Liberty Reservoir Watershed Characterization Plan

Winter 2015

Prepared by
Carroll County Bureau of Resource Management

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I. Characterization Introduction

A. Purpose of the Characterization

The Liberty Watershed Characterization Plan is intended to provide a background on the hydrological, biological and other natural characteristics of the watershed as well as discuss human characteristics that may have an impact within the watershed. The information provided in this report as well as information gathered during the Liberty watershed stream corridor assessment (SCA) will be used as a tool to help direct the watershed implementation plan for the Liberty reservoir watershed. The implementation plan will be used to identify opportunities for water quality improvements within the watershed as required by the County's National Pollutant Discharge Elimination System (NPDES) permit, and is designed to meet approved Total Maximum Daily Loads (TMDLs) for the Liberty watershed.

B. Location and Scale of Analysis

The Liberty Watershed is located in the eastern portion of Carroll County. The watershed is within the Patapsco River Basin in the Piedmont physiographic province of Maryland, and consists of seventeen major sub-watersheds. The Liberty watershed drains into the Liberty reservoir, which is a major drinking water intake for the City of Baltimore. Table 1-1 displays the distribution of acreage between the sub-watersheds within Liberty, while Figure 1-1 depicts the location of Liberty and its watersheds within Carroll County. The analysis presented in this report was done at the sub-watershed scale. This allows for restoration and preservation efforts to be focused on the smaller drainage areas where efforts can be prioritized and more easily monitored.

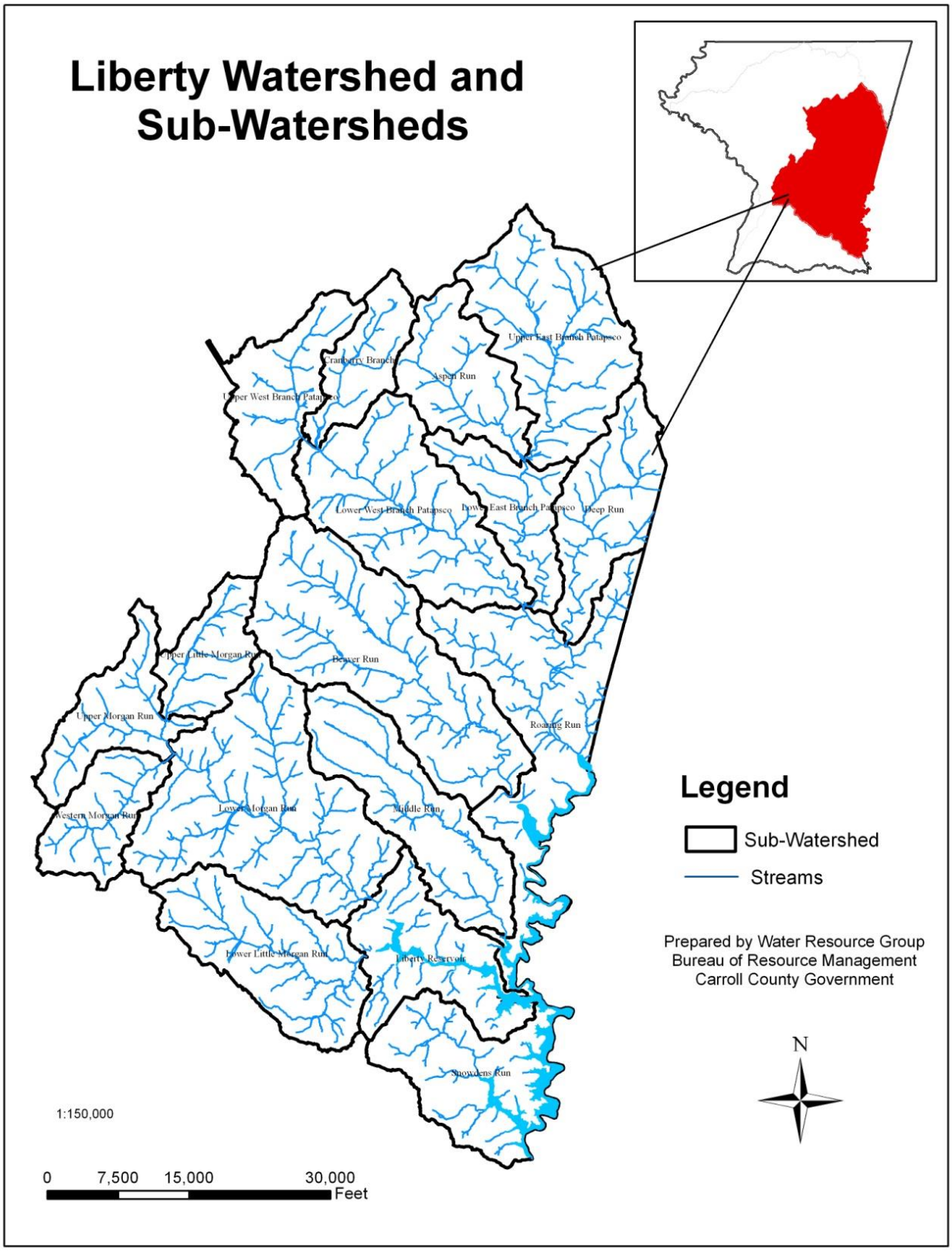

Figure 1-1: Liberty Watershed Location Map

Table 1-1: Liberty Watershed Sub-Watershed Acreage

DNR 12-digit Scale	Subwatershed	Acres
1060	Aspen Run	3,668
1057	Beaver Run	9,322
1061	Cranberry Branch	2,337
1058	Deep Run	4,154
1052	East Branch Patapsco	2,937
1059	East Branch Patapsco	6,781
1046	Snowden's Run	5,142
1047	Liberty Reservoir	4,509
1049	Little Morgan Run	5,529
1055	Little Morgan Run	2,406
1056	Middle Run	5,472
1053	Morgan Run	2,698
1054	Morgan Run	3,169
1050	Morgan Run	10,153
1048	Roaring Run	8,085
1051	West Branch Patapsco	7,065
1062	West Branch Patapsco	3,822
Liberty Watershed Total		**87,249**

C. Report Organization

This report is organized into five different chapters:

Chapter 1 presents the purpose of the characterization plan, shows a general location of the watershed within the County and lists the acreage distribution among the subwatersheds.

Chapter 2 presents background information on the natural characteristics of the watershed. Natural characteristics discussed in this chapter include; climate, topography, soils, geology, wetlands and forest cover.

Chapter 3 focuses on the human characteristics within the watershed. The human component focuses on land use/land cover, impervious surface area, storm drain systems, drinking water, wastewater and other point source locations. Chapter 3 will also discuss best management practices that have been installed, as well as lands that have been protected through various programs.

Chapter 4 focuses on water quality and quantity. This chapter will discuss the stream designations, the water quality data collected within Liberty and the total maximum daily loads associated with the Liberty watershed.

Chapter 5 summarizes the living resources within the Liberty watershed, including both aquatic and terrestrial and any rare, threatened or endangered species within the Liberty watershed.

Chapter 6 summarizes the purpose and use of the Characterization Plan and related work completed within the watershed. This plan will be used in developing the restoration plan for the watershed. This Chapter also lays out approximate cost in completion of this work.

II. Natural Characteristics

A. Introduction

The natural characteristics of a watershed provide the background for the biological and hydrological processes within the system. In this chapter, these characteristics are examined in detail, which will provide a foundation for the later chapters on human characteristics, water quality, and the living resources. The natural characteristics to be covered in this chapter include climate; hydrologic factors such as stream flow, floodplains, and wetlands as well as precipitation; physical landscape features such as topography, geology, soils, and forest cover. This chapter will also establish groundwater resources and ecologically important areas. Potential sources of degradation and the actions needed to address impacted areas can be evaluated by an inventory of these features within the watershed. Each watershed is unique, and the process of gathering information about the watershed may reveal key issues that will influence the watershed restoration plan. The Liberty watershed and its subwatersheds can be found in Figure 2-1.

B. Climate

The climate of the region can be characterized as a humid continental climate with four distinct seasons modified by the proximity of the Chesapeake Bay and Atlantic Ocean (DEPRM, 2000). Rainfall is evenly distributed through all months of the year with most months averaging between 3.0 and 3.5 inches per month. Storms in the fall, winter, and early spring tend to be of longer duration and lesser intensity than summer storms, which are often convective in nature with scattered high-intensity storm cells. The average annual rainfall, measured at the Westminster State Police Barracks, is approximately 44 inches per year. The average annual snowfall is approximately 21 inches with the majority of accumulation in December, January, and February.

The climate of a region affects the rate of soil formation and erosion patterns, and by interacting with the underlying geology, influences the stream drainage network pattern and the resulting topography.

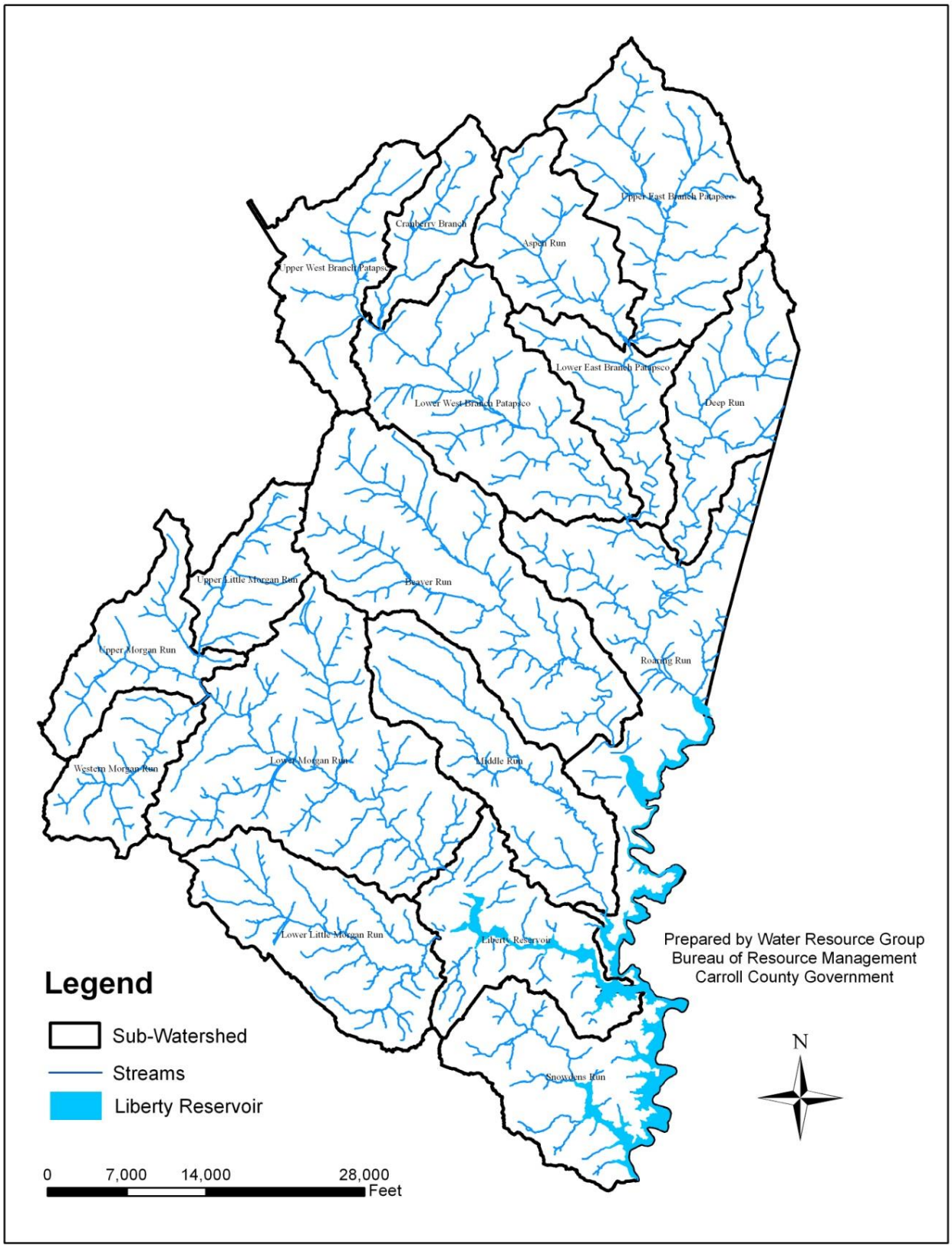

Figure 2-1: Liberty Sub-Watershed Locations

C. Physical Location

The Liberty watershed lies entirely within the Piedmont physiographic province. The Piedmont is classified as low rolling hills with loamy moderately fertile soils and complex geology with numerous rock formations of different materials and ages intermingled with one another.

1. Topography

Topography of the surrounding land, including its steepness and concavity, will affect surface water flows, soil erosion, and development suitability. Steeper slopes are more prone to soil erosion and may have a greater influence on the amount of pollutants generated. For this characterization the slopes were arranged into three categories using soil data from the Carroll County Soil Survey: low slopes (0-8%), medium slopes (8-15%), and high slopes (>15%). Table 2-1 presents the subwatershed slopes as percentages of the 12-digit watershed area.

Table 2-1: Liberty Watershed Slope Categories

DNR 12-Digit Scale	Subwatershed	Slope Category (%)		
		Low	Medium	High
1060	Aspen Run	41	37	22
1057	Beaver Run	46	36	18
1061	Cranberry Branch	50	36	14
1058	Deep Run	63	26	11
1052	East Branch Patapsco	42	30	28
1059	East Branch Patapsco	47	36	17
1046	Snowden's Run	54	26	20
1047	Liberty Reservoir	38	32	30
1049	Little Morgan Run	45	35	20
1055	Little Morgan Run	51	36	13
1056	Middle Run	54	33	13
1053	Morgan Run	51	32	17
1054	Morgan Run	53	35	12
1050	Morgan Run	34	35	31
1048	Roaring Run	44	29	27
1051	West Branch Patapsco	37	33	30
1062	West Branch Patapsco	72	23	5
Liberty Watershed Total		**46**	**33**	**21**

The lower portion of Morgan Run contains the highest proportion of slopes greater than 15% within the Liberty watershed at 31% of the total area; while the upper portion of the West Branch Patapsco contains the lowest proportion of slopes greater than 15% within the Liberty watershed at 5% of the total area. Figure 2-2 displays the slope categories and their distribution throughout the Liberty watershed.

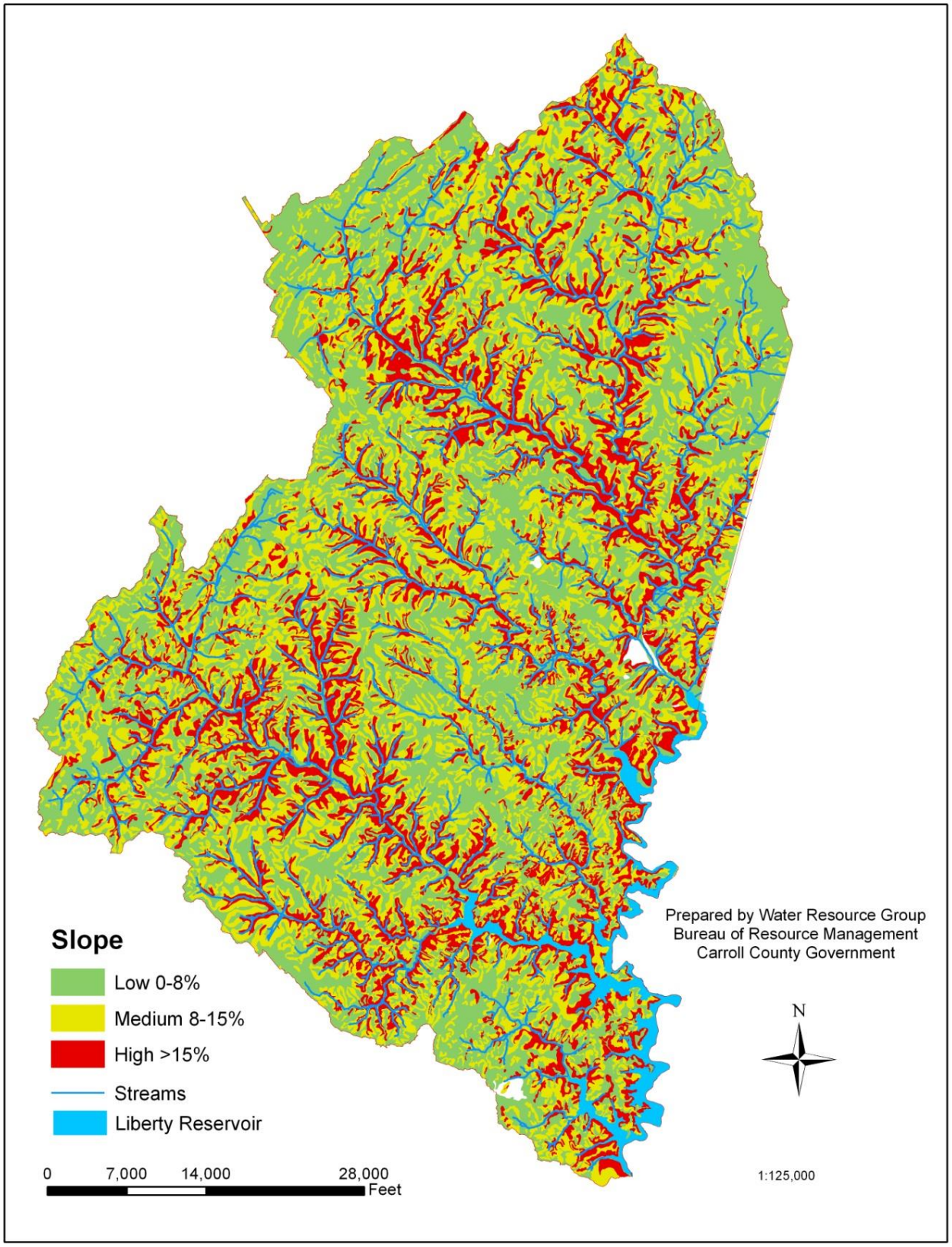

Figure 2-2: Liberty Watershed Topography

2. Soils

The terrestrial system within a watershed is greatly influenced by the type and condition of the underlying soil. Soil factors such as drainage and permeability also greatly reflect the amount of water present in a stream as well as its quality.

Soil composition is determined by factors like climate, organic matter and the type of parent material present. Within the Piedmont, highly metamorphosed schist, gneiss, and granite make up the vast majority of the parent material. Local soil conditions can vary greatly depending on the organic matter and localized climate. Chester and Manor soils are common in the piedmont from Pennsylvania to North Carolina, including the Liberty Watershed (Costa, 1975).

a. Hydrologic Soil Groups

The Natural Resource Conservation Service (NRCS) classifies soils into four Hydrological Soil Groups (HSG) based on the soils runoff potential. Runoff potential is the opposite of infiltration capacity; soils with high infiltration capacity will have low runoff potential, and vice versa. The four Hydrological Soil Groups are A, B, C, and D, where group A generally has the smallest runoff potential and Group D has the greatest. Soils with low runoff potential will be less prone to erosion, and their higher infiltration rates result in faster flow-through of precipitation to groundwater (DEPRM, 2008).

Hydrological Soil Group classification was obtained from USDA technical release-55 'Urban Hydrology for Small Watersheds'.

Group A is composed of sand, loamy sand or sandy loam types of soil. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well-to excessively drained sands or gravels and have a high rate of water transmission.

Group B is composed of loam or silt loam. This group has a moderate infiltration rate when thoroughly wetted and consist mostly of deep to moderately deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C is composed primarily of sandy clay loam. These soils have low infiltration rates when thoroughly wetted and consist mostly of soils with a layer that impedes downward movement of water. These soils also have a moderately fine to fine structure.

Group D is composed of clay loam, silty clay loam, sandy clay, silty clay, or clay. This group has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist mostly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils lying over an impervious material.

The Hydrologic soil data are summarized in Table 2-2 and in Figure 2-3.

Table 2-2: Liberty Subwatershed Hydrologic Soil Group Categories

DNR 12-digit scale	Subwatershed	Hydrologic Soil Group %			
		A	B	C	D
1060	Aspen Run	34	53	9	4
1057	Beaver Run	29	58	10	3
1061	Cranberry Branch	29	52	17	2
1058	Deep Run	5	78	12	5
1052	East Branch Patapsco	29	59	10	2
1059	East Branch Patapsco	24	59	14	3
1046	Snowden's Run	19	66	13	2
1047	Liberty Reservoir	24	69	6	1
1049	Little Morgan Run	40	49	9	2
1055	Little Morgan Run	38	46	14	2
1056	Middle Run	9	76	13	2
1053	Morgan Run	42	43	12	3
1054	Morgan Run	28	60	9	3
1050	Morgan Run	60	29	9	2
1048	Roaring Run	18	69	11	2
1051	West Branch Patapsco	25	64	8	3
1062	West Branch Patapsco	14	66	16	4
Liberty Watershed Total		**28**	**58**	**11**	**3**

The majority of the subwatersheds have a similar percentage of C and D soils. While the overall percentage is fairly low these areas should be targeted when considering where the greatest potential for addressing soil conservation exists. The upper West Branch of the Patapsco contains the highest proportion of C and D soils; with 16% of the watershed classified as a C soil and 4% of the watershed classified as a D soil. Cranberry Branch, which is the adjacent subwatershed to the East, also had a notable high proportion of C and D soils; with 17% of the watershed classified as a C soil and 2% of the watershed classified as a D soil. Deep Run has the highest percentage of D soils at 5% of the total watershed; as stated before D soils have the highest risk of runoff potential.

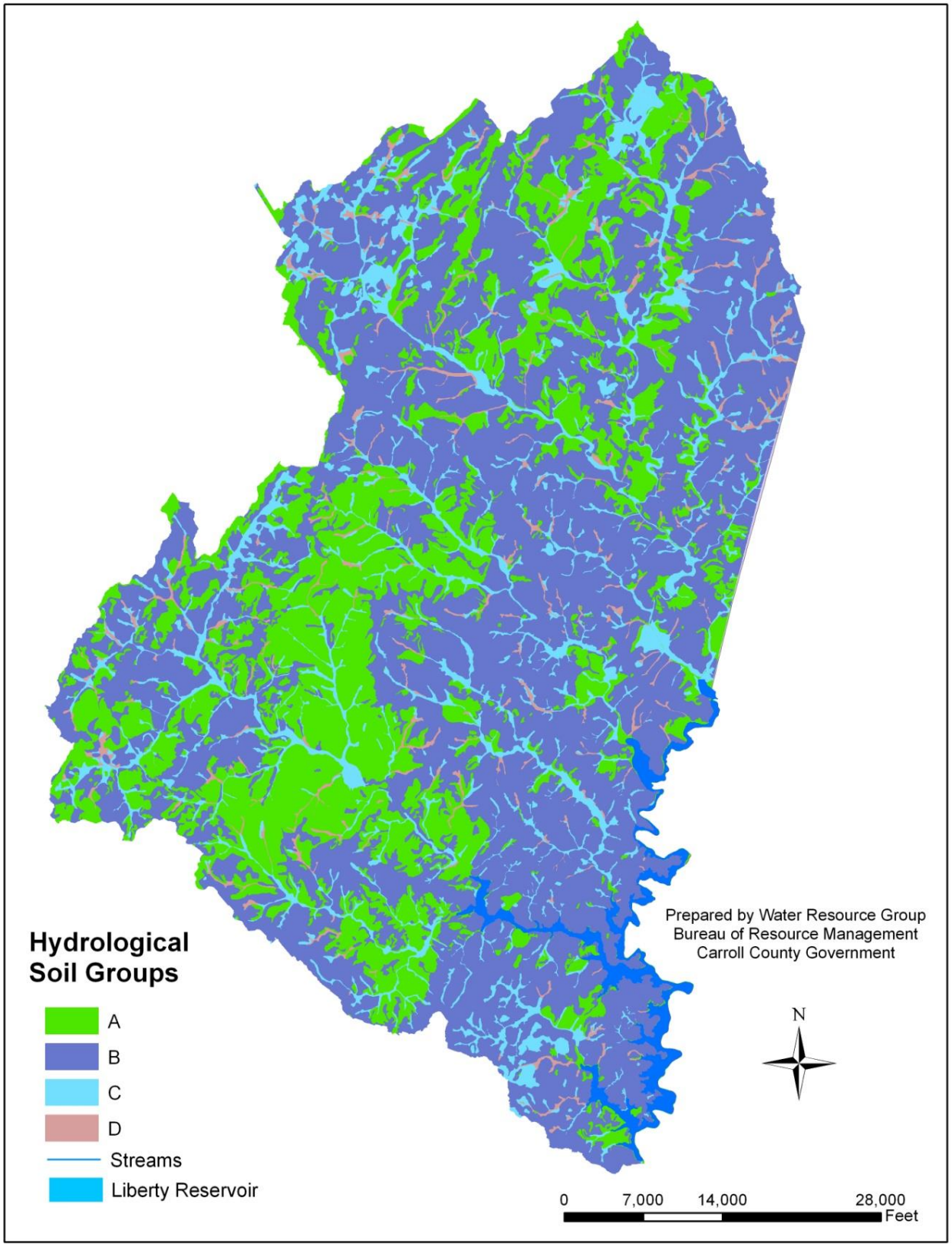

Figure 2-3: Liberty Watershed Hydrological Soil Groups

3. Geology

A simplified map of the geologic units within the Liberty watershed is shown in Figure 2-4. The types of geological formations within a watershed can impact and alter the chemical composition of surface and groundwater as well as the rate of recharge to groundwater. The underlying geology also determines soil formation. Intrinsically, the underlying geology can be closely correlated to the water quality within that system by affecting the buffering capacity.

The Liberty watershed, like most of the Piedmont, consists of metamorphic rock—mainly crystalline schists. These formations have moderate infiltration rates with average recharge to groundwater.

In 1988, Carroll County initiated a water resource study. Part of this study focused on groundwater resource development in Carroll County. Aquifer type is the ultimate governing factor for groundwater development; however, natural factors like precipitation and topography play an important role in recharge. Carroll County has three distinct aquifer types: saprolite, carbonate rock, and triassic rock aquifers—all with varying rates of groundwater recharge. The carbonate rock aquifer has the highest recharge rate of the three types with an estimated drought recharge of 550,000 gallons per day per square mile (GPD/MI^2). The triassic aquifer groundwater recharge under drought conditions is estimated at 220,000 GPD/MI^2. The groundwater recharge rate for the saprolite aquifer varies widely depending on the hydrologic group (Carroll County Water Resource Study, 1998).

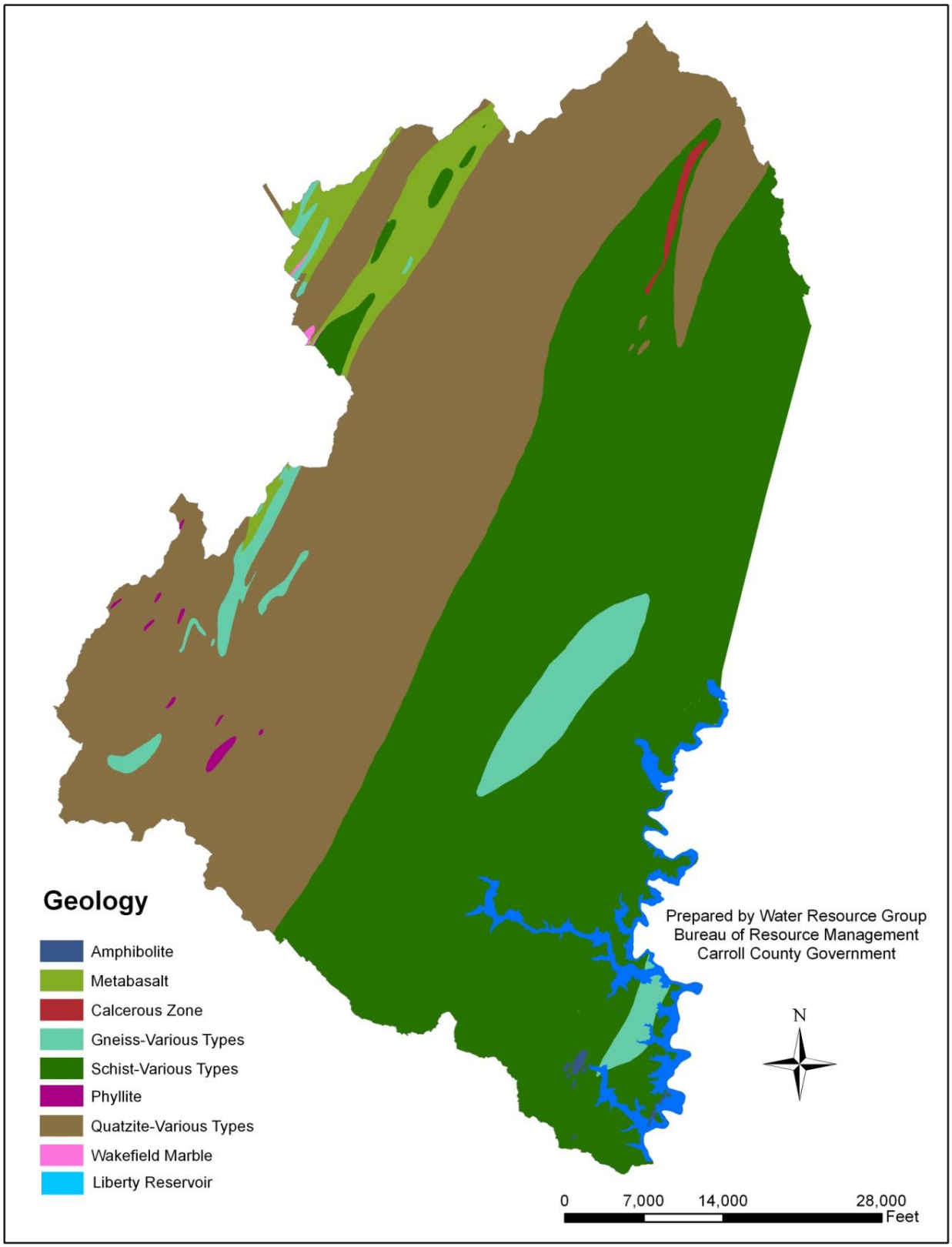

Figure 2-4: Liberty Watershed Geology

D. Surface Water Resources

The physical resources within a watershed can greatly alter the hydrological process and can affect water quality. The following section will take a look at those resources that contribute in stabilizing stream flow as well as help with natural filtration.

