Waste Load Allocation	All Agencies	acres	0.000			
MD-02050306 - Lower Susquehanna	Wastewater	Wastewater-CSO	Waste Load Allocation	All Agencies	acres	0.000			

APPENDIX D

Land Use and
Stream Pollutant Loadings

Sub-Watershed SC-1

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	4.8	40.68	2.95	0.00	40.68	2.95	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	1694.7	2389.58	50.84	36386.07	2389.58	50.84	36369.12
Mixed Open	138.0	265.05	23.47	112560.72	265.05	23.47	112560.72
Agriculture	477.3	8746.48	200.00	148232.97	8746.48	200.00	148232.97
Impervious	324.5	4668.87	259.56	652898.62	4555.31	249.83	625485.64
Turf	363.8	3488.71	396.53	281981.44	3255.88	360.15	275917.13
Tree Canopy over Turf	148.8	1086.28	120.53	80872.54	1011.87	110.12	78683.62

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	3152.0	20685.66	1053.88	1312932.36	20264.87	997.35	1277249.20
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		10.34	0.53	656.47	10.13	0.50	638.62

Sub-Watershed SC-2

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	11.1	92.95	6.74	0.00	92.95	6.74	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	1016.1	1432.66	30.48	21815.02	1432.66	30.48	21804.86
Mixed Open	74.0	142.07	12.58	60334.41	142.07	12.58	60334.41
Agriculture	679.2	12445.29	284.58	210919.35	12445.29	284.58	210919.35
Impervious	307.0	4418.11	245.62	617832.99	4310.66	236.41	591892.30
Turf	427.4	4098.88	465.88	331299.86	3825.34	423.14	324174.91
Tree Canopy over Turf	116.7	852.26	94.57	63450.20	793.89	86.39	61732.84

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	2631.5	23482.23	1140.45	1305651.83	23042.86	1080.32	1270858.66
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		11.74	0.57	652.83	11.52	0.54	635.43

Sub-Watershed SC-3

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	4.9	41.05	2.98	0.00	41.05	2.98	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	889.8	1254.58	26.69	19103.38	1254.58	26.69	19094.49
Mixed Open	74.6	143.17	12.68	60800.94	143.17	12.68	60800.94
Agriculture	315.5	5780.84	132.19	97972.00	5780.84	132.19	97972.00
Impervious	96.6	1390.62	77.31	194465.64	1356.80	74.41	186300.69
Turf	162.0	1553.77	176.60	125586.56	1450.08	160.40	122885.69
Tree Canopy over Turf	62.1	453.30	50.30	33748.10	422.25	45.95	32834.66

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	1605.5	10617.33	478.74	531676.62	10448.77	455.30	519888.47
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		5.31	0.24	265.84	5.22	0.23	259.94

Sub-Watershed SC-4

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	10.7	89.95	6.52	0.00	89.95	6.52	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	598.7	844.15	17.96	12853.77	844.15	17.96	12847.78
Mixed Open	86.3	165.79	14.68	70406.34	165.79	14.68	70406.34
Agriculture	226.4	4148.11	94.85	70301.07	4148.11	94.85	70301.07
Impervious	360.9	5192.92	288.70	726182.97	5066.62	277.87	695693.03
Turf	296.5	2843.34	323.17	229818.29	2653.59	293.53	224875.81
Tree Canopy over Turf	83.3	608.09	67.47	45271.94	566.44	61.64	44046.59

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	1662.8	13892.36	813.36	1154834.37	13534.65	767.05	1118170.62
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		6.95	0.41	577.42	6.77	0.38	559.09

Sub-Watershed SC-5

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	10.5	88.29	6.40	0.00	88.29	6.40	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	347.8	490.39	10.43	7467.14	490.39	10.43	7463.66
Mixed Open	64.9	124.66	11.04	52940.04	124.66	11.04	52940.04
Agriculture	48.4	886.62	20.27	15026.21	886.62	20.27	15026.21
Impervious	372.0	5352.99	297.60	748567.39	5222.80	286.44	717137.61
Turf	230.1	2206.53	250.79	178347.34	2059.28	227.79	174511.79
Tree Canopy over Turf	140.2	1023.39	113.55	76191.00	953.30	103.74	74128.80

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	1213.88	10172.89	710.09	1078539.12	9825.34	666.11	1041208.10
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		5.09	0.36	539.27	4.91	0.33	520.60

Sub-Watershed SC-6

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	3.21919	27.07	1.96	0.00	27.07	1.96	0.00
Non-Tidal Floodplain Wetland	0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	643.624	907.51	19.31	13818.61	907.51	19.31	13812.17
Mixed Open	31.72	60.90	5.39	25863.30	60.90	5.39	25863.30
Agriculture	63.6081	1165.55	26.65	19753.50	1165.55	26.65	19753.50
Impervious	112.260272	1615.43	89.81	225902.47	1576.13	86.44	216417.60
Turf	130.455	1251.06	142.20	101119.58	1167.57	129.15	98944.90
Tree Canopy over Turf	78.2589	571.29	63.39	42532.15	532.16	57.91	41380.96

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	1063.15	5598.82	348.71	428989.60	5436.91	326.82	416172.42
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		2.80	0.17	214.49	2.72	0.16	208.09

Sub-Watershed SC-7

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	29.4797	247.92	17.98	0.00	247.92	17.98	0.00
Non-Tidal Floodplain Wetland	7.95604	10.50	0.24	116.79	10.50	0.24	116.79
True Forest	632.272	891.50	18.97	13574.88	891.50	18.97	13568.56
Mixed Open	144.46	277.36	24.56	117787.39	277.36	24.56	117787.39
Agriculture	111.284	2039.17	46.63	34559.25	2039.17	46.63	34559.25
Impervious	337.506604	4856.72	270.01	679167.91	4738.59	259.88	650651.98
Turf	200.394	1921.78	218.43	155331.40	1793.53	198.39	151990.83
Tree Canopy over Turf	48.4433	353.64	39.24	26327.96	329.41	35.85	25615.36

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	1511.79	10598.59	636.05	1026865.59	10327.99	602.49	994290.16
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		5.30	0.32	513.43	5.16	0.30	497.15

Sub-Watershed SC-8

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	5.10586	42.94	3.11	0.00	42.94	3.11	0.00
Non-Tidal Floodplain Wetland	0.768017	1.01	0.02	11.27	1.01	0.02	11.27
True Forest	182.052	256.69	5.46	3908.66	256.69	5.46	3906.84
Mixed Open	131.74	252.93	22.40	107414.26	252.93	22.40	107414.26
Agriculture	125.982	2308.49	52.79	39123.71	2308.49	52.79	39123.71
Impervious	106.751098	1536.15	85.40	214816.30	1498.79	82.20	205796.90
Turf	98.6114	945.68	107.49	76436.65	882.57	97.63	74792.80
Tree Canopy over Turf	26.9993	197.09	21.87	14673.58	183.60	19.98	14276.42

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	678.01	5541.00	298.54	456384.44	5427.03	283.58	445322.21
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		2.77	0.15	228.19	2.71	0.14	222.66

Sub-Watershed SC-9

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	47.268	397.52	28.83	0.00	397.52	28.83	0.00
Non-Tidal Floodplain Wetland	45.2295	59.70	1.36	663.97	59.70	1.36	663.97
True Forest	655.714	924.56	19.67	14078.18	924.56	19.67	14071.62
Mixed Open	282.78	542.93	48.07	230566.90	542.93	48.07	230566.90
Agriculture	249.369	4569.44	104.49	77441.54	4569.44	104.49	77441.54
Impervious	365.671443	5262.01	292.54	735844.30	5134.03	281.57	704948.72
Turf	263.093	2523.06	286.77	203931.28	2354.68	260.46	199545.52
Tree Canopy over Turf	115.998	846.79	93.96	63042.59	788.79	85.84	61336.26

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	2025.12	15126.01	875.69	1325568.76	14771.65	830.29	1288574.53
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		7.56	0.44	662.78	7.39	0.42	644.29

Sub-Watershed LS-1

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	1.68108	14.14	1.03	0.00	14.14	1.03	0.00
Non-Tidal Floodplain Wetland	0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	1061.58	1496.83	31.85	22792.12	1496.83	31.85	22781.51
Mixed Open	121.24	232.78	20.61	98856.14	232.78	20.61	98856.14
Agriculture	576.427	11421.32	208.67	474075.47	11421.32	208.67	474075.47
Impervious	81.091034	1166.90	64.87	163180.30	1138.52	62.44	156328.92
Turf	236.09	2264.10	257.34	183000.44	2113.01	233.73	179064.82
Tree Canopy over Turf	72.7514	531.09	58.93	39538.93	494.71	53.84	38468.76

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	2150.86	17127.16	643.29	981443.40	16911.31	612.16	969575.61
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		8.56	0.32	490.72	8.46	0.31	484.79

Sub-Watershed LS-2

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	0.017114	0.14	0.01	0.00	0.14	0.01	0.00
Non-Tidal Floodplain Wetland	0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	167.78	236.57	5.03	3602.24	236.57	5.03	3600.56
Mixed Open	2.15	4.13	0.37	1754.02	4.13	0.37	1754.02
Agriculture	37.9147	751.24	13.73	31182.49	751.24	13.73	31182.49
Impervious	4.971046	71.53	3.98	10003.29	69.79	3.83	9583.28
Turf	6.22877	59.73	6.79	4828.11	55.75	6.17	4724.27
Tree Canopy over Turf	3.13783	22.91	2.54	1705.35	21.34	2.32	1659.19

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	222.20	1146.26	32.44	53075.48	1138.96	31.45	52503.81
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		0.57	0.02	26.54	0.57	0.02	26.25

Sub-Watershed LS-3

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	1.41061	11.86	0.86	0.00	11.86	0.86	0.00
Non-Tidal Floodplain Wetland	0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	511.109	720.66	15.33	10973.51	720.66	15.33	10968.40
Mixed Open	73.60	141.31	12.51	60009.57	141.31	12.51	60009.57
Agriculture	127.193	2520.20	46.04	104608.36	2520.20	46.04	104608.36
Impervious	51.818066	745.66	41.45	104274.01	727.53	39.90	99895.90
Turf	133.924	1284.33	145.98	103808.51	1198.62	132.58	101576.00
Tree Canopy over Turf	55.3367	403.96	44.82	30074.39	376.29	40.95	29260.39

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	954.39	5827.99	307.00	413748.35	5696.47	288.18	406318.61
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		2.91	0.15	206.87	2.85	0.14	203.16

Sub-Watershed LS-4

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	2.33769	19.66	1.43	0.00	19.66	1.43	0.00
Non-Tidal Floodplain Wetland	0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	343.589	484.46	10.31	7376.86	484.46	10.31	7373.42
Mixed Open	12.95	24.87	2.20	10560.01	24.87	2.20	10560.01
Agriculture	126.808	2512.57	45.90	104291.72	2512.57	45.90	104291.72
Impervious	9.600997	138.16	7.68	19320.18	134.80	7.39	18508.99
Turf	46.6868	447.73	50.89	36188.34	417.85	46.22	35410.07
Tree Canopy over Turf	5.98	43.65	4.84	3250.01	40.66	4.43	3162.04

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	547.95	3671.10	123.25	180987.12	3634.87	117.88	179306.26
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		1.84	0.06	90.49	1.82	0.06	89.65

Sub-Watershed LS-5

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	0.890275	7.49	0.54	0.00	7.49	0.54	0.00
Non-Tidal Floodplain Wetland	0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	170.884	240.95	5.13	3668.88	240.95	5.13	3667.17
Mixed Open	0.00	0.00	0.00	1.68	0.00	0.00	1.68
Agriculture	72.8298	1443.05	26.36	59898.00	1443.05	26.36	59898.00
Impervious	105.469864	1517.71	84.38	212238.06	1480.80	81.21	203326.91
Turf	17.2241	165.18	18.77	13350.92	154.16	17.05	13063.79
Tree Canopy over Turf	17.6019	128.49	14.26	9566.28	119.69	13.03	9307.36

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	384.90	3502.87	149.44	298723.81	3446.13	143.32	289264.90
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		1.75	0.07	149.36	1.72	0.07	144.63

Sub-Watershed LS-6

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	10.0899	84.86	6.15	0.00	84.86	6.15	0.00
Non-Tidal Floodplain Wetland	0	0.00	0.00	0.00	0.00	0.00	0.00
True Forest	773.239	1090.27	23.20	16601.44	1090.27	23.20	16593.71
Mixed Open	109.65	210.52	18.64	89401.90	210.52	18.64	89401.90
Agriculture	48.9492	969.88	17.72	40257.68	969.88	17.72	40257.68
Impervious	912.235038	13127.06	729.79	1835699.69	12807.78	702.42	1758624.95
Turf	441.282	4231.89	481.00	342050.92	3949.47	436.87	334694.75
Tree Canopy over Turf	274.907	2006.82	222.67	149406.46	1869.37	203.43	145362.57

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	2570.35	21721.30	1499.17	2473418.08	20982.14	1408.43	2384935.56
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		10.86	0.75	1236.71	10.49	0.70	1192.47

BMP-1 Old Post Road Distribution Warehouse

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	1.1	8.92	0.65	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00
True Forest	0.4	0.52	0.01	7.90
Mixed Open Space	1.0	1.98	0.18	841.96
Agriculture	0.0	0.00	0.00	0.00
Impervious without Tree Canopy	18.0	252.35	13.84	34650.08
Non-Regulated Turf Grass	3.2	28.83	3.19	2442.93
Non-Regulated Tree Canopy over Turf Grass	2.0	13.65	1.49	1061.48

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	25.7	306.25	19.35	39004.35
		(ton/yr)	(ton/yr)	(ton/yr)
		0.15	0.01	19.50

BMP-2 Stack & Store

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0.0	0.00	0.00	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00
True Forest	1.7	2.36	0.05	35.99
Mixed Open Space	0.5	1.04	0.09	440.15
Agriculture	0.0	0.00	0.00	0.00
Impervious without Tree Canopy	2.5	34.57	1.90	4746.85
Non-Regulated Turf Grass	1.1	9.69	1.07	821.54
Non-Regulated Tree Canopy over Turf Grass	0.1	0.86	0.09	67.03

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	5.9	48.53	3.20	6111.56
		(ton/yr)	(ton/yr)	(ton/yr)
		0.02	0.00	3.06

BMP-3 Lynn Lee Drive

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0.0	0.00	0.00	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00
True Forest	0.2	0.31	0.01	4.75
Mixed Open Space	0.2	0.36	0.03	153.18
Agriculture	0.0	0.07	0.00	1.19
Impervious without Tree Canopy	1.1	15.30	0.84	2101.32
Non-Regulated Turf Grass	0.6	5.51	0.61	467.34
Non-Regulated Tree Canopy over Turf Grass	0.6	3.88	0.42	302.05

[redacted]

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	2.7	25.45	1.91	3029.83
		(ton/yr)	(ton/yr)	(ton/yr)
		0.01	0.00	1.51

BMP-4 Level Volunteer Fire Dept.

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0.0	0.00	0.00	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00
True Forest	0.0	0.01	0.00	0.18
Mixed Open Space	0.1	0.10	0.01	44.01
Agriculture	0.0	0.00	0.00	0.00
Impervious without Tree Canopy	1.7	23.21	1.27	3186.48
Non-Regulated Turf Grass	0.2	1.53	0.17	129.66
Non-Regulated Tree Canopy over Turf Grass	0.0	0.13	0.01	10.07

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1.9	24.98	1.47	3370.41
		(ton/yr)	(ton/yr)	(ton/yr)
		0.01	0.00	1.69

BMP-5 Aberdeen Middle School

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0.0	0.00	0.00	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00
True Forest	0.8	1.11	0.02	16.82
Mixed Open Space	3.0	5.79	0.51	2458.97
Agriculture	0.1	2.54	0.06	43.00
Impervious without Tree Canopy	9.3	130.37	7.15	17901.46
Non-Regulated Turf Grass	6.5	57.82	6.40	4900.18
Non-Regulated Tree Canopy over Turf Grass	1.2	8.40	0.91	653.43

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	20.9	206.03	15.05	25973.86
		(ton/yr)	(ton/yr)	(ton/yr)
		0.10	0.01	12.99

BMP-6 LDS Church

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0.0	0.00	0.00	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00
True Forest	0.3	0.39	0.01	6.01
Mixed Open Space	0.2	0.30	0.03	128.71
Agriculture	0.5	9.68	0.18	401.93
Impervious without Tree Canopy	1.4	19.15	1.05	2629.99
Non-Regulated Turf Grass	1.3	11.67	1.29	989.02
Non-Regulated Tree Canopy over Turf Grass	0.3	2.14	0.23	166.03

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	3.9	43.34	2.79	4321.68
		(ton/yr)	(ton/yr)	(ton/yr)
		0.02	0.00	2.16

BMP-7 Havre de Grace Elementary

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0.0	0.00	0.00	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00
True Forest	0.6	0.89	0.02	13.58
Mixed Open Space	1.0	1.92	0.17	815.11
Agriculture	0.0	0.61	0.01	25.37
Impervious without Tree Canopy	5.8	81.68	4.48	11216.06
Non-Regulated Turf Grass	5.4	48.06	5.32	4072.64
Non-Regulated Tree Canopy over Turf Grass	4.1	28.17	3.07	2190.40

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	17.0	161.33	13.06	18333.15
		(ton/yr)	(ton/yr)	(ton/yr)
		0.08	0.01	9.17

BMP-8 Bay View HOA

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0.0	0.00	0.00	0.00
Non-Tidal Floodplain Wetland	0.0	0.00	0.00	0.00
True Forest	3.3	4.60	0.10	70.05
Mixed Open Space	3.2	6.12	0.54	2598.07
Agriculture	0.2	3.32	0.06	137.88
Impervious without Tree Canopy	13.5	188.92	10.36	25941.01
Non-Regulated Turf Grass	12.0	107.53	11.89	9112.21
Non-Regulated Tree Canopy over Turf Grass	5.2	35.56	3.87	2764.94

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	37.3	346.05	26.82	40624.16
		(ton/yr)	(ton/yr)	(ton/yr)
		0.17	0.01	20.31

APPENDIX E

Field Sheets

Project Name:			
Site No. 1	Address: Tide~~water~~ Circle		
Date Built:	Imp Credits:	Property Owners: 2301 Tide Cir	Contact Info:

Access (including staging/stockpiling):

1) Easy access along Country Club Rd. Steep down in stream.

2) Fence and private property on south end of stream

Utilities:

1) Electrical lines running parallel to country Club Rd.

2) "

Utility pole 335864 at outfall

Constructability:

Private property

Other Notes:

1) stream has steep sideslopes. ~20' tall banks. Large boulders at outfall. Appears some work was attempted to stabilize outfall. Geotech fabric showing.

2) outfall completely exposed for ~10 feet. Broken concrete structure (headwall?) in channel. Multiple headcuts forming. Eroded banks, exposed tree roots. Steep, high banks.

9:11 am

Project Name:			
Site No. 4	Address: Bloomsbury Ave		
Date Built:	Imp Credits:	Property Owners: 101 Bloomsbury	Contact Info:

Access (including staging/stockpiling):

Bloomsbury Ave - Open Space for stockpile

Utilities:

Electrical lines running parallel to Bloomsbury Ave.
Water main on Bloomsbury Ave, fire hydrant
Electrical box
Gas main on Bloomsbury Ave

Constructability:

Other Notes:

Stream and Road crossing appear in stable condition
Concrete headwall good condition

Banks have some erosion, exposed tree roots

9:20 am

Project Name: Swan Creek / Low Susq			
Site No. 4	Address: Revolution Ave		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Access from road

Utilities:

Electrical, sewer line

OH wires

Constructability:

Open, grassed, mowed, private properties

Fence at upstream

Other Notes: Downstream of Rev. Rd:

Wooden wall along left bank, eroding right bank

Urban area, crosses under Revolution Ave

Upstream of Rd:

Riprap and wooden wall

Wider than DS.

Project Name: Swan Creek / Lower Susq.			
Site No. 5	Address: Across from Havre de Grace HS, Juniata X Penington		
Date Built:	Imp Credits:	Property Owners: Board of Ed	Contact Info:

Access (including staging/stockpiling):

Access from N. Juniata

Utilities:

Constructability:

Behind courts/field is deep gully w/ steep and tall bank, 10ft.

School drains into it.

Other Notes:

- Small riparian zone, surrounded by school property
- no sinuosity
- erosion towards downstream

9:38 am

Project Name:			
Site No. 6	Address: Park n' Ride, Juniata Apts		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Difficult Access, fence and private property surround

Utilities:

Utilities along Juniata Rd/Otsego Rd

Constructability:

Other Notes:

Debris in stream, very urban

"Area Prone to flooding, park at your own risk" signs in parking lot.

Grate clogged - drain at corner of Juniata and Ostego.

stream appears to go into pipe system - back waters to flood parking lot.

Project Name:			
Site No. 7	Address: Park ~~Ave~~ Drive		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

McKinney Park
large area for staging/stockpiling next to stream

Utilities:

no known utilities

Constructability:

Other Notes:

"Lily Run"
Pedestrian bridge
Square concrete outfall

Project Name: Swan Creek / Lower Susq.			
Site No. 8	Address: McLhinney Park Superior St/N. Juniata St.		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Access from Superior St.

Utilities:

Constructability:

County property, Havre de Grace park

Poor MBSS values

Other Notes:

Stream is eroded within the park, ~~bing~~ sharp bends. Appears to flood often. Drain directly into Susq. River.

Upstream (south of Superior St) riparian zone is grassed and mowed. No sinuosity. erosion along banks.

Project Name:			
Site No. 11	Address: Grace Harbor HOA		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

1) Good access to floodplain
2)

Utilities:

No utilities near stream

Constructability:

Erosion and tight meander bends.
4' tall banks, one section w >12' high banks.
- outfall with gabions, riprap washed downstream

Other Notes:

1) Headcuts forming on small side channels
Boulder riprap placed in stream
Washed down riprap
eroded banks, exposed roots
Many areas with washed down cobble/boulders/exposed matting
Fairly sinous
2) Riser structure @ upstream
Entire area is wetland

Project Name:			
Site No. 11	Address:		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Upstream of road

Utilities:

Constructability:

Channel upstream of pond has erosion, low vegetation, bank reach 3 feet high headcuts, exposed tree roots.

Other Notes:

SWM Pond, wet detention pond, riprap outfall to area before riser. Unknown if there is pipe from pond to riser. Unknown where inflow pipe in riser comes from

Project Name:			
Site No. 14	Address: Hopewell Rd		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Access off of Hopewell Rd

Utilities:

OH Electric Lines

Constructability:

Other Notes:

- Stream is in stable condition
  no riparian zone, good access to floodplain
- Wooded / forested at upstream end, goes under Hopewell Rd

Project Name:			
Site No. 15	Address: Aldino Rd.		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Easy access along Aldino Rd

Utilities:

OH Electrical both sides of Aldino Rd

Constructability:

Other Notes:

Road crossing at Aldino Rd.
Riffles and pools, stream appears stable

Project Name: Swan Creek			
Site No. 19	Address: Mt. Royal Ave		
Date Built: 2004	Imp Credits:	Property Owners: Board of Ed	Contact Info:

Access (including staging/stockpiling):

access from gate along Mt. Royal Ave.

Utilities:

Oth Electric, light poles

Constructability:

outfall-flared endsection from Mt. Royal
very vegetated pond
SWM Pond in good condition.

Other Notes:

Multiple outfalls outletting into pond.
~~[illegible]~~ pond outfalls into plunge pool/stream

boulders placed along stream creating
scour pools and erosion on banks.

Deep pools

Project Name: Swan Creek			
Site No. 20	Address: Timber Ln and Oakington Rd		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Access from Timber Ln
Harf. Co. property

Utilities:

No utilities seen near stream

Constructability:

outfall in poor condition, scouring, undercut outfall (2)
lots of LWD

Other Notes:

Deposition, fallen trees

Appears to be in stable condition

8/26/19 = Walked further downstream,
major erosion along ~~left~~ right bank (1) undercut >20 ft bank

tortuous meander bends

Project Name: Swan Creek			
Site No. 22	Address: Alfred B Hilton Park		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Access from park parking lot.

Utilities:

No utilities near BMP

Constructability:

Other Notes:

BMP is stable – no work needed

Project Name:	Swan Creek/Lower Susquehanna		
Site No. 26	Address: N. Osbourne Lane - Michael's Distribution		
Date Built: 2001	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Access from distribution center parking lot

Utilities:

Electrical lines, railroad tracks, light poles

Constructability:

Other Notes:

recieves drainage from
grassed depression - possible bioretention?

Project Name: Swan Creek / Lower Susq			
Site No. 27	Address: LDS Church, Level Rd		
Date Built: 1984	Imp Credits:	Property Owners: Church	Contact Info:

Access (including staging/stockpiling):

Easy access from Church parking lot. SWM Pond has chainlink fence w/ gate. Large area for staging/stockpile

Utilities:

Sattelite adjacent to pond.

Constructability:

Dry Pond. Gabion boxes at outfall. No riser, two concrete blocks at outlet to direct flow.

Other Notes:

Outfalls to dry stream channel.

VRS recommended pond retrofit, bioretention

Project Name: Swan Creek			
Site No. 30	Address: 260 Hopewell Rd Aberdeen MD		
Date Built: Permit→1990s 2005	Imp Credits:	Property Owners: 260 LLC	Contact Info:

Access (including staging/stockpiling):

1) Construction Company Parking Lot
2) Airport Property Pond - wet

Utilities:

Electrical Box

Constructability:

→ Wet Pond
→ Riser, newer construction

Other Notes:

No riser - older
Electrical lines on road

Project Name: Swan Creek			
Site No. 31	Address: Behind Elmer's Used Tires		
Date Built: 1997	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Gated access from storage facility parking lot off of Pulaski Hwy

Utilities:

OH electric lines on Pulaski Hwy

Constructability:

URS recommended retrofit
MS4 Required Stormwater Retrofit

Other Notes:

Project Name: Swan Creek			
Site No. 32	Address: Intersection of Beards Hill / Aberdeen Thruway		
Date Built:	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Access from gate off rodd
Intersection of Beards Hill and Aberdeen Thruway

Utilities:

Constructability:

→ Wet pond - looks newer
Larger Pond closer to Aberdeen Thruway
potential for retrofit.

Other Notes:

One pond appears newer, other is wet pond
that drains to other pond.

~~Has Rinker Materials "stormceptor" installed~~
~~stormceptor.com, used to remove TSS, TPH from~~
~~runoff~~

Project Name: Swan Creek			
Site No. 33	Address: 950 Beards Hill Rd Aberdeen		
Date Built: Permit App = 1985	Imp Credits:	Property Owners:	Contact Info:

Access (including staging/stockpiling):

Utilities:

light poles, underground utilities around shopping center

Constructability:

Other Notes:

large vegetated wet pond
recieves flow from shopping center

Rinker Materials "Stormceptor" installed
stormceptor.com removes TSS, TPH from runoff before entering pond

Project Name: SWM-4 Level Volunteer Fire Dept.			
Site No. SWM-4	Address: 3633 Level Village Rd Havre DeGrace, MD		
Date Built: n/a	Imp Credits: 1.65	Property Owners: Level Volunteer Fire Dept. Inc.	Contact Info: (410) 638-3826

Access (including staging/stockpiling):

- Access from Level Fire Dept. parking lot
- Stockpile

Utilities:

- Electrical sub-station south of parking lot
- Electrical poles

Constructability:

- small SWM facility at edge of parking lot to collect run-off from parking lot.

Other Notes:

- Looked at stream, no flow, some erosion and headcuts.

Project Name:	Aberdeen Middle School Pond		
Site No. SWM-5	Address: 111 Mt. Royal Ave. Aberdeen, MD 21001		
Date Built:	Imp Credits: 11.50	Property Owners: Board of Ed.	Contact Info: 410-273-5510

Access (including staging/stockpiling):

- Access from parking lot on Mt. Royal Ave
- Stockpile in school field.

Utilities:

- Sanitary sewer line

Constructability:

- SWM Pond at intersection of two pipes from school, currently not being treated.

Other Notes:

Project Name:	Havre de Grace Elementary Pond		
Site No. SWM-7	Address: 600 S. Juniata St. Havre de Grace, MD 21078		
Date Built:	Imp Credits: 8.82	Property Owners: Harf. Co. Board of Ed	Contact Info: 410-939-6616

Access (including staging/stockpiling):

- Access from Juniata Rd, Alleghany St
- Stockpile in school field

Utilities:

- No utilities near pr. pond location

Constructability:

- Pr. SWM pond where pipe network joins stream.
- Pipes from school and surrounding neighborhoods
- Currently not being treated.

Other Notes:

- Could be an educational program for elementary school
- Harford Co. property

Project Name: Chapel Rd Park Pond Retrofit			
Site No. SWM-8	Address: 2029 Chapel Rd Havre de Grace, MD 21078		
Date Built:	Imp Credits:	Property Owners: Harford Co.	Contact Info: 410-939-6724

Access (including staging/stockpiling):

- Access from Chapel Rd
- Parking lot and large open space could be used for access / stockpiling.

Utilities:

- no utilities

Constructability:

- Extended detention basin, need to see when facility was built. Possible retrofit.

Other Notes:

- Headwall has small ~3-inch orifice and top slab opening outfalls to riprap channel

Project Name:	Hutchins Ct. Pond Retrofit		
Site No. SWM-9	Address: 306 Heather Way Havre de Grace, MD 21078		
Date Built:	Imp Credits: 13.50	Property Owners: Bay View HOA	Contact Info:

Access (including staging/stockpiling):

- From Heather Way, or behind properties on Lighthouse Ct., Hutchins Ct.
- small access road on south side of stream leading to Pond.

Utilities:

Constructability:

- Eroded stream leading to SWM Pond, possible retrofit, stream restoration

Other Notes:

- Small access road
- steep outfall from road crossing on Heather Way
- Boulder riprap protection being washed out.
- Geotech matting showing
- Eroded banks, headcuts forming
- Riser structure appears older

Project Name:	Carsins Run Stream Restoration		
Site No. SR-1	Address: 3509 Farm Rd Aberdeen, MD 843 Randolph Dr. 3500 Garrett Ct. Aberdeen, MD		
Date Built:	Imp Credits: 20.23	Property Owners: SHA, private prop.	Contact Info:

Access (including staging/stockpiling):

Utilities:

Constructability:

Other Notes:

Project Name:	Grace Manor HOA Stream Restoration		
Site No. SR-4	Address: 133 Grace Manor Dr. Havre de Grace, MD 21078		
Date Built:	Imp Credits: 11.18	Property Owners: Grace Manor HOA	Contact Info:

Access (including staging/stockpiling):

- Access from Grace Manor Dr.

Utilities:

Constructability:

- Need bank stabilization, where pond is outletting is severely eroded
- confluence severely eroded
- adjacent to private properties

Other Notes:

- Headcuts -
- Debris Jams
- Banks up to 7-8 ft tall, 90° banks
- Banks are unstable, especially next to private property

Project Name: Lynn Lee Dr. Pond			
Site No. SWM-3	Address: 804 Lynn Lee Drive Aberdeen MD 21001		
Date Built:	Imp Credits: 1.10	Property Owners: Private property	Contact Info:

Access (including staging/stockpiling):

Access along Lynn Lee Drive.
Private Property

Utilities:

Light pole at end of Lynn Lee Drive. No other noticed utilities.

Constructability:

SWM BMP at outfall of pipe network. to treat runoff from Lynn Lee Drive.

Other Notes:

Outfall eventually drains to Carsins Run

APPENDIX F

Pollutant Removal and Impervious Area Computation

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP-1 Stack & Store	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. Treatment	ST		5.90	2.50	42.4%	48.5	3.2	3.1	25	39	50	0.212	0.106	0.50	12.1	1.2	1.5	1.25
Pr. Total Treatment	ST		5.90	2.50	42.4%	48.5	3.2	3.1	32.5	51	65	0.212	0.212	1.00	15.8	1.6	2.0	2.50
Additional Treatment and Credit	**ST**		**5.90**	**2.50**	**42.4%**	**48.5**	**3.2**	**3.1**	**25**	**39**	**50**	**0.212**	**0.106**	**0.50**	**3.6**	**0.4**	**0.5**	**1.25**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP-2	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Lynn Lee Drive	ESD		2.69	1.09	40.5%	25.4	1.9	1.5	72	85	90	0.093	0.242	2.60	18.3	1.6	1.4	1.53
														TOTAL	**18.3**	**1.6**	**1.4**	**1.53**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP-3	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Level Volunteer Fire Dept.	ESD		1.91	1.65	86.6%	25.0	1.5	1.7	72	85	90	0.132	0.343	2.60	18.0	1.2	1.5	2.31
														TOTAL	**18.0**	**1.2**	**1.5**	**2.31**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP-4	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Aberdeen Middle School	ST		20.92	9.29	44.4%	206.0	15.1	13.0	42	66	85	0.784	2.038	2.60	86.5	9.9	11.0	13.00
														TOTAL	**86.5**	**9.9**	**11.0**	**13.00**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP-5 LDS Church	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. Treatment	ST		3.90	1.40	35.9%	43.3	2.8	2.2	1	1	1	0.121	0.000	0.00	0.0	0.0	0.0	0.00
Pr. Total Treatment	ST		3.90	1.40	35.9%	43.3	2.8	2.2	32.5	51	65	0.121	0.121	1.00	14.1	1.4	1.4	1.40
Additional Treatment and Credit	**ST**		**3.90**	**1.40**	**35.9%**	**43.3**	**2.8**	**2.2**	**32.5**	**51**	**65**	**0.121**	**0.121**	**1.00**	**14.1**	**1.4**	**1.4**	**1.40**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP-6	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Havre de Grace Elementary	ST		16.99	5.82	34.2%	161.3	13.1	9.2	42	66	85	0.507	1.318	2.60	67.8	8.6	7.8	8.14
														TOTAL	**67.8**	**8.6**	**7.8**	**8.14**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP-7	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Bay View HOA	ST		37.30	13.50	36.2%	346.0	26.8	20.3	42	66	85	1.168	3.037	2.60	145.3	17.7	17.3	18.90
														TOTAL	**145.3**	**17.7**	**17.3**	**18.90**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

SR-1	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Tide Circle Outfalls	SR-CP	1610.00							0.075	0.068	0.0075				120.8	109.5	12.1	32.20
														TOTAL	**120.8**	**109.5**	**12.1**	**32.20**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

SR-2	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Gasheys Creek	SR-CP	3500.00							0.075	0.068	0.0075				262.5	238.0	26.3	70.00
														TOTAL	**262.5**	**238.0**	**26.3**	**70.00**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

SR-3	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Grace Manor HOA	SR-NCP	1060.00							0.075	0.068	0.0225				79.5	72.1	23.9	31.80
														TOTAL	**79.5**	**72.1**	**23.9**	**31.80**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

SR-4	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
McLhinney Park	SR-CP	1810.00							0.075	0.068	0.0075				135.8	123.1	13.6	36.20
														TOTAL	**135.8**	**123.1**	**13.6**	**36.20**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

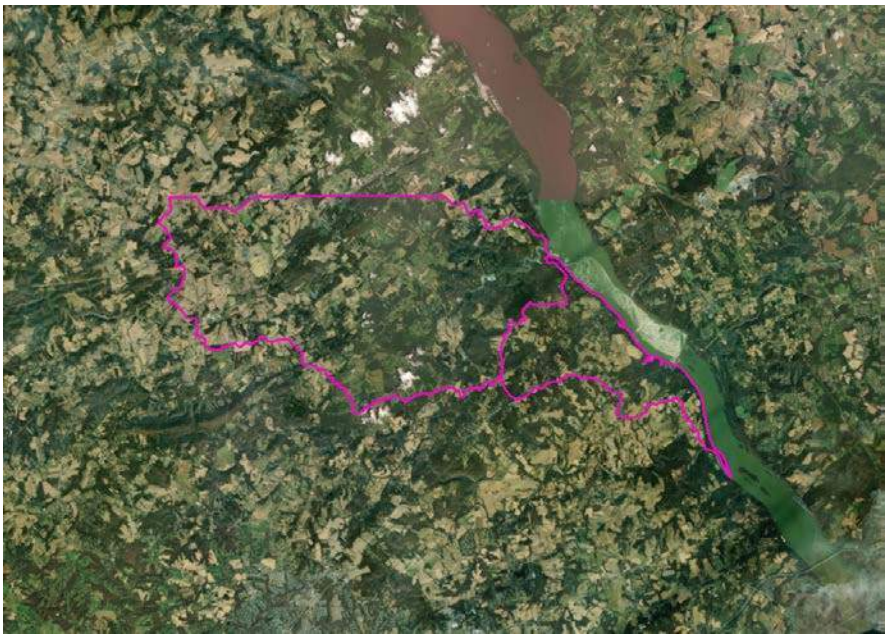
SR-5	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Grace Harbour HOA	SR-NCP	2380.00							0.075	0.068	0.0225				178.5	161.8	53.6	71.40
														TOTAL	**178.5**	**161.8**	**53.6**	**71.40**

Broad Creek and Lower Susquehanna River North Watershed Assessment

Prepared for:

Harford County
Department of Public Works

Broad Creek & Lower Susquehanna North Large Watershed Action Plan



November 2019

Prepared by:

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1. INTRODUCTION

1.1. Overview & Background

The Harford County (the County) Department of Public Works (DPW) has contracted BayLand Consultants & Designers, Inc. (BayLand) to provide a detailed watershed assessment referred to as a Large Watershed Action Plan (LWAP) for Broad Creek and a smaller watershed that drains directly to the Susquehanna River (hereafter referred to as the Lower Susquehanna North Watershed).

The LWAP is intended to satisfy the requirements of the County's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit (11-DP-3310 MD0068268). It is also intended to:

- Determine current water quality conditions;
- Include the results of the visual watershed inspection;
- Identify and rank water quality problems;
- Prioritize all structural and nonstructural water quality improvements;
- Specify pollutant load reduction benchmarks that demonstrate progress toward meeting all applicable stormwater wasteload allocations (WLA).

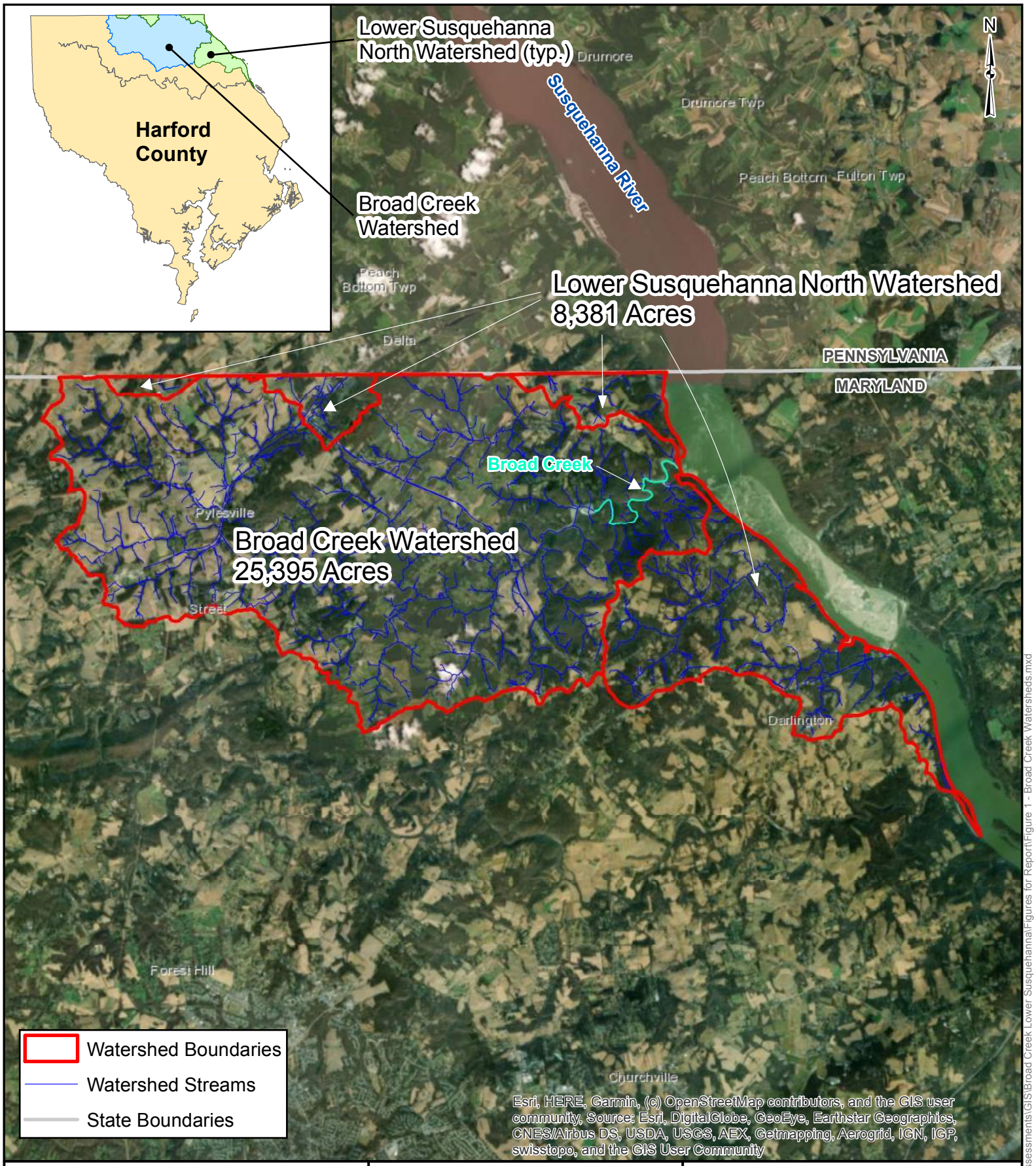
The Broad Creek and Lower Susquehanna North Watersheds are located in the northeast portion of the County. A watershed map is included as Figure 1.

The Broad Creek Watershed is comprised of the Harford County portion of the Broad Creek Watershed (MDE 8-Digit 02120205). The Broad Creek Watershed is approximately 25,395 acres (39.7 square miles) and drains into Broad Creek.

The Lower Susquehanna North Watershed is comprised of the Harford County portion of the Conowingo Dam-Susquehanna River Watershed (MDE 8-Digit 02120204) and the northern Harford County portion of the Lower Susquehanna River Watershed (MDE 8-Digit 02120201). The Lower Susquehanna North Watershed is approximately 8,381 acres (13.1 square miles) and drains into the Susquehanna River.

Historical land use changes throughout the watersheds, including urbanization, deforestation, afforestation, and agricultural intensification has resulted in degraded water quality, accelerated stream bank erosion due to increased stormwater runoff and altered basin hydrology, reduced flood storage capacity, and increased risk to public and private infrastructure and property along the County's stream corridors.

As a result, the watersheds have been targeted for assessment to locate and quantify areas of instability and degradation, identify potential causes of water quality impairments, and recommend structural and non-structural methods to reduce pollutant loads in the watersheds.



Notes:
1. Streams Data from 2013 Harford County GIS

0 1 2 4 Miles
1" = 2.0 miles

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FIGURE 1
BROAD CREEK
AND LOWER
SUSQUEHANNA NORTH
WATERSHEDS
(IN HARFORD COUNTY)

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 1 - Broad Creek Watersheds.mxd

1.2. Scope of Study

Existing conditions for the Broad Creek and Lower Susquehanna North Watersheds were evaluated through desktop analysis, field reconnaissance, review of existing as-built information, and modeling of pollutant loads. The data was utilized to characterize the current conditions of the watersheds and identify sub-watersheds with the highest pollutant loads. Ultimately, results were used to develop and prioritize restoration opportunities in highly impacted sub-watersheds. Cost and pollutant load reduction estimates were developed for each restoration opportunity including best management practices (BMP) and stream restoration projects. Sub-watershed pollutant loads were then recalculated to demonstrate anticipated pollutant reductions associated with the proposed projects.

Ultimately, potential projects were evaluated and prioritized according to the following criteria:

- Location within the Watershed
- Estimated Pollutant Load Reductions
- Impervious Acre Credits
- Property Ownership
- Site Access
- Existing Utility Conflicts
- Cost

2. WATERSHED CHARACTERIZATION

2.1. Watershed

The Broad Creek Watershed is approximately 25,395 acres (39.7 square miles) and the Lower Susquehanna North Watershed is approximately 8,381 acres (13.1 square miles). Both watersheds are comprised of a mix of agricultural, forested and residential land uses.

Section 303(d) of the Clean Water Act (CWA) requires states to develop lists of impaired watersheds, which are commonly referred to as “303(d) Lists” (EPA, 2019). The Broad Creek Watershed was first identified on the 2018 303(d) List submitted to the Environmental Protection Agency (EPA) by Maryland Department of the Environment (MDE) as impaired by Temperature (MDE, 2018). The Lower Susquehanna River Watershed was first identified on the 2018 303(d) List submitted to the EPA by MDE as impaired by Total Phosphorous (TP). Listings of polychlorinated biphenyls (PCB) in fish tissue were added in 2008 (MDE, 2008).

2.2. Physiography

The Broad Creek and Lower Susquehanna North Watersheds fall within the Piedmont Plateau Province, including the Hampstead Upland District (422300), the Susquehanna Gorge District (421200), and the Bel Air Upland District (422100) (MGS, 2008).

The Hampstead Upland District (422300) features rolling to hilly uplands interrupted by steep-walled gorges. This landform features differential weathering of a variety of rock types results in ridges, hills, barrens and valleys. Streams may have short segments of narrow and steep-sided valleys (MGS, 2008).

The Susquehanna Gorge District (421200) is a gorge marked by rapids, bedrock islands, and very steep (greater than 25 degrees) to vertical valley walls (MGS, 2008).

The Bel Air Upload District (422100) features an upland characterized by gently rolling to flat surfaces (MGS, 2008).

2.3. Climate

The climate in the County is largely influenced by its location in the warm temperate zone of the eastern United States. The County typically experiences mild winters and hot, humid summers.

As shown in Table 1, the mean annual temperature is 55.4 degrees Fahrenheit (F) with an average summer temperature of 76.1 degrees F and an average winter temperature of 34.4 degrees F. Mean monthly high and low temperatures range from 22.0 degrees F to 41.8 degrees F for January, and 66.7 degrees F to 89.6 degrees F in July (NCEI, 2019.)

Precipitation is uniformly distributed during the year. Winter rainfall primarily results from low-pressure storms moving through the area and is less variable than summer rainfall. Mean annual precipitation is 47.5 inches, with mean monthly precipitation varying from a low of 2.9 inches in February to a high of 5.0 inches in September.

Table 1 – Average Daily and Annual Values for Temperature and Precipitation at Conowingo Dam in Maryland*

Average Daily and Annual Values													
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean Annual**
Average Temperature (°F)	31.9	34.7	42.8	53.5	63.8	73.7	78.2	76.5	69.0	56.9	46.2	36.6	55.4
Precipitation (inches)	3.4	2.9	4.3	3.9	4.0	4.2	4.3	3.9	5.0	4.1	3.5	4.0	47.5

*Information obtained from NOAA.gov http://www.ncdc.noaa.gov/cdo-web/datatools/normals)

2.4. Geology

According to the Maryland Geological Survey, this region of the County is predominately underlain by precambrian schist, metagraywacke, quartzite, marble and metavolcanics rocks (MGS, 1968). It also has some paleozoic granite igneous rocks and palezoic basic igneous rocks, including quartz diorite to granite, gabbro and serpentinite (MGS, 1968). The geologic characteristics influence the chemical composition of surface water and groundwater, as well as groundwater recharge rates. The properties of soil can also influence the rate and total amount of pollutants entering water bodies in developed areas (Baltimore County Department of Environmental Protection and Sustainability (BC-DEPS), 2014).

2.5. Soils

Soils within the Broad Creek and Lower Susquehanna North Watersheds were determined using the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Web Soil Survey (2019). The hydrologic soil groups are listed in Table 2. Detailed soils maps, reports for drainage class, and hydrologic soil groups are included in Appendix B.

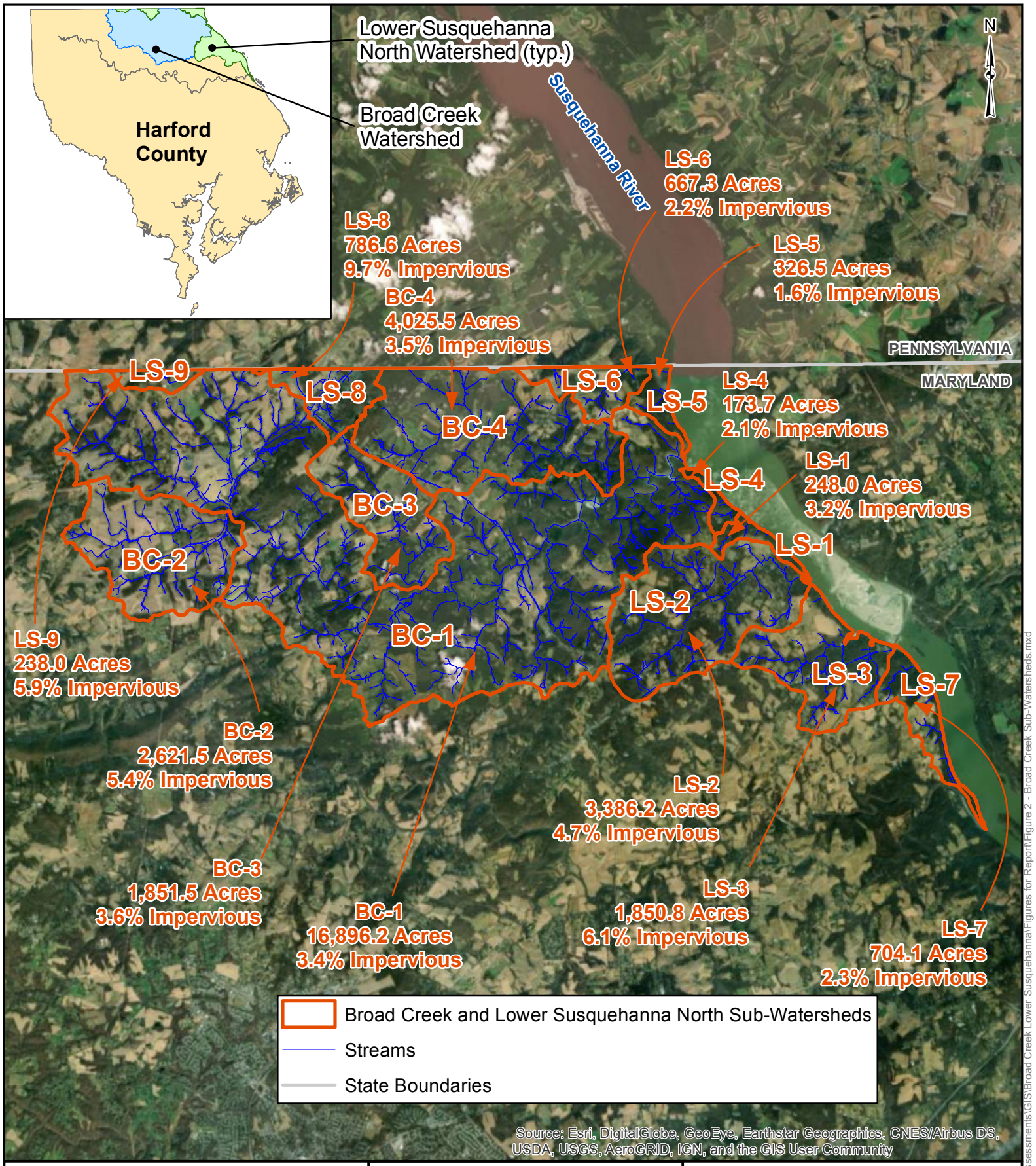
Table 2 – USDA-NRCS Soils		
Hydrologic Soil Group	**Acres in Watershed (acres)**	**Percent of Watershed (%)**
Broad Creek Watershed		
A	107.9	0.4
B	19,882.4	78.3
B/D	362.4	1.4
C	3,793.4	14.9
C/D	1,028.9	4.1
Cut/Fill	22.4	0.1
D	72.3	0.3
Water	125.0	0.5
Broad Creek Total	**25,394.7**	**100.0**
Lower Susquehanna North Watershed		
A	95.5	1.2
B	5,459.3	65.1
B/D	132.0	1.6
C	1,882.5	22.5
C/D	779.3	9.3
Cut/Fill	2.7	0.0
D	10.0	0.1
Water	19.9	0.2
Lower Susquehanna North Total	**8,381.2**	**100.0**

According to the survey, the dominant soil in the Broad Creek Watershed is Chester silt loam with slopes ranging from three to eight percent which comprises 21 percent of the watershed. Chester silt loam consists of very deep, well drained soils on upland divides and upper slopes in the northern Piedmont (Soil Survey Staff, USDA-NRCS, 2019). These soils formed in materials weathered from micaceous schist. The soil color is generally brown but can range from dark grayish brown or black in wooded areas to yellowish-red when it contains traces of clay or gravel. Most areas of Chester silt loam soils are in farmland where principal crops include corn, soybeans, small grains, hay and pasture. The native vegetation for this type of soil is typically red oak, white oak, tulip poplar and hickory.

The dominant soil in the Lower Susquehanna North Watershed is Neshaminy silt loam with slopes ranging from three to eight percent which comprises 15 percent of the watershed. Neshaminy silt loam consists of very deep, well drained soils on uplands (Soil Survey Staff, USDA-NRCS, 2019). These soils formed in materials weathered from diabase and other dark colored basic rocks. The soil color is generally brown but can range from very dark grayish brown to yellowish-red and red. Stony and steep areas are mostly in woodland, dominated by oaks and hickories. Some less steep or non-stony areas are used for cropland, hay, and pasture, as well as developed for urban or suburban communities.

2.6. Sub-Watersheds

The Broad Creek Watershed was delineated into four sub-watersheds and the Lower Susquehanna North Watershed was delineated into nine sub-watersheds at hydrologically significant locations such as stream confluences using Harford County Geographic Information System (GIS) data. The sub-watersheds range from 173.7 to 16,896.2 acres (0.3 to 26.4 square miles) with impervious cover ranging from 1.6 to 9.7 percent. The Broad Creek and Lower Susquehanna North Sub-Watersheds are shown in Figure 2.



Notes:
1. Streams Data from 2013 Harford County GIS
2. Watershed Features from 2013 Harford County GIS
3. Impervious Land use Data from 2014 Harford County GIS

0 1 2 4 Miles

1" = 2.0 miles

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FIGURE 2
BROAD CREEK
AND LOWER
SUSQUEHANNA NORTH
SUB-WATERSHEDS

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 2 - Broad Creek Sub-Watersheds.mxd

2.7. Historical Land Use

Land use changes in a watershed can have large impacts on watershed hydrology (Bierman, 2005; Miller et al., 1993; Costa, 1975; Knox, 1977; Wolman and Schick, 1967). In order to develop a broader understanding of former land use influences on the Broad Creek and Lower Susquehanna North Watersheds, a brief investigation of land use history was conducted.

The majority of the Mid-Atlantic Region was converted from forest to intensive row crop agriculture in the 18th century (Merritts et al., 2004). This is evident in historical aerial imagery obtained from Harford County GIS data that depicts the Broad Creek and Lower Susquehanna Watersheds from 1938 to 1980 (Appendix A). The historic aerials show that by 1938, the watersheds were dominated by agricultural fields. Historically, the lack of soil conservation practices associated with agriculture has led to substantial erosion from the Piedmont upload and subsequent deposition of sediment in the floodplains and stream channels (Jacobson and Coleman, 1986).

Aerial imagery also shows development within the watershed during the 20th century. Majority of the development in the watersheds occurred prior to the implementation of Maryland's Stormwater Management (SWM) Regulations in 1983. Since this development predates current SWM design standards, runoff in these regions is either unmanaged or under-managed. Increasing impervious surface in a watershed has been shown to reduce infiltration and evapotranspiration, and increase runoff into stream networks (MDE, 2000). Watersheds with higher levels of imperviousness generally have lower levels of water quality and biological health.

2.8. Existing Land Use

The Broad Creek Watershed is approximately 25,395 acres (39.7 square miles) with approximately four percent impervious area. The Lower Susquehanna North Watershed is approximately 8,381 acres (13.1 square miles) with approximately five percent impervious area.

Existing land use was originally developed using a combination of various data sources per guidance from MDE (Table 3). Water, wetlands, tree canopy over turf, forest, turf and mixed open land use categories were derived from 2016 Chesapeake Conservancy (CC) GIS data edited by MDE. It should be noted that MDE edited the CC land use categories to account for hydrologic differences between managed and unmanaged vegetative communities within urbanizing areas. Impervious surface was derived from 2014 Harford County Impervious Area GIS data, and agriculture was derived from the United States Geological Survey (USGS)'s Chesapeake Bay Phase 6 Land Use data.

Each existing land use category was assigned an equivalent land use designation compatible with the Chesapeake Bay Program (CBP) Phase 6 Watershed Model. The equivalent Phase 6 existing land use categories are summarized in Table 3.

Table 3 – Harford County Existing Land Use	
Existing Land Use	**Equivalent Phase 6 Existing Land Use**
Water	Water
Wetlands	Non-tidal Floodplain Wetland
Tree Canopy Over Turf	Tree Canopy over Turf
Forest	True Forest
Turf	Turf
Mixed Open	Mixed Open
Agriculture	Agriculture
Impervious Surfaces	Impervious

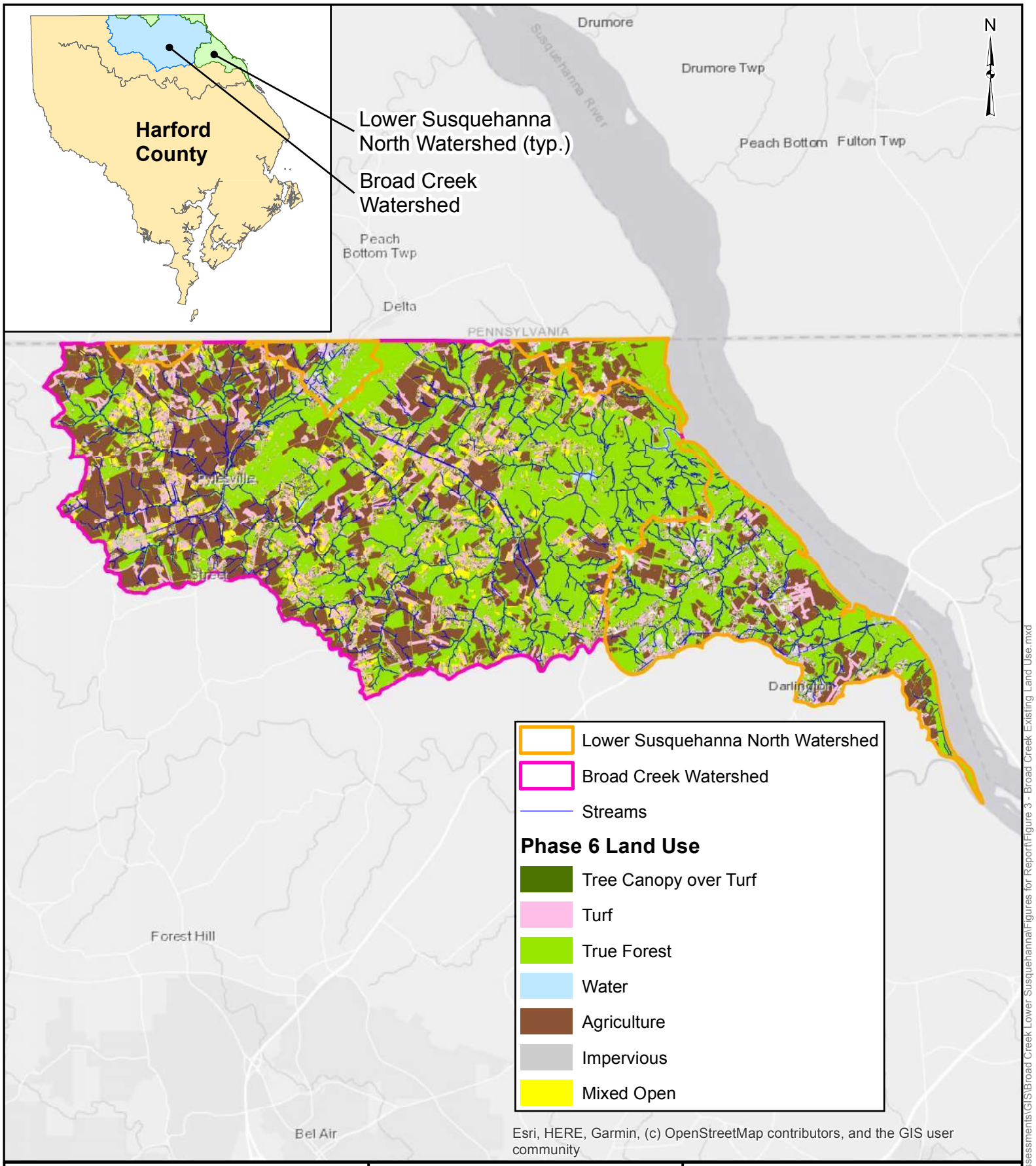
The Phase 6 existing land use categories for the Broad Creek and Lower Susquehanna North Watersheds are depicted in Table 4 and Figure 3. The existing land use analysis shows that both watersheds are primarily forest, agriculture and turf.

Table 4 – Broad Creek and Lower Susquehanna North Watersheds Phase 6 Existing Land Use		
Parameter	**Acres**	**Percentage of Drainage Area (%)**
Broad Creek Watershed		
True Forest	11,172.8	44.0
Agriculture	7,634.7	30.1
Turf	3,285.9	12.9
Mixed Open	1,528.0	6.0
Impervious	926.7	3.7
Tree Canopy Over Turf	718.3	2.8
Water	128.3	0.5
Broad Creek Total	**25,394.7**	**100.0**
Lower Susquehanna North Watershed		
True Forest	4,543.9	54.2
Agriculture	1,796.0	21.4
Turf	949.4	11.3
Mixed Open	372.8	4.5
Impervious	408.5	4.9
Tree Canopy Over Turf	286.9	3.4
Water	23.7	0.3
Lower Susquehanna North Total	**8,381.2**	**100.0**

Existing land use was also determined for each sub-watershed (Table 5). Within the Broad Creek Watershed, Sub-Watershed BC-1 has the largest amount of impervious area (579.8 acres) as well as the largest amount of agricultural area (4,821.2 acres). Sub-Watershed BC-3 has the smallest amount of impervious area (67.4 acres) as it is primarily forested (46 percent).

Within the Lower Susquehanna North Watershed, Sub-Watershed LS-2 has the largest amount of impervious area (157.7 acres) and the largest amount of agricultural area (591.5 acres). Sub-Watershed LS-4 has the smallest amount of impervious area (3.6 acres) as it is primarily forested (92 percent).

Table 5 – Broad Creek and Lower Susquehanna North Sub-Watersheds Phase 6 Existing Land Use							
Sub-Watershed	**Impervious (ac.)**	**Water (ac.)**	**True Forest (ac.)**	**Agriculture (ac.)**	**Mixed Open (ac.)**	**Turf (ac.)**	**Tree Canopy over Turf (ac.)**
Broad Creek Sub-Watersheds							
BC-1	579.8	115.5	7,850.1	4,821.2	968.3	2,071.3	490.1
BC-2	140.7	4.0	502.3	1,335.5	177.4	396.3	65.2
BC-3	67.4	1.8	853.0	471.8	138.6	272.9	46.0
BC-4	138.8	7.0	1,967.4	1,006.2	243.7	545.4	117.0
Broad Creek Total	**926.7**	**128.3**	**11,172.8**	**7,634.7**	**1,528.0**	**3,285.9**	**718.3**
Lower Susquehanna North Sub-Watersheds							
LS-1	8.0	0.0	204.7	13.4	3.0	15.5	3.5
LS-2	157.7	8.4	1,838.2	591.5	183.4	447.8	159.3
LS-3	112.8	1.8	895.9	476.9	76.6	228.6	58.3
LS-4	3.6	0.0	159.2	2.8	0.4	5.1	2.5
LS-5	5.3	0.0	280.7	31.1	2.6	5.3	1.5
LS-6	14.4	0.0	246.4	294.9	44.8	59.6	7.2
LS-7	16.2	1.5	447.4	167.1	9.6	47.8	14.4
LS-8	76.5	12.0	414.6	124.2	37.9	90.1	31.3
LS-9	14.0	0.0	56.8	94.1	14.5	49.6	8.9
Lower Susquehanna North Total	**408.5**	**23.7**	**4,543.9**	**1,796.0**	**372.8**	**949.4**	**286.9**



Notes:
1. Streams Data from 2013 Harford County GIS
2. Agriculture Land Use Data from 2017 USGS Phase 6 Land Use Viewer
3. Impervious Land Use Data from 2014 Harford County GIS
4. All other Land Use Data from 2017 Chesapeake Bay Conservancy modified by MDE

0 1 2 4 Miles

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FIGURE 3
BROAD CREEK
AND LOWER
SUSQUEHANNA NORTH
EXISTING LAND USE

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 3 - Broad Creek Existing Land Use.mxd

2.9. Aquatic Resources

The Maryland Biological Stream Survey (MBSS) is a stream sampling program intended to assess the current condition of ecological resources in Maryland's 1st through 4th order non-tidal streams (DNR, 2019). Biological, physical, and chemical parameters are measured, and site catchment data is also reported. MBSS sampling is conducted at the six-digit river basin and eight-digit watershed levels while a volunteer component of MBSS, Stream Waders, collects samples at the 12-digit sub-watershed level. For the Broad Creek and Lower Susquehanna North Watersheds, MBSS and Stream Waders sampling data was obtained, including Benthic Index of Biotic Integrity (BIBI) and Fish Index of Biotic Integrity (FIBI) scores. For the Broad Creek Watershed, a total of 19 sites were sampled through the MBSS program from 1997 to 2017 for fish and benthic macroinvertebrates. Additionally, 16 sites were sampled through the Stream Waders program from 2005 to 2013 for benthic macroinvertebrates. For the Lower Susquehanna North Watershed, one site was sampled through the MBSS program in 2004 for fish and benthic macroinvertebrates. Additionally, 26 sites were sampled through the Stream Waders program from 2004 to 2017 for benthic macroinvertebrates. It should be noted that BIBI and FIBI scores are classified as either poor, fair, or good. A score of less than 3.0 is poor, 3.0 to 3.9 is fair and 4.0 to 5.0 is good. Streams that scored poor or fair were evaluated for potential stream restoration projects (Table 6).

Scott Creek (MBSS site 342-1-2005), located within Sub-Watershed LS-8, received the lowest BIBI rating of 1.29. Historical aerial imagery shows that a road was constructed adjacent to Scott Creek between 1957 and 1964, potentially contributing to the poor BIBI rating.

Deep Creek (MBSS site BROA-101-R-2003), located within Sub-Watershed BC-4, received a poor BIBI rating of 2.00. Historical aerial imagery shows that residential houses were constructed adjacent to Deep Creek between 1967 and 1971, potentially contributing to its poor BIBI rating.

Carr Run (MBSS site BROA-107-R-2003), located within Sub-Watershed BC-3, received a fair BIBI rating of 3.00. Historical aerial imagery shows that residential houses were constructed adjacent to Carr Run between 1971 and 1977, potentially contributing to its fair BIBI rating.

Table 6 – MBSS and Stream Waders Data					
Type	**Sample Source**	**Number of Sites Sampled**	**Good**	**Fair**	**Poor**
Broad Creek Watershed					
BIBI	MBSS	19	8 (42.1%)	6 (31.6%)	5 (26.3%)
FIBI	MBSS	18	8 (44.5%)	4 (22.2%)	6 (33.3%)
BIBI	Stream Waders	16	5 (31.3%)	8 (50.0%)	4 (18.8%)
Lower Susquehanna North Watershed					
BIBI	MBSS	1	1 (100.0%)	0 (0.0%)	0 (0.0%)
FIBI	MBSS	1	0 (0.0%)	1 (100.0%)	0 (0.0%)
BIBI	Stream Waders	26	10 (38.5%)	10 (38.5%)	6 (23.1%)

3. POLLUTANT LOAD DETERMINATION & MODELING

3.1. Modeling Methodology

The Chesapeake Assessment Scenario Tool (CAST) is a web-based modeling tool used to simulate the impact that the implementation of various BMP technologies has on watershed pollutant loads (CBP, 2017). It is utilized by multiple states and jurisdictions to support the development of Watershed Implementation Plans (WIP) and local Total Maximum Daily Loads (TMDL).

It should be noted that there are several limitations associated with the CAST modeling tool. CAST was developed to model large-scale watersheds, such as the Chesapeake Bay watershed, and in Maryland is limited to modeling watersheds averaging 9,000 acres or larger. Additionally, CAST only runs pollutant loading scenarios for watersheds pre-established by MDE and does not permit the input of unique drainage areas. Since the Broad Creek and Lower Susquehanna North Sub-Watersheds range from approximately 174 to 16,896 acres in size and are not pre-established drainage areas within the CAST model, full application of the CAST model was precluded for use in this analysis. Therefore, after consulting with MDE, it was determined that the CAST model would only be used to determine unit pollutant loading rates for land uses not included within the Maryland Phase III WIP Unit Load Summary Tables. The Maryland Phase III WIP Unit Loads Summary Tables were applied where possible to ensure the most current information was used to develop the loading rates for the Broad Creek and Lower Susquehanna North Watersheds. The pollutant loading rate source for each land use is provided in Table 7 in Section 3.2, below.

The CAST model can be run under a variety of scenarios, including the “Progress” scenario which determines pollutant loading rates while accounting for existing BMPs within the landscape and the “No Action” scenario which determines pollutant loading rates without existing BMPs. For this analysis, the “2017 Progress” scenario was utilized, so pollutant loading rates were determined while accounting for all BMPs constructed and documented within the sub-watersheds up to and including the year 2017.

The results of the CAST output for the Broad Creek and Lower Susquehanna North Watersheds are provided in Appendix C.

3.2. Pollutant Loading Rates

Table 7 depicts the pollutant loading rates associated with the Broad Creek and Lower Susquehanna North Watersheds derived from the Maryland Phase III WIP Unit Load Summary Tables and the CAST model. Predictably, impervious and agricultural land uses produce higher pollutant loads than areas covered by water, wetlands or forests. Impervious land use has a significantly higher total suspended sediment (TSS) loading rate while agriculture has a significantly higher total nitrogen (TN) loading rate. Turf land use has the highest total phosphorus (TP) loading rate.

Table 7 – Unit Loading Rates				
Land Use	**Source of Unit Loading Rates**	**2017 Progress Scenario EOS Unit Loading Rates**		
		TN (lb/ac/yr)	**TP (lb/ac/yr)**	**TSS (lb/acre/yr)**
Water	Maryland Phase III WIP EOS Unit Loads for Harford County	8.41	0.61	0.00
Non-Tidal Floodplain Wetland	Maryland Phase III WIP EOS Unit Loads for Harford County	1.32	0.03	14.68
True Forest	Maryland Phase III WIP EOS Unit Loads for Harford County	1.41	0.03	21.46
Mixed Open	Maryland Phase III WIP EOS Unit Loads for Harford County	1.92	0.17	815.37
Agriculture (Broad Creek Watershed)	CAST Model	21.50	0.33	893.53
Agriculture (Lower Susquehanna North Watershed)	CAST Model	19.81	0.36	822.44
Impervious	Maryland Phase III WIP EOS Unit Loads for Harford County	14.04	0.77	1927.82
Turf	Maryland Phase III WIP EOS Unit Loads for Harford County	8.95	0.99	758.46
Tree Canopy Over Turf	Maryland Phase III WIP EOS Unit Loads for Harford County	6.80	0.74	528.77

Once the Phase 6 existing land use and unit loading rates for the watersheds were finalized, annual pollutant loads were calculated for each sub-watershed according to the following formula:

$$Annual\ Pollutant\ Load\ \left(\frac{lb}{yr}\right) = Land\ Use\ (ac) * Unit\ Loading\ Rate\ \left(\frac{lb}{ac * yr}\right)$$

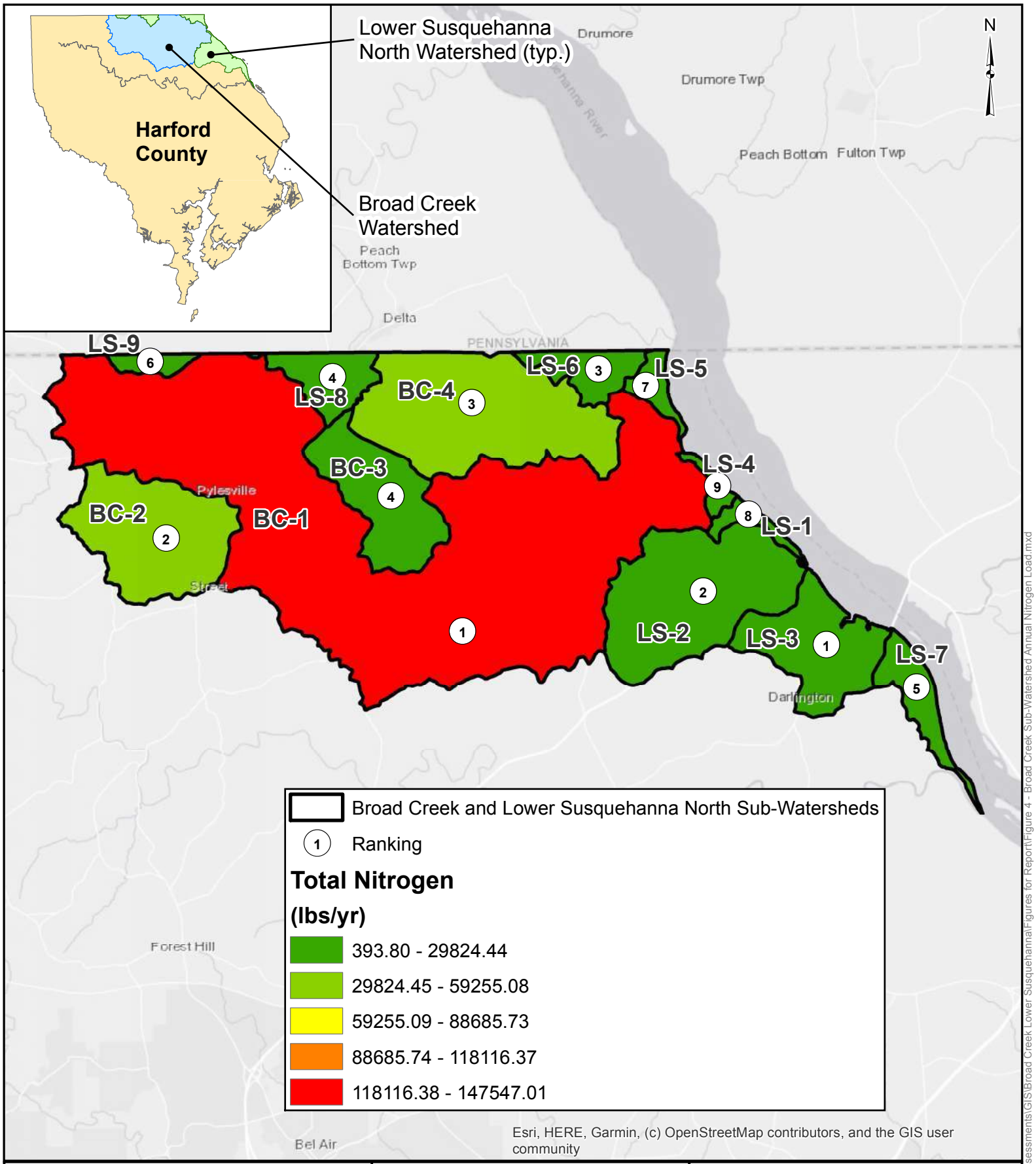
3.3. Modeling Results

The annual pollutant loads for each sub-watershed are provided in Appendix D, Table 8, and Figures 4 to 6. Table 8 depicts the sub-watersheds ranked from highest to lowest total annual pollutant loads.

Table 8 – Broad Creek and Lower Susquehanna North Sub-Watershed Annual Pollutant Loads					
Rank	**Sub-Watershed**	**Area (acres)**	**2017 Progress Scenario**		
			TN (lb/yr)	**TP (lb/yr)**	**TSS (ton/yr)**
Broad Creek Watershed					
1	BC-1	16,896.2	147,547.0	4,921.3	4,106.9
2	BC-2	2,621.5	35,756.2	1,037.3	977.5
3	BC-4	4,025.5	32,555.6	1,170.1	941.6
4	BC-3	1,851.5	12,884.7	291.9	353.6
Broad Creek Total		**25,394.7**	**228,743.5**	**7,420.6**	**6,379.6**
Lower Susquehanna North Watershed					
1	LS-2	3,386.2	22,038.8	988.2	701.6
2	LS-3	1,850.8	14,900.8	569.9	447.8
3	LS-8	786.6	5,312.4	242.4	187.2
4	LS-6	667.3	7,061.8	197.2	180.6
5	LS-7	704.1	4,727.2	147.0	115.0
6	LS-9	238.0	2,673.6	104.7	79.9
7	LS-5	326.5	1,149.8	30.6	24.4
8	LS-1	248.0	833.7	35.6	23.4
9	LS-4	173.7	393.8	15.6	9.1
Lower Susquehanna North Total		**8,381.2**	**59,091.9**	**2,331.2**	**1,769.0**

In the Broad Creek Watershed, Sub-Watershed BC-1 has the highest total annual pollutant loads since it is the largest sub-watershed with the highest impervious area composition.

In the Lower Susquehanna North Watershed, Sub-Watershed LS-4 has the lowest annual pollutant loads since it has the least amount of impervious area and is comprised of approximately 92 percent natural forest.



Notes:
1. Watershed Features from 2013 Harford County GIS

0 1 2 4 Miles
1 inch = 2.0 miles

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FIGURE 4
BROAD CREEK AND LOWER SUSQUEHANNA NORTH SUB-WATERSHED ANNUAL NITROGEN LOAD

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 4 - Broad Creek Sub-Watershed Annual Nitrogen Load.mxd

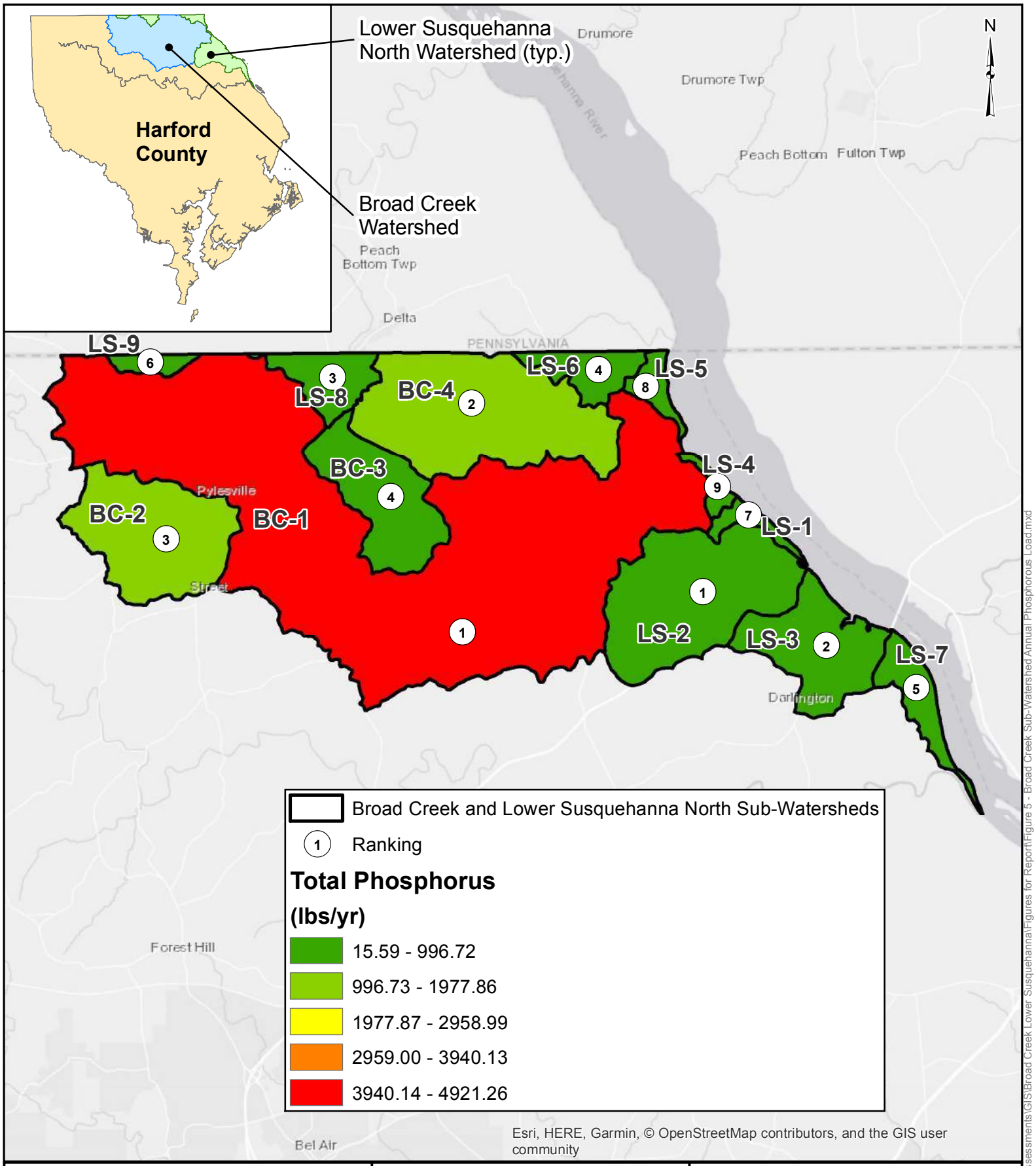

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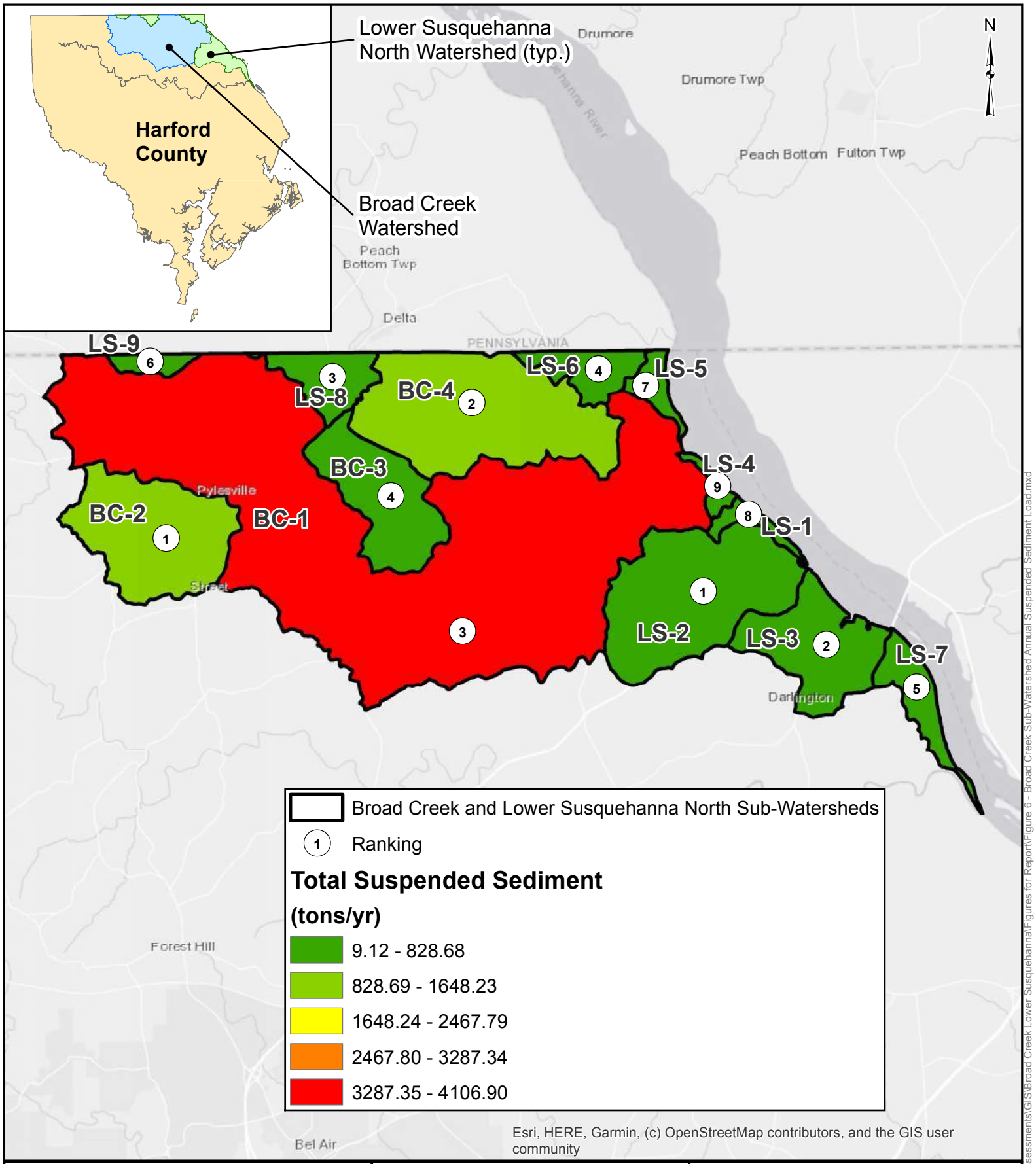
FIGURE 5
BROAD CREEK AND LOWER SUSQUEHANNA NORTH SUB-WATERSHED ANNUAL PHOSPHORUS LOAD

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 5 - Broad Creek Sub-Watershed Annual Phosphorous Load.mxd



Notes:
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FIGURE 6
BROAD CREEK AND LOWER SUSQUEHANNA NORTH SUB-WATERSHED ANNUAL SUSPENDED SEDIMENT LOAD

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 6 - Broad Creek Sub-Watershed Annual Suspended Sediment Load.mxd

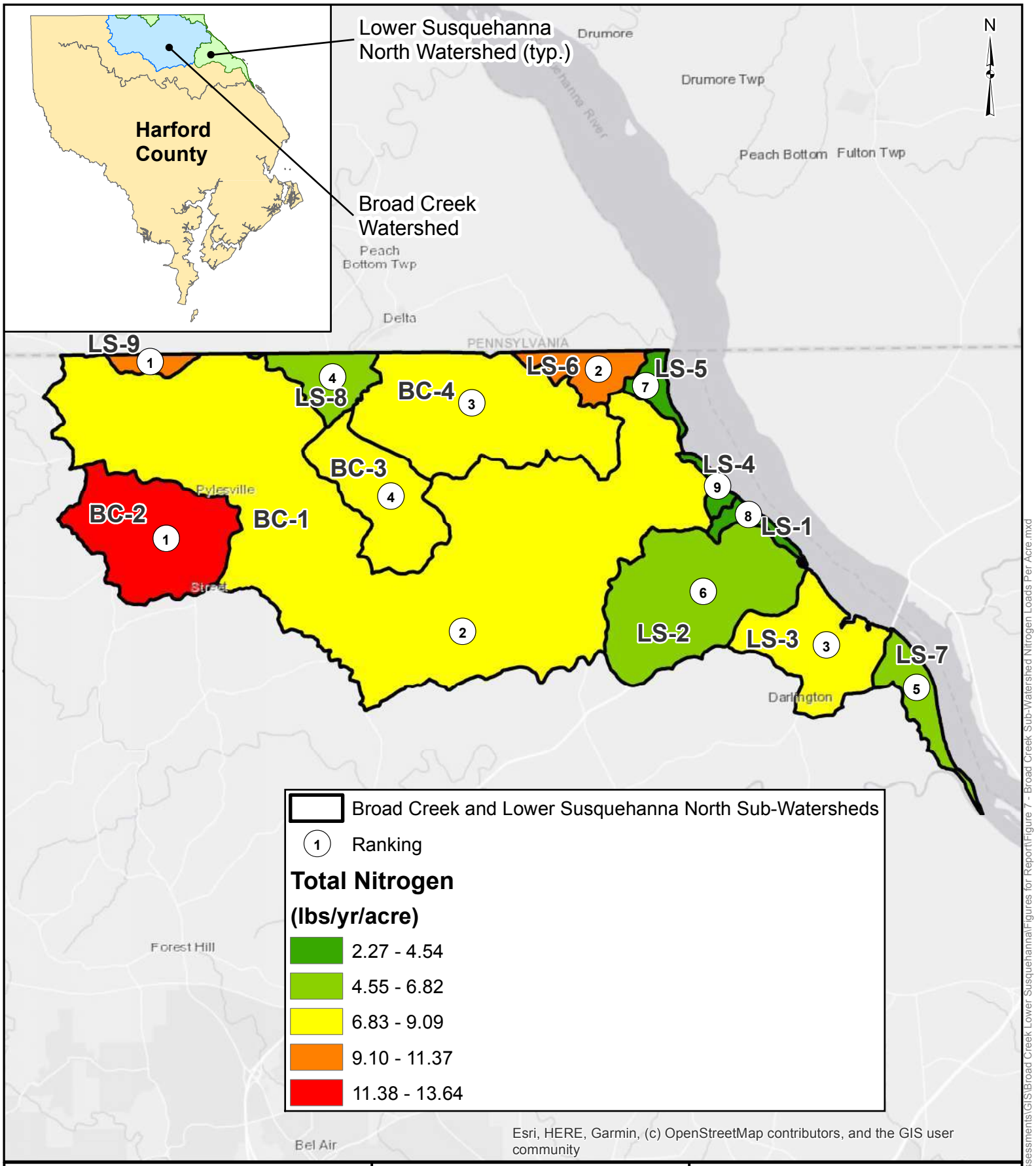
In an effort to normalize sub-watersheds based on their areas, the annual pollutant loads per acre were calculated for each sub-watershed as shown in Appendix D, Table 9 and Figures 7 to 9. Table 9 shows the total annual pollutant loads per acre ranked from highest to lowest.

Table 9 – Broad Creek and Lower Susquehanna North Sub-Watershed Annual Pollutant Loads Per Acre

Rank	Sub-Watershed	Area (acres)	2017 Progress Scenario		
			TN (lb/yr/acre)	TP (lb/yr/acre)	TSS (ton/yr/acre)
Broad Creek Watershed					
1	BC-2	2,621.5	13.64	0.40	0.37
2	BC-1	16,896.2	8.73	0.29	0.24
3	BC-4	4,025.5	8.09	0.29	0.23
4	BC-3	1,851.5	6.96	0.16	0.19
Broad Creek Total		**25,394.7**	**9.01**	**0.29**	**0.25**
Lower Susquehanna North Watershed					
1	LS-9	238.0	11.23	0.44	0.34
2	LS-6	667.3	10.58	0.30	0.27
3	LS-3	1,850.8	8.05	0.31	0.24
4	LS-8	786.6	6.75	0.31	0.24
5	LS-2	3,386.2	6.51	0.29	0.21
6	LS-7	704.1	6.71	0.21	0.16
7	LS-1	248.0	3.36	0.14	0.09
8	LS-5	326.5	3.52	0.09	0.08
9	LS-4	173.7	2.27	0.09	0.05
Lower Susquehanna North Total		**8,381.2**	**7.05**	**0.28**	**0.21**

Similar to the results presented in Table 8, the Lower Susquehanna North Sub-Watershed LS-4 has the lowest total annual pollutant loads per acre. However, unlike the results presented in Table 8, when the sub-watershed area is removed from the analysis, the Broad Creek Sub-Watershed BC-2 has the highest total annual pollutant loads per acre since it is comprised of approximately 5.4 percent impervious area and SWM runoff is largely uncontrolled and untreated.

Through the desktop analysis and field investigation, it was determined that the total pollutant loads per acre would be used as the primary ranking method for the Broad Creek and Lower Susquehanna North Watersheds. Normalizing the rankings based on area allowed for prioritization of projects in highly urbanized sub-watersheds.



Notes:
1. Watershed Features from 2013 Harford County GIS

0 1 2 4 Miles
1 inch = 2.0 miles

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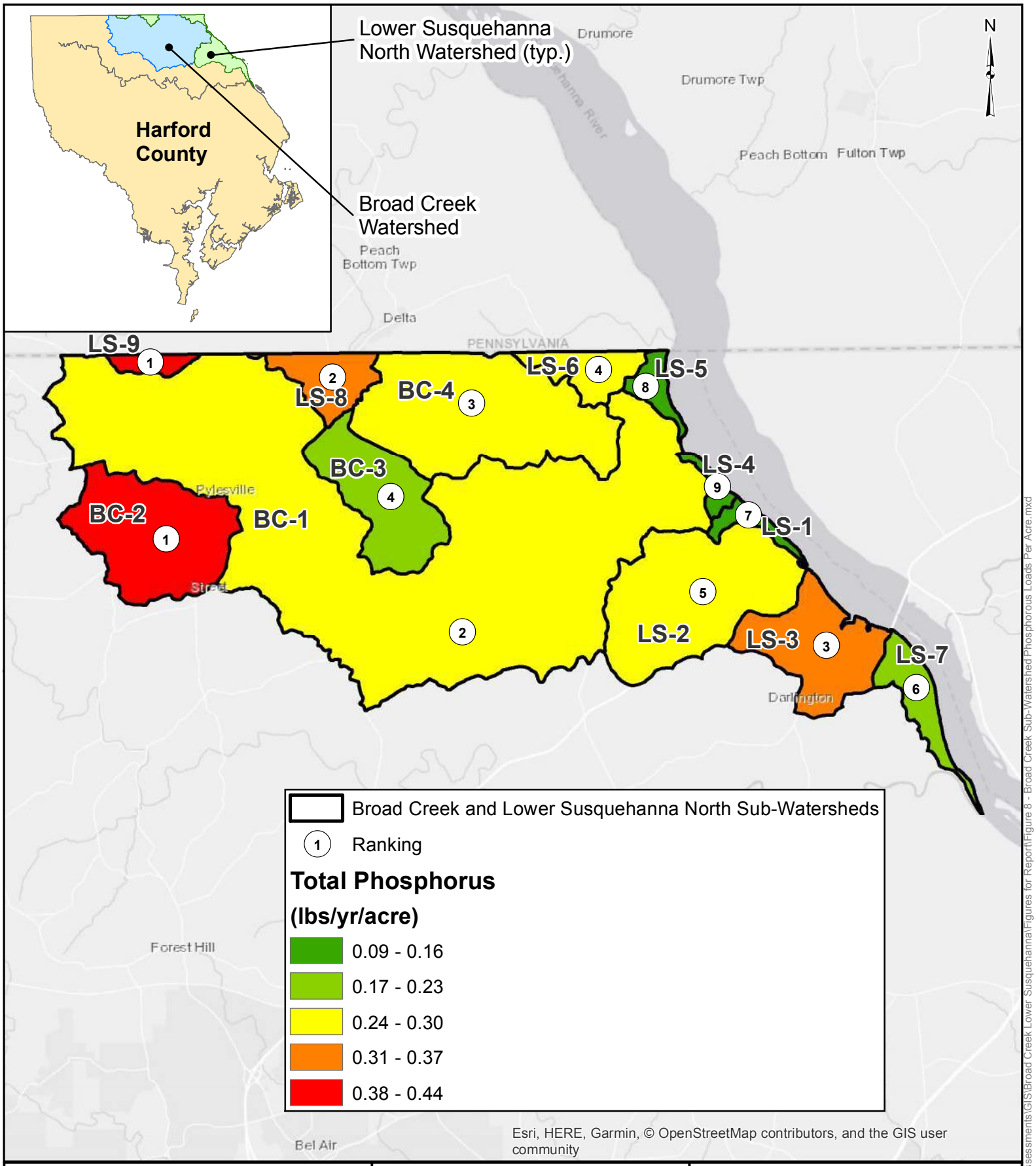
FIGURE 7
BROAD CREEK AND LOWER SUSQUEHANNA NORTH SUB-WATERSHED NITROGEN LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 7 - Broad Creek Sub-Watershed Nitrogen Loads Per Acre.mxd



Notes:
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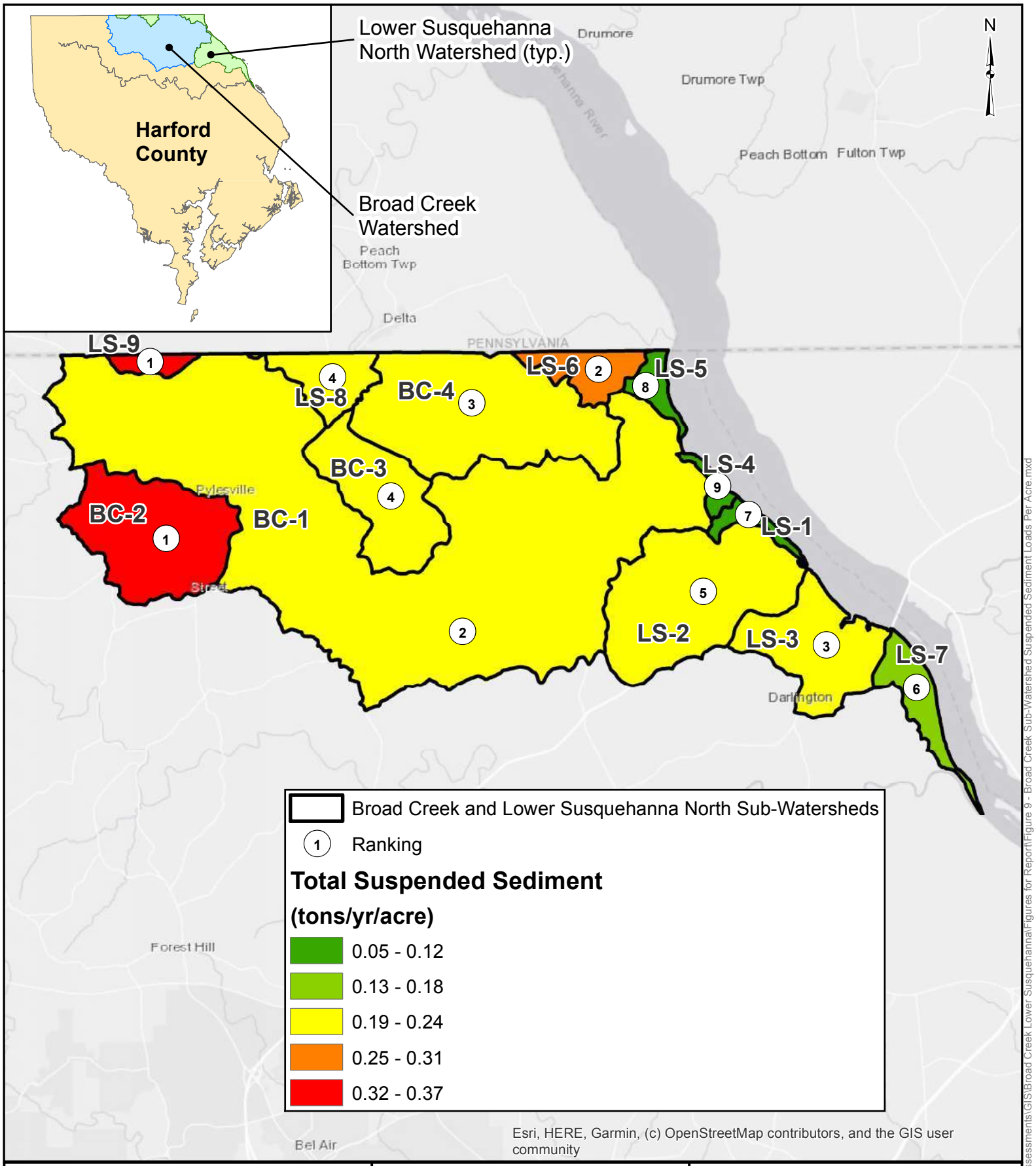
FIGURE 8
BROAD CREEK AND LOWER SUSQUEHANNA NORTH SUB-WATERSHED PHOSPHORUS LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 8 - Broad Creek Sub-Watershed Phosphorous Loads Per Acre.mxd



Notes:
1. Watershed Features from 2013 Harford County GIS

0 1 2 4 Miles
1 inch = 2.0 miles

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FIGURE 9
BROAD CREEK AND LOWER SUSQUEHANNA NORTH SUB-WATERSHED SUSPENDED SEDIMENT LOADS PER ACRE

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 9 - Broad Creek Sub-Watershed Suspended Sediment Loads Per Acre.mxd

To assess the impact of existing BMPs within the sub-watersheds, the “No Action” and “2017 Progress” scenarios were compared. Table 10 shows the annual pollutant loads for each sub-watershed under both scenarios and the difference between the two scenarios. The same methodology described in Sections 3.1 and 3.2 that was used to derive the “2017 Progress” scenario annual pollutant loads was used to derive the “No Action” scenario annual pollutant loads.

For the Broad Creek Watershed, TN, TP and TSS were reduced by 1.1, 4.9 and 1.1 percent respectively from the “No Action” to “2017 Progress” scenario. For the Lower Susquehanna North Watershed, TN, TP and TSS were reduced by 1.5, 5.2 and 1.5 percent respectively from the “No Action” to “2017 Progress” scenario. This indicates that the existing BMPs are reducing the overall pollutant loads within the Project Watersheds.

Table 10 – Broad Creek and Lower Susquehanna North Sub-Watershed "No Action" Versus "2017 Progress" Scenario Annual Pollutant Loads										
Sub-Watershed	**Area (acres)**	**No Action Scenario**			**2017 Progress Scenario**			**Change from No Action to 2017 Progress Scenario**		
		TN (lb/yr)	**TP (lb/yr)**	**TSS (ton/yr)**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (ton/yr)**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (ton/yr)**
Broad Creek Watershed										
BC-1	16,896.2	149,320.6	5,180.1	4,152.3	147,547.0	4,921.3	4,106.9	1,773.6 (1.2%)	258.8 (5.0%)	45.4 (1.1%)
BC-2	2,621.5	36,091.7	1,085.7	987.3	35,756.2	1,037.3	977.5	335.5 (0.9%)	48.4 (4.5%)	9.8 (1.0%)
BC-3	1,851.5	12,931.3	297.1	356.7	12,884.7	291.9	353.6	46.6 (0.4%)	5.2 (1.8%)	3.1 (0.9%)
BC-4	4,025.5	33,011.7	1,237.0	952.9	32,555.6	1,170.1	941.6	456.1 (1.4%)	66.9 (5.4%)	11.3 (1.2%)
Broad Creek Total	**25,394.7**	**231,355.3**	**7,799.9**	**6,449.2**	**228,743.5**	**7,420.6**	**6,379.6**	**2,611.8 (1.1%)**	**379.3 (4.9%)**	**69.6 (1.1%)**
Lower Susquehanna North Watershed										
LS-1	248.0	848.1	37.6	23.9	833.7	35.6	23.4	14.4 (1.7%)	2.0 (5.3%)	0.5 (2.1%)
LS-2	3,386.2	22,460.2	1,048.8	713.2	22,038.8	988.2	701.6	421.4 (1.9%)	60.6 (5.8%)	11.6 (1.6%)
LS-3	1,850.8	15,115.7	600.2	454.9	14,900.8	569.9	447.8	214.9 (1.4%)	30.3 (5.0%)	7.1 1.6%)
LS-4	173.7	399.6	16.4	9.3	393.8	15.6	9.1	5.8 (1.5%)	0.8 (4.9%)	0.2 (2.2%)
LS-5	326.5	1,155.9	31.4	24.7	1,149.8	30.6	24.4	6.1 (0.5%)	0.8 (2.5%)	0.3 (1.2%)
LS-6	667.3	7,108.6	204.1	181.7	7,061.8	197.2	180.6	46.8 (0.7%)	6.9 (3.4%)	1.1 (0.6%)
LS-7	704.1	4,770.7	153.3	116.2	4,727.2	147.0	115.0	43.5 (0.9%)	6.3 (4.1%)	1.2 (1.0%)
LS-8	786.6	5,412.5	255.9	191.4	5,312.4	242.4	187.2	100.1 (1.8%)	13.5 (5.3%)	4.2 (2.2%)
LS-9	238.0	2,714.7	110.7	81.0	2,673.6	104.7	79.9	41.1 (1.5%)	6.0 (5.4%)	1.1 (1.4%)
Lower Susquehanna North Total	**8,381.2**	**59,986.0**	**2,458.4**	**1,796.3**	**59,091.9**	**2,331.2**	**1,769.0**	**894.1 (1.5%)**	**127.2 (5.2%)**	**27.3 (1.5%)**

4. WATERSHED ACTION PLAN

4.1. Project Evaluation Criteria

Projects were evaluated and prioritized according to the criteria listed in Table 11.

Table 11 – Project Prioritization Criteria

Criteria	Description
Location within the watershed	Is the project located in the most degraded sub-watersheds?
Pollutant Load Reduction	Does the project result in high pollutant loading reductions?
Impervious Acre Credits	Does the project result in high amounts of impervious area treatment credit?
Property Ownership	Is the project on public property? On one private property? On multiple private properties?
Site Access	Are there access constraints? Are there natural resources impacts such as mature trees, wetlands and wetland buffers? Are there infrastructure constraints? Steep slopes?
Existing Utility Conflicts	Are there existing utilities that conflict with the design?
Cost	What is the total cost and what is the cost per impervious acre treated?

As part of project prioritization, sub-watersheds with the highest pollutant loadings due to untreated impervious area and degraded stream channels were prioritized over sub-watersheds with minimal impervious area and pollutant loadings.

The amount of eligible impervious acre and pollutant load reduction credits was another major component in project prioritization. For the Broad Creek and Lower Susquehanna North Watersheds, stream restoration projects typically resulted in higher impervious acre and pollutant reduction credits than BMP projects.

Property ownership and site access were also considered. Project locations were considered easily accessible if they were adjacent to public roads, contained an existing access easement, or could be accessed through County property. Projects on County property were prioritized over projects located on private property.

Existing utility conflicts were also noted in the desktop and field investigations, including but not limited to light poles, sanitary sewer infrastructure, and overhead power lines. Projects with existing utility constraints were considered less favorable.

Project costs included design, permitting, construction and construction management. To account for varying project sizes and costs, cost efficiency was evaluated on a cost per impervious acre treated. Typically, larger projects treating extensive amounts of

impervious area are more cost efficient than smaller projects, even though they can be significantly more expensive.

4.2. Stream Restoration

4.2.1. Methodology

An in-depth desktop analysis and field assessment was performed within the Broad Creek and Lower Susquehanna North Watersheds to identify eroded and degraded stream restoration projects that would improve the stability and function of the system, as well as provide the County with TMDL and MS4 credits. The desktop analysis consisted of review of past watershed assessments and reports, review of aerial photography and a detailed GIS query that included drainage and impervious area calculations, land use, property ownership, storm drain networks, utilities and site access. Ultimately 21 stream sites were identified for field assessment, although four sites were eliminated due to inaccessibility. Therefore, 17 potential restoration sites were field assessed in order to document existing stream channel and riparian conditions, map potential sources of sediment, identify causes of instability, and record unstable stream and riparian conditions. Field data sheets are included in Appendix E.

After the field and desktop assessments were completed, two sites were chosen as potential stream restoration projects. A detailed description of these projects is provided in Section 4.2.4.

4.2.2. Pollutant Removal and Impervious Area Accounting Measures

Pollutant reduction and impervious area credit was calculated for the potential stream restoration projects within the Broad Creek and Lower Susquehanna North Watersheds. Pollutant load removal and efficiency was estimated using planning rates for stream restoration from *Final Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (Schueler, T., Stack, B., 2014). Impervious area MS4 credit was calculated using methodologies described in MDE's *Accounting for Stormwater Wasteload Allocation and Impervious Acres Treated* (MDE, 2014) as well as a recent MDE memorandum, *Stream Restoration Crediting Clarification for MS4 Permitting Purposes* (April 30, 2019). The 2019 MDE memorandum indicates that stream restoration projects in the non-coastal plain physiographic region may take credit toward impervious area treatment at a rate of three acres for every 100 linear feet of channel restoration.

The pollutant load reduction planning rates for stream restoration and impervious acre equivalents are shown in Table 12.

Table 12 – Planning Rates for Stream Restoration and Impervious Acre Equivalents				
Geography	**TN[1] (lbs/ft)**	**TP[1] (lbs/ft)**	**TSS[1] (lbs/ft)**	**Equivalent Impervious Acres[2] (acres/ft)**
Coastal Plain	0.075	0.068	15	0.02
Non-Coastal Plain	0.075	0.068	45	0.03

[1] *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects, Schueler and Stack, 2014*
[2] *Stream Restoration Crediting Clarification for MS4 Permitting Purposes, (Memorandum), April 30, 2019*

4.2.3. Proposed Stream Restoration Approaches

Typical stream restoration approaches used to restore function in highly degraded stream systems that were considered for each proposed stream restoration project are described below.

Riffle-Pool Systems/Floodplain Connectivity

Connecting a channel to an abandoned floodplain is essential to restoring the hydrological, morphological and biological functions of a stream. Incised channels with limited floodplain connectivity during large, less frequent storm events experience high shear stresses and velocities within the channel, resulting in increased rates of erosion and nutrient loading downstream. Floodplain connectivity can be achieved either through raising the bed of the existing stream channel to connect with a previously abandoned floodplain or by creating a new floodplain at the existing channel bed elevation. Raising the existing stream to re-connect with the original floodplain or creating a new floodplain within the over-widened channel is often referred to as Stream and Valley Restoration. Restoring floodplain connectivity increases pollutant removal efficiencies and biological habitat, decreases channel shear stresses and erosion, and reduces nutrient loadings downstream. An example of a stream reach with restored floodplain connectivity, designed by BayLand located in Frederick County, Maryland is shown in Photo 1.

Photo 1 – Restored floodplain connectivity

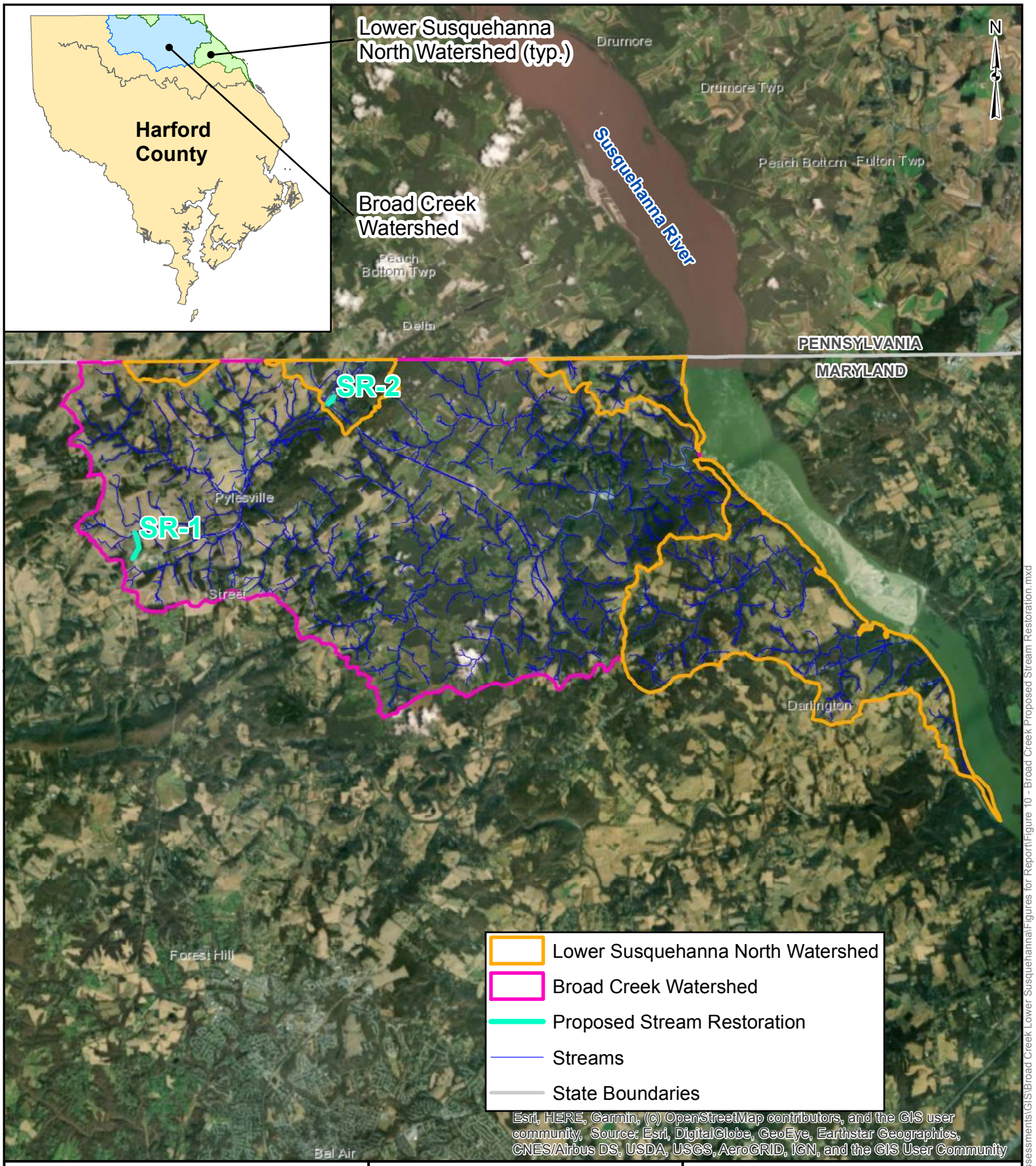
Step Pool Weir Systems

Step pool weir systems consist of a series of one or more instream riffle weirs strategically placed in confined intermittent or perennial channels to provide lateral and vertical stability. Step pool weir systems are typically utilized in confined, high-gradient valleys where floodplain connectivity is limited or where site constraints prohibit flooding increases. An example of a step pool weir system designed by BayLand is shown in Photo 2.

Photo 2 –Step Pool Weir System

4.2.4. Potential Stream Restoration Projects

Two sites were identified as potential stream restoration projects (Figure 10). The projects were carefully selected based on criteria described in Section 4.1. A description of each project is provided in Tables 13 and 14, and pollutant reduction and impervious acre credit information is provided in Appendix E. Locations of individual projects are shown in Figures 11 to 12. A summary of the potential stream restoration projects is provided in Table 15.



Notes:
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2. Watershed Features from 2013 Harford County GIS

0 1 2 4 Miles
1" = 2.0 miles

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FIGURE 10
BROAD CREEK AND LOWER SUSQUEHANNA NORTH PROPOSED STREAM RESTORATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 10 - Broad Creek Proposed Stream Restoration.mxd

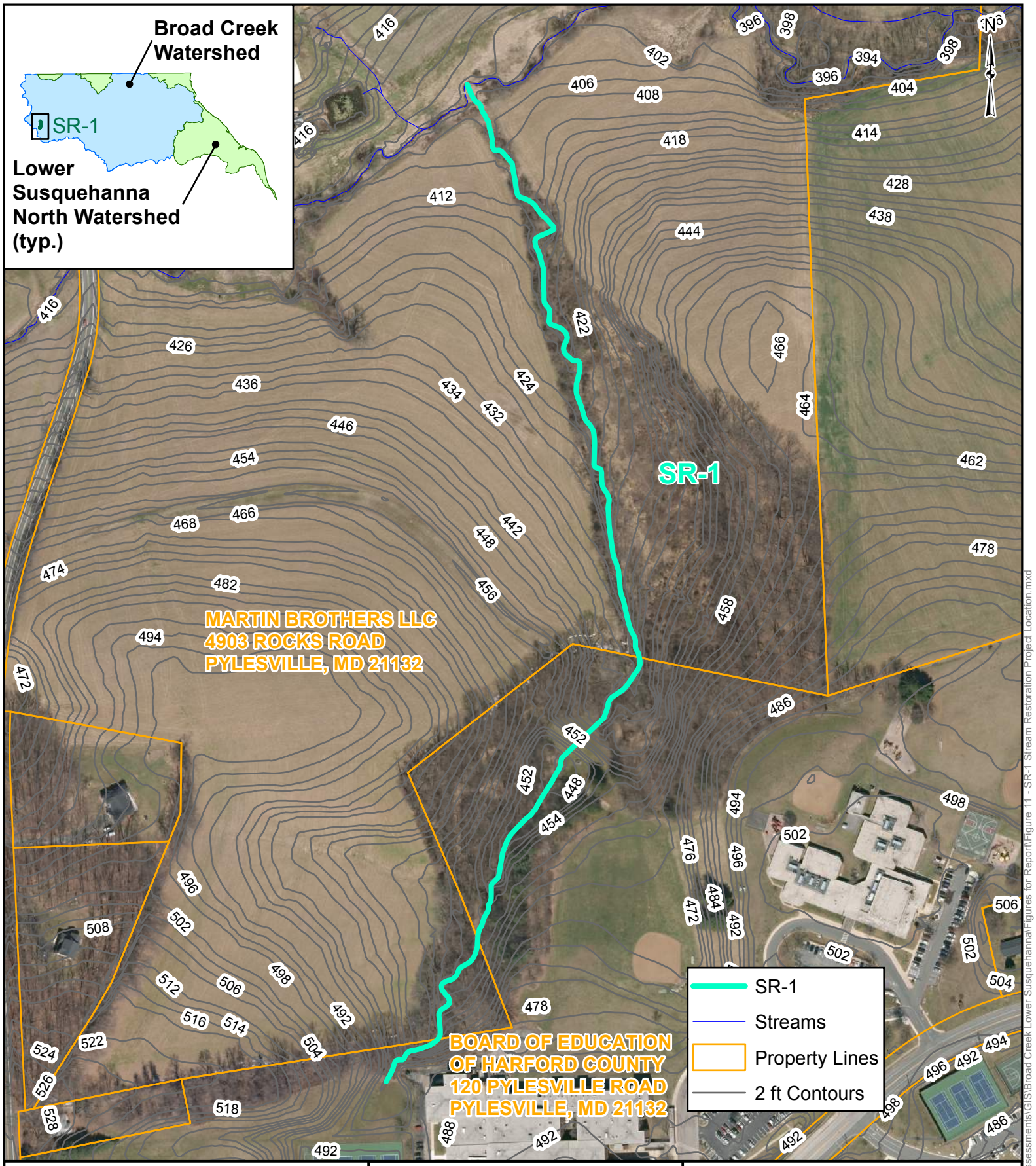
Table 13 – SR-1			
Site Name	North Harford Elementary/Middle School Stream		
Linear Feet of Restoration	2,500		
Proposed Approach	Stream Restoration – Step Pool Weir System		
Sub-Watershed Location	BC-2		
TN/TP/TSS Pollutant Removal	187.5 lb/yr	170.0 lb/yr	56.3 ton/yr
Impervious Acre Credit	75.0		
Property Owner	Board of Education & Martin Brothers LLC		
Site Access	Via Harford School parking lot		
Existing Utility Conflicts	Light poles near the Elementary and Middle School buildings and parking lots, sanitary sewer near the Middle School		
Total Project Cost	$2,063,000		
Description SR-1 is a single-thread, intermittent channel characterized by downed trees (Photo 3), bank erosion (Photo 4) and channel incision. It originates behind North Harford Middle School and extends downstream approximately 2,500 linear feet. Approximately 765 linear feet downstream of where the site originates is an in-line SWM extended detention facility (SWM-0032 per County GIS data) (Photo 5). As-built plans for the facility (No. 970091 to 970093) indicate that it was constructed as a NRCS-MD 378 facility in 1997 to provide some water quality treatment. The facility consists of a reinforced concrete riser with a 42-inch bituminous-coated corrugated metal pipe (BCCMP) outfall (Photo 6). Bank heights average three feet upstream of the facility and six feet downstream of the facility and are predominately composed of silt and sand. Since SR-1 is characterized by a narrow, steep gradient valley, a step pool weir system is the recommended restoration approach. The installation of a step pool weir system will facilitate channel stability while decommissioning the SWM facility as a NRCS-MD 378 facility. The weirs will be sized to safely convey large storm events since opportunities for floodplain connectivity are limited.			

Photo 3 – SR-1 Downed trees

Photo 4 – SR-1 Bank erosion

Photo 5 –SWM-0032

Photo 6 – Outfall from SWM-0032



Notes:
1. Streams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.025 0.05 0.1 Miles

1" = 0.05 miles

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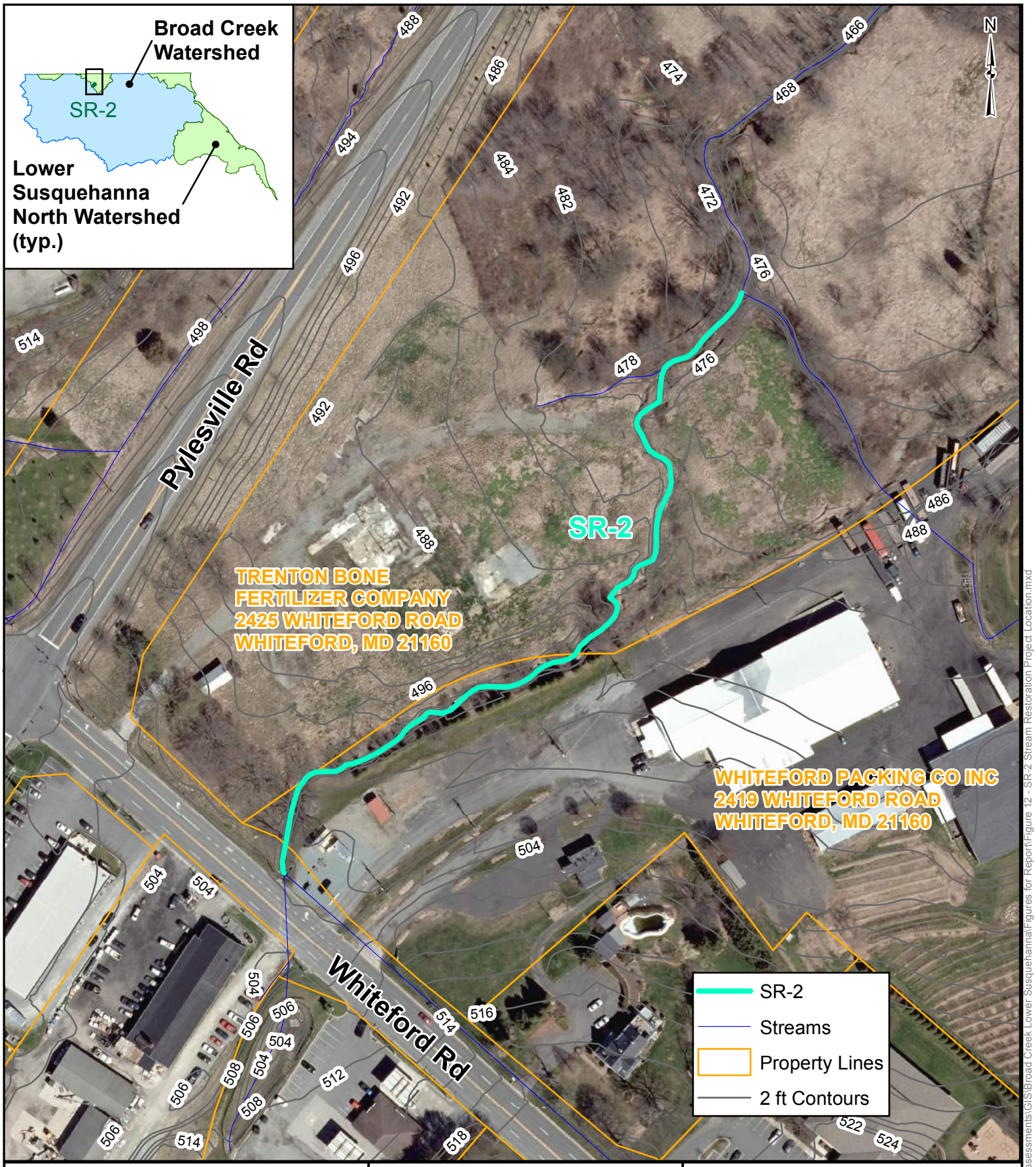
FIGURE 11
SR-1
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 11 - SR-1 Stream Restoration Project Location.mxd

Table 14 – SR-2			
Name	Trenton Bone Fertilizer Company Stream		
Linear Feet of Restoration	925		
Proposed Approach	Stream Restoration – Step Pool Weir System		
Sub-Watershed Location	LS-8		
TN/TP/TSS Pollutant Removal	69.4 lb/yr	62.9 lb/yr	20.8 ton/yr
Impervious Acre Credit	27.8		
Property Owner	Trenton Bone Fertilizer Company; Whiteford Packing Co. Inc.		
Site Access	Via Whiteford Packing Co. Inc. parking lot		
Existing Utility Conflicts	Overhead power lines along Whiteford Road		
Total Project Cost	$763,000		
Description SR-2 is a single thread, intermittent channel that originates at an outfall off of Whiteford Road and extends downstream approximately 925 linear feet. The outfall discharges from a proposed BMP project, BMP-4 (See Section 4.3.4). The upstream end of the channel is lined with concrete for approximately 100 linear feet (Photo 7), after which it transitions to a natural channel characterized by active bed and bank erosion, irregular point bar formations, and exposed roots (Photo 8). Bank heights average four feet high and are predominately composed of clay, silt and sand. SR-2 is characterized by a steep gradient valley so the installation of a step pool weir system is the recommended restoration approach. The proposed restoration approach also includes removal of the concrete channel to restore hyporheic exchange.			

