HARFORD COUNTY DPW

LOWER BYNUM RUN

SMALL WATERSHED ASSESSMENT REPORT

DECEMBER 13, 2019




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HARFORD COUNTY DEPARTMENT OF PUBLIC WORKS

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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).

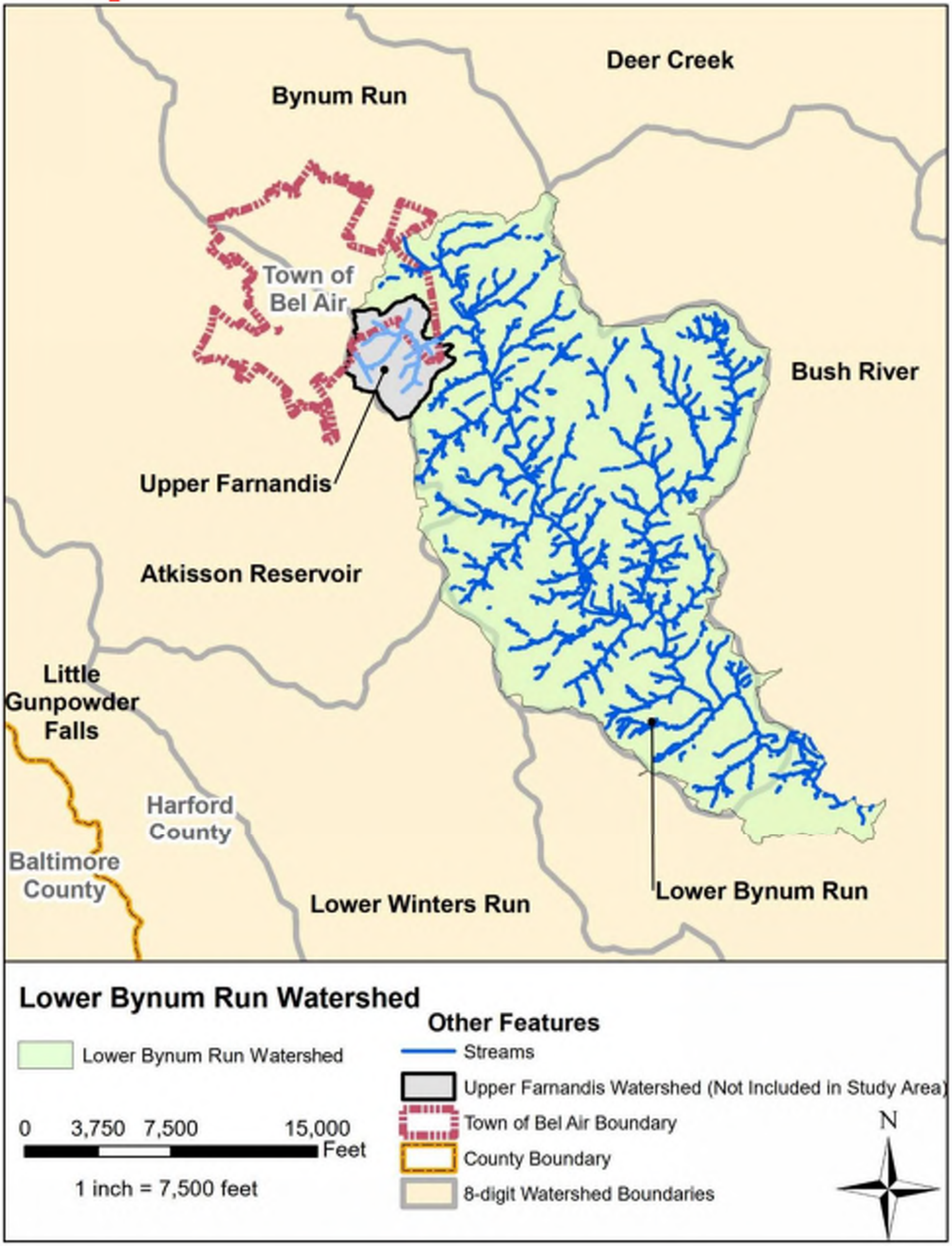

Figure 2-1. Location of Lower Bynum Run Watershed

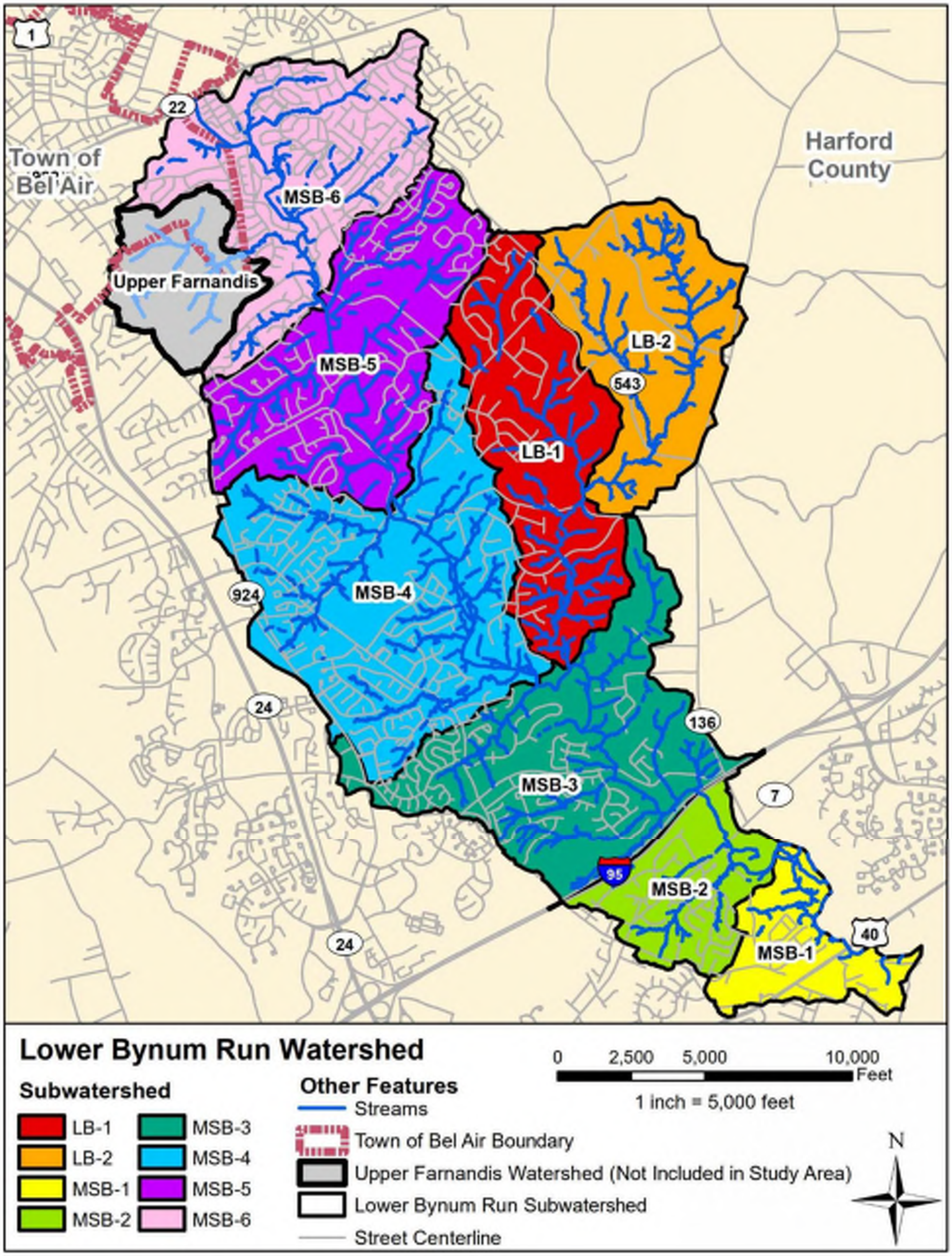

Figure 2-2: Lower Bynum Run Subwatersheds

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.

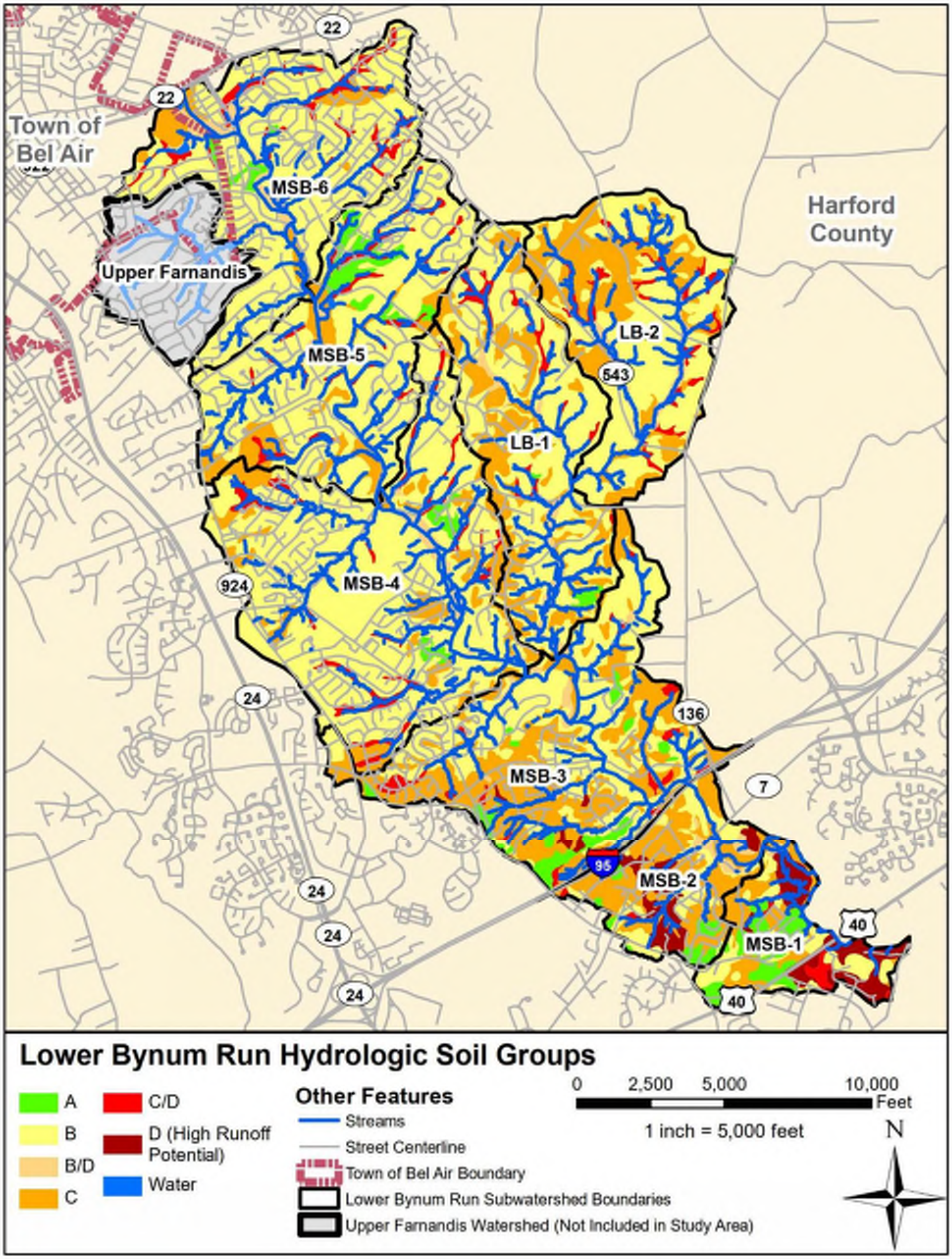

Figure 2-3. Lower Bynum Run Hydrologic Soil Groups

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%**

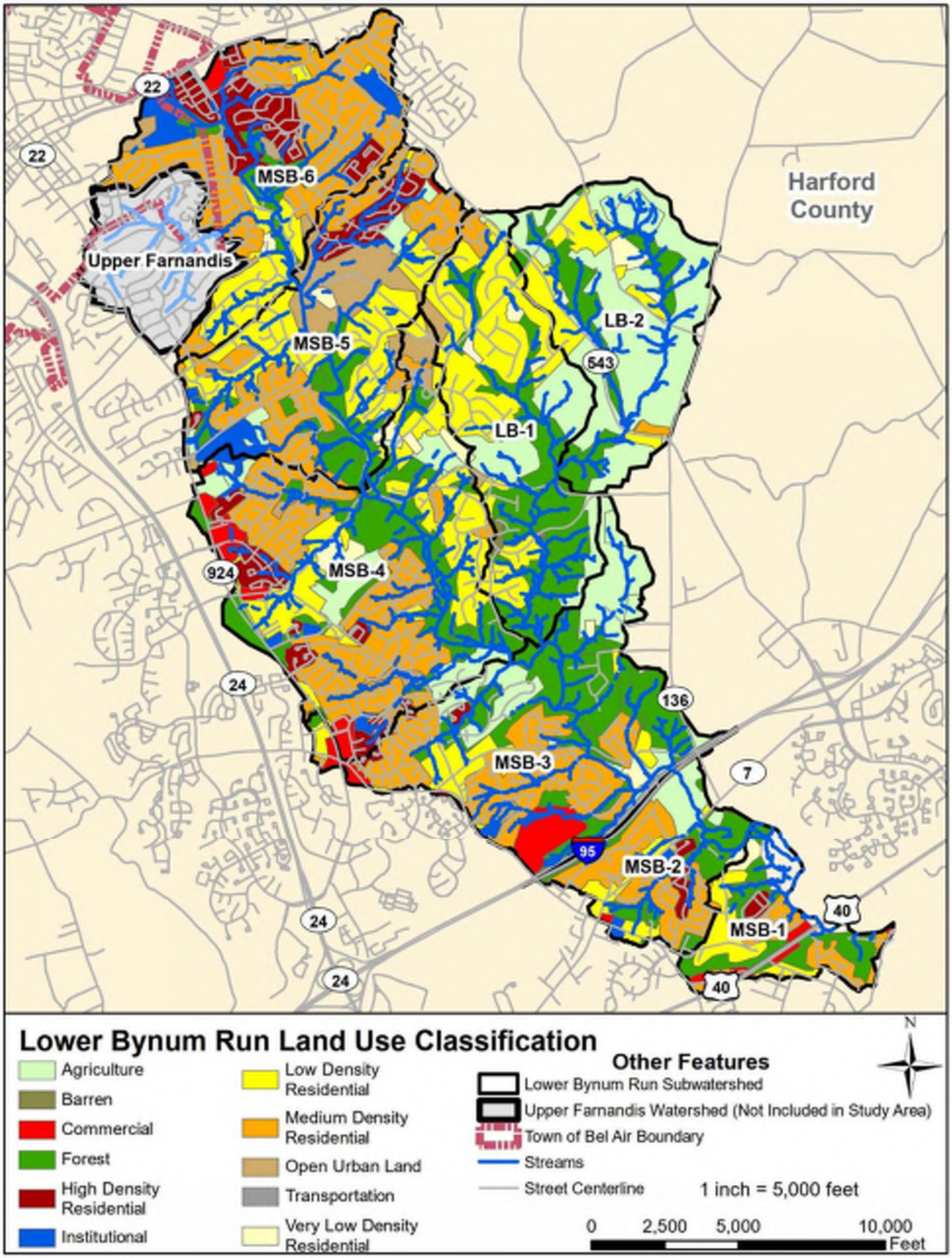

Figure 2-4. Lower Bynum Run Land Use/Land Cover

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.

