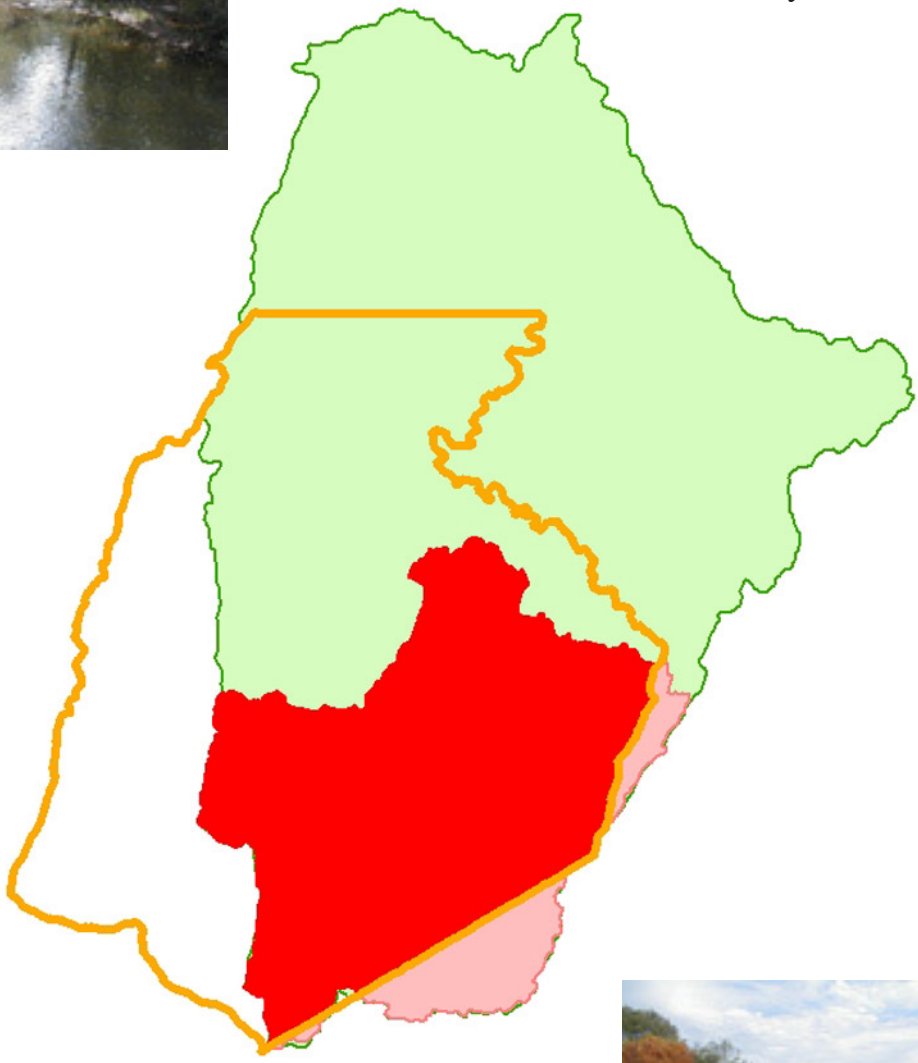
Lower Monocacy River Watershed Characterization

October 2003

In support of Frederick County's Watershed Restoration Action Strategy for the Lower Monocacy River Watershed



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Watershed Services
In partnership with Frederick County

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EXECUTIVE SUMMARY
For the Lower Monocacy River Watershed Characterization

Frederick County, Maryland is receiving Federal grant funding to prepare a Watershed Restoration Action Strategy (WRAS) for the Lower Monocacy River Watershed. The watershed covers about 194,700 acres in three counties. The WRAS project area focuses on the Frederick County portion of the watershed which encompasses nearly 87% of the drainage area -- about 264 square miles which is 40% of Frederick County.

As part of WRAS project, the Maryland Department of Natural Resources (DNR) is providing technical assistance, including preparation of a watershed characterization (compilation of available water quality and natural resources information and identification of issues), a stream corridor assessment (uses field data to catalog issues and rate severity) and a synoptic survey (analyzes benthic macroinvertebrates, fish and water samples with focus on nutrients). The County may use information generated in these efforts as it drafts the County Watershed Restoration Action Strategy.

Water Quality

Designated uses for waterbodies in the Lower Monocacy River watershed include selected natural or recreational trout streams and the remainder are designated for recreation and aquatic life. Water quality impairments that affect these uses include nutrients, sediment, fecal coliform bacteria and biological impairment (poor or very poor ranking for fish or benthic macroinvertebrates). To address some of the impairments, a Total Maximum Daily Load (TMDL) has been approved for Lake Linganore that caps both phosphorus and sediment loads to the lake. A fish consumption advisory for several fish species is in effect due to methyl-mercury mostly from atmospheric deposition.

Long term water quality monitoring of the Monocacy River mainstem for nitrogen, phosphorus and sediment show generally fair conditions upstream and generally poor conditions down stream in the watershed. Trends in this data are mixed.

Locally collected information tends to be consistent with findings by MDE for the TMDL and by DNR based on long term monitoring. The County assessed Ballenger Creek and Lower Bush Creek. Additionally, water quality data has been collected since 1999 by Frederick County's consultant VERSAR, Inc. to meet requirements of the County's NPDES permit.

Point source contribution of nutrients arise from sewage effluent including three facilities that discharge more the one millions per day (MGD) and 14 that discharge less than 1 MGD.

The Landscape

Agriculture is the dominant land use / land cover covering nearly 47% of the Lower Monocacy River watershed. Forest covers over 30% and development covers nearly 22% of the watershed. Wetlands and other land cover types cover about 1%. Development is most concentrated in Carroll Creek, Ballenger Creek and Upper Bush Creek subwatersheds. The Carroll Creek and Ballenger Creek subwatersheds have the greatest impervious area compared to

other subwatersheds – 18.6% and 13.4% respectively. Land use development trends in the project area and throughout Maryland suggest that impervious area will tend to increase and increasing water quality impacts will tend to occur.

The largest Green Infrastructure hub in the watershed is the Sugar Loaf Mountain area. A large percentage of this hub is protected from development by a conservation easement. Several small hubs are not protected. Nearly 22,000 acres of forest are identified as forest interior habitat, however most of these lands are not protected from land use conversion.

Living Resources and Habitat

The self-sustaining native brook trout population in Bear Branch is the only one identified in the Lower Monocacy River watershed. The headwaters area of Ballenger Creek support a self-sustaining population of naturalized brown trout. The small amount of cold water fish habitat may, in part, relate to the absence of naturally vegetated stream buffers on 65% of the streams in the watershed.

In the Lower Monocacy River watershed, the warmwater fishery usually experiences adequate reproduction to support recreational fishing. The Monocacy River supports a popular sport fishery for smallmouth bass, channel catfish, redbreast sunfish and carp. Many Monocacy tributaries also have smallmouth bass and redbreast sunfish.

Maryland tracks nine sensitive species of animals in the watershed that are mostly birds. Eleven species of sensitive plants, mostly Maryland-designated threatened species, are also tracked. These species are found in at least five ecologically significant areas (ESAs).

Restoration Targeting Tools

The 1997 stream corridor assessment of Rock and Carroll Creeks, which is in the City of Frederick vicinity, found seven miles of streams that lack naturally vegetated stream buffers. This assessment was used to help prioritize areas for restoration. Projects in this area have restored nearly 3000 feet of stream correcting erosion problems and reducing fish passage limitations. Stream buffer plantings have been completed in several areas including 18 acres along 1.1 miles of stream in October 2000 and enhancement of marginal stream buffers with additional planting on 6 acres along one half mile of stream.

Information from the Watershed Characterization will be integrated using GIS with analysis from the 2003 Stream Corridor Assessment including prioritization by type and severity, and with nutrient yield estimates and biological assessment developed in the Synoptic Survey. Preliminary GIS scenarios for stream buffer restoration and wetland restoration are included in the Watershed Characterization. DNR will collaborate with Frederick County to support the County's drafting of a Lower Monocacy River Watershed Restoration Action Strategy.

Related WRAS Watershed Activities

The Potomac Conservancy and their work under the Potomac Watershed Partnership is ongoing in the WRAS project area with projects at Villages of Urbana Forest Stewardship Plan,

the Backyard Buffers Program for area homeowners, in addition to the Frederick City Watershed Forest Stewardship Plan and the Frederick City Greenway Project.

The Soil Conservation District continues to work helping agricultural land owners plan and implement best management practices for soil and water conservation with a special emphasis on the Linganore Creek Watersheds.

Carrolton Manor Land Trust continues to do land owner outreach and education to promote permanent land conservation in collaboration with the Potomac Conservancy and is now partnering with Frederick County to conduct a fish survey on Rocky Fountain Run.

Community Commons continues to perform outreach activities in the WRAS watershed including its Building A Greener Lifestyle series of workshops, low impact design seminars, and the Monocacy River Paddle event. Community Commons is also launching an environmental story project to further build awareness of the Monocacy River and its heritage and value.

The University of MD Environmental Finance Center is facilitating the Linganore Source Water Assessment and Protection.

As a part of the Frederick County's NPDES permit activities, a stream restoration project near Ballenger Elementary is planned.

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INTRODUCTION

Background

In 1998, Maryland completed an assessment of all the state's watersheds in order to identify high priorities for restoration action based on impaired waters and high priorities for conservation action based on high or unique natural resource value. The assessment, called the Unified Watershed Assessment, was conducted by the Maryland Department of Natural Resources (DNR) under the direction of the US Environmental Protection Agency's Clean Water Action Plan initiative with assistance from the Maryland Departments of Environment, Agriculture and Planning and the University of Maryland. It moved beyond consideration of water quality in the streams in the state, which had been assessed regularly since the early 1970's, to a larger consideration of living resources in the streams and the landscape conditions which could impact both water quality and living resources.[1,2]

In response to the findings of the Unified Watershed Assessment, DNR offers technical and financial assistance to local governments who are willing to develop and implement Watershed Restoration Action Strategies (WRAS) addressing needs for restoration and conservation in priority watersheds. One of these projects is the Lower Monocacy River Watershed in Frederick County, where the County, DNR and other local cooperators, both public and private, are engaged in developing a watershed management strategy.

Location

The Lower Monocacy River Watershed is in the Potomac River basin and mostly in Frederick County as shown in Map1 Location. Map 2 WRAS Project Area shows that Frederick County's portion of the watershed is the focus of the Watershed Restoration Action Strategy. Because activities in upstream areas in Carroll and Montgomery Counties impact downstream portions of the watershed, this report supporting the Frederick County's WRAS project addresses the entire watershed.

Lower Monocacy River Watershed
County Acreage Summary
MDP 2000 Land Use/Land Cover

County	Acres
Frederick (incl. WRAS)	169,093
Carroll	5,478
Montgomery	20,120
TOTAL (to nearest 100)	194,700

For analytical purposes, both the Frederick County and the State of Maryland divide the watershed into subwatersheds. Frederick County's subwatershed boundaries are shown in Map 3 Frederick County Subwatersheds and described in the table Frederick County Subwatersheds. The Watershed Characterization document will use these subwatershed boundaries whenever possible. The State's subwatershed designations, presented in Map 4 State Subwatersheds and the table State Subwatersheds, may also be employed in the Characterization.

Purpose of the Characterization

One of the earliest steps in devising a Watershed Restoration Action Strategy is to characterize the watershed using immediately available information. This Watershed Characterization is intended to meet several objectives:

– briefly summarize the most important or relevant information and issues
– provide preliminary findings based on this information
– identify sources for more information or analysis
– suggest opportunities for additional characterization and restoration work.
– provide a common base of knowledge about the Lower Monocacy River Watershed for local governments, citizens, businesses and other organizations

Additional Characterization Work

The Watershed Characterization is intended to be one starting point that can be updated as needed. It is part of a framework for a more thorough assessment involving an array of additional inputs:

– self-investigation by Frederick County
– targeted technical assistance and assessment by partner agencies or contractors
– input from local citizens
– completion of a Stream Corridor Assessment, in which DNR personnel physically walk the streams and catalogue important issues.
– completion of a synoptic water quality survey, i.e. a program of water sample analysis, that can be used to focus on local issues like nutrient hot spots, point source discharges or other selected issues. This is also part of the technical assistance offered by DNR. Findings of the 2003 synoptic survey of the streams in the Lower Monocacy River Watershed are reported in Appendix D.

Identifying Gaps in Information

It is important to identify gaps in available watershed knowledge and gauge the importance of these gaps. In assessing data gaps, it is helpful to review information categories:

– Habitat: physical structure, stream stability, biotic community (incl. the riparian zone)
– Water Quantity: high water–storm flow and flooding; low water–baseflow problems from dams, water withdrawals, reduced infiltration
– Water Quality: water chemistry; toxics, nutrients, sediment, nuisance odors/scums, etc.
– Cumulative effects associated with habitat, water quantity and water quality.

Because restoration is an active evolving process, the Watershed Characterization and the resulting Watershed Restoration Action Strategy should be maintained as living documents within an active evolving restoration process. These documents will need to be updated periodically as new, more relevant information becomes available and as the watershed response is monitored and reassessed.

State Subwatersheds In The Lower Monocacy Watershed / WRAS Project Area				
Name	Number	Subwatershed Area in Acres		
	02140302-XXXX	Frederick Co., WRAS Area	Outside Frederick Co.	Total
Ballenger Creek	0230	12,781	0	12,781
Bens Branch	0234	10,107	0	10,107
Bennett Cr. Lower	0224	11,087	0	11,087
Bennett Cr. Upper	0225	4,275	6,266	10,541
Bush Creek	0229	12,387	0	12,387
Bush Cr. Upper	0228	8,690	0	8,690
Carroll/Rock Creeks	0233	18,139	0	18,139
Fahrney Creek	0226	4,776	806	5,582
Israel Creek Lower	0237	12,248	0	12,248
Israel Creek Upper	0239	8,957	0	8,957
Lake Linganore	0232	7,856	0	7,856
Linganore Creek	0236	13,487	0	13,487
Linganore Cr. North	0238	10,466	2,585	13,051
Linganore Cr. South	0235	9,657	2,827	12,484
Little Bennett Cr.	0223	2,669	12,306	14,975
Mainstem #1	0222	7,350	741	8,091
Mainstem #2	0227	10,947	0	10,947
Mainstem #3	0231	3,276	0	3,276
Lower Monocacy Watershed		169,155	25,531	194,686

WATER QUALITY

Water quality is in many respects the driving condition in the health of Maryland's streams. Historically, efforts to protect water quality have focused on chemical water quality. More recently, additional factors are being considered like measurements of selected biological conditions and physical conditions that affect habitat quality in streams and estuaries . This developmental path is reflected in the ways in which streams have been monitored, the types of data gathered, and the regulatory approach taken.

Frederick County Subwatersheds In The Lower Monocacy Watershed / WRAS Project Area	
Name	Subwatershed Area in Acres
Ballenger Creek	14,547
Bennett Creek	30,569
Bush Creek, Lower	12,831
Bush Creek, Upper	8,321
Carroll Creek	14,443
Israel Creek	24,354
Linganore Creek, Lower	24,250
Linganore Creek, Upper	28,928
Monocacy Direct Southwest	9,445
02140302 Lower Monocacy Watershed	167,688 In Frederick County

Water Quality Standards and Designated Uses

All streams and other water bodies in Maryland are assigned a "designated use" in the Code of Maryland Regulation (COMAR) 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. The following table summarizes the regulations that apply to the Lower Monocacy River watershed. Map 5 Designated Uses depicts the distribution the designations. (COMAR or MDE should be consulted for official regulatory information.) [3,5]

Designated Uses for Surface Waters: Lower Monocacy River Watershed		
Designation	**Stream Segment Designated**	**Within the following Frederick Co. Subwatersheds**
Use I-P: Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply	Potomac River and all tributaries except those designated below as Use III-P or Use IV-P from Frederick/Montgomery County line to confluence with Shenandoah River	Bennett Creek, Bush Creek Lower and Upper, Lower Linganor Creek, Monocacy Direct SW, Monocacy Direct with the Ballenger Creek subwatershed
Use III-P: Natural Trout Waters and Public Water Supply	Ballenger Creek and all tributaries	Ballenger Creek
	Bear Branch and all tributaries from its confluence with Bennett Creek	Bennett Creek
	Carroll Creek and all tributaries above U.S. Route 15	Carroll Creek
	Rocky Fountain Run and all tributaries	Monocacy Direct Southwest
	Little Bennett Creek and all tributaries above MD Rt. 355	Bennett Creek
	Furnace Branch and all tributaries	Bennett Creek
Use IV-P: Recreational Trout Waters and Public Water Supply	Monocacy River and tributaries except those designated above as Use III-P above U.S. Rt. 40	Carroll Creek, Lower Linganor Creek, Upper Linganor Creek
	Israel Creek and all tributaries	Israel Creek

Use Impairments [4]

Some streams or other water bodies in the WRAS project area can not be used to the full extent envisioned by their designated use in Maryland regulation due to water quality or habitat impairments. These areas, known as "impaired waters", are tracked by the Maryland Department of the Environment under Section 303(d) requirements of the Federal Clean Water Act as summarized in the table below.

Draft 2002 303(d) List of Impaired Waters
Lower Monocacy Watershed Summary[4,5]

Name Stream or Watershed	Impairment	Sources	Priority
Lower Monocacy River	fecal coliform bacteria	unknown	medium
	nutrients (nitrogen and phosphorus)	nonpoint sources and natural sources	low
	sediment		
Numerous Stream Sites: Addison Run Ballenger Cr. (2 sites) and two unnamed tributaries Bennett Cr. (2 sites) Bush Creek (2 sites) Cabbage Run (2 sites) Carroll Cr. unnamed tributary Church Creek trib. to Bush Cr. Israel Creek unnamed tributary Linganore Cr. South Fork Talbot Branch (several sites) Unnamed trib. to Monocacy R. Weldon Cr. unnamed tributary Woodville Branch	biological (poor or very poor fish or benthic organism populations/conditions)	unknown	low

These listings affecting portions of the WRAS project area are addressed below. Each water body listed may require preparation of a Total Maximum Daily Load (TMDL) to address the water quality and/or habitat impairment. A TMDL for phosphorus and sediment has already been approved for Lake Linganore. [4]

1. Nutrients

The Monocacy River was listed for impairment associated with nutrients in both the 1996 and the draft 2000 303(d) lists. The source of these nutrients is both natural and nonpoint source.

Nutrients, phosphorus and nitrogen, are essential to support aquatic life but excess nutrients can cause problems. In Maryland, most water bodies naturally have low levels of the nutrients nitrogen and phosphorus. In nontidal waters like the Monocacy River, high levels of nitrogen and phosphorus seldom cause water quality problems in areas where the water flows rapidly. However, in areas where water flow rates slow and nutrient concentrations are high, water quality problems can arise when nutrients are readily available to support growth of algae. In these areas of slow moving water or impoundments, under certain conditions with warm weather, sufficient light, etc., algae populations can grow to excessive levels. The algae can then crowd out other small organisms, cloud the water limiting light penetration, and eventually die-off. The decomposition of the dead algae consumes dissolved oxygen that other aquatic life needs to survive.

Nutrient pollution problems may arise from numerous sources including all types of land and from the atmosphere. Residential land can be an important contributor of nutrients depending on fertilizer use, extent of lawn and the status of septic systems. Farmers apply nutrients using different approaches, so nutrients entering waterways from crop land vary greatly depending on management techniques. Typically, streams and other surface waters receive relatively small amounts of nutrients from forest land and relatively large amounts from land uses that involve soil disturbance and application of fertilizer. Most of the nutrients in the Monocacy River are generated within the Monocacy watershed. However, the atmosphere can contribute various forms of nitrogen produced by burning fossil fuels in power plants and other industries, and from automobiles.

2. Fecal Coliform Bacteria

Water quality monitoring during the late 1990s identified high levels of bacteria in the Monocacy River including fecal coliform bacteria. The source of this impairment is not known.

Fecal coliform bacteria are a class of bacteria typically found in the digestive tract of warm-blooded animals, including humans. They are always found in animal waste and human sewage unless it is treated to kill them. In unpolluted streams and tidal waters, it is common for water samples to contain very few of these bacteria. Water samples exhibiting significantly larger fecal coliform bacteria populations are “indicators” of contamination by animal and/or human waste. Depending on local conditions, sources of fecal contamination may include any combination of the following: inadequately treated sewage, failing septic systems, wild or domestic animals, urban stormwater carrying pet waste and similar sources.

3. Sediment

The Monocacy River was listed for impairment associated with suspended sediment in the 1996 303(d) list. The source of this suspended sediment is both natural and nonpoint source.

Suspended sediment can cause water quality and habitat problems in several ways. Most unpolluted streams and tidal waters naturally have limited amounts of sediment moving “suspended” in the water. Excessive amounts of suspended sediment in waterways are

considered pollution because they can inhibit light penetration, prevent plant growth, smother fish eggs, clog fish gills, etc. Sediment in streams tends to arise from stream bed and bank erosion and from land that is poorly vegetated or disturbed. Suspended sediment pollution may arise from construction sites, crop land, bare ground and exposed soil generally. The amount of sediment contributed varies greatly site to site depending upon stream stability, hydrology, management controls and other factors.

4. Biological Impairment

In selected stream segments statewide, populations of benthic macroinvertebrates and fish and their associated physical habitat have been assessed by the Maryland Biological Stream Program. Based on criteria developed for each physiographic/ecological zone in Maryland, each stream segment is rated as either good, fair, poor or very poor. Ratings of poor and very poor were listed as biological impairment for the first time in Maryland in the draft 2002 303(d) list of impaired waters. In the WRAS project area, 21 stream sites appear in the list because of biological impairment. See the section on Maryland Biological Stream Survey Findings for additional details.

Total Maximum Daily Loads

The Maryland Department of the Environment (MDE) uses the 303(d) list to determine the need for establishing Total Maximum Daily Loads (TMDLs). A TMDL is the amount of pollutant that a waterbody can assimilate and still meet its designated use. A waterbody may have multiple impairments and multiple TMDLs to address them. MDE is responsible for establishing TMDLs in Maryland. In general, TMDLs include several key parts:

1- Maximum pollutant load that the water can accept while still allowing the water body to meet its intended use.
2- Allocation of the maximum pollutant load to specific pollutant sources.

Most impairments identified in the 303(d) list for the Lower Monocacy River watershed do not currently have a TMDL completed or in draft. The exception is the *Total Maximum Daily Loads of Phosphorus and Sediment for Lake Linganore, Frederick County, MD* dated December 2002 and approved by US EPA May 13, 2003.

Lake Linganore is impacted by a high sediment load. During warm months, the lake also experiences frequent nuisance algal blooms, due to over-enrichment by nutrients. These algae blooms interfere with the water supply and recreational uses of the lake. Additionally, the death and decay of excessive algae can cause violations of the water quality standard for dissolved oxygen (DO), possibly resulting in a fish kills and other disruptions of the lake's ecosystem balance. Analysis of conditions in Lake Linganore by MDE indicates that phosphorus is the limiting nutrient for the production of algae. Due to the propensity of phosphorus to bind to sediments, the overall approach employed in the TMDL is to simultaneously address the water quality problems associated with phosphorus and sediments. [5]

The approved TMDL lists the following limitations:

PHOSPHORUS TMDL for Lake Linganore: 2,403,832 g/yr = 5,288 lbs/yr
This presents a 90% reduction from current loads.

SEDIMENT TMDL for Lake Linganore: 7,073 tons/yr
This presents a 45% reduction from current loads (based on the phosphorus reduction above).

Water Quality Indicators–Setting Priority for Restoration and Protection

This comparison using indicators was first created to support the Clean Water Action Plan's 1998 *Unified Watershed Assessment* which established priorities for watersheds in the State for restoration and protection. In the Plan, there were two categories for priority action: highest priority for restoration, and priority for protecting valued resources.

As the basis for the prioritization, indicators of water quality, landscape and living resources were developed for all watersheds in Maryland. Other approaches to assessing water quality have been in use for several years and are further described below. In general they do not look comparatively at watersheds as the Unified Assessment did in an effort to set priorities. The Unified Assessment also considered a range of living resource and landscape indicators described a little later.

Water Quality Indicator Summary
Lower Monocacy River Watershed
From: 1998 *Unified Watershed Assessment*

Indicator Name	Finding
Nontidal Index: TP	4.5 ranking
Nontidal Index: TN	5.0 ranking
Modeled Load: TP	1.31 lbs/acre
Modeled Load: TN	10.31 lbs/acre

Comparison with similar Maryland watersheds
Green shading: goal or benchmark was met.
Orange shading: goal or benchmark not met.

The Unified Assessment looked at five water quality indicators to compare the State's 138 "8-digit" watersheds though not all watersheds had information to allow generation of each indicator.

1. Nontidal Indexes for Phosphorus and Nitrogen

In comparison to the other watersheds that drain to the Chesapeake Bay in Maryland, the Lower Monocacy River watershed ranked "4.5" for total phosphorus (TP) and 5.0 for total nitrogen (TN). Both of these ranks exceed Maryland's benchmarks for these nutrients.

To create a benchmark for the nontidal index for TP and for TN, the 8-digit watersheds draining to the Chesapeake Bay in Maryland with core station data were assessed for in-stream TP and TN concentrations using consistent statewide methods for status/trends. The results were ranked highest to lowest on a 1 to 10 scale with 1 representing the highest TP (or TN) concentration and 10 representing the lowest. Then, these numerical ranks were divided into

four groups each containing 25% of the watersheds (quartiles). The watersheds with the highest TP (or TN) concentrations, i.e. the watersheds ranked in the lowest quartile (25%) of the watersheds, "exceeded" the benchmark.

2. Modeled Loads for Phosphorus and Nitrogen

In comparison to the other watersheds that drain to the Chesapeake Bay in Maryland, it is estimated that the Lower Monocacy River watershed receives 1.31 pounds of total phosphorus (TP) per acre in the watershed and 10.31 lbs/acre total nitrogen (TN). Both of these nutrient yields exceed Maryland's benchmarks for these nutrients used in the *Unified Watershed Assessment*.

Computer models are used to estimate how much TP and TN reaches the streams and how much of each is available for transport to the Bay. To generate the yield estimates reported in the Unified Assessment, the following information was used for the models: 1) monitoring data of point source nutrient discharges; 2) estimated nonpoint sources loads, based on 1996 land use and estimates of selected land management practices, and 3) consideration of other factors like deposition from the air.

2002 modeling conducted by DNR using 2000 data shows that the average yields for the Lower Monocacy River watershed are 6.71 pounds per acre annually of total phosphorus and 0.549 pounds per acre annually of total nitrogen. These load estimates may differ from the estimates used in the *Unified Watershed Assessment* for several reasons: changes in point source discharges and land use, and differing consideration of best management practices and septic system loads.

An additional gauge of nutrient loads will be available in the results of the synoptic survey conducted in 2003.

Water Quality Monitoring

1. State Long Term Monitoring

The State of Maryland maintains five water quality monitoring stations in the Monocacy River watershed. As shown on Map 6 Water Quality Monitoring, two stations, MON0020 and MON0155, are on the Monocacy River's mainstem in the WRAS project area. Both of these stations are downstream of the Frederick and Ballenger Creek wastewater treatment plants (WWTPs). Station MON0269 is located upstream of the WRAS watershed on the river mainstem so it may be useful in measuring input from upstream. The remaining two stations are located upstream MON0269 which makes them less useful for this WRAS project.

2. Lake Linganore Monitoring 2002

To support drafting of TMDLs for Lake Linganore, MDE conducted monitoring at several sites in the Lake between February 19 and April 30, 2002. See Map 6 Water Quality Monitoring for locations and the section on Water Quality Analysis for a results summary.