Photo 7 – Concrete channel

Photo 8 – SR-2 Bank Erosion



Notes:
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0 0.0125 0.025 0.05 Miles

1" = 0.025 miles

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FIGURE 12
SR-2
STREAM RESTORATION
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 12 - SR-2 Stream Restoration Project Location.mxd

Table 15 – Proposed Stream Restoration Projects										
Project ID	**Name**	**Sub-Watershed**	**Length (ft)**	**Property Owner**	**Pollutant Reduction**			**Project Cost**	**Impervious Acre Credits***	**Cost/Imp. Acre**
					TN (lb/yr)	**TP (lb/yr)**	**TSS (ton/yr)**			
Broad Creek Watershed										
SR-1	North Harford Elementary/Middle School Stream	BC-2	2,500	Board of Education of Harford County; Martin Brothers LLC	187.5	170.0	56.3	$2,063,000	75.0	$28,000
Broad Creek Total			**2,500**	**N/A**	**187.5**	**170.0**	**56.3**	**$2,063,000**	**75.0**	**$28,000**
Lower Susquehanna North Watershed										
SR-2	Trenton Bone Fertilizer Company Stream	LS-8	925	Trenton Bone Fertilizer Company; Whiteford Packing Co. Inc.	69.4	62.9	20.8	$763,000	27.8	$27,000
Lower Susquehanna North Total			**925**	**N/A**	**69.4**	**62.9**	**20.8**	**$763,000**	**27.8**	**$27,000**

**See Section 4.2.2 for a description of the method used in calculating impervious acre credits.*

4.3. Best Management Practices (BMP)

4.3.1. Methodology

An in-depth desktop analysis and field assessment was conducted within the Broad Creek and Lower Susquehanna North Watersheds to identify BMP projects that would improve water quality treatment, enhance functionality and aesthetics, as well as assist the County in meeting its TMDL and MS4 permit requirements.

In addition to the criteria listed in Section 4.1, additional criteria were utilized to narrow the list of potential BMP projects. Specifically, existing SWM facilities were targeted since they typically yield the greatest potential increase in impervious acre and pollutant removal credits.

During the desktop analysis, as-built records for existing SWM facilities were obtained as available and reviewed to determine the year the facility was constructed, the volume of water quality treatment provided, existing hydraulic controls and potential for retrofit. Typically, facilities built prior to 1985 were designed to provide quantity control, as opposed to water quality treatment. Facilities built after 1985 and prior to 2002 were typically designed to capture and treat one half inch of rainfall runoff. Current SWM regulation in Maryland requires treatment of at least one inch of rainfall runoff. Therefore, existing SWM facilities not meeting current design standards were targeted for retrofit to provide additional water quality treatment.

Ultimately, 15 potential BMP projects were identified for field assessment, nine of which were BMP retrofit opportunities and six of which were new BMP opportunities. Facilities with small amounts of impervious area, difficult access, confined facility footprints and negligible retrofit potential were removed from consideration.

In August 2019, BayLand field investigated the 15 potential BMP sites. At the existing SWM facilities of interest, key parameters were documented including existing structures (headwall, riser, outfall pipe, etc.), hydraulic controls (presence/location of a low flow orifice, shape and sizes of openings, condition and size of outfall pipes), stability of the outfall pipe, the condition of the embankment, the size of the existing footprint and site access.

After the field assessments were completed, five existing facilities were identified as potential SWM retrofit projects and three sites were identified for new BMP construction. Field data sheets are provided in Appendix E.

4.3.2. Pollutant Load Reduction and Impervious Area Accounting Measures

Pollutant load reduction and impervious acre credits were calculated according to MDE WLA accounting measures (MDE, 2014). Pollutant removal efficiencies were determined by the depth of rainfall runoff that the proposed BMP will capture and treat.

A series of pollutant removal adjustor curves (Schueler and Lane, 2012) were used to determine nutrient and sediment load reductions for BMP implementation. BMPs are classified as either environmental site design (ESD) or stormwater treatment (ST) practices and there are separate pollutant removal curves for each type.

Impervious acre credits are calculated based on the fraction of water quality volume (WQv) (one inch of rainfall runoff) that a facility can treat. If a facility stores the entire WQv, then credit can be achieved for all the impervious area draining to the facility. If only half of the target WQv is treated, then the facility is eligible to receive credit for half of the impervious area within its drainage area. The accounting measures also permit additional impervious acre credits if a BMP stores more than the required one inch of WQv runoff. A 0.1 impervious acre credit is allocated for every 0.4 inches of additional rainfall depth treated above the initial one inch of runoff (MDE, 2014), up to a maximum of 2.6 inches.

4.3.3. Proposed BMP Approaches

Summaries of typical structural water quality SWM BMPs frequently used to control runoff and mitigate water quality degradation are provided below.

Wet SWM Ponds

Wet SWM ponds maintain a permanent pool with a storage volume equivalent to the WQv. They are intended to control excess stormwater runoff and improve water quality by removing pollutants through sediment settling and biological uptake. It is illegal to construct stormwater ponds in jurisdictional waters, which include wetlands, interstate waters, and navigable waters, without both a Clean Water Act Section 404 permit and a State of Maryland wetlands and waterway permit. They have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats. An example of a stormwater pond with a fountain, retrofitted by BayLand, located in Anne Arundel County, Maryland is shown in Photo 9.

Photo 9 – Stormwater pond with fountain

SWM Wetlands

SWM wetlands are areas that are saturated with water either permanently or seasonally and are designed to remove pollutants through settling and biological uptake. They have variable micro-topography including above-pool vegetation, shallow pools and deep pools to promote dense and diverse vegetative cover. They can treat large impervious areas, are aesthetically pleasing, enhance faunal and floral habitat, and have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats.

SWM wetlands require a large facility footprint and require a water balance to be performed to ensure hydric soil conditions. An example of a stormwater wetland, designed by BayLand, located in Anne Arundel County, Maryland is shown in Photo 10.

Photo 10 – Stormwater Wetland

Infiltration Basins

Infiltration basins provide nutrient and sediment reduction through attenuation and infiltration of storm flow runoff. Runoff is temporarily stored within the basin, removing sediments and nutrients from the water column through settling and percolation into the underlying soil media. Excess storm flows are conveyed downstream or returned to the main conveyance system (storm drain) through a riser structure, diversion or overflow spillway.

Infiltration basins have various design requirements to ensure the anticipated sediment and nutrient reduction efficiencies and credits are achieved. Infiltration basins must be underlain by Hydrologic Soil Groups (HSG) A, B or C soils with an infiltration rate of 0.52 inch per hour or greater. The bottom of the facility must be at least 4 feet vertically from the seasonally high water table or bedrock layer and they are prohibited from areas of karst topography. Typically, pretreatment of at least 25 percent of the WQv is required prior to entering the facility via sedimentation basins, plunge pools, stilling basins or other acceptable measures.

Infiltration basins have pollutant removal efficiencies of 33 percent TN, 52 percent TP and 66 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats. An example of an infiltration basin, designed by BayLand, located in Howard County, Maryland is shown in Photo 11.

Photo 11 – Infiltration Basin

Bioretention Basins

Bioretention basins capture and treat runoff from impervious surfaces by passing the water through a filter bed mixture of sand, soil and organic matter. Filtered stormwater partially infiltrates into the ground or is returned to a conveyance system.

Bioretention basins are versatile and can be implemented as parking lot islands, median filters, terraced slope facilities, cul-de-sac islands or planter boxes to provide WQv. If designed to meet ESD criteria, the contributing drainage area is limited to half an acre and the slopes must be mild (less than or equal to five percent). The pollutant removal efficiencies are 57 percent TN, 66 percent TP and 70 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats.

An example of a bioretention basin, designed by BayLand, located in Anne Arundel County, Maryland is shown in Photo 12.

Photo 12 – Bioretention basin in a parking lot median.

Step Pool Storm Conveyance Systems

A Step Pool Storm Conveyance System (SPSC) is a series of open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow. These systems safely convey, attenuate, and treat the quality of storm flow. SPSC systems utilize a series of constructed shallow aquatic pools, riffle grade control, native vegetation, and an underlying sand/woodchip mix filter bed media. For steeper slopes, boulder cascades can be used to transverse grade. The pollutant removal efficiencies are 57 percent TN, 66 percent TP and 70 percent TSS. Impervious acre credit is based on the fraction of WQv the facility captures and treats.

An example of a SPSC system designed by BayLand located in Anne Arundel County, Maryland is shown in Photo 13.

Photo 13 -– Step Pool Storm Conveyance (SPSC)

4.3.4. Potential BMP Projects

Five sites were identified as potential SWM retrofit projects and three sites were identified where new BMP facilities could be built (Figure 13).

The BMP projects were selected to maximize pollutant removal efficiency and impervious acre credits, provide WQv storage to the current State standard, and minimize the total cost per impervious acre treated. The BMP pollutant removal rates were calculated assuming full WQv treatment and follow the stormwater WLA accounting measures described in Section 4.3.2. Design and construction costs were estimated by comparing the magnitude of proposed retrofits to recently designed and constructed projects. The total cost includes design, permitting, construction and construction oversight. Table 24 provides an overview of the selected BMP projects, while Figure 13 shows their locations within the Broad Creek and Lower Susquehanna North Watersheds. A description of each project is provided in Tables 16 to 23. Locations of individual projects are shown in Figures 14 to 21. Pollutant loading information is provided in Appendix D, and impervious acre credit information is provided in Appendix F.

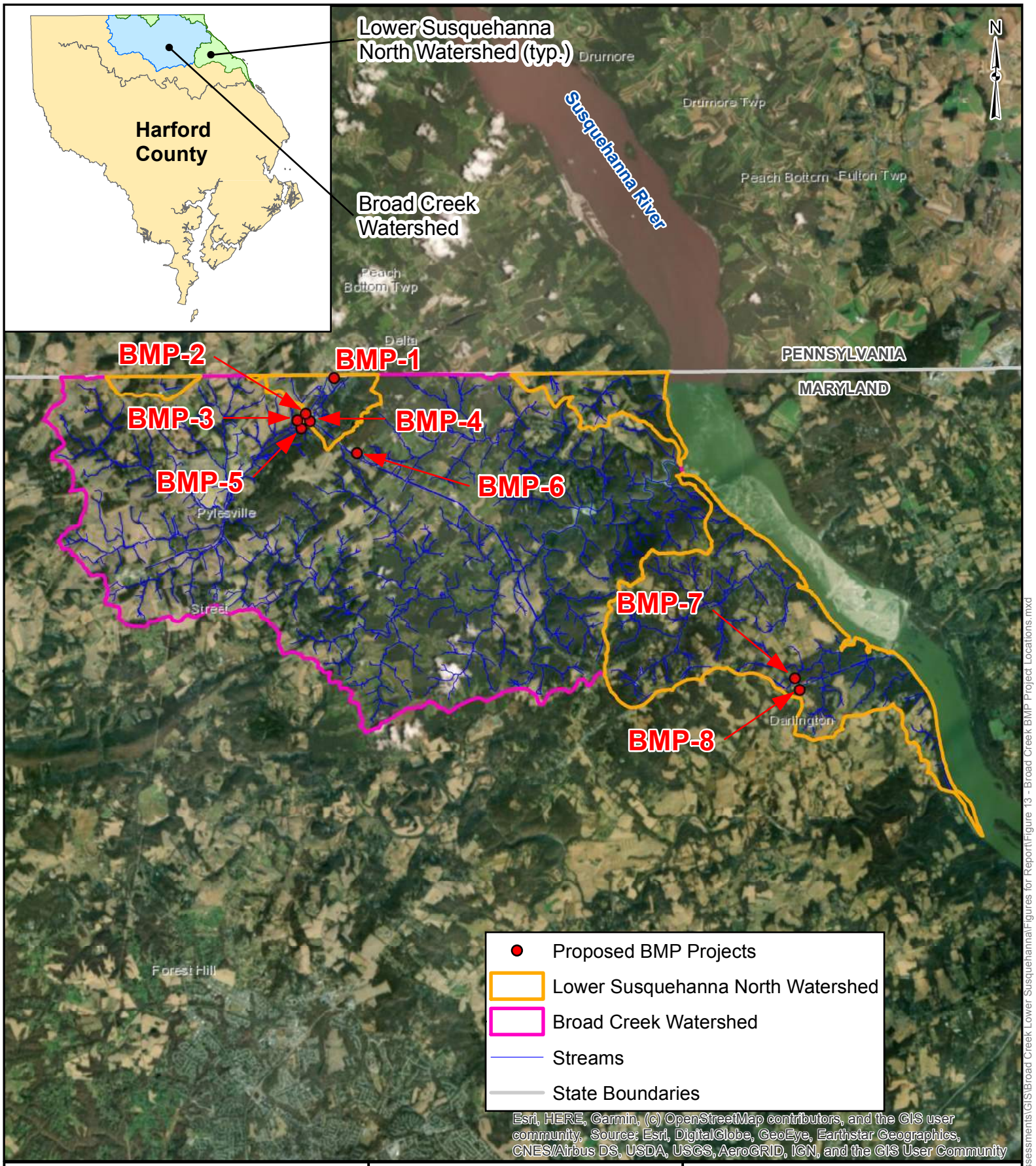

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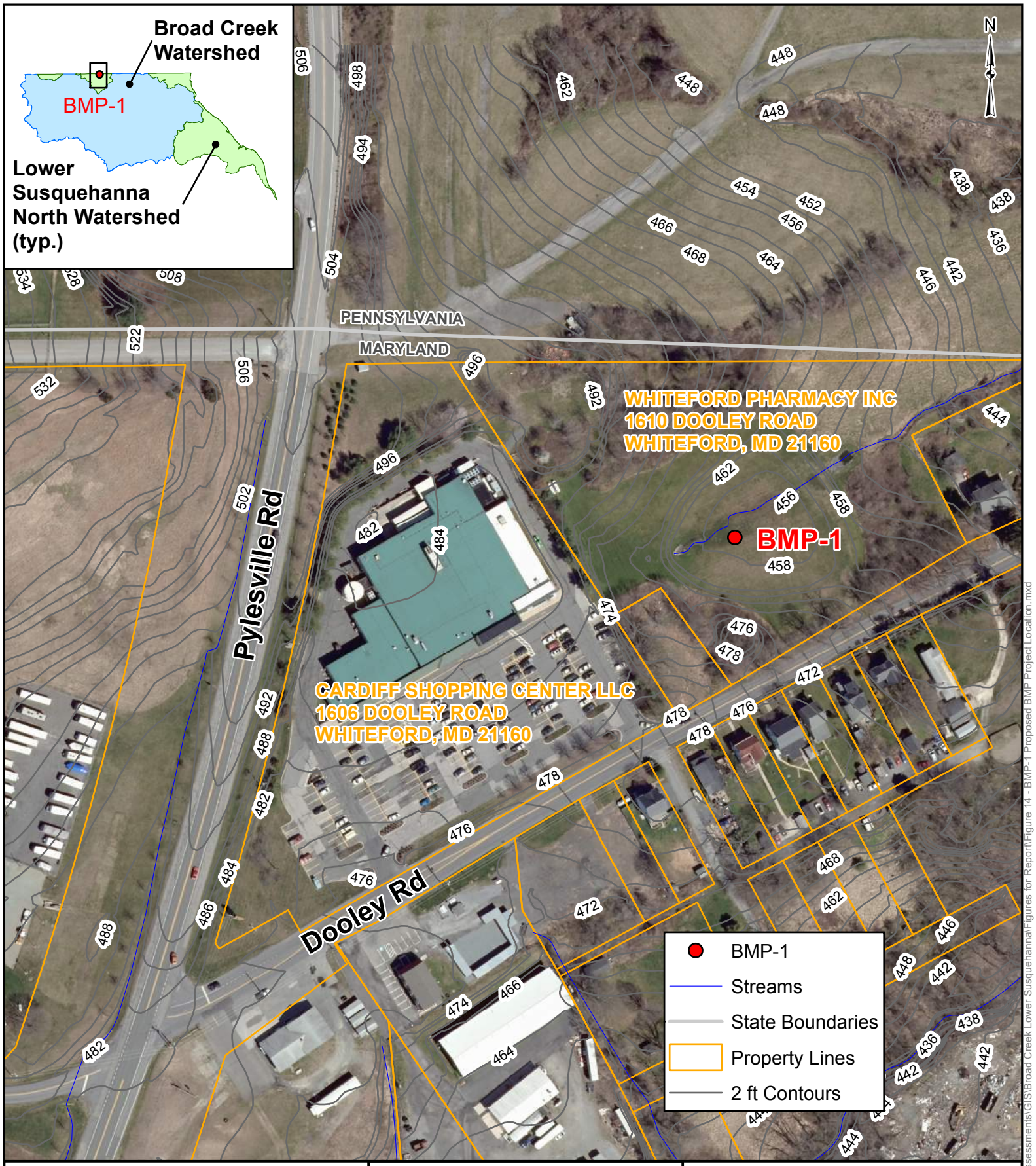
FIGURE 13
BROAD CREEK AND LOWER SUSQUEHANNA NORTH BMP PROJECT LOCATIONS

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 13 - Broad Creek BMP Project Locations.mxd

Table 16 – BMP-1			
Name	Integrated Community Shop Center Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	LS-8		
TN/TP/TSS Pollutant Removal	6.7 lb/yr	0.7 lb/yr	0.7 ton/yr
Property Owner	Tomran Inc.		
Property Location	1610 Dooley Road Whiteford, MD 21160		
Site Access	Via Shop Rite's parking lot		
Existing Utility Conflicts	Sanitary sewer line west of facility		
Total Project Cost	$173,000		
Drainage Area (acres)	8.2		
Impervious Area (acres)	3.5 (43.3%)		
Required WQv (ac-ft)	0.30		
Anticipated Proposed WQv (ac-ft)	0.30		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	1.8		
Description BMP-1 (SWM-0387 per County GIS data) is an existing extended detention facility located adjacent to the Integrated Community Shop Center. The facility receives runoff from the adjacent parking lot via a storm drain pipe. According to as-built plans (No. 171162 to 171164), the facility was constructed in 2002 underwent repairs in 2015. The facility consists of a reinforced concrete riser with a principle spillway that outfalls into an open channel (Photo 14). The 2015 repairs involved bringing the facility into compliance with NRCS-MD 378 criteria and included replacement of the principle spillway pipe with a 24-inch aluminized corrugated metal pipe (ACMP) (Photo 15) and installation of an impervious core. As-built plans indicate that the facility was originally designed to treat 0.5 inches of rainfall runoff. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.30 ac-ft). The facility could potentially be converted into a SWM wetland with replacement of the riser structure.			

Photo 14 – BMP-1

Photo 15 – 24-inch ACMP outfall



Notes:
1. Streams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.015 0.03 0.06 Miles
1" = 0.03 miles

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FIGURE 14
BMP-1
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 14 - BMP-1 Proposed BMP Project Location.mxd

Table 17 – BMP-2			
Name	Backyard Boys, Inc. Pond		
Proposed Approach	New BMP (Bioretention Basin)		
Sub-Watershed Location	LS-8		
TN/TP/TSS Pollutant Removal	13.9 lb/yr	1.1 lb/yr	1.1 ton/yr
Property Owner	EAW Realty LLC		
Property Location	2501 Whiteford Road Whiteford, MD 21160		
Site Access	Via Backyard Boys, Inc. parking lot		
Existing Utility Conflicts	Overhead power lines along Whiteford Road and Pylesville Road		
Total Project Cost	$156,000		
Drainage Area (acres)	1.5		
Impervious Area (acres)	1.1 (73.4%)		
Required WQv (ac-ft)	0.09		
Anticipated Proposed WQv (ac-ft)	0.24		
EX. Rainfall Depth Treated (inches)	0.0		
PR. Rainfall Depth Treated (inches)	2.6		
Impervious Acre Credits	1.6		
Description BMP-2 involves the construction of a new BMP south of the Backyard Boys, Inc. parking lot (Photo 16). The proposed BMP would entail construction of a curb and gutter system along the perimeter of the parking lot to collect overland flow and convey it into the facility. The facility would be installed in a grass, open space area (Photo 17) and would be designed to treat 2.6 inches of rainfall runoff (0.24 ac-ft). Due to the small footprint of the proposed facility, the new BMP could potentially be an ESD facility such as a bioretention basin.			

Photo 16 – Backyard Boys, Inc. parking lot

Photo 17 – Proposed location for BMP-2

Notes:
1. Streams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.01 0.02 0.04 Miles

1" = 0.02 miles

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FIGURE 15
BMP-2
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 15 - BMP-2 Proposed BMP Project Location.mxd

Table 18 – BMP-3			
Name	Whiteford Maintenance Shop Pond		
Proposed Approach	New BMP (Bioretention Basin)		
Sub-Watershed Location	BC-1		
TN/TP/TSS Pollutant Removal	7.8 lb/yr	0.6 lb/yr	0.6 ton/yr
Property Owner	Harford County, MD		
Property Location	1405 Pylesville Road Whiteford, MD 21160		
Site Access	Via Whiteford Maintenance Shop parking lot		
Existing Utility Conflicts	None		
Total Project Cost	$92,000		
Drainage Area (acres)	4.1		
Impervious Area (acres)	0.7 (75.6%)		
Required WQv (ac-ft)	0.05		
Anticipated Proposed WQv (ac-ft)	0.14		
EX. Rainfall Depth Treated (inches)	0.0		
PR. Rainfall Depth Treated (inches)	2.6		
Impervious Acre Credits	0.9		
Description BMP-3 involves the construction of a new BMP adjacent to the Whiteford Maintenance Shop. The proposed BMP would be designed to capture and treat runoff from the adjacent parking lot. The facility would be designed to treat 2.6 inches of rainfall runoff (0.14 ac-ft). Due to the small footprint of the proposed facility, the new BMP could potentially be an ESD facility such as a bioretention basin.			

Notes:
1. Streams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.01 0.02 0.04 Miles

1" = 0.02 miles

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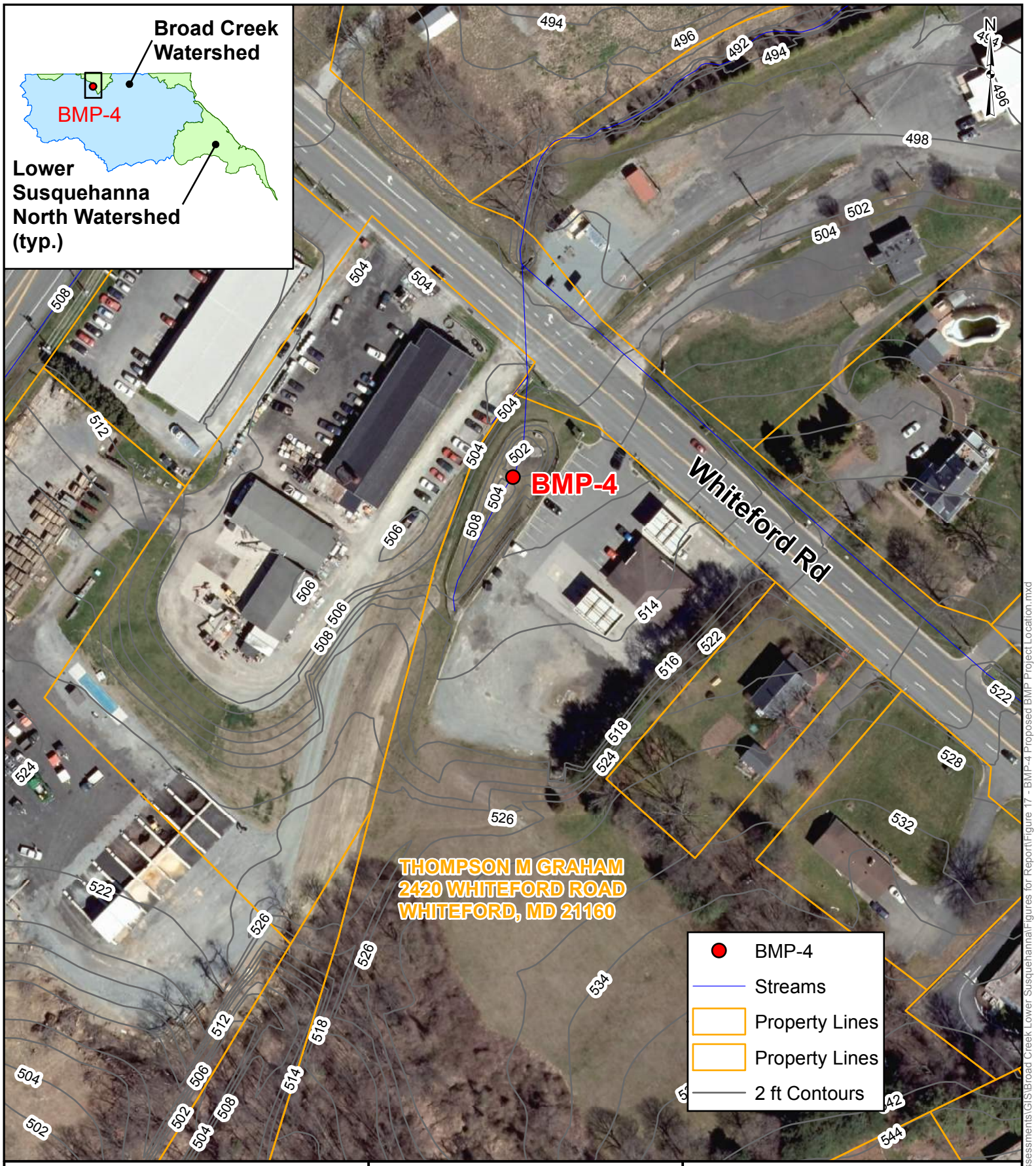
FIGURE 16
BMP-3
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 16 - BMP-3 Proposed BMP Project Location.mxd

Table 19 – BMP-4			
Name	Whiteford High Gas Station Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	LS-8		
TN/TP/TSS Pollutant Removal	2.4 lb/yr	0.2 lb/yr	0.2 ton/yr
Property Owner	Thompson M. Graham		
Property Location	2420 Whiteford Road Whiteford, MD 21160		
Site Access	Via Whiteford High Gas Station parking lot		
Existing Utility Conflicts	Overhead power lines along Whiteford Road		
Total Project Cost	$80,000		
Drainage Area (acres)	1.8		
Impervious Area (acres)	0.9 (47.8%)		
Required WQv (ac-ft)	0.07		
Anticipated Proposed WQv (ac-ft)	0.07		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	0.4		
Description BMP-4 (SWM-0067 per County GIS data) is an existing infiltration facility located adjacent to the Whiteford High gas station (Photo 18). According to design plans (No. 930327 to 930328) the facility was designed in 1993 to provide quantity control and to treat 0.5 inches of rainfall runoff. The facility receives runoff from the adjacent development through a riprap lined channel. It is enclosed by a wooden fence and is primarily vegetated with a reinforced concrete riser (Photo 19) that outfalls into an 18-inch BCCMP. The proposed design approach involves retrofitting the facility through modification of the riser structure to increase water quality treatment to 1.0 inch of rainfall runoff (0.07 ac-ft).			

Photo 18 – Existing BMP-4

Photo 19 – BMP-4 Riser



Notes:
1. Streams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.01 0.02 0.04 Miles

1" = 0.02 miles

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FIGURE 17
BMP-4
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 17 - BMP-4 Proposed BMP Project Location.mxd

Table 20 – BMP-5			
Name	Whiteford Volunteer Fire Company Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	BC-1		
TN/TP/TSS Pollutant Removal	2.2 lb/yr	0.2 lb/yr	0.3 ton/yr
Property Owner	Whiteford Volunteer Fire Company		
Property Location	1407 Pylesville Road Whiteford, MD 21160		
Site Access	Via Whiteford Volunteer Fire Company's parking lot		
Existing Utility Conflicts	Overhead power lines along Pylesville Road, electrical box located northeast of the facility		
Total Project Cost	$102,000		
Drainage Area (acres)	2.8		
Impervious Area (acres)	2.0 (72.0%)		
Required WQv (ac-ft)	0.16		
Anticipated Provided WQv (ac-ft)	0.16		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	1.0		
Description BMP-5 (SWM-0250 per County GIS data) is an existing extended detention facility located south of the Whiteford Volunteer Fire Company (Photo 20 & 21). According to as-built plans (No. 000791 to 000792) the facility was designed in 1996 and certified as-built in 2000. The facility currently treats 0.5 inches of rainfall runoff from the adjacent parking lot and consists of a riser that outfalls to an 18-inch outflow pipe. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.16 ac-ft). The facility could potentially be converted into a wet pond through modification of the riser structure and expansion of the existing facility footprint.			

Photo 20 – Existing BMP-5

Photo 21 – Existing BMP-5

Notes:
1. Streams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.01 0.02 0.04 Miles
1" = 0.02 miles

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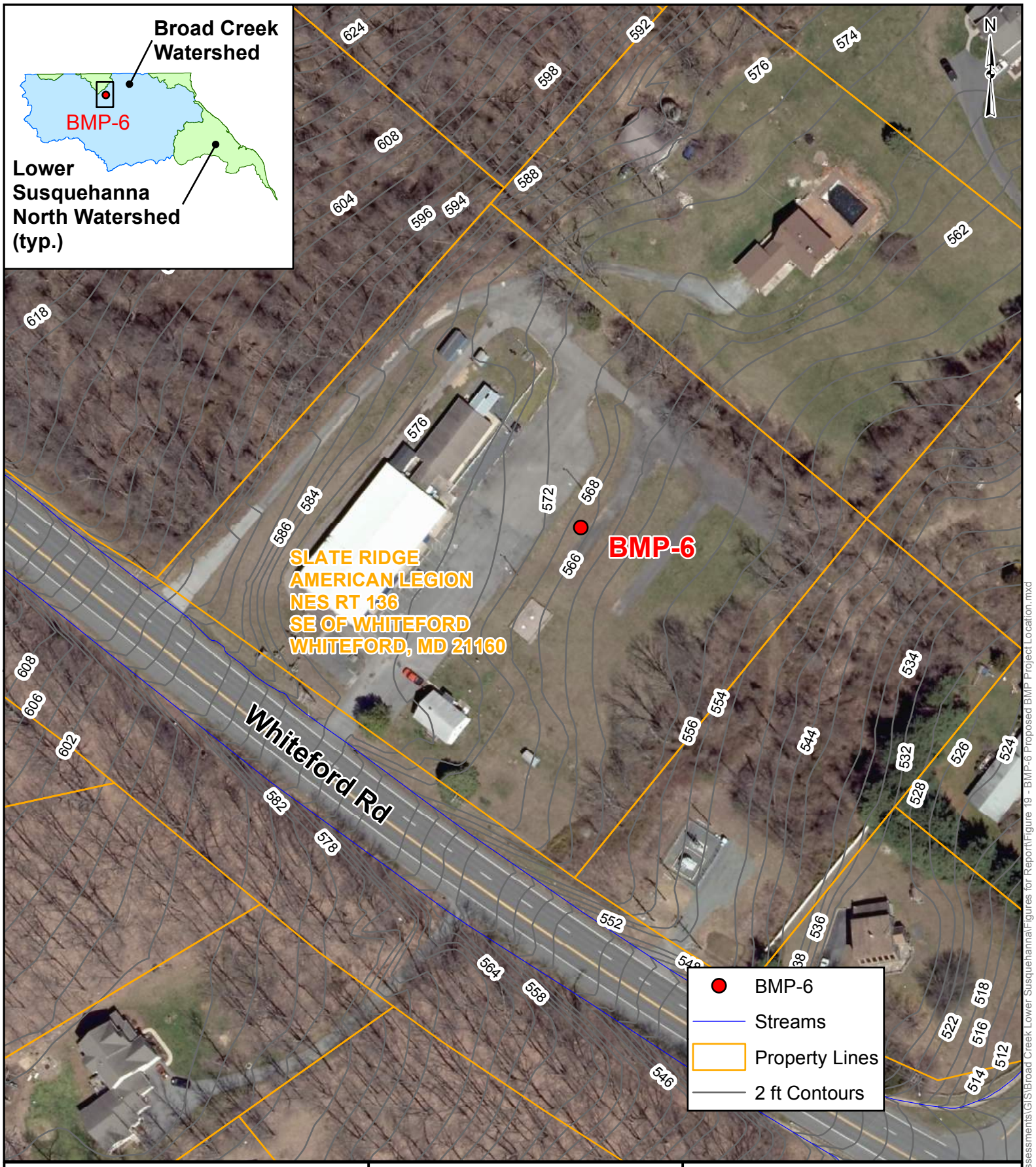
FIGURE 18
BMP-5
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 18 - BMP-5 Proposed BMP Project Location.mxd

Table 21 – BMP-6			
Name	Slate Ridge American Legion Pond		
Proposed Approach	New BMP (Bioretention Basin)		
Sub-Watershed Location	BC-4		
TN/TP/TSS Pollutant Removal	55.3 lb/yr	2.1 lb/yr	2.2 ton/yr
Property Owner	Slate Ridge American Legion		
Property Location	2217 Whiteford Road Whiteford, MD 21160		
Site Access	Via Slate Ridge American Legion parking lot		
Existing Utility Conflicts	Overhead power lines along Whiteford Road		
Total Project Cost	$147,000		
Drainage Area (acres)	7.2		
Impervious Area (acres)	1.0 (14.5%)		
Required WQv (ac-ft)	0.12		
Anticipated Provided WQv (ac-ft)	0.31		
EX. Rainfall Depth Treated (inches)	0.0		
PR. Rainfall Depth Treated (inches)	2.6		
Impervious Acre Credits	1.5		
Description BMP-6 involves the installation of a new BMP adjacent to the Slate Ridge American Legion parking lot (Photo 22). The proposed BMP would entail construction of a curb and gutter system along the perimeter of the parking lot to collect overland flow and convey it into the facility. The facility would be installed in a grass, open space area (Photo 23) and would be designed to treat 2.6 inches of rainfall runoff (0.31 ac-ft). Due to the small footprint of the proposed facility, the new BMP could potentially be an ESD facility such as a bioretention facility.			

Photo 22 – Ex. Slate Ridge American Legion parking lot

Photo 23 – Proposed location for BMP-6



Notes:
1. Streams Data from 2013 Harford County GIS
2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.01 0.02 0.04 Miles

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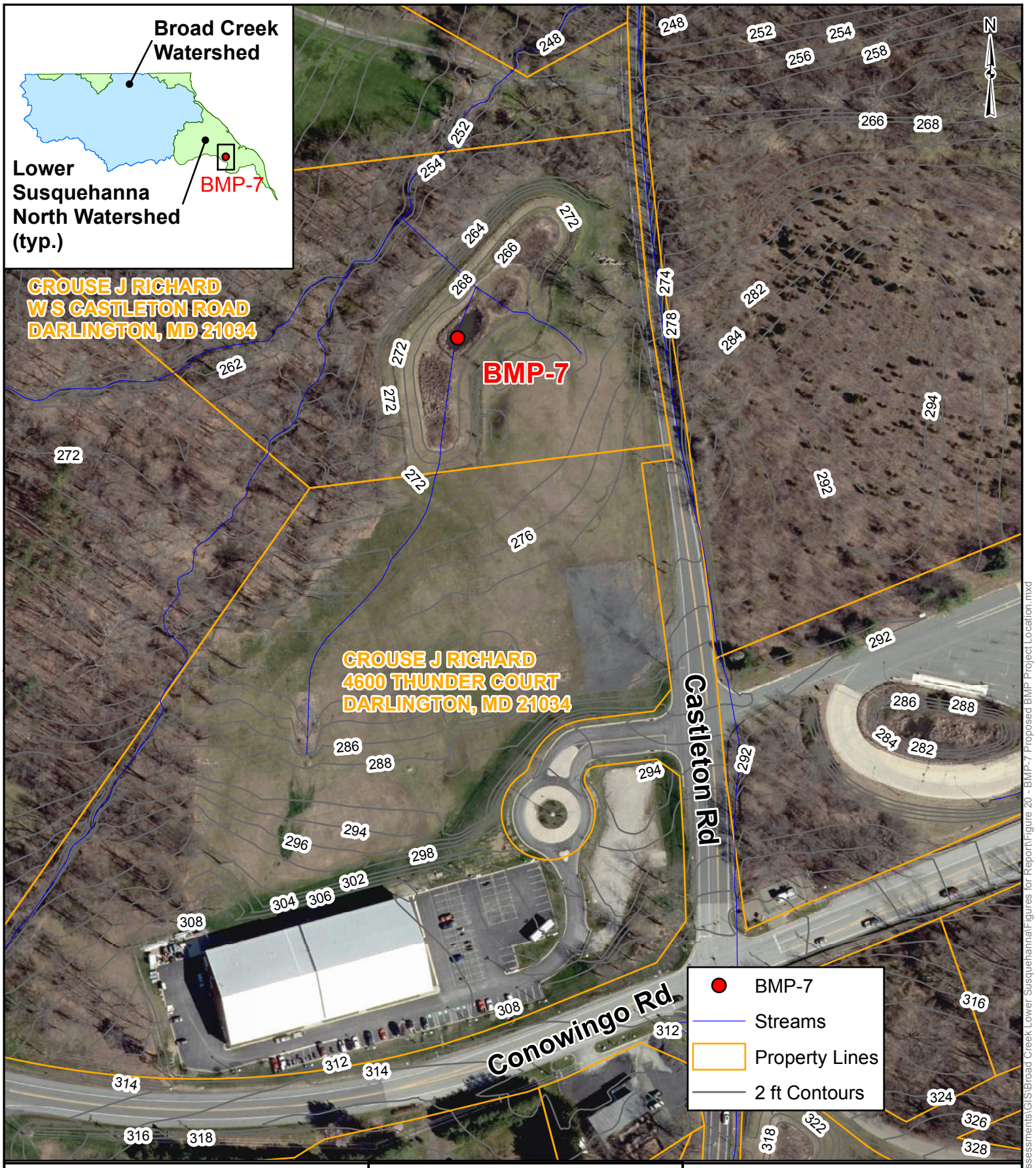
FIGURE 19
BMP-6
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 19 - BMP-6 Proposed BMP Project Location.mxd

Table 22 – BMP-7			
Name	Lands of Richard Crouse Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	LS-3		
TN/TP/TSS Pollutant Removal	6.4 lb/yr	0.6 lb/yr	0.8 ton/yr
Property Owner	Castleton Road LLC		
Property Location	Intersection of Route 1 & MD Route 623 Castleton Road Darlington, MD 21034		
Site Access	Via gravel lot off MD Route 623 Castleton Road		
Existing Utility Conflicts	Overhead power lines that parallel Castleton Road		
Total Project Cost	$147,000		
Drainage Area (acres)	10.5		
Impervious Area (acres)	3.0 (28.9%)		
Required WQv (ac-ft)	0.27		
Anticipated Proposed WQv (ac-ft)	0.27		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	1.5		
Description BMP-7 (SWM-0389 per County GIS data) is an existing extended detention facility that is located near the intersection of Route 1 and MD Route 623 Castleton Road. According to as-built plans (No. 020459 to 020461), the facility was designed in 1999 and certified as-built in 2002 and treats 0.5 inches of rainfall runoff from the adjacent Chesapeake Harley-Davidson parking lot (Photo 24). The facility consists of a reinforced concrete riser with a metal rack (Photo 25) that outfalls into a 36-inch RCP. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.27 ac-ft). The facility could potentially be converted into a SWM wetland by modifying the existing riser structure and increasing the facility footprint.			

Photo 24 – BMP-7 lot

Photo 25 – BMP-7 concrete riser



Notes:
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2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.015 0.03 0.06 Miles

1" = 0.03 miles

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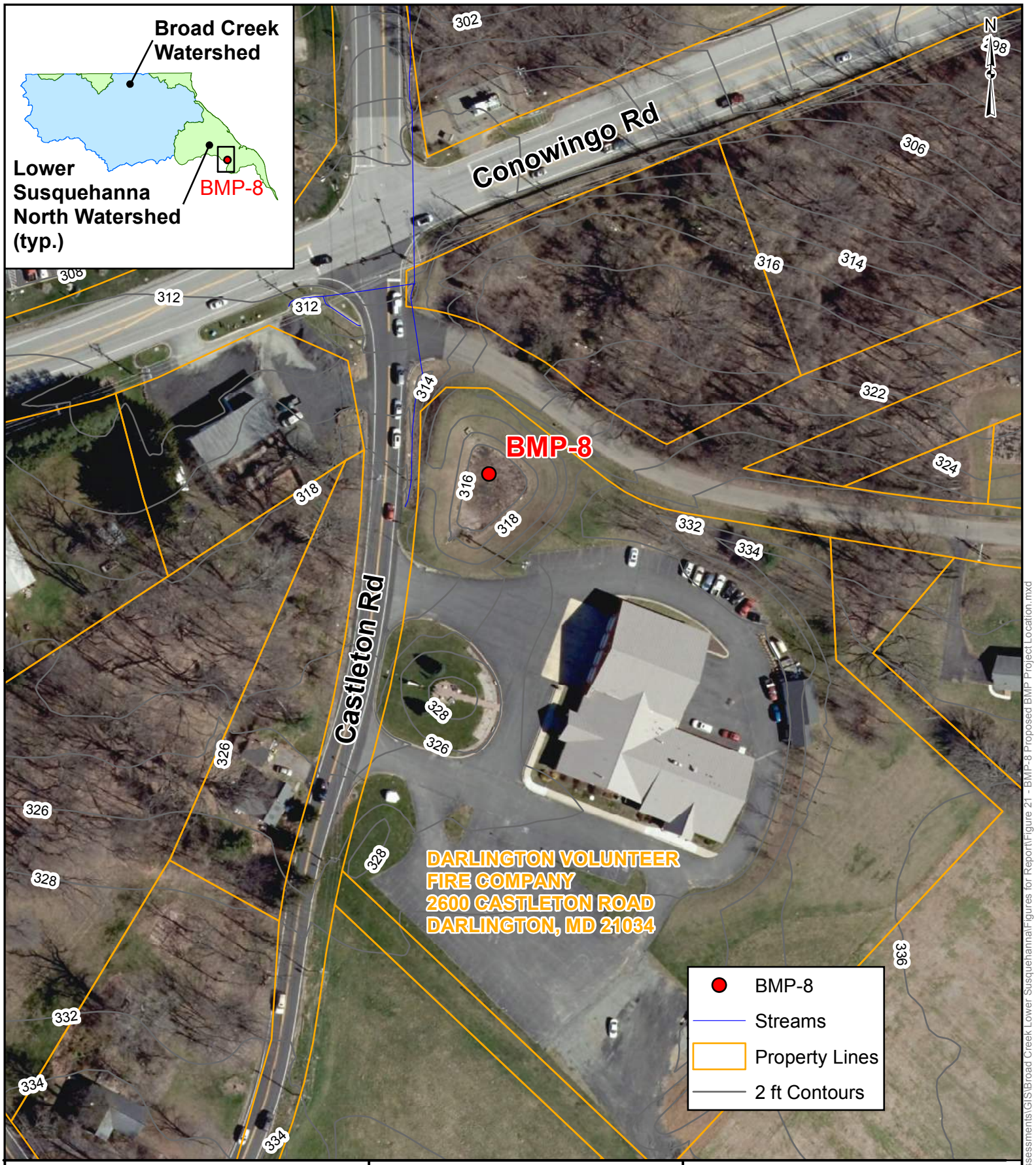
FIGURE 20
BMP-7
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 20 - BMP-7 Proposed BMP Project Location.mxd

Table 23 – BMP-8			
Name	Darlington Volunteer Fire Company Pond		
Proposed Approach	Existing SWM Facility Retrofit		
Sub-Watershed Location	LS-3		
TN/TP/TSS Pollutant Removal	3.9 lb/yr	0.4 lb/yr	0.4 ton/yr
Property Owner	Darlington Volunteer Fire Company		
Property Location	2600 Castleton Road Darlington, MD 21034		
Site Access	Via Darlington Volunteer Fire Company's parking lot		
Existing Utility Conflicts	Overhead power lines along Castleton Road and in Darlington Volunteer Fire Company parking lot, light poles in parking lot		
Total Project Cost	$120,000		
Drainage Area (acres)	4.6		
Impervious Area (acres)	2.3 (49.9%)		
Required WQv (ac-ft)	0.19		
Anticipated Proposed WQv (ac-ft)	0.19		
EX. Rainfall Depth Treated (inches)	0.5		
PR. Rainfall Depth Treated (inches)	1.0		
Impervious Acre Credits	1.2		
Description BMP-8 (SWM-0313 per County GIS data) is an existing extended detention facility located next to the Darlington Volunteer Fire Company. According to as-built plans (No. 000632 to 000634), the facility was designed in 1997 and certified as-built in 2000. The facility currently treats 0.5 inches of rainfall runoff that inflows into the facility via a storm drain pipe (Photo 26) conveying runoff from the Darlington Volunteer Fire Company parking lot. The facility consists of a reinforced concrete riser (Photo 27) that discharges into an 18-inch RCP that outfalls into a closed storm drain system. The proposed design approach involves retrofitting the facility to increase water quality treatment to 1.0 inch of rainfall runoff (0.19 ac-ft). The facility could potentially be converted into a wet pond by modifying the riser structure.			

Photo 26 – Inflow into BMP-8

Photo 27 – BMP-8 with concrete riser



Notes:
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2. Property Lines Data from 2018 Harford County GIS
3. 2 ft Contours from 2018 Harford County GIS

0 0.01 0.02 0.04 Miles

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FIGURE 21
BMP-8
PROPOSED BMP
PROJECT LOCATION

P:\4_4101_HCo Large Watershed Assessments\GIS\Broad Creek Lower Susquehanna\Figures for Report\Figure 21 - BMP-8 Proposed BMP Project Location.mxd

Table 24 – Proposed BMP Projects											
Project ID	**Name**	**Sub-Watershed**	**BMP Type**	**Drainage Area (acres)**	**Property Owner**	**Pollutant Reduction**			**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
						TN (lbs/yr)	**TP (lbs/yr)**	**TSS (tons/yr)**			
Broad Creek Watershed											
BMP-3	Whiteford Maintenance Shop Pond	BC-1	New BMP	4.1	Harford County, MD	7.8	0.6	0.6	$92,000	0.9	$102,000
BMP-5	Whiteford Volunteer Fire Company Pond	BC-1	Existing SWM Facility Retrofit	2.8	Whiteford Volunteer Fire Company	2.2	0.2	0.3	$102,000	1.0	$102,000
BMP-6	Slate Ridge American Legion Pond	BC-4	New BMP	7.2	Slate Ridge American Legion	55.3	2.1	2.2	$147,000	1.5	$98,000
Broad Creek Total				**14.1**	**N/A**	**65.3**	**2.9**	**3.1**	**$341,000**	**3.4**	**$101,000**
Lower Susquehanna North Watershed											
BMP-1	Integrated Community Shop Center Pond	LS-8	Existing SWM Facility Retrofit	8.2	Castleton Road LLC	6.7	0.7	0.7	$173,000	1.8	$96,000
BMP-2	Backyard Boys, Inc. Pond	LS-8	New BMP	1.5	EAW Realty LLC	13.9	1.1	1.1	$156,000	1.6	$97,000
BMP-4	Whiteford High's Pond	LS-8	Existing SWM Facility Retrofit	1.8	Thompson M. Graham	2.4	0.2	0.2	$80,000	0.4	$200,000
BMP-7	Lands of Richard Crouse Pond	LS-3	Existing SWM Facility Retrofit	10.5	Tomran Inc.	6.4	0.6	0.8	$147,000	1.5	$98,000
BMP-8	Darlington Volunteer Fire Company Pond	LS-3	Existing SWM Facility Retrofit	4.6	Darlington Volunteer Fire Company	3.9	0.4	0.4	$120,000	1.2	$100,000
Lower Susquehanna North Total				**26.6**	**N/A**	**33.3**	**3.0**	**3.2**	**$676,000**	**6.5**	**$104,000**

4.4. Revised Watershed Pollutant Loading Rates

A summary of the revised pollutant loading rates for each sub-watershed (Table 25) and the Broad Creek and Lower North Susquehanna Watersheds (Table 26) are provided below. The greatest pollutant and sediment load reductions occurred in Sub-Watersheds BC-2 and LS-8 due to the presence of degraded channels and existing SWM facilities with potential for retrofit. There are no proposed projects within Sub-Watersheds BC-3, LS-1, LS-2, LS-4, LS-5, LS-6, LS-7 and LS-9 which all have lower associated annual pollutant loads.

It should be noted that the pollutant and sediment load reductions listed in Tables 25 and 26 do not fully reflect the realized benefit the proposed restoration projects will have on the Broad Creek and Lower Susquehanna North Watersheds. Current TMDL accounting guidelines (Schueler and Stack, 2014) limit the amount of pollutant and sediment reduction credits for stream restoration projects to one half of the total annual pollutant and sediment loadings to account for project inefficiencies and naturally occurring erosional processes. The proposed stream restoration methodologies; however, are highly efficient at reducing in-channel bank erosion and capturing sediment from unstable upland sources, resulting in increased sediment reduction efficiencies and decreased annual sediment loads within the sub-watersheds.

Table 25 – Summary of Sub-Watershed Pollutant Reduction & Efficiency

Sub-Watershed	Annual Pollutant Loads			Annual Pollutant Reduction from Restoration Projects			Percent Reduction of Annual Pollutant Loads		
	TN (lbs/yr)	TP (lbs/yr)	TSS (tons/yr)	TN (lbs/yr)	TP (lbs/yr)	TSS (tons/yr)	TN (%)	TP (%)	TSS (%)
Broad Creek Watershed									
BC-1	147,547.0	4,921.3	4,106.9	10.0	0.8	0.9	0.01	0.02	0.02
BC-2	35,756.2	1,037.3	977.5	187.5	170.0	56.3	0.52	16.39	5.76
BC-3	12,884.7	291.9	353.6	0.0	0.0	0.0	0.00	0.00	0.00
BC-4	32,555.6	1,170.1	941.6	55.3	2.1	2.2	0.17	0.18	0.23
Broad Creek Total	**228,743.5**	**7,420.6**	**6,379.6**	**252.8**	**172.9**	**59.4**	**0.11**	**2.33**	**0.93**
Lower Susquehanna North Watershed									
LS-1	833.7	35.6	23.4	0.0	0.0	0.0	0.00	0.00	0.00
LS-2	22,038.8	988.2	701.6	0.0	0.0	0.0	0.00	0.00	0.00
LS-3	14,900.8	569.9	447.8	10.3	1.0	1.2	0.07	0.18	0.27
LS-4	393.8	15.6	9.1	0.0	0.0	0.0	0.00	0.00	0.00
LS-5	1,149.8	30.6	24.4	0.0	0.0	0.0	0.00	0.00	0.00
LS-6	7,061.8	197.2	180.6	0.0	0.0	0.0	0.00	0.00	0.00
LS-7	4,727.2	147	115	0.0	0.0	0.0	0.00	0.00	0.00
LS-8	5,312.4	242.4	187.2	92.4	64.9	22.8	1.74	26.77	12.18
LS-9	2,673.6	104.7	79.9	0.0	0.0	0.0	0.00	0.00	0.00
Lower Susquehanna North Total	**59,091.9**	**2,331.2**	**1,769.0**	**102.7**	**65.9**	**24.0**	**0.17**	**2.83**	**1.36**

Table 26 – Watershed Pollutant Removal & Impervious Acre Summary			
Pollutant/ Impervious Area	**Total Watershed Pollutant Loading**	**Total Pollutant Load Removal for Completed Projects**	**Removal Efficiency (%)**
Broad Creek Watershed			
TN (lbs/yr)	228,743.5	252.8	0.11
TP (lbs/yr)	7,420.6	172.9	2.33
TSS (tons/yr)	6,379.6	59.4	0.93
Impervious Area (Acres)	926.7	78.4	8.46
Lower Susquehanna North Watershed			
TN (lbs/yr)	59,091.9	102.7	0.17
TP (lbs/yr)	2,331.2	65.9	2.83
TSS (tons/yr)	1,769.0	24.0	1.36
Impervious Area (Acres)	408.5	34.3	8.40

The proposed projects for the Broad Creek Watershed would reduce TN by 252.8 pounds per year or 0.11 percent, TP by 172.9 pounds per year or 2.33 percent, and TSS by 59.4 tons per year or 0.93 percent. The total impervious area treated is 78.4 acres or 8.46 percent of the total impervious area within the Broad Creek Watershed.

The proposed projects for the Lower Susquehanna North Watershed would reduce TN by 102.7 pounds per year or 0.17 percent, TP by 65.9 pounds per year or 2.83 percent, and TSS by 24.0 tons per year or 1.36 percent. The total impervious area treated is 34.3 acres or 8.40 percent of the total impervious area within the Lower Susquehanna North Watershed.

4.5. Project Prioritization

As mentioned in Section 4.1, prioritization of stream and BMP projects was based on several factors including location within the watershed, pollutant reduction and impervious acre credits, property ownership, site access, existing utility conflicts and design and construction costs. High priority projects are located within severely degraded systems and sub-watersheds, have favorable site access and property ownership, are eligible for pollutant reduction and impervious acre credits, and are cost efficient. Proposed projects in order of prioritization are listed in Table 27.

Within the Broad Creek Watershed, stream restoration projects SR-1 is the highest priority project due to the large anticipated sediment reduction and impervious acre credit as well as the low cost per acre treated. SR-1 is located in Sub-Watershed BC-2 which has the highest pollutant loadings per acre and it is partially on County property. BMP-3 and BMP-5 are next highest priority projects since they are located in Sub-Watershed BC-1 which has the second highest pollutant loadings per acre after BC-2. Additionally, BMP-3 is located on County property.

Within the Lower Susquehanna North Watershed, SR-2 is the highest priority project due to the large anticipated sediment reduction and impervious acre credit as well as the low cost per acre treated. BMP-7 and BMP-8 are next highest priority projects since they are location in Sub-Watershed LS-3 which has the third highest pollutant loadings per acre.

Table 27 – Project Prioritization										
Project Ranking	**Project ID**	**Sub-Watershed**	**Type**	**Owner**	**TN (lbs/yr)**	**TP (lbs/yr)**	**TSS (tons/yr)**	**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
Broad Creek Watershed										
1	SR-1	BC-2	Stream Restoration – Step Pool Weir System	Board of Education of Harford County; Martin Brothers LLC	187.5	170.0	56.3	$2,063,000	75.0	$28,000
2	BMP-3	BC-1	New Bioretention Basin BMP	Harford County, MD	7.8	0.6	0.6	$92,000	0.9	$102,000
3	BMP-5	BC-1	Existing Stormwater Pond BMP Retrofit	Whiteford Volunteer Fire Company	2.2	0.2	0.3	$102,000	1.0	$102,000
4	BMP-6	BC-4	New Bioretention Basin BMP	Slate Ridge American Legion	55.3	2.1	2.2	$147,000	1.5	$98,000
Broad Creek Total					**252.8**	**172.9**	**59.4**	**$2,404,000**	**78.4**	**$31,000**
Lower Susquehanna North Watershed										
1	SR-2	LS-8	Stream Restoration – Step Pool Weir System	Trenton Bone Fertilizer Company; Whiteford Packing Co. Inc.	69.4	62.9	20.8	$763,000	27.8	$27,000
2	BMP-7	LS-3	Existing Stormwater Pond BMP Retrofit	Tomran Inc.	6.4	0.6	0.8	$147,000	1.5	$98,000
3	BMP-8	LS-3	Existing Stormwater	Darlington Volunteer Fire Company	3.9	0.4	0.4	$120,000	1.2	$100,000

Table 27 – Project Prioritization										
Project Ranking	**Project ID**	**Sub-Watershed**	**Type**	**Owner**	**TN (lbs/yr)**	**TP (lbs/yr)**	**TSS (tons/yr)**	**Project Cost**	**Impervious Acre Credits**	**Cost/Imp. Acre**
			Pond BMP Retrofit							
4	BMP-1	LS-8	Existing Stormwater Pond BMP Retrofit	Castleton Road LLC	6.7	0.7	0.7	$173,000	1.8	$96,000
5	BMP-2	LS-8	New Bioretention Basin BMP	EAW Realty LLC	13.9	1.1	1.1	$156,000	1.6	$97,000
6	BMP-4	LS-8	Existing Stormwater Pond BMP Retrofit	Thompson M. Graham	2.4	0.2	0.2	$80,000	0.4	$200,000
Lower Susquehanna North Total					**102.7**	**65.9**	**24.0**	**$1,439,000**	**34.3**	**$42,000**

5. IMPLEMENTATION SCHEDULE

Projects shall be implemented according to the prioritization rankings established in Section 4.5. The number of projects in the different phases of design, construction, and post-construction monitoring may vary from year to year and will depend on available County resources. Although design and construction timelines for BMP and stream restoration projects are highly variable due to site specific factors such as access, property ownership, environmental impacts, permitting, utilities, and design methodology, typical timelines for design, permitting and construction for BMP projects is one and a half to two years. Typical timelines for design, permitting, utilities for stream restoration projects is two and a half to three years. Each project will be monitored, and the efficacy of design techniques and methodologies will be evaluated. This on-going analysis will allow future projects and techniques to be adapted to changing conditions and allow for better allocation of resources to areas and projects with the highest probability of success.

6. CONCLUSION

The LWAP for the Broad Creek and Lower Susquehanna North Watersheds has identified potential projects to assist the County in meeting TMDL and MS4 permit requirements. The recommendations in this plan are based on the results of desktop analysis and field assessment which targeted the developed areas of the watersheds where the effects of unmanaged stormwater runoff are a primary concern. Prioritization of stream and BMP projects was based on several factors including location within the watershed, pollutant reduction and impervious acre credits, site access, property ownership, and design and construction costs.

In the Broad Creek Watershed, proposed projects include implementing one step pool weir system, two new bioretention basins, and one stormwater pond retrofit. Full implementation of these projects would reduce TN by 252.8 pounds per year or 0.11 percent, TP by 172.9 pounds per year or 2.33 percent, and TSS by 59.4 tons per year or 0.93 percent. The total impervious area treated by all four projects is 78.4 acres or 8.46 percent of the total impervious area within the Broad Creek Watershed. The total cost for all proposed projects is estimated to be $2,404,000, with a cost per acre treated of $31,000. This cost includes design, permitting, and construction.

In the Lower Susquehanna North Watershed, proposed projects include implementing one step pool weir system, and one new bioretention basin, and four stormwater pond retrofits. Full implementation of these projects would reduce TN by 102.7 pounds per year or 0.17 percent, TP by 65.9 pounds per year or 2.83 percent, and TSS by 24.0 tons per year or 1.36 percent. The total impervious area treated by all six projects is 34.3 acres or 8.40 percent of the total impervious area within the Lower Susquehanna North Watershed. The total cost for all of the projects is estimated to be $1,439,000 with a cost per acre treated of $42,000. This cost includes design, permitting, and construction.

Since this LWAP represents the current understanding of the overall condition and impairments to the watersheds, it should be reevaluated at regular intervals to assess its progress towards meeting TMDL and MS4 permit requirements. In addition, lessons learned from the implementation of projects in surrounding watersheds may be incorporated in this assessment.

7. REFERENCES

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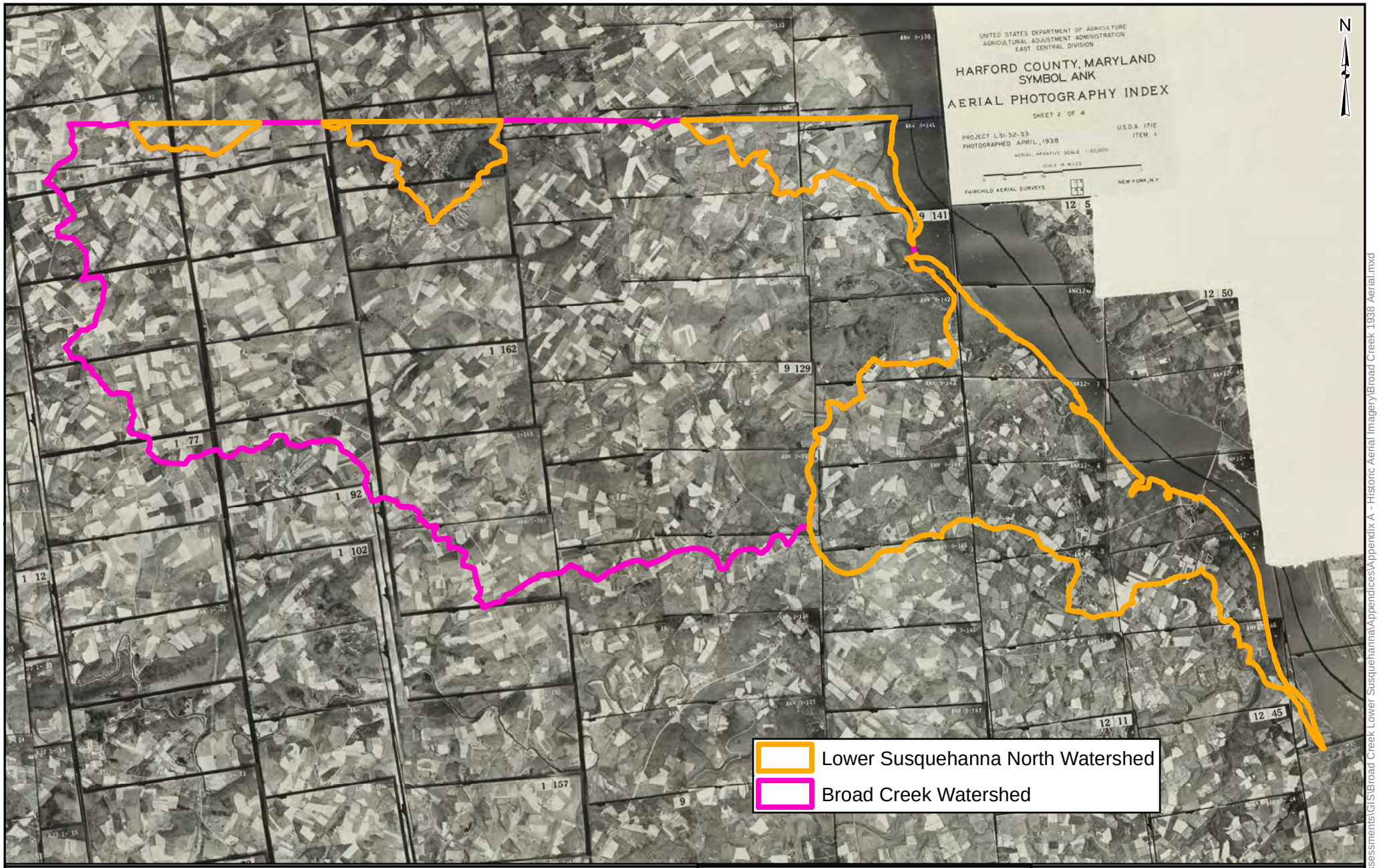
APPENDIX A

Historic Aerial Imagery



Notes:
1. 1938 Historic Aerial Photography from 1938 U.S. Agriculture Stabilization and Conservation Service (ASCS)

0 0.75 1.5 3 Miles

1" = 1.5 miles

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APPENDIX A
BROAD CREEK AND LOWER SUSQUEHANNA NORTH, 1938

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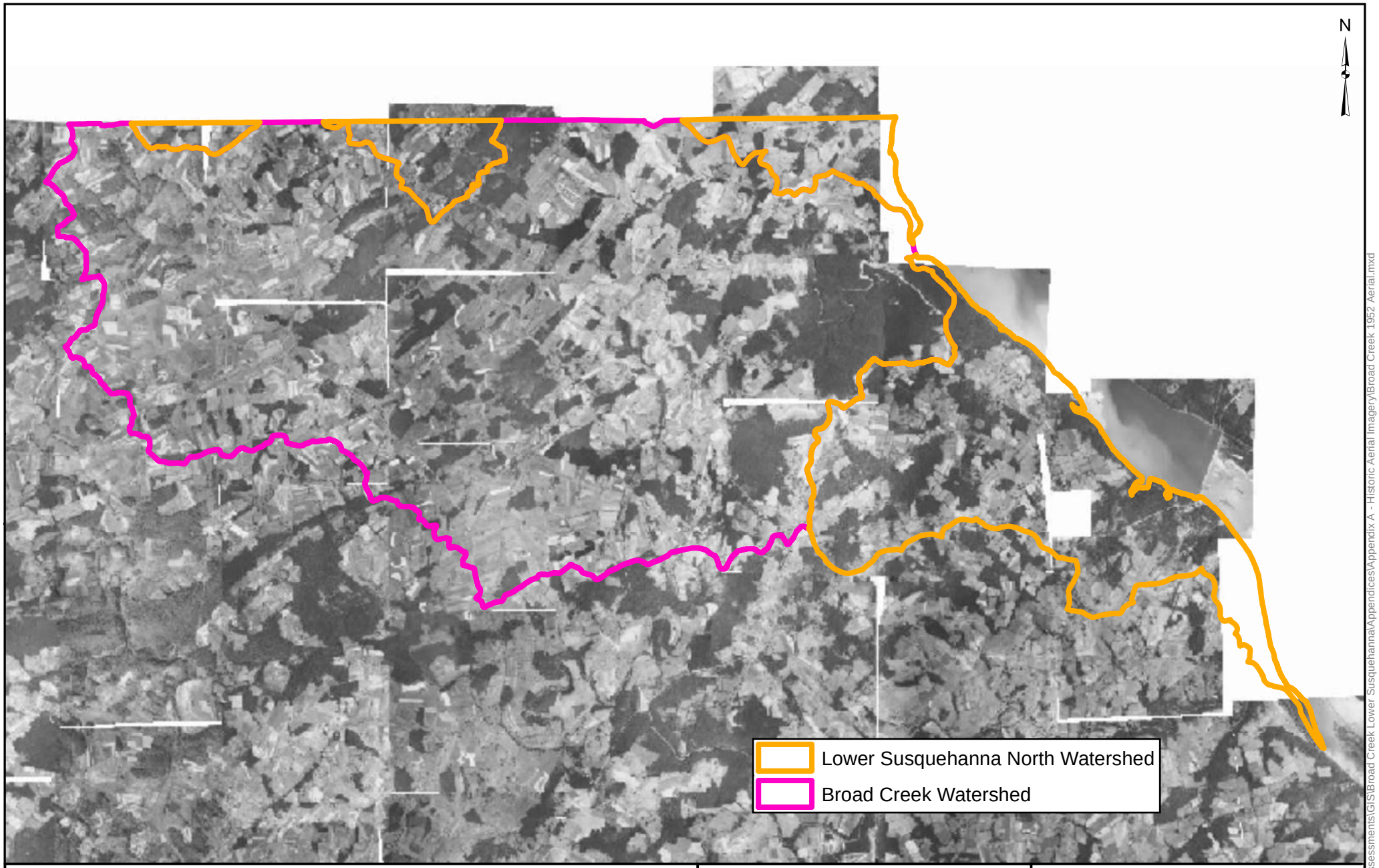

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1. 1952 Historic Aerial Photography from 2015 Harford County GIS

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APPENDIX A
BROAD CREEK
AND LOWER
SUSQUEHANNA,
1952

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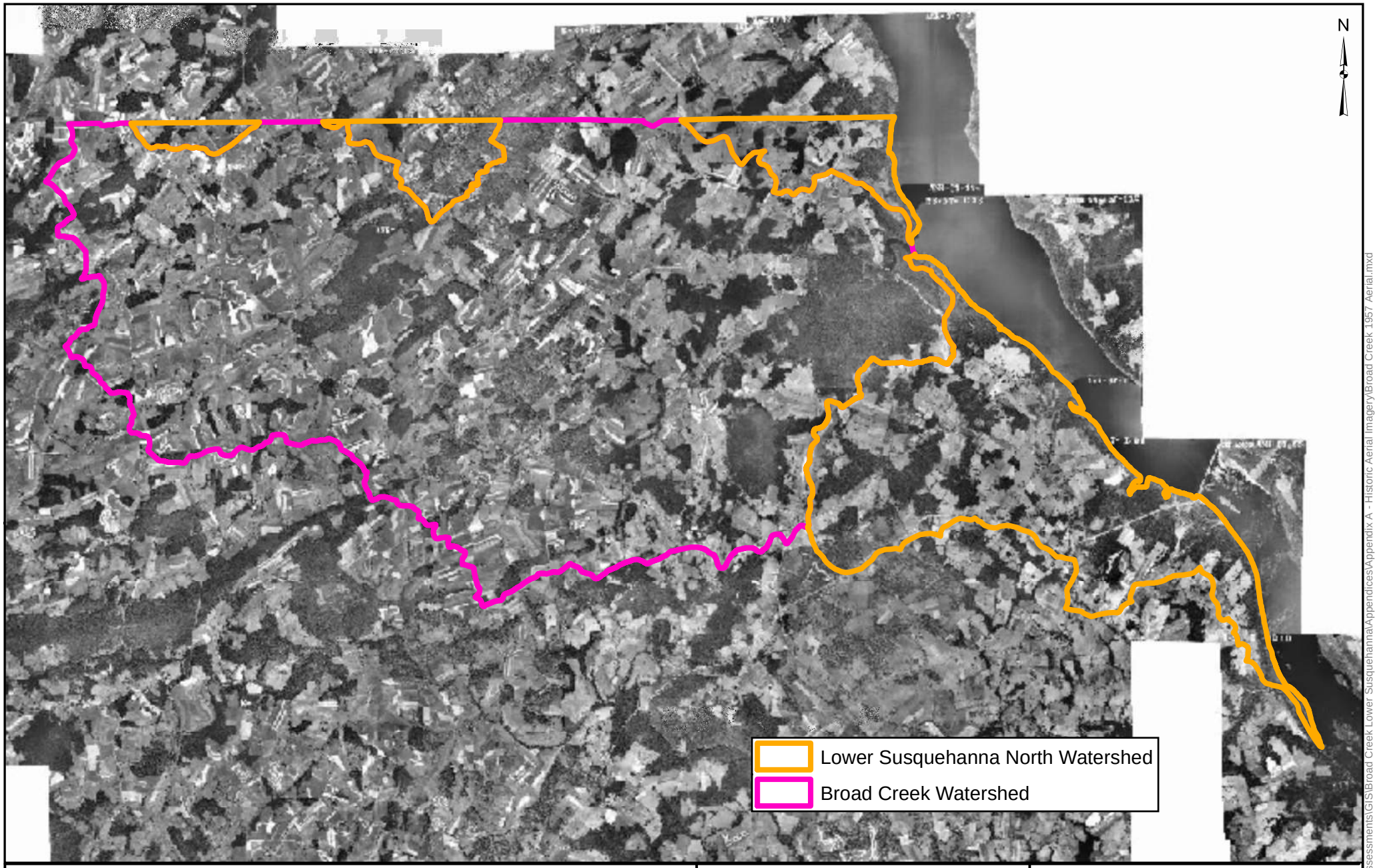

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APPENDIX A
BROAD CREEK AND LOWER SUSQUEHANNA NORTH, 1957

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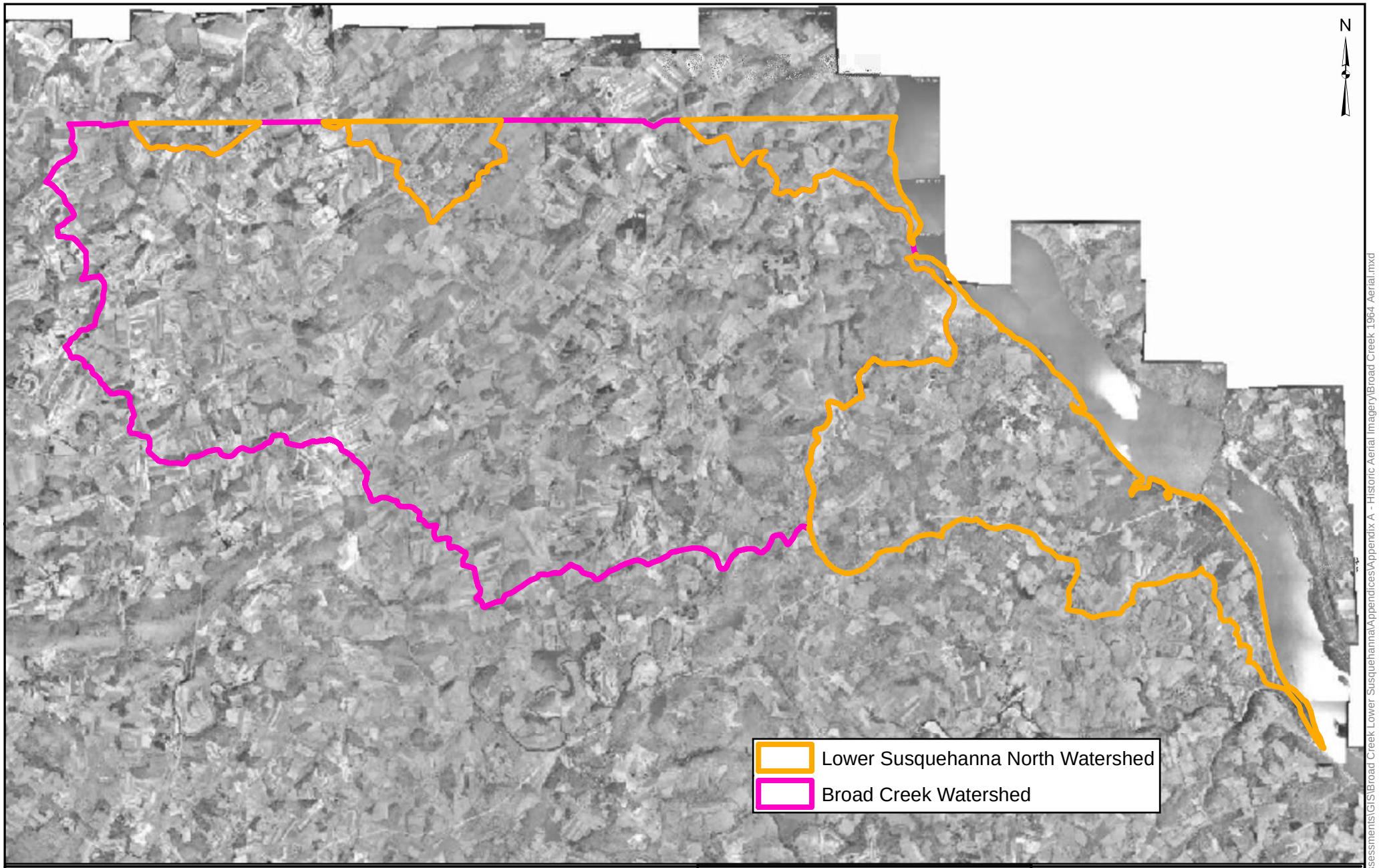

Notes:
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APPENDIX A
BROAD CREEK AND LOWER SUSQUEHANNA NORTH, 1964

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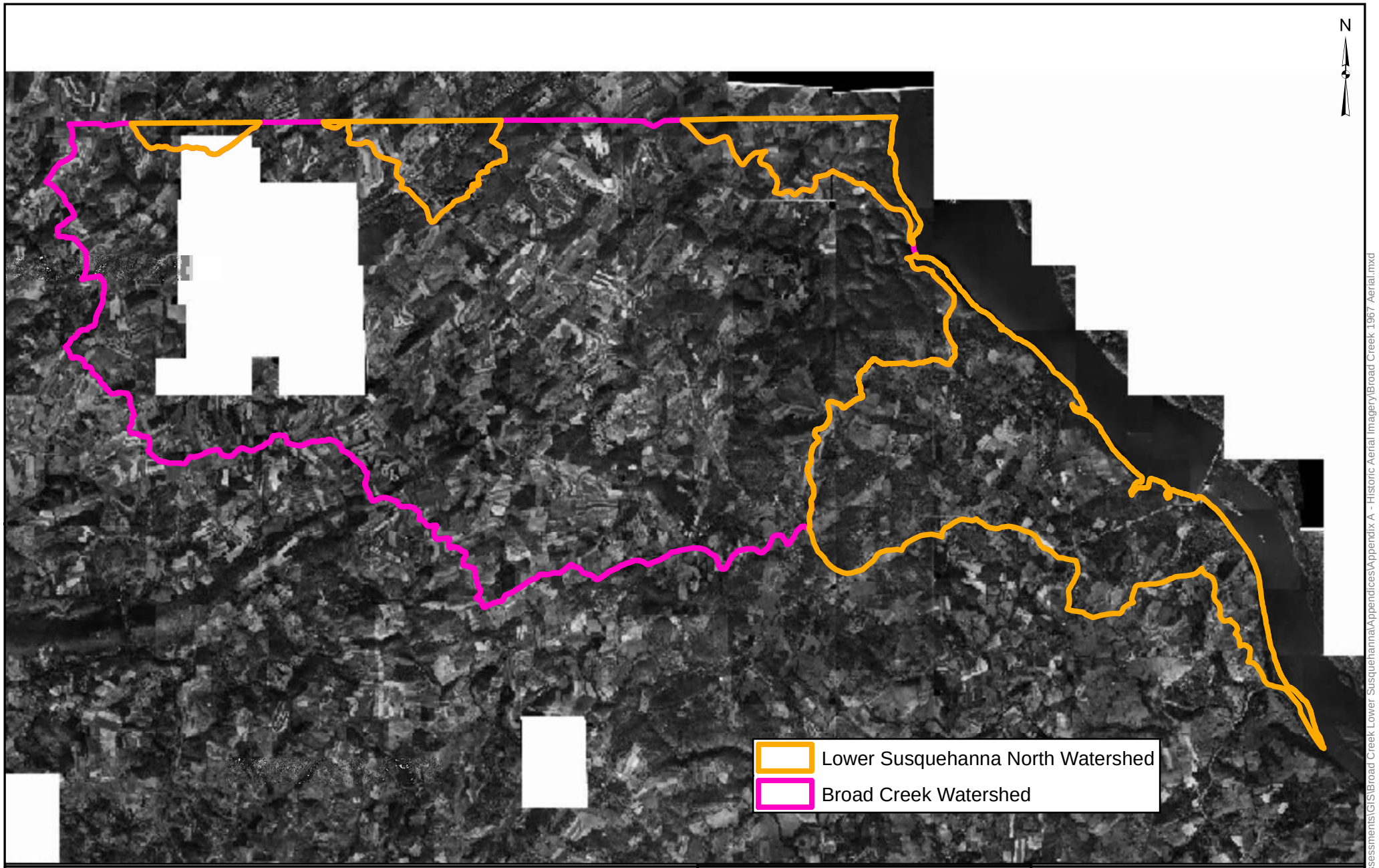

Notes:
1. 1967 Historic Aerial Photography from 2015 Harford County GIS

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APPENDIX A
BROAD CREEK AND LOWER SUSQUEHANNA NORTH, 1967

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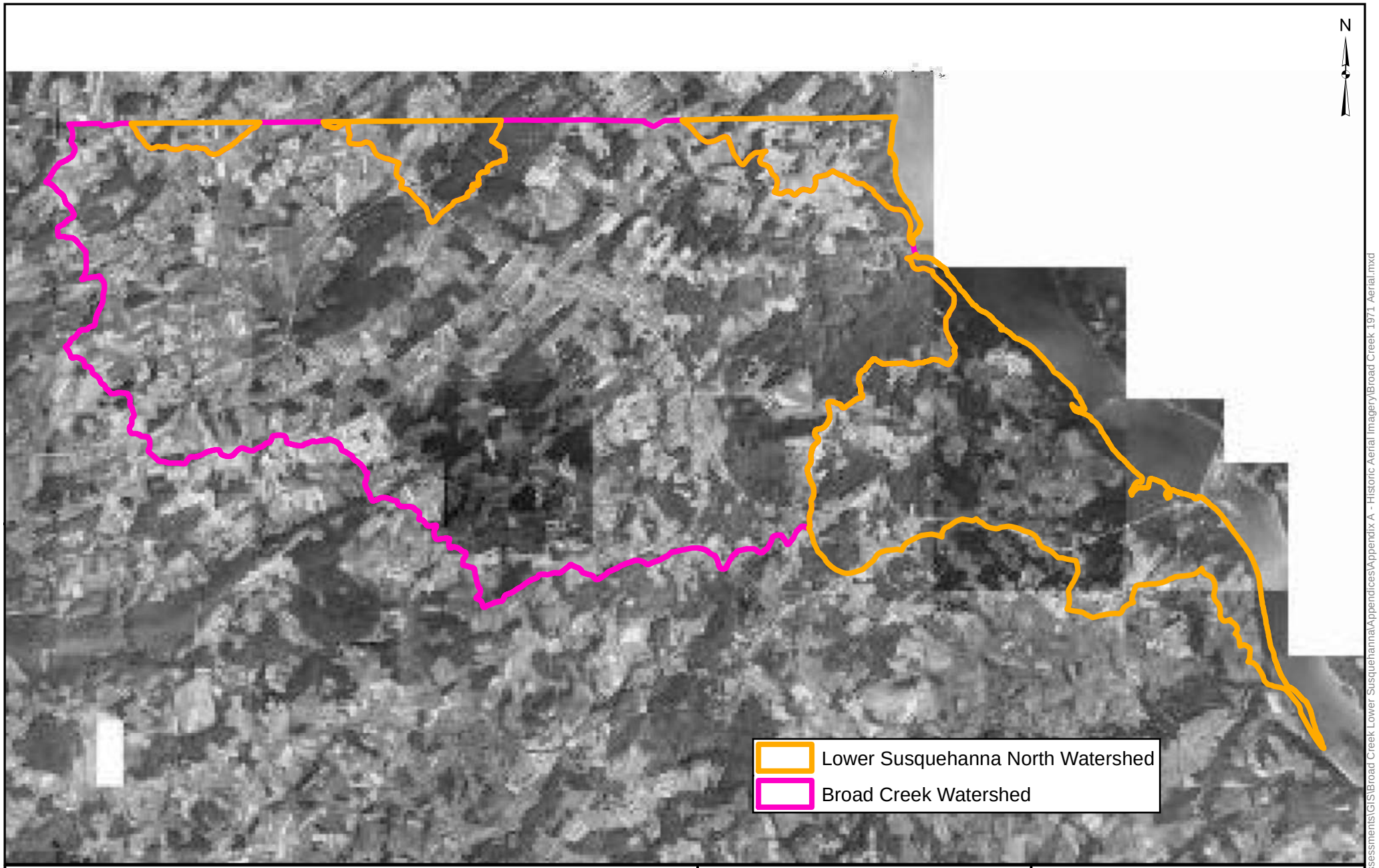

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APPENDIX A
BROAD CREEK AND LOWER SUSQUEHANNA NORTH, 1971

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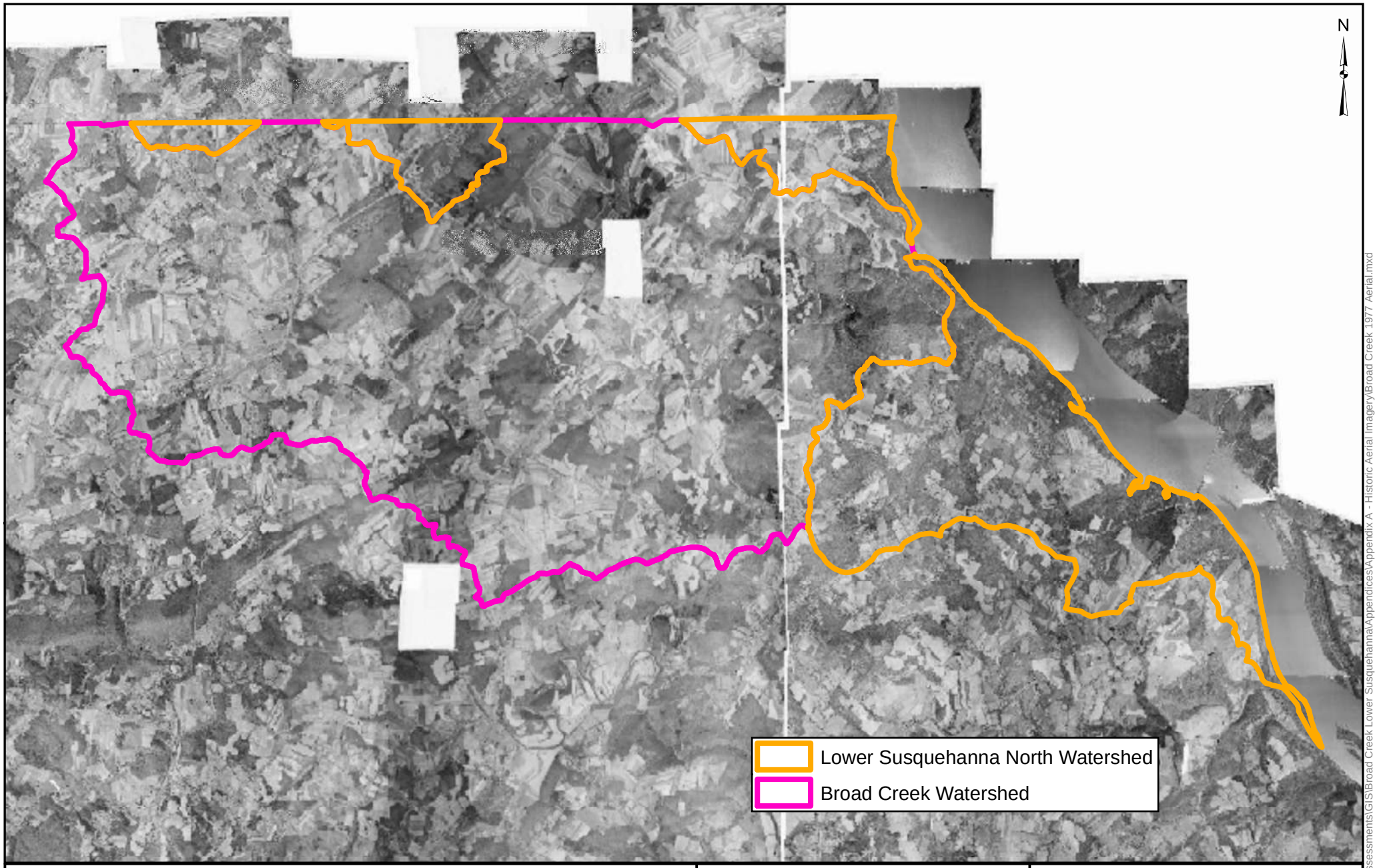

Notes:
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APPENDIX A
BROAD CREEK AND LOWER SUSQUEHANNA NORTH, 1977

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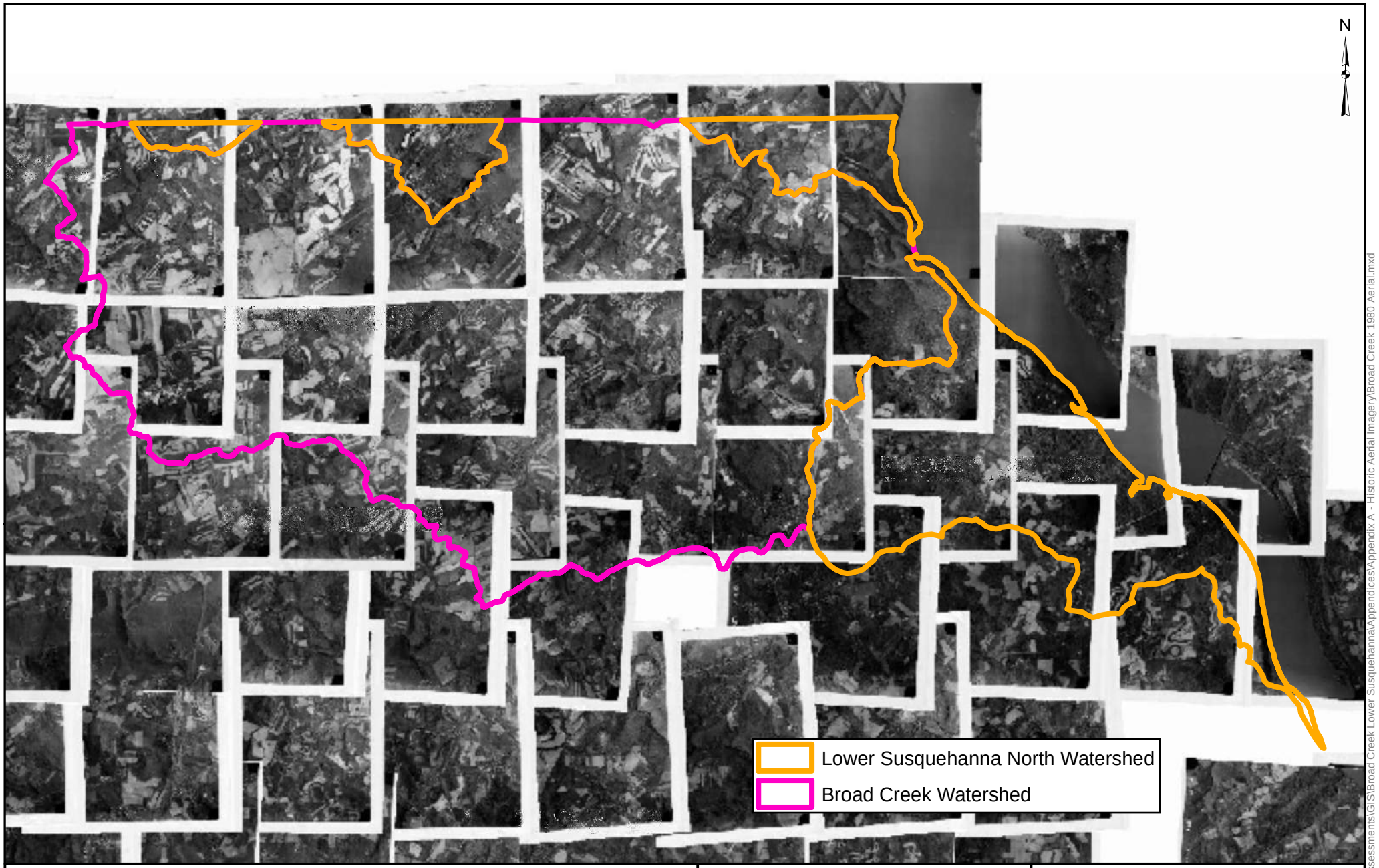

Notes:
1. 1980 Historic Aerial Photography from 2015 Harford County GIS

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1" = 1.5 miles

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APPENDIX A
BROAD CREEK AND LOWER SUSQUEHANNA NORTH, 1980

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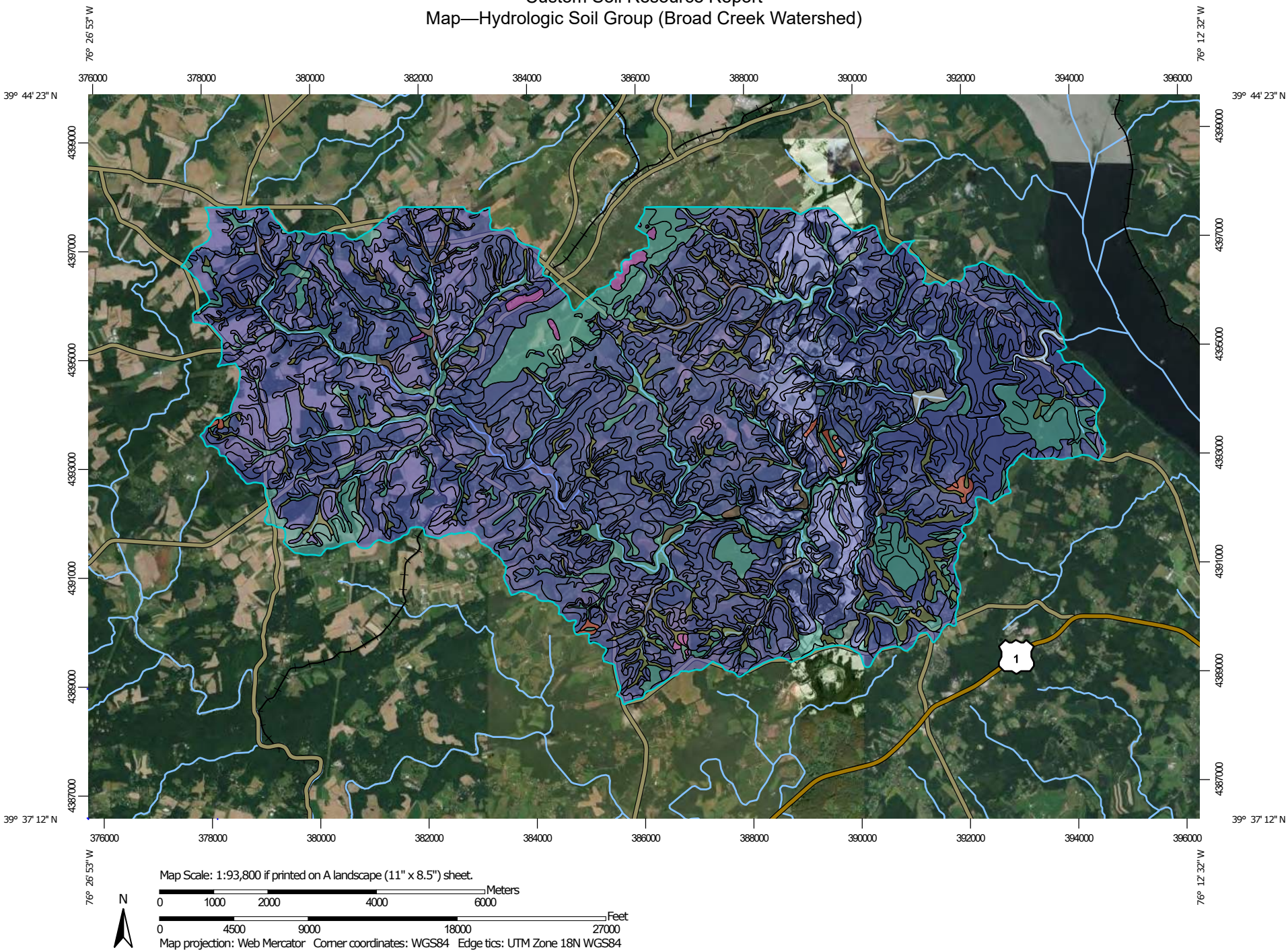
APPENDIX B

Soils

Custom Soil Resource Report
Map—Hydrologic Soil Group (Broad Creek Watershed)



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 scales ranging from 1:15,800 to 1:24,000.

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: Harford County Area, Maryland
Survey Area Data: Version 13, Sep 13, 2019

Soil Survey Area: York County, Pennsylvania
Survey Area Data: Version 14, Sep 17, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jun 29, 2011—Jul 25, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (Broad Creek Watershed)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Aldino silt loam, 0 to 3 percent slopes	C	2.4	0.0%
AdB	Aldino silt loam, 3 to 8 percent slopes	C	170.3	0.7%
AdC	Aldino silt loam, 8 to 15 percent slopes	C	21.1	0.1%
AsB	Aldino very stony silt loam, 0 to 8 percent slopes	C	63.0	0.2%
BaA	Baile silt loam, 0 to 3 percent slopes	C/D	142.0	0.6%
BaB	Baile silt loam, 3 to 8 percent slopes	C/D	21.9	0.1%
BrC2	Brandywine gravelly loam, 8 to 15 percent slopes, moderately eroded	A	9.1	0.0%
BrD3	Brandywine gravelly loam, 15 to 25 percent slopes, severely eroded	A	5.2	0.0%
CcA	Chester silt loam, 0 to 3 percent slopes	B	52.2	0.2%
CcB2	Chester silt loam, 3 to 8 percent slopes	B	5,294.7	20.9%
CcC2	Chester silt loam, 8 to 15 percent slopes	B	1,509.5	5.9%
CgB2	Chester gravelly silt loam, 3 to 8 percent slopes, moderately eroded	B	1,156.5	4.6%
CgC2	Chester gravelly silt loam, 8 to 15 percent slopes, moderately eroded	B	1,294.4	5.1%
CgD2	Chester gravelly silt loam, 15 to 25 percent slopes, moderately eroded	B	228.2	0.9%
CrE	Chrome channery silty clay loam, 15 to 45 percent slopes	C	78.5	0.3%
Cu	Codorus silt loam	C	1,176.8	4.6%
Cv	Comus silt loam	B	171.1	0.7%
Cx	Cut and fill land		22.4	0.1%
DcA	Delanco silt loam, 0 to 3 percent slopes	C	3.5	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
EhB2	Elioak silt loam, 3 to 8 percent slopes, moderately eroded	C	291.8	1.1%
EhC2	Elioak silt loam, 8 to 15 percent slopes, moderately eroded	C	150.6	0.6%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	B	5.8	0.0%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	B	1.7	0.0%
GcB2	Glenelg loam, 3 to 8 percent slopes	B	375.8	1.5%
GcC	Glenelg loam, 8 to 15 percent slopes	B	735.0	2.9%
GcC3	Glenelg loam, 8 to 15 percent slopes, severely eroded	B	38.4	0.2%
GcD	Glenelg loam, 15 to 25 percent slopes	B	260.2	1.0%
GcD3	Glenelg loam, 15 to 25 percent slopes, severely eroded	B	56.8	0.2%
GgB2	Glenelg channery loam, 3 to 8 percent slopes	B	563.5	2.2%
GgC2	Glenelg gravelly loam, 8 to 15 percent slopes, moderately eroded	B	1,181.5	4.7%
GgC3	Glenelg gravelly loam, 8 to 15 percent slopes, severely eroded	B	71.2	0.3%
GgD2	Glenelg gravelly loam, 15 to 25 percent slopes, moderately eroded	B	519.1	2.0%
GgD3	Glenelg gravelly loam, 15 to 25 percent slopes, severely eroded	B	212.1	0.8%
GnA	Glenville silt loam, 0 to 3 percent slopes	C	437.1	1.7%
GnB	Glenville silt loam, 3 to 8 percent slopes	C/D	578.0	2.3%
Hb	Hatboro silt loam	B/D	345.9	1.4%
HcA	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	B/D	16.6	0.1%
KeB	Kelly silt loam, 3 to 8 percent slopes	D	21.5	0.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
KeC2	Kelly silt loam, 8 to 15 percent slopes, moderately eroded	D	50.8	0.2%
KfD	Kelly very stony silt loam, 3 to 25 percent slopes	B	66.4	0.3%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	C	39.8	0.2%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	C	49.0	0.2%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	B	195.3	0.8%
LeE	Legore silt loam, 25 to 45 percent slopes	B	72.6	0.3%
LfC	Legore very stony silt loam, 0 to 15 percent slopes	B	64.4	0.3%
LfD	Legore very stony silt loam, 15 to 25 percent slopes	B	112.1	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	B	153.9	0.6%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	B	13.4	0.1%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	B	25.4	0.1%
MbB2	Manor loam, 3 to 8 percent slopes, moderately eroded	B	83.1	0.3%
MbC	Manor loam, 8 to 15 percent slopes	B	321.5	1.3%
MbD	Manor loam, 15 to 25 percent slopes	B	55.4	0.2%
McB2	Manor channery loam, 3 to 8 percent slopes, moderately eroded	B	80.0	0.3%
McC2	Manor channery loam, 8 to 15 percent slopes, moderately eroded	B	660.5	2.6%
McC3	Manor channery loam, 8 to 15 percent slopes, severely eroded	B	74.4	0.3%
McD2	Manor channery loam, 15 to 25 percent slopes, moderately eroded	B	708.7	2.8%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
McD3	Manor channery loam, 15 to 25 percent slopes, severely eroded	B	370.6	1.5%
MdE	Manor very stony loam, 25 to 45 percent slopes	B	484.0	1.9%
MfE	Manor soils, 25 to 45 percent slopes	B	776.5	3.1%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	B	303.8	1.2%
MgD	Manor and Glenelg very stony loams, 15 to 25 percent slopes	B	342.1	1.3%
MsA	Montalto silt loam, 0 to 3 percent slopes	B	4.5	0.0%
MsB2	Montalto silt loam, 3 to 8 percent slopes, moderately eroded	B	268.9	1.1%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	B	89.4	0.4%
NeA	Neshaminy silt loam, 0 to 3 percent slopes	B	3.5	0.0%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	B	456.7	1.8%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	B	344.9	1.4%
NsC	Neshaminy and Montalto very stony silt loams 0 to 15 percent slopes	C	380.2	1.5%
NsD	Neshaminy and Montalto very stony silt loams, 15 to 25 percent slopes	C	185.5	0.7%
NsE	Neshaminy and Montalto very stony silt loams, 25 to 45 percent slopes	B	18.5	0.1%
Sa	Sand and gravel pits	A	93.5	0.4%
W	Water		124.9	0.5%
WaA	Watchung silt loam, 0 to 3 percent slopes	C/D	20.4	0.1%
WaB	Watchung silt loam, 3 to 8 percent slopes	C/D	56.7	0.2%
WcB	Watchung very stony silt loam, 0 to 8 percent slopes	C/D	209.9	0.8%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
WhB	Whiteford silt loam, 3 to 8 percent slopes	C	518.9	2.0%
WhC2	Whiteford silt loam, 8 to 15 percent slopes, moderately eroded	C	223.4	0.9%
Subtotals for Soil Survey Area			**25,388.7**	**100.0%**
Totals for Area of Interest			**25,392.2**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CeB	Chester silt loam, 3 to 8 percent slopes	B	0.6	0.0%
GbB	Glenelg channery loam, 3 to 8 percent slopes	B	0.3	0.0%
GbC	Glenelg channery silt loam, 8 to 15 percent slopes	B	1.3	0.0%
MOB	Mt. Airy and Manor soils, 3 to 8 percent slopes	C	0.3	0.0%
MOD	Mt. Airy and Manor soils, 15 to 25 percent slopes	C	1.0	0.0%
Subtotals for Soil Survey Area			**3.5**	**0.0%**
Totals for Area of Interest			**25,392.2**	**100.0%**

Rating Options—Hydrologic Soil Group (Broad Creek Watershed)

Aggregation Method: Dominant Condition

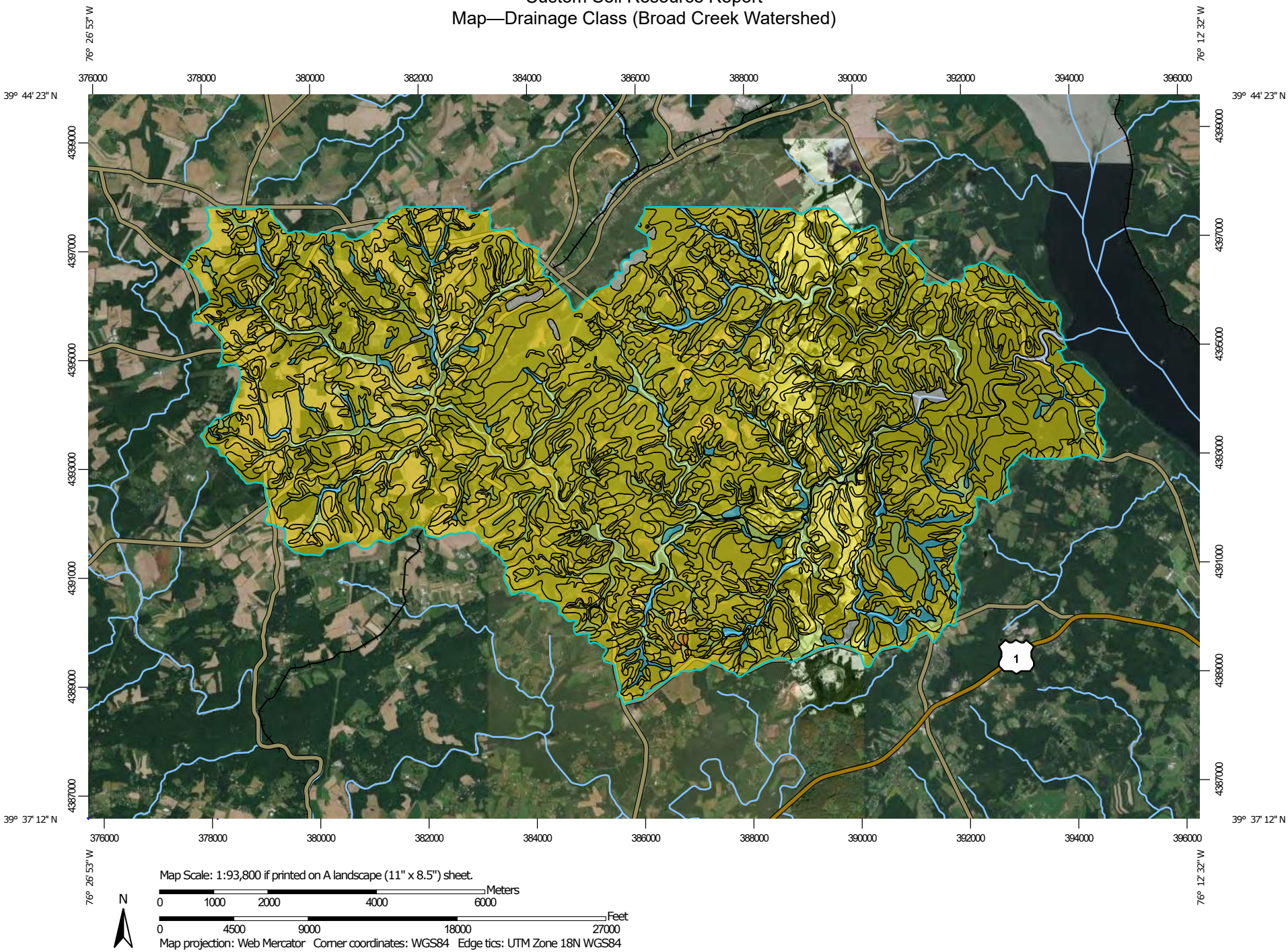
Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Drainage Class (Broad Creek Watershed)

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Map—Drainage Class (Broad Creek Watershed)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Soil Rating Lines

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Soil Rating Points

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- 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 scales ranging from 1:15,800 to 1:24,000.

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: Harford County Area, Maryland
Survey Area Data: Version 13, Sep 13, 2019

Soil Survey Area: York County, Pennsylvania
Survey Area Data: Version 14, Sep 17, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jun 29, 2011—Jul 25, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Drainage Class (Broad Creek Watershed)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Aldino silt loam, 0 to 3 percent slopes	Moderately well drained	2.4	0.0%
AdB	Aldino silt loam, 3 to 8 percent slopes	Moderately well drained	170.3	0.7%
AdC	Aldino silt loam, 8 to 15 percent slopes	Moderately well drained	21.1	0.1%
AsB	Aldino very stony silt loam, 0 to 8 percent slopes	Moderately well drained	63.0	0.2%
BaA	Baile silt loam, 0 to 3 percent slopes	Poorly drained	142.0	0.6%
BaB	Baile silt loam, 3 to 8 percent slopes	Poorly drained	21.9	0.1%
BrC2	Brandywine gravelly loam, 8 to 15 percent slopes, moderately eroded	Somewhat excessively drained	9.1	0.0%
BrD3	Brandywine gravelly loam, 15 to 25 percent slopes, severely eroded	Somewhat excessively drained	5.2	0.0%
CcA	Chester silt loam, 0 to 3 percent slopes	Well drained	52.2	0.2%
CcB2	Chester silt loam, 3 to 8 percent slopes	Well drained	5,294.7	20.9%
CcC2	Chester silt loam, 8 to 15 percent slopes	Well drained	1,509.5	5.9%
CgB2	Chester gravelly silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	1,156.5	4.6%
CgC2	Chester gravelly silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	1,294.4	5.1%
CgD2	Chester gravelly silt loam, 15 to 25 percent slopes, moderately eroded	Well drained	228.2	0.9%
CrE	Chrome channery silty clay loam, 15 to 45 percent slopes	Well drained	78.5	0.3%
Cu	Codorus silt loam	Moderately well drained	1,176.8	4.6%
Cv	Comus silt loam	Well drained	171.1	0.7%
Cx	Cut and fill land		22.4	0.1%
DcA	Delanco silt loam, 0 to 3 percent slopes	Moderately well drained	3.5	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
EhB2	Elioak silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	291.8	1.1%
EhC2	Elioak silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	150.6	0.6%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	Well drained	5.8	0.0%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	Well drained	1.7	0.0%
GcB2	Glenelg loam, 3 to 8 percent slopes	Well drained	375.8	1.5%
GcC	Glenelg loam, 8 to 15 percent slopes	Well drained	735.0	2.9%
GcC3	Glenelg loam, 8 to 15 percent slopes, severely eroded	Well drained	38.4	0.2%
GcD	Glenelg loam, 15 to 25 percent slopes	Well drained	260.2	1.0%
GcD3	Glenelg loam, 15 to 25 percent slopes, severely eroded	Well drained	56.8	0.2%
GgB2	Glenelg channery loam, 3 to 8 percent slopes	Well drained	563.5	2.2%
GgC2	Glenelg gravelly loam, 8 to 15 percent slopes, moderately eroded	Well drained	1,181.5	4.7%
GgC3	Glenelg gravelly loam, 8 to 15 percent slopes, severely eroded	Well drained	71.2	0.3%
GgD2	Glenelg gravelly loam, 15 to 25 percent slopes, moderately eroded	Well drained	519.1	2.0%
GgD3	Glenelg gravelly loam, 15 to 25 percent slopes, severely eroded	Well drained	212.1	0.8%
GnA	Glenville silt loam, 0 to 3 percent slopes	Moderately well drained	437.1	1.7%
GnB	Glenville silt loam, 3 to 8 percent slopes	Moderately well drained	578.0	2.3%
Hb	Hatboro silt loam	Poorly drained	345.9	1.4%
HcA	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	Poorly drained	16.6	0.1%
KeB	Kelly silt loam, 3 to 8 percent slopes	Moderately well drained	21.5	0.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
KeC2	Kelly silt loam, 8 to 15 percent slopes, moderately eroded	Moderately well drained	50.8	0.2%
KfD	Kelly very stony silt loam, 3 to 25 percent slopes	Well drained	66.4	0.3%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	39.8	0.2%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	49.0	0.2%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Well drained	195.3	0.8%
LeE	Legore silt loam, 25 to 45 percent slopes	Well drained	72.6	0.3%
LfC	Legore very stony silt loam, 0 to 15 percent slopes	Well drained	64.4	0.3%
LfD	Legore very stony silt loam, 15 to 25 percent slopes	Well drained	112.1	0.4%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Well drained	153.9	0.6%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Well drained	13.4	0.1%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Well drained	25.4	0.1%
MbB2	Manor loam, 3 to 8 percent slopes, moderately eroded	Well drained	83.1	0.3%
MbC	Manor loam, 8 to 15 percent slopes	Well drained	321.5	1.3%
MbD	Manor loam, 15 to 25 percent slopes	Well drained	55.4	0.2%
McB2	Manor channery loam, 3 to 8 percent slopes, moderately eroded	Well drained	80.0	0.3%
McC2	Manor channery loam, 8 to 15 percent slopes, moderately eroded	Well drained	660.5	2.6%
McC3	Manor channery loam, 8 to 15 percent slopes, severely eroded	Well drained	74.4	0.3%
McD2	Manor channery loam, 15 to 25 percent slopes, moderately eroded	Well drained	708.7	2.8%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
McD3	Manor channery loam, 15 to 25 percent slopes, severely eroded	Well drained	370.6	1.5%
MdE	Manor very stony loam, 25 to 45 percent slopes	Well drained	484.0	1.9%
MfE	Manor soils, 25 to 45 percent slopes	Well drained	776.5	3.1%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Well drained	303.8	1.2%
MgD	Manor and Glenelg very stony loams, 15 to 25 percent slopes	Well drained	342.1	1.3%
MsA	Montalto silt loam, 0 to 3 percent slopes	Well drained	4.5	0.0%
MsB2	Montalto silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	268.9	1.1%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	89.4	0.4%
NeA	Neshaminy silt loam, 0 to 3 percent slopes	Well drained	3.5	0.0%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	456.7	1.8%
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	344.9	1.4%
NsC	Neshaminy and Montalto very stony silt loams 0 to 15 percent slopes	Well drained	380.2	1.5%
NsD	Neshaminy and Montalto very stony silt loams, 15 to 25 percent slopes	Well drained	185.5	0.7%
NsE	Neshaminy and Montalto very stony silt loams, 25 to 45 percent slopes	Well drained	18.5	0.1%
Sa	Sand and gravel pits		93.5	0.4%
W	Water		124.9	0.5%
WaA	Watchung silt loam, 0 to 3 percent slopes	Poorly drained	20.4	0.1%
WaB	Watchung silt loam, 3 to 8 percent slopes	Poorly drained	56.7	0.2%
WcB	Watchung very stony silt loam, 0 to 8 percent slopes	Poorly drained	209.9	0.8%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
WhB	Whiteford silt loam, 3 to 8 percent slopes	Well drained	518.9	2.0%
WhC2	Whiteford silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	223.4	0.9%
Subtotals for Soil Survey Area			**25,388.7**	**100.0%**
Totals for Area of Interest			**25,392.2**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CeB	Chester silt loam, 3 to 8 percent slopes	Well drained	0.6	0.0%
GbB	Glenelg channery loam, 3 to 8 percent slopes	Well drained	0.3	0.0%
GbC	Glenelg channery silt loam, 8 to 15 percent slopes	Well drained	1.3	0.0%
MOB	Mt. Airy and Manor soils, 3 to 8 percent slopes	Somewhat excessively drained	0.3	0.0%
MOD	Mt. Airy and Manor soils, 15 to 25 percent slopes	Somewhat excessively drained	1.0	0.0%
Subtotals for Soil Survey Area			**3.5**	**0.0%**
Totals for Area of Interest			**25,392.2**	**100.0%**

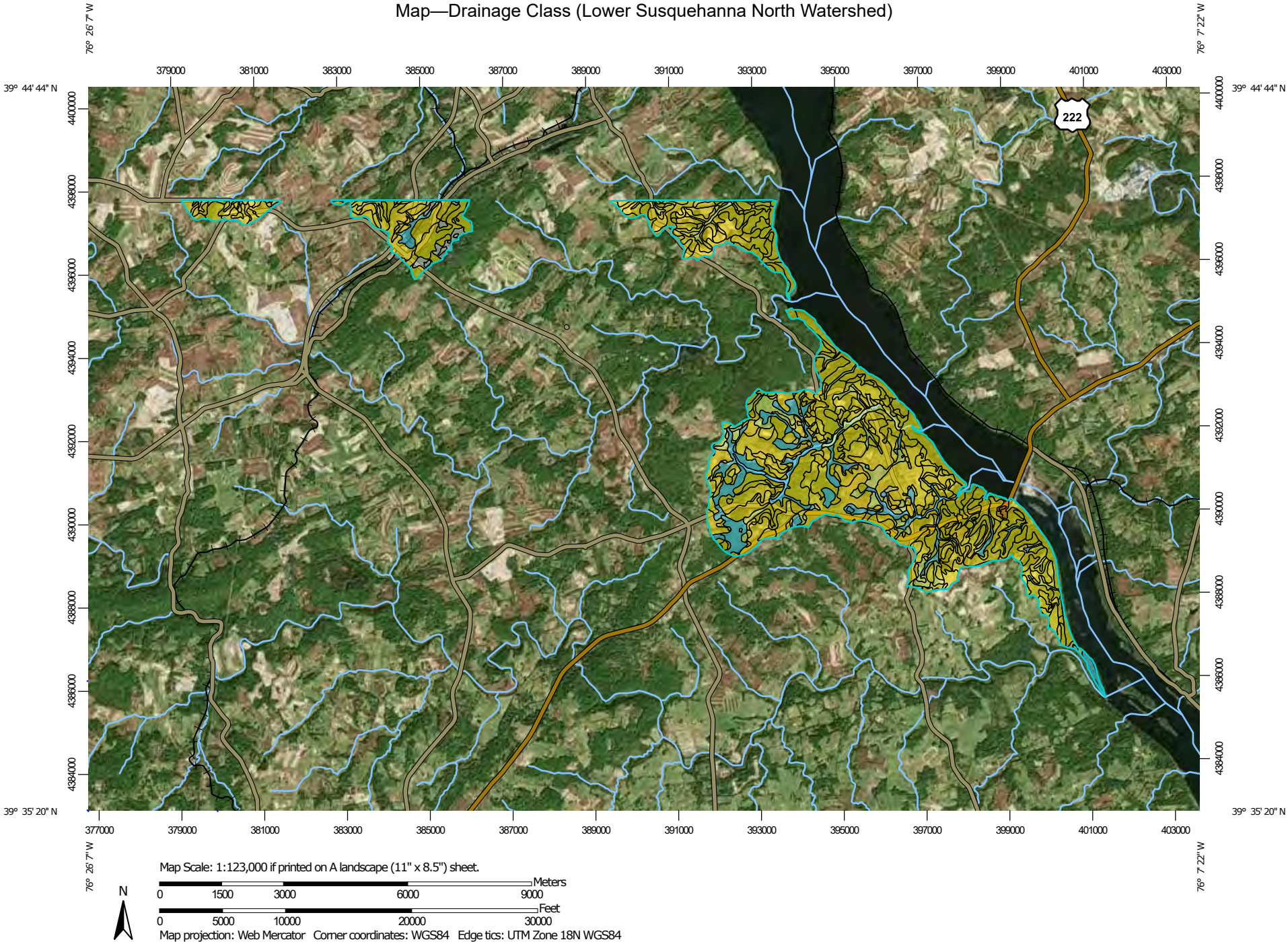
Rating Options—Drainage Class (Broad Creek Watershed)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Map—Drainage Class (Lower Susquehanna North Watershed)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Soil Rating Lines

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Soil Rating Points

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- 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 scales ranging from 1:15,800 to 1:24,000.