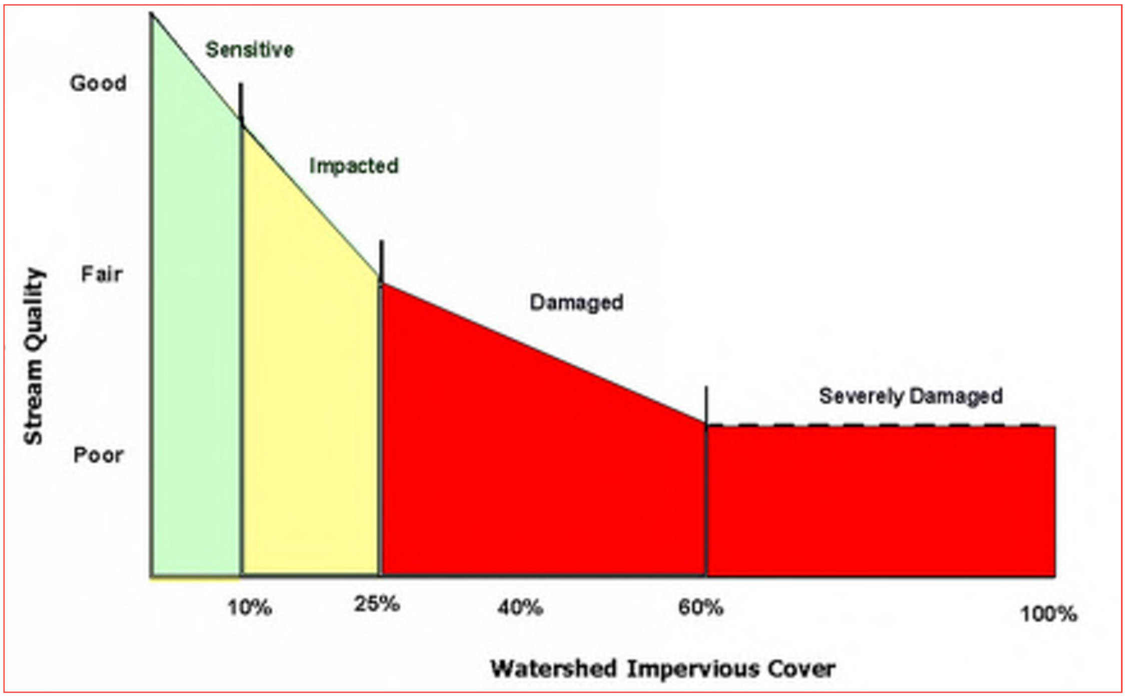

Figure 2-5. Impervious Cover Model (adapted from (CWP, 2003))

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.

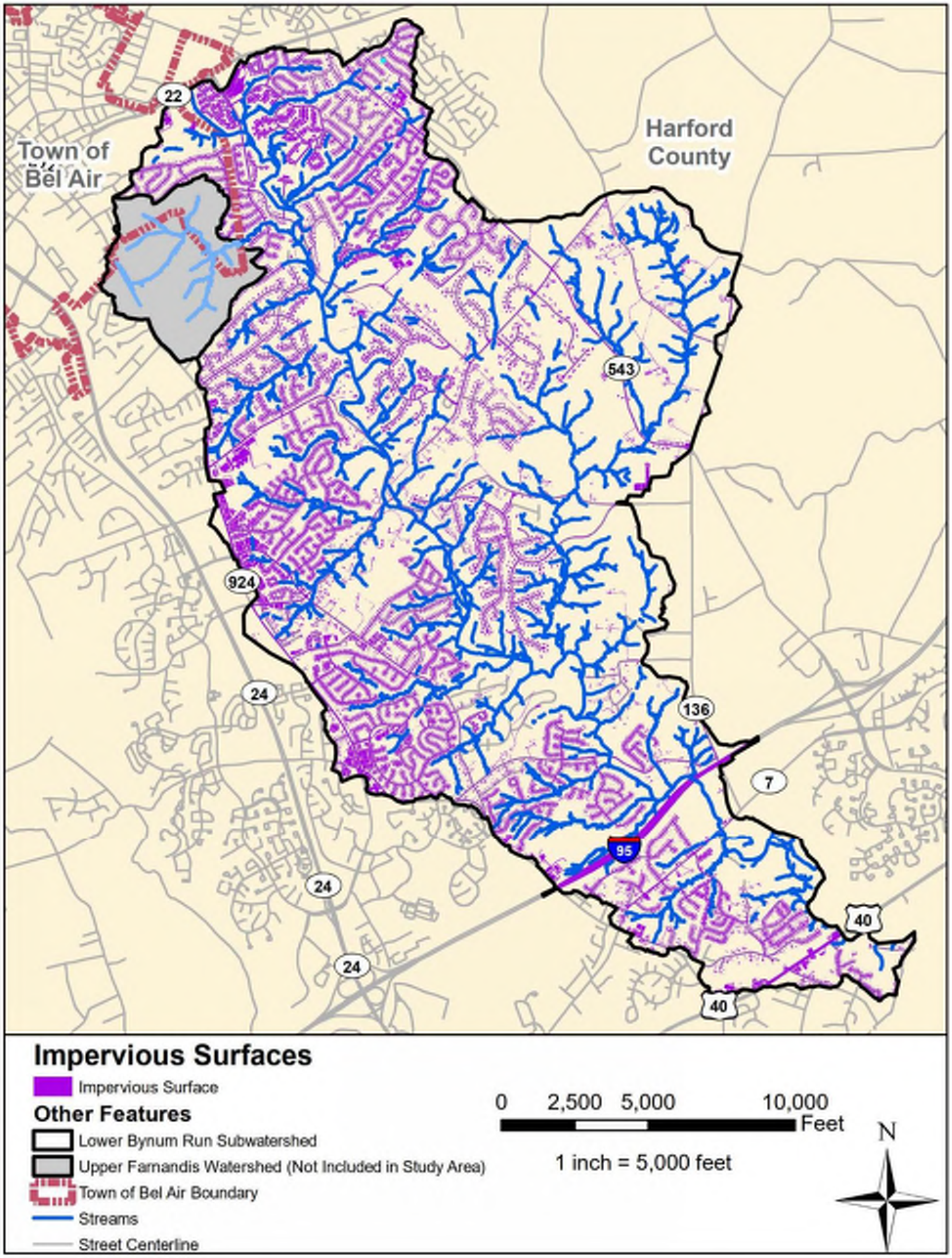

Figure 2-6. Lower Bynum Run Impervious Surfaces

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.

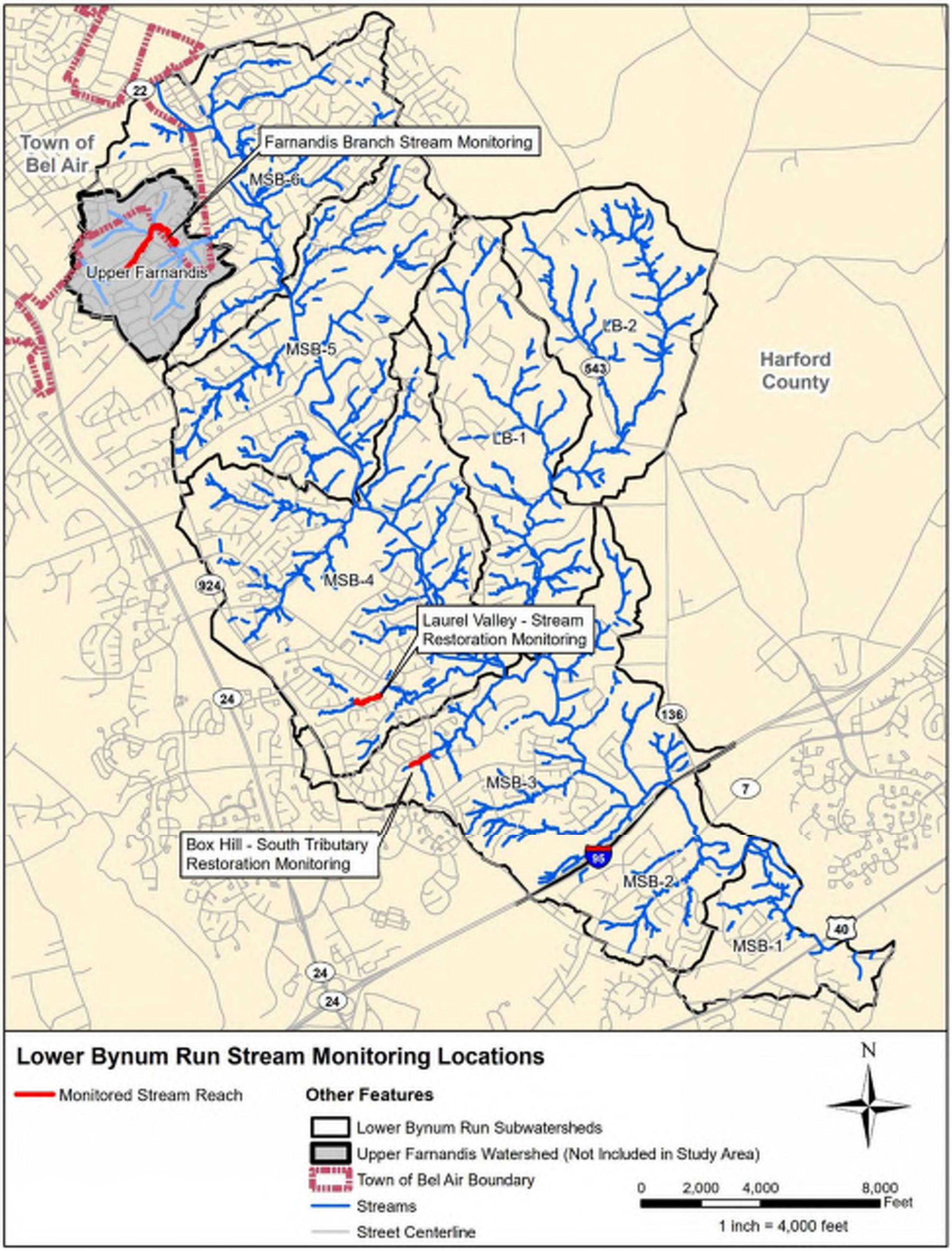

Figure 3-1. Stream Monitoring Study Locations within the Lower Bynum Run Watershed

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.

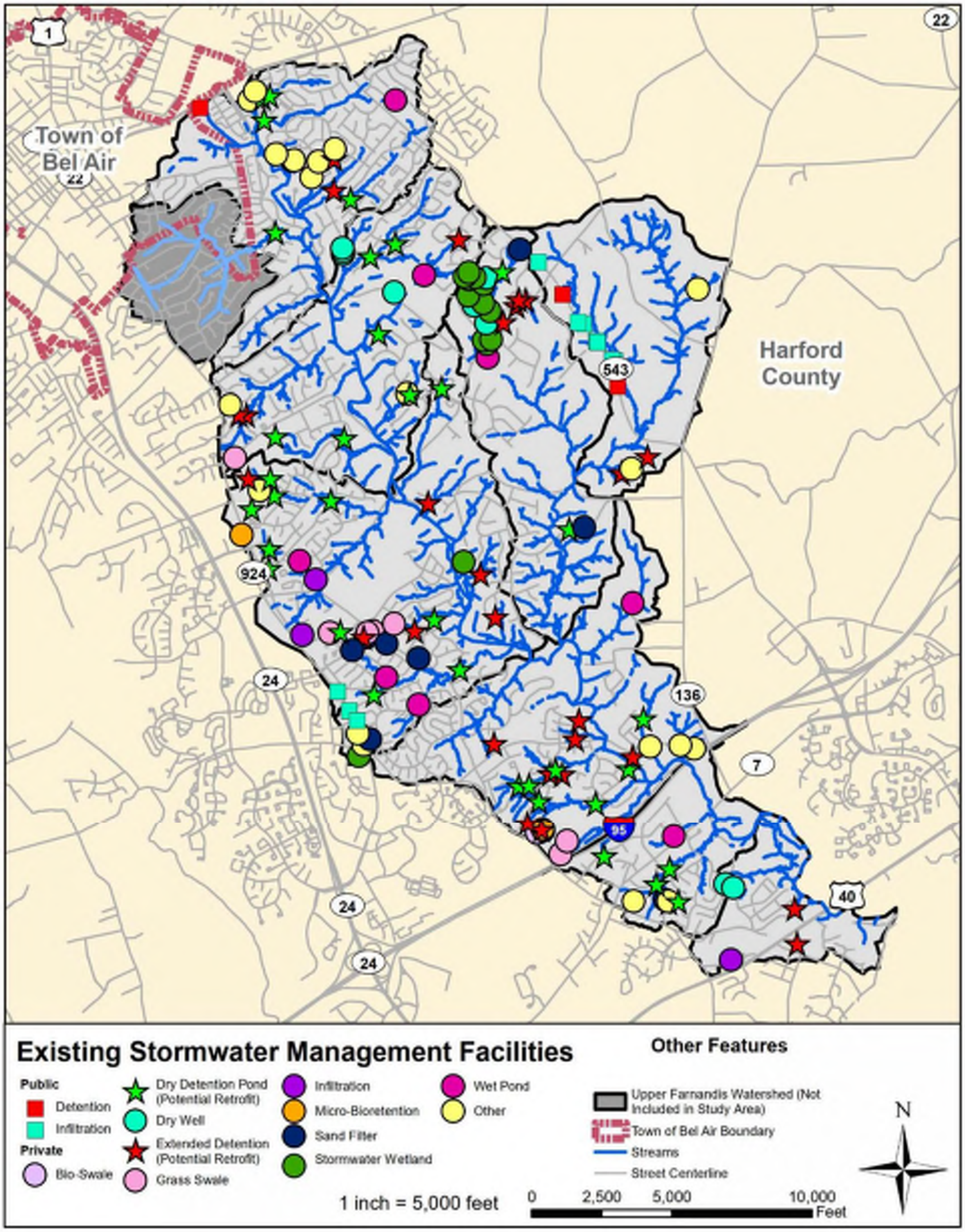

Figure 4-1. Distribution of Stormwater Management Facilities in Lower Bynum Run Watershed

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

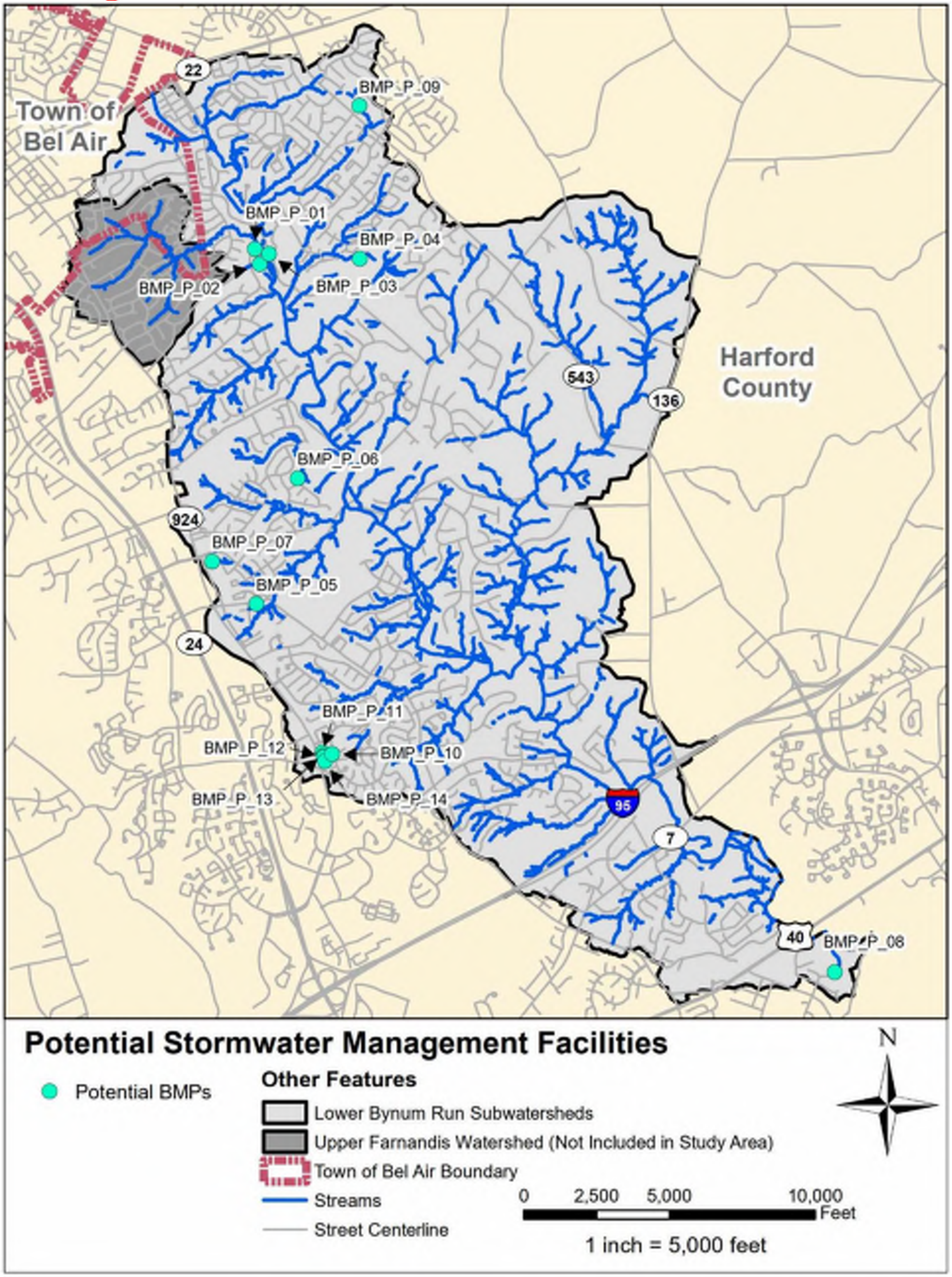

Figure 4-2. Potential BMPs in the Lower Bynum Run Watershed

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.