3. County Long Term Monitoring

Frederick County established a long term monitoring program in the late 1990s to meet

NPDES monitoring requirements. Priority subwatersheds were selected for monitoring and will be evaluated in rotating order every two years or more. It is anticipated that assessments of other subwatersheds not listed below may also be initiated periodically:

– Lower Bush Creek monitoring was initiated in 1999. Annual monitoring of the Bush Creek tributary Peter Pan Run, was also begun. Map 6 Water Quality Monitoring shows locations of Bush Creek subwatershed monitoring sites.
– Ballenger Creek was assessed in 2000.
– Lower Linganore Creek sampling was initiated in 2001

4. Maryland Biological Stream Survey Monitoring

The Maryland Biological Stream Survey (MBSS) sampled streams in the Lower Monocacy River watershed in 1996 and 2000 that were selected randomly on a state-wide basis. (See maps and findings in the Living Resources section.) Similar to these earlier efforts, monitoring 2003 is also underway. In addition to biological information collected at each site, some water quality information is collected. Collection occurs one-time at each site some time during the spring-summer months.

Water Quality Analysis

1. Status and Trends at Long Term Monitoring Stations

The Lower Monocacy River water quality was characterized by DNR using several parameters at three monitoring sites shown on Map 6 Water Quality Monitoring. The status for each parameter in the table below is a relative ranking at three levels: good, fair and poor. For example in the tables below, good means that assessment of the Monocacy River for particular site and parameter ranks as good compared to similar fresh water Chesapeake Bay tributaries. (See www.dnr.maryland.gov/bay/tribstrat/index.html).

Monocacy River at Route 28 – Station MON0020		
Parameter	**Status 1998 -2001 data**	**Trend 1985 through 2001**
Nitrogen: total	Poor	Improving (20%)
Phosphorus: total	Poor	No Trend
Suspended Solids: total	Poor	No Trend

Station MON0020 is located on the Monocacy River at the Route 28 crossing and it is the furthest downstream of the Monocacy long term stations. DNR has sampled benthic macroinvertebrates here 25 times since 1976 using a surber sampler. Based on interpretation of these organisms, overall water quality shows a moderate improvement shifting from the middle fair range to the upper fair range over the 25 years sampled. This interpretation is drawn from three measurements of the bethic community that showed significant correlation:[8]

– The trend in average taxa number shows slight improvement over the 25 years (within the fair range). This number is the total number of genera found at the site at each sampling. It reflects the health of the community by a direct measure of the types of organism and the number will increase with better water quality and better suitability for the organisms.
– The trend in the average biotic index score is improvement (shifting from the middle fair range to the upper fair range). This index is used to detect organic pollution and its influence on the macroinvertebrate community. Improvement in the index means that more pollution sensitive (or intolerant) organisms are present and less pollution tolerant ones.
– The diversity index trend is also toward improvement (shifting from the lower good range to the middle good range). This index is based on the general observation that relatively undisturbed habitats support communities having large number of taxa with no individual taxa dominating. The diversity index is a measure of the benthic community that indicates improvement in water quality as it increases.

Monocacy River at Reels Mill – Station MON0155		
Parameter	**Status 1998 -2001 data**	**Trend 1985 through 2001**
Nitrogen: total	Poor	No Trend
Phosphorus: total	Poor	Degrading
Suspended Solids: total	Fair	No Trend

Station MON0155 is also located upstream at Reich's Ford Road in the Monocacy River below the Frederick WWTP discharge. Between 1978 and 2002 this site was sampled 23 times using a surber sampler. Overall the water quality at this site has shown a strong improvement shifting from the upper fair range to the good range based on significant trends identified in three measurements of the benthic community:[8]

– The trend in taxa number shows improvement, increasing slightly over the 23 years of data.
– The diversity index went from the fair/good range to the middle good range.
– The proportion of clean water (relatively intolerant) organisms in each sample (percent EPT) showed improvement from the fair to the good range since 1976. The average percent EPT doubled from the first half of the 23-year sampling period to second half of the sampling period. This measurement considers the percent of the total organisms belonging to Ephemeroptera, Plecoptera and Trichoptera (considered clean water) orders divided by the total number of organisms in the sample.

Monocacy River at Bigg's Ford – Station MON0269 (Station is located upstream of WRAS project area.)		
Parameter	**Status 1998 -2001 data**	**Trend 1985 through 2001**
Nitrogen: total	Fair	Improving (40%)
Phosphorus: total	Fair	Improving (32%)
Suspended Solids: total	Fair	No Trend

Station MON0269 is just upstream of the WRAS project area. At this station, the benthic community and water quality information analysis suggest that water quality did not change significantly from 1978 to 1992. It remained in the fair to good condition range through 1992.[8]

2. Phosphorus

The Monocacy mainstem has a relatively high concentration of the total phosphorus compared to other streams where data was collected monthly from 1986 to 2001. This finding is consistent with findings from central Maryland streams.

In the Bush Creek tributary Peter Pan Run, average phosphorus concentration during base flow for each year 1999 through 2002 varied from very small amounts to near 0.1 mg/l. However, storm flow phosphorus concentrations were consistently above 0.1 mg/l and reached around 0.8 mg/l in 2000/2001. This finding is consistent with the general understanding that phosphorus tends to move in association with soil particles during high flows (storms).[13]

3. Nitrogen

The Monocacy mainstem has a relatively high concentration of the total nitrogen compared to other streams where data was collected monthly from 1986 to 2001. In the Bush Creek tributary Peter Pan Run, average nitrate concentration during base flow for each year 1999 through 2002 was consistently greater than 2.5 mg/l. In 2001, the year with the highest average concentration, nitrate approached 4 mg/l. (Note: Nitrate is one component of total nitrogen. Others constituents include nitrite and ammonia.)[13]

These findings of high nitrogen concentrations are consistent with findings from other streams where agriculture or urban land use dominates the watershed.

4. Lake Linganore

Lake Linganore is an impoundment on Linganore Creek which is a Monocacy River tributary. The lake receives tributary stream flows from a large watershed of nearly 52,000 acres which encompasses almost 27% of the entire Lower Monocacy River watershed. Hydraulic residency time in the lake is estimated to be slightly less the 15 days.[5]

The water quality conditions in the lake measured from February through April 2002 support several findings (Also see Appendix A in the TMDL document):

– Algae conditions in Lake Linganore, as measured by chlorophyll *a* concentration, ranged from

0.84 to 101.6 Fg/l. A chlorophyll a concentration of 10 Fg/l is typically considered the threshold above which lakes are considered eutrophic.

– Dissolved oxygen (DO) concentrations measured in the lake during the sampling period commonly met the State water quality standard of 5 mg/l. However, April 30, 2002 DO concentrations deeper than four meters consistently failed to meet the standard. This suggests that the lake has DO problems in bottom waters during warm months.

– Total phosphorus concentrations ranged from 0.025 mg/l to 0.14 mg/l and total nitrogen ranged from 1.7 to 3.4 mg/l in the lake.

Sources of Pollution

Since European settlement of North America there has been an explosive growth in human population, supported by more intensive agriculture and the growth of industry. The entire continent has been cris-crossed and made mutually interdependent by vast transportation systems. All of this contributes to the decline in quality of our water and other natural resources.

1. Point Sources

Discharges from pipes or other "discrete conveyances" are called "point sources." Point sources may contribute pollution to surface water or to groundwater. For example, wastewater treatment discharges may contribute nutrients or microbes that consume oxygen (measured as Biochemical Oxygen Demand (BOD)) reducing oxygen available for other aquatic life. Industrial point sources may contribute various forms of pollution. Some understanding of point source discharges in a watershed can be useful in helping to identify and prioritize potential restoration measures.

In February 2003, the Maryland Department of the Environment (MDE) had about 80 permits in the Lower Monocacy River Watershed based on information from the MDE permit data base. Map 7 MDE Permits shows the distribution of permits across the watershed.

– Sewage effluent is discharged to surface waters in the Lower Monocacy River watershed from 17 facilities. As listed in the MDE Permits Table, three dischargers are larger than one million gallons per day (MGD) and 14 discharge smaller than 1 MGD. These discharges have the potential to affect the nutrient impairment identified in the watershed.

– Stormwater management accounts for about 30 permits in the Lower Monocacy River watershed. Most of these facilities are in Frederick County, three are Montgomery County and one is in Carroll County. These discharges have the potential to be associated with sediment and biological impairments.

– Other surface water discharge permits are typically for cooling water, wash water, swimming pools, quarries, petroleum distribution facilities and small commercial/residential permitees. All are in Frederick County except for one in Montgomery County.

– Groundwater discharges from three permitees include two in Frederick County and one in Montgomery County.

Characteristics of the these permitted discharges (volume, temperature, pollutants, etc.) are tracked by MDE through the permit system. Most of this information is accessible to the public and can be obtained from MDE. (Note: MGD refers to million gallons per day.)

MDE Permits for Sewage Effluent Discharges to Surface Water Lower Monocacy River Watershed (2/2003 data)			
	Name	**MDE Permit / NPDES Permit**	**Location**
Over 1MGD	Ballenger Creek	00DP0809 / MD0021822	Frederick
	Fort Detrick Area C	97DP2527 / MD0020877	Frederick
	Frederick City	01DP0801 / MD0021610	Frederick
Less Than 1MGD	Concord Trailer Park	94DP0784 / MD0023060	Jefferson
	Cracked Claw	97DP1024 / MD0024244	Ijamsville
	Dan-Dee Motel & Country Inn	97DP0607 / MD0023710	Frederick
	Hyattstown	96DP3200 / MD0067768	Hyattstown
	Kemptown School	00DP1574 / MD0056481	Monrovia
	Libertytown	95DP2108 / MD0060577	Libertytown
	Mill Bottom	96DP2841 / MD0065439	Mt. Airy
	Monovia	94DP1990A / MD0059609A	Monrovia
	New Life Church & School	94DP1633 / MD0057100	Frederick
	New Market	96DP0478 / MD0020729	Frederick
	Pleasant Branch	97DP2814 / MD0065269	Pleasant Grove
	Springview Mobile Home Park	98DP1036 / MD0022870	Frederick
	Urbana High School	98DP3073 / MD0066940	Urbana
	Woodsboro	99DP1855 / MD0058661	Woodsboro

2. Diffuse or Nonpoint Sources

Sources of pollution that include areas of land and other sources that do not have a specific point of origin are called nonpoint sources. Nonpoint sources are commonly significant contributors of pollutants, particularly nutrients and sediment. These diffuse sources include rain water that runs off roofs, streets and parking lots (sometimes via storm drains) into nearby surface waters, as well as run-off from farm fields and, to a much lesser extent, forests. Also included in nonpoint source pollution is deposition from the atmosphere and contributions from ground water, where septic systems are a factor.

A. Nutrients

Throughout most of the Lower Monocacy River watershed, point sources of nutrients are small or do not exist so that nonpoint sources are the largest source of nutrients. In areas like Lake Linganore where nutrients are causing water quality problems, nonpoint sources have been identified as the primary cause. The TMDL for the Lake has established limits phosphorus based on these findings:

Average Annual Total Phosphorus Allocations	
Nonpoint Source	4,150 pounds per year
Point Source	609 pounds per year

B. Sediment

Nonpoint source sediment loads have not been estimated for the Lower Monocacy River Watershed. However, several current sources of information identify sediment as a problem:

– Long term monitoring on the Moncacy River mainstem shows fair/poor water quality based on total suspended solids.
– Lake Linganore has experienced excessive sediment loads resulting in a significantly shortened projected life span for the lake. Figures presented in the Lake Linganore TMDL estimated that nonpoint sources account for more than 99% of the sediment reaching the lake.

The TMDL for the Lake has established limits phosphorus based on these findings:

Average Annual Sediment Allocations	
Nonpoint Source	6,346 tons per year
Point Source	707 tons per year

Water Supply

The Lower Monocacy River Watershed encompasses numerous public water supplies using both groundwater and surface water sources. The Map 8 Community Water Systems shows the general distribution of these system and the tables below lists permits for these facilities. Several water supply concerns have been identified in the WRAS project area. Water quality problems affecting Lake Linganore as a water supply have been assessed as part of the TMDL for the lake. Following the 2002 drought, the County and others are working on water supply quantity concerns in both surface water and groundwater sources.

Community Water Systems in the Lower Monocacy River WRAS Project Area [11]		
Source	**Facility Name**	**Permit Number**
Groundwater	Bradford Estates	FR1988G002
	Concord Estates M.H.P.	FR1970G010
	Gilberts M.H.P.	FR1997G038
	Lake Linganore	FR1969G023, FR1981G006, FR1984G005
	Libertytown Apartments	FR1985G001
	Libertytown East	FR1989G024
	Mill Bottom (Samhill)	FR1990G013
	Mount Airy, Town of	FR1976G007, FR1995G020
	New Design	FR1977G108
	Polings M.h.p.	FR1970G005
	Spring View M.h.p.	FR1963G013
	Waterside	FR1983G013
	Woodsboro	FR1979G010
	Woodspring	FR1985G021
Surface	Fort Detrick	FR1943S001
	Frederick, City of	FR1940S001, FR1961S001
	Lake Linganore	FR1985S002

LANDSCAPE

Water quality, particularly in streams and rivers, is affected by the land in the riparian zone and by soils, vegetative cover and the land use throughout the watershed. In an effort to gauge the affects of land use on water quality, and to allow comparison between watersheds, DNR has developed a series of Landscape Indicators. These indicators can be used to portray landscape conditions on a watershed scale that tend to support good water quality or that tend to degrade water quality.

Landscape Indicators

The 1998 *Maryland Clean Water Action Plan* included a unified watershed assessment that used a number of landscape indicators to assess the State's 138 watersheds.[2] Most indicators are relative measures by which Maryland's watersheds can be compared. The following sections identify the findings for the Lower Monocacy River Watershed from the 1998 Plan, with the exception of the population density, which is based on more recent Year 2000 Census data.

Landscape Indicator Summary
Lower Monocacy River Watershed
From: 1998 *Unified Watershed Assessment*

Indicator Name	Finding
Year 2000 Population Density	0.69 people/acre
Historic Wetland Loss	11,799 acres
Unbuffered Streams	65 %
Soil Erodibility	0.27 value/acre

Comparison with similar Maryland watersheds
Green shading: goal or benchmark was met.
Orange shading: goal or benchmark not met.

1. Population Density

Based on the Year 2000 Census, the population density in the Lower Monocacy River Watershed was 0.69 people per acre of land. This differs from the 0.71 people/acre shown in the *Unified Watershed Assessment* which used 2000 population projections. A comparison with other watersheds in the state has not been completed using the 2000 census data.[2]

While population density may be beyond the scope of a WRAS, directing growth is a potential WRAS component. As human population increases, the effects of human activity that degrades, displaces, or eliminates natural habitat also tend to increase. Watersheds with higher populations, assuming other factors are equal, tend to exhibit greater impacts on waterways and habitat. However, growth can be directed in ways to reduce negative impacts.

2. Historic Wetland Loss

The Lower Monocacy River Watershed is estimated to have lost nearly 11,799 acres of wetlands over the years. This is a relatively large loss of wetlands compared with other similar Maryland watersheds.[2]

This interpretation is based on the assumption that the hydric soils in the watershed were all, at one time, wetlands. Thoughtful selective restoration of historic wetland areas can be an effective WRAS component. In most of Maryland's watersheds, extensive wetland areas have been converted to other uses by draining and filling. This conversion unavoidably reduces or eliminates the natural functions that wetlands provide.

3. Unbuffered Streams

Approximately 65% of streams in the Lower Monocacy River Watershed were not buffered with trees, based on 1998 information. This finding indicates that other comparable Maryland watersheds tend to have more streams with buffers. Corridors 100 feet wide (50 feet either side) along streams were combined with forest cover to develop this indicator. This estimate of streams lacking forested buffer was generated for the 1998 Maryland Clean Water Action Plan by using Maryland Department of State Planning GIS data for streams and for 1994 land use..[2]

In most of Maryland, trees are key to healthy natural streams. They provide numerous essential habitat functions: shade to keep water temperatures down in warm months, leaf litter "food" for aquatic organisms, roots to stabilize stream banks, vegetative cover for wildlife, etc. In general, reduction or loss of riparian trees / stream buffers degrades stream habitat while replacement of trees / natural buffers enhances stream habitat. (For this indicator only "blue line streams" were included. Intermittent streams were not considered.)

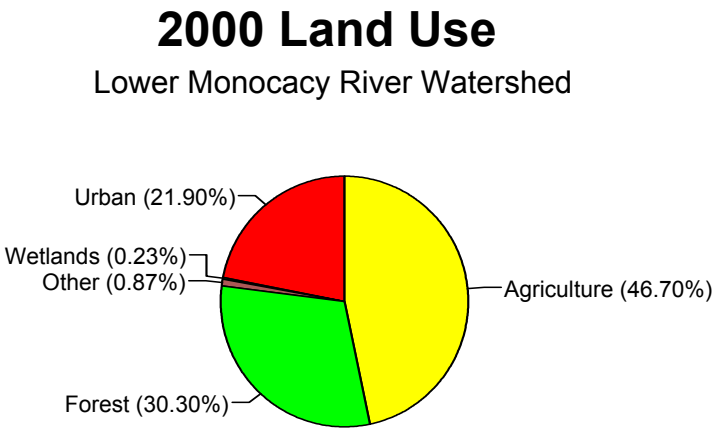
4. Soil Erodibility

Soil erodibility for the Lower Monocacy River Watershed is represented by what is known as the K factor, in this case estimated to be 0.27 based on the Soil Survey that predates the new SSURGO soils data.[2] The K factor normally varies from approximately zero to about 0.6. A K value of 0.17 has a very low erosion potential, a value of 0.32 has a moderate erosion potential, a value of 0.37 has a high erosion potential, and a value of 0.43 has a very high erosion potential. The Lower Monocacy River watershed's overall erodiblility is moderate, although its ranking among all watersheds in the state was fairly high.

Watersheds with more highly erodible soils are naturally more susceptible to surface erosion, sedimentation, streambank erosion and other problems related to soil movement. These negative effects of soil erodibility on water quality can be minimized through careful management. The soil erodibility indicator accounts for natural soil conditions but not for management of the land. (Existing cropland management was not considered.) The naturally erodible soils in the watershed are addressed by techniques called Best Management Practices (BMPs) to prevent soil loss, practices that are typically in use on local farms. BMPs like no-till or reduced till cropping, planting cover crops, field strips, or retiring erodible soils from production can significantly reduce erosion and sediment movement. These BMPs can be seen in use in many places in the watershed.

Because soils can vary significantly within very small areas, a generalized erodibility indicator must be used with caution and supplemented with site-specific evaluation prior to implementing any management action.

Land Use



The following table and pie chart summarize 2000 land use / land cover for the Lower Monocacy River Watershed as categorized by the Maryland Department of Planning. Map 9 Land Use / Land Cover shows the distribution of these land use categories in the watershed.

Agriculture is the dominant land use/cover for the entire watershed and in each county.

For forest and developed land use / land cover, the entire watershed and Frederick County exhibit similar percentages of cover – about one-third forest and one-fifth developed land types. However, the Carroll County portion of the watershed has significantly greater developed area while the Montgomery County portion has significantly greater forest area as a percentage of their total area in the watershed.

Viewing these generalized land use categories as potential nonpoint sources of nutrients, agricultural lands are likely to contribute the greatest loads to local waterways. Developed lands may also contribute significant nutrient loads.

2000 Land Use Summary, Lower Monocacy River Watershed By County							
Category	**Description**	**Frederick**		**Carroll**		**Montgomery**	
		Acres	%	Acres	%	Acres	%
Agriculture	Field, pasture, farm buildings	79,526	47	2,089	38	9,308	46
Forest	Woodlands and brush	48,761	29	1,431	26	8,790	44
Developed	Areas with significant improvements	38,697	23	1,943	36	2,005	10
Wetlands	Including open water	419	0	15	0	17	0
Other	Surface mines, bare ground, gravel pits, etc.	1,690	1	0	0	0	0
Total Area By County		**169,093**		**5,478**		**20,120**	

Considering land use / land cover within the subwatersheds used by Frederick County, significant variation is exhibited. Several subwatersheds are dominated by agriculture: Monocacy Direct Southwest, Linganore Creek Upper and Israel Creek. Carroll Creek is mostly developed by portions of the City of Frederick. The greatest percentage of forest cover is in the Bennett Creek subwatershed.

Land Use / Land Cover In Frederick County Subwatersheds
Lower Monocacy Watershed / WRAS Project Area
Acres / Percent, MDP 2000 Data

Subwatershed	Ag	Forest	Developed	Wetland, Water	Other	Total
Ballenger Creek	5,896 41%	2,232 15%	5,837 40%	4 --	578 4%	14,547
Bennett Creek	11,907 39%	13,999 46%	4,619 15%	44 --	0 --	30,569
Bush Creek, Lower	5,989 47%	4,622 36%	2,218 17%	3 --	0 --	12,832
Bush Creek, Upper	2,090 25%	2,676 32%	3,547 43%	8 --	0 --	8,321
Carroll Creek	3,034 21%	2,028 14%	9,357 65%	14 --	10 --	14,443
Israel Creek	14,666 60%	6,498 27%	2,447 10%	13 --	730 3%	24,354
Linganore Creek, Lower	9,647 40%	7,728 32%	6,628 27%	242 1%	5 --	24,250
Linganore Creek, Upper	18,776 65%	7,446 26%	2,627 9%	42 --	16 --	28,907
Monocacy Direct Southwest	6,577 70%	1,461 15%	1,024 11%	32 --	351 4%	9,445
Lower Monocacy in Frederick County/ WRAS Area						167,688

Impervious Surface

Roads, parking areas, roofs and other human constructions are collectively called impervious surface. Impervious surface blocks the natural seepage of rain into the ground. Unlike many natural surfaces, impervious surface typically concentrates stormwater runoff, accelerates flow rates and directs stormwater to the nearest stream. Watersheds with small amounts of impervious surface tend to have better water quality in local streams than watersheds with greater amounts of impervious surface.

Urbanization and the increase in impervious surfaces that accompanies development can significantly impact stream health. Increases in the extent of upstream impervious surface are strongly associated with a decrease in stream quality. As impervious surfaces cover more of the landscape, less water infiltrates the soil and more water enters stream systems through runoff or stormwater discharge. This increased stormwater runoff from impervious surfaces contributes to stream quality degradation by introducing more non-point source pollution, higher temperatures, reduced stream baseflow and more erosive flood flow.

The table below shows the relationship between upstream impervious land cover and in-stream quality. These thresholds are based on extensive biological monitoring conducted by the Maryland Biological Stream Survey:[9]

Upstream Impervious Cover Thresholds	
Percent	**Affects on Stream Quality**
Less Than 2	Imperviousness is relatively insignificant compared to other factors affecting habitat quality. In cold-water habitats, brook trout may be found.
Above 2	Negative impacts to stream health begin. Brook trout are never found in streams with watershed imperviousness above this threshold.
Above 15	Stream health is never rated good, based on a combined fish and benthic macroinvertebrate Index of Biotic Integrity.
Above 25	Only hardy, pollution-tolerant reptiles and amphibians can thrive, while more pollution-sensitive species are eliminated.

Map 10 Impervious Surface Lower Monocacy River Watershed and the table Average Subwatershed Imperviousness, reflects data developed by the University of Maryland's Regional Earth Sciences Application Center (RESAC).[10] The map and table are color coded to show the relative average amount of impervious cover for each subwatershed. The map also shows higher concentrations of impervious coverage as darker areas. The subwatersheds encompassing the City of Frederick, Carroll and Ballenger Creeks, have the highest average impervious cover. Stream segments downstream from these highly impervious areas will likely exhibit more degraded conditions relative to those draining forested regions.

Map 11 Impervious Cover City of Frederick Vicinity shows the distribution of impervious surface around the most urbanized portion of the Lower Monocacy River watershed.

At this scale, it is possible to see that much of the middle and lower Carroll Creek watershed has high concentrations of impervious cover. Also, the majority of the impervious surface in the Ballenger Creek watershed tends to be concentrated in the downstream end of the watershed. These findings are consistent with the thresholds identified by MBSS and the available fisheries information. Brook trout continue to maintain naturally reproducing populations in the headwaters of these watersheds. However, they are unable to survive downstream in the watershed.

These findings also suggest that the brook trout populations are isolated in separate headwater habitats. It is unlikely that fish from one stream could move to the next. This isolation endangers the long term survival of these populations due to catastrophic events (natural recolonization can not occur if a population is lost) or genetic inbreeding (the local in-stream diversity of trout may be insufficient to maintain a healthy population).

Long term survival of the local brook trout populations be depend on several efforts like those suggested below:

– Limiting the expansion of impervious area through land use controls,
– Protecting existing habitat and restoring potential habitat, and
– Intervention by DNR Fisheries Service to ensure diversity within individual local breeding populations by transporting fish or eggs.

Average Subwatershed Imperviousness

Frederick County Subwatershed Name	Percent
Ballenger Creek	13.4
Bennett Creek	1.2
Bush Creek - Upper	3.0
Bush Creek - Lower	2.0
Carroll Creek	18.6
Israel Creek	2.0
Linganore Creek - Lower	2.7
Linganore Creek - Upper	1.5
Monocacy Direct Southwest	3.5
Overall Lower Monocacy River Watershed	**4.4**

Protected Lands

As used in the context of watershed restoration, "protected land" includes any land with some form of long term limitation on conversion to urban / developed land use. This protection may be in various forms: public ownership for natural resource or low impact recreational intent, private ownership where a third party acquired the development rights or otherwise acquired the right to limit use through the purchase of an easement, etc. The extent of "protection" varies greatly from one circumstance to the next. Therefore, for some protected land, it may be necessary to explore the details of land protection parcel by parcel through the local land records office to determine the true extent of protection.

For purposes of watershed restoration, a knowledge of existing protected lands can provide a starting point in prioritizing potential restoration activities. In some cases, protected

lands may provide opportunities for restoration projects because owners of these lands may value natural resource protection or enhancement goals.

The following listing and Map 12 Protected Land summarize the status of protected lands in the Lower Monocacy River Watershed. (NOTE: Some land parcels are affected by more than one type of protected land listed below. For example, it is common for County parks to be included in Priority Funding Areas. Similarly, government-owned land may also have a conservation easement on it.)

– Conservation easements associated with the Maryland Environmental Trust (MET) and private conservation organizations are shown on the map. MET holds conservation easements on 14 parcels covering over 540 acres in the WRAS project area. Stronghold, Inc. holds conservation easements on over 2,450 acres on Sugar Loaf Mountain in the WRAS area.
– DNR owns about 3,320 acres in the WRAS area, mostly in the Monocacy Natural Resources Management Area. Also included in that total are the Urbana Lake property (67 acres) and a portion of Gambrill State Park (about 1,130 acres).
– Frederick County's parks in the WRAS area total about 1500 acres in 41 parcels. In the remainder of the Lower Monocacy River watershed, Montgomery County parks encompass about 3690 acres in two areas.
– Federal land in the WRAS area covers about 5,225 acres. The C&O Canal National Historical Park and the Monocacy National Battlefield cover about 1,600 acres in the watershed. The remainder is part of Fort Detrick.
– Agricultural easements include about 3,360 acres of farmland in the WRAS watershed (Frederick County) on 26 parcels. In the remainder of the Lower Monocacy River watershed, 158 acres in Carroll County on two parcels are under agricultural easement.
– Rural Legacy is a funding program designed to target Program Open Space funds to protect rural lands from development in areas selected by counties and approved by the State. Currently, there are no Rural Legacy areas in the WRAS project area. The Monocacy River watershed includes about 2,560 acres of Montgomery County's Mid-Maryland Rural Legacy Area. The Frederick County portion of the Mid-Maryland Rural Legacy Area is outside of the Monocacy River watershed.
– Priority Funding Areas is a funding program designed to help direct State funding for development to appropriate areas selected by Counties and approved by the State. Nearly 41,700 acres (25%) of the WRAS project area are designated as Priority Funding Areas. An additional 1270 acres of Priority Funding area are located in other portions of the Lower Monocacy River watershed in Montgomery or Carroll Counties.