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: Harford County Area, Maryland
Survey Area Data: Version 13, Sep 13, 2019

Soil Survey Area: York County, Pennsylvania
Survey Area Data: Version 14, Sep 17, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jun 29, 2011—Jul 25, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Drainage Class (Lower Susquehanna North Watershed)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Aldino silt loam, 0 to 3 percent slopes	Moderately well drained	4.9	0.1%
AdB	Aldino silt loam, 3 to 8 percent slopes	Moderately well drained	371.4	4.4%
AdC	Aldino silt loam, 8 to 15 percent slopes	Moderately well drained	49.6	0.6%
AsB	Aldino very stony silt loam, 0 to 8 percent slopes	Moderately well drained	26.0	0.3%
BaA	Baile silt loam, 0 to 3 percent slopes	Poorly drained	20.4	0.2%
BaB	Baile silt loam, 3 to 8 percent slopes	Poorly drained	70.5	0.8%
BrC2	Brandywine gravelly loam, 8 to 15 percent slopes, moderately eroded	Somewhat excessively drained	7.3	0.1%
BrD3	Brandywine gravelly loam, 15 to 25 percent slopes, severely eroded	Somewhat excessively drained	14.5	0.2%
CcA	Chester silt loam, 0 to 3 percent slopes	Well drained	39.3	0.5%
CcB2	Chester silt loam, 3 to 8 percent slopes	Well drained	540.6	6.5%
CcC2	Chester silt loam, 8 to 15 percent slopes	Well drained	62.2	0.7%
CgB2	Chester gravelly silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	310.6	3.7%
CgC2	Chester gravelly silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	80.1	1.0%
CgD2	Chester gravelly silt loam, 15 to 25 percent slopes, moderately eroded	Well drained	52.9	0.6%
Cu	Codorus silt loam	Moderately well drained	82.0	1.0%
Cv	Comus silt loam	Well drained	25.2	0.3%
Cx	Cut and fill land		2.7	0.0%
EhB2	Elioak silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	20.3	0.2%
GcB2	Glenelg loam, 3 to 8 percent slopes	Well drained	33.3	0.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
GcC	Glenelg loam, 8 to 15 percent slopes	Well drained	109.4	1.3%
GcC3	Glenelg loam, 8 to 15 percent slopes, severely eroded	Well drained	5.7	0.1%
GcD	Glenelg loam, 15 to 25 percent slopes	Well drained	37.1	0.4%
GcD3	Glenelg loam, 15 to 25 percent slopes, severely eroded	Well drained	9.3	0.1%
GgB2	Glenelg channery loam, 3 to 8 percent slopes	Well drained	68.8	0.8%
GgC2	Glenelg gravelly loam, 8 to 15 percent slopes, moderately eroded	Well drained	377.3	4.5%
GgC3	Glenelg gravelly loam, 8 to 15 percent slopes, severely eroded	Well drained	39.6	0.5%
GgD2	Glenelg gravelly loam, 15 to 25 percent slopes, moderately eroded	Well drained	179.1	2.1%
GnA	Glenville silt loam, 0 to 3 percent slopes	Moderately well drained	15.8	0.2%
GnB	Glenville silt loam, 3 to 8 percent slopes	Moderately well drained	78.4	0.9%
Hb	Hatboro silt loam	Poorly drained	48.2	0.6%
HcA	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	Poorly drained	5.4	0.1%
KeB	Kelly silt loam, 3 to 8 percent slopes	Moderately well drained	5.3	0.1%
KeC2	Kelly silt loam, 8 to 15 percent slopes, moderately eroded	Moderately well drained	4.7	0.1%
KfD	Kelly very stony silt loam, 3 to 25 percent slopes	Well drained	27.1	0.3%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	6.8	0.1%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	3.7	0.0%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	Well drained	37.3	0.4%
LeE	Legore silt loam, 25 to 45 percent slopes	Well drained	7.2	0.1%
LfC	Legore very stony silt loam, 0 to 15 percent slopes	Well drained	29.1	0.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
LfD	Legore very stony silt loam, 15 to 25 percent slopes	Well drained	5.8	0.1%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	Well drained	58.2	0.7%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	Well drained	6.6	0.1%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	Well drained	21.1	0.3%
MbB2	Manor loam, 3 to 8 percent slopes, moderately eroded	Well drained	30.1	0.4%
MbD	Manor loam, 15 to 25 percent slopes	Well drained	19.8	0.2%
McB2	Manor channery loam, 3 to 8 percent slopes, moderately eroded	Well drained	43.0	0.5%
McC2	Manor channery loam, 8 to 15 percent slopes, moderately eroded	Well drained	89.2	1.1%
McD2	Manor channery loam, 15 to 25 percent slopes, moderately eroded	Well drained	170.2	2.0%
MdE	Manor very stony loam, 25 to 45 percent slopes	Well drained	97.7	1.2%
MfE	Manor soils, 25 to 45 percent slopes	Well drained	57.2	0.7%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	Well drained	34.0	0.4%
MgD	Manor and Glenelg very stony loams, 15 to 25 percent slopes	Well drained	27.8	0.3%
MsA	Montalto silt loam, 0 to 3 percent slopes	Well drained	67.8	0.8%
MsB2	Montalto silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	906.6	10.8%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	165.7	2.0%
NeA	Neshaminy silt loam, 0 to 3 percent slopes	Well drained	10.7	0.1%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	Well drained	950.3	11.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	285.0	3.4%
NsC	Neshaminy and Montalto very stony silt loams 0 to 15 percent slopes	Well drained	850.3	10.1%
NsD	Neshaminy and Montalto very stony silt loams, 15 to 25 percent slopes	Well drained	168.1	2.0%
NsE	Neshaminy and Montalto very stony silt loams, 25 to 45 percent slopes	Well drained	86.3	1.0%
Sa	Sand and gravel pits		73.7	0.9%
St	Stony land, steep	Well drained	246.7	2.9%
W	Water		19.9	0.2%
WaA	Watchung silt loam, 0 to 3 percent slopes	Poorly drained	29.9	0.4%
WaB	Watchung silt loam, 3 to 8 percent slopes	Poorly drained	133.2	1.6%
WcB	Watchung very stony silt loam, 0 to 8 percent slopes	Poorly drained	524.2	6.3%
WhB	Whiteford silt loam, 3 to 8 percent slopes	Well drained	137.1	1.6%
WhC2	Whiteford silt loam, 8 to 15 percent slopes, moderately eroded	Well drained	139.1	1.7%
Subtotals for Soil Survey Area			**8,364.4**	**99.8%**
Totals for Area of Interest			**8,380.5**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CeB	Chester silt loam, 3 to 8 percent slopes	Well drained	0.2	0.0%
Cm	Codorus silt loam	Moderately well drained	0.6	0.0%
GbB	Glenelg channery loam, 3 to 8 percent slopes	Well drained	1.6	0.0%
GbC	Glenelg channery silt loam, 8 to 15 percent slopes	Well drained	5.8	0.1%
GdA	Glenville silt loam, 0 to 3 percent slopes	Moderately well drained	0.3	0.0%
GdB	Glenville silt loam, 3 to 8 percent slopes	Moderately well drained	0.9	0.0%
MOB	Mt. Airy and Manor soils, 3 to 8 percent slopes	Somewhat excessively drained	0.3	0.0%
MOC	Mt. Airy and Manor soils, 8 to 15 percent slopes	Somewhat excessively drained	1.4	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
MOD	Mt. Airy and Manor soils, 15 to 25 percent slopes	Somewhat excessively drained	3.6	0.0%
MRF	Mt. Airy and Manor soils, 25 to 60 percent slopes, extremely stony	Somewhat excessively drained	0.3	0.0%
UfC	Urban land-Mt. Airy complex, 8 to 15 percent slopes		1.0	0.0%
Subtotals for Soil Survey Area			**16.0**	**0.2%**
Totals for Area of Interest			**8,380.5**	**100.0%**

Rating Options—Drainage Class (Lower Susquehanna North Watershed)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Hydrologic Soil Group (Lower Susquehanna North Watershed)

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.

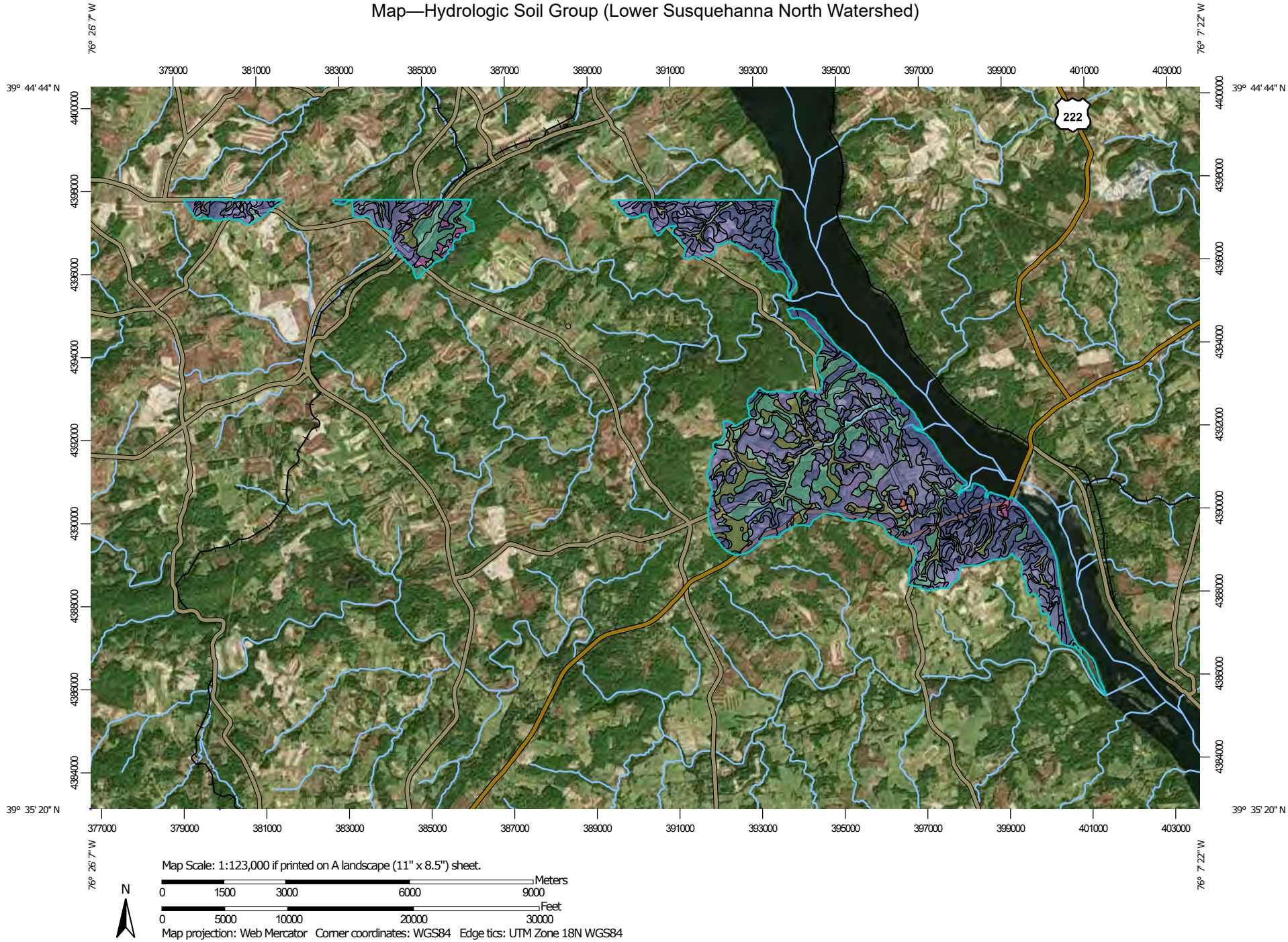
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Map—Hydrologic Soil Group (Lower Susquehanna North Watershed)



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 scales ranging from 1:15,800 to 1:24,000.

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: Harford County Area, Maryland
Survey Area Data: Version 13, Sep 13, 2019

Soil Survey Area: York County, Pennsylvania
Survey Area Data: Version 14, Sep 17, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jun 29, 2011—Jul 25, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (Lower Susquehanna North Watershed)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Aldino silt loam, 0 to 3 percent slopes	C	4.9	0.1%
AdB	Aldino silt loam, 3 to 8 percent slopes	C	371.4	4.4%
AdC	Aldino silt loam, 8 to 15 percent slopes	C	49.6	0.6%
AsB	Aldino very stony silt loam, 0 to 8 percent slopes	C	26.0	0.3%
BaA	Baile silt loam, 0 to 3 percent slopes	C/D	20.4	0.2%
BaB	Baile silt loam, 3 to 8 percent slopes	C/D	70.5	0.8%
BrC2	Brandywine gravelly loam, 8 to 15 percent slopes, moderately eroded	A	7.3	0.1%
BrD3	Brandywine gravelly loam, 15 to 25 percent slopes, severely eroded	A	14.5	0.2%
CcA	Chester silt loam, 0 to 3 percent slopes	B	39.3	0.5%
CcB2	Chester silt loam, 3 to 8 percent slopes	B	540.6	6.5%
CcC2	Chester silt loam, 8 to 15 percent slopes	B	62.2	0.7%
CgB2	Chester gravelly silt loam, 3 to 8 percent slopes, moderately eroded	B	310.6	3.7%
CgC2	Chester gravelly silt loam, 8 to 15 percent slopes, moderately eroded	B	80.1	1.0%
CgD2	Chester gravelly silt loam, 15 to 25 percent slopes, moderately eroded	B	52.9	0.6%
Cu	Codorus silt loam	C	82.0	1.0%
Cv	Comus silt loam	B	25.2	0.3%
Cx	Cut and fill land		2.7	0.0%
EhB2	Elioak silt loam, 3 to 8 percent slopes, moderately eroded	C	20.3	0.2%
GcB2	Glenelg loam, 3 to 8 percent slopes	B	33.3	0.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
GcC	Glenelg loam, 8 to 15 percent slopes	B	109.4	1.3%
GcC3	Glenelg loam, 8 to 15 percent slopes, severely eroded	B	5.7	0.1%
GcD	Glenelg loam, 15 to 25 percent slopes	B	37.1	0.4%
GcD3	Glenelg loam, 15 to 25 percent slopes, severely eroded	B	9.3	0.1%
GgB2	Glenelg channery loam, 3 to 8 percent slopes	B	68.8	0.8%
GgC2	Glenelg gravelly loam, 8 to 15 percent slopes, moderately eroded	B	377.3	4.5%
GgC3	Glenelg gravelly loam, 8 to 15 percent slopes, severely eroded	B	39.6	0.5%
GgD2	Glenelg gravelly loam, 15 to 25 percent slopes, moderately eroded	B	179.1	2.1%
GnA	Glenville silt loam, 0 to 3 percent slopes	C	15.8	0.2%
GnB	Glenville silt loam, 3 to 8 percent slopes	C/D	78.4	0.9%
Hb	Hatboro silt loam	B/D	48.2	0.6%
HcA	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	B/D	5.4	0.1%
KeB	Kelly silt loam, 3 to 8 percent slopes	D	5.3	0.1%
KeC2	Kelly silt loam, 8 to 15 percent slopes, moderately eroded	D	4.7	0.1%
KfD	Kelly very stony silt loam, 3 to 25 percent slopes	B	27.1	0.3%
LeB2	Legore silt loam, 3 to 8 percent slopes, moderately eroded	C	6.8	0.1%
LeC2	Legore silt loam, 8 to 15 percent slopes, moderately eroded	C	3.7	0.0%
LeD2	Legore silt loam, 15 to 25 percent slopes, moderately eroded	B	37.3	0.4%
LeE	Legore silt loam, 25 to 45 percent slopes	B	7.2	0.1%
LfC	Legore very stony silt loam, 0 to 15 percent slopes	B	29.1	0.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
LfD	Legore very stony silt loam, 15 to 25 percent slopes	B	5.8	0.1%
LfE	Legore very stony silt loam, 25 to 45 percent slopes	B	58.2	0.7%
LgC3	Legore silty clay loam, 8 to 15 percent slopes, severely eroded	B	6.6	0.1%
LgD3	Legore silty clay loam 15 to 25 percent slopes, severely eroded	B	21.1	0.3%
MbB2	Manor loam, 3 to 8 percent slopes, moderately eroded	B	30.1	0.4%
MbD	Manor loam, 15 to 25 percent slopes	B	19.8	0.2%
McB2	Manor channery loam, 3 to 8 percent slopes, moderately eroded	B	43.0	0.5%
McC2	Manor channery loam, 8 to 15 percent slopes, moderately eroded	B	89.2	1.1%
McD2	Manor channery loam, 15 to 25 percent slopes, moderately eroded	B	170.2	2.0%
MdE	Manor very stony loam, 25 to 45 percent slopes	B	97.7	1.2%
MfE	Manor soils, 25 to 45 percent slopes	B	57.2	0.7%
MgC	Manor and Glenelg very stony loams, 3 to 15 percent slopes	B	34.0	0.4%
MgD	Manor and Glenelg very stony loams, 15 to 25 percent slopes	B	27.8	0.3%
MsA	Montalto silt loam, 0 to 3 percent slopes	B	67.8	0.8%
MsB2	Montalto silt loam, 3 to 8 percent slopes, moderately eroded	B	906.6	10.8%
MsC2	Montalto silt loam, 8 to 15 percent slopes, moderately eroded	B	165.7	2.0%
NeA	Neshaminy silt loam, 0 to 3 percent slopes	B	10.7	0.1%
NeB2	Neshaminy silt loam, 3 to 8 percent slopes, moderately eroded	B	950.3	11.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NeC2	Neshaminy silt loam, 8 to 15 percent slopes, moderately eroded	B	285.0	3.4%
NsC	Neshaminy and Montalto very stony silt loams 0 to 15 percent slopes	C	850.3	10.1%
NsD	Neshaminy and Montalto very stony silt loams, 15 to 25 percent slopes	C	168.1	2.0%
NsE	Neshaminy and Montalto very stony silt loams, 25 to 45 percent slopes	B	86.3	1.0%
Sa	Sand and gravel pits	A	73.7	0.9%
St	Stony land, steep	B	246.7	2.9%
W	Water		19.9	0.2%
WaA	Watchung silt loam, 0 to 3 percent slopes	C/D	29.9	0.4%
WaB	Watchung silt loam, 3 to 8 percent slopes	C/D	133.2	1.6%
WcB	Watchung very stony silt loam, 0 to 8 percent slopes	C/D	524.2	6.3%
WhB	Whiteford silt loam, 3 to 8 percent slopes	C	137.1	1.6%
WhC2	Whiteford silt loam, 8 to 15 percent slopes, moderately eroded	C	139.1	1.7%
Subtotals for Soil Survey Area			**8,364.4**	**99.8%**
Totals for Area of Interest			**8,380.5**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CeB	Chester silt loam, 3 to 8 percent slopes	B	0.2	0.0%
Cm	Codorus silt loam	C	0.6	0.0%
GbB	Glenelg channery loam, 3 to 8 percent slopes	B	1.6	0.0%
GbC	Glenelg channery silt loam, 8 to 15 percent slopes	B	5.8	0.1%
GdA	Glenville silt loam, 0 to 3 percent slopes	C/D	0.3	0.0%
GdB	Glenville silt loam, 3 to 8 percent slopes	C/D	0.9	0.0%
MOB	Mt. Airy and Manor soils, 3 to 8 percent slopes	C	0.3	0.0%
MOC	Mt. Airy and Manor soils, 8 to 15 percent slopes	C	1.4	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
MOD	Mt. Airy and Manor soils, 15 to 25 percent slopes	C	3.6	0.0%
MRF	Mt. Airy and Manor soils, 25 to 60 percent slopes, extremely stony	C	0.3	0.0%
UfC	Urban land-Mt. Airy complex, 8 to 15 percent slopes		1.0	0.0%
Subtotals for Soil Survey Area			**16.0**	**0.2%**
Totals for Area of Interest			**8,380.5**	**100.0%**

Rating Options—Hydrologic Soil Group (Lower Susquehanna North Watershed)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX C

CAST

Broad Creek Watershed

	Sector	LoadSource	Allocation	Agency	Unit	Broad Creek_Amount	Broad Creek_NLoadRateEOS	Broad Creek_PLoadRateEOS	Broad Creek_SLoadRateEOS
020503061710 - Broad Creek (CBWS Portion Only)	Agriculture	Agriculture	Load Allocation	All Agencies	acres	8238.836	21.496	0.330	893.532
020503061710 - Broad Creek (CBWS Portion Only)	Agriculture	Regulated Agriculture	Waste Load Allocation	All Agencies	acres	0.018	1896.202	207.537	1536.995
020503061710 - Broad Creek (CBWS Portion Only)	Developed	Non-Regulated Developed	Load Allocation	All Agencies	acres	87.140	12.493	0.586	965.144
020503061710 - Broad Creek (CBWS Portion Only)	Developed	Regulated Developed	Waste Load Allocation	All Agencies	acres	5023.318	11.019	0.781	1290.504
020503061710 - Broad Creek (CBWS Portion Only)	Natural	Natural	Load Allocation	All Agencies	acres	12156.581	2.799	0.250	1017.315
020503061710 - Broad Creek (CBWS Portion Only)	Natural	Non-Tidal Water Deposition	Load Allocation	All Agencies	acres	262.386	8.453	0.610	0.000
020503061710 - Broad Creek (CBWS Portion Only)	Septic	Septic	Load Allocation	All Agencies	systems	2055.245	13.358	0.000	0.000
020503061710 - Broad Creek (CBWS Portion Only)	Wastewater	Wastewater	Waste Load Allocation	All Agencies	acres	0.000			
020503061710 - Broad Creek (CBWS Portion Only)	Wastewater	Wastewater-CSO	Waste Load Allocation	All Agencies	acres	0.000			

Geography	Sector	LoadSource	Allocation	Agency	Unit	2017 Progress V9_Amount	2017 Progress V9_NLoadRateEOS	2017 Progress V9_PLoadRateEOS	2017 Progress V9_SLoadRateEOS
MD-02050306 - Lower Susquehanna	Agriculture	Agriculture	Load Allocation	All Agencies	acres	51686.981	19.814	0.362	822.438
MD-02050306 - Lower Susquehanna	Agriculture	Regulated Agriculture	Waste Load Allocation	All Agencies	acres	3.897	889.227	134.154	3258.023
MD-02050306 - Lower Susquehanna	Developed	Non-Regulated Developed	Load Allocation	All Agencies	acres	963.569	10.177	0.942	1026.152
MD-02050306 - Lower Susquehanna	Developed	Regulated Developed	Waste Load Allocation	All Agencies	acres	34527.639	10.957	0.813	1315.420
MD-02050306 - Lower Susquehanna	Natural	Natural	Load Allocation	All Agencies	acres	83552.872	2.732	0.265	1114.752
MD-02050306 - Lower Susquehanna	Natural	Non-Tidal Water Deposition	Load Allocation	All Agencies	acres	6476.194	8.860	0.608	0.000
MD-02050306 - Lower Susquehanna	Septic	Septic	Load Allocation	All Agencies	systems	17485.129	13.209	0.000	0.000
MD-02050306 - Lower Susquehanna	Wastewater	Wastewater	Waste Load Allocation	All Agencies	acres	0.000			
MD-02050306 - Lower Susquehanna	Wastewater	Wastewater-CSO	Waste Load Allocation	All Agencies	acres	0.000			

APPENDIX D

Land Use and
Stream Pollutant Loadings

Sub-Watershed BC-1

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	115.45	970.935	70.425	0.000	970.935	70.425	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	7850.08	11068.613	235.502	168541.218	11068.613	235.502	168462.717
Mixed Open	968.28	1859.098	164.608	789506.464	1859.098	164.608	789506.464
Agriculture - Broad Creek	4821.22	103636.945	1591.003	4307914.349	103636.945	1591.003	4307914.349
Impervious	579.81	8343.466	463.848	1166757.461	8140.532	446.454	1117769.314
Turf	2071.30	19863.767	2257.717	1605526.769	18538.135	2050.587	1570998.198
Tree Canopy over Turf	490.11	3577.803	396.989	266364.983	3332.748	362.681	259155.465

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	16896.25	149320.63	5180.09	8304611.24	147547.01	4921.26	8213806.51
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		74.66	2.59	4152.31	73.77	2.46	4106.90

Sub-Watershed BC-2

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	3.97	33.388	2.422	0.000	33.388	2.422	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	502.33	708.285	15.070	10785.025	708.285	15.070	10780.002
Mixed Open	177.42	340.646	30.161	144662.945	340.646	30.161	144662.945
Agriculture - Broad Creek	1335.50	28707.908	440.715	1193311.986	28707.908	440.715	1193311.986
Impervious	140.70	2024.673	112.560	283132.017	1975.428	108.339	271244.274
Turf	396.34	3800.901	432.011	307215.024	3547.243	392.377	300608.036
Tree Canopy over Turf	65.19	475.887	52.804	35429.461	443.292	48.241	34470.516

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	2621.45	36091.69	1085.74	1974536.46	35756.19	1037.32	1955077.76
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		18.05	0.54	987.27	17.88	0.52	977.54

Sub-Watershed BC-3

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	1.79	15.054	1.092	0.000	15.054	1.092	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	853.00	1202.730	25.590	18313.910	1202.730	25.590	18305.380
Mixed Open	138.58	266.074	23.559	112993.975	266.074	23.559	112993.975
Agriculture - Broad Creek	471.80	10141.813	155.694	421568.398	10141.813	155.694	421568.398
Impervious	67.37	969.454	53.896	135569.325	945.875	51.875	129877.233
Turf	272.88	0.000	0.000	0.000	0.000	0.000	0.000
Tree Canopy over Turf	46.05	336.165	37.301	25027.254	313.140	34.077	24349.859

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	1851.47	12931.29	297.13	713472.86	12884.69	291.89	707094.84
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		6.47	0.15	356.74	6.44	0.15	353.55

Sub-Watershed BC-4

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	7.03	59.122	4.288	0.000	59.122	4.288	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	1967.41	2774.048	59.022	42240.293	2774.048	59.022	42220.619
Mixed Open	243.75	468.000	41.438	198746.438	468.000	41.438	198746.438
Agriculture - Broad Creek	1006.19	21629.060	332.043	899062.963	21629.060	332.043	899062.963
Impervious	138.82	1997.620	111.056	279348.874	1949.033	106.891	267619.972
Turf	545.35	5229.907	594.432	422717.146	4880.883	539.897	413626.161
Tree Canopy over Turf	116.98	853.954	94.754	63576.290	795.464	86.565	61855.515

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	4025.53	33011.71	1237.03	1905692.00	32555.61	1170.14	1883131.67
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		16.51	0.62	952.85	16.28	0.59	941.57

Sub-Watershed LS-1

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	204.64	288.542	6.139	4393.621	288.542	6.139	4391.574
Mixed Open	3.04	5.837	0.517	2478.725	5.837	0.517	2478.725
Agriculture - Lower Susquehanna North	13.36	264.715	4.836	10987.772	264.715	4.836	10987.772
Impervious	7.99	114.976	6.392	16078.357	112.180	6.152	15403.282
Turf	15.51	148.741	16.906	12022.266	138.815	15.355	11763.715
Tree Canopy over Turf	3.47	25.331	2.811	1885.876	23.596	2.568	1834.832

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	248.01	848.14	37.60	47846.62	833.68	35.57	46859.90
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		0.42	0.02	23.92	0.42	0.02	23.43

Sub-Watershed LS-2

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	8.44	70.980	5.148	0.000	70.980	5.148	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	1838.21	2591.876	55.146	39466.369	2591.876	55.146	39447.987
Mixed Open	183.36	352.051	31.171	149506.243	352.051	31.171	149506.243
Agriculture - Lower Susquehanna North	591.47	11719.387	214.112	486447.404	11719.387	214.112	486447.404
Impervious	157.66	2268.727	126.128	317260.795	2213.546	121.398	303940.101
Turf	447.79	4294.306	488.091	347095.463	4007.721	443.312	339630.803
Tree Canopy over Turf	159.30	1162.890	129.033	86576.364	1083.240	117.882	84233.061

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	3386.23	22460.22	1048.83	1426352.64	22038.80	988.17	1403205.60
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		11.23	0.52	713.18	11.02	0.49	701.60

Sub-Watershed LS-3

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	1.76	14.802	1.074	0.000	14.802	1.074	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	895.90	1263.219	26.877	19234.973	1263.219	26.877	19226.014
Mixed Open	76.58	147.034	13.019	62441.035	147.034	13.019	62441.035
Agriculture - Lower Susquehanna North	476.91	9449.495	172.641	392228.907	9449.495	172.641	392228.907
Impervious	112.82	1623.480	90.256	227028.814	1583.993	86.871	217496.652
Turf	228.60	2192.274	249.174	177194.718	2045.970	226.314	173383.956
Tree Canopy over Turf	58.27	425.371	47.199	31668.580	396.236	43.120	30811.428

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	1850.84	15115.67	600.24	909797.03	14900.75	569.92	895587.99
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		7.56	0.30	454.90	7.45	0.28	447.79

Sub-Watershed LS-4

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	0.03	0.252	0.018	0.000	0.252	0.018	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	159.19	224.458	4.776	3417.809	224.458	4.776	3416.217
Mixed Open	0.42	0.806	0.071	342.455	0.806	0.071	342.455
Agriculture - Lower Susquehanna North	2.74	54.290	0.992	2253.480	54.290	0.992	2253.480
Impervious	3.63	52.236	2.904	7304.685	50.965	2.795	6997.987
Turf	5.15	49.389	5.614	3991.920	46.093	5.099	3906.069
Tree Canopy over Turf	2.49	18.177	2.017	1353.265	16.932	1.843	1316.637

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	173.65	399.61	16.39	18663.61	393.80	15.59	18232.85
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		0.20	0.01	9.33	0.20	0.01	9.12

Sub-Watershed LS-5

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	0.02	0.168	0.012	0.000	0.168	0.012	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	280.66	395.731	8.420	6025.770	395.731	8.420	6022.964
Mixed Open	2.56	4.915	0.435	2087.347	4.915	0.435	2087.347
Agriculture - Lower Susquehanna North	31.11	616.414	11.262	25586.046	616.414	11.262	25586.046
Impervious	5.32	76.555	4.256	10705.489	74.693	4.096	10256.002
Turf	5.30	50.827	5.777	4108.189	47.435	5.247	4019.838
Tree Canopy over Turf	1.54	11.242	1.247	836.959	10.472	1.140	814.306

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	326.51	1155.85	31.41	49349.80	1149.83	30.61	48786.50
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		0.58	0.02	24.67	0.57	0.02	24.39

Sub-Watershed LS-6

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	246.39	347.410	7.392	5289.993	347.410	7.392	5287.529
Mixed Open	44.75	85.920	7.608	36487.808	85.920	7.608	36487.808
Agriculture - Lower Susquehanna North	294.93	5843.743	106.765	242561.639	5843.743	106.765	242561.639
Impervious	14.40	207.216	11.520	28977.264	202.176	11.088	27760.608
Turf	59.59	571.468	64.953	46189.997	533.331	58.994	45196.631
Tree Canopy over Turf	7.24	52.852	5.864	3934.795	49.232	5.358	3828.295

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	667.30	7108.61	204.10	363441.50	7061.81	197.20	361122.51
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		3.55	0.10	181.72	3.53	0.10	180.56

Sub-Watershed LS-7

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	1.52	12.783	0.927	0.000	12.783	0.927	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	447.43	630.876	13.423	9606.322	630.876	13.423	9601.848
Mixed Open	9.63	18.490	1.637	7852.013	18.490	1.637	7852.013
Agriculture - Lower Susquehanna North	167.14	3311.712	60.505	137462.287	3311.712	60.505	137462.287
Impervious	16.19	232.974	12.952	32579.299	227.308	12.466	31211.406
Turf	47.85	458.882	52.157	37089.971	428.258	47.372	36292.311
Tree Canopy over Turf	14.38	104.974	11.648	7815.242	97.784	10.641	7603.713

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	704.14	4770.69	153.25	232405.13	4727.21	146.97	230023.58
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		2.39	0.08	116.20	2.36	0.07	115.01

Sub-Watershed LS-8

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	11.95	100.500	7.290	0.000	100.500	7.290	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	414.57	584.544	12.437	8900.818	584.544	12.437	8896.672
Mixed Open	37.93	72.826	6.448	30926.984	72.826	6.448	30926.984
Agriculture - Lower Susquehanna North	124.21	2461.097	44.964	102155.024	2461.097	44.964	102155.024
Impervious	76.51	1100.979	61.208	153961.838	1074.200	58.913	147497.508
Turf	90.08	863.867	98.187	69823.710	806.216	89.179	68322.077
Tree Canopy over Turf	31.32	228.636	25.369	17021.794	212.976	23.177	16561.076

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	786.57	5412.45	255.90	382790.17	5312.36	242.41	374359.34
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		2.71	0.13	191.40	2.66	0.12	187.18

Sub-Watershed LS-9

Land Use	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Water	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Non-Tidal Floodplain Wetland	0.00	0.000	0.000	0.000	0.000	0.000	0.000
True Forest	56.86	80.173	1.706	1220.784	80.173	1.706	1220.216
Mixed Open	14.53	27.898	2.470	11847.326	27.898	2.470	11847.326
Agriculture - Lower Susquehanna North	94.12	1864.894	34.071	77407.865	1864.894	34.071	77407.865
Impervious	13.99	201.316	11.192	28152.217	196.420	10.772	26970.202
Turf	49.57	475.376	54.031	38423.194	443.652	49.074	37596.862
Tree Canopy over Turf	8.91	65.043	7.217	4842.407	60.588	6.593	4711.341

	Acres	No Action TN (lb/yr)	No Action TP (lb/yr)	No Action TSS (lb/yr)	2017 Progress TN (lb/yr)	2017 Progress TP (lb/yr)	2017 Progress TSS (lb/yr)
Totals	237.98	2714.70	110.69	161893.79	2673.62	104.69	159753.81
		(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)	(ton/yr)
		1.36	0.06	80.95	1.34	0.05	79.88

BMP-1

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0	0	0	0
Non-Tidal Floodplain Wetland	0	0	0	0
True Forest	0.27	0.3807	0.0081	5.7942
Mixed Open	0.39	0.7488	0.0663	317.9943
Agriculture - Lower Susquehanna North	0.95	18.8233	0.3439	781.3161
Impervious	3.54	49.7016	2.7258	6824.4828
Turf	2.5	22.375	2.475	1896.15
Tree Canopy over Turf	0.53	3.604	0.3922	280.2481

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	8.18	95.63	6.01	10105.99
		(ton/yr)	(ton/yr)	(ton/yr)
		0.05	0.00	5.05

BMP-2

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0	0	0	0
Non-Tidal Floodplain Wetland	0	0	0	0
True Forest	0	0	0	0
Mixed Open	0.02	0.0384	0.0034	16.3074
Agriculture - Lower Susquehanna North	0	0	0	0
Impervious	1.13	15.8652	0.8701	2178.4366
Turf	0.36	3.222	0.3564	273.0456
Tree Canopy over Turf	0.03	0.204	0.0222	15.8631

[redacted]

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1.54	19.33	1.25	2483.65
		(ton/yr)	(ton/yr)	(ton/yr)
		0.01	0.00	1.24

BMP-3

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0	0	0	0
Non-Tidal Floodplain Wetland	0	0	0	0
True Forest	0.01	0.0141	0.0003	0.2146
Mixed Open	0.01	0.0192	0.0017	8.1537
Agriculture - Broad Creek	0	0	0	0
Impervious	0.65	9.126	0.5005	1253.083
Turf	0.18	1.611	0.1782	136.5228
Tree Canopy over Turf	0.01	0.068	0.0074	5.2877

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	0.86	10.84	0.69	1403.26
		(ton/yr)	(ton/yr)	(ton/yr)
		0.01	0.00	0.70

BMP-4

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0	0	0	0
Non-Tidal Floodplain Wetland	0	0	0	0
True Forest	0.12	0.1692	0.0036	2.5752
Mixed Open	0.06	0.1152	0.0102	48.9222
Agriculture - Lower Susquehanna North	0	0	0	0
Impervious	0.87	12.2148	0.6699	1677.2034
Turf	0.56	5.012	0.5544	424.7376
Tree Canopy over Turf	0.21	1.428	0	111.0417

[redacted]

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	1.82	18.94	1.24	2264.48
		(ton/yr)	(ton/yr)	(ton/yr)
		0.01	0.00	1.13

BMP-5

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0	0	0	0
Non-Tidal Floodplain Wetland	0	0	0	0
True Forest	0.06	0.0846	0.0018	1.2876
Mixed Open	0.00	0	0	0
Agriculture - Broad Creek	0.12	2.57952	0.0396	107.22384
Impervious	2.03	28.5012	1.5631	3913.4746
Turf	0.86	0	0	0
Tree Canopy over Turf	0.01	0.068	0.0074	5.2877

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	3.08	31.23	1.61	4027.27
		(ton/yr)	(ton/yr)	(ton/yr)
		0.02	0.00	2.01

BMP-6

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0	0	0	0
Non-Tidal Floodplain Wetland	0	0	0	0
True Forest	2.92	4.1172	0.0876	62.6632
Mixed Open	0.10	0.192	0.017	81.537
Agriculture - Broad Creek	2.39	51.37544	0.7887	2135.541
Impervious	1.04	14.6016	0.8008	2004.933
Turf	0.72	6.444	0.7128	546.0912
Tree Canopy over Turf	0.02	0.136	0.0148	10.5754

[redacted]

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	7.19	76.87	2.42	4841.34
		(ton/yr)	(ton/yr)	(ton/yr)
		0.04	0.00	2.42

BMP-7

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0	0	0	0
Non-Tidal Floodplain Wetland	0	0	0	0
True Forest	0.38	0.5358	0.0114	8.1548
Mixed Open	3.55	6.816	0.6035	2894.5635
Agriculture - Lower Susquehanna	0.94	18.62516	0.34028	773.09172
Impervious	3.04	42.6816	2.3408	5860.5728
Turf	2.45	21.9275	2.4255	1858.227
Tree Canopy over Turf	0.15	1.02	0.111	79.3155

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	10.51	91.61	5.83	11473.93
		(ton/yr)	(ton/yr)	(ton/yr)
		0.05	0.00	5.74

BMP-8

Land Use	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Water	0	0	0	0
Non-Tidal Floodplain Wetland	0	0	0	0
True Forest	0.02	0.0282	0.0006	0.4292
Mixed Open	0.22	0.4224	0.0374	179.3814
Agriculture - Lower Susquehanna	0.39	7.72746	0.14118	320.75082
Impervious	2.3	32.292	1.771	4433.986
Turf	1.59	14.2305	1.5741	1205.9514
Tree Canopy over Turf	0.09	0.612	0.0666	47.5893

	Acres	2017 Progress TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)
Totals	4.61	55.31	3.59	6188.09
		(ton/yr)	(ton/yr)	(ton/yr)
		0.03	0.00	3.09

APPENDIX E

Field Sheets

Project Name: Francis Silver Park – 0333-01-2006			
Site No. 1	Address: 2124 Shuresville Rd Darlington, MD		
Date Built:	Imp Credits:	Property Owners: Harford County	Contact Info:

Access (including staging/stockpiling):

- access off of parking lot
- open grassy fields for staging/stockpiling
- large parking lot can be used for staging/stockpiling as well

Utilities:

Constructability:

Other Notes:

- dry channel
- channel piped through embankments

Project Name: Darlington Volunteer Fire Dept (SWM0313)			
Site No. 2	Address: 2600 Castleton Rd Darlington, MD		
Date Built: 1999	Imp Credits:	Property Owners: Darlington Volunteer Fire Company	Contact Info:

Access (including staging/stockpiling):

- large parking lot off of fire department
- located in front of fire department in way of fire truck route
- curb only around inlet

Utilities:

- power lines
- light pole

Constructability:

- good potential project

Other Notes:

- volunteer firefighter said BMP gets filled with trash
- lots of frogs and cattails
- has a riser

Project Name:	Conowingo Visitors Center - 0F000755/0F000756		
Site No. 3	Address: 4948 Conowingo Rd Conowingo, MD		
Date Built:	Imp Credits:	Property Owners: PECO Energy Power company	Contact Info:

Access (including staging/stockpiling):

- curbed parking lot can be used for staging/stockpiling
- gate blocks sidewalk/channel

Utilities:

Constructability:

- very steep channel next to sidewalk
- channel appears to be in good condition

Other Notes:

- outfall flows into concrete channel

Project Name: 333-3-2004 - Susquehanna River			
Site No. 4	Address: near 2505 Castleton Rd Darlington, MD		
Date Built:	Imp Credits:	Property Owners: multiple (private)	Contact Info:

Access (including staging/stockpiling):
- guardrails next to road
- fairly large paved ~~/gravel~~ area next to driveway

Utilities:
- power lines

Constructability:

Other Notes:
- stream in excellent condition
- good floodplain access
- lots of established vegetation

Project Name: 333-1-2004 - Peddler Run			
Site No. 5	Address: near 3631 Dublin Rd Darlington, MD		
Date Built:	Imp Credits:	Property Owners: multiple (private), Harford County	Contact Info:

Access (including staging/stockpiling):

- guardrails on either side of road
- no shoulder on road
- two dirt driveways on either side of stream

Utilities:

- power lines

Constructability:

Other Notes:

- no stream visible near Emma Rockey Park
- some bank erosion (most likely due to mowed lawn and few amount of trees)

Project Name: BROA-105-R-2003			
Site No. 6	Address: near 3624 Scarboro Rd Dublin, MD		
Date Built:	Imp Credits:	Property Owners: multiple (private)	Contact Info:

Access (including staging/stockpiling):

- busy road with wide shoulder
- next to farm field
- guardrails on either side of road

Utilities:

- power lines

Constructability:

Other Notes:

- ~~lo~~ lots of vegetation
- large pool before road crossing causing some bank erosion

Project Name: HA-P-138-302-97			
Site No. 7	Address: 1801 Robinson Mill Rd Darlington, MD		
Date Built:	Imp Credits:	Property Owners: Boy Scouts of America	Contact Info:

Access (including staging/stockpiling):

Utilities:

Constructability:

Other Notes:

- did not visit - not accessible

Project Name: BRDA-101-R-2003 - Deep Creek			
Site No. 8	Address: near 4140 Prospect Rd Dublin, MD		
Date Built:	Imp Credits:	Property Owners: multiple (private)	Contact Info:

Access (including staging/stockpiling):

- guardrails on either side of road
- no shoulder on road
- stockpile area on front yard of private resident or pasture area

Utilities:

- power lines

Constructability:

- potential stream restoration project

Other Notes:

- 3 pipes cross under road
- pool is eroding private resident's yard
- large bamboo patch
- some sediment deposition evident in stream

Project Name: BRDA-107-R-2003 - Carr Run			
Site No. 9	Address: near 1426 Ridge Rd Whiteford, MD		
Date Built:	Imp Credits:	Property Owners: multiple (private)	Contact Info:

Access (including staging/stockpiling):

- on private property
- stream located between two driveways
- narrow road - no shoulder

Utilities:

- power lines

Constructability:

- potential stream restoration project

Other Notes:

- some evidence of streambank erosion
- steep channel

Project Name:	SWM0236 - Harford County Public Library		
Site No.	Address:		
10	2407 Whiteford Rd Whiteford, MD		
Date Built:	Imp Credits:	Property Owners:	Contact Info:
unknown		Harford County	

Access (including staging/stockpiling):

- library parking lot can be used for staging/ stockpiling

Utilities:

- power lines next to Whiteford Rd

Constructability:

- appears to be in good shape

Other Notes:

- ITCE: infiltration complete

Project Name:	SWM0067 - Whiteford High's		
Site No. 11	Address: 2420 Whiteford Rd Whiteford, MD		
Date Built: 1993	Imp Credits:	Property Owners: Thompson M. Graham	Contact Info:

Access (including staging/stockpiling):

- located between gas station and The Mill of Whiteford
- parking lots could be used for access
- wooden/metal fence around BMP (w/ a gate)
- curb and gutter on gas station side
- large gravel area behind gas station parking lot

Utilities:

- power lines

Constructability:

- good potential project

Other Notes:

- not visually appealing
- wetland area is white in color?

Project Name:	OF000702 channel		
Site No. 12	Address: behind 1606 Main St Whiteford, MD		
Date Built:	Imp Credits:	Property Owners: private	Contact Info:

Access (including staging/stockpiling):

- gravel parking lot

Utilities:

- power lines

Constructability:

- appears to be in good condition

Other Notes:

- lots of vegetation

Project Name:	342-1-2005 - Scott Creek		
Site No. 13	Address: near 1603 Dooley Rd Whiteford, MD		
Date Built:	Imp Credits:	Property Owners: Whiteford Gregory Scott	Contact Info:

Access (including staging/stockpiling):

- guardrail on side of road
- busy road with wide shoulder

Utilities:

- power lines

Constructability:

Other Notes:

- waterfall out of outfall into eroded pool
- dense vegetation

Project Name: SWM0250 - Whiteford Volunteer Fire Company			
Site No. 14	Address: 1407 Pylesville Rd Whiteford, MD		
Date Built: 2000	Imp Credits:	Property Owners: Whiteford Volunteer Fire Company	Contact Info:

Access (including staging/stockpiling):

- wooden fence surrounding w/ metal gate
- behind fire department

Utilities:

- electrical box? speaker system?

Constructability:

- good potential project

Other Notes:

- dry pond
- well maintained
- ~~[illegible]~~ riser
- emergency spillway

Project Name: [New Site]			
Site No. 14b	Address: near 4042 Heaps School Rd Whiteford, MD		
Date Built:	Imp Credits:	Property Owners: private	Contact Info:

Access (including staging/stockpiling):

- next to farm field
- guardrail

Utilities:

- power lines

Constructability:

Other Notes:

- well vegetated

Project Name: Whiteford Maintenance Shop			
Site No. 15	Address: 1405 Pylesville Rd Whiteford, MD		
Date Built:	Imp Credits:	Property Owners: Harford County	Contact Info:

Access (including staging/stockpiling):

Utilities:

Constructability:

Other Notes:

-did not visit - not accessible

Project Name:			
0F000719 channel			
Site No.	**Address:**		
16	4042 Grande View Dr Pylesville, MD		
Date Built:	**Imp Credits:**	**Property Owners:**	**Contact Info:**
		private	

Access (including staging/stockpiling):

Utilities:

Constructability:

Other Notes:

- did not visit - not accessible

Project Name: Highland Park			
Site No. 17	Address: 718 Highland Rd Street, MD		
Date Built:	Imp Credits:	Property Owners: Harford County	Contact Info:

Access (including staging/stockpiling):

- access off of parking lot
- open grassy fields for staging/stockpiling
- parking lot can be used for staging/stockpiling as well

Utilities:

Constructability:

Other Notes:

- dry channel

Project Name:	0F000410 Channel		
Site No. 18	Address: 4102 Bell Farm Rd Pylesville, MD		
Date Built:	Imp Credits:	Property Owners: private	Contact Info:

Access (including staging/stockpiling):

Utilities:

Constructability:

Other Notes:

-did not visit - not accessible

Project Name:	0F000411 channel		
Site No.	Address:		
19	4106 Bell Farm Rd Pylesville, MD		
Date Built:	Imp Credits:	Property Owners:	Contact Info:
		private	

Access (including staging/stockpiling):

Utilities:

Constructability:

Other Notes:

-did not visit- not accessible

Project Name: SWM0032 and North Harford Elementary/Middle School Stream			
Site No. 20	Address: 120 Pylesville Rd Pylesville, MD		
Date Built: 1997	Imp Credits:	Property Owners: Board of Education; Martin Brothers LLC	Contact Info:

Access (including staging/stockpiling):

- open fields
- old access road still present
- metal fence in front of stream

Utilities:

- light poles
- sanitary sewer

Constructability:

- good potential project

Other Notes:

- 2 pipe outfalls flow into pond
- then one pipe flows into stream
- has a riser
- eroded dry channel flowing into pond
- eroded wet channel flowing out of pond (eroded banks >5ft high in places)
- headcut 30 ft upstream of facility

Project Name: 0341-93-2008 - Jack's Hole			
Site No. 22	Address: 4937 Rocks Rd Pylesville, MD		
Date Built:	Imp Credits:	Property Owners: private (multiple)	Contact Info:

Access (including staging/stockpiling):

- farm fields could be used for staging/stockpiling

Utilities:

- power lines

Constructability:

Other Notes:

- dry channel
- highly vegetated

Project Name:	SWM00389 - Lands of Richard Crouse		
Site No. 23	Address: Rte 1 & Rte 623 (Castleton Rd) Darlington, MD		
Date Built: 2002	Imp Credits:	Property Owners: Lands of Richard Crouse	Contact Info:

Access (including staging/stockpiling):

- gravel parking lot for staging/stockpiling
- large grassy area

Utilities:

- power lines/telephone wires running along road

Constructability:

Other Notes:

- very large pond area - 3 separate marshy areas
- riser structure
- well vegetated w/ trees
- Harley Davidson store next door

Project Name:	Deep Creek		
Site No.	Address:		
24	1780 Deep Run Rd Whiteford, MD		
Date Built:	Imp Credits:	Property Owners:	Contact Info:
		multiple (private)	

Access (including staging/stockpiling):

- 1809 Deep Run Rd ford crossing (driveway)
- 3932 Tabernacle Rd ford crossing (road)
- stream runs alongside roads - easy to access

Utilities:

- power line along Deep Run Rd

Constructability:

- stream appears stable at Tabernacle Rd

Other Notes:

- no floodplain access
- bamboo patch (Cooper Rd + Deep Run Rd)
- bank erosion - stream running along Cooper Rd
- private properties - some have stairs to stream for access
- undercut banks - exposed roots

Project Name: SWM00387 - Integrated community Shop Center			
Site No. 25	Address: 1610 Dooley Rd Whiteford, MD		
Date Built: 2002	Imp Credits:	Property Owners: Tomran Inc.	Contact Info:

Access (including staging/stockpiling):

- very steep slope off parking lot
- grocery store parking lot ~~of~~ or grassy area near pond for staging/stockpiling

Utilities:

- sanitary sewer

Constructability:

- convert from dry to wet pond?

Other Notes:

- dry
- "pond" is mowed
- extended detention dry pond
- can see pipe from riser structure
- riser structure has orifice
- PVC clean out
- drains into small pond

Project Name:	Pylesville/Wheeler stream		
Site No.	Address:		
26	532 Pylesville Rd Pylesville, MD		
Date Built:	Imp Credits:	Property Owners:	Contact Info:
		multiple (private)	

Access (including staging/stockpiling):

- dirt road off of Wheeler School Rd (711?) downstream side
- grassy area on private property on upstream side

Utilities:

- power lines

Constructability:

- very small channel on next bend of Wheeler School Rd

Other Notes:

- very large pool and eroding banks - downstream side near 711? Wheeler School Rd
- very tight bend going into upstream side near 711? Wheeler School Rd - eroding banks
- firepit and small cabin off of dirt road near 711? Wheeler School Rd
- private properties
- very large pool on downstream side of Pylesville Rd, then multiple channels come together

Project Name:	Broad Creek		
Site No. 27	Address: 4400 Graceton Rd Pylesville, MD		
Date Built:	Imp Credits:	Property Owners: Martin Brothers LLC	Contact Info:

Access (including staging/stockpiling):

- farm land next to stream
- road has small shoulder

Utilities:

- power lines
- transmission lines

Constructability:

- stream appears to be in stable condition

Other Notes:

- sand bags in river next to road crossing
- transmission line facility near stream
- slightly eroded near road crossing

Project Name: 341-4-2005 - Jack's Hole			
Site No. 21	Address: near 4900 Rocks Rd Pylesville, MD		
Date Built:	Imp Credits:	Property Owners: multiple (private)	Contact Info:

Access (including staging/stockpiling):

-dirt road off main road

Utilities:

-power lines

Constructability:

Other Notes:

- stream runs through farm fields
- pipe above water surface
- larger pool ~~above~~ in before road crossing
- some evidence of bank erosion

Project Name:	SWM0031 - North Harford Middle School		
Site No. 28	Address: 120 Pylesville Rd Pylesville, MD		
Date Built: unknown	Imp Credits:	Property Owners: Board of Education	Contact Info:

Access (including staging/stockpiling):

- large grassy fields next to school

Utilities:

Constructability:

Other Notes:

- dry pond appears to now be where a soccer field is located

Project Name:	~~[illegible]~~ Trenton Bone Fertilizer Co.		
Site No. 29	Address: 2425 Whiteford Rd/ Whiteford, MD		
Date Built:	Imp Credits:	Property Owners: Trenton Bone Fertilizer Co; Whiteford Packing Co. Inc.	Contact Info:

Access (including staging/stockpiling):

- grassy area next to channel for staging/ stockpiling

Utilities:

- power lines

Constructability:

- potential stream restoration project

Other Notes:

- originates at an outfall off of Whiteford Rd.
- upstream section of channel is concrete lined
- natural channel bank heights ~ 4 ft high

Project Name:			
Backyard Boys Inc.			
Site No.	**Address:**		
30	2501 Whiteford Rd / Whiteford, MD		
Date Built:	**Imp Credits:**	**Property Owners:**	**Contact Info:**
		EAW Realty LLC	

Access (including staging/stockpiling):

- large paved and gravel parking lots for staging/stockpiling

Utilities:

- power lines

Constructability:

- potential new BMP project

Other Notes:

Project Name:	~~SWAMPOOCK~~ Slate Ridge American Legion		
Site No. 31	Address: 2217 Whiteford Rd / Whiteford, MD		
Date Built:	Imp Credits:	Property Owners: Slate Ridge American Legion	Contact Info:

Access (including staging/stockpiling):

- paved parking lot
- gravel drive and grassy area for staging/stockpiling

Utilities:

- power lines

Constructability:

- potential new BMP project

Other Notes:

Project Name:			
Conestoga Wood			
Site No.	Address:		
32	3502 Hughes Rd / Darlington, MD		
Date Built:	Imp Credits:	Property Owners: Laird Land and Lease LLC	Contact Info:

Access (including staging/stockpiling):

- large gravel parking lot for staging/stockpiling

Utilities:

- power lines

Constructability:

- potential new BMP project

Other Notes:

- inlet in parking lot drains to outfall

Project Name:	SWM0582 - Jerusalem Evangelical Lutheran Church		
Site No. 33	Address: 717 Wheeler School Rd / Whiteford, MD		
Date Built: unknown	Imp Credits:	Property Owners: Enfield Richard H Etal	Contact Info:

Access (including staging/stockpiling):

- large grassy areas for staging/stockpiling

Utilities:

- light poles

Constructability:

Other Notes:

- inlet in parking lot drains to pond
- riser structure
- extended detention pond

APPENDIX F

Pollutant Removal and Impervious Area Computation

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. BMP-1 Treatment	ST		8.18	3.54	43.3%	95.6	6.0	5.1	26	41	52	0.300	0.150	0.50	24.9	2.5	2.6	1.77
Pr. BMP-1 Total Treatment	ST		8.18	3.54	43.3%	95.6	6.0	5.1	33	52	66	0.300	0.300	1.00	31.6	3.1	3.3	3.54
Additional Treatment and Credit	**ST**		**8.18**	**3.54**	**43.3%**	**95.6**	**6.0**	**5.1**	**26**	**41**	**52**	**0.300**	**0.150**	**0.50**	**6.7**	**0.7**	**0.7**	**1.77**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Pr. BMP-2 Treatment	ESD		1.54	1.13	73.4%	19.3	1.3	1.2	72	85	90	0.091	0.237	2.60	13.9	1.1	1.1	1.58

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Pr. BMP-3 Treatment	ESD		0.86	0.65	75.6%	10.8	0.7	0.7	72	85	90	0.052	0.136	2.60	7.8	0.6	0.6	0.91

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. BMP-4 Treatment	ESD		1.82	0.87	47.8%	18.9	1.2	1.1	44.5	52	56	0.073	0.037	0.50	8.4	0.6	0.6	0.44
Pr. BMP-4 Total Treatment	ESD		1.82	0.87	47.8%	18.9	1.2	1.1	57	66	70	0.073	0.073	1.00	10.8	0.8	0.8	0.87
Additional Treatment and Credit	**ESD**		**1.82**	**0.87**	**47.8%**	**18.9**	**1.2**	**1.1**	**44.5**	**52**	**56**	**0.073**	**0.037**	**0.50**	**2.4**	**0.2**	**0.2**	**0.44**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. BMP-5 Treatment	ST		2.82	2.03	72.0%	31.2	1.6	2.0	26	41	52	0.164	0.082	0.50	8.1	0.7	1.0	1.02
Pr. BMP-5 Total Treatment	ST		2.82	2.03	72.0%	31.2	1.6	2.0	33	52	66	0.164	0.164	1.00	10.3	0.8	1.3	2.03
Additional Treatment and Credit	**ST**		**2.82**	**2.03**	**72.0%**	**31.2**	**1.6**	**2.0**	**26**	**41**	**52**	**0.164**	**0.082**	**0.50**	**2.2**	**0.2**	**0.3**	**1.02**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Pr. BMP-6 Treatment	ESD		7.19	1.04	14.5%	76.9	2.4	2.4	72	85	90	0.120	0.312	2.60	55.3	2.1	2.2	1.46

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. BMP-7 Treatment	ST		10.51	3.04	28.9%	91.6	5.8	5.7	26	41	52	0.272	0.136	0.50	23.8	2.4	3.0	1.52
Pr. BMP-7 Total Treatment	ST		10.51	3.04	28.9%	91.6	5.8	5.7	33	52	66	0.272	0.272	1.00	30.2	3.0	3.8	3.04
Additional Treatment and Credit	**ST**		**10.51**	**3.04**	**28.9%**	**91.6**	**5.8**	**5.7**	**26**	**41**	**52**	**0.272**	**0.136**	**0.50**	**6.4**	**0.6**	**0.8**	**1.52**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
Ex. BMP-8 Treatment	ST		4.61	2.30	49.9%	55.3	3.6	3.1	26	41	52	0.192	0.096	0.50	14.4	1.5	1.6	1.15
Pr. BMP-8 Total Treatment	ST		4.61	2.30	49.9%	55.3	3.6	3.1	33	52	66	0.192	0.192	1.00	18.3	1.9	2.0	2.30
Additional Treatment and Credit	**ST**		**4.61**	**2.30**	**49.9%**	**55.3**	**3.6**	**3.1**	**26**	**41**	**52**	**0.192**	**0.096**	**0.50**	**3.9**	**0.4**	**0.4**	**1.15**

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
SR-1	SR-NCP	2500.00							0.075	0.068	0.0225				187.5	170.0	56.3	75.00

Notes:
-Type: ESD=Environmental Site Design; ST=Structural; SR-CP=Stream Restoration Coastal Plain; SR-NCP=Stream Restoration Non-Coastal Plain; SLM=Shoreline Management; RIMPV=Reforestation of Impervious Area; RPERV=Reforestation of Pervious Area; IR=Impervious Area Reduction; VSS=Vacuum Street Sweeping
-Provided WQv only applies to ESD and ST practices, do not insert a value for alternative BMPs.
-For RIMPV, IR, and VSS, the Drainage Area and Impervious Area must be equal.

BMP	TYPE	Stream/ Shoreline Length	Drainage Area	Impervious Area	Impervious Area	Direct Annual Pollutant Loads			BMP Pollutant Removal Rate			Target DA WQv	Provided WQv	Rainfall Depth Treated	Proposed Annual Pollutant Load Removal			Impervious Area Treated
						TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	
		ft	Acres	Acres	%	lbs/yr	lbs/yr	tons/yr	% or per LF	% or per LF	% or per LF	ac-ft	ac-ft	inches	lbs/yr	lbs/yr	tons/yr	Acres
SR-2	SR-NCP	925.00							0.075	0.068	0.0225				69.4	62.9	20.8	27.75

Lower Bynum Run Watershed Study

HARFORD COUNTY DPW

LOWER BYNUM RUN

SMALL WATERSHED ASSESSMENT REPORT

DECEMBER 13, 2019

LOWER BYNUM RUN

SMALL WATERSHED ASSESSMENT REPORT

HARFORD COUNTY DEPARTMENT OF PUBLIC WORKS

DATE: DECEMBER 2019

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1 EXECUTIVE SUMMARY

A watershed study was conducted in the Lower Bynum Run watershed in Harford County and the Town of Bel Air, Maryland, in response to Harford County's National Pollutant Discharge Elimination System (NPDES) MS4 permit requirements. The Lower Bynum Run watershed is a subshed of the larger 8-digit Bynum Run watershed (02-13-07-04). It also includes the small mid-western portion of the Bush River watershed (02-13-07-01). Flow from the Lower Bynum Run watershed drains to Bush Creek and eventually reaches Chesapeake Bay. The goals of this study were to assess the current physical conditions of the Lower Bynum Run watershed, including the current land use, soils, and impervious area; conduct a field survey of the streams, outfalls, and best management practices (BMPs) within the watershed; and provide potential restoration projects to meet pollutant reduction requirements within the County. The watershed study resulted in the identification of 32 potential restoration projects.

The Lower Bynum Run watershed is an urban watershed that covers portions of the Town of Bel Air and Harford County and encompasses approximately 9,746 acres. The Lower Bynum Run watershed is contained within the Bush River sub-basin draining to the Chesapeake Bay and is located on the western side of the Bynum Run watershed. The Lower Bynum Run watershed includes the Upper Farnandis Branch watershed. Since a prior watershed study was performed on the Upper Farnandis Branch, it was not assessed during the Lower Bynum Run watershed assessment. The remaining watershed was divided into eight subwatersheds to facilitate assessment and classification and encompasses approximately 9,262 acres.

Land use, soils, and impervious area are three existing conditions that were assessed at the onset of this project. The majority of the soil within the watershed (nearly 60%) falls into hydrologic soil group B which has a moderate infiltration rate and a relatively low runoff potential.

The predominant land use types present within the Lower Bynum Run watershed are low- and medium-density residential, forest, and agriculture. These four land use classifications equate to 83% of the total watershed area. The remaining 17% is divided between commercial, open urban land, very low-density residential, high-density residential, barren land, water and wetlands, transportation, and institutional, each covering less than 6% of the total watershed. Due to the high percentage of residential land use within the watershed, the impervious area was a significant portion of the watershed. The total impervious area calculated is 1,322 acres or 14.3% of the watershed. Stream watersheds with 10% or more impervious area have a higher potential for negative impacts because of the high percentage of impervious area. The subwatershed with the highest percentage of impervious cover is Main Stem Bynum (MSB) 6, with 23.2% impervious area.

An NPDES MS4 permit has been issued to Harford County that mandates restoration of pollutant laden streams from stormwater sources. The permit requires Harford County to treat 20% of the impervious area by the end of the permitting period (December 29, 2019). Impervious area is treated through stream restoration, outfall stabilization, and BMP stormwater management facilities.

This watershed study assessed 15.5 miles of stream, 79 outfalls, 65 existing BMPs, and 11 potential BMPs. Of the assessed features, 17 stream and outfall restoration projects, thirteen retrofit BMP projects, and

two proposed BMP projects are being recommended within the Lower Bynum Run watershed. Table 1-1 provides the list of potential projects and a description. If implemented, these projects would provide 861 acres of impervious area treatment, 2,988 lbs of nitrogen reductions, 1,997 lbs of phosphorus reductions, and 1,310,395 lbs of sediment reductions. Refer to Appendix B and Appendix C for a detailed summary of each potential project

Table 1-1: List of Potential Restoration Projects in the Lower Bynum Run Watershed

PROJECT NAME	PROJECT DESCRIPTION
SWM0554	Wet Pond Retrofit
SWM000118	Submerged Gravel Wetland
SWM000257	Submerged Gravel Wetland
SWM000287	Submerged Gravel Wetland
SWM000312	Submerged Gravel Wetland
SWM000342	Submerged Gravel Wetland
SWM000347	Submerged Gravel Wetland
SWM000415	Submerged Gravel Wetland
SWM000428	Submerged Gravel Wetland
SWM000472	Submerged Gravel Wetland
SWM000622	Submerged Gravel Wetland
SWM000683	Submerged Gravel Wetland
SWM000685	Submerged Gravel Wetland
BMP-PR2-4	Bioretention
BMP-PR2-7	Bioretention
MSB-2A Stream Restoration	2,220 feet of stream restoration
MSB-2B Stream Restoration	1,160 feet of stream restoration
MSB-2C Outfall Stabilization	1 outfall stabilization
MSB-4A Stream Restoration	2,385 feet of stream restoration
MSB-4B Stream and Outfall Restoration	2,440 feet of stream restoration and 1 outfall stabilization
MSB-4C Stream Restoration	1,296 feet of stream restoration
MSB-4D Stream and Outfall Restoration	2,105 feet of stream restoration and 2 outfall stabilization
MSB-4E Stream and Outfall Restoration	3,325 feet of stream restoration and 1 outfall stabilization
MSB-4F Outfall Stabilization	1 outfall stabilization
MSB-4G Outfall Stabilization	1 outfall stabilization
MSB-5A Stream Restoration	2,058 feet of stream restoration
MSB-5B Stream Restoration	1,327 feet of stream restoration
MSB-5C Stream and Outfall Restoration	3,236 feet of stream restoration and 2 outfall stabilization
MSB-5D Stream and Outfall Restoration	3,354 feet of stream restoration and 3 outfall stabilization
MSB-5E Stream Restoration	743 feet of stream restoration
MSB-5F Outfall Stabilization	1 outfall stabilization
MSB-6A Stream Restoration	2,649 feet of stream restoration

2 WATERSHED CHARACTERISTICS

The Lower Bynum Run watershed includes the southern end of the Bynum Run watershed and a small mid-west portion of the Bush River watershed, which will collectively be referred to as the Lower Bynum Run watershed. The Lower Bynum Run watershed is an urban watershed that covers portions of the Town of Bel Air and Harford County and encompasses approximately 9,746 acres. The information presented in this report summarizes the basic watershed elements including water quality, natural resources, and restoration.

2.1 WATERSHED DELINEATION

A watershed-based approach was used to evaluate water quality conditions and improvement potential within the watershed. The first step in this process determines watershed drainage area. Drainage areas vary greatly in size depending on the scale of the stream system of interest. Drainage areas for large rivers, estuaries, and lake systems are typically on the order of several thousand square miles and are often referred to as basins. The Chesapeake Bay basin covers over 64,000 square miles, which includes over 100,000 tributaries and spans across portions of six different states (CBP, 2017). Basins are comprised of smaller sub-basins, which refer to drainage areas on the order of several hundred square miles and may consist of one or more major stream networks. Maryland has 13 sub-basins including the Upper Western Shore sub-basin, which encompasses the study area for this report. Sub-basins are further subdivided into watersheds and then subwatersheds, which are the most commonly used and practical hydrologic units for management and restoration purposes.

There are 138 state-defined watersheds (called 8-digit watersheds) in Maryland, ranging in size from 20 to 100 square miles, and these are comprised of over 1,100 subwatersheds (called 12-digit watersheds) identified by the Maryland Department of Natural Resources (DNR). A subwatershed refers to the drainage area of a specific stream and typically covers 10 square miles or less (DNR, 2005). The Lower Bynum Run watershed is contained within the 8-digit Bynum Run watershed (02-13-07-04) and Bush River watershed (02-13-07-01), which are located in Harford County, Figure 2-1 The Lower Bynum Run watershed boundary for this study has been delineated based on GIS contours, roadways, and storm drain network data. For this reason, the watershed differs slightly from the Maryland 8-digit watershed boundaries. The Lower Bynum Run watershed was subdivided into smaller drainage areas or subwatersheds, which are listed in Table 2-1 with respective drainage areas in acreage and square miles. In addition to characterizing the entire watershed, analyses were conducted on a subwatershed scale to provide detailed information for smaller areas. Success of restoration efforts can be more easily monitored on this smaller scale.

Figure 2-2 shows the 9 subwatersheds in the Lower Bynum Run watershed, including Upper Farnandis. The Upper Farnandis subwatershed was already assessed in the Upper Farnandis Small Watershed Assessment Report and is therefore excluded from this analysis of the Lower Bynum Run watershed (Harford County, 2019).

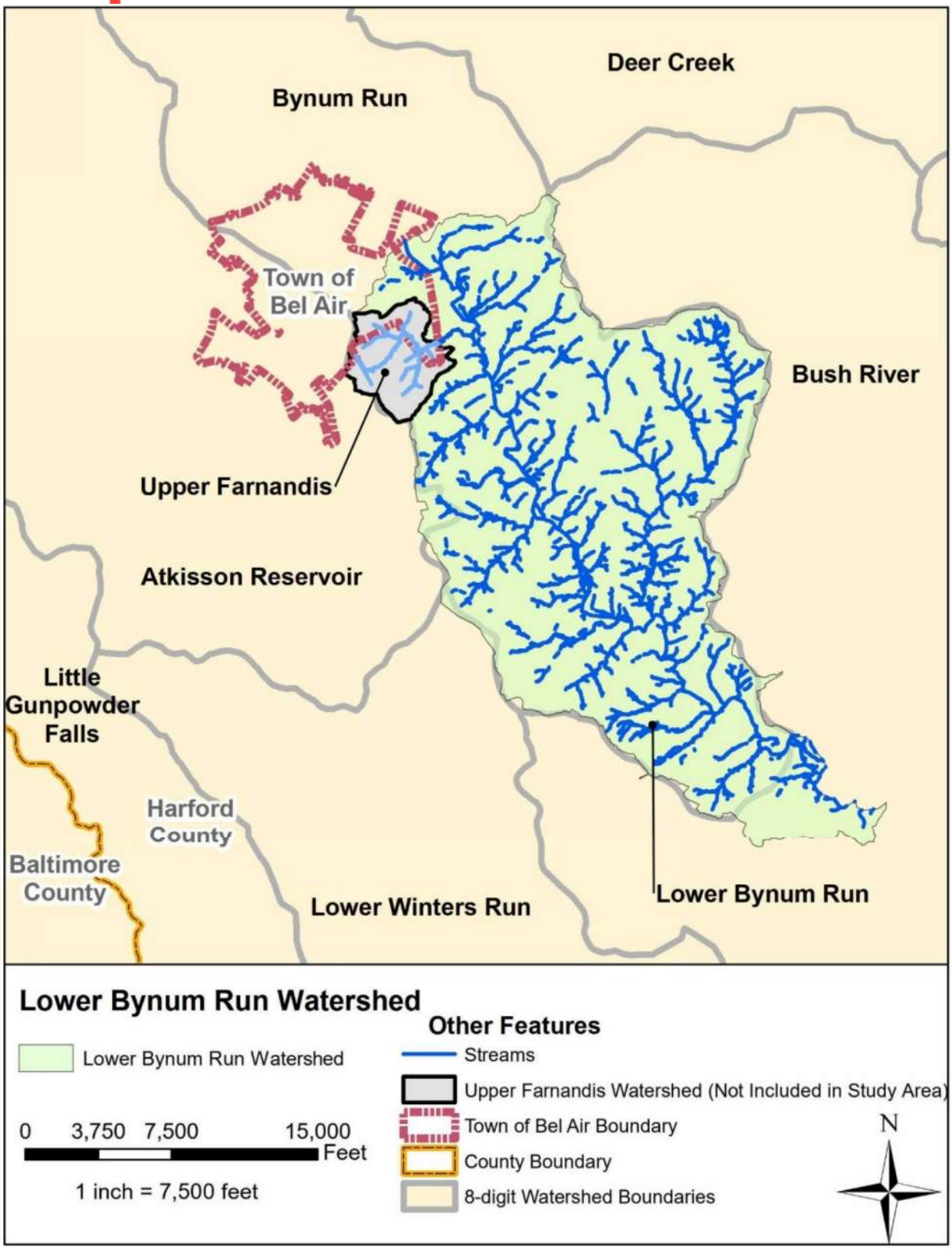

Figure 2-1. Location of Lower Bynum Run Watershed

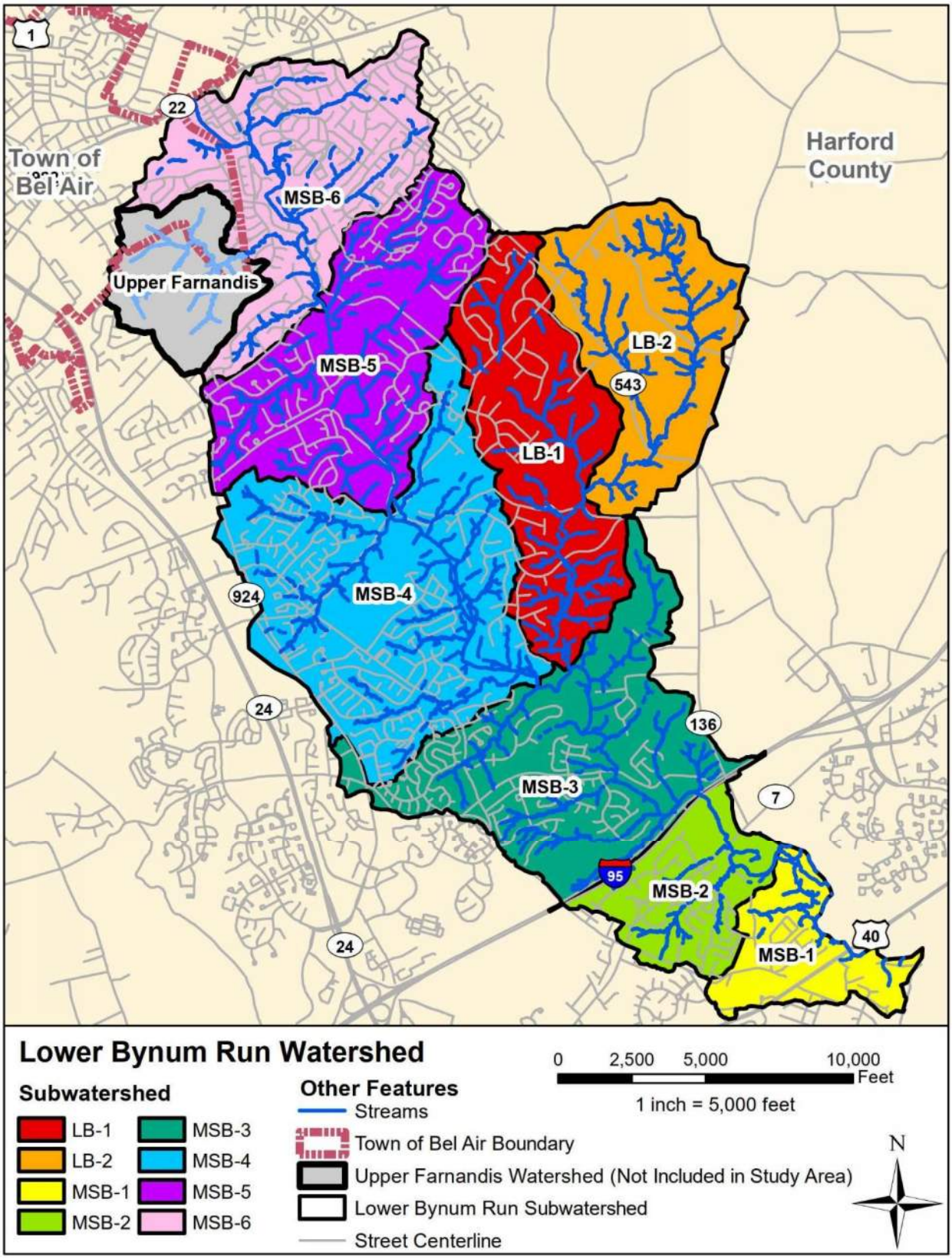

Figure 2-2: Lower Bynum Run Subwatersheds

Table 2-1: Lower Bynum Run Subwatershed Areas

Subwatershed	Subwatershed Code	Area (acres)	Area (sq miles)
Little Bynum 1	LB-1	1,167	1.82
Little Bynum 2	LB-2	1,067	1.67
Main Stem Bynum 1	MSB-1	451	0.7
Main Stem Bynum 2	MSB-2	554	0.86
Main Stem Bynum 3	MSB-3	1,487	2.32
Main Stem Bynum 4	MSB-4	1,896	2.96
Main Stem Bynum 5	MSB-5	1,346	2.1
Main Stem Bynum 6	MSB-6	1,294	2.02
Total		**9,262**	**14.45**

2.2 HYDROLOGIC SOIL GROUPS

Soil characteristics are an important consideration when evaluating water quantity and quality in streams and rivers. Soil type and moisture content impact how land may be used and its potential for vegetation and habitat. Soil conditions are also evaluated for projects aimed at improving water quality and habitat. Soils data including hydrologic soil groups (HSG) and soil erodibility for the Lower Bynum Run watershed was obtained from spatial data provided by the NRCS SSURGO database (USDA, 2017).

The NRCS classifies soils into four HSGs based on their runoff potential and infiltration rates. Soils with high runoff potential have low infiltration capacity and tend to cause overland flow instead of allowing stormwater to infiltrate. Infiltration rates are highly variable among soil types and are influenced by disturbances to the soil profile such as land development activities. For example, urbanization on land composed of high infiltration soils (such as sands and gravels) will greatly increase runoff from the pre-development runoff rate. Whereas development on land composed of low infiltration soils (such as silts and clays) will have less of an impact on runoff.

The four HSGs range from A to D, lowest runoff potential to highest, respectively. Brief descriptions of each hydrologic soil group are provided below. Further explanation can be found in Chapter 7 of the USDA/NRCS publication, *National Engineering Handbook- Hydrology Chapters* (USDA & NRCS, 2009).

Group A soils include sand, loamy sand, or sandy loam types. These soils have low runoff potential when thoroughly wet and a high infiltration rate. This type of soil generally consists of sands and gravels, typically have less than 10 percent clay, and have gravel or sand textures. These soils have a high rate of water transmission.

Group B soils include well aggregated loam, silt loam, or sandy clay loam. These soils have a moderately low runoff potential when thoroughly wet. These soils generally contain between 10 to 20 percent clay and 50 to 90 percent sand with a loamy sand or sandy loam texture. Water transmission through these soils is moderate.

Group B/D soils are wet Group B soils, including well aggregated loam, silt loam, or sandy clay loam. These wet soils are placed in a dual category due to the presence of a water table within 24 inches of the

surface. The first letter refers to the drained condition while the second letter describes the undrained condition. Only wet soils that can be adequately drained are placed into dual categories.

Group C soils include silt loam, sandy clay loam, clay loam, and silty clay loam textures. These soils have a moderately high runoff potential when thoroughly wet. This soil typically contains between 20 to 40 percent clay and less than 50 percent sand. Water transmission through these soils is low and somewhat restricted.

Group C/D soils are wet Group C soils, including silt loam, sandy loam, clay loam, and silty clay loam. These wet soils are placed in a dual category due to the presence of a water table within 24 inches of the surface. The first letter refers to the drained condition while the second letter describes the undrained condition. Only wet soils that can be adequately drained are placed into dual categories.

Group D soils include clayey textures. These soils have high runoff potential when thoroughly wet. These soils generally contain greater than 40 percent clay and less than 50 percent sand. These consist mainly of clays with high swell potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. Water transmission through this soil is very restricting with very low infiltration rates.

As shown in Table 2-2 and Figure 2-3, the Lower Bynum Run subwatersheds possess similar HSG characteristics. Nearly 60% of the Lower Bynum Run watershed falls into hydrologic soil group B which has a moderate infiltration rate and therefore, relatively low runoff potential. Approximately, 24% of the watershed falls into hydrologic soil group C, with relatively low infiltration potential. Most of the remaining soil types are split between hydrologic soil group A, B/D, C/D, and D, based on their saturated hydraulic conductivity and the water table depth when drained as discussed above. Six percent of the watershed falls into soil group C/D, while roughly 5% of the watershed falls into soil group B/D. A small portion of the MSB-1, MSB-2, and MSB-3 areas fall into the D soil group (low infiltration, high runoff potential), representing about 2% of the total watershed area. Hydrologic soil group A (high infiltration potential, low runoff potential) represents less than 4% of the total watershed area. As seen Figure 2-3, areas classified as soil group B cover the vast extent of the watershed. The other soil groups found in the watershed are almost exclusively located adjacent to major streams where higher water table depths would be expected or in very urbanized areas.

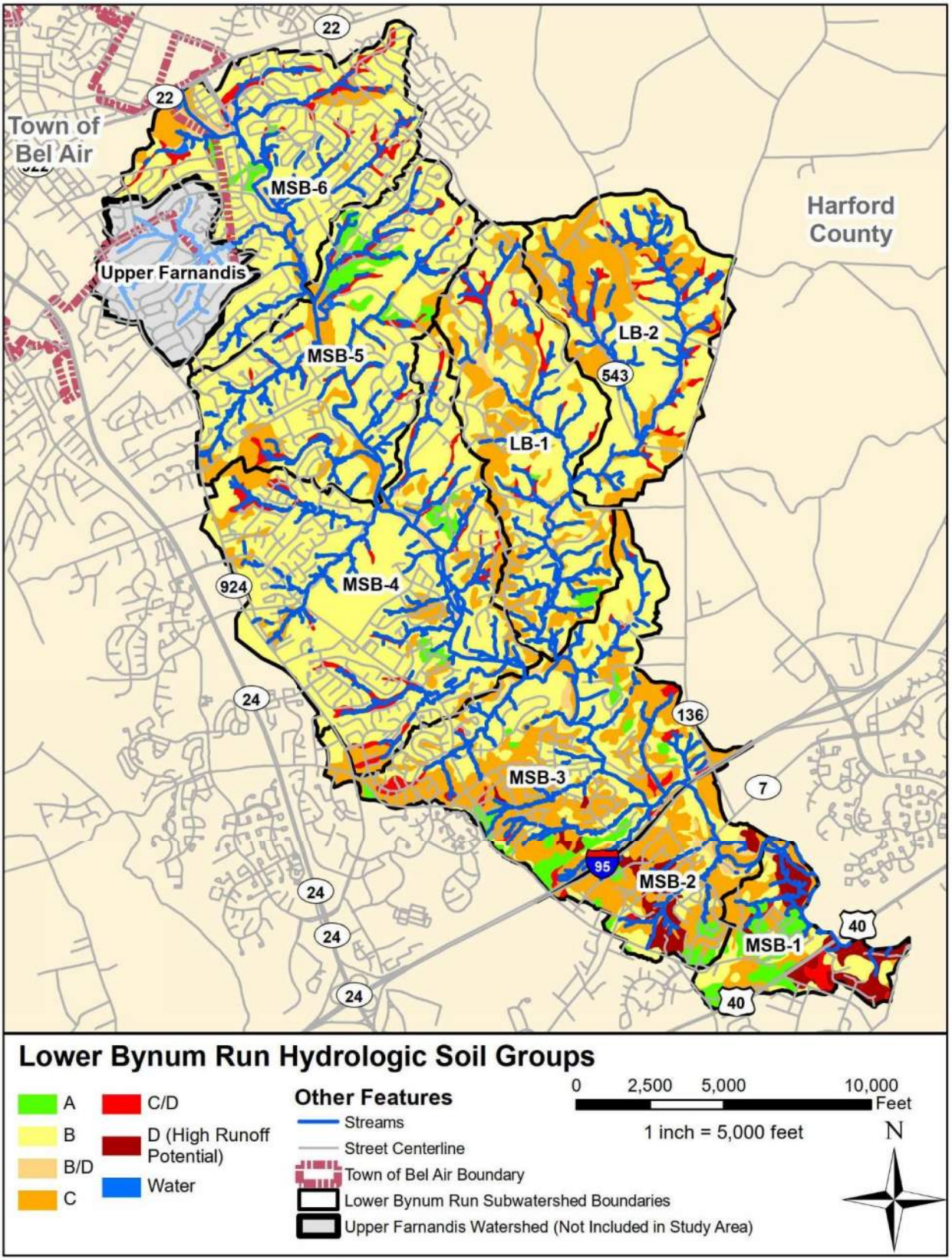

Figure 2-3. Lower Bynum Run Hydrologic Soil Groups

Table 2-2: Lower Bynum Run Hydrologic Soil Groups

	Hydrologic Soil Group (%)						
Subwatershed	**A**	**B**	**B/D**	**C**	**C/D**	**D**	**Water**
LB-1	0.9%	56.4%	8.4%	29.1%	5.0%	0.0%	0.2%
LB-2	0.0%	53.2%	5.3%	33.8%	7.6%	0.0%	0.1%
MSB-1	20.8%	21.9%	1.0%	24.0%	3.9%	27.5%	0.9%
MSB-2	6.3%	19.9%	5.6%	52.2%	0.8%	14.0%	1.3%
MSB-3	5.2%	42.2%	5.5%	41.5%	3.7%	0.9%	1.0%
MSB-4	1.5%	73.5%	5.2%	12.3%	6.8%	0.0%	0.7%
MSB-5	5.6%	71.9%	1.6%	12.9%	7.1%	0.0%	0.8%
MSB-6	1.6%	74.2%	8.3%	6.8%	8.4%	0.0%	0.7%
% of Watershed Area	**3.7%**	**58.1%**	**5.4%**	**23.8%**	**5.9%**	**2.3%**	**0.7%**

2.3 LAND USE AND LAND COVER

Land use represents the types of human activities taking place within a watershed and has pronounced impacts on water quality and habitat. The extent of these impacts, including types and amounts of pollutants generated, will vary depending on the land uses that are present in the watershed. For example, a forested watershed has the ability to absorb pollutants such as sediment and nutrients and to reduce the flow rate of runoff into streams. Developed areas have impervious surfaces that block the natural infiltration of precipitation into the ground. These impervious surfaces include roads, parking lots, and roofs. Unlike most natural surfaces, impervious surfaces tend to concentrate stormwater runoff, accelerate flow rates, and direct stormwater to the nearest stream. This behavior can cause bank erosion and destruction of the in-stream and riparian habitat of the receiving water body. Impervious areas also prevent infiltration which would otherwise filter pollutants and recharge groundwater aquifers that help to maintain baseflow in a stream channel. For these reasons, undeveloped watersheds and those with smaller amounts of impervious surfaces tend to have higher water quality in local streams than developed watersheds with greater impervious coverage.

Maryland Department of Planning (MDP) develops statewide land use/land cover (LU/LC) spatial data to provide a general overview of predominant land cover and usage and to monitor development activities throughout the state. The LU/LC delineations are based on high altitude aerial photography and satellite imagery. In this report, land use analyses were performed using 2010 MDP land use spatial data. This data was originally based on the 2007 National Agriculture Imagery Program (NAIP) aerial imagery and parcel information from Maryland Property View 2008. Figure 2-4 and Table 2-3 summarize land use categories and their percent composition in each subwatershed.

The predominant land use types present within the Lower Bynum Run watershed are medium- and low-density residential, forest, and agriculture. These four land use classifications equate to nearly 83% of the total watershed area. The remaining 17% is divided between high- and very low- density residential, commercial, barren, water/wetland, open urban land, transportation, and institutional, each covering

less than 6% of the total watershed. Although a small percentage, these areas cover approximately 1,565 acres of the watershed.

The distribution of predominant land use type is fairly consistent between the subwatersheds within Lower Bynum Run watershed as either medium- and low-density residential or forest. LB-2 is the one exception, with a predominantly agricultural subwatershed. Residential areas present an opportunity for community involvement in restoration efforts, neighborhood pollutant source control, and environmental stewardship.

Table 2-3: Lower Bynum Run Land Use/Land Cover Classification (%)

Subwatershed	High Density Residential	Medium Density Residential	Low Density Residential	Very Low Density Residential	Forest	Open Urban Land	Agriculture	Barren	Water / Wetland	Commercial	Institutional	Transportation
LB 1	0.0%	2.2%	39.7%	1.1%	36.0%	1.8%	17.7%	0.9%	0.6%	0.0%	0.0%	0.0%
LB 2	0.0%	0.8%	14.9%	3.3%	19.8%	0.0%	61.2%	0.0%	0.0%	0.0%	0.0%	0.0%
MSB 1	2.8%	24.3%	19.4%	2.8%	30.3%	0.0%	0.0%	0.0%	12.2%	5.5%	0.0%	2.7%
MSB 2	5.0%	38.4%	11.1%	1.1%	23.9%	0.0%	12.4%	0.4%	0.0%	0.6%	2.3%	4.8%
MSB 3	1.5%	28.6%	7.9%	1.3%	31.3%	0.7%	18.9%	0.2%	0.0%	6.8%	0.5%	2.3%
MSB 4	6.6%	30.3%	20.0%	2.9%	22.0%	3.6%	8.9%	0.0%	0.0%	4.1%	1.7%	0.0%
MSB 5	7.9%	26.8%	28.1%	1.0%	14.8%	13.8%	4.3%	0.0%	0.0%	0.3%	3.1%	0.0%
MSB 6	17.9%	50.2%	13.4%	0.5%	7.3%	3.1%	0.0%	0.2%	0.0%	1.1%	6.1%	0.0%
Total % of Watershed Area	**5.2%**	**25.2%**	**19.3%**	**1.8%**	**23.2%**	**2.9%**	**15.4%**	**0.2%**	**1.6%**	**2.3%**	**1.7%**	**1.2%**

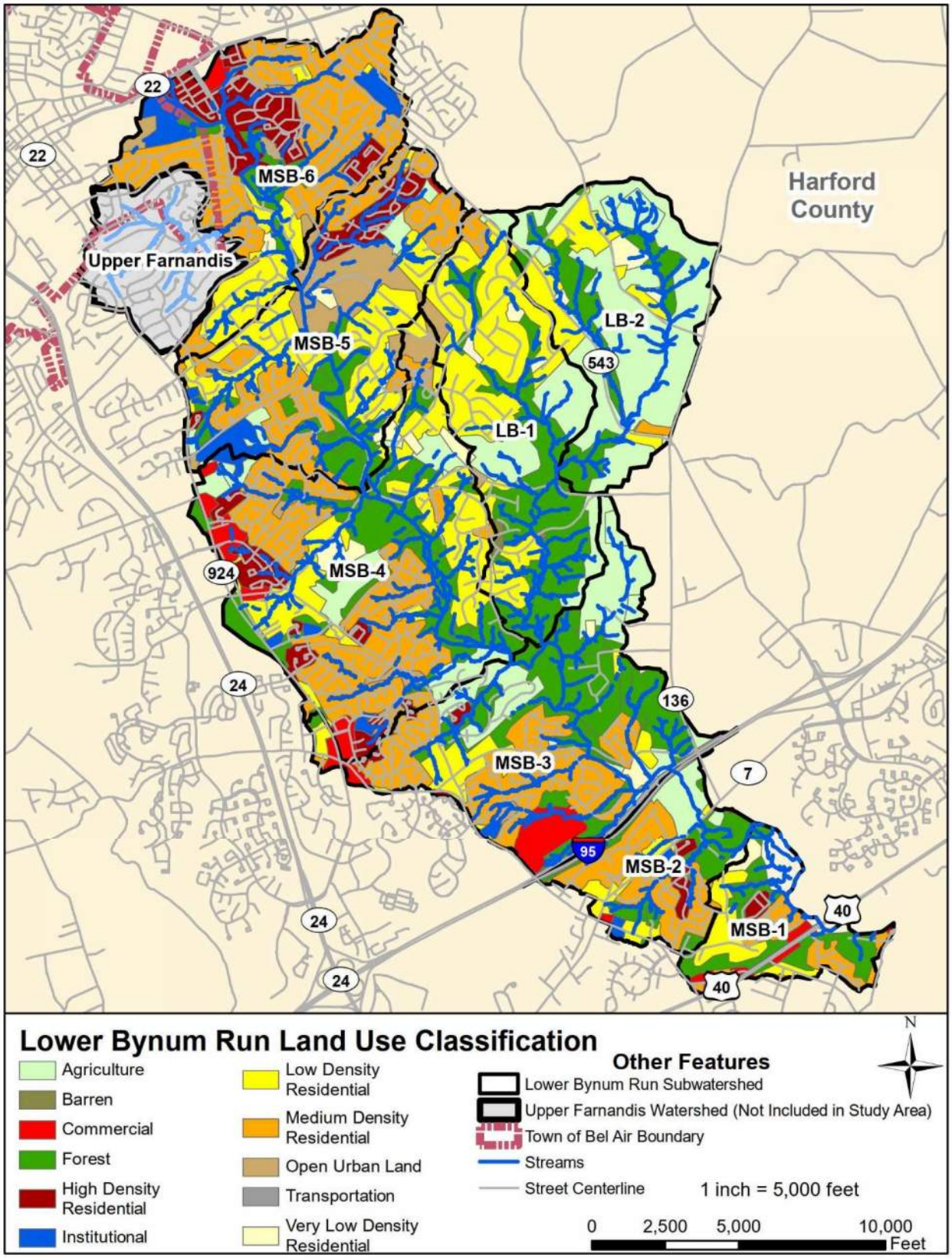

Figure 2-4. Lower Bynum Run Land Use/Land Cover

2.4 IMPERVIOUS SURFACES

Impervious cover is a primary factor when determining pollutant characteristics and quantities in stormwater runoff. Research has been conducted to link the degree of urbanization (typically measured by amount of impervious cover) with various watershed-based indicators of water quality such as diversity and abundance of aquatic and terrestrial life. The Center for Watershed Protection (CWP) compiled stream research conducted in various parts of the country and developed a simple model that relates potential stream quality to percentage of impervious cover in a watershed. Studies used to develop the impervious cover model (Figure 2-5) measured stream quality based on a variety of indicators such as number of aquatic insect species, stream temperature, channel stability, aquatic habitat, wetland plant diversity, and fish communities present.

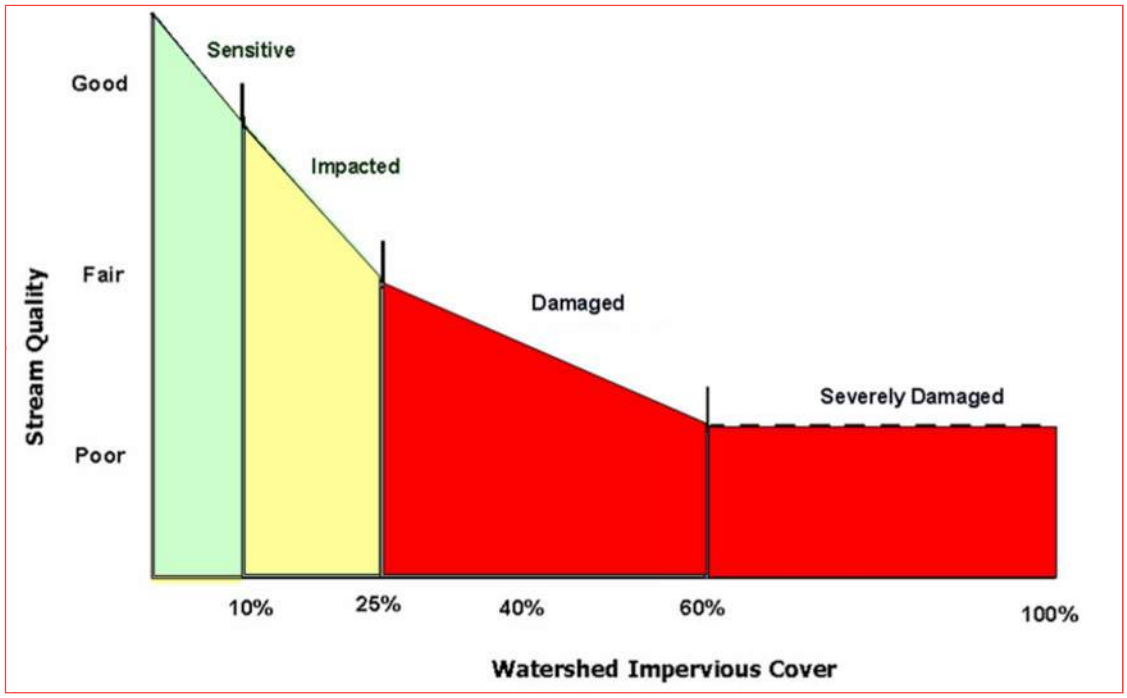

Figure 2-5. Impervious Cover Model (adapted from (CWP, 2003))

Based on the compiled research, CWP determined four classifications that predict stream quality based on watershed imperviousness: sensitive; impacted; damaged; or severely damaged. Watersheds with less than 10 percent impervious cover are referred to as sensitive and typically have high quality streams with stable channels, good habitat conditions, and good to high water quality. These watersheds are considered sensitive because they are susceptible to environmental degradation with increased urbanization and impervious cover. The model predicts that with between 10 and 25 percent impervious cover, watersheds become impacted and show clear signs of degradation such as erosion, channel widening, and a decline in stream habitat. There is potential to restore streams to a somewhat natural functioning system within this category. When a watershed has more than 25 percent impervious cover, streams are classified as damaged and characterized by fair to poor water quality, unstable channels, severe erosion, and inability to support aquatic life and provide habitat; many streams in this category

are typically piped or channelized, or in some areas, may be piped beneath the impervious surfaces resulting in a lack of continuity between natural riparian areas along the stream corridor.

Figure 2-5 shows that when impervious cover exceeds 60 percent, a watershed is classified as severely damaged which means that most of the natural stream system has diminished. Management of damaged and severely damaged streams may focus on decreasing pollutant loads to downstream receiving waters (e.g., installing Best Management Practices (BMPs)) but the ability to restore natural functions, such as habitat, is unlikely. Restoration efforts may also focus on making the remaining stream systems stable, aesthetically pleasing, and an amenity to the community. It should be noted that the impervious cover model is a simplified approach for classifying the potential stream quality. Although it is based on research, there are inherent model assumptions and limitations that should be considered such as regional variations and scale effects. In addition, while impervious cover is a relevant and significant indicator for watershed health, it is only one of many different factors affecting stream health and contributing to the cumulative impacts of development on water quality. For example, agricultural land uses may also contribute sediment and nutrient loads to receiving waters. Furthermore, the ability of BMPs to offset adverse impacts from urbanized areas is not specifically accounted for in the model (CWP, 2003).

Impervious cover data for the Lower Bynum Run watershed was obtained from 2013 impervious spatial data provided by Harford County. Impervious area quantities shown in Table 2-4 are the sum of road and building areas. Table 2-4 also shows the percentage of impervious cover within each subwatershed. It should be noted that parking lots and driveways are included in the roads column of Table 2-4, whereas sidewalks are included in the buildings column. Figure 2-6 illustrates the location of impervious surfaces within the Lower Bynum Run watershed. The total impervious area calculated is approximately 1,322 acres or 14% of the watershed. The subwatershed with the highest percentage of impervious cover is MSB-6, with 23% impervious.

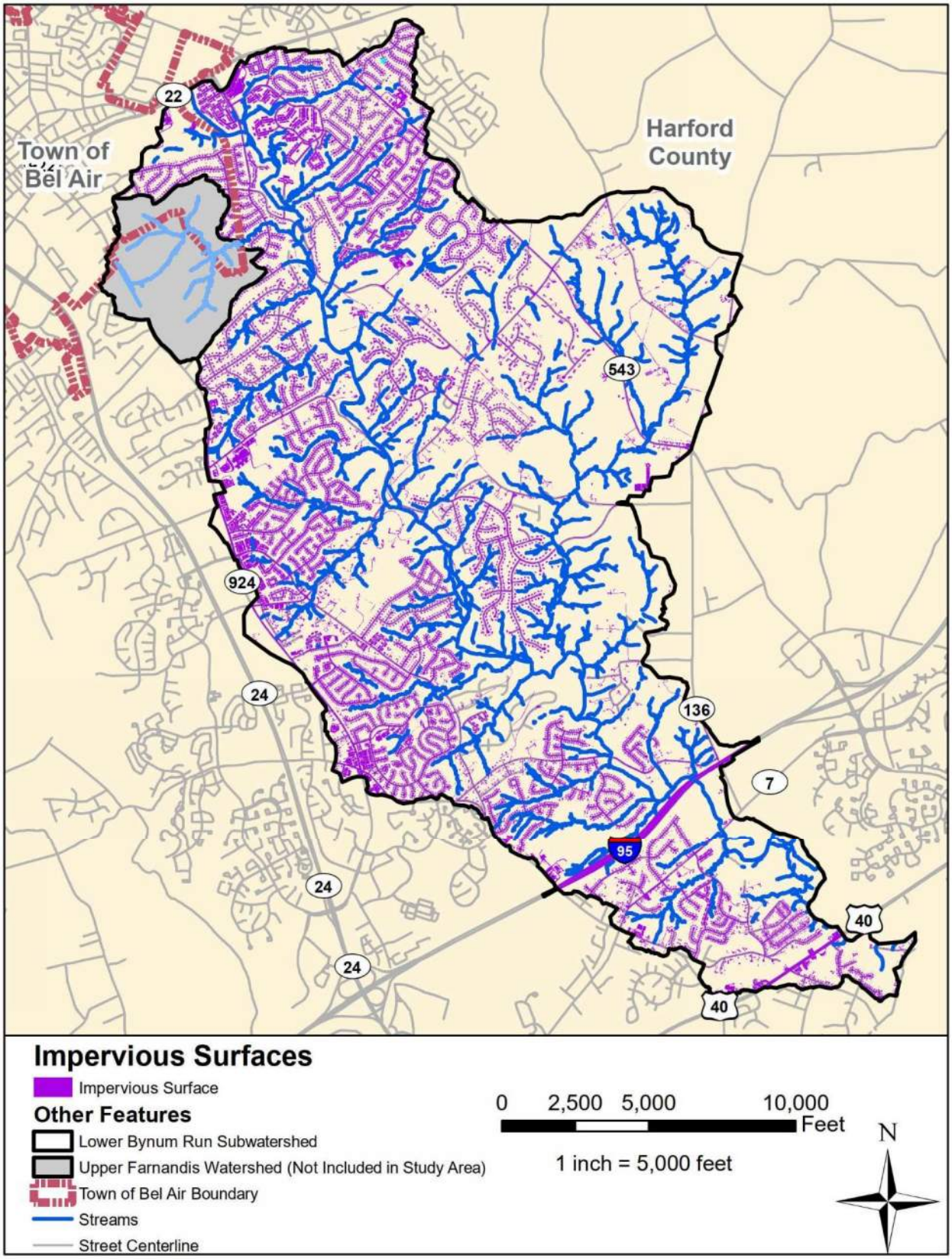

Figure 2-6. Lower Bynum Run Impervious Surfaces

Table 2-4: Lower Bynum Run Impervious Area Estimates

Subwatershed	Total Area (Acres)	Roads (Acres)	Buildings (Acres)	Impervious Area (Acres)	% Impervious	CWP Impervious Rating
LB-1	1,167	46	36	82	7.1%	Sensitive
LB-2	1,067	33	10	43	4.0%	Sensitive
MSB-1	451	40	22	62	13.7%	Impacted
MSB-2	554	61	31	92	16.6%	Impacted
MSB-3	1,487	122	66	188	12.6%	Impacted
MSB-4	1,896	200	146	345	18.2%	Impacted
MSB-5	1,346	116	94	210	15.6%	Impacted
MSB-6	1,294	165	135	300	23.2%	Impacted
Total	**9,261**	**781**	**541**	**1,322**	**14.3%**	**Impacted**

Based on the CWP model (Figure 2-5), six of the subwatersheds within the Lower Bynum Run watershed fall into the impacted impervious rating. The overall CWP impervious rating for the entire Lower Bynum Run watershed is impacted. "Impacted" subwatersheds mainly correspond to those with high amounts of residential development. In addition to impervious cover, other key watershed indicators must be examined to determine watershed health and restoration potential.

2.5 TMDL STATUS

The Clean Water Act (CWA) requires states, territories, and authorized tribes to: develop water quality standards for all jurisdictional surface waters; monitor these surface waters; and identify and list impaired waters. More specifically, Section 305(b) of the CWA requires annual water quality assessments to determine the status of jurisdictional waters. Section 303(d) requires states to identify and periodically update a list of impaired waters that fail to meet applicable state water quality standards. States must also establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for waters on the 303(d) list, which generally target pollutants including sediment, metals, bacteria, nutrients, and pesticides. According to the United States Environmental Protection Agency (USEPA), a TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet state water quality standards.

Water quality standards are developed from a combination of the designated use for a given water body and the water quality criteria designed to protect that use. Table 2-5 provides the definition for each designated class.

Table 2-5: Maryland's Designated Uses for Surface Waters

Class	Definition
Use I	Water Contact Recreation, and Protection of Nontidal Warm Water Aquatic Life
Use I-P	Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply
Use II	Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting
Use II-P	Tidal Fresh Water Estuary – includes applicable Use II and Public Water Supply
Use III	Nontidal Cold Water
Use III-P	Nontidal Cold Water and Public Water Supply
Use IV	Recreational Trout Waters
Use IV-P	Recreational Trout Waters and Public Water Supply

The surface waters (e.g. streams) within the Bynum Run watershed are designated as Use III – nontidal cold water (COMAR, 2014), until its confluence with Bush Creek which is designated as Use I - Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life. Based on the water quality criteria associated with the above designated uses, the Bynum Run and Bush River watersheds are listed in Maryland's Integrated Report (IR) of Surface Water Quality for various pollutants of concern. Each listing is applicable to either the Bynum Run watershed (basin 02130704) or the Bush River watershed (basin 02130701) and sorted by attainment status or category upon which a water body is placed. As the Lower Bynum Run watershed comprises portions of both these larger watersheds, this Report will review impairments for both Bynum Run and Bush River watersheds. Table 2-6 provides the definition for each attainment status or listing category within the report (MDE, 2017).

Table 2-6: Maryland Integrated Report Listing Categories (MDE, 2012a)

Listing Category	Definition
2	Waters meeting the standards for which they have been assessed
3	Waters that have insufficient data or information to determine whether any water quality standard is being attained
4a	Waters that are still impaired but have a TMDL developed that establishes pollutant loading limits designed to bring the waterbody back into compliance
4b	Waters that are impaired but for which a technological remedy should correct the impairment
4c	Waters that are impaired but not for a conventional pollutant. This includes pollution caused by habitat alteration or flow limitations
5	Water bodies that may require a TMDL

Maryland's IR is updated every two years. While Maryland's Final 2016 IR is the latest finalized report, Maryland's Draft 2018 IR is currently under review by the USEPA and is available for viewing at this time.

Once the USEPA approves the IR, it will become the Final 2018 IR. The Bynum Run watershed (02130704) stream segments are listed in the Maryland's Final 2016 IR for the following water quality impairments: total suspended solids (TSS), channelization, and temperature (MDE, 2017). The Bush River watershed (02130701) stream segments are listed in the Maryland's Final 2016 IR for the following water quality impairments: total suspended solids (TSS), channelization, lack of riparian buffer, chlorides and sulfates (MDE, 2017).

Impairment listings within categories 4a, 4b, 4c, or 5 reflect an inability to meet water quality standards. When a stream segment is listed as impaired, action can be taken by developing and/or adhering to a TMDL or by submitting a Water Quality Analysis (WQA) to remove a specific pollutant from the impairment listing. TMDLs can be developed for a single pollutant or group of pollutants of concern. WQAs are performed to determine if the pollutant of concern is actually the cause of the impairment. If it is determined that the pollutant of concern is not causing the impairment, a report documenting the findings is submitted to the USEPA for concurrence. Maryland's 2016 IR represents a fully combined 303(d) and 305(b) report approved by USEPA (MDE, 2017). Maryland's 2018 Final IR (MDE, 2019) does not have any changes for the Bynum Run or Bush River watershed listings.

Table 2-7 summarizes the status of the current listings for the Bynum Run watershed, while Table 2-8 summarizes the status of the current listings for the Bush River watershed.

Table 2-7: Bynum Run Water Quality Impairment Listings and Status

		2016/2018 Integrated Report		
Impairment	**Applicable Segment**	**Listing Category**	**Status**	**Approval Date**
Total Suspended Solids (TSS)	MD-02130704	4a	TMDL	2011
Channelization	MD-02130704	4c	Impaired	N/A
Temperature	MD-021307041131-UTBynum_Run	5	Impaired - Low Priority	N/A

As shown in Table 2-7, there are currently three listings for the Bynum Run watershed (MDE, 2017). A WQA was approved in 2007 for nitrogen and phosphorus, indicating the concentrations of nitrogen and phosphorus fall below the water quality standard (MDE, 2007). The results of the WQA are reflected in the 2008 and subsequent IR's with the shift from category 5 to category 2 for mercury (MDE, 2008). Mercury in fish tissue was also placed in category 2 in the 2008 IR. A biological impairment was listed under category 5 in 2002 with an unknown source. A biological stressor identification (BSID) analysis was developed in 2011 to determine the cause of biological impairments. The BSID analysis determined the cause of degraded biological communities to be urban runoff through storm sewers (MDE, 2007). As a result of the BSID study, the biological impairment was updated to a Total Suspended Solids (TSS) impairment in the 2012 IR (MDE, 2012). The Total Suspended Solids (TSS) listing was placed under category 4a, meaning a TMDL has been completed for this impairment. A listing for channelization was placed under category 4c, meaning that waters are impaired but not by a conventional pollutant. The

watershed is an urbanized high-density area. The bio-stressor analysis indicates that stream channelization due to urban development is a major stressor affecting the biological integrity in this watershed. This listing replaces the biological listing. The 2014 IR has one additional impairment listed under category 5 for temperature with an unknown source (MDE, 2017). In the listing, temperature was observed above criteria and no cold water obligate taxa were found.

PCBs in fish tissue were listed in category 3, due to conflicting available monitoring data. PCBs in fish tissue were initially listed as an impairment in category 5 in the 2006 IR. High PCB concentrations were found in smallmouth bass between 1999-2003. New redbreast sunfish data meets the PCB fish tissue threshold; however, new eel samples exceed the threshold. Eels are not necessarily representative species since they are catadromous. As a result, additional monitoring data on other species is needed to determine if PCBs are an impairment within the watershed.

Table 2-8: Bush River Water Quality Impairment Listings and Status

		2016/2018 Integrated Report		
Impairment	**Applicable Segment**	**Listing Category**	**Status**	**Approval Date**
Channelization	MD-02130701	4c	TMDL	2011
Lack of Riparian Buffer	MD-02130701	4c	Impaired	N/A
Chlorides	MD-02130701 1st through 4th order streams	5	Impaired - Low Priority	N/A
Sulfates	MD-02130701 1st through 4th order streams	5	Impaired - Low Priority	N/A
Total Suspended Solids (TSS)	MD-02130701 1st through 4th order streams	5	Impaired - Low Priority	N/A
PCB in Fish Tissue	MD-BSHOH	5	Impaired – Med Priority	N/A

As shown in Table 2-8, there are currently (MDE, 2017) six listings for the Bush River watershed. A listing for channelization was placed under category 4c, meaning that waters are impaired but not by a conventional pollutant. The biostressor analysis indicates that stream channelization due to anthropogenic changes to stream channel is a major stressor affecting the biological integrity in this watershed. This listing replaces the biological listing. Lack of riparian buffer is also placed under the 4c category citing the cause as urban development in the riparian buffer. The biostressor analysis indicated that the lack of riparian buffer is a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing (MDE, 2017). Mercury in fish tissue was also in category 2 in the 2016 IR, meaning that the water bodies met the standards for this biostressor.

Chlorides, sulfates, and total suspended solids are placed under category 5, meaning a TMDL for the water body may be required. The IR cites urban runoff/storm sewers as the pollution sources for chlorides, sulfates and TSS. These three biostressors have a low priority ranking according to the IR and therefore do not have a TMDL associated with them. PCBs in fish tissue is also currently listed under category 5 in both the 2016 and 2018 IRs; however, a PCB TMDL was developed by Harford County in 2017 and is described in the following section.

2.5.1 SEDIMENT TMDL

A TMDL for sediment was established for the Bynum Run watershed in 2011 and was set to 4,690.1 tons/yr. (14% reduction) (MDE, 2011). This TMDL includes nonpoint source loads from unregulated stormwater runoff, stream bank erosion for example, point source loads from industrial facilities that discharge process water, and National Pollutant Discharge Elimination System (NPDES) for regulated stormwater discharges within the Bynum Run watershed. To reduce pollution levels, implementation of best management practices (BMP's) and environmental site design (ESD's) can take place via the municipal separate storm sewer system (MS4) permitting process for medium and large municipalities. MDE intends for the required reductions to be an iterative process, first addressing the sources with the largest impact to water quality. The Harford County urban load is responsible for reducing its sediment loading by 18% (MDE, 2011). The TMDL will ensure that the watershed sediment loads are at a level to support the Use III designation for the Bynum Run watershed, and more specifically, at a level to support aquatic life. The TMDL, however, will not completely resolve the impairment to biological communities within the watershed since the watershed analysis identifies other possible stressors (i.e., acute and chronic ammonia toxicity) as impacting the biological conditions (MDE, 2011).

2.5.2 PCB TMDL

Bush River was first identified as impaired in MDE's 2002 Integrated Report based on fish tissue sampling. Four 8-digit basins drain into the Bush River including Atkisson River (02130703), Lower Winters Run (02130702, Bynum Run (02130704) and Bush River (02130701). The Bush River TMDL for Polychlorinated Biphenyls (PCBs) was developed by Harford County and approved by the EPA on August 2, 2017 (Harford County, 2017). The Bush River is located entirely within Harford County and receives drainage from the Town of Bel Air and portions of the City of Aberdeen, both of which are Phase II MS4 jurisdictions. Bynum Run Watershed is the most urbanized watershed that drains to the Bush River and contributes the largest watershed runoff load of PCBs. Since PCBs have a strong affinity to sediment, and Bynum Run has a TMDL for sediment, it can be concluded that reductions in TSS should lead to reductions in PCBs (Harford County, 2017). The stormwater wasteload allocation developed by Harford County has based the watershed runoff loads on a limited number of sample dates and results with considerable variability. Therefore, the County proposes to provide additional monitoring to better quantify the extent of the PCB loads before investing large quantities of funding for capital improvement projects (Harford County, 2017).

2.5.3 CHESAPEAKE BAY NUTRIENT AND SEDIMENT IMPAIRMENT

The Chesapeake Bay Program (CBP) has developed the Phase 5 Watershed Model, which, in conjunction with the Estuary Model, is used to determine the sources and reductions of nitrogen, phosphorus, and sediment needed to meet Chesapeake Bay tidal water quality standards. The Phase 5 model was used to develop a Chesapeake Bay-wide TMDL and to assign nutrient and sediment load reductions to individual states and ultimately local jurisdictions based on the segment loads. In Maryland, nutrient and sediment

load reductions were assigned on a county basis for achievement by a 2025 timeframe. Table 2-9 lists the pollutant load reduction requirements for Harford County under the Chesapeake Bay TMDL.

Table 2-9: Harford County Required 2025 Stormwater Sector Pollutant Load Reduction (County, 2012)

TMDL Pollutant	% Pollutant Load Reduction
Nitrogen	37.9%
Phosphorus	24.0%

2.6 MS4 NPDES PERMIT

The Clean Water Act also requires jurisdictions to obtain a permit for any point source discharges to the waters of the U.S. Point source discharges are concentrated flows through pipes and ditches. The National Pollutant Discharge Elimination System (NPDES) was established to reduce and/or maintain pollutant loads through point sources to acceptable levels. For jurisdictions with urban land uses, NPDES municipal separate storm sewer systems (MS4) permits are required to treat a portion of polluted stormwater runoff before it enters the waters of the U.S.

Harford County currently has a NPDES MS4 permit (11-DP-3310, MD0068268). One requirement within the plan is the development of restoration plans for all watersheds within the County. The County's NPDES permit (effective December 2014) also requires the County to address 20% of the untreated impervious cover during each 5-year permit term (MDE, 2014). It is anticipated that future permits will have the same requirement. This report meets the systematic assessment and planning requirements of the NPDES permit and provides proposed projects to help Harford County meet goals for addressing impervious cover.

3 EXISTING MONITORING DATA SUMMARY

Water quality monitoring studies have been conducted for three locations within the Lower Bynum Run Watershed at Farnandis Branch, Box Hill, and Laurel Valley. These locations have been monitored for a variety of data including geomorphic, biological, and water quality. The results from each monitoring study provide insight into the health of those individual stream reaches as well as a general idea of the water quality within the entire watershed. The result of each monitoring study is summarized below. See Figure 3-1 for a vicinity map of the monitoring studies that have taken place within the Lower Bynum Run watershed.

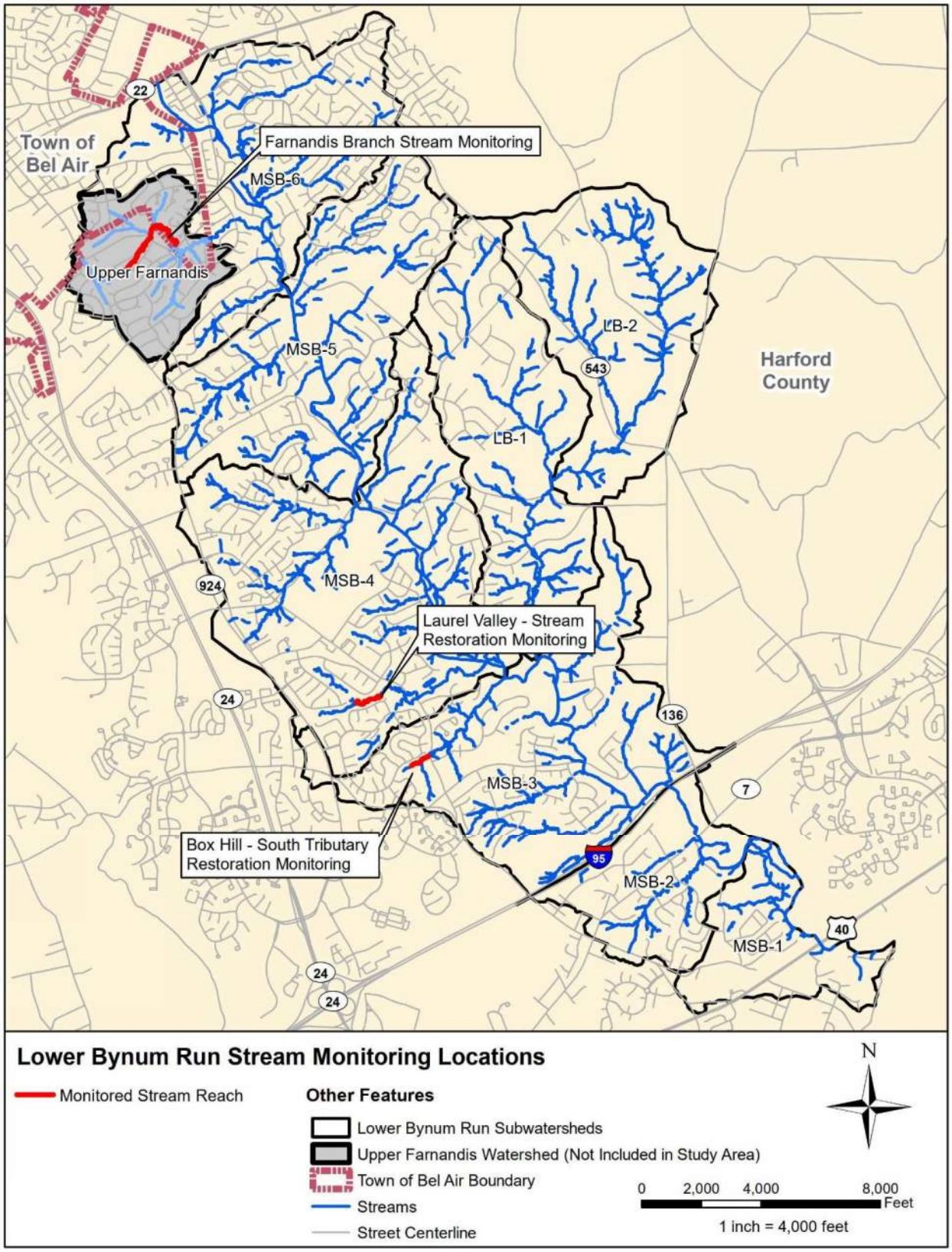

Figure 3-1. Stream Monitoring Study Locations within the Lower Bynum Run Watershed

3.1 FARNANDIS BRANCH STREAM MONITORING

In the late 2000's, KCI Technologies, Inc. (KCI) conducted a two-year geomorphic, biological, and water quality monitoring study within a 4,400-foot reach of the Farnandis Branch, below Woodland Drive. This site is within the Upper Farnandis subwatershed and has been included in this section because it provides applicable data to the Lower Bynum Run watershed. A summary of the results is provided below. Data and additional details conducted during this study can be reviewed within the Farnandis Branch – Stream Restoration Project Pre-Construction Monitoring Report (KCI Technologies, 2010).

3.1.1 GEOMORPHIC MONITORING

During geomorphic monitoring, bed and bank stability, a channel profile and bed features were evaluated. Cross sectional surveys indicate degradation of the channel bed and/or bank erosion throughout the study area. Bank pin measurements throughout the study reach indicate substantial erosion in some areas.

3.1.2 BIOLOGICAL MONITORING

The biological monitoring program included the collection and analysis of the macroinvertebrate community, a physical habitat assessment, and measurements of in situ water chemistry at two locations within the stream reach. The biological monitoring sampling results indicate impaired biological conditions (low Benthic Index of Biotic Integrity scores) throughout the study reach. Overall, Benthic Index of Biotic Integrity (BIBI) scores remained relatively consistent with only minor changes observed. The biological rating for both on-site stations indicate impaired and highly impaired biological communities that will require restoration/mitigation measures for any chance of recovery.

Physical habitat assessments were conducted in conjunction with the benthic macroinvertebrate sampling and indicated relatively consistent degraded and severely degraded physical habitat index (PHI) scores throughout the study reach.

3.1.3 WATER QUALITY MONITORING

The water quality monitoring program analyzed all samples for *E. coli* bacteria, total phosphorus, total nitrogen, chlorides, total suspended solids, lead, copper, zinc, and nickel. Both physical habitat degradation and water quality conditions have contributed to impaired biota in the study reach. Water quality monitoring showed that concentrations of phosphorus and nitrogen were elevated in the second year of monitoring. While *E. coli* levels were an issue throughout the monitoring periods.

3.2 BOX HILL – SOUTH TRIBUTARY RESTORATION MONITORING REPORT

From 2005 to 2008, and again in 2012, KCI conducted geomorphic, water quality and macroinvertebrate monitoring within a 1,100-foot restored reach of the Box Hill – South Tributary, located south of Kensington Parkway between Harrogate Way and Laurel Bush Road. Stream restoration along this reach was completed in 2003. A summary of the monitoring results is provided below. Data and additional details conducted during this study can be found within the Box Hill – South Tributary Restoration Monitoring Report (KCI Technologies, Inc., 2008).

3.2.1 GEOMORPHIC MONITORING

Fluvial geomorphologic monitoring has been conducted to evaluate the bed and bank stability and the establishment of riffle/pool sequences. Topographic survey of the entire restored stream reach was completed during baseline monitoring for comparison to as-built and/or final design plans to assess changes to the channel and floodplain.

Over the 4-year monitoring period, channel bed features became more pronounced, most notably, were scour pools that formed below the cross vane weirs and boulder spurs. In years three and four, further adjustments were visible, following the trends of year two. Following remedial actions to address the concerns identified in the year three monitoring report, the installed structures continue to function in accordance with their associated design goals and objectives. Within the months following the remedial work, vegetation had begun to establish on the areas above the boulder banks and the actual structures appeared to be stable.

3.2.2 BIOLOGICAL MONITORING

Pre- and post-construction macroinvertebrate sampling has been conducted within the study Reach. The pre-construction monitoring was initiated in 1998. Additionally, fish sampling was conducted in 2006 by DNR to supplement benthic macroinvertebrate data.

Both pre- and post-construction data indicate poor to very poor BIBI scores for each year sampling occurred. As the habitat conditions, which remain rated as severely degraded for one site based on the Physical Habitat Index (PHI), improve over time (vegetation establishment, riffle/pool sequencing, etc.), the macroinvertebrate populations are expected to improve.

In 2012, KCI sampled the fish community during the Summer Index Period. The overall FIBI score was rated 'Poor' for 2012, with a score of 2.67, which is the highest FIBI score of all years sampled. Both the total number of individuals and the variety of species increased from previous sampling years. Given the difference in the number of individuals collected in 2012, the score for Biomass per square meter also increased.

3.2.3 WATER QUALITY MONITORING

The Maryland Department of the Environment (MDE) has established acceptable standards for several of the water chemistry parameters measured in this study for each designated Stream Use Classification. Specific designated uses for Use I streams include water contact sports, fishing, the growth and propagation of fish, and agricultural, and industrial water supply. Currently, there are no standards available for conductivity; however, Raymond Morgan and Kathleen Kline with University of Maryland Center for Environmental Science identified a critical threshold between 'Fair' and 'Poor' stream quality for Maryland streams at 247 µS/cm (Morgan, R.P., K.K., 2007). For 2012, all regulated parameters fell within acceptable COMAR ranges. Although not regulated under COMAR, specific conductance was elevated (321.3 µS/cm), signifying possible effects of impervious surface upstream in the watershed.

3.3 LAUREL VALLEY – STREAM RESTORATION MONITORING REPORT

Approximately 1,400 linear feet of the Laurel Valley stream reach was restored with construction completed in February 2009. Pre-construction and post construction stream monitoring took place at Laurel Valley. Pre-construction stream monitoring was conducted by KCI in 2008 and 2009. Post construction stream monitoring was conducted by URS Corporation (URS) from 2010 to 2012. This stream is situated between Parallel Path and Boxthorn Road. The study reach extends from downstream of the stormwater retention pond near Merrick way to Laurel Bush Road.

3.3.1 GEOMORPHIC MONITORING

The Laurel Valley geomorphic monitoring program consisted of establishing benchmarks and cross-sections, surveying and analyzing cross-sections and thalweg profile, installing and monitoring bankpins, and evaluating substrate particle size distribution. Pre-construction baseline conditions indicate the channel was incised and the banks were eroding in several locations within the restoration reach. The downstream reach appeared to be the most active with shifts in bed features and areas of erosion. Post-construction baseline conditions indicated the Restoration Reach to be functioning as a stable reach. The Downstream Reach showed similar active characteristics to the pre-construction conditions. The evaluation of structures indicated most of the log weirs are functioning as intended and are stable in their placement, with a few requiring adjustments to prevent to stream from flowing under them.

3.3.2 BIOLOGICAL MONITORING

A biological monitoring program was employed, which included the collection and analysis of the macroinvertebrate community and a physical habitat assessment. The macroinvertebrate sampling indicated impaired biological conditions throughout the study reach. As a result of habitat degradation and recent construction, low benthic macroinvertebrate scores continue to be observed for Stations 1, 2, and 3. Benthic and instream habitat declined from 2010 to 2011 (2012). This is at least partially attributed

to human activities. The restoration reach has become the focal point of a play area for local children, which includes activities along the top of bank and instream. This area has been cleaned up since the spring 2012 evaluation. Shading of the Restoration Reach will continue to improve with time as the planted trees and shrubs mature.