1. Wetlands

Wetlands are a beneficial surface water resource. Wetlands provide downstream flood protection by absorbing and slowly releasing storm flow after an event. Wetlands also naturally improve water quality with their filtering capability, nutrient uptake and transformation.

Wetlands are defined by the US Army Corps of Engineers and the US Environmental Protection Agency (EPA) as: "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." Wetlands in the Liberty watershed, as seen in Figure 2-5, can generally be found in low lying areas around streams. This is common of the Piedmont province due to the relief in topography, geology and depth to groundwater.

There are three main sources of wetland information available in Maryland. The first is the National Wetlands Inventory (NWI), which covers the entire country. The second is the Maryland Department of Natural Resources (DNR) which has mapped wetlands for the State, and the third is the National Land Cover Database (NLCD). The statistical data in this report was based off of the delineations from the NLCD. Actual acreage may be greater when field verified. The estimated wetland acreage for the Liberty Watershed can be found in Table 2-5.

Table 2-5: Liberty Watershed Wetland Estimates

DNR 12-Digit Scale	Subwatershed	DNR Wetland Estimates	
		Acres	%
1060	Aspen Run	25	<1%
1057	Beaver Run	196	2.1%
1061	Cranberry Branch	18	<1%
1058	Deep Run	48	1.2%
1052	East Branch Patapsco	10	<1%
1059	East Branch Patapsco	43	<1%
1046	Snowden's Run	92	1.8%
1047	Liberty Reservoir	68	1.5%
1049	Little Morgan Run	48	<1%
1055	Little Morgan Run	78	3.2%
1056	Middle Run	84	1.5%
1053	Morgan Run	34	1.3%
1054	Morgan Run	65	2.1%
1050	Morgan Run	134	1.3%
1048	Roaring Run	269	3.3%
1051	West Branch Patapsco	38	<1%
1062	West Branch Patapsco	36	<1%
Liberty Watershed Total:		**1,286**	**1.5%**

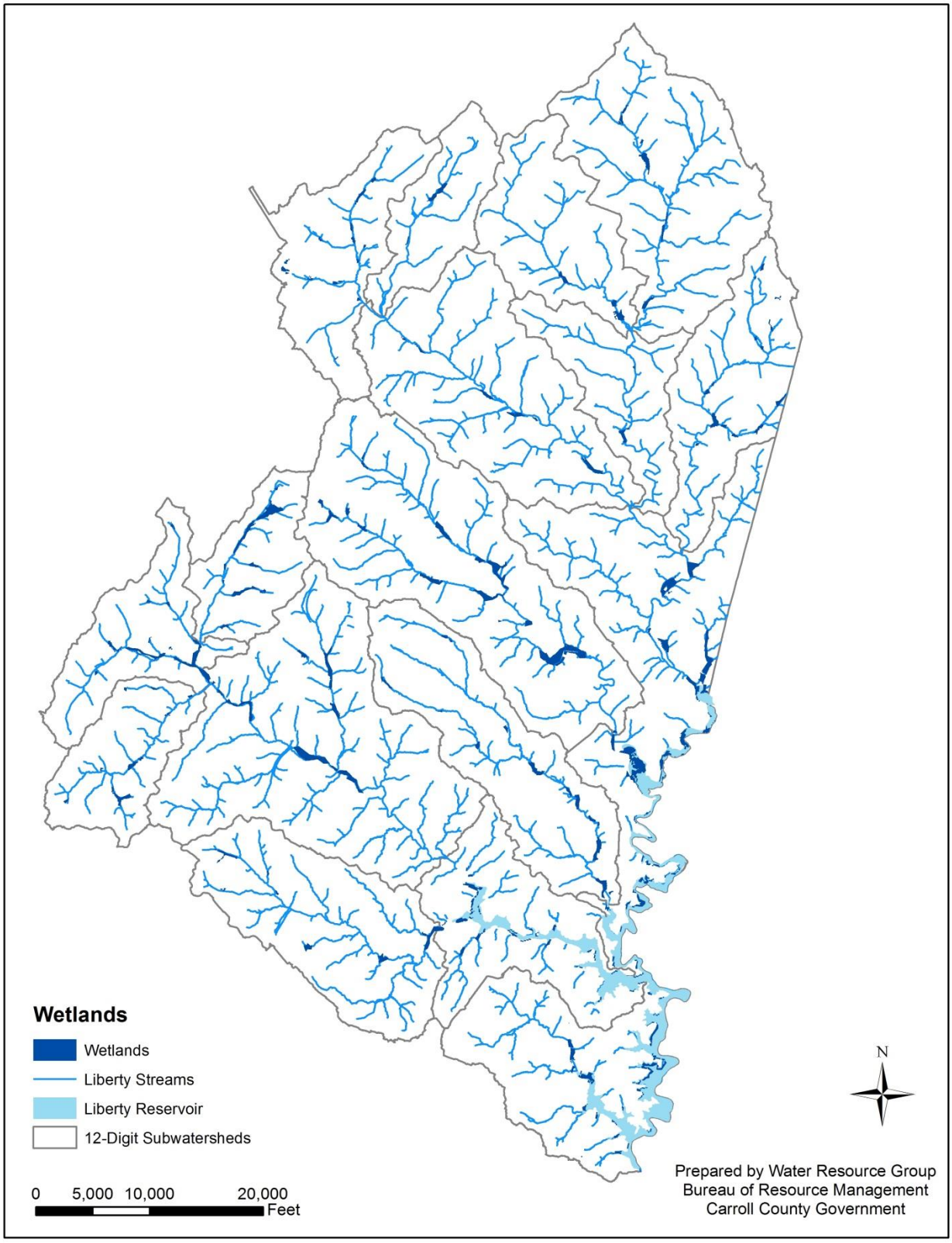

Figure 2-5: Liberty Watershed Wetland Estimates

2. Floodplains

Floodplains in their natural state provide benefits to both human and natural systems. Benefits range from reducing the number and severity of floods to handling stormwater runoff and minimizing non-point source pollutants. A natural floodplain will slow the velocity of water moving through a system, which allows sediment to settle and nutrients to be absorbed by the surrounding vegetation. Natural floodplains also contribute to groundwater recharge by allowing infiltration. Infiltration will reduce the frequency of low surface flows and allow for a healthier ecosystem.

Many floodplains are ideal locations for bike paths, open spaces, and wildlife conservation which will create a more appealing community. A floodplain in its natural state will provide outdoor education and scientific study.

The Liberty watershed contains about 4,245 acres (5%) of floodplain (Table 2-4) that are regulated under the National Flood Insurance Program (NFIP). The Federal Emergency Management Agency (FEMA) has updated flood risk identification using newer technology to establish flood risk zones and base flood elevations. Floodplain information obtained from Federal Emergency Management Agency (FEMA) 2015 effective mapped data. The total regulated floodplain area within the Liberty watershed is shown in Figure 2-6.

Table 2-4: Liberty Watershed Floodplain Estimates

DNR 12-Digit Scale	Subwatershed	FEMA Floodplain Estimates	
		Acres	%
1060	Aspen Run	118	3.2
1057	Beaver Run	517	5.5
1061	Cranberry Branch	160	6.8
1058	Deep Run	230	5.5
1052	East Branch Patapsco	158	5.4
1059	East Branch Patapsco	191	2.8
1046	Snowden's Run	263	5.1
1047	Liberty Reservoir	223	4.9
1049	Little Morgan Run	158	2.9
1055	Little Morgan Run	90	3.7
1056	Middle Run	359	6.6
1053	Morgan Run	60	2.2
1054	Morgan Run	67	2.1
1050	Morgan Run	331	3.3
1048	Roaring Run	729	9.0
1051	West Branch Patapsco	382	5.4
1062	West Branch Patapsco	209	5.5
Liberty Watershed Total:		**4,245**	**4.8**

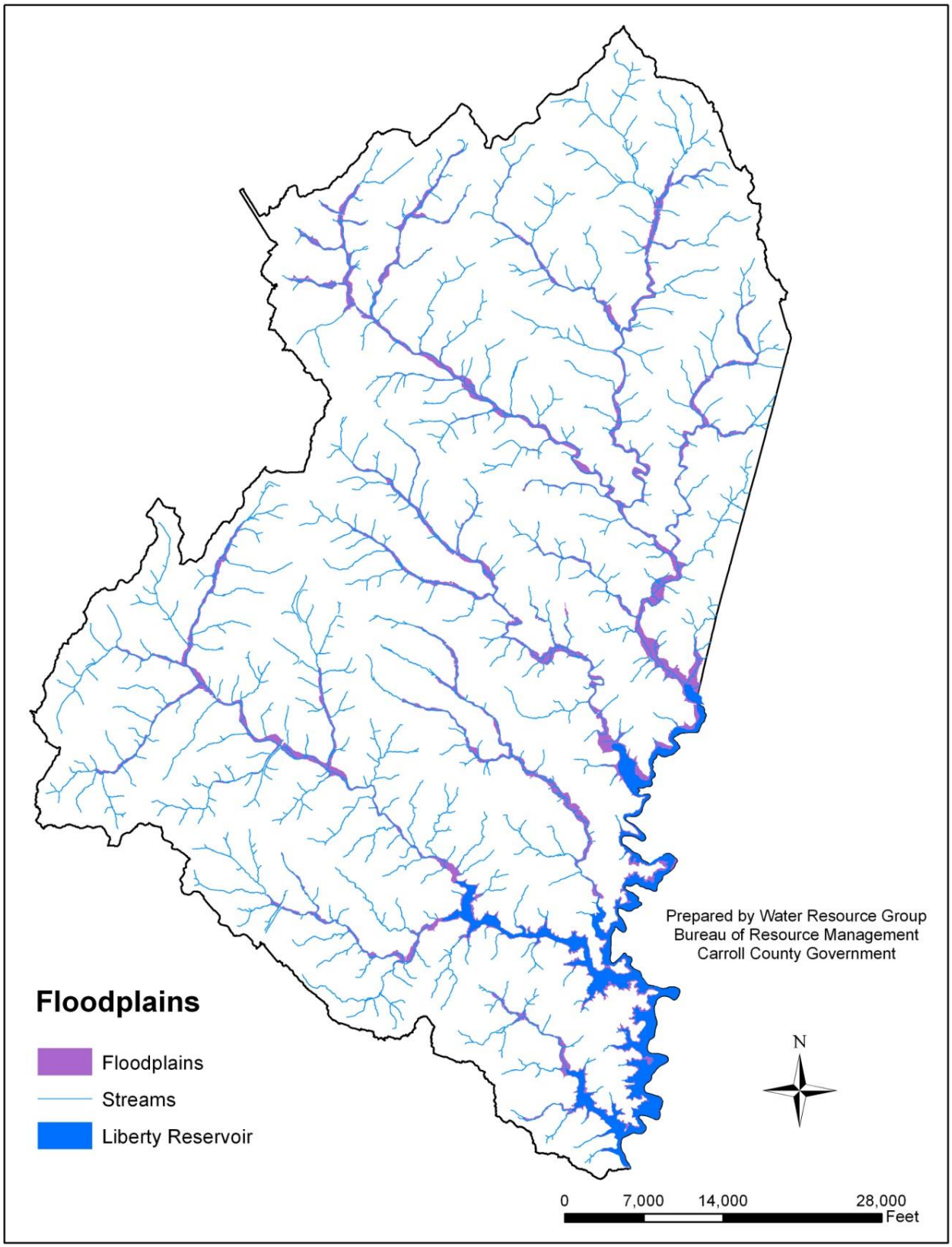

Figure 2-6: Liberty Watershed Floodplains

3. Forest

Forests are home to many forms of life and play many essential roles environmentally including climatic regulation, carbon cycling, biodiversity preservation, and soil and water conservation. Among land cover types, the forest provides the greatest protection for soil and water quality. A healthy forest will hold soil in place which reduces runoff, conserves nutrients, and protects streams from erosion. The riparian forest or corridor directly adjacent to the stream helps to moderate stream temperatures, which in many cases can support coldwater fisheries. In addition to supplying much-needed shade for streams, the riparian forest is responsible for supplying the detritus matter to the stream, which is the natural food and energy input for streams in the Piedmont region. The following will detail the forest cover within the Liberty watershed as well as the network of hubs and corridors which have been prioritized by DNR.

a. Forest Cover

A healthy forest not only plays an important role environmentally, but it can have great aesthetic and recreational benefits as well. The forest areas within the Liberty watershed today consist of succession forests that have regrown and matured. Larger forest blocks will provide greater benefits ecologically than smaller blocks. Typically there is less fragmentation of the landscape in a larger forest block which benefits interior dwelling species.

Liberty Watershed contains 26,804 acres of forest over multiple land uses, and covers about 31 percent of the land within the watershed. The forest cover within the Liberty Watershed can be found in Figure 8 and is shown in Table 2-5.

Table 2-5: Liberty Watershed Forest Cover

DNR 12-Digit Scale	Subwatershed	Total Acres	Forested Acres	% Forested
1060	Aspen Run	3,668	967	26.4%
1057	Beaver Run	9,322	2,481	26.6%
1061	Cranberry Branch	2,337	548	23.4%
1058	Deep Run	4,154	891	21.4%
1052	East Branch Patapsco	2,937	993	33.8%
1059	East Branch Patapsco	6,781	1,421	21.0%
1046	Snowden's Run	5,142	1,864	36.3%
1047	Liberty Reservoir	4,509	2,308	51.2%
1049	Little Morgan Run	5,529	1,811	32.8%
1055	Little Morgan Run	2,406	484	20.1%
1056	Middle Run	5,472	1,479	27.0%
1053	Morgan Run	2,698	701	26.0%
1054	Morgan Run	3,169	689	21.7%
1050	Morgan Run	10,153	4,310	42.5%
1048	Roaring Run	8,085	2,988	37.0%
1051	West Branch Patapsco	7,065	2,633	37.3%
1062	West Branch Patapsco	3,822	236	6.2%
Liberty Watershed Total		**87,249**	**26,804**	**31%**

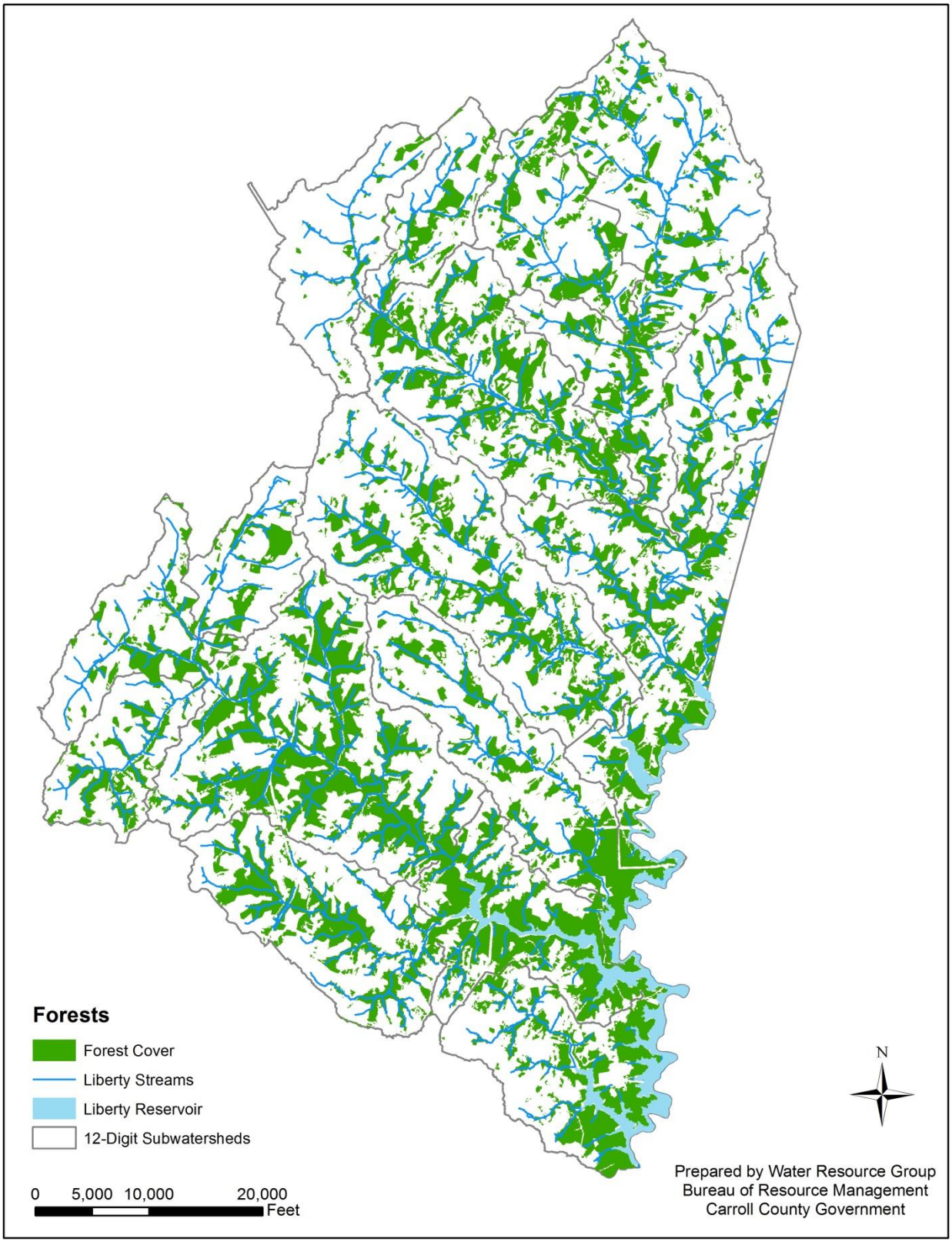

Figure 2-7: Liberty Watershed Forest Cover

E. Ecologically Important Areas

DNR has mapped a statewide network of ecologically important areas across the state called "Green Infrastructure". These areas are known as hubs and corridors. Hubs consist of large blocks of important natural resource land, and corridors connect one hub to the next. The large blocks of land that form this green infrastructure consist primarily of contiguous forest land but also may include wetlands and other naturally vegetated lands.

DNR mapped this network of ecologically important land by using several geographic information system (GIS) data layers to develop the areas that met specific parameters for green infrastructure. Hubs will contain one or more of the following:

- Areas containing sensitive plant or animal species
- Large blocks of contiguous interior forest (at least 250 contiguous acres)
- Wetland complexes with at least 250 acres of unmodified wetlands
- Streams or rivers with aquatic species of concern, rare coldwater or blackwater ecosystems, or important to anadromous fish and their associated riparian forest and wetlands
- Conservation areas already protected by public and private organizations (i.e. DNR, The Nature Conservancy)

This "Green Infrastructure" provides the bulk of the state's natural support system. As stated previously, forest systems are important resources that attribute to filtering and cooling water, storing and cycling nutrients, conserving soils, protecting areas from storm and flood damage, and maintaining the hydrologic function of the watershed. For more information on the Green Infrastructure identification project through DNR, see www.dnr.maryland.gov/greenways.

Lands identified through the Green Infrastructure project where protection is needed may be addressed through various programs including rural legacy, program open space, or conservation easements.

Figure 2-8 shows the hubs and corridors within the Liberty watershed as identified through the DNR Green Infrastructure project.

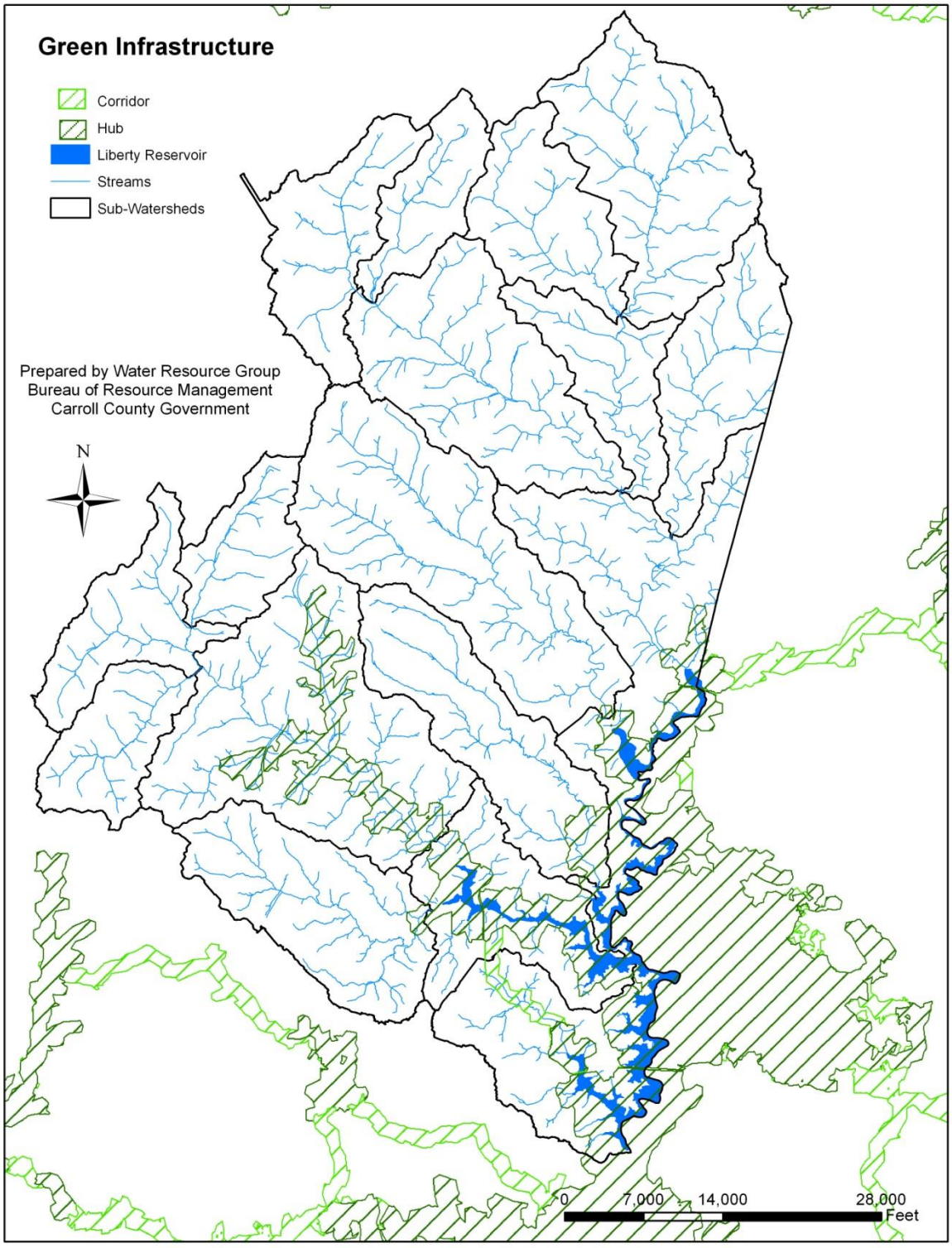

Figure 2-8: Liberty Watershed Green Infrastructure

F. Groundwater Resources

Groundwater development potential in Carroll County is limited to the aquifer type of that area. Of the aquifer types within Carroll County, each has unique water-bearing and yielding properties. The underlying bedrock units have minimal primary porosity and permeability. As such, groundwater occurs principally in interconnected joints, fractures, and faults within the rock mass, as well as in the relatively shallow weathered zone overlying the bedrock and beneath the soil horizon (Carroll County Water Resources Study, 1998).

The ease at which groundwater moves through an aquifer in response to a water table gradient is indicated by aquifer transmissivity. Transmissivity is a governing factor in determining the amount of water which may be withdrawn in a given area. A highly transmissive aquifer will allow a greater volume of water to be withdrawn than an aquifer with low transmissivity with a given water table drawdown. Low transmissivity will cause significantly less flow in the groundwater and restrict withdrawal rates.

To obtain satisfactory yield, well location is critical and must intersect a permeable fracture. Fracture trace zones are evident on aerial photographs as alignments of valleys and swales, contrasting soil tones, differences in vegetation type, and growth along with the occurrence of springs and seeps. Aquifers are replenished by the seepage of precipitation, but the amount that is absorbed is dependent on geologic, topographic, and human factors which determine the extent and rate that aquifers are replenished.

The ground works as an excellent mechanism for filtering out particulate matter, but natural occurring contaminants such as iron and manganese, as well as human induced contaminants like chemicals and oil, are easily dissolved and can be transmitted via groundwater to surface water bodies. Since the underlying rocks have varying porosity and permeability characteristics, water quality will also vary greatly.

III. Human Characteristics

A. Population

The natural landscape of the Liberty watershed has been modified for human use over time. This modification has the potential to degrade both the terrestrial and aquatic ecosystems. The Liberty watershed currently has an estimated population of 72,288 persons with most of that being within the Westminster-Eldersburg urban area. The population density outside of the municipalities equates to about one person for every 1.37 acres. The following chapter will discuss the human characteristics of the watershed and how these modifications could possibly impact the natural ecosystem. This chapter will examine the general land use and land cover of the watershed as well as the specific human modifications like impervious surface cover, stormwater systems, drinking water, and wastewater systems.

B. Land Use and Land Cover

The land use information was obtained from the National Land Cover Database (GIS) land use data. Land use data summary for the Liberty Watershed can be found in Table 3-1. Figure 3-1 shows the land use cover within the Liberty Watershed.

Agriculture is the dominant land use within the Liberty Watershed, followed by forest and residential. Mixed urban uses account for less than 5 percent of the total land use, which represents the relatively rural nature of the Liberty Watershed.

Table 3-1: Liberty Land Use Data by Acres and Percentage

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	1,097	1%	1,284	1%	1,290	1%	1,289	1%
Low-Density Residential	11,711	13%	11,733	13%	11,904	14%	19,080	22%
Low-Density Mixed Urban	2,684	3%	2,720	3%	2,795	3%	2,795	3%
Medium-Density Mixed Urban	1,067	1%	1,205	1%	1,323	1.5%	1,323	1.5%
High-Density Mixed Urban	284	<1%	371	<1%	412	<1%	412	<1%
Barren Land	246	<1%	228	<1%	201	<1%	197	<1%
Forest	27,748	32%	27,606	32%	27,616	32%	26,804	31%
Shrub/Scrub	1,796	2%	1,774	2%	1,786	2%	1,476	1.7%
Grassland	177	<1%	289	<1%	276	<1%	224	<1%
Pasture/Hay	14,686	17%	14,277	16%	14,195	16%	12,078	14%
Cropland	24,275	28%	24,427	28%	24,116	28%	20,323	23%
Wetland	1,453	2%	1,309	1.5%	1,308	1.5%	1,286	1.5%

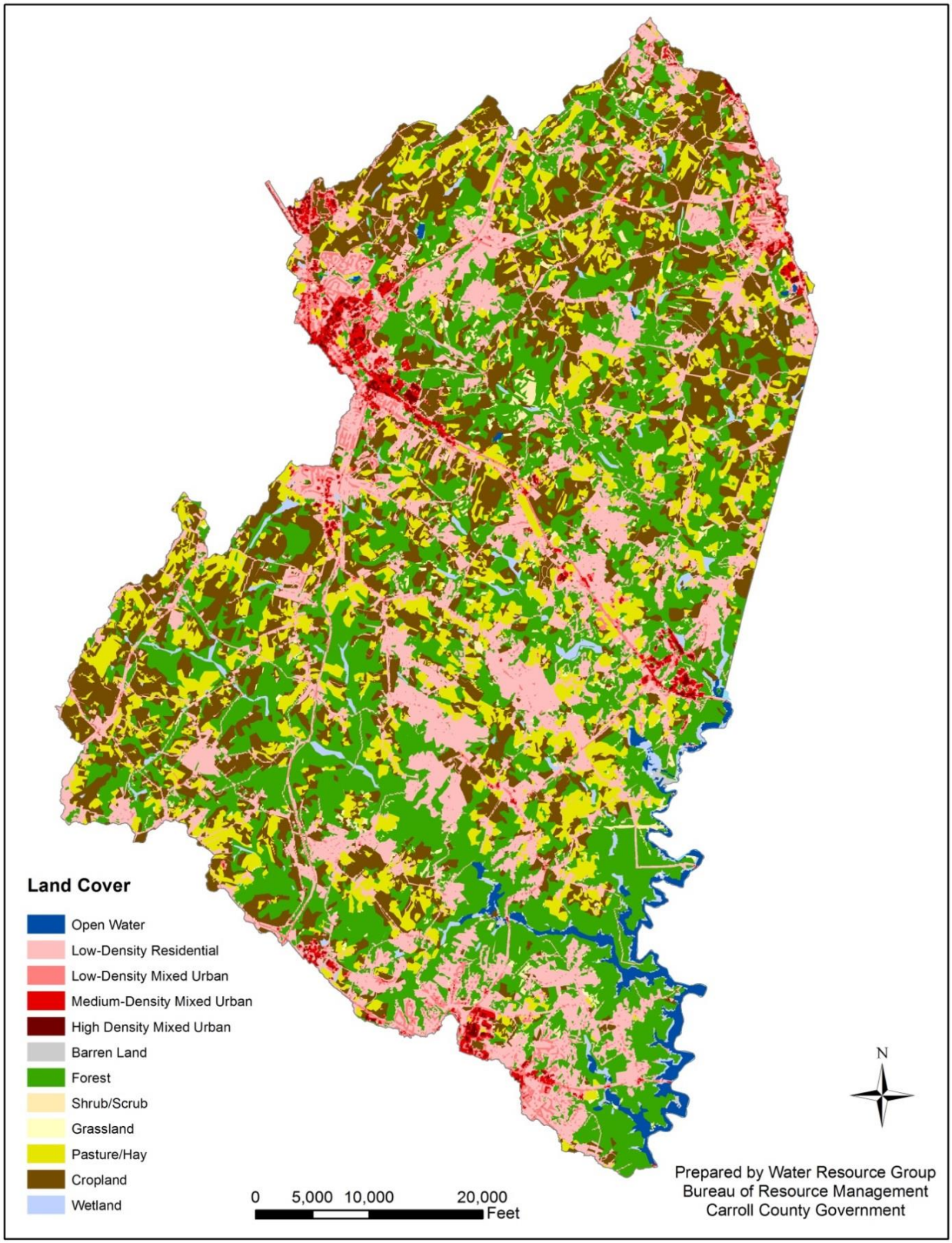

Figure 3-1: Liberty Watershed Land Use/Land Cover

C. Priority Funding Areas, Zoning and Build Out

1. Priority Funding Areas

The Maryland Smart Growth Areas Act of 1997 introduced the concept of Priority Funding Areas (PFA's). The Maryland Planning Act and Smart Growth initiatives require that the local jurisdictions map specific growth areas to target infrastructure dollars from the State. PFA's are existing communities and locations where state funding for future growth will be designated. Within the Liberty watershed the towns of Manchester, Hampstead, Westminster, Finksburg, Freedom and Bethel Road are designated PFA's. In addition to these towns, there are also eight rural villages that are designated PFA's, these rural villages include Warfieldsburg, Shipley, Smallwood, Patapsco, Snydersburg, Louisville, Gamber and Winfield. These designated areas have specific boundaries and are the focal area for employment, social and commercial activity within the watershed. Figure 3-2 shows the designated PFA's within the Liberty Watershed.