The information on protected lands in the WRAS project area could be used in various ways to assist in watershed strategy development. Protected lands may offer several types of opportunities:

– Sites for implementation projects and/or demonstration projects.
– Areas for management enhancement or additional protection
– Expansion of protection from currently protected land to adjacent parcels.

Lands With Significant Natural Resource Value and Large Area

Forest lands in the Lower Monocacy River watershed, particularly extensive areas of contiguous forest, provide valuable water quality and habitat benefits. In general, actions taken to assure that forest cover will be maintained, to avoid fragmentation of forest, and to restore forest in areas that have been cleared will contribute significantly to improving the water quality in this watershed and to conserving the biodiversity of the State.

1. Green Infrastructure

DNR has mapped a network of ecologically important lands, comprised of hubs and linking corridors, using several of the GIS data layers used to develop other indicators. Hubs 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, plus the 300 foot transition zone);
- 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; and
- conservation areas already protected by public (primarily DNR or the federal government) and private organizations like The Nature Conservancy or Maryland Ornithological Society.

This "Green Infrastructure" provides the bulk of the state's natural support system. Ecosystem services, such as cleaning the air, filtering and cooling water, storing and cycling nutrients, conserving and generating soils, pollinating crops and other plants, regulating climate, protecting areas against storm and flood damage, and maintaining hydrologic function. For more information on the Green Infrastructure identification project in Maryland, see www.dnr.maryland.gov/greenways/

Protection of Green Infrastructure lands may be addressed through various existing programs including Rural Legacy, Program Open Space, conservation easements and others. Within Program Open Space, the Green Print program helps to target funds to protect Green Infrastructure areas.

Map 13 Green Infrastructure shows that, from the statewide perspective that guided the analysis, several Green Infrastructure are found in the Lower Monocacy River Watershed:

– The only large Green Infrastructure hub in the WRAS project area, Sugar Loaf Mountain in southern Frederick County, is mostly protected by the Monocacy Natural Resource Management Area and the conservation easements held by Stronghold, Inc. However, some hub areas are not protected.
– Small Green Infrastructure Hubs area found in the WRAS project area are mostly unprotected. Two hubs on Linganore Creek, one on Bush Creek and one in the headwaters of Ballenger Creek are unprotected. One hub in the headwaters of Carroll is partially protected by Gambrill State Park.
– Montgomery County's Little Bennett Regional Park encompasses most of a GI Hub.

2. Large Forest Blocks

Large blocks of forest provide habitat for species that are specialized for conditions with relatively little influence by species from open areas or humans. For example, forest interior dwelling birds require forest interior habitat for their survival and they cannot tolerate much human presence. Map 14 Forest Interior shows blocks of contiguous forest that are at least 50 acres in size with at least 10 acres of forest interior (forest edge is at least 300 feet away) that may be important locally within the Lower Monocacy River Watershed. This size threshold was chosen to help ensure that the forest interior is large enough to likely provide locally significant habitat for sensitive forest interior dwelling species. The forest interior assessment shown in Map 14 differs from the Green Infrastructure assessment forest interior areas are more numerous and more widely distributed because the forest interior size threshold is lower.

Several findings on forest interior can be seen on the map or interpreted in comparing it with the Green Infrastructure and protected lands maps:

– Forest interior encompasses about 45% (21,980 acres) of the forest and brush land in the WRAS project area. Another 4,270 acres of forest interior are in the Carroll and Montgomery County portions of the Monocacy River watershed
– About three-quarters of this forest interior is considered to be high quality (15,000 acres in the WRAS area and another 3,000 acres Carroll and Montgomery Counties).
– Most of the forest interior areas are not protected. In the WRAS project area, which is Frederick County's portion of the Lower Monocacy River watershed, about 16% (about 3,450 out of 21,980 acres) is protected. In Montgomery County's portion of the watershed, about 53% of the forest interior is protected (2,030 out of 3,860 acres). In Carroll County's portion of the watershed, none of the 400 acres of forest interior is protected.

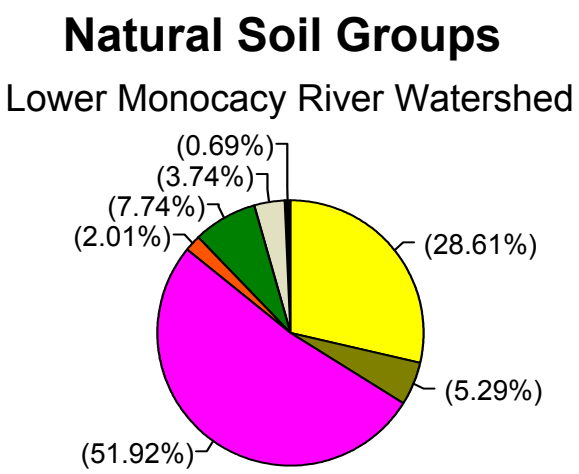
Floodplains

Map 17 Hydric Soil and Floodplain shows that the 100-year floodplain extends the entire length of the Monocacy River in the WRAS project area and up many of its major tributary streams.

In recent years, stormwater management requirements have provided a means to limit impacts of new development and impervious area that would otherwise contribute to stream degradation and flooding. However, these new projects may not significantly improve water quality or quantity problems that are driven by systemic watershed factors.

For existing development and impervious area, retrofitting controls to enhance water quality and limit peaks in stormwater runoff may offer an additional way to protect waterways.

Soils of the
Lower Monocacy River Watershed



1. Interpreting Local Conditions with Natural Soil Groups

Soil conditions like soil type and moisture conditions greatly affect how land may be used and the potential for vegetation and habitat on the land. Soil conditions are one determining factor for water quality in streams and rivers. Local soil conditions vary greatly from site to site as shown in the Soil Survey for Frederick County. This information has been summarized into Natural Soil Groups to help identify useful generalizations about groups of soils.

Map 15 Natural Soils Groups shows the distribution of natural soils groups in the Lower Monocacy River Watershed. The pie chart creates even broader categories from the natural soils groups (clockwise from 12 o'clock):

– Prime agricultural land covers 28.61% of the watershed. Development, including the City of Frederick, currently uses significant areas of this valuable natural resource.
– Well drained soils with over 8% slope (5.29%).
– Shallow acidic soils (51.92%) account for the majority of the watershed.
– Seasonally wet or hydric soils (2.01%) are a minor part of the watershed.
– Poorly drained floodplain along streams (7.74%) is very common.
– Stoney soils (3.74%) tend to occur in the western part of the watershed associated with steep terrain.
– All other categories of soils (0.69%) are a uncommon occurrence.

2. Erodible and Hydric Soil Limitations

Map 16 Highly Erodible Soils shows the distribution of soils in the WRAS project area that have significant potential for erosion. Most of these soils are associated with steep slopes but some are susceptible to erosion on moderate slopes 8 to 15%. These soils are widely distributed in the project area.

As shown in Map 17 Hydric Soil and Floodplain, hydric soils in the Lower Moncacy River watershed tend to be associated with streams and rivers. Some areas of the floodplains shown on the map are also hydric soils.

The table Soils With Highly Erodible Or Hydric Conditions lists the relative acreage and percentage of each Frederick County subwatershed that has limitations associated with soil erodibility or wetness.

Soils With Highly Erodible Or Hydric Conditions For The Lower Monocacy River Watershed In Frederick County					
Frederick County Subwatershed	**Total Land Acreage**	**Highly Erodible**		**Hydric**	
		Acres	**%**	**Acres**	**%**
Ballenger Creek	14,547	1,809	12	638	4
Bennett Creek	30,569	9,083	30	2,049	7
Bush Creek, Lower	12,831	3,062	24	510	4
Bush Creek, Upper	8,321	1,975	24	603	7
Carroll Creek	14,443	1,788	12	114	1
Israel Creek	24,354	4,830	20	1,799	7
Linganore Creek, Lower	24,250	7,045	29	1,132	5
Linganore Creek, Upper	28,928	6,761	23	1,715	6
Monocacy Direct Southwest	9,445	1,666	18	1,734	18
Lower Monocacy River Watershed Total	167,688	38,019	23	10,294	6

3. Soils and Watershed Planning

Soil conditions frequently drive land use decisions. For example, note that the City of Frederick is located on an area with relatively little highly erodible and hydric soils (Ballenger Creek and Carroll Creek subwatersheds). Local soil conditions can also be a useful element in watershed planning and for targeting restoration projects. Soils with limitations like wetness or slope naturally inhibit active use for farming or development and may then be available as restoration project sites. By comparing Map 15 Natural Soils Groups with the preceding maps listed below, it may be possible to discern how patterns of active or passive land use relate to soil conditions:

– Map 9 Land Use/Cover
– Map 13 Green Infrastructure

Natural Soils Groups and other soils assessments can be used to help identify potential areas for restoration projects or habitat protection. Hydric soils, for example, are more easily restored as wetlands than soils that were never saturated with water. Highly erodible soils may be considered a priority for protection from disturbance or restoration with natural vegetative cover in stream buffer areas. Once areas of interest are targeted and landowner interest is verified, additional detailed soil assessment is an essential step in identifying viable restoration project sites.

Wetlands

1. Wetland Categories

In the Lower Monocacy River watershed, there are slightly over 8,000 acres of wetlands based on DNR's Wetlands Inventory as summarized in the adjacent table. As Map 18 Wetlands shows, they tend to occur adjacent to streams and in scattered upland depressions that collect stormwater.

Wetland Acreage Summary Table Lower Monocacy River Watershed		
Wetland Class		Acres
Lacustrine	unconsolidated bottom	212
	unconsolidated shore	1
Palustrine	aquatic bed	2
	emergent	1,446
	flooded semipermanently	319
	forested	3,906
	scrub shrub	1,019
	unconsolidated bottom	1,111
	unconsolidated shore	3
Riverine	all types present	2
Total Wetlands (DNR mapped wetlands)		8,021

Wetlands of Special State Concern (WSSC)
None of the wetlands in the Lower Monocacy watershed are subject to WSSC regulations. Also see the Sensitive Species Section.

Palustrine wetlands account for nearly all the wetlands in the Lower Monocacy River watershed. They are freshwater wetlands that are not associated with streams or lakes. In general, palustrine wetlands are associated with freshwater, high water tables and/or intermittent ponding on land. Forested wetlands are the most abundant wetland type in the watershed (almost 49% of the total). These wetlands are found on floodplains along rivers and streams, and in upland depressions.

Lacustrine wetlands (associated with lakes, ponds and freshwater impoundments) and riverine wetlands (associated with flowing fresh water) account for less than three percent of the total wetlands area in the watershed.

In the WRAS project area, the table Wetlands By Frederick County Subwatersheds shows that the greatest concentration of wetlands tends to be in the southern down-stream subwatersheds like Bennett Creek and Bush Creek (Upper and Lower). Conversely, the lowest concentration of wetlands tends to occur in the northern up-stream portions of the WRAS project area like Carroll Creek, Ballenger Creek, Israel Creek and Linganore Creek (Upper and Lower).

2. Tracking Wetlands

Oversight of activities affecting wetlands involves several regulatory jurisdictions. The Maryland Department of the Environment (MDE) is the lead agency for the State and cooperates with DNR, the Army Corps of Engineers and other Federal and local agencies. As part of its responsibility, MDE tracks State permitting and the net gain or loss of wetlands over time.

As the table Tracking Nontidal Wetland Change shows, the State regulatory program has measured a small net increase of wetland acreage in the Lower Monocacy River Watershed over the past 11 years. This limited reversal of wetland loss in the watershed contrasts significantly with the estimated historic 11,799 acre wetland loss in the watershed as described in the Landscape Indicators section.

Wetlands By Frederick County Subwatersheds Lower Monocacy River Watershed			
Subwatershed	Wetland Acres	Subwatershed Acres	Percent of Subwatershed
Ballenger Creek	388	14,547	3
Bennett Creek	2,404	30,569	8
Bush Creek - Lower	867	12,832	7
Bush Creek - Upper	542	8,321	7
Carroll Creek	184	14,443	1
Israel Creek	405	24,354	2
Linganore Creek - Lower	758	24,250	3
Linganore Creek - Upper	870	28,927	3
Monocacy Direct Southwest	405	9,445	4
Total for Frederick Co. WRAS Project Area	6,823	167,688	4

Tracking Nontidal Wetland Change For The Lower Monocacy River Watershed In Acres 1/1/1991 through 12/31/2002 [17]				
Permanent Impacts	**Permittee Mitigation**	**Programmatic Gains**	**Other Gains**	**Net**
-5.79	6.02	37.50	0.11	37.85

Notes: 1) Regulatory tracking for authorized nontidal wetland losses began in 1991. Comprehensive tracking of voluntary wetland gains began in 1998. Acreage presented cover the entire watershed; it does not identify County and it is not normalized. For example, the listing for the Lower Monocacy River watershed includes Frederick, Carroll and Montgomery Counties.
2) "Permanent Impacts" refers to acres altered (e.g., filled, drained) under permit from MDE.
3) "Permittee Mitigation" refers to acres restored by a permit holder as required by terms of the permit from MDE.
4) "Programmatic Gains" refers to acres restored by MDE using fees paid into a compensation fund by a permit holder in lieu of undertaking mitigation himself.
5) "Other Gains" refers to acres of wetlands restored when not required as mitigation for permitted losses.

LIVING RESOURCES AND HABITAT

Living resources, including all the animals, plants and other organisms that call the land and waters of the Lower Monocacy River Watershed home, are being affected by human activity. The information summarized here suggests that some of the significant stresses on living resources in the watershed are alteration and destruction of habitat, excessive movement of sediment and excessive availability of nutrients.

The living resource information summarized here should be considered a partial representation, because numerous areas of potential interest or concern could not be included due to lack of information, time, etc. For example, information on many forms of aquatic life, woodland communities, terrestrial habitats, etc. should be considered as watershed restoration decisions are being made. Therefore, it is recommended that stakeholders in the watershed identify important living resource issues or priorities so that additional effort can be focused where it is most needed. New information should be added or referenced as it becomes available.

Living Resource Indicators

Aquatic organisms are sensitive, in varying degrees, to changes in water quality and aquatic habitat. They are also sensitive to landscape changes. This association offers two perspectives that are important for watershed restoration. First, improvements for living resources offer potential goals, objectives and opportunities to gauge progress in watershed restoration. Second, the status of selected species can be used to gauge local conditions for water quality, habitat, etc. This second perspective is the basis for using living resources as an "indicator."

Living Resource Indicator Summary
Lower Monocacy River Watershed
From: 1998 *Unified Watershed Assessment*

Indicator Name	Finding
Nontidal Fish	**8.2 rank**
Nontidal Benthic	**5.6 rank**
Nontidal Habitat	**6.1 rank**
Trout Spawning Area	**9 rank**

Comparison with similar Maryland watersheds
Green shading: goal or benchmark was met.
Orange shading: goal or benchmark not met.

The *Maryland Clean Water Action Plan's Unified Watershed Assessment,* published in 1998, included a number of living resource indicators for the Lower Monocacy River Watershed.[2] Several of these indicators rely on extrapolations from a limited number of sampling sites which were then generalized to represent entire watersheds. Some are indices comprising several conditions. Considering this limitation on field data, it would be beneficial to conduct additional assessments to provide a more complete understanding of local conditions.

1. Nontidal Fish Index of Biotic Integrity (IBI)

The Lower Monocacy River watershed's rank above 8 compares well with other similar watersheds in Maryland.

As interest in whole ecosystems, and ecosystem health, has grown, Indexes of Biotic Integrity (IBIs) for fishes have been developed for small (first- to third-order) non-tidal streams. Several characteristics of the fish community are measured–numbers of native species, of benthic species and of tolerant individuals; the percent of tolerant species, of dominant species, and of generalists, omnivores and insectivores; the number of individuals per square meter; biomass in grams per square meter; percent of lithophilic spawners; and percent insectivores. These characteristics are scored and summed to calculate a fish IBI for each sampled stream. Scores for watersheds are reported as means for the sites within each watershed (one most degraded, 10 best condition).

2. Nontidal Benthic Index of Biotic Integrity (IBI)

The Lower Monocacy River watershed's overall index of 5.6 for benthic biotic integrity does not compare well with other similar watersheds in Maryland. A rank less than 6 means that restoration is recommended. This rank corresponds to an MBSS score of 2.8 which is in the "poor" range for MBSS reporting.

The nontidal benthic IBI looks at the insects and other invertebrates, like crayfish, living in streams, considering the overall community composition, the number and diversity of species and presence of sensitive species. To calculate the benthic IBI, reference conditions were established for minimally-impacted streams. IBI values are relative to conditions in these minimally-impacted streams. An index of 6.0 or less means that restoration is recommended and an index of 8.0 or higher means that protection is recommended.

3. Nontidal Habitat Index of Biotic Integrity (IBI)

The Lower Monocacy River watershed's overall index of 6.1 for habitat biotic integrity compares well with similar Maryland watersheds. A rank less than 6 means that restoration is recommended.

This physical habitat indicator is developed for small (first- to third-order) non-tidal streams. It is based on several measures of in-stream habitat quality that are scored for each site based on observations of habitat condition in streams during sampling visits. The habitat measures rate the quantity and quality of physical habitat available in the stream for fish and benthic macroinvertebrate colonization and rate the degree to which the stream channel has been altered due to changes in watershed landscape.

The physical habitat characteristics are measured, scored, weighted, and summed to calculate the indicator for each sampled stream. A low score, or a decline in score over time, reflects both natural disturbances and human-induced alterations of the stream habitat relative to minimally-disturbed reference sites. The mean habitat score for watersheds is reported on a 1 to 10 scale, 1 being most degraded, 10 representing the best condition.

Physical habitat conditions in non-tidal streams and rivers are influenced by land use and land cover patterns in the watershed, such as the destruction of riparian forests and increasing the area of impervious land cover. Other major influences are channelization, encroachment by livestock, and blockages to upstream/downstream movements of fish.

4. Trout Spawning Area

The Lower Monocacy River watershed's rank of 9 for trout spawning compares well with similar Maryland watersheds. This rank means that spawning habitat for both brook trout and brown trout are found in this watershed.

Trout spawning is an indicator both of watershed condition and vulnerability to adverse human impacts. Trout spawning requires water of high dissolved oxygen levels, clean gravel bottoms, low water temperatures and clarity. Areas where this occurs are near pristine condition and are highly valued. Streams where these conditions prevail, or were historically thought to prevail, are also afforded the highest level of protection in the State's water quality standard.

This indicator was developed using Maryland Biological Stream Survey data and information provided by the Fisheries Service. It scores watersheds based on the diversity of trout spawning areas within the watershed. Because brook trout are the only native trout (Salmonidae) species that spawn in Maryland waters, they were weighted more heavily than either rainbow or brown trout. The scale used varies from zero (no trout spawning conditions) to 10 (spawning conditions for brook, brown and rainbow trout).

Fish

1. Warmwater Resources In The Lower Monocacy River Watershed

The warmwater fishery usually experiences adequate reproduction to support recreational fishing. The Monocacy River supports a popular sport fishery for smallmouth bass, channel catfish, redbreast sunfish and carp. Many Monocacy tributaries also have smallmouth bass and redbreast sunfish. Annual stocking of sterile tiger muskie fingerlings is done in the Monocacy River in the vicinity of the Monocacy Natural Resources Management Area to support a recreational fishery for trophy sport fish.[15]

Sampling of fish populations was conducted in selected stream segments of the Lower Monocacy River watershed in 1996 and 2000 by the Maryland Biological Stream Survey (MBSS). A complete listing of fish species that were identified are listed in Appendix A, Fish Species By County Subwatershed. While these findings are limited and they are aggregated by County subwatershed, they do offer some insights summarized below:

– Bennett Creek subwatershed streams have the greatest diversity of fish species of any Lower Monocacy subwatershed. This suggests that good water quality and habitat conditions are more widely distributed in this watershed than other Lower Monocacy areas.
– Two species of fish that require good water quality and habitat conditions were identified. Northern Hogsucker was found in five of Frederick County's subwatersheds and Rosyside Dace was found in six. This finding indicates that at least some portions of each of these subwatersheds has a combination of good quality water and habitat.
– Carroll Creek and the North Fork Linganore Creek subwatersheds have the least diversity of fish species. In Carroll Creek, this appears to be the result of impacts from development around the City of Frederick. Streams in the North Fork Linganore Creek subwatershed are affected by extensive agricultural lands, some development and runoff from Rt. 26. It appears that both urban and rural watersheds can contribute to low fish diversity.

– Fish species like bluegill, blacknose dace and fantail darter are found in the most Lower Monocacy watershed streams. In general, these species are relatively tolerant of poor habitat conditions and/or poor water quality.

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Information on fish in nontidal streams is gathered as part of the Maryland Biological Stream Survey. See Biological Monitoring In Streams for summary information. Additional information on fish populations and related recreational activities will be incorporated as it becomes available.

2. Trout Populations

Trout populations of various species in the Lower Monocacy River watershed exist in about four areas as summarized below:[15]

– Bear Branch has a self-sustaining population of native brook trout. This population was started by transplanting wild fish from Fishing Creek in the Upper Monocacy River watershed.

– Ballenger Creek has a self-sustaining population of naturalized brown trout upstream of Ballenger Creek Park. Below the park, adults are found but no reproduction.

– Furnace Branch once supported a quality brown trout resource but the population has nearly disappeared for unknown reasons. Transplanting and stocking efforts have been unsuccessful in reestablishing a viable population.

– Carroll Creek near Rt. 15 is managed as a put-and-take fishing area for youth and blind enthusiasts. Each year, this part of the creek is stocked with adult rainbow trout in Spring three times and once in October. These fish survive but no reproduction occurs.

3. Fish Consumption Advisory

In January 2003, MDE issued revised fish consumption advisories. None of the advisory singled-out water bodies in the Lower Monocacy River watershed. However, several statewide advisories that affect portions of the Lower Monocacy River watershed are listed in the table below.

Statewide - 2003 Advisory On Fish Consumption For Methyl-Mercury Recommended Maximum Allowable Meals Per Month

Species	Area	General Population 8oz meal	Women 6oz meal	Children 3oz. meal
Smallmouth & Largemouth Bass, Pickerel, Northern Pike, Walleye	Lakes, Impoundments	4	4	4
	Rivers and Streams	no advisory	8	8
Bluegill	Lakes, Impoundments	8	8	8

Biological Monitoring In Streams

The Maryland Biological Stream Survey (MBSS) sampled stream conditions in the Lower Monocacy River watershed in 1996 and 2000. The results of 2003 MBSS sampling in the Lower Monocacy River watershed was not available for inclusion in this watershed characterization.

Results from the 1996 and 2000 sampling periods address three broad categories of stream conditions as listed below. The findings in each of these categories, which are each summarized on a separate map, allow comparison of stream conditions across the watershed:
– Fish as summarized in Map 19 MBSS Fish Index and Trout Populations
– Benthic macroinvertebrates (benthos or stream bugs) in Map 20 MBSS Benthic Index
– Physical habitat in Map 21 Physical Index
– Index data summary table Appendix B

Additionally, overall conditions in a stream or subwatershed may be interpreted by considering fish, benthos and physical habitat together like the interpretations offered below:
– Conditions that underlie the indices are complex and apply primarily to a local stream segment. No streams ranked as good or very poor for all indices. Typically, a stream segment ranks as a mix of good, fair, poor and/or very poor for the three indices.
– There is a tendency for good/fair conditions to be associated with watersheds with the least disturbance (natural vegetation, forest) and for poor/very poor conditions to be assoiciated with greater disturbance (impervious area, agriculture, construction sites).

Prior to creation of the MBSS method of assessment and random site selection technique, DNR used a biological assessment approach in nontidal steams known as rapid bio-assessment. While results of this assessment is not directly comparable to the current day MBSS data, it does provide a way to compare stream conditions during the early 1990s. The table DNR Rapid Bio-Assessment Data Summary lists these results.

DNR Rapid Bio-Assessment Data Summary [14]				
Location	**Sample Year**	**Benthic**	**Habitat**	**Water Quality**
Little Bennett Creek at Covell Road BEN0054	91, 93, 95	good	good/excellent	good
Bennett Creek at Dixon Road BEN0060	90	fair	good	good
Bennett Creek at Big Woods Rd. BEN0089	91, 93, 95	good/excellent	good/excellent	good
Fahrney Branch at Big Woods Rd. FAH0013	91, 93, 95	good/excellent	good/excellent	good/excellent
Bush Creek at Ball Road BSC0013	91, 93, 95	good	good	good
Bens Branch at Linganore pump station	93, 95	good/excellent	good	good/excellent
Linganore Creek at Gas House Pike	90, 93, 95	good	fair/good	good
South Fork Linganore at Glissans Mill Road	91, 93, 95	fair	poor/fair	good
North Fork Linganore at Dollyhyde Road	91, 93, 95	good	fair/good	good
Glade Creek at Retreat Road	90, 91, 93, 95	poor	poor/fair	fair
Israel Cr at Cash Smith Rd.	91, 93, 95	good/excellent	good/excellent	good/excellent
Cabbage Run at Daysville Rd.	90, 91, 93, 95	fair	fair	fair

Why Look at Benthos in Streams?

Unimpaired natural streams may support a great diversity of species like bacteria, algae, invertebrates like crayfish and insects to fish,birds, reptiles and mammals. All these groups of organisms have been extensively assessed relative to water quality and habitat quality. One group, benthic invertebrates, was found to serve as a good indicator of stream condition including water quality and habitat quality.

Benthic invertegrates are sometimes called "stream bugs" though that name overly simplifies the diverse membership of this group. This group includes mayflies, caddisflies, crayfish, etc., that inhabit the stream bottom, its sediments, organic debris and live on plant life (macrophytes) within the stream. Benthic macro-invertebrates are an important component of a stream's ecosystem.

The food web in streams relies significantly on benthic organisms. Benthos are often the most abundant source of food for fish and other small animals. Many benthic macroinvertebrates live on decomposing leaves and other organic materials in the stream. By this activity, these organisms are significant processors of organic materials in the stream. Benthos often provide the primary means that nutrients from organic debris are transformed to other biologically usable forms. These nutrients become available again and are transported downstream where other organisms use them.

Assessment of benthic organisms is a valuable tool for stream evaluation. This group of species has been extensively used in water quality assessment, in evaluating biological conditions of streams and in gauging influences on streams by surrounding lands. These organisms serve as good indicators of water resource integrity because they are fairly sedentary in nature and their diversity offers numerous ways to interpret conditions. They have different sensitivities to changing conditions. They have a wide range of functions in the stream. They use different life cycle strategies for survival.

Sensitive Species

Sensitive species are generally recognized as being the plants or animals that are most at risk in regards to their ability to maintain healthy population levels. The most widely known are perhaps the State and Federally-listed Endangered or Threatened animals such as the bald eagle and Delmarva fox squirrel. In addition to charismatic animals such as these however, both the United States Fish and Wildlife Service and the Maryland DNR work through their respective Federal and State programs to protect a wide variety of declining non-game animals, rare plants, and the unique natural communities that support them.

For the purposes of watershed restoration, it is valuable to account for the known locations and areas of potential habitat for sensitive species in a given area. They are often indicators, and sometimes important constituents, of the network of natural areas which form the foundation for many essential natural watershed processes. In fact, in addition to conserving biodiversity in general, protecting these species and/or promoting expansion of their habitats can be an effective component for a watershed restoration program.