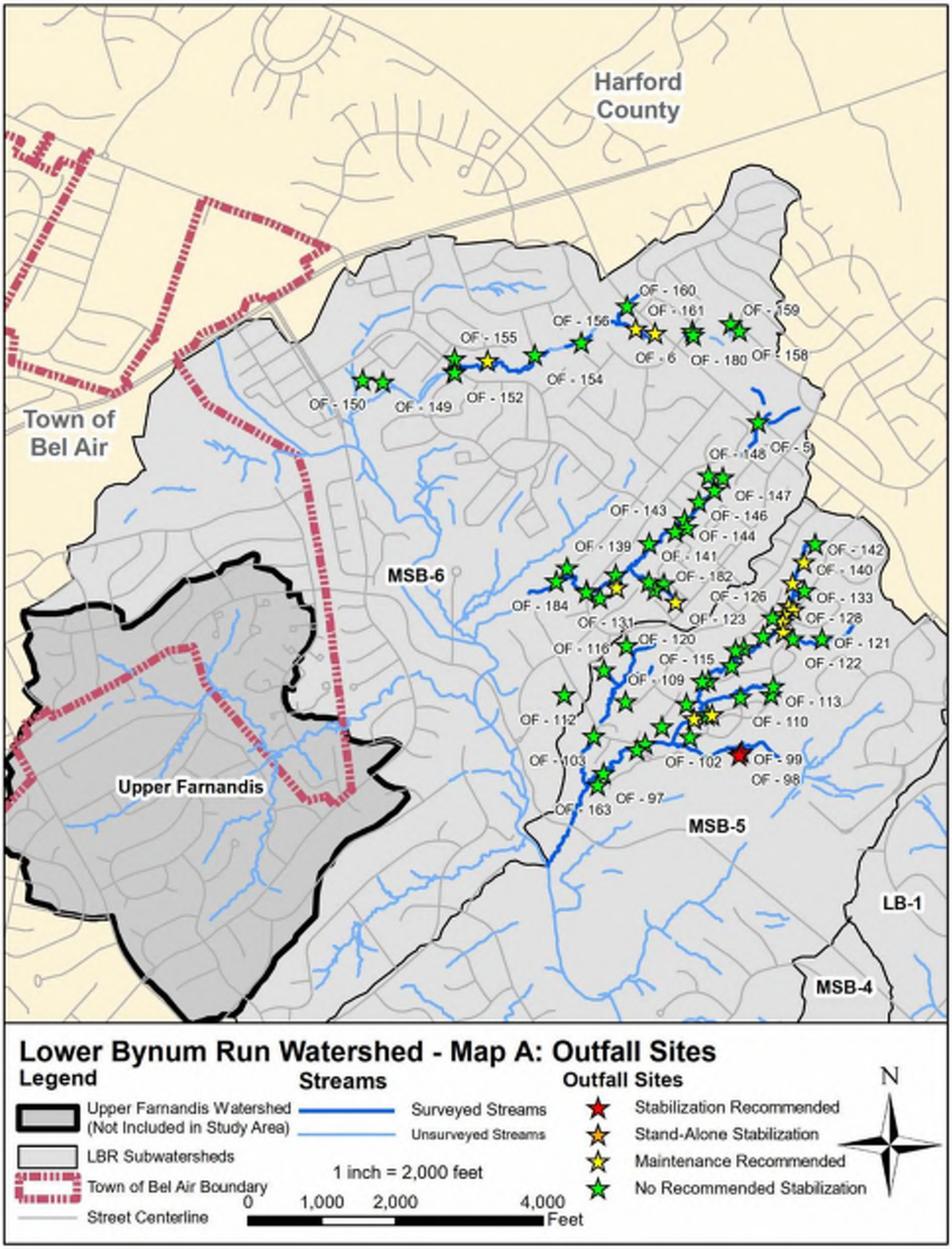

Figure 4-3. Lower Bynum Run Map A Outfall Sites

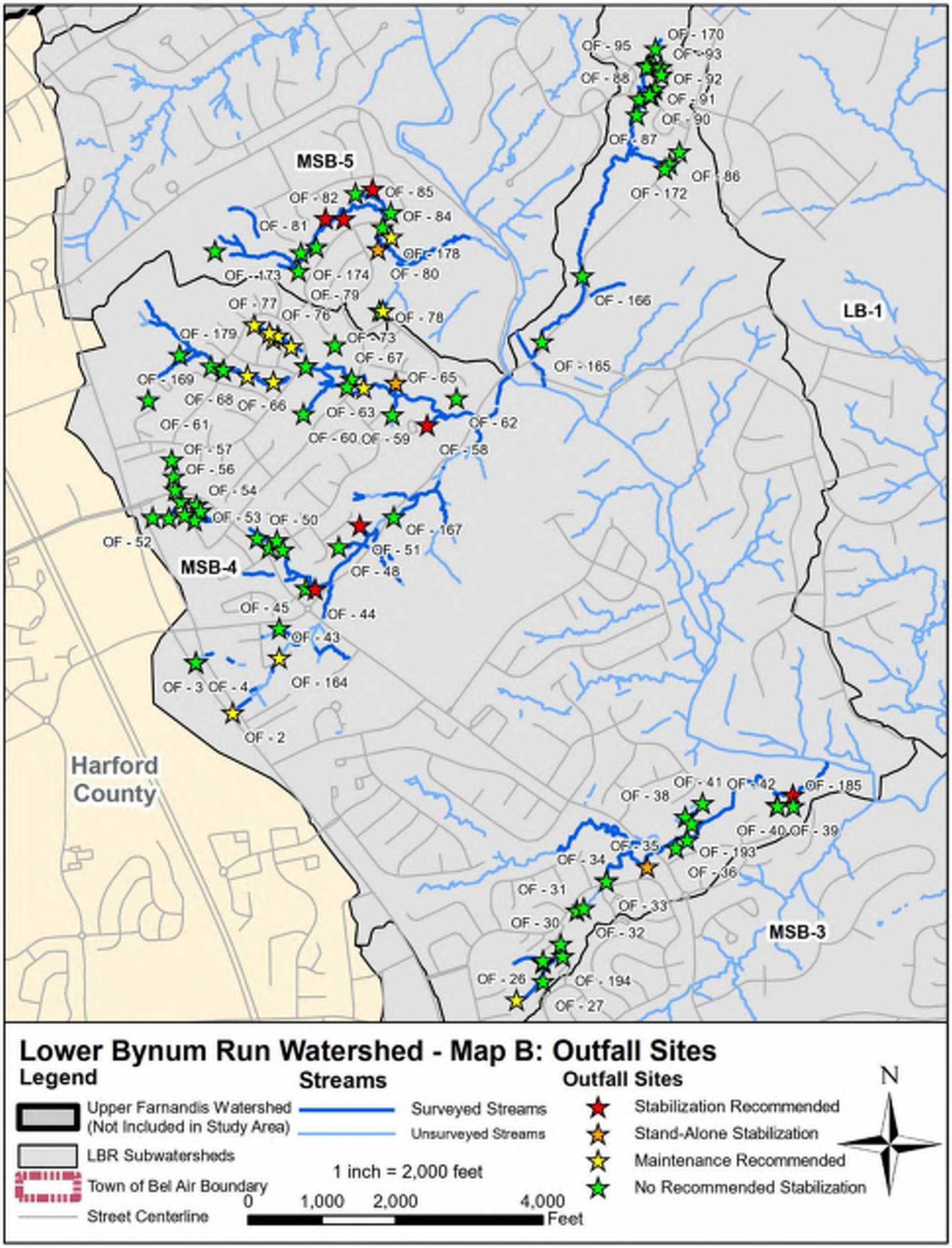

Figure 4-4: Lower Bynum Run Map B Outfall Sites

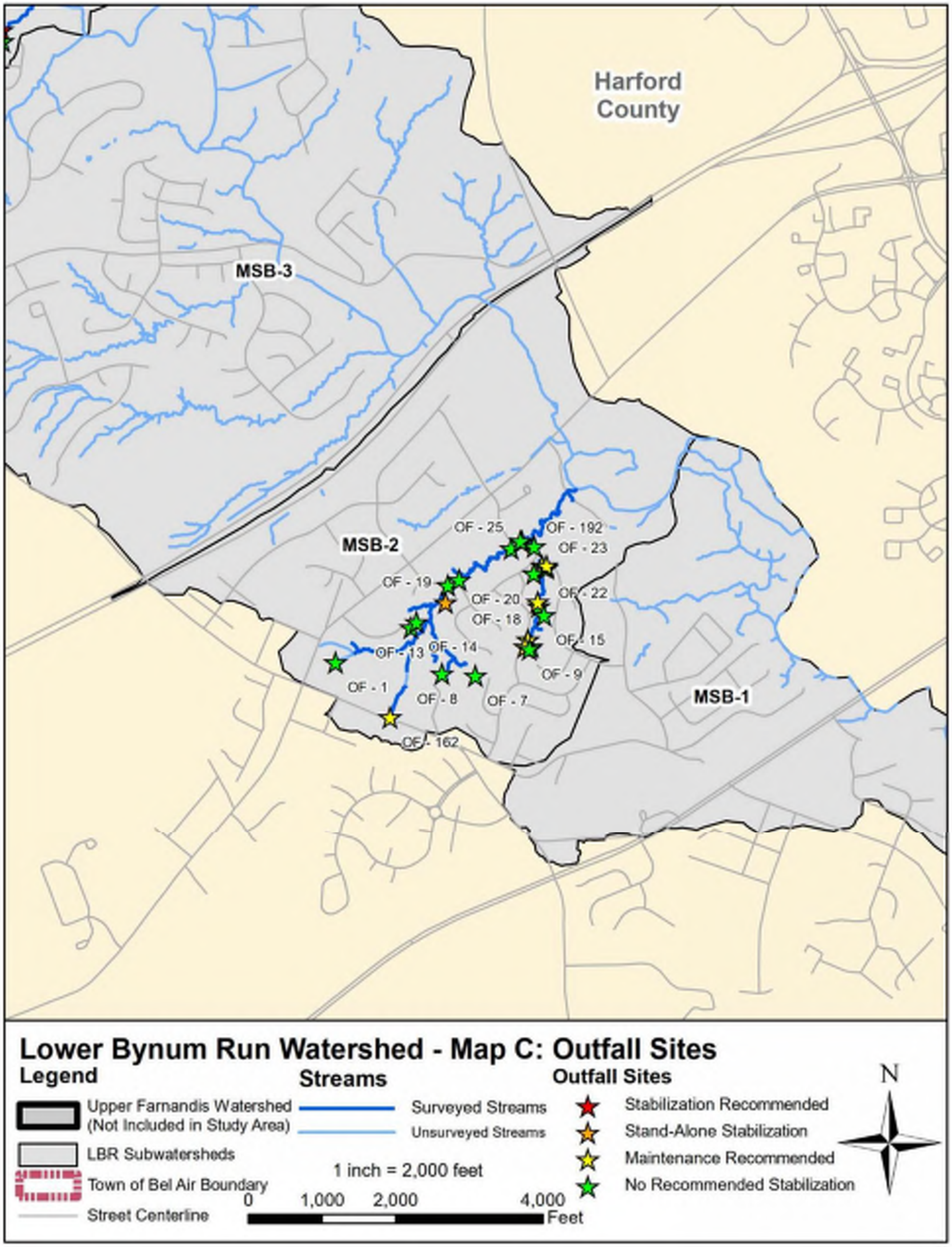

Figure 4-5: Lower Bynum Run Map C Outfall Sites

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.