3.3.3 WATER QUALITY MONITORING

To supplement the macroinvertebrate sampling and habitat assessment, instream water quality measurements were performed in 2012. Field water quality measurements were collected in situ at all monitoring stations. Water quality conditions in the study reach were similar to or better than those observed in the reference reach.

4 FIELD ASSESSMENT

4.1 OVERVIEW

Field assessments were conducted throughout the Lower Bynum Run watershed to evaluate existing conditions within Lower Bynum Run, a portion of Bush River Branch, and their tributaries. A total of 15.5 miles (81,925 linear feet) of stream, 79 outfalls, 65 existing BMPs, and 11 proposed BMPs were assessed during the field reconnaissance. During the field assessments, GPS enabled tablets were used to collect field information, location data of outfalls, and stream characteristics as well as pictures that were taken at each location. Field maps were created for each existing and proposed BMP site at a scale to allow the entire drainage area to be shown on each map. For the stream and outfall assessments, a 1 inch = 150 feet grid was created. Field maps were printed at this scale to allow field notes and documentation of stream features and outfall locations during the assessment. These maps allowed for field notes and verification of drainage area and BMP locations. Protocols and field findings for each type of assessment can be found in the next several sections.

4.2 STORMWATER MANAGEMENT FACILITIES

During the field assessments, field teams assessed the conditions of existing BMPs and identified locations for proposed BMPs. The recommendations below represent opportunities where new or enhanced stormwater control measures can be developed that deliver greater management of stormwater runoff than is currently realized.

The Maryland Department of the Environment (MDE) developed stormwater management (SWM) regulations over 35 years ago to control the quantity of runoff. Since that time, SWM practices have evolved and will continue to progress as new technology and research are developed. SWM is a significant consideration for new development and redevelopment within Maryland. Per Title 4, Subtitle 2, of the Environment Article of Annotated Code of Maryland, management of stormwater runoff is required to reduce erosion, sedimentation, pollution, and flooding. Increased importance of water quality and water resource protection has led to the development of the Maryland Stormwater Design Manual in 2000 to provide Best Management Practice (BMP) design standards and environmental incentives and has promoted a general shift toward low-impact SWM practices that mimic natural hydrologic processes and achieve pre-development conditions. The latter is evident by the Maryland Stormwater Management Act of 2007 which requires that Environmental Site Design (ESD) be implemented to the maximum extent practicable via nonstructural BMPs and/or other innovative design techniques.

There are many types of BMP options for managing stormwater runoff and providing stormwater quality treatment. SWM facilities can target specific objectives, depending on the BMP type, such as improving overall stormwater quality before it enters the stream, soil stabilization and erosion control, stormwater flow control or detention, and stream protection. In addition, different SWM facilities have different pollutant removal capabilities. Considerations such as space requirements, maintenance needs, cost,

stream designated use, and community acceptance are considered when selecting the appropriate stormwater treatment measures. Existing BMP retrofits and new BMP locations are detailed in Appendix B.1 and B.2.

4.2.1 EXISTING STORMWATER MANAGEMENT FACILITIES

BMPs constructed prior to the 2000 MDE Stormwater Manual may not provide water quality treatment for runoff. These facilities may have the capacity to be retrofitted to help improve water quality. Stormwater retrofits improve water quality by capturing and treating runoff before it reaches receiving water bodies. Based on initial desktop evaluations, 153 existing BMPs were identified in the watershed. Due to limitations on budget and time, a subset of these 153 BMPs were selected for field assessments. A total of 65 dry detention and extended detention ponds were identified in Harford County's GIS database and were selected for field visits based on retrofit potential. The dry detention and extended detention ponds are assumed to provide only water quantity treatment. The remaining facilities are assumed to provide some form of water quality management and were not investigated.

Table 4-1 summarizes the number of various types of public and private SWM facilities in the Lower Bynum Run watershed. The SWM facilities are categorized into 11 categories: bioswales, dry detention ponds, dry wells, extended detention ponds, grass swales, infiltration practices, micro-bioretentions, sand filters, wetlands, wet ponds, and other ESD practices such as underground storage and unknown ESDs. Figure 4-1 shows the distribution of these facilities throughout the watershed. Data for SWM facilities and their drainage areas were obtained from Harford County and through desktop analysis.

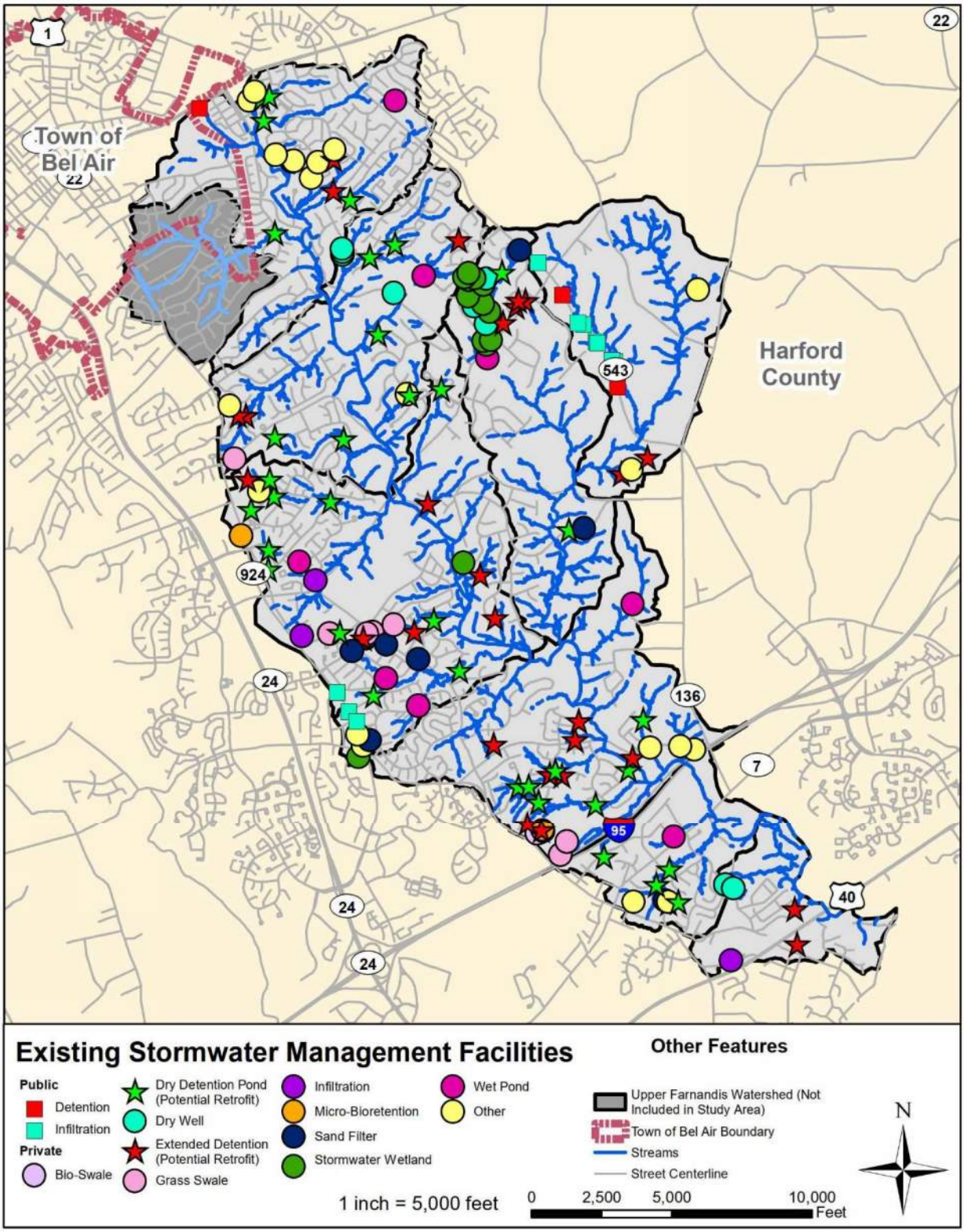

Figure 4-1. Distribution of Stormwater Management Facilities in Lower Bynum Run Watershed

Table 4-1. Stormwater Management Facilities in the Lower Bynum Run Watershed

SWM Facility Type	Subwatershed								
	LB-1	LB-2	MSB-1	MSB-2	MSB-3	MSB-4	MSB-5	MSB-6	Subtotals*
Bioswale	0	0	0	0	3	0	0	0	3
Dry Detention Pond	2	0	0	4	7	11	7	5	36
Dry Well	3	0	2	0	0	0	4	0	9
Extended Detention Pond	4	2	2	1	8	6	4	2	29
Grass Swale	0	0	0	0	2	4	1	0	7
Infiltration	0	7	1	0	1	4	0	0	13
Micro-Bioretention	0	0	0	0	2	1	0	0	3
Sand Filter	2	0	0	1	0	5	0	0	8
Stormwater Wetland	11	0	0	0	1	1	0	0	13
Wet Pond	1	2	0	1	1	4	1	3	13
Other	0	2	0	2	5	1	2	7	19
Total SWM Facilities	**23**	**13**	**5**	**9**	**30**	**37**	**19**	**17**	**153**

*Shaded totals indicate facilities that were identified as potential retrofit opportunities

SWM facilities are present in all subwatersheds that make up the Lower Bynum Run watershed. The most common SWM facility type is dry detention ponds followed by extended detention facilities. MSB-4 has the largest number of SWM facilities. Drainage areas to SWM facilities in the Lower Bynum Run watershed tend to have residential and forest land uses. Approximately 90% of the facilities are privately owned, while the remaining facilities are publicly owned.

The stars shown in Figure 4-1 indicate dry detention and extended detention ponds on the initial list of potential retrofits. Out of the 153 existing SWM facilities within Lower Bynum Run, 65 facilities (privately owned) were identified as having a potential retrofit opportunity. The identified facilities include dry detention ponds and extended detention ponds. These types of facilities have the potential for BMP retrofits to submerged gravel wetlands or wet ponds. Further analysis would need to be performed to determine if these facilities are functioning as designed. All BMP retrofit designs will need to be coordinated with property owners.

EXISTING BMP ASSESSMENT PROTOCOL

Existing BMP assessments were attempted for the 65 dry detention ponds and extended detention ponds in the Lower Bynum Run watershed. Five BMPs were not located based on their GIS point. Most of these BMPs were duplicates of existing BMPs with a different ID number; therefore, full assessments were conducted on 60 BMPs. The assessments were conducted based on protocols developed by WSP as a tool for field teams to quickly evaluate the current conditions of the facility and determine retrofit potential. The following sections present a description of the BMP protocol employed, an overview of the sites assessed, and general results for the Lower Bynum Run watershed. Further detail on the sites listed for potential retrofit can be found in Appendix B.

The BMP Assessment is used to quickly assess the physical conditions of existing BMPs and identify potential retrofit opportunities. The assessments were conducted in the summer of 2019 by two-person field crews from WSP. The teams walked each of the selected sites in the Lower Bynum Run watershed. All of the sites had stormwater easements or were located on HOA open space, allowing the field crews access to each site. Due to the different types of existing BMPs, the following protocols were used to collect information at each site. Items in the protocol that were not applicable to a specific site were not filled out at that site.

- Verification of desktop/design plan drainage area
- Measurement of facility bottom width and length
- Descriptions of any maintenance needs
- Observations of accessibility for construction and maintenance access
- Identification of all inflow points into the facility and verification of the elevation change between the inflow inverts and the outflow structure invert for the facility.
- Evaluation of the condition of the inlets and outfall structure.
- Identification of standing water and/or wetland vegetation in the facility
- Identification of the facility's emergency spillway, if present
- Inspection of manholes near facility to verify storm drain network leading to facility

Field teams walked the selected sites while sketching a plan view of the facility and noting all inflow points and outfall points as well as the location of the emergency spillway and the facility bottom dimensions. A general sketch of the riser control structure was drawn to include the height of the structure from the facility bottom and the location and dimensions of the orifices and/or weirs. The outfall condition was also noted on the sketches. A third sketch of the embankment was drawn to include the embankment height from the facility bottom, the embankment top width, and the embankment condition.

Notes were collected to show if the facility currently appears to provide water quality treatment, based on the site visits. Specifically, cleanout pipes and wetland vegetation were noted. Photographs were taken of the overall site and throughout the site assessment to document the conditions observed. Drainage areas were modified on the field maps, if needed.

GENERAL FINDINGS

Extended detention ponds are present in all 8 subwatersheds that make up the Lower Bynum Run watershed. Drainage areas to SWM facilities in the Lower Bynum Run watershed tend to include residential and forest land uses.

Stormwater retrofits for the purposes of this Small Watershed Assessment Report refer to optimization of existing BMPs to capture and provide greater treatment of runoff from impervious surfaces (i.e. parking lots, roadways), which are currently untreated or treated to a lesser extent. Of the 60 existing BMPs assessed, 13 sites were selected for retrofit projects based on drainage area restrictions for BMP

retrofit designs, accessibility, and space within BMP footprint for retrofit practice. These 13 sites are listed in Table 4-2. A detailed site description and recommended projects for these facilities can be found in Appendix B.1.

Table 4-2: Stormwater Retrofits in Lower Bynum Run

BMP ID	Subwatershed	Existing BMP Type	Retrofit Type	Drainage Area (Acres)	Ownership
SWM0554	MSB-1	Extended Detention	Wet Pond	18.27	HOA
SWM000118	MSB-4	Extended Detention	Submerged Gravel Wetland	7.32	HOA
SWM000257	MSB-4	Extended Detention	Submerged Gravel Wetland	9.13	HOA
SWM000287	MSB-3	Extended Detention	Submerged Gravel Wetland	6.26	HOA
SWM000312	MSB-4	Extended Detention	Submerged Gravel Wetland	3.52	HOA
SWM000342	MSB-4	Extended Detention	Submerged Gravel Wetland	3.05	HOA
SWM000347	MSB-3	Extended Detention	Submerged Gravel Wetland	4.58	HOA
SWM000415	MSB-3	Extended Detention	Submerged Gravel Wetland	11.00	HOA
SWM000428	MSB-3	Extended Detention	Submerged Gravel Wetland	6.09	HOA
SWM000472	MSB-2	Extended Detention	Submerged Gravel Wetland	11.48	HOA
SWM000622	MSB-3	Extended Detention	Submerged Gravel Wetland	2.46	HOA
SWM000683	MSB-2	Extended Detention	Submerged Gravel Wetland	3.41	HOA
SWM000685	LB-1	Extended Detention	Submerged Gravel Wetland	14.67	HOA

The 47 existing BMPs not recommended for retrofits are described in Appendix A. A site description has been provided along with site photos and any maintenance recommendations.

4.2.2 POTENTIAL STORMWATER MANAGEMENT FACILITIES

In addition to evaluating existing BMPs for retrofit opportunities, the watershed was canvased for potential new BMP placement. A desktop evaluation was performed to identify ideal locations for potential facilities which tend to be open, public spaces that collect impervious runoff from nearby

neighborhoods, roads, and commercial lots. Due to the large percentage of residential land use in the watershed, open space was limited to within the road right-of-way along neighborhood streets, HOA open space areas, and private commercial properties.

Table 4-3 provides a listing of 14 locations identified by the initial desktop assessment and includes, the potential BMP name, subwatershed, ownership, and if it was removed from consideration during the second desktop evaluation. Figure 4-2 provides the locations of all the potential BMP sites after the desktop evaluation.

Table 4-3: Summary of Potential BMPs from Desktop Evaluation

BMP ID	Subwatershed	Ownership	Removed from Consideration Prior to Assessment	BMP Proposed?
BMP-P-01	MSB-6	Harford County	Yes	No
BMP-P-02	MSB-6	Harford County	No	No
BMP-P-03	MSB-6	Harford County	Yes	No
BMP-P-04	MSB-5	Golf Course	No	Yes
BMP-P-05	MSB-4	Private Homeowner	No	No
BMP-P-06	MSB-5	HOA	Yes	No
BMP-P-07	MSB-4	Harford County	No	Yes
BMP-P-08	MSB-1	Private Homeowner	No	No
BMP-P-09	MSB-6	Harford County	No	No
BMP-P-10	MSB-4	Commercial	No	No
BMP-P-11	MSB-4	Commercial	No	No
BMP-P-12	MSB-4	Commercial	No	No
BMP-P-13	MSB-4	Commercial	No	No
BMP-P-14	MSB-4	Commercial	No	No

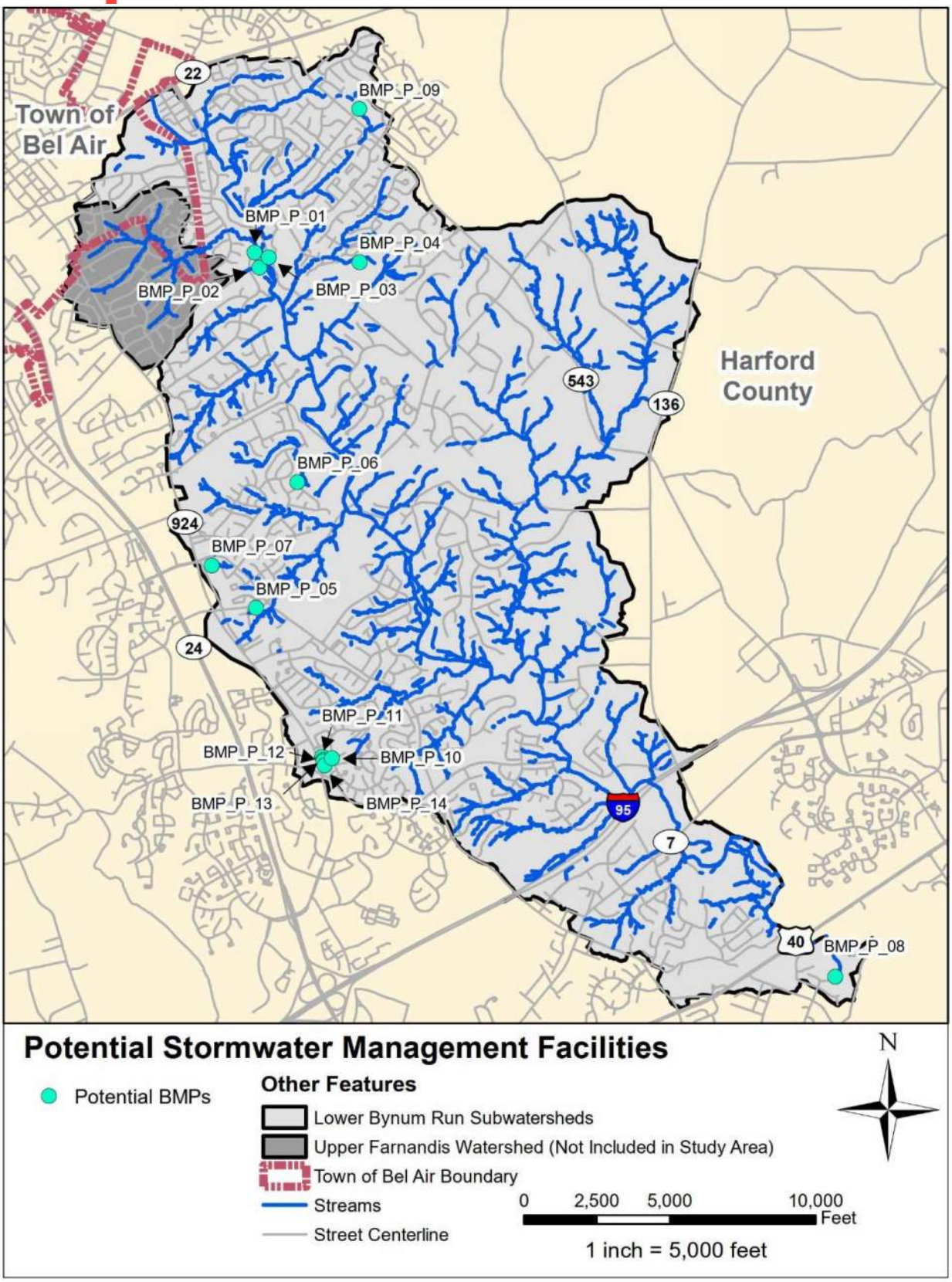

Figure 4-2. Potential BMPs in the Lower Bynum Run Watershed

POTENTIAL BMP ASSESSMENT PROTOCOL

After the desktop evaluation was completed, 11 in-depth field assessments were performed for the remaining potential BMP locations. The assessments were conducted based on protocols developed by WSP; these protocols allow field teams to quickly evaluate the current site conditions and determine potential BMP placement. The following section presents a description of the BMP protocol employed, an overview of the sites assessed, and general results for the Lower Bynum Run watershed. Further detail on the sites listed for potential new BMP projects can be found in Appendix B.2.

The BMP assessment quickly evaluated the physical conditions of the potential site and any new BMP opportunities. The assessments were conducted in the summer of 2019 by WSP two-person field crews, whom walked each site in the Lower Bynum Run watershed. Property access was previously granted for all sites. The following protocols were used to collect information at each site. Items in the protocol that were not applicable to a specific site were not completed.

- Verification of desktop drainage area
- Measurement of available space for potential facility footprint
- Observations of accessibility for construction and maintenance access
- Identification of how inflow would enter the potential site and if alterations to the existing drainage patterns were needed to maximize impervious area runoff to the site
- Verification if adequate elevation change was available for the facility from outfall location to existing drainage patterns
- Identification of standing water and/or wetland vegetation near the potential footprint
- Inspection of manholes near facility to verify storm drain network leading to potential facility
- Identification of potential hotspot at site
- Identification of trees and/or steep slopes present in the footprint
- Identification of private residences, businesses, or pedestrian areas that may be impacted by construction of facility
- Identification of utility conflicts within the footprint and/or disturbance area

Using the protocol list, the field team determined if the site constraints allowed for the construction of a BMP or ESD facility. Each site was assigned a unique identification number. A general sketch of the footprint for the potential facility was drawn to include the footprint bottom width and length and placement based on side slopes and site constraints in the area. Photographs were taken of the site to document the conditions observed. Drainage areas were modified on the field maps, if needed.

GENERAL FINDINGS

From these 11 field assessments, two locations are being recommended for proposed BMPs: BMP-P-04 and BMP-P-07. Detailed information on the proposed BMPs can be found in Appendix B.2. The 12 potential BMPs that have been removed from consideration are described in this section.

BMP-P-01 is in a residential area beyond the cul-de-sac at the end of Glenwood Road. There is a new residential development in this area. The initial aerial maps did not show a stormwater facility at this location. After a second review of the potential BMP site, the stormwater facility was identified; therefore, the potential BMP was removed from consideration prior to the field assessments.

BMP-P-02 is in a residential area, at the bottom of a steep slope, behind the property at 411 Glenwood Road. During the desktop assessment, a bioretention facility appeared to be an option at this site to collect impervious runoff from the new development along Glenwood Road. While in the field, two outfalls were observed, both are in the backyard of 411 Glenwood Road, downhill of Glenwood Road. One outlets onto a steep slope with riprap protection that disperses the flow before crossing a driveway at the bottom of the hill. The other outlets into a dry detention area, at the base of the hill, with no obvious outfall, adjacent to the same driveway. Both outfalls are on private property and space and topography constraints prohibit construction of a BMP.

BMP-P-03 is located near the intersection of E. MacPhail Road and St. Andrews Way, near a residential area. An outfall at this location is on Harford County owned land and receives impervious area from a nearby road and neighborhood. During the desktop assessment, the site was chosen due to public ownership and gradual slopes. It was removed from consideration during a second, in office, review of the site because the outfall and nearby stream channel had already been restored as part of a stream restoration project.

BMP-P-05, near E. Wheel Road and Turner Lane, is in a very wooded area constrained by steep slopes with a small drainage area. From the desktop assessment, it looked possible to construct a bioretention adjacent to the road to collect road runoff, but the field visit determined there was not adequate space. No BMP is proposed at this location.

BMP-P-06 is located on HOA property behind the residence of 433 Fox Catcher Road. A bioretention facility was initially recommended for this location. During the field assessments, the focus was redirected towards public properties, large private properties, and commercial sites. This site was removed from consideration due to it being located on HOA open space property.

BMP-P-08 is in a residential area beyond the cul-de-sac at the end of Saint Albans Court. During the desktop assessment, a bioretention facility appeared to be an option at this site to collect runoff, at an outfall, from the surrounding neighborhood. In the field, two outfalls were identified within close proximity of one another. Both convey flows from Frans Drive. One outfall also conveys flow from Saint Albans Court. The outfall that conveys flows from Frans Drive and behind private residences, is in good condition with minor sediment buildup in the outfall channel. The second, larger outfall, is experiencing 6-foot to 8-foot bank erosion in the outfall channel. A BMP is not recommended at this location due to the size the drainage area.

BMP-P-09 is located at Fountain Green Elementary School with an existing wet pond. GIS storm drain features were not available for this site during the desktop evaluation. The site was evaluated to determine if a portion of the impervious area from the parking lot and school were not being treated by the wet pond. The field team verified that all of the impervious area was being treated by the wet pond; therefore, the site was removed from consideration.

BMP-P-10 is located at a small commercial property at 37 Kensington Parkway. The desktop assessment indicated that a bioretention may be possible at the parking lot inlet, but the field team discovered the inlet was too shallow to allow construction of an underdrained bioretention. The location also had a small drainage area and likely underground electric utilities in the area that precluded construction of a BMP.

BMP-P-11, ***BMP-P-12***, ***BMP-P-13***, and ***BMP-P-14*** are all located within the parking lot at Box Hill Square commercial area at 2900 Emmorton Road. Multiple grate inlets in the parking lots have the potential for nearby bioretention installation, but no BMPs are proposed at these locations. The drainage areas for all inlets are small and removal of parking spaces would be required to construct any BMPs. There are also underground electric utility conflicts.

4.3 OUTFALL ASSESSMENTS

In urban areas, runoff from impervious areas, such as streets, parking lots, driveways, and buildings, is typically collected by storm drain networks, which outfall to nearby streams. Without stormwater control measures or outfall stabilization methods, high flows during storm events from these stormwater outfalls tend to cause erosion along the receiving channel. Stabilizing the outfall channel and dissipating flows prior to entering the stream channel will alleviate stream degradation downstream.

Prior to field assessment, stream reaches were selected for field assessments. There are 163 outfalls that were identified through Harford County GIS data, that flow to the selected stream reaches to be surveyed. An additional 34 outfalls were identified during the field assessments, for a total of 197 outfalls. Most of these outfalls are located on homeowner association property or residential private property. Prior to the outfall assessments, written permission requests were sent out to all homeowner's impacted by the study. Field crews were able to access homeowner's association property as well as private homeowner's who gave approval. The following sections provide details on the outfall assessment protocol, a summary of sites, and the general findings.

4.3.1 OUTFALL ASSESSMENT PROTOCOL

Field crews attempted to access all 197 outfalls; however, due to limited budget and time, 79 of the 197 outfalls were fully assessed based on established criteria. The remaining outfalls were documented through pictures, unless property access was restricted or the structure was not located. An outfall was assessed if the pipe was 24 inches or larger in diameter. If the outfall pipe diameter was smaller than 24 inches, it was assessed if the structure, outfall protection, or outfall channel were experiencing active erosion or in need of maintenance. The assessments were conducted based on protocols developed by WSP, which were developed as a tool for field teams to quickly evaluate the current conditions of the outfall and determine outfall stabilization opportunities. Potential outfall stabilization projects are proposed along with stream restoration projects and can be found in Appendix C.

The outfall assessment is used to quickly assess the physical conditions of outfalls and identify potential restoration opportunities. The assessments were conducted in the summer of 2019 by two-person field crews from WSP. The teams walked each site in the Lower Bynum Run watershed. Of the 197 sites, access was granted by the property owners for 185 outfalls. An additional 9 outfalls could not be located at the

GIS identified locations. The following protocols were used to collect information at each site. Items in the protocol that were not applicable to a specific site were not filled out at that site.

- Identification of type of flow at outfall
- Description of any maintenance needs
- Observation of accessibility for construction and maintenance access
- Identification of utilities within 10 feet of outfall protection
- Description of outfall structure (Pipe material, diameter, condition)
- Description of outfall protection (Material, length, width, condition)
- Identification of scour hole dimensions, if present
- Observation of active channel erosion occurrence within the outfall channel

Field teams walked the selected sites while sketching a plan view of the outfall, outfall protection, and outfall channel. Dimensions were documented for any features added to the sketch. A profile sketch was also drawn in the field of the outfall, outfall protection, and outfall channel. The last sketch drawn was for a cross section at the outfall structure. Any pertinent information discovered at the site, including utilities, scour holes, damages, and steep slopes, were included in the sketches. An electronic form was filled out on a GIS enabled iPad to collect all the information in the protocol. Photographs were taken of the overall site and throughout the site assessment to document the conditions observed. Each site was assigned a unique identification number.

4.3.2 GENERAL FINDINGS

At the conclusion of the field assessments, 79 outfalls had been fully assessed based on the protocols in Section 4.3.1. Each of the 79 sites assessed and the pipe size and material is identified in Table 4-4. The locations of all 197 outfalls within the study area are shown in Figure 4-3 through Figure 4-5. The 79 outfalls that were assessed are shown with distinct symbology. Some of these outfalls are located at least 10-15 feet of a stream bank, making it possible to perform outfall stabilization in conjunction with an adjacent stream restoration project. Some of the outfalls needing stabilization are recommended along with a stream restoration project. Outfalls that require stabilization but are not near a potential stream restoration project are considered stand-alone projects. Potential outfall stabilization projects with stream stabilization or as stand-alone stabilization can be found in Appendix C.

Table 4-4: List of Fully Assessed Outfalls

Outfall #	Pipe Size (in.)	Outfall #	Pipe Size (in.)	Outfall #	Pipe Size (in.)
OF-2	24	OF-80	30	OF-141	24
OF-5	36	OF-81	18	OF-142	36
OF-6	36	OF-82	18	OF-144	36
OF-11	42	OF-85	30	OF-145	24
OF-16	36	OF-88	60	OF-146	18
OF-17	30	OF-94	38 × 60	OF-147	42
OF-23	21	OF-100	42	OF-148	36
OF-25	36	OF-103	36	OF-151	53x83
OF-26	36	OF-105	30	OF-152	58x91
OF-28	48	OF-106	24	OF-160	54
OF-34	60	OF-107	18	OF-161	18
OF-43	24	OF-116	24	OF-164	24
OF-46	60	OF-118	30	OF-168	30
OF-48	24	OF-119	24	OF-170	9
OF-51	42	OF-124	24	OF-171	24
OF-58	36	OF-125	30	OF-172	24
OF-60	36	OF-128	24	OF-175	30
OF-62	30	OF-129	18	OF-176	24
OF-65	36	OF-130	36	OF-180	48
OF-68	15	OF-131	24	OF-181	24
OF-69	18	OF-134	96	OF-182	18
OF-70	15	OF-135	18	OF-185	30
OF-71	96	OF-136	24	OF-190	66
OF-76	18	OF-137	30	OF-191	12
OF-77	36	OF-138	24	OF-192	60
OF-78	18	OF-140	24	OF-193	30
OF-79	18				

Nine outfalls are being recommended for outfall stabilization projects in conjunction with a stream restoration project. Four outfall stabilization projects are recommended as stand-alone projects. Thirty-four (34) additional outfalls are recommended for maintenance due to sediment accumulation in the outfall and outfall channel or damaged end pipe or end sections. Table 4-5 provides a list of outfalls that are recommended for outfall stabilization or outfall maintenance. Additional information on the type of project recommended can be found in Appendix C.

Table 4-5: Outfalls Recommended for Outfall Stabilization or Maintenance

Outfall #	Project Type	Outfall #	Project Type
OF-2	Maintenance	OF-80	Stand-Alone Stabilization
OF-6	Maintenance	OF-82	Stabilization
OF-10	Maintenance	OF-85	Stabilization
OF-12	Maintenance	OF-98	Stabilization
OF-17	Stand-Alone Stabilization	OF-99	Stabilization
OF-18	Maintenance	OF-105	Maintenance
OF-23	Maintenance	OF-107	Maintenance
OF-24	Maintenance	OF-124	Maintenance
OF-26	Maintenance	OF-125	Maintenance
OF-34	Maintenance	OF-127	Maintenance
OF-35	Stand-Alone Stabilization	OF-128	Maintenance
OF-44	Stabilization	OF-129	Maintenance
OF-51	Stabilization	OF-130	Maintenance
OF-58	Stabilization	OF-136	Maintenance
OF-63	Maintenance	OF-137	Maintenance
OF-65	Stand-Alone Stabilization	OF-140	Maintenance
OF-66	Maintenance	OF-153	Maintenance
OF-68	Maintenance	OF-161	Maintenance
OF-72	Maintenance	OF-162	Maintenance
OF-74	Maintenance	OF-164	Maintenance
OF-75	Maintenance	OF-175	Stabilization
OF-76	Maintenance	OF-178	Maintenance
OF-77	Maintenance	OF-185	Stabilization
OF-78	Maintenance		

141 outfalls were not recommended for outfall stabilization or maintenance. In most cases, the outfall structures and outfall channels were in good condition and do not require outfall stabilization. In a few cases, the outfall structure and/or channel were in fair condition. While minor bank stabilization may be an option for these outfalls, the sites are difficult to access with construction equipment and/or are not connected with a proposed stream restoration project. The sites were deemed in stable condition and not added to the list of outfall stabilization projects.

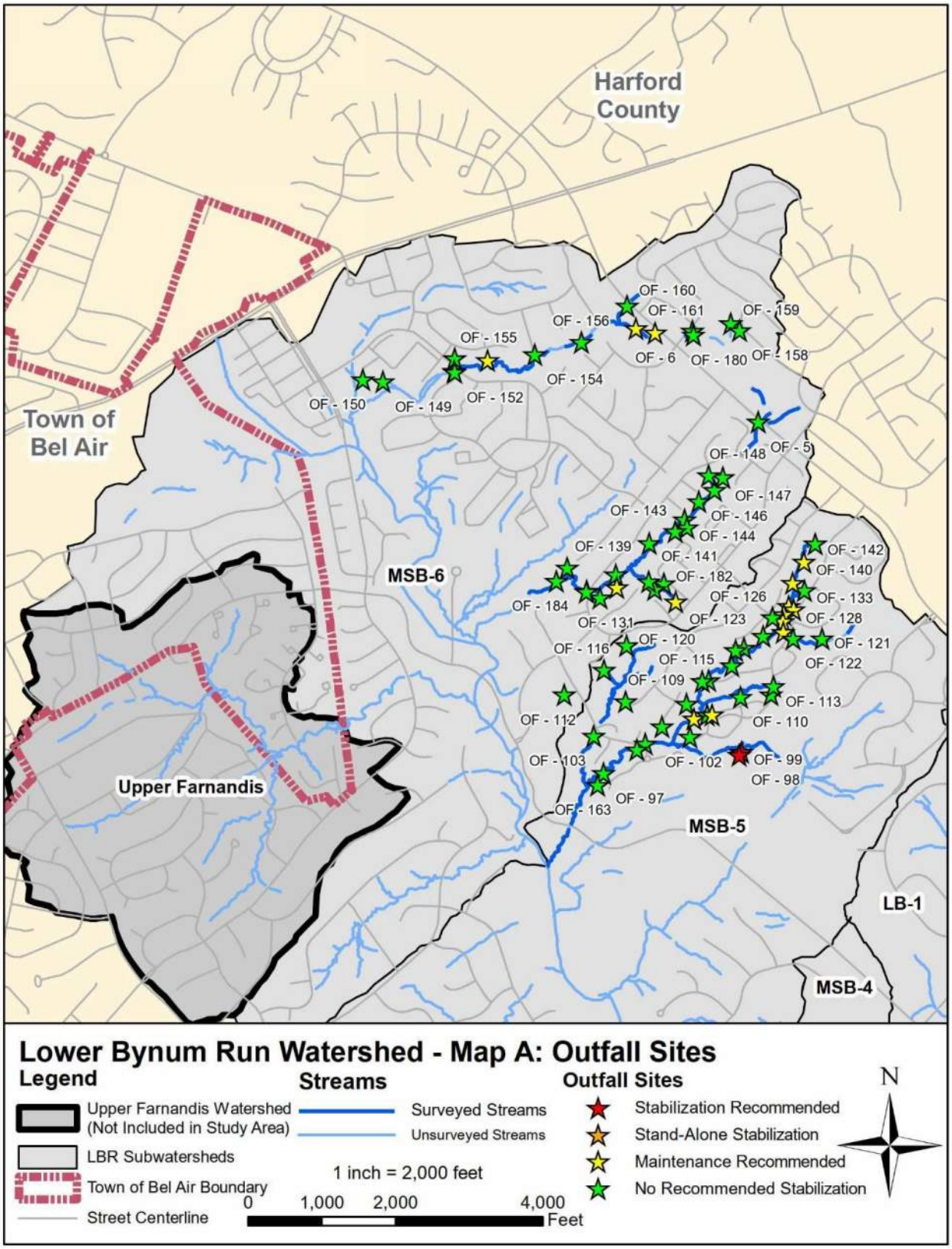

Figure 4-3. Lower Bynum Run Map A Outfall Sites

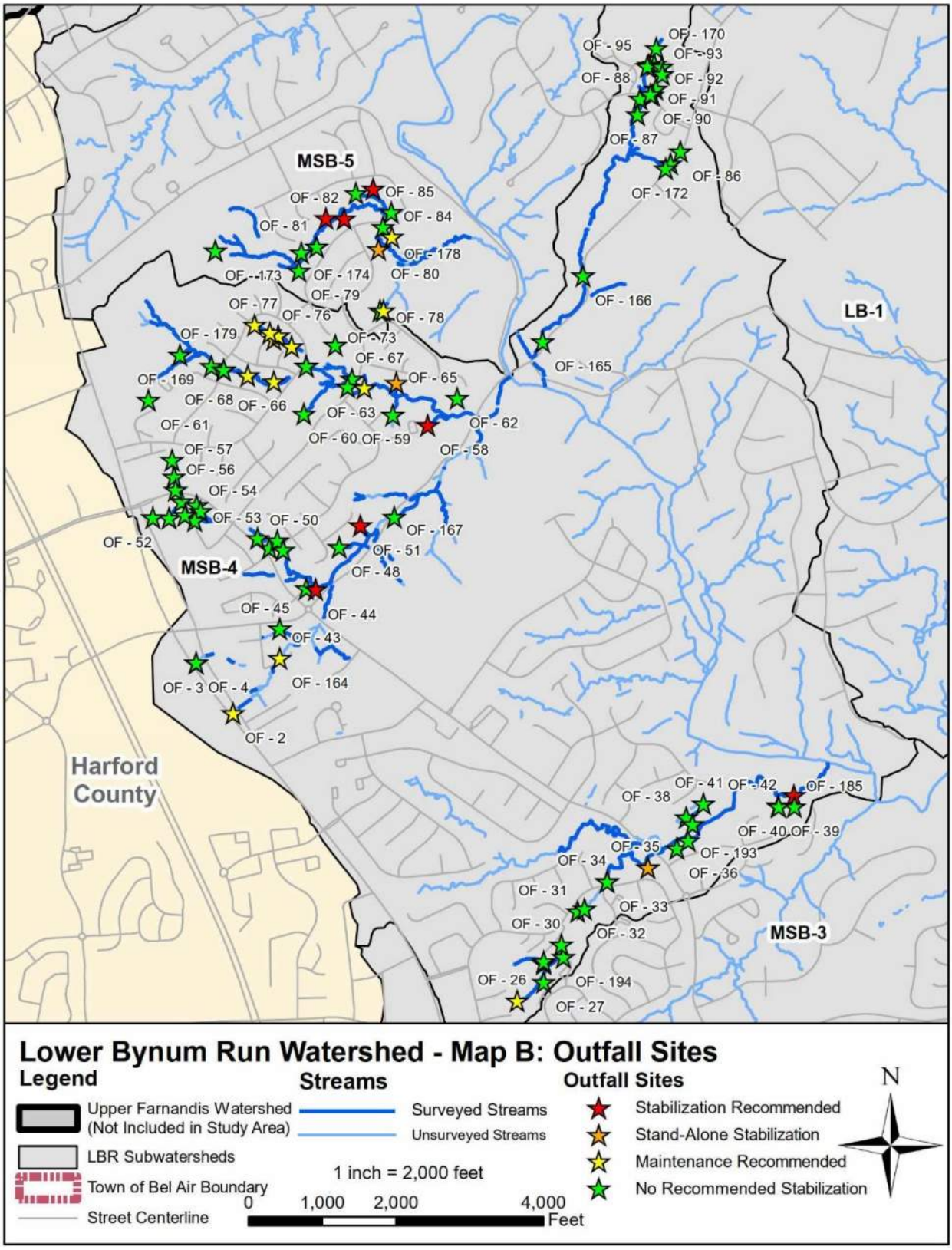

Figure 4-4: Lower Bynum Run Map B Outfall Sites

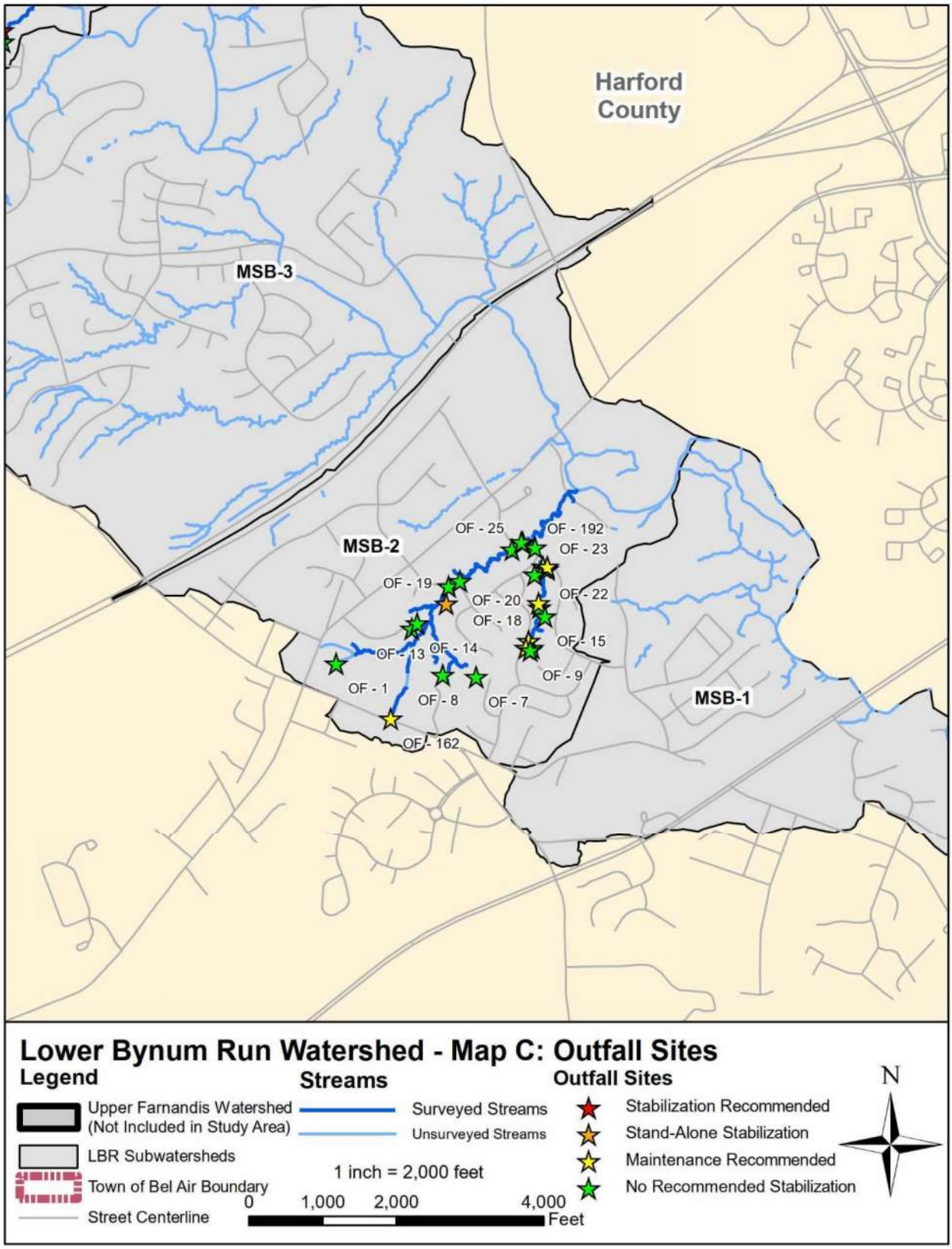

Figure 4-5: Lower Bynum Run Map C Outfall Sites

4.4 STREAM CORRIDOR ASSESSMENTS

Stream Corridor Assessments (SCAs) were conducted for several representative stream reaches in the Lower Bynum Run watershed. Lower Bynum Run contains 95.4 stream miles. Prior to the assessments, several stream reaches totaling 18.2 miles within 4 of the 8 subwatersheds were selected for the SCA. The assessments were conducted based on Maryland DNR's SCA Survey Protocols, which were developed as a tool for environmental managers to quickly identify environmental problems within a watershed's stream network (Yetman, 2001). This methodology presents a rapid field survey, rather than a detailed scientific assessment, to better target monitoring, management, and conservation efforts on the watershed and subwatershed scale. The following sections present a description of the SCA protocol employed, an overview of the streams that were assessed, and general results for the Lower Bynum Run watershed.

4.4.1 STREAM ASSESSMENT PROTOCOL

The SCA method is used to quickly assess the physical conditions and identify common environmental problems in a stream corridor. The assessments were conducted in the summer of 2019 by two-person field crews from WSP. The teams walked the stream segments in the Lower Bynum Run watershed that were selected based on accessibility, owner permission, and stream feature. Following the SCA method, each field crew looked for the following environmental problems during the assessment. More information is provided for each environmental problem in Section 4.4.3.

- Channel Alteration Sites (CA)
- Erosion Sites (ES)
- Exposed Pipes (EP)
- Fish Migration Barriers (FB)
- Inadequate Stream Buffers (IB)
- Pipe Outfalls (PO)
- Trash Dumping (TD)

Field teams walked the selected stream corridors while noting the location of the problem sites on field maps and filling out the appropriate data at each site on a GPS enabled tablet. Electronic field forms were based on guidance provided in DNR's SCA manual. Multiple photographs were taken at each site to document the conditions observed. Each site was assigned a unique identification number by its map grid ID number, the two letters corresponding to the respective problem type, as shown in the list above, and followed by a sequential site number. The map grid is based on a 150-scale grid system used to generate paper field maps and assign unique IDs to field data items.

SCA problem sites were rated on a scale of one to five indicating the severity of the problem from very severe to minor. Severity is a measure of how serious a problem site is compared to other problems

within the same category. The most severe problems are those with a direct impact on stream resources. The severity ratings are intended to help prioritize potential restoration opportunities, ranging from a score of 5 which represents a minor problem, to a score of 1 denoting the worst or most severe observed.

4.4.2 SUMMARY OF SITES INVESTIGATED

Streams within the watershed were determined using county GIS hydrology lines data along streams and rivers. Due to the size of the watershed, select stream corridors were identified within the watershed for the SCA assessment. Prior to walking the stream corridors, permission request letters were mailed to all property owners of properties that intersected the proposed stream corridors. Stream corridors that were located on properties whose landowner denied permission for an assessment, a "No" response (Figure 4-8 through Figure 4-10), or whose reaches could not be accessed were not included in the SCAs, unless the stream could be viewed from an adjacent property. For stream corridors that were located on properties whose landowner did not respond to the written request for access, the County evaluated each property and determined if the field crews would be able to enter those properties. For example, HOA open spaces were granted access ("No Response-Yes"). Properties with residential homes were denied permission if the property owner did not respond to the written request ("No Response-No"). While walking the accessible stream corridor, if a confluence was identified with an undocumented channel, the unidentified channel was assessed as long as landowner permission had already been given. Based on these criteria, a total of 15.5 miles of stream were assessed, herein referred to as surveyed streams. Table 4-6 summarizes the total miles of surveyed streams in each of the 4 subwatersheds.

Table 4-6: Surveyed Streams in Lower Bynum Run Watershed

Subwatershed	Surveyed Stream Miles
MSB-2	1.9
MSB-4	7.5
MSB-5	4.2
MSB-6	1.9
Total	**15.5**

Figure 4-6 and Figure 4-7 shows the stream network within the watershed. The streams surveyed are shown in dark blue. Figure 4-8 through Figure 4-10 shows plots of land where landowner permission was given (Yes), denied (No), given to properties with no response (No Response-Yes), and denied to properties with no response (No response-No). These maps illustrate why certain stream segments could not be assessed.

As described previously, SCA problem sites were assigned unique identification numbers according to a map grid ID number. Each site was numbered sequentially during the assessment. The map grid used for the Lower Bynum Run SCAs is shown in Figure 4-6 and Figure 4-7. The field teams walked stream segments by map number. For example, the first SCA problem site located in MSB-2 subwatershed within

map number “A7” was an erosion site and was numbered as ES-1; the remaining inadequate buffer sites were numbered consecutively along the remaining stream segments within the map. Each problem type was numbered, starting at 01 within a map grid (i.e. ES-02, ES-03, IB-01, IB-02, etc.). An additional “right” (R) or “left” (L) identification was added to the end of the unique identification number when it was necessary to specify the bank containing the problem, such as channel alteration sites, erosion sites and inadequate buffers. This same numbering convention was implemented using the map grid across the watershed.

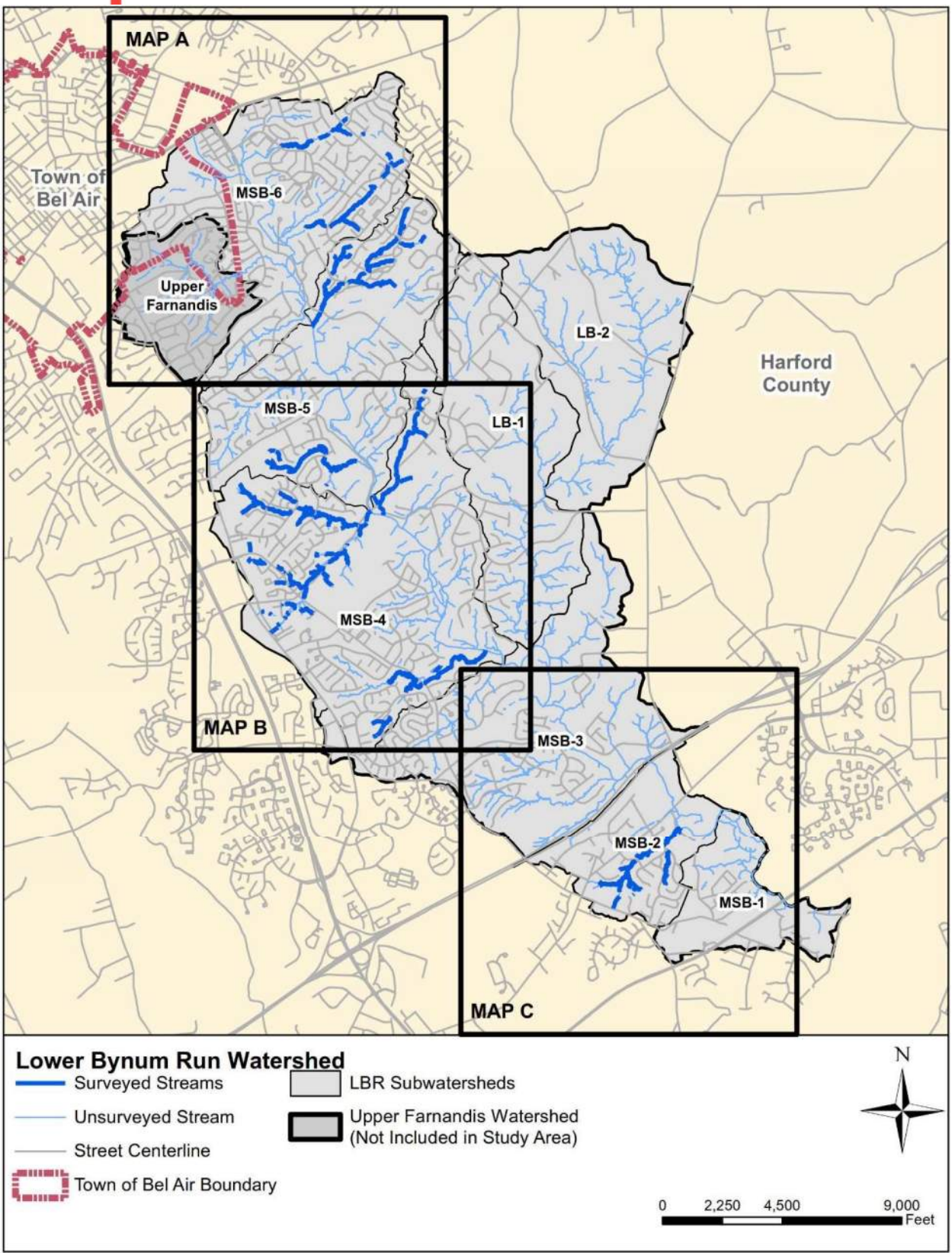

Figure 4-6. Lower Bynum Run SCA Survey Grid

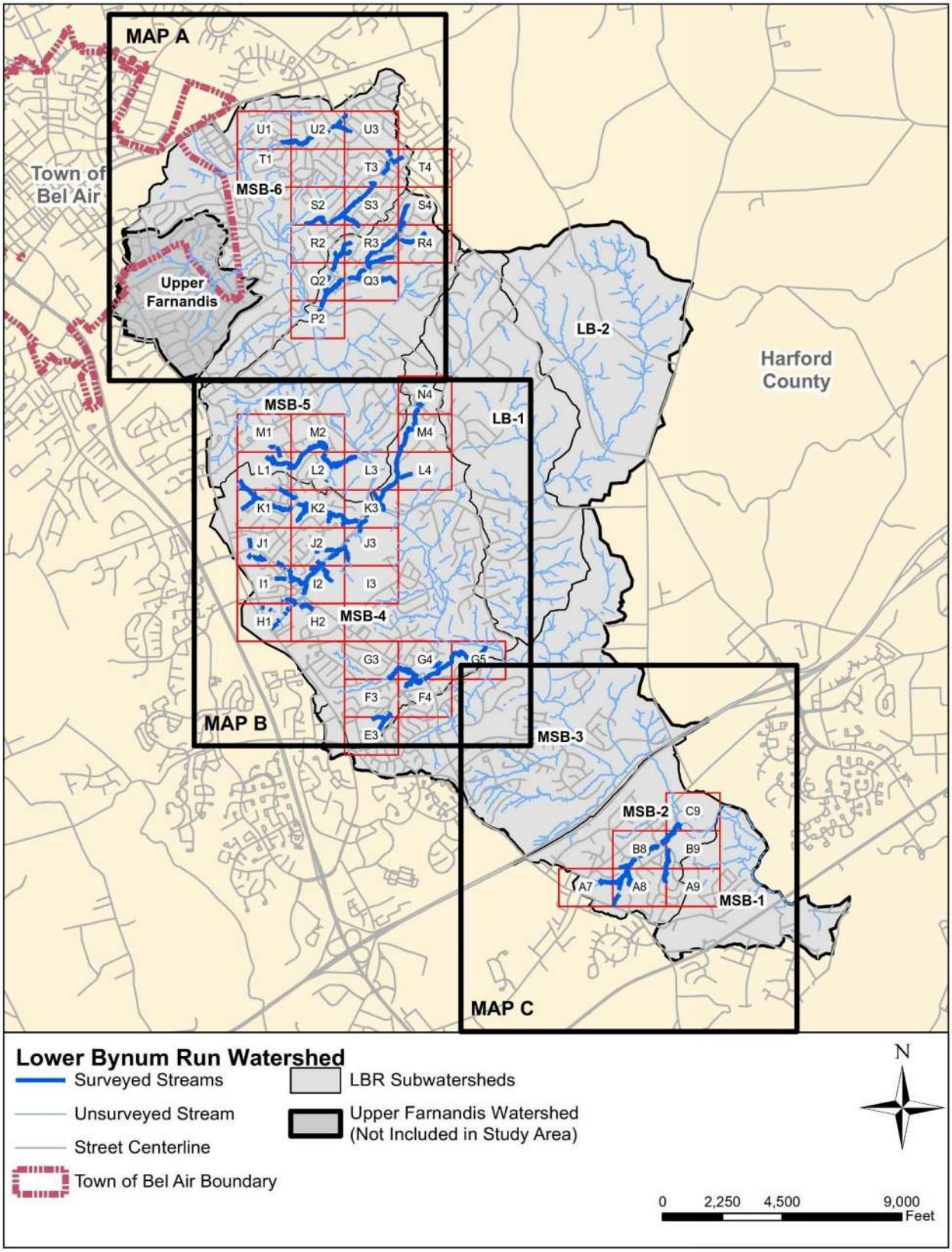

Figure 4-7. Lower Bynum Run SCA Survey Grid and Map Numbers

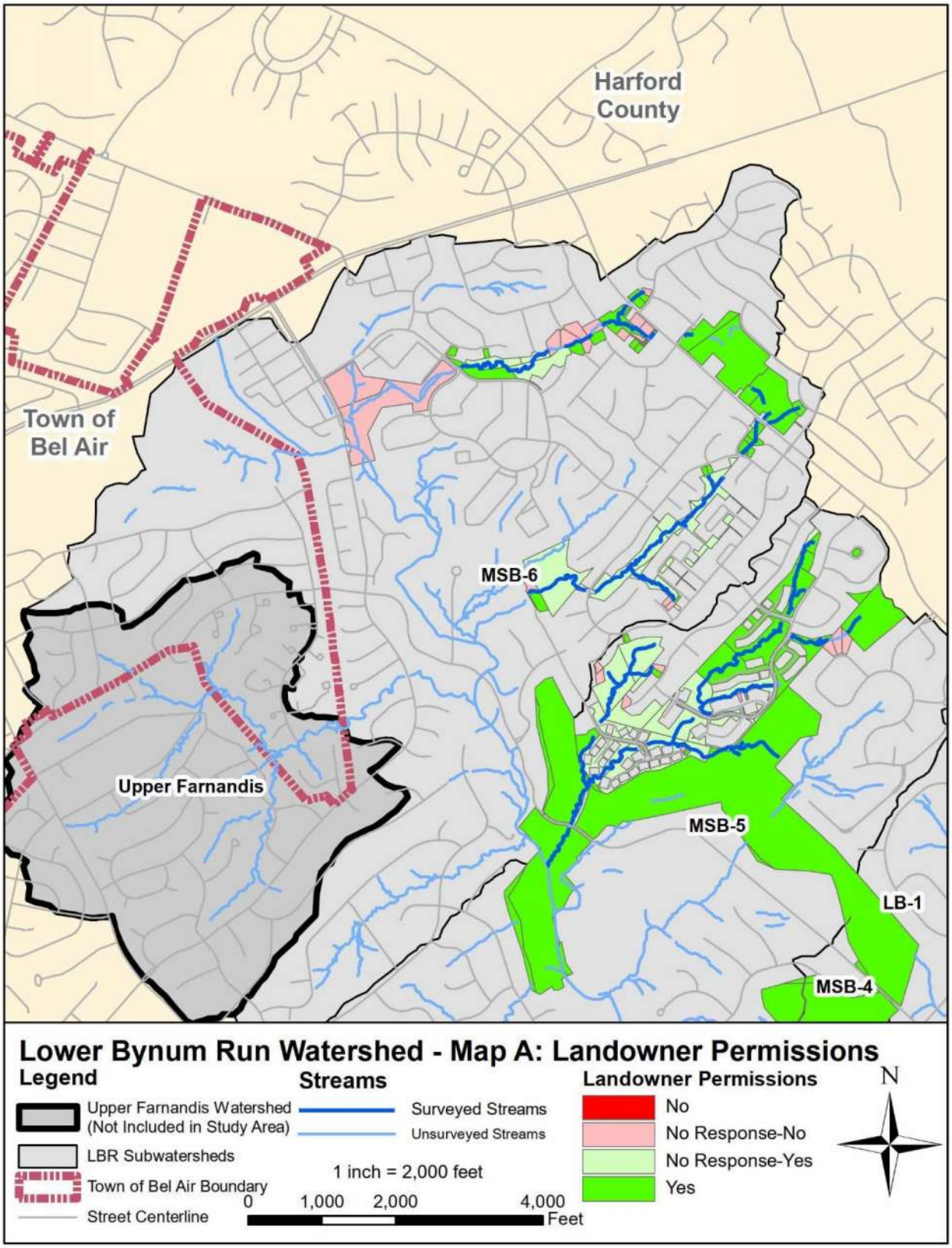

Figure 4-8: Lower Bynum Run Map A Landowner Permissions

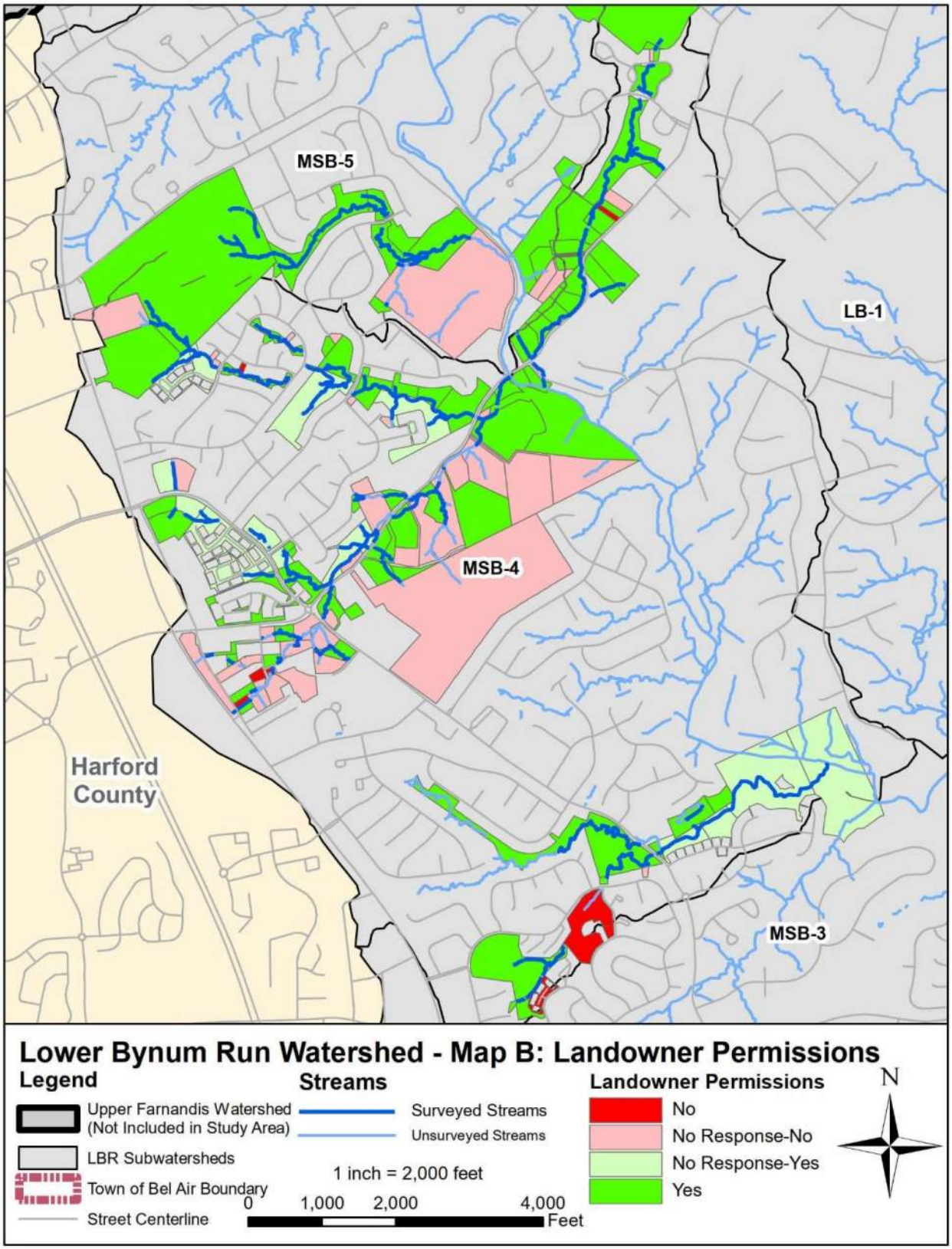

Figure 4-9. Lower Bynum Run Map B Landowner Permissions

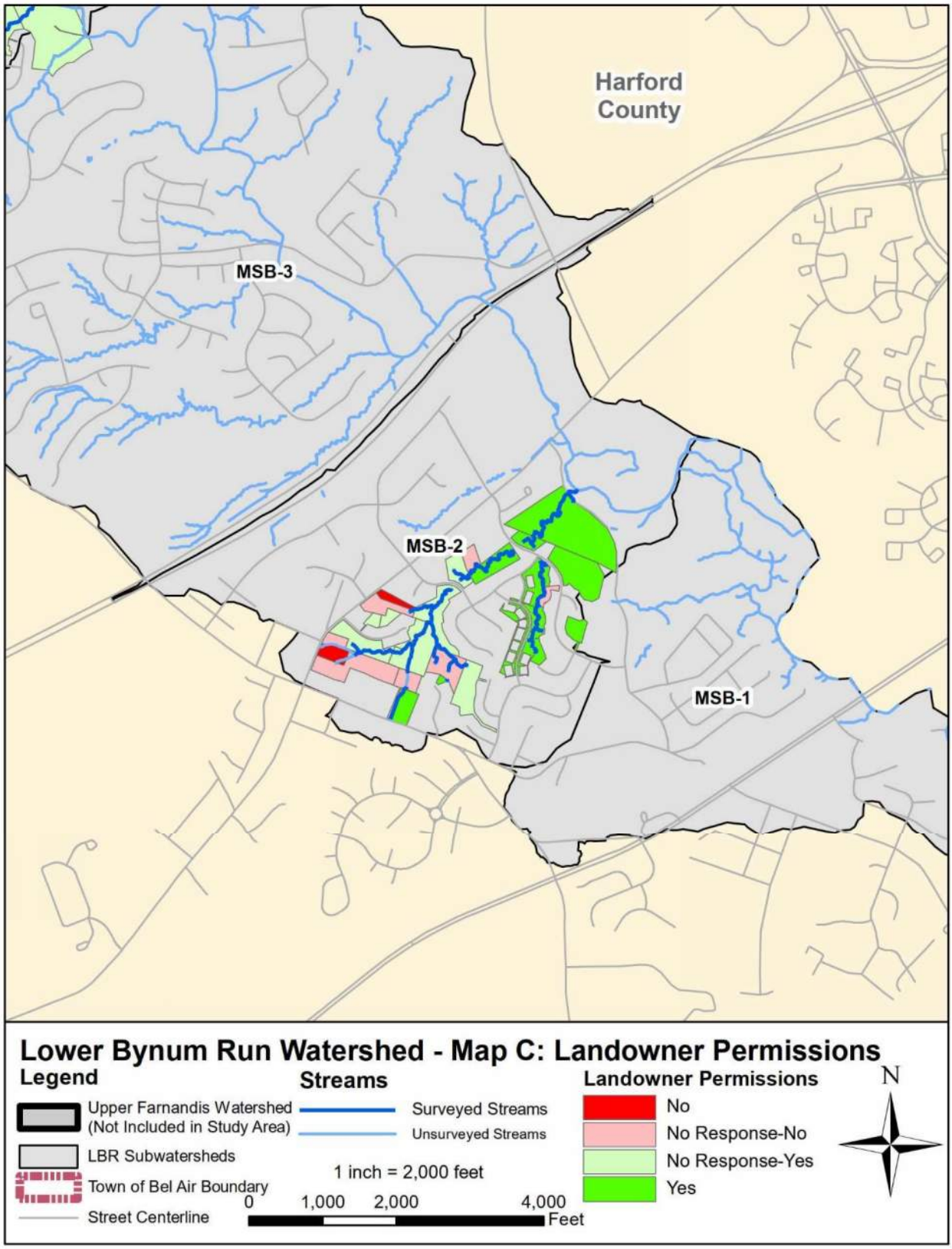

Figure 4-10: Lower Bynum Run Map C Landowner Permissions

4.4.3 GENERAL FINDINGS

Along the 15.5 miles of stream assessed within the Lower Bynum Run watershed, 350 potential environmental problem sites were observed. The total number of potential problem sites observed within each of the assessed subwatersheds is summarized in Table 4-7.

Table 4-7: Lower Bynum Run Subwatershed SCA Survey Results - Number of Potential Problems

Subwatershed	Inadequate Buffer	Erosion Sites	Fish Barriers	Pipe Outfalls	Exposed Pipes	Channel Alteration	Trash Dumping	Total
MSB-2	0	28	0	1	1	1	0	31
MSB-4	15	101	1	12	1	13	2	145
MSB-5	22	64	0	22	10	3	1	122
MSB-6	8	32	2	9	1	0	0	52
Total	**45**	**225**	**3**	**44**	**13**	**17**	**3**	**350**

Erosion sites were the most frequent problem observed (225) followed by inadequate buffers (45) and pipe outfalls (44). Fish barriers (3) and trash dumping (3) were observed the least within the watershed. A summary of the lengths of channel alterations, erosion sites, and inadequate buffers are summarized in Table 4-8 for the Lower Bynum Run watershed. A description of each potential problem category is provided in the proceeding sections.

Table 4-8: Lower Bynum Run Subwatershed Survey Results – Length of Potential Problems

Subwatershed	Length of Channel Alteration (ft)	Length of Erosion (ft)	Length of Inadequate Buffer (ft)
MSB-2	32	12,006	0
MSB-4	1,040	41,060	7,498
MSB-5	84	31,132	7,631
MSB-6	0	10,254	2,305
Total	**1,156**	**94,452**	**17,434**

For erosion and inadequate buffer sites, survey results were further broken up by Stream Analysis Zones. These zones grouped surveyed stream reaches into 13 distinct areas within the watershed to determine the severity of the problems observed in individual stream reaches. The results from these summaries helped to select potential stream restoration sites.

INADEQUATE STREAM BUFFERS

Forested buffer areas along streams are important for improving water quality for flood mitigation as they provide stream bank stabilization through their root systems, reduce the rate of surface runoff, supply shade to streams, remove pollutants such as nutrients and sediments from runoff, and provide habitat for various types of terrestrial and aquatic life, including fish. For the SCA, a stream buffer was considered inadequate if it was less than 50 feet wide from the edge of either stream bank. Inadequate stream buffers were observed in three of the subwatersheds. The field teams identified 45 inadequate buffer sites with a total length of approximately 3.3 miles. This equates to approximately 21.3% of the total streams surveyed having inadequate buffers on one or both stream banks.

The severity of inadequate stream buffers was rated according to length and width. The most severe rating (very severe) of 1 would be given to inadequate buffer lengths with limited or no trees on either stream bank and no evidence that a tree buffer is beginning to form for a significant length of stream. The existing land use was also taken into consideration, such as pavement, lawn, or shrubs and trees. The highest inadequate buffer rating assigned in the assessed subwatersheds was a severe rating, which was given to three sites. The three sites were in MSB-5 subwatershed. Two of the sites are shown in Figure 4-11. Most sites were rated between moderate (3) and minor (5). Stream buffer restoration potential depends on various factors such as accessibility, property ownership, and current land use. Many of the more severe inadequate buffer sites in the watershed were due to land clearing up to the stream banks in residential yards.

Figure 4-11. Examples of severe (left) and moderate (right) inadequate stream buffers in Lower Bynum Run Watershed

The raw field data was simplified for inadequate buffers to reflect the more severe condition along either bank. This analysis removed duplicate lengths of inadequate buffers within each stream reach. When an inadequate buffer was called out on both stream banks, only the more severe inadequate buffer was retained. Moderate to very severe inadequate buffers were grouped in a single category. Existing buffer was assigned for the remaining stream reach to recognize stream segments that have at least a 50-foot buffer. Table 4-9 summarizes the length of inadequate buffer associated with the severity rating and the stream analysis zones. Thirteen stream analysis zones were assigned to evaluate individual stream

reaches. The percentage of surveyed streams having inadequate buffer (moderate to severe, minor, and low) are also shown.

Table 4-9: Lower Bynum Run SCA Survey Results - Inadequate Stream Buffers

Stream Analysis Zones	Subwatershed	Moderate to Severe Inadequate Buffer (ft)	Minor Inadequate Buffer (ft)	Low Severity Inadequate Buffer (ft)	Existing Buffer (ft)	Total Surveyed Stream Length (ft)	% of Surveyed Streams
1	MSB-2	0	0	0	4,996	4,996	0%
2	MSB-2	0	0	0	5,196	5,196	0%
3	MSB-4	2,503	0	492	5,849	8,844	34%
4	MSB-4	1,041	0	0	8,129	9,170	11%
5	MSB-4	0	0	0	6,705	6,705	0%
6	MSB-4	455	0	761	6,061	7,278	17%
7	MSB-4	762	0	0	6,689	7,451	10%
8	MSB-5	1,579	0	0	6,227	7,806	20%
9	MSB-5	602	667	462	3,205	4,935	35%
10	MSB-5	146	0	831	2,106	3,083	32%
11	MSB-5	1,176	0	129	5,049	6,353	21%
12	MSB-6	804	0	0	5,625	6,429	13%
13	MSB-6	1,500	0	0	2,180	3,680	41%
Total		**10,569**	**667**	**2,674**	**68,016**	**81,925**	**17%**

Most of the inadequate buffer sites were in MSB-4 and MSB-5; approximately 17% of all streams assessed were identified as having some sort of inadequate buffer. Many of the inadequate buffers are due to residential lawns. Unshaded conditions can be detrimental to aquatic life as shade protects streams from excessive solar heating. A TMDL listing for temperature in the watershed indicates that unshaded reaches are currently experiencing solar heating. The locations of stream segments with inadequate buffers and their corresponding severity ratings are shown in Figure 4-12 through Figure 4-14.

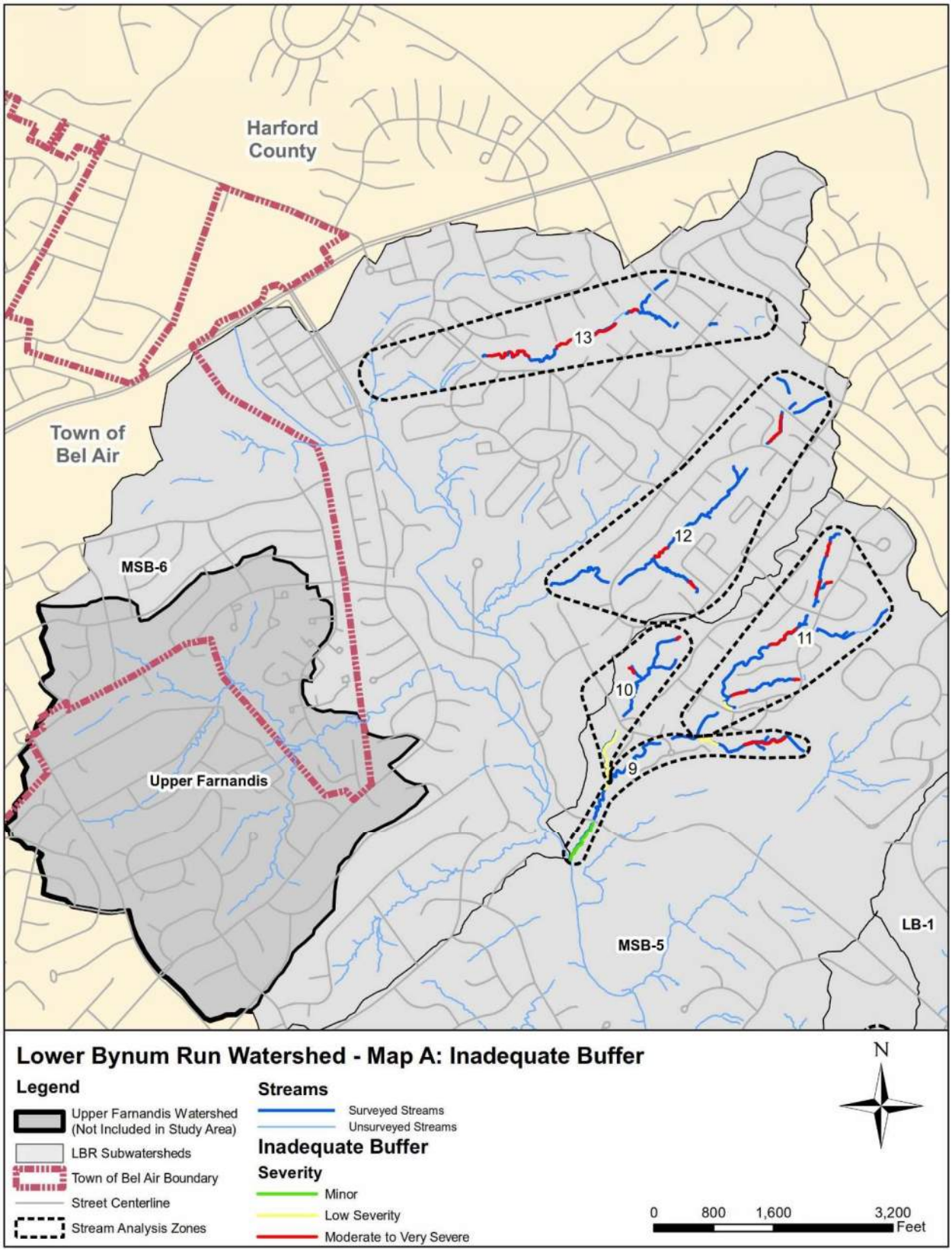

Figure 4-12: Inadequate Stream Buffer Locations in Lower Bynum Run SCA (Map A)

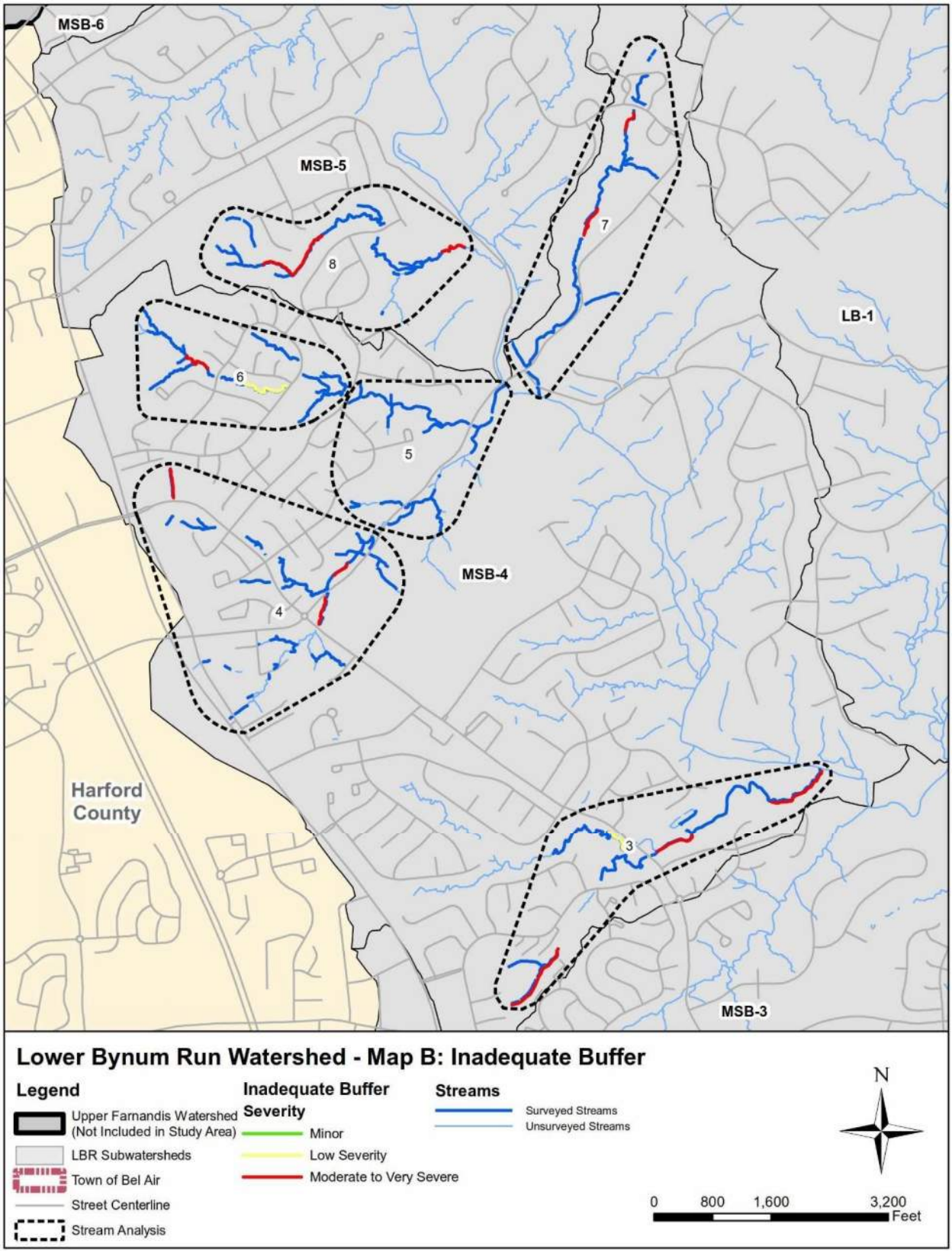

Figure 4-13: Inadequate Stream Buffer Locations in Lower Bynum Run SCA (Map B)

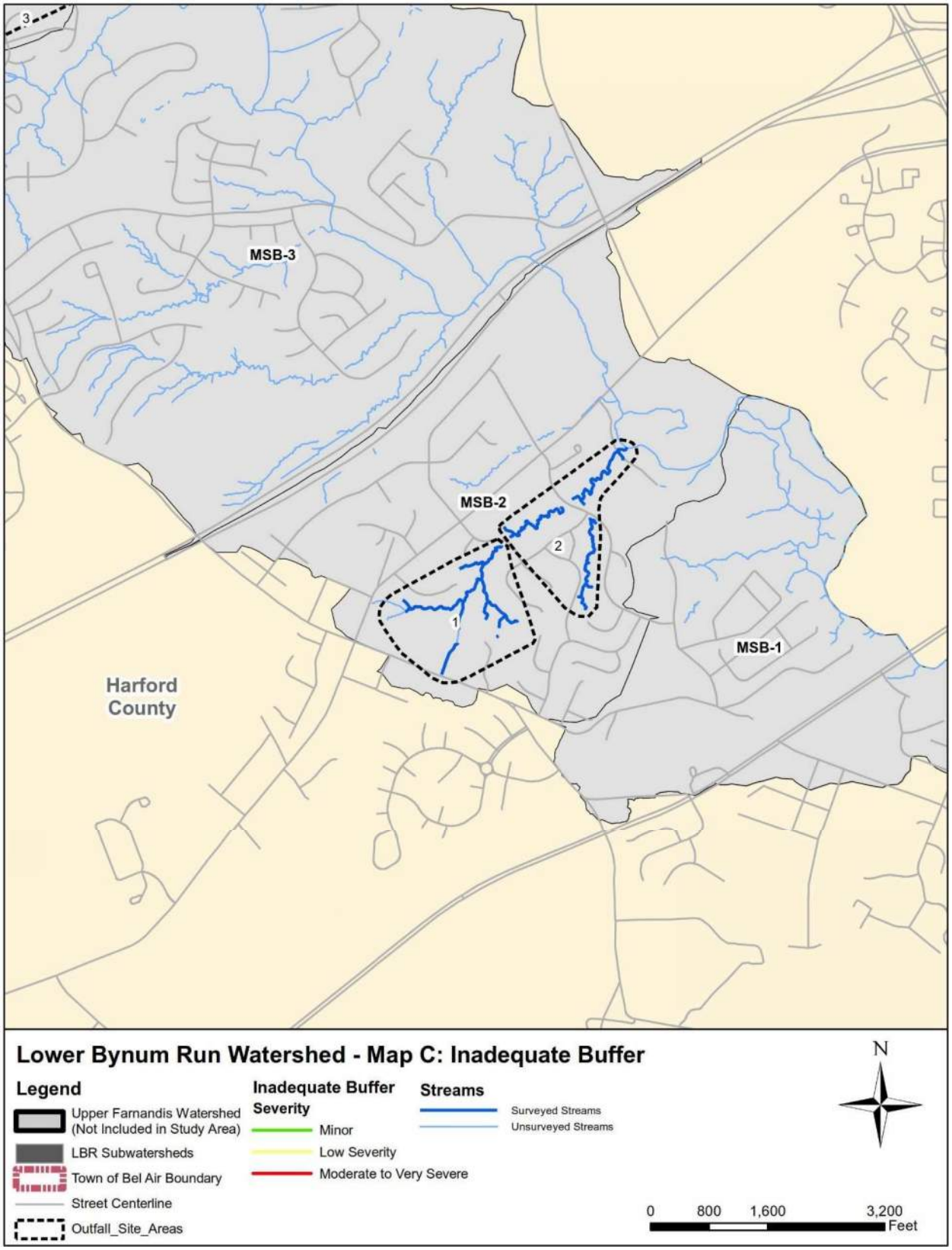

Figure 4-14: Inadequate Stream Buffer Locations in Lower Bynum Run SCA (Map C)

EROSION SITES

Stream bank erosion is a natural process necessary to maintain a healthy aquatic habitat. Conversely, too much erosion can have the opposite effect on a stream system by destabilizing banks, destroying in-stream habitat, and causing sediment pollution problems downstream. Significant erosion problems are the result of changes to stream hydrology or sediment supply which is often attributed to land use changes in a watershed (e.g., urbanization, increased impervious cover). This results in a much greater in-stream flow rate during storm events and leads to eroded streambeds and banks. Although streams in forested areas may have adequate 50-foot forest buffers, they can also experience erosion problems due to these high flows from upstream.

Because erosion is a natural process, it was not the purpose of the SCA survey to identify every erosion occurrence. Significant erosion sites were defined by vertical stream banks with exposed soil and overall instability. The type of erosion, possible cause, adjacent land use, and whether there was a threat to nearby infrastructure were noted for each erosion site.

As with the inadequate buffer sites, the raw field data was simplified to reflect eroded banks based on the more severe condition on either bank. This analysis removed duplicate lengths of eroded banks within each stream reach. When an erosion segment was called out on both stream banks, only the bank experiencing more severe erosion was retained. Moderate to very severe erosion were grouped in a single category. Areas with minimal to no erosion were assigned for the remaining stream reach to recognize stream segments that currently are not actively eroding. Table 4-10 below summarizes the length of erosion associated with the severity rating and the stream analysis zones. Thirteen stream analysis zones were assigned to evaluate individual stream reaches. The percentage of surveyed streams having erosion are also shown.

Table 4-10: Lower Bynum Run SCA Survey Results - Erosion Sites

Stream Analysis Zones	Moderate to Severe Erosion (ft)	Minor Erosion (ft)	Low Severity Erosion (ft)	No Erosion (ft)	Total Surveyed Stream Length (ft)	% of Surveyed Streams
1	1,745	0	666	2,585	4,996	48%
2	2,786	0	1,097	1,313	5,196	75%
3	5,569	925	491	1,859	8,844	79%
4	1,977	446	1,214	5,532	9,170	40%
5	3,541	553	0	2,612	6,705	61%
6	2,855	255	1,349	2,818	7,278	61%
7	2,410	0	1,176	3,865	7,451	48%
8	3,722	0	802	3,282	7,806	58%
9	3,093	988	269	585	4,935	88%
10	1,637	200	1,003	243	3,083	92%
11	1,310	541	2,654	1,848	6,353	71%
12	2,529	823	793	2,284	6,429	64%
13	1,239	0	448	1,993	3,680	46%
Total	**34,413**	**4,731**	**11,963**	**30,819**	**81,925**	**62%**

A total of 62% of the surveyed streams experienced some degree of erosion. Erosion was the most documented potential problem identified from the SCA surveys. The length of eroded banks along the surveyed streams along with the urban nature of the watershed indicate potential sediment pollution impacts. The length of stream channel identified with erosion totaled 9.7 miles. The severity of the stream segments within the thirteen stream analysis zones led to the development of seventeen (17) potential stream and outfall projects. These projects are discussed in detail in Appendix C; however, it is important to note the degree of erosion seen in the proposed project stream reaches during the field assessment.

Figure 4-15 shows the two very severe erosion sites. The figure on the left is of site J2-ES-1L, a very severe erosion site with a six-foot average vertical bank height over a 49-foot distance. The section of erosion featured illustrates the threat to the outfall structure and adjacent roadway. The erosion site has been classified as Stage I – Incision. The figure on the right is of site R3-ES-3L, a very severe erosion site in MSB-5 with 15-foot vertical bank heights over a 146-foot distance. The erosion at this site is currently threatening an outfall structure downstream of the bend pictured. The erosion site has been classified as Stage II – Widening. The location of all erosion sites can be seen in Figure 4-16 through Figure 4-18.

Figure 4-15. Example of a Very Severe Erosion Site in MSB-4 (left) and a Very Severe Erosion Site in MSB-5 (right)

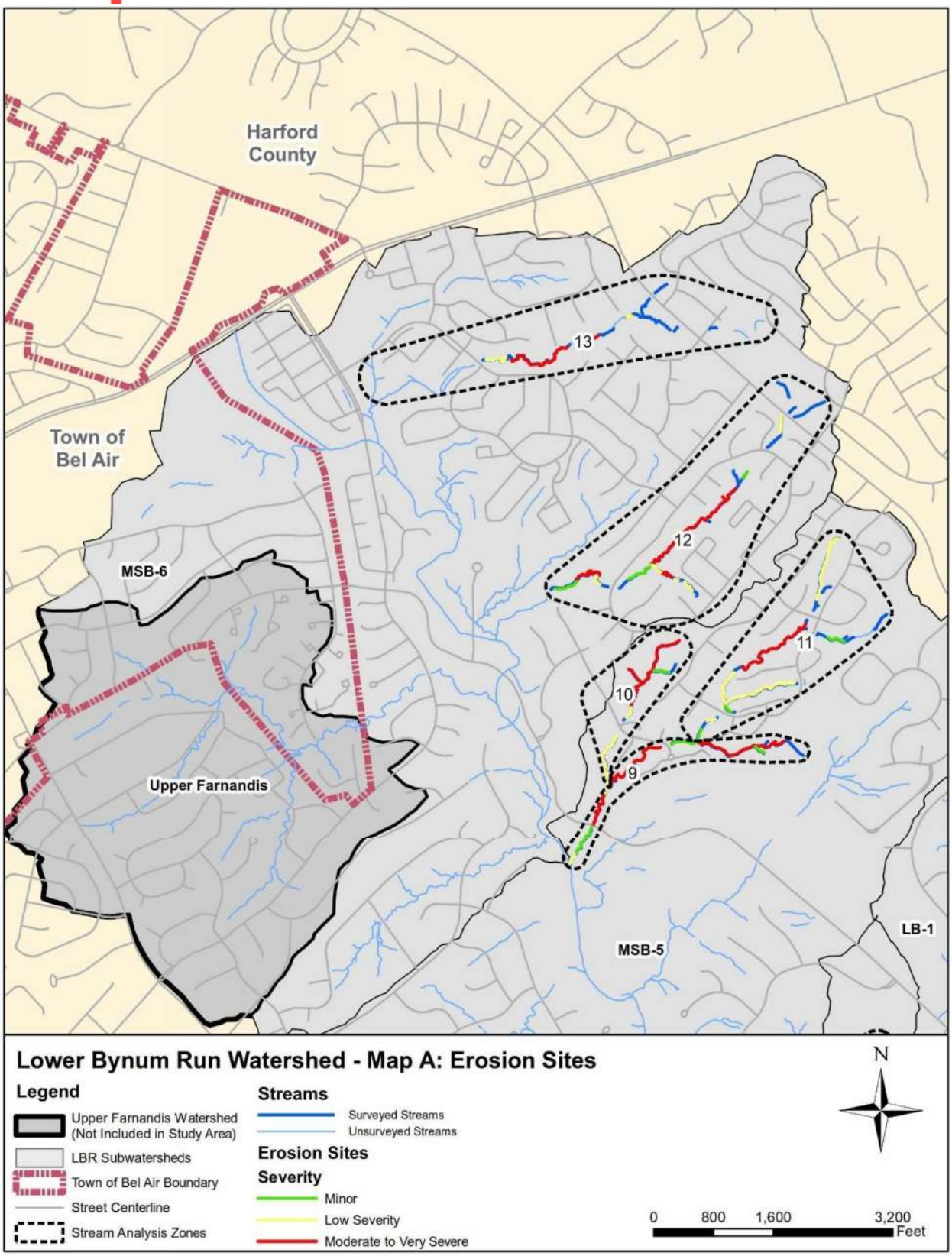

Figure 4-16: Location of Erosion Sites in the Lower Bynum Run Watershed (Map A)

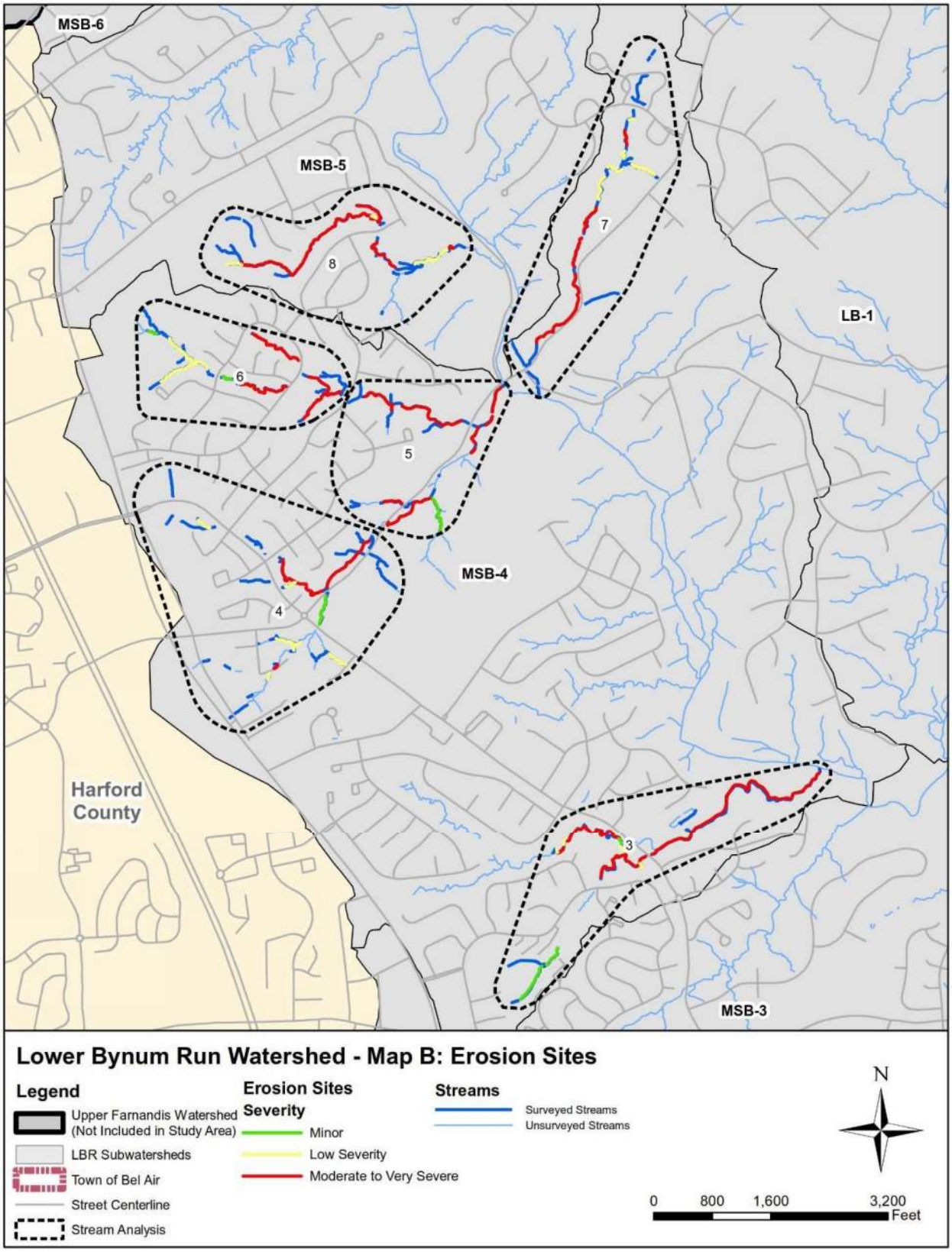

Figure 4-17: Location of Erosion Sites in the Lower Bynum Run Watershed (Map B)

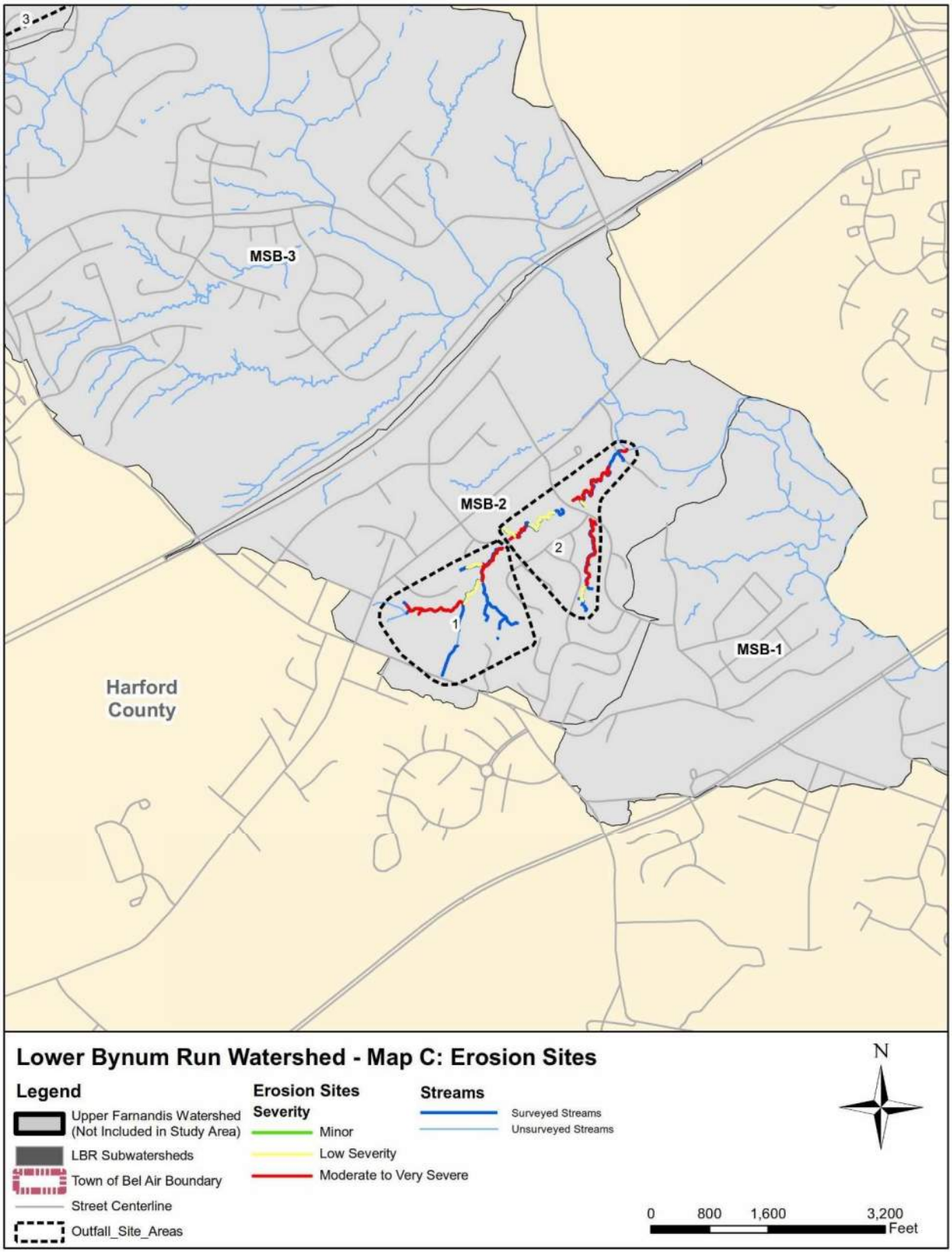

Figure 4-18: Location of Erosion Sites in the Lower Bynum Run Watershed (Map C)

FISH MIGRATION BARRIERS

Fish migration barriers refer to anything in the stream that significantly interferes with the upstream movement of fish. Unobstructed upstream movement is important for various species of fish that move up and downstream during different cycles of their life such as spawning. Fish barriers can reduce the fish population and diversity in stream sections. These barriers include manmade structures such as dams or roadway culverts and natural features such as waterfalls or debris jams. Three main problems regarding fish barriers were evaluated when identifying blockages:

1) vertical drop is too high (>6 inches) for fish to swim over;
2) water depth is too shallow such as when water is spread over a large area at channelized sections or road crossings; and
3) water is moving too fast such as when a steep culvert pipe is discharging high velocity flow.

The variety of barrier is also noted, including man-made dam, debris dam, road or pipe crossing, natural falls, beaver dam, pond, or other causes.

The severity of the barrier was rated based on location in the stream network and whether the blockage was total, partial, or temporary. A fish migration barrier was considered very severe when a structure completely blocked a large stream. A minor rating was assigned to temporary and/or natural fish barriers that blocks little in-stream habitat. Locations of fish migration barrier sites are shown on Figure 4-24 through Figure 4-26. Table 4-11 summarizes the number of fish migration barrier sites identified in the Lower Bynum Run watershed and their severity rating.

Table 4-11: Lower Bynum Run SCA Survey Results - Fish Passage Barriers

	Severity Rating					
	Very Severe				Minor	
Subwatershed	**1**	**2**	**3**	**4**	**5**	**Total**
MSB-2	0	0	0	0	0	0
MSB-4	0	0	1	0	0	1
MSB-5	0	0	0	0	0	0
MSB-6	0	0	0	2	0	2
Total	**0**	**0**	**1**	**2**	**0**	**3**

Figure 4-19 shows two low severity fish barriers where the drop between the respective pipe crossing or concrete weir and the natural channel is too high for the fish to pass and/or too shallow. In all cases, the location of the fish barrier within the subwatershed has an impact on the severity rating.

Figure 4-19. Example of a low severity fish barrier created by a pipe crossing (left) and a low severity fish barrier created by a concrete weir (right)

PIPE OUTFALLS AND EXPOSED PIPES

Pipe outfalls include pipes or small manmade channels that discharge into the stream. These pipes are typically downspout drains and other small pipes whose source is unknown. They are usually less than 12 inches in diameter. They are considered a potential environmental problem because they can carry uncontrolled runoff and pollutants such as oil, heavy metals, and nutrients into a stream system. Pipe outfalls can also create significant erosion problems as high flows without proper velocity dissipation can lead to extensive erosion and scour in the receiving channel. Erosion problems associated with outfalls can be seen by comparing the pipe outfalls and erosion site maps. The severity rating for a pipe outfall was primarily based on the discharge including whether discharge was present, color, odor, amount, and downstream impacts (not including erosion, which was assessed separately). A total of 44 pipe outfalls were surveyed during the SCAs in Lower Bynum Run (Table 4-12). The highest severity rating for pipe outfalls was moderate, shown in Figure 4-20.

Table 4-12: Lower Bynum Run SCA Survey Results - Pipe Outfalls

	Severity Rating					
	Very Severe				Minor	
Subwatershed	1	2	3	4	5	Total
MSB-2	0	0	0	0	1	1
MSB-4	0	0	1	5	6	12
MSB-5	0	0	0	6	16	22
MSB-6	0	0	0	4	5	9
Total	**0**	**0**	**1**	**15**	**28**	**44**

Figure 4-20. Example of a moderate pipe outfall (Left) and a minor underdrain pipe outfall (right)

Exposed pipes were also assessed and include any pipes that are in the stream or along the stream's immediate banks that could be damaged by a high flow event. These pipes are usually utilities other than stormwater, such as electrical, sewer, etc. Exposed pipes include manhole stacks and pipes exposed along the stream banks or under the stream bed. These pipes can be vulnerable to puncture by debris in the stream and pose a threat to water quality depending on the contents within the pipe.

Thirteen exposed pipes were observed during the Lower Bynum Run SCAs (Table 4-13). The exposed pipes are located within four different subwatersheds. Four pipes were found protruding up from the bottom of the stream bed, three were exposed along the stream bank, and six pipes were found above the stream. Most these exposed pipes were within the MSB-5 subwatershed (Figure 4-21, left). The only pipe with evidence of discharge was also found within MSB-5 subwatershed (Figure 4-21, right).

Table 4-13: Lower Bynum Run SCA Survey Results - Exposed Pipes

	Severity Rating					
	Very Severe				Minor	
Subwatershed	**1**	**2**	**3**	**4**	**5**	**Total**
MSB-2	0	1	0	0	0	1
MSB-4	0	1	0	0	0	1
MSB-5	0	3	4	1	2	10
MSB-6	0	0	1	0	0	1
Total	**0**	**5**	**5**	**1**	**2**	**13**

Figure 4-21: Moderate exposed pipe (left) and discharging exposed pipe (right) in the MSB-5 subwatershed

CHANNEL ALTERATIONS

Channel alterations refer to significantly altered channel or stream banks from their naturally occurring structure or condition. This includes channelized stream sections where a stream channel has been straightened, widened, deepened, or lined with concrete or rock. This can increase flow rates and decrease habitat and nutrient uptake in the waterway.

Channelized streams are typically intended to convey more water and to prevent flooding but often create adverse environmental impacts such as impairing habitat and increasing water temperature. Table 4-14 summarizes the number and length of channel alteration sites in each subwatershed and their associated severity rating. Locations of channel alteration sites are shown on Figure 4-24 through Figure 4-26.

Table 4-14: Lower Bynum Run SCA Survey Results - Channel Alterations

	Severity Rating						Length		
	Severe				Minor				% of Surveyed Streams
Subwatershed	1	2	3	4	5	Total	ft	mi	
MSB-2	0	0	0	0	1	1	32	0.01	0.29%
MSB-4	0	0	5	7	1	13	1,040	0.20	2.79%
MSB-5	0	0	1	2	0	3	84	0.01	0.34%
MSB-6	0	0	0	0	0	0	0	0.00	0.00%
Total	**0**	**0**	**6**	**9**	**2**	**17**	**1,156**	**0.22**	**3.42%**

A total of 17 channel alteration sites were documented during the survey for a total length of 1,156 feet or 3.42% of the entire stream lengths surveyed. Moderate channel alterations were the highest ranking for the Lower Bynum Run watershed. The remaining sites inventoried for channel alterations, ranked either low severity or minor. One severe channel alteration involves upstream and downstream gabion baskets added to the banks of the pictured stream to stabilize a road-crossing and shared driveway, as

pictured in Figure 4-22 (left). A common type of channel alteration observed throughout the Lower Bynum Run watershed was upstream and downstream armoring of channels and banks for road-crossing stabilization (Figure 4-22, right).

Figure 4-22. Examples of two severe channel alterations to convey flow under a roadway (left) or by hardening the channel with concrete (right)

TRASH DUMPING

Trash dumping sites are locations where large amounts of trash are inside the stream corridor; either as a site of deliberate dumping or as a place where trash tends to accumulate (often because of wind or storm drainage). Identifying trash dumping sites serves two main purposes: 1) to limit access to the areas of the stream corridor where dumping and accumulation is a problem and 2) to encourage volunteer stream clean-ups which promote community involvement and raises awareness among the community of the condition of their local streams. Table 4-15 summarizes the number of trash dumping sites in each subwatershed and their associated severity rating. Locations of channel alteration sites are shown on Figure 4-24 through Figure 4-26.

Table 4-15: Lower Bynum Run SCA Survey Results – Trash Dumping

	Severity Rating					
	Very Severe				Minor	
Subwatershed	**1**	**2**	**3**	**4**	**5**	**Total**
MSB-2	0	0	0	0	0	0
MSB-4	0	0	1	0	1	2
MSB-5	0	0	0	0	1	1
MSB-6	0	0	0	0	0	0
Total	**0**	**0**	**1**	**0**	**2**	**3**

A total of 3 trash dumping sites were documented during the survey for the stream lengths surveyed. A moderate trash dumping was the highest ranking for the Lower Bynum Run watershed. The remaining sites inventoried for trash dumping were ranked minor. Both examples in Figure 4-23 are accessible and could be cleared by volunteers within a few days.

Figure 4-23. The moderate trash dumping site found within the MSB-4 subwatershed (left) and a low severity trash dumping within the MSB-5 subwatershed (right).

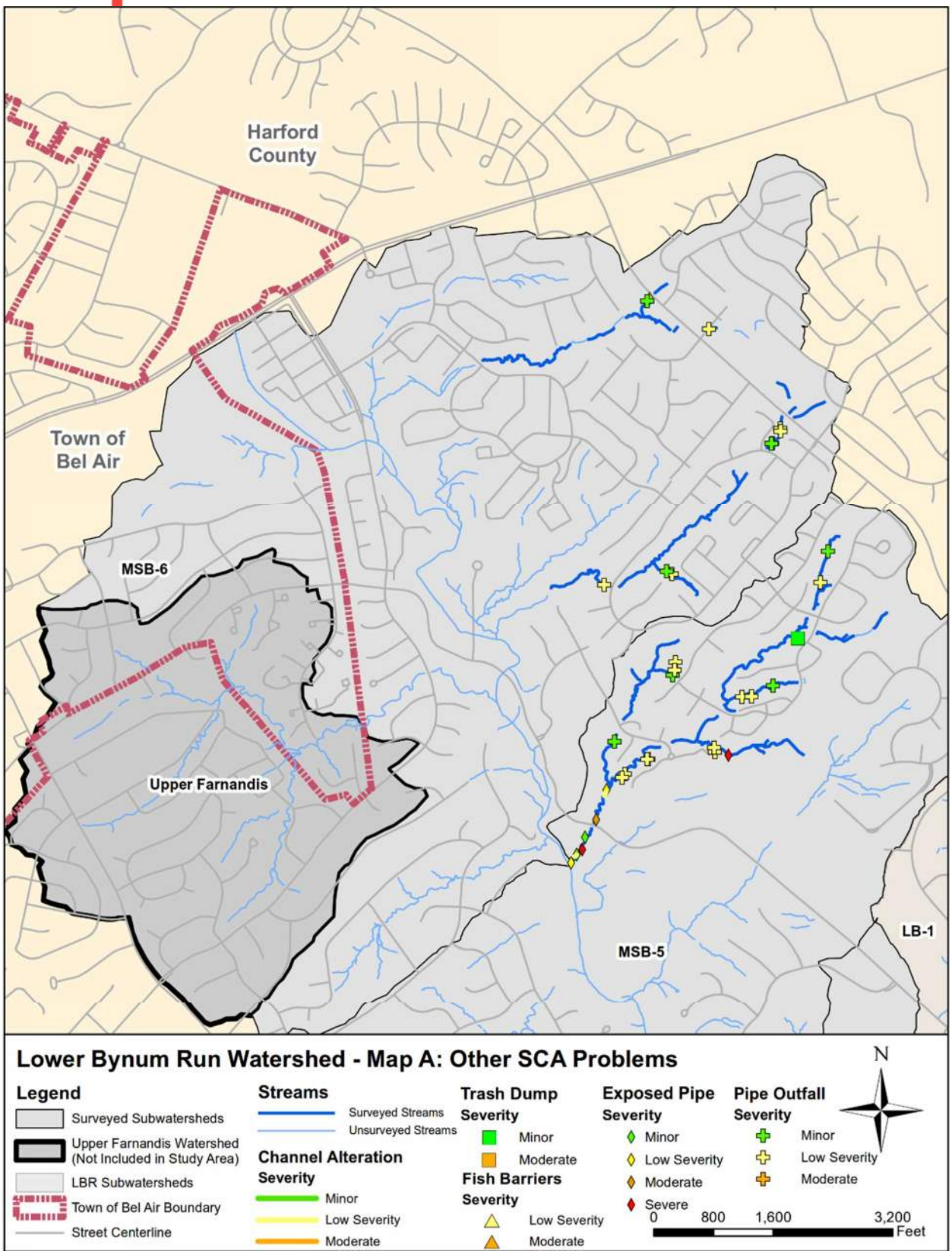

Figure 4-24: Location of Other SCA Problem Sites in the Lower Bynum Run Watershed (Map A)

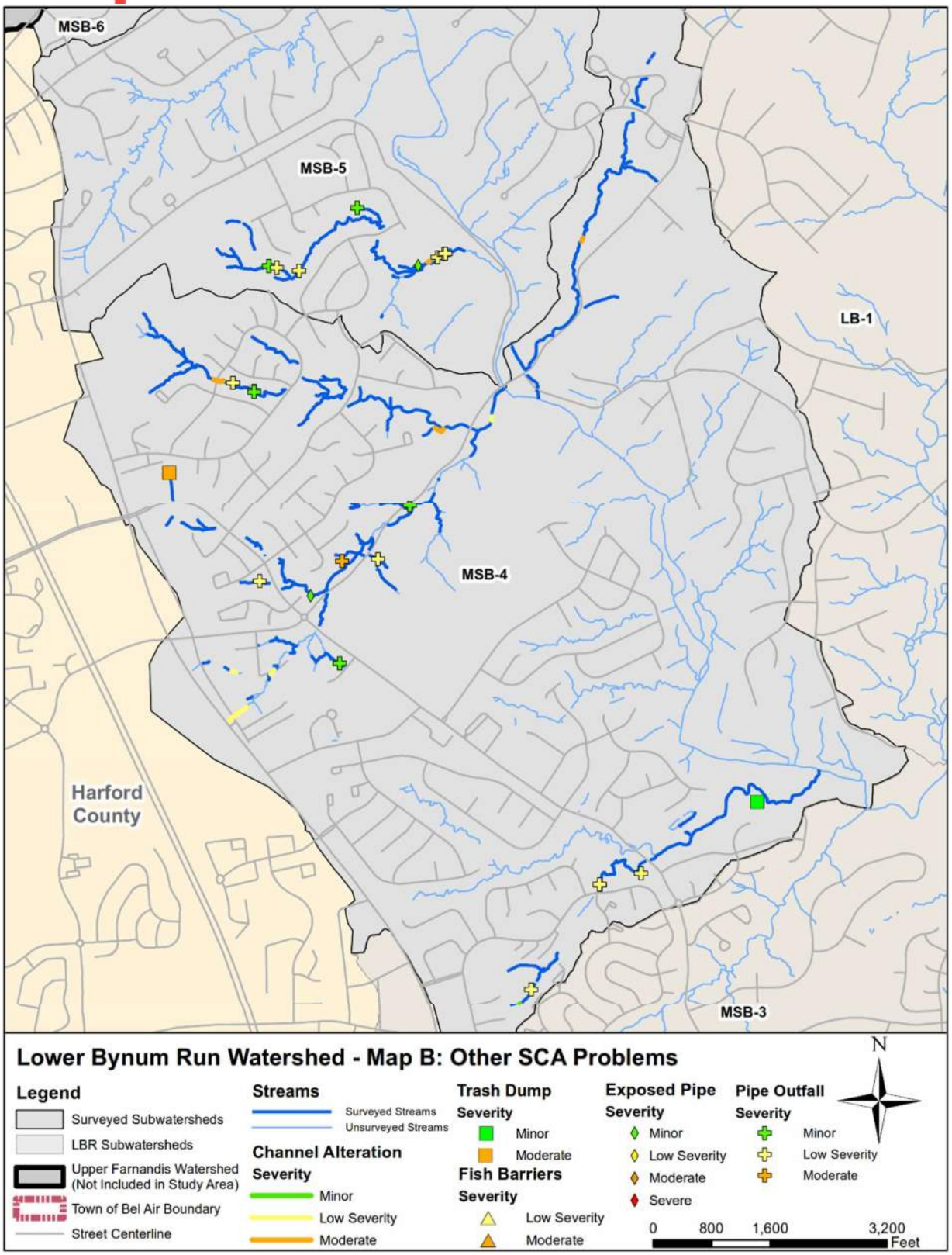

Figure 4-25. Location of Other SCA Problem Sites in the Lower Bynum Run Watershed (Map B)

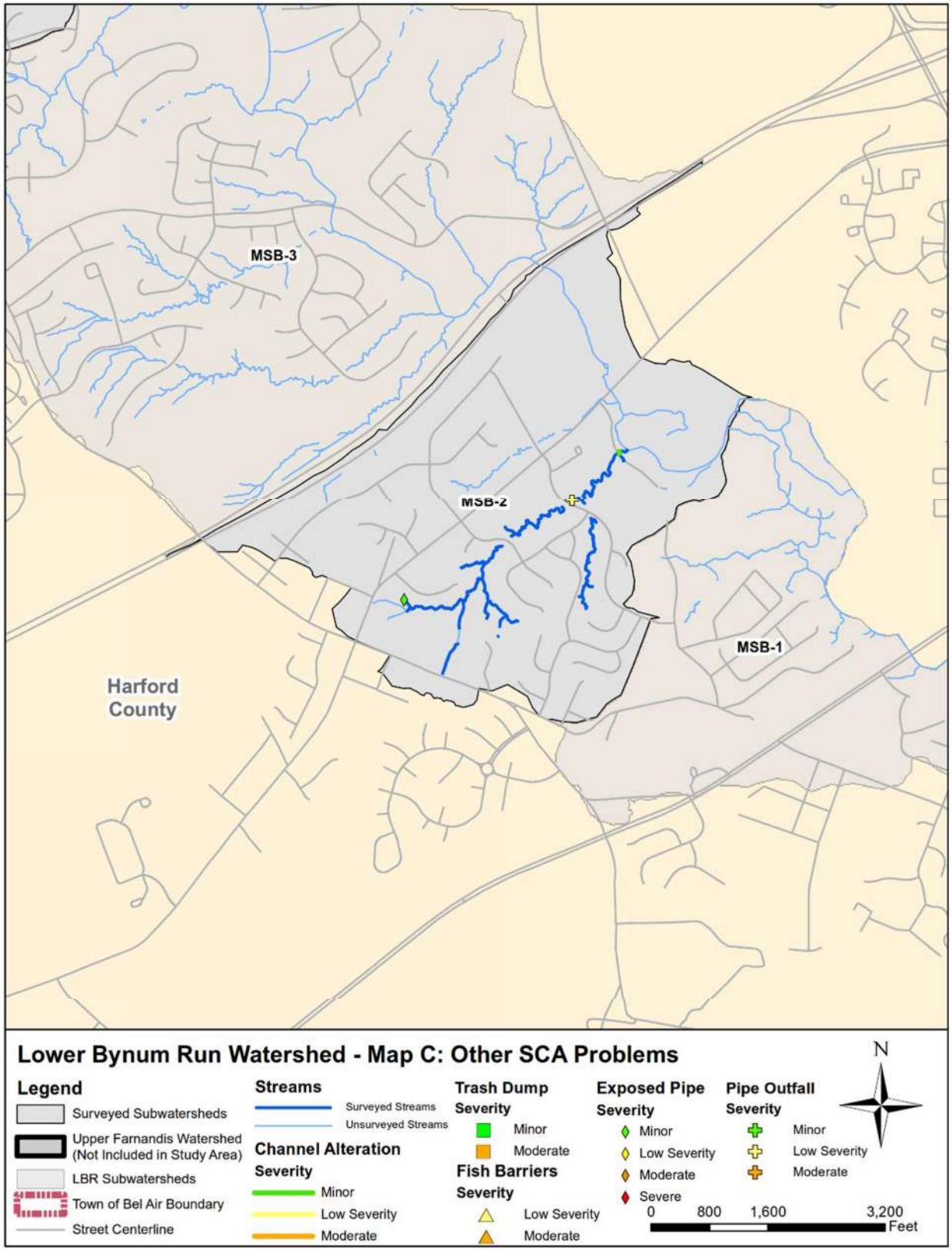

Figure 4-26: Location of Other SCA Problem Sites in the Lower Bynum Run Watershed (Map C)

4.5 SUBWATERSHED ASSESSMENTS

Following the general field findings, an assessment of each subwatershed was performed to assist in the development of proposed projects for the Lower Bynum Run watershed. Each subwatershed assessment summarizes the location of the subwatershed, watershed characteristics, and field findings.

4.5.1 LITTLE BYNUM 1 (LB-1) SUBWATERSHED

LB-1 subwatershed encompasses a drainage area of 1,167 acres (see Figure 4-27). It is the third smallest subwatershed and sits in the center of the assessed area. The drainage area is constrained by Kings View Drive to the east and by Greencedar Drive and Shelburne Road to the west. It stretches north to the residences on Beechview Court. Flows from LB-1 outfall to Bynum Run adjacent to the southern cul de sac of Greencedar Drive and enter MSB-3. The largest land use in the subwatershed is forest at 36%. This is the largest percentage of forest land of all the subwatersheds. The remaining land use is low density residential at 39.7%, and agriculture at 17.7%. Agriculture lands are in the southern half of the subwatershed. The buildings, roads, and other impervious surfaces in LB-1 total 82 acres of impervious area or 7.1% of the subwatershed. The hydrologic soil group in the subwatershed is characterized as 56.4% group B soil and 29.1% group C soil.

The low-density residential land is predominately single-family homes built on roughly one-acre plots. In the north, these homes are found in the Todd Lakes and the Stone Ridge at Fountain Green neighborhoods. The Estates of Cedar Day neighborhood exists in the southeast corner of the subwatershed; this community was built after 2010.

There are 6 dry extended detention ponds that provide quantity control for 4.17% of the subwatershed. An additional 17 BMPs within LB-1 are believed to provide water quality credit and water quantity control; these BMPs were not field assessed. None of the streams or outfalls in LB-1 were assessed by field teams.