1. Habitat Conservation Measures

DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation in different ways. The geographic delineations most commonly used are described in the text box Marylands Sensitive Species Conservation Areas. As shown in Map 22 Sensitive Species, three specific sensitive species overlays used by the State of Maryland are found in the Lower Monocacy River Watershed. The purpose of utilizing these delineations is to help protect sensitive species by identifying the areas in which they are known to occur. Doing so allows DNR to work toward the conservation of these sensitive resources by evaluating potential impacts of proposed actions that may affect them. Specifically, working within an established procedural framework, the Wildlife and Heritage Service reviews projects and provides recommendations for activities falling within these overlays.

The geographic areas covered by these overlays are course filters. To allow for uncertainty pertaining to interpretation discrepancies, the polygons used on the map to depict these locations have been buffered. Accurate on the ground information regarding species locations and habitat delineations for a specific area can be obtained from DNR's Natural Heritage Program. It is also important to note that outside of the Chesapeake Bay Critical Area, DNR generally only places requirements on projects requiring a permit/approval or those which are utilizing State funds. However, there are more broadly applied State and Federal laws and regulations which address "takings" of listed species. In addition, many counties have incorporated safeguards for areas associated with sensitive species into their project and permit review processes as well as adopting specific ordinances in some cases to protect them. In all instances, property owners are encouraged to seek advice on protecting the sensitive species / habitat within their ownership.

2. Rare, Threatened and Endangered Species List

The table below lists the rare, threatened and endangered species found in the Lower Monocacy River Watershed. In general, these species are located within area on the Sensitive Species Map labeled as Ecologically Sensitive Area (ESA).

Sensitive Species Tracked by Maryland in the Lower Monocacy River Watershed			
	Scientific Name	**Common Name**	**Status***
Animals	Bartramia longicauda	Upland sandpiper	E
	Gallinula chloropus	Common moorhen	O
	Ixobrychus exilis	Least bittern	O
	Lanius ludovicianus	Loggerhead shrike	E
	Podilymbus podiceps	Pied-billed grebe	O
	Porzana carolina	Sora	O
	Sorex hoyi winnemana	Southern pygmy shrew	O
	Stygobromus pizzinii	Pizzini's amphipod	O
	Stygobromus sp 14	Roundtop amphipod	O
Plants	Botrychium oneidense	Blunt-lobe grape-fern	E
	Castanea dentata	American chestnut	O
	Cyperus refractus	Reflexed cyperus	O
	Gentiana andrewsii	Fringe-tip closed gentian	T
	Juglans cinerea	Butternut	O
	Platanthera ciliaris	Yellow fringed orchid	T
	Platanthera grandiflora	Large purple fringed orchid	T
	Platanthera peramoena	Purple fringeless orchid	T
	Rhododendron calendulaceum	Flame azalea	O
	Satyrium edwardsii	Edwards' hairstreak	E
	Spiza americana	Dickcissel	O
* Key for Maryland Status. E - endangered, T - threatened, O - Other			

Sensitive Species Protection Areas In the Lower Monocacy River Watershed

Ecologically Sensitive Area (ESA)

At least eight ESAs are identified in the Lower Monocacy River Watershed, including five in Frederick County, as shown in Map 22 Sensitive Species. Each ESA contains one or more sensitive species habitats. However, the entire ESA is not considered sensitive habitat. The ESA is an envelope identified for review purposes to help ensure that applications for permit or approval in or near sensitive areas receive adequate attention and safeguards for the sensitive species / habitat they contain.

Natural Heritage Area (NHA)

No NHAs are located in the Lower Monocacy River Watershed. In general, NHAs have been designated as such because they represent rare ecological communities. These are areas which provide important sensitive species habitat. They are designated in State regulation (COMAR 08.03.08.10) and are afforded specific protections in the Critical Area Law criteria. For proposed projects that could potential affect a particular NHA, recommendations and/or requirements may be put in place during the permit or approval process. These would be specifically aimed at protecting the ecological integrity of the NHA itself. To help ensure that proposed projects which may affect a given NHA are adequately reviewed, an ESA is always designated to encompass each NHA and the area surrounding it.

Wetlands of Special State Concern (WSSC)

No WSSCs are designated in the Lower Monocacy River Watershed. These selected wetlands, which generally represent the best examples of Maryland's nontidal wetland habitats, are afforded additional protection in state law beyond the permitting requirements that apply to wetlands generally. The Maryland Department of the Environment may be contacted for more information regarding these regulations. To help ensure that proposed projects that may affect a WSSC are adequately reviewed, an ESA is always designated to encompass each WSSC and the area surrounding it. For a listing of designated sites see COMAR 26.23.06.01 at www.dsd.state.md.us

RESTORATION AND CONSERVATION TARGETING

There are a number of programs and tools available to assist in targeting and implementing projects to restore and protect watershed resources that are degraded. This chapter presents projects, programs and scenarios that relate to the Lower Monocacy River watershed.

Rock and Carroll Creeks 1997 Stream Corridor Assessment

Rock and Carroll Creeks southwest of the City of Frederick were assessed by DNR in 1997. Using the Stream Corridor Assessment Methodology (SCAM) developed by DNR, trained teams from the Maryland Conservation Corps walked 19 miles of streams to document potential problems and restoration opportunities. Their findings appear in the Dec. 2000 final report and are summarized in the adjacent table. The report also indicated that many of the inadequate buffer sites along Rock Creek had associated erosion problems. The majority of erosion sites were on Rock Creek but the two most severe sites were on Carroll Creek. The five severe areas of stream channel alternation are in the City of Frederick on a tributary flowing out of Baker Park behind West Frederick High School.

Rock and Carroll Creeks
Stream Corridor Assessment Results Summary

Finding	# of Sites	Estimated Length
Channel Alteration	16	0.9 miles
Erosion Sites	37	1.2 miles
Exposed Pipes	9	NA
Fish Barries	22	NA
Inadequate Buffers	56	7.0 miles
Livestock	5	NA
Near Stream Construction	1	NA
Pipe Outfalls	40	NA
Unusual Conditions	5	NA
TOTAL	191	- -
Representative Sites	42	- -

Rock and Carroll Creeks Restoration Targeting

The December 2000 report also noted that restoration project targeting based on the survey led to implementation of several projects in the Rock & Carroll Creek Riparian Habitat Restoration and Greenway Project. Partners in this effort include City of Frederick and two DNR units: Maryland Forest Service and the Watershed Restoration Division:

– Stream restoration has been completed in areas above and below Baughmans Lane in two phases totaling up to nearly 3000 feet of stream. Projects are designed to address a severe erosion problems and to improve riparian habatit and fish passage. For example, 513 feet of stream below Baughmans Lane was restored using bioengineering methods in 1998.
– Stream buffer plantings have been completed in several areas including 18 acres along 1.1 miles of stream in October 2000 and enhancement of marginal stream buffers with additional planting on 6 acres along one half mile of stream.
– Aquatic habitat improvement has included a project on Carroll Creek inside Baker Park.

2003 Stream Assessments Conducted By DNR

During 2003 in partnership with Frederick County, DNR conducted two types of assessment of selected streams in Frederick County's portion of the Lower Monocacy River watershed. The reports are available at www.dnr.maryland.gov/watersheds/surf/proj/wras.html.

A Stream Corridor Assessment focused on several subwatersheds selected by Frederick County and employs the same methods as the 1997 stream corridor assessment. Findings are also reported in the same manner.

In the Synoptic Survey and Aquatic Community Assessment, DNR staff collected water quality samples and assessed fish and benthic macroinvertebrates in selected nontidal streams within the following Frederick County subwatersheds: Linganore Creek (upper and lower), Bennett Creek, Lower Bush Creek and several sites along the Monocacy River mainstem.

The water quality findings in the report can help identify problem areas and relative conditions among local streams based on measurements of dissolved oxygen, pH, nutrients (phosphorus and nitrogen), conductivity and flow. The nutrient yields estimated at each sampling site allow ranking the subwatersheds based on the nutrient load estimates.

For some of these nontidal stream sampling sites, DNR staff has also assessed fish and benthic organism populations. These assessments provide additional perspectives to gauge local water quality and habitat conditions.

Agricultural Conservation Programs

Agriculture is a major land use in the Monocacy River watershed and the implementation of agricultural best management practices (BMPs) make a significant contribution to nutrient reductions in these watersheds. Implementation of nutrient management plans, new animal waste management systems, conservation tillage, Soil Conservation and Water Quality Plans (SCWQPs) and treatment of lands with high erosion potential all contribute to nutrient reduction. Annual cover crops are highly effective in managing nutrients when planted in the early fall following the harvest of corn, soybeans, vegetables or tobacco. Cover crops reduce the leaching of excess crop nutrients from the root zone and provide valuable erosion protection. It is estimated that the utilization of cereal grain cover crops can reduce nitrate leaching loss by 60% following a corn or a soybean crop.

To help pay for implementing these BMPs, the Maryland Agricultural Cost-Share program (MACS), the Conservation Reserve Program (CRP and CREP) and the Environmental Quality Incentive Program (EQIP) are some of the state and federal programs promoted and administered by the Frederick Soil Conservation District (SCD) and Natural Resource Conservation Service (NRCS). [28]

As part of the WRAS project, farmers in the watershed who are already using good management practices that benefit water quality could provide examples to promote adoption of similar practices by other farmers.

Stream Buffer Restoration

1. Benefits and General Recommendations

Natural vegetation in stream riparian zones, particularly forest, provides numerous valuable environmental benefits:

– Reducing surface runoff
– Preventing erosion and sediment movement
– Using nutrients for vegetative growth and moderating nutrient entry into the stream
– Moderating temperature, particularly reducing warm season water temperature
– Providing organic material (decomposing leaves) that are the foundation of natural food webs in stream systems
– Providing overhead and in-stream cover and habitat
– Promoting high quality aquatic habitat and diverse populations of aquatic species.

2. Headwater Stream Buffers

Headwater streams are also called first order streams. For many watersheds, first order streams drain the majority of the land within the entire watershed. Therefore, stream buffers restored along headwater streams (First Order) tend to have greater potential to intercept nutrients and sediments than stream buffers placed elsewhere. In targeting stream buffer restoration projects, giving higher priority to headwater streams is one approach to optimizing nutrient and sediment retention.

Restoring headwater stream buffers can also provide habitat benefits that can extend downstream of the project area. Forested headwater streams provide important organic material, like decomposing leaves, that "feed" the stream's food web. They also introduce woody debris which enhances in-stream physical habitat. The potential for riparian forest buffers to significantly influence stream temperature is greatest in headwater regions. These factors, in addition to positive water quality effects, are key to improving aquatic habitat.

Since the Lower Monocacy River Watershed has a substantial percentage of its headwater streams in interior forests, protection of these forests against impacts from development may be an important part of WRAS strategies, along with reforestation where necessary.

3. Land Use and Stream Buffers

One factor that affects the ability of stream buffers to intercept nonpoint source pollutants is adjacent land use. Nutrient and sediment loads from different land uses can vary significantly. The loading rates shown in the table here were calculated for the Chesapeake Bay Watershed Model.

Annual Nonpoint Source Pollution Load Rates By Land Use Chesapeake Bay Watershed Model (2000)

Land Use	Nitrogen (lbs/ac)	Phosphorus (lbs/ac)	Sediment (tons/ac)
Crop land	17.11	1.21	0.74
Developed	7.5	0.7	0.09
Pasture	8.40	1.15	0.30
Forest	1.42	0.00	0.03

Stream buffers are a common agricultural Best Management Practice (BMP). Map 9 Land Use/Cover presents a GIS scenario to help identify potential areas for agricultural BMP application.

4. Highly Erodible Soil Scenario for Stream Buffer Targeting

Map 23 Highly Erodible Soil Scenario for Linganore watershed stream buffers focuses on soils within 300 feet of a stream that are identified as highly erodible by Frederick County. These soils tend to be steep. Therefore, they tend to be marginal for agricultural use. These soils may also be good candidates to be taken out of production to reduce erosion and to improve wildlife habitat. The map shows sites where forest buffer restoration projects were done. It also shows extensive riparian areas that lack sufficient could be additionally screened based on current buffer conditions and farm plans. This scenario, supplemented with the land use pollution loading rates, suggests potential buffer restoration opportunities that could minimize phosphorus and sediment loads. (Note: The 300 foot width was used to capture highly erodible soils that are close to streams but not immediately adjacent to them. Width for potential stream buffer restoration would be determined based on local conditions and land owner preferences.)

5. Hydric Soil Scenario for Stream Buffer Targeting

Map 24 Hydric Soil Scenario shows riparian areas categorized by soil and land use for the Linganore watershed. In this watershed, most hydric soils are near streams so all are shown. Places where forest buffer restoration projects have already been implemented are shown on the map.

In the stream riparian areas that naturally vegetated stream buffers, hydric soils can be used as one factor to help select potential stream buffer restoration sites. Siting buffer restoration on hydric soils would offer several benefits:

– Hydric soils tend to be marginal for many agricultural and developed land uses
– Naturally vegetated stream buffers on hydric soil have the potential to intercept nitrogen which is a significant pollutant in the lower Monocacy River, the tidal Lower Potomac River

and the Chesapeake Bay. Plant roots are more likely to be in contact with groundwater for longer periods of time. Plants with roots deep enough to intercept groundwater as it moves toward the stream and plants with high nitrogen uptake capability are most beneficial.

– Natural vegetation in wet areas often offers greater potential for habitat.

6. Optimizing Water Quality Benefits by Combining Priorities

Strategic targeting of stream buffer restoration projects may provide many different benefits. To maximize multiple benefits, site selection and project design need to incorporate numerous factors. For example, finding a site with a mix of attributes like those in the following list could result in the greatest control of nonpoint source pollution and enhancement to living resources:

– land owner willingness / incentives
– marginal land use in the riparian zone
– headwater stream
– soil type including highly erodible or hydric
– selecting appropriate woody/grass species
– adjacent to existing wetlands / habitat

Additionally, selecting restoration projects that are likely to produce measurable success is an important consideration in prioritizing projects for implementation. In the early stages of a watershed restoration program, measurable water quality improvement can be one of the strongest ways to demonstrate project success.

In general, targeting restoration projects to one or a few selected tributaries or small watersheds will tend to offer the greatest probability of producing measurable water quality improvement in the short term. By selecting small areas like a small first order stream for restoration, there is greater likelihood that water quality problems arise locally and that they can be corrected by limited investment in carefully selected local restoration projects. In addition, water quality improvements achieved in the tributary will also inevitably contribute to improving the Lower Monocacy River, the Potomac River and eventually the Chesapeake Bay.

Wetland Restoration

Wetlands serve important environmental functions such as providing habitat and nursery areas for many organisms, facilitating nutrient uptake and recycling, providing erosion control. However, most watersheds in Maryland have significantly fewer wetland acres today than in the past. This loss due to draining, filling, etc., has led to habitat loss and negative water quality impacts in streams and in the Chesapeake Bay. Reversing this historic trend is an important goal of wetland restoration. One approach to identifying candidate wetland restoration sites involves identifying "historic" wetland areas based on the presence of hydric soils. GIS can be used to view wetland and soil information in various scenarios to consider opportunities and target implementation.

Map 25 Wetland Restoration Scenario shows one of many possible GIS scenarios for identifying potential places to create wetlands. The process used to generate the map are listed below:

– Data used: Hydric soils (Natural Soil Groups), existing wetlands (DNR Wetlands), land use (Maryland Dept. of Planning, 2000).
– Identify candidate hydric soil areas based on land use in several land use categories.
– Select hydric soils based on proximity to existing wetlands.

The potential wetland restoration sites suggested in this scenario can be filtered further by using more accurate wetlands and soil information, considering land ownership, etc. Additional steps would be beneficial in applying this information such as considering additional criteria like habitat enhancement opportunities, sensitive species protection, targeting specific streams or subwatersheds for intensive restoration, and using Conservation Reserve Enhancement Program (CREP) information.

PROJECTS RELATED TO THE WRAS PROCESS

There are numerous projects and programs that have the potential to contribute to successful development and implementation of a Watershed Restoration Action Strategy (WRAS). The following list suggests opportunities for cooperation and coordination that can improve the likelihood of success for the WRAS. This listing is not all-inclusive. It is recommended that this list be augmented as new information becomes available and that follow-up should continue to promote the WRAS process with these and other projects and programs.

Projects Using Federal 319(h) Funding

1. Western Maryland Cover Crop Project

Use of cover crops has been identified as one of the most cost-effective ways to keep nutrients and soils in agricultural fields and to prevent them from reaching waterways. The purpose of the Western Maryland Cover Crop project was to help pay for planting of cover crops on a per acre basis using Federal 319 funds from each fiscal year 1999 through 2002. This short-term funding assistance is intended to encourage farm managers to learn first-hand about the benefits of cover crops (operational, economic and environmental). Once farm managers experience these benefits in their operations, it is anticipated that many will continue the practice on their own which will provide long term pollution reduction/prevention benefits in local waterways.[16]

2. Rock & Carroll Creek Stream Restoration Projects - Completed

The Rock & Carroll Creek Stream Corridor Assessment (SCA) identified inadequate forest buffers and stream bank erosion as the most frequently reported problems along these

streams. The Rock & Carroll Creek SCA identified BelAire/Baughmans Lane as a priority restoration area. The Rock and Carroll Creek Restoration Project was a successive partnership among the City of Frederick, MD Department of Natural Resources Shore Erosion Control, Eastern Shore Resource Conservation and Development Council, Maryland Department of Environment, and private design and construction firms for stream restoration. Improvements realized through this project using Federal 319 fiscal year 2000 Incremental Funds and other funding sources include:

– Creation of 20,865 square feet of stream buffer along 1,560 feet of stream;
– Improved passage for fish through culverts at Baughmans Lane and Bel Aire Lane;
– Education/outreach regarding bioengineering techniques reached over 45 local residents in multiple public meetings and about 50 other public works officials in the Monocacy watershed vicinity;
– Pollution reductions resulting from the project: sediment - 374.4 tons/year, nitrogen - 273 pounds/year; and phosphorus - 180 pounds/year.

3. Carroll Creek Stream Restoration – Underway 2003

In the City of Frederick, 3,330 feet along Carroll Creek will be restored using a variety of innovative, non-structural, bioengineering techniques to stabilize eroding streambanks and to improve riparian and in-stream habitat. A wide riparian forest buffer will be planted between Fairview Avenue and Route 15. The project began 2003 and should be completed in 2004 using Federal 319 fiscal year 2002 funds and other funding sources.

4. Carroll Creek Habitat Restoration – Underway 2003

This project in Frederick County will implement recommendations from the Rock and Carroll Creek Forestry Master Plan and the Carroll Creek Stream Corridor Assessment using Federal 319 Incremental Funds from fiscal year 2003 and other funding sources. The project is scheduled to begin in July 2003 and be completed by September 2004. Anticipated resulted are

– Restoration of 2,880 linear feet of stream
– Reforestation of approximately 24 acres including 15 acres of riparian buffer. Planting of about four acres of the riparian forest buffer will be accomplished by volunteers during hands-on restoration training sessions;
– Creation of three acres of non-tidal wetland;
– Pollution reduction is projected to include elimination of actual/potential sediment load of about 724 cubic yards per year;
– Long-term monitoring program will be conducted by Hood College.

Other Projects/Programs

This section summarizes projects and programs that have the potential to contribute to development and implementation of the Watershed Restoration Action Strategy that have not been addressed elsewhere in the watershed characterization.

1. Potomac Watershed Partnership

The Lower Monocacy River watershed is one of several focus watersheds for the Potomac Watershed Partnership. The Partnership is one of fifteen nationwide that were selected by the US Dept. of Agriculture Forest Service (USFS). In addition to USFS, other primary partners are Md DNR Forest Service, Virginia Dept. of Forestry, Ducks Unlimited, Inc., and the Potomac Conservancy. Goals of the project include protecting water quality, restoring riparian forests and wetland, increasing participation in watershed restoration, reducing forest loss/fragmentation in urbanizing areas and improving forest health.

Within the Lower Monocacy River watershed and the other focus watersheds, information applicable to watershed and forest management has been assessed and several projects have been initiated.

2. Frederick County Site Planning Roundtable [12]

Frederick County, with the support of the Center for Watershed Protection, convened the Frederick County Site Planning Roundtable in 1999 to analyze the County's existing development codes and ordinances. Through a consensus process, a diverse group of development, environmental, local government, civic, non-profit, business, and other community professionals the Roundtable recommended some County codes and ordinances could be revised to better protect water resources and aquatic communities. The Roundtable recommended 23 model development principles designed to guide future development towards the goals of measurably reducing impervious cover, conserving natural areas, and minimizing stormwater pollution. Recommended changes addressing streets and parking lots, lot development, and conservation of natural areas including the following issues, many of which are potentially applicable to the WRAS project:

– Shorter, narrower streets
– Fewer and smaller cul-de-sacs
– Smaller parking lots
– Increased stormwater treatment practices
– More community open space
– Flexible sidewalk standards
– Increased vegetated buffers
– Enhanced native vegetation
– Limited clearing and grading

3. Special Rivers Project – Riparian Forest Restoration and Management

The Monocacy River watershed is one of several Maryland watersheds that was targeted for Federal Chesapeake Bay Implementation Grant funds to promote restoration of forested stream buffers and to manage forest lands effectively. During the course of 13 years, the following accomplishments were accumulated across the entire Monocacy River watershed in Maryland:

– Forest Stewardship plans: 627 plans covering 25,435 acres
– Afforestation plans: 392 sites with 869 acres planted

– Buffers created: 314 sites encompassing 2,281 acres
– Reforestation: 3 sites planted on 25 acres and 15 sites allowed to naturally regenerate on 298 acres

4. Hood College Environmental Education Outreach

For about seven years, Hood College has maintained an educational program that, in part, used sampling of local streams to teach environmental principles. The program was aimed at teachers in high schools and middle schools and also students in advanced placed curriculums for biology and environment. Beginning in 2003, the program's emphasis shifted to involve citizen volunteers in monitoring of local streams in cooperation with DNR's Stream Waders Program which is associated with the Maryland Biological Stream Survey. Local water quality data collected during 2003 should be available by early 2004.

5. Monocacy Scenic River Plan

In May 1990, the Frederick County Commissioners and Carroll County Commissioners approved the Monocacy Scenic River Plan. Under Maryland's Scenic and Wild River statute, the purpose of the plan was to protect river resources through inventory and land use planning with seven objectives. The four most relevant to the WRAS project are listed here:

– Improve water quality
– Help maintain and restore the ecological health and productivity of the river
– Encourage land use compatibility and attention to environmentally sensitive areas to maximize conservation and use of riparian resources
– Identify and facilitate appropriate uses and alternative protective measures of significant scenic and ecological areas.

Several findings in the 1990 document continue to be relevant today:
– The Monocacy River watershed had only about 27% forest cover overall.
– Sedimentation, associated with nonpoint sources, was reported as the major contributor to the river's water quality problems. The Monocacy River watershed was said to contribute more sediment to the Potomac River, on a per acre basis, than any other watershed upriver from Point of Rocks.
– Nutrient enrichment, mostly from nonpoint sources, was reported as the second greatest water quality problem. It is relatively high in the Monocacy River compared to other Potomac tributaries in Maryland. In the Lower Monocacy, a significant trend toward increasing total nitrogen was reported.
– Fecal coliform contamination, associated with animal operations and sewage treatment plants, was listed as a problem.

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GLOSSARY

303(d)	A section of the federal Clean Water Act requiring the states to report waters impaired for the uses for which they have been designated, and the reasons for the impairment. Waters included in the "303(d) list" are candidates for having TMDLs developed for them.
319	A section of the federal Clean Water Act dealing with non-point sources of pollution. The number is often used alone as either a noun or an adjective to refer to some aspect of that section of the law, such as grants.
8-digit watershed	Maryland has divided the state into 138 watersheds, each comprising an average of about 75 square miles, that are known as 8-digit watersheds because there are 8 numbers in the identification number each has been given. These nest into the 21 larger 6-digit watersheds in Maryland which are also called Tributary Basins or River Basins. Within the Chesapeake Bay drainage, 8-digit watersheds also nest into 10 Tributary Team Basins.
Anadromous fish	Fish that live most of their lives in salt water but migrate upstream into fresh water to spawn.
Benthic	Living on the bottom of a body of water.
CBIG	Chesapeake Bay Implementation Grant Program, a DNR-administered program that awards grants from the Chesapeake Bay Program to reduce and prevent pollution and to improve the living resources in the Bay.

