R E V I S E D

august 1996

TECHNICAL REPORT

Environmental Resources

EASTERN MONTGOMERY COUNTY MASTER PLAN AREAS

Four Corners ✦ White Oak ✦ Cloverly ✦ Fairland

The Maryland-National Capital Park and Planning Commission
Montgomery County Department of Park and Planning

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Abstract

Title	Environmental Resources: Eastern Montgomery County Master Plan Areas
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The Patuxent watershed, particularly the upper portion, is mainly rural in character. much of its total land cover is in agriculture or forest. However, farmland and open space throughout the watershed are rapidly,.Oeing converted to low to medium density single-family residential development.

The Washington Suburban Sanitary Commission owns approximately 850 acres that provide a buffer area adjacent to the reservoir forffing the northern border of eastern Montgomery County. Tho'ese areas are carefully maintained for protection of the reservoirs and for recreational purposes including boating, fishing and hunting.

Wetlands

The majority of wetlands in eastern Montgomery County are upland, fresh water wetlands with varying types of vegetation (see Table 1, page 15). Most occur in narrow bands along the streams or are associated with springs, seeps, farm ponds or stormwater management ponds. The frequency, size, distribution and diversity of wetlands is far less in the more urbanized areas than in the upper or headvvatet sections of the watersheds.

Due to the eroding action of high storm flow velocities in urbanized areas, many of the urban streams are deeply incised and therefore have a @ow floodplm area and few adjacent wetlands. Functions of these wetlands typically mclude flood attenuation and nutnent/pollutant trapping. Although these wetlands do not provide exceptional wildlife habitat, they are part of stream systems that function as the only natural corridors for wildlife m the more urbamzed portions of watersheds.

Wetlands identified in the suburban and rural watersheds are also typically associated with the stream valleys. However, the wetlands tend to spread out in the gentler slopes of headwater valleys and are both more frequent in distribution and larger in size than in the urban areas. Wetland functions in the less urbanized areas include groundwater recharge/ ge, baseflow maintenance, flood attenuation, nutrient/sediment trapping, food chain support, and terrestrial and aquatic wildlife habitat.