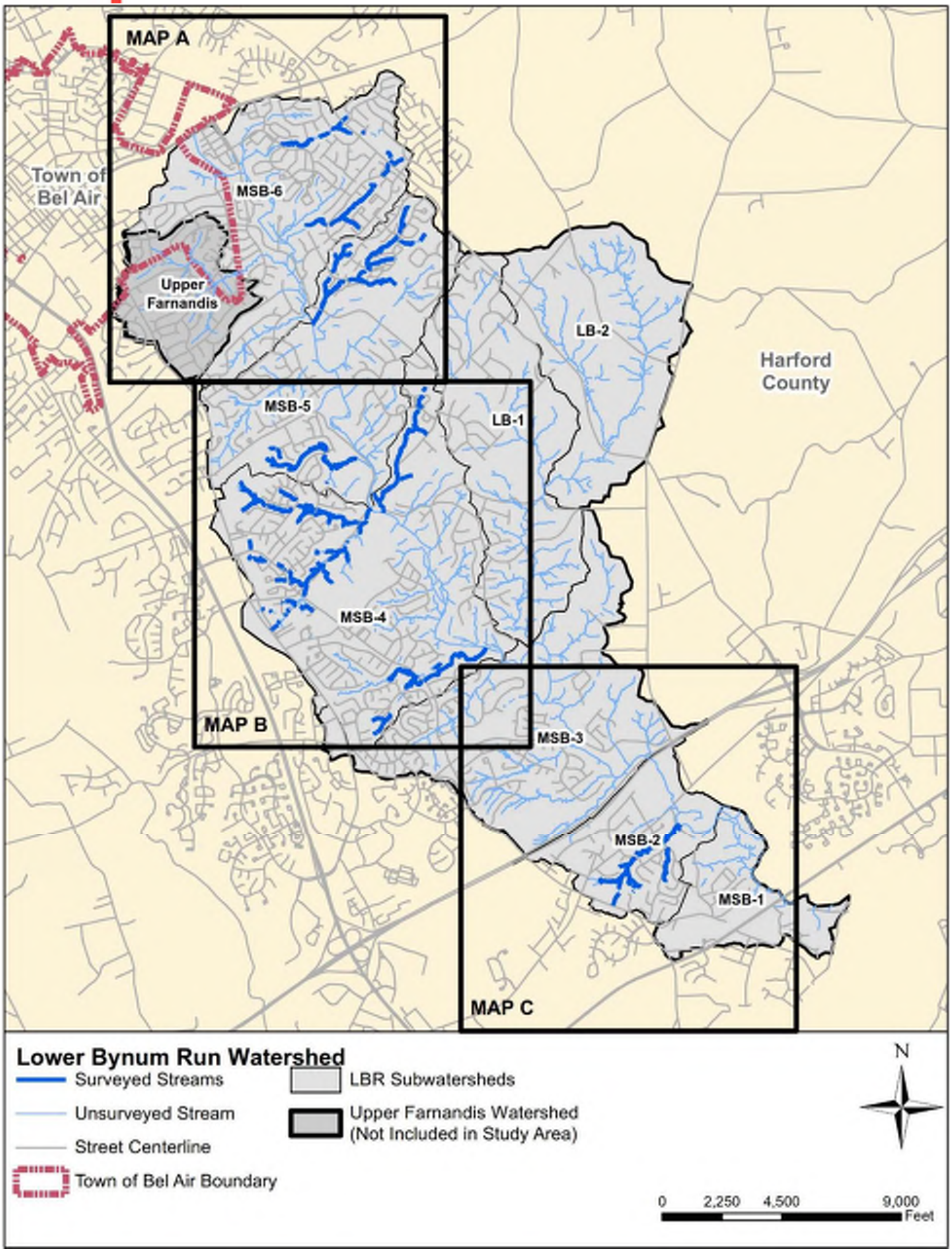

Figure 4-6. Lower Bynum Run SCA Survey Grid

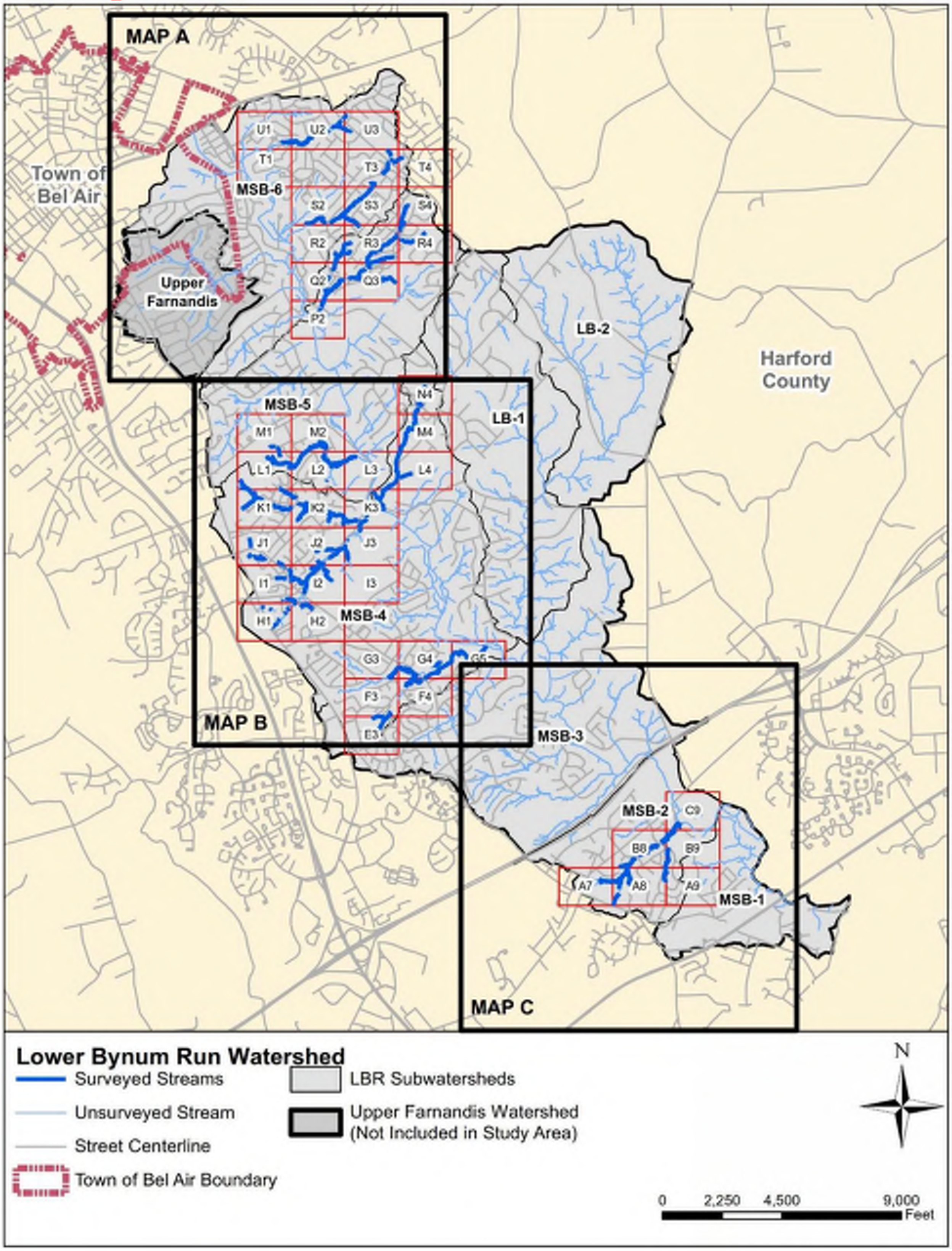

Figure 4-7. Lower Bynum Run SCA Survey Grid and Map Numbers

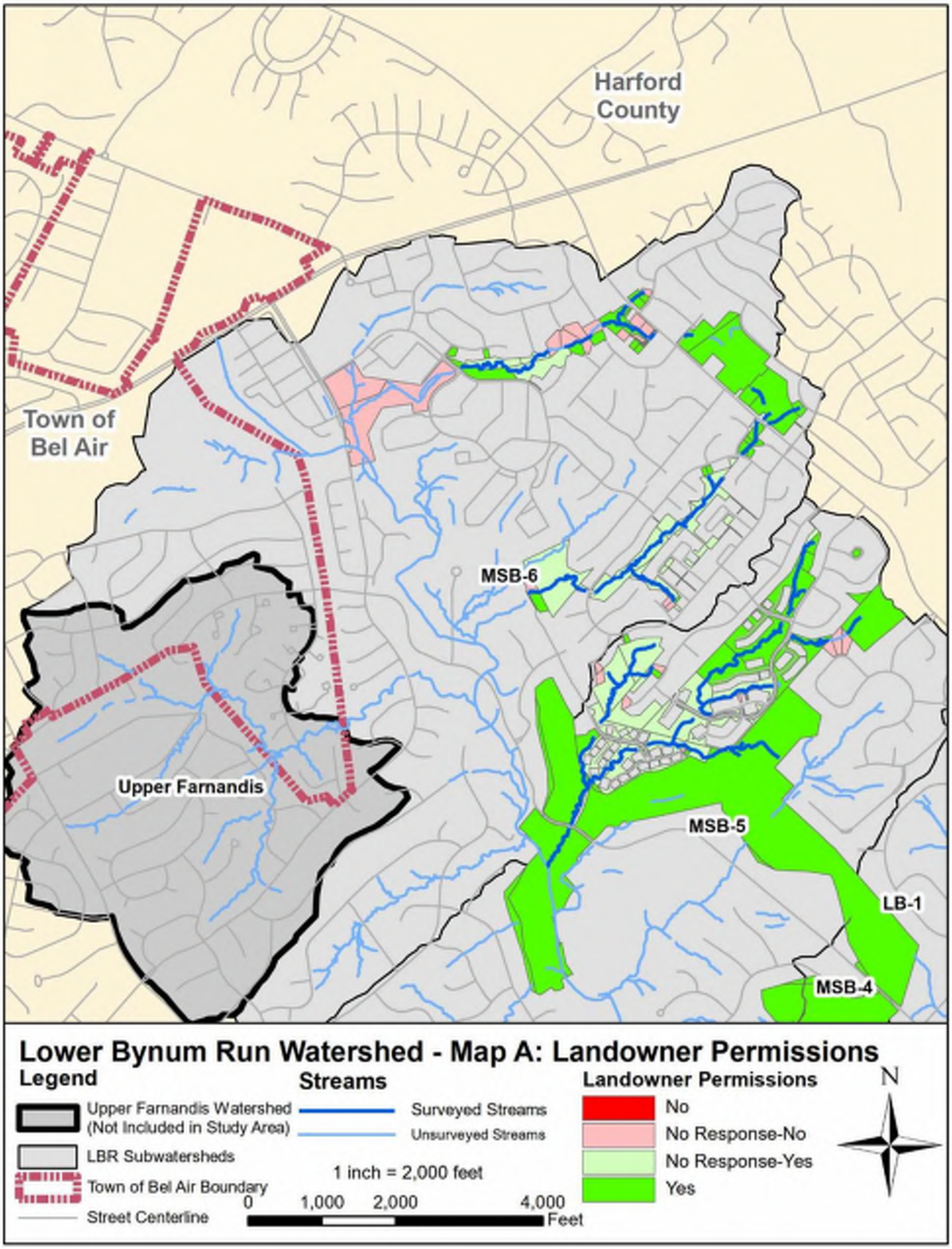

Figure 4-8: Lower Bynum Run Map A Landowner Permissions

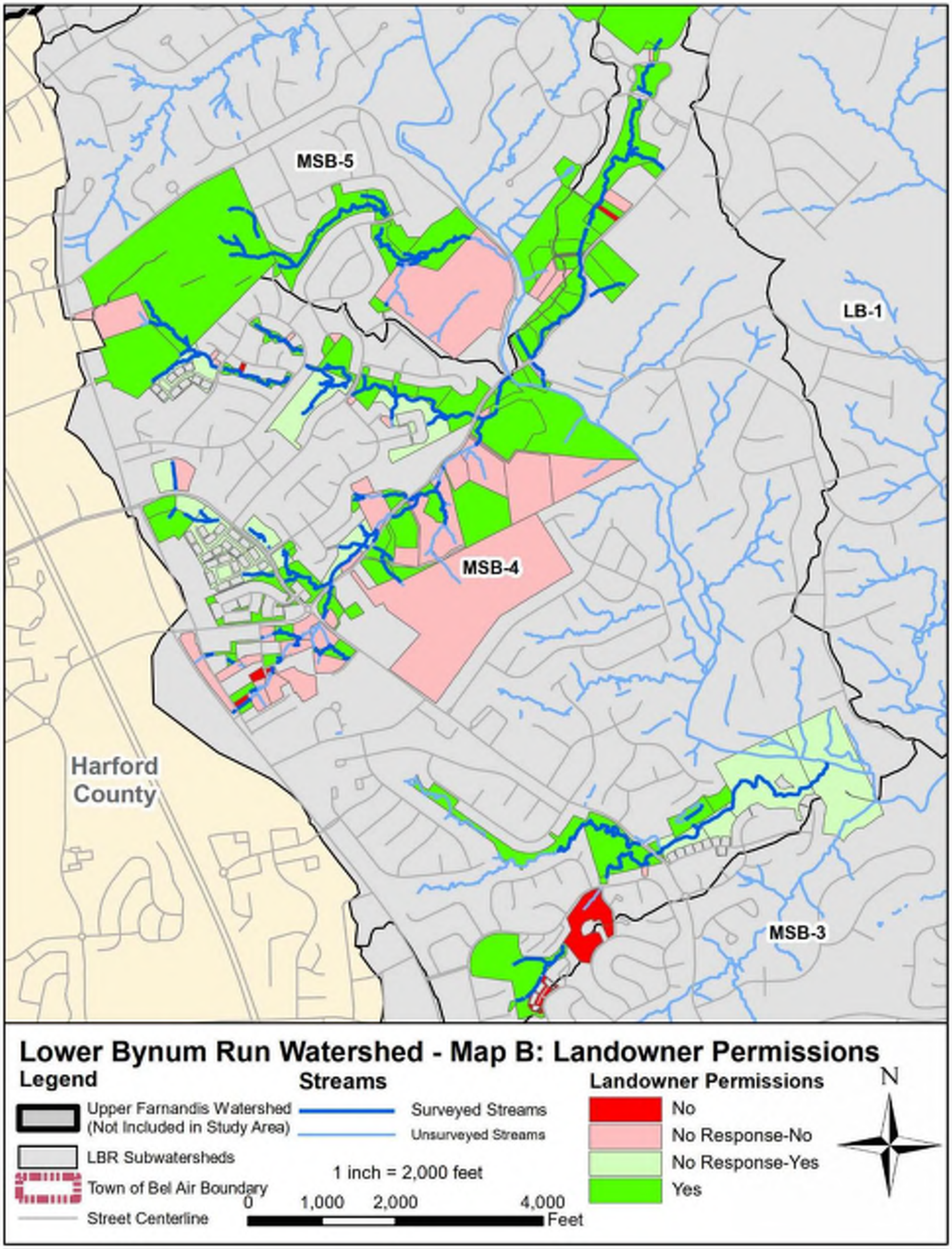

Figure 4-9. Lower Bynum Run Map B Landowner Permissions

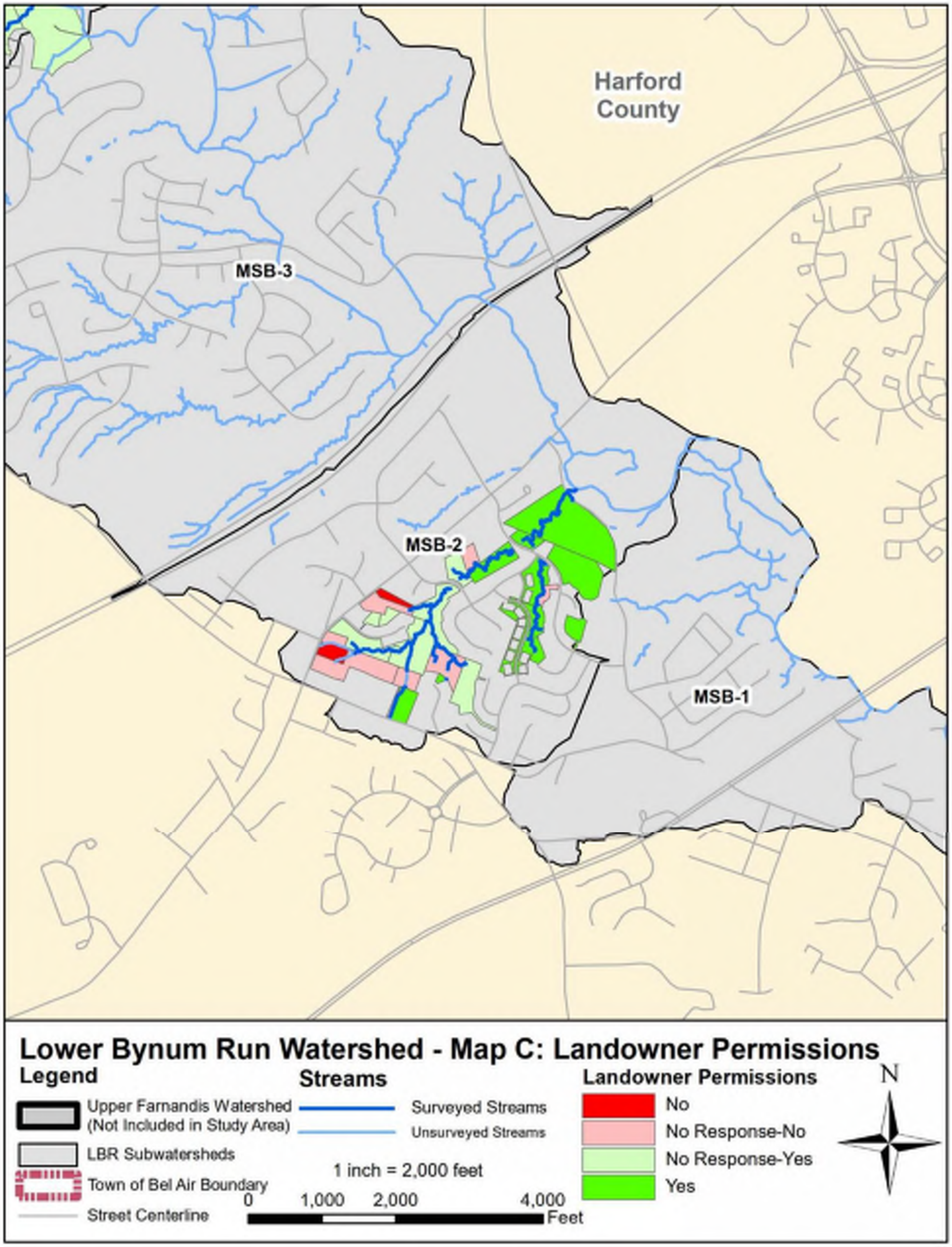

Figure 4-10: Lower Bynum Run Map C Landowner Permissions

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.