2. Zoning and Build Out

Zoning refers to the regulation of land use for the purpose of promoting compatible land uses. Typically zoning specifies the areas in which residential, industrial, recreational or commercial activities may take place. The current zoning for the Liberty watershed can be found in Figure 3-3. Carroll County does not regulate zoning within the municipalities. The majority of the Liberty reservoir watershed (46%) is zoned agricultural.

Build out analyzes the number of residential units in a given area that could be built, based on the current zoning of that area. Build-out looks at the existing development and based on the density, determines how many more residential units can be built in the future. Within the Liberty watershed there are 2,965 parcels remaining on 32,448 acres for a potential lot yield (PLY) of 9,975 (build out data was provided by Carroll County Department of Land Use, Planning and Development). This data is based on medium range buildable land inventory estimates by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplan/bli/. Figure 3-4 shows the remaining parcels in Liberty watershed where residential units could be built.

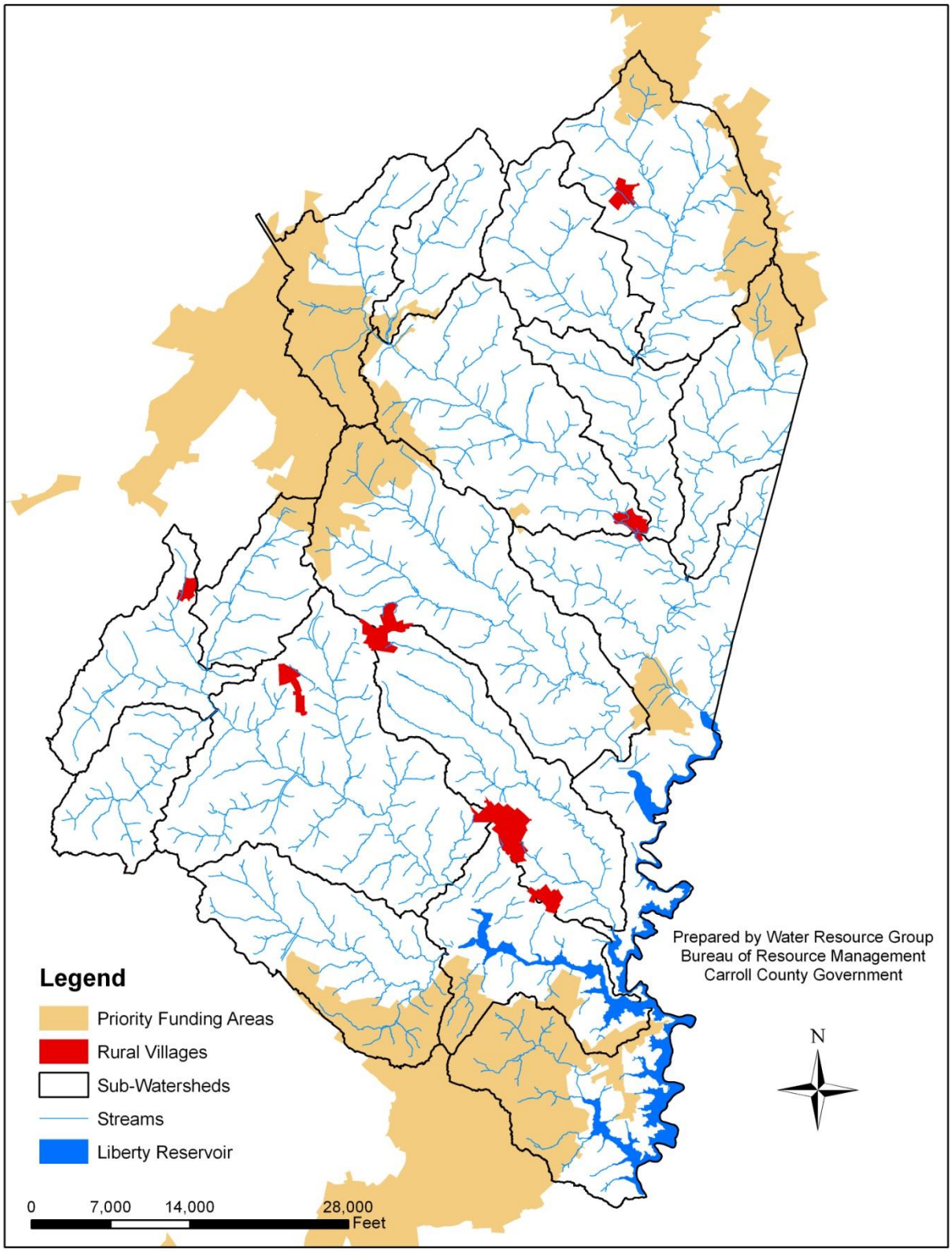

Figure 3-2: Liberty Watershed Priority Funding Areas

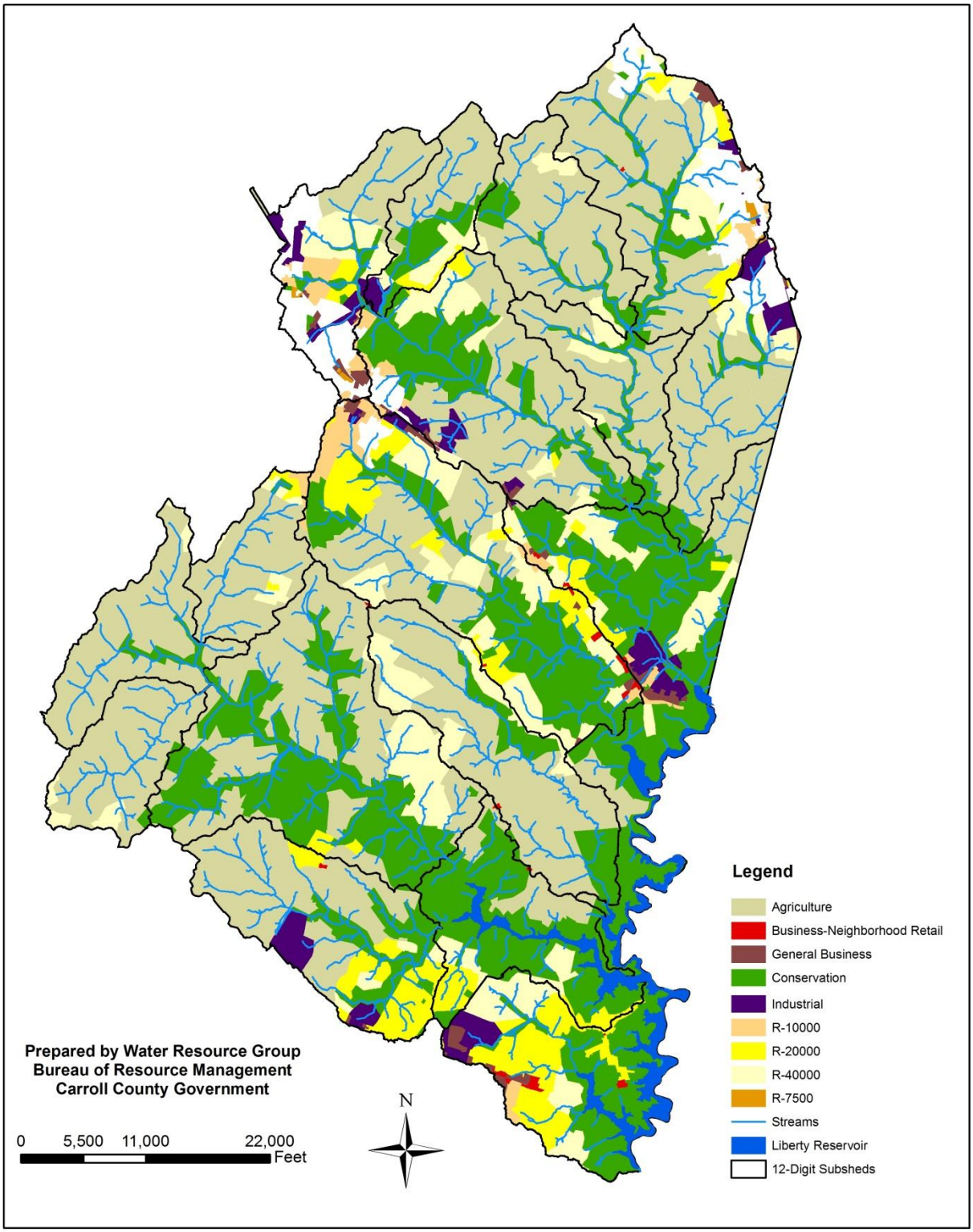

Figure 3-3: Liberty Watershed Zoning

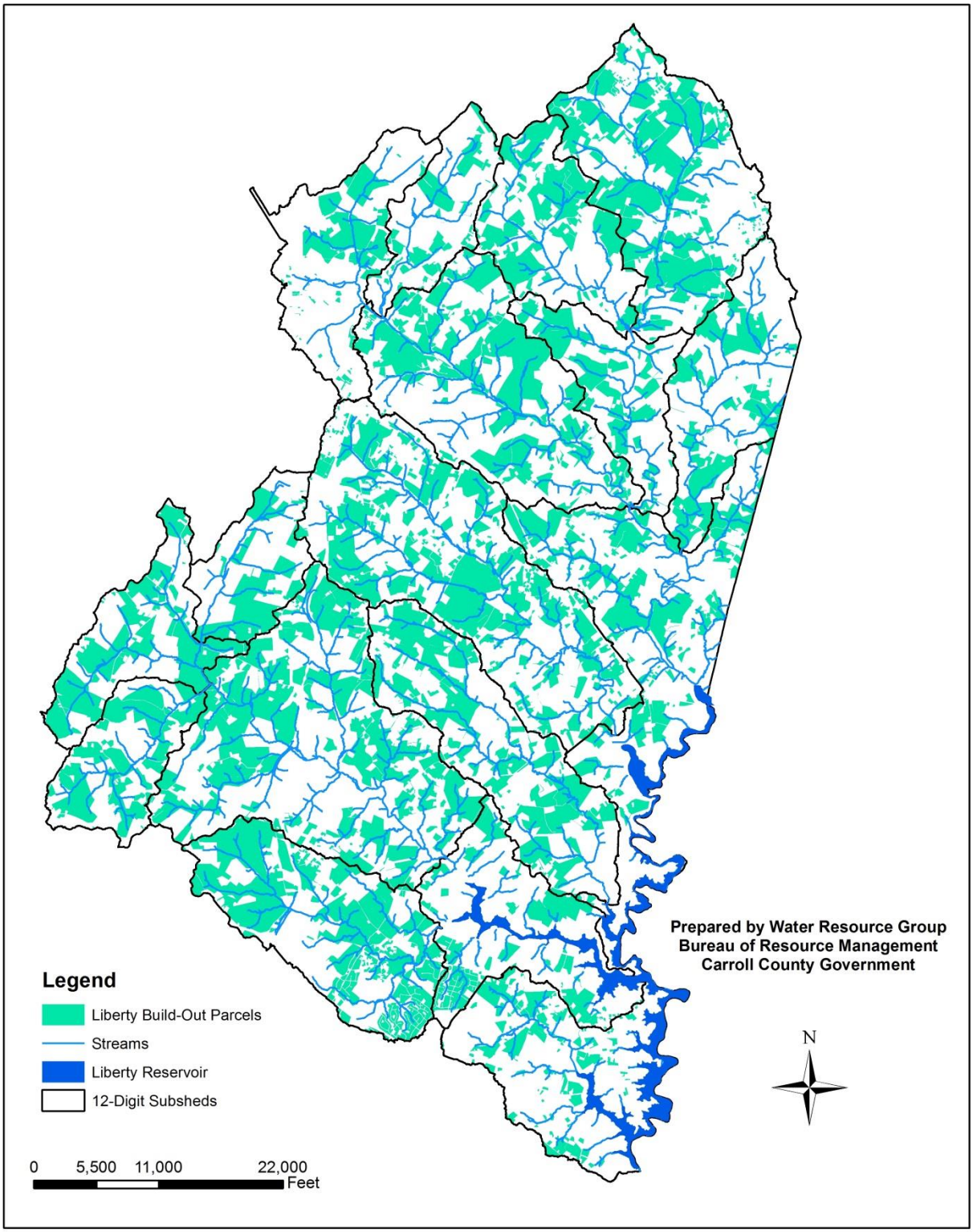

Figure 3-4: Liberty Watershed Build-Out Parcels

D. Impervious Surfaces

Watershed and stream health have been tied, via various studies to the amount of impervious surface that lies within the system. Impervious surfaces such as roads, parking areas, and rooftops block the natural seepage of rainwater into the ground, resulting in concentrated stormwater runoff with an accelerated flow rate. There are two general ways to quantify impervious cover: total impervious and effective impervious. Total impervious accounts for all impervious surfaces within a catchment, and effective impervious is the impervious area within the watershed that is directly connected to stream channels. Table 3-2 shows the estimated total impervious area by subwatershed for the Liberty watershed.

Table 3-2: Liberty Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
1060	Aspen Run	3,668	127	3.5%
1057	Beaver Run	9,322	751	8.1%
1061	Cranberry Branch	2,337	165	7.1%
1058	Deep Run	4,154	220	5.3%
1052	East Branch Patapsco	2,937	125	4.3%
1059	East Branch Patapsco	6,781	468	6.9%
1046	Snowden's Run	5,142	564	11.0%
1047	Liberty Reservoir	4,509	214	4.7%
1049	Little Morgan Run	5,529	395	7.1%
1055	Little Morgan Run	2,406	95	3.9%
1056	Middle Run	5,472	267	4.9%
1053	Morgan Run	2,698	95	3.5%
1054	Morgan Run	3,169	103	3.3%
1050	Morgan Run	10,153	415	4.1%
1048	Roaring Run	8,085	489	6.0%
1051	West Branch Patapsco	7,065	442	6.3%
1062	West Branch Patapsco	3,822	835	21.8%
Liberty Watershed		**87,249**	**5,770**	**6.6%**

The Liberty watershed is estimated to have 5,770 acres of total impervious within the catchment and accounts for approximately 6.6 percent of the total land area. Effective impervious was not calculated for this exercise because it is difficult to accurately determine without proper field verification, but it is a much lesser percent. The West Branch Patapsco watershed which originates within the city limits of Westminster had the highest percentage of total impervious for the entire watershed (21.8%). Some aquatic species begin to disappear once the impervious area of a watershed reaches a certain threshold. This threshold was established at 10 percent back in the 1970's, but a change in this number has been considered by DNR after drastic declines in Brook Trout populations became evident in watersheds where the impervious surface is at or above the 4 percent range (Southerland, 2005). Figure 3-5 shows the estimated total impervious surface area within the Liberty watershed.

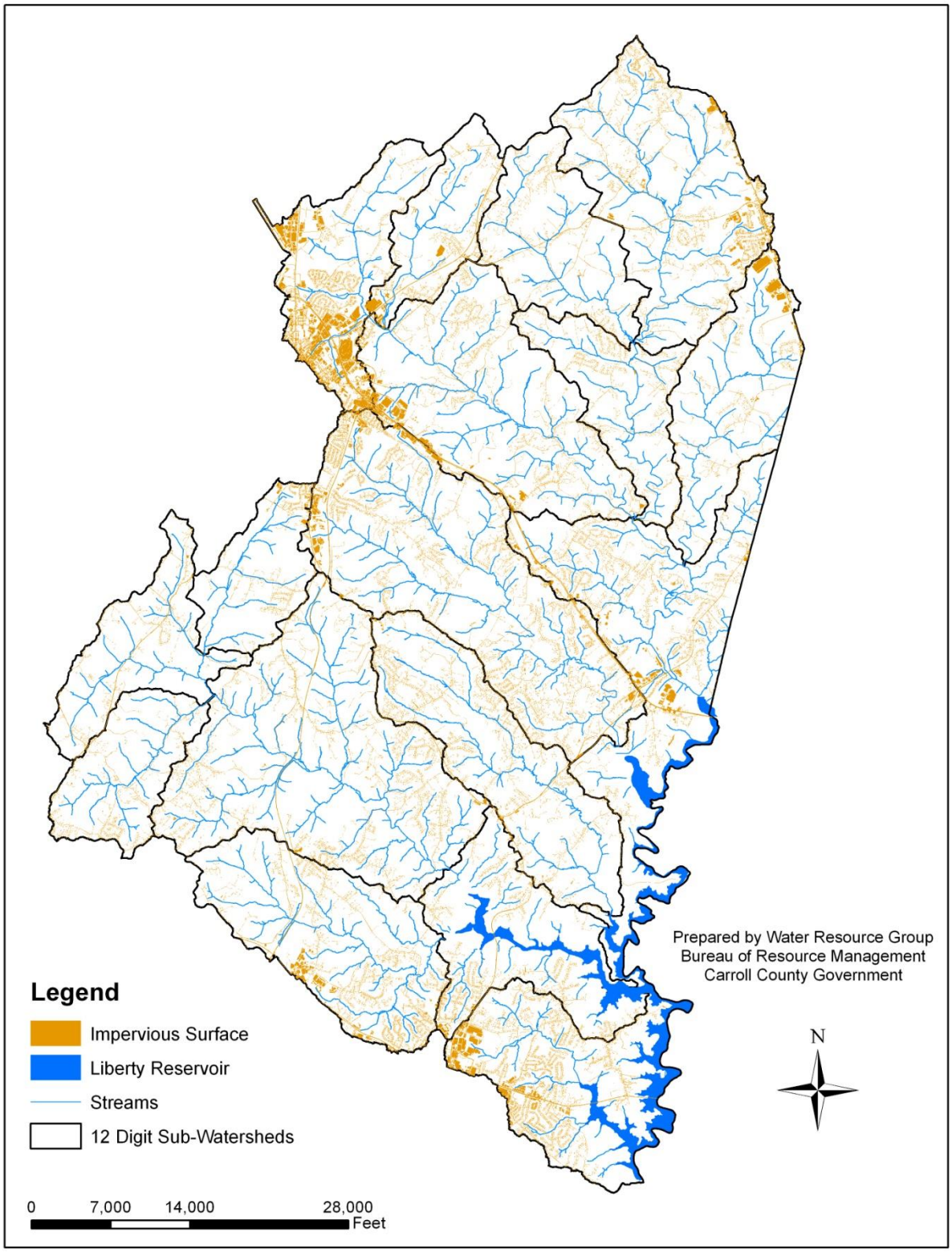

Figure 3-5: Liberty Watershed Impervious Surface Area

E. Stormwater

Stormwater consists of runoff from precipitation and snowmelt that flows over the land or an impervious surface and is unable to infiltrate into the ground. As the runoff flows across a surface it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. Increased amounts of unmanaged effective impervious surface within a watershed likely increase the amount of contaminated stormwater reaching the stream channel.

1. Stormwater Management Facilities

In the 1980's, the State of Maryland required stormwater management for new development to manage the quantity of runoff. These requirements were initially put in place to treat subdivisions with less than 2 acre lots. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000 Maryland Department of Environment (MDE) released a new design manual for stormwater which required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres.

There are different types of management facilities with varying degrees of pollutant removal capability. Facilities that infiltrate stormwater runoff have among the highest pollutant removal capability, while the initial dry pond design has the lowest pollutant removal efficiency and was designed to control water quantity. In total there are 339 stormwater management facilities within the Liberty watershed, with the majority being located within the Westminster-Eldersburg urban area. Table 3-3 lists the facility type, number of structures, and associated drainage acreage of the structures. Appendix A lists the subwatershed location, facility type, drainage area, and facility name along with a definition of each facility and the pollutant removal capability. Figure 3-6 shows the location of the stormwater management facilities in the Liberty watershed.

2. Storm Drain Systems

A storm drainage system will consist of either contoured drainage swales or a curb and gutter system with inlets and associated piping. Both systems function to quickly remove water from impervious areas in order to prevent flooding, but they have varying effects on water quality. The curb and gutter system directly connects to the stream through its piping network and delivers increased volumes of water as well as untreated pollutants from the connected impervious surface. Contoured drainage swales do not move water as efficiently as the curb and gutter system which allows for filtration of some pollutants, and infiltration, reducing the amount of water delivered to the stream.

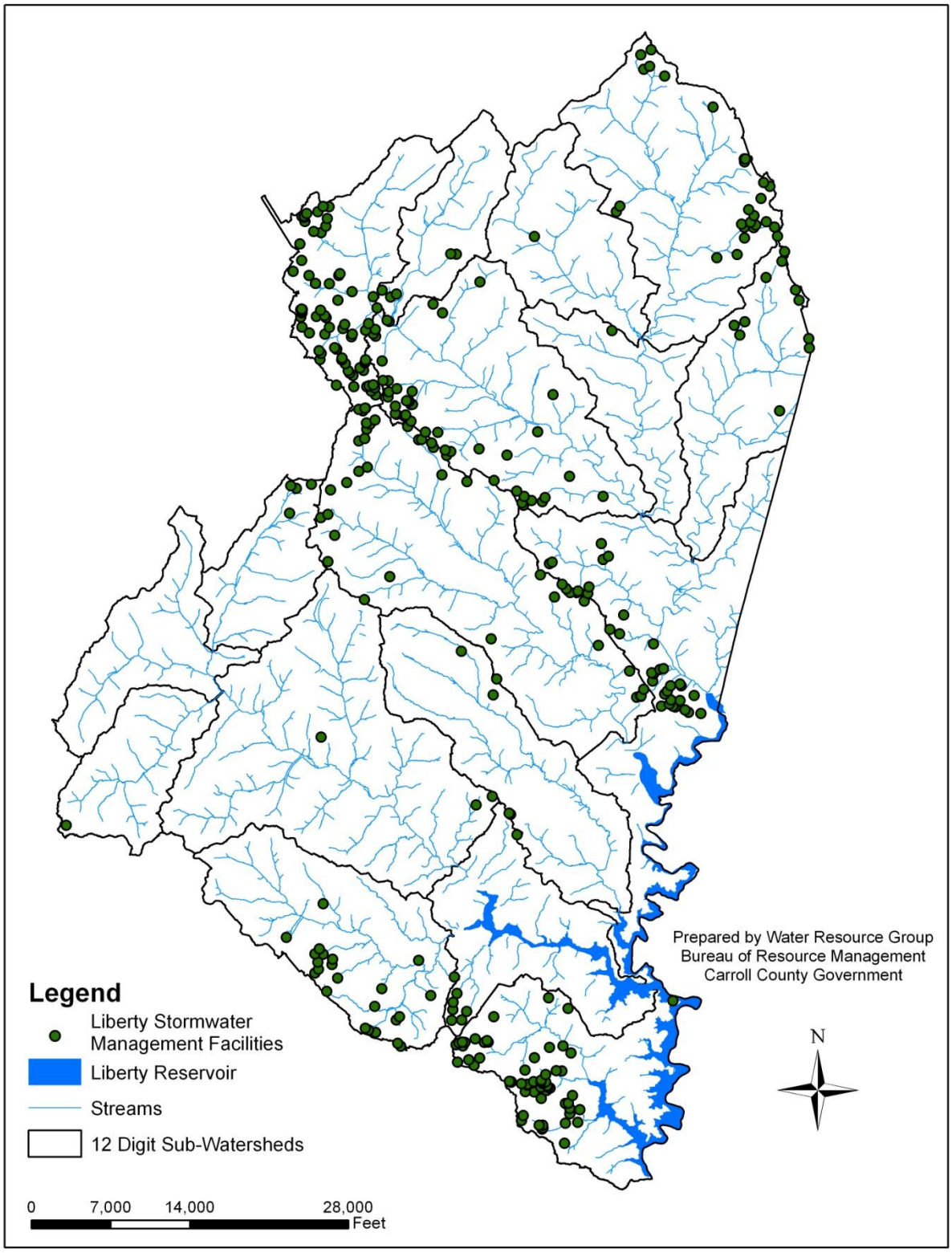

Figure 3-6 Stormwater Management Facilities

Table 3-3: Liberty Watershed Stormwater Facility Types

Above Ground		
Facility Type	**Number of Structures**	**Drainage Area**
Swale	4	68.46
Swale w/ check dams	4	8.08
Wetland Forebay Detention	1	79.46
Shallow Marsh/Wetland	18	938.19
Filtration basin (sand filter & underdrain)	61	9,024.23
Dry Infiltration Basin	51	1,095.59
Retention Basin	26	1,013.54
Water Quality Basin	3	19.41
Water Quality Pavers	1	19
Flow Attenuation	3	15.24
Dry Detention Pond	68	1,051.35
Subtotal	**240**	**13,332.55**
Underground		
Facility Type	**Number of Structures**	**Drainage Area**
Infiltration Trench	68	388.06
Dry Detention Tank	10	26.92
Underground Sand Filter	1	0.75
Underground Tank	8	23.69
Infiltration Dry Well	4	35.76
Filtration Inlet	3	1.84
Infiltration Inlet	3	12.66
Oil Grit Separator	1	0.09
Subtotal	98	489.77
Total	**338**	**13,822.32**

Stormwater management facilities proposed for implementation to assist in addressing the stormwater wasteload allocation TMDLs are listed within the Liberty Reservoir Watershed TMDL restoration plan.

F. Drinking Water

Having safe drinking water is fundamentally important to support human and livestock populations within a watershed. Within the Liberty watershed drinking water comes from two main sources; public water systems and private wells.

1. Wellhead Protection Areas

Wellhead protection areas defined under the Safe Drinking Water Act are surface and subsurface regulated land areas around public drinking water wells or well fields that prevent contamination of that water supply. Ideally, a wellhead protection area will encompass the entire potential recharge area for that well. Wellhead protection areas within the Liberty watershed are shown in Figure 3-7.

2. Water Supply

The majority of the residents within the Liberty watershed obtain their water from private wells located on their property. (There are about 13,700 private water wells within the watershed.) Since the underlying geology within the Liberty watershed consists mainly of crystalline metamorphosed rock, the associated water withdrawals from these wells come from an unconfined aquifer. The fractured rock of the Piedmont physiographic region allows surface water to pass through the soil and into the underlying rock fractures; therefore, the source of the water is locally derived.

3. Public Water Service Area

Within the Liberty watershed the towns of Hampstead, Manchester, Westminster and Freedom provide residents with public treated water. Hampstead currently has 18 production wells appropriated, Manchester has 17 wells and 2 springs, Westminster has 13 wells and Freedom has just 2 wells. At any given time these wells could be either online or offline depending on maintenance and demand. Each well has its own appropriation, which is determined by MDE's water supply program. Each service area sits along the topographical watershed divide and obtains their water from community wells located in the Liberty watershed as well as the Prettyboy, Double Pipe and South Branch Patapsco watersheds. The community well locations and associated public service area is shown in Figure 3-7.