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introduction

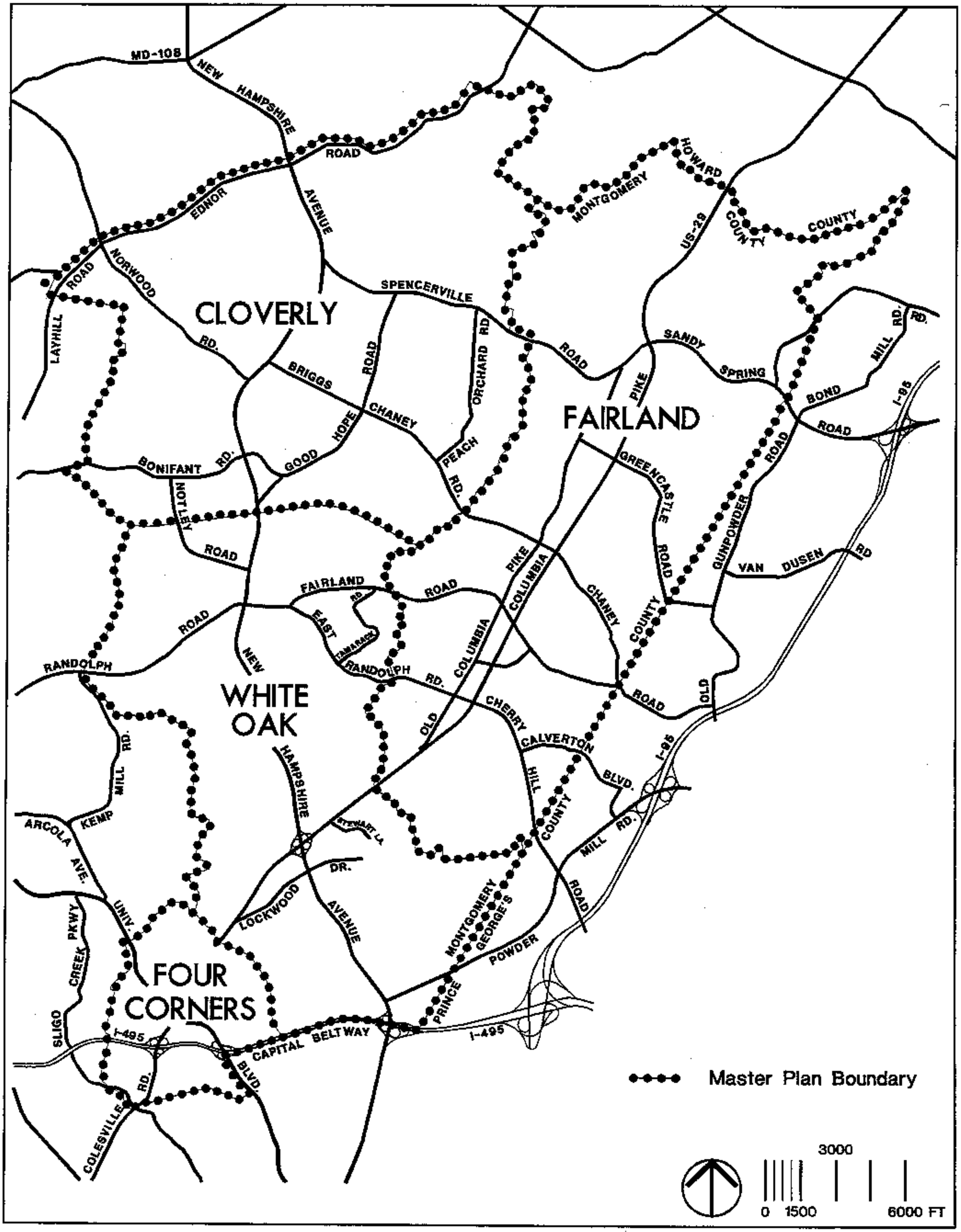
THE *EASTERN MONTGOMERY COUNTY ENVIRONMENTAL RESOURCES Report* contains technical and historical background to support the environmental recommendations of the four Eastern Montgomery County master plans: Four Corners, White Oak, Cloverly, and Fairland. Each separate master plan should be consulted for the specific area environmental recommendations.

The report has three main sections and an appendix. Section I gives an overview of the environmental features and natural resources. A discussion of the environmental planning issues follows in section II with information on past and present management programs and relevant legislation. The environmental goals and objectives for the planning areas are presented in section III.

A separate document *The Upper Paint Branch Watershed Planning Study* details conditions and recommendations for the Paint Branch watershed, focussing particularly on the area north of Fairland Road. Information from that document is summarized in this report.

Master Plan Areas

Figure 1



Natural Resources of Eastern Montgomery County

Geology, Soils and Topography

Eastern Montgomery County lies within the geologic provinces of the Piedmont and the Coastal Plain. Subsurface conditions in these two provinces support a wide range of natural features and are generally conducive to development. The most dramatic geologic feature of the area is the fall line, occurring at the provinces' boundary, which roughly parallels US 29, Columbia Pike/Colesville Road. Water flowing from the more resistant, metamorphic rock of the Piedmont into the erodible sedimentary rock and unconsolidated deposits of the Coastal Plain has created steep, rocky gorges with rapids and waterfalls. While this area is highly scenic, bike paths, sewers and road crossings are difficult to locate and construct because of the steep topography.

The topography of eastern Montgomery County is generally characterized as rolling hills with steeper slopes found along streams. Most of eastern Montgomery County has slopes of 15 percent or less. The steepest slopes are found in the Northwest Branch stream valley, around the fall line of the Northwest, Paint and Little Paint branches, and along the streams flowing into the Patuxent River system. The average elevation for the eastern part of the County is between 200 and 400 feet above sea level to the south and between 400 and 600 feet above sea level in the northern portions.