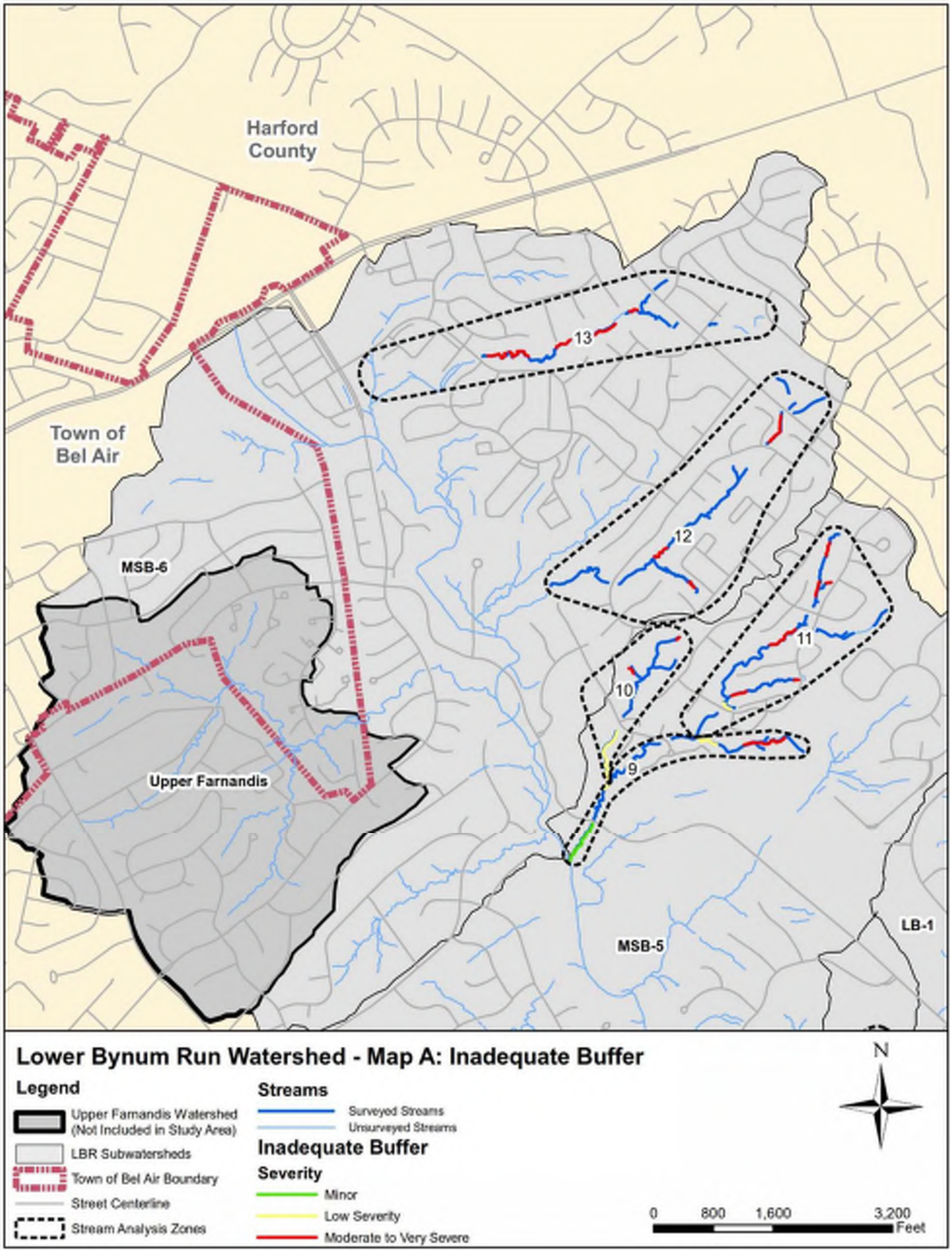

Figure 4-12: Inadequate Stream Buffer Locations in Lower Bynum Run SCA (Map A)

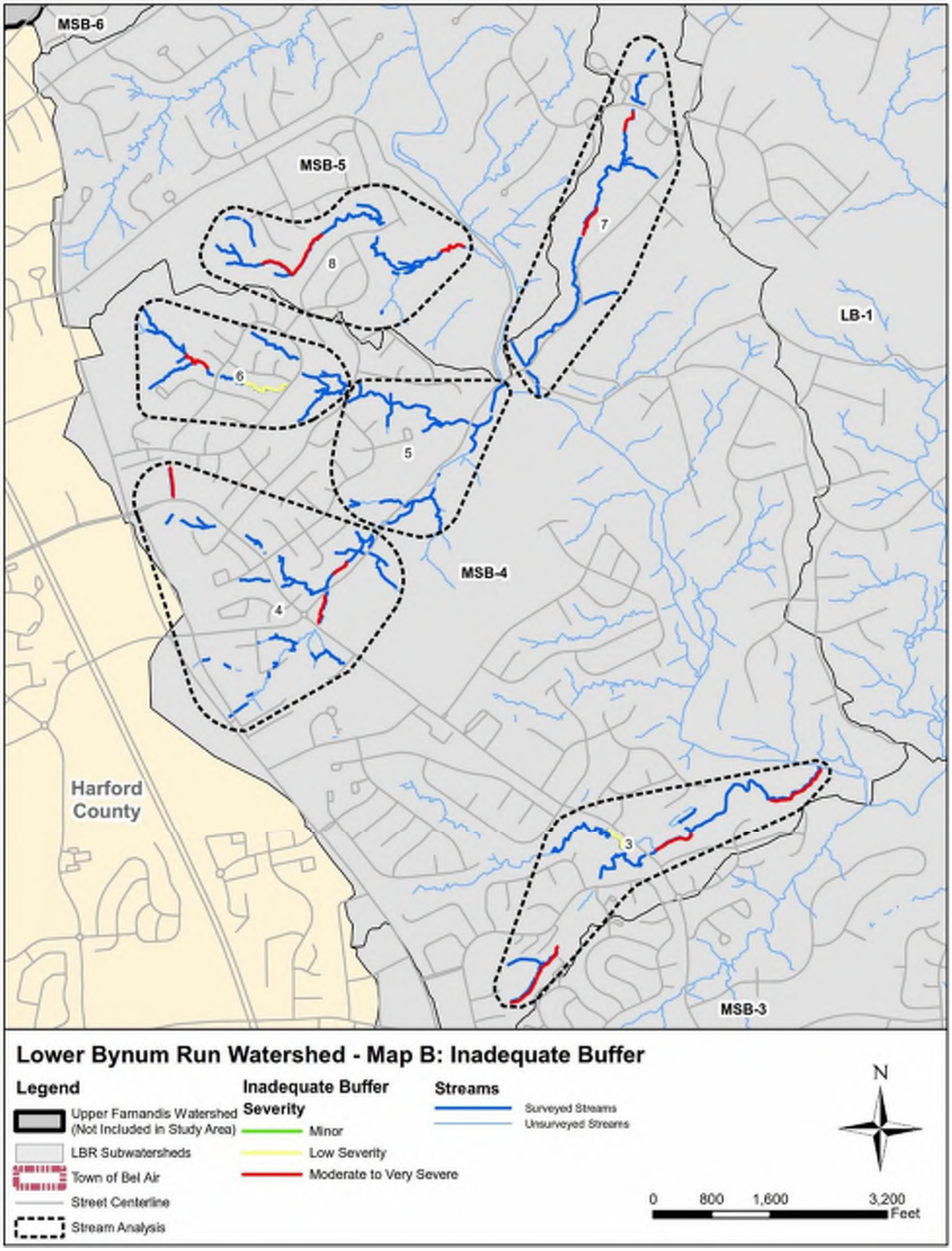

Figure 4-13: Inadequate Stream Buffer Locations in Lower Bynum Run SCA (Map B)

![WSP logo]

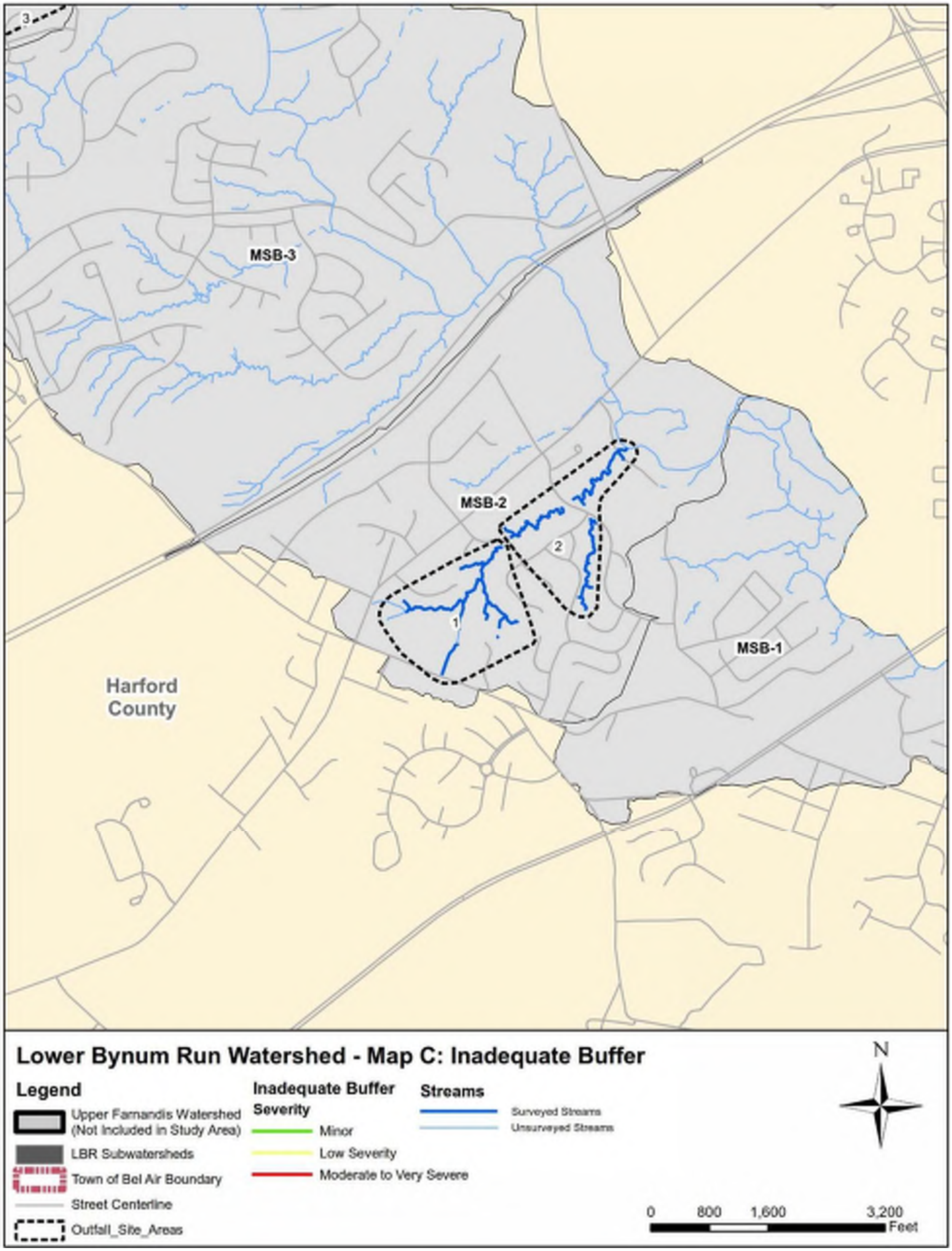

Figure 4-14: Inadequate Stream Buffer Locations in Lower Bynum Run SCA (Map C)

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)

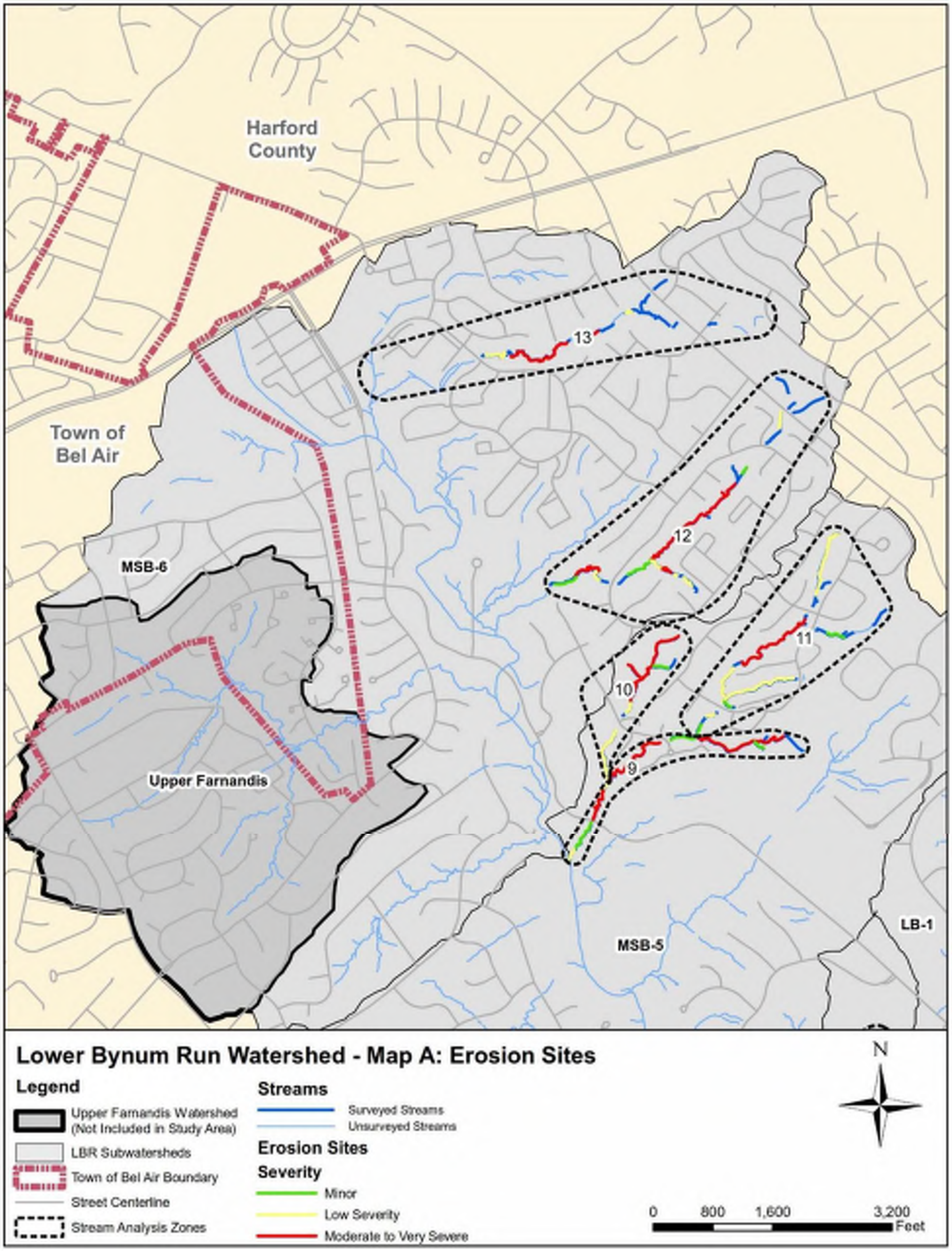

Figure 4-16: Location of Erosion Sites in the Lower Bynum Run Watershed (Map A)

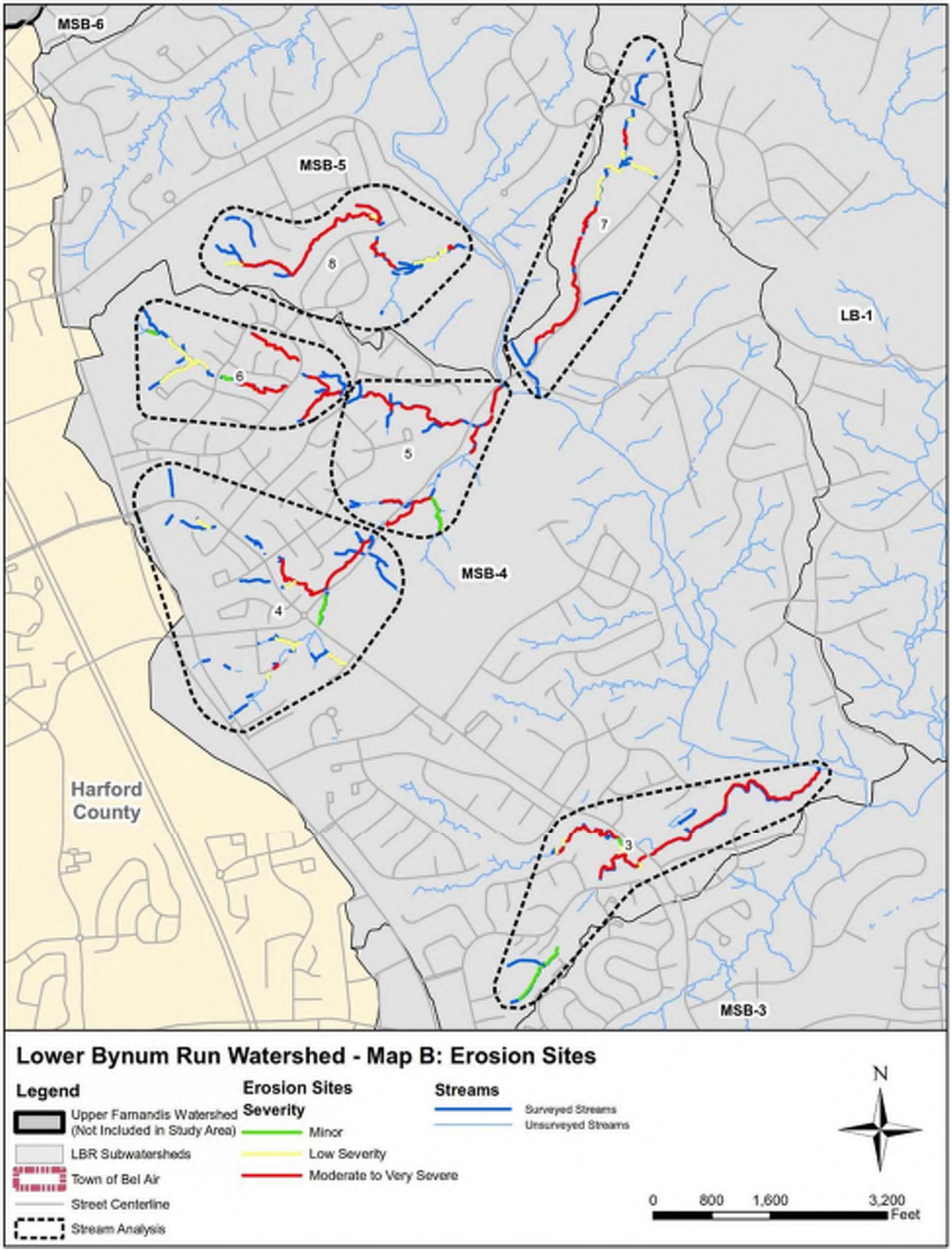

Figure 4-17: Location of Erosion Sites in the Lower Bynum Run Watershed (Map B)