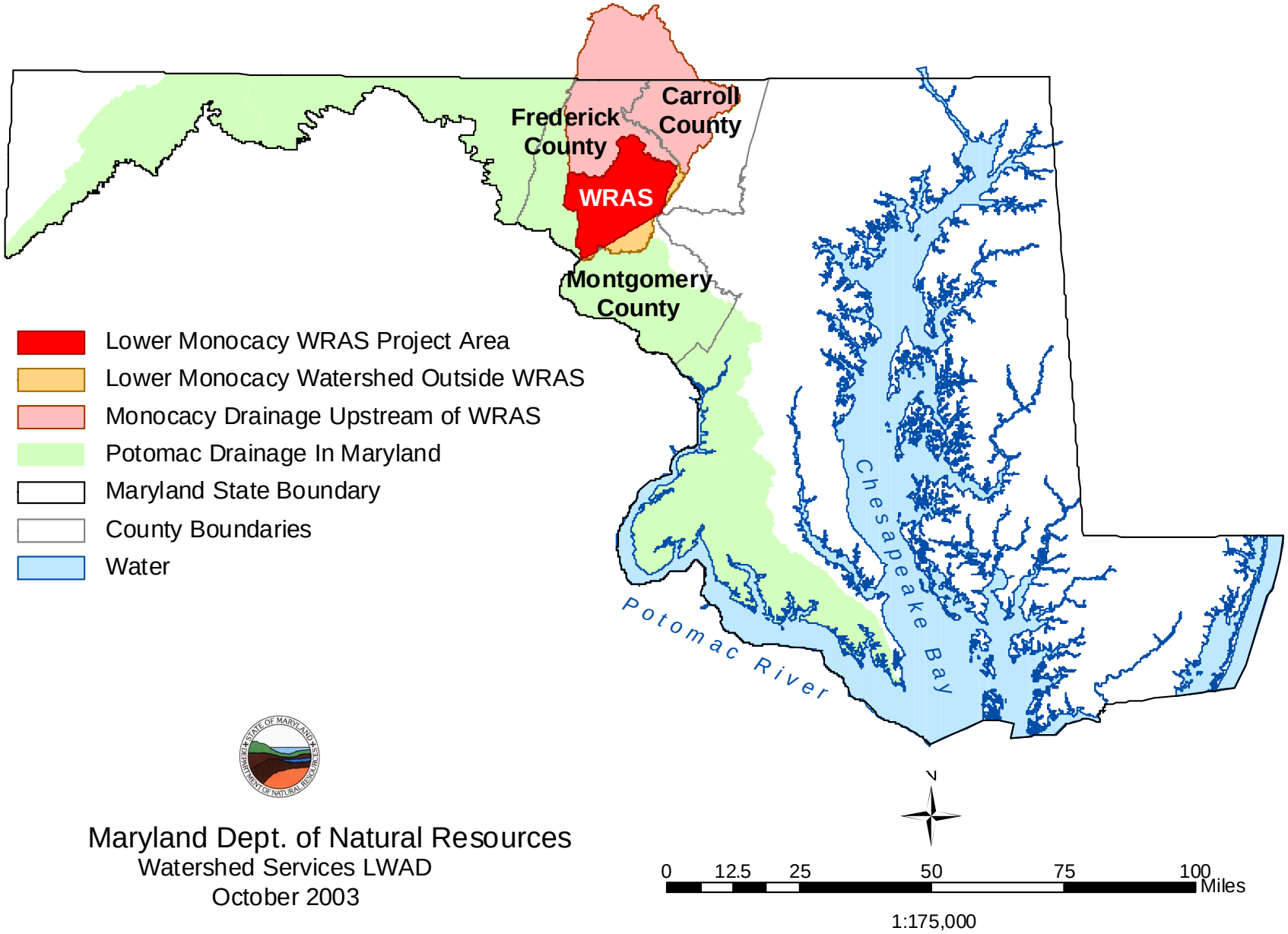
CBNERR	The Chesapeake Bay National Estuarine Research Reserve in a federal, state and local partnership to protect valuable estuarine habitats for research, monitoring and education. The Maryland Reserve has three components: Jug Bay on the Patuxent River in Anne Arundel and Prince Georges' Counties, Otter Point Creek in Harford County and Monie Bay in Somerset County.
COMAR	Code Of Maryland Regulations (Maryland State regulations)
CREP	Conservation Reserve Enhancement Program, a program of MDA. CREP is a federal/state and private partnership which reimburses farmers at above normal rental rates for establishing riparian forest or grass buffers, planting permanent cover on sensitive agricultural lands and restoring wetlands for the health of the Chesapeake Bay.
CRP	Conservation Reserve Program, a program of Farm Service Agency in cooperation with local Soil Conservation Districts. CRP encourages farmers to take highly erodible and other environmentally-sensitive farm land out of production for ten to fifteen years.
CWAP	Clean Water Action Plan, promulgated by EPA in 1998. It mandates a statewide assessment of watershed conditions and provides for development of Watershed Restoration Action Strategies (WRASs) for priority watersheds deemed in need of restoration
CWiC	Chesapeake 2000 Agreement watershed commitments. CWiC is a shorthand phrase used in the Chesapeake Bay Program.
CZARA	The Coastal Zone Reauthorization Amendments of 1990, intended to address coastal non-point source pollution. Section 6217 of CZARA established that each state with an approved Coastal Zone Management program must develop and submit a Coastal Non-Point Source program for joint EPA/NOAA approval in order to "develop and implement management measures for NPS pollution to restore and protect coastal waters".
CZMA	Coastal Zone Management Act of 1972, establishing a program for states and territories to voluntarily develop comprehensive programs to protect and manage coastal resources (including the Great Lakes). Federal funding is available to states with approved programs.
Conservation Easement	A legal document recorded in the local land records office that specifies conditions and/or restrictions on the use of and title to a parcel of land. Conservation easements run with the title of the land and typically restrict

	development and protect natural attributes of the parcel. Easements may stay in effect for a specified period of time, or they may run into perpetuity.
DNR	Department of Natural Resources (Maryland State)
EPA	Environmental Protection Agency (United States)
ESA	Ecologically Significant Area, an imprecisely defined area in which DNR has identified the occurrence of rare, threatened and/or endangered species of plants or animals, or of other important natural resources such as rookeries and waterfowl staging areas.
Fish blockage	An impediment, usually man-made, to the migration of fish in a stream, such as a dam or weir, or a culvert or other structure in the stream
GIS	Geographic Information System, a computerized method of capturing, storing, analyzing, manipulating and presenting geographical data.
MBSS	Maryland Biological Stream Survey, a program in DNR that samples small streams throughout the state to assess the condition of their living resources.
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
MET	Maryland Environmental Trust, an organization that holds conservation easements on private lands and assists local land trusts to do similar land protection work.
MGS	Maryland Geological Survey, a division in DNR.
NHA	Natural Heritage Area, a particular type of DNR land holding, designated in COMAR.
NOAA	National Oceanic and Atmospheric Administration, an agency of the US Department of Commerce that, among other things, supports the Coastal Zone Management program, a source of funding for some local environmental activities, including restoration work.
NPS	Non-Point Source, pollution that originates in the landscape that is not

	collected and discharged through an identifiable outlet.
NRCS	Natural Resources Conservation Service, formerly the Soil Conservation Service, an agency of the US Department of Agriculture that, through local Soil Conservation Districts, provides technical assistance to help farmers develop conservation systems suited to their land. NRCS participates as a partner in other community-based resource protection and restoration efforts.
PDA	Public Drainage Association
Palustrine Wetlands	Fresh water wetlands, including bogs, marshes and shallow ponds.
RAS	Resource Assessment Service, a unit of DNR that carries out a range of monitoring and assessment activities affecting the aquatic environment.
Riparian Area	1. Land adjacent to a stream. 2. Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e. a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines. (National Research Council, *Riparian Areas: Functions and Strategies for Management*. Executive Summary page 3. 2002)
SAV	Submerged Aquatic Vegetation, important shallow-water sea grasses that serve as a source of food and shelter for many species of fin- and shell-fish.
SCA[M]	Stream Corridor Assessment is an activity carried out by DNR Watershed Services in support of WRAS development and other management needs, in which trained personnel walk up stream channels noting important physical features and possible sources of problems.
SCD	Soil Conservation District is a county-based, self-governing body whose purpose is to provide technical assistance and advice to farmers and landowners on the installation of soil conservation practices and the management of farmland to prevent erosion.
Synoptic survey	A short term sampling of water quality and analysis of those samples to measure selected water quality parameters. A synoptic survey as

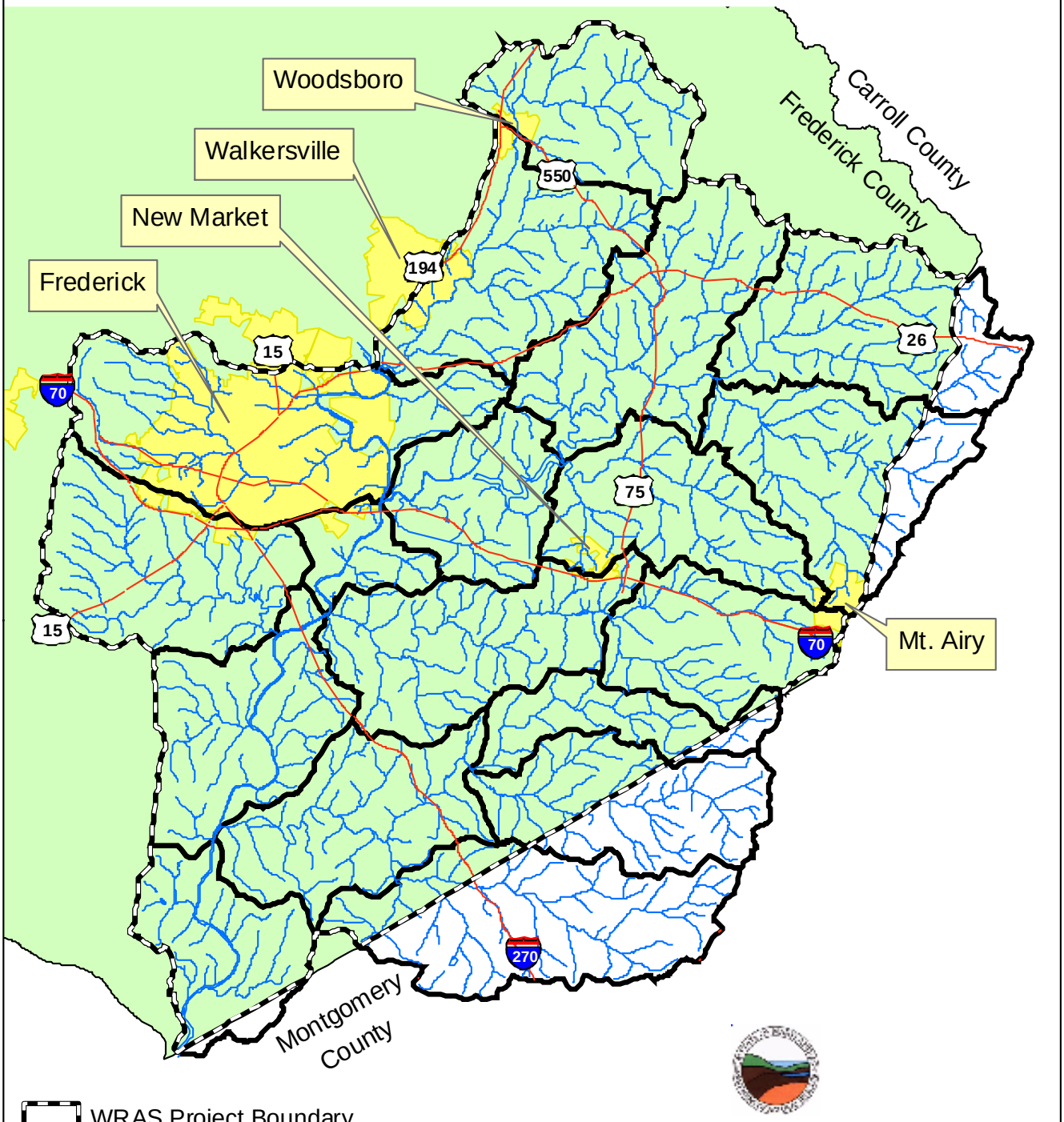
	performed by DNR in support of watershed planning may be expanded to include additional types of assessment like benthic macroinvertebrate sampling or physical habitat assessment.
TMDL	Total Maximum Daily Load, a determination by MDE of the upper limit of one or more pollutants that can be added to a particular body of water beyond which water quality would be deemed impaired.
Tributary Teams	Geographically-focused groups, appointed by the Governor, oriented to each of the 10 major Chesapeake Bay tributary basins found in Maryland. The teams focus on policy, legislation, hands-on implementation of projects, and public education. Each basin has a plan, or Tributary Strategy.
USFWS	United States Fish and Wildlife Service, in the Department of Interior.
USGS	United States Geological Survey
Water Quality Standard	Surface water quality standards consist of two parts: (a) designated uses of each water body; and (b) water quality criteria necessary to support the designated uses. Designated uses of for all surface waters in Maryland (like shell fish harvesting or public water supply) are defined in regulation. Water quality criteria may be qualitative (like "no objectionable odors") or quantitative (toxic limitations or dissolved oxygen requirements).
Watershed	All the land that drains to an identified body of water or point on a stream.
WRAS	Watershed Restoration Action Strategy, a document outlining the condition of a designated watershed, identifying problems and commiting to solutions of prioritized problems.
WSSC	Wetland of Special State Concern, a designation by MDE in COMAR.

Map 1 Location: Lower Monocacy River WRAS Project Area



Maryland Dept. of Natural Resources
Watershed Services LWAD
October 2003

Map 2 Project Area: Lower Monocacy River WRAS



WRAS Project Boundary
Subwatershed Boundaries (12-digit)
Town
Frederick County
Streams
Highways

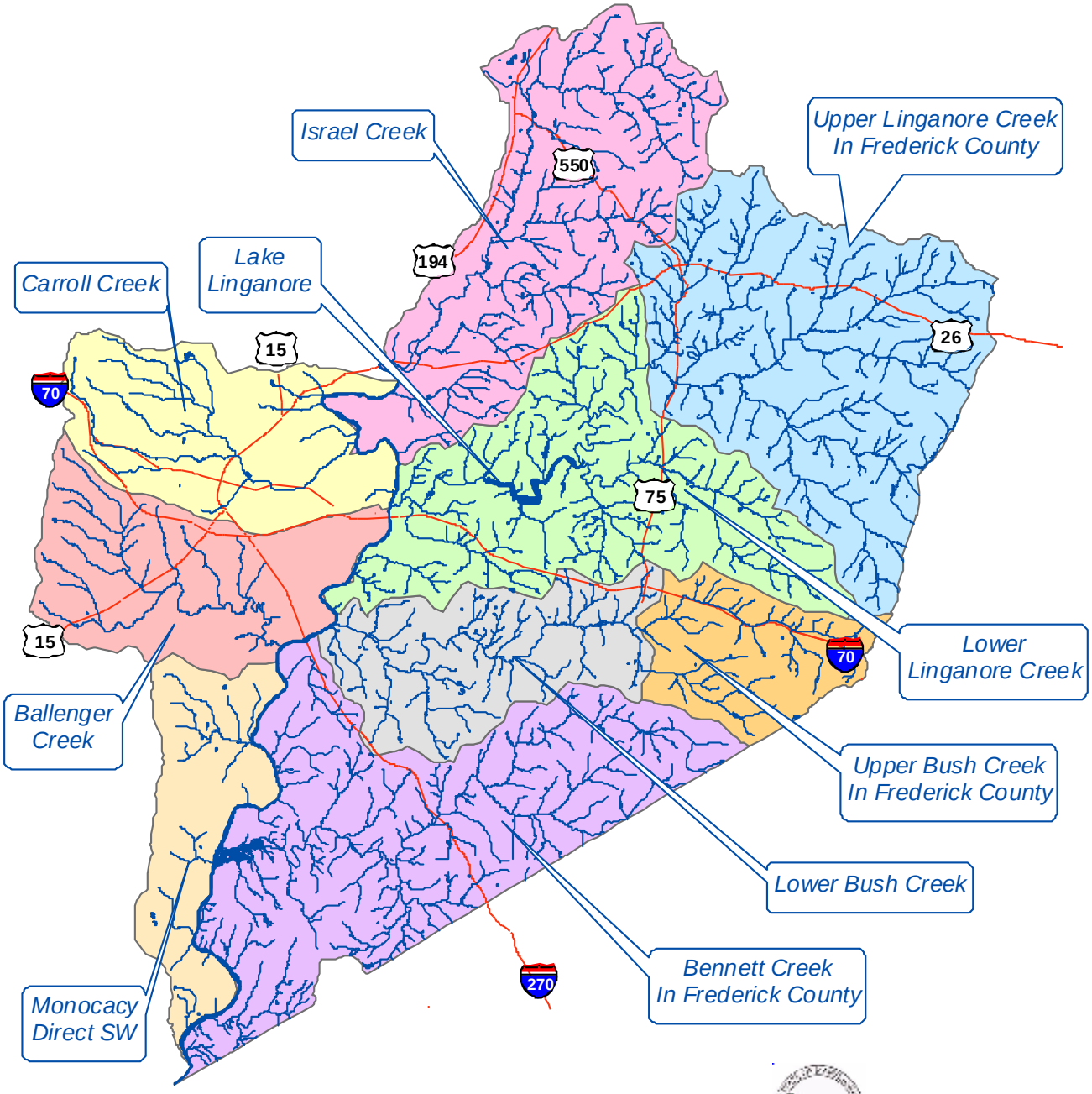
N

Maryland Dept. of Natural Resources
Watershed Services LWAD
October 2003

0 1 2 4 6 8 Miles

1:225,000

Map 3 County Subwatersheds
Lower Monocacy River WRAS



Name
County Name For Subwatershed

Streams (County Data)

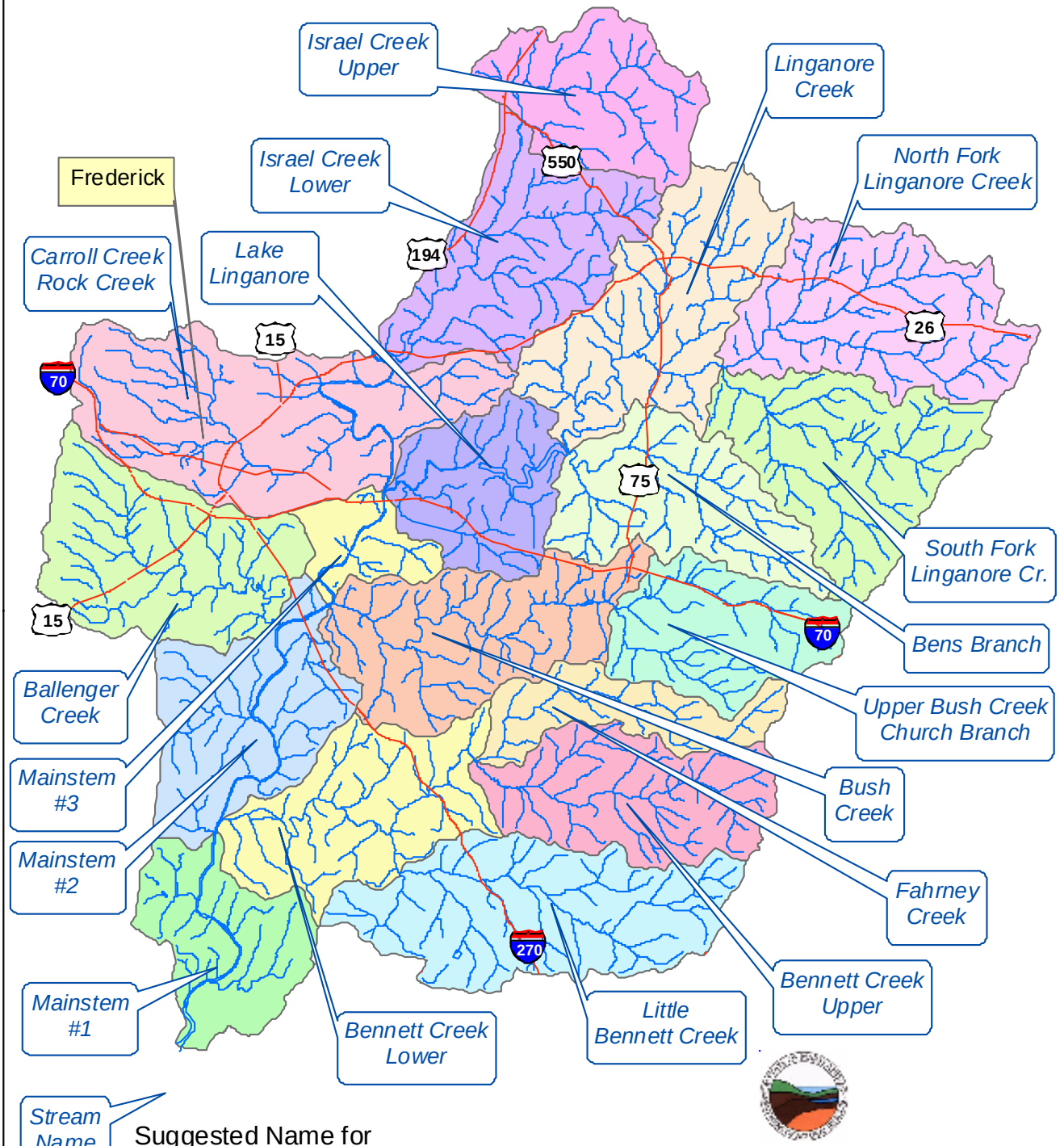
Highways

Maryland Dept. of Natural Resources
Watershed Services LWAD
Data: Frederick Co., DNR GIS: Oct. 2003