Generally, soils in eastern Montgomery County are deep and have few limitations for development. This compares favorably with the rest of Montgomery County, where 40 percent of the soil has development constraints due to one or more of the following factors: a high groundwater table; shallow bedrock which is less than three feet below the surface, or excessive slopes. Soils most favorable for development in eastern Montgomery County are located in the southernmost areas near the District of Columbia and intensive development has, in fact occurred in White Oak, Four Corners and southern portions of Fairland.

Conditions in The Piedmont

Most of eastern Montgomery County lies within the Piedmont province. The subsurface geological formations found in this part of the province are generally resistant metamorphic rocks of gneiss and granite interspersed with mica schist. A metamorphic rock is one whose original mineralogy, texture or composition has been altered due to pressure or temperature. This process is often associated with the formation of mountain ranges; hence, metamorphic rocks are typically found in upland areas (on a regional scale). Soils are composed of mainly micaceous schist and tend to be deep, well drained and moderately sloping. Average depth to bedrock is 20 to 50 feet.

Conditions in The Coastal Plain

A small portion of the planning area along the Prince George's County border is within the Coastal Plain province. The Coastal Plain geology, which is a part of the Patuxent Formation, consists of unconsolidated sedimentary rock with interbedded gravel, sand and clay. A sedimentary rock is made up of particles transported by wind, water or ice to the site of deposition or by chemical precipitation at the deposition site. These rock types are usually found along existing or ancient riverine systems and coast lines, where wave action has caused erosion of the rock to form sand, pebbles and boulders. Soils here tend to be moderately well drained to well drained, gently sloping, and have a sandy and gravelly texture. The gravel and sand deposits in the Coastal Plain portion of eastern Montgomery County have historically been extracted for their mineral value. In the Coastal Plain the limitations on development are fewer than in the Piedmont, since the alluvial-type soils are much easier to work with. Depth to bedrock can be as much as 350 feet.

Ground Water Resources

The feasibility and productivity of wells is vastly different in the Piedmont and Coastal Plain areas due to the underlying geology. The rocky substrate of the Piedmont holds potable groundwater at deep levels (120-150 feet) but groundwater yields west of the fall line may be limited by low transmissivity. Groundwater typically lies near the surface of sandy Coastal Plain soils; generally, water supplies are plentiful in the Patuxent Formation. Currently, private wells provide less than 10 percent of the area's drinking water and this is not expected to increase, given the expansion of the public water supply system. Community water service is either provided or proposed for most of the area, with the exception of the Patuxent watershed, where most of the potable water is obtained from wells.

Groundwater resources are very important to the health of stream ecosystems. Most of the eastern Montgomery County streams are fed by springs and seeps, especially in the headwaters (Chesapeake Environmental Management, Inc., 1996). Rainfall percolates through the soil to replenish or recharge the groundwater table, which is gradually released, feeding the base flow of the streams. The base flow is that water which makes up the majority of stream flow between rainfall events. Without this consistent source of water, streams would dry between storms, making it impossible to sustain most stream life. The amount of consistently cold, clear water is key to the quality of the stream system.