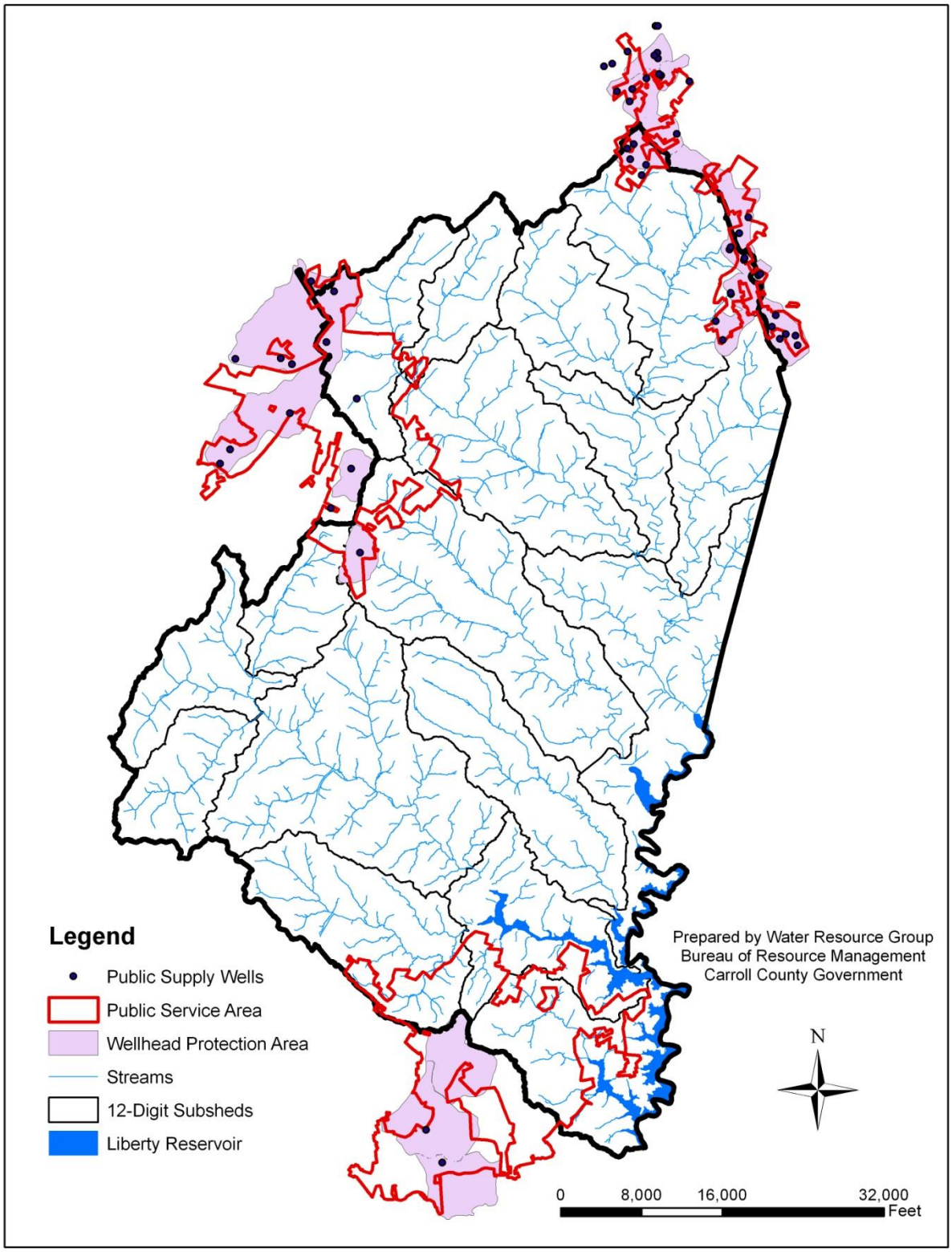

Figure 3-7 Liberty Public Water Supply

G. Wastewater

Wastewater is any water created through human use that has been adversely affected in quality by anthropogenic influence, and must be properly treated and disposed. Treatment and disposal of wastewater can be accomplished by either on-site septic systems or through public conveyance to a community wastewater treatment plant. The treatment of wastewater is essential because any untreated waste either from a residential or industrial operation has the potential for carrying harmful contaminants to the natural environment.

1. Public Wastewater Service Area

The public service area conveys wastewater through a piping system from residences and businesses to a treatment facility prior to discharge. Each hookup to the sewer line has a cleanout in which the private landowner is responsible for maintaining. The main part of the system consists of gravity flow lines with manholes for access, pumping stations, and force mains. The public utility is responsible for maintenance on the main part of the wastewater system. Within the Liberty watershed there are approximately 7,700 homes utilizing public service and about 210 homes that are within the area slated for future service. Figure 3-8 shows the public wastewater service area for the Liberty watershed.

2. Wastewater Discharge Locations

Within the Liberty watershed the towns of Hamptead, Manchester, Freedom, and Westminster are serviced through a public wastewater system. Only the town of Freedom discharges treated wastewater effluent into the Liberty watershed. The Hampstead wastewater treatment plant discharges into Piney Run stream, which is part of the Loch Raven reservoir watershed. Manchester's effluent discharge is located in the Prettyboy watershed, and the Westminster effluent is discharged into the Double Pipe creek watershed.

3. On-Site Septic Systems

On-site septic systems are the main source of waste disposal in rural areas. When maintained and functioning properly, on-site septic's are effective at treating nitrogen. (Phosphorus binds with soil particles and is not considered an issue.) Improved treatment of nitrogen can be achieved by making sure the leach field is properly located to prevent effluent from directly entering a body of water; however, when these systems fail or are inadequately maintained, excessive nutrients and bacteria can be released, which causes degradation of the groundwater and nearby aquatic systems. There are currently about 15,800 septic systems within the Liberty watershed.

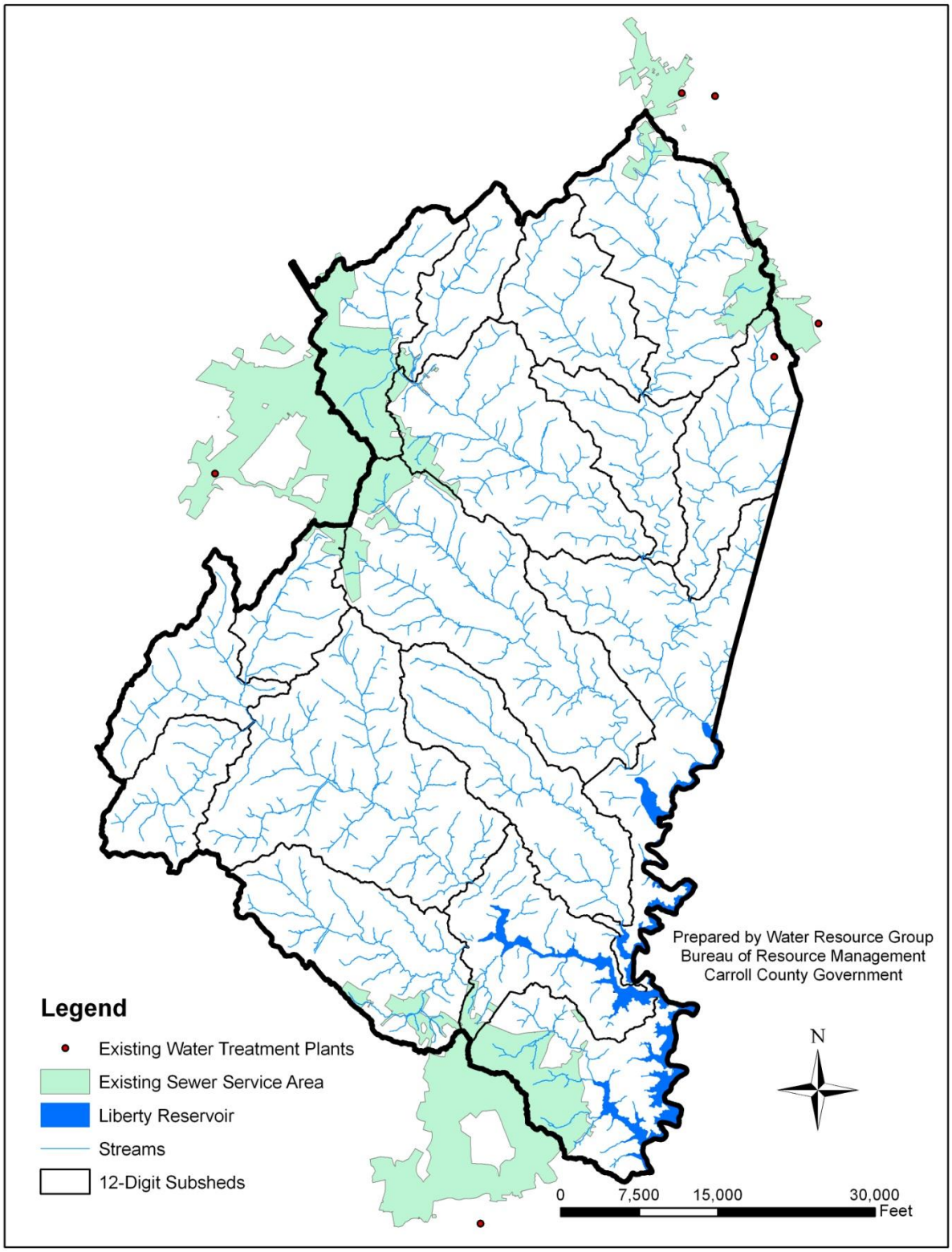

Figure 3-8 Liberty Wastewater Service Area

H. NPDES Point Sources

Any facility that discharges wastewater whether it is industrial or municipal; or any facility that performs activities in which those activities could have a negative impact on a waterway by introducing pollutants into the watershed must obtain a National Pollutant Discharge Elimination System (NPDES) permit. Table 3-4 shows a list of NPDES permits within the Liberty watershed (information obtained from EPA.GOV).

Table 3-4 NPDES Permits in Liberty Watershed

Permit Holder	Permit Number	Subwatershed	Permit Type
Congoleum Corporation	MD0001384	Roaring Run	WMA1M
Cranberry WTP	MD0067644	Cranberry Branch	WMA2
Freedom District WTP	MD0067652	Snowden's Run	WMA2
Herbert R. Shipley, Inc.	MD2670G06	Little Morgan Run	WMA3
Finch Services	MD3684G09	Upper W. Branch Patapsco	WMA3
North Carroll Shopping Plaza	MD3154G06	Upper E. Branch Patapsco	WMA4
Todd Village Mobile Home Park	MD3268G98	Roaring Run	WMA4
Gerstell Academy	MD3276G06	Roaring Run	WMA4
Lakeview Mobile Home Park	MD3597G08	Direct Drainage	WMA4
Rill's Bus Service / pond	MD0070734	Lower W. Branch Patapsco	WMA4
Thomas, Bennett & Hunter, Inc.	MDR000078	Upper W. Branch Patapsco	WMA5
Northern Municipal Landfill	MDR000660	Lower W. Branch Patapsco	WMA5
Maryland Paving - Finksburg	MDG490720	Roaring Run	WMA5
Hodges Landfill	MDR000664	Little Morgan Run	WMA5
Tobacco Technology, Inc.	MDR000794	Little Morgan Run	WMA5
Jones Auto and Salvage	MDR000954	Morgan Run	WMA5
M & M Truck & Equipment Co., Inc	MDR001144	Roaring Run	WMA5
SEH Excavating, Inc	MDR001219	Roaring Run	WMA5
SHA - Westminster Shop	MDR001345	Upper W. Branch Patapsco	WMA5
Condons Auto Parts, Inc	MDR001452	Cranberry Branch	WMA5
Carroll County Regional Airport	MDR001755	Upper W. Branch Patapsco	WMA5
Smith Brothers Used Auto Parts	MDR001908	Upper E. Branch Patapsco	WMA5
Carleton Technologies, Inc	MDR001838	Upper W. Branch Patapsco	WMA5
General Dynamics Robotics Systems	MDR001920	Upper W. Branch Patapsco	WMA5
General Dynamics Robotics Systems	MDR002169	Upper W. Branch Patapsco	WMA5
Public Works Facility	MDR002213	Upper E. Branch Patapsco	WMA5
Larry Hentz Public Works	MDR002214	Upper E. Branch Patapsco	WMA5
Carroll Scrap Metal, Inc	MDR002286	Roaring Run	WMA5
S & G Concrete Company, Inc - Finksburg	MDG492472	Roaring Run	WMA5
Bullock's Meats, Inc	MDR003001	Beaver Run	WMA5
BTR Hampstead, inc - Black 7 Decker WWTP	MDG675154	Deep Run	WMA5
Stag-Hampstead Industrial Exchange	MDG675163	Deep Run	WMA5
Carroll County Family YMCA	MDG766057	Beaver Run	WMA5
The Boston Inn, Inc	MDG766199	Upper W. Branch Patapsco	WMA5
4 Seasons Sports Complex	MDG766210	Upper E. Branch Patapsco	WMA5
Freedom Swim Club	MDG766371	Direct Drainage	WMA5
C.J. Miller, LLC	MDG498017	Roaring Run	WMA5
Freedom District Water Supply System / Carroll	MDG498017	Snowden's Run	WMA5

I. Protected Lands

The protection of land ensures that non-urban land uses will remain intact over time on the specific parcel that is being protected. These lands are preserved through various programs and the extent of "protection" can vary greatly from one easement to the next. Preservation and protection include areas such as parks or watershed protection zones where non extractive uses predominate, as well as areas that are being intensively managed for agriculture.

Table 3-5 lists the type of protected lands within the Liberty watershed along with the representative acreage. Nearly 8,000 acres (9%) of the total land area within Liberty has some sort of protection associated with the land. Open space and recreational areas have the highest percentage of protection within the watershed at 3 percent with about 2,800 acres preserved. Figure 3-9 shows where the protected areas are located within the watershed.

Table 3-5: Protected Lands in Liberty Watershed

Type of Protection	Acres	Percentage
Agricultural Easement	2,438	2.7
Open Space and Parks	2,808	3
Forest Conservation Easement	1,526	1.7
Water Resource Easement	954	1
Floodplain Easement	245	<1
Total	**7,971**	**9**

1. Rural Legacy Program

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the rural legacy program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Liberty watershed lies within the Upper Patapsco Rural Legacy Area. The Rural Legacy Area encompasses 21,541 acres (25%) of the Liberty watershed depicted in Figure 3-10.

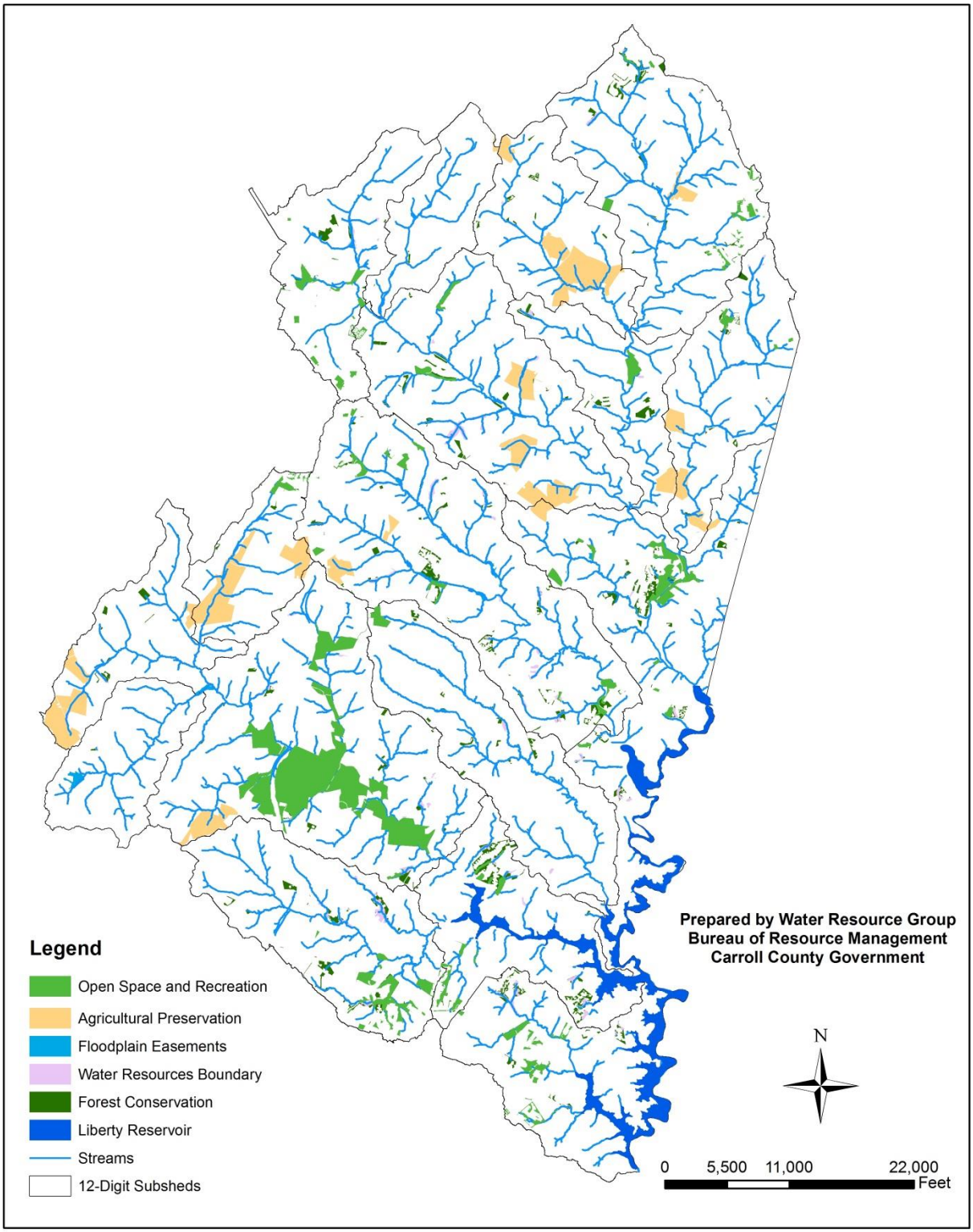

Figure 3-9: Liberty Protected Lands

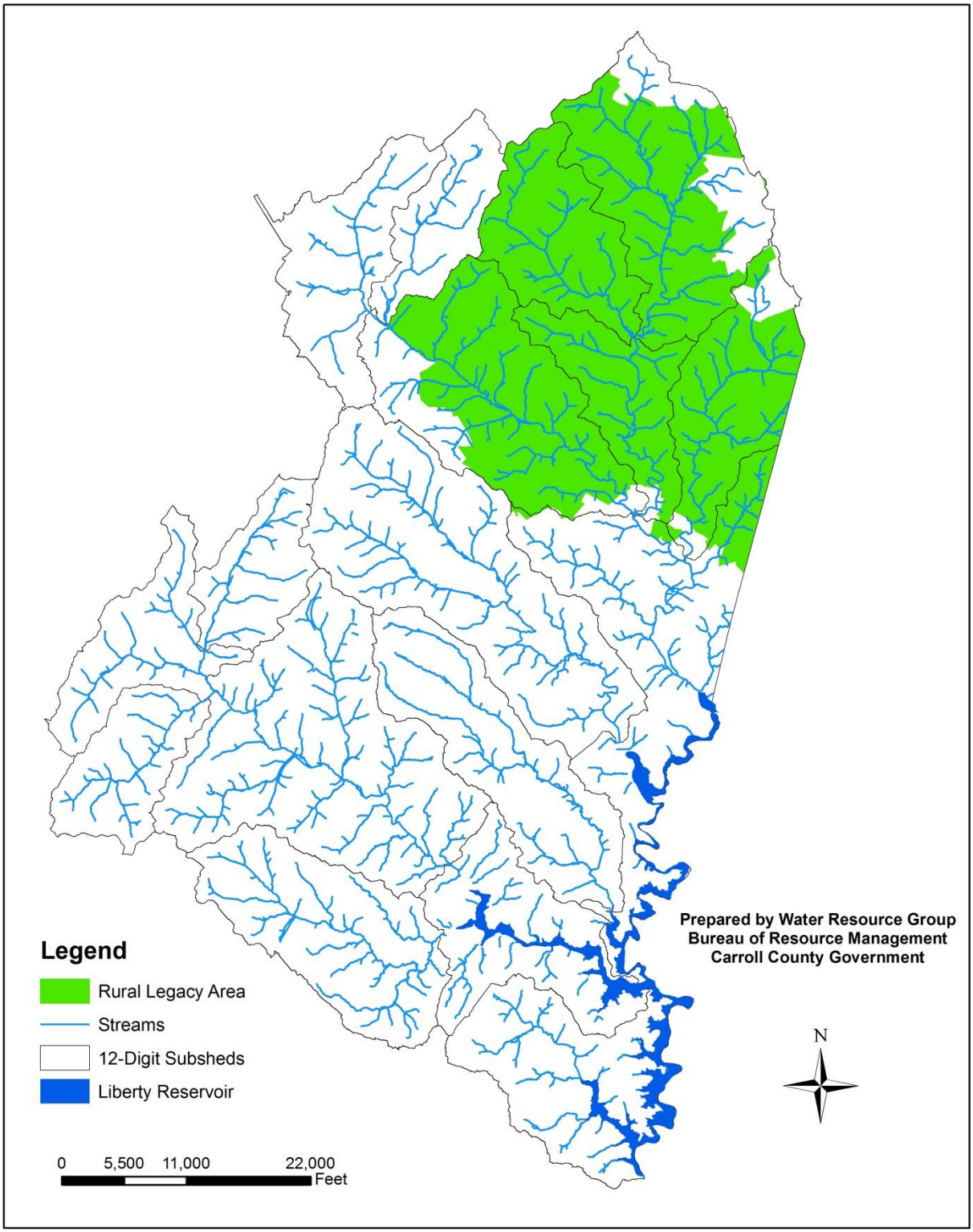

Figure 3-10: Upper Patapsco Rural Legacy Area

J. Agricultural Best Management Practices

Agricultural best management practices (BMPs) are on-the-ground practices that help minimize runoff and the delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Appendix B lists the agricultural BMPs located in the Liberty watershed as of summer 2014 and provides a detailed explanation of the types of practices used throughout Carroll County. Figure 3-11 shows the locations of the agricultural BMPs within the Liberty watershed.

1. Farm Plan Acres

Farm plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A farm plan is written for each individual operation and dictates the management practices that are necessary to protect and improve soil and water quality. Nutrient management is prescribed as part of the farm plan and assists the operator with managing the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield. As of summer 2014, the Liberty watershed had approximately 22,138 acres (25%) of the total land area in a farm plan.

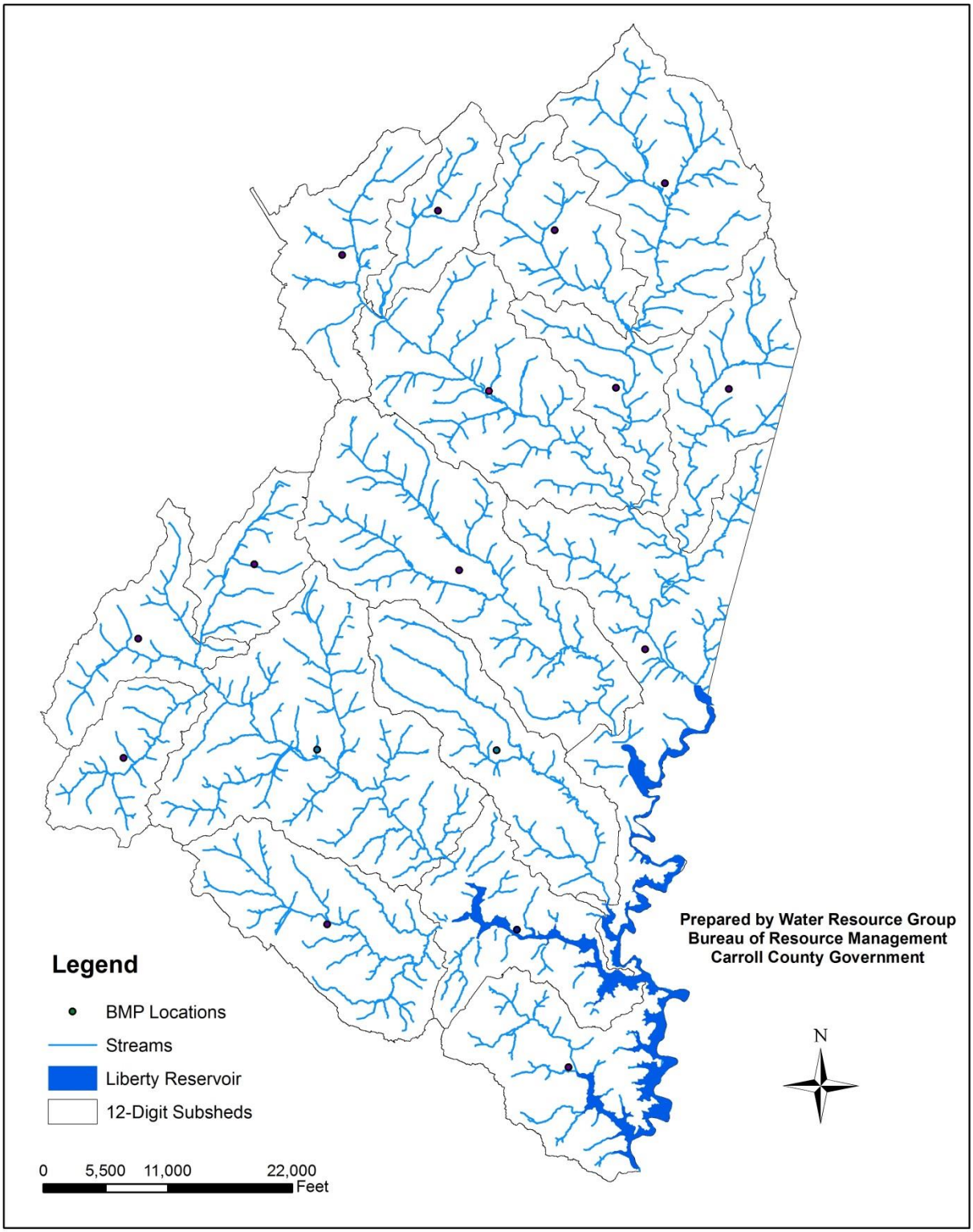

Figure 3-11: Liberty Agricultural BMP Locations

IV. Water Quality

A. Introduction

Maryland water quality standards have been adopted from the Federal Clean Water Act, Section 101, "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support beneficial use of waterbodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation and protection for terrestrial wildlife. Local monitoring allows for documenting the status of local waterbodies and where restoration or mitigation may be needed. This chapter will look at the designated uses within Liberty Reservoir Watershed, current water quality impairments that have been assigned and existing water quality data within the watershed. Water quality data is utilized along with identified impairments from the stream corridor assessment (Chapter 5) to prioritize preservation and restoration.

B. Designated Uses

All bodies of water, including streams, are assigned a designated use specified by each state's regulations. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use, and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a waterbody.

The State of Maryland has defined the following general uses:

Use I: Water contact recreation, and protection of nontidal warmwater 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 Liberty Reservoir Watershed contains Use I, Use III, Use I-P, Use III-P, and Use IV-P waters. The majority of waters in this watershed are Use III-P. Use I, Use III, Use I-P, Use III-P, and Use IV-P waters within the state of Maryland allow for contact water sports and leisure activities that allow direct contact with water; fishing; growth and propagation of non-trout fish and other aquatic and wildlife; and agricultural and industrial water supplies. Use III and Use III-P waters also allow for growth and propagation of trout. Use I-P, Use III-P and Use IV-P waters allow for use in public water supply. Use IV-P waters are also capable of supporting adult trout for a 'put and take fishery'.

C. Total Maximum Daily Loads

Streams and other waterbodies that are unable to meet their designated use as defined by the COMAR are known as impaired waters. Impaired waters are placed on the 303(d) list, which is a section of the Clean Water Act that tracks impaired and threatened waterbodies.

The MDE uses the 303(d) list of impaired waters to establish TMDL's. A TMDL establishes the maximum amount of a pollutant or stressor that a waterbody can assimilate and still meet water quality standards for its designated use. Each TMDL addresses a single pollutant, whereas one waterbody may have multiple TMDL's. TMDL's are calculated by adding the sum of the allowed pollutant loads for point sources, non-point sources, projected growth, with a margin of safety built in. Load allocations are calculated through the use of watershed modeling using existing and historical data collected in the field.

More information on TMDL's and the 303(d) list can be found at: http://www.mde.maryland.gov/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/index.aspx

1. Current Impairments

The current impairments within the Liberty watershed that have been assigned a TMDL include; Bacteria, Phosphorus, and Sediment.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Liberty Reservoir Watershed was determined by (MDE, 2009) to be 86,352 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 9,326 billion MPN/year, which is a reduction of 77,026 billion MPN/year (89.2%) from the current estimated loading.

These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009). Table 4-1 outlines the bacteria baseline and TMDL for the Carroll County portion of the Liberty Reservoir Watershed.

Table 4-1: Liberty Reservoir 8-digit Watershed Bacteria TMDL

Liberty Reservoir Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	67,250	7,263	89.2%
Hampstead	4,241	458	89.2%
Manchester	2,250	243	89.2%
Westminster	12,611	1,362	89.2%
Total	**86,352**	**9,326**	**89.2%**

a. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 13,889 lbs. /yr., the TMDL for the stormwater WLA was determined to be 6,995 lbs. /yr., which is a reduction of 6,934 lbs. /yr. (50%) from the current loading (Table 4-2). The baseline loads for the County and Towns were derived from the TMDL Data Center. These baseline loads were combined and compared to the combined allocations for the County and Towns to derive the total percent reduction required. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2012).

Table 4-2: Liberty 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	12,204	6,102	50%
Municipalities	1,685	893	47%
Total	**13,889**	**6,995**	**50%**

The purpose of phosphorus reductions is to reduce high chlorophyll a (Chla) concentrations that reflect excessive algal blooms and to maintain dissolved oxygen (DO) at a level supportive of the designated uses for Liberty Reservoir. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

c. Sediment

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 4,630 tons/yr., the TMDL for the stormwater WLA was determined to be 2,880 tons/yr., which is a reduction of 1,750 tons/yr. (38%) from the current loading (Table 4-3).

Table 4-3: Liberty 8-digit Watershed Sediment TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	4,016	2,530	37%
Municipalities	614	350	43%
Total	**4,630**	**2,880**	**38%**

D. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Tier II designated stream segments for the Liberty watershed can be found in Figure 4-1.