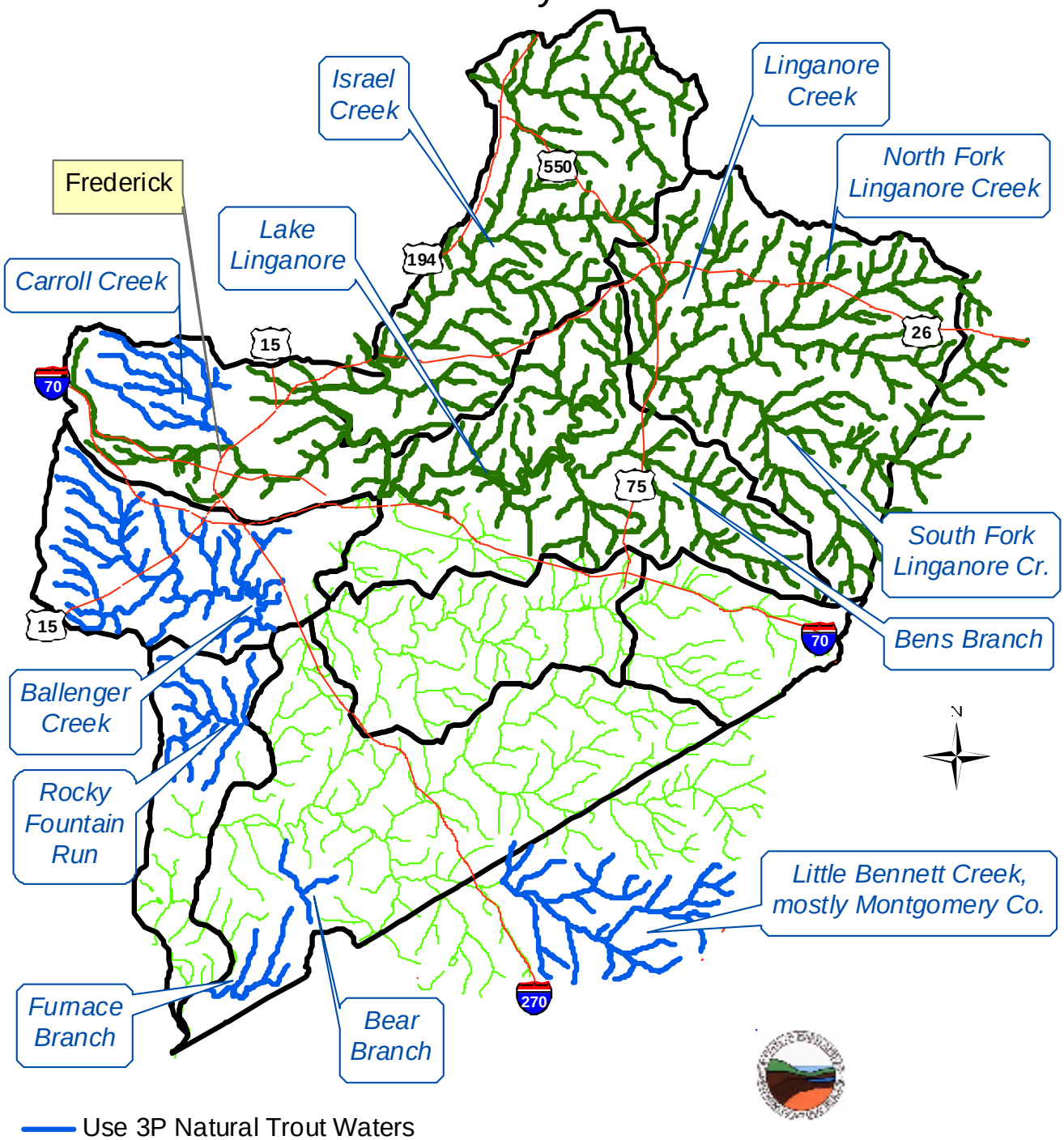
0 1 2 4 6 8 Miles

1:225,000

Map 4 State Subwatersheds
Lower Monocacy River WRAS



Map 5 Designated Uses
Lower Monocacy River WRAS



Use 3P Natural Trout Waters

Use 4P Recreational Trout Waters

Use 1P Aquatic Life, Recreational Use

Frederick Co. Subwatersheds

Highways

Maryland Dept. of Natural Resources

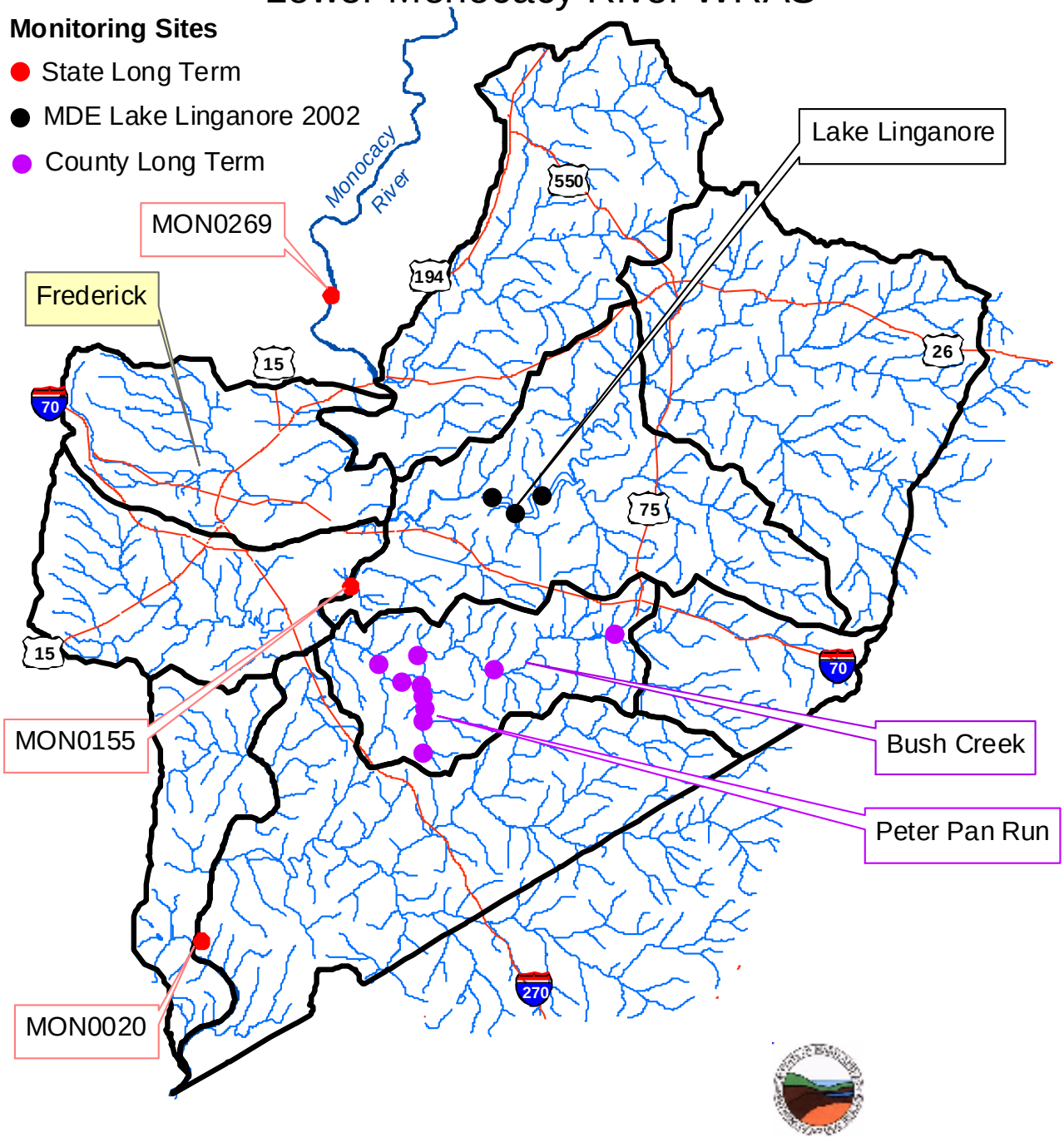
Watershed Services LWAD

Data: MDE March 2003 GIS: Oct. 2003

0 1 2 4 6 8 Miles

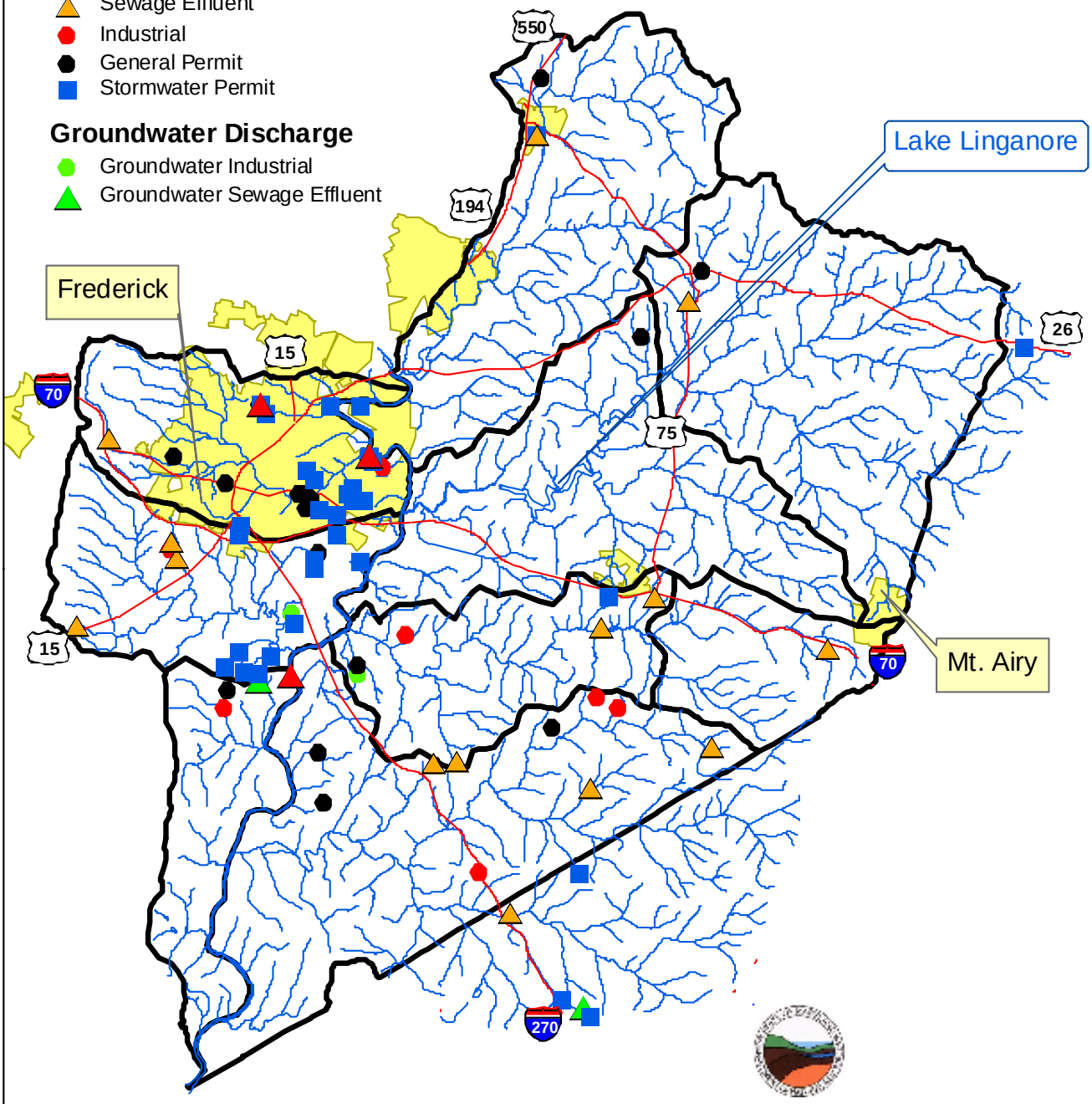
1:225,000

Map 6 Water Quality Monitoring
Lower Monocacy River WRAS



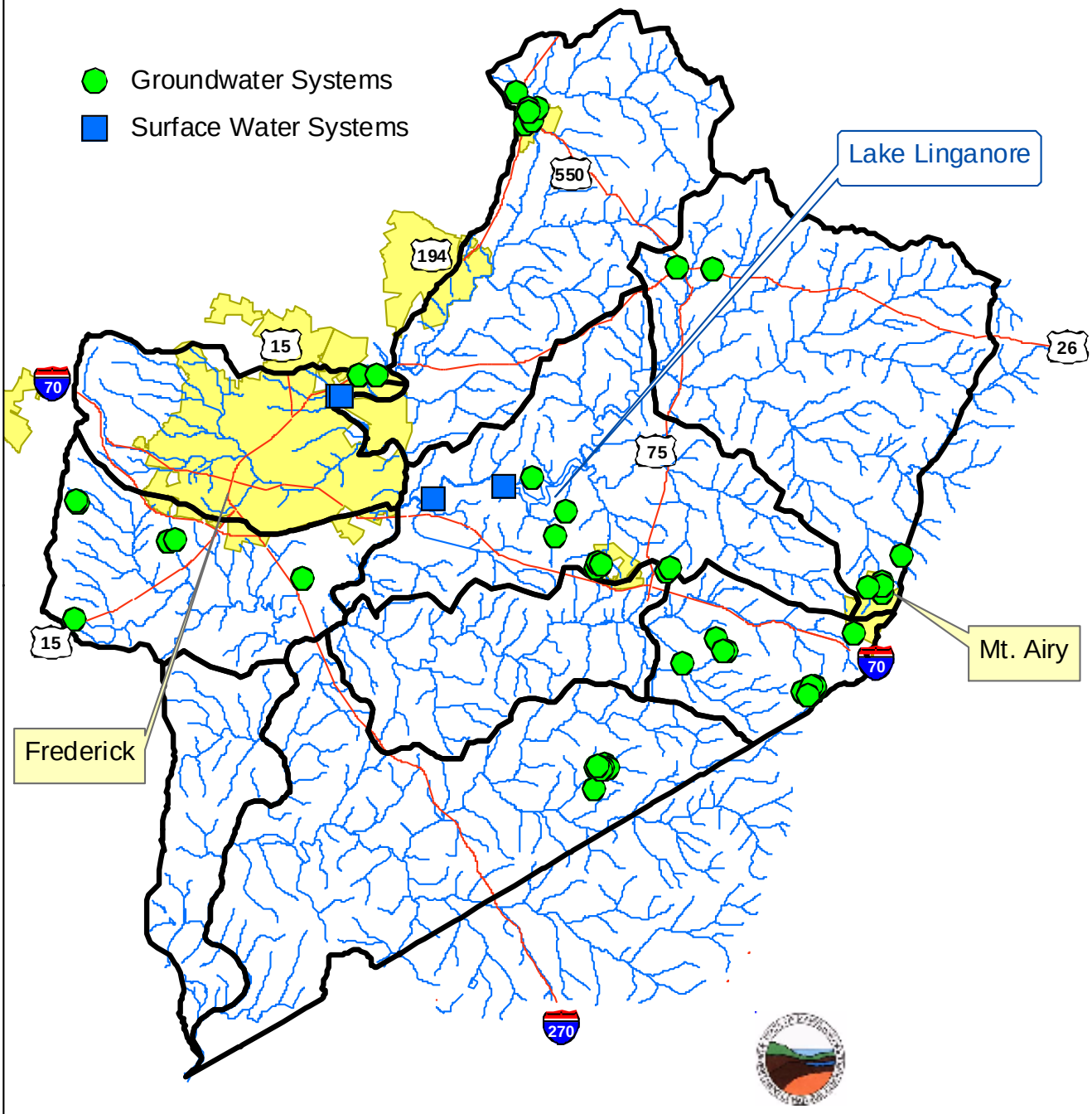
Maryland Dept. of Natural Resources
Watershed Services LWAD
Data: DNR, MDE, VERSAR GIS: Oct. 2003

Map 7 MDE Permits: Lower Monocacy River WRAS



Maryland Dept. of Natural Resources
Watershed Services LWAD
Data: February 2003 GIS: Oct. 2003

Map 8 Community Water Systems
Lower Monocacy River WRAS



Frederick Co. Subwatersheds
Municipalities
Streams
Highways

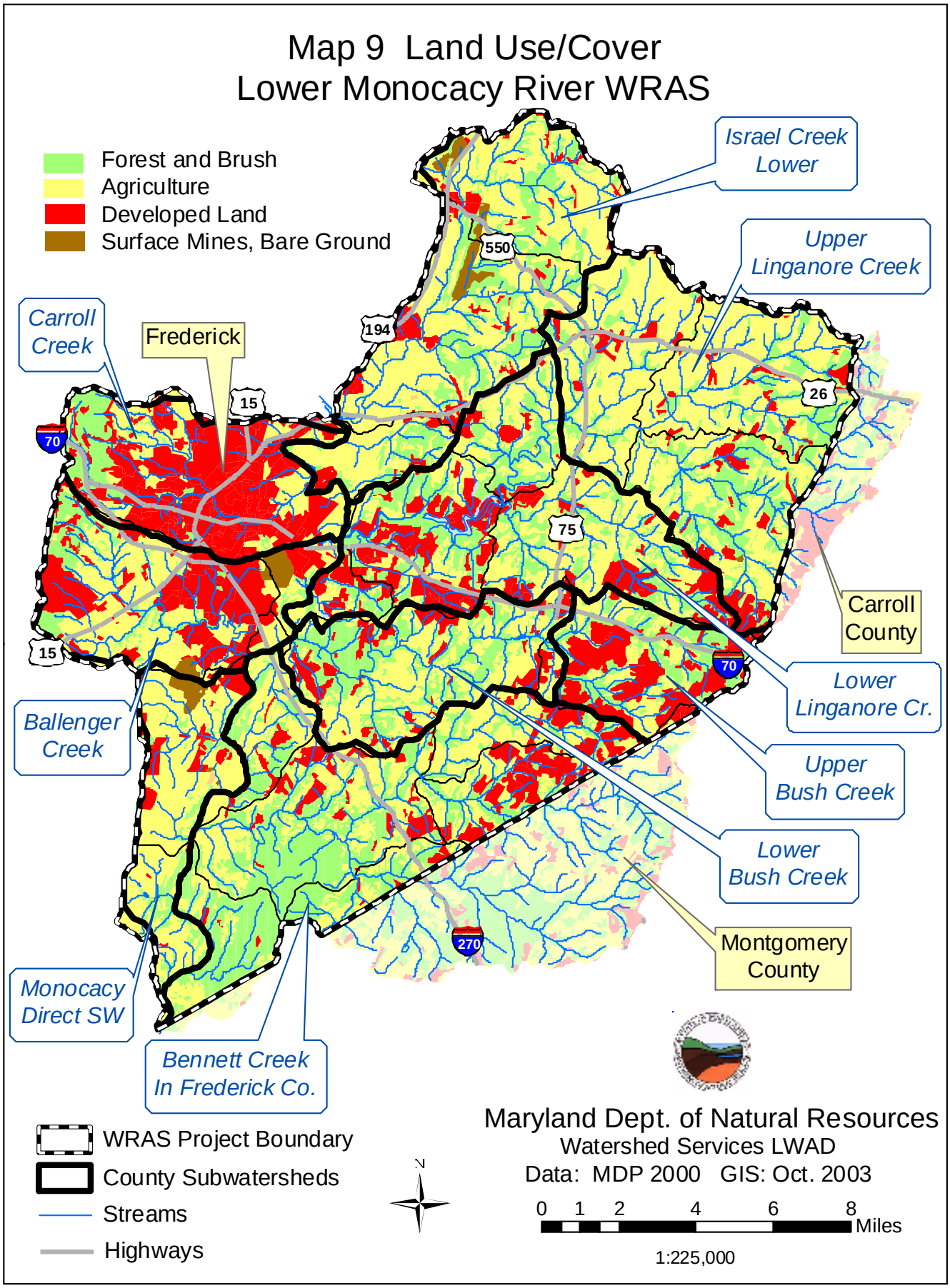
N

Maryland Dept. of Natural Resources
Watershed Services LWAD
Data: April 2003 GIS: Oct. 2003

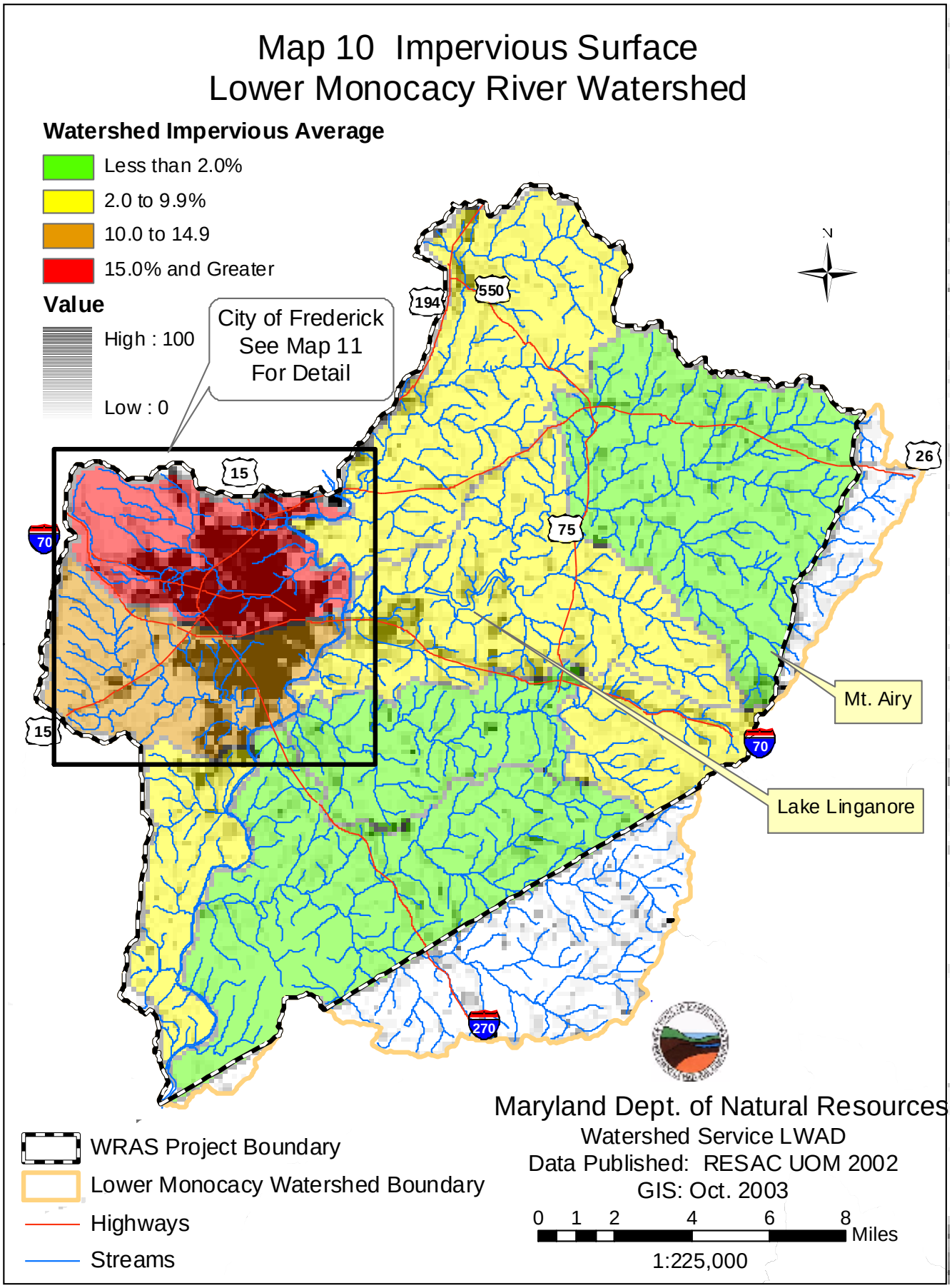
0 1 2 4 6 8 Miles

1:225,000

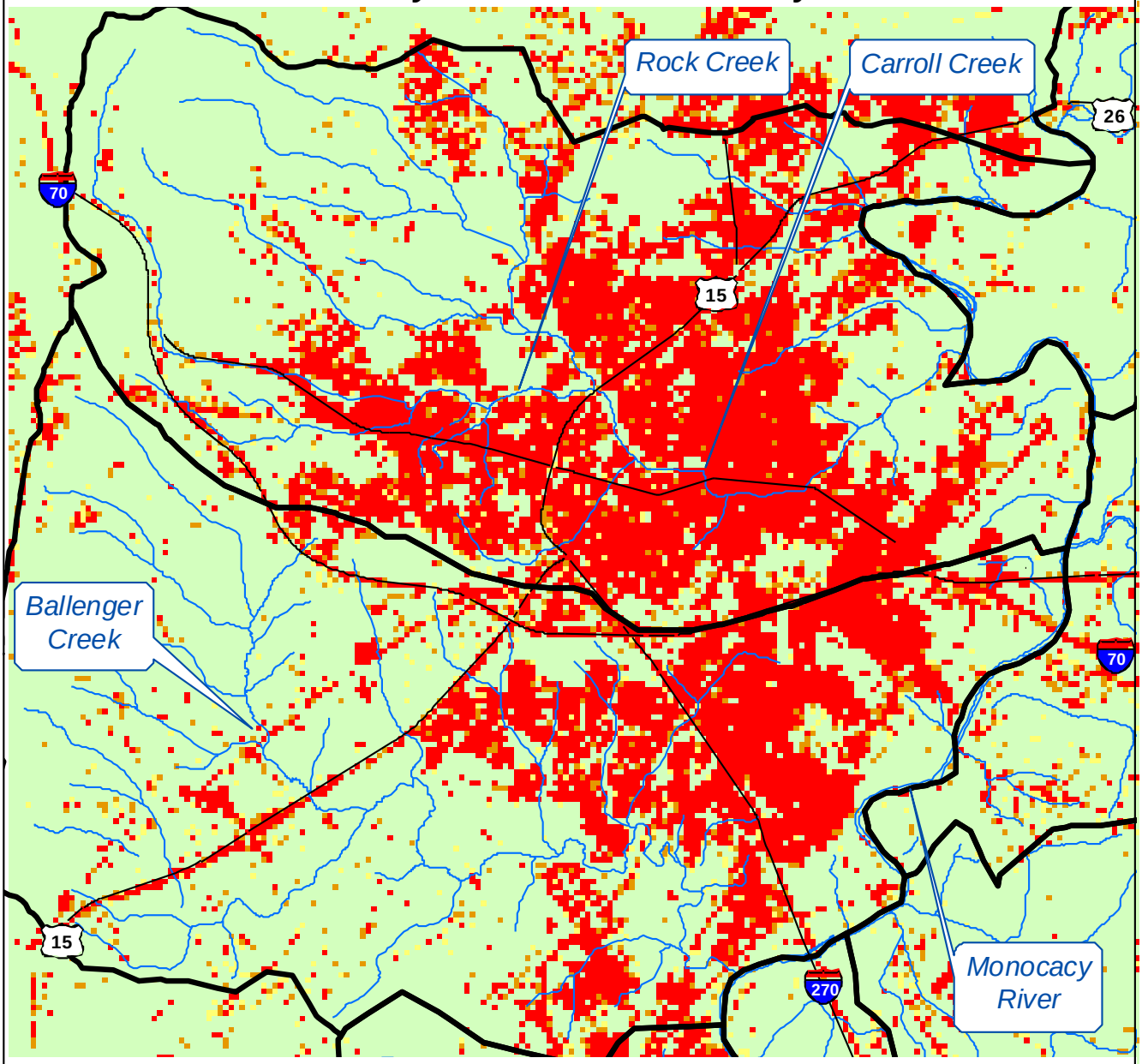
Map 9 Land Use/Cover
Lower Monocacy River WRAS



Map 10 Impervious Surface
Lower Monocacy River Watershed



Map 11 Impervious Cover
City of Frederick Vicinity



Value

- Less than 2.0%
- 2.0 to 9.9%
- 10.0 to 14.9%
- 15.0% and Greater
- Frederick Co. Subwatersheds
- Highways
- Streams

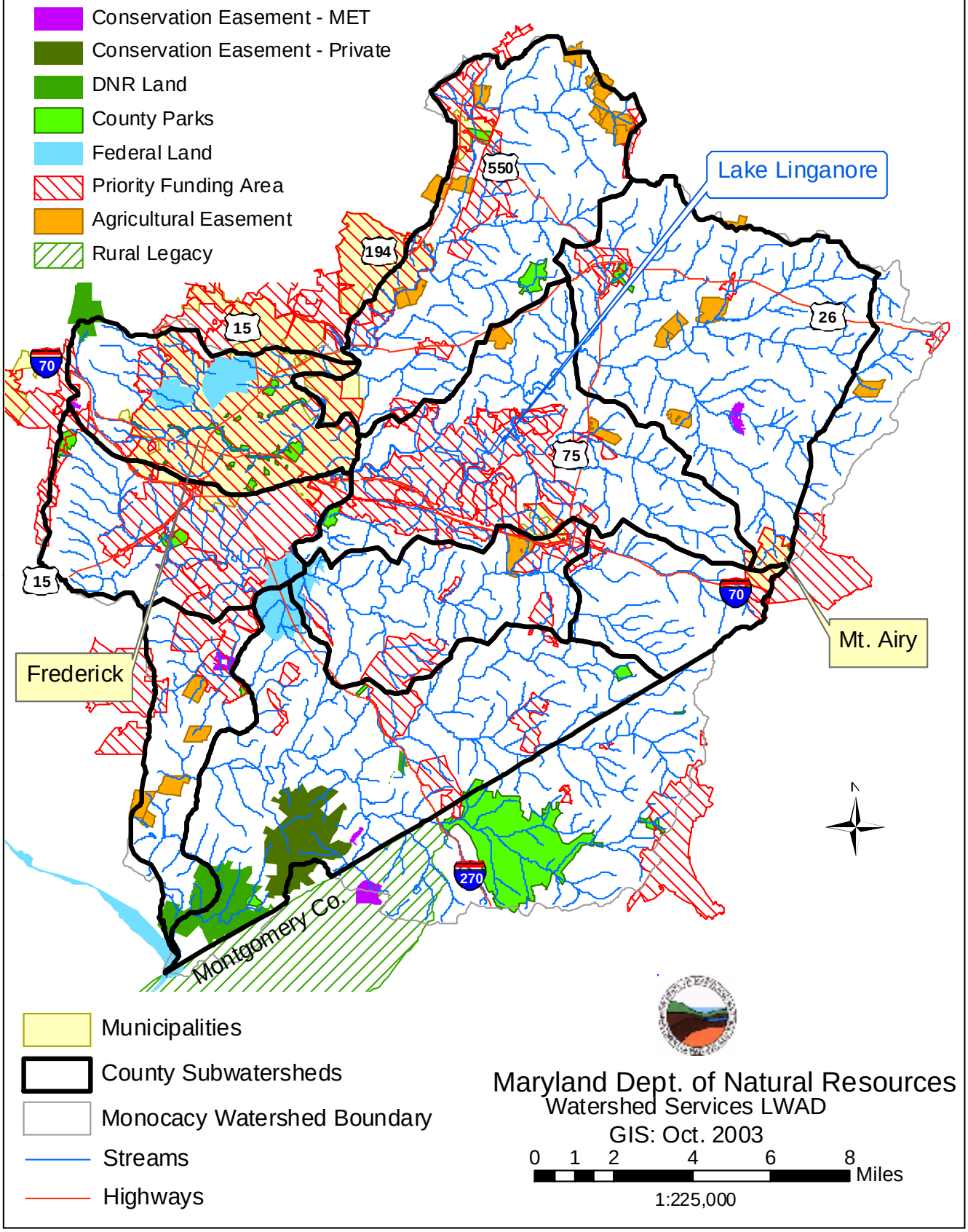
N

Maryland Dept. of Natural Resources
Watershed Service LWAD
Data Publication: RESAC UOM 2002
GIS: Oct. 2003

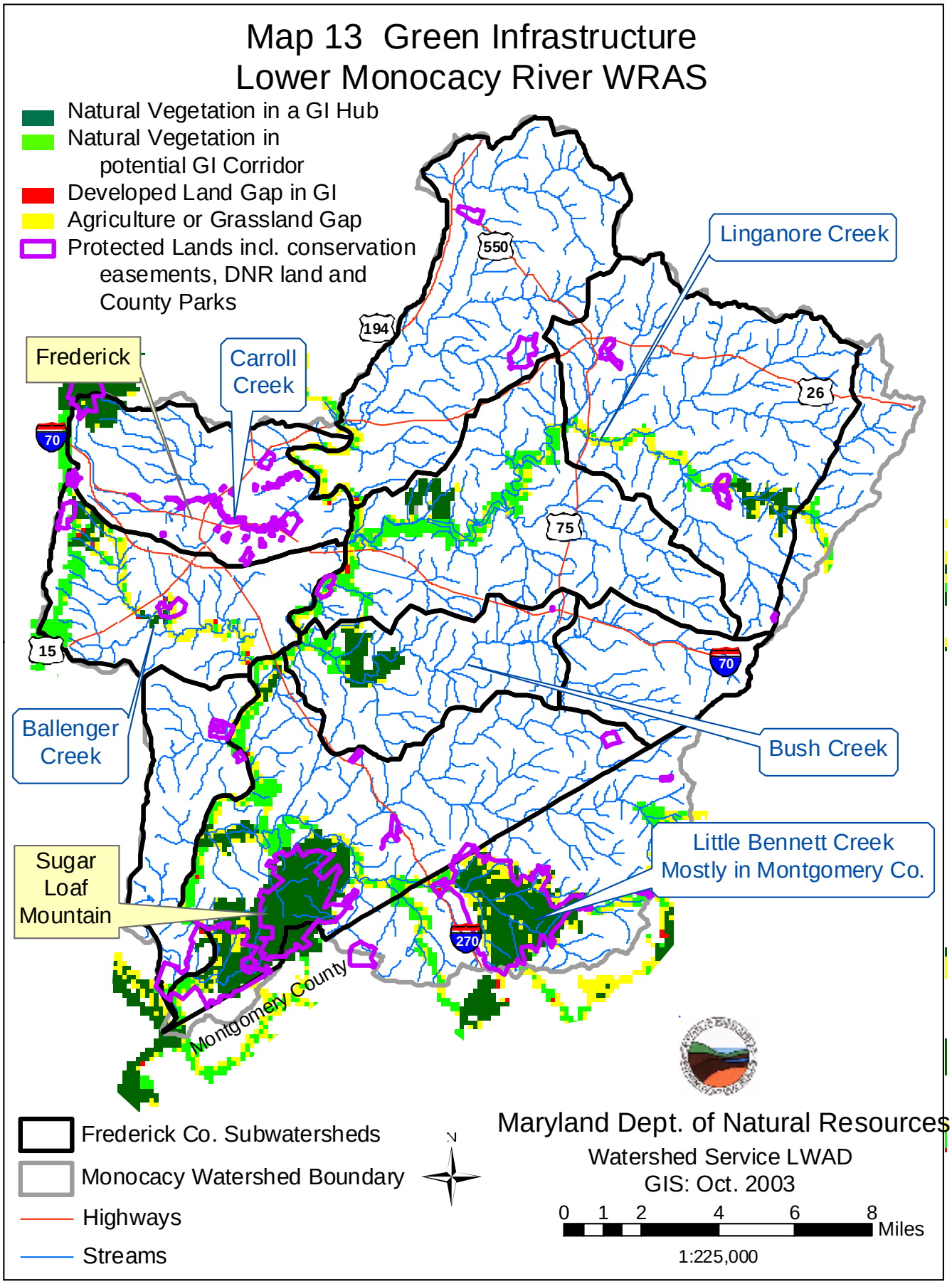
0 0.5 1 2 3 4 Miles

1:75,000

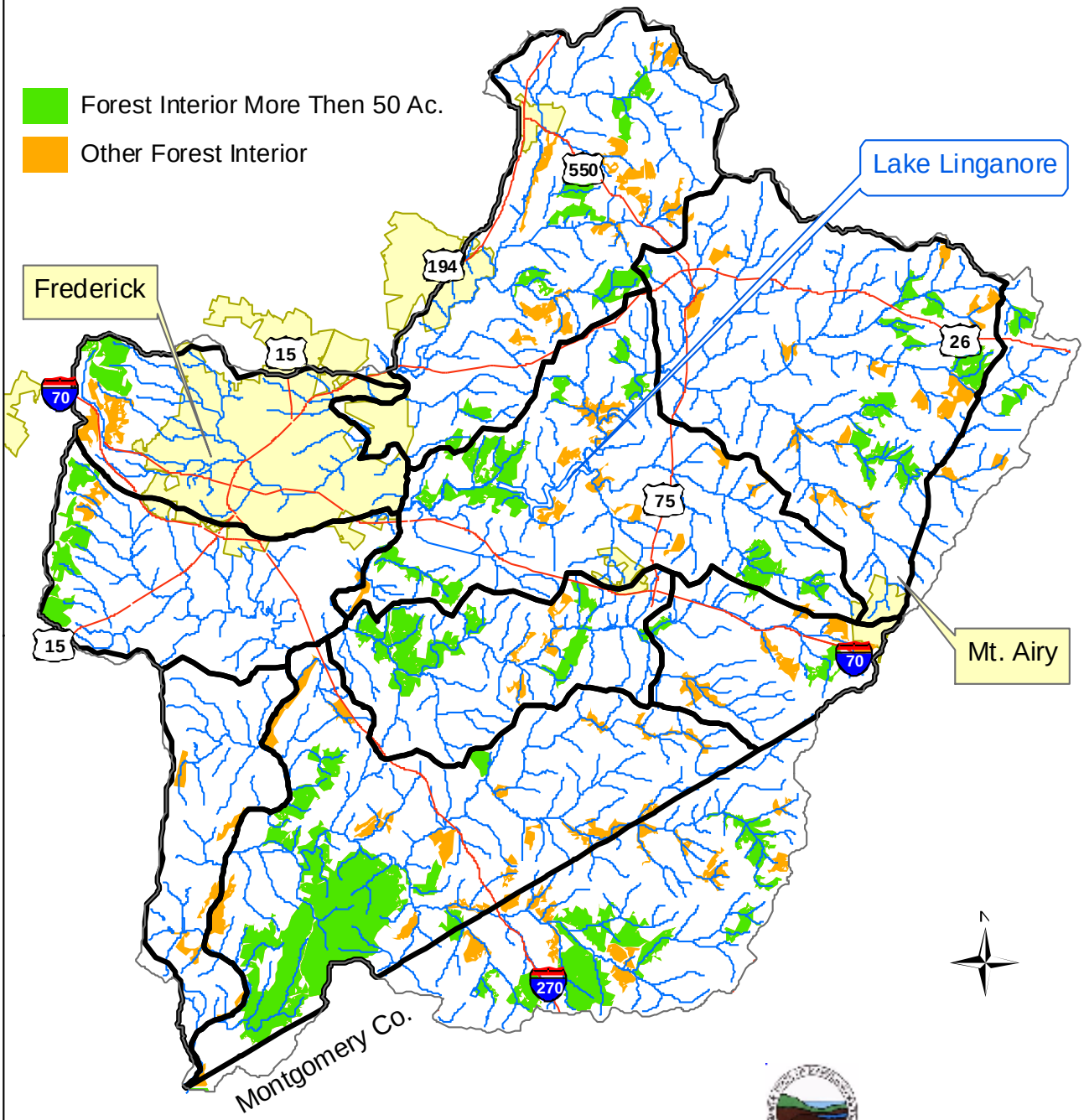
Map 12 Protected Land: Lower Monocacy River WRAS