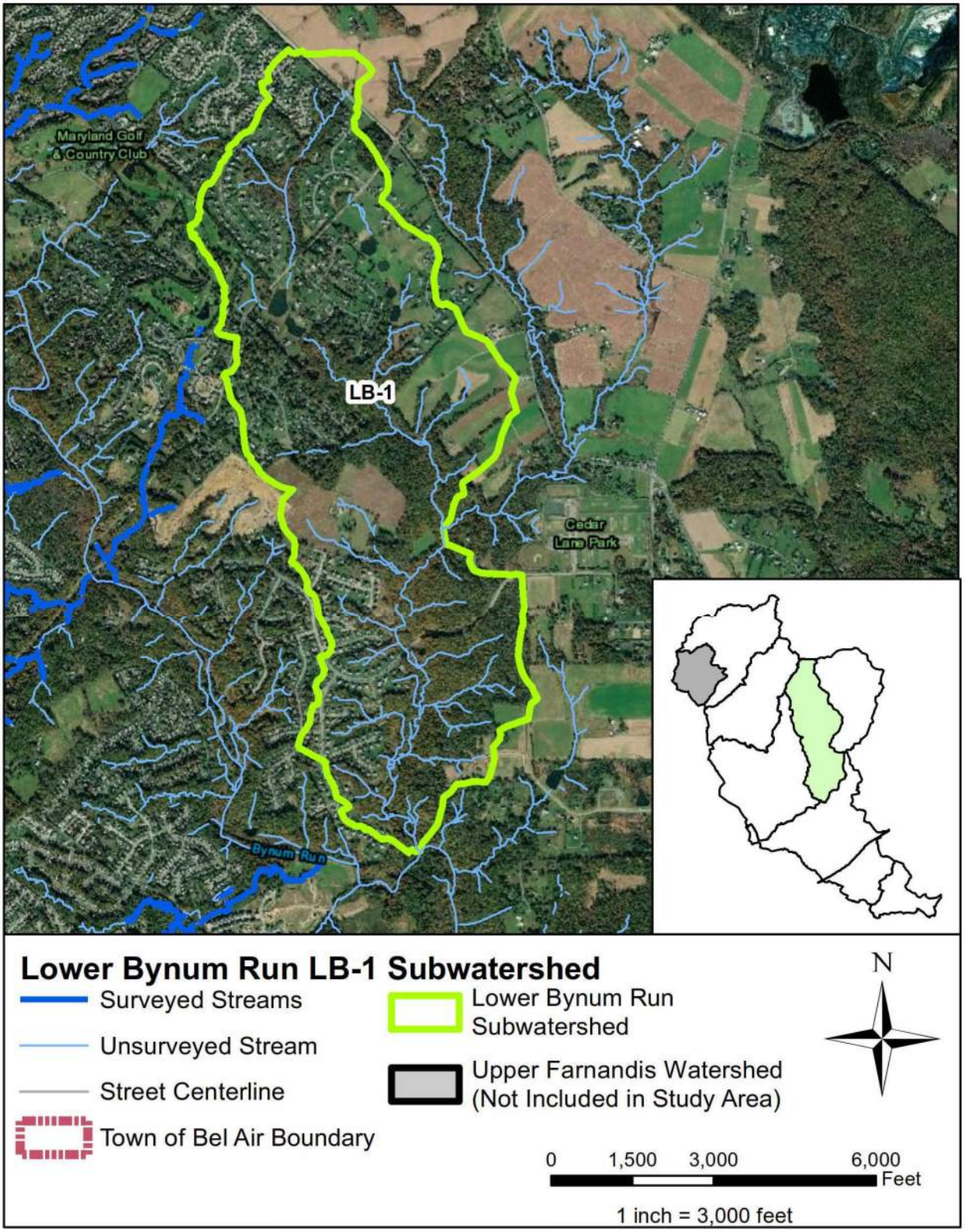

Figure 4-27. Lower Bynum Run LB-1 Subwatershed

4.5.2 LITTLE BYNUM 2 (LB-2) SUBWATERSHED

LB-2 subwatershed encompasses a drainage area of 1,067 acres and outfalls to LB-1 (see Figure 4-28). The drainage area extends south to Cedar Lane and north to the western end of James Run Road. The subwatershed stretches east to Calvary Road and west to Kings View Drive. The hydrologic soil group in the subwatershed is characterized as 53.8% group B and 33.8% group C. The land use in LB-2 is dominated by agriculture at 61.2%, the highest percentage of agriculture among all the subwatersheds. Due to the large amount of agriculture, the percentage of impervious area in the subwatershed is the lowest at 4%, or 43 acres. The remaining land use is split between forest and low density residential. The low-density residential communities in LB-2 are located north of King's View Drive and along Shirley Drive.

There are two dry extended detention ponds that provide quantity control for 2.18% of the subwatershed. They are located adjacent to Cedar Lane Regional Park. An additional 11 BMPs within LB-2 are believed to provide water quality credit and water quantity control; these BMPs were not field assessed. Of these additional 11 BMPs, 9 are located on the sides of South Fountain Green Road. None of the streams or outfalls in LB-2 were assessed by field teams.

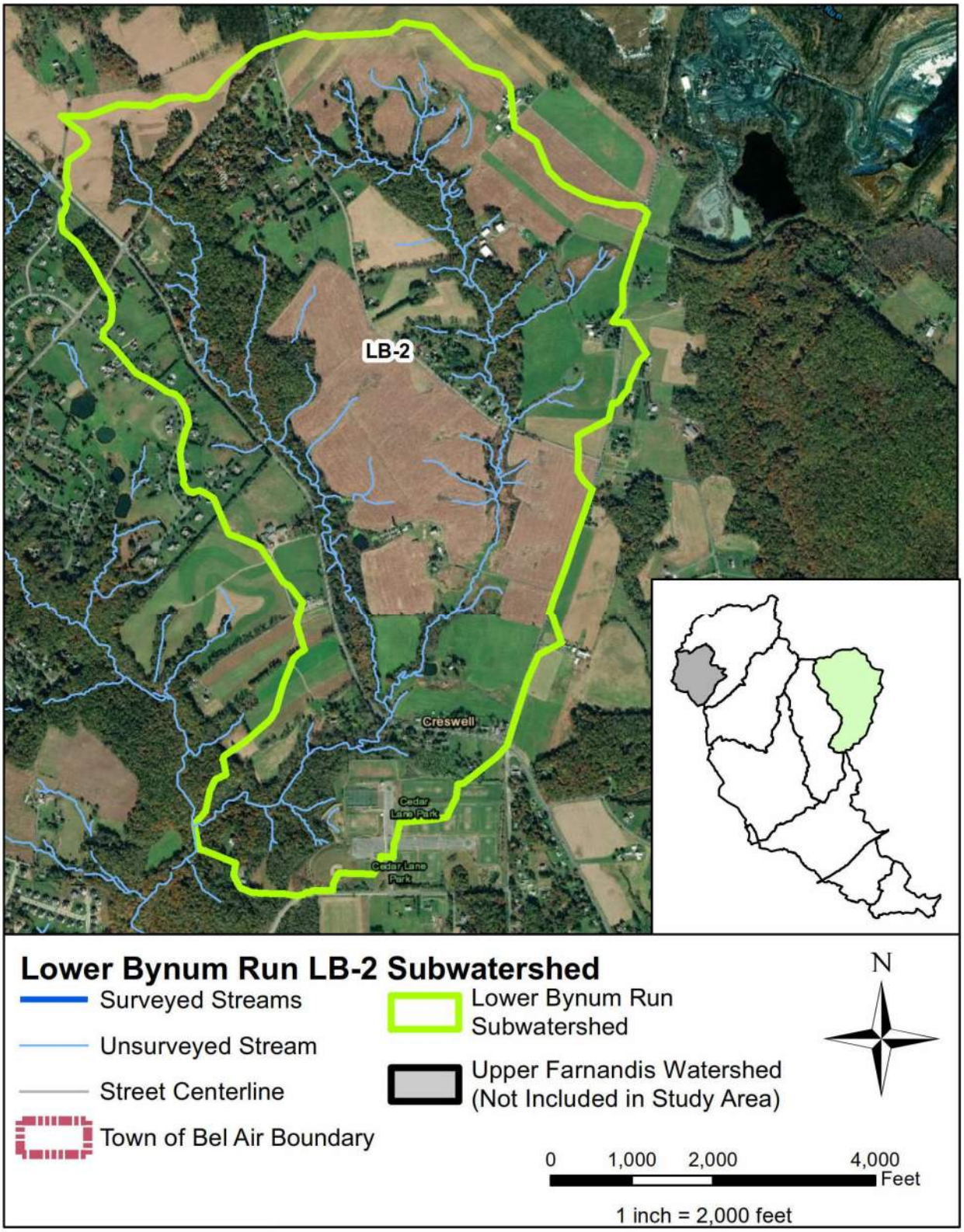

Figure 4-28. Lower Bynum Run LB-2 Subwatershed

4.5.3 MAIN STEM BYNUM 1 (MSB-1) SUBWATERSHED

MSB-1 subwatershed encompasses 451 acres of the southern portion of Bush Creek and it outlets into Bush River (see Figure 4-29). The subwatershed includes the southern half of Bush Road to East Baker Avenue. The subwatershed stretches east to B&O Road and north to the confluence of Bynum Run and Bush Creek. MSB-1 subwatershed has the highest percentage of water/wetland land use at 12.2%. Another 30% of the land use is forest. The remaining land use for the subwatershed consists of medium and low density residential. Hydrologic soil groups A, B, C, and D each account for about one quarter of the subwatershed's soils. MSB-1 is 13.7% impervious or 62 acres of impervious area.

The subwatershed is divided in half by Pulaski Highway. The northern half contains one major tributary that originates near an unnamed pond adjacent to Abinrox Drive and conveys flows into Bush River. The residential land use in the northern half of MSB-1 is mainly single-family manufactured homes on roughly half acre plots. The community is located on Timothy Drive and the homes were built in the 1970s and 1980s. The southern half of the subwatershed has one residential community on Frans Drive. These are single family homes on roughly half acre plots; they were constructed in the 1990s.

There are two dry extended detention ponds that provide quantity control for 5.33% of the subwatershed. An additional three BMPs within MSB-1 are believed to provide water quality credit and water quantity control; these BMPs were not field assessed. No streams or outfalls were field assessed in this subwatershed.

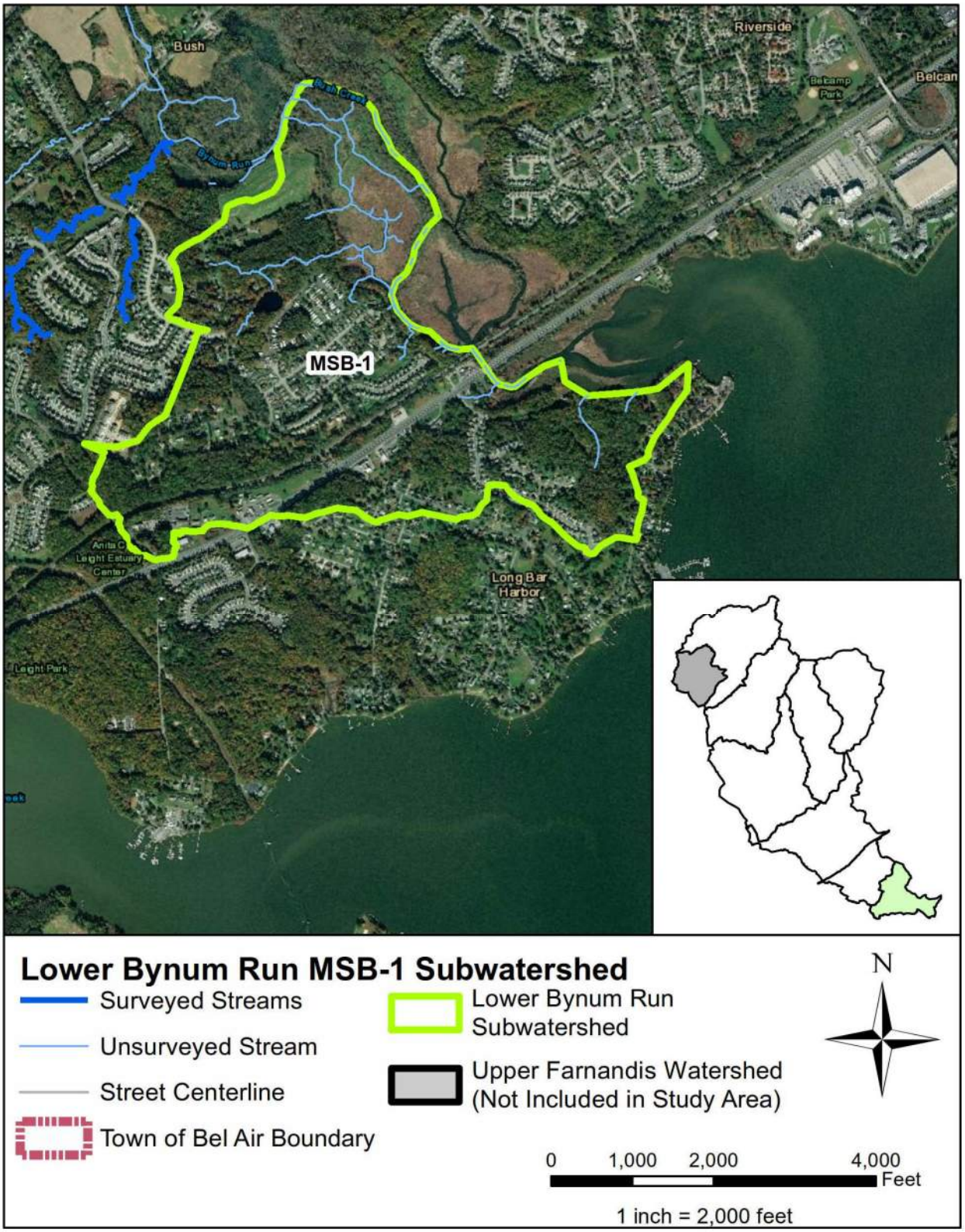

Figure 4-29. Lower Bynum Run MSB-1 Subwatershed

4.5.4 MAIN STEM BYNUM 2 (MSB-2) SUBWATERSHED

MSB-2 subwatershed encompasses a drainage area of 554 acres (see Figure 4-30). The northwest and southwest portions of the drainage area are constrained by I-95 and Abingdon Road respectively. The southeastern portion of the subwatershed encompasses the residences on Wolf Trail Drive, Walnut Hill Court, and Harford Town Drive. The northeast portion of the subwatershed consists of Bynum Run extending from I-95 to the confluence with Bush Creek. MSB-2 subwatershed has the highest percentage of transportation land use at 4.8%. The highest land uses are medium density residential, at 38.4%, and forest, at 23.9%. The subwatershed is about 50% type C soil. MSB-2 contains 92 acres of impervious area, or 16.6% of the entire subwatershed.

Field teams assessed 2.22 miles of stream along one tributary in this subwatershed. The assessed tributary originates adjacent to Pomeroy Avenue and outlets to Bynum Run behind Bush Court. It receives flows from four communities. Three of which are single family neighborhoods: the Hidden Stream neighborhood, the Abingdon Estates neighborhood, and the residences of Cokesbury Manor. They sit on roughly half acre plots and were constructed in the 1990s and 2000s. The fourth community is made up of townhouses built in the 1990s. These residences belong to the Harford Town Homeowners. The only other major neighborhood in the MSB-2 subwatershed is the Philadelphia Station Community. It drains into a tributary that was not assessed.

There are five dry extended detention ponds that provide quantity control for 7.54% of the subwatershed. An additional four BMPs within MSB-2 are believed to provide water quality credit and water quantity control; these BMPs were not field assessed. The assessed tributary receives flows from three dry extended detention ponds and three additional, not assessed BMPs. There were eight outfalls assessed in this subwatershed.

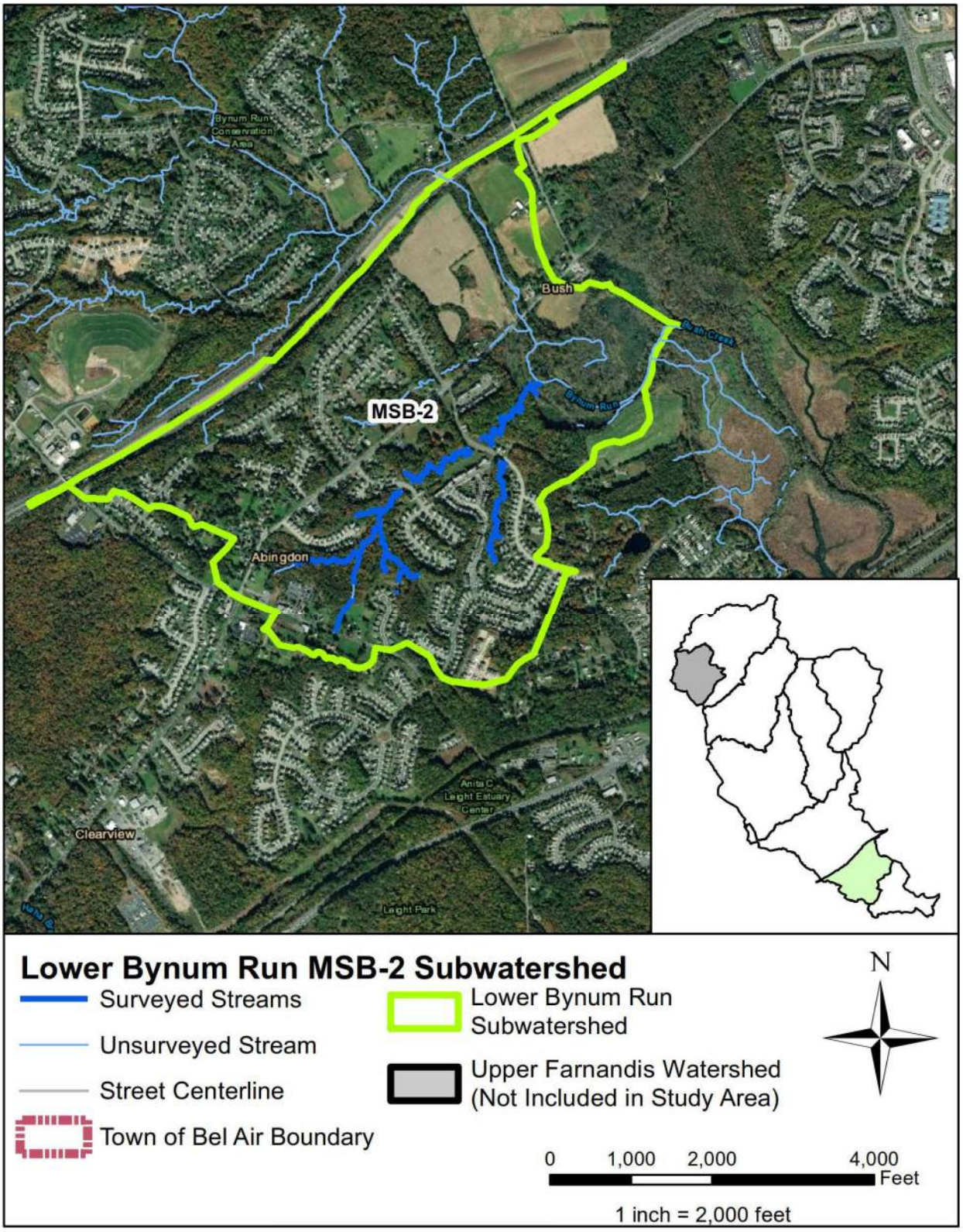

Figure 4-30. Lower Bynum Run MSB-2 Subwatershed

4.5.5 MAIN STEM BYNUM 3 (MSB-3) SUBWATERSHED

MSB-3 subwatershed encompasses a drainage area of 1,487 acres, making it the second largest of the eight subwatersheds (see Figure 4-31). The drainage area is constrained by I-95 to the south and Abingdon Road to the west. The northwest portion of the drainage area extends to residences along Strathaven Lane and Salford Drive. The subwatershed stretches to the northeast to include the tributary that flows under 12 Stones Road. Most soils in the subwatershed are hydrologic soil group B or C. MSB-3 contains the second highest percentage of forest land use at 31.3%, and agriculture land use at 18.9%. There are 188 acres, or 12.6%, of impervious area in the subwatershed.

The residential land in MSB-3 is mainly single-family property sitting on roughly half acre plots. Existing MSB-3 neighborhoods built in the 1990s include: Tiffany Woods community, the Village of Bynum Run Estates, the Woodland Run neighborhood, and the Bynum Overlook neighborhood. The western portion of the subwatershed includes half of the Box Hill community. These are on smaller plots, about one quarter acres each, and were built in the 1970s.

A covered landfill surrounded by Harford County offices sits at the southern toe of the subwatershed. The northern tip of the drainage area is farmland and a portion of the Bynum Run Conservation Area.

There are 14 dry extended detention ponds that provide quantity control for 15.72% of the subwatershed. An additional 15 BMPs within MSB-3 are believed to provide water quality credit and water quantity control; these BMPs were not field assessed. There were no streams or outfalls assessed in this subwatershed. The streams in the drainage area ultimately outlet to Bynum Run and flow into MSB-2 under I-95.

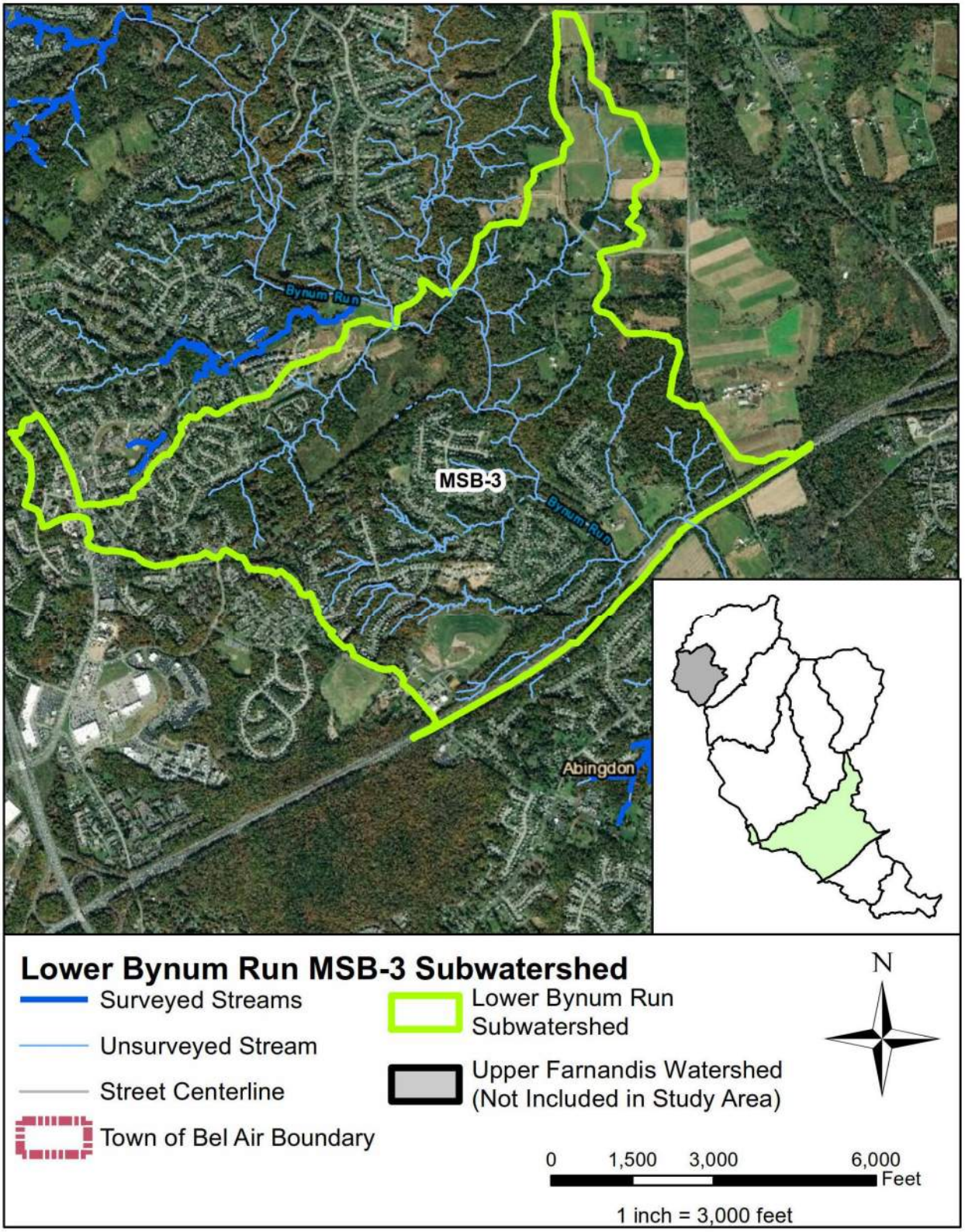

Figure 4-31. Lower Bynum Run MSB-3 Subwatershed

4.5.6 MAIN STEM BYNUM 4 (MSB-4) SUBWATERSHED

MSB-4 subwatershed is the largest subwatershed and encompasses 1,896 acres (see Figure 4-32). It stretches west to Emmorton Road and east to Green Cedar Drive. The drainage area is constrained by Old Emmorton Road to the west and by Sidehill Drive and Greencedar Drive to the east. The majority, 73.5%, of MSB-4 is hydrologic soil group B. The subwatershed is about 60% residential land use, but the center of the subwatershed is forested and contains agriculture. The buildings, roads, and other impervious surfaces in the subwatershed amount to 345 acres of impervious area, or 18.2% impervious.

There are 16 dry extended detention ponds that provide quantity control for 19.39% of the subwatershed. An additional 20 BMPs within MSB-4 are believed to provide water quality treatment and water quantity control; these BMPs were not field assessed.

Field teams assessed four major tributaries, which sum to 7.63 miles of stream, in this subwatershed. One tributary originates north of Bynum Run at a pond on the Maryland Golf and Country Club. This tributary runs south, adjacent to East Wheel Road, until it enters Bynum Run near Patterson Mill Road. It flows from half of the Glenangus community and residences along East Wheel Road. One dry detention pond, from the Glenangus community, drains to this tributary.

The second tributary in this subwatershed originates around Hunters Run Village and the Temple Hills Homeowners, two townhouse communities built in the early 1990s. The tributary runs north along East Wheel Road until it enters Bynum Run near Patterson Mill Road. Two dry detention ponds and two additional, not assessed BMPs convey flows into this tributary. A third tributary begins behind the Lorien Bel Air building. It collects flows from four dry extended detention ponds and from one additional, not assessed BMP. The Saddle Ridge neighborhood and the Hunters Run neighborhood are single family communities that drain into this tributary. These properties were built on roughly half acre plots and constructed in the 1970s and 1980s. The Bright Oaks Village Townhouses, constructed in the 1990s, also drain into it. It enters the second tributary at East Wheel Road.

The last assessed stream in this subwatershed originates behind William S. James Elementary School. It enters Bynum Run behind Oatgrass Court. Two single family communities, the Laurel Valley neighborhood and the Overview Estates neighborhood, and the Box Hill community of townhouses drain into this tributary. An additional community of townhouses and a single-family neighborhood are being constructed and will drain into the tributary. One dry detention pond and one not assessed BMP convey flows into this tributary. Flows from the entire subwatershed are conveyed through Bynum Run and into the MSB-3 subwatershed. There were 27 outfalls assessed in this subwatershed.

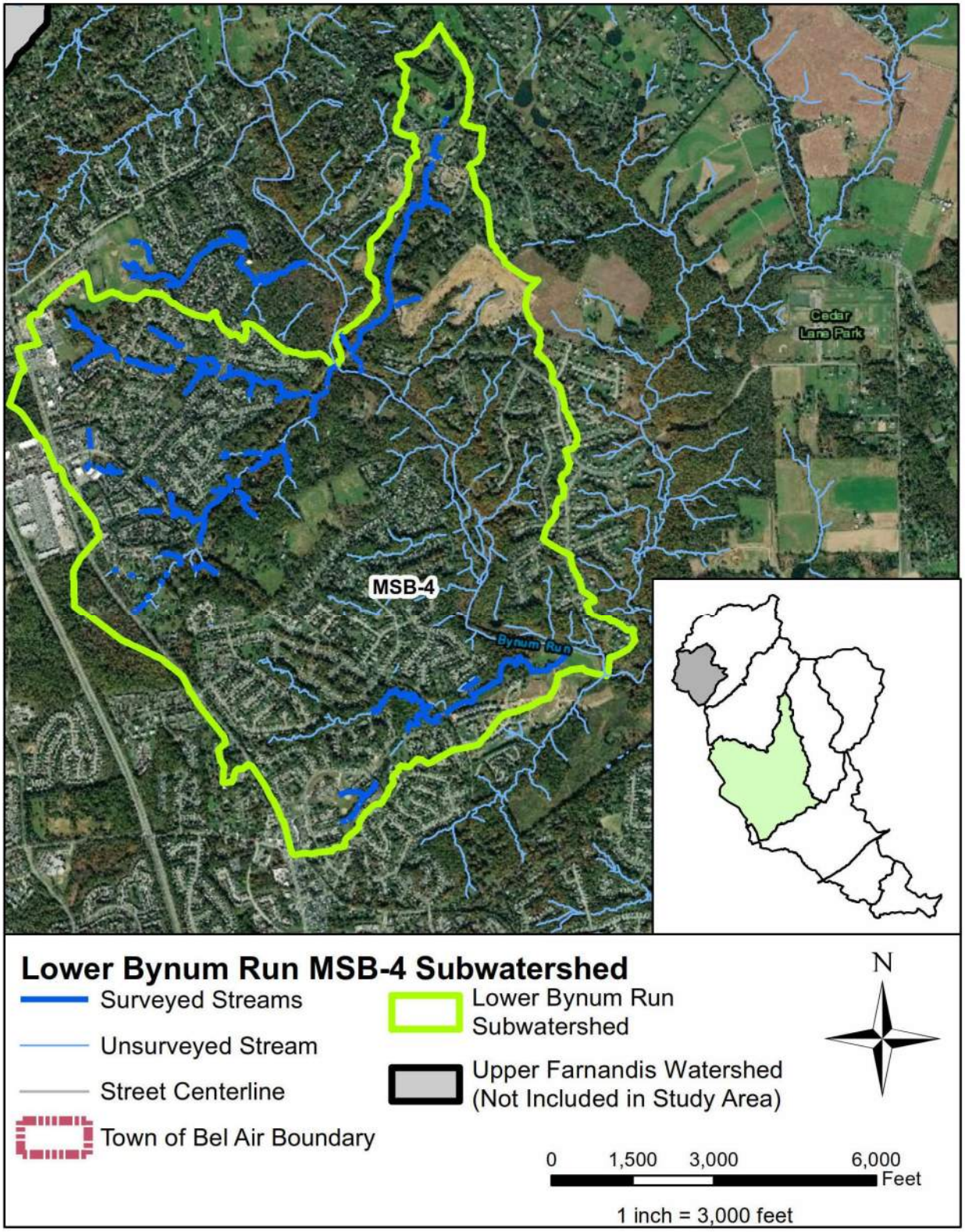

Figure 4-32. Lower Bynum Run MSB-4 Subwatershed

4.5.7 MAIN STEM BYNUM 5 (MSB-5) SUBWATERSHED

MSB-5 subwatershed encompasses a drainage area of 210 acres (see Figure 4-33). The subwatershed encompasses lands north to Glenwood Road and Brierhill Estates Drive. The northeast drainage area extends to residences along Brierhill Estates Drive and Sparrow Mill Way. The Maryland Gold and Country Club exists at the center of MSB-5. Like MSB-4, the dominant hydrologic soil group in MSB-5 is B at 71.9%. The MSB-5 subwatershed has the highest percentage of open urban land at 13.8%, and another 60% of the land is residential. The impervious area within this subwatershed covers 210 acres and accounts for 15.6% of the subwatershed area.

There are eight dry extended detention ponds that provide quantity control for 17.84% of the subwatershed. An additional eight BMPs within MSB-5 are believed to provide water quality treatment and water quantity control; these BMPs were not field assessed.

Field teams assessed 4.25 stream miles along two major tributaries in this subwatershed. One tributary originates across from Clymer Court and flows into Bynum Run north of the Maryland Golf and Country Club. Two dry detention ponds and three unassessed BMPs drain into this tributary. Single family properties off Briehill Estates Drive drain into the tributary. Two communities of townhouses also drain into it. They are the Woodland Greens Homeowners and the Foxborough Farms Homeowners. All these properties were constructed in the 1980s and 1990s. The second assessed tributary originates behind the Patterson Mill Middle and High School athletic fields. This tributary enters Bynum Run north of the intersection of Patterson Mill Road and East Wheel Road. Two dry detention ponds convey flows into this tributary. In addition to the school, the Kings Charter Homeowners Association also drains into this tributary. This is a single-family neighborhood that was built in the 1990s.

The MSB-5 subwatershed also includes the Maryland Golf and Country and Country Club and four single family communities that do not drain into tributaries that were assessed. They are the Stone Ridge at Fountain Glen Homeowners Association, the Parsons Ridge community, half of the Glenangus community, and half of the Glenwood community.

Flows from MSB-5 drain into MSB-4 via Bynum Run. There were 23 outfalls assessed in this subwatershed.

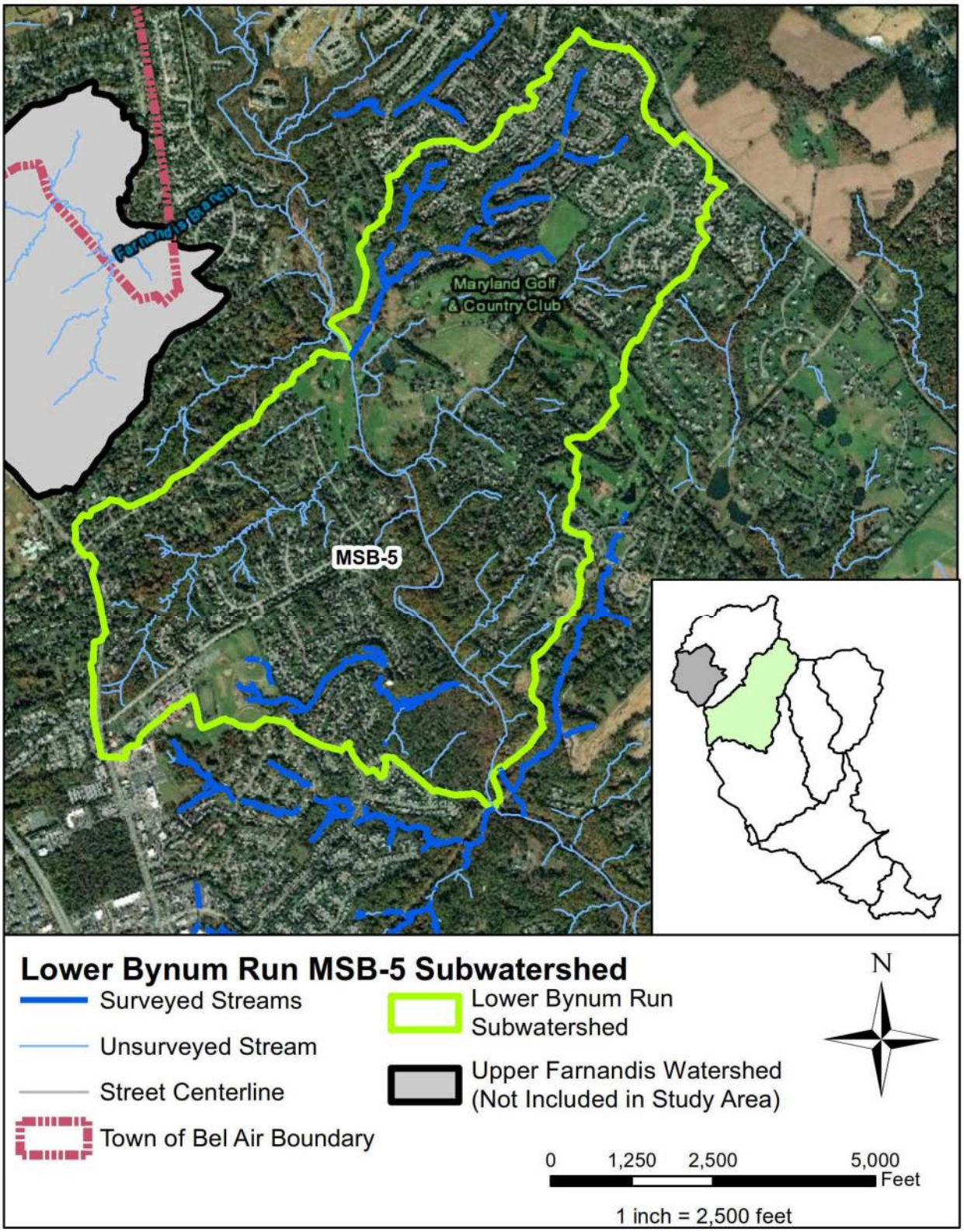

Figure 4-33. Lower Bynum Run MSB-5 Subwatershed

4.5.8 MAIN STEM BYNUM 6 (MSB-6) SUBWATERSHED

MSB-6 subwatershed encompasses a drainage area of 1,294 acres, making it the third largest subwatershed (see Figure 4-34). It stretches west to the Upper Farnandis subwatershed, and it extends east to Forehand Court and Fountain Green Elementary School. The drainage area is constrained by Churchville Road to the north and to the south by Glenwood Road and Brierhill Estates Drive. Hydrologic soil group B is most common in the subwatershed, encompassing 74.2% of the area. Over 81% of the land use in MSB-6 is classified as residential and it also has the highest percentage of institutional land use at 6.1%. The impervious area within this subwatershed is 300 acres or 23.2% of the total area, the highest percentage of all the subwatersheds.

Field teams assessed 3.08 stream miles along two major tributaries in this subwatershed. One tributary originates adjacent to the Fountain Green Elementary School athletic fields. It enters Bynum Run adjacent to the intersection of East Macphail Road and Macphail Woods Crossing. Two dry extended detention ponds drain into this tributary. In addition to the school's athletic fields, this tributary also receives flows from the Greenbrier Hills neighborhood, the Fountain Glen neighborhood, and part of the Greenridge neighborhood. Most these communities are single-family residences built in the late 1990s and early 2000s. There are a few townhouses in the Fountain Glen neighborhood as well. The second tributary begins at a BMP next to the Fountain Green Elementary School parking lot. It enters Bynum Run behind the Seasons at Bel Air Apartments. It collects flows from the school, the school parking lot, and most the Greenridge neighborhood. The Greenridge neighborhood consists of single-family properties built in the 1960s and 1970s on roughly half acre plots.

The MSB-6 subwatershed also includes the John Carroll School, the Greenbrier Shopping Center, and many residential communities that drain into tributaries that were not assessed. In the western part of the subwatershed there are single family communities that were built in the 1960s and 1970s on roughly quarter acre plots. Their names are the Bradford neighborhood, the Glenwood Garth neighborhood, the Colonial neighborhood, and the Glenwood neighborhood. The Greenbrier Hills neighborhood in the center of the subwatershed is another single-family residential neighborhood that does not drain to an assessed tributary. Many apartment buildings and townhouses also exist in the center of the subwatershed and do not drain to assessed tributaries. They are called the Greenbrier Townhouses, the Uppercrest Townhomes, the Victorian Square Townhouses, and the Emerald Hills Community. The last type of residential properties in MSB-6 are apartment buildings. There are apartment buildings east of Redfield Road, around Mason Drive, Scotts Dale Drive, Martha Court, Selvin Drive, and at the end of Macphail Woods Crossing.

There are seven dry extended detention ponds that provide quantity control for 26.67% of the subwatershed. An additional ten BMPs within MSB-6 are believed to provide water quality treatment and water quantity control; these BMPs were not field assessed. Flows from MSB-6 drain into MSB-5 via Bynum Run. There were 21 outfalls assessed in this subwatershed.

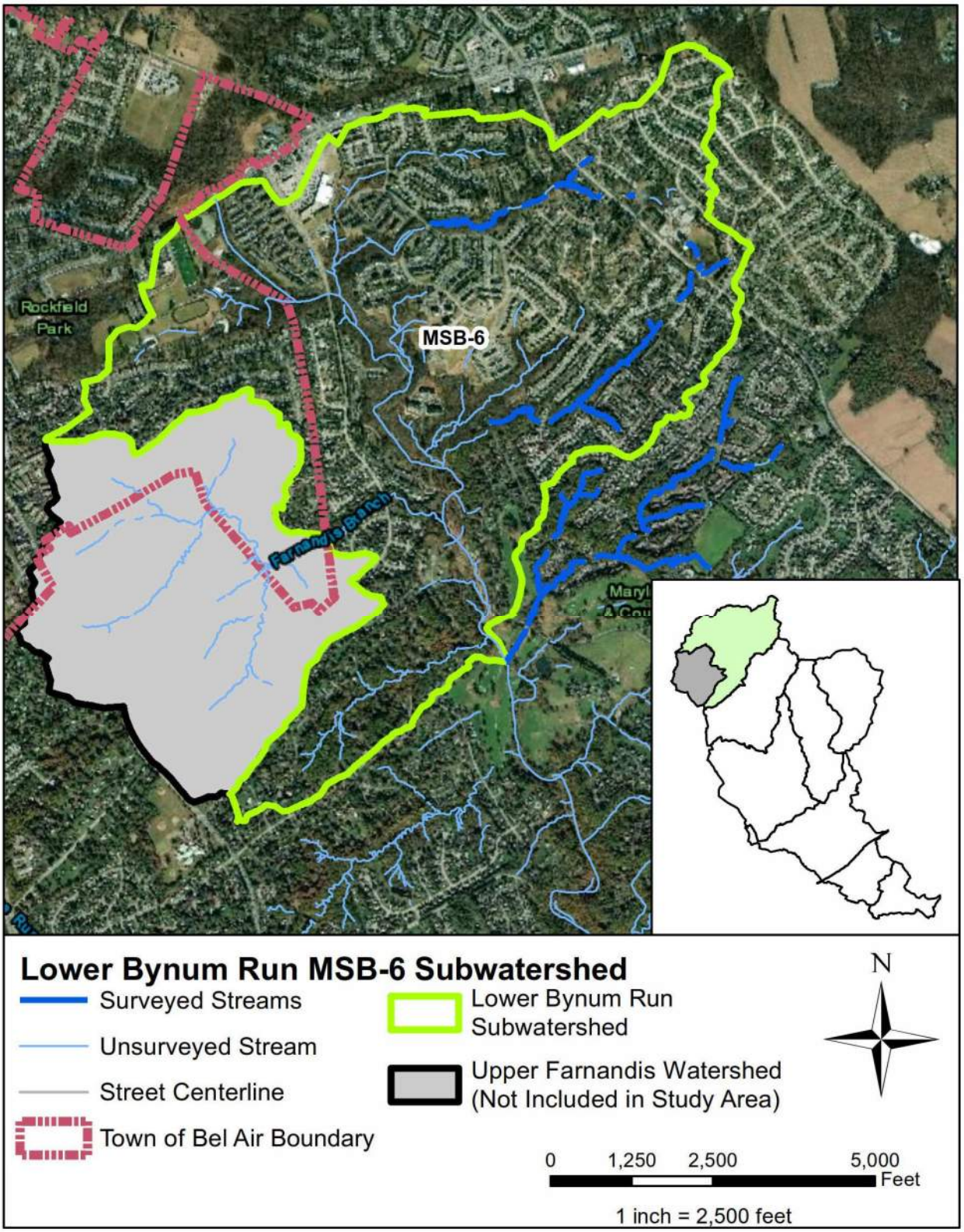

Figure 4-34. Lower Bynum Run MSB-6 Subwatershed

5 RESTORATION STRATEGIES

5.1 INTRODUCTION

This chapter presents an overview of the proposed stream and outfall restoration and BMP projects as well as potential pollutant load reductions for the Lower Bynum Run watershed. The watershed pollutant loading analysis performed to estimate current nutrient loads generated by the various non-point sources within the Lower Bynum Run watershed is discussed in Section 5.3.1. Section 5.3.2 discusses the pollutant removal calculations for proposed practices to ensure that regulatory requirements are met in Lower Bynum Run. Section 5.3.3 discusses the impervious area treatment crediting for the proposed practices.

5.2 STORMWATER MANAGEMENT

Increased importance of water quality and water resource protection has led to the development of the Maryland Stormwater Design Manual which provided BMP design standards and environmental incentives (MDE, 2000). Since that time there has been a general shift towards adopting low-impact practices that mimic natural hydrologic processes and achieve pre-development conditions. The Maryland Stormwater Act of 2007 takes those principles one step further and requires that environmental site design (ESD) be implemented to the maximum extent practicable via nonstructural BMPs and/or other better site design techniques. The intent of ESD BMPs is to distribute flow throughout a development site and reduce stormwater runoff leaving the site. This will also reduce pollutant loads and prevent stream channel erosion. Key municipal strategies proposed for restoring the Lower Bynum Run watershed are discussed in the following sections.

5.2.1 EXISTING STORMWATER MANAGEMENT

A total of 153 existing stormwater management facilities are located within the Lower Bynum Run watershed including underground detention, infiltration practices, filtration practices, and extended detention.

5.2.2 STORMWATER RETROFITS

Stormwater retrofits involve modifying existing BMPs that may not currently provide water quality treatment. Stormwater retrofits improve water quality by capturing and treating runoff before it reaches receiving water bodies. Based on initial field and desktop evaluations, 13 existing BMPs were identified as having sufficient space for retrofitting. These BMPs are described further in Appendix B.1.

5.2.3 NEW STORMWATER BEST MANAGEMENT PRACTICE FACILITIES

New stormwater BMPs are implemented in existing developed areas where SWM practices do not currently exist to help improve water quality. Based on initial field and desktop evaluations, two sites were identified that have sufficient open space for placement of new stormwater BMPs to treat runoff from impervious areas. These BMPs are described further in Appendix B.2.

5.2.4 STREAM AND OUTFALL RESTORATION

Stream restoration practices are used to enhance the aquatic function, appearance, and stability of stream corridors. Stream restoration practices range from routine, simple stream repairs such as vegetative bank stabilization and localized grade control to comprehensive repairs such as full channel redesign and realignment. Stream corridor assessments (SCAs) performed in the Lower Bynum Run watershed identified restoration opportunities for stream repair and outfall stabilization. Stream segments identified during the SCAs with significant erosion and channel alteration are used to estimate pollutant load reductions which would result from stream repair efforts. Stabilizing the stream channel improves water quality by preventing soil and the pollutants contained in them, from eroding into the stream and receiving waters. Lengths of eroded and altered channel segments were recorded during the SCAs.

5.3 POLLUTANT REMOVAL ANALYSIS AND IMPERVIOUS AREA TREATED CREDITING

This section presents potential pollutant removal calculations for proposed BMPs and stream restoration projects to provide options for meeting the TMDL requirements in the Lower Bynum Run watershed.

5.3.1 POLLUTANT LOADING RATES

The annual pollutant loading rates for total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) used for this analysis were obtained from the Chesapeake Bay Program Phase 6 Watershed Model (Chesapeake Bay Program, 2017). The load for each pollutant was calculated for both pervious and impervious land cover (Table 5-1).

Table 5-1. Annual Pollutant Loading Rates

Land Cover	Total Nitrogen (lb/ac/yr)	Total Phosphorus (lb/ac/yr)	Total Suspended Solids (lb/ac/yr)
MS4 Roads (Impervious)	22.87	0.86	1,880
MS4 Turf Grass (Pervious)	11.19	0.86	1,600

5.3.2 POLLUTANT REMOVAL ANALYSIS

As discussed in Chapter 2, as part of the local Bynum Run Sediment TMDL, a reduction in total urban

sediment loads from stormwater discharges is necessary to meet water quality standards. Section 2.5.1 provides more information on the Bynum Run Sediment TMDL and the sediment reduction goal of 18%. Since the Lower Bynum Run watershed is within the Bynum Run watershed, the sediment reduction goal is also 18%. In addition to the local sediment TMDL, the Lower Bynum Run watershed falls within the Chesapeake Bay watershed. Section 2.5.3 provides more detail on the pollutant reduction goals for Bynum Run. The pollutant reductions for nitrogen and phosphorus within the Lower Bynum Run Watershed, based on the Chesapeake Bay TMDL are 37.9% and 24%, respectively.

Due to the high percentage of residential land use in the Lower Bynum Run watershed, most of the pollutant loads within the watershed are from impervious and pervious urban land uses. Since Harford County is responsible for reducing the urban loads within the County, pollutant reductions are applied only to the urban loads within the watershed.

The following subsections present a quantitative analysis of pollutant removal capabilities of proposed restoration practices to understand how each project may contribute to the pollutant load reduction goals. Note that the removal efficiencies used to estimate pollutant reductions are based on the 2014 MDE *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The runoff reduction (RR) pollutant removal rate adjustor curves were used for both bioretention and submerged gravel wetlands. Also, note that the calculations and estimates presented in the following subsections represent maximum potential pollutant removal capabilities. Not all of these projects in the Lower Bynum Run watershed will be implemented. The total reductions for the proposed projects exceed the 2025 Bynum Run TMDL reduction goals for nitrogen, phosphorus, and sediment.

EXISTING URBAN RESTORATION PRACTICES – STORMWATER MANAGEMENT

As described in Chapter 4, there are 153 existing SWM facilities in the Lower Bynum Run watershed including bioswales, dry detention ponds, dry wells, extended detention ponds, grass swales, infiltration practices, micro-bioretentions, sand filters, wetlands, wet ponds, and other ESD practices such as underground storage. The pollutant load reductions for these existing SWM facilities are included in the Bayfast model pollutant load scenario. Therefore, the pollutant load reductions from the existing facilities were not included in the pollutant load reductions analysis.

PROPOSED URBAN RESTORATION PROJECTS – STORMWATER RETROFITS AND NEW BMP FACILITIES

Proposed stormwater retrofits for the purposes of this study refer to implementing BMPs to capture and treat runoff from impervious surfaces (i.e. parking lots, roadways), which are currently untreated. This includes sites identified for retrofit potential during the existing BMP site assessments and new BMPs locations. Pollutant reductions for stormwater retrofits and new BMPs are calculated based on the approximate pollutant load received from the drainage area (DA) and removal efficiency of BMPs, as shown in the following equation.

$$\left(Impervious\ Pollutant\ Load\ \frac{lb}{ac} \times Impervious\ DA\ (ac) + Pervious\ Pollutant\ Load\ \frac{lb}{ac} \times Pervious\ DA\ (ac)\right) \times Pollutant\ Removal\ Efficiency\ (\%)$$

The equation used to estimate yearly TN load reductions for stormwater retrofits and new BMPs is expressed as follows:

$$\left(22.87\frac{lb}{ac}\times Impervious\ DA\ (ac) + 11.19\frac{lb}{ac}\times Pervious\ DA\ (ac)\right)\times TN\ Removal\ Efficiency\ (\%)$$

The equation used to estimate yearly TP load reductions for stormwater retrofits and new BMPs is expressed as:

$$\left(0.86\frac{lb}{ac}\times Impervious\ DA\ (ac) + 0.86\frac{lb}{ac}\times Pervious\ DA\ (ac)\right)\times TP\ Removal\ Efficiency\ (\%)$$

The equation used to estimate yearly TSS load reductions for stormwater retrofits and new BMPs is expressed as:

$$\left(1{,}880\frac{lb}{ac}\times Impervious\ DA\ (ac) + 1{,}600\frac{lb}{ac}\times Pervious\ DA\ (ac)\right)\times TSS\ Removal\ Efficiency\ (\%)$$

A summary of stormwater retrofit and new BMP load reductions for the Lower Bynum Run watershed are shown in Table 5-2.

Table 5-2. Stormwater Retrofit and New BMP Load Reductions

SWM Facility Type	Facility Type	Impervious Drainage Area (acres)	Pervious Drainage Area (acres)	TN Load from Drainage Area (lbs/yr)	TN Removal Efficiency (%)	TN Load Reduction (lbs/yr)	TP Load from Drainage Area (lbs/yr)	TP Removal Efficiency (%)	TP Load Reduction (lbs/yr)	TSS Load from Drainage Area (lbs/yr)	TSS Removal Efficiency (%)	TSS Load Reduction (lbs/yr)
SWM0554	Wet Pond	3.09	15.18	240.53	20%	48.11	15.71	45%	7.07	30,097	60%	18,058
SWM000118	Submerged Gravel Wetland	2.27	5.05	108.42	43%	46.82	6.30	50%	3.17	12,348	54%	6,660
SWM000257	Submerged Gravel Wetland	2.37	6.76	129.85	63%	81.27	7.85	73%	5.75	15,272	78%	11,986
SWM000287	Submerged Gravel Wetland	1.81	4.45	91.19	68%	61.74	5.38	79%	4.24	10,523	85%	8,934
SWM000312	Submerged Gravel Wetland	1.39	2.13	55.62	67%	37.13	3.03	78%	2.36	6,021	84%	5,044
SWM000342	Submerged Gravel Wetland	0.68	2.37	42.07	66%	27.58	2.62	77%	2.01	5,070	82%	4,166
SWM000347	Submerged Gravel Wetland	1.65	2.93	70.52	67%	47.23	3.94	78%	3.08	7,790	84%	6,553
SWM000415	Submerged Gravel Wetland	3.76	7.24	167.01	61%	102.63	9.46	72%	6.80	18,653	77%	14,373
SWM000428	Submerged Gravel Wetland	1.55	4.54	86.25	68%	58.31	5.24	79%	4.12	10,178	85%	8,632
SWM000472	Submerged Gravel Wetland	3.31	8.17	167.12	67%	112.65	9.87	79%	7.76	19,295	85%	16,330
SWM000622	Submerged Gravel Wetland	0.31	2.15	31.15	68%	21.09	2.12	79%	1.67	4,023	85%	3,415
SWM000683	Submerged Gravel Wetland	1.18	2.23	51.94	67%	34.83	2.93	78%	2.30	5,786	84%	4,877
SWM000685	Submerged Gravel Wetland	3.93	10.74	210.06	66%	139.04	12.62	77%	9.76	24,572	83%	20,395
BMP-P-4	Bioretention	0.52	0.56	18.16	68%	12.29	0.93	79%	0.73	1,874	85%	1,591
BMP-P-7	Bioretention	1.34	0.65	37.92	60%	22.93	1.71	71%	1.21	3,559	76%	2,699
Totals:		**29.16**	**75.15**			**853.64**			**62.05**			**133,714**

PROPOSED URBAN RESTORATION PROJECTS – STREAM CORRIDOR RESTORATION

Stream corridor restoration practices are used to enhance the appearance, stability, and aquatic function of stream corridors. These practices include stream stabilization (i.e. grading and vegetative stabilization) and stream restoration (i.e. redesign and realignment). Several potential stream restoration sites were identified during the stream corridor assessments (SCAs) to improve water quality and address potential environmental problem sites, such as significant erosion and channel alterations. The SCAs are explained in Chapter 4. Stream corridor assessments were conducted along 15.5 miles of stream segments within the Lower Bynum Run watershed. Pollutant reduction for stream corridor restoration are calculated based on EPA approved interim load reduction factors reported in the 2014 MDE report, *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE, 2014a) and are multiplied by the linear feet of identified significant erosion and channel alteration sites.

The equation used to estimate TN load reductions for stream restoration is expressed as:

$$0.075\ lbs\ TN\ \frac{reduced}{linear\ ft} \times Restoration\ Length\ (ft)$$

The equation used to estimate TP load reductions for stream restoration is expressed as:

$$0.068\ lbs\ TP\ \frac{reduced}{linear\ ft} \times Restoration\ Length\ (ft)$$

The equation used to estimate TSS load reductions outside of the Coastal Plain for stream restoration is expressed as:

$$44.9\ lbs\ TSS\ \frac{reduced}{linear\ ft} \times Restoration\ Length\ (ft)$$

The equation used to estimate TSS load reductions within the Coastal Plain for stream restoration is expressed as:

$$15\ lbs\ TSS\ \frac{reduced}{linear\ ft} \times Restoration\ Length\ (ft)$$

Stream restoration projects along with a summary of stream corridor restoration reduction results are shown in Table 5-3.

Table 5-3: Stream Restoration Load Reductions for Stream Reaches in the Lower Bynum Run Watershed

Stream Restoration Site	Length of Restoration (ft)	Reduction in Loading Rate (lbs/ft/yr)	TN Load Reduction (lbs/yr)	Reduction in Loading Rate (lbs/ft/yr)	TP Load Reduction (lbs/yr)	Reduction in Loading Rate (lbs/ft/yr)	TSS Load Reduction (lbs/yr)
MSB-2A	2,220	0.075	166.50	0.068	150.96	15.0*	33,300
MSB-2B	1,160	0.075	87.00	0.068	78.88	15.0*	17,405
MSB-4A	2,385	0.075	178.85	0.068	162.16	44.9	107,070
MSB-4B	2,440	0.075	183.00	0.068	165.92	44.9	109,556
MSB-4C	1,296	0.075	97.22	0.068	88.15	44.9	58,202
MSB-4D	2,105	0.075	157.88	0.068	143.14	44.9	94,515
MSB-4E	3,325	0.075	249.38	0.068	226.11	44.9	149,297
MSB-4G	160	0.075	12.00	0.68	10.88	44.9	7,184
MSB-5A	2,058	0.075	154.35	0.068	139.94	44.9	92,404
MSB-5B	1,327	0.075	99.51	0.068	90.22	44.9	59,571
MSB-5C	3,236	0.075	242.71	0.068	220.06	44.9	145,304
MSB-5D	3,354	0.075	251.58	0.068	228.10	44.9	150,615
MSB-5E	743	0.075	55.69	0.068	50.49	44.9	33,339
MSB-6A	2,649	0.075	198.64	0.068	180.10	44.9	118,919
Totals:	**28,458**		**2,134.31**		**1,935.11**		**1,176,681**

*Coastal Plain pollutant removal rate

5.3.3 IMPERVIOUS AREA CREDIT

Jurisdictions across the country have been mandated to improve the water quality of runoff and control stormwater pollution through the National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit. Through this permit, Harford County is required to treat 20% of the impervious runoff from roadways, parking lots, driveways, buildings, etc. Runoff from impervious area is treated through BMPs, stream restoration and outfall stabilization. The County's current NPDES permit expires on December 29, 2019.

BMP

Using the 2014 MDE *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* guidance, the amount of impervious acre credit for BMPs depends on the amount of water quality volume treated.

- Scenario 1: If the BMP treats less than 1 inch of rainfall, then a proportional acreage of credit is given for each impervious acre in the drainage area.

- Scenario 2: If the BMP treats 1 inch of rainfall, then 1 acre of impervious credit is given for each impervious acre in the drainage area.
- Scenario 3: If the BMP treats more than 1 inch of rainfall, then the impervious area credit will increase by 0.1 acres for every 0.4 inches treated above 1 inch.

Examples of these 3 scenarios are provided in Table 5-4.

Table 5-4. Impervious Acres Credited based on Rainfall Depth Treated

Scenario	Rainfall Depth Treated (inch)	Impervious Drainage Area (acres)	Impervious Acre Credit
1: BMP treats < 1 inch	0.5	5	2.5
2: BMP treats 1 inch	1	5	5
3: BMP treats > 1 inch	1.8	5	6

STREAM AND OUTFALLS

Using the 2019 MDE *Stream Restoration Crediting Clarification for MS4 Permitting Purposes* memo, the amount of impervious acre credit for stream restoration depends on the length of existing stream that is being restored.

- Scenario 1: If the stream is within the Coastal Plain, then the length of existing stream channel that is being restored is multiplied by 0.02 to calculate the equivalent impervious acres.
- Scenario 2: If the stream is outside of the Coastal Plain, then the length of existing stream channel that is being restored is multiplied by 0.03 to calculate the equivalent impervious acres.

Using the 2014 MDE *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* guidance, the amount of impervious acre credit for outfall stabilization depends on the length of existing outfall channel that is being restored. The length of outfall channel stabilized typically is less than 100 feet and is always multiplied by 0.01, regardless of the physiographic region.

The credit multiplier for streams and outfalls are summarized in Table 5-5.

Table 5-5. Impervious Acres Credited for Streams and Outfalls

Scenario	Impervious Area Credit Multiplier (acres/ft.)
1: Stream within Coastal Plain	0.02
2: Stream outside Coastal Plain	0.03
3: Outfall Stabilization	0.01

For proposed projects that involve both a stream and outfall component, the impervious area credit is calculated for each component separately and then summed for the total project impervious area credit.

Table 5-6 lists all the proposed restoration projects and their impervious area treated. A total of 1,322 acres of land is impervious in this watershed. To meet the MS4 permit requirements and treat 20% of the impervious area, 264.4 acres of impervious area needs to be treated through restoration efforts. The total impervious area treated for all projects is 860.66 acres.

Table 5-6. Summary of Potential Impervious Area Credit from Proposed Restoration Projects

Project	Stream Restoration Length (ft)	Outfall Stabilization Length (ft)	Impervious Area Treated (Ac)	% Impervious Treated in Watershed
SWM0554	-	-	3.09	0.23%
SWM000118	-	-	2.27	0.17%
SWM000257	-	-	2.37	0.18%
SWM000287	-	-	1.81	0.14%
SWM000312	-	-	1.39	0.11%
SWM000342	-	-	0.68	0.05%
SWM000347	-	-	1.65	0.12%
SWM000415	-	-	3.76	0.28%
SWM000428	-	-	1.55	0.12%
SWM000472	-	-	3.31	0.25%
SWM000622	-	-	0.31	0.02%
SWM000683	-	-	1.18	0.09%
SWM000685	-	-	3.93	0.30%
BMP-PR2-4	-	-	0.52	0.04%
BMP-PR2-7	-	-	1.34	0.10%
MSB-2A Stream Restoration	2,220	-	44.40	3.36%
MSB-2B Stream Restoration	1,160	-	23.21	1.76%
MSB-2C Outfall Restoration	-	55	0.55	0.04%
MSB-4A Stream Restoration	2,385	-	71.54	5.41%
MSB-4B Stream and Outfall Restoration	2,440	95	74.16	5.54%
MSB-4C Stream Restoration	1,296	-	38.89	2.94%
MSB-4D Stream and Outfall Restoration	2,105	100	64.15	4.78%
MSB-4E Stream and Outfall Restoration	3,325	12	99.87	7.55%
MSB-4F Outfall Restoration	-	96	0.96	0.07%
MSB-4G Stream and Outfall Restoration	160	30	5.10	0.39%
MSB-5A Stream Restoration	2,058	-	61.74	4.67%
MSB-5B Stream Restoration	1,327	-	39.80	3.01%
MSB-5C Stream and Outfall Restoration	3,236	137	98.46	7.55%
MSB-5D Stream and Outfall Restoration	3,354	216	102.76	7.61%
MSB-5E Stream Restoration	743	-	22.28	1.69%
MSB-5F Outfall Restoration	-	90	0.90	0.07%
MSB-6A Stream Restoration	2,649	-	79.46	6.01%
Total	**-**	**-**	**860.66**	

Three proposed restoration projects provide impervious area credit of a total of 22.7% of the watershed or 300 acres of impervious area. These three projects are MSB-4E Stream and Outfall Restoration, MSB-5C Stream and Outfall Restoration, and MSB-5D Stream and Outfall Restoration. Constructing these three projects would provide the impervious area credit needed to meet the MS4 permit requirements for this watershed.

5.3.4 OVERALL POLLUTANT LOAD REDUCTIONS AND IMPERVIOUS AREA CREDITING

The sum of maximum potential pollutant load reductions calculated for individual BMPs and stream and outfall restoration projects represents the overall pollutant removal capacity for a maximum implementation scenario (i.e., 100% of the projects implemented). Table 5-7 lists the total potential pollutant removal if all retrofits, new BMPs, and stream and outfall restoration projects were implemented.

Table 5-7. Total Potential Pollutant Removal

	TN Removal (lbs/yr)	TP Removal (lbs/yr)	TSS Removal (lbs/yr)
Retrofits and new BMPs	854	62	133,714
Stream and Outfall Restoration	2,134	1,935	1,176,681
Total	**2,988**	**1,997**	**1,310,395**

The impervious area credited for all projects also represents the overall impervious acres credited for a maximum implementation scenario (i.e., 100% of the projects implemented). Table 5-8 lists the total impervious acres credited if all retrofits, new BMPs, and stream and outfall restoration projects were implemented.

Table 5-8. Total Potential Impervious Acres Treated

	Impervious Area Treated (acre)
Retrofits and new BMPs	32.43
Stream and Outfall Restoration	828.23
Total	**860.66**

While these tables include all potential projects proposed within the watershed, not all projects will be implemented within the watershed due to costs and property ownership constraints. The total pollutant load reductions exceed the 2025 Bynum Run TMDL reduction goals for nitrogen, phosphorus, and sediment. The total impervious acres treated for all projects exceed the NPDES requirements for this watershed.

6 PUBLIC OUTREACH PROCESS

Harford County provides continual public outreach to keep the public informed of watershed assessments and restoration plans to reduce stormwater pollutants. For the Lower Bynum Run watershed assessment, Harford County created a website with information on the Lower Bynum Run watershed to inform the public. The County will make this watershed assessment report available for public review and will provide a visual online aid to educate and inform the public of the results of the watershed assessment and potential restoration plans.

6.1 WATERSHED ASSESSMENT

This report, The Lower Bynum Run Small Watershed Assessment Report, will be made available in its entirety to the public electronically. The public will have a 30-day window to read through the existing physical conditions in the watershed, understand the general findings of the assessment, and learn about the potential restoration projects that the County is considering for the Lower Bynum Run watershed. The public will be able to comment on the findings in the report during the 30-day review period. The public comments will be incorporated into this report and into the restoration plans.

6.2 STORY MAP

A story map uses the ArcGIS Online application to share information in an easy to follow and systematic way. Story maps are useful for showcasing spatial data through a map interface. For the Lower Bynum Run watershed assessment, a series of maps have been provided to show existing physical conditions within the watershed as well as potential restoration projects. The existing conditions include land use and soils maps while the proposed restoration map shows proposed BMP retrofits and new BMPs and stream and outfall restoration projects. The Lower Bynum Run Stream Study Story Map can be viewed through Harford County's website.

Figure 6-1 shows a snapshot of the Watershed Land Use tab in the Story Map. The panel on the left provides information to the public on why land use types are important when assessing a watershed. The map shows the different types of land use within the Lower Bynum Run watershed.

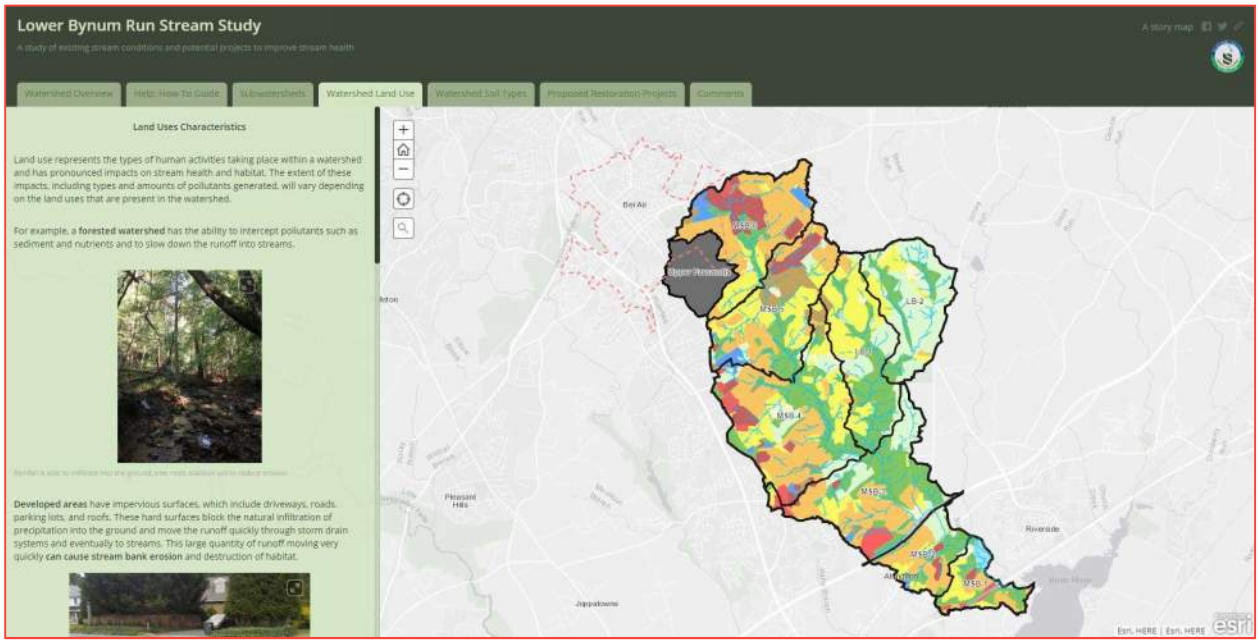

Figure 6-1. Snapshot of Land Use in the Lower Bynum Run Stream Study Story Map

The public has the capability to view the story map at their own convenience and at their own pace. The maps are interactive and include text to guide the user through the application. The user can zoom in and out and see different features on the map. They can type in their address to see what the existing conditions are at their property as well as find out if there are any proposed projects nearby. The public can see the proposed stream projects as well as click on popup images throughout the watershed to gain additional information. These popups provide pictures of the watershed at that location.

The story map provides a link to an online comments form at the Harford County website that allows the public to post questions, concerns, and comments. The comments provided by the public through the story map and the 30-day public review period of this report are considered when selecting potential restoration projects.

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HARFORD COUNTY DPW

LOWER BYNUM RUN

SMALL WATERSHED ASSESSMENT REPORT APPENDICES

DECEMBER 13, 2019

LOWER BYNUM RUN

SMALL WATERSHED ASSESSMENT REPORT APPENDICES

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APPENDIX A EXISTING BMP SUMMARIES

This appendix summarizes the BMP assessments that were conducted on the dry detention ponds and extended detention ponds in the Lower Bynum Run watershed. The following information was collected during the assessments. Some was not applicable to all of the sites and are not included in the site summaries.

- Verification of desktop/design plan drainage area
- Measurement of facility bottom width and length
- Descriptions of any maintenance needs
- Observations of accessibility for construction and maintenance access
- Identification of all inflow points into the facility and verification of the elevation change between the inflow inverts and the outflow structure invert for the facility.
- Evaluation of the condition of the inlets and outfall structure.
- Identification of standing water and/or wetland vegetation in the facility
- Identification of the facility's emergency spillway, if present
- Inspection of manholes near facility to verify storm drain network leading to facility

Existing HA14BMP000933 is located behind residences on the north end of Cogswell Court. There is unobstructed access from Cogswell Court to an 18-foot swing gate. It is within the MSB-2 subwatershed. It consists of a sediment forebay on the eastern part of the facility that conveys flows to a dry pond. The dry pond drains through a riser control structure and into a natural channel. A 24-foot grass emergency spillway exists on the northeast part of the facility. Flows from Cogswell Court are split before entering the facility at two inflow points. A 12-inch CMP pipe conveys flows into the forebay. There is wetland vegetation in the forebay, and it is in good condition. A 24-inch CMP conveys flows directly into the dry pond. The facility appears to be relatively new, and all structures are in excellent condition.

Figure A-1. Forebay from access gate (left); 24-inch CMP inflow point and riser structure from access gate (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There was 0.02 inch of rainfall in the area on the two days prior to the site visit. A concrete riser structure sits on the northern border of the facility. Flows enters through a 6-inch PVC low flow orifice with trash rack and discharges through a 30-inch CMP principal spillway. The outfall is in excellent condition. The outfall channel is in good condition up until 50 feet upstream of confluence with a natural channel. There is a 4-foot headcut and minor erosion at this point in the channel.

Figure A-2. Facing upstream at outfall and outfall protection (left); Facing upstream at headcut and erosion in outfall channel (right)

Existing HA15BMP000094 is located off Kenna Court, surrounded by townhouses including 2500 Kenna Court. The facility is accessible from the road and has an 18-foot swing fence. It is within the MSB-4 subwatershed. The facility consists of a dry pond and sand filter that discharge to the storm sewer system. Incoming flows originate from the sand filter at the eastern end of the site and from the inlet located in the western portion of the site. There was no shallow standing water or wetland vegetation observed within the facility.

There was 0.1 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall recorded in the area on the two days prior to the site visit. Low flow enters through a 12-inch HDPE pipe with an orifice plate constricting the flow diameter to 1.5 inches. The low-flow orifice is housed in a riser structure consisting of triangular prism trash rack. Flows discharge out the riser from a 24-inch RCP principal spillway and enter the municipal storm sewer system.

Figure A-3. Facing southwest towards facility at inflow pipe (left); facing west towards sand filter (right)

Existing SWM000029 is located off St. Mary's Church Road on the side of New Covenant Presbyterian Church. It is accessible from the road and has an 18-foot swing gate. The facility is within the MSB-4 subwatershed. It consists of a dry pond that is routed through a riser and drains to the storm sewer system. A 24-inch corrugated HDPE pipe conveys flow from a northern parking lot into a wetland on the eastern side of the facility. A 6-inch PVC riser conveys flow from the eastern wetland area to the main dry pond in the center of the facility. Flows from the roof, field, and playground areas are conveyed into the facility and the inflow is protected by riprap. A French drain at the base of the western parking lot collects runoff and conveys it via a 12-inch CMP into the facility's western wetland area. Water in the wetland covers the 12-inch CMP, its 6-inch PVC control structure, and is nearly overflowing its eastern berm. There are lily pads and cattails in the wetland, and trees on the edges have been partially submerged. The submerged 6-inch PVC control structure conveys flow into the dry pond. A 14-foot wide grass emergency spillway exists on the east part of the southern border of the facility.

Figure A-4. Facing west at the dry pond and wetland area from the inflow point (left); Eastern wetland region of the facility (right)

There was no rainfall observed in the area on the day of the site visit (5/29/19). There were 0.09 inch of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits just outside the western wetland in the facility. Low flow enters through a 6-inch PVC pipe. Flow is discharged from the facility through a 12-inch CMP principal spillway and immediately enters a 24-inch CMP at the outfall. Both the outfall and 24-inch CMP end sections have major rust damage. Riprap protection in good condition surrounds the outfall. Flow enters the 24-inch CMP, flows under St. Mary's Church Road, and

enters the storm sewer system. An individual inside the church indicated that recent work on the BMP had been completed in the summer of 2018. Expenses to the church exceeded $30,000.

Figure A-5. Facing south, towards St. Mary's Church Road, at the riser (left); Outfall (right)

Existing SWM000039 is located behind residences off Bigmount Court. Access is difficult due to steep slopes and is only accessible from private property. The facility is within the MSB-4 subwatershed. The facility consists of a dry pond that drains through a riser to a channel. An 18-inch CMP discharges flows from residences on Bigmount Court into the northeast part of the facility. Flows enter a 5-foot wide riprap channel which conveys runoff to the riser. Another 18-inch CMP conveys flows from residences on Smallwood Drive into the southeast part of the facility. A riprap channel directly behind this CMP pipe acts as the third inflow point. There is minor riprap displacement around the southeast inflow points.

Figure A-6. Facing west towards facility at inflow pipe (left); Facing east toward facility at inflow channel (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02 inch of rainfall in the area on the two days prior to the site visit. A 38-inch diameter cylindrical CMP riser structure sits in the center of the northern border. Flows enter through a 5-inch CMP low flow orifice and discharge through an 18-inch CMP principal spillway. There is minor riprap displacement at the outfall. There is minor channel erosion extending up to approximately 100 feet downstream from the outfall.

Figure A-7. Riser structure and embankment (left); Facing downstream towards outfall protection and outfall channel (right)

Existing SWM000040 is located south of residences off of Lindsay Court. There is very good access from the remnants of a construction access path west of the facility. The facility consists of a dry pond that drains through a riser control structure and into a channel. It is within the MSB-4 subwatershed. An 18-foot riprap emergency spillway sits in the southwest corner of the facility. The facility has four inflow points. A 30-inch CMP conveys flows from residences along Smallwood Drive and Boeing Court into the eastern part of the facility. Flows travel in a riprap channel to the riser structure. A silt fence runs along the south bank of this channel. A riprap channel acts as another inflow point in this area. It conveys flows from residences into the east part of the facility. A 24-inch CMP conveys flows from residences along Colpepper Road and Lindsay Court into the center of the facility. The fourth inflow point is a riprap channel entering the west part of the facility.

Figure A-8. 24-inch inflow pipe and riser structure (left); Facing north towards riser structure, breached embankment, and stabilizing matting (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02 inch of rainfall in the area on the two days prior to the site visit. A 57-inch diameter cylindrical CMP riser structure sits on the southern border of the facility. Flows enter through a 6-inch CMP low flow orifice and discharge out an 18-inch CMP principal spillway. There is a failed super silt fence a few feet east of the riser. The embankment behind the riser has been completely eroded; stabilizing matting and silt fences are failing. Dry mud is visible on the top of the riser structure. There is substantial debris in the outfall channel.

Figure A-9. Outfall and outfall protection (left); Facing upstream at outfall and outfall protection (right)

Existing SWM000041 is located off West Rhododendron Drive, behind residences including 2608 W. Rhododendron Drive. It is accessible from the roadway and has an 18-foot swing gate. A portion of the fence behind the riser was removed when the field team visited the site. The facility is in the MSB-4 subwatershed. It consists of a partial wet pond that is routed through a riser control structure and drains to a channel. A 32-inch RCP with concrete end section conveys flows from W. Rhododendron Drive into an 8-foot wide by 13-foot long plunge pool on the eastern part of the facility. The seal connecting the end section to the rest of the pipe is broken and there is major erosion surrounding the pipe at this damaged area. Another inflow is located at the southeastern tip of the facility. Flows from residences naturally enter the facility and flow down an 8-foot wide by 42-foot long riprap slope. A 36-inch RCP with end section conveys flows into the facility's southern tip. There are numerous animal burrows and major erosion around the inflow. There is minor riprap displacement and minor erosion along the route the flows take from the inflow to the wet pond. The western part of the facility is covered with wet soil. Numerous 4-inch residential HDPE pipes were observed by the field team conveying flow into this area. They contribute a negligible amount of flow to the western part of the facility. An inflow exists on the western tip of the facility conveying flows onto a 16-foot wide by 71-foot long riprap slope. A 26-foot grass emergency spillway exists on the northern border of the western part of the facility.

Figure A-10. Facing west towards riser, embankment, and broken fence (left); Facing south towards erosion behind the 36-inch RCP inflow pipe (right)

There was no rainfall observed in the area on the day of the site visit (5/29/19). There were 0.09 inch of rainfall in the area on the two days prior to the site visit. A concrete riser structure exists in the eastern

half of the facility. There are a few animal burrows and minor erosion around the riser structure. Low flow enters through a 4-inch PVC pipe. The low flow pipe sits 2 feet above the pond bottom. The low flow pipe is broken 27 feet from the riser. Flows discharge out the riser from a 36-inch CMP principal spillway. A 20-foot wide by 34-foot long riprap protection exists at the outfall where flows enter an unnamed tributary to Bynum Run. The immediate outfall area extending to 100 feet downstream has minor erosion. Flows pass under W. Rhododendron Drive about 200 feet downstream of the outfall via a 90-inch CMP.

Figure A-11. Facing east toward facility at 36-inch RCP inflow pipe (left); Outfall and outfall protection (right)

Existing SWM000058 is located at the southern end of Balmoral Drive, behind residences including 1 McGregor Way. It is within the MSB-5 subwatershed. The facility consists of a dry pond that drains into a riser control structure and discharges to a natural channel. Flow enters the facility from the east via a CMP orifice that drains into a forebay. The CMP was buried under water and sediment. A natural channel conveys flows from the south into the pond. The dry pond has major sediment build up but appears to still function.

Figure A-12. Eastern CMP inflow point and forebay (left); The channel that conveys flow to the pond (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There were 1.45 inches of rainfall in the area on the two days prior to the site visit. A 7.5-foot diameter cylindrical CMP riser with vortex cover sits on the northern part of the facility. Low flows are designed to enter the riser through a

12-inch CMP dewatering device with trash rack. The pipe is buried under 3 feet of sediment and the trash rack was not located. Erosion has formed a 3-foot deep hole behind the riser. Flows discharge out of a 42-inch CMP principal spillway and into an unnamed tributary to Bynum Run. Downstream of the outfall there is moderate erosion (1 to 3 feet cuts) of the natural channel. The overall condition of the channel extending to approximately 100 feet downstream is good.

Figure A-13. Facing south towards facility and riser (left); Facing downstream at the outfall channel (right)

Existing SWM000084 is located west of Eastbend Court, behind residences including 3231 Eastbend Court. It is accessible from the road and is within the MSB-3 subwatershed. The facility consists of a dry pond and two natural streams that are routed through a riser control structure that drains to a natural channel. A 24-inch RCP with concrete end section conveys flows from residences to riprap on the northern part of the facility. Flows enter a forebay pretreatment pond. The pond has wetland vegetation and a 9-inch PVC control structure with mesh wrap. The two streams that feed into the dry pond have low flow rates. There is heavy wetland vegetation in the dry pond and the embankments surrounding the facility are covered with young trees (less than 10 years old).

Figure A-14. Facing east towards the 24-inch RCP inflow pipe (left); The embankment between the forebay and the riser control structure (right)

There was no rainfall observed in the area on the day of the site visit (5/29/19). There were 0.09 inch of rainfall in the area on the two days prior to the site visit. A 11.5-foot diameter cylindrical CMP riser sits on the eastern part of the facility. Flows enter through an 18-inch CMP orifice and discharge through a

48-inch CMP principal spillway with end section. High flows are conveyed over a circular weir inside the riser. A 31-foot wide by 26-foot long riprap outlet protection exists at the outfall where flows enter an unnamed tributary of Bynum Run. Flows undercut a gabion structure 30 feet from the outfall, and geotextile is visible. There is major erosion in the outfall area and extends hundreds of feet downstream.

Figure A-15. Facing west towards the facility from Eastbend Court (left); Facing upstream towards the undercut gabion structure (right)

Existing SWM000085 is located off of Birch Brook Lane adjacent to the property located at 3120 Birch Brook Lane. It is accessible via a chain link swing gate located along the southeast edge of the facility. The facility is within the MSB-3 subwatershed. One 28-inch RCP into the facility conveys flows originating from the storm sewer system to the southwest. One 20-inch RCP into the facility conveys flows originating from the storm sewer system to the northeast. The facility is in-line with an existing stream that enters the site from the northwest. A concrete riser structure controls flows out of the facility and discharges through a 54-inch CMP principal spillway. The principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the south. Shallow standing water and wetland vegetation were observed within the facility.

Figure A-16. Channel protection for the 28-inch RCP inflow point at western part of the facility (left); View of facility from access gate (right)

Rainfall totaling 0.05 inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on field observation, an 18-inch CMP conveys flows into the riser via a low-flow orifice. The size of the orifice could not be confirmed because the upstream end could not be located due

to heavy sediment buildup upstream of the riser. Overflow is conveyed through the inner lip of the 9-foot diameter circular CMP riser.

Figure A-17. Riser control structure and embankment (left); Outfall channel from Birch Brook Lane (right)

Existing SWM000089 is located off of Federal Lane adjacent to properties located at 1423 Crystal Ridge Court and 3717 Federal Lane. It is accessible from Federal Lane although a guardrail currently is present along the northern edge of the site. The facility is within the MSB-2 subwatershed. One 24-inch CMP into the facility conveys flows originating from the storm sewer system to the southwest. The facility is in-line with an existing stream that enters the site from the southeast. A concrete riser structure controls flows out of the facility and discharges through a 27-inch CMP principal spillway transitioning to a 42-inch CMP upstream of the outfall. The principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the north. Shallow standing water and wetland vegetation were observed within the facility.

Figure A-18. Facing south towards the facility from the 24-inch CMP inflow point (left); Facing upstream towards the channel that flows into the facility (right)

Rainfall totaling 0.05 inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observation), an 8-inch CMP conveys flows into the riser via a low-flow orifice. Overflow is conveyed through the 8-foot diameter circular CMP riser.

Figure A-19. Riser structure (left); Facing upstream towards the outfall channel and embankment (right)

Existing SWM000118 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000123(1) is located across from the APGFCU credit union building, 2113 Laurel Bush Road. It is accessible from Laurel Bush Road. The facility is within the MSB-4 subwatershed. One 42-inch RCP with a concrete end section conveys flows into the facility from the storm sewer system to the northwest. One 24-inch RCP with concrete end section conveys flows into the facility from the storm sewer system to the northeast. There is also a riprap ditch in the southwest corner of the site conveying flows from a natural channel to the southwest. The riprap ditch has mild to moderate erosion and riprap displacement. A CMP riser structure controls flows out of the facility and discharges through a 66-inch CMP principal spillway. A gabion reinforced plunge pool at the outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the east. Dense vegetation and saturated soils were observed within the facility.

Figure A-20. The 42-inch RCP inflow pipe and plunge pool (left); Riser control structure and low flow orifice (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field work), a low-flow 24-inch CMP is installed at the pond bottom. Overflows enter the 84-inch diameter corrugated metal riser structure and are conveyed through a 66-inch CMP principal spillway. The immediate outfall area is in good condition; however, there is some debris jamming approximately 30

feet downstream of the spillway where a gabion basket structure is creating a 2-foot to 3-foot elevation drop.

Figure A-21. Facing downstream at the outfall channel and debris jam (left); The 2 foot to 3 foot elevation drop in outfall channel after gabion basket structure (right)

Existing SWM000124 was field investigated on 5/16/19, but no existing facility could be located. There is a facility located approximately 0.4 miles northeast in the vicinity of 201 Royal Oak Drive (SWM000312) which matches the as-built (Bright Oaks Courtyard).

Figure A-22. Supposed location of SWM000124

Existing SWM000125 is located at the intersection between Hookers Mill Road and Bynum Overlook Drive. It has no fence surrounding it and is well maintained. There is good access to the facility from the roadway. The facility is within the MSB-3 subwatershed. The facility consists of an infiltration basin that drains to a natural channel. The basin collects flows from residences on Bynum Overlook Drive. Flows enter the northeast part of the facility through a 36-inch RCP and into a riprap forebay. The inflow needs currently bypasses the infiltration basin. A 32-foot riprap emergency spillway exists on the eastern part of the facility. Two 8-inch PVC dewatering devices, spaced on the southern border of the basin, drain flows to Bynum Run confluent to James Run. The outfall is in good condition, and there is minor erosion where the outflow enters the natural channel extending to approximately 100 feet downstream of the outfall.

Figure A-23. Facing northwest, adjacent to Hookers Mill Road, at the facility (left); Channel protection of the 36-inch RCP inflow that bypasses the facility (right)

There was 0.47 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit.

Figure A-24. Facing southeast toward facility (left); Channel downstream of the facility (right)

Existing SWM000126 is located off Deer Court, in between 911 Deer Court and 913 Deer Court. Access from the roadway is difficult due to steep embankments and heavy vegetation. The facility is within the MSB-3 subwatershed. It consists of a dry pond that collects flows from two pipes and a natural stream. The pond drains through a triple culvert that runs under Deer Court and returns flow into a natural stream. The stream providing inflows to the facility is in fair condition. It brings flows from the north to the facility and only has minor erosion. A 24-inch RCP conveys flows from residences from the east into a forebay on the east side of the facility. Another 24-inch RCP conveys flows from residences from the west into a forebay on the west side of the facility. In between these two inflows sits the triple culvert. There is standing water upstream of the culvert.

Figure A-25. Natural stream upstream of the facility (left); Forebay (right)

The triple culvert consists of two 48-inch RCPs and a 24-inch CMP that sits a little below and in between them. The 24-inch CMP's inlet is buried under sediment. The outfall has minor riprap displacement and sediment build up is impacting the 24-inch CMP. The western RCP at the outfall did not have flowing water, but the eastern RCP did. Flows drain into an unnamed tributary to Bynum Run. The immediate outfall area extending to approximately 100 feet downstream is in fair condition.

There was 0.47 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit.

Figure A-26. Upstream end of the triple culvert (left); Downstream end of the triple culvert (right)

Existing SWM000163 is surrounded by residences and is adjacent to 1407 Fountain Glen Drive. It is accessible from the roadway, but vegetation is overgrown in the pond. The facility is within the MSB-6 subwatershed. It consists of two pipe inflows and a stream inflow that convey flows to a dry pond. The pond drains through a riser control structure and back into a natural channel. A 24-inch RCP conveys flows from residences from the southeast into a forebay on the northern part of the facility. The pipe is half-full of sediment. Another 24-inch RCP conveys flows from residences from the northwest into a forebay on the northern part of the facility. A small berm separates the northern part of the facility from the pond in the southern part. A natural channel conveys flows from the north. The stream is by-passing the facility, leaving little flow for the facility to treat. A portion of the roadway acts as an emergency spillway.

Figure A-27. Stream that bypasses the facility (left); Riser structure (right)

There was no rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit. A non-traditional, concrete riser sits at the southwestern tip of the facility. Flows enter the riser through a 36-inch RCP orifice and discharge through an 8-foot RCP principal spillway. A plunge pool exists at the outfall where flows enter an unnamed tributary to Bynum Run. The riprap/gabion section of the outfall is in good condition, and downstream of the outfall only has minor erosion.

Figure A-28. Downstream view of outfall (left); Upstream view of outfall (right)

Existing SWM000166 could not be located during field investigations. GIS information indicates it is located along Foxborough Drive west of Bennett Place. The Foxborough Farms Section 3 Phase 2 record drawing calls out a structure in this vicinity called Stone Outlet Trap #2. The outfall channel adjacent to Bennett Place is eroded with the majority of the riprap displaced. The outfall's location is within the MSB-5 subwatershed.

Figure A-29. Record drawings of the site (left); Satellite imagery of the site (right)

Figure A-30. Facing downstream at the outfall channel (left); Outfall protection (right)

Existing SWM000198 is located behind residences on the west end of Royal Troon Court. There is unobstructed access from private properties around the facility. It is within the MSB-5 subwatershed. The facility consists of a dry pond that drains through a riser control structure to a natural channel. A 24-inch CMP conveys flows from residences on Royal Troon Court into the southern part of the facility. The pipe is half buried by sediment; there is a 24-inch headcut downstream out the inflow point. A 36-inch RCP conveys flows from residences on Muirfield Close into the northern part of the facility. A natural stream flows from east to west into the facility. A 48-foot grass emergency spillway exists on the southwest end of the facility.

Figure A-31. Facing downstream from the 36-inch RCP inflow pipe (left); Facing downstream towards the 24-inch CMP inflow channel (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02 inch of rainfall in the area on the two days prior to the site visit. A concrete riser structure sits on the northwest border of the facility. Flows enter through an 18-inch CMP. There is debris and sediment buildup at the pipe. Flows discharge through a 36-inch CMP principal spillway, enter an ex-SD manhole, and outfall through a 48-inch CMP. There is minor outfall sediment and outfall erosion. The channel extending 100 feet downstream is in good condition.

Figure A-32. Embankment and riser structure (left); Facing downstream at outfall (right)

Existing SWM000199 is located on East Ring Factory Road adjacent to 418 Sunny View Rd. The facility is within the MSB-6 subwatershed. One 30-inch corrugated metal pipe with a concrete headwall conveys flow from the east side of East Ring Factory Road and from a conveyance system running along East Ring Factory Road from the south. The outfall is partially enclosed by a wooden privacy fence that forms a square perimeter around the concrete headwall. The downstream wall has become damaged and misaligned due to channel flows. Gabion material and exposed geotextile were observed in portions of the channel immediately downstream of the outfall. The site is classified as a dry retention pond. The location discharges to an 8-foot width riprap lined channel that drains to an unnamed tributary to Bynum Run, crossing under East Ring Factory Road through a 97-inch by 154-inch arch RCP.

Figure A-33. Facing east towards outfall and wooden privacy fence (left); Damaged part of the fence downstream of the outfall (right)

Rainfall totaling 0.02 inch had been observed in the area two days prior to site visit. A puddle of standing water was observed at the outfall but the riprap channel was dry.

Figure A-34. Facing north downstream of the outfall channel (left); Facing south at the confluence of the outfall channel and an unnamed tributary to Bynum Run (right)

Existing SWM000203(1) is located behind the Seasons at Bel Air Apartments, 1001 Todd Road, near Royston Place. The facility is within the MSB-6 subwatershed. One 30-inch corrugated metal pipe with a concrete headwall conveys flow from a storm sewer system to the northwest. An additional 30-inch CMP with headwall conveys flows from the storm sewer system to the northwest. The inner pipe shows deterioration including rusting and loss of material. The facility discharges through a concrete riser structure with a 30-inch CMP principal spillway to a drainage channel discharging to Bynum Run to the southwest. The riser contains a low-flow orifice which was visibly flowing during the field visit. The facility is classified as a dry pond. Less than half a foot of standing water was observed within the facility.

Figure A-35. Facing northeast towards facility (left); Damaged 30-inch CMP inflow pipe (right)

Rainfall totaling 0.02 inch had been observed in the area two days prior to site visit.

Figure A-36. Riser structure and embankment behind it (left); Erosion from stream under facility's outer fence (right)

Existing SWM000204 and SWM000338 is located in the natural area bounded by Tredmore Road to the east, Todd Road to the south, Greenbrier Shopping Center to the west, and residences including 1313 through 1349 Artists Lane to the north. Records state that this area has two BMPs; however, field observation indicates it is one continuous facility. It is accessible from Todd Road. The riser structure is accessible via an 18-foot maintained access path along the upstream embankment, perpendicular to Todd Road. The facility is within the MSB-6 subwatershed. One 48-inch pipe into the facility conveys flows originating from the storm sewer system to the northeast. One 30-inch pipe into the facility conveys flows originating from the storm sewer system to the southeast. One 30-inch RCP into the facility conveys flows originating from the storm sewer system to the north. A concrete riser structure controls flows out of the facility and discharges through a 36-inch RCP principal spillway. The principal spillway drains to a channel discharging to Bynum Run to the west. Heavy vegetation was observed in the facility including approximately 75% small diameter tree cover and wetland vegetation.

Figure A-37. 30-inch RCP at northern end (left); Riser structure with overgrown plants (right)

No precipitation had been observed in the area on the day of the site visit (4/30/19). Rainfall totaling 0.02 inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observation), a 24-inch BCCMP conveys flows into the riser via a low-flow orifice. Overflow is conveyed through a 30-foot width emergency spillway north of the riser.

Figure A-38. Overgrown plants in facility (left); Emergency spillway (right)

Existing SWM000223 is adjacent to properties located at 1318 Hidden Stream Drive and 1302 Hidden Stream Drive. It is accessible from Hidden Stream Drive. Guardrails run along the width of the ROW on the upstream and downstream embankments. The facility is within the MSB-2 subwatershed. One 30-inch RCP into the facility conveys flows originating from the storm sewer system to the west. The site also receives inflow from a natural stream flowing from the southwest. A concrete riser structure controls flows out of the facility and discharges through a 78-inch BCCMP principal spillway. The

principal spillway drains to a channel discharging to Bynum Run to the northeast. Approximately 3 feet of accumulated silt was observed in the facility. The low flow pipe and headwall were not visible due to the material buildup.

Figure A-39. 30-inch RCP inflow pipe and forebay at northwest edge of facility (left); Facing south towards facility (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings, a 36-inch BCCMP with concrete headwall conveys flows into the riser via a low-flow orifice. There is no emergency spillway.

Figure A-40. Slope between the riser structure and Hidden Stream Drive (left); Slope from Hidden Stream Drive down to the outfall (right)

Existing SWM000229 is located off Hunters Run Drive, adjacent to residences including 400 Hunters Run Drive. It is accessible from the road, but the slopes off the road are moderately steep. The facility is within the MSB-4 subwatershed. It consists of twin water quality treatment beds that convey flow into two separate natural streams. The two streams then converge onto a spillway. All flow is collected at the spillway and conveyed to the outfall. A 24-inch CMP receives flow from the Saddle Run Community to the north and conveys it into the northern water quality treatment bed. There are 2 to 3 inches of standing water in the water quality bed and there is moderate sediment build up. The end section of the CMP is rusted and there is minor riprap displacement at the inflow point. A 15-inch RCP with 58-inch headwall also conveys flow into the northern water quality bed. The trash rack attached to the end of the pipe is loose. A 36-inch CMP receives flow from the Hunters Run Community to the south and conveys

it into the southern water quality treatment bed. There are 4 inches of standing water in the water quality bed and there is major sediment build up. There is major erosion at the point where the water quality bed discharges flow into its natural stream. There is minor riprap displacement at the inflow. Both streams are in good condition upstream of the facility.

Figure A-41. Erosion in natural stream near the outfall of the southern water quality treatment bed's overflow pipe (left); 15-inch RCP inflow pipe, the northern CMP inflow pipe, and the northern water quality treatment bed

There was no rainfall observed in the area on the day of the site visit (5/29/19). There was 0.09 inch of rainfall in the area on the two days prior to the site visit. There is no riser structure. A 36-inch RCP with 17-foot headwall serves as the principal spillway. There is moderate erosion behind the headwall. A log blocked part of the pipe, causing major sediment buildup in front of it. Flow is conveyed under Hunters Run Drive, which serves as the embankment (61 feet), to the outfall on the other side. At the outfall, flow enters a silted pool that is approximately 3 feet deep. The slopes that lead down to the outfall from the roadway are reinforced with riprap in good condition. A 6-inch PVC pipe and a 3-inch corrugated HDPE pipe convey flow into the riprap on the northern slope. There is minor erosion downstream of the outfall where the flow enters an unnamed tributary of Bynum Run. The overall condition downstream of the outfall is good.

Figure A-42. Facing south toward the facility (left); Outfall, silted pool, and the embankment behind the outfall (right)

Existing SWM000257 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000259 is located off Glenangus Drive behind residences including 1500 Parkland Drive. It is accessible from Glenangus Drive. The facility is within the MSB-5 subwatershed. The facility consists of an infiltration basin that drains to a natural channel that is routed through a riser control structure. The infiltration basin is separated from the downstream natural channel by a timber weir. A 30-foot length PVC pipe at the floor of the facility drains low flows around the weir wall. In its current condition the infiltration basin has several feet of standing water (up to the top of the wood weir) and wetland vegetation, indicating the PVC low flow orifice may be clogged. The PVC pipe was not visible during field inspection. There is severe slope erosion along a portion of the slope leading from the infiltration basin toward the stream. The inflow pipes into the infiltration basin include one 18-inch BCCMP conveying flows from two dual grate inlets along Glenangus Drive and one 24-inch RCP with a concrete end section conveying flows from the residential area to the east. Damaged silt fence is visible around the 24-inch RCP outfall.

Figure A-43. Infiltration basin from behind the RCP inflow pipe (left); Infiltration basin from behind the timber weir (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The concrete riser structure sits at the toe of the embankment of Glenangus Drive. Flows enter through a 24-inch RCCP pipe orifice and discharge through a 24-inch RCCP principal spillway. A plunge pool exists at the outfall where flows enter Bynum Run confluent to James Run to the southwest. Multiple fallen large diameter trees were observed upstream of the riser area. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-44. View of riser structure from Glenangus Drive (left); Facing southwest towards riser structure, fallen trees behind the infiltration basin (right)

Existing SWM000286 is located northeast of Towson Road, behind residences including 1008 Towson Road. The facility is accessible from private backyards, and the field team had to go around existing yard fences. A utility road exists behind the facility. It is located within the MSB-3 subwatershed. It consists of a dry pond that is routed through a riser control structure and drains to Bynum Run. A 24-inch CMP with headwall conveys flows from residences along Hamburg Drive into the northwest part of the facility. A riprap slope also conveys flows from 922 Hamburg Drive into the northwest part of the facility. A 24-inch CMP with headwall conveys flows from residences along Towson Road into the southeast part of the facility. A 5-foot scour hole and minor riprap displacement exists at this inflow.

Figure A-45. Facing north towards facility (left); Facing downstream at inflow scour hole (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02 inch of rainfall in the area on the two days prior to the site visit. A 57-inch diameter cylindrical CMP riser structure sits on the northern border of the facility. Flows enter through an 8-inch CMP low flow orifice and discharge through a 24-inch principal spillway. There is minor sediment buildup in the principal spillway. The outfall and outfall protection is in fair condition. The outfall channel extending 100 feet downstream is in good condition.

Figure A-46. Facing downstream at outfall channel and Bynum Run (left); Facing south at embankment and access point behind residential yard fences (right)

Existing SWM000287 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000295 is encircled by Dunkeld Way and its residences. It is easily accessible from the road, well maintained, and does not have a fence. The facility is within the MSB-4 subwatershed. The facility consists of two infiltration basins that drain to an extended dry detention pond. The pond drains through a riser control structure and discharges to a natural channel. Two inflows convey flow into the southeast infiltration basin: a 24-inch RCP and an 18-inch RCP. Both have moderate sediment build up in front of their inflows. The bottom of the infiltration basin is sediment filled. This basin drains over a riprap spillway westward, towards the riser structure which sits at the southern part of the facility. Another inflow exists just north of this basin. A 21-inch RCP conveys flows onto a riprap plunge pool, but flows do not enter the infiltration basin right next to it. Instead, they travel to the pond at the center of the facility. Two inflows convey flow into the northeast infiltration basin: an 18-inch RCP and a 24-inch RCP. This infiltration basin has a 26-foot grass emergency spillway that conveys flow to the pond in the center of the facility. There are three more pipe inflows on the northern border of the facility. A double culvert reinforced with gabions conveys flows into the central pond. The culvert consists of a 36-inch RCP and a 5-foot by 3-foot elliptical RCP. The inflow is in good condition. The other inflow on the northern border (eighth total) is a 24-inch RCP with moderate sediment build up. It conveys flows to the central pond as well.

Figure A-47. Facing south towards southeast inflow pipes, the southeast infiltration basin, and the riser structure (left); Facing north towards the facility and the elliptical culvert inflow pipe (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There were 1.45 inches of rainfall in the area on the two days prior to the site visit. The concrete riser structure on the south end of the facility has weir openings on all sides. The riser is in good condition but has graffiti on the inside. Low flows from the pond enter the riser through an 18-inch RCP and discharge through a 60-inch RCP principal spillway. A riprap plunge pool exists at the outfall where flows enter an unnamed tributary to Bynum Run. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-48. View of riser structure from Glenangus Drive (left); Looking upstream to the outfall (right)

Existing SWM000312 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000332 is located off Hookers Mill Road, across the street from residences including 810 Eastridge Road. It is surrounded by a fence and has an 18-foot gate located behind the riser structure. The site has steep embankments that are well maintained. The facility is within the MSB-3 subwatershed.

It consists of a wet pond (1.5 feet deep) that drains through a riser control structure and into a natural channel. A 38.5-inch CMP inflow pipe conveys flows into the northwest part of the facility. A plunge pool exists at this inflow. The inflow is in good condition. A riprap channel on the southwest corner of the facility acts as the second inflow point. It conveys flows from the roadway into the facility.

Figure A-49. Facing northwest towards the 38.5-inch CMP inflow (left); Facing northeast towards riser structure, access gate, and east side of the facility (right)

There were 0.47 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the northern border of the facility. Flows enter through a 12-inch PVC pipe and discharge through a 48-inch RCP principal spillway. A plunge pool exists at the outfall and there is a steep 6-foot drop at the end of the riprap. Flows enter an unnamed tributary to Bynum Run. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-50. Access to facility from Hookers Mill Road (left); Embankment behind the riser structure and the outfall's riprap channel protection (right)

Existing SWM000333 is located directly east of Old Ridgeline Way, between 817 Oak Mill Court and 816 Bynum View Court. It is surrounded by a fence and has an easily accessible gate. The embankments are mowed and well maintained. The facility is within the MSB-3 subwatershed. It consists of a dry extended detention pond that drains through a riser control structure and into a natural channel. A 24-inch RCP conveys inflows from residences along Oak Mill Drive into a forebay on the northern part of the facility. A plunge pool in good condition exists at this inflow. Two more inflows exist at the southern end of the facility and convey flows into another forebay. A riprap channel conveys flows off Old Ridgeline Way and

an 18-inch RCP conveys flows from Bynum View Court into the forebay. There is minor vegetation in the riprap channel.

Figure A-51. Southern inflow points (left); View of facility from southern inflow points (right)

There were 0.47 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the eastern border of the facility. Flows enter through a 12-inch PVC pipe dewatering device. Flows discharge out a 27-inch RCP principal spillway and into an 8.5-foot wide plunge pool. There is a 7-foot drop with moderate erosion at the end of the riprap and geotextile is visible. Flows enter Bynum Run confluent to James Run. The outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-52. Access path to facility from Old Ridge Way (left); Downstream at outfall channel (right)

Existing SWM000342 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000347 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000359 could not be located during field investigations. GIS information indicates it is located along Foxborough Drive west of Bennett Place. The as-built for this facility instead matches that for SWM000084. Its GIS location is in the MSB-3 subwatershed.

Figure A-53. GIS location of SWM000359

Existing SWM000363 is located off David Drive, adjacent to residences including 540 David Drive. It has an access road and no fence. The facility is within the MSB-5 subwatershed. It consists of an infiltration basin and two streams that convey flow to a dry pond. Flows from the pond are routed through a riser control structure and into a natural channel. The western stream has severe (greater than 5 to 6-foot) bank erosion upstream, while the eastern stream has moderate (greater than 3-foot) erosion along its channel. There is a 3-foot cut in the channel at the point where the streams converge before the pond. An RCP with an unspecified diameter conveys flows into the infiltration basin on the east part of the facility. There was standing water in the basin at the time of the site visit. High flows travel over a riprap weir and enter the pond.

Figure A-54. Facing east towards riser structure and infiltration basin (left)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There were 1.45 inches of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits at the southern border of the facility, next to David Drive. Flows enter the riser through an 18-inch vertical CMP with trash rack. There is a small chain link fence around the orifice. Sediment and sticks were covering the orifice. Flows discharge through a 66-inch CMP that conveys flows under David Drive and into an unnamed tributary to Bynum Run. Large amounts of sediment are transported downstream through the riser. The immediate outfall area extending to approximately 100 feet downstream is in good condition. Downstream channel past 100 feet has 2 to 3-foot cuts and 6 to 7-foot bank erosion.

Figure A-55. Slope from David Drive to riser structure (left); Slope from David Drive to outfall (right)

Existing SWM000393 is located adjacent to Old Emmorton Commons, 2225 Old Emmorton Road. It is accessible from Old Emmorton Road. The facility is within the MSB-4 subwatershed. One 36-inch HDPE with a metal end section conveys flows into the facility from the storm drain system to the southwest. One 36-inch HDPE with a metal end section and trash rack conveys flows out of the facility toward the storm sewer system to the southeast. The trash rack has become disconnected from the pipe opening. There is no riser control structure onsite. Based on record drawings, the facility appears to convey flows

to an underground storage facility located approximately 242 feet downstream. The storage facility then discharges to the storm sewer system.

Figure A-56. Facing northwest towards facility (left); Disconnected trash rack (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The facility had standing water and wetland vegetation.

Figure A-57. Facing east towards the facility (left); Facing west towards the facility (right)

Existing SWM000415 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000416 is located off of Tiffany Trail behind the properties located at 4007 and 4009 Andrew Court. It is accessible via an access path off Tiffany Trail leading to a chain link swing gate. The facility is within the MSB-3 subwatershed. One 24-inch RCP conveys flows into the forebay upstream of the main facility. One 12-inch RCP conveys flows directly into the pond. Flows in the 12-inch and 24-inch inflow pipes originate from the storm sewer system running along Tiffany Trail to the northeast. One riprap slope measuring approximately 30-foot wide conveys overland flows from the southwest. A concrete riser structure controls flows out of the facility and discharges through a 24-inch CMP principal spillway. A riprap plunge pool at the principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the north. Shallow standing water and wetland vegetation were observed within the facility.

Figure A-58. Facing west towards facility at access gate (left); 24-inch RCP with broken seal (right)

Rainfall totaling 0.05 inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field work), a low-flow 6-inch perforated PVC pipe is installed at the pond bottom. Flows exiting the 6-inch PVC pipe travel overland across riprap and through a trash rack along the base of the concrete riser structure to enter an 8-inch low flow orifice. Overflow is conveyed through trash racks along the front face and top of the riser

Figure A-59. Access path from Tiffany Trail (left); Embankment behind riser structure (right)

Existing SWM000428 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000453 is located east of the cul-de-sac at the south end of Sidehill Drive; the surrounding area is residential. It is accessible from a 12-foot wide access road and 18-foot swing gate that is between 925 Sidehill Drive and 927 Sidehill Drive. The facility is within the MSB-4 subwatershed. It consists of a dry pond that is routed through a riser structure and drains to a natural channel. A 24-inch RCP conveys flow from Sidehill Drive to the western part of the facility. The seal six feet from the end section of the pipe is deteriorating. A 15-foot wide by 19-foot long plunge pool exists at the inflow. A 4-inch HDPE pipe conveys flow to the northwestern part of the facility. The HDPE pipe has no end section and is located at the top of the embankment. Flow is conveyed onto sloped riprap. A 24-inch RCP conveys flow into the northwestern part of the facility as well. It conveys flow from South Hill Court and discharges into a 12-

foot wide by 15-foot long plunge pool at the bottom of the facility. There is standing water in the plunge pool.

Figure A-60. Facility from northeast corner (left); Facility from southern corner (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). There was no rainfall observed in the area on the two days prior to the site visit either. The concrete riser structure is on the eastern side of the facility. Low flow enters through a 6-inch PVC pipe and high flow enters through a 9-inch PVC pipe. The opening of the 9-inch PVC pipe bends 90 degrees downward toward the facility floor. Flow drains through a 30-inch PVC pipe out of the riser. On the other side of the embankment, the flow drops 8 feet before being discharged by a 24-inch RCP to a plunge pool. Grouting has deteriorated at the seam 6 feet from the outfall. The outfall discharges with some incision. The plunge pool is 12 feet wide by 15 feet long and has some riprap displacement. The outflow has caused minor erosion and sedimentation of the natural channel behind the facility. The stream is in fair to good condition.

Figure A-61. Riser structure (left); Outfall and outfall channel from top of embankment (right)

Existing SWM000455 is located at the south end of Streamview Court behind residences, including 1302 Streamview Court. It has a fence and an 18-foot gate. The site is accessible from the road but has steep embankments. It is within the MSB-6 subwatershed. The facility consists of a dry pond that drains through a riser control structure to a natural channel. A 30-inch RCP conveys flows from residences on Streamview Court into the eastern part of the facility. Flows enter a riprap forebay and travel over riprap gabions before reaching the pond. The riprap is in good condition. A riprap channel conveys flows into

the northern tip of the facility. There is a minor amount of vegetation growing in the riprap. A 23-foot grass emergency spillway exists behind the riser structure on the southern border of the facility.

Figure A-62. Facility from behind the 30-inch RCP inflow pipe (left); Riser structure (right)

There was no rainfall observed in the area on the day of the site visit (4/30/19). There was 0.02 inch of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the southern border of the facility. Flows enter through a 4-inch PVC pipe orifice and discharge through a 30-inch RCP principal spillway. A plunge pool exists at the outfall where flows enter an unnamed tributary to Bynum Run. There is moderate channel erosion extending up to approximately 100 feet from the outfall, but the channel is stabilized beyond.

Figure A-63. Outfall and plunge pool (left); Downstream at outfall channel (right)

Existing SWM000469 is located behind residences off Kelsey Court, Blair Court, and Harling Court. It is accessible behind 1304 Harling Court. The site has a fence and gate and is well maintained. It is within the MSB-6 subwatershed. The facility consists of a dry extended detention pond that drains through a riser control structure to a natural channel. A riprap channel conveys flows from residences along Kelsey

Court and Brunswick Drive into the northern corner of the facility. There are three check dams in the channel upstream of the inflow channel. The riprap, channel, and dams are in good condition and are well maintained. A 24-inch RCP conveys flows from residences on Harling Court and most of Moonshadow Road into the eastern corner of the facility. The plunge pool has a moderate amount of vegetation growing in it. A riprap channel adjacent to the 24-inch RCP conveys flows into the same plunge pool. An 18-inch RCP conveys flows from Blair Court into a forebay in the western corner of the facility.

Figure A-64. Check dams upstream of facility (left); Facility and riser structure (right)

There was no rainfall observed in the area on the day of the site visit (4/30/19). There was 0.02 inch of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the southern border of the facility. Flows enter through a 2 inch by 2 inch concrete opening at the bottom of the pond and discharges through a 36-inch CMP principal spillway. A plunge pool exists at the outfall. A 22-foot wide grass emergency spillway exists above the principal spillway. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-65. Facility from behind the 18-inch RCP inflow pipe (left); Upstream at outfall and embankment (right)

Existing SWM000472 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000506 is located along Pulaski Highway (MD-40) immediately east of the 7-Eleven, 3901 Pulaski Highway. The location of the facility does not match the location in the database, which shows it in the wooded area behind Bush River Books & Video, 3909 Pulaski Highway. It is accessible from the 7-Eleven parking lot through a chain link swing gate. There is no other fencing around the facility. The facility is within the Bush River subwatershed. One 18-inch HDPE into the facility conveys flows originating from the storm sewer system that includes drainage from the 7-Eleven parking lot. A concrete riser structure controls flows out of the facility and discharges through an 18-inch CMP principal spillway. The principal spillway drains to a riprap ditch upstream of a 15-inch RCP running under the Bush River Books & Video driveway. There is no emergency spillway. No standing water or wetland vegetation were noted.

Looking at the facility with the Pulaski Highway (MD-40) behind it (left); Looking at the outfall and outfall channel (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observations), low flows enter the riser through an 18-inch CMP pipe constricted to 6-inch by an orifice plate. High flows enter the top of the riser through a trash rack. Currently flows in the roadside ditch along Pulaski Highway bypass the facility.

Figure A-66. Western side of the facility and access point from 7-Eleven (left); Confluence of outfall channel and roadside ditch (right)

Existing SWM000526 is located at the south end of Balmoral Drive, in front of the residences 1518 and 1522 Balmoral Drive. It has a fence and a gate that is easily accessible from the roadway. The facility is within the MSB-5 subwatershed. It consists of a dry extended detention pond that drains through a control structure to a natural channel. A riprap channel provides the only inflow to facility. It conveys flows from the residences to the west into the pond. The inflow is in good condition.

Figure A-67. Facing west towards facility and residences (left); Facility from top of riprap inflow point (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There were 1.45 inch of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the eastern part of the facility. Flows enter through a 6-inch PVC pipe orifice that is buried under gravel. Flows discharge through a 24-inch CMP principal spillway that conveys flows under Balmoral Dr. A well-maintained plunge pool exists at the outfall where flows dissipate into the woods. The immediate outfall area was in good condition, and there was no observed downstream channel.

Figure A-68. Upstream view of outfall and outfall protection (left); Downstream view of outfall where flows enter the woods (right)

Existing SWM0554 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000597 is located behind the Lorien Bel Air assisted living center, 1909 Emmorton Road. It is accessible from the service driveway that runs behind the building. The facility is within the Atkisson Reservoir subwatershed. One 12-inch corrugated HDPE pipe conveys flows upstream of a riprap slope running into the facility from the storm sewer system to the northwest. The riprap slope shows minor erosion where it meets the bottom of the facility. A 30-inch RCP with concrete end section conveys flows into the facility from the southwest. A concrete riser structure controls flows out of the facility and discharges through a 27-inch RCP principal spillway. The downstream segment of pipe has become detached from the previous segment approximately 6 feet from the outfall. A riprap plunge pool at the outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the south. No ponding water or wetland vegetation were observed within the facility.

Figure A-69. View of facility from parking lot of Lorien Bel Air assisted living center (left); View of facility from riprap inflow point (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during

field work), a low-flow 12-inch perforated PVC pipe is installed at the pond floor. High flows enter a 6-inch RCP orifice, while overflow is conveyed through a three-sided weir with a U-shaped opening in the front.

Figure A-70. Riser control structure (left); Upstream view of outfall and embankment (right)

Existing SWM000621 is located off Sparrow Mill Way behind residences including 1154 through 1160 Sparrows Mill Way to the north and 1200 through 1204 Sparrow Mill Way to the south. The pond is functioning as a wet pond in its current condition and contains a decorative fountain. It is accessible from the homeowners association property between the residences at 1160 and 1200 Sparrows Mill Way. The facility is within the MSB-5 subwatershed. One 24-inch RCCP into the facility conveys flows originating from the storm sewer system to the north. One 24-inch RCCP into the facility conveys flows originating from the storm sewer system to the northwest. One 48-inch RCCP into the facility conveys flows originating from the storm sewer system to the south. Since the inflow pipes discharge below the permanent pool elevation, they are not visible, and the sizes and conditions could not be field verified. A concrete weir structure controls flows out of the facility and discharges through a Class II riprap principal spillway. The principal spillway drains to a channel ultimately discharging to Bynum Run to the south. There is a 32-foot grass emergency spillway along the northern edge of the pond. Wetland vegetation was present within the facility.

Figure A-71. View of facility from Sparrow Mill Way (left); Concrete weir and outfall protection (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the field site visit. Based on record drawings, base flows

exit the pond through a low flow release device consisting of a vertical 12-inch BCCMP pipe conveying flows through a 12-inch DIP drain discharging through the gabion basket wall downslope of the weir wall crest. High flows enter the weir and spill onto the gabion baskets and riprap spillway.

Figure A-72. Downstream view of outfall channel (left); Natural spring in emergency spillway channel from manhole on northern part of the facility (right)

Existing SWM000622 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000683 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000685 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000700 is located on the western side of Cedar Lane Regional Park behind the field with artificial turf. It is accessible from the western parking lot. The facility is surrounded by a fence and the outfall is only accessible through a chain link fence about 200 feet north of the facility. The area around the facility is used for recreation. The facility is within the LB-2 subwatershed. It consists of a dry pond that drains to a natural channel. A 24-inch HDPE inflow pipe with a plastic end section conveys flow from the east into the northern part of the facility and into a plunge pool. The plunge pool has some riprap displacement. A 24-inch HDPE with a plastic end section conveys flow from the east into the southern part of the facility. A wetland has formed at the south inflow.

Figure A-73. Wetland surrounding southern inflow pipe (left); Riser structure at northern end of facility (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). There was no rainfall observed in the area on the two days prior to the site visit. The concrete riser structure sits on the west side of the facility. Low flows enter through twin 6-inch PVC pipes with agri-drain caps at the bottom of the facility and discharge through a 24-inch CMP principal spillway. There is some standing water surrounding the twin low flow pipes. A 13-foot wide by 26-foot long plunge pool exists at the outfall. There is a minor amount of sediment in the outfall plunge pool. The outfall discharges to an unnamed tributary to Bynum Run. Minor soil erosion was observed.

Figure A-74. Facing north towards facility and riser structure (left); Upstream at outfall and outfall protection (right)

Existing SWM000704 is behind the Harford County Water and Sewer Division building at 3340 Abingdon Road. It is accessible from the parking area south of the building. The facility is within the MSB-3 subwatershed. Based on field observation and per a conversation with a County employee, the location was retrofitted three to four years ago. Retrofits included micro-bioretention along a series of yard inlets along the northeast side of the building and a check dam system leading from the parking lot. Flows from both treatment areas are conveyed to the existing pond immediately northwest of the transmission tower.

Figure A-75. Downstream end of check dams (left); Upstream end of check dams (right)

Figure A-76. Micro-bioretentions (left); Yard inlet that conveys flows to existing pond (right)

Existing SWM000761 is located on the north end of Cedar Lane Regional Park surrounded by recreational fields. It is accessible from the northern most parking lot. There is no fence surrounding the facility. There is a chain link fence separating the riser from the outfall, and the closest fence opening is 200 feet east of the facility. It is within the LB-2 subwatershed. It consists of a dry pond that is routed through a riser control structure and drains to a natural channel. A 12-inch CMP with metal end section conveys flow from the southern fields into a sloped plunge pool on the southeast part of the facility. There is minor erosion above the inflow pipe. A 15-inch HDPE with plastic end section conveys flow from a southern parking lot into a 48-foot long by 8-foot wide plunge pool on the southwest part of the facility. There was major clogging of the HDPE by riprap that the field workers removed. A 27-foot grass emergency spillway is located on the west side of the facility.

Figure A-77. Facing north towards facility (left); Facing northwest towards facility from foot path above southeastern inflow point (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). There was no rainfall observed in the area on the two days prior to the site visit. A cylindrical aluminum riser structure sits at the northern most point of the facility. The riser is 39 inches in diameter and 22 inches high, and it is elevated 19 inches off the ground by a smaller aluminum cylinder. A 6-inch CMP with trash rack conveys flow into the riser and a 12-inch CMP drains flow to the principal spillway. A plunge pool exists at the outfall and flow is conveyed into an unnamed tributary to Bynum Run. The plunge pool has major sediment built up in the riprap. Most of the riprap has been displaced. There are wetland plants in the plunge pool. There is minimal erosion from the outfall into the natural channel and the outfall area 100 feet downstream is in good condition.

Figure A-78. Riser and low flow orifice (left); Downstream view of outfall protection an outfall channel (right)

Existing SWM000769 is located behind the tennis courts of Patterson Mill Jr-Sr High School. It is accessible from a paved walking path that connects to the school's eastern parking lot. The site has no fence and is well maintained. The facility is within the MSB-5 subwatershed. It consists of a shallow wetland that drains through a CMP principal spillway to a natural channel. An 18-inch RCP conveys flows from the tennis courts into the pond. The pipe was underwater during the site visit. A 21-inch RCP conveys flows from the parking lot into the pond. The pond has two PVC pipe observation wells in the standing water area.

Figure A-79. Facing north toward facility (left); PVC pipe observation well in shallow wetland (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There was 1.45 inches of rainfall in the area on the two days prior to the site visit. An 18-inch RCP principal spillway exists on the eastern tip of the facility. The pipe was submerged during the site visit. Flows are conveyed through the pipe, which transitions to a 24-inch RCP, and into a plunge pool. Outflow drains into an unnamed tributary to Bynum Run. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-80. Outfall and plunge pool (left); Facing west towards paved walking path leading to school parking lot (right)

Existing SWM000775 is located north of Patterson Mill Jr-Sr High School's western parking lot. It has no fence and is accessible from the parking lot. The facility is within the MSB-5 subwatershed. It consists of two forebays that drain to a shallow wetland. The wetland drains through a riser control structure to a natural channel. A 24-inch RCP conveys flows from the school's roof and part of the parking lot into the eastern forebay. The field team was unable to see this inflow pipe during their site visit. A 21-inch RCP

conveys flow from the parking lot and the field team could not see the pipe during their site visit. An 18-inch RCP conveys flow from the northwest into the forebay. It was visible, but half filled with water.

Figure A-81. Facility from behind the 18-inch RCP inflow pipe (left); 18-inch RCP inflow pipe (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There was 1.45 inches of rainfall in the area on the two days prior to the site visit. The concrete riser structure, which sits on the northern border of the facility, was unable to be located under the thick vegetation. Flows enter through a 4-inch PVC pipe orifice and discharge through a 24-inch RCP. The immediate outfall area extending to approximately 100 feet downstream is so severely overgrown with bamboo that the field team could not verify the outfall condition. The outflow connects to an unnamed tributary to Bynum Run.

Figure A-82. Facility northern border adjacent to Patterson Mill Road (left); Overgrown outfall area (right)

Existing SWM000785 is located behind Patterson Mill Middle High School, 85 Patterson Mill Road. It is accessible from school property as well as from a wooded area at the end of Wetterhorn Drive to the southeast. The facility is within the MSB-4 subwatershed. One 30-inch RCP conveys flows into the facility forebay from the storm sewer system to the west. Flows exit the treatment pond through a control

structure located underground and discharge through a 24-inch RCP principal spillway. The downstream segment of pipe has become detached from the previous segment approximately 6 feet from the outfall. A riprap plunge at the outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the southwest. Ponded water and abundant wetland vegetation were observed within the facility.

Figure A-83. Facing north towards facility (left); Facing south towards facility (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The pond is functioning as a wet facility in its current condition. Based on record drawings, a low-flow 6-inch DIP at the pond bottom is equipped with a 6-inch valve. With the valve in closed state, a permanent pool results with high flows entering a 24-inch RCP and discharging downstream though a 24-inch RCP spillway.