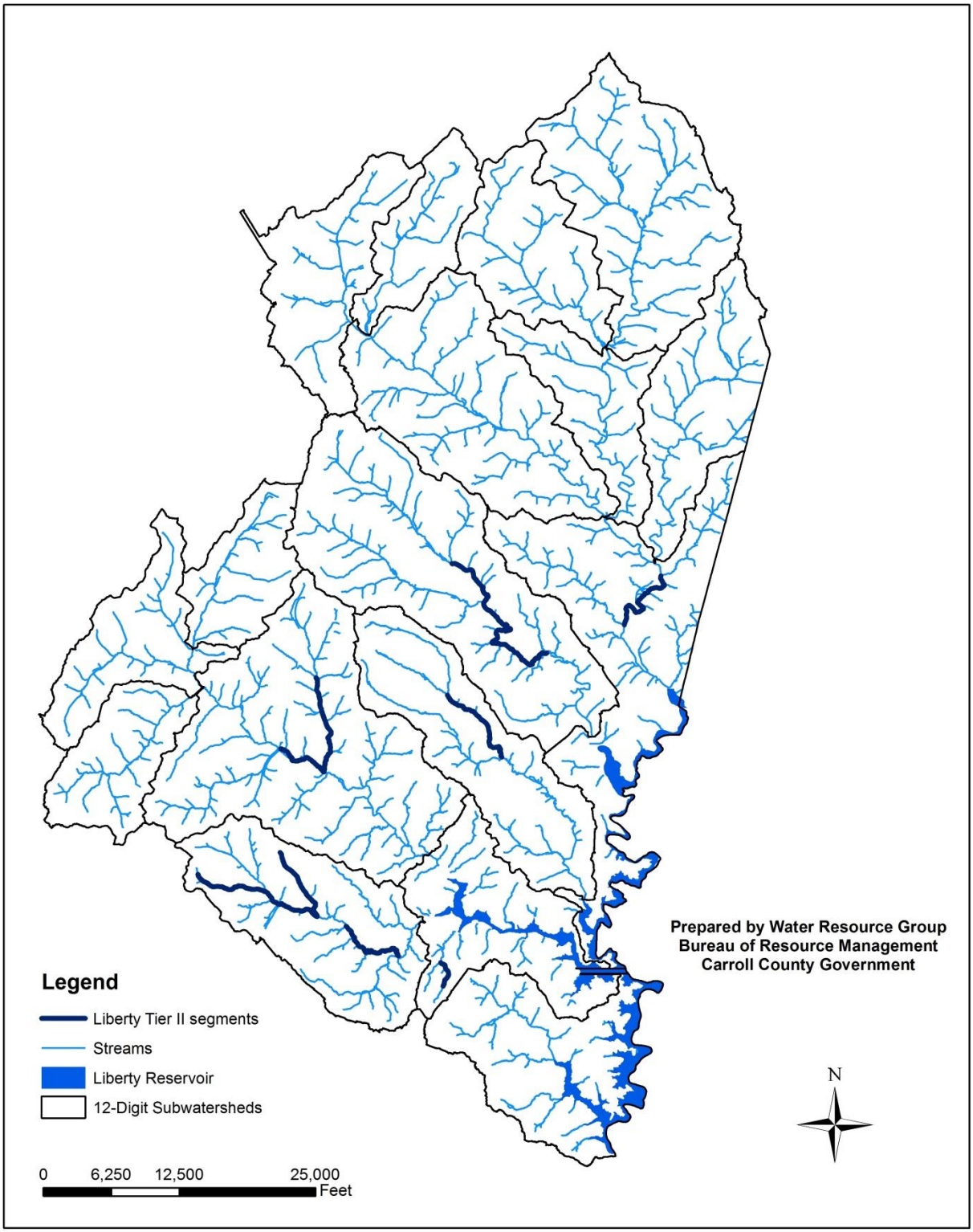

Figure 4-1: Liberty Watershed Tier II Stream Segments

E. Water Quality Data

1. Watershed Restoration Action Strategy

Water quality data within the Liberty Reservoir Watershed has been collected and monitored throughout the years by varying agencies with different program goals. One such program is the Watershed Restoration Action Strategy (WRAS). The key goal of the WRAS program is to protect and restore water quality and habitat. The WRAS program was developed to support the efforts of local governments to conduct watershed plans, and intended to help Maryland meet the 2000 Chesapeake Bay Agreement's Watershed Planning goal to have two-thirds of the Bay Watershed addressed with comprehensive watershed management plans.

A WRAS was completed for the Liberty Reservoir Watershed in March 2003. The WRAS focused on selected subwatersheds to maintain and enhance water quality of the streams draining into Liberty Reservoir.

2. Current Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach.

The Bureau of Resource Management currently monitors one location within the Liberty reservoir watershed. The Air Business Center regional stormwater management facility, shown in Figure 4-2, is used as the County's monitoring location for NPDES reporting, and is located within the West Branch Patapsco river subwatershed.

This stormwater management facility was originally constructed as a wet pond in 1979 and was retrofitted in 2008 as a wet pond with a forebay to provide water quality, recharge volume, and channel protection volume. The drainage area is approximately 562 acres, of which, 128 acres or 23% is impervious.

Chemical monitoring began at the Air Business site in August of 2000 and consists of; eight storm events at each location sampled throughout the year. All sampling is completed with automated equipment so that each limb of the storm; ascending, peak, and descending can be characterized. The chemical monitoring parameters, methods, and detection limits required for calculating event mean concentrations (EMC's) for NPDES reporting are listed in Table 4-4. Additional monitoring at this location includes geomorphic channel surveys as well as spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 4-4: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
First Flush Sample		
pH	-	EPA 150.1
Temperature	-	EPA 170.1
Specific Conductance	1.0 µmhos/cm	SM 2510 B-97
Total Petroleum Hydrocarbons	5.0 mg/L	EPA 1664
Escherichia Coli	1.0 organisms/ 100mL	SM 9223 B-94
Limb Samples		
Nitrate/Nitrite Nitrogen	0.05 mg/L	SM 4500NO3-H00
Biological Oxygen Demand	2.0 mg/L	SM 5210 B-01
Total Copper	2.0 µg/L	EPA 200.8
Total Lead	2.0 µg/L	EPA 200.8
Total Zinc	20.0 µg/L	EPA 200.8
Total Kjeldahl Nitrogen	0.5 mg/L	SM 4500NH3 C-97
Total Phosphorus	0.01 mg/L	SM 4500P-P E-99
Total Suspended Solids	3.0 mg/L	SM 2540 D-97

In addition to NPDES monitoring requirements, the Bureau has also been performing monthly bacteria trend monitoring in conjunction with Baltimore County in the Liberty reservoir watershed since 2012.

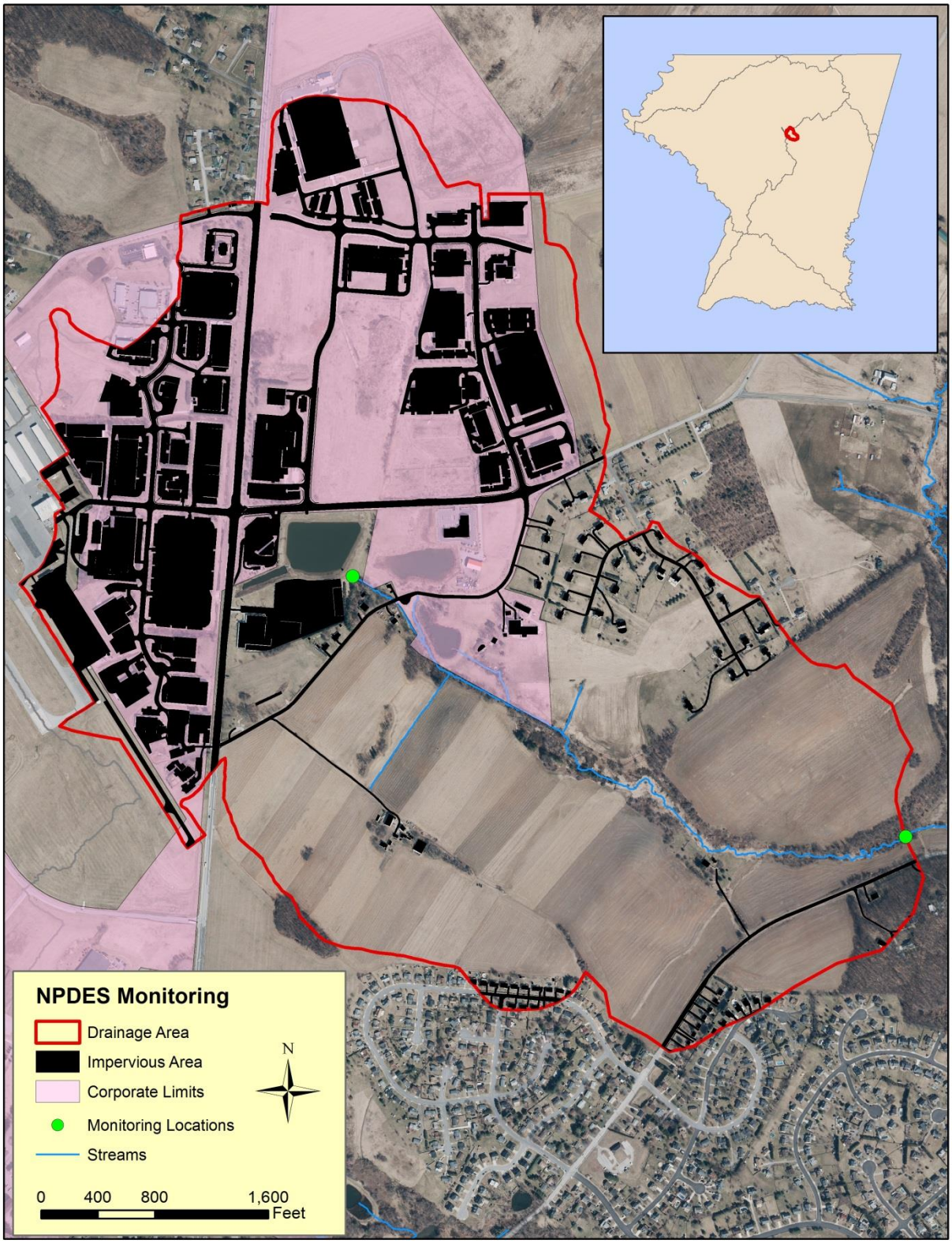

Figure 4-2: NPDES Monitoring Location

3. Maryland Biological Stream Survey

The Maryland biological stream survey (MBSS) was started by the DNR in 1993 and expanded statewide in 1994 to characterize the health of Maryland's 10,000+ miles of freshwater streams. The MBSS was Maryland's first stream sampling program intended to provide unbiased estimates of stream conditions. Data is collected at each site on the physical, chemical, and biological characteristics, and then combined into an overall assessment. In this chapter we will discuss the chemical data of the MBSS, and in Chapter 5 we will focus on the biological data of the MBSS. The goal of the MBSS is to provide the best possible information for the protection and restoration of Maryland's stream ecological resources. The MBSS's objectives to help meet this goal include:

- Assess the current condition of ecological resources in Maryland's streams and rivers;
- Identify the impacts of acidic deposition, climate change, and other stressors on ecological resources in Maryland's streams and rivers;
- Provide an inventory of biodiversity in Maryland's streams;
- Assess the efficacy of stream restoration and conservation efforts to stream ecological resources;
- Continue to build a long-term database and document changes over time in Maryland's stream ecological condition and biodiversity status; and
- Communicate results to the scientific community, the public, and policy makers.

The DNR has conducted three rounds of MBSS: Round 1 in 1995-1997, Round 2 in 2000-2004 and Round 3 in 2005-2009, with an additional Round scheduled for 2014. Each Round surveyed random and targeted stream reaches from first through fourth order streams. As the MBSS program has progressed, it has shifted to include more targeted sampling, focused on a wide range of other program objectives such as TMDL and watershed delineation needs. Information on MBSS site surveys throughout the State can be seen here: http://www.streamhealth.maryland.gov/map.asp.

Site locations for the DNR MBSS sites within Liberty Reservoir Watershed are shown in Figure 4-3.

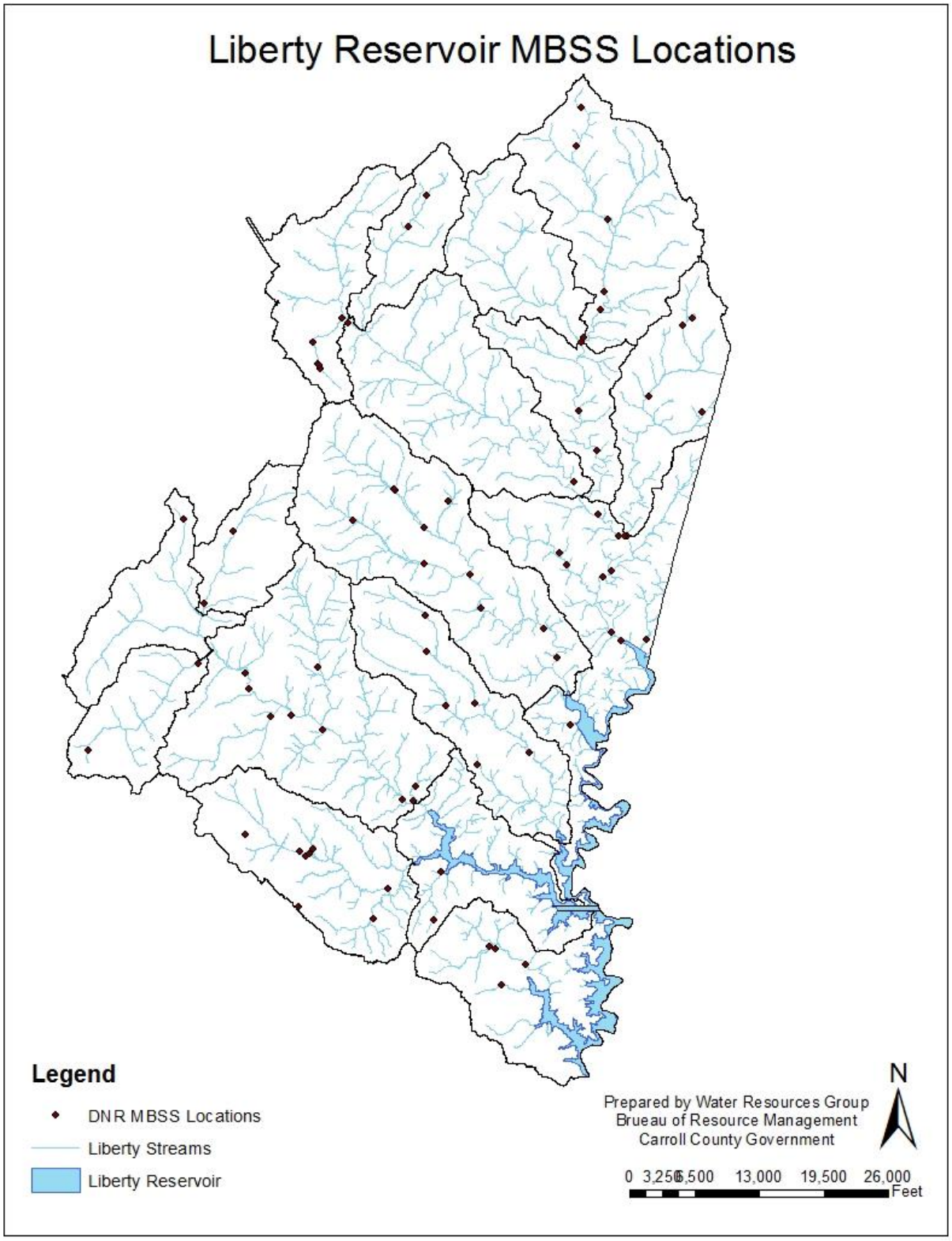

Figure 4-3: Liberty Reservoir Watershed DNR MBSS Locations

a. Chemical Results

The chemical characteristics of a water body influence stream health impacting the habitat and biota. Stream acidification is known to have detrimental effects on aquatic animals. High acidity environments can affect animals' physiological functions, and influences the availability and toxicity of metals to aquatic animals. All streams contain a background level of nitrogen that is essential to the survival of the plants and animals in that stream; however the amount of nitrogen in many streams has increased as a result of anthropogenic influences. Agricultural runoff, wastewater discharge, and nonpoint sources are common culprits leading to an increased nitrogen load. Elevated levels of phosphorus in Maryland waters are usually associated with agricultural impacts. Elevated nitrogen and phosphorus concentrations can cause nutrient enrichment in aquatic systems which leads to decreased amounts of dissolved oxygen. Continued exposure to low dissolved oxygen environments can suffocate biota or lead to reduced spawning success. The COMAR states that dissolved oxygen concentrations greater than 5 mg/l are standard, and a level generally considered healthy for aquatic life. Increased nutrient loads are also linked to toxic algal blooms. Conductivity is a measure of the ability of water to pass an electrical current, as affected by inorganic dissolved solids. Organic compounds like oil and phenol do not conduct electrical current very well, and therefore have a low conductivity when in water. Discharges to streams can change the conductivity depending on the pollutant. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate, while an oil spill would lower the conductivity. The DNR MBSS chemical results for the Liberty Reservoir Watershed for the several rounds of sampling are displayed in Table 4-6. Table 4-5 displays all sampling sites as divided by subwatershed. When a location was sampled but chemical results were not obtained a "- -" is shown in lieu of data.

Table 4-5: Liberty Reservoir Watershed DNR's MBSS Chemical Results

12-Digit Scale / Site Identification	**Subwatershed** / Stream Segment	**Field pH**	**Temperature (°C)**	**Dissolved Oxygen**	**Conductivity**
21309071046	**Snowden's Run**				
CR-P-115-111-95	Liberty Reservoir UT1	7.51	20.2	8.3	162
CR-P-020-208-96	--	--	--	--	--
LIBE-105-C-2000	--	--	--	--	--
LIBE-214-R-2003	Liberty Reservoir UT1	7.14	14.7	9.4	0.181
21309071047	**Liberty Reservoir**				
CR-P-112-122-95	Liberty Reservoir UT1	7.42	14.5	8.5	232
CR-P-112-112-96	--	--	--	--	--
21309071048	**Roaring Run**				
CR-P-240-225-95	North Branch Patapsco River UT1	7.36	20.3	8.2	174
CR-P-152-318-95	North Branch Patapsco River	7.56	22.2	8.1	204
CR-P-077-309-95	North Branch Patapsco River	8.35	20.8	9.2	186

12-Digit Scale / Site Identification	Subwatershed / Stream Segment	Field pH	Temperature (°C)	Dissolved Oxygen	Conductivity
CR-P-227-305-96	--	--	--	--	--
CR-P-215-127-96	Liberty Reservoir UT2	7.35	16.3	10.3	176
CR-P-409-320-96	--	--	--	--	--
CR-P-149-118-96	Roaring Run	6.78	16.9	8.9	223
CR-P-152-302-96	--	--	--	--	--
LIBE-115-R-2000	Roaring Run	7.72	15.6	9.4	0.229
LIBE-333-R-2003	North Branch Patapsco River	7.29	20.8	8.3	0.22
LIBE-356-A-2007	--	--	--	--	--
21309071049	**Little Morgan Run**				
CR-P-166-221-95	Little Morgan Run	7.48	16.2	9.5	168
CR-P-175-113-95	Little Morgan Run UT1	7.43	14.8	9.0	126
CR-P-345-923-95	--	--	--	--	--
CR-P-341-125-95	--	--	--	--	--
CR-P-341-121-96	Little Morgan Run UT2	6.85	16.6	9.5	204
LIBE-109-R-2003	Little Morgan Run UT3	7.25	14.1	11.0	0.219
LIBE-266-A-2007	Little Morgan Run	7.48	16.2	8.9	200
LIBE-262-A-2007	Little Morgan Run	7.56	16.9	8.8	221
21309071050	**Morgan Run**				
CR-P-048-922-95	--	--	--	--	--
CR-P-165-921-95	--	--	--	--	--
CR-P-345-321-96	Morgan Run	7.72	19.2	9.0	139
CR-P-084-309-96	Morgan Run	7.36	16.9	9.3	156
LIBE-318-R-2000	Morgan Run	7.50	16.7	8.8	0.161
LIBE-203-R-2000	Morgan Run	7.84	20.7	9.1	0.163
LIBE-303-R-2000	--	--	--	--	--
LIBE-209-R-2000	Joe Branch	7.14	16.5	9.0	0.232
LIBE-127-R-2003	Morgan Run UT2	7.16	14.4	9.4	0.138
LIBE-111-R-2003	Morgan Run UT3	7.36	14.0	8.6	0.151
21309071051	**West Branch Patapsco**				
LIBE-214-A-2007	West Branch of North Branch Patapsco River	8.29	23.8	8.6	286

12-Digit Scale / Site Identification	Subwatershed / Stream Segment	Field pH	Temperature (°C)	Dissolved Oxygen	Conductivity
21309071052	**East Branch Patapsco**				
CR-P-242-224-96	East Branch of North Branch Patapsco River	7.41	20.3	9.1	162
LIBE-202-R-2000	East Branch of North Branch Patapsco River	8.09	20.0	8.1	0.188
21309071053	**Morgan Run**				
CR-P-143-218-95	Morgan Run UT1	7.39	18.8	9.1	122
CR-P-119-102-95	--	--	--	--	--
21309071054	**Morgan Run**				
CR-P-379-123-96	Morgan Run	6.26	14.1	9.5	130
21309071055	**Little Morgan Run**				
LIBE-216-R-2000	--	--	--	--	--
LIBE-206-A-2007	Little Morgan Run	7.57	14.5	10.0	188
21309071056	**Middle Run**				
CR-P-079-209-96	Middle Run	7.58	19.7	8.3	144
LIBE-119-R-2000	Middle Run UT1	7.76	18.7	8.5	0.179
LIBE-111-R-2000	Middle Run UT2	7.56	16.6	8.1	0.14
LIBE-110-R-2000	Middle Run	7.65	17.3	8.4	0.104
LIBE-106-R-2003	Prugh Branch	6.53	17.4	7.7	0.143
LIBE-202-A-2007	Middle Run	7.43	17.9	9.0	138
21309071057	**Beaver Run**				
CR-P-999-323-95	Beaver Run	7.27	17.4	9.2	172
CR-P-260-212-95	Beaver Run	7.04	19.3	8.1	208
CR-P-050-106-95	Beaver Run UT1	7.58	13.6	9.2	318
CR-P-224-226-95	Middle Run	7.46	24.2	7.4	202
CR-P-193-311-96	Beaver Run	7.34	20.1	8.8	174
CR-P-260-210-96	Beaver Run	7.26	20.7	8.6	267
CR-P-999-323-96	Beaver Run	7.16	17.6	9.4	187
LIBE-218-R-2003	Beaver Run	7.30	20.3	9.0	0.229
LIBE-105-R-2003	Middle Run	7.13	15.7	8.9	0.273
LIBE-208-R-2007	Beaver Run	7.82	23.6	8.8	263
21309071058	**Deep Run**				

12-Digit Scale / Site Identification	Subwatershed / Stream Segment	Field pH	Temperature (°C)	Dissolved Oxygen	Conductivity
CR-P-294-124-95	Aspen Run	7.49	15.3	8.9	278
CR-P-402-121-95	Deep Run	7.22	20.1	8.7	178
LIBE-207-R-2000	Deep Run	7.56	19.9	8.5	0.312
LIBE-104-R-2000	Deep Run UT1	7.33	22.3	7.2	0.413
LIBE-251-A-2007	Deep Run	7.81	20.9	9.1	198
21309071059	**East Branch Patapsco**				
CR-P-344-219-96	Cascade Lake UT1	7.07	18.2	10.4	154
CR-P-330-229-96	East Branch of North Branch Patapsco River	7.84	20.2	10.2	175
LIBE-204-R-2003	East Branch of North Branch Patapsco River	7.46	20.4	8.6	0.21
LIBE-124-R-2003	Cascade Lake UT2	7.36	17.3	8.6	0.19
LIBE-201-R-2007	East Branch of North Branch Patapsco River	7.95	21.2	8.2	212
LIBE-107-R-2007	Cascade Lake UT2	7.59	19.7	7.9	248
21309071060	**Aspen Run**				
CR-P-330-201-96	East Branch of North Branch Patapsco River	7.25	17.4	9.2	174
21309071061	**Cranberry Branch**				
CR-P-270-104-95	Cranberry Branch	7.21	17.5	8.3	176
LIBE-110-R-2003	Cranberry Branch	7.34	18.2	7.1	0.25
21309071062	**West Branch Patapsco**				
CR-P-038-227-95	West Branch of North Branch Patapsco River	7.81	23.6	7.8	326
CR-P-000-920-96	--	--	--	--	--
LIBE-101-X-2001	--	--	--	--	--
LIBE-102-X-2001	--	--	--	--	--
LIBE-103-X-2001	--	--	--	--	--
LIBE-103-X-2002	West Branch of North Branch Patapsco River UT1	7.26	17.2	8.0	0.639
LIBE-102-X-2002	West Branch of North Branch Patapsco River UT1	7.70	17.7	8.7	0.649
LIBE-101-X-2002	--	--	--	--	--
LIBE-107-R-2003	West Branch of North Branch Patapsco River UT1	6.92	13.5	9.2	0.793

12-Digit Scale	Subwatershed	Field pH	Temperature (°C)	Dissolved Oxygen	Conductivity
Site Identification	Stream Segment				
LIBE-103-X-2004	--	--	--	--	--
LIBE-101-X-2004	--	--	--	--	--
LIBE-102-X-2004	West Branch of North Branch Patapsco River UT1	7.77	16.0	8.7	0.713

Table 4-6: Liberty Reservoir Watershed DNR's MBSS Chemical Results Summary

	Field pH	Temperature (°C)	Dissolved Oxygen	Conductivity
Maximum	8.35	24.20	11.00	326
Minimum	6.26	13.50	7.10	0.10
Average	7.43	18.18	8.81	119.66

The Liberty Reservoir Watershed DNR MBSS data demonstrates there is sufficient dissolved oxygen to adequately support aquatic life. The lowest dissolved oxygen level measured during the DNR MBSS sampling events was 7.10 mg/l, which is greater than the COMAR standard of 5.0 mg/l, a level generally considered healthy for aquatic life. During most of the sampling events the water temperature was below 20°C, averaging around 18.2°C in the watershed. Stream waters below 20°C are generally considered optimal for fish and most other aquatic benthos. The pH of the water was relatively neutral, averaging 7.43, and ranging as acidic as 6.26 to a more alkaline pH of 8.35. The relatively low range of pH suggests overall pH stability in the Liberty Reservoir Watershed. The DNR sampling year of 2003 yielded the lowest conductivity results throughout the sampling years.

4. Nutrient Concentrations and Loadings

Annual background data has been collected for nutrient concentrations during baseflow and storm events at six locations in Liberty Reservoir Watershed, shown in Figure 4-4.

Baseflow conditions are the natural conditions present during most of the year when the stream consists of only groundwater discharge. Groundwater feeds into streams when the water table, or ground water saturation, is above the streambed. Perennial streams continuously flow because sufficient groundwater causes the water table to be above the streambed year round, allowing for flow. Intermittent streams flow when greater than usual groundwater supply raises the water table above the streambed; during dry weather the water table is too low to cause stream flow.

Storm events can affect stream flow in several ways. One way a storm event can directly impact stream flow is by increasing the quantity of groundwater feeding the stream. The increase in ground water will raise the water table causing an increase in groundwater discharge to the stream. Another way storm events can impact stream flow is from ground surface runoff. Storm runoff flows directly into the streambed increasing stream flow and washing pollutants from the ground directly into the stream.

At each location, samples were taken to analyze for concentrations of total phosphorus as well as total suspended solids (TSS). Each site was sampled on a monthly basis to ensure that a variety of hydrological conditions would be encountered during both dry and wet weather conditions. A detailed summary of nutrient concentrations at each sample location can be found in Appendix C. Discharge velocity, or flow, was taken in conjunction with the nutrient samples at each site to determine yield and to calculate a daily nutrient loading. The following subsections will discuss the yearly average loadings by sample site.

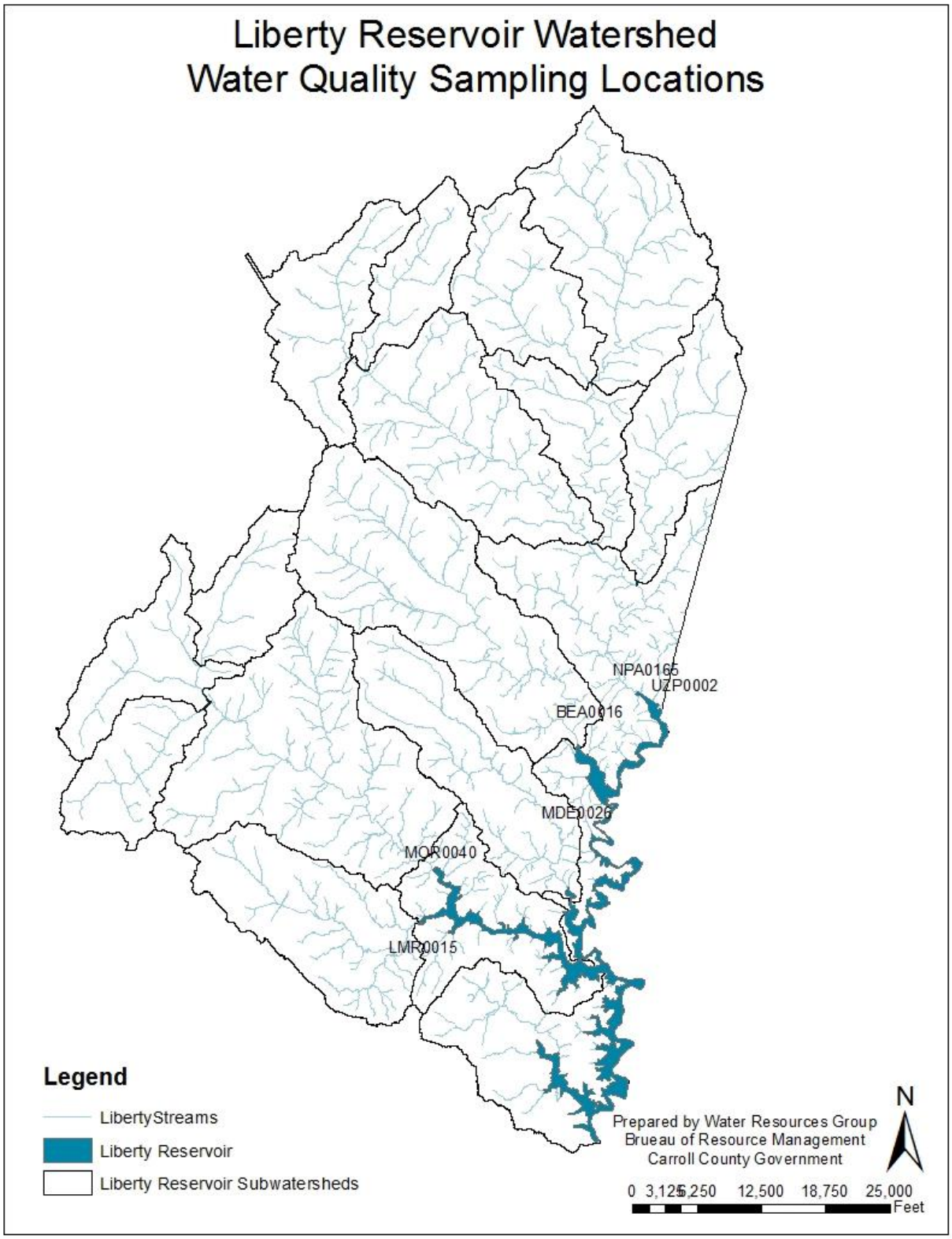

Figure 4-4: Liberty Reservoir Watershed Nutrient Concentration Sampling Locations

a. BEA0016

Sample site BEA0016 is located in Beaver Run subwatershed (1057) at Hughes Road. Baseflow and storm flow data have been collected at this site. Table 4-7 displays the yearly averages for TSS and total phosphorus during baseflow, as well as flow rate. Table 4-8 displays the yearly averages for TSS, total phosphorus and flow as averaged during storm events.