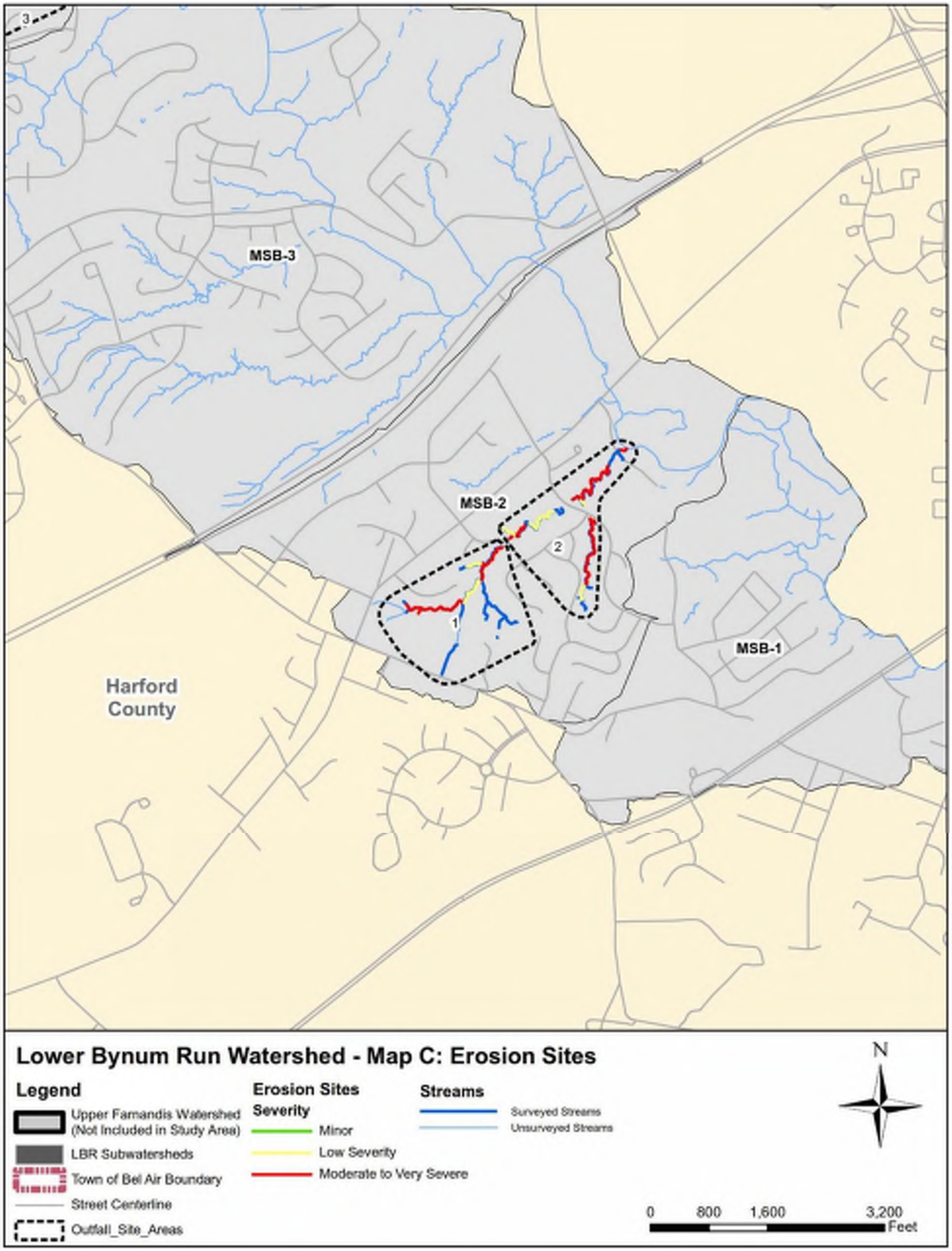

Figure 4-18: Location of Erosion Sites in the Lower Bynum Run Watershed (Map C)

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).

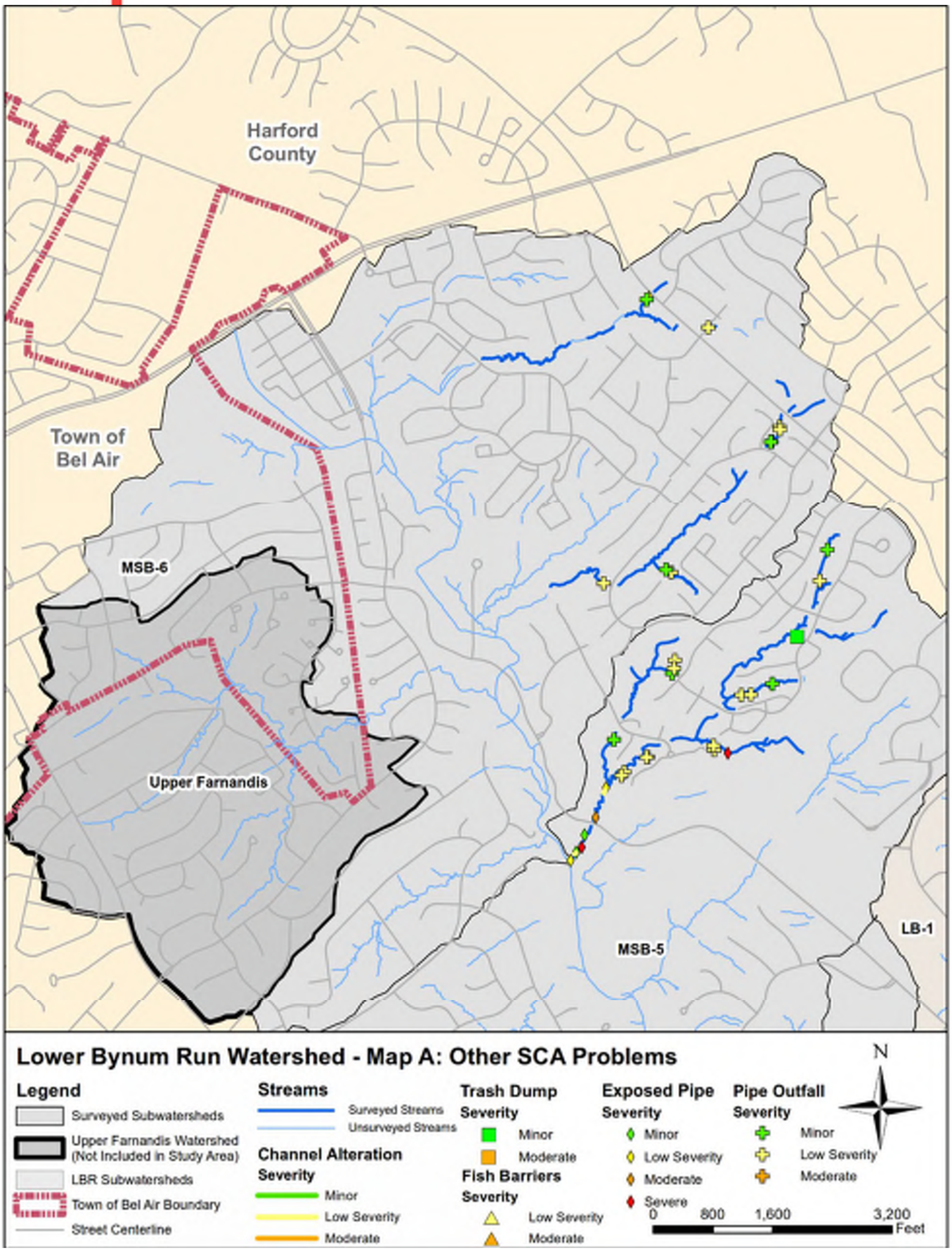

Figure 4-24: Location of Other SCA Problem Sites in the Lower Bynum Run Watershed (Map A)

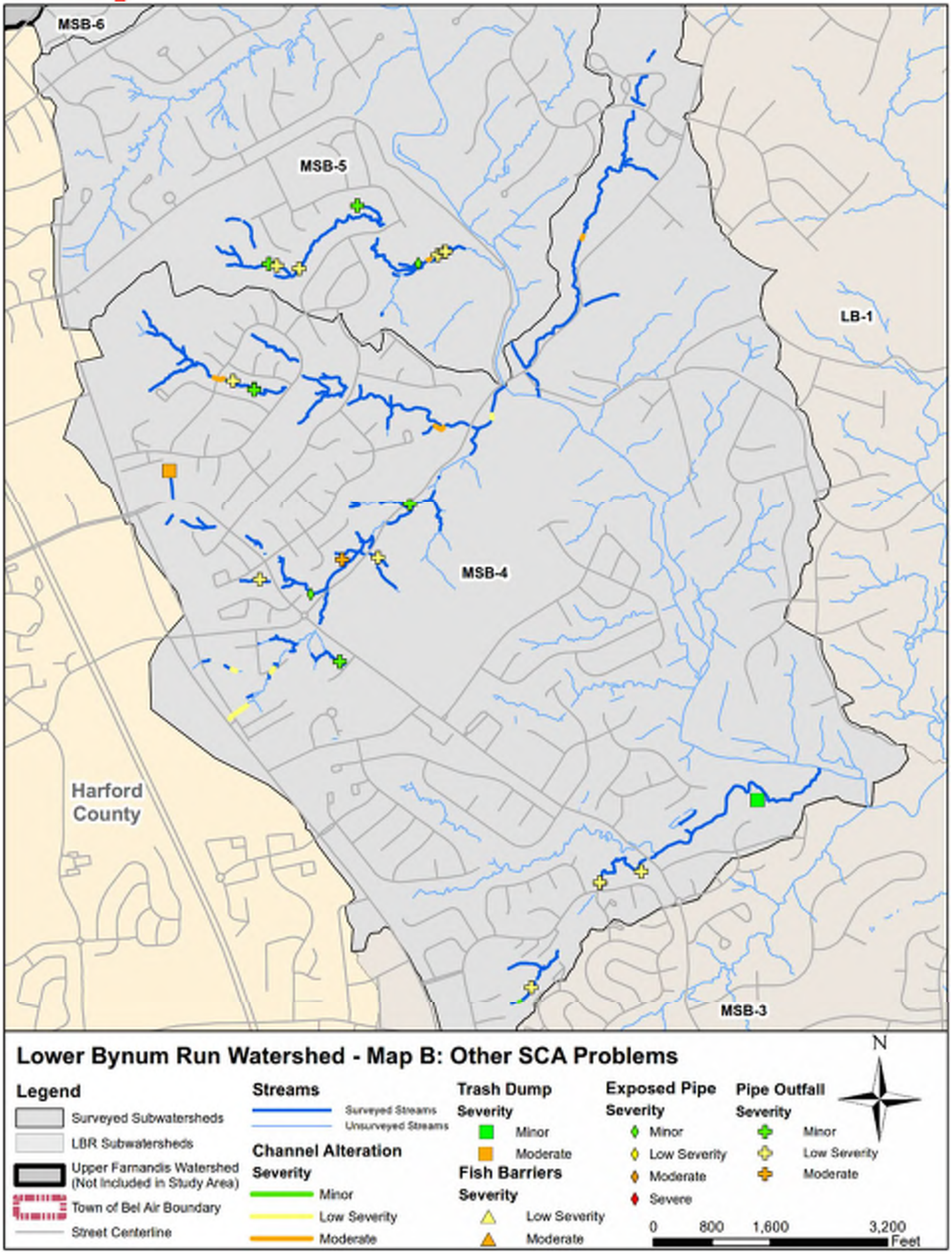

Figure 4-25. Location of Other SCA Problem Sites in the Lower Bynum Run Watershed (Map B)

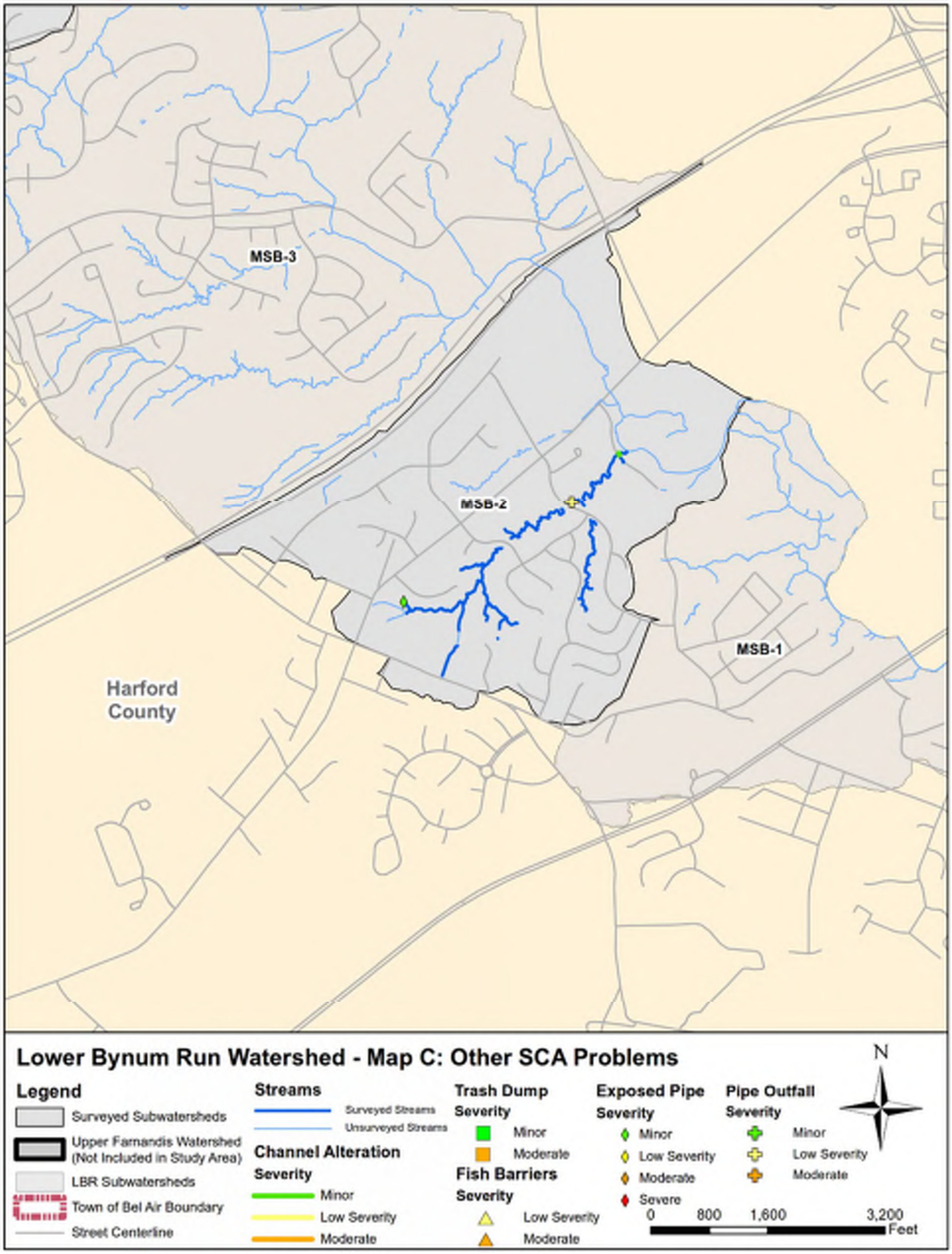

Figure 4-26: Location of Other SCA Problem Sites in the Lower Bynum Run Watershed (Map C)

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.