Figure A-84. Facing downstream towards outfall and outfall channel (left); Facing upstream at outfall and outfall protection (right)

Existing SWM0807(1)/SWM000807 could not be located during field investigations. GIS information indicates it is located northeast of the intersection of Starmount Lane and Chateau Green Court behind residences including 1236 through 1242 Chateau Green Court. The GIS location is within the MSB-5 subwatershed. The as-built for this site matches SWM000312.

Figure A-85. GIS location for facility SWM0807(1) / SWM000807

Existing SWM000813 is located behind residences, including 1602 Willowdale Drive. It does not have a fence and is well maintained. The site is accessible from the road and is within the LB-1 subwatershed. The facility consists of a dry pond that drains through a riser control structure into the nearby woods. There is one inflow pipe and one inflow channel. A 24-inch RCP conveys flow from Willowdale Drive to the eastern part of the facility. The inflow is in good condition. A long riprap channel conveys flow from residences along Willowdale Drive and Beechview Court into the northeastern part of the facility. The riprap channel is in good condition.

Figure A-86. Facing north towards riser structure and riprap inflow point (left); Facing east towards both inflow points (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the southern border of the facility. Low flows enter through a 5-inch by 5-inch orifice in the concrete with a circular 5-inch PVC pipe lining it. Flows discharge through a 24-inch RCP principal spillway. A plunge pool exists at the outfall where flows dissipate into the woods. There was no observed downstream channel, but the immediate outfall area was in good condition.

Figure A-87. Facing east towards facility (left); Facing downstream at outfall and outfall protection (right)

Existing SWM000814 is located behind residences, including 1600 Willowdale Drive. It does not have a fence and is well maintained. The site is accessible from the road. It is within the LB-1 subwatershed. The facility consists of a dry pond that drains through a riser control structure into the nearby woods. The only inflow is a 15-inch RCP that conveys flows from Beechview Court and a few residences on Willowdale Drive. The inflow riprap has a minor amount of sediment.

Figure A-88. Facing west towards the RCP inflow pipe and riser structure (left); Facing east towards facility (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the southern border of the facility. Flows enter through a 5-inch by 5-inch orifice in the concrete and discharge through a 24-inch RCP principal spillway. An 80-foot long plunge pool exists at the outfall where flows dissipate into the woods. There was no observed downstream channel, but the immediate outfall area was in good condition.

Figure A-89. View of downstream outfall and outfall channel (left); Upstream view of outfall and outfall protection (right)

Existing SWM000815 is located behind residences, including 1504 Willowdale Drive. It is accessible between 1504 and 1502 Willowdale Drive. The site does not have a fence and is well maintained. It is within the LB-1 subwatershed. The facility consists of a dry pond that drains through a riser control structure into the nearby woods. The only inflow is a 24-inch RCP that conveys flows from residences along Willowdale Drive. The inflow has moderate sediment build up. A 12-foot grass emergency spillway exists along the northeastern part of the facility.

Figure A-90. View of facility from behind RCP inflow (left); 5-inch by 5-inch orifice (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the eastern border of the facility. Flows enter through a 5-inch by 5-inch orifice in the concrete and discharge through a 24-inch RCP principal spillway. A 36-foot long plunge pool exists at the outfall where flows dissipate into the woods. There was no observed downstream channel, but the immediate outfall area was in good condition.

Figure A-91. Downstream view of outfall and outfall channel (left); Upstream view of channel and outfall protection (right)

Existing SWM000892 is located north of Cedarday Drive. It receives flows from roadways and is in the LB-1 subwatershed. It is accessible via a swing gate off the road. The facility consists of a sediment forebay and a dry pond. Flow drains out of the facility into a natural channel. A 15-inch RCP at the southern part of the facility is the only inflow point. It conveys flow into the facility from drainage ditches on either side of the roadway to the east. Flow enters the facility at riprap outlet protection. There is minor sediment build up in the plunge pool. Overflow from the plunge pool drains over a riprap weir into the sediment forebay. A 6-inch PVC pipe conveys flow from the bottom of the sediment forebay into the dry pond.

Figure A-92. Facing southeast towards the facility (left); Sediment forebay (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). There was no rainfall observed in the area on the two days prior to the site visit. The concrete riser structure sits in the western part of the facility. Flow enters through a 6-inch PVC plated pipe at the bottom of the pond and it drains through a 24-inch RCP with an end section at the outfall. An 18-foot wide by 20-foot long plunge pool exists at the outfall. There is standing water in the plunge pool, but the riprap is in good condition. There was no observable outfall erosion leading down to an unnamed tributary to Bynum Run.

Figure A-93. Embankment behind riser structure (left); Downstream view of outfall and plunge pool (right)

APPENDIX B BMP PROJECTS

BMP field findings identified areas within the Lower Bynum Run watershed where potential restoration projects have the opportunity to protect infrastructure, improve water quality, and/or reduce flooding. These projects fall into two categories: BMP retrofits and new BMP facilities. A total of 13 BMP retrofits and 2 new BMP projects have been recommended. Table B-1 lists all 15 BMP projects.

Each project description begins with an "at a glance" summary of the recommended restoration, the location of the project, the number of properties impacted, the pollutant load reductions and impervious area treated. The project description also includes a site description, recommended actions, threats to infrastructure, impacted property addresses, a cost estimate, and a map showing the extents of the project.

BMP projects listed below have been separated into two sections, existing BMP retrofits and new BMP projects. Due to a high percentage of residential land use within the watershed and limited right of way space adjacent to streets, space is limited within this watershed for the construction of BMPs. The types of retrofits and new BMPs being recommended include bioretention, submerged gravel wetlands, and a wet pond.

Project costs for BMPs were calculated using three different methods. For the wet pond, BMP construction costs were estimated based on the BMP type and cost per impervious area treated (King & Hagan, 2011). The King and Hagen document uses 2011 dollars; the construction costs were inflated to 2019 values. For the submerged gravel wetlands, construction costs were calculated using the average material costs of BMP components along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs. For the bioretention, construction costs were based on actual Maryland bioretention construction costs and engineering judgement. Design costs for BMP types were estimated as a percentage of the construction costs to provide total project costs.

Table B-1. Existing and Proposed BMP Retrofit Summary

PROJECT NAME	TYPE	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	IMPERVIOUS AREA TREATED (ACRES)	TN REDUCTIONS (LBS/YR)	TP REDUCTIONS (LBS/YR)	TSS REDUCTIONS (LBS/YR)	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
SWM0554	Extended Detention Retrofit	18.27	3.09	3.18	48.11	7.07	18,058	$261,253	$82,085
SWM000118	Submerged Gravel Wetland	7.32	2.27	1.00	46.82	3.17	6,660	$103,251	$103,375
SWM000257	Submerged Gravel Wetland	9.13	2.37	2.44	81.27	5.75	11,986	$214,570	$87,899
SWM000287	Submerged Gravel Wetland	6.26	1.81	2.52	61.74	4.24	8,934	$258,475	$102,736
SWM000312	Submerged Gravel Wetland	3.52	1.39	1.70	37.13	2.36	5,044	$209,402	$123,483
SWM000342	Submerged Gravel Wetland	3.05	0.68	0.75	27.58	2.01	4,166	$113,519	$151,764
SWM000347	Submerged Gravel Wetland	4.58	1.65	2.08	47.23	3.08	6,553	$259,395	$124,769
SWM000415	Submerged Gravel Wetland	11	3.76	3.84	102.63	6.80	14,373	$300,984	$78,479
SWM000428	Submerged Gravel Wetland	6.09	1.55	2.05	58.31	4.12	8,632	$288,689	$141,099
SWM000472	Submerged Gravel Wetland	11.48	3.31	4.37	112.65	7.76	16,330	$511,508	$117,071
SWM000622	Submerged Gravel Wetland	2.46	0.31	0.42	21.09	1.67	3,415	$80,864	$193,224
SWM000683	Submerged Gravel Wetland	3.41	1.18	1.51	34.83	2.30	4,877	$208,985	$138,364
SWM000685	Submerged Gravel Wetland	14.67	3.93	4.52	139.04	9.76	20,395	$450,193	$99,611
BMP-P-4	Bioretention	1.08	0.52	0.71	12.29	0.73	1,591	$150,394	$212,661
BMP-P-7	Bioretention	1.99	1.34	1.37	22.93	1.21	2,699	$165,384	$121,001
Total		**104.31**	**29.16**	**32.46**	**853.64**	**62.05**	**133,714**	**$3,576,866**	

B.1 EXISTING BMP RETROFITS

The field assessment of 65 existing dry detention BMPs within the Lower Bynum Run watershed resulted in 13 with potential retrofit opportunities. The 13 facilities currently provide stormwater quantity control. Retrofitting these 13 BMPs would provide impervious area credit for these facilities as well as pollutant load reductions. Although retrofitting the dry detention pond to become wet ponds is usually the most cost effective option, only one wet pond is proposed. This is because the surface waters in the watershed in all but one of the dry ponds are designated as Use III – nontidal cold water (COMAR, 2014), and wet ponds are discouraged in these areas. The one wet pond proposed is in an area where the surface waters are designated as Use I - Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life, where wet ponds are allowed.

Another BMP retrofit possibility is an infiltration trench below the bottom of the pond. This option was rejected because it is likely that the soil in these ponds are compacted and would not allow stormwater to infiltrate within the 2-day window allowed for this BMP. Bioretention in the pond bottom was also rejected because they would likely require underdrains, and the existing risers in the pond did not have enough head to allow an underdrain connection.

The BMP that was proposed for the remaining 12 facilities is submerged gravel wetland. This BMP is not designed to infiltrate, so soil compaction is not an issue. It also does not require an underdrain and only needs minimal head, which would work in these facilities. Each of the 13 retrofit projects is described in detail in this section. Chapter 4 provides background information on the field identification process.

RETROFIT OF EXISTING SWM0554: EXTENDED DETENTION RETROFIT

Project Description	Retrofit existing extended detention facility (Existing SWM0554) with wet pond
Location	Smiths Landing Court
Property Ownership	Smiths Landing Homeowners Association, Inc.
Subwatershed	MSB-1
Potential Impervious Acres Treated	3.18 Acres
Potential Load Reductions TP	48.11 lbs/year
Potential Load Reductions TN	7.07 lbs/year
Potential Load Reductions TSS	18,058 lbs/year
Estimated Design/Construction Costs	$261,253 $82,085/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM0554 is an extended detention facility with a shallow marsh located off Smiths Landing Court behind residences including 4043 Smiths Landing Court and 4045 Smiths Landing Court (Figure B-1). A split row wooden fence with a gate encloses the facility. It is accessible via the Homeowners Association property adjacent to 4029 Smiths Landing Court (Figure B-2). The facility is within the MSB-1 subwatershed. One 36-inch CMP into the facility conveys flows originating from the storm sewer system

to the south and west. There is a concrete riser structure controls with a 30-inch CMP principal spillway. The principal spillway outlets to a channel discharging to an unnamed tributary to Bush Creek (use I). There is no emergency spillway. Standing water was observed at the inflow point of the 36-inch CMP. Wetland vegetation was present within the facility.

Figure B-1. Wetland vegetation around the riser and inflow pipe (left); Embankment behind the riser structure (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observations), the facility dewaters through a 12-inch pipe constricted by a 2-inch orifice plate. The riser structure has a 10-inch low flow CMP and a 2-foot wide high flow weir at the front of the open-top riser with trash racks.

Figure B-2. Access path behind residences on Smiths Landing Court (left); Continuing view of access to facility (right)

- Drainage Area: 18.27 Acres
- Impervious Drainage Area: 3.09 Acres

<u>Recommended Restoration Actions</u>

- A wet pond retrofit is recommended to target improved water quality for flow exiting the facility into the perennial stream. Permanent pools excavated down from the existing dry pond bottom are to be created to improve water quality.

- A forebay can be placed at the inflow to slow flow entering the facility and reduce sediment loadings.
- Proposed retrofit plans are shown in Figure B-3.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Smith's Landing Association, Inc.

Access

- Good Access: The existing facility is located on communal HOA land and is accessed from Smiths Landing Court. Moderately steep slopes and a fence surround the entire existing extended detention basin. There is a chain-link gated access.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP SWM0554 are shown in Table B-2. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed wet pond treats 1.12 inches of rainfall which corresponds to 1.03 impervious acre credit per acre of watershed impervious area. This proposed wet pond would provide 3.18 impervious acres of treatment.

While the existing BMP does provide stormwater quantity control, the proposed wet pond retrofit will also target water quality. Wet ponds provide a pollutant load reduction of 20% for nitrogen, 45% for phosphorus, and 60% for sediment (MDE, 2011).

Items of Note

There may be concerns from the community about the conversion from dry to wet pond as the pond will look different because of the permanent wet pool. Community outreach/buy in should be obtained early to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $261,253 for retrofitting existing SWM0554. Project costs are broken down by cost per impervious acre treated (Table B-3). BMP construction costs were estimated based on the BMP type and cost per impervious area treated (King & Hagan, 2011). The King and Hagen document uses 2011 dollars; the construction costs were inflated to 2019 values. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-2: Summary of Improvements for Existing SWM0554

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM00554	18.27	3.09	-	3.18	48.11	7.07	18,058
Outfall								
Stream								
Total Credit/ Reductions					3.18	48.11	7.07	18,058

Table B-3: Summary of Project Costs for Retrofitting Existing SWM0554

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000554	$261,253	$82,085
Outfall			
Stream			
Total Costs		$261,253	$82,085

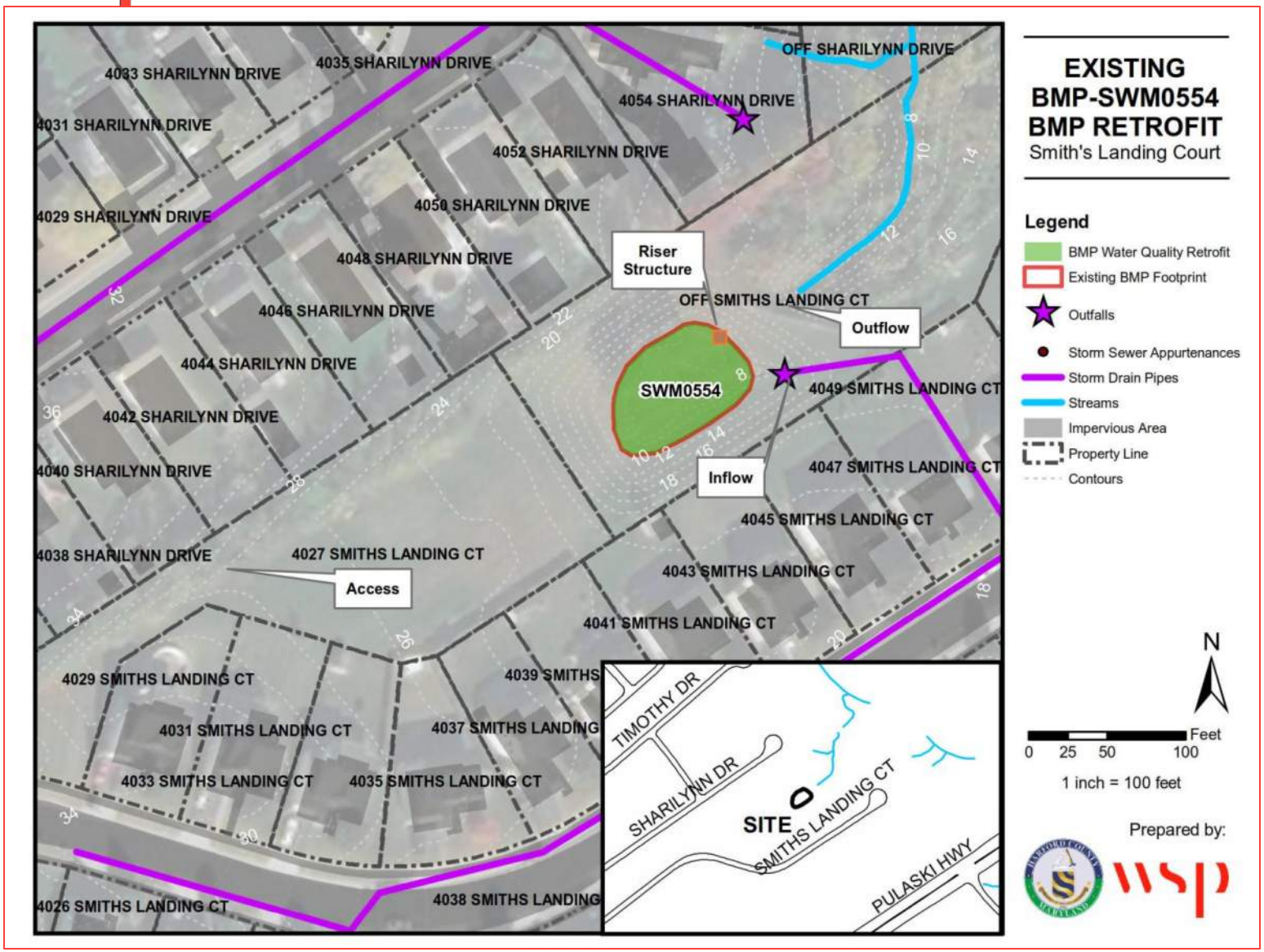

Figure B-3: Site Location and Proposed Retrofit for Existing SWM0554

RETROFIT OF EXISTING BMP-SWM000118: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of existing extended detention facility (Existing BMP-SWM000118) with a submerged gravel wetland
Location	Behind the property at 34 Mitchell Drive
Property Ownership	Box Hill Community Services
Subwatershed	MSB-4
Potential Impervious Acres Treated	1.00 Acres
Potential Load Reductions TP	46.82 lbs/year
Potential Load Reductions TN	3.17 lbs/year
Potential Load Reductions TSS	6,660 lbs/year
Estimated Design/Construction Costs	$103,251 $103,375/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM000118 is an extended detention facility surrounded by residences including 34 Mitchell Drive. It can be accessed between 24 Mitchell Drive and 28 Mitchell Drive. The facility is bordered by a gated chain link fence and is well mowed. It is within the MSB-4 subwatershed. A 24-inch RCP conveys flows from residences along Mitchell Drive into a riprap outlet protection on the western tip of the facility. The metal apron has major rust damage. There is minor sediment build up and minor riprap displacement in the outlet protection. The channel conveying flow from the inflow to the center of the facility cuts into the ground (Figure B-4).

Figure B-4. The 24-inch RCP inflow pipe and riprap outlet protection (left); The channel from the inflow pipe to the facility (right)

There was 0.47-inch of rainfall observed in the area on the day of the site visit (5/23/19). No rainfall was observed during the two days prior to the field site visit. There is a concrete riser structure in the center of the facility. Low flows entering through a 4-inch PVC orifice with headwall and trash rack. High flows enter the riser through a 17-inch wide by 29-inch tall concrete weir on the riser. Flows discharge through a 15-inch CMP principal spillway and enter an unnamed tributary to Bynum Run. Riprap exists at the

outfall with no observed outfall erosion or sediment build up. The stream extending to approximately 100 feet downstream of the outfall was in good condition (Figure B-5).

Figure B-5. Riser structure and embankment behind it (left); downstream at the outfall channel (right)

- Drainage Area: 7.32 Acres
- Impervious Drainage Area: 2.27 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the western portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-6.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Box Hill Community Services

Access

- Good Access: Access through an easement between 24 Mitchell Drive and 28 Mitchell Drive.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000118 are shown in Table B-4. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 0.44 inch of rainfall which corresponds to 0.44 impervious acre credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 1.00 impervious acre of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 43% for nitrogen, 50% for phosphorus, and 54% for sediment (MDE, 2014a).

Items of Note

There may be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $103,251 for retrofitting existing BMP-SWM000118. Project costs are broken down by cost per impervious acre treated (Table B-5). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-4: Summary of Improvements for Existing BMP SWM000118

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000118	7.32	2.27	-	1.00	46.82	3.17	6,660
Outfall								
Stream								
Total Credit/ Reductions					1.00	46.82	3.17	6,660

Table B-5: Summary of Project Costs for Retrofitting Existing BMP SWM000118

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000118	$103,251	$103,375
Outfall			
Stream			
Total Costs		$103,251	$103,375

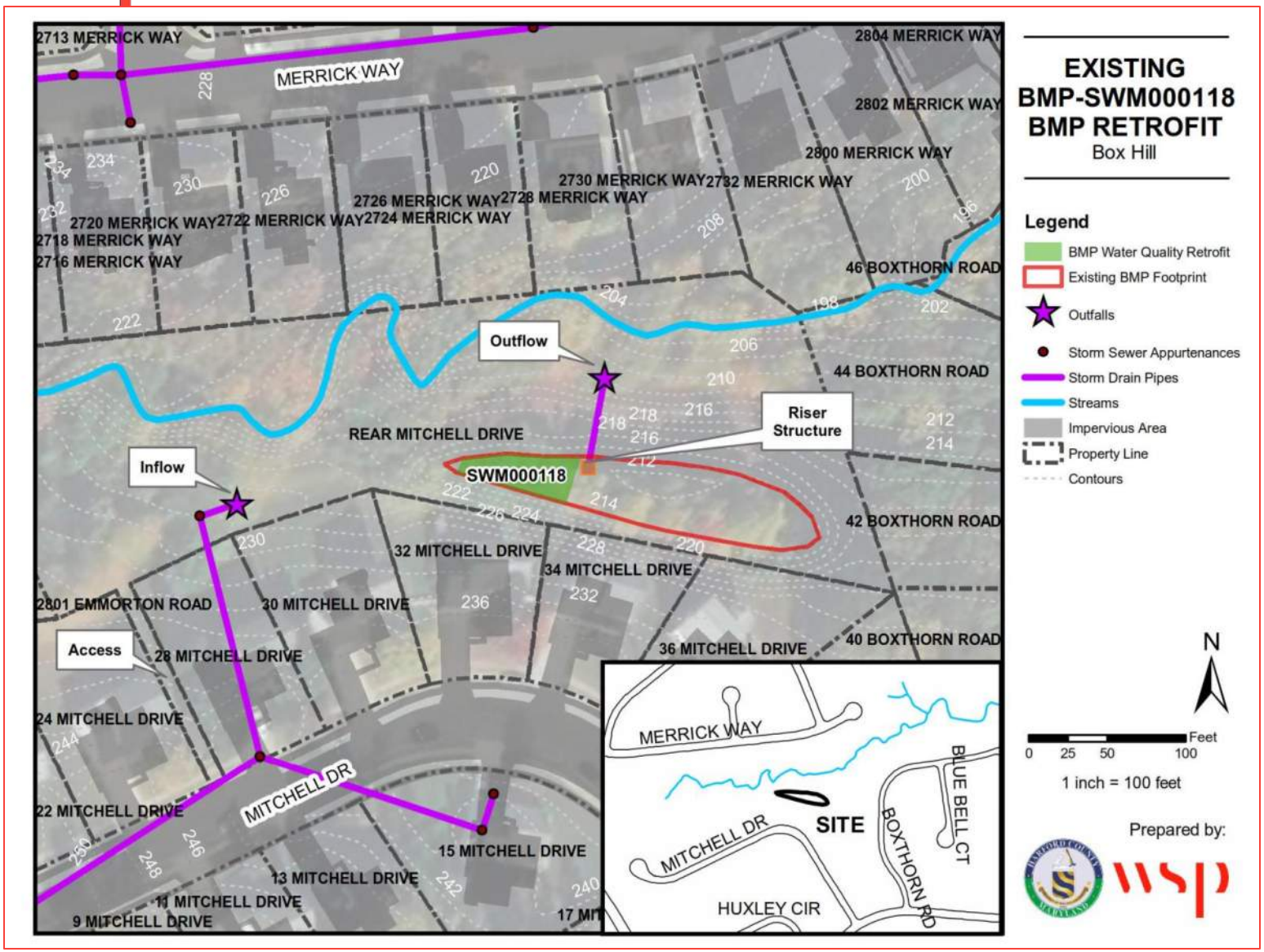

Figure B-6. Site Location and Proposed Retrofit for Existing BMP-SWM000118

RETROFIT OF EXISTING BMP-SWM000257: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000257) with a submerged gravel wetland
Location	Behind the property at 803 Deepwood Court
Property Ownership	Cedarday Community
Subwatershed	MSB-4
Potential Impervious Acres Treated	2.44 Acres
Potential Load Reductions TP	81.27 lbs/year
Potential Load Reductions TN	5.75 lbs/year
Potential Load Reductions TSS	11,986 lbs/year
Estimated Design/Construction Costs	$214,570 $87,899/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM000257 is an extended detention facility located north of Deepwood Court, behind the residential properties of 803 Deepwood Court and 805 Deepwood Court. It is surrounded by a chain link fence and is accessible from a 12-foot wide access road and an 18-foot swing gate. The facility is within the MSB-4 subwatershed. The facility has two inflow points. One is a 30-inch RCP with headwall in the eastern part of the facility. Water has pooled at the inflow point to a depth of 8 inches and there is wetland vegetation around the pool. The second is a 21-inch RCP with a 14-foot long headwall in the southern part of the facility. Water has pooled at the inflow point and there is wetland vegetation surrounding the pool (Figure B-7). There is a 22-foot emergency spillway with riprap in the southwest part of the facility. The slope above the southern inflow is reinforced with riprap in good condition. The slopes of the facility are steep, except for the vehicle access path.

Figure B-7. The southern inflow point and the riser structure (left); The eastern inflow point and the pool in front of it (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). No rainfall was observed during the two days prior to the field site visit. The concrete riser structure sits at the northern part of the facility. The riser has a 6-inch PVC low flow orifice. At 11 feet away from the riser, the low flow orifice extends vertically 5 feet and is supported by gravel. The riser has an 18-inch CMP about halfway up.

There is a weir above that equipped with a trash rack for high flows. The riser outlet is a 36-inch RCP with a 17-foot long headwall (Figure B-8). There is a 12-foot-wide by 21-foot-long riprap protection at the outfall where flow enters Bynum Run confluent to James Run to the northwest. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure B-8. The embankment behind the riser structure (left); Outfall headwall (right)

- Drainage Area: 9.13 Acres
- Impervious Drainage Area: 2.37 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the eastern portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-9.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Cedarday Community

Access

- Good Access: Access from ROW between two residences via easement.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000257 are shown in Table B-6. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.11 inches of rainfall which

corresponds to 1.03 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 2.44 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 63% for nitrogen, 73% for phosphorus, and 78% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $214,570 for retrofitting existing BMP-SWM000257. Project costs are broken down by cost per impervious acre treated (Table B-7). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-6: Summary of Improvements for Existing BMP SWM000257

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000257	9.13	2.37	-	2.44	81.27	5.75	11,986
Outfall								
Stream								
Total Credit/ Reductions					2.44	81.27	5.75	11,986

Table B-7: Summary of Project Costs for Retrofitting Existing BMP SWM000257

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000257	$214,570	$87,899
Outfall			
Stream			
Total Costs		$214,570	$87,899

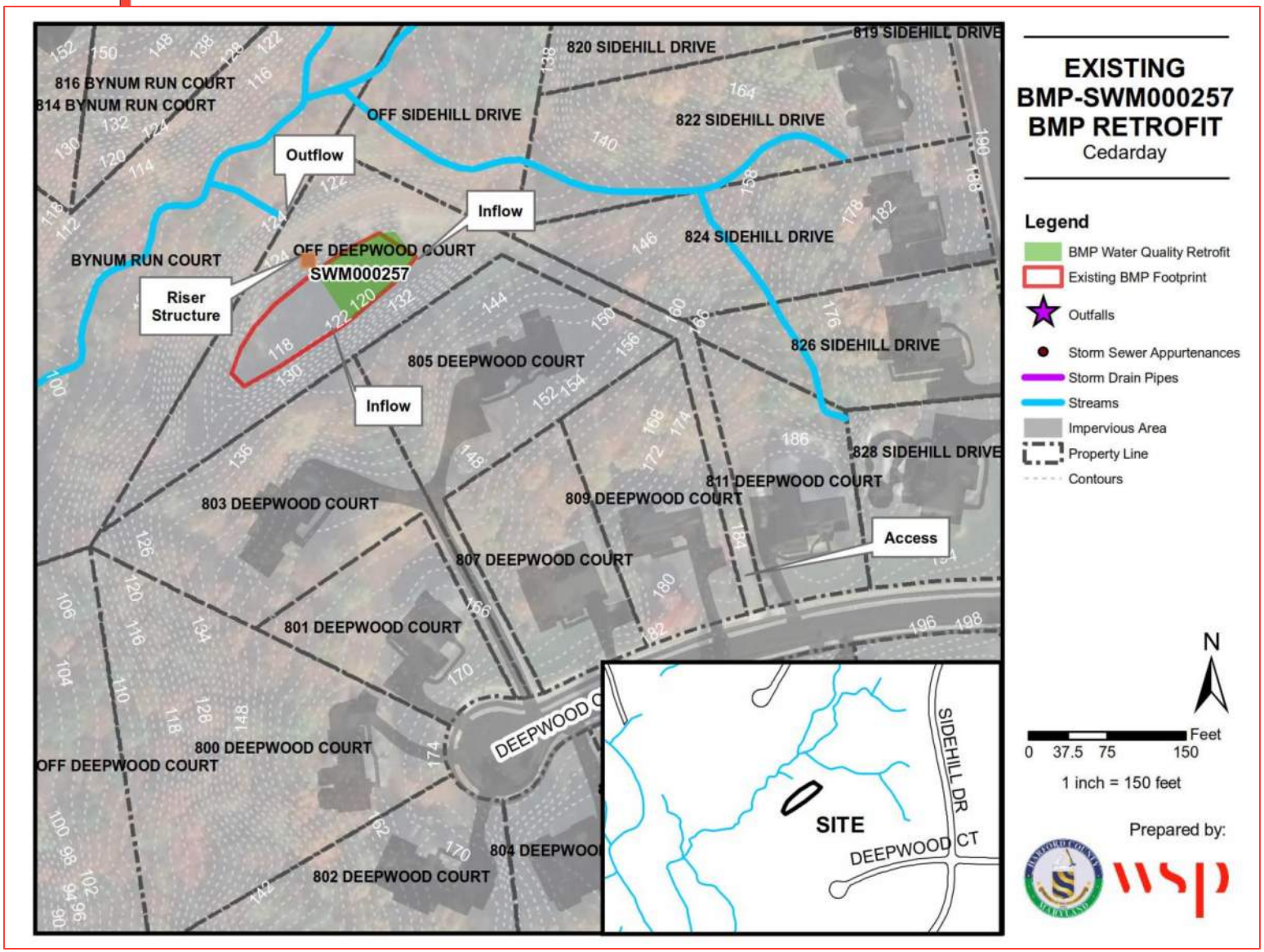

Figure B-9. Site Location and Proposed Retrofit for Existing BMP-SWM000257

RETROFIT OF EXISTING BMP-SWM000287: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000287) with a submerged gravel wetland
Location	Behind the property at 3301 Pouska Road
Property Ownership	Village of Bynum Run I
Subwatershed	MSB-3
Potential Impervious Acres Treated	2.52 Acres
Potential Load Reductions TP	61.74 lbs/year
Potential Load Reductions TN	4.24 lbs/year
Potential Load Reductions TSS	8,934 lbs/year
Estimated Design/Construction Costs	$258,475 $102,736/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM000287 is an extended detention facility located southeast of the intersection of Gittings Court and Pouska Road, and behind residences 3301 Pouska Road and 899 Gittings Court. It is accessible from Pouska Road adjacent to 3305 Pouska Road. The facility is within the MSB-3 subwatershed. One 18-inch CMP into the facility conveys flows originating from the storm drainage system to the northwest. Another 18-inch CMP into the facility conveys flows originating from the storm drainage system to the northeast. There is a concrete riser structure that discharges through a 24-inch BCCMP principal spillway, which drains to a channel discharging to an unnamed tributary to Bynum Run to the south (Figure B-10). One to three inches of standing water and wetland vegetation were observed in the facility.

Figure B-10. The riser structure, pond, and the northwest inflow pipe (left); Facing southwest towards the facility from the manhole above the northwest inflow pipe (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observations), there is an 8-inch BCCMP in the riser for low flows. There is no emergency spillway (Figure B-11).

Figure B-11. Riser structure (left); The outfall channel (right)

- Drainage Area: 6.26 Acres
- Impervious Drainage Area: 1.81 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended in the extended detention basin footprint. The submerged gravel wetland would have a forebay at each inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-12.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Village of Bynum Run I

Access

- Fair Access: Access from ROW between a residence and the natural stream.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000287 are shown in Table B-8. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.60 inches of rainfall which corresponds to 1.40 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 2.52 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 68% for nitrogen, 79% for phosphorus, and 85% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $258,475 for retrofitting existing BMP-SWM000287. Project costs are broken down by cost per impervious acre treated (Table B-9). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-8: Summary of Improvements for Existing BMP SWM000287

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000287	6.26	1.81	-	2.52	61.74	4.24	8,934
Outfall								
Stream								
Total Credit/ Reductions					2.52	61.74	4.24	8,934

Table B-9: Summary of Project Costs for Retrofitting Existing BMP SWM000287

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000287	$258,475	$102,736
Outfall			
Stream			
Total Costs		$258,475	$102,736

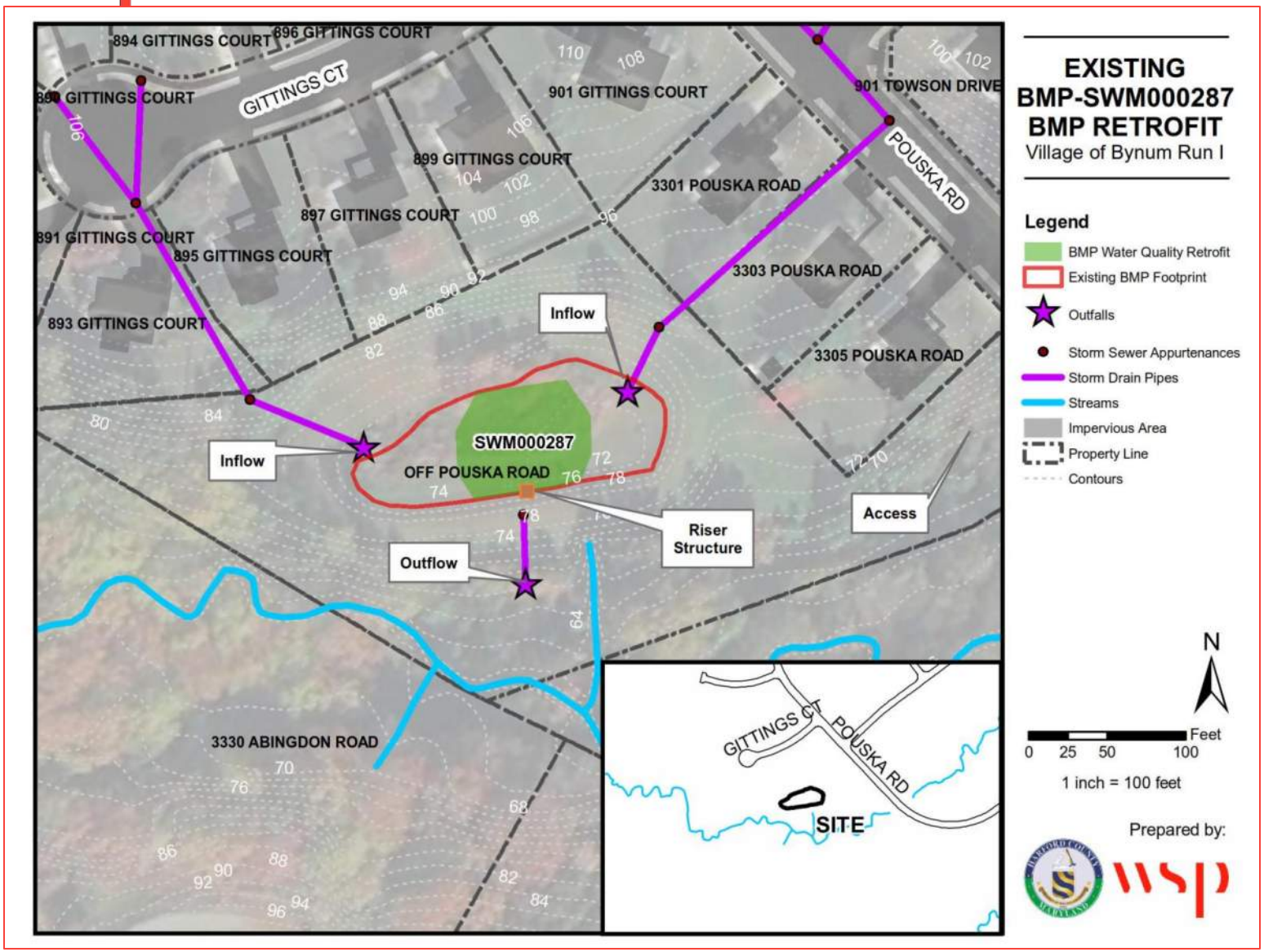

Figure B-12. Site Location and Proposed Retrofit for Existing BMP-SWM000287

RETROFIT OF EXISTING BMP-SWM000312: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000312) with a submerged gravel wetland
Location	Behind the property at 210 Royal Oak Drive
Property Ownership	Bright Oaks Village Townhomes
Subwatershed	MSB-4
Potential Impervious Acres Treated	1.70 Acres
Potential Load Reductions TP	37.13 lbs/year
Potential Load Reductions TN	2.36 lbs/year
Potential Load Reductions TSS	5,044 lbs/year
Estimated Design/Construction Costs	$209,402 $123,483/impervious acre treated
Adjacent Projects	MSB-4A Stream and Outfall Restoration

Site Description

Existing SWM000312 is an extended detention facility located at the intersection of Ranier Avenue and Royal Oak Drive behind residences, including 210 Royal Oak Drive. It is well maintained and accessible from Royal Oak Drive. It has a chain link fence around the embankment and an 18-foot gate on its border with Ranier Avenue. It is within the MSB-4 subwatershed. There are two inflow pipes to the facility. On the western part of the facility, an 18-inch BCCMP conveys flow into a water quality basin. There was less than 6 inches of standing water and wetland vegetation in the basin. The metal end section has major rust damage. Another 18-inch BCCMP with metal end section conveys flows from residences along Royal Oak Drive into the eastern part of the facility. There is a plunge pool at this inflow, and it is in good condition. An 11.5-foot grass emergency spillway exists at the northern edge of the facility (Figure B-13).

Figure B-13. Rusted 18-inch inflow pipe (left): Facility view from emergency spillway (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). No rainfall was observed during the two days prior to the field site visit. There is a concrete riser structure at the northern end of

the facility with an 8-inch PVC pipe orifice inflow and an 18-inch CMP principal spillway outflow (Figure B-14). Riprap protection exists at the outfall and flows into an unnamed tributary to Bynum Run 25 feet from the outfall. The end section of the outfall is rusted and there is moderate riprap displacement. The stream area extending approximately 100 feet downstream is in good condition.

Figure B-14. Riser structure and emergency spillway in the background (left): Outfall (right)

- Drainage Area: 3.52 Acres
- Impervious Drainage Area: 1.39 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the western portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-15.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Bright Oaks Village Townhomes

Access

- Good Access: Access from Royal Oak Drive.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000312 are shown in Table B-10. The table includes the drainage area, the impervious area within the drainage area, the impervious area

treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.88 inches of rainfall which corresponds to 1.22 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 1.70 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 67% for nitrogen, 78% for phosphorus, and 84% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $209,402 for retrofitting existing BMP-SWM000312. Project costs are broken down by cost per impervious acre treated (Table B-11). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-10: Summary of Improvements for Existing BMP SWM000312

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000312	3.52	1.39	-	1.70	37.13	2.36	5,044
Outfall								
Stream								
Total Credit/ Reductions					1.70	37.13	2.36	5,044

Table B-11: Summary of Project Costs for Retrofitting Existing BMP SWM000312

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000312	$209,402	$123,483
Outfall			
Stream			
Total Costs		$209,402	$123,483

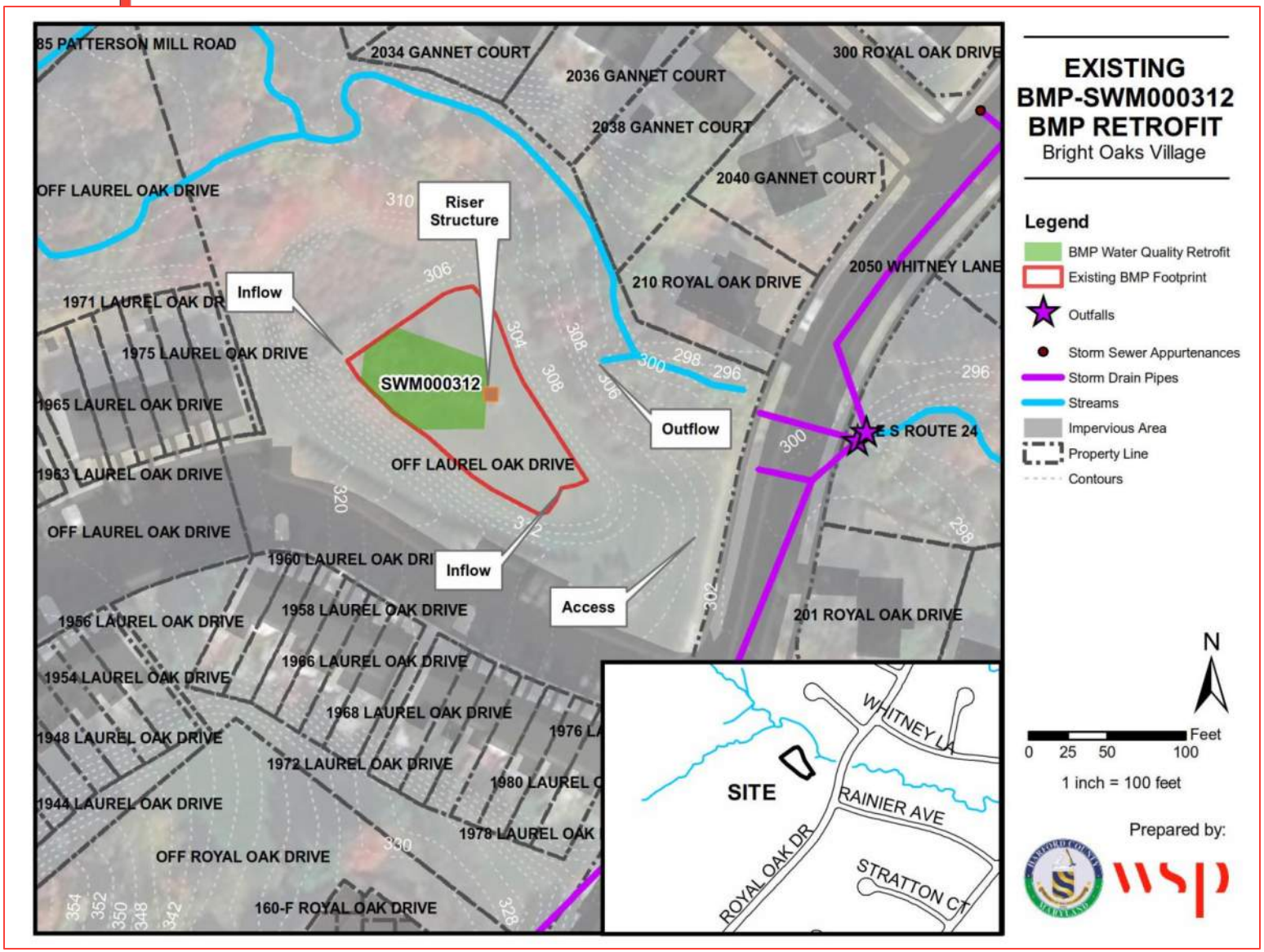

Figure B-15. Site Location and Proposed Retrofit for Existing BMP-SWM000312

RETROFIT OF EXISTING BMP-SWM000342: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of existing extended detention facility (Existing BMP-SWM000342) with a submerged gravel wetland
Location	Behind the property at 511 Cedar Hill Court
Property Ownership	Cedar Hill Homeowners
Subwatershed	MSB-4
Potential Impervious Acres Treated	0.75 Acres
Potential Load Reductions TP	2.01 lbs/year
Potential Load Reductions TN	27.58 lbs/year
Potential Load Reductions TSS	4,166 lbs/year
Estimated Design/Construction Costs	$113,519 $151,764/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM000342 is an extended detention facility located behind 511 Cedar Hill Court in a residential area and is accessible from Cedar Hill Court. The facility is in the MSB-4 subwatershed. There is high grassy vegetation in and around the pond. The facility drains through a riser structure that conveys flow into a natural channel. There is standing water and wetland vegetation around the riser structure. The facility has two inflow points. The first is a 24-inch RCP with end section that conveys flow from Cedar Hill Court into the northeastern part of the facility. There is some riprap displacement at the inflow. The second consists of surface drainage from behind residences on Cedar Hill Court entering the facility from the west. There is also a corrugated 4-inch HDPE conveying flow from the property at 511 Cedar Hill Court into a 10-foot wide spillway on the northern part of the facility (Figure B-16). A 10-foot wide grass emergency spillway is on the eastern part of the facility.

Figure B-16. Facing east towards the facility with the 10-foot spillway entering from the residence (left); The surface drainage inflow point (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). No rainfall was observed during the two days prior to the field site visit. The concrete riser structure sits on the southern part of the facility. There is a 6-inch low flow PVC pipe and an 18-inch RCP with a wingwall at the outfall. There is severe outfall sediment, but the outfall is still hydrologically connected to the natural stream behind

it. There is some erosion where the outfall enters Bynum Run confluent to James Run. Flow travels southeast, under Cedar Lane, via a 60-inch wide and 44-inch high elliptical CMP culvert (Figure B-17).

Figure B-17. Looking upstream at the sediment build-up at the outfall (left): The upstream end of the elliptical CMP culvert conveying flows under Cedar Lane (right)

A portion of the extended detention facility is being recommended as a submerged gravel wetland retrofit opportunity. Generally, submerged gravel wetlands have lengths that are twice their width to promote water quality treatment. As the outlet riser structure location for the existing pond is fixed, the submerged gravel wetland is placed where most of the drainage inflow to the pond can be captured (i.e. long length), without also collecting runoff from the other inflow points that travel a shorter distance to the outlet. The drainage area listed below is the area draining from the 24-inch RCP from the northeast.

- Drainage Area: 3.05 acres
- Impervious Drainage Area: 0.68 acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the eastern portion of the current extended detention basin footprint and would capture stormwater entering through the 24-inch RCP. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom and include a forebay at the inlet.
- Proposed project plans are shown in Figure B-18.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Cedar Hill

Access

- Fair Access: Moderate slope into facility via Cedar Hill Court through gated chain-link fence. The existing facility is located on communal HOA land.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000342 are shown in Table B-12. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.41 inch of rainfall which corresponds to 1.10 impervious acre credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 0.75 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 66% for nitrogen, 77% for phosphorus, and 82% for sediment (MDE, 2014a).

Items of Note

The appearance of the retrofit would change from mown grass to wetland plantings; therefore, there may be concerns from the community about the conversion from dry pond to submerged gravel wetland. Also, since the facility is privately owned, community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $113,519 for retrofitting existing BMP-SWM000342. Project costs are broken down by cost per impervious acre treated (Table B-13). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-12: Summary of Improvements for Existing BMP-SWM000342

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000342	3.05	0.68	-	0.75	27.58	2.01	4,166
Outfall								
Stream								
Total Credit/ Reductions					0.75	27.58	2.01	4,166

Table B-13: Summary of Project Costs for Retrofitting Existing BMP-SWM0000342

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000342	$113,519	$151,764
Outfall			
Stream			
Total Costs		$113,519	$151,764

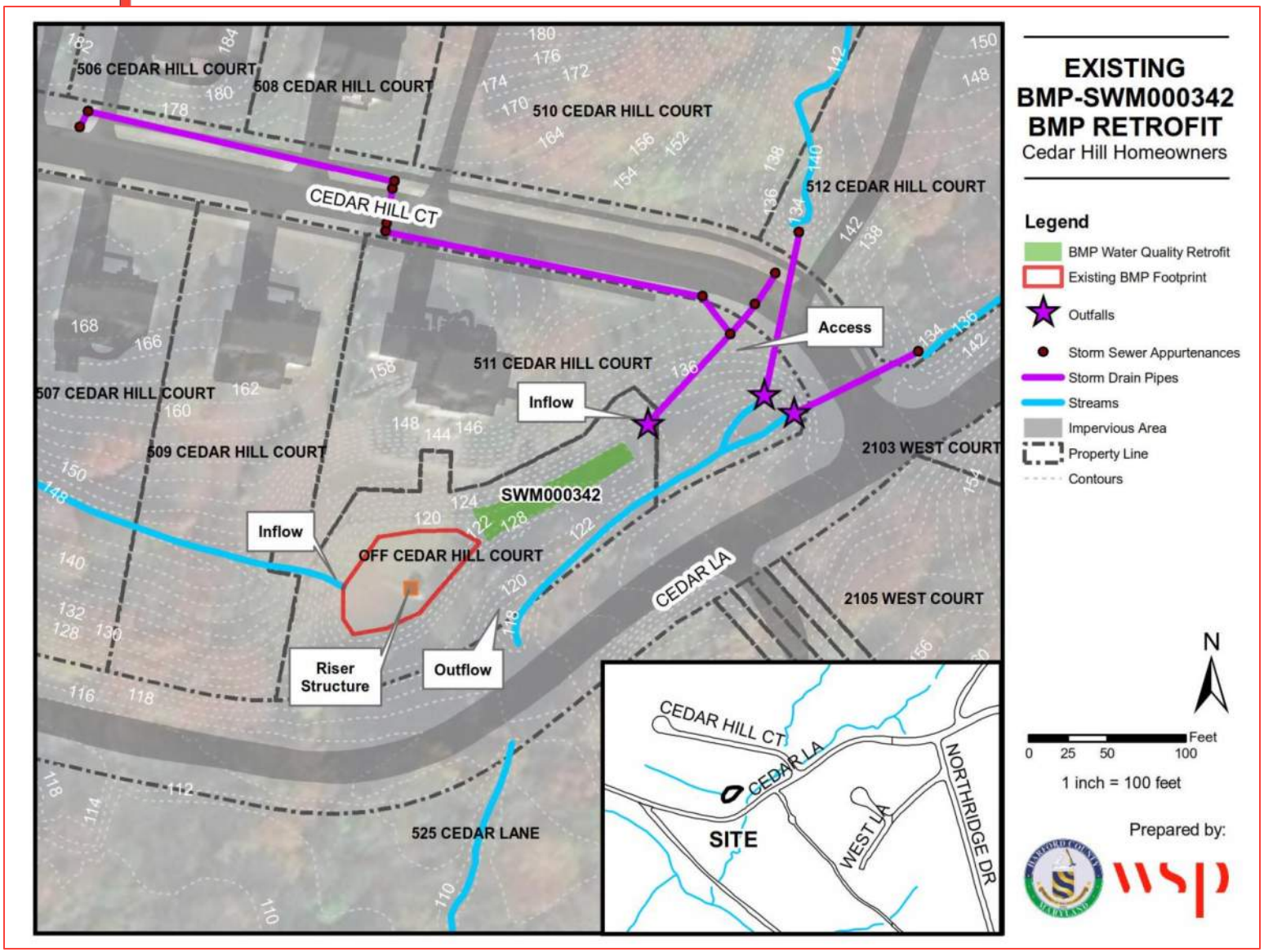

Figure B-18: Site Location and Proposed Retrofit for Existing BMP SWM000342.

RETROFIT OF EXISTING BMP-SWM000347: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of existing extended detention facility (Existing BMP-SWM000347) with a submerged gravel wetland
Location	Adjacent to the property at 3030 Clarkson Drive
Property Ownership	Tiffany Woods Community Association, Inc.
Subwatershed	MSB-3
Potential Impervious Acres Treated	2.08 Acres
Potential Load Reductions TP	47.23 lbs/year
Potential Load Reductions TN	3.08 lbs/year
Potential Load Reductions TSS	6,553 lbs/year
Estimated Design/Construction Costs	$259,395 $124,769/impervious acre treated
Adjacent Projects	SWM000415

Site Description

Existing BMP-SWM000347 is an extended detention facility located adjacent to 3030 Clarkson Drive within the MSB-3 subwatershed. One 21-inch RCP with a concrete end section conveys flows into the site from the storm drain system. Incoming flows originate from the west and are conveyed through the system under Clarkson Drive (Figure B-19). One riprap slope measuring approximately 30 feet wide conveys overland flows from the southwest. Shallow standing water and wetland vegetation were observed within the facility. A concrete riser structure controls flows out of the facility and discharges through a 24-inch RCP principal spillway. The principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the south.

Figure B-19. Facing southeast towards the facility (left); Erosion behind the 21-inch RCP inflow point (right)

Rainfall totaling 0.05-inch had been observed in the area on the day of the site visit (6/5/19). The facility is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field work), there is a low-flow 6-inch perforated PVC pipe. Overflow is conveyed through a two-sided weir with trash racks (Figure B-20).

Figure B-20. The access path from Clarkson Drive (left): The riser structure (right)

- Drainage Area: 4.58 Acres
- Impervious Drainage Area: 1.65 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the northern portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Stabilize the slope behind the 21-inch inlet.
- Proposed project plans are shown in Figure B-21.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowners Association, Tiffany Woods Community Association, Inc.

Access

- Good Access: Moderate slope into facility through gated chain-link fence. Existing facility located on communal HOA land.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000347 are shown in Table B-14. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.02 inch of rainfall which

corresponds to 1.26 impervious acre credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 2.08 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 67% for nitrogen, 78% for phosphorus, and 84% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $259,395 for retrofitting existing BMP-SWM000347. Project costs are broken down by cost per impervious acre treated (Table B-15). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-14: Summary of Improvements for Existing BMP-SWM000347

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000347	4.58	1.65	-	2.08	47.23	3.08	6,553
Outfall								
Stream								
Total Credit/ Reductions					2.08	47.23	3.08	6,553

Table B-15: Summary of Project Costs for Retrofitting Existing BMP-SWM0000347

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000347	$259,395	$124,769
Outfall			
Stream			
Total Costs		$259,395	$124,769

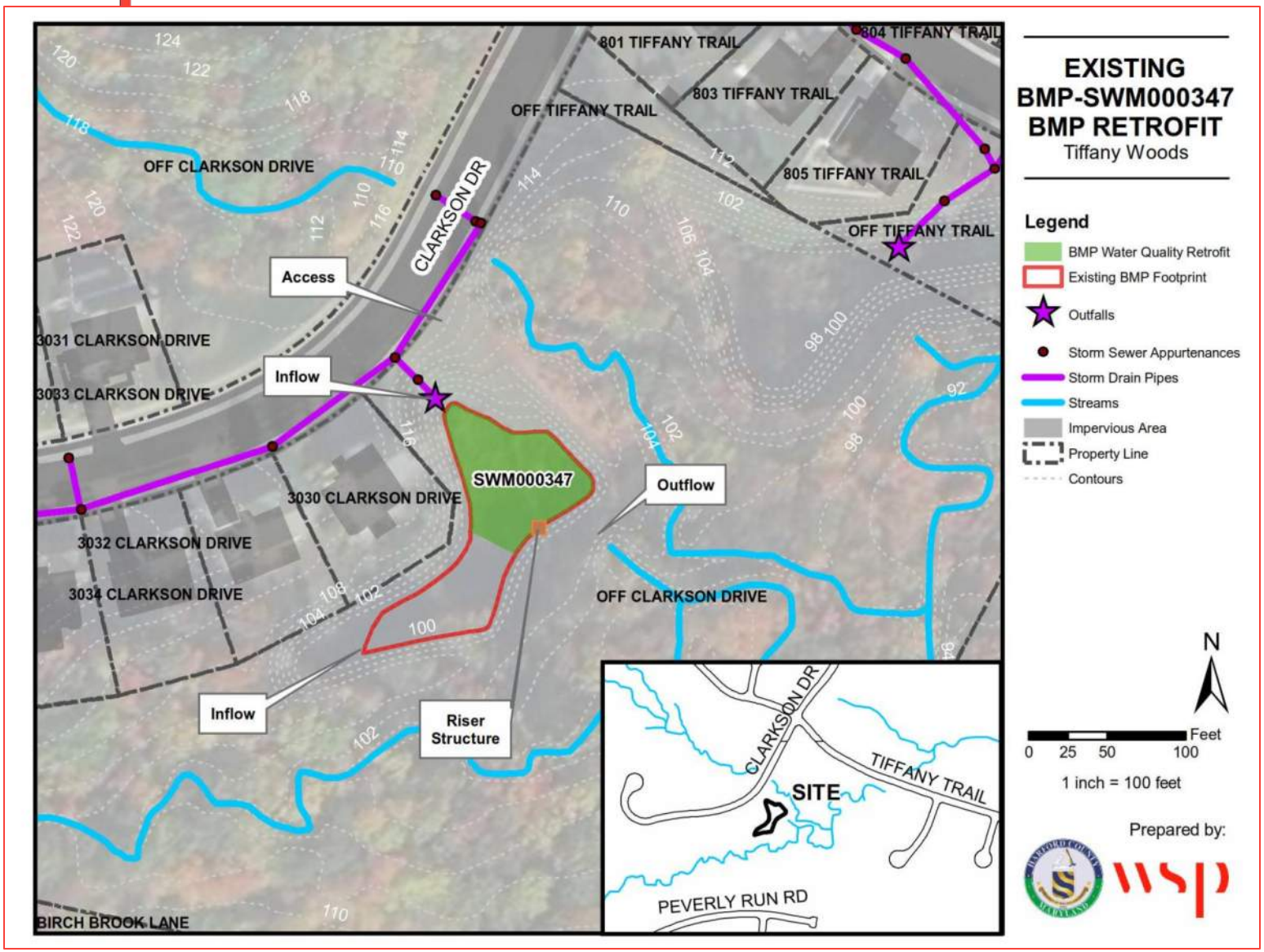

Figure B-21: Site Location and Proposed Retrofit for Existing BMP SWM000347.

RETROFIT OF EXISTING BMP-SWM000415: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000415) with a submerged gravel wetland
Location	Behind the property at 805 Tiffany Trail
Property Ownership	Tiffany Woods Community Association, Inc.
Subwatershed	MSB-3
Potential Impervious Acres Treated	3.84 Acres
Potential Load Reductions TP	102.63 lbs/year
Potential Load Reductions TN	6.80 lbs/year
Potential Load Reductions TSS	14,373 lbs/year
Estimated Design/Construction Costs	$300,984 $78,479/impervious acres treated
Adjacent Projects	SWM000347

Site Description

Existing SWM000415 is an extended detention facility located behind the property at 805 Tiffany Trail. It is fenced and accessible via a chain link swing gate located directly off Tiffany Trail. It is within the MSB-3 subwatershed. One 36-inch RCP conveys flows originating from the storm sewer system from the northeast into the facility. One riprap slope at the northwest corner of the facility conveys overland flows from the northwest. There is a concrete riser structure with a 36-inch CMP principal spillway. A riprap apron at the principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the south. Shallow standing water and wetland vegetation were observed within the facility (Figure B-22).

Figure B-22. Facing west towards the facility from Tiffany Trail (left): The embankment behind the riser structure (right)

Rainfall totaling 0.05-inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field work), there is an 8-inch low flow CMP in the riser structure. Overflow is conveyed through a trash racks along the front face and two sides of the riser (Figure B-23).

Figure B-23. Access gate from Tiffany Trail (left); The outfall and outfall channel (right)

- Drainage Area: 11.00 Acres
- Impervious Drainage Area: 3.76 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within a portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. A berm is needed to extend the time stormwater is in the facility. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-24.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Tiffany Woods Community Association, Inc.

Access

- Good Access: Access from Tiffany Trail.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000415 are shown in Table B-16. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.07 inches of rainfall which corresponds to 1.02 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 3.84 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 61% for nitrogen, 72% for phosphorus, and 77% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $300,984 for retrofitting existing BMP-SWM000415. Project costs are broken down by cost per impervious acre treated (Table B-17). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-16: Summary of Improvements for Existing BMP SWM000415

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000415	11.00	3.76	-	3.84	102.63	6.80	14,373
Outfall								
Stream								
Total Credit/ Reductions					3.84	102.63	6.80	14,373

Table B-17: Summary of Project Costs for Retrofitting Existing BMP SWM000415

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000415	$300,984	$78,479
Outfall			
Stream			
Total Costs		$300,984	$78,479

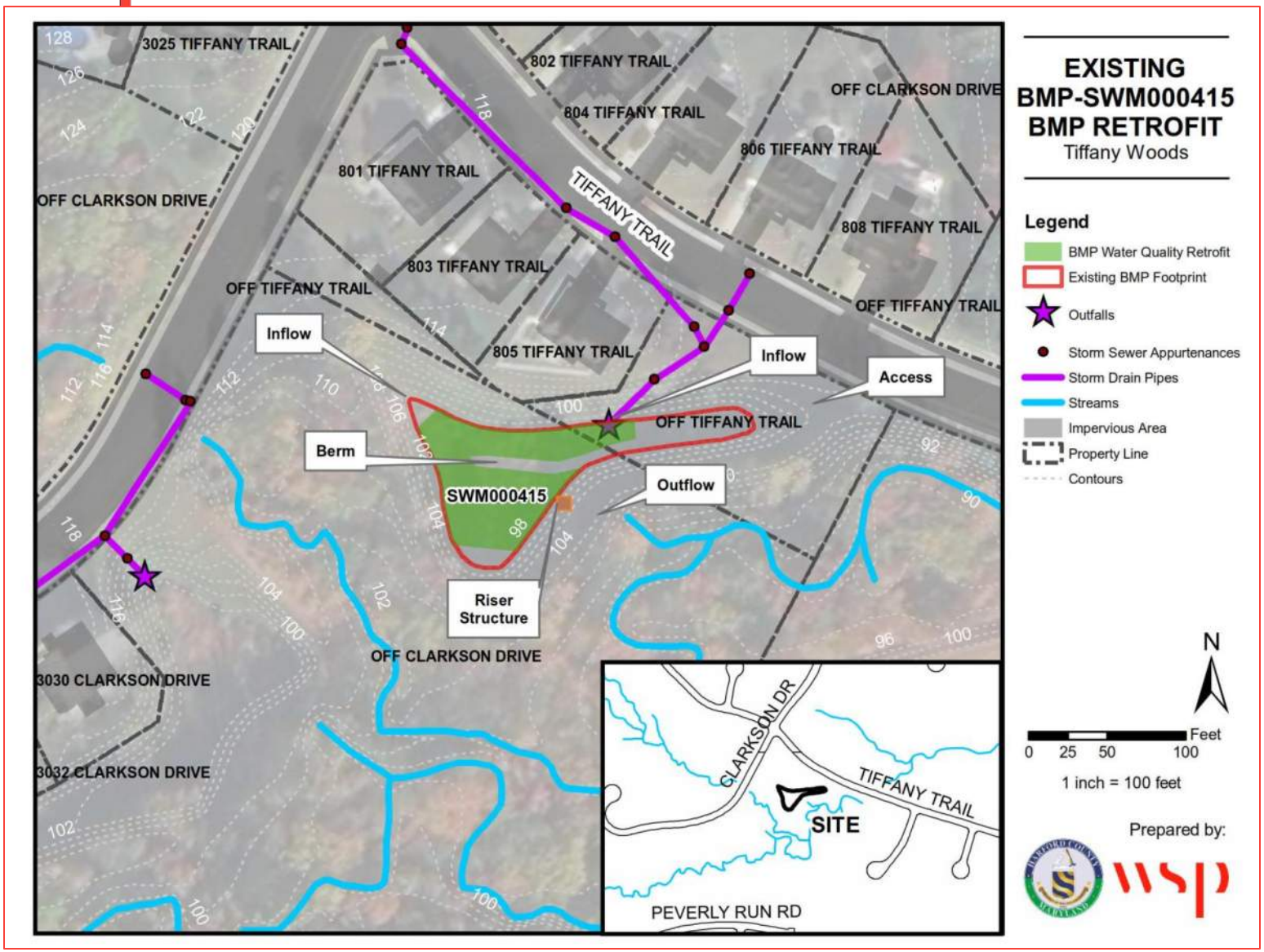

Figure B-24. Site Location and Proposed Retrofit for Existing BMP-SWM000415

RETROFIT OF EXISTING BMP-SWM000428: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000428) with a submerged gravel wetland
Location	Behind the property at 3139 Birch Brook Lane
Property Ownership	Woodland Run
Subwatershed	MSB-3
Potential Impervious Acres Treated	2.05 Acres
Potential Load Reductions TP	58.31 lbs/year
Potential Load Reductions TN	4.12 lbs/year
Potential Load Reductions TSS	8,632 lbs/year
Estimated Design/Construction Costs	$288,689 $141,099/impervious acres treated
Adjacent Projects	None

Site Description

Existing SWM000428 is an extended detention facility located behind the residence at 3139 Birch Brook Lane. It is accessible from Birch Brook Lane between 3139 Birch Brook Land and 3137 Birch Brook Lane. It is fenced with unobstructed access to an 18-foot swing gate. The facility is within the MSB-3 subwatershed. A 24-inch RCP conveys flows from residences along Birch Brook Lane into the northeast part of the facility. Another inflow point is an 8-foot gabion reinforced slope in the southwest corner of the facility (Figure B-25). Two 4-inch HDPE residential drains convey flows to the top of this slope. This area of the facility has moderate erosion. There is a 4-inch HDPE residential drain into the southeast corner of the facility.

Figure B-25. The 24-inch RCP and facility from access path (left): Southwest corner of facility (right)

There was 0.41-inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02-inch of rainfall in the area on the two days prior to the site visit. A 36-inch diameter cylindrical CMP riser structure sits on the northern border of the facility. Low flows enter through a 24-inch CMP and discharge through a 24-inch CMP principal spillway. The end section of the principal spillway is rusted out. The outfall channel acts as the head of a natural channel. A 5-foot headcut exists 16 feet downstream of the outfall. The channel downstream has 5 to 6 feet of erosion on its banks (Figure B-26).

Figure B-26. The outfall and end section (left); Upstream at outfall channel erosion – headcut visible in upper left corner (right)

- Drainage Area: 6.09 Acres
- Impervious Drainage Area: 1.55 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the current extended detention basin footprint. A berm is needed to extend the time stormwater is in the facility. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Repair slope where the 4-inch HDPE residential pipes are located.
- Proposed project plans are shown in Figure B-27.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Woodland Run

Access

- Good Access: Access from ROW between two residences.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000428 are shown in Table B-18. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.26 inches of rainfall which corresponds to 1.32 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 2.05 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 68% for nitrogen, 79% for phosphorus, and 85% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $288,689 for retrofitting existing BMP-SWM000428. Project costs are broken down by cost per impervious acre treated (Table B-19). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-18: Summary of Improvements for Existing BMP SWM000428

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000428	6.09	1.55	-	2.05	58.31	4.12	8,632
Outfall								
Stream								
Total Credit/ Reductions					2.05	58.31	4.12	8,632

Table B-19: Summary of Project Costs for Retrofitting Existing BMP SWM000428

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000428	$288,689	$141,099
Outfall			
Stream			
Total Costs		$288,689	$141,099

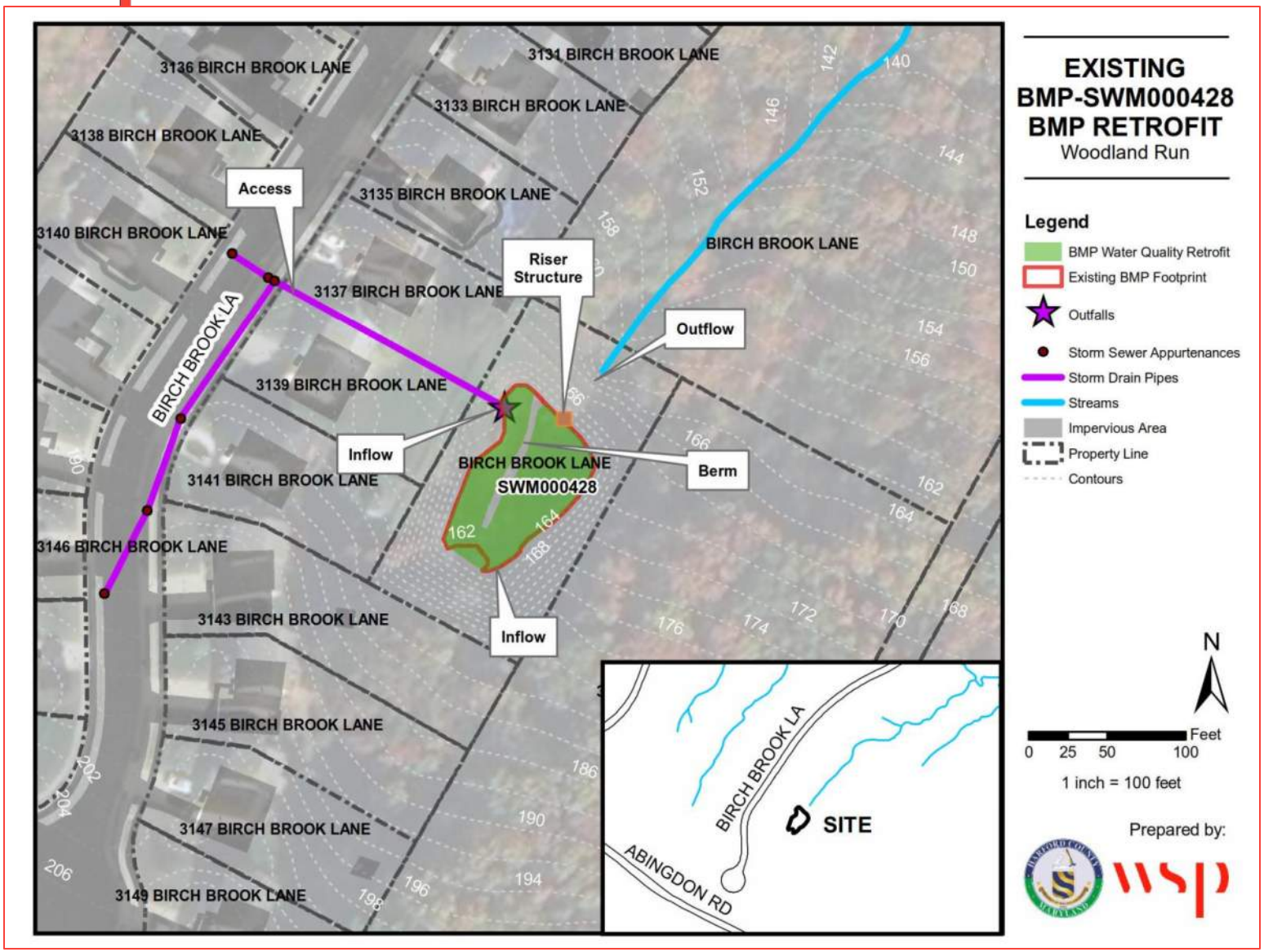

Figure B-27. Site Location and Proposed Retrofit for Existing BMP-SWM000428

RETROFIT OF EXISTING BMP-SWM000472: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of the existing extended detention facility (Existing BMP-SWM000472) with a submerged gravel wetland
Location	Behind the property at 1219 Lobo Court
Property Ownership	Cokesbury Manor Community
Subwatershed	MSB-2
Potential Impervious Acres Treated	4.37 Acres
Potential Load Reductions TP	112.65 lbs/year
Potential Load Reductions TN	7.76 lbs/year
Potential Load Reductions TSS	16,330 lbs/year
Estimated Design/Construction Costs	$511,508 $117,071/impervious acres treated
Adjacent Projects	SWM000683, MSB-2A Stream Restoration

Site Description

Existing SWM000472 is an extended detention facility located northeast of Lobo Court. It is accessible from Lobo Court between 1219 Lobo Court and 1220 Lobo Court. The facility is within the MSB-2 subwatershed. One 36-inch CMP into the facility conveys flows originating from the storm sewer system to the east and south. The facility also receives runoff along a grass slope to the south. There is a concrete riser structure with a 24-inch RCP principal spillway. The principal spillway drains to a channel discharging to Bynum Run to the north. Overflows drain to a 40-foot grass emergency spillway along the southwest corner. No standing water or wetland vegetation were noted (Figure B-28).

Figure B-28. The riser structure behind the 36-inch CMP inflow pipe (left); The embankment behind riser structure (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07-inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition (Figure B-29). Based on record drawings (and confirmed during field observations), there is a 5-inch low flow RCP orifice with a trash rack. Note that the 24-inch principal spillway is currently smaller than the 36-inch inflow pipe.

Figure B-29. Access path from Lobo Court (left); Western border of facility and emergency spillway in the background (right)

- Drainage Area: 11.48 Acres
- Impervious Drainage Area: 3.31 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within a portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-30.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Cokesbury Manor

Access

- Good Access: Access from ROW between two residences.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000472 are shown in Table B-20. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.26 inches of rainfall which corresponds to 1.32 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 4.37 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 67% for nitrogen, 79% for phosphorus, and 85% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $511,508 for retrofitting existing BMP-SWM000472. Project costs are broken down by cost per impervious acre treated (Table B-21). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-20: Summary of Improvements for Existing BMP SWM000472

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000472	11.48	3.31	-	4.37	112.65	7.76	16,330
Outfall								
Stream								
Total Credit/ Reductions					4.37	112.65	7.76	16,330

Table B-21: Summary of Project Costs for Retrofitting Existing BMP SWM000472

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000472	$511,508	$117,071
Outfall			
Stream			
Total Costs		$511,508	$117,071

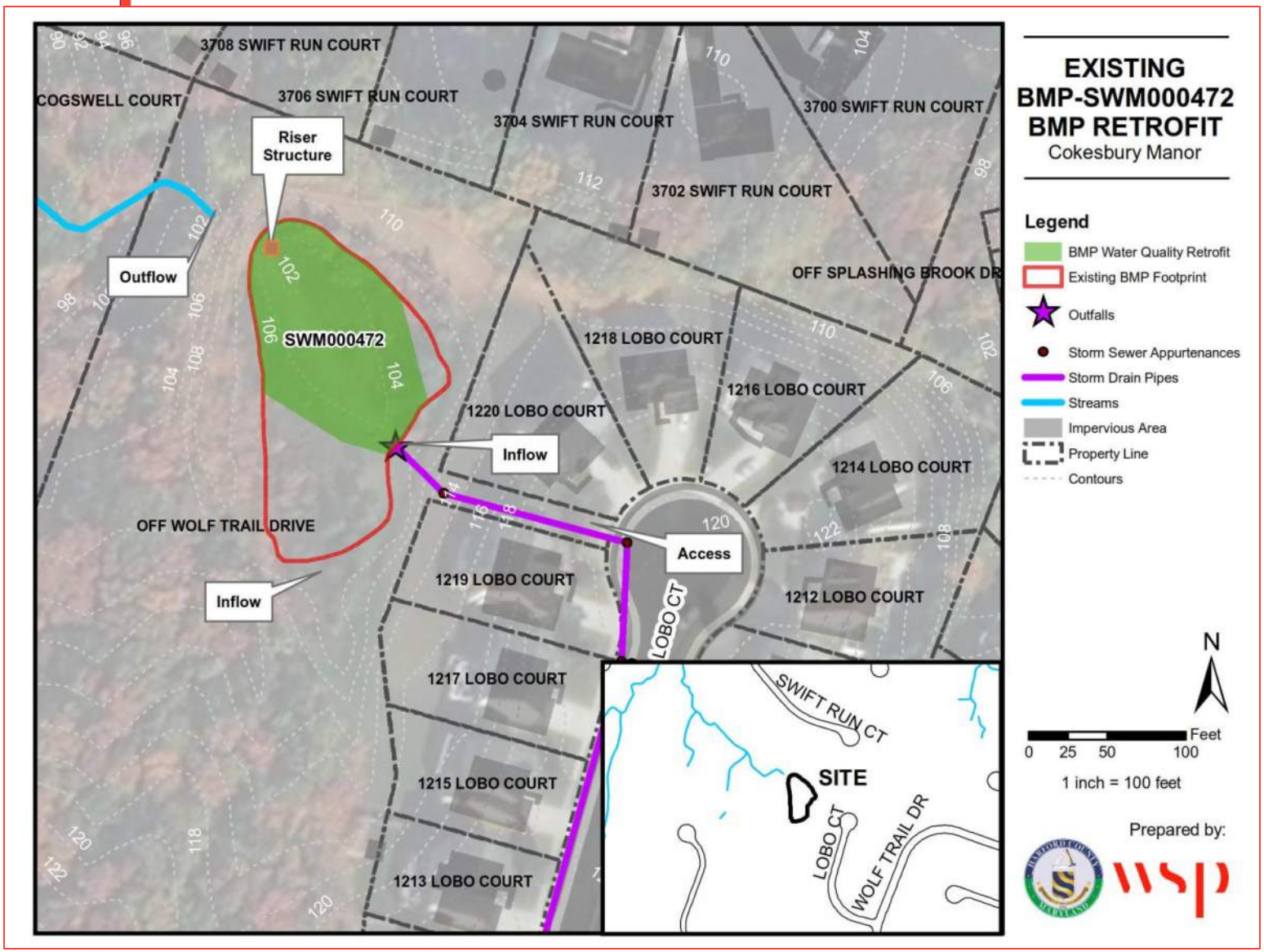

Figure B-30. Site Location and Proposed Retrofit for Existing BMP-SWM000472

RETROFIT OF EXISTING BMP-SWM000622: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of existing extended detention facility (Existing BMP-SWM000622) with a submerged gravel wetland
Location	Behind the property at 720 Hookers Mill Road
Property Ownership	Woodlands Homeowners Association
Subwatershed	MSB-3
Potential Impervious Acres Treated	0.42 Acres
Potential Load Reductions TP	21.09 lbs/year
Potential Load Reductions TN	1.67 lbs/year
Potential Load Reductions TSS	3,415 lbs/year
Estimated Design/Construction Costs	$80,864 $193,224/impervious acres treated
Adjacent Projects	None

Site Description

Existing SWM000622 is an extended detention facility located off Hookers Mill Road, behind residences including 720 Hookers Mill Road. It is accessible from a 12-foot wide access driveway off the road. It is fenced and has an 18-foot swing gate. The facility is within the MSB-3 subwatershed. A 15-inch HDPE pipe conveys flows into the eastern part of the facility. The inflow has severe sediment build-up that may hinder flows during high flow events. Most of the fencing around the facility needs repair (Figure B-31).

Figure B-31. Clogged inflow pipe (left); Broken fence behind inflow pipe (right)

There was no rainfall observed in the area on the day of the site visit (5/29/19). There was 0.09-inch of rainfall in the area on the two days prior to the site visit. There is no riser structure on the facility. There is a 6-inch plated PVC principal spillway for low flows and a 12-inch wide concrete weir for high flows. A 19-foot wide by 17-foot long riprap outfall protection exists at the outfall where flows dissipate into an open field downstream (Figure B-32). The immediate outfall area extending to approximately 100-feet downstream is in good condition but may need channel protection if flows increase.

Figure B-32. Concrete weir and outfall channel (left); Facility from northern corner (right)

- Drainage Area: 2.46 Acres
- Impervious Drainage Area: 0.31 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within a portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Repair and unclog the 15-inch HDPE inflow pipe.
- Proposed project plans are shown in Figure B-33.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Woodlands Homeowners Association

Access

- Good Access: Access from ROW between a residence and the natural stream.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000622 are shown in Table B-22. The table includes the drainage area of each improvement, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.60 inches of rainfall which corresponds to 1.40 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 0.42 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 68% for nitrogen, 79% for phosphorus, and 85% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $80,864 for retrofitting existing BMP-SWM000622. Project costs are broken down by cost per impervious acre treated (Table B-23). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-22: Summary of Improvements for Existing BMP SWM000622

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000622	2.46	0.31	-	0.42	21.09	1.67	3,415
Outfall								
Stream								
Total Credit/ Reductions					0.42	21.09	1.67	3,415

Table B-23: Summary of Project Costs for Retrofitting Existing BMP SWM000622

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000622	$80,864	$193,224
Outfall			
Stream			
Total Costs		$80,864	$193,224

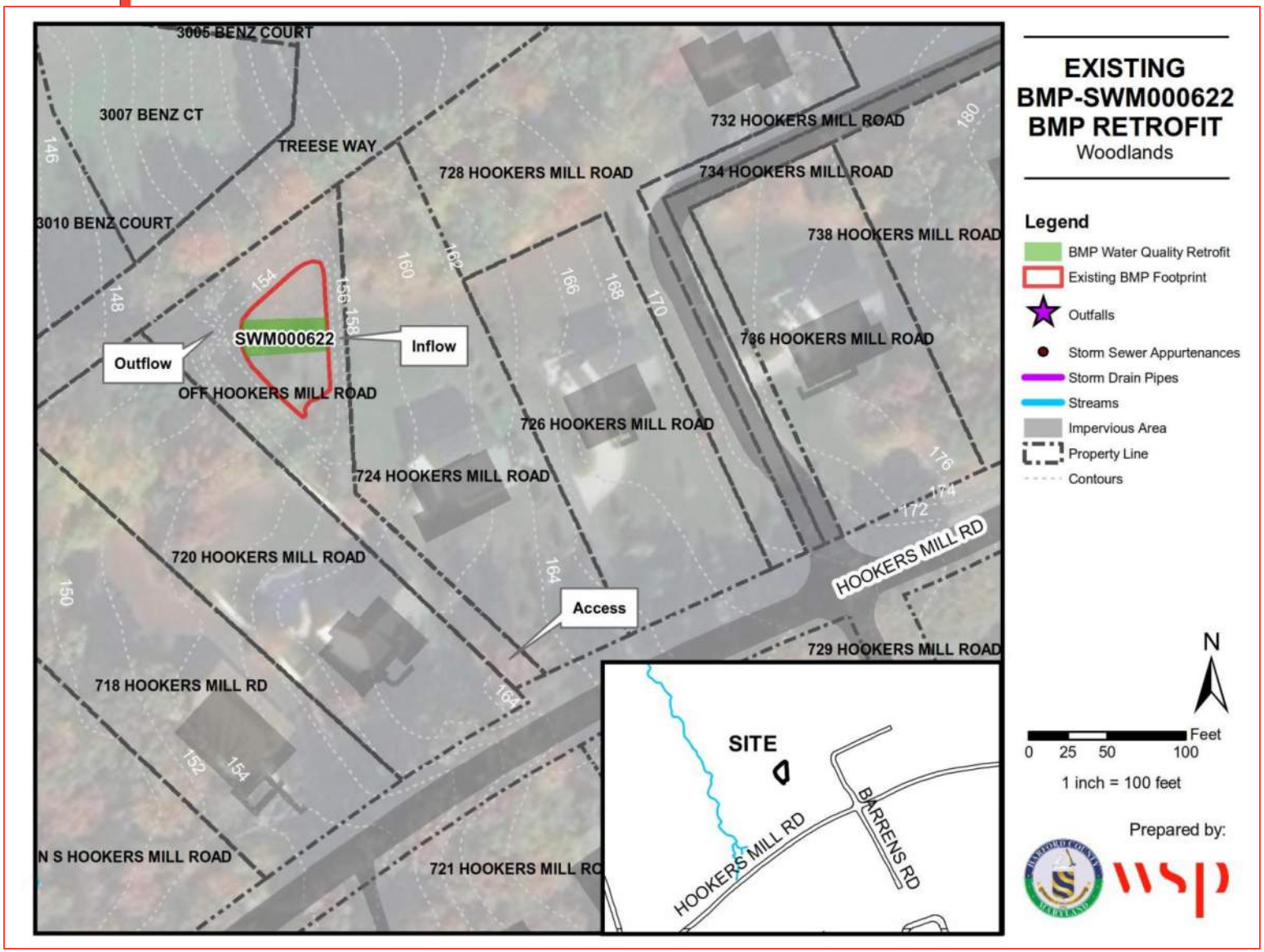

Figure B-33. Site Location and Proposed Retrofit for Existing BMP-SWM000622

RETROFIT OF EXISTING BMP-SWM000683: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000683) with a submerged gravel wetland
Location	Adjacent to the property at 1300 Hidden Brook Court
Property Ownership	Abingdon Estates
Subwatershed	MSB-2
Potential Impervious Acres Treated	1.51 Acres
Potential Load Reductions TP	34.83 lbs/year
Potential Load Reductions TN	2.30 lbs/year
Potential Load Reductions TSS	4,877 lbs/year
Estimated Design/Construction Costs	$208,985 $138,364/impervious acres treated
Adjacent Projects	SWM000472, MSB-2A Stream Restoration

Site Description

Existing SWM000683 is an extended detention facility located off Hidden Brook Court adjacent to residences including 1300 Hidden Brook Court and 1302 Hidden Brook Court. It is accessible from the Homeowners Association property between the residences noted above and is within the MSB-2 subwatershed. One 18-inch CMP into the facility conveys flows originating from the storm sewer system to the west. One 15-inch CMP into the facility conveys flows originating from the storm sewer system to the north. There is a CMP riser structure with an 18-inch CMP principal spillway. The principal spillway drains to a channel ultimately discharging to Bynum Run to the north. The slope spanning approximately 5 feet downstream of the spillway to the confluence with the existing natural channel is severely eroded. Undercutting, vertical bank incision of 5 to 10 feet, and various downed large diameter trees were observed along the eroded slope. There is a 20-foot grass emergency spillway at the southeast corner of the pond. No standing water or wetland vegetation were observed within the facility (Figure B-34).

Figure B-34. Access gate from Hidden Brook Court (left); Emergency spillway and riprap inflow point (right)

Precipitation totaling 0.05-inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry

pond in its current condition. Based on record drawings, there is a 6-inch CMP low flow orifice. High flows enter the CMP riser structure (Figure B-35).

Figure B-35. Embankment behind riser structure and 15-inch CMP inflow pipe (left); Eroded outfall channel (right)

- Drainage Area: 3.41 Acres
- Impervious Drainage Area: 1.18 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within a portion of the current extended detention basin footprint. The submerged gravel wetland would have a forebay at each inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-36.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Abingdon Estates

Access

- Good Access: Access from Hidden Brook Court.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000683 are shown in Table B-24. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.13 inches of rainfall which corresponds to 1.28 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 1.51 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 67% for nitrogen, 78% for phosphorus, and 84% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $208,985 for retrofitting existing BMP-SWM000683. Project costs are broken down by cost per impervious acre treated (Table B-25). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-24: Summary of Improvements for Existing BMP SWM000683

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000683	3.41	1.18	-	1.51	34.83	2.30	4,877
Outfall								
Stream								
Total Credit/ Reductions					1.51	34.83	2.30	4,877

Table B-25: Summary of Project Costs for Retrofitting Existing BMP SWM000683

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000683	$208,985	$138,364
Outfall			
Stream			
Total Costs		$208,985	$138,364

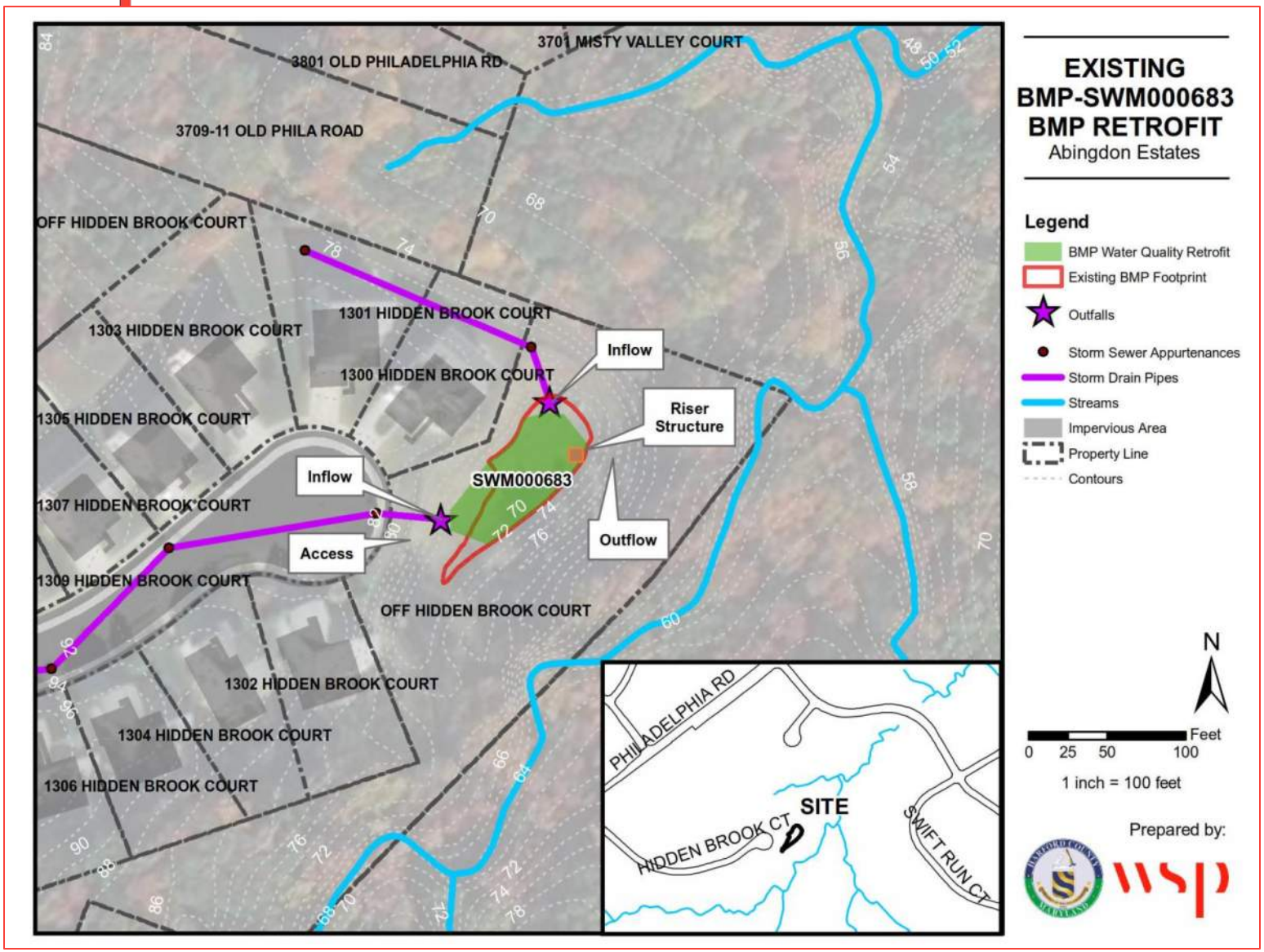

Figure B-36. Site Location and Proposed Retrofit for Existing BMP-SWM000683

RETROFIT OF EXISTING BMP-SWM000685: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000685) with a submerged gravel wetland
Location	Behind the property at 1306 Forest Oak Court
Property Ownership	Stone Ridge
Subwatershed	LB-1
Potential Impervious Acres Treated	4.52 Acres
Potential Load Reductions TP	139.04 lbs/year
Potential Load Reductions TN	9.76 lbs/year
Potential Load Reductions TSS	20,395 lbs/year
Estimated Design/Construction Costs	$450,193 $99,611/impervious acres treated
Adjacent Projects	None

Site Description

Existing SWM000685 is an extended detention facility located on the south end of Forest Oak Court, behind the residence at 1306 Forest Oak Court. It is accessible between 1306 Forest Oak Court and 1307 Forest Oak Court. The site has a painted wooden fence and gate. A resident is concerned about a damaged portion of the fence on the northwestern border. The facility is within the LB-1 subwatershed. A 36-inch RCP conveys flows from residences along Stone Ivy Place, Briar Post Court, and Forest Oak Court into the facility. Flows enter a forebay with minor riprap displacement. A 23-foot grass emergency spillway exists at the southern end of the facility. There is wetland vegetation, but no standing water, in the pond (Figure B-37).

Figure B-37. Facility from behind riser structure (left); Western part of the facility from access path via Forest Oak Court (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). No rainfall was observed during the two days prior to the field site visit. There is concrete riser structure at the east part of the facility with weir openings on all sides. The riser has a 12-inch low flow CMP orifice, an 8-inch high flow PVC pipe orifice, and a 30-inch RCP principal spillway where flows enter an unnamed tributary to Bynum

Run. There is minor riprap displacement at the outfall. There are minor outfall issues extending to approximately 100 feet downstream (Figure B-38).

Figure B-38. The embankment behind the riser structure (left); Facing upstream at the outfall and outfall protection (right)

- Drainage Area: 14.67 Acres
- Impervious Drainage Area: 3.93 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended the current extended detention basin footprint. A berm is needed to extend the time stormwater is in the facility. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-39.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Stone Ridge

Access

- Good Access: Access from ROW between two residences.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000685 are shown in Table B-26. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.59 inches of rainfall

which corresponds to 1.15 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 4.52 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 66% for nitrogen, 77% for phosphorus, and 83% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $450,193 for retrofitting existing BMP-SWM000685. Project costs are broken down by cost per impervious acre treated (Table B-27). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-26: Summary of Improvements for Existing BMP SWM000685

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000685	14.67	3.93	-	4.52	139.04	9.76	20,395
Outfall								
Stream								
Total Credit/ Reductions					4.52	139.04	9.76	20,395

Table B-27: Summary of Project Costs for Retrofitting Existing BMP SWM000685

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000685	$450,193	$99,611
Outfall			
Stream			
Total Costs		$450,193	$99,611

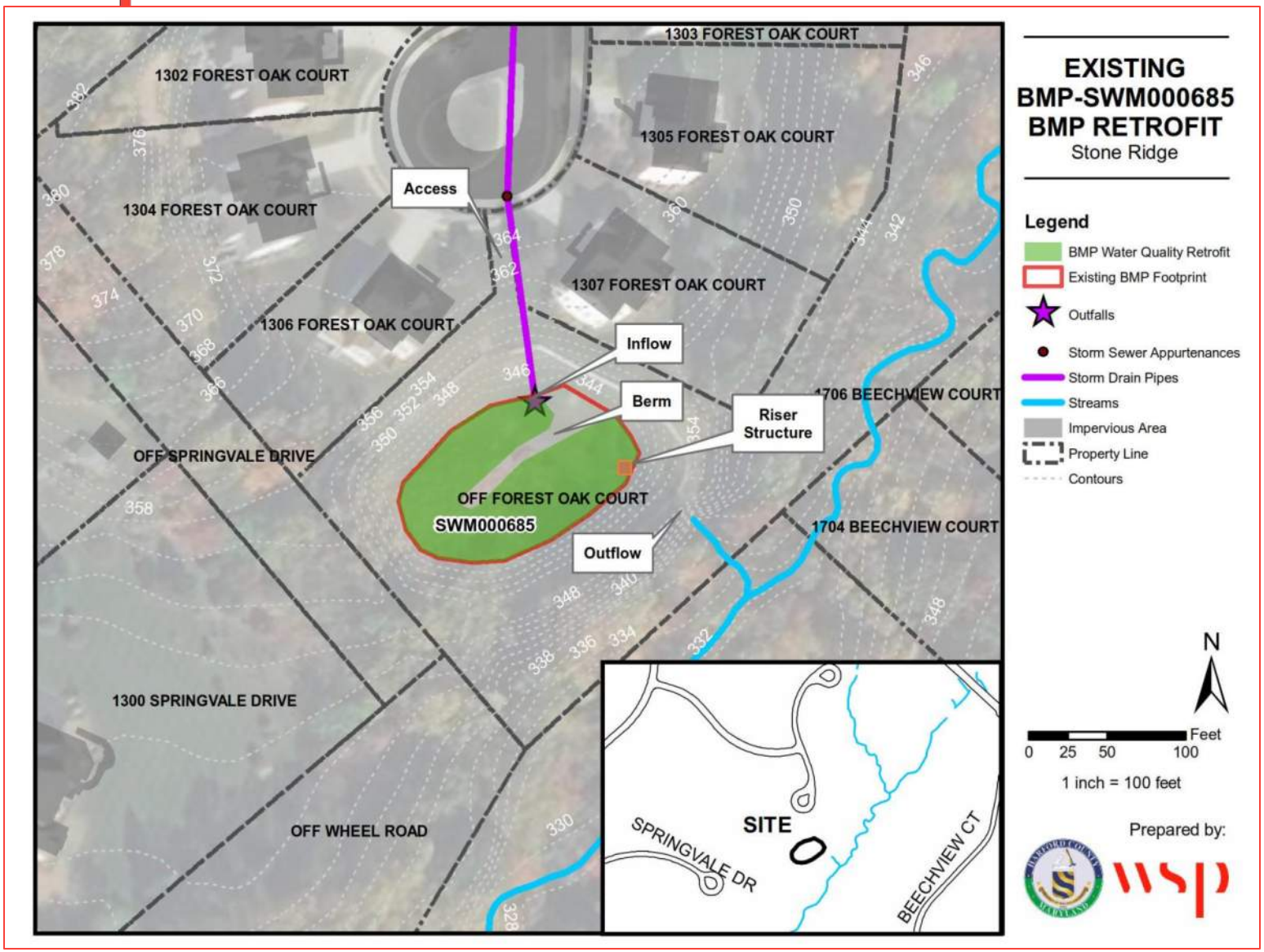

Figure B-39. Site Location and Proposed Retrofit for Existing BMP-SWM000685

B.2 PROPOSED BMP PROJECTS

A desktop evaluation of the watershed and an evaluation of previous studies within the watershed identified 2 potential new BMP projects within the watershed. As a result of the initial screening of sites during the assessment, a total of 5 of the 14 sites were identified for an in-depth field assessment. The field assessment identified 2 sites with adequate space, accessibility, and limited constructability constraints. The two proposed BMP projects are described in detail in this section. Chapter 4 provides background information on the field identification process.

PROPOSED BMP-P-4: BIORETENTION

Project Description	Bioretention
Location	Maryland Golf and Country Club 1335 East MacPhail Road
Property Ownership	Maryland Country Club, Inc.
Subwatershed	MSB-5
Potential Impervious Acres Treated	0.71 Acres
Potential Load Reductions TP	12.29 lbs/year
Potential Load Reductions TN	0.73 lbs/year
Potential Load Reductions TSS	1,591 lbs/year
Estimated Design/Construction Costs	$150,394 $212,661/impervious acres treated
Adjacent Projects	MSB-5C Stream and Outfall Restoration

Site Description

The Maryland Golf and Country Club is located near the intersection of East Macphail Road and Old Macphail Drive within the MSB-5 subwatershed. Under current conditions, a portion of the pool area and lower parking lot sheet flows to a grassy area adjacent to the lower parking lot (Figure B-40) prior to discharging into an existing stream in the woods. Additionally, there are two 12-inch RCP outfall pipes located near the proposed BMP that are heavily damaged. Both pipes are separated/broken at the joints and undermined approximately 3 feet (Figure B-41). The downstream outfall channel is significantly eroded. Approximately 1.08 acres of drainage area with 0.52 acres of impervious area drain to the existing grassy area adjacent to the parking lot.

Figure B-40: Existing grass area adjacent to parking lot – facing North (left); Existing lower parking lot – facing South (right)

Figure B-41: Heavily damaged outfall prior to discharge into stream

Recommended Restoration Actions

- A bioretention facility is proposed in the flat area adjacent to the lower parking lot near the pool to treat impervious area runoff (Figure B-42). Most soils in the area are hydrologic soil type A, indicating high infiltration rates. An underdrain is not recommended to convey treated runoff that does not infiltrate into the ground to the nearby stream. The two 12-inch RCP outfalls are inaccurately shown on the aerial. The proposed BMP will be located on top of the pipes.
- The proposed bioretention has the potential to treat 0.71 impervious acres.
- Proposed BMP plans are shown in Figure B-43.

Figure B-42: West view of proposed bioretention location (left); East view of proposed bioretention location (right)

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Maryland Country Club, Inc.

Access

- Minor Access: Existing facility located on private land. Mature trees near vicinity of proposed BMP footprint.

Summary of Restoration Improvements

A summary of improvements for the proposed bioretention facility are shown in Table B-30. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed bioretention facility treats 2.60 inches of rainfall which corresponds to 2.60 impervious acre credit per acre of watershed impervious area. This proposed bioretention facility would provide a total of 0.71 impervious acres of treatment. This bioretention facility would provide a pollutant load reduction of 68% for nitrogen, 79% for phosphorus, and 85% for sediment (Schueler, 2015).

Items of Note

The responsibility of maintenance and routine inspection of the bioretention facility will need to be established with the property owner. Harford County should consider taking of maintenance responsibilities in order to ensure credit into perpetuity.

Project Costs

Total project costs are $150,394 for the proposed bioretention. Project costs are broken down by cost per impervious acre treated (Table B-29). BMP construction costs were based on actual Maryland bioretention construction costs and engineering judgement. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-28: Summary of Improvements for Proposed BMP-P-4

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	BMP-P-4 (Bioretention)	1.08	0.52	-	0.71	12.29	0.73	1,591
Outfall								
Stream								
Total Credit/ Reductions					0.71	12.29	0.73	1,591

Table B-29: Summary of Project Costs for Proposed BMP-P-4

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	BMP-P-4	$150,394	$212,661
Outfall			
Stream			
Total Costs		$150,394	$212,661

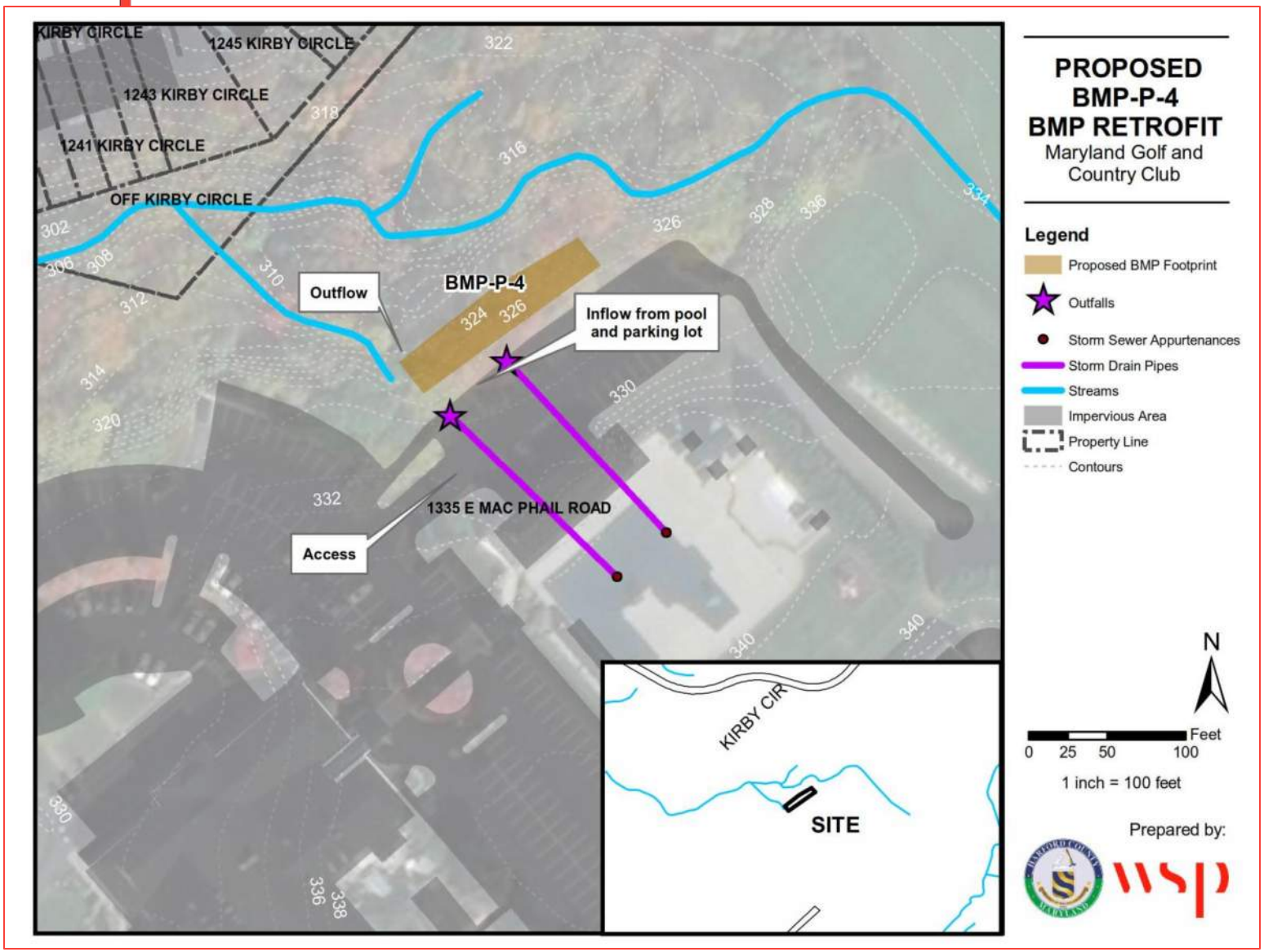

Figure B-43: Proposed BMP-P-4 Site Location

PROPOSED BMP-P-7: BIORETENTION

Project Description	Bioretention
Location	Emmorton Recreation Office 2213 Old Emmorton Road
Property Ownership	Harford County
Subwatershed	MSB-4
Potential Impervious Acres Treated	1.37 Acres
Potential Load Reductions TP	22.93 lbs/year
Potential Load Reductions TN	1.21 lbs/year
Potential Load Reductions TSS	2,699 lbs/year
Estimated Design/Construction Costs	$165,384 $121,001/impervious acres treated
Adjacent Projects	None

Site Description

Emmorton Recreation Office is located at near the intersection of Emmorton Rd. and Laurel Bush Rd. within the MSB-4 subwatershed. Under current conditions, a portion of the rooftop of Emmorton Recreation Office and the parking lot drains through an existing storm drain system prior to discharging to an adjacent stream next to Emmorton Recreation Office (Figure B-44). The rooftop drains through gutters to downspouts directly connected to the existing storm drain system. The parking lot drains through curb and gutter to an existing storm drain system inlet. Approximately 1.99 acres of drainage area with 1.34 acres of impervious area drain to the existing stream.

Figure B-44: Facing south toward the parking lot adjacent to Emmorton Recreation Office (left); Facing north at the existing inlet in the parking lot adjacent to Emmorton Recreation Office (right)

Recommended Restoration Actions

- A bioretention facility is proposed in the flat area between two Emmorton Recreation Office buildings, located downstream of the parking lot to treat impervious area runoff (Figure B-45). The soils in the area are hydrologic soil type C, indicating low infiltration rates. An underdrain is recommended to convey treated runoff that does not infiltrate into the ground to the nearby stream.

- The proposed bioretention has the potential to treat 1.37 impervious acres.
- Proposed BMP plans are shown in Figure B-46.

Figure B-45: Facing east toward the Emmorton Recreation Office building (left); Facing north toward the existing outfall channel adjacent to the Emmorton Recreation Office building (right)

Threats to Infrastructure

- There is no critical infrastructure in the project limits.
- There are surrounding recreation buildings.
- There are no utility conflicts.

Property Ownership

- Public: Harford County

Access

- Minor Access: Existing facility located on public land. Some mature trees near vicinity of proposed BMP footprint.

Summary of Restoration Improvements

A summary of improvements for the proposed bioretention facility are shown in Table B-30. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed bioretention facility treats 1.0-inch of rainfall which corresponds to 1 impervious acre credit per acre of watershed impervious area. This proposed bioretention facility would provide a total of 1.37 impervious acres of treatment. This bioretention facility would provide a pollutant load reduction of 61% for nitrogen, 71% for phosphorus, and 76% for sediment (Schueler, 2015).

Project Costs

Total project costs are $165,384 for the proposed bioretention. Project costs are broken down by cost per impervious acre treated (Table B-31). BMP construction costs were based on actual Maryland

bioretention construction costs and engineering judgement. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-30: Summary of Improvements for Proposed BMP-P-7

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	BMP-P-7	1.99	1.34	-	1.37	22.93	1.21	2,699
Outfall								
Stream								
Total Credit/ Reductions					1.37	22.93	1.21	2,699

Table B-31: Summary of Project Costs for Proposed BMP-P-7

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	BMP-P-7	$165,384	$121,001
Outfall			
Stream			
Total Costs		$165,384	$121,001

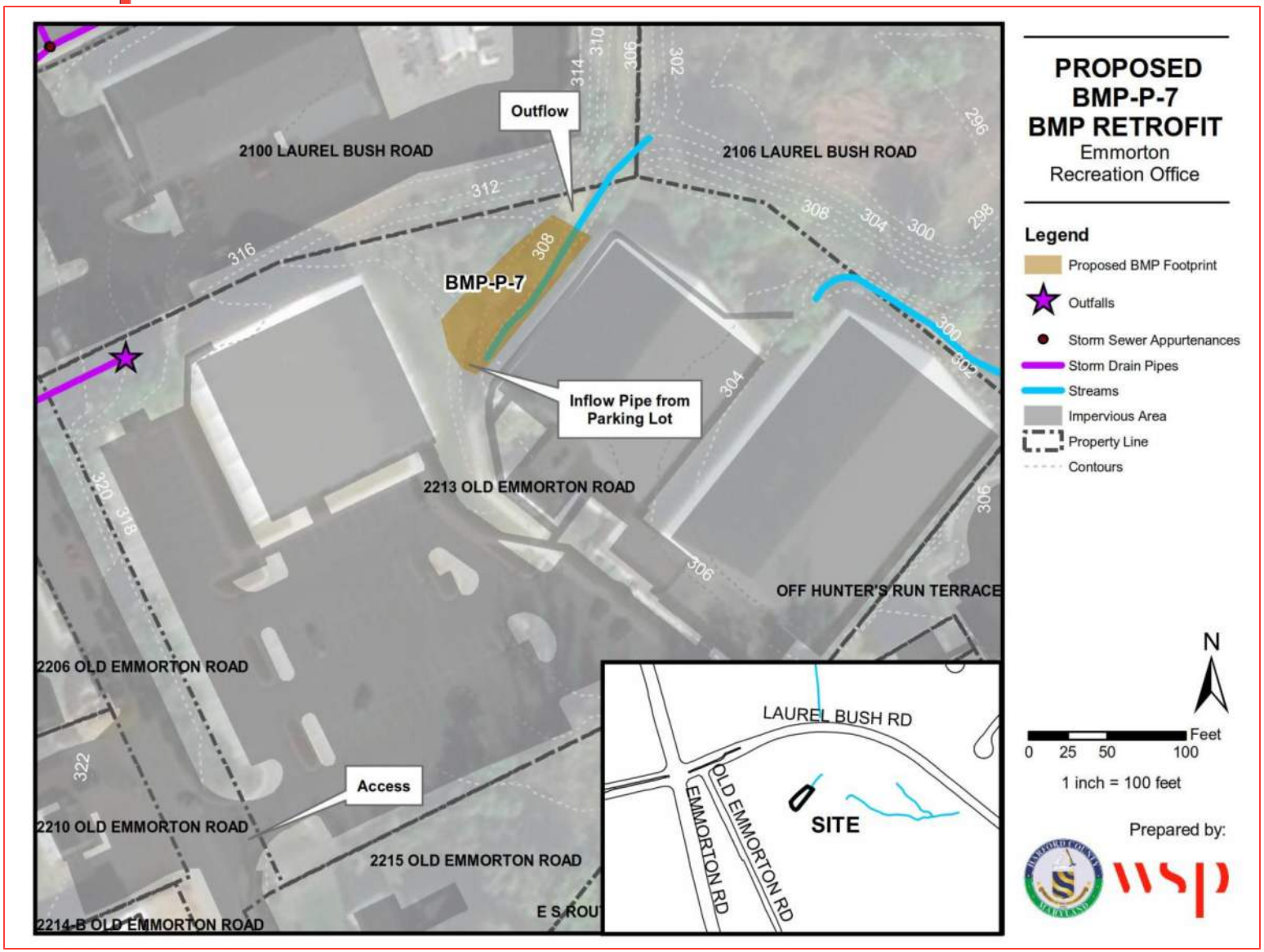

Figure B-46: Proposed BMP-P-7 Site Location

APPENDIX C STREAM AND OUTFALL RESTORATION PROJECTS

Combination stream restoration and outfall stabilization projects are presented in this appendix. Seventeen projects have been recommended for the Lower Bynum Run watershed. These projects include stream restorations from 743 linear feet to 3,354 linear feet. Eight projects are stream restoration only projects, three are outfall stabilization only projects, and the remaining six projects are a combination of stream restoration and outfall stabilization projects. Outfalls have been identified at the headwater of the stream or on the left or right bank of the stream that need repair, replacement, or stabilization. Table C-3 lists all 17 stream and outfall restoration projects.

Each project description begins with an "at a glance" summary of the recommended restoration, the location of the project, the number of properties impacted, the pollutant load reductions and impervious area treated. The project description also includes a site description, recommended actions, threats to infrastructure, impacted property addresses, a cost estimate, and a map showing the extents of the project.

Cost estimates for each stream restoration project are based on three project sizes: small, medium, and large. Small projects have less than 1,000 linear feet of restoration, medium projects have between 1,000 and 3,000 linear feet of stream restoration, and large projects have more than 3,000 linear feet of stream restoration. Each project type was assigned a cost per linear foot; small projects had a higher cost per linear feet than large projects due to economies of scale. These values were estimated based on estimates from other Maryland counties as well as state agencies. The cost estimates for the types of stream projects are shown in Table C-1.

Table C-1: Stream Design and Construction Cost Estimates for Small, Medium, and Large Stream Projects

Project Type	Cost/L.F.
Small	$750
Medium	$650
Large	$550

Several of the stream projects include outfall stabilization efforts. A cost was assigned to each outfall and added to the overall stream and outfall restoration project cost estimate. The outfall cost was assigned a cost related to the magnitude of the project. Small projects require a design component along with grading and riprap stabilization. Medium projects require a design component plus a new outfall structure, plunge pool, and less than 40 feet of additional pipe. Large projects include all items in the medium project list; however, the amount of additional pipe needed to convey flow to the stream is greater than 40 feet. Table C-2 provides the breakdown of cost for the small, medium, and large outfall and stream projects.

Table C-2: Cost Estimates for Outfall Stabilization Projects

Outfall Project Type	Project Cost
Small	$25,000
Medium	$50,000
Large	$100,000

Outfall maintenance is an additional cost category associated with the stream restoration projects. Outfall maintenance to remove accumulated sediment or replace an endwall is estimated at $5,000 for each outfall.

Table C-3. Stream and Outfall Restoration Project Summary

PROJECT NAME	TYPE	LENGTH OF STREAM RESTORATION (FT)	LENGTH OF OUTFALL RESTORATION (FT)	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	IMPERVIOUS AREA TREATED (ACRES)	TN REDUCTIONS (LBS/YR)	TP REDUCTIONS (LBS/YR)	TSS REDUCTIONS (LBS/YR)	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
MSB-2A	Stream Restoration	2,220		88.96	14.58	44.40	166.50	150.96	33,300	$1,443,000	$32,500
MSB-2B	Stream Restoration	1,160		65.69	18.41	23.21	87.00	78.88	17,405	$769,000	$33,132
MSB-2C	Outfall Restoration		55	10.00	3.23	0.55	N/A	N/A	N/A	$50,000	$90,909
MSB-4A	Stream Restoration	2,385		178.08	48.6	71.54	178.85	162.16	107,070	$1,550,250	$21,809
MSB-4B	Stream and Outfall Restoration	2,440	95	646.26	148.90	74.16	183.00	165.92	109,556	$1,686,000	$22,735
MSB-4C	Stream Restoration	1,296		154.51	15.93	38.89	97.22	88.15	58,202	$842,400	$21,661
MSB-4D	Stream and Outfall Restoration	2,105	100	286.51	78.08	64.15	157.88	143.14	94,515	$1,518,250	$23,667
MSB-4E	Stream and Outfall Restoration	3,325	12	425.28	105.19	99.87	249.38	226.11	149,297	$1,853,750	$18,562
MSB-4F	Outfall Restoration		96	7.30	2.60	0.96	N/A	N/A	N/A	$25,000	$26,042
MSB-4G	Stream and Outfall Restoration	160	30	15.50	6.60	5.10	12.00	10.88	7,184	$170,000	$33,333
MSB-5A	Stream Restoration	2,058		24.23	3.91	61.74	154.35	139.94	92,404	$1,337,700	$21,667
MSB-5B	Stream Restoration	1,327		96.10	24.61	39.80	99.51	90.22	59,571	$872,550	$21,923
MSB-5C	Stream and Outfall Restoration	3,236	137	231.06	51.46	98.46	242.71	220.06	145,304	$2,005,150	$20,365
MSB-5D	Stream and Outfall Restoration	3,354	216	107.52	20.33	102.76	251.58	228.10	150,615	$1,969,700	$19,168
MSB-5E	Stream Restoration	743		147.23	24.82	22.28	55.69	50.49	33,339	$556,890	$24,995
MSB-5F	Outfall Restoration		90	14.10	4.76	0.90	N/A	N/A	N/A	$100,000	$111,111
MSB-6A	Stream Restoration	2,649		169.76	47.22	79.46	198.64	180.10	118,919	$1,721,850	$21,669
Total		**28,458**	**831**	**2,668.09**	**619.23**	**828.23**	**2,134.31**	**1,935.11**	**1,176,681**	**$18,471,490**	

MSB-2A STREAM RESTORATION

Project Description	Restore 2,220 feet of stream
Location	Hidden Brook Court
Property Ownership	Five private properties
Length of Project	2,220 feet of stream restoration
Potential Impervious Acres Treated	44.40 Acres
Potential Load Reductions TP	150.96 lbs/yr
Potential Load Reductions TN	166.50 lbs/yr
Potential Load Reductions TSS	33,300 lbs/yr
Estimated Design/Construction Costs	$1,443,000 $32,500/ impervious acres treated
Adjacent Projects	SWM000472 and SWM000683

Site Description

MSB-2A is south of Hidden Brook Court and west of Swift Run Court. This project contains 2,220 feet of proposed stream restoration, including the main stem and a tributary. The stream project ends at the confluence of the tributary and main stem. No outfalls within this stream project are recommended for stabilization or maintenance. The main stem experiences severely eroded banks for the first 883 feet and has an average exposed bank height of 7 feet (Figure C-1, left). The stream channel is steeper in this section. As the channel slope decreases, the eroded bank heights decrease to 2-feet, with low severity erosion (Figure C-2, left). The SWM000683 BMP outfall channel is eroded approximately 70 feet prior to entering the main stem (Figure C-1, right).

Figure C-1: Left bank severely eroded (left); Left and right banks are severely eroded and channel is dry (right).

Throughout the stream there is some deposition (Figure C-2, left). There are two headcuts, one 3 feet and the other 4 feet (Figure C-2, right). Lastly, there is some debris accumulation and one area with trash in the stream.

Figure C-2: Stream deposition (left); 4-foot headcut along tributary (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-2A, main stem:* 2,220 feet from approximately 370 feet downstream of Outfall 1 to the confluence with a tributary in Abingdon Estates HOA.
- Proposed project limits are shown in Figure C-3, Figure C-4, and Figure C-5.

Threats to Infrastructure

- There is no threat to infrastructure within the project area.

Property Ownership

There are several private property owners along this reach. The majority of the stream project is located within HOA property. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: LLC, 3605 Philadelphia Road
- Private: HOA, Abingdon Estates Homeowner's Association Inc.
- Private: HOA, Hidden Stream Homeowner's Association Inc.
- Private: Cogswell Court
- Private: HOA, Cokesbury Manor Community Association Inc.

Access

- Moderate Access at SWM000472 easement, east of the BMP, located between 1219 and 1220 Lobo Court for stream restoration.
- Moderate Access at SWM000683 between 1300 and 1302 Hidden Brooke Court for stream restoration.

- Moderate Access at Open Area west of 1312 Hidden Brooke Court for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-4. The restoration of 2,220 linear feet of stream restoration in this project will treat 44.40 impervious acres within the watershed. This treatment amount accounts for approximately 3.4% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $1,443,00 for the MSB-2A Stream Restoration project. This cost estimate includes one medium stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-5.