Table 4-7: Liberty Reservoir Watershed: BEA0016 Average Baseflow Data

BEA0016 Yearly Average Baseflow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	14.96	36,600,768	3.38	277.77	0.02	1.62
2006	12.51	30,605,990	2.87	188.00	0.02	1.05
2007	15.08	36,902,917	1.82	170.81	0.06	4.16
2008	11.16	27,302,746	2.22	123.91	0.05	3.31
2009	13.84	33,868,454	1.27	96.84	0.03	1.78
2010	12.28	30,051,742	8.84	1089.71	0.02	1.43

Table 4-8: Liberty Reservoir Watershed: BEA0016 Average Storm Flow Data

BEA0016 Yearly Average Storm Flow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	198.08	484,679,808	422.58	868,800	0.51	1,057.37
2006	47.33	115,817,472	70.50	29,381	0.05	9.75
2007	113.47	277,645,282	206.90	336,132	0.18	240.53
2008	107.47	262,954,598	269.67	402,199	0.12	118.89
2009	52.50	128,459,520	191.50	48,137	0.05	9.91
2010	214.71	525,373,221	278.43	598,534	0.43	946.37

BEA0016 has a baseflow of approximately 13 cubic feet per second (CFS) with little fluctuation over the six year sampling period, suggesting a relatively consistent groundwater supply. During baseflow conditions from 2005 - 2009, the yearly average TSS concentration was around 2.3 mg/l which, on average, correlates to an average daily TSS loading rate of approximately 170 lbs/day. In 2010, the yearly average TSS concentration at BEA0016 was much greater than the previous years, at nearly four times the previous yearly averages. Total phosphorous concentrations were relatively consistent at around 0.02 mg/l, with the greatest concentrations in 2007 and 2008. The average daily loading rate of total phosphorus from BEA0016 during average baseflow conditions was approximately 1.4 lbs/day. During 2007-2008 the average total phosphorus loading rate was over double the other yearly averages.

Storm flow data collected at BEA0016 demonstrates that on average storm events lead to a nine fold increase in flow rate. The average flow at BEA0016 during storm events was approximately

122 CFS, with annual variations as high as 214.71 CFS to a low of 47.33 CFS. Concentrations of TSS and total phosphorus also increased during storm events at BEA0016. The concentration of TSS increased to an average of approximately 240 mg/l, a nearly 85 fold increase from baseflow conditions. The corresponding TSS loading rate during storm flow increased to an average of approximately 380,530 lbs/day. Total phosphorus concentrations during storm flow fluctuated greatly from year to year. The lowest concentration of total phosphorus during storm flow was in 2006 and 2009, with an average of 0.05 mg/l; the highest concentration of total phosphorus was 0.51 mg/l followed by 0.43 mg/l in 2005 and 2010, respectively. The corresponding total phosphorus loading rate during storm flow ranged from 9.91 lbs/day to 1,057.37 lbs/day.

b. MOR0040

Sample site MOR0040 is located in Morgan Run subwatershed (1050) at London Bridge Road. Baseflow and storm flow data have been collected at this site. Table 4-9 displays the yearly averages for TSS and total phosphorus during baseflow, as well as flow rate. Table 4-10 displays the yearly averages for TSS, total phosphorus and flow as averaged during storm events.

Table 4-9: Liberty Reservoir Watershed: MOR0040 Average Baseflow Data

MOR0040 Yearly Average Baseflow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	30.49	74,606,620	1.82	371.42	0.02	3.40
2006	24.92	60,967,296	2.03	291.93	0.02	2.32
2007	24.80	60,681,830	1.65	286.79	0.03	3.69
2008	18.33	44,844,051	1.15	95.68	0.03	2.62
2009	24.36	59,614,115	1.45	195.92	0.03	3.80
2010	24.42	59,752,028	8.08	532.87	0.02	1.96

Table 4-10: Liberty Reservoir Watershed: MOR0040 Average Storm Flow Data

MOR0040 Yearly Average Storm Flow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	330.25	808,071,552	468.08	1,654,950	0.61	1,673.80
2006	60.00	146,810,880	5.83	2,032	0.03	8.76
2007	106.01	259,384,710	109.93	86,133	0.13	86.80
2008	172.60	422,325,965	518.70	701,430	0.27	349.92
2009	38.11	93,252,096	146.11	31,200	0.02	3.64
2010	387.86	949,027,474	350.86	1,119,570	0.54	1,796.85

The average baseflow at MOR0040 is approximately 24.5 CFS, with 2005 having the greatest yearly average baseflow at 30.49 CFS, and 2008 having the least amount of baseflow at 18.33 CFS. The yearly average TSS concentration from 2005 to 2009 was approximately 1.6 mg/l; the

yearly average TSS concentration in 2010 was nearly five times greater than the previous years at 8.08 mg/l. The average TSS loading rate ranged from approximately 96 lbs/day in 2008, to approximately 533 lbs/day in 2010 with an average TSS loading rate around 280 lbs/day. Total phosphorus concentration at baseflow averaged at 0.02 to 0.03 mg/l through the years sampled. The corresponding average baseflow total phosphorus loading rate was about 2 to 3 lbs/day, ranging from 1.96 to 3.80 lbs/day.

The flow rate at MOR0040 significantly increases from 24.5 CFS at baseflow to 182.5 CFS during storm events, over a seven fold increase in flow rate. In 2010, the yearly average for storm flow was over 15 times greater than the yearly average baseflow for that year. During storm flow the average TSS concentration at MOR0040 increases nearly 99 times the baseflow average, with a storm flow average TSS concentration of approximately 267 mg/l. The TSS loading rate increased by over 2,000 times the average baseflow rate as a result of the substantially higher TSS concentration in storm flow waters and a higher flow rate. The total phosphorus concentration fluctuated greatly over the years during storm events. The lowest yearly average total phosphorus concentration was in 2009 at 0.02 mg/l, while the highest concentration was 0.61 mg/l in 2005, followed by 0.54 mg/l in 2010. The average total phosphorus concentration in storm flow at MOR0040 was approximately 0.27 mg/l, over a 10 fold increase from baseflow conditions. Total phosphorus loading rates vary greatly from year to year with the lowest rate of 3.64 lbs/day in 2009 to over 1,796 lbs/day in 2010. The average total phosphorus loading rate of nearly 653 lbs/day is over 220 times the average total phosphorus loading at baseflow conditions.

c. NPA0165

Sample site NPA0165 is located in Roaring Run subwatershed (1048), North Branch Patapsco at Route. 91, downstream of the outfall. Baseflow and storm flow data have been collected at this site. Table 4-11 displays the yearly averages for TSS and total phosphorus during baseflow, as well as flow rate. Table 4-12 displays the yearly averages for TSS, total phosphorus and flow as averaged during storm events.

Table 4-11: Liberty Reservoir Watershed: NPA0165 Average Baseflow Data

NPA0165 Yearly Average Baseflow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	53.50	130,906,368	4.96	1254.01	0.02	7.80
2006	44.75	109,496,448	7.37	1575.25	0.03	7.25
2007	52.75	129,071,232	2.30	813.38	0.05	19.54
2008	38.17	93,388,032	1.55	351.71	0.04	10.51
2009	48.25	118,060,416	1.91	465.41	0.04	10.99
2010	44.91	109,885,719	9.52	4277.74	0.02	5.75

Table 4-12: Liberty Reservoir Watershed: NPA0165 Average Storm Flow Data

NPA0165 Yearly Average Storm Flow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	991.33	2,425,641,984	429.25	3,792,135	0.61	5,302.88
2006	135.67	331,955,712	94.17	101,680	0.05	41.68
2007	391.06	956,861,500	230.53	1,204,849	0.24	1,027.25
2008	327.20	800,608,666	285.87	935,414	0.24	589.63
2009	128.78	315,099,648	51.78	40,057	0.05	41.25
2010	638.71	1,562,836,773	294.71	1,279,891	0.41	1,777.12

The average baseflow rate at NPA0165 is much greater than the average baseflow rates at both BEA0016 and MOR0040. The average baseflow rate for NPA0165 is approximately 47 CFS with a range of approximately 38 – 53 CFS. During baseflow conditions, the average TSS concentration varied from 1.91 - 9.52 mg/l, with an average of approximately 4.6 mg/l. The average TSS loading rate was approximately 3,790 lbs/day, with a range as low as 351.71 lbs/day in 2008 to as high as 4,277.74 lbs/day in 2010. The average TSS concentration and daily loading rates are substantially greater at NPA0165 than the two previously mentioned sites. The total phosphorus concentration fluctuated from 0.02 – 0.05 mg/l, with an average similar to BEA0016 at approximately 0.3 mg/l. The total phosphorus loading rate ranged from 5.75 lbs/day in 2010 to 19.54 lbs/day in 2007. Baseflow conditions at this site have a large range of nutrient concentrations and large annual fluctuations.

During storm events the average stream flow rate increased 3 to 18 times the average baseflow rate. The greatest storm flow was in 2005 at 991 CFS, followed by 2010 at 638 CFS, which are over 18 and 14 times greater than the baseflow rates for those years, respectively. During storm events, the average TSS concentration increased about 50 times the baseflow average. The corresponding TSS loading rate increased significantly to an average loading rate of 1,225,671 lbs/day, an increase of over 75 times the baseflow rate. The total phosphorus concentration during storm events increased on average by about 9 times the average baseflow concentration. The resulting daily total phosphorus loading rate increased substantially from an average of approximately 10.31 lbs/day to 1,463.32 lbs/day, a 142 fold increase from baseflow.

d. LMR0015

Sample site LMR0015 is located in Little Morgan Run subwatershed (1049) at Bartholow Road. Table 4-13 displays the yearly baseflow averages for TSS and total phosphorus as well as flow rate.

Table 4-13: Liberty Reservoir Watershed: LMR0015 Average Baseflow Data

LMR0015 Yearly Average Baseflow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	6.53	15,972,534	4.22	127.37	0.02	0.69
2006	5.06	12,384,387	2.50	61.66	0.03	0.78
2007	5.87	14,351,171	1.94	89.41	0.04	1.54
2008	4.15	10,161,537	1.40	32.42	0.04	0.89
2009	6.04	14,785,568	2.25	70.81	0.03	0.79
2010	6.31	15,436,274	6.00	265.07	0.02	0.57

Baseflow at LMR0015 is substantially lower than the previously mentioned locations, with an average flow rate of approximately 5.7 CFS. Despite having a consistently lower flow rate than the previously mentioned locations, the TSS and total phosphorous average concentrations are relatively comparable to the other locations with an average TSS concentration of 3.05 mg/l and total phosphorus concentration at 0.03 mg/l. The resulting daily loading rates are much lower since there is less flow at this location. The average TSS loading rate at LMR0015 was about 107 lbs/day, and the average total phosphorus loading rate is about 0.88 lbs/day.

e. MDE0026

Sample site MDE0026 is located in Middle Run subwatershed (1056) at Louisville Road. Table 4-14 displays the yearly baseflow averages for TSS and total phosphorus as well as flow rate.

Table 4-14: Liberty Reservoir Watershed: MDE0026 Average Baseflow Data

MDE0026 Yearly Average Baseflow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	5.98	14,633,708	5.00	146.27	0.03	0.84
2006	4.93	12,056,510	4.83	112.51	0.03	0.81
2007	5.55	13,586,531	1.83	58.04	0.05	1.60
2008	3.88	9,489,989	1.90	44.76	0.05	1.19
2009	5.24	12,819,526	1.62	52.49	0.04	1.15
2010	5.86	14,346,315	8.52	420.56	0.02	0.80

Sample location MDE0026 has a similar baseflow to LMR0015, with an average of approximately 5.24 CFS. The TSS concentration at this location fluctuated through the years, ranging from 1.62 - 8.52 mg/l, with an average of 3.95 mg/l. The average total phosphorus concentration ranged from 0.02 – 0.05 mg/l, with an average around 0.04 mg/l. The average nutrient loading rate at MDE0026 varied greatly year to year. The year 2008 had the lowest TSS nutrient loading with an average rate of less than 45 lbs/day. The greatest TSS loading occurred in 2010 with an average rate of nearly 421 lbs/day, over 9 times the lowest occurrence in 2008. Conversely, 2010 had the lowest average total phosphorus loading rate at only 0.80 lbs/day. The year 2007 had the greatest average total phosphorus loading rate at 1.60 lbs/day, while the average total phosphorus loading rate was approximately 1.06 lbs/day.

f. UZP0002

Sample site UZP0002 is located in Roaring Run subwatershed (1048) at Bonds Run by Hollingsworth Road. Table 4-15 displays the yearly baseflow averages for TSS and total phosphorus as well as flow rate.

Table 4-15: Liberty Reservoir Watershed: UZP0002 Average Baseflow Data

UZP0002 Yearly Average Baseflow						
Year	Flow (CFS)	Flow (L/day)	Total Suspended Solids (mg/L)	Total Suspended Solids (lbs/day)	Total Phosphorus (mg/L)	Total Phosphorus (lbs/day)
2005	6.21	15,200,907	3.62	101.24	0.02	0.78
2006	4.96	12,138,813	4.35	105.82	0.03	0.85
2007	4.88	11,938,375	1.98	60.60	0.07	2.24
2008	3.68	9,008,627	1.87	44.21	0.05	0.99
2009	5.83	14,276,869	1.62	56.65	0.04	1.08
2010	5.39	13,179,391	4.60	174.68	0.02	0.65

Sample site UZP0002 has relatively consistent low flow, averaging approximately 5.2 CFS, and ranging from 3.86 – 6.21 CFS. The TSS concentration peaked at 4.60 mg/l in 2010, and was lowest in 2009 at 1.62 mg/l. The average TSS concentration at UZP0002 was approximately 3.0 mg/l. The TSS loading rate ranged from 44.21 – 174.68 lbs/day, rates relatively comparable to the other lower flow sample sites. The total phosphorus concentration ranged from 0.02 – 0.07 mg/l, with an average around 0.04 mg/l. Total phosphorus loading rate was relatively low, averaging approximately 1.01 lbs/day.

g. Nutrient Concentration and Loadings Summary

Of the six site locations where baseflow readings were recorded from 2005 through 2010, MOR0040 in Morgan Run subwatershed had the lowest average nutrient concentrations. The average TSS concentration recorded at MOR0040 was approximately 2.69 mg/l, and the average total phosphorus concentration was approximately 0.025 mg/l. Site location MOR0040 has relatively consistent baseflow averaging at 24.55 CFS.

Sample site NPA0165, in Roaring Run subwatershed, had the greatest TSS concentrations with an average of 4.6 mg/l. Sample site UZP0002, also in Roaring Run subwatershed, had the greatest total phosphorus concentration with an average of 0.038 mg/l.

Sample site NPA0165, with the greatest flow rate, had the greatest average TSS loading rate of 1,456.25 lbs/day during baseflow; and the greatest average total phosphorus loading rate of 10.31 lbs/day.

Sample site LMR0015, in Little Morgan Run subwatershed, had the lowest average total phosphorus loading rate during baseflow at only 0.88 lbs/day. Sample site UZP0002 had the lowest average TSS loading rate during baseflow at 90.5 lbs/day.

Sample site MOR0040 had the largest increase in nutrient concentrations during storm events when compared to baseflow for both TSS and total phosphorus. The greatly increased concentrations of these nutrients during storm events, suggests large quantities of groundwater runoff into the streams. Sample site MOR0040 in Morgan Run subwatershed would benefit from stormwater practices that reduce surface runoff.

During storm events, sample site NPA0165 had the greatest increase in flow rate and substantial increases in nutrient loading rates. Sample site NPA0165 had the greatest amount of nutrient loadings during storm events, and would most benefit from stormwater management practices.

V. Living Resources

A. Introduction

Living resources is the basic knowledge about how living things function and interact with one another and their environment. Water is an integral component of the habitat of all species. Living resources require water to survive, and will respond to changes not only in water availability but water quality as well. These responses allow us to gain a better understanding of how watershed conditions can have an effect on living habitats, and determine whether or not current water management practices are adequately providing for the needs of the natural communities. This Chapter will focus on the aquatic biology within the Liberty Reservoir Watershed, including any RTE species that may be present within the watershed.

B. Aquatic Biology

A number of programs and agencies regularly collect biological data from streams, including the DNR fisheries program in conjunction with MBSS, as well as individual efforts within the County. Biological indicators such as fish and benthic invertebrates are used to study watershed health. Metrics such as species diversity, percent abundance of pollution-sensitive or pollution-indicative organisms, and total organism abundance are used to determine if the benthic community shows signs of stress. Signs of stress in the watershed include poor species diversity, large abundances of a few organisms, and presence of pollution-tolerant organisms.

Signs of biological impairment are indicative of an environmental stressor within the watershed. Such stressors can be natural or anthropogenic in nature; and further analyses need to be conducted to determine the potential cause of environmental stress. Additional analyses to habitat, water quality and land use can help in finding indications of specific biological stressors or pollutants.

Biological data has become a critical component in assessing water quality, and has been incorporated into the Maryland water quality standards. The Biological Water Quality Standard states:

26.08.02.03-4 Biological Water Quality Criteria
A. Quantitative assessments of Biological communities in streams (biological criteria) may be used separately or in conjunction with the chemical and physical criteria promulgated in this chapter to assess whether water quality is consistent with purposes and uses in Regulations .01 and .02 of this chapter.
B. The results of the quantitative assessments of biological communities shall be used for purposes of water quality assessment, including, but not limited to, those assessments required by §§ 303(d) and 305 (b) of the federal Clean Water Act (33 U.S.C. §§ 1313 (d) and 1315(b)).
C. These assessments shall use documented methods that have been subject to technical review, produce consistent and repeatable results, and are objectively interpretable.
D. In using biological criteria to determine whether aquatic life uses are being met, the Department shall allow for the uncertainty and natural variability in environmental monitoring results by using established quantitative and statistical methodologies to establish the appropriate level of uncertainty for these determinations.
E. The Department shall determine whether the application and interpretation of the assessment method are appropriate. In those instances where the Department determines the assessment method is not appropriate, it will provide its justification for that determination.

1. Index of Biotic Integrity

The biological aspects of the MBSS include fish index of biotic integrity (IBI) and benthic IBI. The fish IBI is a quantitative rating of the health of the fish assemblage found at each site. Scores range from 1 (very poor) to 5 (good). No fish IBI were calculated for sites with a catchment area less than 300 acres. The benthic IBI scores are similar, but focus on benthic macroinvertebrates collected in the stream segment. The scores rate how the stream segments compare to reference streams that are considered minimally impacted. Low scores indicate significant deviation from reference conditions, indicating severe degradation; while high scores indicate the segment is comparable to reference streams and are minimally impacted.

a. Maryland's DNR Results

Locations of the specific sites sampled can be seen in Figure 4-3. Specific IBI information for fish and benthic macroinvertebrates from the sites surveyed within the Liberty Reservoir Watershed are listed in Table 5-1.

Table 5-1: Liberty Reservoir Watershed DNR's MBSS Index of Biotic Integrity

12-Digit Scale	Subwatershed	Fish IBI			Benthic IBI		
Site Identification	Stream Segment	Good	Fair	Poor	Good	Fair	Poor
21309071046	**Snowden's Run**						
CR-P-115-111-95	Liberty Reservoir UT1	4.67				3.33	
CR-P-020-208-96	--	--	--	--	--	--	--
LIBE-105-C-2000	--	--	--	--	--	--	--
LIBE-214-R-2003	Liberty Reservoir UT1		3.67			3.00	
21309071047	**Liberty Reservoir**						
CR-P-112-122-95	Liberty Reservoir UT1	4.67			4.00		
CR-P-112-112-96	--	--	--	--	--	--	--
21309071048	**Roaring Run**						
CR-P-240-225-95	North Branch Patapsco River UT1	5.00				3.33	
CR-P-152-318-95	North Branch Patapsco River	4.00				3.00	
CR-P-077-309-95	North Branch Patapsco River	4.33				3.00	
CR-P-227-305-96	--	--	--	--	4.33		
CR-P-215-127-96	Liberty Reservoir UT2			2.33			2.67
CR-P-409-320-96	--	--	--	--	--	--	--
CR-P-149-118-96	Roaring Run	4.33				3.33	
CR-P-152-302-96	--	--	--	--			2.33
LIBE-115-R-2000	Roaring Run	5.00				3.67	
LIBE-333-R-2003	North Branch Patapsco River	4.00			4.00		
LIBE-356-A-2007	--	--	--	--	--	--	--
21309071049	**Little Morgan Run**						
CR-P-166-221-95	Little Morgan Run	5.00			5.00		
CR-P-175-113-95	Little Morgan Run UT1	5.00			5.00		
CR-P-345-923-95	--	--	--	--	--	--	--
CR-P-341-125-95	--	--	--	--	--	--	--
CR-P-341-121-96	Little Morgan Run UT2	4.00					2.33
LIBE-109-R-2003	Little Morgan Run UT3	4.33			4.00		
LIBE-266-A-2007	Little Morgan Run	4.00			4.33		
LIBE-262-A-2007	Little Morgan Run	5.00			4.33		
21309071050	**Morgan Run**						

12-Digit Scale	Subwatershed	Fish IBI			Benthic IBI		
Site Identification	Stream Segment	Good	Fair	Poor	Good	Fair	Poor
CR-P-048-922-95	--	--	--	--	--	--	--
CR-P-165-921-95	--	--	--	--	--	--	--
CR-P-345-321-96	Morgan Run	4.33				3.67	
CR-P-084-309-96	Morgan Run	5.00				3.33	
LIBE-318-R-2000	Morgan Run	4.33			4.00		
LIBE-203-R-2000	Morgan Run	5.00				3.00	
LIBE-303-R-2000	--	--	--	--	--	--	--
LIBE-209-R-2000	Joe Branch	5.00			4.33		
LIBE-127-R-2003	Morgan Run UT2		3.33		4.00		
LIBE-111-R-2003	Morgan Run UT3	4.00				3.67	
21309071051	**West Branch Patapsco**						
LIBE-214-A-2007	West Branch of North Branch Patapsco River	5.00					2.33
21309071052	**East Branch Patapsco**						
CR-P-242-224-96	East Branch of North Branch Patapsco River	4.33				3.33	
LIBE-202-R-2000	East Branch of North Branch Patapsco River	5.00				3.33	
21309071053	**Morgan Run**						
CR-P-143-218-95	Morgan Run UT1	5.00				3.33	
CR-P-119-102-95	--	--	--	--	--	--	--
21309071054	**Morgan Run**						
CR-P-379-123-96	Morgan Run			2.33			2.67
21309071055	**Little Morgan Run**						
LIBE-216-R-2000	--	--	--	--	--	--	--
LIBE-206-A-2007	Little Morgan Run	5.00					2.33
21309071056	**Middle Run**						
CR-P-079-209-96	Middle Run	5.00				3.67	
LIBE-119-R-2000	Middle Run UT1	4.33					2.00
LIBE-111-R-2000	Middle Run UT2	4.33					1.67
LIBE-110-R-2000	Middle Run	4.67				3.67	
LIBE-106-R-2003	Prugh Branch			1.00		3.00	

12-Digit Scale	Subwatershed	Fish IBI			Benthic IBI		
Site Identification	Stream Segment	Good	Fair	Poor	Good	Fair	Poor
LIBE-202-A-2007	Middle Run	5.00			4.33		
21309071057	**Beaver Run**						
CR-P-999-323-95	Beaver Run	4.67			4.00		
CR-P-260-212-95	Beaver Run	5.00					1.67
CR-P-050-106-95	Beaver Run UT1			2.67		3.67	
CR-P-224-226-95	Middle Run	4.33				3.33	
CR-P-193-311-96	Beaver Run	5.00				3.33	
CR-P-260-210-96	Beaver Run	5.00					2.67
CR-P-999-323-96	Beaver Run	4.67				3.67	
LIBE-218-R-2003	Beaver Run	4.33			4.00		
LIBE-105-R-2003	Middle Run	4.00				3.67	
LIBE-208-R-2007	Beaver Run	4.33				3.00	
21309071058	**Deep Run**						
CR-P-294-124-95	Aspen Run	4.33					2.67
CR-P-402-121-95	Deep Run	5.00				3.67	
LIBE-207-R-2000	Deep Run		3.67				2.67
LIBE-104-R-2000	Deep Run UT1	4.00					2.00
LIBE-251-A-2007	Deep Run	4.67				3.00	
21309071059	**East Branch Patapsco**						
CR-P-344-219-96	Cascade Lake UT1	5.00				3.33	
CR-P-330-229-96	East Branch of North Branch Patapsco River	5.00				3.33	
LIBE-204-R-2003	East Branch of North Branch Patapsco River	4.67				3.33	
LIBE-124-R-2003	Cascade Lake UT2	4.00			4.33		
LIBE-201-R-2007	East Branch of North Branch Patapsco River	4.67			4.00		
LIBE-107-R-2007	Cascade Lake UT2	4.00				3.33	
21309071060	**Aspen Run**						
CR-P-330-201-96	East Branch of North Branch Patapsco River	4.67				3.33	
21309071061	**Cranberry Branch**						
CR-P-270-104-95	Cranberry Branch	5.00				3.00	

12-Digit Scale	Subwatershed	Fish IBI			Benthic IBI		
Site Identification	Stream Segment	Good	Fair	Poor	Good	Fair	Poor
LIBE-110-R-2003	Cranberry Branch			2.33		3.00	
21309071062	**West Branch Patapsco**						
CR-P-038-227-95	West Branch of North Branch Patapsco River		3.67				1.00
CR-P-000-920-96	--	--	--	--	--	--	--
LIBE-101-X-2001	--	--	--	--	--	--	--
LIBE-102-X-2001	--	--	--	--	--	--	--
LIBE-103-X-2001	--	--	--	--	--	--	--
LIBE-103-X-2002	West Branch of North Branch Patapsco River UT1			1.67			1.33
LIBE-102-X-2002	West Branch of North Branch Patapsco River UT1			1.67			1.33
LIBE-101-X-2002	--	--	--	--	--	--	--
LIBE-107-R-2003	West Branch of North Branch Patapsco River UT1			1.67			2.00
LIBE-103-X-2004	--	--	--	--	--	--	--
LIBE-101-X-2004	--	--	--	--	--	--	--
LIBE-102-X-2004	West Branch of North Branch Patapsco River UT1			1.33			1.00

In total there are 66 samples contributing to the MBSS IBI data set from 1995 to 2009. Within the Liberty Reservoir Watershed, 80% of the fish samples were in 'good' condition, with an overall average rating of 4.16. Of the benthic samples, 48% were in 'fair' condition with an overall average rating of 3.20. The IBI for fish throughout the years and locations sampled were mostly within the 'good' range, suggesting fish populations are, for the most part, similar to reference streams that are unaffected by pollutants. The benthic IBI for the Liberty Reservoir Watershed is for the most part within the 'fair' range, suggesting some adverse impacts to the benthic community within the watershed. The West Branch Patapsco (21309071062) subwatershed is noted as having the lowest overall IBI ratings. East Branch Patapsco (21309071059) subwatershed is noted as having the highest overall IBI rating.

b. Carroll County Results

Carroll County's Bureau of Resource Management conducted MBSSs in Liberty Reservoir Watershed from 2010 – 2013. Site locations for the Carroll County MBSS sites specific for Benthic IBI are shown in Figure 5-1. Specific IBI information for benthic macroinvertebrates from the sites surveyed within the Liberty Reservoir Watershed are listed in Table 5-2.

Table 5-2: Liberty Reservoir Watershed Carroll County's MBSS Benthic IBI

12-Digit Scale	**Subwatershed**	**Benthic IBI**		
Sample Year	Site Identification	Good	Fair	Poor
21309071062	**West Branch Patapsco**			
2010	WPU01			2.00
2010	WPU02		3.00	
2011	WPU01			2.33
2011	WPU02			1.67
2012	WPU01			1.33
2012	WPU02		3.00	
2013	WPU01			2.67
2013	WPU02		3.33	
21309071051	**West Branch Patapsco**			
2010	WPL01			2.00
2010	WPL02			2.33
Liberty Reservoir Watershed Total Counts:		**0**	**3**	**7**
Liberty Reservoir Watershed Average:		**--**	**3.11**	**2.05**

In total there are 10 samples contributing to the County's MBSS data set from 2010 to 2013. Within the Liberty Reservoir Watershed the overall benthic IBI rating was 2.37, putting the Watershed in 'poor' condition. The benthic IBI for the Liberty Reservoir Watershed is for the most part within the 'fair' to 'poor' range, suggesting some adverse impacts to the benthic community within the watershed.