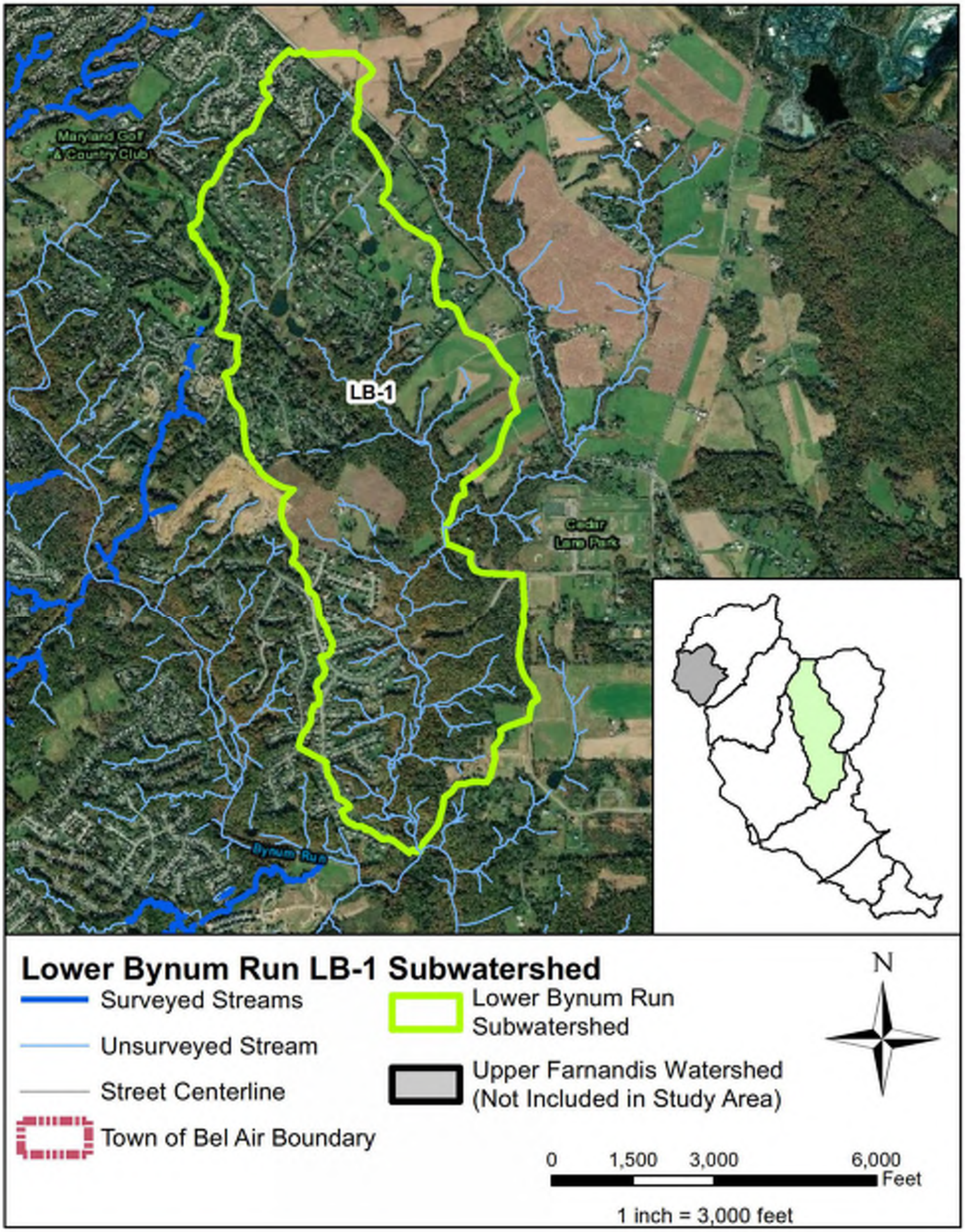

Figure 4-27. Lower Bynum Run LB-1 Subwatershed

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.

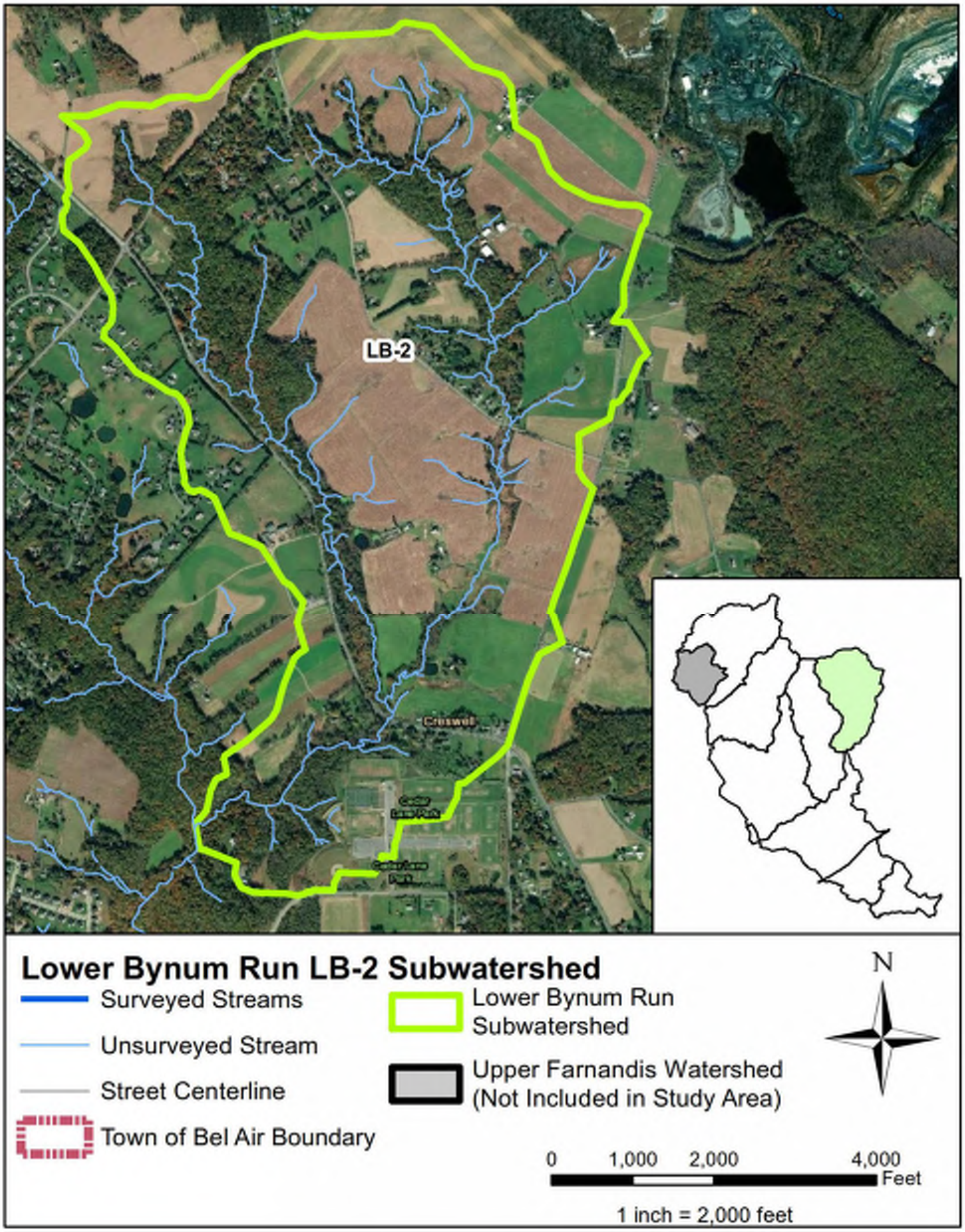

Figure 4-28. Lower Bynum Run LB-2 Subwatershed

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.

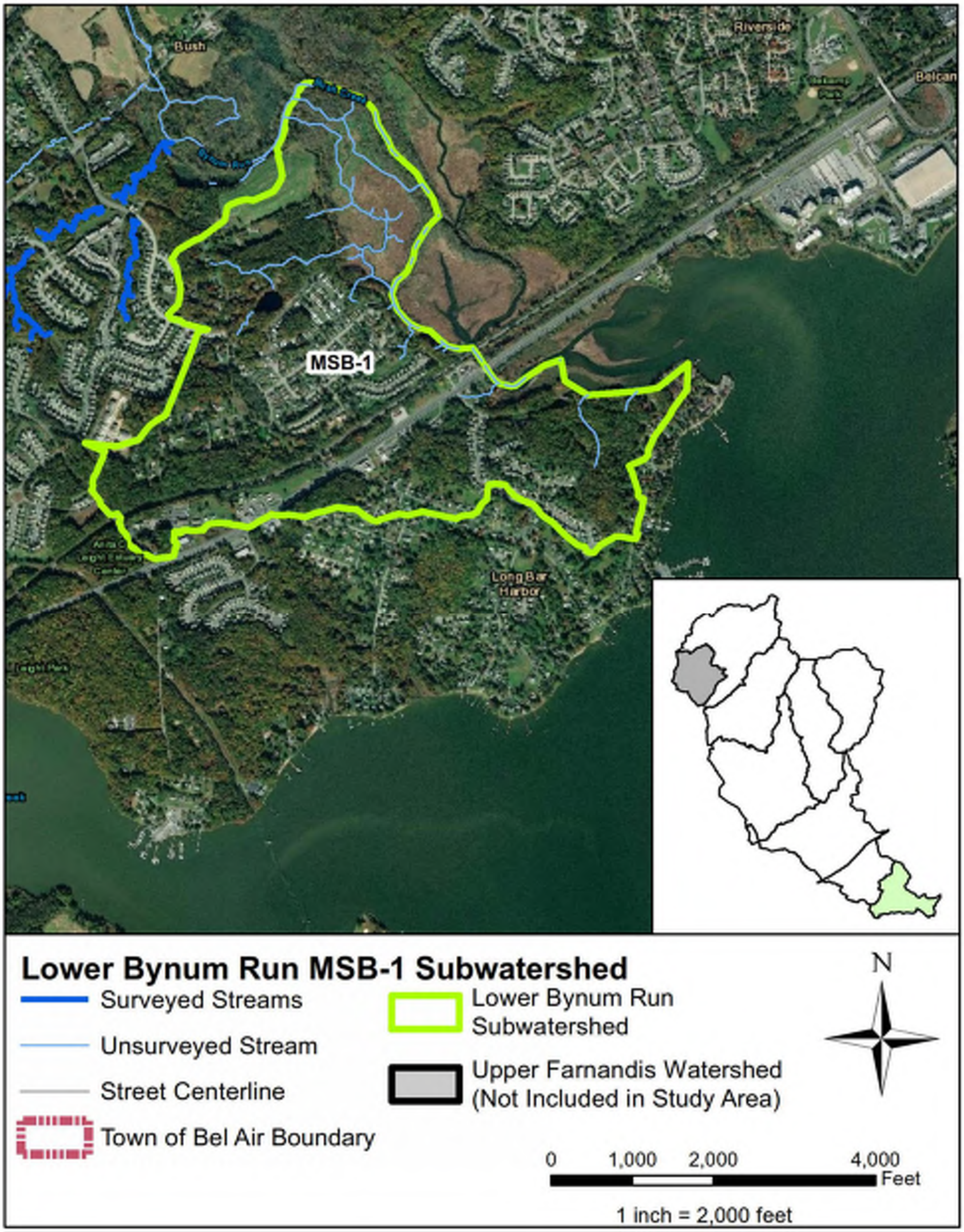

Figure 4-29. Lower Bynum Run MSB-1 Subwatershed

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.

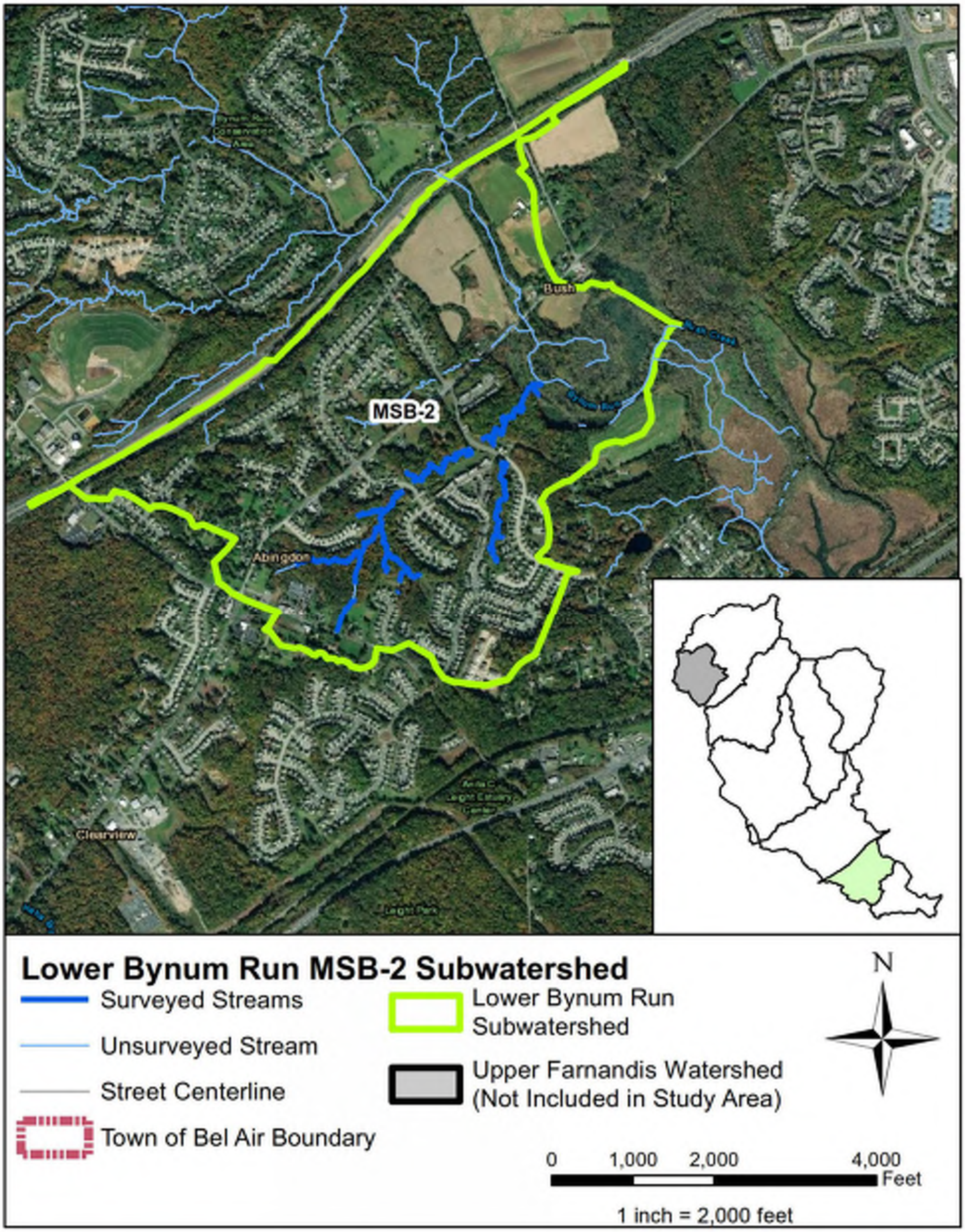

Figure 4-30. Lower Bynum Run MSB-2 Subwatershed

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.