Map 13 Green Infrastructure
Lower Monocacy River WRAS



Map 14 Forest Interior
Lower Monocacy River WRAS



Municipalities

Frederick Co. Subwatersheds

Lower Monocacy Watershed

Streams

Highways

Maryland Dept. of Natural Resources

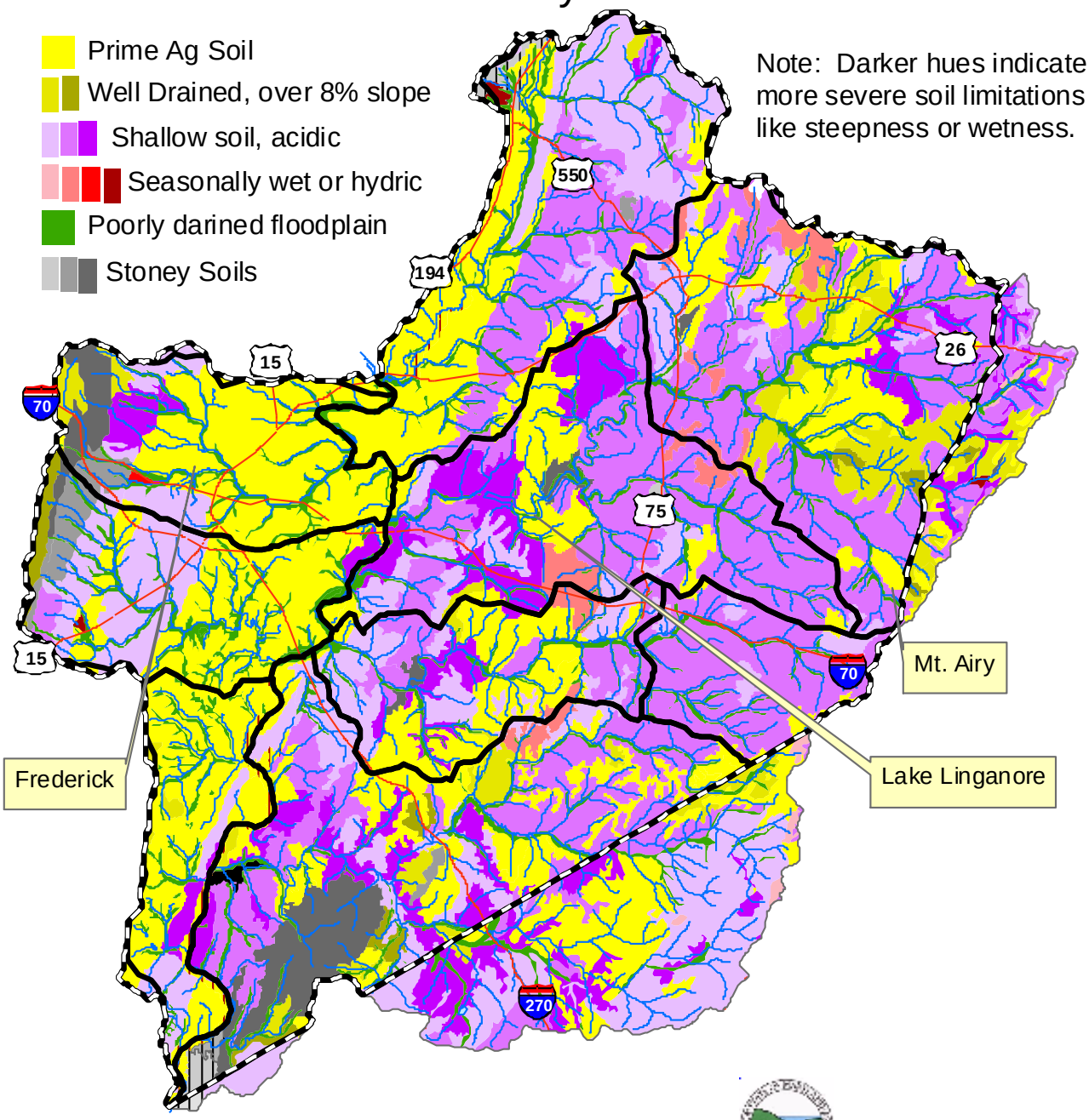
Watershed Services LWAD

Data: MRLC 1999 GIS: Oct. 2003

0 1 2 4 6 8 Miles

1:225,000

Draft Map X Natural Soils Groups
Lower Monocacy River WRAS



WRAS Project Boundary
County Subwatersheds
Monocacy Watershed
Highways
Streams

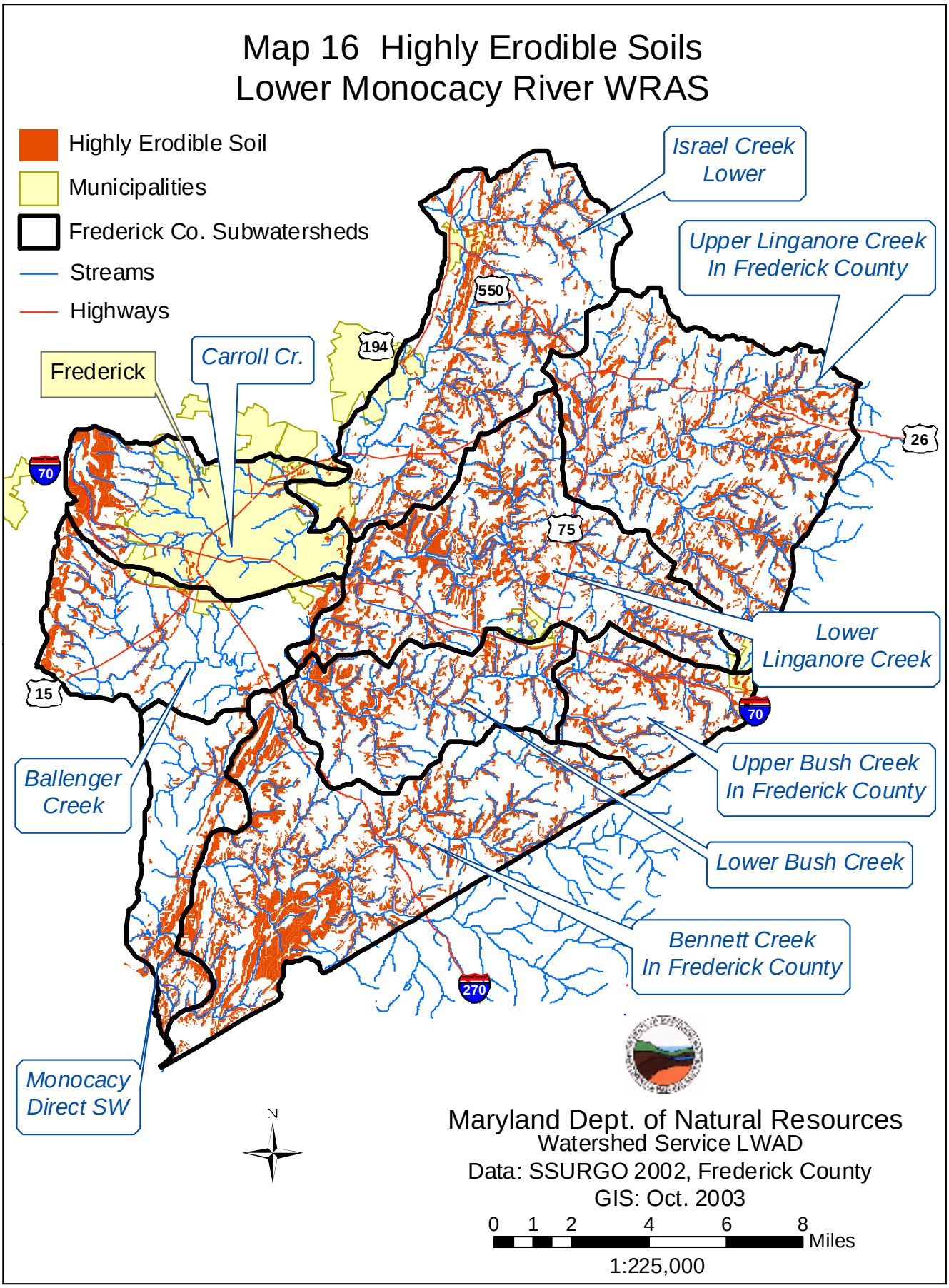
N

1:225,000

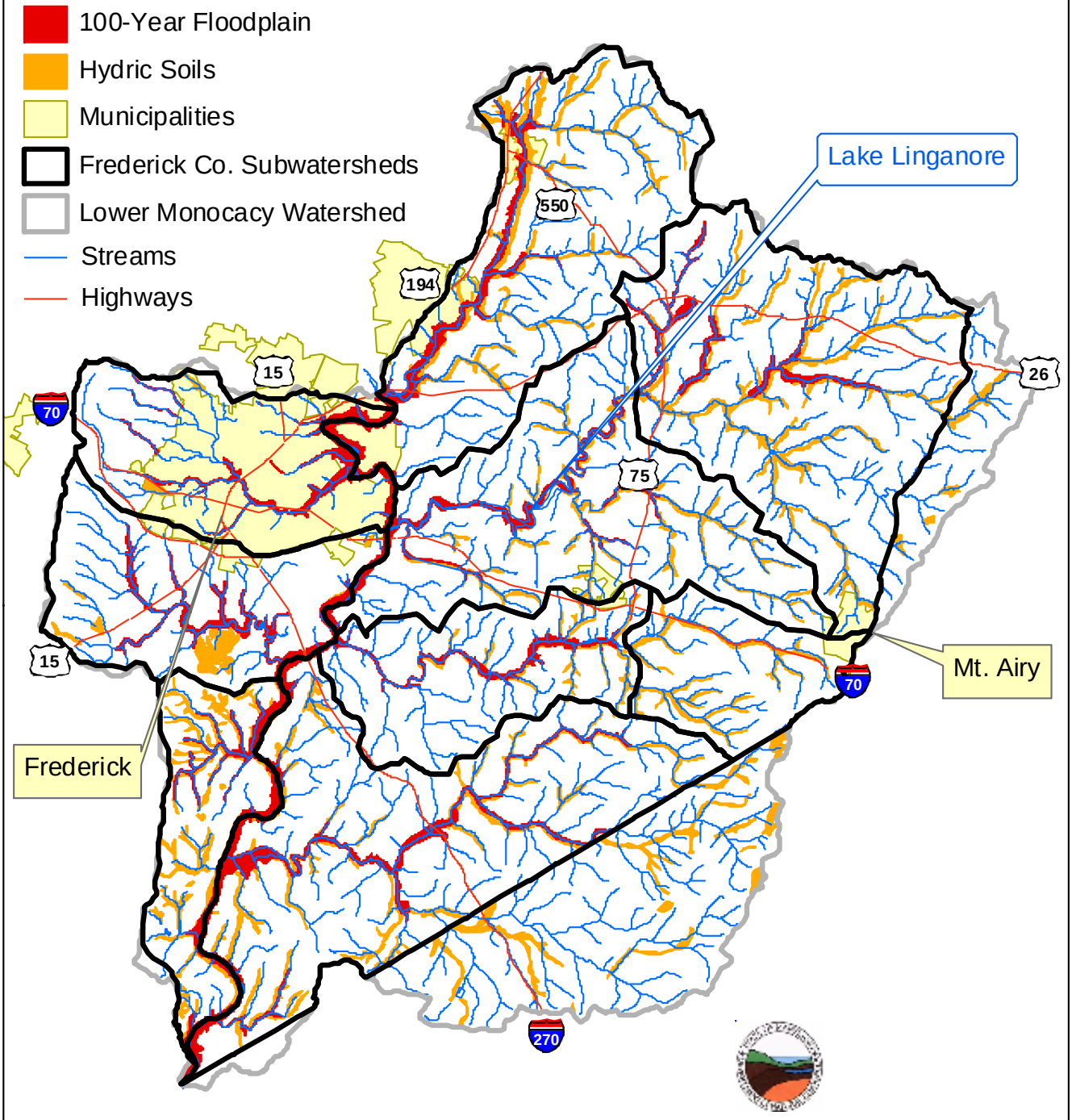
Maryland Dept. of Natural Resources
Chesapeake and Coastal Watershed Service
Watershed Management and Analysis Division
March 2003

0 1 2 4 6 8 Miles

Map 16 Highly Erodible Soils
Lower Monocacy River WRAS



Map 17 Hydric Soil and Floodplains
Lower Monocacy River WRAS



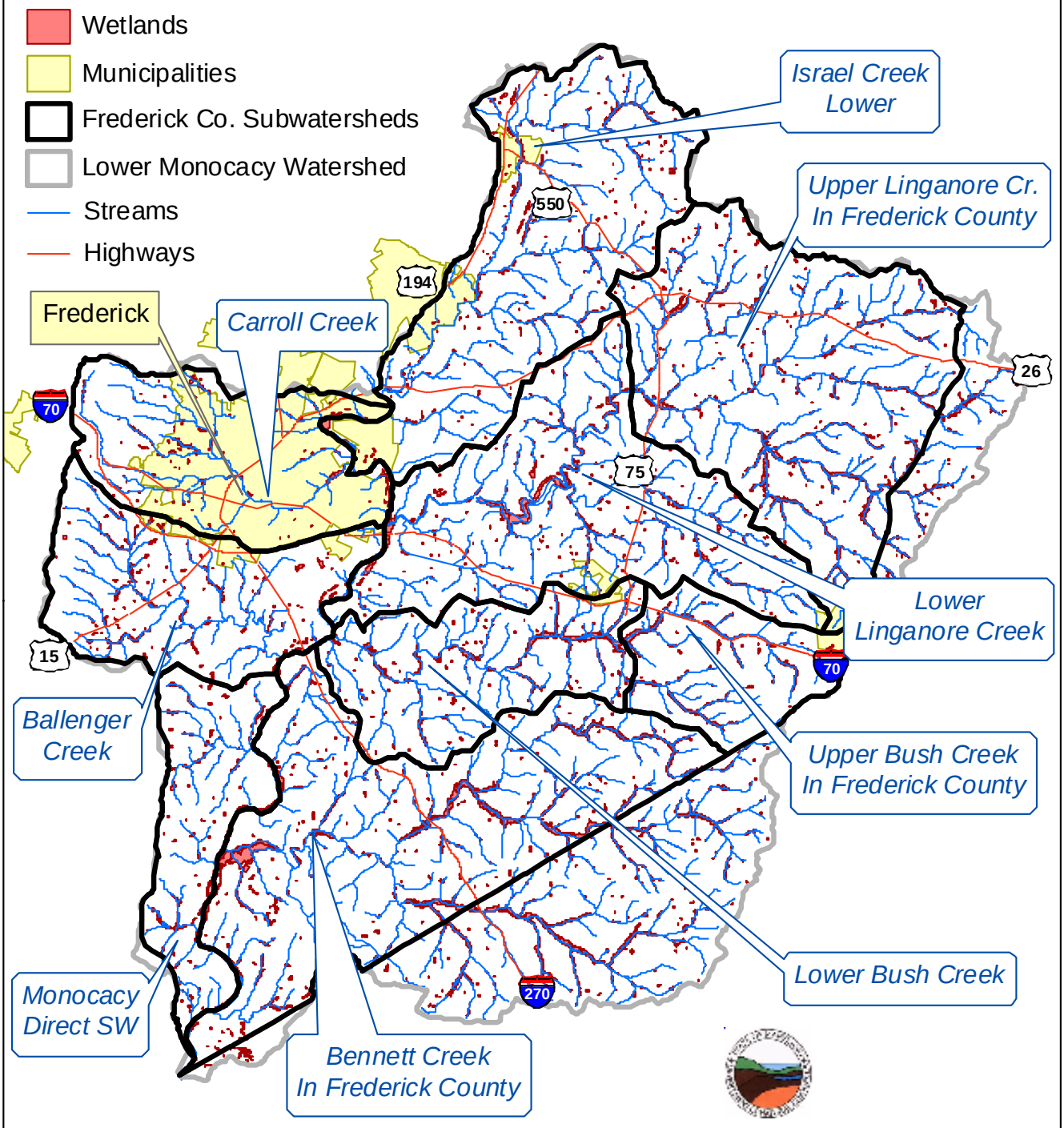
NOTE: Floodplains are from FEMA maps and hydric soils are based on Md. State Planning Natural Soils Groups

Maryland Dept. of Natural Resources
Watershed Services LWAD
GIS: Oct. 2003

0 1 2 4 6 8 Miles

1:225,000

Map 18 Wetlands
Lower Monocacy River WRAS



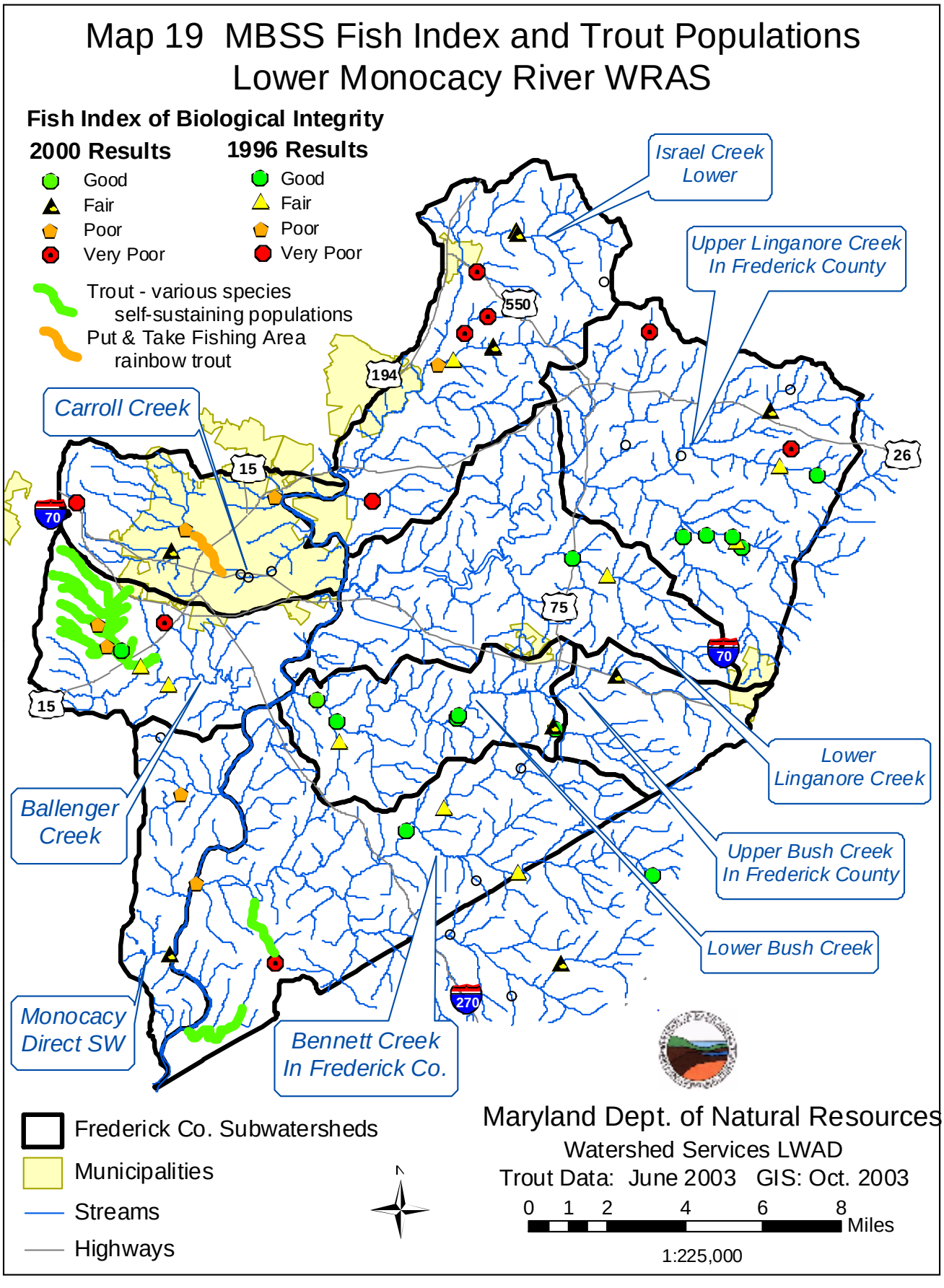
NOTE: Wetlands shown here are from the DNR Wetland Inventory.

Maryland Dept. of Natural Resources
Watershed Service LWAD
GIS: Oct. 2003

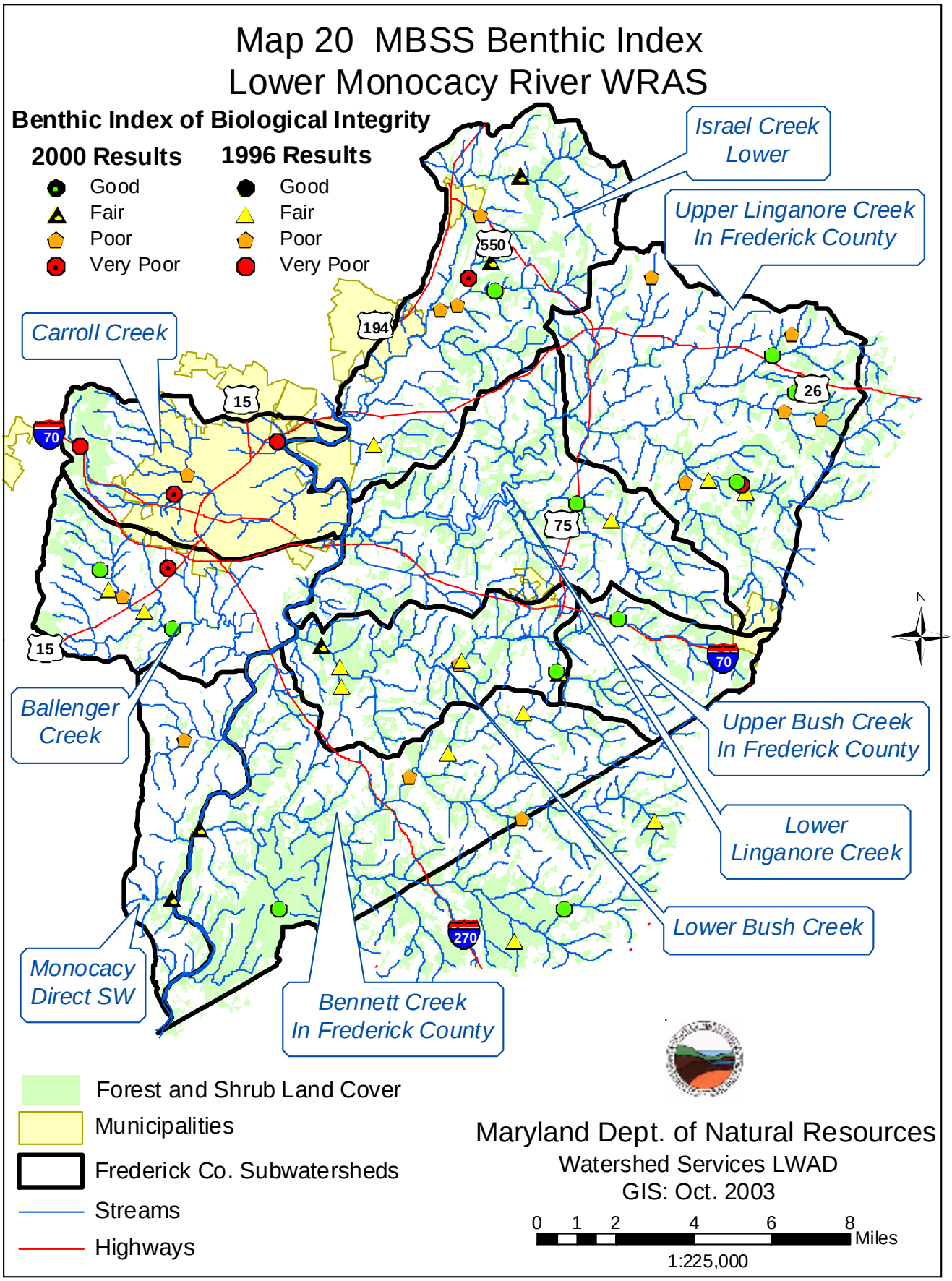
0 1 2 4 6 8 Miles

1:225,000

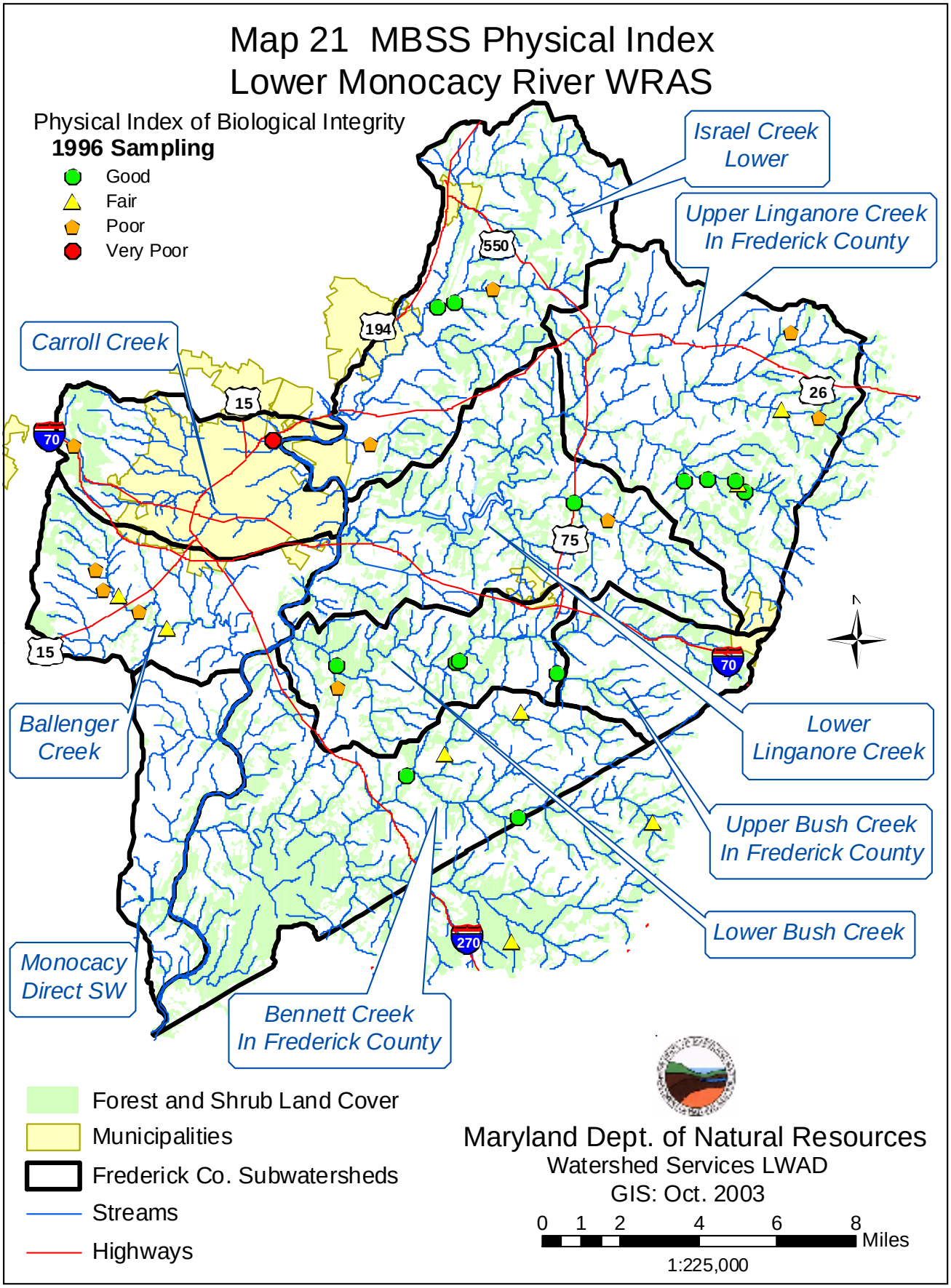
Map 19 MBSS Fish Index and Trout Populations
Lower Monocacy River WRAS