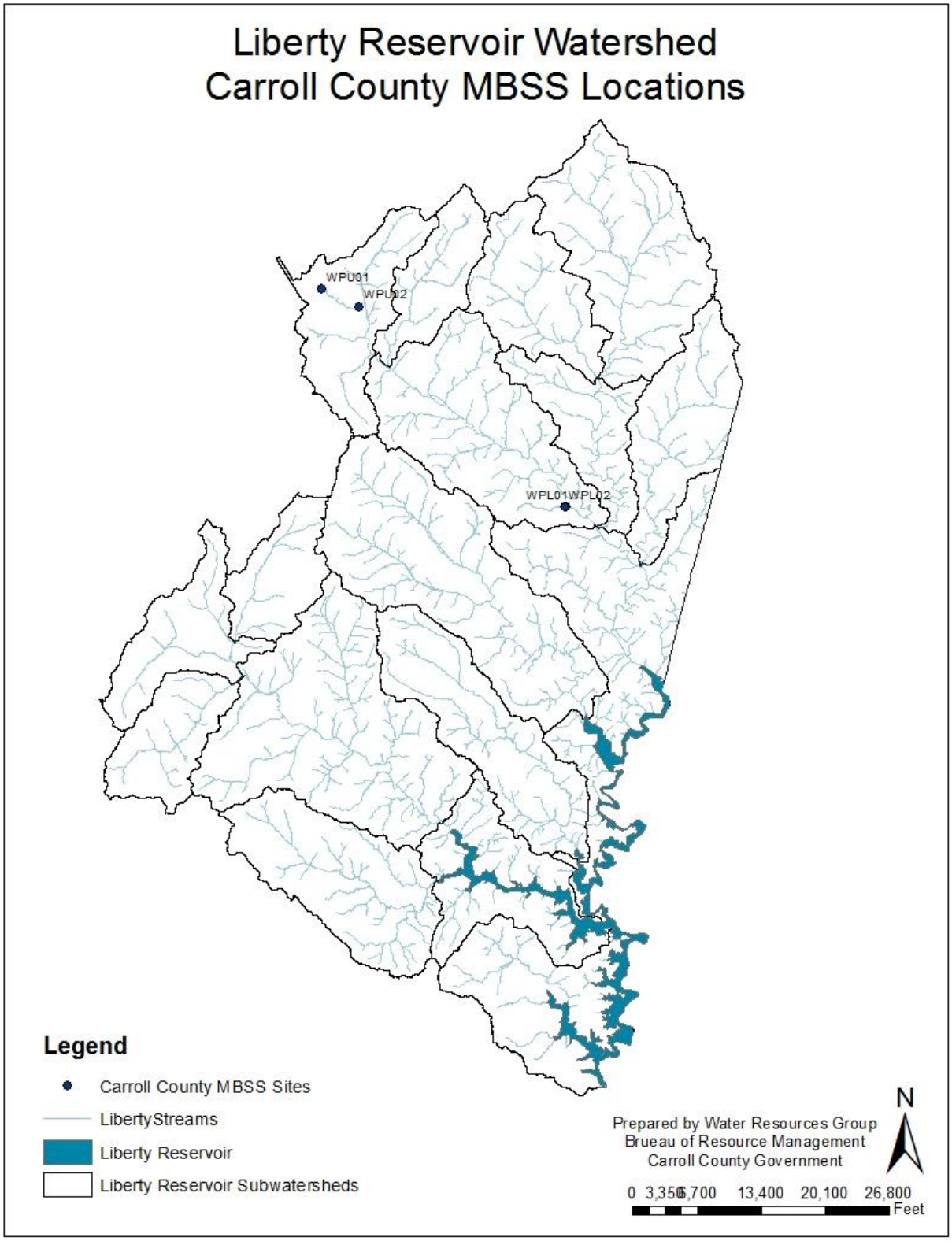

Figure 5-1: Liberty Reservoir Watershed Carroll County MBSS Locations

C. Sensitive Species

Sensitive species are those plants and animals that are among the rarest in Maryland and most in need of conservation efforts. These species are at the greatest risk of local extinction, and are generally the most sensitive to environmental degradation.

1. Rare, Threatened and Endangered Species

RTE species are those plants and animals that are the most at risk to maintain healthy populations. For watershed restoration purposes, it is important to know and account for the habitats of such sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. The DNR's Wildlife and Heritage Program identifies important areas for sensitive species conservation known as stronghold watersheds. Stronghold watersheds are the places where RTE species have the highest abundance of natural communities. Within the Liberty Reservoir Watershed the Liberty Reservoir (1046, 1047), Morgan Run (1050), Little Morgan Run (1055), Roaring Run (1048), Deep Run (1058), Aspen Run (1060) and East Branch Patapsco (1059) subwatersheds are identified as having sensitive state-listed species, and special protection is necessary to ensure the persistence of these communities. A complete list of all RTE plants and animals within Carroll County and throughout the state of Maryland can be found at: http://dnr.maryland.gov/wildlife/Plants_Wildlife/espaa.asp

Figure 5-2 shows targeted ecological areas for sensitive species within the Liberty Reservoir Watershed. Sensitive species areas where designated by the DNR.

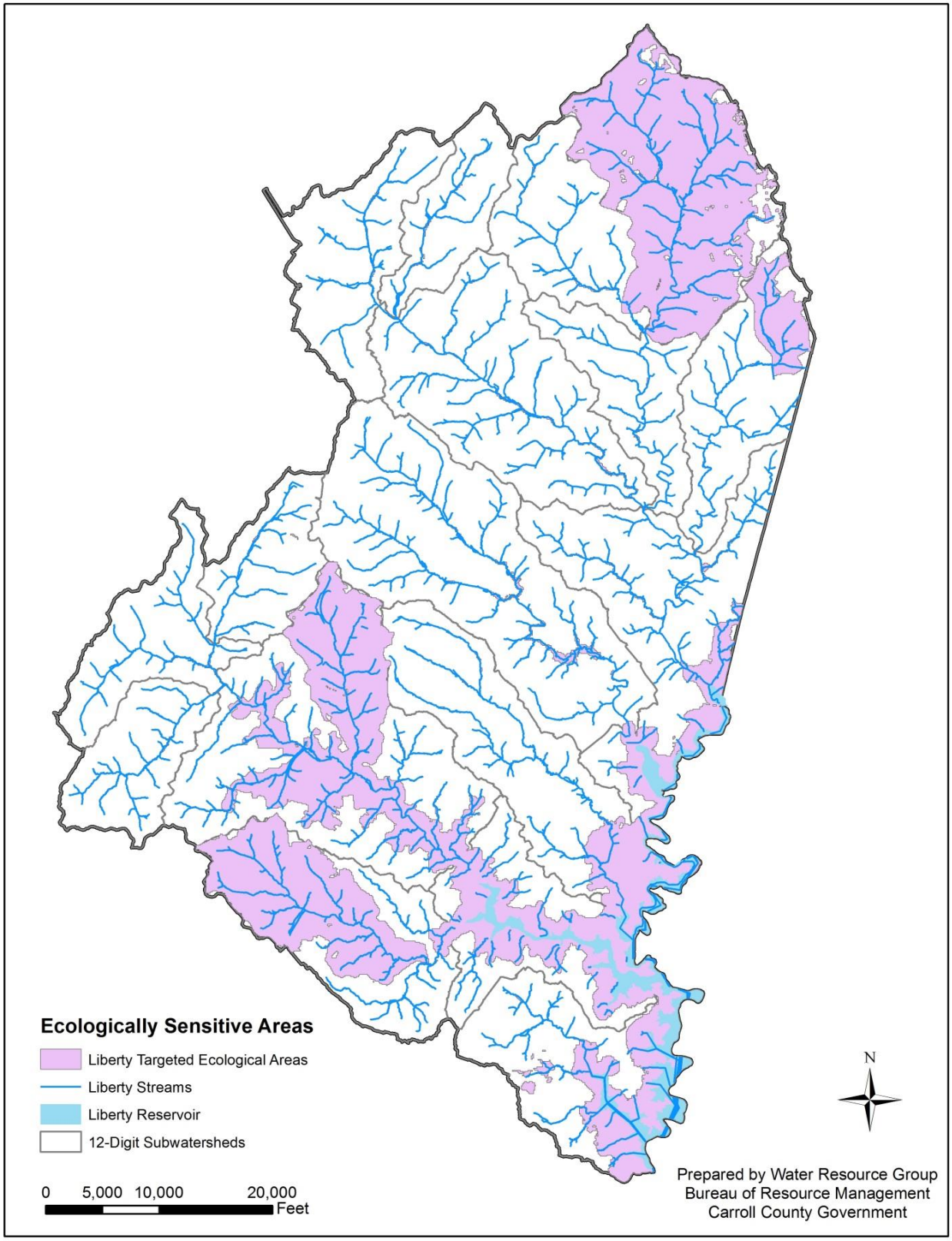

Figure 5-2: Liberty Reservoir Watershed Targeted Ecological Areas

D. Stream Corridor Assessment

A Stream Corridor Assessment (SCA) of the Liberty watershed was conducted during the winter of 2012 by Carroll County Bureau of Resource Management staff. The Liberty SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation.

This assessment reached out to 2,319 landowners within the Liberty watershed whose property is intersected by a stream corridor. Landowner permission was obtained through a mailing that detailed the assessment, permission results can be found in Figure 5-3. A response card was also included for the landowner to send back with their permission response. Only properties with owner permission were assessed. Access was granted for approximately 235 of the 404 stream miles within the Liberty watershed.

The most common impairments identified during the assessment are shown in Figure 5-4, and consisted primarily of erosion sites and inadequate streamside buffers followed by fish barriers. Table 5-3 lists the data points by severity across the entire watershed, and Table 5-4 presents a summary of the number of impacts identified in each subwatershed.

Table 5-3: Data Points by Severity

Identified Impacts	Total	Very Severe	Severe	Moderate	Low	Minor
Erosion	**415**	11	31	64	20	289
Inadequate Buffer	**272**	64	75	70	43	20
Pipe Outfall	**68**	6	4	15	16	27
Fish Barrier	**138**	7	6	27	20	78
Trash Dump	**27**	1	3	8	4	11
Channel Alteration	**13**	3	4	2	4	0
Construction	**0**	0	0	0	0	0
Exposed Pipe	**11**	0	2	1	2	6
Unusual Condition	**19**	1	5	11	2	0
Total	**963**	**93**	**130**	**198**	**111**	**431**

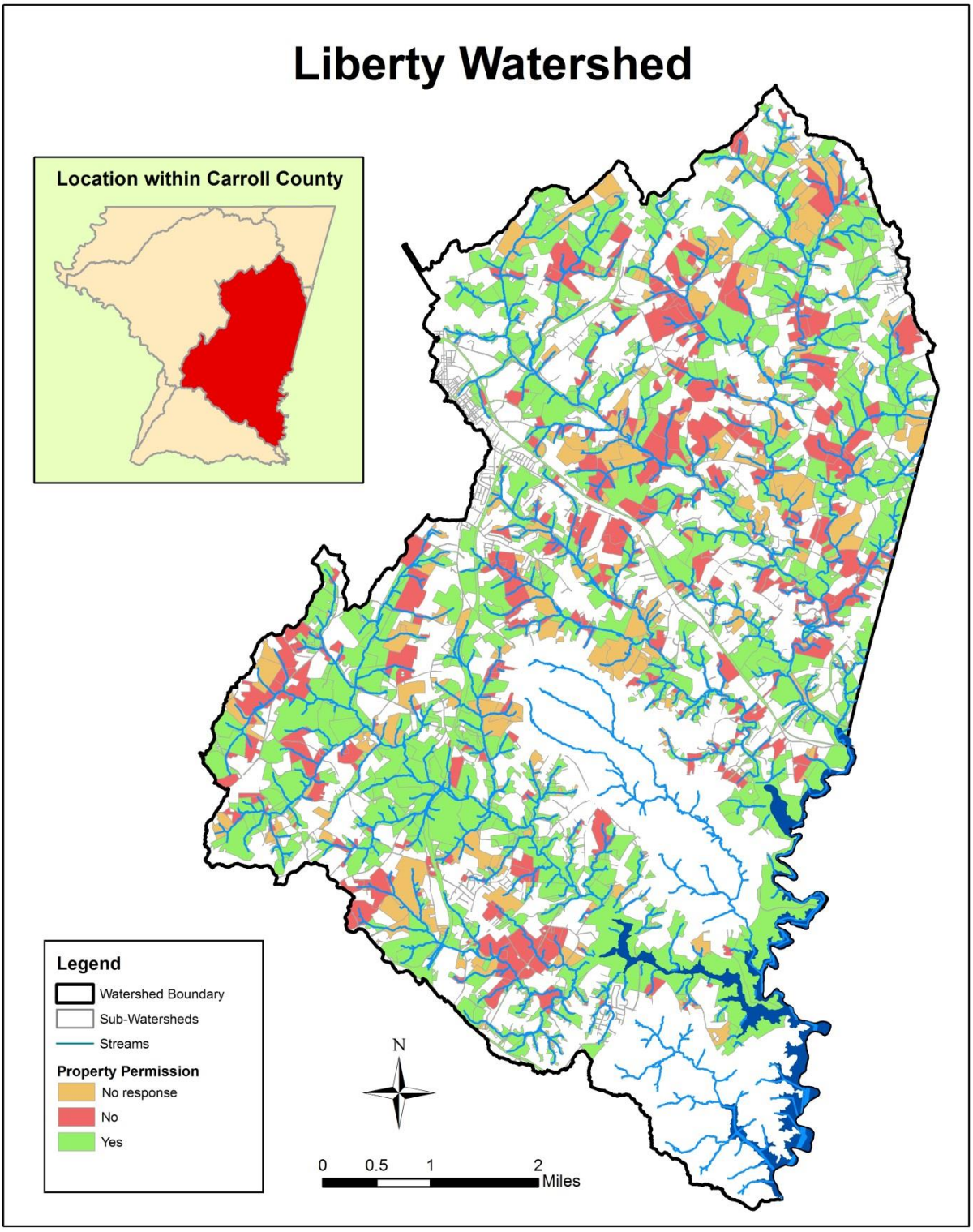

Figure 5-3: Landowner Participation

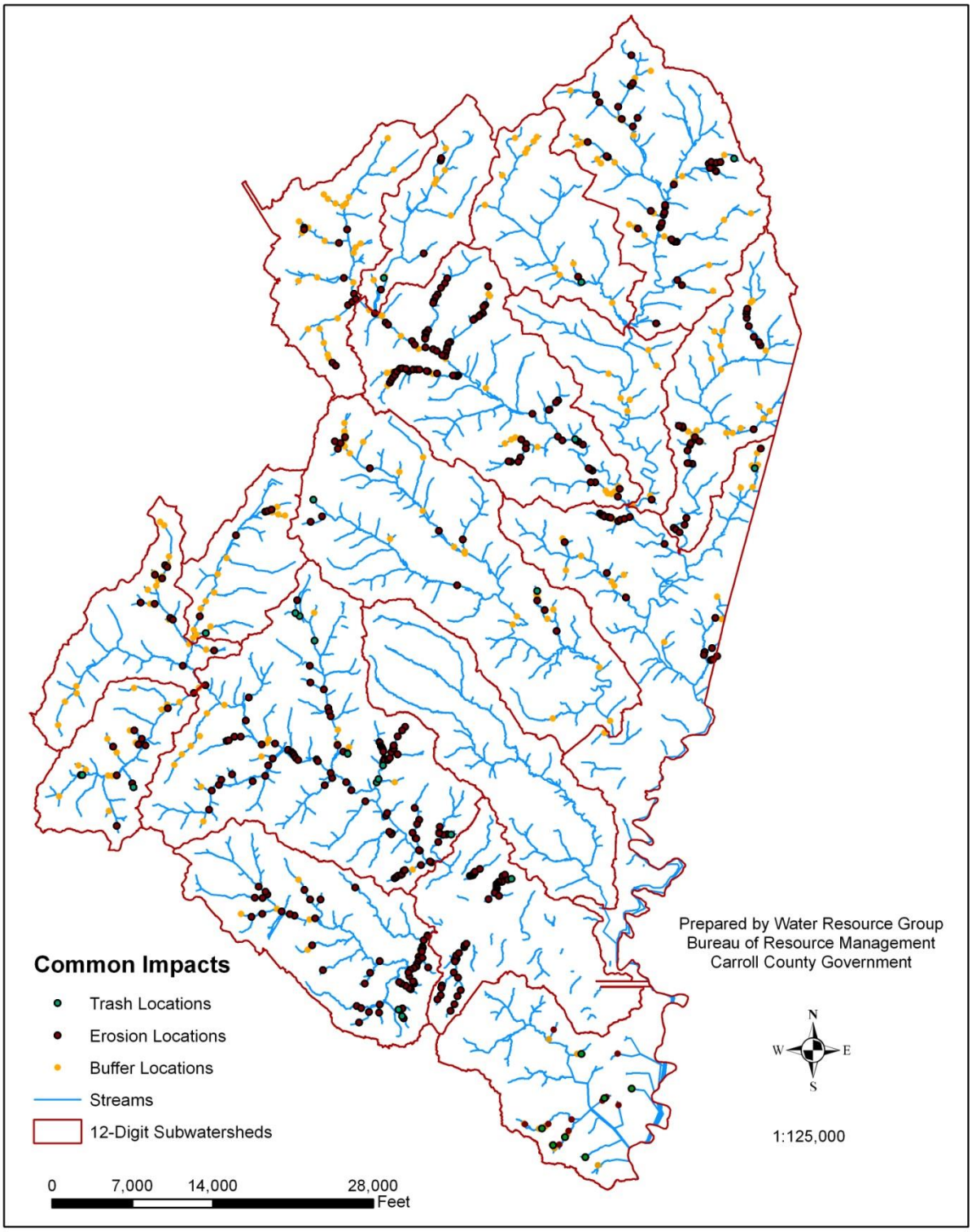

Figure 5-4: Most Commonly Identified Impacts

Table 5-4: Stream Corridor Assessment – Identified Impacts

DNR 12-Digit	In-Stream Construction	Erosion	Fish Barrier	Inadequate Buffer	Trash Dump	Channel Alteration	Pipe Outfall	Exposed Pipe	Total
1060	0	1	2	11	2	0	0	0	**16**
1057	0	13	8	28	2	1	6	1	**59**
1061	0	4	1	8	2	2	2	2	**21**
1058	0	26	2	26	0	0	3	0	**57**
1052	0	1	0	8	0	0	0	0	**9**
1059	0	37	15	31	1	1	8	1	**94**
1046	0	34	13	15	7	12	19	0	**100**
1047	0	42	22	0	1	0	0	1	**66**
1049	0	54	16	9	2	1	2	0	**84**
1055	0	5	4	14	1	0	2	0	**26**
1053	0	11	0	19	2	0	0	0	**32**
1054	0	10	0	20	0	0	0	0	**30**
1050	0	96	31	19	12	2	15	1	**176**
1048	0	22	15	17	1	0	0	0	**55**
1051	0	80	21	33	1	0	9	1	**145**
1062	0	11	1	28	0	6	21	4	**71**
1056	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**n/a**
Total	**0**	**447**	**151**	**286**	**34**	**25**	**87**	**11**	**1,041**

VI. Characterization Summary

A. Summary

This Characterization Plan was developed to describe the unique background of the Liberty watershed. The contents and data presented in this plan along with information gathered during the SCA will be used by the Bureau of Resource Management to develop a Watershed Restoration Plan that will define the Bureau's goals for addressing environmental impacts within the watershed. The purpose of the Watershed Restoration Plan will be to focus on identified impacts discovered during the Stream Corridor Assessment and prioritize projects at a subwatershed scale based on the water quality data collected by MDE as well as County staff initiatives. The Watershed Restoration Plan will also be used by the Bureau as a document to track project implementation in each subwatershed and monitor progress toward meeting applicable goals within the watershed.

B. Cost Summary

The following breakdown shows an approximate cost summary for the completion of the Liberty Reservoir Watershed stream corridor assessment, as well as the development of this Liberty Reservoir Watershed Characterization Plan.

Field Time: Assessment was completed over a span of 10 weeks; field crew averaged 4 days per week for a total of 40 field days.

Field Hours: Field crew averaged 5 hours/day over the 40 days for a total of 200 hours. Field crew consisted of 2 people performing the assessment for a cumulative total of 400 field hours. Total cost of staff time in field was roughly $12,000 (400 hours at an average of $30/hour).

Plan Development: Watershed plan development took approximately 2 months ($6,700 staff time) and consisted of a full analysis of the stream corridor assessment as well as a complete characterization of the watershed.

Cost: Total estimated cost to complete the Liberty Reservoir stream corridor assessment and the Watershed Characterization Plan was approximately $18,700.

VII. References:

Costa, J.E., 1975. Effects of agriculture on erosion and sedimentation in the Piedmont Province, Maryland. Geological Society of America Bulletin 86, 1281–1286.

Maryland Department of the Environment (MDE). (2008). Total Maximum Daily Loads of Fecal Bacteria for the Liberty Reservoir Basin in Carroll and Baltimore Counties, Maryland.

Maryland Department of the Environment (MDE). (2012). Total Maximum Daily Loads of Phosphorus and Sediments for Liberty Reservoir, Baltimore and Carroll Counties, Maryland.

Southerland, M., L. Erb, G. Rogers, R. Morgan, K. Eshleman, M. Kline, K. Kline, S. Stranko, P. Kazyak, J. Kilian, J. Ladell, and J. Thompson. 2005. Maryland Biological Stream Survey 2000-2004, Volume 14: Stressors Affecting Maryland Streams (CBWP-MANTA-EA-05-11). Report prepared for Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division, Annapolis, MD.

Walker, S., Mostaghimi, S., Dillaha, T. A., & Woeste, R. E. (1990). MODELING ANIMAL WASTE MANAGEMENT PRACTICES: IMPACTS ON BACTERIA LEVELS IN RUNOFF FROM AGRICULTURAL LANDS. *American Society of Agricultural Engineers VOL. 33(3): MAY-JUNE 1990*

Yetman, K.T. 2001. Stream Corridor Assessment Survey, SCA Survey Protocols. Watershed Restoration Division, Annapolis, MD.

Appendix A:

Liberty Watershed Stormwater Management Facilities/Definitions

Liberty Watershed Stormwater Management Facilities

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
DRY-DETENTION	6.30	0.88	CARROLL HIGHLAND SEC.5	104
WATER QUALITY BASIN #4	4.49	1.63	QUAIL MEADOWS BASIN #2	176
RETENTION POND	55.00	4.49	QUAIL MEADOWS BASIN #1	174
WATER QUALITY BASIN #2	4.49	0.72	QUAIL MEADOWS BASIN #4	176
WATER QUALITY BASIN #1	1.63	0.67	QUAIL MEADOWS BASIN #3	175
SURFACE SAND FILTER	8.86	2.04	MARRIOTT WOOD 1 POND 2 RETROFIT	70
INFILTRATION BASIN	1.44	0.36	MARRIOTT WOOD 1 POND1 RETROFIT	71
INFILTRATION TRENCH	4.28	2.50	MARVIN GARDENS	168
DRY-DETENTION POND& UNDERGROUNDTANK	4.73	0.00	STAFFORD ESTATES, SEC. 1	113
INFILTRATION BASIN	7.51	1.35	MARRIOTT WOOD 2 POND 1 RETROFIT	75
EXTENDED DETENTION	23.16	10.36	NELL'S ACRES	196
INFILTRATION BASIN	2.20	0.00	ST.STEPHENS CHURCH	139
EXTENDED DETENTION SWALE	1.83	0.75	HOLY SPRIT LUTHERAN CHURCH	185
INFILTRATION BASIN	2.85	1.31	FREEDOM MASONIC LODGE	278
INFILTRATION DETENTION	17.17	0.00	WINIFRED MANOR	200
WET-RETENTION POND	38.00	0.00	SQUIRES SUBDIVISION	550
INFILTRATION TRENCH SWALE	0.51	0.33	LIBERTY TWIN KISS	198
EXTENDED DETENTION	80.60	27.72	CARROLLTOWNE 4A	4
INFILTRATION TRENCH	1.14	0.68	GODDARD SCHOOL PEDDLERSSQ	215
INFILTRATION TRENCH	3.54	1.62	GODDARD SCHOOL (FACILITY #1)	784
WQ.RV. UD STONE	0.65	0.65	ELDERWOOD VILLAGE LOT 3	469
INFILTRATION TRENCH	3.54	0.54	GODDARD SCHOOL (FACILITY #2)	784
INTILTRATION TRENCH	3.54	0.53	GODDARD SCHOOL (FACILITY #3)	784
FILTRATION BASIN	0.50	0.47	MR. TIRE AUTO SERVICE CTR	326
UNDERGROUND RESERVIOR W/SAND FILTE	0.42	0.42	SOUTH CARROLL COM. LOT 3	620
WQ FILTRATION	0.32	0.15	ST. CYR DENTAL OFFICE	594
RETENTION WQ #3	7.42	7.40	ELDERWOOD VILLAGE	165
INFILTRATION TRENCH	3.54	0.31	GODDARD SCHOOL (FACILITY #4)	784
NO PIPE	1.10	0.94	OKLAHOMA STRIP	154
SURFACE SAND FILTER	7.64	2.30	ELDERWOOD VILLAGE # 4	166
INFILTRATION TRENCH	1.49	1.26	DICKENSON RD. BUS.COMPLEX	294
DRY-DETENTION POND	7.29	0.00	SOUTH CARROLL COMM. PARK	395
RETENTION WQ #1	11.82	11.80	ELDERWOOD VILLAGE	164
INFILTRATION TRENCH	0.88	0.69	CARROLL STATION PBC	797
DETENTION POND	145.34	53.09	ELDERWOOD VILLAGE	163
DRY-DETENTION PONDS	15.00	0.00	OKLAHOMA IV PHASE 4	83
DRY-DETENTION POND	23.60	0.00	OKLAHOMA PHASE 1 - POND #2	82
SURFACE SAND FILTER	23.60	7.27	OKLAHOMA PHASE 1 - POND #1	82
INFILTRATION DETENTION	20.09	6.79	OKLAHOMA RD. MIDDLE SCHOO	161
DRY-DETENTION POND	11.90	0.00	ELDERSBURG PLAZA, LOT 3B	409

INFILTRATION TRENCH	1.81	1.25	WALGREEN PHARMACY	738
EXTENDED DETENTION	30.35	0.00	WALMART ELDERSBURG	181
WETLAND FOREBAY DETENTION	79.46	61.71	BEVARD SQUARE BUS. PARK	170
WQ RV UNDERGROUND STON	0.67	0.42	LUTHERS GARDEN	506
DETENTION	0.00	0.00	OKLAHOMA 2 SWEETWATER	136
DRY-DETENTION POND	25.90	8.09	HERITAGE HEIGHTS	94
DRY-INFILTRATION TRENCH	2.60	0.98	OLD LIBERTY PROF. CTR.	472
SURFACE SAND FILTER	23.72	6.63	OKLAHOMA 2 FOOTHILLS	159
FILTRATION INLET	0.25	0.00	CHILIS GRILL&BAR	403
DRY-INFILTRATION TRENCH	2.45	0.00	SANDOSKY BLDG. EQIP. STRG	586
INFILTRATION BASIN	4.03	1.35	OLD LIBERTY PROFESSIONAL	121
UNDERGROUND TANK	5.82	0.00	TEVCO CROSS COUNTRY	149
OIL GRIT SEPERATOR	0.09	0.00	MARTINS FUELISLAND ELDERSBURG MKT.	924
WQ. RV. SAND FILTER	12.00	0.00	ELDERSBURG BUS. CTR LOT 9	477
RETENTION POND	88.18	0.00	ELDERSBURG BUSINESS PARK	588
INFILTRATION TRENCH RV WQ	0.63	0.00	SUSQUEHANNA BANK	480
SANDER FILTER W/UNDERDRAIN	1.39	0.00	FRIENDSHIP SCHOOL	625
SHALLOW MARSH DETENTION	54.78	46.50	ELDERSBURG MKT. PLACE	302
DETENTION POND	0.00	0.00	LIBERTY ROLLER SKATING CE	155
WATER QUALITY SWALE	16.00	8.66	RIDGEWAY SELF STORAGE	355
RETENTION POND	17.25	9.98	RIDGEWAY SELF STORAGE	147
SHALLOW MARSH	14.38	0.00	STONE MANOR 2	331
INFILTRATION/DETENTION POND	39.92	12.20	EDGEWOOD SECT. 1	128
SHALLOW MARSH	14.38	0.00	STONE MANOR 2	331
INFILTRATION BASIN/TRENCH	3.99	0.00	SPRINGMOUNT EST. SEC. 2	118
EXTENDED DETENTION POND	10.80	2.70	EDGEWOOD SECTION 7	221
SAND FILTER	14.38	0.00	STONE MANOR 2	331
SAND FILTER	37.50	0.00	STONE MANOR 2	328
SURFACE SAND FILTER	4.97	1.90	HIGH POINT	547
SHALLOW MARSH/DETENTION	13.22	0.00	SUMNERS HOLLOW POND 2	226
SAND FILTER	5.64	0.00	STONE MANOR 2	329
INFILTRATION TRENCH	0.27	0.27	FREEDOM DISTRICT WTP	797
INFILTRATION TRENCH	1.65	0.00	SHERLOCK HOLMES SECT. 3B	69
EXTENDED DETENTION POND	26.20	5.24	COLLINS EST. SEC. 2	607
EXTENDED DETENTION	21.85	0.00	STONE MANOR POND 1	189
SHALLOW MARSH	58.63	36.17	LINTON SPRINGS ELEMENTARY	242
SHALLOW MARSH	13.88	0.00	SUMNERS HOLLOW POND 1	225
EXTENDED DETENTION	12.80	0.00	RONSDALE RD.	237
EXTENDED DETENTION	14.00	0.00	STONE MANOR POND 2	190
DRY-DETENTION POND	52.90	0.00	CTRL MD SERV. DISTR. CNTR	377
FILTRATION SWALE	0.50	0.50	BURNS SEPTIC	325
SAND FILTRATION WQ RV Q10	1.32	0.42	TIME FOR KIDS DAY CARE	546
FILTRATION STONE VOID	0.50	0.00	STOEHR PROPERTIES L.L.C.	449