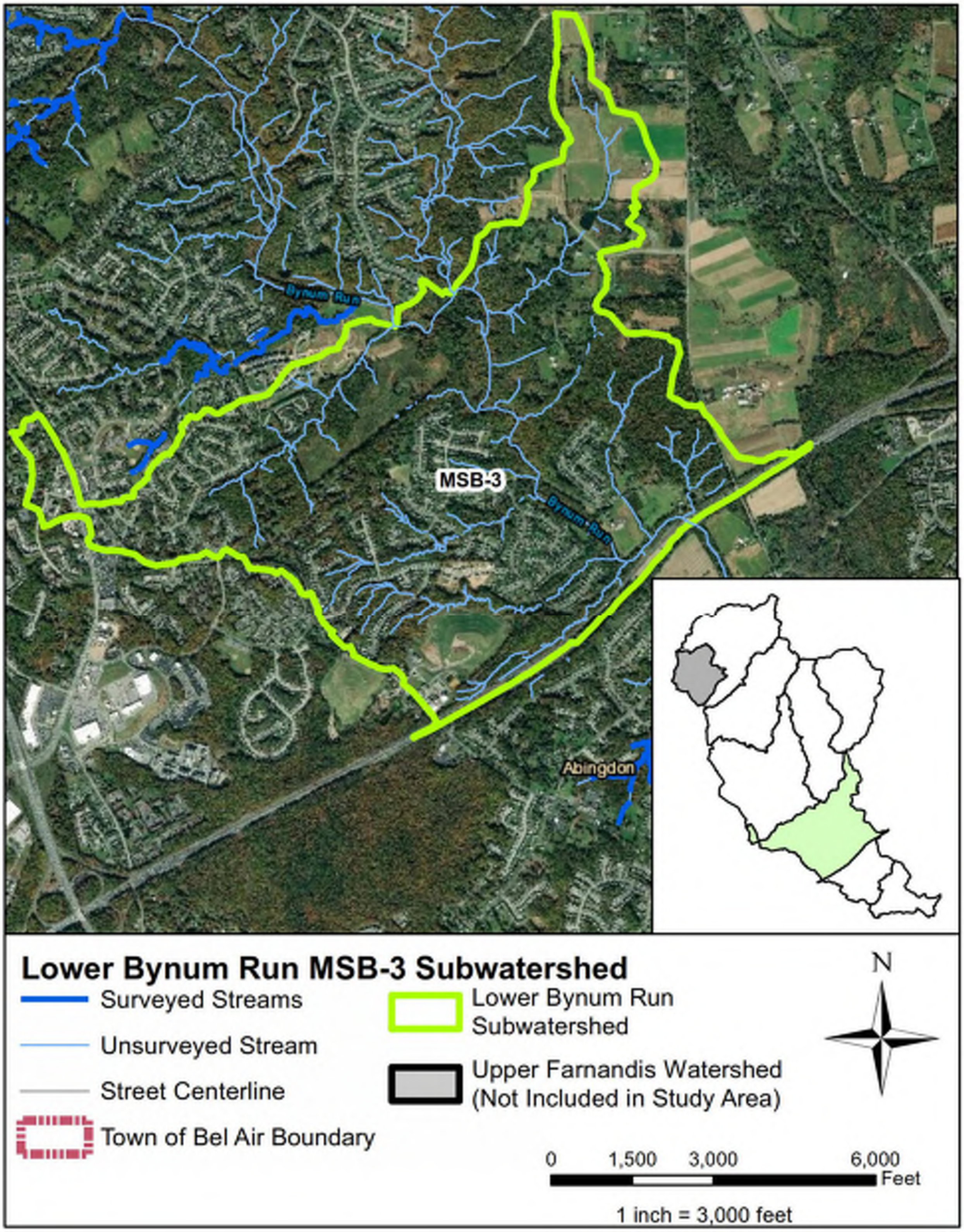

Figure 4-31. Lower Bynum Run MSB-3 Subwatershed

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.

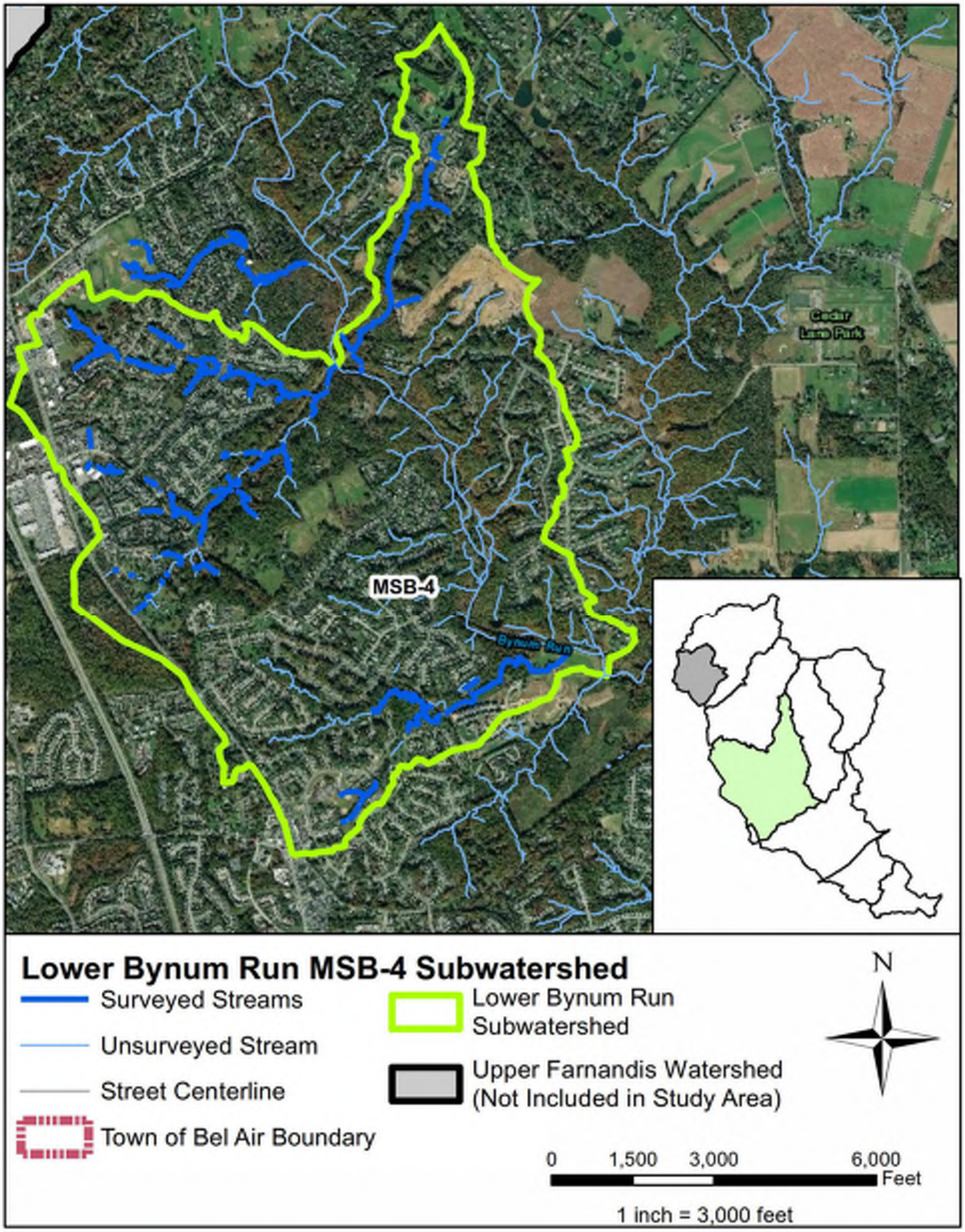

Figure 4-32. Lower Bynum Run MSB-4 Subwatershed

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.

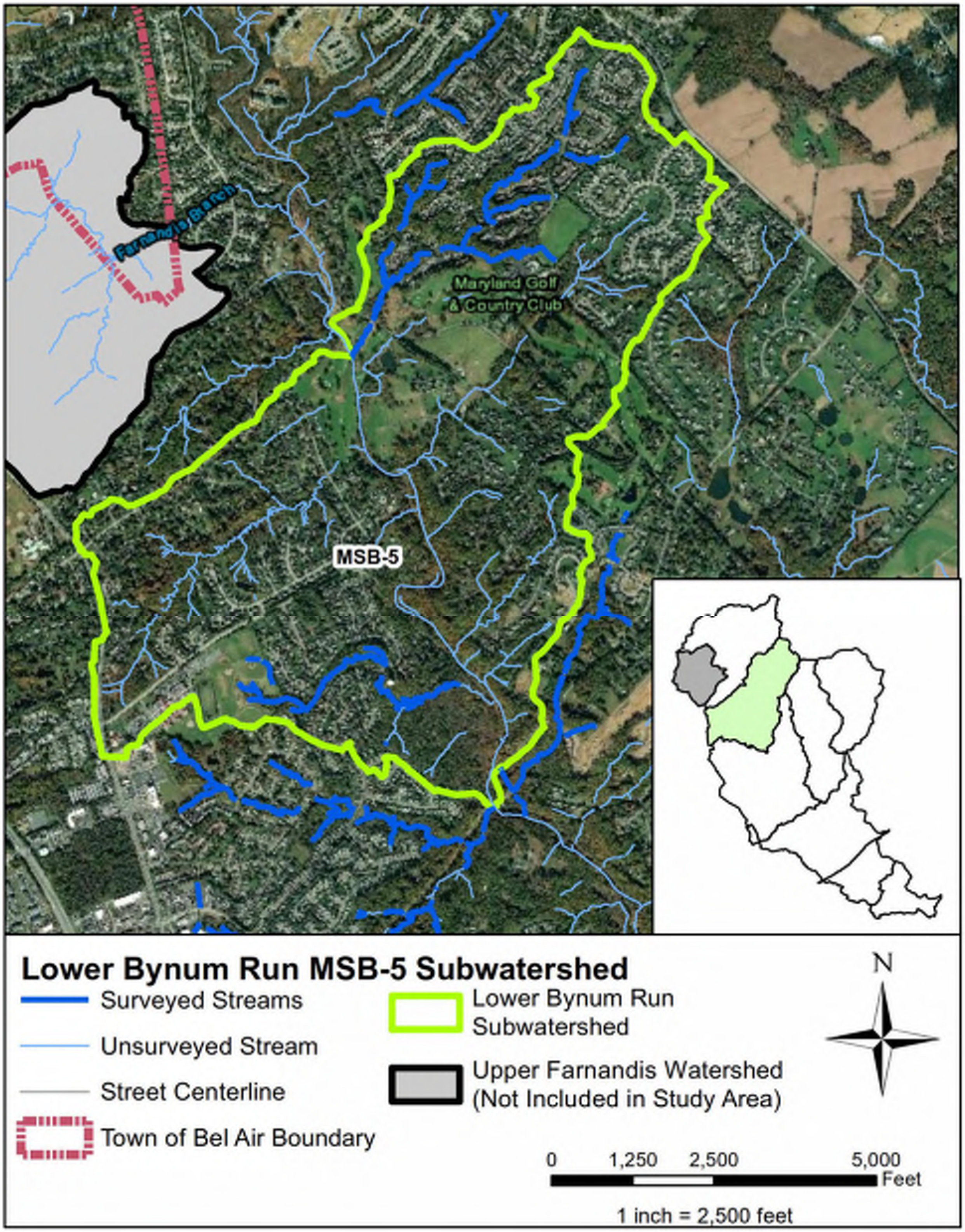

Figure 4-33. Lower Bynum Run MSB-5 Subwatershed

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.

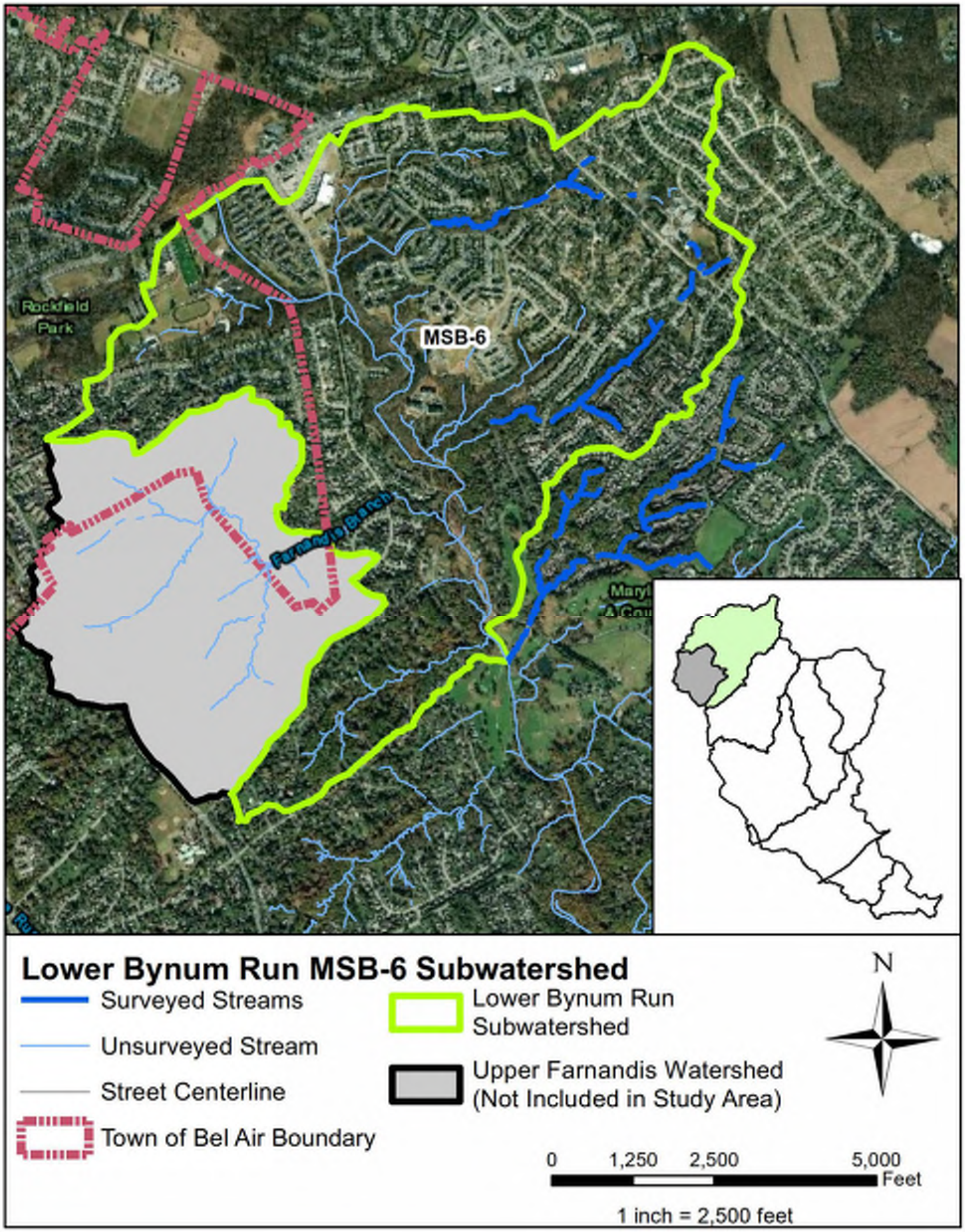

Figure 4-34. Lower Bynum Run MSB-6 Subwatershed

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.

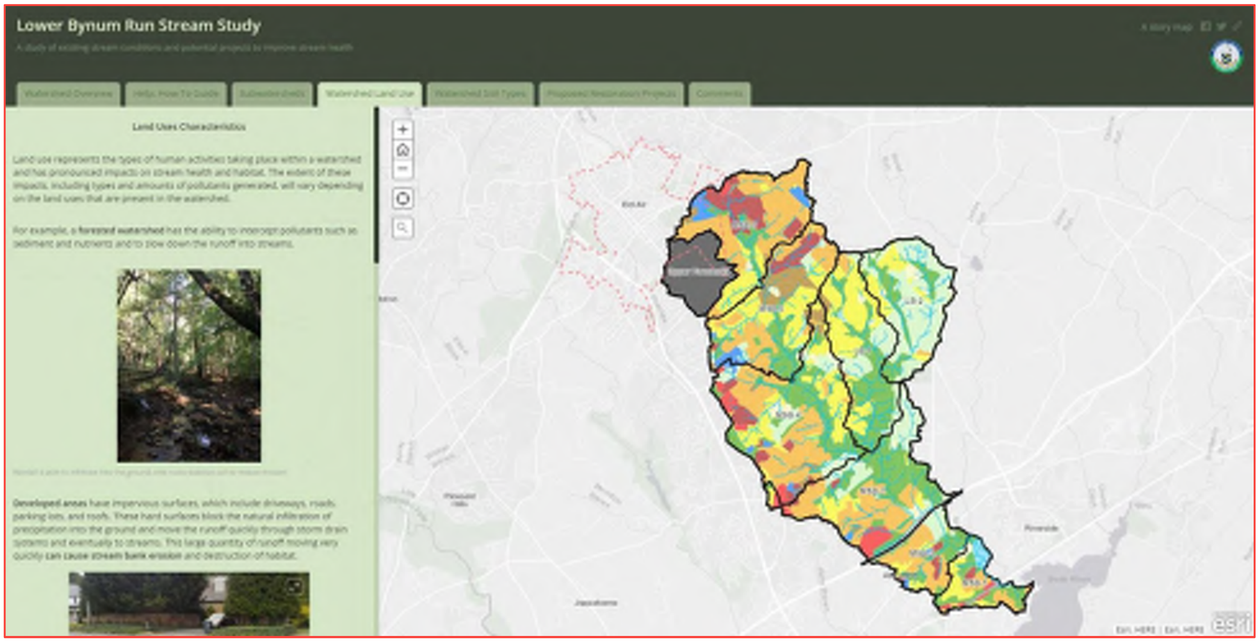

Figure 6-1. Snapshot of Land Use in the Lower Bynum Run Stream Study Story Map

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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