Table C-4:Summary of Improvements for MSB-2A Stream Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-2A	88.96	14.58	2,220	44.40	166.50	150.96	33,300
Total Credit/ Reductions				**2,220**	**44.40**	**166.50**	**150.96**	**33,300**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-5: Summary of Project Costs for MSB-2A Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-2A	Medium	$650	L.F.	$1,443,000	$32,500
Total Costs					**$1,443,000**	**$32,500**

*Project cost divided by stream restoration impervious area treated

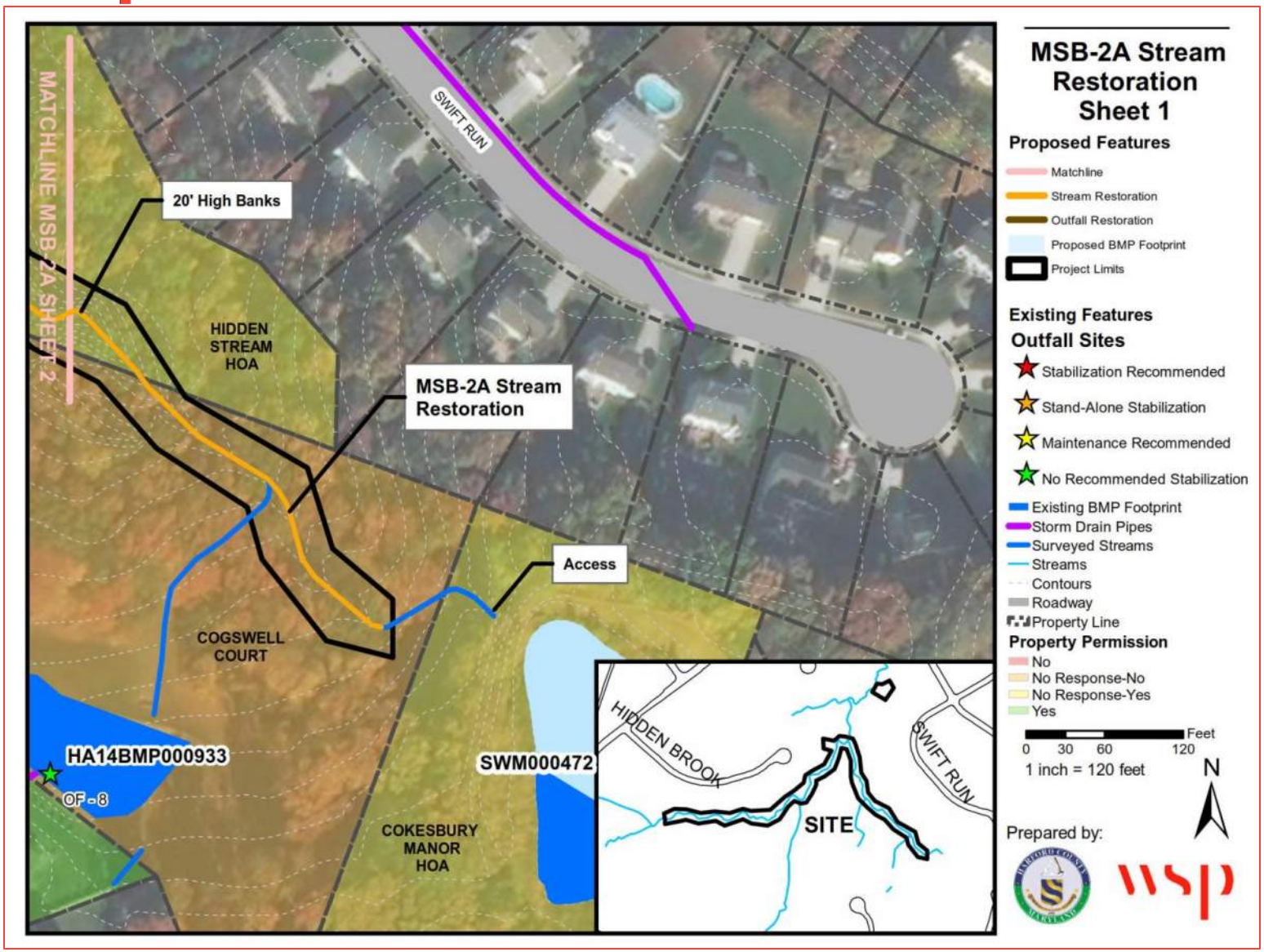

Figure C-3: Site Location and Proposed Project Plan for MSB-2A Stream Restoration (Sheet 1 of 3)

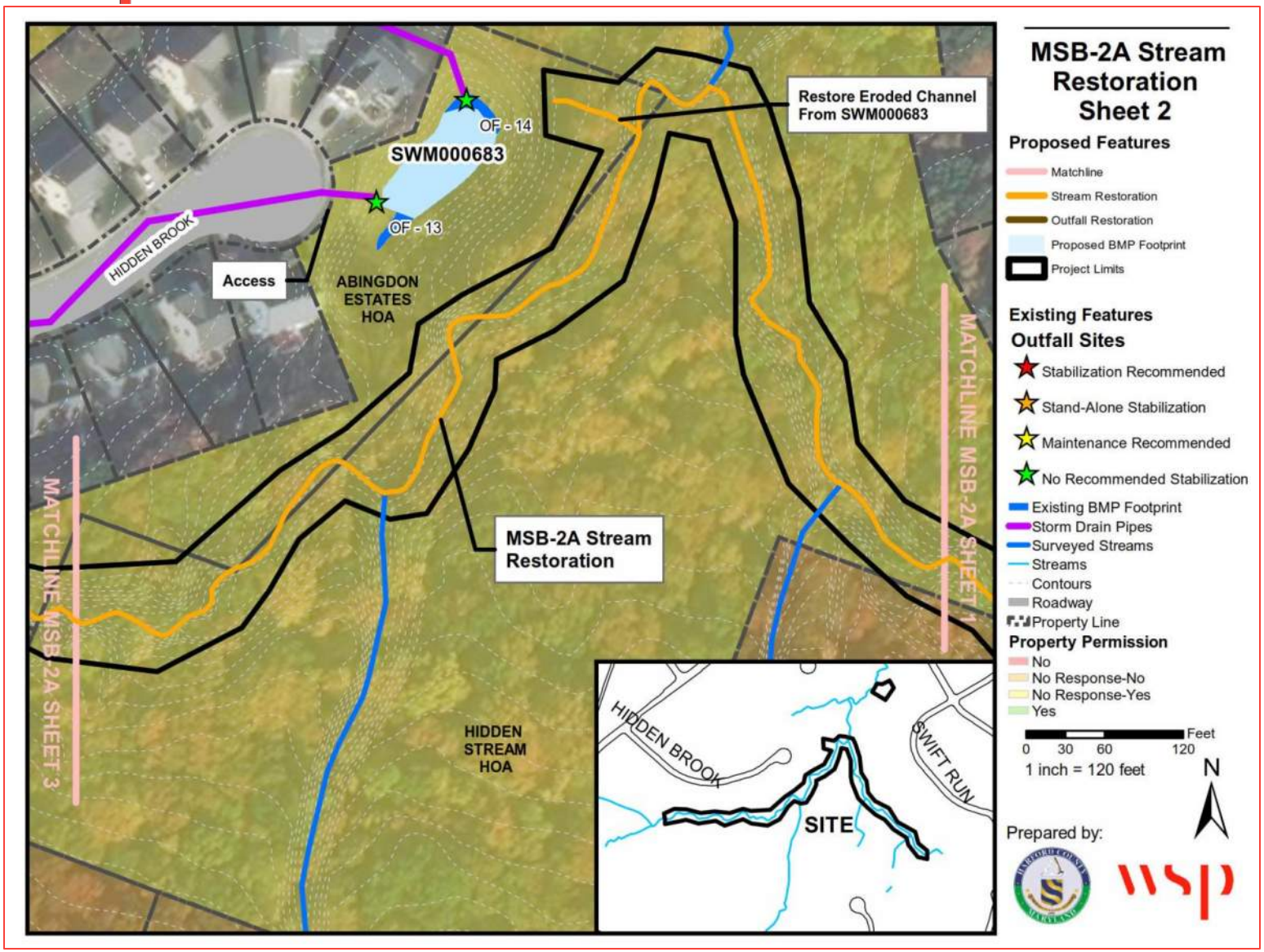

Figure C-4: Site Location and Proposed Project Plan for MSB-2A Stream Restoration (Sheet 2 of 3)

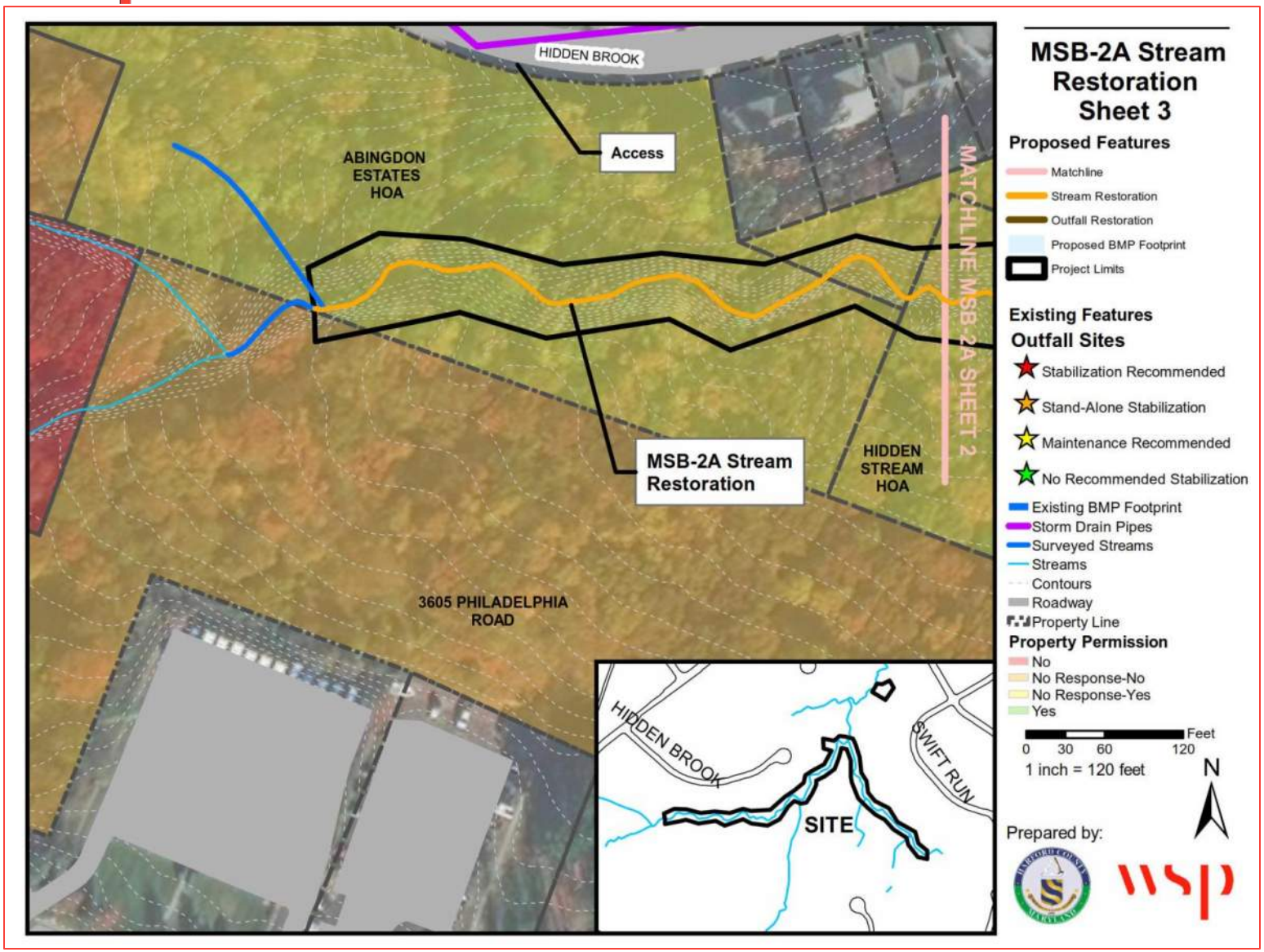

Figure C-5: Site Location and Proposed Project Plan for MSB-2A Stream Restoration (Sheet 3 of 3)

MSB-2B STREAM RESTORATION

Project Description	Restore 1,160 feet of stream
Location	Swift Run Drive and Harford Town Drive
Property Ownership	Two private properties
Length of Project	1,160 feet of stream restoration
Potential Impervious Acres Treated	23.21 Acres
Potential Load Reductions TP	78.88 lbs/yr
Potential Load Reductions TN	87.00 lbs/yr
Potential Load Reductions TSS	17,405 lbs/yr
Estimated Design/Construction Costs	$769,000 $33,132/impervious acres treated
Adjacent Projects	None

Site Description

The upstream limit of MSB-2B is located between Splashing Brook Drive and Harford Town Drive. It proposes a total of 1,160 feet of stream restoration and maintenance of outfalls 18, 23, and 24. There are an additional 4 outfalls within the vicinity of this project which are not recommended for stabilization or maintenance. The main stem of the stream contains multiple erosion sites of varying severity. At the upstream limits, there is low severity erosion with an average exposed bank height of 2 feet on both the left and right banks. This continues for approximately 222 feet downstream. The remaining length of the main stem includes severe erosion on the left bank and moderate erosion on the right bank. For the first 430 feet, the left and right bank heights are 3 feet (Figure C-6, left). The next 380 feet of stream, the exposed bank height on the left increases to 7 and the right height increases to 5 feet (Figure C-6, left). In the final 250 feet of the main stem, the exposed bank heights are reduced to an average of 3 feet on both sides.

Figure C-6: Start of severe left bank and moderate right bank erosion within MSB-2B (left); Deposition and debris jams (right)

Outfall 18 is located approximately 370 feet downstream from the beginning of the stream project. This outfall is the only outfall assessed that was in the Harford County GIS database and was less than 12 inches. The outfall is a 6-inch overflow pipe from a BMP that is also not in the Harford County BMP

database. The pipe extends 5 feet from the edge of the right stream bank, leaving it susceptible to damage from debris. Severe erosion has occurred along the banks near Outfall 18 (Figure C-7, right).

A tributary converges on the main stem near the end of the stream restoration project. The tributary conveys flow from a storm drain network (Outfall 23) along Harford Town Drive. A portion of the flow from this storm drain network is diverted into a BMP. Outfall 24 is the outlet of the BMP and flows directly into the main stem, approximately 85 feet upstream of the end of the project area. The tributary experiences active erosion with an average exposed height of 4 feet from the channel of outfall 23 (Figure C-7, left).

Figure C-7: Severe erosion around overflow pipe, Outfall 18 (left); Headcut at the intersection of the channel of Outfall 23 with the main stem (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB -2B Main stem*: 1,077 feet from approximately 650 feet downstream of Outfall 11 to the outlet at Harford Town Drive.
  - *MSB-2BR, Tributary*: 83 feet from 40 feet downstream of Outfall 23 to the confluence with the main stem.
- **Outfall Maintenance**
  - *Outfalls 18:* Repair 12-inch pipe when restoring stream channel
  - *Outfall 23:* Shift riprap back into outfall channel and tie end of outfall channel in with stream restoration
  - *Outfall 24:* Remove sediment from outfall pipe and outfall channel to restore positive grade towards stream
- Proposed project limits are shown in Figure C-8 and Figure C-9.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are two private property owners along this reach and coordinating buy in from them at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Harford Town Homeowners Association Inc.
- Private: 1202 Harford Town Drive

Access

- Good Access at the corner of Cooper Beech Drive and Swift Run Road for stream restoration.
- Good Access at the easement between 1146 and 1148 Harford Town Drive for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-6. The construction of 1,160 linear feet of stream restoration in this project will treat 23.21 impervious acres within the watershed. This treatment amount accounts for approximately 1.8% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $769,000 for the MSB-2B Stream Restoration project. This cost estimate includes three outfall maintenance projects and one medium stream restoration project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-7.

Table C-6: Summary of Improvements for MSB-2B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance	OF-18	-	-	-	-	-	-	-
	OF-23	-	-	-	-	-	-	-
	OF-24	-	-	-	-	-	-	-
Outfall								
Stream	MSB-2B	65.69	18.41	1,160	23.21	87.00	78.88	17,405
Total Credit/ Reductions				**1,160**	**23.21**	**87.00**	**78.88**	**17,405**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-7: Summary of Project Costs for MSB-2B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance	OF-18	Small	$5,000	Project	$5,000	
	OF-23	Small	$5,000	Project	$5,000	
	OF-24	Small	$5,000	Project	$5,000	
Outfall						
Stream	MSB-2B	Medium	$650	L.F.	$754,000	$32,486
Total Costs					**$769,000**	**$33,132**

*Project cost divided by stream restoration impervious area treated

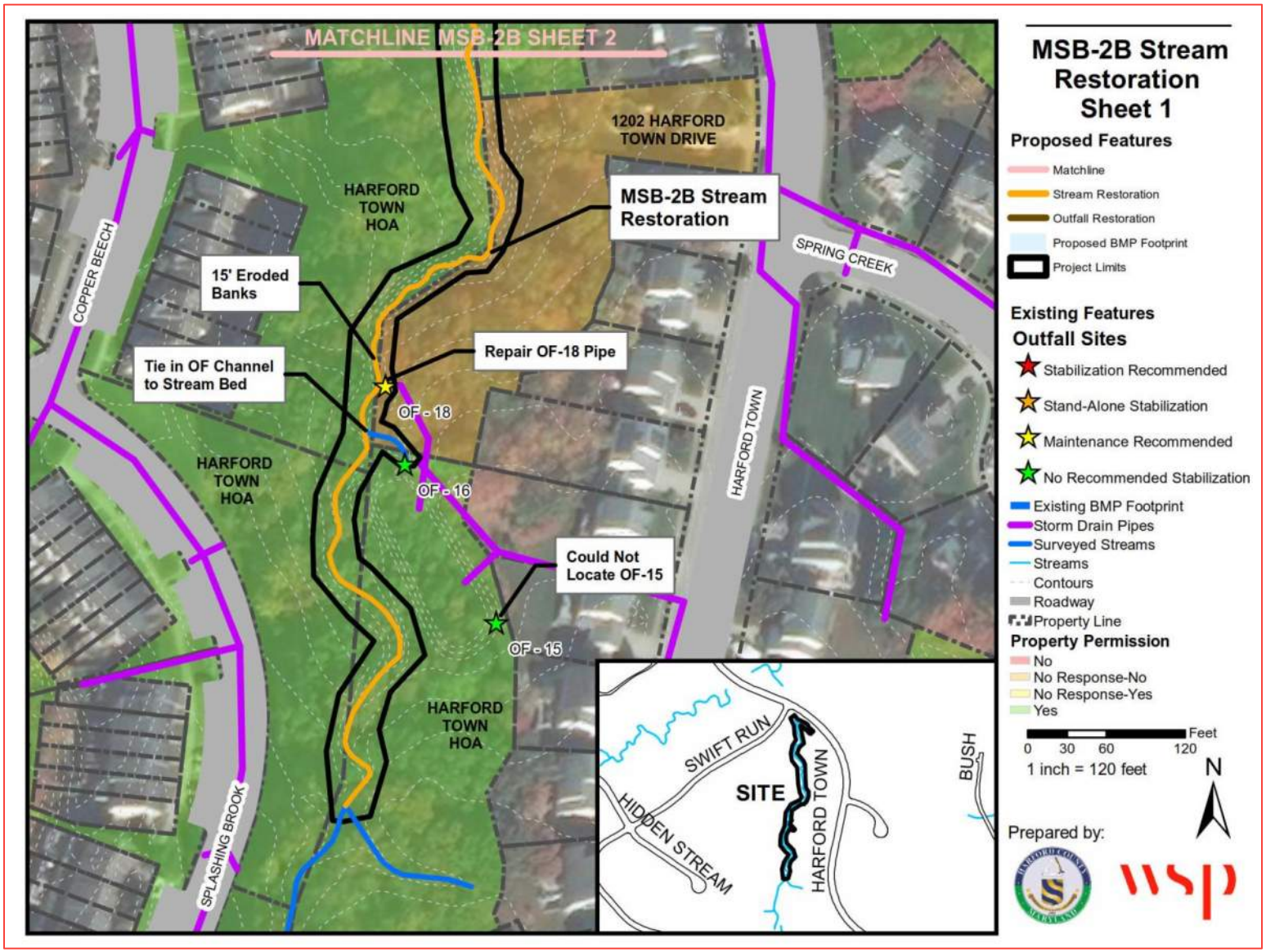

Figure C-8: Site Location and Proposed Project Plan for MSB-2B Stream Restoration (Sheet 1 of 2)

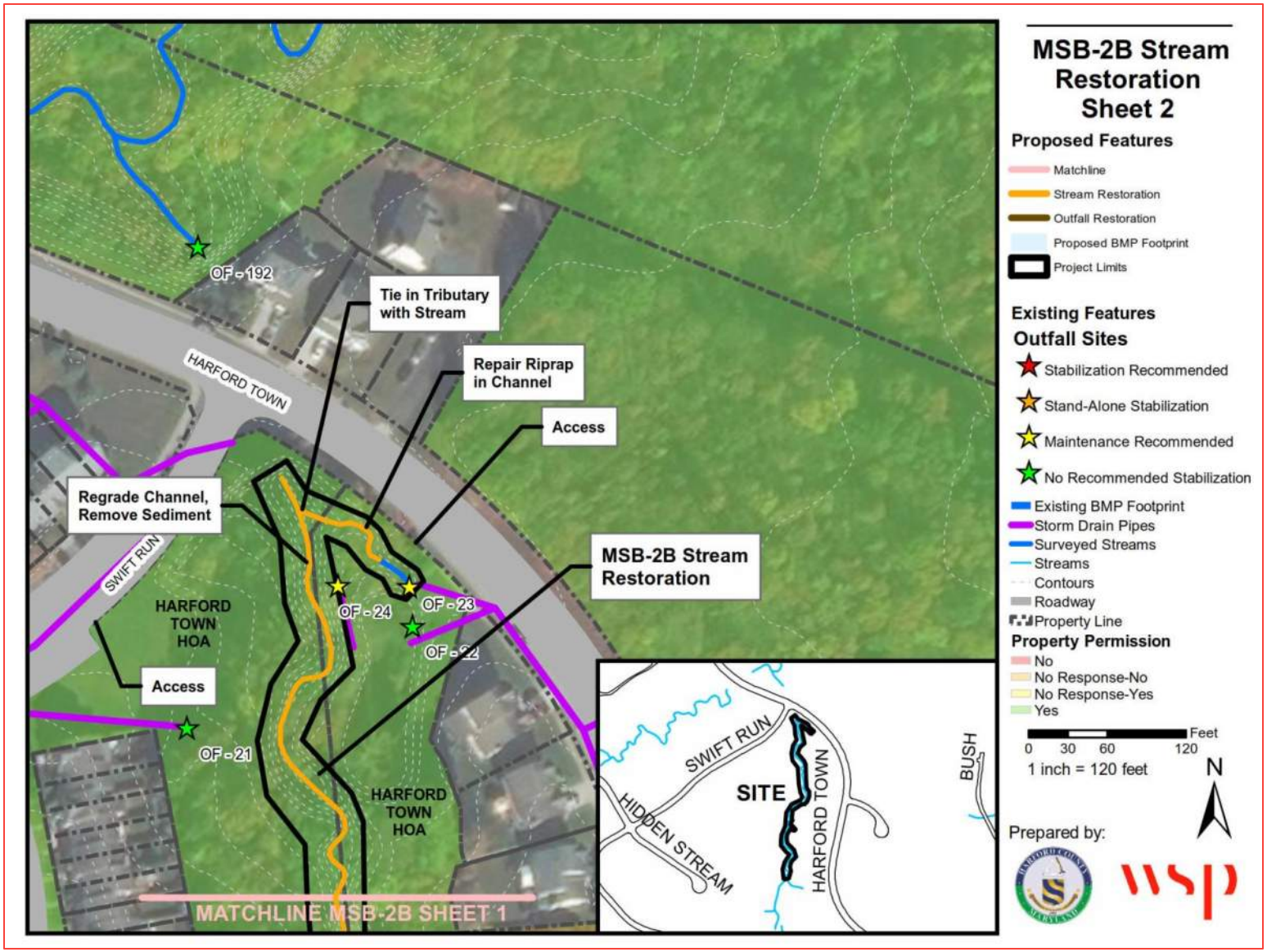

Figure C-9: Site Location and Proposed Project Plan for MSB-2B Stream Restoration (Sheet 2 of 2)

MSB-2C OUTFALL RESTORATION

Project Description	Stabilize 55 feet of channel at Outfall 17
Location	Swift Run Drive and Hidden Stream Drive
Property Ownership	One private property
Length of Project	55 feet of outfall stabilization
Potential Impervious Acres Treated	0.55 Acres
Potential Load Reductions TP	N/A
Potential Load Reductions TN	N/A
Potential Load Reductions TSS	N/A
Estimated Design/Construction Costs	$50,000 $90,909/impervious acres treated
Adjacent Projects	None

Site Description

The upstream limit of MSB-2C is located between Swift Run Court and Hidden Stream Drive. It proposes a stand-alone stabilization of Outfall 17 which receives discharge from the southeastern portion of the Hidden Stream community. The outfall consists of a 30-inch diameter RCP pipe and a concrete end section. Both the outfall pipe and end section are in good condition (Figure C-10). The outfall channel protection is comprised of riprap and extends approximately 55 feet until the channel's confluence with its receiving stream. A 4-foot headcut is located 30 feet downstream of the end section, where the riprap protection has been pushed downstream, leaving exposed geotextile. Downstream of the headcut, there is an additional exposed, 6-inch underdrain PVC pipe, surrounded by eroded, bare earth where geotextile and riprap have been disturbed, which is visible from the receiving stream channel (Figure C-11).

Figure C-10: Upstream view of OF-17 pipe and structure (left); Downstream view of OF-17 channel (right)

Figure C-11: Headcut and exposed geotextile (left). Outfall 17 confluence with stream (right).

Recommended Restoration Actions

- **Outfall Stabilization:**
    - *Outfall 17:* Fill in sediment basin, install plunge pool, grade channel towards stream, and line with riprap protection.
- Proposed project limits are shown in Figure C-12.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are two private property owners along this reach and coordinating buy in from them at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Hidden Stream Homeowners Association Inc.
- Private: 3724 Swift Run Court
- Private: 3726 Swift Run Court

Access

Good Access between 3724 Swift Run Court and 3726 Swift Run Court for outfall stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-8. The construction of 55 linear feet of outfall stabilization in this project will treat 0.55 impervious acres within the watershed. This treatment amount accounts for approximately 0.04% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $50,000 for the MSB-2C Outfall Restoration project. This cost estimate includes one medium outfall stabilization project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-9.

Table C-8: Summary of Improvements for MSB-2C Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-17	10	3.23	55	0.55	-	-	-
Stream								
Total Credit/ Reductions				**55**	**0.55**	**-**	**-**	**-**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-9: Summary of Project Costs for MSB-2C Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-17	Medium	$50,000	Project	$50,000	
Stream						
Total Costs					**$50,000**	**$90,909**

*Project cost divided by stream restoration impervious area treated

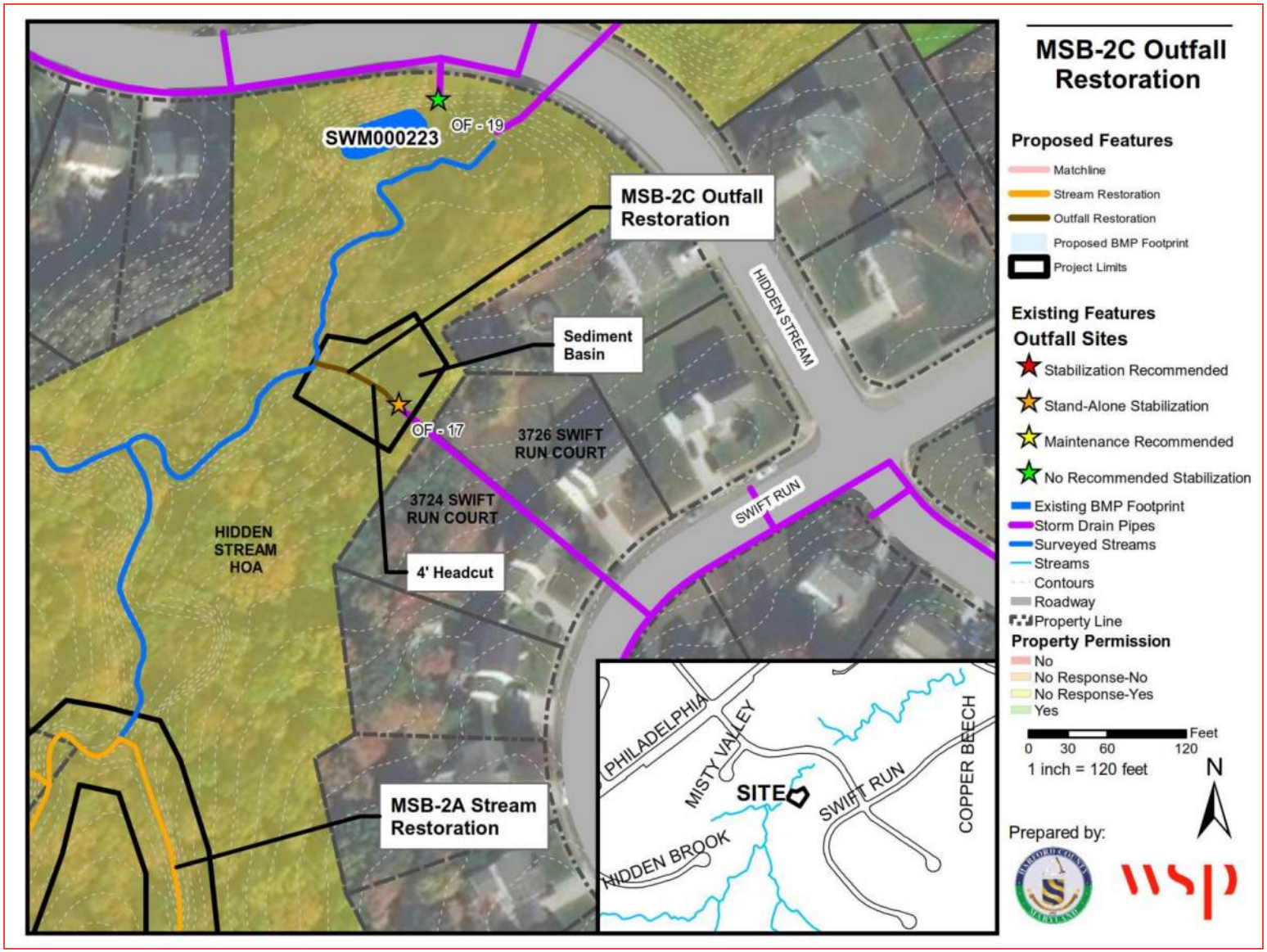

Figure C-12: Site Location and Proposed Project Plan for MSB-2C Outfall Restoration

MSB-4A STREAM RESTORATION

Project Description	Restore 2,385 feet of stream
Location	Royal Oak Drive to Hunters Run Drive
Property Ownership	16 Private Properties
Length of Project	Restore 2,385 feet of stream restoration
Potential Impervious Acres Treated	71.54 Ac
Potential Load Reductions TP	162.16 lbs/yr
Potential Load Reductions TN	178.85 lbs/yr
Potential Load Reductions TSS	107,070 lbs/yr
Estimated Design/Construction Costs	$1,560,250 $21,809/impervious acres treated
Adjacent Projects	MSB-4B Stream Restoration

Site Description

MSB-4A consists of two main stem stream segments and one tributary. The main stem is split by Bright Oaks Road. The tributary flows into the main stem (segment 2) reach approximately 500 feet downstream of outfalls 71 and 168. In addition to the stream restoration, two outfalls are recommended for maintenance.

MSB-4A, Segment 1, is located south of Whitney Ln and North of Rainier Ave, running parallel to the road. It contains 1,190 feet of proposed stream restoration and four outfalls, two of which are proposed for maintenance (Figure C-13). Outfall 66 and Outfall 68 are both 15-inch CMP pipes with concrete endwalls. Outfall 68 is located 450 feet downstream of the beginning of MSB-4A, Segment 1. The end pipe and endwall are both hovering over the stream channel a couple of feet. The concrete outfall protection has broken away from the endwall. Outfall 66 is located an additional 500 feet downstream of Outfall 68. The structure and endwall is in good condition; however, flow exits the pipe and flows under the concrete channel protection.

Figure C-13: Outfalls proposed for maintenance, OF-66 (left); and Outfall 68 (right)

Along the right bank there are three 4 in PVC diameter downspout pipes. Approximately 360 feet downstream of the start of MSB-4A, there is a debris jam that is too high to allow fish passage (Figure C-14). The last 760 feet of the left bank have an inadequate buffer of only shrubs and small trees.

Figure C-14: Debris jam/fish barrier

At the beginning of MSB-4A, Segment 1 reach, there is over 100 feet of minor erosion containing average exposed banks of 2 feet (Figure C-15, left). The last 858 feet of stream have average exposed bank heights of 4 feet (Figure C-15, right).

Figure C-15: Minor erosion on left bank (left) and moderate erosion on right bank (right).

MSB-4A, Segment 2 is located between Bright Oaks Drive and Hunters Run Drive. It contains 648 feet of proposed stream restoration with a tributary flowing into the main stem approximately 430 downstream of outfall 71. Outfall 71 conveys perennial flow. The channel has eroded and the outfall protection failed in two spots creating 5-foot and 6-foot headcuts (Figure C-16).

Figure C-16: Looking upstream at Outfall 71 (left); Looking upstream to Outfall 71, failed outfall protection (right).

The tributary has moderately eroded banks containing average exposed bank heights of 5 feet. After the confluence, moderate erosion continues with average exposed bank heights of 6 feet (Figure C-17, left). The left bank changes to severe erosion and has average exposed bank heights of 5 feet. (Figure C-17, right).

Figure C-17: Moderate erosion on the right bank downstream of the confluence (left); Moderate bank erosion on right bank further downstream (right)

<u>Recommended Restoration Actions</u>

- **Stream Restoration**
  - *MSB-4A, Segment 1*: 1,190 feet between Outfall 70 and Bright Oaks Drive.
  - *MSB-4A, Segment 2*: 430 feet from approximately 97 feet downstream of Outfall 71 and Outfall 168 and confluence with the tributary. An additional 218 feet from the confluence to end of restoration.
  - *MSB-4A, Tributary*: 547 feet between approximately 60 feet downstream of Outfall 60 confluence with Main Stem Segment 2.

- **Outfall Maintenance**
    - *Outfall 66*: Remove 4 feet of concrete outfall protection in order to properly implement adjacent stream restoration
    - *Outfall 68*: Replace last outfall pipe segment and endwall
- Proposed project limits are shown in Figure C-18, Figure C-19, and Figure C-20.

Threats to Infrastructure

- There are no current threats to infrastructure within the project area.

Property Ownership

There are numerous private property owners along this reach. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: LLC: Art Builders Inc.
- Private: 2052 Whitney Lane
- Private: 2054 Whitney Lane
- Private: 2056 Whitney Lane
- Private: 2058 Whitney Lane
- Private: 2060 Whitney Lane
- Private: 2062 Whitney Lane
- Private: 2066 Whitney Lane
- Private: 2068 Whitney Lane
- Private: 2070 Whitney Lane
- Private: 224 Bright Oaks Drive
- Private: 2067 Rainier Avenue
- Private: 2065 Rainier Avenue
- Private: HOA, Hunter's Run Community Association Inc.
- Private: 303 Bright Oaks Drive

Access

- Good Access off Royal Oak Drive at Outfalls 69 and 70 for MSB-4A, Segment 1 stream restoration.
- Good Access at the intersection of Whitney Lane and Bright Oaks Drive for MSB-4A, Segment 1 stream restoration.
- Good Access off Hunters Run Drive at Outfalls 64 and 67 for MSB-4A, Segment 2 and tributary stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-10. The construction of 2,385 linear feet of stream restoration in this project will treat 71.54 impervious acres within the watershed. This treatment amount accounts for approximately 5.4% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,560,250 for the MSB-4A Stream Restoration project. This cost estimate includes two outfall maintenance projects as well as a medium stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-11.

Table C-10: Summary of Improvements for MSB-4A Stream Restoration

PROJECT TYPE	PROJECT NUMBER	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance	OF- 66	-	-	-	-	-	-	-
	OF-68	-	-	-	-	-	-	-
Outfall								
Stream	MSB-4A	178.08	48.60	2,385	71.54	178.85	162.16	107,070
Total Credit/ Reductions				**2,385**	**71.54**	**178.85**	**162.16**	**107,070**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions equal restoration length times 44.9 lbs/ft/yr

Table C-11: Summary of Project Costs for MSB-4A Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Impervious Removal						
Outfall Maintenance	OF- 66	Small	$5,000	Project	$5,000	
	OF-68	Small	$5,000	Project	$5,000	
Outfall						
Stream	MSB-4A	Medium	$650	L.F.	$1,550,250	$21,670
Total Costs					**$1,560,250**	**$21,809**

*Project cost divided by stream restoration impervious area treated

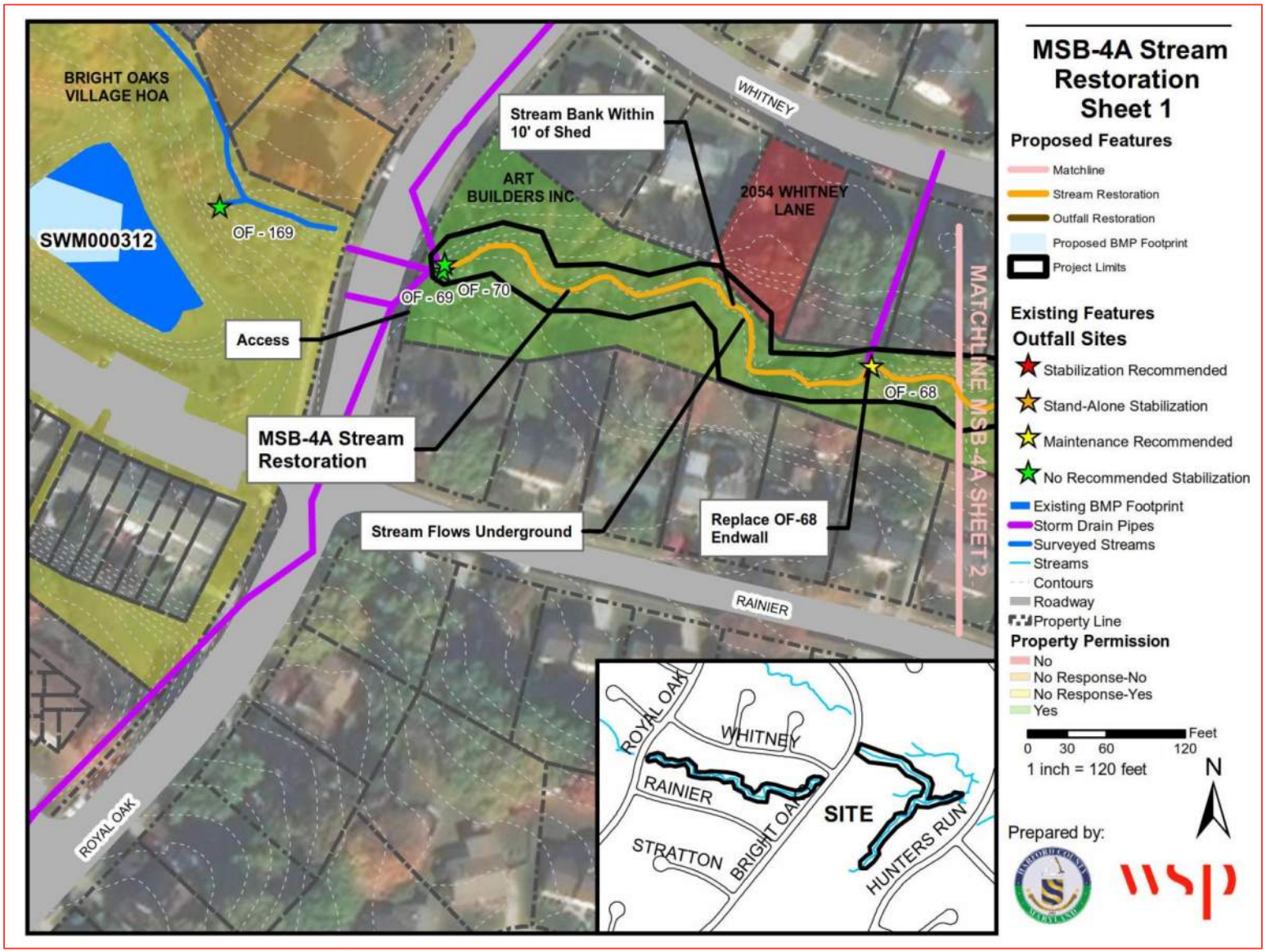

Figure C-18: Site Location and Proposed Project Plan for MSB-4A Stream Restoration (Sheet 1 of 3)

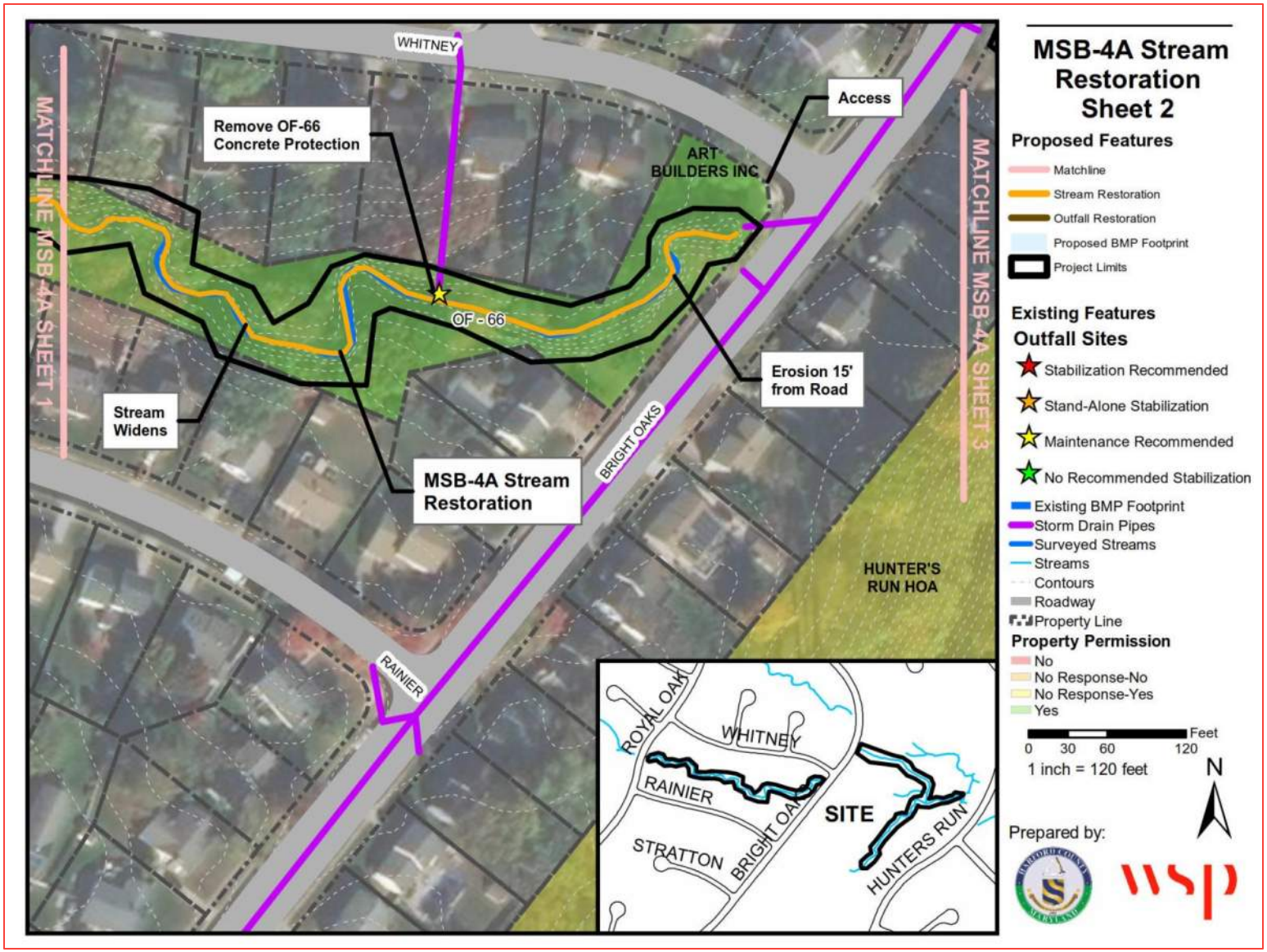

Figure C-19: Site Location and Proposed Plan for MSB-4A Stream Restoration (Sheet 2 of 3)

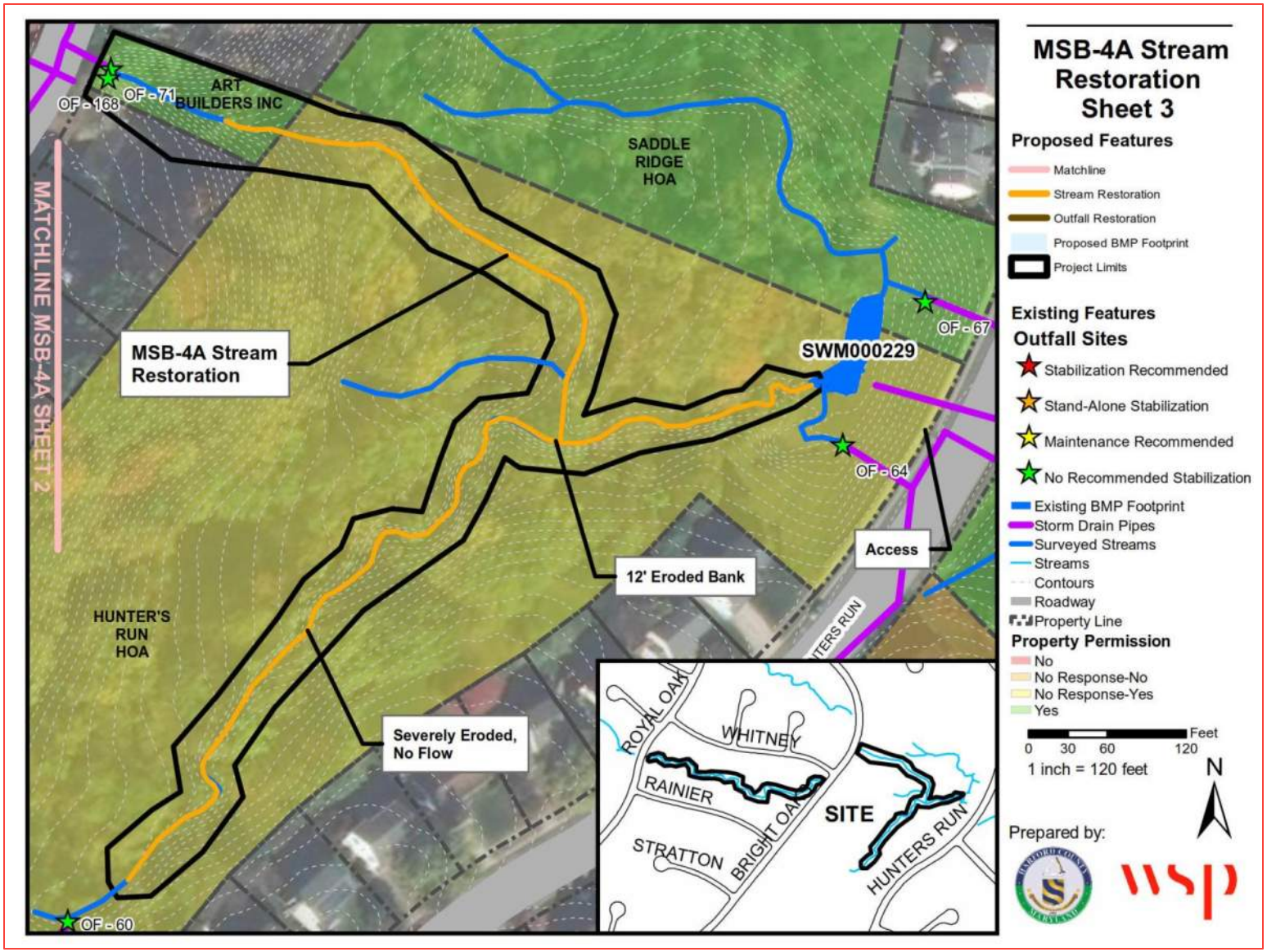

Figure C-20: Site Location and Proposed Plan for MSB-4A Stream Restoration (Sheet 3 of 3)

MSB-4B STREAM AND OUTFALL RESTORATION

Project Description	Restore 2,440 feet of stream, and stabilize 95 feet of channel at Outfall 58
Location	605 Wheel Road
Property Ownership	One Harford County Property and Seven Private Properties
Length of Project	2,440 feet of stream restoration and 95 feet of outfall stabilization
Potential Impervious Acres Treated	74.16 Acres
Potential Load Reductions TP	165.92 lbs/yr
Potential Load Reductions TN	183.00 lbs/yr
Potential Load Reductions TSS	109,556 lbs/yr
Estimated Design/Construction Costs	$1,686,000 $22,735/impervious acres treated
Adjacent Projects	None

Site Description

MSB-4B consists of 2 stream segments, for a total of 2,440 feet of stream restoration. MSB-4B, Segment 1, is located south of Gelding way and contains 1,304 feet of proposed stream restoration and two outfalls. One outfall, Outfall 58, is proposed for stabilization. The first 840 feet of the stream have average eroded bank heights of 4 feet. (Figure C-21, left). The remaining 280 ft of MSB-4B, Segment 1, becomes more eroded, with average exposed bank heights of 6 feet (Figure C-21, right). There is a 100-foot section of stream downstream of the project area that is stable before it ties into MSB-4B, Segment 2. The stable portion of the reach conveys flow to a culvert under East Wheel Road.

Figure C-21: Severe erosion on the right bank (left); Moderate erosion on the right bank further downstream (right).

Outfall 58 enters the stream on the right bank approximately 800 feet downstream of the beginning of the project. The metal apron has begun to rust and the outfall channel is steep and severely eroded (Figure C-22, left). The original outfall channel is lined in riprap. At some point, the outfall channel eroded to the west, forming a new channel for approximately 85 feet. The new channel is actively eroding

and does not have riprap protection (Figure C-22, right). The new channel and original channel converge approximately 70 feet downstream of the outfall.

Figure C-22: Rusted apron at outfall 58 (left); Looking downstream from outfall towards erosion along new channel (right)

The next 100 feet of channel is steep and 20 feet wide. Boulders and riprap line the channel. This portion of the channel appears stable (Figure C-23, left). Approximately 185 feet downstream of the outfall, the riprap channel ends, the ground levels out, and the channel becomes undefined. From the outfall to this location is about a 45-foot elevation change. Twenty feet further downstream is a 36-inch HDPE pipe that may have been installed and left in place during construction (Figure C-23, right). The pipe conveys flow parallel to the stream for 150 feet before it outfalls to the stream channel. The outfall of this 36-inch pipe is just downstream of a sewer manhole structure along the stream bank.

Figure C-23: Stable, riprap lined steep channel, Outfall 58 (left); 36-inch HDPE pipe downstream of Outfall 58 (right).

MSB-4B, Segment 2, runs parallel to Wheel Rd and contains 1,136 feet of proposed stream restoration and no outfalls. This stream segment receives flow from MSB-4B, Segment 1, after it flows under East Wheel Road as well as the stream that runs parallel to Wheel Road. The 460 feet of stream upstream of the confluence with MSB-4B, Segment 1, is severely eroded. One stream bend has a 20' high eroded stream

bank (Figure C-24, left). In other areas of this stream reach, stream banks are consistently over 7 feet high (Figure C-24, right).

Figure C-24: Severe erosion on the right bank (left); Severe erosion on the left bank (right)

Approximately 170 feet downstream from the start of the second segment, there is a downed tree causing a debris jam (Figure C-25, left). At the confluence of the main stem and MSB-4B, Segment 1, there is significant erosion on the left bank, deposition occurring on the right bank, and a wide channel (Figure C-25, right).

Figure C-25: Upstream view of the debris jam (left); Wide channels and significant erosion at confluence. (right)

About 210 feet downstream of the confluence, there is a double-barrel, concrete culvert to convey flow under a community private driveway (Figure C-26). Upstream of the culvert, deposition of cobble stones and sediment has created a wide, shallow channel. Flows through this area are causing several of the lower gabion baskets on the right bank to fail. Scouring is occurring next to the right culvert. Downstream of the culvert, the gabion baskets are collapsing, and the banks are beginning to erode.

Figure C-26: Upstream (left) and downstream (right) of driveway culvert, illustrating the failing gabion baskets.

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-4B, Segment 1*: 1,304 feet from 690 feet downstream of Outfall 63 to approximately 100 feet upstream of Wheel Road.
  - *MSB-4B, Segment 2:* 1,136 feet from 455 feet upstream of the confluence with MSB-4B, Segment 1 under Wheel Rd to 67 feet upstream of the Bynum Run confluence.
- **Outfall Stabilization**
  - *Outfall 58:* 95 feet of stabilization; remove existing 36-inch HDPE pipe, add two drop structures at outfall, grade outfall channel, and line channel with riprap.
- Proposed project limits are shown in Figure C-27, Figure C-28, Figure C-29, and Figure C-30.

Threats to Infrastructure

- There are multiple sewer and water utility crossings through the project area. The sections of erosion threaten to expose these utilities to damage once uncovered and made vulnerable to debris.

Property Ownership

There are numerous private property owners along this reach. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Hunter's Run Community Association Inc.
- Private: HOA, Saddle Ridge Homeowners Association
- Private: 513 East Wheel Road
- Private: 603 East Wheel Road

- Private: 601 East Wheel Road
- Private: 605 East Wheel Road
- Private: 607 East Wheel Road
- Public: Harford County

Access

- Moderate Access at Open Space east of East Wheel Road for MSB-4B, Segment 1 stream restoration.
- Moderate Access within the storm drain easement between 2226 Kempton Park Circle and 2228 Kempton Park Circle for Outfall 58 stabilization.
- Good Access at private drive for 600 block of East Wheel Road for access to 605 East Wheel Road and Harford County property for MSB-4B, Segment 2 stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-12. One outfall stabilization project, totaling 95 linear feet is recommended alongside 2,440 linear feet of stream restoration. The construction of 2,440 linear feet of stream restoration and 95 feet of outfall stabilization in this project will treat 74.16 impervious acres within the watershed. This treatment amount accounts for approximately 5.6% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,686,000 for the MSB-4B Stream and Outfall Restoration project. This cost estimate includes one large outfall stabilization project and one medium stream restoration project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for the project is provided in Table C-13.

Table C-12: Summary of Improvements for MSB-4B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NUMBER	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-58	14.1	4.92	95	0.95	-	-	-
Stream	MSB-4B	632.16	143.98	2,440	73.21	183.00	165.92	109,556
Total Credit/ Reductions				**2,535**	**74.16**	**183.00**	**165.92**	**109,556**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-13. Summary of Project Costs for MSB-4B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-58	Large	$100,000	Project	$100,000	
Stream	MSB-4B	Medium	$650	L.F.	$1,586,000	$21,664
Total Costs					**$1,686,000**	**$22,735**

*Project cost divided by stream restoration impervious area treated

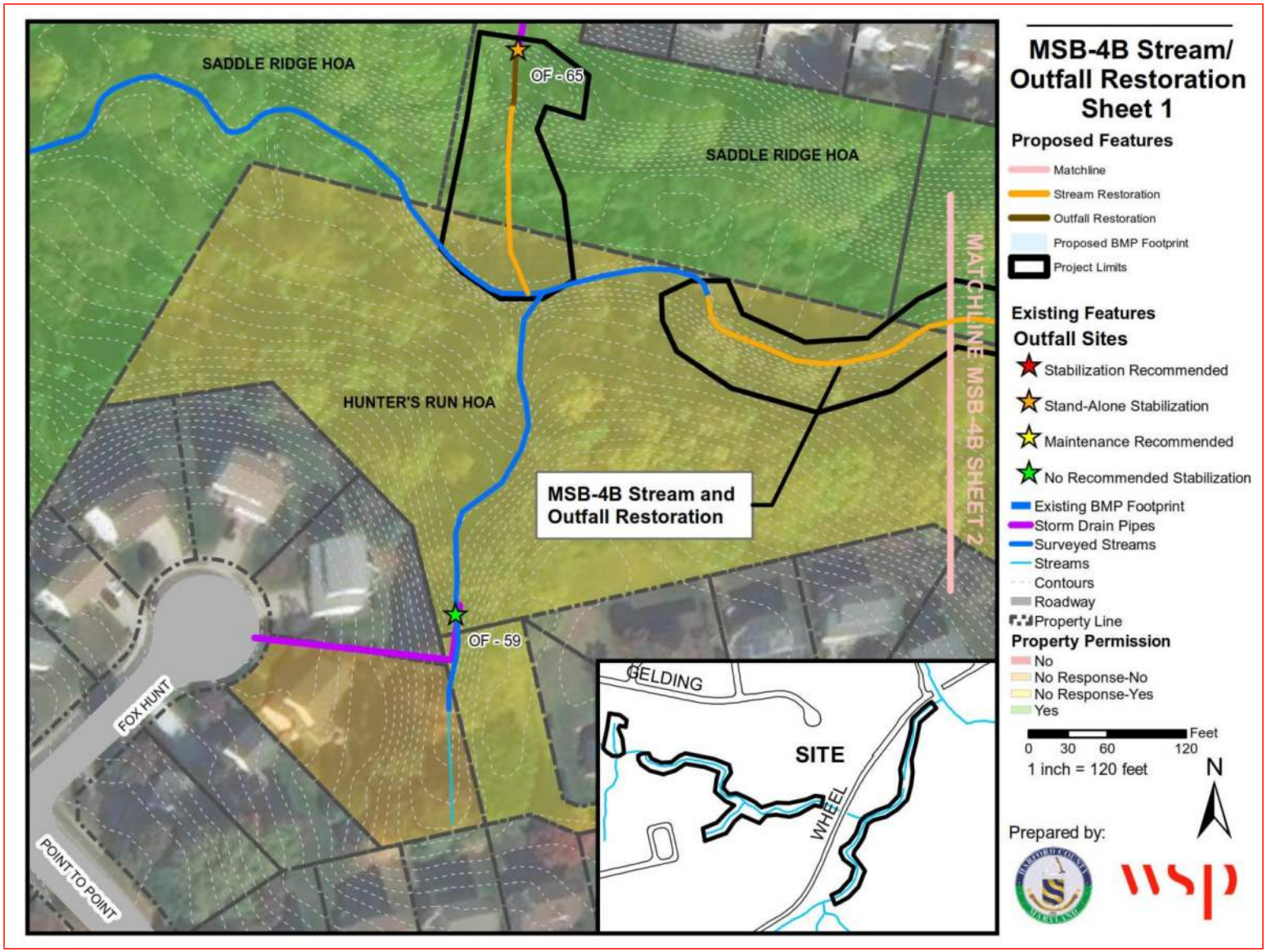

Figure C-27: Site Location and Proposed Project Plan for MSB-4B Stream and Outfall Restoration (Sheet 1 of 4)

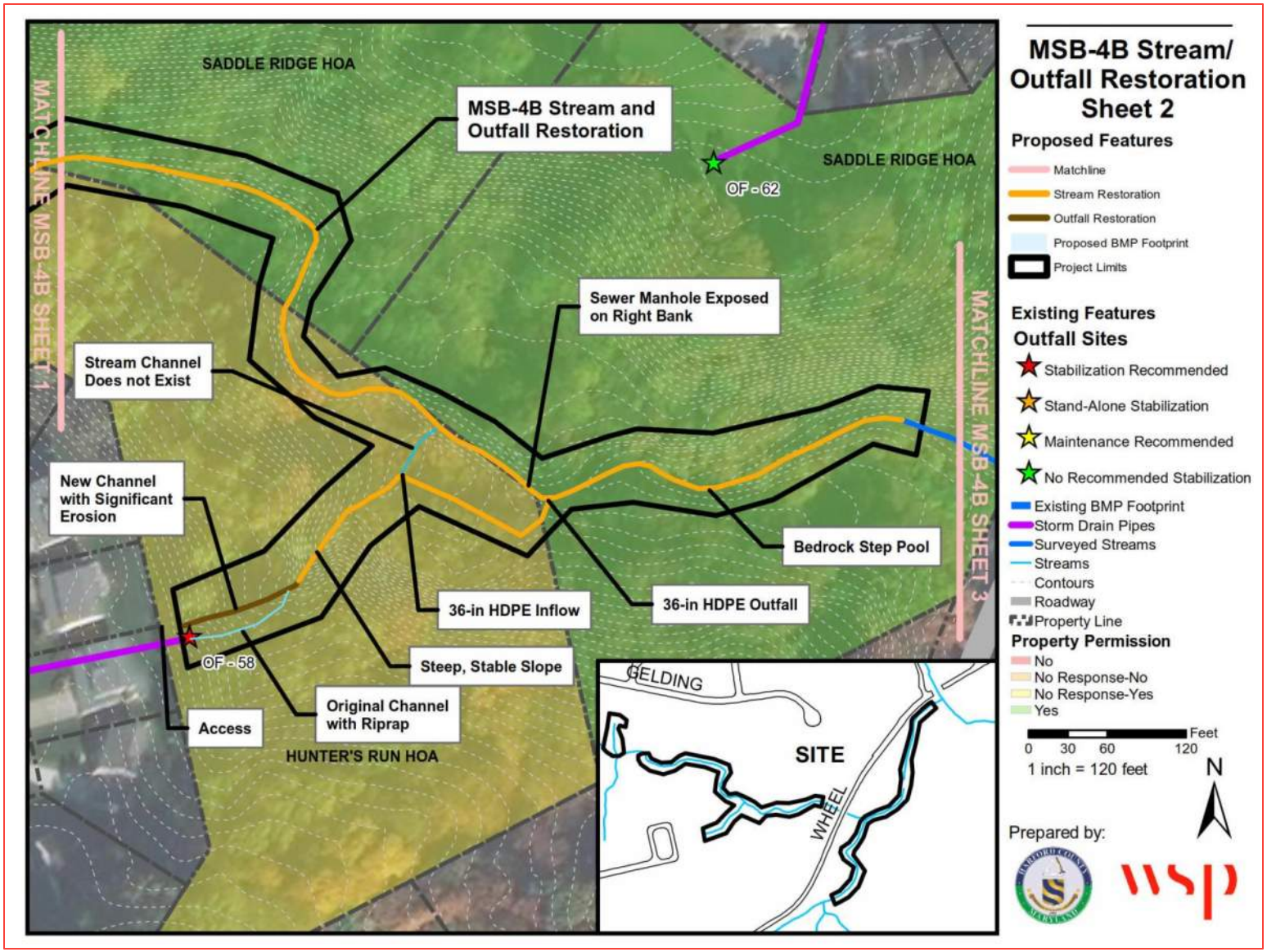

Figure C-28: Site Location and Proposed Project Plan for MSB-4B Stream and Outfall Restoration (Sheet 2 of 4)

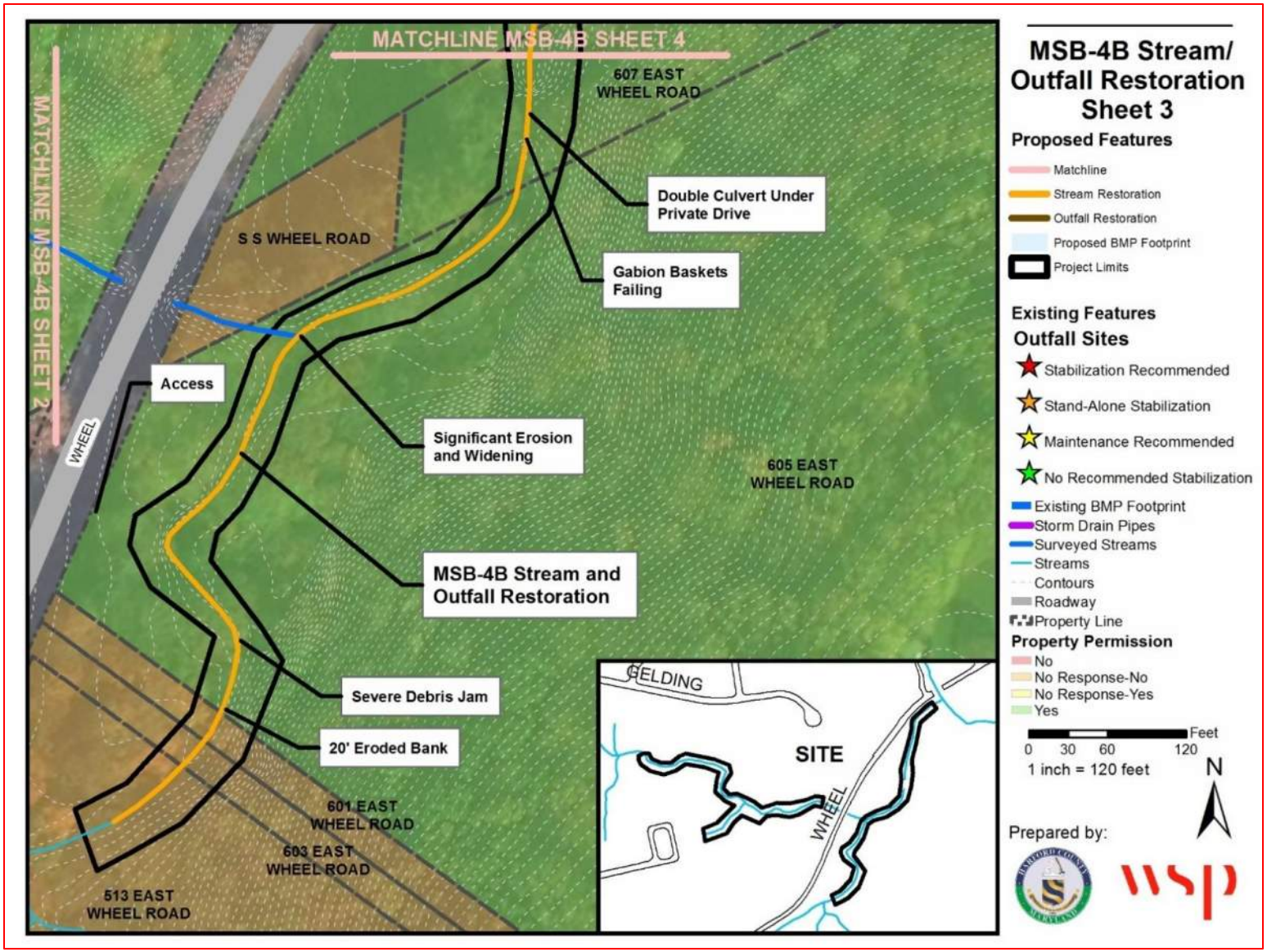

Figure C-29: Site Location and Proposed Project Plan for MSB-4B Stream and Outfall Restoration (Sheet 3 of 4)

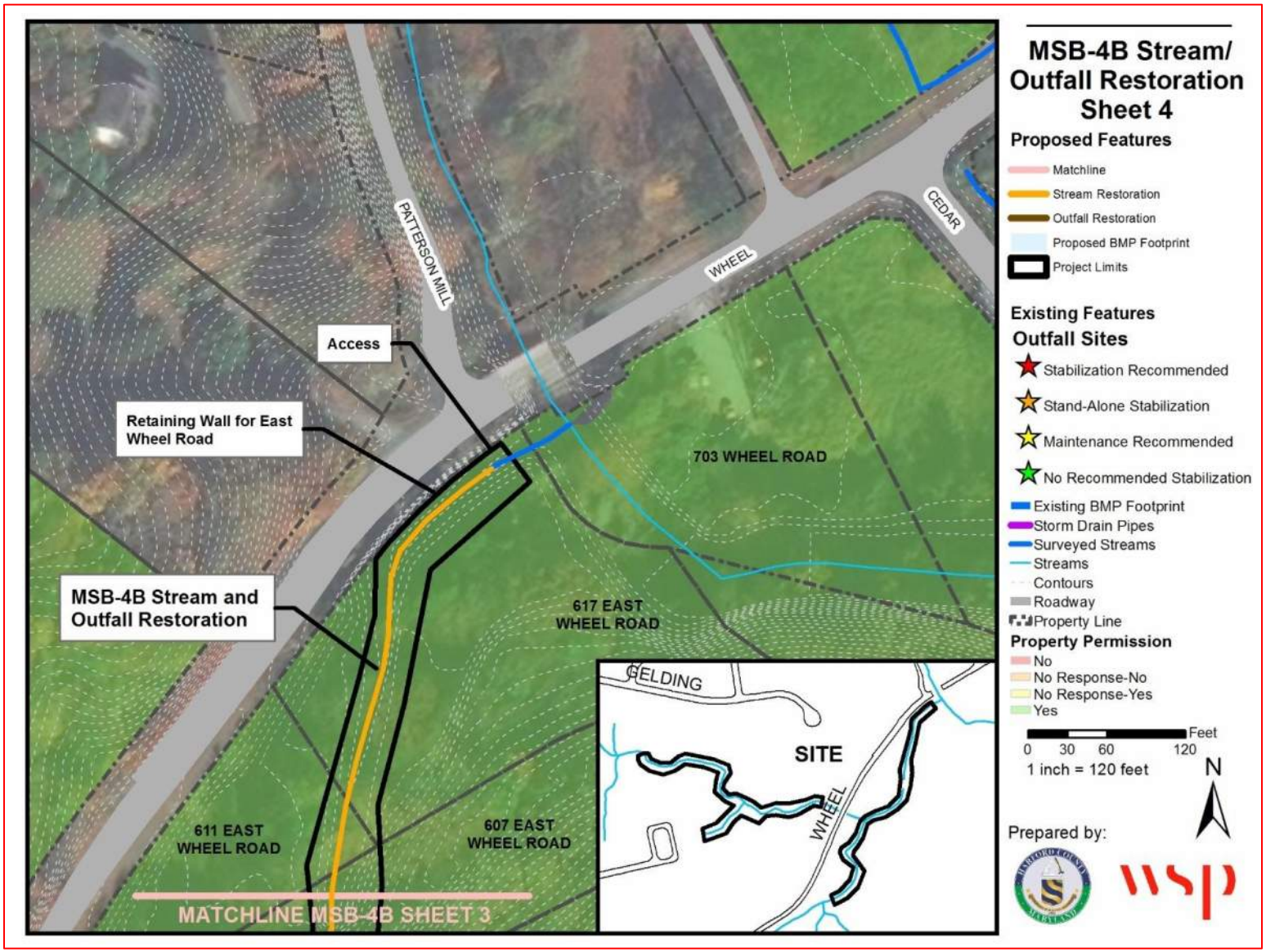

Figure C-30: Site Location and Proposed Project Plan for MSB-4B Stream and Outfall Restoration (Sheet 4 of 4)

MSB-4C STREAM RESTORATION

Project Description	Restore 1,296 feet of stream
Location	824 E. Wheel Rd to 818 E. Wheel Rd
Property Ownership	Five Private Properties
Length of Project	1,296 feet of stream restoration
Potential Impervious Acres Treated	38.89 Acres
Potential Load Reductions TP	88.15 lbs/yr
Potential Load Reductions TN	97.22 lbs/yr
Potential Load Reductions TSS	58,202 lbs/yr
Estimated Design/Construction Costs	$842,400 $21,661/impervious acres treated
Adjacent Projects	None

Site Description

MSB-4C runs parallel to East Wheel Road and contains 1,304 feet of proposed stream restoration and an outfall that is not recommended for stabilization or maintenance. At the beginning of MSB-4C, there is a bridge crossing with large boulders to protect the bank upstream (Figure C-31, left); however, there is no protection downstream where both banks have eroded. The first 1,043 feet of the left bank is severely eroded with average exposed bank heights of 4 feet (Figure C-31, right).

Figure C-31: Upstream view of the bridge (left); Severe erosion on the left bank (right)

The final 111 feet of the left bank has low severity erosion with an average exposed bank height of 3 feet. There are a couple of stream bends that are in close proximity to the road and are experiencing active erosion. Riprap from a previously stabilized stream bank, next to East Wheel Road, has been washed downstream (Figure C-32, left). Further downstream, a debris jam has caused sediment to accumulate in a stream bend (Figure C-32, right).

Figure C-32: Eroding banks within close proximity to the road creating a threat to infrastructure (left); Downstream view of the debris jam (right)

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-4C*: 1,296 feet from 162 upstream of Outfall 166 to 128 feet upstream of Outfall 165.
- Proposed project limits are shown in Figure C-33 and Figure C-34.

Threats to Infrastructure

- Erosion along outside bend of the stream channel is currently encroaching on East Wheel Road. If this erosion continues it could make the street vulnerable to collapse.

Property Ownership

There are multiple private property owners along this reach. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: LLC, 818 East Wheel Road
- Private: 820 East Wheel Road
- Private: 822 East Wheel Road
- Private: LLC, 824 East Wheel Road
- Private: 826 East Wheel Road

Access

- Good Access at 818 East Wheel Road for stream restoration.
- Good Access at 824 East Wheel Road, across private bridge, for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-14. This project recommends 1,296 linear feet of stream restoration. The construction of 1,296 linear feet of stream restoration in this project will treat 38.89 impervious acres within the watershed. This treatment amount accounts for approximately 2.9% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $842,400 for the MSB-4C Stream Restoration project. This cost estimate includes zero outfall stabilization projects and one medium stream restoration project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for the project is provided in Table C-15.

Table C-14: Summary of Improvements for MSB-4C Stream Restoration

PROJECT TYPE	PROJECT NUMBER	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-4C	154.51	15.93	1,296	38.89	97.22	88.15	58,202
Total Credit/ Reductions				**1,296**	**38.89**	**97.22**	**88.15**	**58,202**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-15: Summary of Project Costs for MSB-4C Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-4C	Medium	$650	L.F.	$842,400	$21,661
Total Costs					**$842,400**	**$21,661**

*Project cost divided by stream restoration impervious area treated

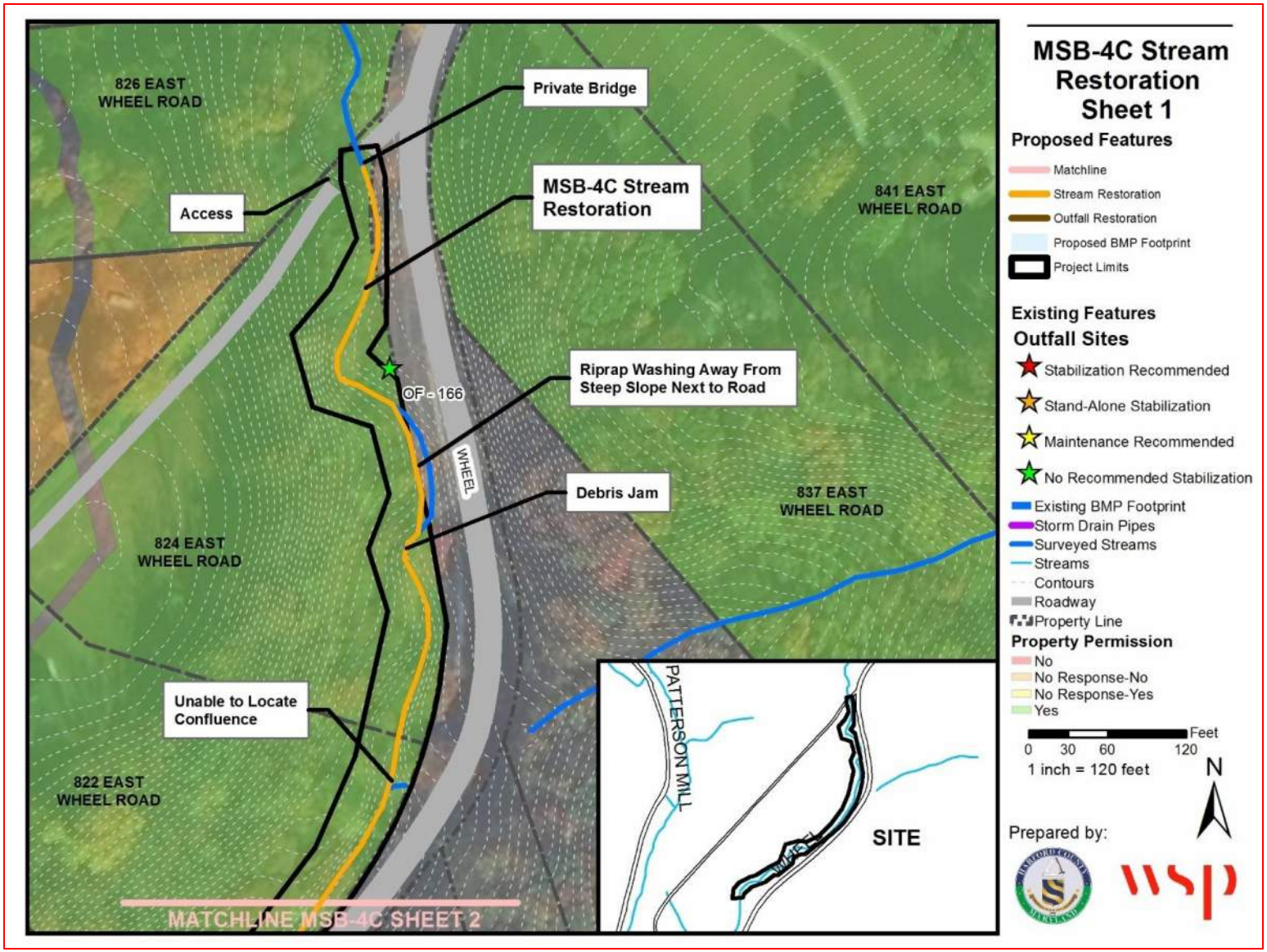

Figure C-33: Site Location and Proposed Project Plan for MSB-4C Stream Restoration (Sheet 1 of 2)

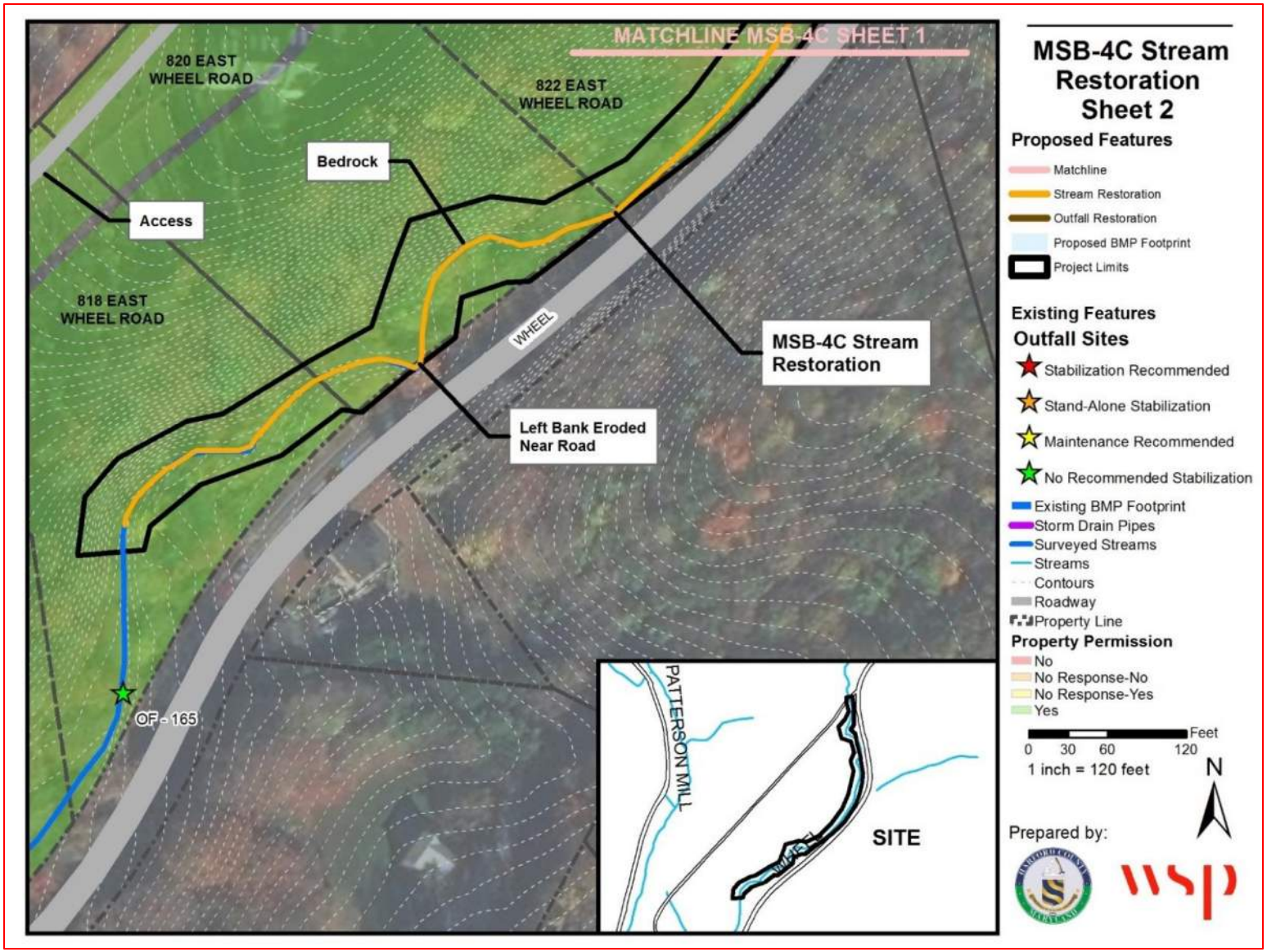

Figure C-34: Site Location and Proposed Project Plan for MSB-4C Stream Restoration (Sheet 2 of 2)

MSB-4D STREAM AND OUTFALL RESTORATION

Project Description	Restore 2,105 feet of stream and stabilize 100 feet of outfall channel • Outfall 44: Stabilize 10 feet • Outfall 51: Stabilize 90 feet
Location	Laurel Bush Road and East Wheel Road
Property Ownership	Three Private Properties
Length of Project	2,105 feet of stream restoration and 100 feet of outfall stabilization
Potential Impervious Acres Treated	64.15 Acres
Potential Load Reductions TP	143.14 lbs/yr
Potential Load Reductions TN	157.88 lbs/yr
Potential Load Reductions TSS	94,515 lbs/yr
Estimated Design/Construction Costs	$1,518,250 $23,667/impervious acres treated
Adjacent Projects	None

Site Description

MSB-4D is located northwest of East Wheel Rd and northeast of Laurel Bush Road. MSB-4D is 2,105 feet of proposed stream restoration and contains five outfalls, two of which are proposed for stabilization. The first 987 feet of MSB-4D is moderately eroded with average exposed bank heights of 5 feet. More severe erosion was seen in a few stream bends. In one instance, the stream bank was over 10 feet high, downstream of a cascading bedrock feature (Figure C-35, left).

Outfall 44 is located approximately 810 feet downstream and is a candidate for channel stabilization. The end of the pipe for this outfall could not be located; however, a hole was identified at the beginning of the outfall channel that is assumed to be the outfall (Figure C-35, right). This outfall is on the downstream side of the embankment for BMP SWM000066. The BMP has sediment covering the pond bottom, making it difficult to find the riser structure or dewatering device; however, Outfall 44 may be the outfall for the BMP. The outfall channel is eroding and will need to be stabilized.

Figure C-35: Moderate erosion on right bank with exposed bedrock in the stream channel (left); Hole assumed to be OF-44 (right).

The final 723 feet of stream has heavily eroded banks, with an average exposed bank height of 7 feet. Along with the severe erosion, there are 243 feet of inadequate buffer where lawns are mowed to the banks of the stream. There are two debris jams within MSB-4D, one being at the confluence of a tributary and the other in the middle of the stream. Lastly, there is a concrete dam with eroded banks and a scour hole (Figure C-36, left) and an exposed plastic sewer pipe (Figure C-36, right).

Figure C-36: Concrete dam with scour hole and eroded banks (left). Exposed plastic sewer pipe above bedrock on a moderately eroded bank (right).

Outfall 51 is located near the end of MSB-4D and is recommended for channel stabilization (Figure C-37, left). The flat outfall channel is lined with 30 feet of riprap before reaching a steep slope. Originally, the runoff was then piped approximately 100 feet down the steep slope by two 24-inch HDPE pipes. These pipes may have been installed and left in place during construction. At the original outfall of the two 24-inch HDPE pipes, the steep slope is lined with riprap before reaching the stream. Over time, flows eroded the channel under the 24-inch HDPE pipes, the pipes became disconnected and a new channel formed parallel to the original channel (Figure C-37, right). The outfall is approximately 35 feet higher than the stream bed.

Figure C-37: Outfall 51 (left); Outfall 51's eroding channel with broken HDPE pipe scattered throughout (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-4D, Main Stem*: 2,105 feet from Outfall 46 to 420 feet upstream of Outfall 167.
- **Outfall Stabilization**
  - *Outfall 44:* Replace end pipe and install riprap in channel
  - *Outfall 51:* Install drop structure to lower elevation of outfall, raise outfall channel, grade outfall channel to stream, and install riprap protection.
- Proposed project limits are shown in Figure C-38, Figure C-39, and Figure C-40.

Threats to Infrastructure

- The exposed sanitary sewer line with is exposed is threatened by continuous erosion in the channel undermining the surrounding soil stability and puncture by high flow debris.

Property Ownership

There are three private property owners along this reach and coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Hunter's Run Homeowner Association Inc.
- Private: HOA, Temple Hills Homeowner Association Inc.
- Private: 312 Wheel Road

Access

- Good Access at the corner of Point to Point Road and Laurel Bush Road for stream restoration.
- Good Access at 312 E. Wheel Road for stream restoration.

- Good Access at the storm drain easement between 313 Sedgefield Court and 315 Sedgefield Court for outfall stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-16. Two outfall stabilization projects, totaling 100 linear feet are recommended alongside 2,105 linear feet of stream restoration. The construction of 2,105 linear feet of stream restoration and 100 feet of outfall stabilization in this project will treat 62.13 impervious acres within the watershed. This treatment amount accounts for approximately 4.7% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,518,250 for the MSB-4D Stream and Outfall Restoration project. This cost estimate includes two outfall stabilization projects and one medium stream restoration project. The cost estimate for the project type is described in Appendix B. The cost estimate for the project is provided in Table C-17.

Table C-16: Summary of Improvements for MSB-4D Stream and Outfall Restoration

PROJECT TYPE	PROJECT NUMBER	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-44	6.3	2.6	10	0.1	-	-	-
	OF-51	17.43	6.48	90	0.90	-	-	-
Stream	MSB-4D	262.78	69.00	2,105	63.15	157.88	143.14	94,515
Total Credit/ Reductions				**2,205**	**64.15**	**157.88**	**143.14**	**94,515**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-17: Summary of Project Costs for MSB-4D Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-44	Medium	$50,000	Project	$50,000	
	OF-51	Large	$100,000	Project	$100,000	
Stream	MSB-4D	Medium	$650	L.F.	$1,368,250	$21,667
Total Costs					**$1,518,250**	**$23,667**

*Project cost divided by stream restoration impervious area treated

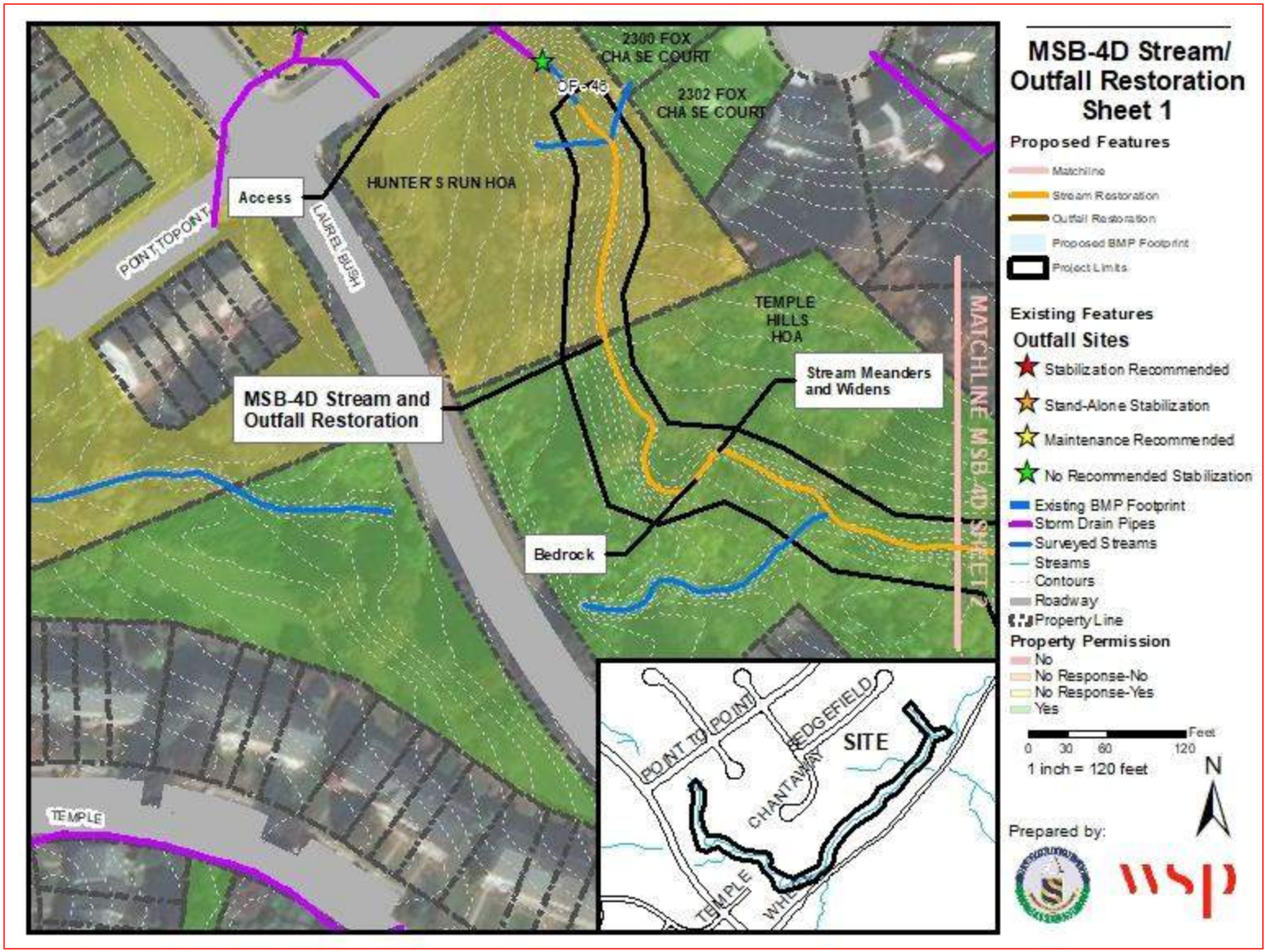

Figure C-38: Site Location and Proposed Project Plan for MSB-4D Stream and Outfall Restoration (Sheet 1 of 3)

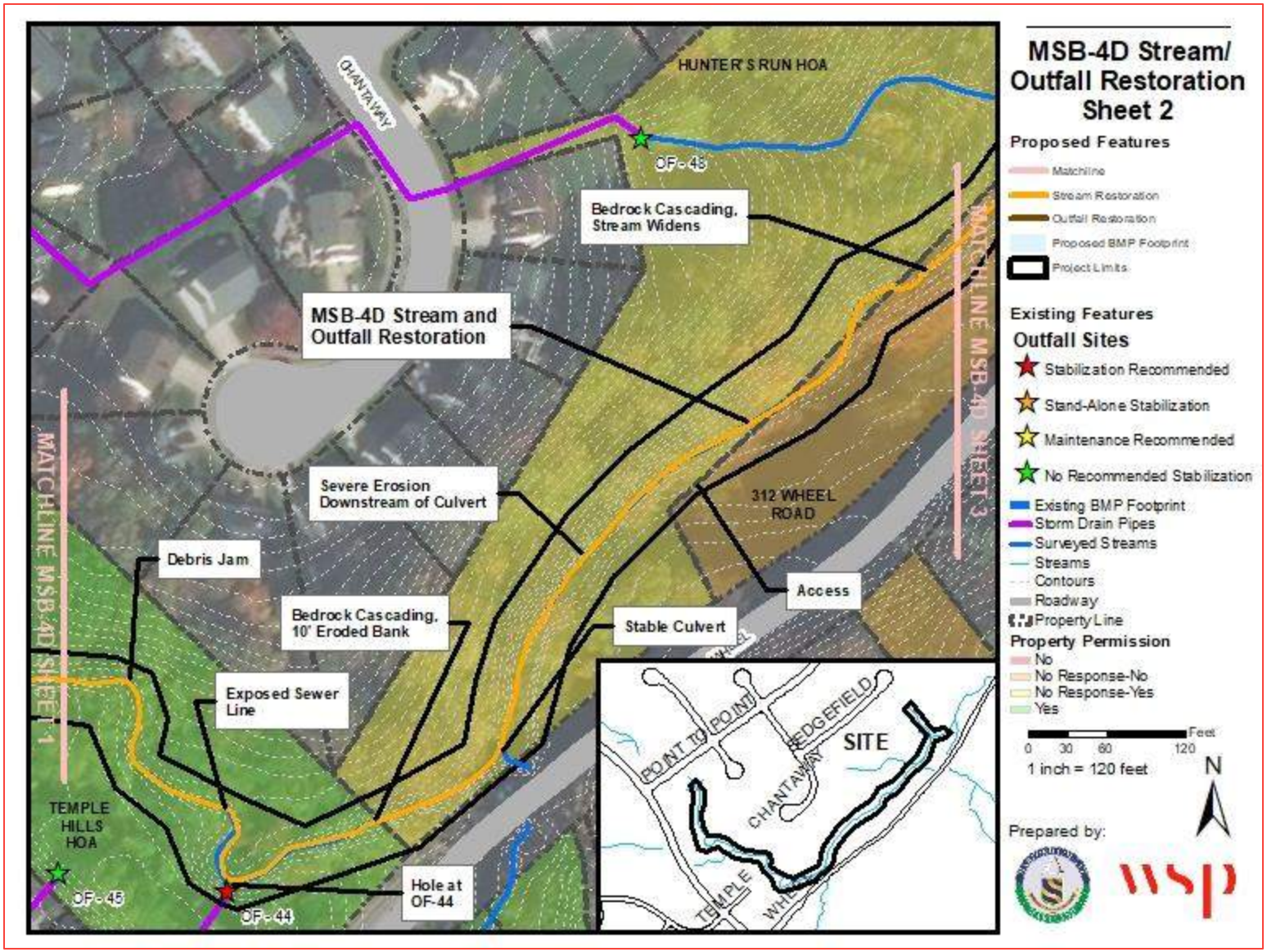

Figure C-39: Site Location and Proposed Project Plan for MSB-4D Stream and Outfall Restoration (Sheet 2 of 3)

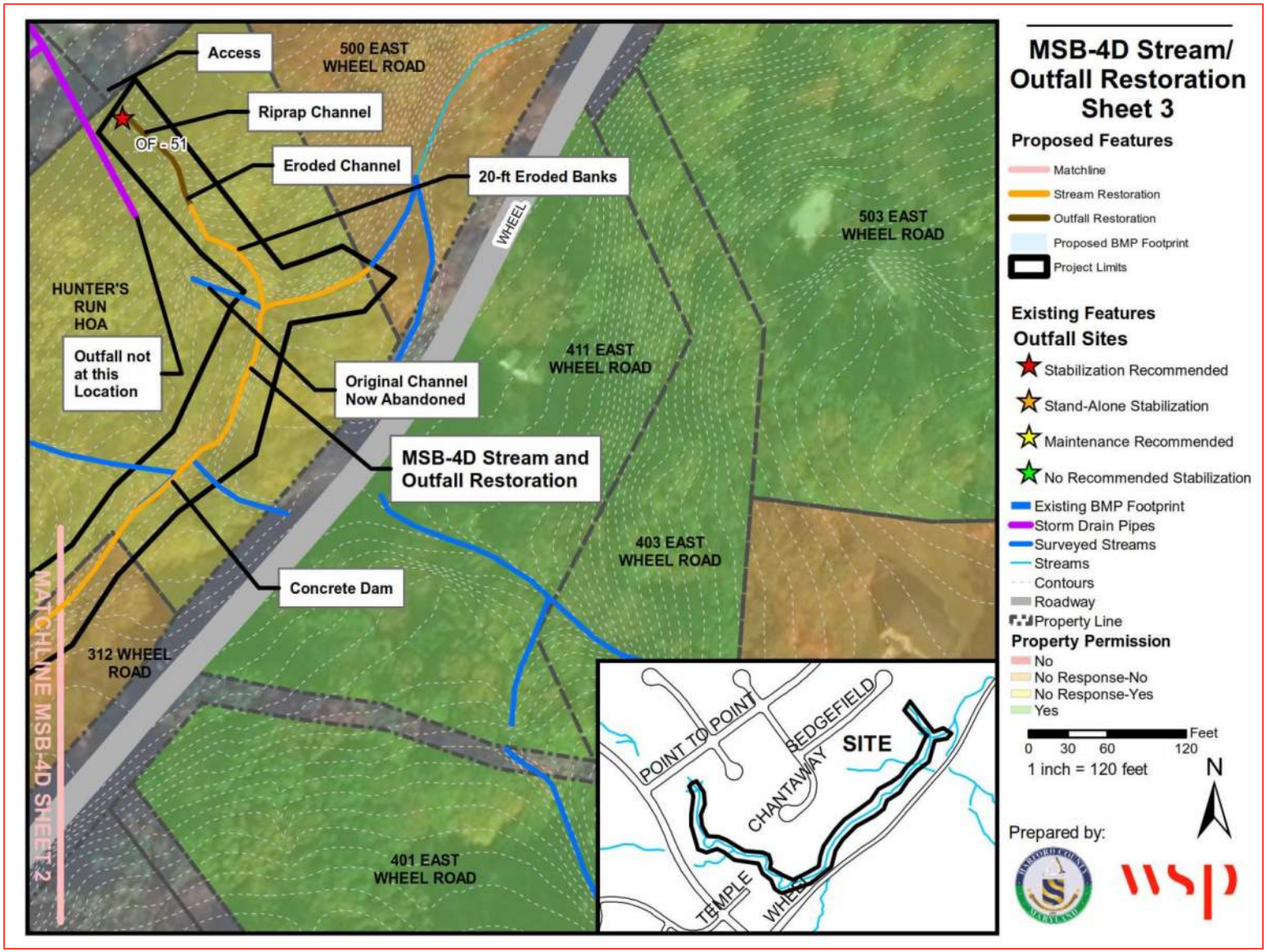

Figure C-40: Site Location and Proposed Project Plan for MSB-4D Stream and Outfall Restoration (Sheet 3 of 3)

MSB-4E STREAM AND OUTFALL RESTORATION

Project Description	Restore 3,325 feet of stream restoration and 12 feet of channel stabilization at Outfall 185
Location	Laurel Bush Road, North of Spruce Pine Road
Property Ownership	Three Private Properties
Length of Project	3,325 feet of stream restoration and 12 feet of outfall stabilization
Potential Impervious Acres Treated	99.87 Acres
Potential Load Reductions TP	226.11 lbs/yr
Potential Load Reductions TN	249.38 lbs/yr
Potential Load Reductions TSS	149,297 lbs/yr
Estimated Design/Construction Costs	$1,853,750 $18,562/impervious acres treated
Adjacent Projects	None

Site Description

MSB-4E is south of Lindsay Court and runs perpendicular to Laurel Bush Road. This project proposes 3,325 feet of stream restoration and the stabilization of outfall 185. The left and right banks are severely eroded for the entire length of the stream project with an average exposed bank height of 4 feet and in some areas, erosion is threatening a paved path (Figure C-41, left). Approximately, 900 feet of both banks have an inadequate buffer due to pasture and residential land use (Figure C-41, right).

Figure C-41: Severe erosion on the left bank's proximity to the paved path (left); Inadequate buffer on the right due to lawns (right)

BMP SWM000040 outfalls to the left bank of MSB-4E approximately 400 feet downstream of the start of the project and receives runoff from nearby neighborhoods. A gap in the embankment has been stabilized with geotextile material (Figure C-42). The outfall channel is approximately 100 feet long and is stable.

Figure C-42: BMP under construction.

A large debris jam has occurred approximately 1,200 feet downstream. Upstream of the debris jam, the stream has widened and is very shallow. Sediment and stone have accumulated behind the debris jam. The stream is narrower and deeper downstream of the debris jam (Figure C-43).

Figure C-43: Stream widening before debris jam constriction.

Outfall 185 is the outfall for an unnumbered BMP and is located northwest of Oat Grass Court. The outfall channel has eroded and caused undercutting of the outfall endwall (Figure C-44).

Figure C-44: Undercutting of Outfall 185 endwall.

Recommended Restoration Actions

- **Stream Restoration**
    - *MSB-4E*: 3,325 feet from Laurel Bush Road culvert to 77 feet upstream of the confluence with Lower Bynum Run

- **Outfall Stabilization**
    - Outfall 185: 12 feet of stabilization; raise the outfall channel, and install riprap protection
- Proposed project plans are shown in Figure C-45, Figure C-46, Figure C-47, Figure C-48, and Figure C-49.

Threats to Infrastructure

- There are currently 3 sanitary sewer crossings within the stream restoration limits.
- Recreation path crossing vulnerable to collapse with further bank erosion.

Property Ownership

There are multiple private property owners along this reach and coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

In addition, one of the outfalls is on MDOT SHA property. There is a potential partnering opportunity for this location.

- Public: MDOT SHA Property
- Private: HOA, Laurel Valley Homeowners Association Inc
- Private: LP, Toll MD VIII LP
- Private: HOA, Overview Estates Homeowners Association Inc

Access

- Good Access at HOA Open Space adjacent to 302 Spruce Pine Road for stream restoration.
- Good Access at BMP easement between 2756 Oat Grass Court and 2750 Oat Grass Court for stream restoration and outfall stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-18. One outfall stabilization project, totaling 12 linear feet is recommended alongside 3,325 linear feet of stream restoration. The construction of 3,325 linear feet of stream restoration and 12 feet of outfall stabilization in this project will treat 99.87 impervious acres within the watershed. This treatment amount accounts for approximately 7.6% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,853,750 for the MSB-4E Stream and Outfall Restoration project. This cost estimate includes one small outfall stabilization project as well as a large stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-19.

Table C-18: Summary of Improvements for MSB-4E Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-185	9.6	0.13	12	0.12	-	-	-
Stream	MSB-4E	415.68	105.06	3,325	99.75	249.38	226.11	149,297
Total Credit/ Reductions				**3,337**	**99.87**	**249.38**	**226.11**	**149,297**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-19: Summary of Project Costs for MSB-4E Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-185	Small	$25,000	Project	$25,000	
Stream	MSB-4E	Large	$550	L.F.	$1,828,750	$18,333
Total Costs					**$1,853,750**	**$18,562**

*Project cost divided by stream restoration impervious area treated

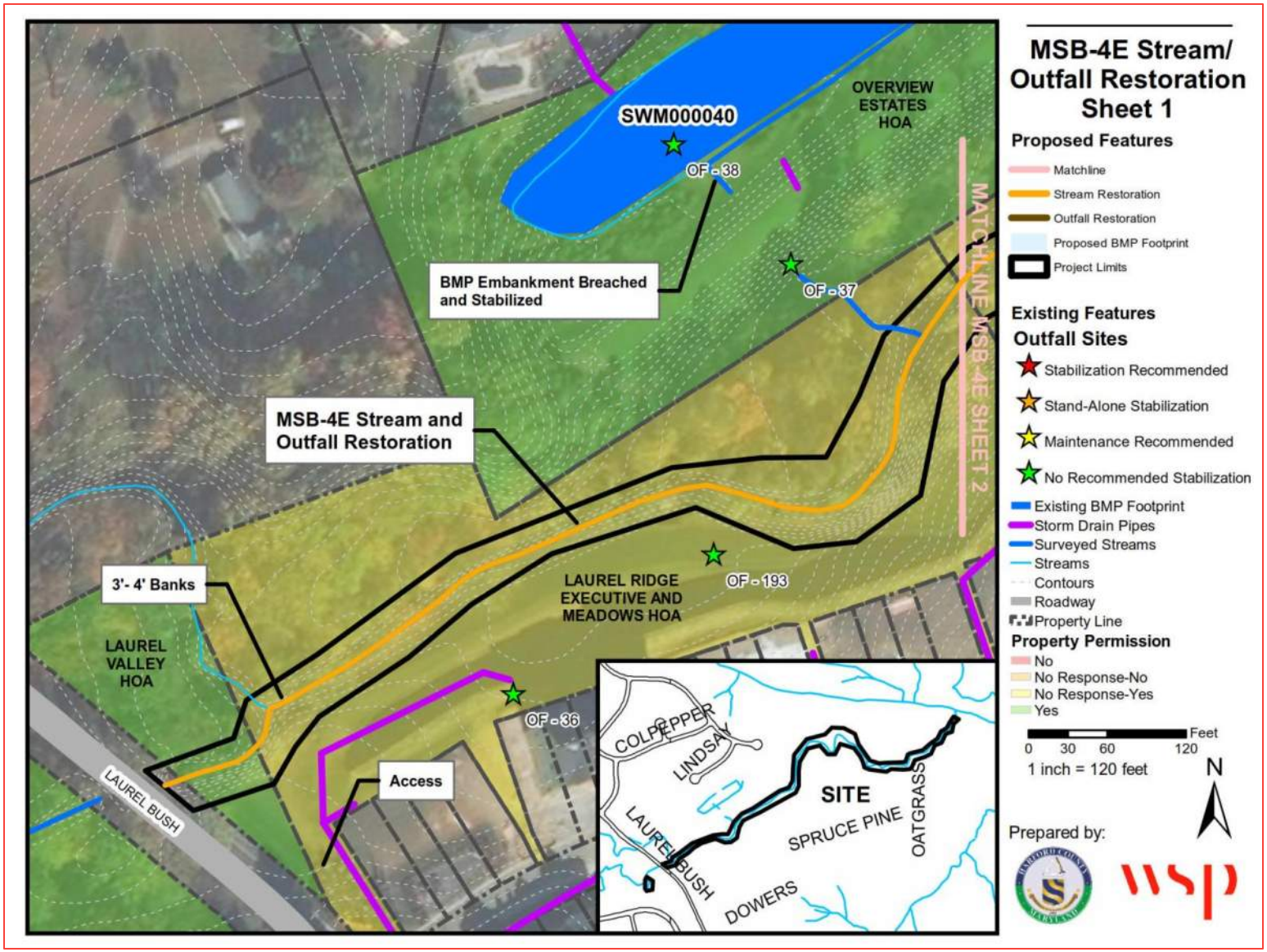

Figure C-45: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 1 of 5)

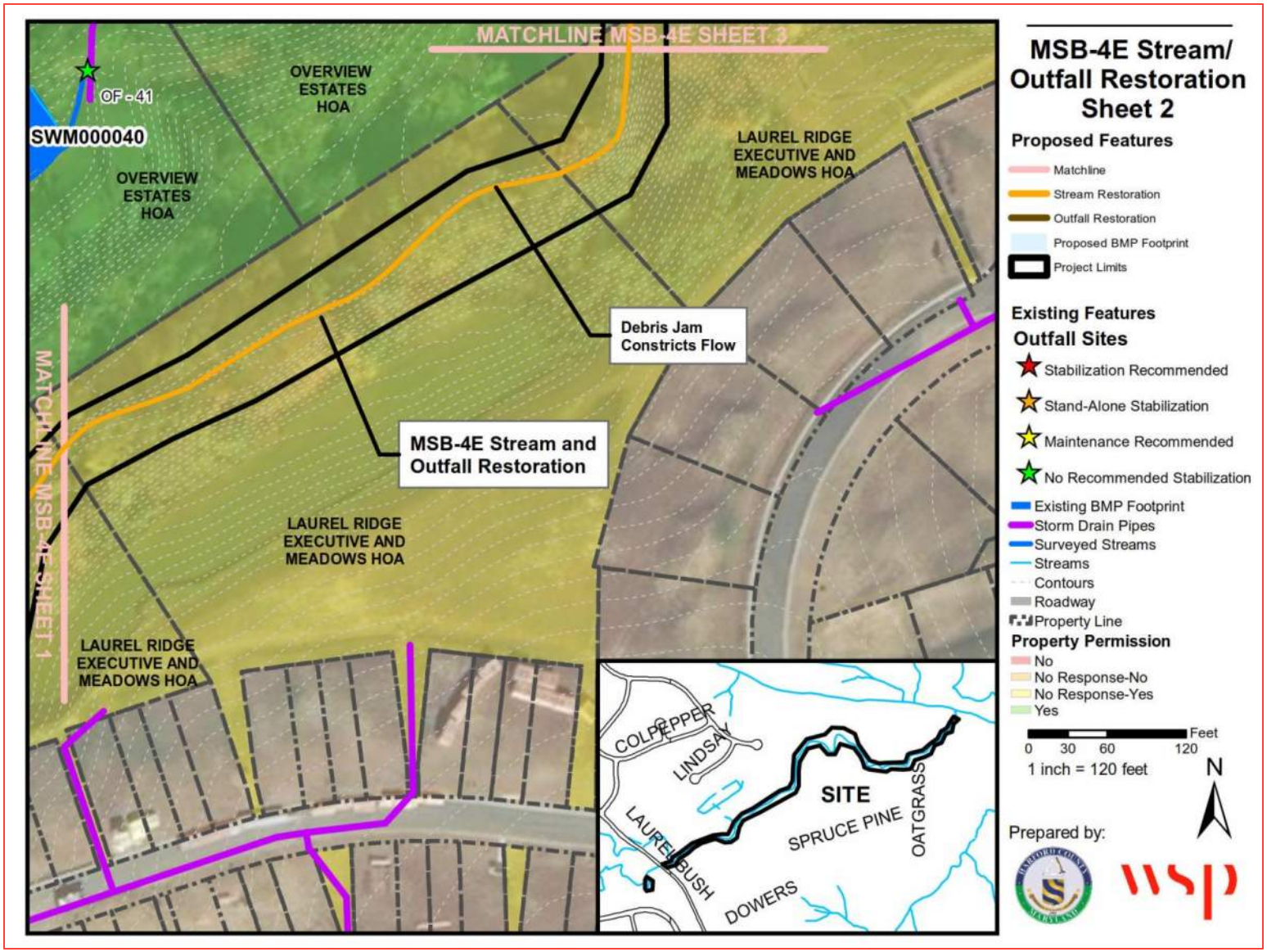

Figure C-46: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 2 of 5)

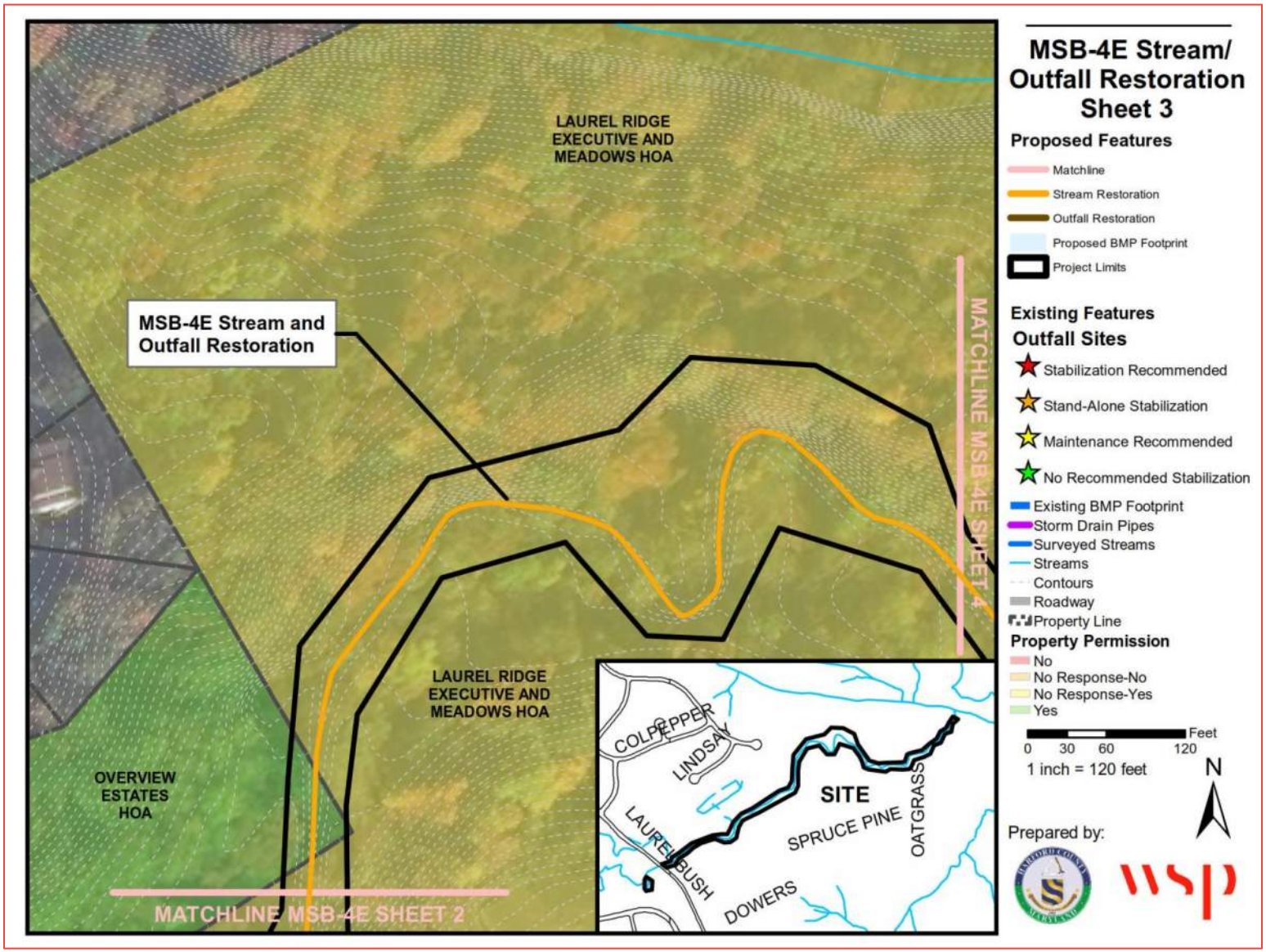

Figure C-47: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 3 of 5)

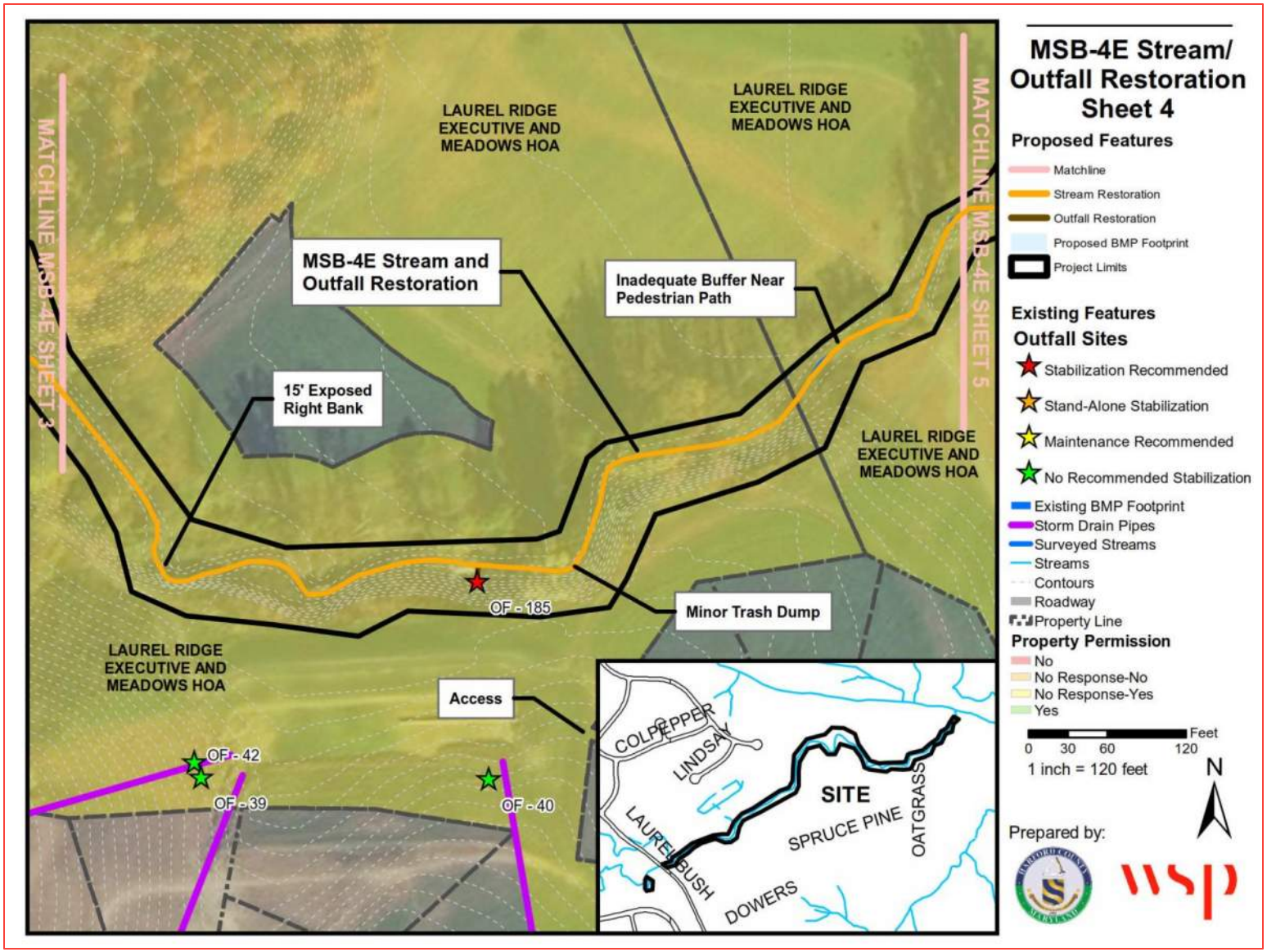

Figure C-48: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 4 of 5)

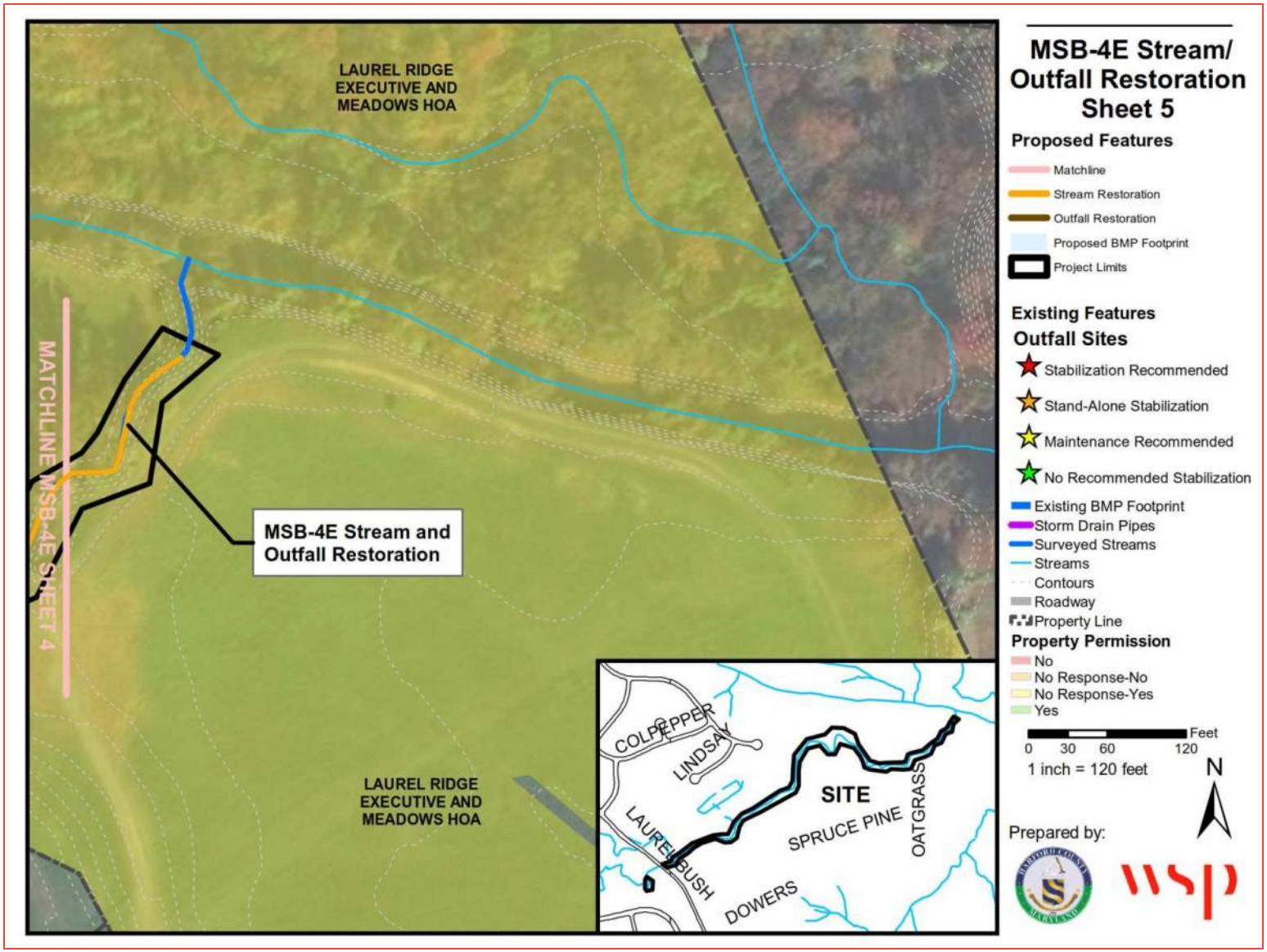

Figure C-49: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 5 of 5)

MSB-4F OUTFALL RESTORATION

Project Description	Stabilize 96 feet of channel at Outfall 35
Location	Between 214 Laurentum Parkway and 216 Laurentum Parkway
Property Ownership	Two private properties
Length of Project	96 feet of outfall stabilization
Potential Impervious Acres Treated	0.96 Acres
Potential Load Reductions TP	N/A
Potential Load Reductions TN	N/A
Potential Load Reductions TSS	N/A
Estimated Design/Construction Costs	$25,000 $26,042/impervious acres treated
Adjacent Projects	N/A

Site Description

The upstream limit of MSB-4F is located at the northeast corner of 214 Laurentum Parkway, a private residence. It proposes a restoration of Outfall 35 which receives discharge from the northeastern portion of the Box Hill community. The outfall consists of a 15-inch diameter CMP pipe and a winged, plastic endwall. Both the outfall pipe and endwall are in good condition (Figure C-50) but are suspended 5 feet above the channel bed. There is minimal outfall channel protection comprised of riprap and 5 feet of exposed bank extend 80 feet from the outfall structure (Figure C-51, left). Erosion has exposed bedrock within the outfall channel. The eroded banks continue approximately 80 feet until the channel's confluence with its receiving stream (Figure C-51, right).

Figure C-50: View of Outfall 35 showing distance from the top and bottom of bank (left); View of outfall height above channel bottom (right)

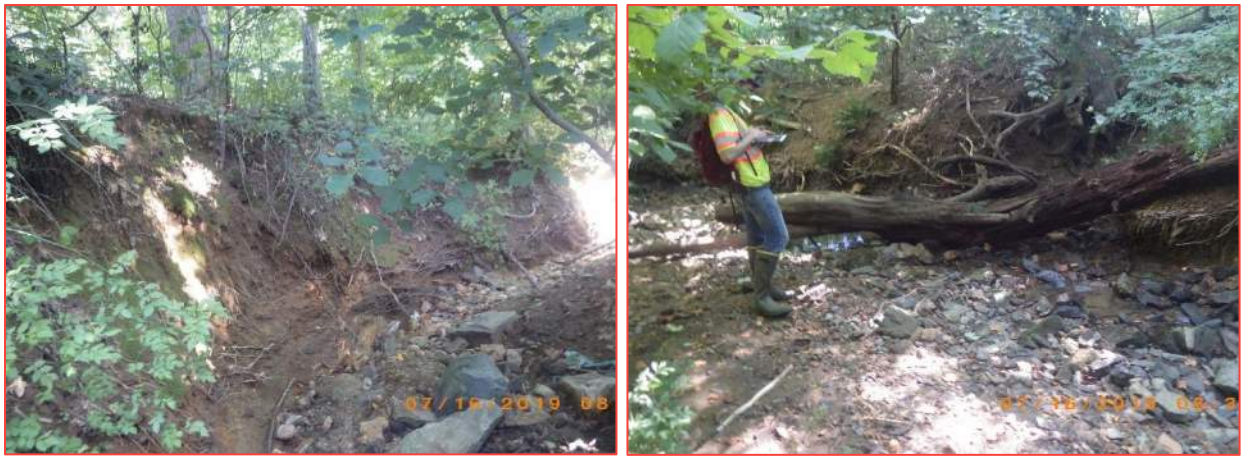

Figure C-51: Average 5-foot high exposed banks from Outfall 35 (left); Outfall 35 confluence with stream channel (right).

Recommended Restoration Actions

- **Outfall Stabilization**
  - *Outfalls 35:* Remove metal apron, partially fill in channel, install plunge pool, grade outfall channel and line with riprap protection.
- Proposed project limits are shown in Figure C-52.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are two private property owners along this reach and coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the outfall channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Laurel Valley Homeowners Association Inc.
- Private: 214 Laurentum Parkway
- Private: 216 Laurentum Parkway

Access

- Difficult Access due to private fence between 214 Laurentum Parkway and 216 Laurentum Parkway outfall restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-20. The construction of 96 linear feet of outfall stabilization in this project will treat 0.96 impervious acres within the watershed. This treatment amount accounts for approximately 0.07% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $25,000 for the MSB-4F Outfall Restoration project. This cost estimate includes one small outfall stabilization project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-21.