RETENTION POND	26.30	2.80	MATTHEW MEADOWS, SEC. 2	612
INFILTRATION BASIN	0.33	0.33	MISTY RIDGE ASSISTED LIV.	730
WET-RETENTION POND	87.50	38.36	CTRL MD SERV. DISTR. CNTR	407
WET RETENTION	4.90	0.00	SHIPLEY WAREHOUSE LOT 32A	287
INFILTRATION TRENCH	0.91	0.57	BARNES BODY SHOP	721
SURFACE SANDFILTER	0.98	0.64	FALLING LEAF INVESTMENTS	803
FILTRATION UNDERDRAIN	0.44	0.00	TIRA ESTATES	490
DRY-INFILTRATION TRENCHES	5.40	0.00	FAITH FAM. BAPTIST CHURCH	599
DRY-INFILTRATION TRENCH	19.45	0.00	SUN VALLEY WATERLOO SEC.I	537
UNDERGROUND TANK SAND F	1.42	0.00	ROYAL FARMS GAMBER	375
SAND FILTER QUAILTY ONLY	0.35	0.35	HIGHS DAIRY STORE GAMBER	178
EXTENDED DETENTION	5.39	2.62	MECHANICSVILLE	7
INFILTRATION TRENCH	1.50	1.48	GAMBER FIRE CO.	720
INFILTRATION TRENCH	4.78	0.77	OMNIPOINT COMM. CAP OP.	386
FILTRATION U.D.	0.40	0.08	LAKEWOOD MANOR	444
INFILTRATION TRENCH	2.37	1.83	ONE FORTY MINI STORAGE	183
RETENTION POND	1.17	0.00	SEIBOLD RV STORAGE YARD	125
INFILTRATION TRENCH	0.76	0.00	JAS PROPERTIES INC.	401
INFILTRATION TRENCH	6.01	0.00	TEVCO	9
EXTENDED DETENTION	0.76	0.07	DAN'S REPAIR SHOP	503
SURFACE SAND FILTER	5.00	0.00	MUDGET BUS. PARK	922
WET-RETENTION #1	6.01	3.47	CJ MILLER ASPHALT #1	387
W.Q. FILTRATION BASIN	0.86	0.86	MUDGETT AUTO BODY	378
EXTENDED DETENTION	3.73	1.40	GREATER BALTIMORE TEMPLE	197
SURFACE SAND FILTER SF	0.06	0.06	FINKSBURG PLAZA - SURF SAND FIL #1	879
SURFACE SAND FILTER SF	0.14	0.14	FINKSBURG PLAZA - SURF SAND FIL #2	880
SURFACE SAND FILTER SF	0.09	0.09	FINKSBURG PLAZA - SURF SAND FIL #3	881
FLOW ATTENTUATION	6.93	1.17	KIBLER CONSTRUCTION	8
DETENTION POND	32.12	0.00	ST. GEORGES GATE SECT.2	162
DRY-LEVEL SPREADER	6.20	0.00	WALNUT PARK IND. LOT 3	487
DETENTION POND	6.47	3.90	BEE'S DISTRIBUTING CO.	406
WET-RETENTION POND	10.78	9.16	FINKSBURG PLAZA	561
DRY DETENTION POND #2	26.50	14.31	CJ MILLER ASPHALT #2	712
SURFACE FILTRATION	3.90	3.90	ROLL-OFF EXPRESS	791
UNDERGROUND DETENTION TANK	0.00	0.00	SAGAMORE HEATING	184
INFILTRATION TRENCH	0.80	0.00	SHOWCASE PAINT BODY	295
DRY-STONE CHECK DAM	3.97	0.80	KIRKNER ESTATES	519
INFILTRATION BASIN #1	2.40	1.00	B & C UTILITY	436
INFILTRATION BASIN	10.67	0.00	S & G CONCRETE	592
SAND FILTER	1.50	0.43	SMOKERS PIT BEEF	725
INFILTRATION BASIN #2	2.40	0.80	B & C UTILITY	436
INFILTRATION DRY WELL	17.00	0.00	SHEPARD PROPERTY	635
INFILTRATION TRENCH	0.30	0.28	COUNTRY CARE FARMS ASST.	781

RETENTION BASIN	40.00	0.00	HILLANDALE PARK #2	120
WQ SAND FILTER U.D.	1.50	0.16	CONGOLEUM WWTP UPGRADE	494
FLOW ATTENUATION	2.00	0.40	GREEN MILL SUBD.RESUB LT1	106
WET-RETENTION POND	0.00	0.00	TODD VILLAGE TRAILER PARK	354
SHALLOW MARSH DETENTION	32.19	6.05	GERSTELL ACADEMY	296
INFILTRATION/DETENTION	44.22	12.90	GERSTELL ACADEMY	297
DRY-INFILTRATION TRENCH	1.13	0.00	TOWER BUSINESS CTR.	515
SHALLOW MARSH	2.60	0.32	RAINBOW AND REASONS	279
FILTRATION U.D.	31.10	18.62	COPART	597
INFILTRATION DRY WELLS	18.56	8.09	AT&T	10
INFILTRATION TRENCH	2.77	1.75	FINKSBURG LIBRARY	799
DRY-DETENTION TANK	1.54	0.00	SUFFOLK WEST.,LOT #5	465
SAND FILTRATION RV	0.33	0.33	BONDS FOREST COUNTRY CARE	412
INFILTRATION/DETENTION	17.60	2.73	ATT FINKSBURG ADDITION	285
EXTENDED DETENTION	8.20	0.00	SANDYMOUNT ELEMENTARY SCHOOL	820
INFILTRATION BASIN	6.20	0.00	WILMOT MANOR	12
RECHARGE & WATER QUALITY	1.05	0.00	SANDYMOUNT U. METHODIST	452
EXTENDED DETENTION	6.83	0.83	AMOCO OIL COMPANY	613
W.Q.FILTRATION INLET	1.09	0.92	HIGH'S SANDYMOUNT RD.	319
EXTENDED DETENTION POND	5.68	3.06	CARROLL COUNTY Y.M.C.A.	58
WATER QUALITY INFILTRATION #3	40.05	1.90	BROOKSHIRE	539
WATER QUALITY INFILTRATION #2	40.05	1.77	BROOKSHIRE	539
WATER QUALITY INFILTRATION #1	40.05	1.80	BROOKSHIRE	539
INFILTRATION BASIN	52.00	21.07	CARROLL COMMUNITY COLLEGE	742
INFILTRATION TRENCH	1.95	1.54	CARROLL COUNTY YOUTH SERVICES	826
EXTENDED DETENTION	7.67	4.98	C. C. FIREMANS TRAINING	187
SHALLOW MARSH	30.81	14.08	GATEWAY POND RETROFIT	947
INFILTRATION/DETENTION	5.20	0.57	B.G.E.MORGAN RUN	216
DETENTION SAND FILTER UD	1.69	0.00	ROYAL FARMS BETHEL RD.	485
DRY POND	1.79	1.28	LARAY BUSINESS CENTER	61
GRASS SWALE	50.31	0.00	UPPER PATAPSCO PHASE 2	916
SURFACE SAND FILTER	24.60	10.10	UPPER PATAPSCO PHASE 1	915
SURFACE SAND FILTER	101.80	13.00	UPPER PATAPSCO PHASE 3	940
SURFACE SANDFILTER S.F. WITH RECHARGE CAVITY	47.25	7.40	BATEMAN POND	860
INFILTRATION BASIN	2.67	1.15	INTERSTATE BATTERIES	247
INFILTRATION BASIN	2.16	1.55	PRIDE PAINTING	233
DRY-DETENTION POND	11.00	0.00	WASHINGTON SQUARE	86
EXTENDED DETENTION WALL	55.20	16.69	DIAMOND HILLS SECT. FIVE	22
EXTENDED DETENTION	19.32	8.60	FRIENDSHIP VALLEY ELE SCH	615
DRY-DETENTION POND	13.14	0.00	WASHINGTON COURT	90
WQ. UD. STONE VOID	0.60	0.60	WESTMINSTER BAPTIST CHURC	475
INFILTRATION TRENCH 2	21.31	0.16	POOL RIDGE SECTION 2	780
FILTRATION SWALE	4.87	0.60	PLAYTIME DAYCARE FACILTY	349

WQ PAVERS PP	19.00	0.19	CHURCH OF GOD CARROLLTON	587
INFILTRATION/DETENTION	22.39	1.03	LARASH MANOR	64
EXTENDED DETENTION POND	44.60	0.00	WINDEMERE ESTATES P #1	213
SHALLOW MARSH	97.50	0.00	WINDEMERE ESTATES P#2	214
INFILTRATION TRENCH IT	5.56	4.27	TSC	766
RETENTION	19.05	0.00	C.C.NORTHERN LANDFILL	260
EXTENDED DETENTION POND	3.20	2.30	E Z STORE	553
INFILTRATION BASIN	2.09	1.78	BOULEVARD EXCHANGE	629
RETENTION POND	41.00	3.73	NORTHEN LANDFILL	122
DRY-DETENTION TANK/UNDERGROUND TANK	1.40	4.10	BOHN PONTIAC	495
INFILTRATION TRENCH	0.31	0.25	MEINEKE MUFFLER MD.140	179
DRY DETENTION TANK	2.03	1.18	POOLE PROFESSIONAL CTR.	428
DRY-DETENTION POND	29.30	9.84	MID-ATLANTIC CARS, INC.	713
DRY-DETENTION PARKING LOT STORAGE	0.60	0.00	FRIENDLY FARMS, WESTM.	390
INFILTRATION/DETENTION POND	36.10	6.23	POOLE MEADOWS	127
FILTRATION BOT. DETENTION	48.00	0.00	WESTMINSTER GATEWAY	334
UNDERGROUND STORAGE	0.79	0.57	1ST MARINER BANK	812
SURFACE SAND FILTER	6.00	0.01	DRESCHLER ESTATES SEC. 2	532
SHALLOW MARSH E.D.	2.89	1.87	PLAYERS FAMILY AMUS.CTR.	191
DRY-DETENTION TANK	1.44	0.00	WEST. INDUSTRIAL CENTER	479
WQ INF. WQ & Q BASIN #1	1.48	0.00	KNIT BUILDING COMPLEX	429
EXTENDED DETENTION	3.52	1.72	CARROLL INDOOR SPORTS CTR	137
DRY-DETENTION PIPES	2.70	0.00	TSC	389
WQ INF. WQ & Q BASIN #2	1.48	0.00	KNIT BUILDING COMPLEX	429
SAND FILTER WATER QUALITY #2	0.50	0.50	WAWA	570
SAND FILTER WATER QUALITY #6	0.50	0.50	WAWA	570
DRY-INFILTRATION BASIN	1.20	0.00	STU'S MUSIC SHOP	529
INFILTRATION TRENCH	0.35	0.20	CARROLL DENTAL BLDG.	610
INFILTRATION TRENCH IT	0.76	0.44	KRM ASSISTED LIVING	858
INFILTRATION TRENCH	1.78	0.42	MAIN ST. EXCHANGE, PH. 1	463
DRY-INFILTRATION TRENCH	0.53	0.00	KIDDE CONSULTANTS OFFICE	443
INFILTRATION TRENCH	1.52	0.80	MAIN ST. EXCHANGE 2	364
INFILTRATION TRENCH	1.81	1.52	MAIN ST. EXCHANGE, PH. 2	523
EXTENDED DETENTION	2.65	2.00	APPLE BEES	224
UNDERGROUND INFILT. - WQ # 1	1.36	0.32	GREEN TURTLE LOT 4A MARKE	787
EX. INFILT. - WQ # 2	1.36	0.41	GREEN TURTLE LOT 4A MARKE	787
SAND EXFILTRATION FACILITY #2	0.75	0.03	NEW WINDSOR STATE BANK	716
SAND EXFILTRATION FACILITY #1	0.75	0.03	NEW WINDSOR STATE BANK	716
I FILTRATION INLET	0.10	0.00	B J WHOLESALE CLUB	394
WATER QUALITY BASIN #1	106.66	0.00	CHURCH OF OPEN DOOR	212
UNDERGROUND TANK+SEPATOR	1.95	1.51	GRIFFTH AUTO PARK	231
SURFACE SAND FILT W/INFILTR CAVITY BELOW SFI	5.87	2.63	RILLS BUS SERVICE - 218 DUTROW RD	867
WATER QUALITY BASIN #2	106.66	61.96	CHURCH OF OPEN DOOR	212

SHALLOW MARSH	52.07	0.00	WESTMINSTER MARKET PLACE	308
DRY-DETENTION TANKS	0.00	0.00	WEST. PROFESSIONAL CENTER	402
WET RETENTION POND	106.66	0.00	CHURCH OF OPEN DOOR	212
DRY-DETENTION TANK	11.40	0.00	CHURCH OF THE OPEN DOOR	381
UNDERGROUND TANK AND 2 STORMSCEPTOR	3.66	2.31	OLIVE GARDEN	251
DRY-INFILTRATION BASIN	1.75	0.00	WEST. MOOSE LODGE #1381	527
INFILTRATION TRENCH	0.20	0.20	McDONALDS ADD. PARKING	636
INFILTRATION TRENCH	0.41	0.00	EAST MAIN STREET (249)	685
SAND FILTER UNDER DRAIN	19.37	15.19	CHURCH OF OPEN DOOR 4TH	544
WQ RV INFILTRATION UNDERDRAIN	9.08	0.00	WESTMINSTER MEWS	591
SAND FILTER WATER QUALITY	0.10	0.09	CENTER ST/GORSUCH RD ROUN	571
EXTENDED DETENTION	2.24	0.00	TOYOTA INDUSTRIAL PARK	193
WATER QUALITY FACILITY MARSH RET.	0.27	0.27	RALPH STREET EXTENSION	239
DRY-DETENTION TANK	3.70	0.00	WESTMINSTER TOYOTA	568
E D SHALLOW MARSH	58.30	0.00	WINTERS MILL HIGH SCHOOL	227
UNDERGROUND TANK	3.75	3.19	DAYS INN	482
SHALLOW MARSH	76.80	64.50	COUNTY PARK WETLAND	268
SAND FILTER #2 WQ SWALES	1.21	0.00	DAVID'S DIAMOND CENTER	656
SAND FILTER #1 WQ SWALES	1.21	0.00	DAVID'S DIAMOND CENTER	656
SHALLOW MARSH	19.10	9.13	CENTER ST. RD. EXTENSION	236
3 INFILTRATION TRENCHS WQ RV	1.58	1.02	PIZZA HUT CTR. ST. STATIO	552
WATER QU.WETLAND	0.60	0.60	CARROLL CO.MULTI PARKING	234
INFILTRATION TRENCH	1.71	0.32	LONGWELL PARKING GARAGE	536
SHALLOW MARSH	10.18	10.18	EAST MIDDLE SCHOOL WETLAN	270
SAND FILTER	0.25	0.12	HIGH'S DAIRY STORE RT.27	284
GABION CHECK DAMS	1.00	0.60	GRACE LUTERAN CHURCH WES	426
DRY-DETENTION POND	6.80	0.00	TIMES NEWSPAPER ADDITION	691
DRY-DETENTION POND	10.20	0.00	LANDMARK PAPER	350
INFILTRATION/UNDER GROUND DETENTION	0.75	0.00	7-11 CONVENICE STORE	290
SAND/SOIL FILTRATION	0.30	0.00	CARROLL COUNTY TIMES	413
DRY-PARKING LOT STORAGE	0.46	0.46	CROWN PETROLEUM.	498
WQ SAND FILTER UD. DRAIN	0.83	0.00	TOWN MALL OF WESTMINSTER	510
DRY-DETENTION	10.75	4.66	CARROLL MEADOWS,SEC 1&2	662
SHALLOW MARSH POND#4	28.00	0.00	SPRUCE MEADOWS P#4	348
DRY-DETENTION POND	2.30	0.20	BG&E WESTMINSTER SUBSTAT.	665
DRY DETENTION POND	172.66	0.00	TOWN MALL OF WESTMINSTER	62
EXTENDED DETENTION	5.41	0.00	TREMONT PLACE	160
WET RETENTION	0.00	0.00	WINTER STREET POND	0
DRY-DETENTION POND	14.50	0.00	ASPEN RUN--WINTERBERRY	88
INFILTRATION BASIN	3.46	1.25	CRANBERRY HILL RESUB LOT	313
INFILTRATION/DETENTION	7.39	0.00	SQUIRE VILLAGE	199
WET RETENTION	95.00	79.50	ENGLAR BUSINESS PARK	674
WATER QUALITY FACILITY SAND FILTER	0.22	0.22	PAPA JOHNS PIZZA	240

INFILTRATION TRENCH	1.20	0.73	UNION STREET HOUSING WESTMINSTER	902
SHALLOW MARSH POND#2	33.00	0.00	SPRUCE MEADOWS P #2	346
WQ RV INTILTRATION TRENCH	1.64	0.00	CARROLL CO NONPROFIT CENT	593
DRY-DETENTION TANK	4.94	0.72	CRANBERRY HILL	103
WATER QUALITY FILTRATION 3	28.00	0.00	SPRUCE MEADOWS WQ#3	347
SURFACE SAND FILTER	0.00	0.43	CRANBERRY WATER TREATMENT PLANT	887
DRY-DETENTION POND	0.00	0.00	CRANBERRY INDUSTRIAL PARK	451
W.Q.#1 FILTRATION BASIN	9.50	4.99	ST.JOHNS CATHOLIC CHURCH	388
UNDERGROUND SAND FILTER	0.75	0.75	MCDANIEL COLLEGE GILL FIT	750
INFILTRATION TRENCH	0.51	0.00	ST. JOHNS CATHOLIC	15
INFILTRATION TRENCH	0.93	0.30	ST. JOHN CATHOLIC SWM #3	608
WQ SAND FILTER 1	0.78	0.78	MCDANIEL COLLEGE	420
FILTRATION U. D.	4.28	0.00	BRADFORD KNOLL	445
WQ SAND FILTER 2	0.78	0.78	MCDANIEL COLLEGE	420
WQ SAND FILTER 3	0.78	0.78	MCDANIEL COLLEGE	420
W.Q.#2 FILTRATION BASIN	0.70	0.69	ST. JOHNS CATHOLIC	16
WQ SAND FILTER 4	0.78	0.78	MCDANIEL COLLEGE	420
WQ SAND FILTER 5	0.78	0.78	MCDANIEL COLLEGE	420
INFILTRATION TRENCH	0.93	0.49	MCDANIEL COLL. VILL PH 2	778
UNDER GROUND DETENTION TANK	0.47	0.47	RANDOM HOUSE	286
INFILTRATION TRENCH	6.20	0.35	CHINQUAPIN HILL	542
DETENTION	16.33	2.58	BIRTIC PROPERTY J+J TRASH	564
UNDERGROUND TANK	5.88	0.00	SULLIVAN HEIGHTS	17
POND 2 SHALLOW MARSH	15.40	0.00	RANDOM HOUSE	358
POND 1 SHALLOW MARSH	24.00	0.00	RANDOM HOUSE 6 TH AM.	703
POND 1	15.40	0.00	RANDOM HOUSE	358
INFILTRATION TRENCH	1.26	0.00	WESTMINSTER CHURCH GOD	257
WET RETENTION	76.80	29.18	EDEN FARMS,LATRIOMPE SEC.	596
GRASS WATERWAY U-DRAIN	1.50	0.00	WESTMINSTER RESCUE MISSIO	344
INFILTRATION TRENCH	0.70	0.60	HAMPSTEAD AMOCO STATION	647
WET-RETENTION POND	31.00	0.00	AUTUMN RIDGE(LOWERY POND)	95
EXTENDED DETENTION	27.62	17.92	C.C. COMMERCE CENTER	49
INFILTRATION BASIN	28.70	0.00	HICKORY RIDGE ADDITION	92
SHALLOW MARSH POND	64.00	0.00	SOLO CUP	419
DRY-DETENTION POND/EXT. DETENTION	6.20	0.00	DEVLIN SQUARE	96
INFILTRATION TRENCH	1.20	0.00	CARROLL CO. COMMERCE "D"	808
EXTENDED DETENTION	10.20	0.00	DEVLIN SQUARE	710
DRY-FLOW ATTENUATION	6.31	0.85	C.C.ASSOC.RETARED CITIZEN	101
SAND FILTER UNDER DRAIN	3.50	0.00	SOLO CUP	622
DETENTION	34.20	0.40	C.C.REGIONAL AIRPORT	430
EXTENDED DETENTION	8.80	2.30	WESTWOOD PARK POND 4	204
SHALLOW MARSH	77.40	0.00	SHILOH MIDDLE SCHOOL	202
INFILTRATION TRENCH	0.20	0.00	BGE SUBSTATION - HAMPSTEAD MEXICO R	795

WET-RETENTION POND	10.00	0.00	CONDON PROPERTY JUNK YARD	372
INFILTRATION TRENCH	2.29	0.72	ILLIANO PHAZA II	728
INFILTRATION TRENCH RV	1.38	1.38	C.C.AIR BUSINESS CTR. LO1	557
EXTENDED DETENTION	15.42	0.00	WESTWOOD PARK POND 1	201
RV WQ INFILTRATION TRENCH	0.13	0.13	FOX RIDGE HUNT	489
INFILTRATION TRENCH	0.89	0.54	HAMPSTEAD POLICE STATION	288
SHALLOW MARSH	71.16	0.00	WEST BRANCH TRADE CTR.	289
WET-RETENTION POND	205.65	0.00	WESTMIN. AIR BUS. CENTER	393
EXTENDED DETENTION E-2/3	0.49	0.49	SHILOH RUN	39
EXTENDED DETENTION E-1	1.05	1.05	SHILOH RUN	38
INFILTRATION TRENCH	0.70	0.64	M & T BANK HAMPSTEAD	653
SAND FILTRATION WQ RV	1.48	0.17	WEST BRANCH TRADE LOT 5	555
EXTENDED DETENTION E-6	0.86	0.86	SHILOH RUN	40
WET-RETENTION POND	0.00	0.00	NORTH CARROLL HIGH SCHOOL	85
EXTENDED DETENTION E-7	1.02	1.02	SHILOH RUN	41
PERIMETER SWALE	0.65	0.67	HAMPSTEAD MUNCIPAL PARK	717
STONE CHECK DAM WQ	1.60	0.00	DAYS WAREHOUSE 3	486
INFILTRATION AND UNDERGROUND FILTR.	11.20	7.60	WEST BRANCH TRADE LOT 2	726
DOWNSPOUT DRYWELL	0.20	0.00	GLAMOUR MOVING CO.	746
INFILTRATION TRENCH RV	1.27	1.27	WEST. AIR BUS CTR. LOT 3	560
DOWNSPOUT DRYWELL	0.00	0.00	GLAMOUR MOVING CO.	746
DRY-DETENTION	21.61	12.06	BRANDYWINE STATION	690
INTILTRATION TRENCH	3.28	0.00	AILERON CENTER,LOT 5	741
CHECK DAMS SWALE	1.51	1.51	FOUR SEASONS SPORTS 2ND.	210
INFILTRATION TRENCH	0.92	0.00	GENERAL DYNAMICS	822
INFILTRATION TRENCH	1.45	0.75	NORTH CARROLL HS PARKING	631
INFILTRATION BASIN	3.43	0.00	G. T. BROTHERS CUST. CAB.	602
INFILTRATION TRENCH	0.89	0.00	RICHTER USA INC.	807
EXTENDED DETENTION	0.98	0.98	FOUR SEASONS SPORTS COM.	192
INFILTRATION TRENCH	1.31	0.45	BRIDGE FIELD	705
WQ INFILTRATION IT TRENCH	0.87	0.05	GOLDEN CREST SHELTER HOUSING	840
INFILTRATION DETENTION BASIN	41.62	27.05	NORTH CARROLL FARM SEC 4	157
INFILTRATION TRENCHES	2.60	1.30	GREENMOUNT SELF STORAGE	134
INFILTRATION TRENCH D	5.58	2.86	LIZZIES LOCKERS	581
INFILTRATION TRENCH D	5.58	0.70	LIZZIES LOCKERS	581
DRY-DETENTION POND	14.50	0.00	NORTH CARROLL PLAZA	366
INFILTRATION/DETENTION	47.30	6.11	MANCHESTER FARMS SECT 4	246
INFILTRATION/DETENTION	35.53	0.00	MANCHESTER FARMS SEC. 5	424
INFILTRATION/DETENTION	35.53	0.00	MANCHESTER FARMS SEC. 5	424
RETENTION POND	33.00	4.87	PARK RIDGE ESTATES	219
INFILTRATION TRENCH	0.61	0.00	ARNOLD RD. IMPROVEMENT	914

Urban Best Management Practices: BMPs that are structural, vegetative, or managerial designed to reduce stormwater runoff volume, maximize natural groundwater recharge, and treat, prevent, or reduce degradation of water quality due to stormwater runoff.

Dry Detention Ponds: Stormwater design features that provide a gradual release of water in order to increase the settling of pollutants and protect downstream channels from frequent storm events. This type of facility remains dry between storm events.

Dry Extended Detention Ponds: Stormwater management structures that provide a gradual release of a specific volume of water in order to increase the settling of pollutants in the pond and to protect downstream channels from frequent storm events. They are often designed with small pools at the inlet and outlet of the pond. These BMPs can also be used to provide flood control by including additional detention storage above the extended-detention level.

ESD and Microscale Treatment Practices: A diverse group of on-site techniques that capture, store, and partially treat rooftop runoff in residential areas and highly urban landscapes. These practices include drywells, rain barrels, rain gardens, green rooftops, and permeable pavers.

Filtering Practices: BMPs that capture and temporarily store water quality volume and pass it through a filter of sand, organic matter, and vegetation, which promotes pollutant treatment and groundwater recharge.

Impervious Surface Reduction: A practice that reduces the total area of impervious cover and captures stormwater to divert it to a previous area, subsequently enhancing stormwater infiltration.

Infiltration Practices: Facilities used to capture and temporarily store water quality volume before allowing it to infiltrate into the soil, promoting pollutant treatment and groundwater recharge.

Riparian Forest Buffer: Riparian forest buffers are area of trees usually accompanied by other vegetation that are adjacent to a body of water. Riparian forests maintain the integrity of stream channels; reduce the impact of upland pollution sources by trapping, filtering, and converting sediments, nutrients, and other chemicals; and supply food, cover, and thermal protection to fish and other wildlife. The recommended width of riparian forest buffers is 100 feet with a 35-foot minimum.

Stream Restoration: This BMP is used to restore the stream ecosystem by restoring the natural hydrology and landscape of a stream. Stream restoration is used to help improve habitat and water quality conditions in degraded streams. The objectives of using this practice include, but are not limited to, reducing stream channel erosion, promoting physical channel stability, reducing the transport of pollutants downstream, and working toward a stable habitat with a self-sustaining, diverse aquatic community.

Urban Nutrient Management: A BMP that reduces fertilizer when applied to grass lawns and other urban areas. This practice is based on public education and awareness, targeting suburban residences and businesses, with emphasis on reducing excessive fertilizer use.

Wetponds and Wetland Practices: Facilities that collect and increase the settling of pollutants in the structure and protect downstream channels from frequent storm events. Wetponds retain a permanent pool of water.

Appendix B:

Liberty Watershed Agricultural Best Management Practices/Definitions

Agricultural Best Management Practices as of summer 2014-Liberty Watershed

Best Management Practice	Practice Code	Extent	Unit
Stream Crossing	728	20	Number
Waste Storage Structure	313	18	Number
Access Control	472	21.1	Acres
Conservation Cover	327	755.8	Acres
Contour Farming	330	910	Acres
Conservation Crop Rotation	328	303	Acres
Diversion	362	2,672	Feet
Critical Area Planting	342	4.46	Acres
Livestock Pipeline	516	3,700	Feet
Grade Stabilization Structure	410	3	Number
Fencing	382	121,872	Feet
Residue & Tillage Management	329 & 345	52.3	Acres
Riparian Forest Buffer	391	291.3	Acres
Tree/Shrub Establishment	612	13	Acres
Riparian Herbaceous Cover	390	49.1	Acres
Filter Strip	393	118.4	Acres
Grassed Waterway	412	56.2	Acres
Forage and Biomass Planting	512	3	Acres
Roof Runoff Management	558	36	Number
Heavy Use Area Protection	561	0.58	Acres
Spring Development	574	37	Number
Farm Plans	192 & 193	22,138	Acres
Prescribed Grazing	528	163.2	Acres
Sediment Basin	350	1	Number
Drain Tile	606	3,934	Feet
Sediment Control Pond	378	1	Number
Underground Outlet	620	140	Feet
Upland Habitat Management	645	97.4	Acres
Seasonal High Crop Tunnel System	798	4,218.4	Sq. Feet
Watering Facility	614	79	Number
Wastewater Treatment Strip	635	3.65	Acres

Practices that are used by farmers to minimize soil loss, trap nutrients, and minimize the amount of nutrients and pesticides used on the land. The following definitions are related to best management practices used throughout Carroll County:

Conservation Cover: Establishing and maintaining permanent vegetative cover to protect soil and water resources.

Conservation Cropping: Growing crops in a planned sequence on the same field.
Contour Farming: Tillage, planting, and other farming operations performed on or near the contour of the field slope.

Mulch Till: Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while limiting the soil-disturbing activities used to grow crops in systems where the entire field surface is tilled prior to planting.

No-Till: Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round, while limiting soil disturbing activities to only those necessary to place nutrients, condition residue and plant crops.

Critical Area Planting: Planting vegetation, such as trees, shrubs, vines, grasses, or legumes, on highly erodible or critically eroding areas.

Drain Tile: A conduit, such as corrugated plastic tubing, tile, or pipe, installed beneath the ground surface to collect and/or convey drainage water.

Fencing: A constructed barrier to livestock, wildlife, or people.

Filter Strip: A strip or area of herbaceous vegetation that removes contaminants from overland flow.

Grassed Waterway: A natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation.

Cover Crop: Crops including grasses, legumes, and forbs for seasonal cover and other conservation purposes.

Heavy Use Area: The stabilization of areas frequently and intensively used by people, animals, or vehicles by establishing vegetative cover, surfacing with suitable materials, and/or installing needed structures.

Nutrient Management Plan: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments for each field or management unit.

Pest Management: A site-specific combination of pest prevention, pest avoidance, pest monitoring, and pest suppression strategies.

Riparian Forest Buffer: An area of predominately trees and/or shrubs located adjacent to and up-gradient from water bodies.

Roof Runoff Management: Structures that collect, control, and transport precipitation from roofs.

Spring Development: Collection of water from springs or seeps to provide water for a conservation need.

Stream Crossing: A stabilized area or structure constructed across a stream that provide a travel way for people, livestock, equipment, or vehicles.

Tree Planting: Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration.

Waste Storage Structure: A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.

Wastewater Treatment Strip: An area of vegetation designed to remove sediment, organic matter, and other pollutants from wastewater.