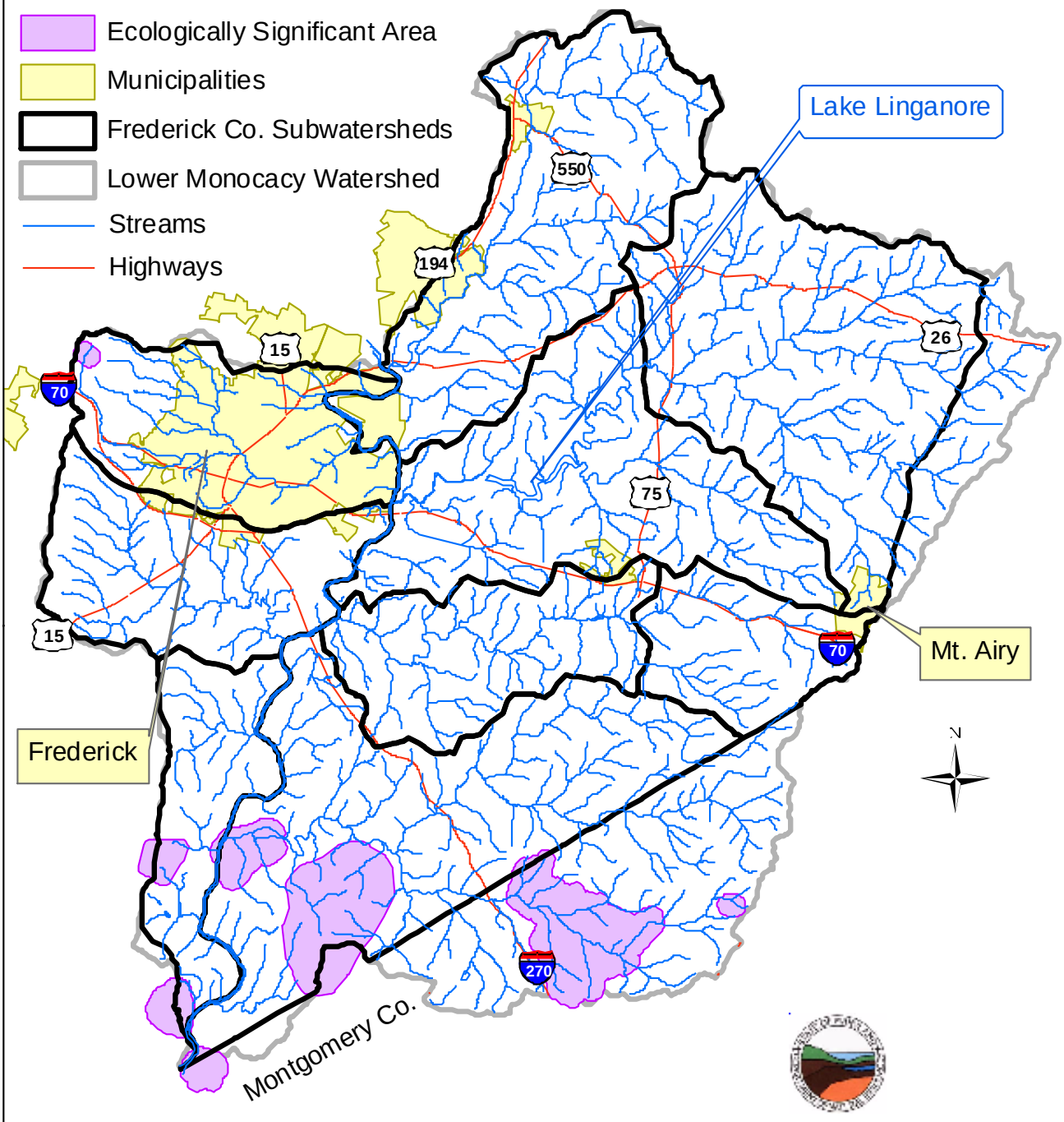
Map 20 MBSS Benthic Index
Lower Monocacy River WRAS



Map 21 MBSS Physical Index
Lower Monocacy River WRAS



Map 22 Sensitive Species
Lower Monocacy River WRAS



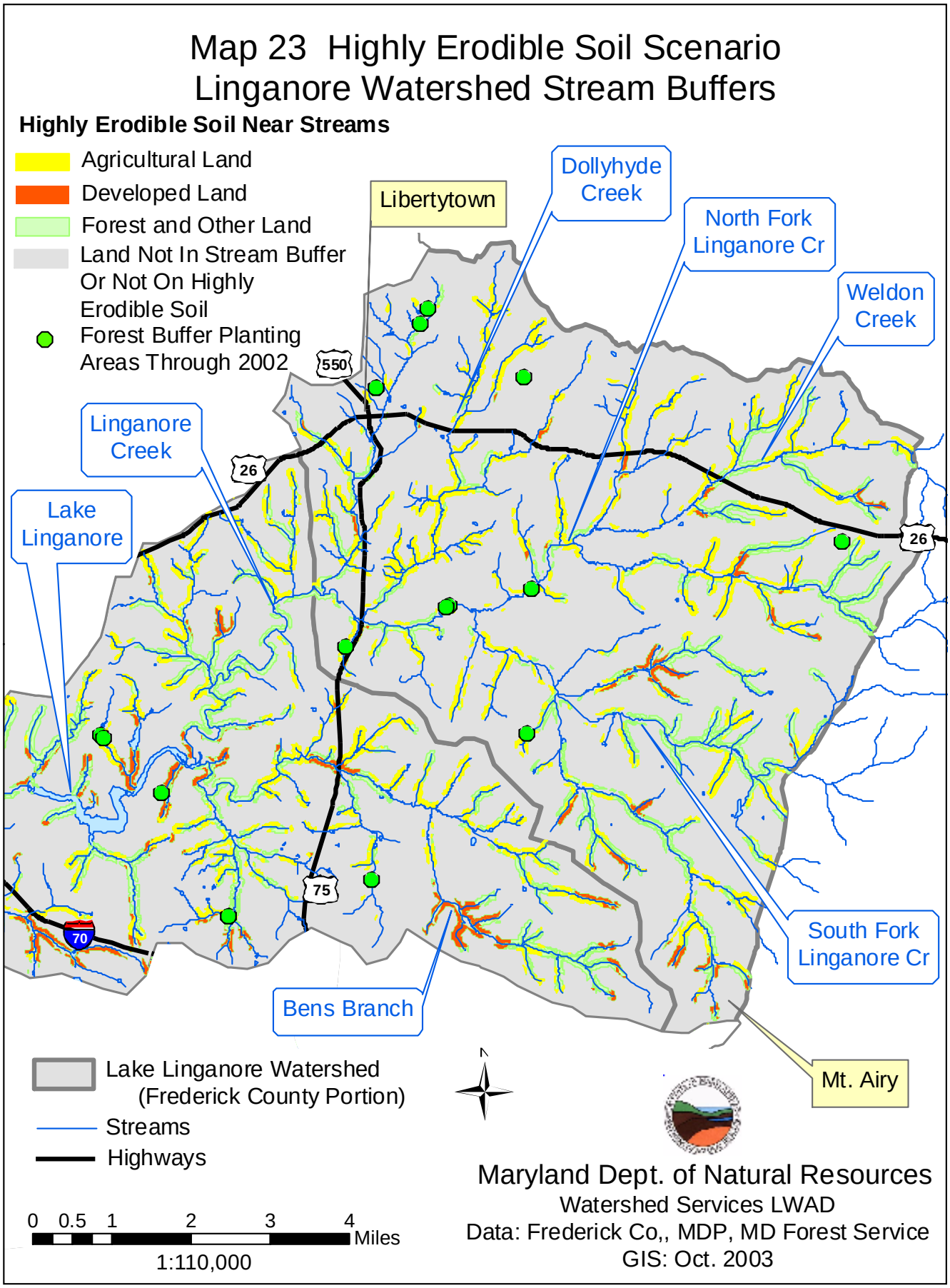
NOTE: The Lower Monocacy River watershed does not contain any Natural Heritage Areas or Wetlands of Special State Concern

Maryland Dept. of Natural Resources
Watershed Services LWAD
Data: Natural Heritage Prog. May 2003
GIS: Oct. 2003

0 1 2 4 6 8 Miles

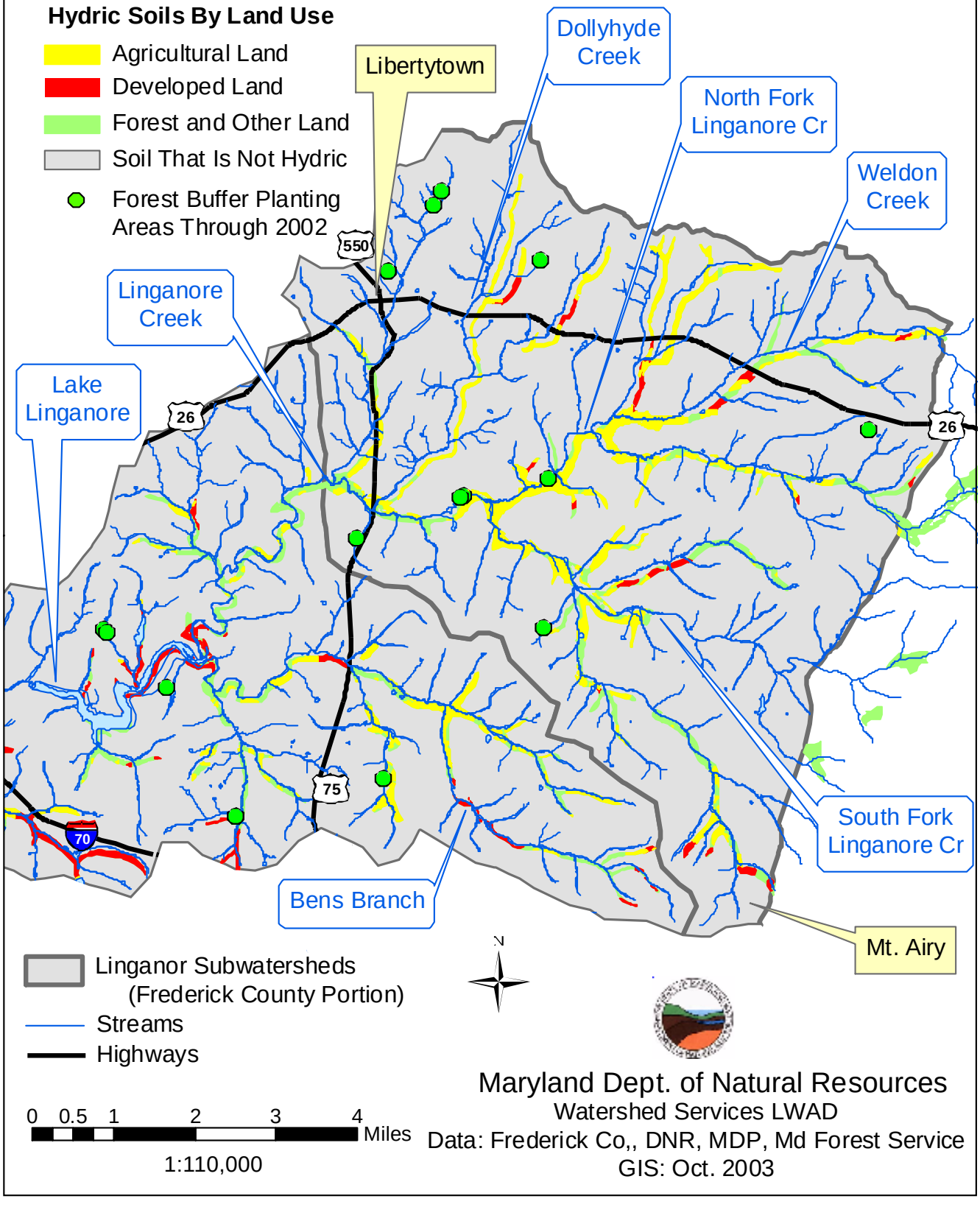
1:225,000

Map 23 Highly Erodible Soil Scenario
Linganore Watershed Stream Buffers



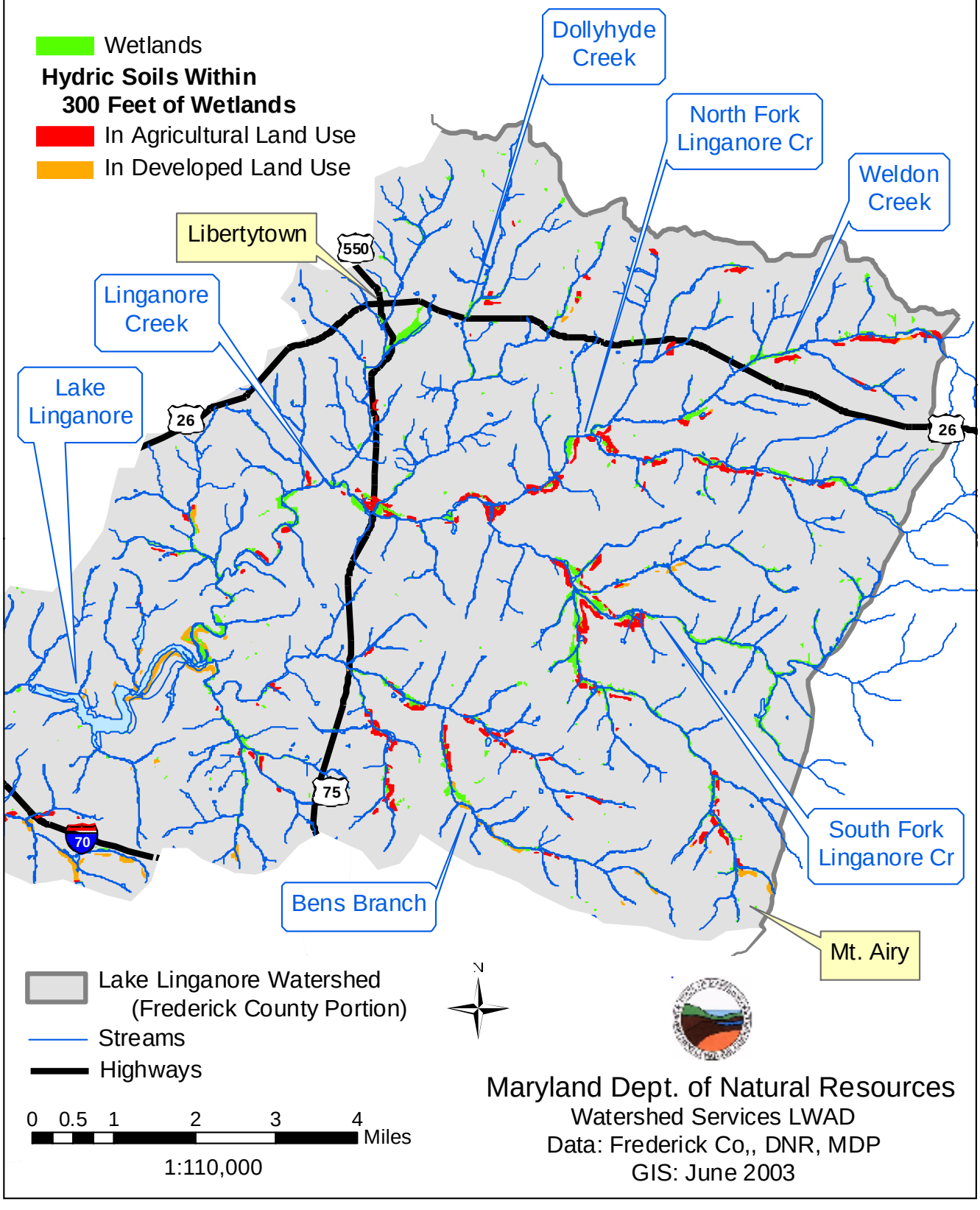
Maryland Dept. of Natural Resources
Watershed Services LWAD
Data: Frederick Co,, MDP, MD Forest Service
GIS: Oct. 2003

Map 24 Hydric Soil Scenario
Linganore Watershed Stream Buffers



Maryland Dept. of Natural Resources
Watershed Services LWAD
Data: Frederick Co,, DNR, MDP, Md Forest Service
GIS: Oct. 2003

Map 25 Wetland Restoration Scenario
Linganore Watershed Hydric Soils Near Wetlands



Maryland Dept. of Natural Resources
Watershed Services LWAD
Data: Frederick Co,, DNR, MDP
GIS: June 2003

APPENDIX A MBSS Fish Species Findings By Frederick County Watershed

Key For Color/Font Code* for fish species in the table below (white: no data)	**Tolerant** Fish that tend to survive greater pollution and poorer habitat conditions	*Moderate Tolerance Fish with mid-range ability to co-exist with pollution and varied habitat conditions*	**Intolerant** Fish that require good water quality and good habitat conditions

Fish Species By Subwatershed Lower Monocacy River Watershed "**P**" means species is present	Ballenger Cr.	Bennett Cr.	Bush Cr. (all)	Carroll Creek	Israel Creek	Linganore Watershed			Direct SW
						Bens Br.	South Fork	North Fork	
American Eel			**P**						
Banded Killfish					**P**				
Blacknose Dace	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**
Bluegill	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**	
Bluntnose Minnow	**P**	**P**	**P**	**P**	**P**	**P**			**P**
Brown Trout	**P**	**P**							
Central Stoneroller		**P**	**P**	**P**	**P**	**P**	**P**		**P**
Checked Sculpin	**P**			**P**					
Common Shiner	**P**	**P**	**P**		**P**	**P**	**P**		**P**
Creek Chub	**P**	**P**	**P**		**P**	**P**	**P**	**P**	**P**
Creek Chubsucker					**P**				
Cutlips Minnow	**P**		**P**				**P**		
Cyprinella SP.		**P**					**P**		
Eastern Silvery Minnow		**P**							

Fish Species By Subwatershed Lower Monocacy River Watershed "**P**" means species is present	Ballenger Cr.	Bennett Cr.	Bush Cr. (all)	Carroll Creek	Israel Creek	Linganore Watershed			Direct SW
						Bens Br.	South Fork	North Fork	
Fallfish		**P**	**P**				**P**		
Fantail Darter	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**
Fathead Minnow									**P**
Golden Redhorse		**P**							
Golden Shiner					**P**				**P**
Green Sunfish	**P**	**P**	**P**		**P**	**P**			**P**
Greenside Darter	**P**	**P**	**P**		**P**	**P**	**P**	**P**	**P**
Largemouth Bass		**P**	**P**	**P**	**P**	**P**	**P**		**P**
Lemomis Hybrid	**P**	**P**			**P**	**P**			
Longear Sunfish		**P**	**P**						**P**
Longnose Dace	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**
Mosquitofish		**P**							**P**
Mottled Sculpin	**P**	**P**	**P**		**P**	**P**	**P**	**P**	
Northern Hogsucker		**P**	**P**			**P**	**P**	**P**	
Pearl Dace	**P**			**P**					**P**
Potomac Sculpin	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**	
Pumpkinseed		**P**	**P**		**P**				**P**
Rainbow Darter			**P**						
Redbreast Sunfish	**P**	**P**	**P**	**P**	**P**	**P**			**P**
River Chub		**P**							
Rock Bass	**P**	**P**	**P**				**P**		
Rosyface Shiner		**P**							

Fish Species By Subwatershed Lower Monocacy River Watershed "**P**" means species is present	Ballenger Cr.	Bennett Cr.	Bush Cr. (all)	Carroll Creek	Israel Creek	Linganore Watershed			Direct SW
						Bens Br.	South Fork	North Fork	
Rosyside Dace		**P**	**P**		**P**	**P**	**P**	**P**	**P**
Satinfin Shiner					**P**				
Silverjaw Minnow		**P**	**P**		**P**	**P**	**P**		
Smallmouth Bass		**P**	**P**						**P**
Spotfin Shiner	**P**	**P**	**P**		**P**				**P**
Spottail Shiner		**P**	**P**		**P**				**P**
Tessellated Darter		**P**	**P**						**P**
White Sucker	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**
Yellow Bullhead		**P**			**P**	**P**	**P**		**P**

* Rating of nontidal fish by tolerance level is adapted from the following document: *Maryland Biological Stream Survey, Ecological Status of Nontidal Streams in Six Basins Sampled in 1995.* Maryland Dept. of Natural Resources, Chesapeake Bay and Watershed Programs, Monitoring and Nontidal Assessment. CBWP-MANTA-EA-97-2. May 1997.

APPENDIX B MBSS Indices

Key for MBSS Data Table					
Index of Biotic Integrity	Ranges for Index	Very Poor	Poor	Fair	Good
Fish	1.0 (worst) to 5.0 (best)	1.0 - 1.9	2.0 - 2.9	3.0 - 3.9	4.0 - 5.0
Benthic	1.0 (worst) to 5.0 (best)	1.0 - 1.9	2.0 - 2.9	3.0 - 3.9	4.0 - 5.0
Physical Habitat	0 (worst) to 100 (best)	0 - 11.9	12 - 41.9	42 - 71.9	72 - 100

* Additional details are available at http://www.dnr.maryland.gov/streams/mbss/index.html
– Click on "Search Online Data" (button on left)
– Enter "Lower Monocacy" in dialog box for "8 Digit watershed name" and click on search

2000 and 1996 MBSS Findings * Lower Monocacy River Watershed In Frederick County				
Watershed	Station #	Score		
		Fish	Benthos	Physical
Ballenger Creek	FR-P-100-117-96	2.43	3.89	19.48
	FR-P-103-230-96	3.0	2.78	11.57
	FR-P-277-115-96	2.14	2.56	18.53
	FR-P-349-204-96	4.43	2.33	48.82
	FR-P-429-307-96	3.86	3.67	70.56
	LMON-231-T-2000	--	1.89	--
Bennett Creek	FR-P-015-304-96	4.71	2.33	92.21
	FR-P-101-233-96	3.86	3.0	67.95
	FR-P-351-112-96	--	3.22	42.23
	FR-P-377-242-96	3.86	2.33	85.36
	MO-P-111-136-96	--	3.22	46.78
	MO-P-495-312-96	4.43	3.22	96.48
	LMON-421-T-2000	2.43	3.44	--

2000 and 1996 MBSS Findings * Lower Monocacy River Watershed In Frederick County				
Watershed	Station #	Score		
		Fish	Benthos	Physical
	LMON-130-T-2000	--	4.33	--
	LMON-240-T-2000	3.29	4.56	--
Bush Creek (all)	FR-P-275-239-96	4.71	2.56	92.21
	FR-P-360-220-96	3.29	3.22	35.9
	FR-P-421-306-96	4.14	3.0	87.2
	FR-P-545-345-96	4.43	1.67	88.51
	FR-P-545-325-96	4.43	2.78	98.94
	LMON-227-T-2000	3.29	4.11	--
	LMON-252-T-2000	3.57	4.33	--
	LMON-316-T-2000	4.71	3.44	--
Carroll Creek	FR-P-005-141-96	1.0	1.44	14.84
	FR-P-335-110-96	2.43	1.44	3.55
	LMON-220-T-2000	3.0	1.67	--
	LMON-237-T-2000	2.43	2.56	--
Israel Creek	FR-P-050-354-96	2.71	2.11	79.67
	FR-P-116-221-96	3.29	2.33	17.04
	FR-P-394-317-96	3.0	1.89	88.08
	FR-P-409-210-96	1.57	2.56	16.75
	LMON-104-T-2000	3.29	3.44	--
	LMON-106-T-2000	1.57	1.67	--
	LMON-122-T-2000	1.86	2.78	--
	LMON-136-T-2000	--	3.22	--
	LMON-203-T-2000	3.29	3.89	--

2000 and 1996 MBSS Findings * Lower Monocacy River Watershed In Frederick County					
Watershed		Station #	Score		
			Fish	Benthos	Physical
		LMON-210-T-2000	3.29	4.11	--
Linganore	Bens Br.	FR-P-411-305-96	4.14	3.67	77.96
		FR-P-461-251-96	3.86	3.22	34.04
	South Fork	FR-P-156-252-96	4.14	3.22	81.28
		FR-P-156-217-96	3.86	--	64.75
		FR-P-156-231-96	4.43	3.67	86.26
		FR-P-156-234-96	4.14	2.78	94.79
		FR-P-321-214-96	4.43	2.33	95.85
	North Fork	FR-P-388-246-96	4.14	2.33	39.75
		FR-P-388-208-96	3.57	1.67	57.46
		FR-P-399-126-96	--	1.67	17.62
		LMON-119-T-2000	--	4.56	--
		LMON-209-T-2000	3.57	4.56	--
Monocacy Direct		LMON-239-T-2000	2.71	2.33	--
		LMON-202-T-2000	3.57	3.67	--