Table C-20: Summary of Improvements for MSB-4F Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-35	7.3	2.60	96	0.96	-	-	-
Stream								
Total Credit/ Reductions				**96**	**0.96**			

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-21: Summary of Project Costs for MSB-4F Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-35	Small	$25,000	Project	$25,000	
Stream						
Total Costs					**$25,000**	**$26,042**

*Project cost divided by stream restoration impervious area treated

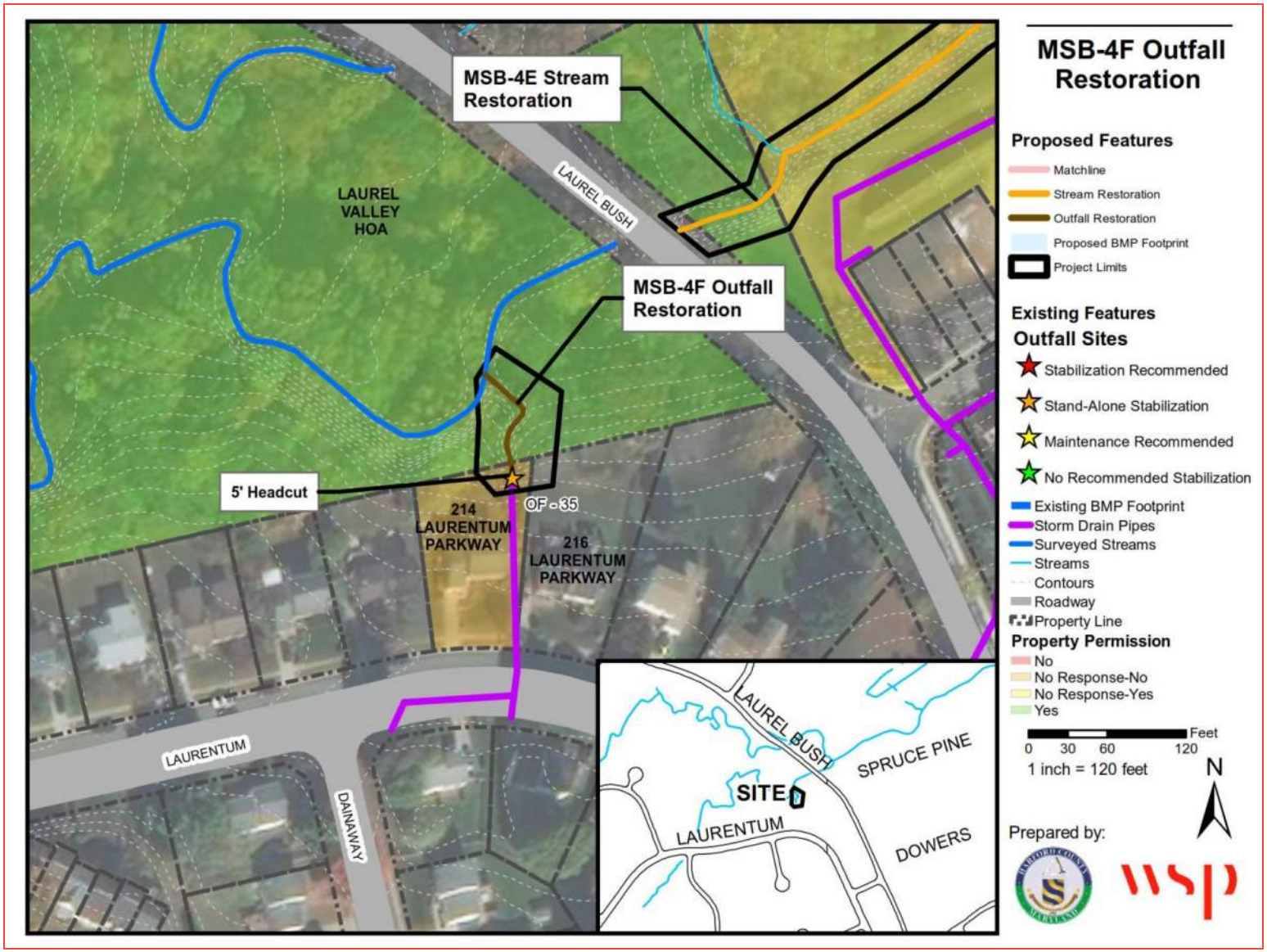

Figure C-52: Site Location and Proposed Project Plan for MSB-4F Outfall Restoration

MSB-4G STREAM AND OUTFALL RESTORATION

Project Description	Restore 160 feet of stream restoration and 30 feet of channel stabilization at Outfall 65
Location	Saddle Ridge HOA open space south of Hurdle Court
Property Ownership	No private properties
Length of Project	160 feet of stream restoration and 30 feet of outfall stabilization
Potential Impervious Acres Treated	5.1 Acres
Potential Load Reductions TP	10.88 lbs/yr
Potential Load Reductions TN	12.00 lbs/yr
Potential Load Reductions TSS	7,184 lbs/yr
Estimated Design/Construction Costs	$170,000 $33,333/impervious acres treated
Adjacent Projects	N/A

Site Description

MSB-4G is located between 2210 and 2212 Gelding Way in a designated open space area owned by the Saddle Ridge Homeowner's Association. It proposes a restoration of Outfall 65 which receives discharge from the central portion of the Saddle Ridge community. The outfall consists of a 36-inch diameter CMP pipe and a metal end section. Both the outfall pipe and end section are in good condition (Figure C-53, left). The outfall structure is located at the end of a series of three drop structures and adjacent to a shallow, residential BMP (Figure C-53, right). There is a water quality basin at the outfall.

Figure C-53: View of 3 drop structures to Outfall 65 (left); Adjacent water quality basin to Outfall 65 (right)

There is 25 feet of riprap channel protection immediately downstream of the outfall structure and upstream of a 7-foot headcut (Figure C-54, left). The riprap and geotextile has been disturbed upstream and downstream of the headcut and banks are exposed as a result. The outfall channel converges with the stream channel 160 feet downstream of the 7-foot headcut. There is an additional 2-foot headcut, 45 feet downstream of the 7-foot headcut. The channel following the 2-foot headcut splits into two separate,

parallel lengths consisting of braided channels to the left and a new and eroded channel to the right. The new, eroded channel lacks channel protection (Figure C-54, right).

Figure C-54: 7 ft high headcut with exposed geotextile and soil (left); View of exposed geotextile downstream of large headcut moving towards the new, eroded, channel to the right (right).

Recommended Restoration Actions

- **Stream Restoration**
  - MSB-4G: Grade channel towards stream and line with riprap protection.
- **Outfall Maintenance**
  - *Outfalls 65:* Replace drop structure with one that is 7 feet deep and install plunge pool.
- Proposed project limits are shown in Figure C-55.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are is one private homeowner's association along this reach and coordinating buy in from the property owner at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the stream and outfall channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Saddle Ridge Homeowners Association Inc.

Access

- Difficult Access at Saddle Ridge HOA open space south of Hurdle Court for outfall stabilization and stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-22. The construction of 160 linear feet of stream restoration and 30 feet of outfall stabilization in this project will treat 5.10 impervious acres within the watershed. This treatment amount accounts for approximately 0.34% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $170,000 for the MSB-4G Stream and Outfall Restoration project. This cost estimate includes one medium outfall stabilization project and one small stream restoration project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-23 .

Table C-22: Summary of Improvements for MSB-4G Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-65	7.5	3.29	30	0.30	-	-	-
Stream	MSB-4G	8.0	3.31	160	4.8	12.00	10.88	7,184
Total Credit/ Reductions				**190**	**5.1**	**12.00**	**10.88**	**7,184**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-23: Summary of Project Costs for MSB-4G Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-65	Medium	$50,000	Project	$50,000	
Stream	MSB-4G	Small	$750	L.F.	$120,000	
Total Costs					**$170,000**	**$33,333**

*Project cost divided by stream restoration impervious area treated

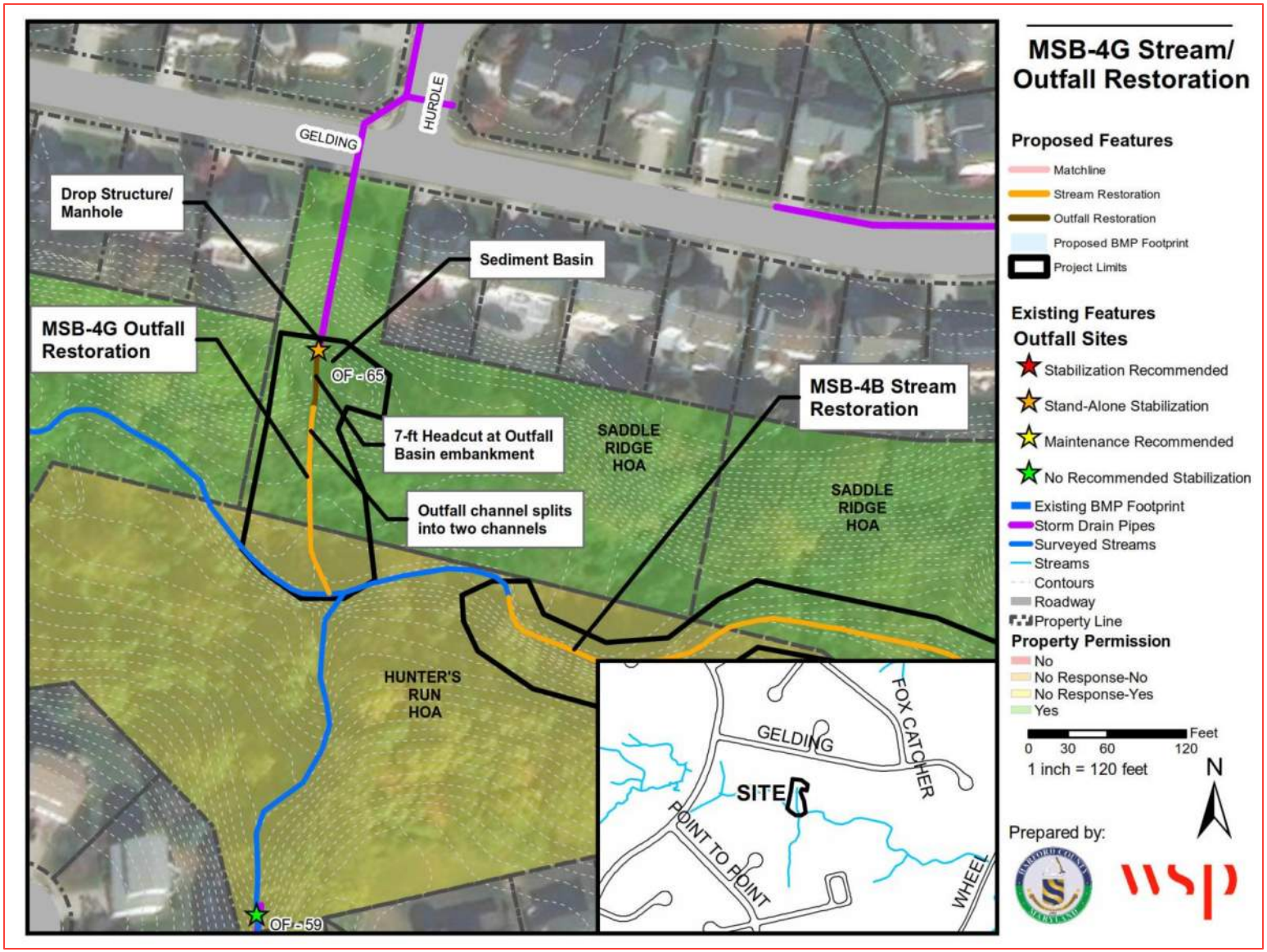

Figure C-55: Site Location and Proposed Project Plan for MSB-4G Stream and Outfall Restoration

MSB-5A STREAM RESTORATION

Project Description	Restore 2,058 feet of stream restoration
Location	Starmount Lane, North of Echo Court
Property Ownership	Four Private Properties
Length of Project	2,058 feet of stream restoration
Potential Impervious Acres Treated	61.74 Acres
Potential Load Reductions TP	139.94 lbs/yr
Potential Load Reductions TN	154.35 lbs/yr
Potential Load Reductions TSS	92,404 lbs/yr
Estimated Design/Construction Costs	$1,337,700 $21,667/impervious acres treated
Adjacent Projects	None

Site Description

MSB-5A is located southwest of Redfield Road and northwest of Brierhill Estates Drive. This project area includes 2,058 feet of stream restoration. The first 300 feet of erosion is moderate and has an average exposed bank height of 5 feet. The remaining length of stream has bank heights that vary from 1 to 3 feet high (Figure C-56). Multiple debris jams provide grade control in the middle of this stream reach.

Figure C-56: Moderate erosion with 2-foot banks (left) and 1-foot banks (right)

Approximately 900 feet downstream of the beginning of the project, the outfall channel for Outfall 116 ties in with the stream. Though the structure of outfall 116 and approximately 20 feet of channel protection is in good condition (Figure C-57, left), the remaining outfall channel is experiencing moderate erosion with an average exposed bank height of 6 feet. There is bedrock in the eroded outfall channel (Figure C-57, right).

Figure C-57: Outfall 116 structure (left) and channel stabilization of 6-foot tall exposed banks with exposed bedrock (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-5A:* 2,058 feet from behind 1421 Redfield Road to Starmount Lane.
- Proposed project plans are shown in Figure C-58, Figure C-59, and Figure C-60.

Threats to Infrastructure

- No current threat to infrastructure within the project area.

Property Ownership

There are multiple private property owners along this reach and coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, The Village of Scots Fancy Homeowners Association Inc.
- Private: HOA, Brierhill Estates Homeowners Association Inc.
- Private: HOA, Foundation Glen Homeowners Association Inc.
- Private: 1405 Loch Carron Way

Access

- Moderate Access between 1425 and 1419 Redfield Road at a sanitary sewer easement for stream restoration.
- Moderate Access between 1407 and 1409 Loch Carron at a stormwater easement for stream restoration and Outfall stabilization.
- Difficult Access at the Open Space south of 1214 Starmount Lane for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-24. This project recommends 2,058 linear feet of stream restoration. The construction of 2,058 linear feet of stream in this project will treat 61.74 impervious acres within the watershed. This treatment amount accounts for approximately 4.7% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,337,700 for the MSB-5A Stream Restoration project. This cost estimate includes a medium stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-25.

Table C-24: Summary of Improvements for MSB-5A Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-5A	24.23	3.91	2,058	61.74	154.35	139.94	92,404
Total Credit/ Reductions				**2,058**	**61.74**	**154.35**	**139.94**	**92,404**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-25: Summary of Project Costs for MSB-5A Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-5A	Medium	$650	L.F.	$1,337,700	$21,667
Total Costs					**$1,337,700**	**$21,667**

*Project cost divided by stream restoration impervious area treated

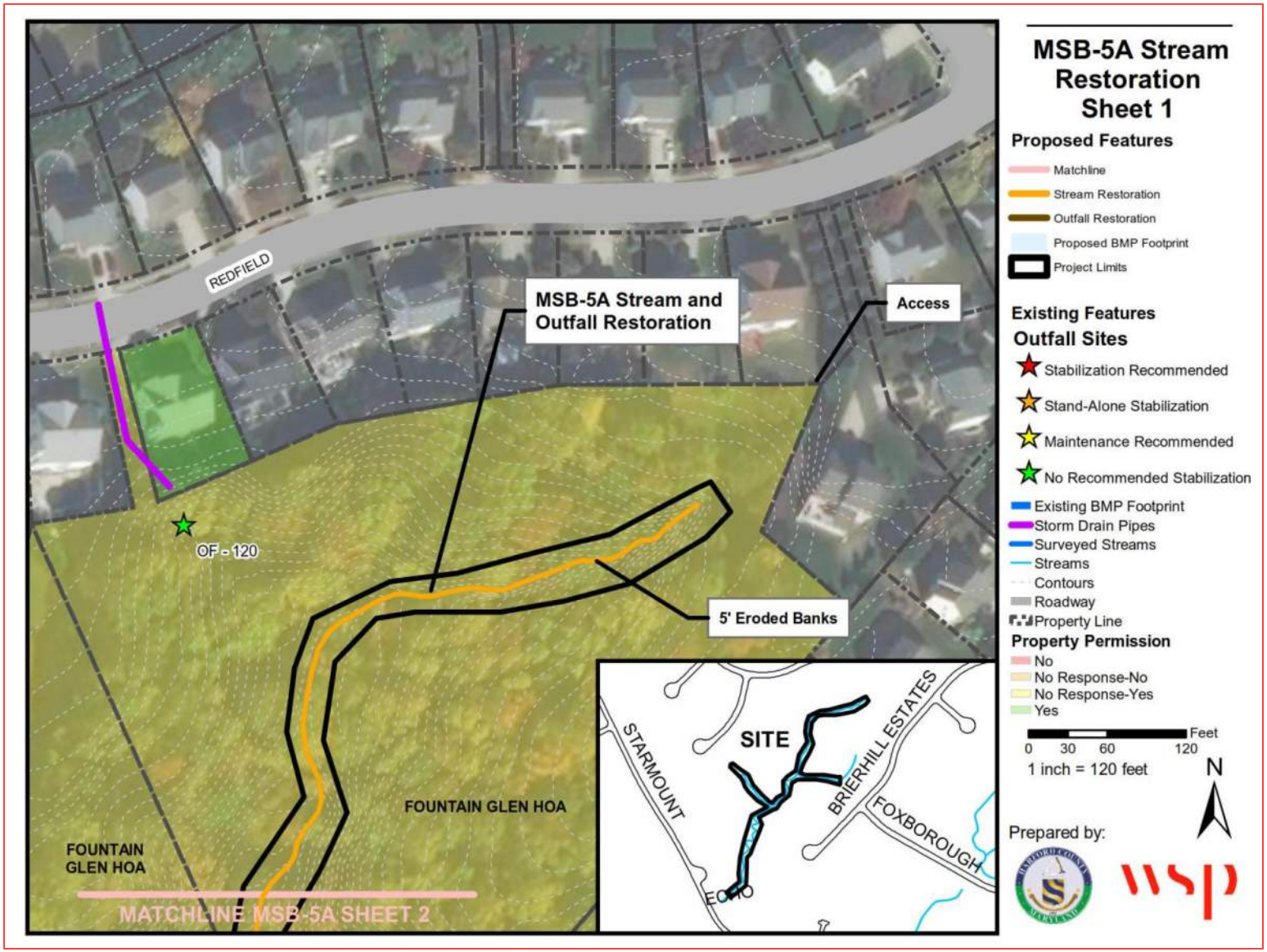

Figure C-58: Site Location and Proposed Project Plan for MSB-5A Stream and Outfall Restoration (Sheet 1 of 3)

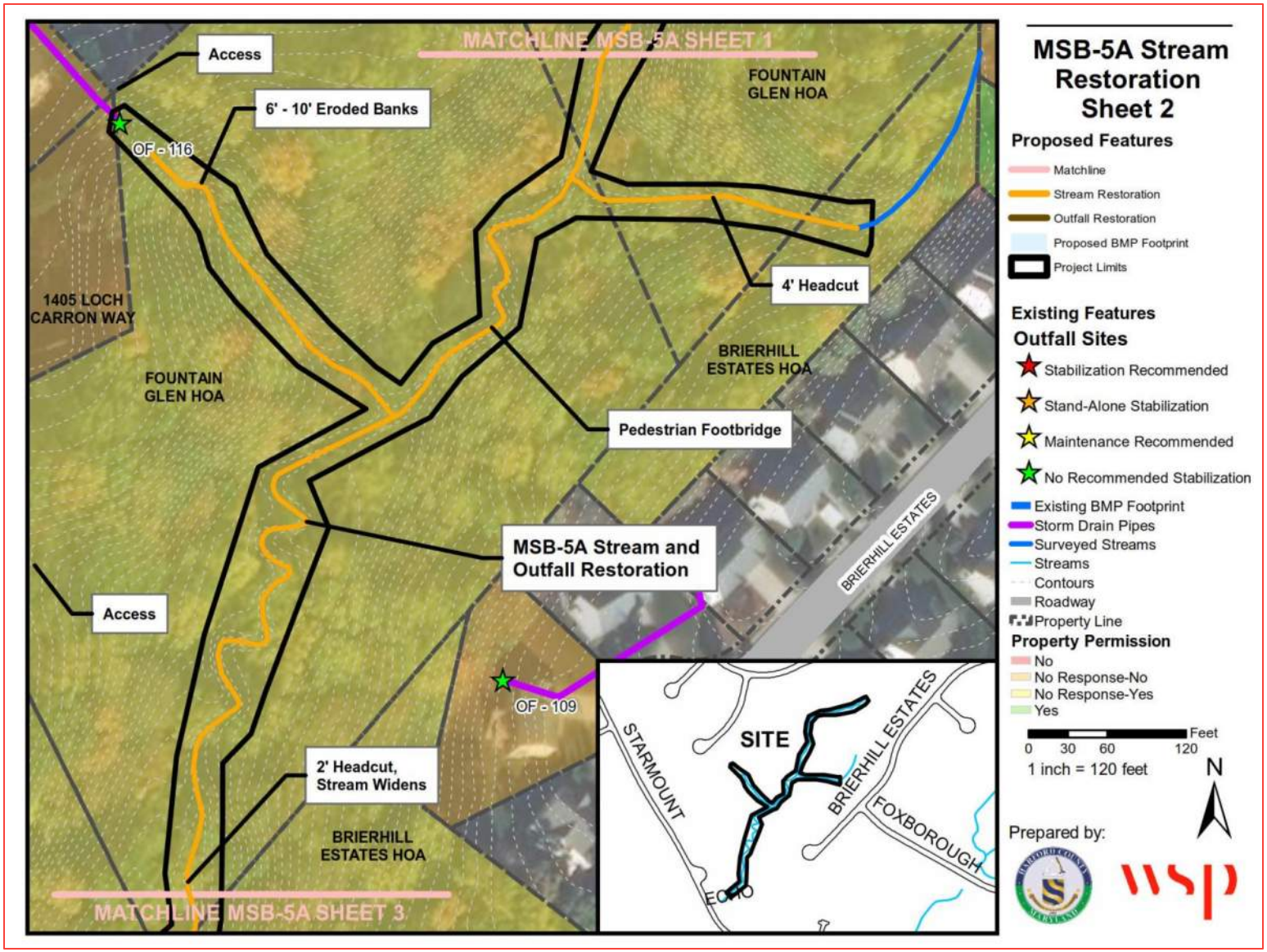

Figure C-59: Site Location and Proposed Project Plan for MSB-5A Stream and Outfall Restoration (Sheet 2 of 3)

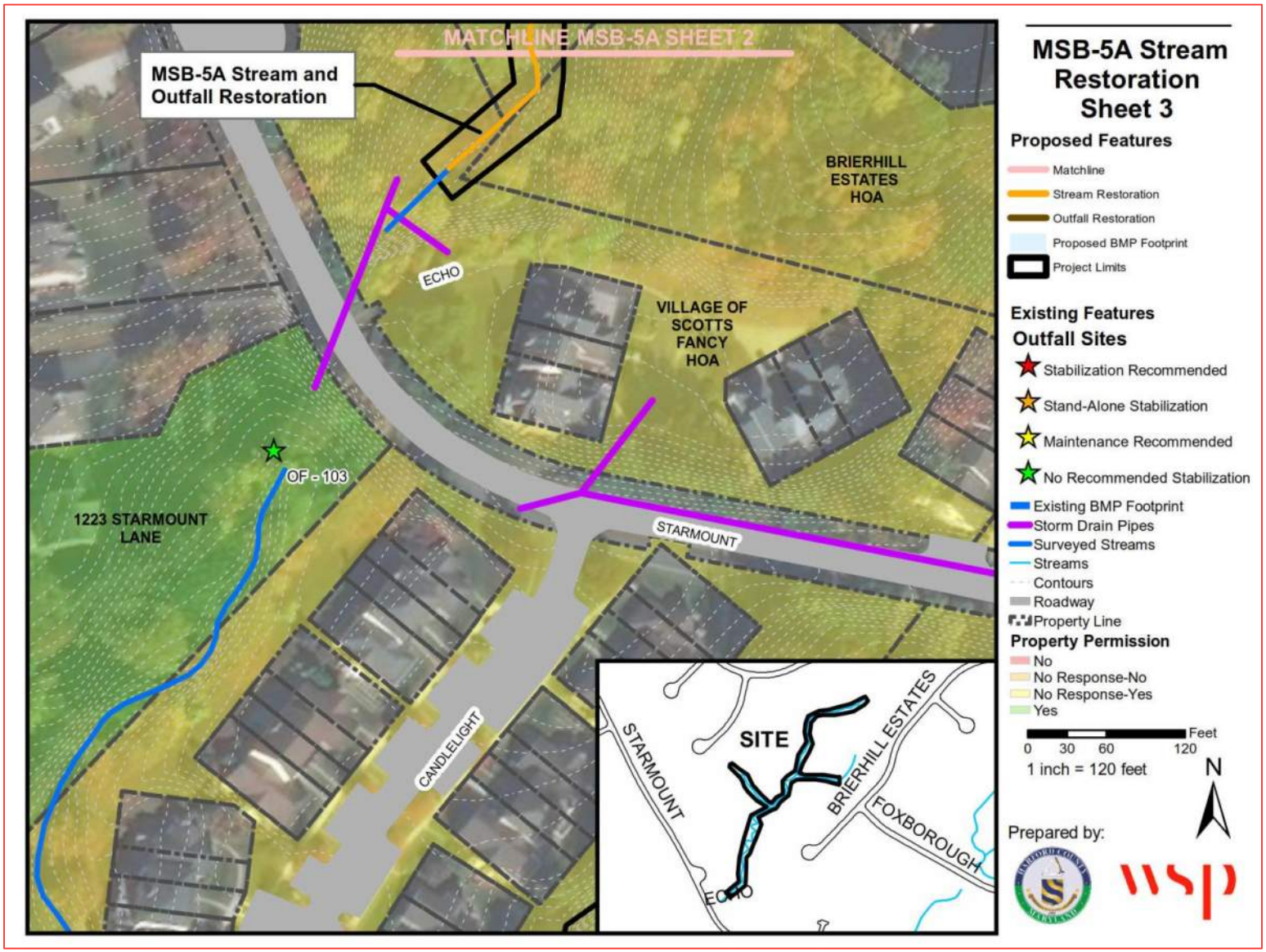

Figure C-60: Site Location and Proposed Project Plan for MSB-5A Stream and Outfall Restoration (Sheet 3 of 3)

MSB-5B STREAM RESTORATION

Project Description	Restore 1,327 feet of stream restoration
Location	Cambry Drive and Foxborough Drive
Property Ownership	One Private Property
Length of Project	1,327 feet of stream restoration
Potential Impervious Acres Treated	39.80 Acres
Potential Load Reductions TP	90.22 lbs/yr
Potential Load Reductions TN	99.51 lbs/yr
Potential Load Reductions TSS	59,571 lbs/yr
Estimated Design/Construction Costs	$872,550 $21,923/impervious acres treated
Adjacent Projects	None

Site Description

Project MSB-5B is located between Valbrook Court S. to the north and Merryhill Court to the south. This project proposes 1,327 feet of stream restoration and maintenance on two outfalls. The entire 1,327 feet of the right bank contains moderate severity bank erosion. (Figure C-61, left), The stream channel in this area has experienced widening (Figure C-61, right).

Figure C-61: Left bank severe erosion section with 15-foot average exposed bank height (left); Moderate severity erosion with 3-foot average exposed bank height at downstream limits of project MSB-5B (right).

Outfall 124 is at the headwater of the stream and conveys flow from neighborhoods east of Foxborough Drive. The outfall is a 30-inch diameter RCP pipe with an endwall (Figure C-62, left). The structure is in good condition; however, a large earth and tree debris jam is blocking the flow from the rest of the outfall channel and stream (Figure C-62, right).

Figure C-62: Looking at Endwall for Outfall 124 (left); Looking downstream of Outfall 124 at large debris jam (right).

Outfall 125 is also at the headwater of the stream and conveys flows from north of Cambry Drive. The outfall is a 30-inch diameter metal pipe discharging from a concrete headwall into a 2 feet deep channel (Figure C-63, left). The bed of the channel is armored with gabion baskets and the sides of the channel are earthen. Downstream, multiple debris jams have fallen across the channel preventing positive flow towards the stream (Figure C-63, right). The channels for outfall's 125 and 124 converge approximately 140 feet downstream of outfall 125.

Figure C-63: Upstream view of outfall 125 structure and immediate channel protection (left); Downstream view of outfall 125 channel with debris jam in foreground and background (right).

<u>Recommended Restoration Actions</u>

- **Stream Restoration**
  - *MSB-5B*: 1,327 feet from 74 feet from Outfall 125 to 233 feet upstream of Outfall 115.
- **Outfall Maintenance**
  - *Outfall 124:* Remove tree debris jam to restore positive grade and repair riprap channel

- *Outfall 125:* Remove tree debris jam to restore positive grade
- Proposed project plans are shown in Figure C-64 and Figure C-65.

Threats to Infrastructure

- There is a sanitary sewer pipe crossing near the upstream limit of the project area. The sanitary line continues to follow the general profile of the stream through the rest of the stream length. Continued erosion throughout this area leaves the sanitary line vulnerable to future exposure.

Property Ownership

There is only private property owner along this reach. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Foxborough Farms Homeowners Association No. 3 Inc.

Access

- Good Access at the Open Space on Foxborough Drive north of Merry Hill Court for stream restoration and Outfall 124 maintenance.
- Moderate Access at the Open Space on Merry Hill Court, west of 1350 Merry Hill Court for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-26. The construction of 1,327 linear feet of stream restoration in this project will treat 39.8 impervious acres within the watershed. This treatment amount accounts for approximately 3.0% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $872,550 for the MSB-5B Stream Restoration project. This cost estimate includes two small outfall maintenance projects as well as a medium stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-27.

Table C-26: Summary of Improvements for MSB-5B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance	OF-124	-	-	-	-	-	-	-
	OF-125	-	-	-	-	-	-	-
Outfall								
Stream	MSB-5B	96.10	24.61	1,327	39.80	99.51	90.22	59,571
Total Credit/ Reductions				**1,327**	**39.80**	**99.51**	**90.22**	**59,571**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-27: Summary of Project Costs for MSB-5B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance	OF-124	Small	$5,000	Project	$5,000	
	OF-125	Small	$5,000	Project	$5,000	
Outfall						
Stream	MSB-5B	Medium	$650	L.F.	$862,550	$21,672
Total Costs					**$872,550**	**$21,923**

*Project cost divided by stream restoration impervious area treated

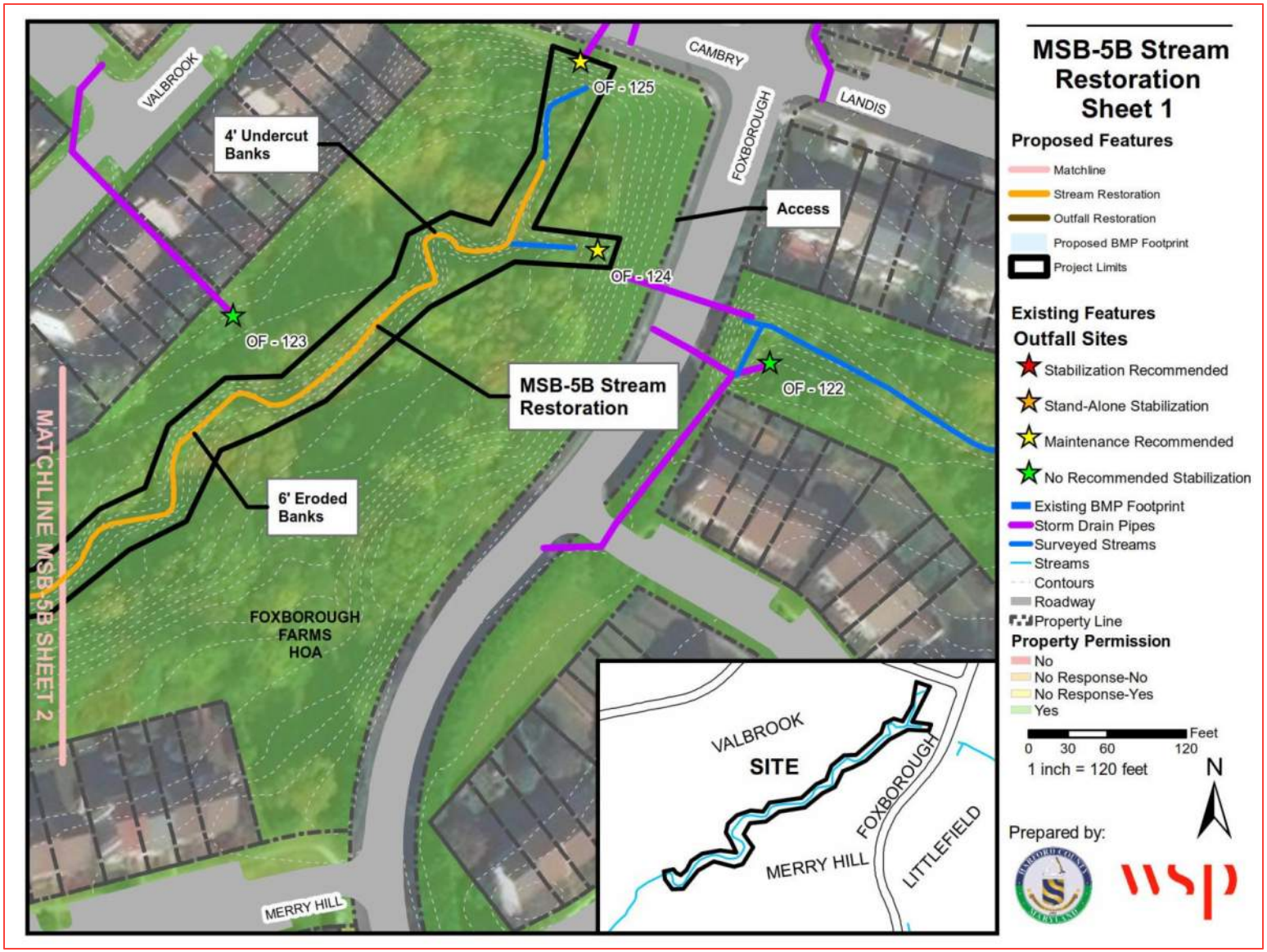

Figure C-64: Site Location and Proposed Project Plan for MSB-5B Stream Restoration (Sheet 1 of 2)

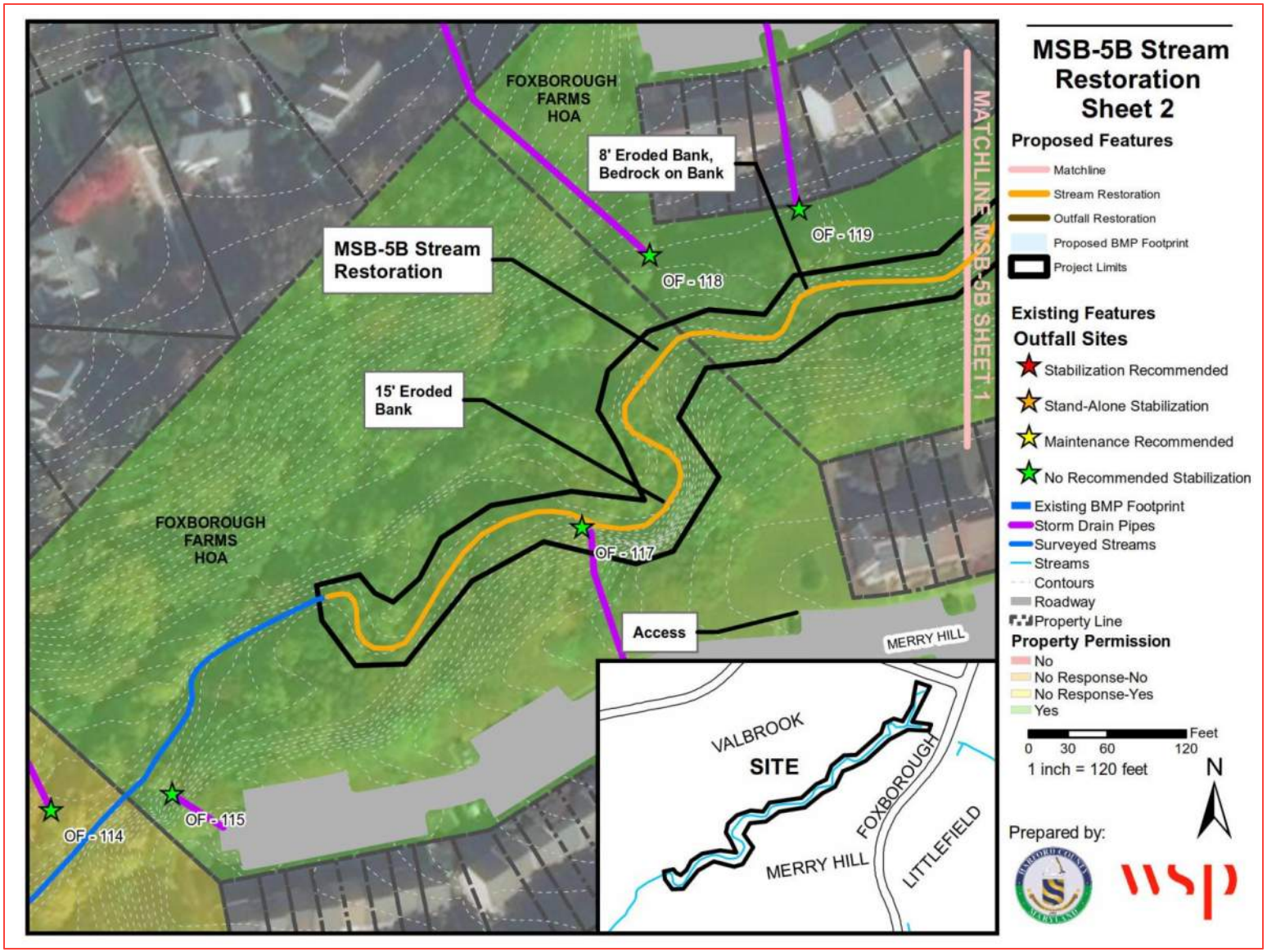

Figure C-65: Site Location and Proposed Project Plan for MSB-5B Stream Restoration (Sheet 2 of 2)

MSB-5C STREAM AND OUTFALL RESTORATION

Project Description	Restore 3,235 feet of stream and stabilize 137 feet of outfall channel • Outfall 98: Stabilize 97 feet • Outfall 99: Stabilize 40 feet
Location	South of Starmount Lane
Property Ownership	Nineteen Private Properties
Length of Project	3,235 feet of stream restoration and 137 feet of outfall stabilization
Potential Impervious Acres Treated	98.46 Acres
Potential Load Reductions TP	220.06 lbs/yr
Potential Load Reductions TN	242.71 lbs/yr
Potential Load Reductions TSS	145,304 lbs/yr
Estimated Design/Construction Costs	$2,055,150 $20,365/impervious acres treated
Adjacent Projects	BMP-P-4

Site Description

MSB-5C is comprised of two segments of stream totaling 3,235 feet and two outfall stabilizations. MSB-5C, Segment 1, contains a headwater stream and proposes two outfall stabilizations, outfalls 98 and 99, and 1,485 feet of stream restoration. The first 460 feet of the main stem have an average exposed height of 5 feet on both stream banks (Figure C-66, left). Throughout this section there are multiple, dry, stormwater runoff channels entering the stream from outfall structures, such as outfalls 98 and 99 as well as overland flow from adjacent residential units. The remaining MSB-5C, Segment 1, stream length has average exposed stream banks of 2 to 3 feet (Figure C-66, right).

Figure C-66: Left and right bank erosion with an average exposed height of 5 feet (left); Section of average exposed banks of 3 feet on the left bank (right)

Outfalls 98 and 99 convey flow from the Maryland County Club (Figure C-67). Multiple pipe sections have broken off into the eroded outfall channel. The eroded banks in these outfall channels are approximately 6 to 8 feet high. Both outfalls convey flow the left stream bank. Outfall 99 enters the left bank 300 feet downstream of the start of the project. The outfall channel for Outfall 98 ties into the stream on the left bank an additional 160 feet downstream of the Outfall 99 channel.

Figure C-67: Looking upstream toward Outfall 98 (left); Looking upstream toward Outfall 99 (right).

MSB-5C, Segment 2, is located southeast of Starmount Lane and includes 1,751 feet of proposed stream restoration. MSB-5C begins at Outfall 100 and conveys flow from Segment 1 as perennial flow. The outfall structure is in good condition, but the gabion baskets that protect the channel banks on either side of the outfall's wings and the channel bottom immediately downstream are impacted by erosion (Figure C-68, left). The gabion baskets create two steps, approximately two feet in height, ten feet and twenty-five feet linearly from the outfall's concrete apron to the main stream channel, respectively (Figure C-68, right).

Figure C-68: Downstream view of outfall 100 with erosion behind the left bank gabion baskets (left); Outfall 100 gabion basket channel protection (right).

The first 420 feet of stream below Outfall 100 contains 3 feet of exposed banks on either bank (Figure C-69, left). The next 300 feet, a more sinuous section, contains average exposed bank heights of 4 feet. The final 430 feet upstream of the tributary confluence has an of average 5 feet exposed bank. A silt fence currently runs along the right bank (Figure C-69, right).

Figure C-69: Downstream view of left bank erosion (left); Silt fence adjacent to stream channel (right).

A golf cart bridge crosses the stream approximately 550 feet upstream of the end of the project area. Twin 30-inch concrete pipes convey flow under the golf cart crossing. Upstream of the golf cart bridge crossing, stream banks average 4 feet of exposed banks and lack a riparian buffer on both banks (Figure C-70, left). Additionally, there are two exposed pipes along the stream bed within this stream channel section. Golf course personal identified these pipes as an irrigation pipe and its associated electric connection during the field assessment of the area.

Downstream of the golf cart crossing, stream banks average 5 feet of exposed bank (Figure C-70, right). A smooth metal pipe is exposed across the bottom of the stream approximately 70 feet from the

downstream limit of MSB-5C. Although the use of the pipe is unknown and there are no current signs of the pipe leaking, the presence of multiple, large, upstream, pieces of debris leave this pipe vulnerable to future impacts.

Figure C-70: Downstream view towards the channel golf cart crossing with inadequate buffer and erosion (left); five-foot exposed bank height downstream of golf cart crossing (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-5C, Main Stem 1*: 1,485 feet from 296 feet upstream of Outfall 99 to 364 feet upstream of Starmount Lane outlet.
  - *MSB-5C, Main Stem 2*: 1,751 feet from the channel of Outfall 100 to the outlet at East Macphail Road.
- **Outfall Stabilization**
  - *Outfall 98*: Pipe replacement and 97 feet of stabilization
  - *Outfall 99*: Pipe replacement and 40 feet of stabilization
- Proposed project plans are shown in Figure C-71, Figure C-72, Figure C-73, Figure C-74, and Figure C-75.

Threats to Infrastructure

- Stream channel is within 20 feet of the buildings on and adjacent to 958 Whispering Ridge Lane.
- There are two exposed pipe locations (irrigation and electrical conduit) within the length of the stream restoration. The first is located above the stream channel and is susceptible to debris impacts during a large storm event. The second is exposed along the stream channel and will become vulnerable to debris impacts should erosion continue to occur around the pipe.

Property Ownership

There are numerous private property owners along this reach. Coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process.

Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, The Village of Scots Fancy Homeowners Association Inc.
- Private: 954 Whispering Ridge Lane
- Private: 956 Whispering Ridge Lane
- Private: 958 Whispering Ridge Lane
- Private: The Maryland Country Club Inc.
- Private: HOA, Woodland Greens Homeowners' Association Inc.
- Private: 1233 Kirby Circle
- Private: 1235 Kirby Circle
- Private: 1237 Kirby Circle
- Private: 1239 Kirby Circle
- Private: 1241 Kirby Circle
- Private: 1243 Kirby Circle
- Private: The Maryland Country Club Inc.
- Private: HOA, The Village of Scots Fancy Homeowners Association Inc.
- Private: 906 Whispering Ridge Lane
- Private: 904 Whispering Ridge Lane
- Private: 907 Candlelight Court
- Private: 905 Candlelight Court
- Private: 903 Candlelight Court

Access

- Moderate Access at the headwaters of the project area from the Maryland Country Club Parking lot for stream restoration and Outfalls 98 and 99 stabilization.
- Good Access at East Macphail Road at the golf cart entrance, St. Andrew's Way, for stream restoration.
- Moderate Access at the Open Space along Starmount Lane for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-28. Two outfall stabilization projects, totaling 137 linear feet are recommended alongside 3,236 linear feet of stream restoration. The construction of 3,236 linear feet of stream restoration and 137 feet of outfall stabilization in this project will treat 98.46 impervious acres within the watershed. This treatment amount accounts for approximately 7.4% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $2,055,150 for the MSB-5C Stream and Outfall Restoration project. This cost estimate includes one medium outfall stabilization project, one large outfall stabilization project and a large stream restoration project. Cost estimates for each project type

are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-29.

Table C-28: Summary of Improvements for MSB-5C Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-98	1.38	0.8	97	0.97	-	-	-
	OF-99	1.42	0.57	40	0.40	-	-	-
Stream	MSB-5C	228.26	50.09	3,236	97.09	242.71	220.06	145,304
Total Credit/ Reductions				**3,373**	**98.46**	**242.71**	**220.06**	**145,304**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-29: Summary of Project Costs for MSB-5C Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-98	Medium	$50,000	Project	$50,000	
	OF-99	Large	$100,000	Project	$100,000	
Stream	MSB-5C	Large	$550	L.F.	$1,855,150	$19,108
Total Costs					**$2,005,150**	**$20,365**

*Project cost divided by stream restoration impervious area treated

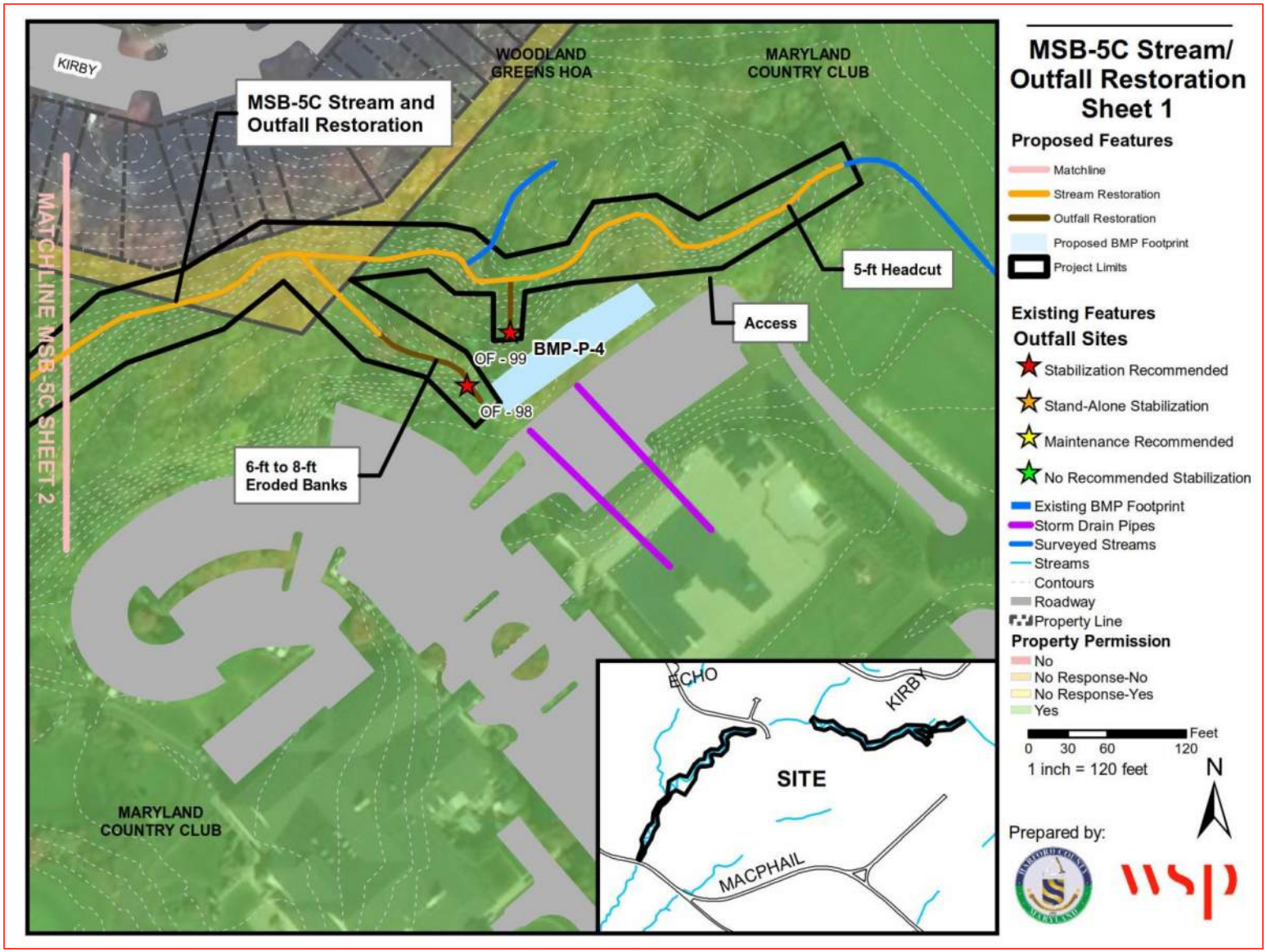

Figure C-71: Site Location and Proposed Project Plan for MSB-5C Stream and Outfall Restoration (Sheet 1 of 5)

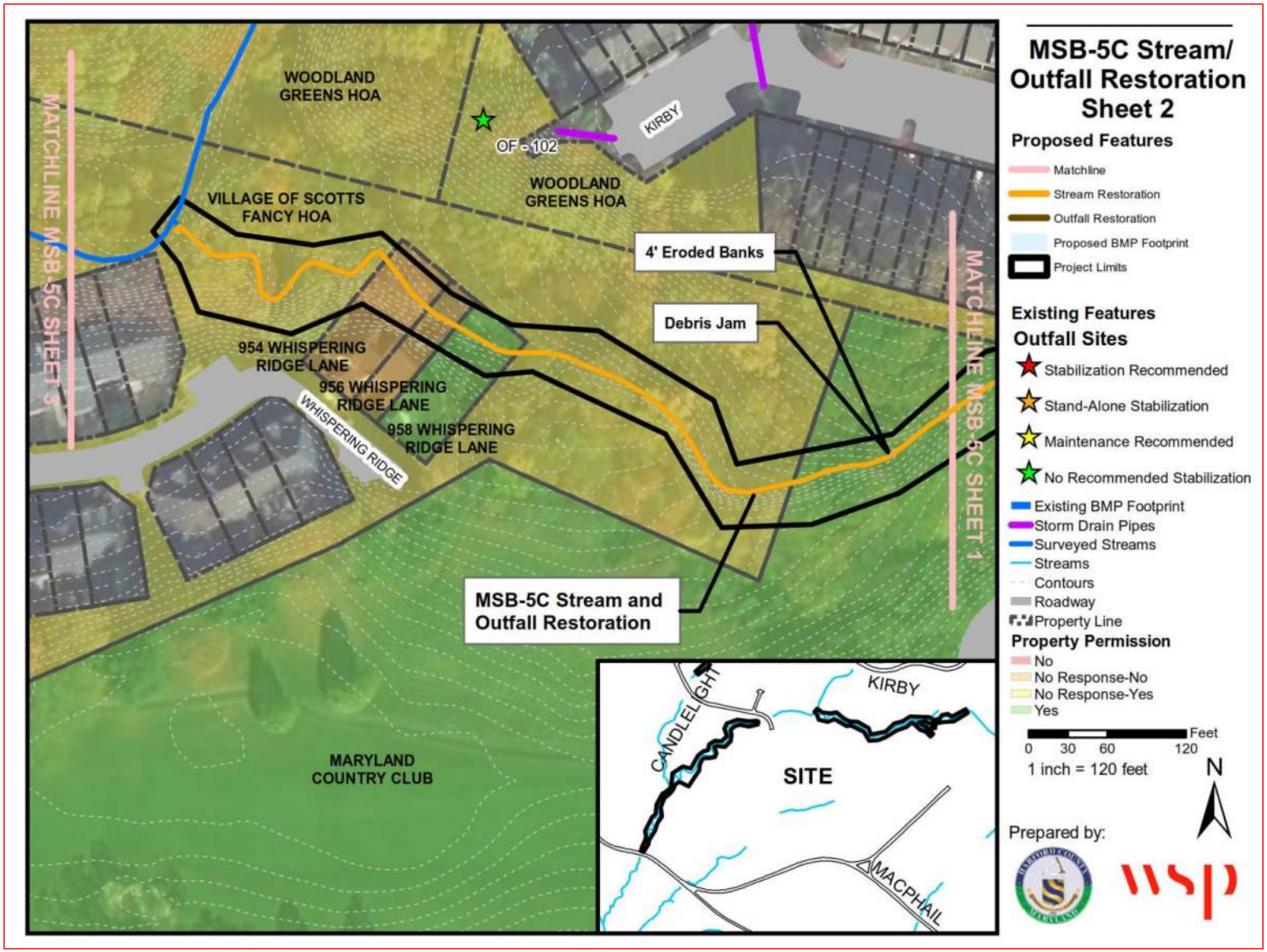

Figure C-72: Site Location and Proposed Project Plan for GrMSB-5C Stream and Outfall Restoration (Sheet 2 of 5)

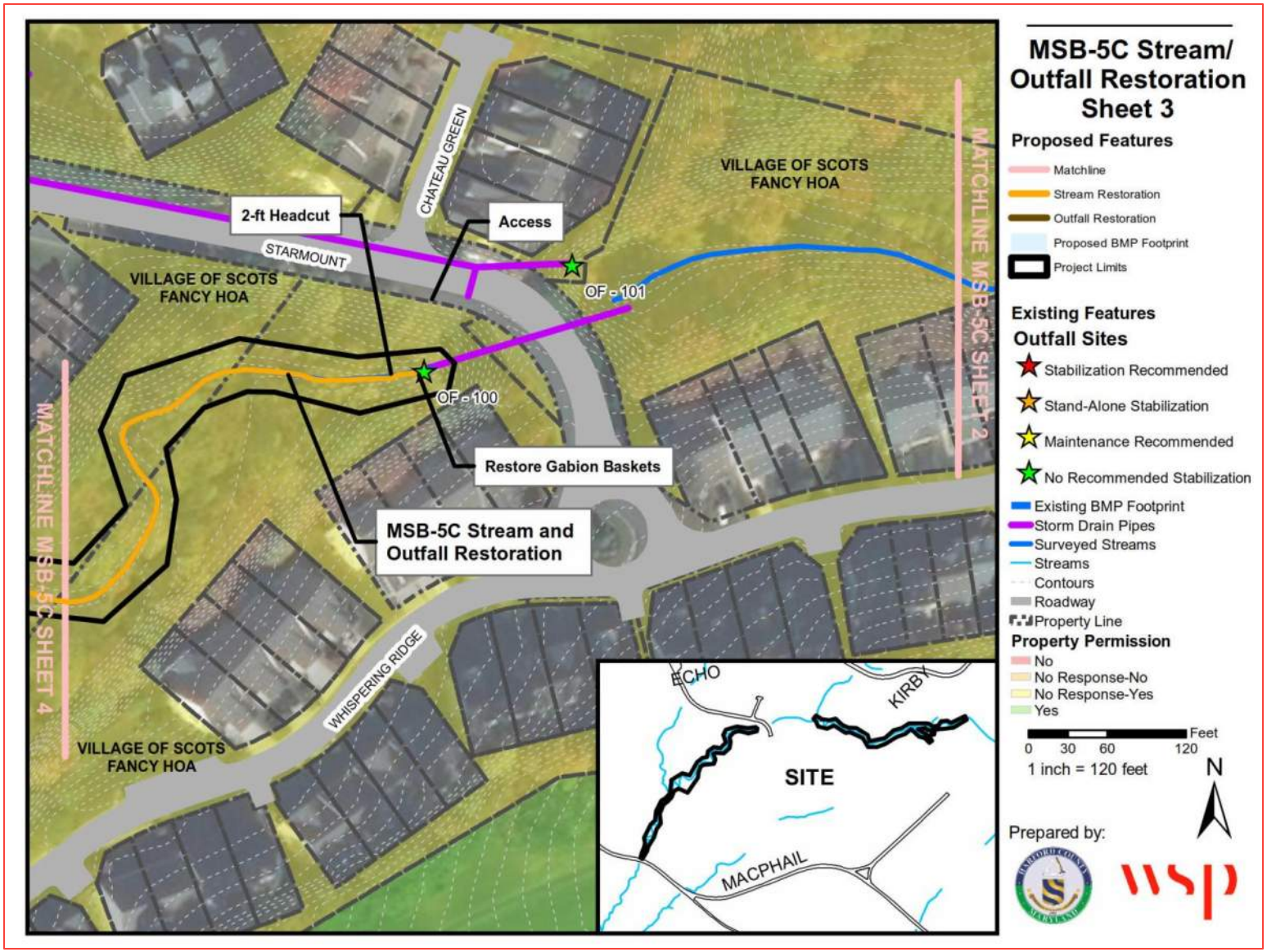

Figure C-73: Site Location and Proposed Project Plan for MSB-5C Stream and Outfall Restoration (Sheet 3 of 5)

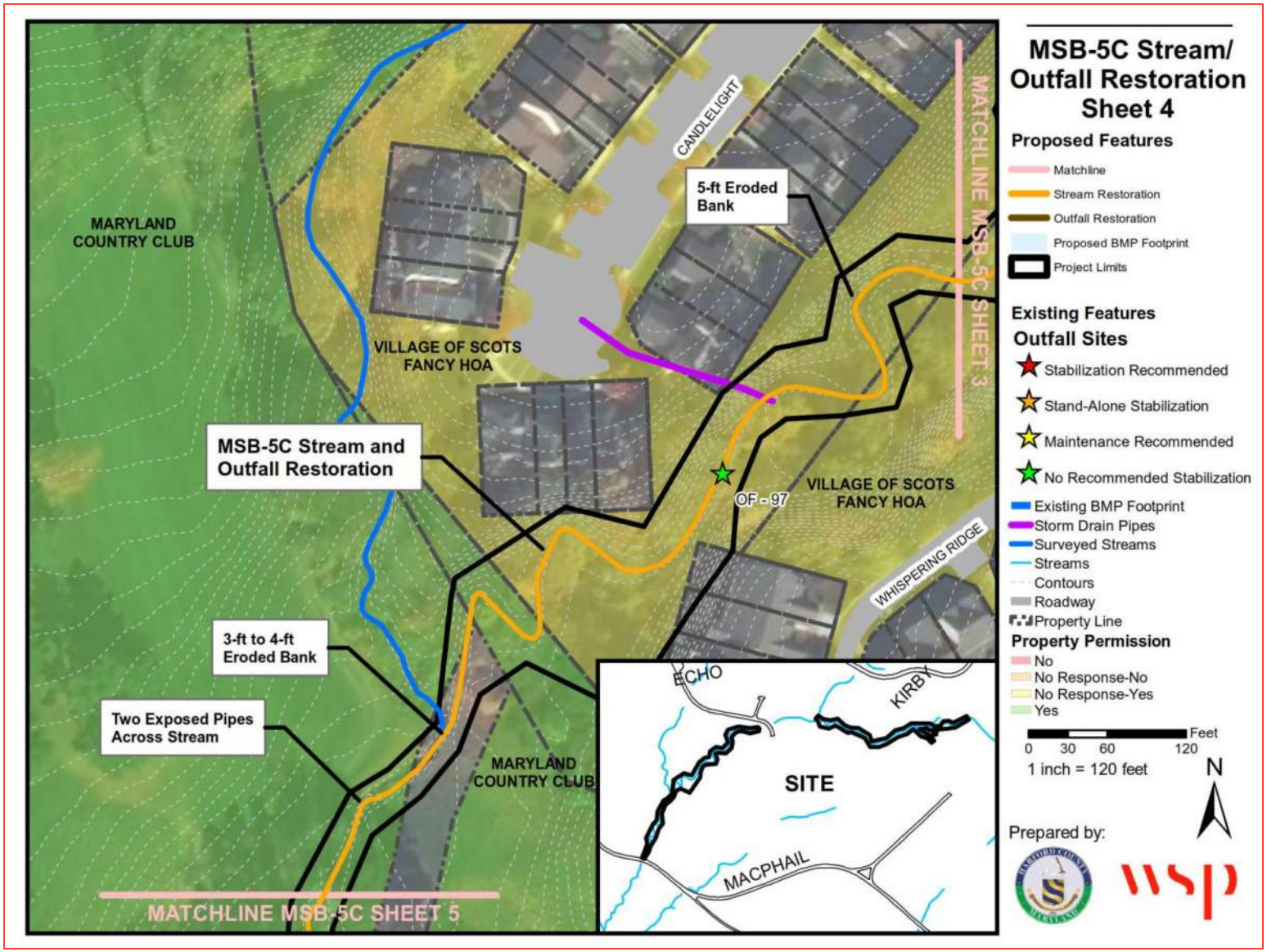

Figure C-74: Site Location and Proposed Project Plan for MSB-5C Stream and Outfall Restoration (Sheet 4 of 5)

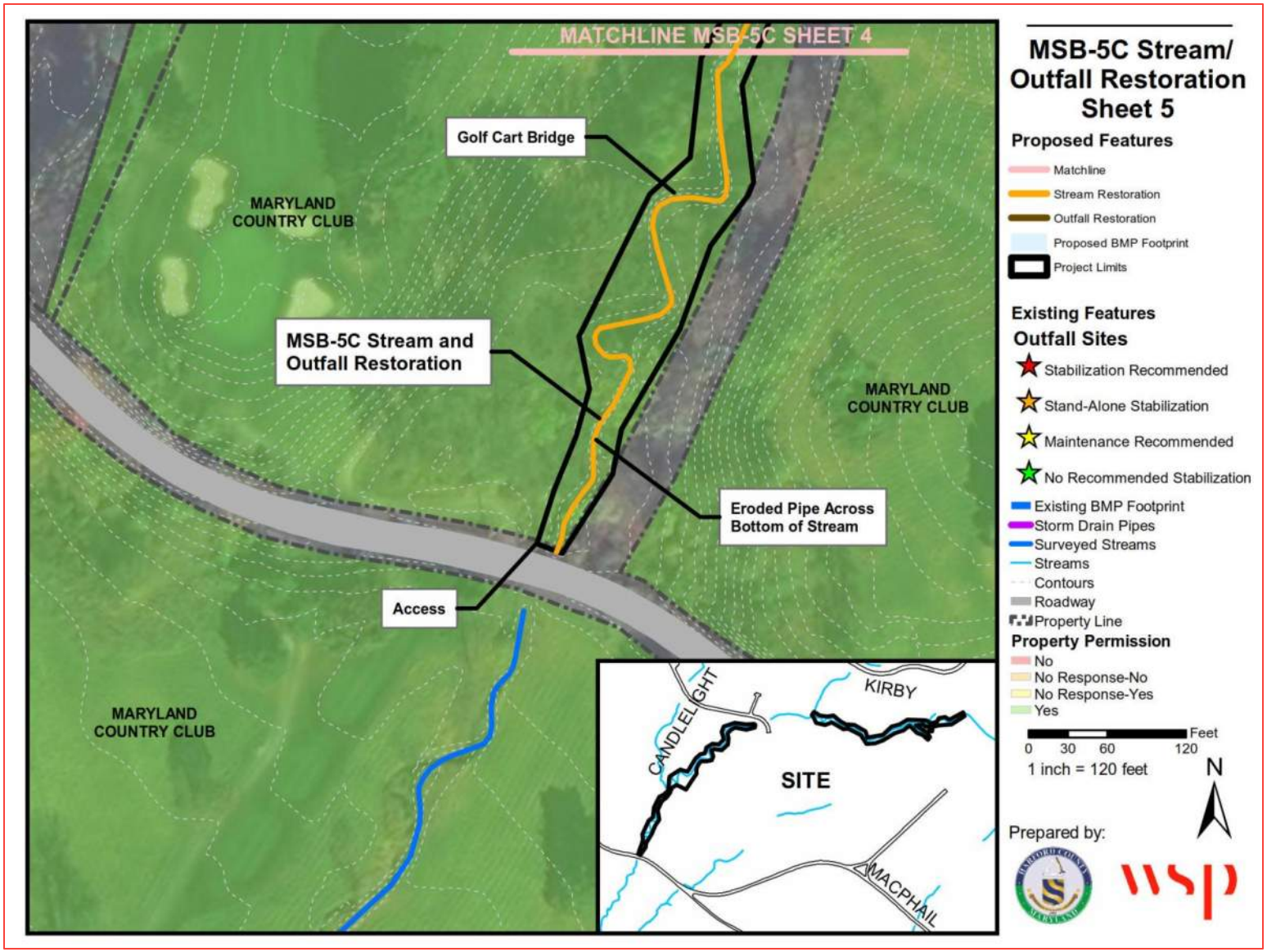

Figure C-75: Site Location and Proposed Project Plan for MSB-5C Stream and Outfall Restoration (Sheet 5 of 5)

MSB-5D STREAM AND OUTFALL RESTORATION

Project Description	Restore 3,354 linear feet of stream and stabilize 216 feet of outfall channel • Outfall 82: Stabilize 47 feet • Outfall 85: Stabilize 79 feet • Outfall 175: Stabilize 90 feet
Location	Kings Charter HOA: near David Drive
Property Ownership	One Private Property and One Public Property
Length of Project	3,354 feet of stream restoration and 216 feet of outfall restoration
Potential Impervious Acres Treated	102.76 Acres
Potential Load Reductions TP	228.10 lbs/yr
Potential Load Reductions TN	251.58 lbs/yr
Potential Load Reductions TSS	150,615 lbs/yr
Estimated Design/Construction Costs	$1,969,700 $19,168/impervious acres treated
Adjacent Projects	None

Site Description

Project MSB-5D is bordered by Inglewood Road to the northeast, David Drive to the south, and Patterson Mill Junior High School to the west. It proposes 3,354 feet of stream restoration on two converging headwater streams as well as three outfall stabilization projects, outfalls 82, 85, and 175. From the upstream limit of the mainstem of Project MSB-5D, stream banks experience an average of 3 feet for 800 feet (Figure C-76, left). An inadequate buffer develops on the right bank for approximately 200 feet, within the first 800 feet of the project. For the next 480 feet, the exposed stream banks increase to 5 feet. Eroded banks increase in height from 5 feet to 7 feet for the next 1000 feet of stream channel (Figure C-76, right).

Figure C-76: Left bank moderate severity with an average of 3 feet exposed banks (left); Severe Severity Erosion on the right and left banks at 7 feet exposed bank heights (right)

The channel slope decreases for the last 800 feet of stream, the stream channel widens, and the bank heights decrease to 3 feet. The tributary has average exposed banks of 4 feet (Figure C-77, left).

Figure C-77: Moderate eroded banks with an average exposed bank height of 4 feet in the second tributary (left); Erosion downstream of Outfall 79 at the confluence with the main stem (right)

Although the structures of all six of the proposed outfall stabilization projects are in good condition, there is evidence of active erosion occurring in and damage to the outfall channels connecting the outfalls to the streams, despite the presence of outfall protection at each of the sites. Outfall 175 is approximately 1800 feet downstream of the beginning of MSB-5D, main stem. The outfall is a 30-inch RCP pipe with a concrete endwall. A sediment basin, to the left of the outfall, receives a portion of the flow leaving the outfall; however, the majority of the runoff flows over gabion basket outfall protection to a severely incised outfall channel. At the end of the gabion basket, a headcut lowers the outfall channel by 3.5 feet. There is 2-foot headcut an additional 40 feet downstream. A 4-foot headcut was observed where the outfall channel ties into the stream channel (Figure C-78, right).

Outfall 82 is located 170 feet downstream of Outfall 175. Outfall 82 is an 18-inch RCP pipe with a concrete endwall. The outfall channel is lined with riprap; however, the riprap has shifted in some places, exposing the underlying geotextile material. A sediment basin is located adjacent to the outfall structure and receives a portion of the flow from the outfall. The majority of the runoff flows down the outfall channel, causing erosion and displacement of riprap. A 5-foot headcut was observed at where the outfall channel ties into the stream channel (Figure C-78, right).

Figure C-78: 3 feet exposed banks downstream of basin outlet protection for Outfall 175 (left); Outfall 82 riprap channel protection extending to the stream channel with adjacent erosion (right)

Outfall 85 is located along the tributary, approximately 165 feet downstream of the start of the project. The outfall is a 30-inch RCP pipe with a concrete endwall. A sediment basin is located at the outfall and is in poor condition. The outfall basin is surrounded by a wooden fence, is overgrown with trees and shrubs, and is filled with sediment. Approximately 65 feet downstream of the outfall, the outfall channel experiences a 2-foot headcut along with steep slopes. Riprap in this section of the outfall channel has been pushed downstream, revealing the underlying geotextile material (Figure C-79). Another 3.5-foot headcut was observed where the outfall channel ties in with the stream.

Figure C-79: Exposed geotextile and missing riprap along steep section of Outfall 85 channel

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-5D, Main Stem*: 2,849 feet from Outfall 173 to SWM000363.
  - *MSB-5D, Tributary*: 505 feet from Outfall 176 to SWM000363.
- **Outfall Stabilization**
  - *Outfall 82*: Remove sediment and small trees from water quality basin and stabilize 47 feet of outfall channel from edge of water quality basin to the stream channel
  - *Outfall 85*: Remove sediment and trees from water quality basin and stabilize 79 feet of outfall channel from the edge of the water quality basin to the stream channel
  - *Outfall 175*: Remove sediment and trees from water quality basin and stabilize 90 feet of outfall channel from the edge of the water quality basin to the stream channel.
- Proposed project plans are shown in Figure C-80, Figure C-81, Figure C-82, and Figure C-83.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There is one private property owner and one public property owner along this reach. Coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. It is recommended that the County try to obtain buy in after conceptual design level.

- Public: Board of Education of Harford County
- Private: HOA, Kings Charter Homeowners Association Inc.

Access

- Good Access at Patterson Mill Junior High School for stream restoration and Outfall 79 maintenance.

- Good Access at 1817 Bayonne Court along stormwater easement for stream restoration and Outfall 82 and Outfall 175 stabilization.
- Good Access behind 535 Inglewood Drive at stormwater easement for stream restoration and Outfall 85 stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-30. Three outfall stabilization projects, totaling 216 linear feet are recommended alongside 3,354 linear feet of stream restoration. The construction of 3,354 linear feet of stream restoration and 216 feet of outfall stabilization in this project will treat 102.76 impervious acres within the watershed. This treatment amount accounts for approximately 7.8% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,969,700 for the MSB-5D Stream and Outfall Restoration project. This cost estimate includes one small outfall stabilization project, two medium outfall stabilization projects, and a large stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-31.

Table C-30: Summary of Improvements for MSB-5D Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-82	1.2	0.6	47	0.47	-	-	-
	OF-85	4.2	1.5	79	0.79	-	-	-
	OF-175	6.8	3.0	90	0.90	-	-	-
Stream	MSB-5D	95.32	15.23	3,354	100.6	251.58	228.10	150,615
Total Credit/ Reductions				**3,670.6**	**102.76**	**251.58**	**228.10**	**150,615**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions equal restoration length times 44.9 lbs/ft/yr

Table C-31: Summary of Project Costs for MSB-5D Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-82	Small	$25,000	Project	$25,000	
	OF-85	Medium	$50,000	Project	$50,000	
	OF-175	Medium	$50,000	Project	$50,000	
Stream	MSB-5D	Large	$550	L.F.	$1,844,700	$18,337
Total Costs					**$1,969,700**	**$19,168**

*Project cost divided by stream restoration impervious area treated

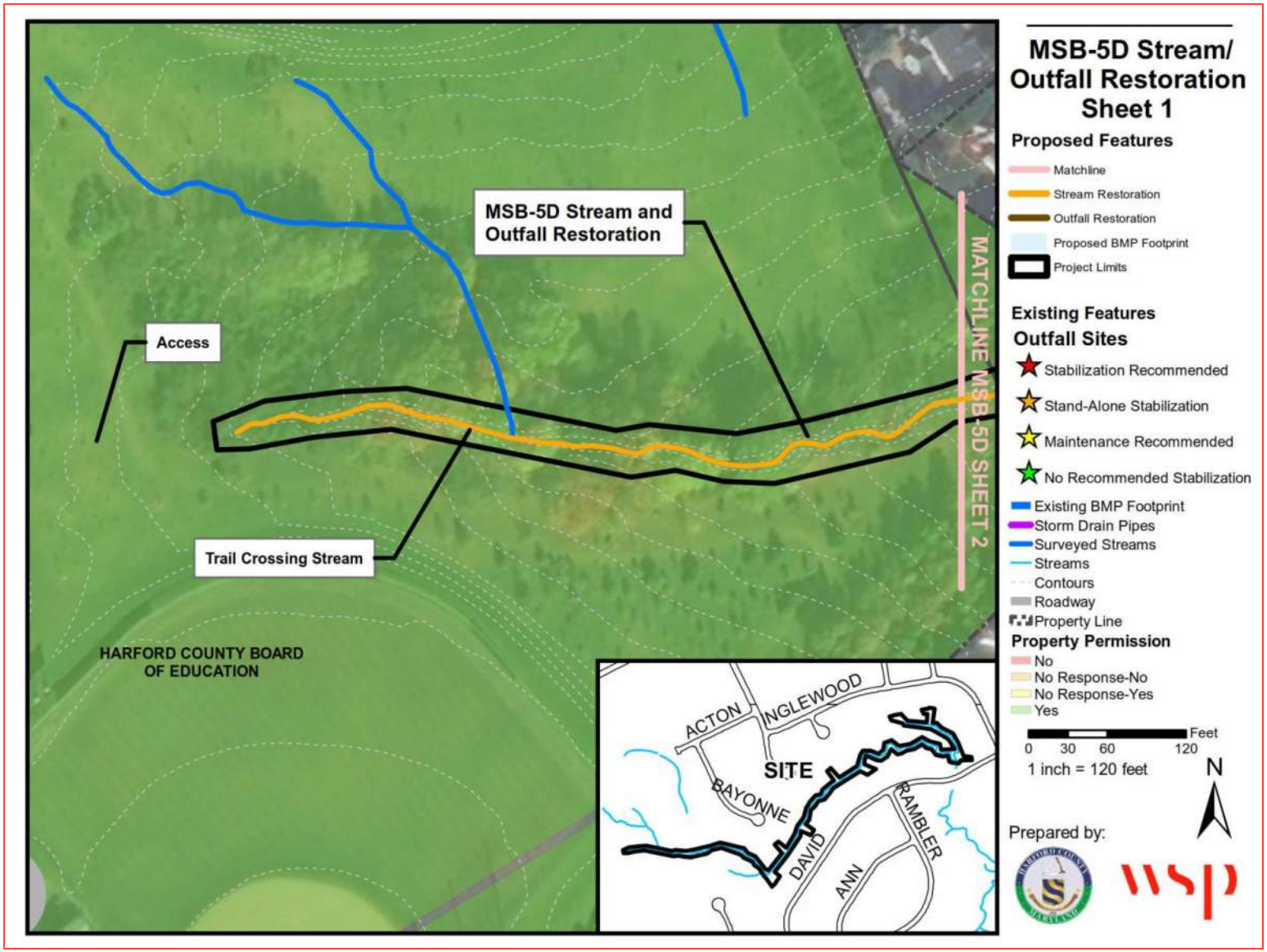

Figure C-80: Site Location and Proposed Project Plan for MSB-5D Stream and Outfall Restoration (Sheet 1 of 4)

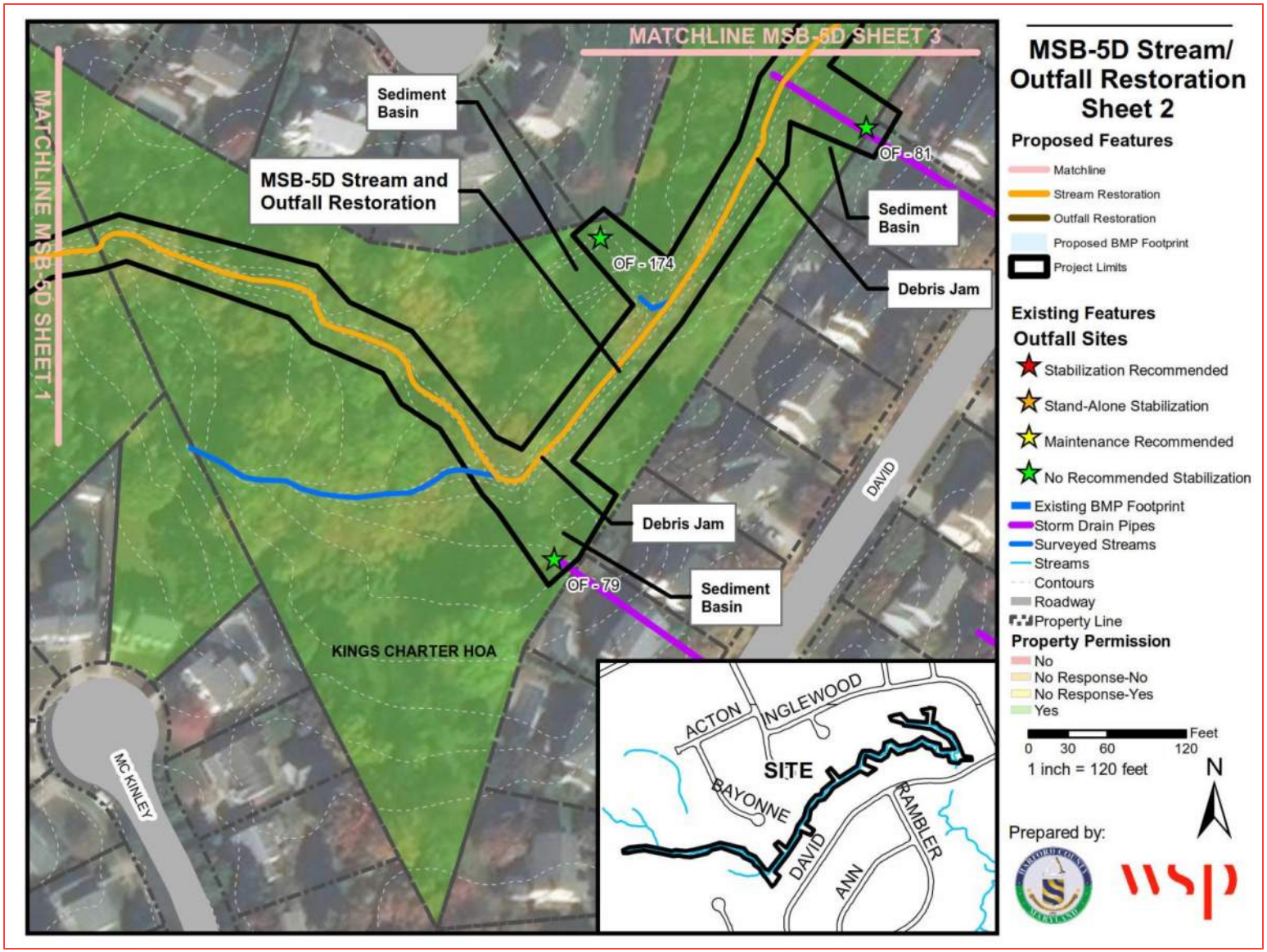

Figure C-81: Site Location and Proposed Project Plan for MSB-5D Stream and Outfall Restoration (Sheet 2 of 4)

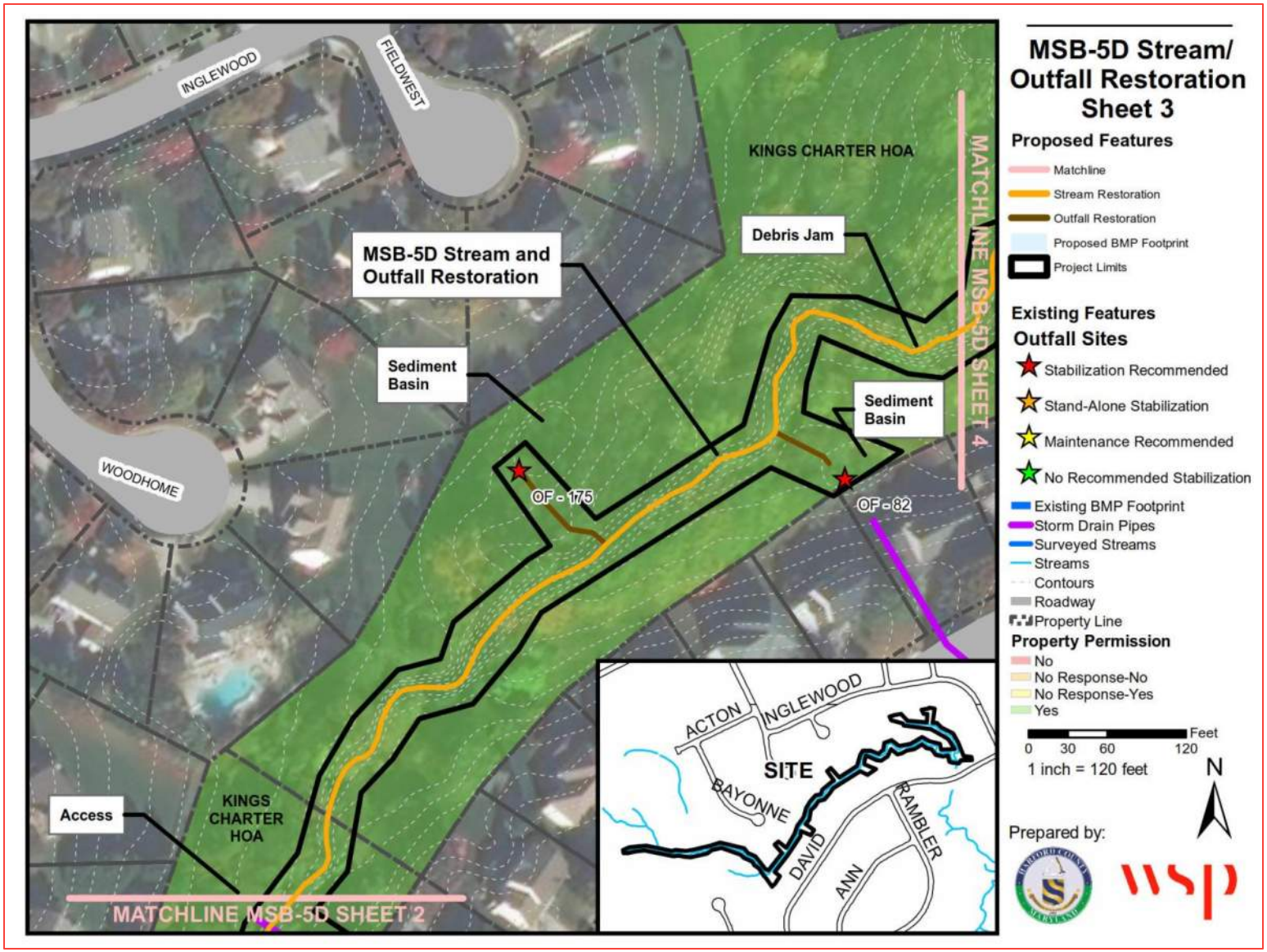

Figure C-82: Site Location and Proposed Project Plan for MSB-5D Stream and Outfall Restoration (Sheet 3 of 4)

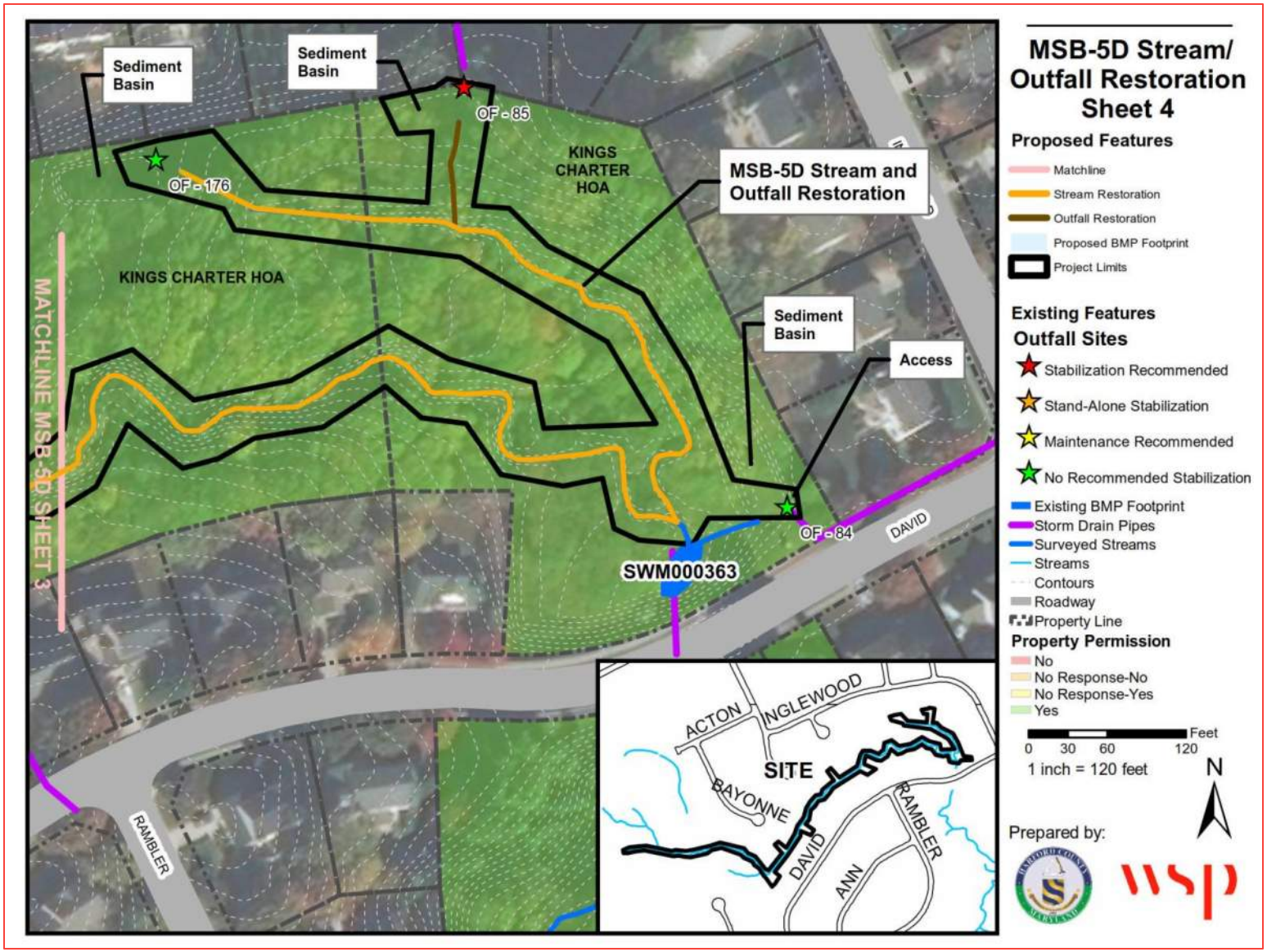

Figure C-83: Site Location and Proposed Project Plan for MSB-5D Stream and Outfall Restoration (Sheet 4 of 4)

MSB-5E STREAM RESTORATION

Project Description	Restore 743 feet of stream.
Location	South of Inglewood Road and North of David Drive
Property Ownership	One Private Property
Length of Project	743 feet of stream restoration
Potential Impervious Acres Treated	22.28 Acres
Potential Load Reductions TP	50.49 lbs/yr
Potential Load Reductions TN	55.69 lbs/yr
Potential Load Reductions TSS	33,339 lbs/yr
Estimated Design/Construction Costs	$556,980 $24,995/impervious acres treated
Adjacent Projects	None

Site Description

Project MSB-5E is located east of Patterson Mill Road and contains 743 feet of stream restoration. From the upstream limit, approximately 225 feet of stream has an average exposed height of 3 feet (Figure C-84, left). There is an exposed pipe crossing above the stream bed within this section which is vulnerable to debris impacts during storm events. An additional 165 feet of stream banks are eroded 6 feet high (Figure C-84, right).

Figure C-84: 3-foot vertical exposed heights on the left and right banks and exposed pipe. (left); Right bank erosion with a height of 6 foot banks (right)

Approximately 260 feet downstream of the start of the project, the stream bank curves around a private property pond and private residence. The left stream bank has been stabilized with riprap and is in good condition. The stream near the pond and residence is unshaded due to mowing up to the stream bank (Figure C-85, left). A bridge for the private residence crosses the stream 110 feet upstream of the end of the project area. Erosion and sediment deposition is occurring upstream of the bridge crossing. The

remaining 110 feet of stream have exposed banks 4 feet high at the edge of a horse pasture. The stream has eroded and shifting, requiring the posts to be placed in the stream channel (Figure C-85, right).

Figure C-85: Residential pipe outfalls and inadequate buffer at the back of residential property (Left); Moderate severity bank erosion with an average of 4 feet exposed bank height on both banks (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-5E, Main Stem*: 743 feet from southwestern corner of 445 Patterson Mill Road to 131 feet upstream of the property line of 445 Patterson Mill Road.
- Proposed project plans are shown in Figure C-86.

Threats to Infrastructure

- An exposed pipe with an unknown use is threatened due to its height above the stream channel bottom. This makes it more vulnerable to debris impacts.
- A private pond embankment has been reinforced with riprap where the stream runs along the pond embankment. Erosion may threaten the pond embankment.
- A private driveway bridge crosses the stream. Significant erosion has widened the channel upstream of the bridge and will impact the bridge in the future.

Property Ownership

There is one private property owner along this reach. Buy in from this property owner at the beginning of the project is necessary for the successful completion of the restoration design. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: 445 Patterson Mill Road

Access

- Good Access on 445 Patterson Mill Road for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-32. This project recommends 742.52 linear feet of stream restoration. The construction of 742.52 linear feet of stream restoration in this project will treat 22.28 impervious acres within the watershed. This treatment amount accounts for approximately 1.7% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $556,890 for the MSB-5E Stream Restoration project. This cost estimate includes one small stream restoration project. Cost estimates for each project type are described at beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-33.

Table C-32: Summary of Improvements for MSB-5E Stream Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-5E	147.23	24.82	742.52	22.28	55.69	50.49	33,339
Total Credit/ Reductions				**742.52**	**22.28**	**55.69**	**50.49**	**33,339**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-33: Summary of Project Costs for MSB-5E Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-5E	Small	$750	L.F.	$556,890	$24,995
Total Costs					**$556,890**	**$24,995**

*Project cost divided by stream restoration impervious area treated

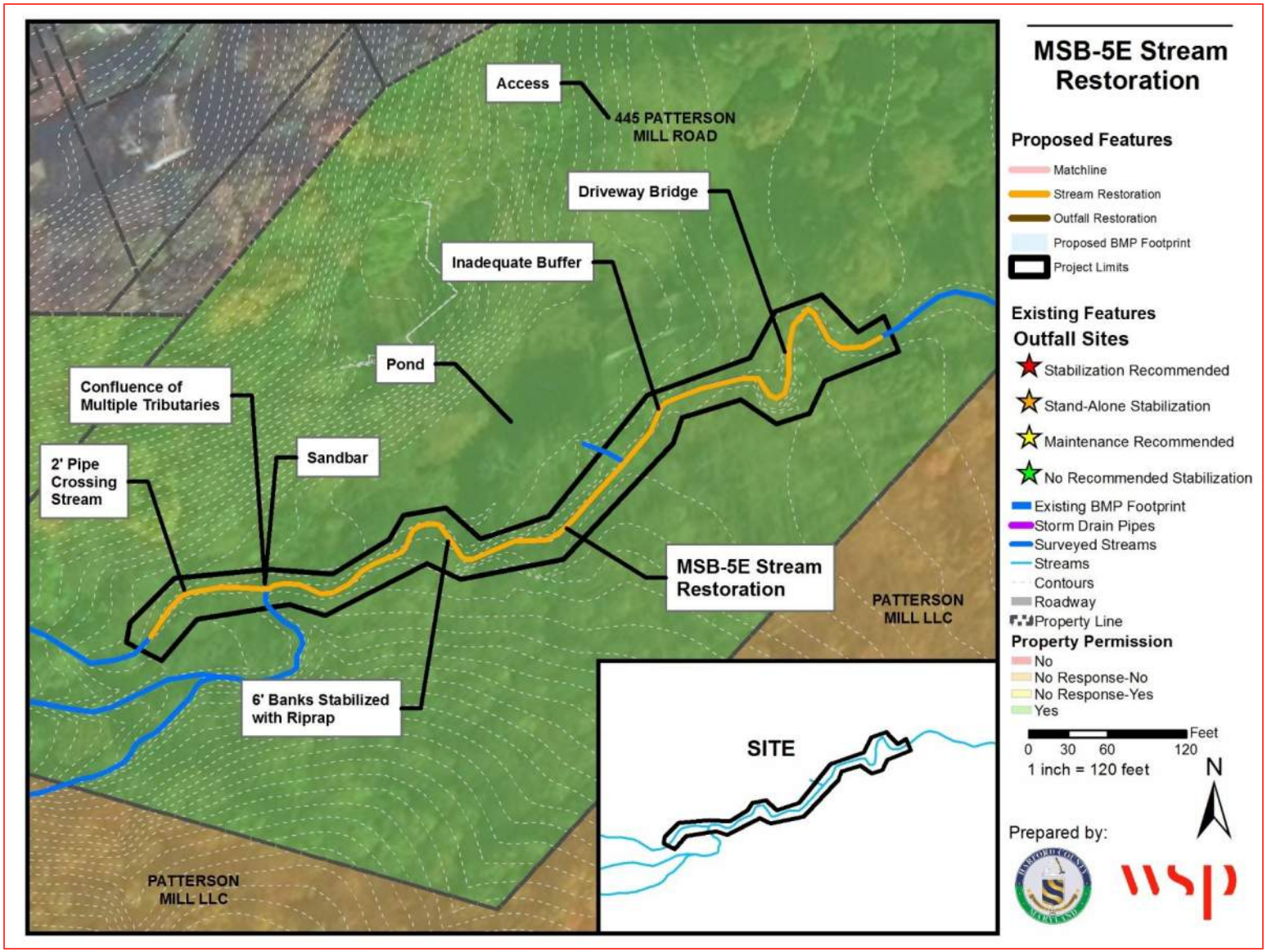

Figure C-86: Site Location and Proposed Project Plan for MSB-5E Stream Restoration (Sheet 1 of 1)

MSB-5F OUTFALL RESTORATION

Project Description	Stabilize 90 feet of channel at Outfall 80
Location	Between 435 Rambler Road and 437 Rambler Road
Property Ownership	Two private properties
Length of Project	90 feet of outfall stabilization
Potential Impervious Acres Treated	0.90 Acres
Potential Load Reductions TP	N/A
Potential Load Reductions TN	N/A
Potential Load Reductions TSS	N/A
Estimated Design/Construction Costs	$100,000 $111,111/impervious acres treated
Adjacent Projects	N/A

Site Description

The upstream limit of MSB-5F is located behind the private residences of 435 Rambler Road and 437 Rambler Road. It proposes a stand-alone stabilization of 90 feet of channel at outfall 80. The outfall consists of a 30-inch diameter RCP with a concrete end section. The manhole structure is cracked with exposed rebar and the end section is no longer connected to the RCP (Figure C-87, left). The outfall protection consists of a gabion mattress, with riprap displaced and a fence missing at the overflow location (Figure C-87, right).

Figure C-87: Outfall 80 (left); Gabion mattress at outfall (right)

At the outfall, there is a sediment basin covered in leaf litter (Figure C-88, left). There is severe erosion in the downstream channel for the 80 feet until the channel's confluence with the receiving stream (Figure C-88, right).

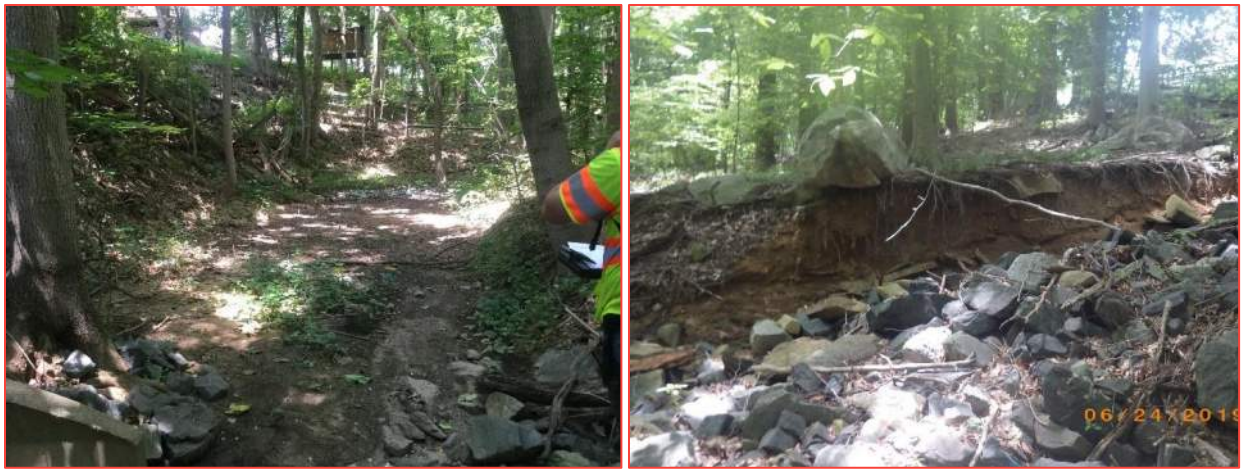

Figure C-88: Sediment basin (left); Severe erosion downstream of outfall 80 (right).

Recommended Restoration Actions

- **Outfall Stabilization**
  - *Outfalls 80:* Fill in sediment basin, replace drop structure with 6-foot deep drop structure, install plunge pool, grade outfall channel and line with riprap protection.
- Proposed project limits are shown in Figure C-89.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are two private property owners along this reach and coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the outfall and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Kings Charter Homeowners Association Inc.
- Private: 435 Rambler Road
- Private: 437 Rambler Road

Access

- Moderate Access between 435 Rambler Road and 437 Rambler Road for outfall stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-34. The construction of 90 linear feet of outfall stabilization in this project will treat 0.9 impervious acres within the watershed. This treatment amount accounts for approximately 0.07% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $100,000 for the MSB-5F Outfall Restoration project. This cost estimate includes one large outfall stabilization project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-35.

Table C-34: Summary of Improvements for MSB-5F Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-80	14.1	4.76	90	0.90	-	-	-
Stream								
Total Credit/ Reductions				**90**	**0.90**			

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-35: Summary of Project Costs for MSB-5F Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-80	Large	$100,000	Project	$100,000	
Stream						
Total Costs					**$100,000**	**$111,111**

*Project cost divided by stream restoration impervious area treated

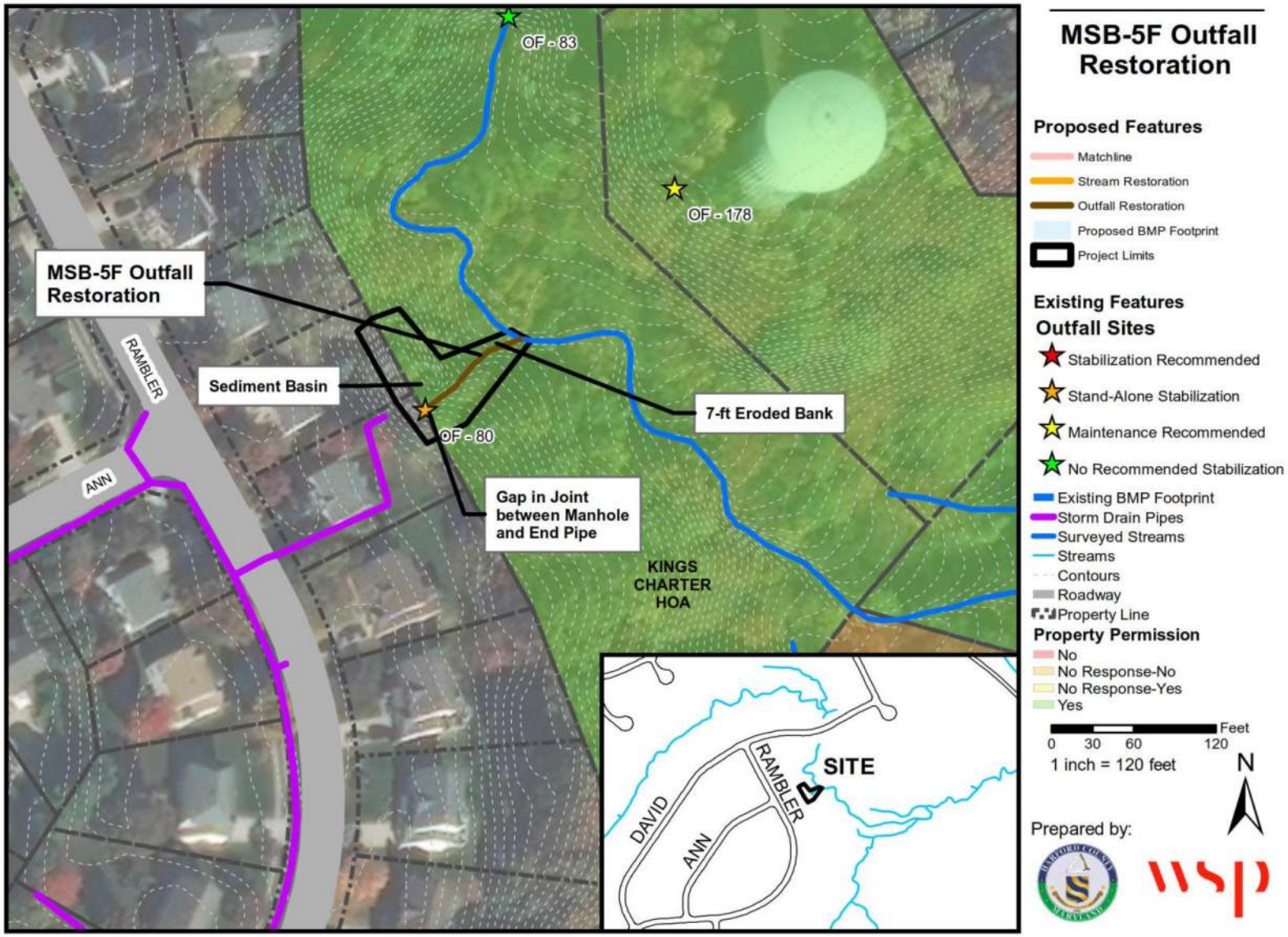

Figure C-89: Site Location and Proposed Project Plan for MSB-5F Outfall Restoration

MSB-6A STREAM RESTORATION

Project Description	Restore 2,649 feet of stream
Location	South of Fountain Glen Drive, West of Fountain Glen Drive
Property Ownership	Six Private Properties
Length of Project	2,649 feet of stream restoration
Potential Impervious Acres Treated	79.46 Acres
Potential Load Reductions TP	180.10 lbs/yr
Potential Load Reductions TN	198.64 lbs/yr
Potential Load Reductions TSS	118,919 lbs/yr
Estimated Design/Construction Costs	$1,781,850 $21,669/impervious acres treated
Adjacent Projects	None

Site Description

Project MSB-6A is comprised of two segments of stream, totaling 2,649 feet. The first segment is located southeast of Fountain Glen Drive and contains 1,752 feet of proposed stream restoration and five outfalls. Four of the outfalls (141, 143, 144, and 145) have eroded at the end of the outfall protection (Figure C-90 & Figure C-91).

Figure C-90: Eroded end of outfall protection for Outfall 141 (left); Outfall 143 (right).

Figure C-91: Eroded end of outfall protection for Outfall 144 (left): Outfall 145 (right).

Along the right bank, the entire length of MSB-6A has bank heights of 7 feet (Figure C-92, left). The first 606 feet of the left side have average exposed bank heights of 2 feet while the remaining stream reach has banks averaging 5 feet high (Figure C-92, right).

Figure C-92: Severe erosion along the right bank (left); Low severity along the left bank (right)

The second segment is located west of Fountain Glen Drive and south of Streamview Court. It contains 897 feet of proposed stream restoration and two outfalls. One outfall, OF 184, is an outfall from a SWM facility and is in good condition but due to its proximity to the stream could be included in the stream restoration (Figure C-93, left). Approximately 150 feet upstream of MSD-6A, there are two outfalls conveying flow from a neighborhood and the stream. The outfall channel is protected with gabion baskets and does not need stabilization. The first 178 feet of the left side and 66 feet of the right side of MSB-6A, Segment 2, have average exposed bank heights of 3 feet (Figure C-93, right).

Figure C-93: Outfall 184 from SWM facility (left); Left bank low severity erosion (right)

Continuing downstream, there are 241 feet on the left bank and 481 feet on the right bank of severe erosion containing 8 feet and 9 feet average exposed bank heights, respectively (Figure C-94, left). The last 353 feet of the left bank and last 214 feet of the right bank have minor erosion and average exposed bank heights of 3ft (Figure C-94, right).

Figure C-94: Left bank severe erosion (left); Right bank minor erosion (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-6A, Segment 1*: 1,752 feet from Outfall 181 to 496 feet upstream of SWM000163.
  - *MSB-6A, Segment 2*: 897 feet from Outfall 134 and Outfall 132 to 1138 Starmount Court.
- Proposed project plans are shown in Figure C-95, Figure C-96, Figure C-97, and Figure C-98.

Threats to Infrastructure

- Due to the proximity of a sanitary sewer line along the profile of the steam, any meandering from the stream profile could expose the line and risk the line's stability.

Property Ownership

There are numerous private property owners along this reach. Coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Fountain Glen Homeowners Association Inc.
- Private: 606 Carloway Place
- Private: 1138 Starmount Court
- Private: 1140 Starmount Court
- Private: HOA, Emerald Hills Community Association Inc.
- Private: HOA, Fountain Glen Homeowners Association Inc.

Access

- Good Access at the stormwater easement parallel to 610 Lochern Terrace for stream restoration and Outfall 143 and Outfall 144 stabilization.
- Good Access at the sanitary sewer easement parallel to 631 Kildonan Court for stream restoration.
- Good Access at the Open Space adjacent to 642 Gairloch Place for stream restoration.
- Good Access at the stormwater easement between 1139 and 1140 Starmount Court for stream restoration.
- Good Access at the Open Space north of 1406 Fountain Glen Drive for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-36. Stream restoration along 2,649 linear feet of stream is recommended for this project. The construction of 2,649 linear feet of stream restoration will treat 79.46 impervious acres within the watershed. This treatment amount accounts for approximately 6.0% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,781,850 for the MSB-6A Stream Restoration project. This cost estimate includes a medium stream restoration project. Cost estimates for each project type are described at beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-37.

Table C-36: Summary of Improvements for MSB-6A Stream Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-6A	169.76	47.22	2,649	79.46	198.64	180.10	118,919
Total Credit/ Reductions				**2,649**	**79.46**	**198.64**	**180.10**	**118,919**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-37: Summary of Project Costs for MSB-6A Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-6A	Medium	$650	L.F.	$1,721,850	$21,669
Total Costs					**$1,721,850**	**$21,669**

*Project cost divided by stream restoration impervious area treated

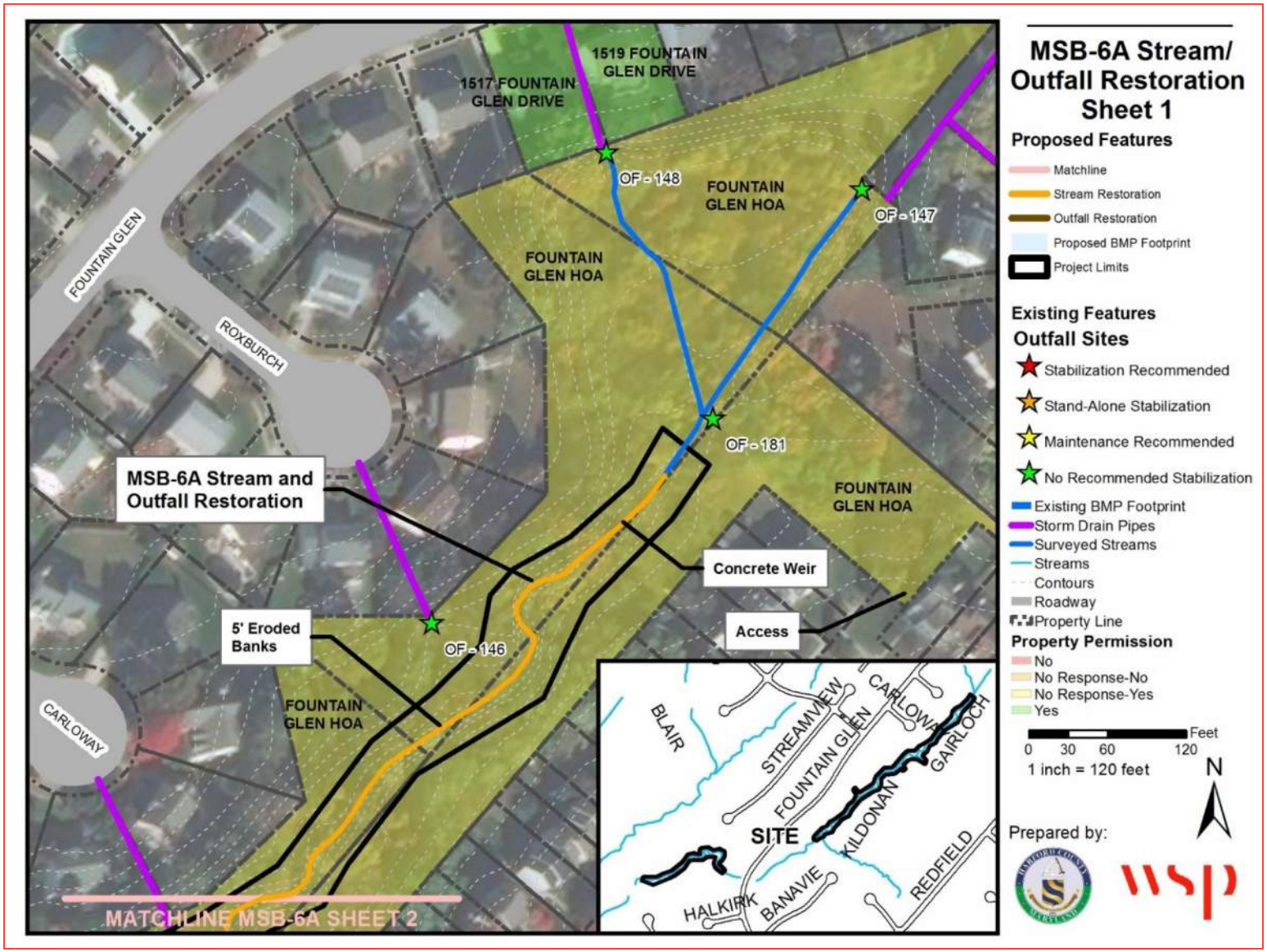

Figure C-95: Site Location and Proposed Project Plan for MSB-6A Stream Restoration (Sheet 1 of 4)

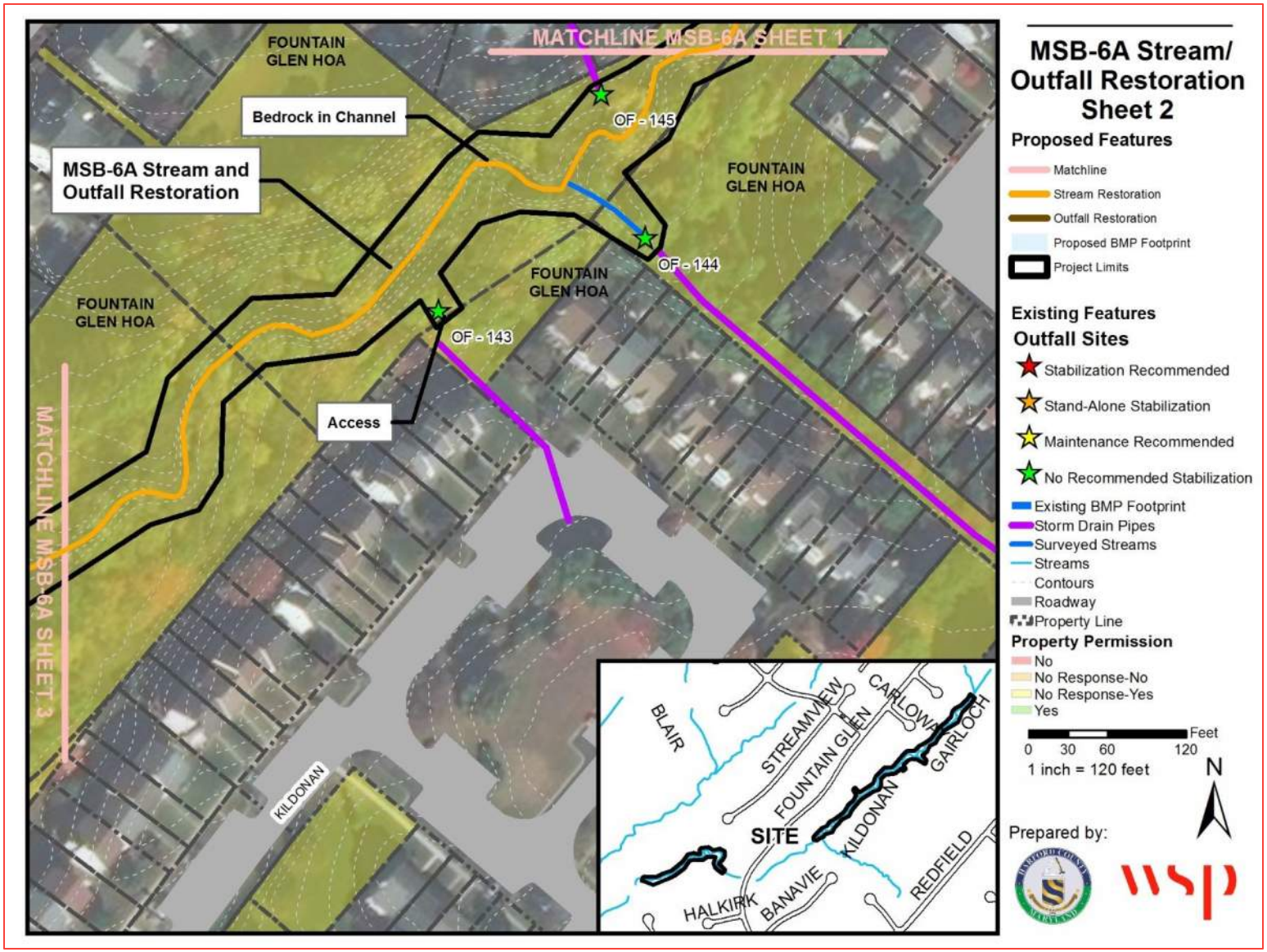

Figure C-96: Site Location and Proposed Project Plan for MSB-6A Stream Restoration (Sheet 2 of 4)

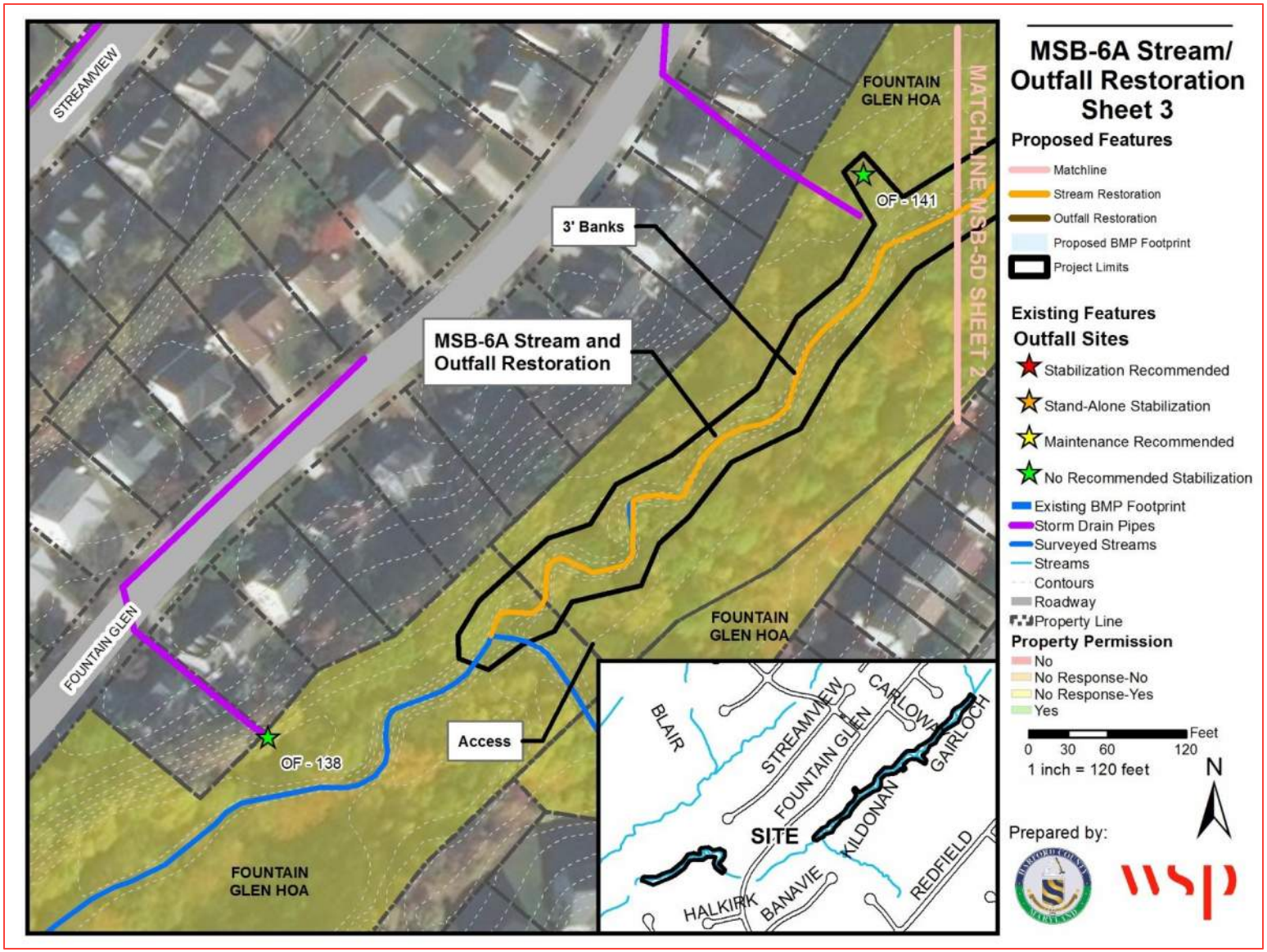

Figure C-97: Site Location and Proposed Project Plan for MSB-6A Stream Restoration (Sheet 3 of 4)

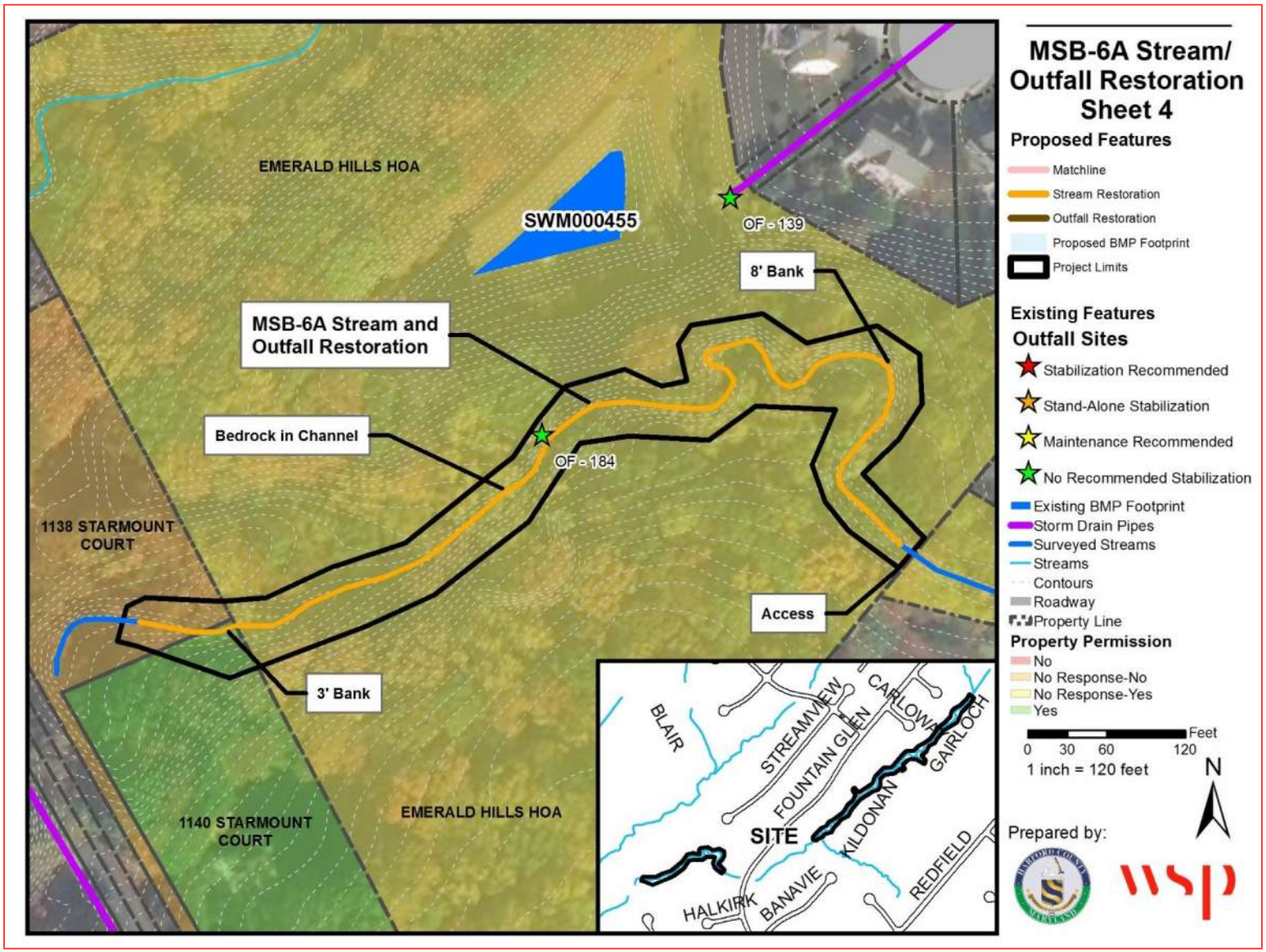

Figure C-98: Site Location and Proposed Project Plan for MSB-6A Stream Restoration (Sheet 4 of 4)