Forests and Vegetation

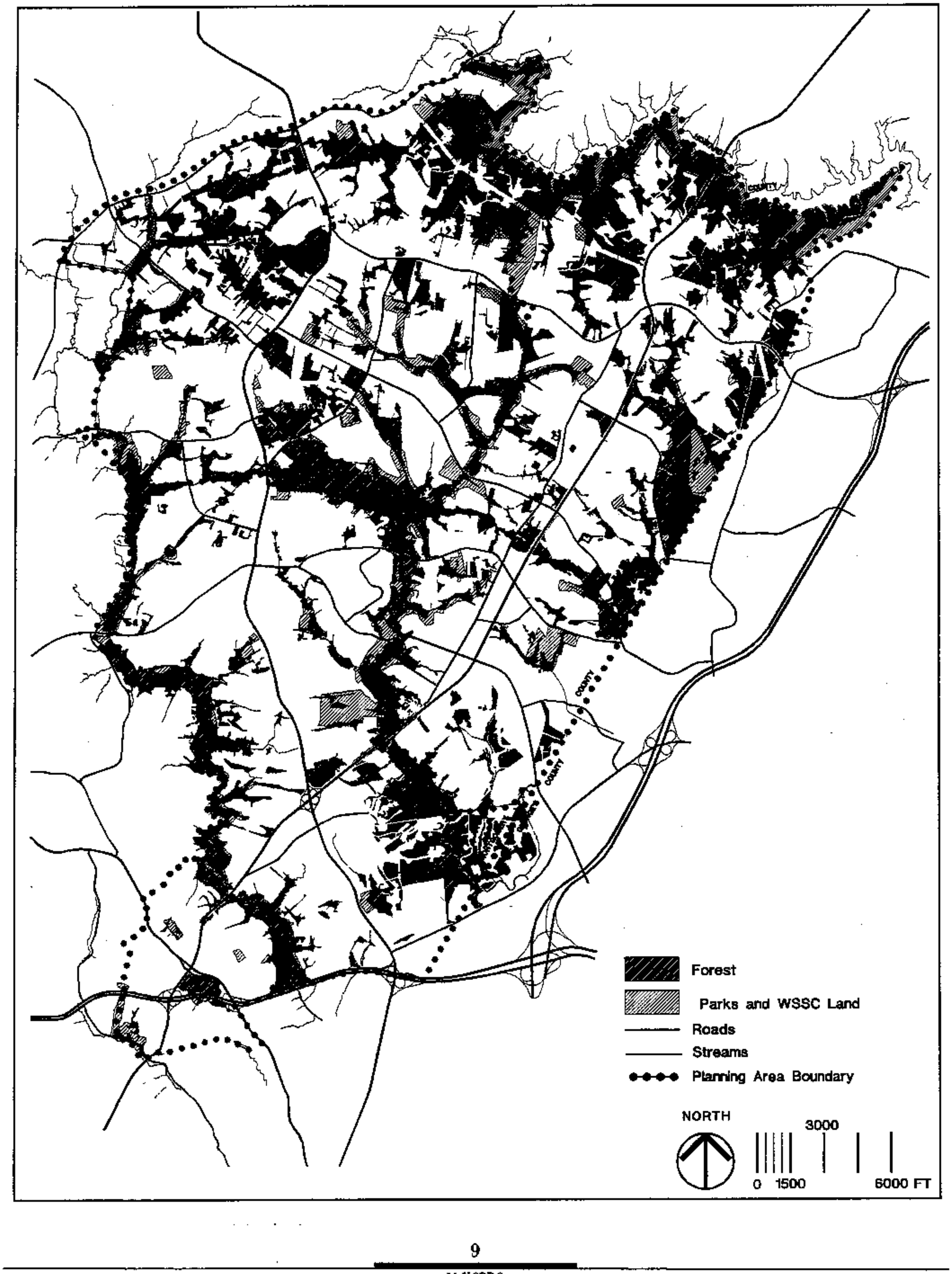
The remaining undeveloped natural areas in eastern Montgomery County are primarily in forest cover. The forests are a combination of deciduous and mixed deciduous and coniferous trees. They comprise a variety of species dominated by oaks in the drier upland areas and red maple in the bottomlands. Tulip poplar is a common co-dominant in both areas. Other species which occur often and may be dominant or co-dominant in some areas are hickory, American beech, sycamore, ash, silver maple, black walnut and Virginia pine (see Figure 2, page 9 for location of existing forest).

On a regional scale, Montgomery County is in a transition zone between vegetation zones with northern or southern affinities. It is also bounded on the south by the Potomac River, one of the major pathways in the eastern United States for the spread of plant species between the Appalachian Mountains and the Atlantic Coast. These factors originally gave the County one of the most diverse native floras in Maryland. Although the forests which once blanketed the County have been fragmented or converted to agriculture, meadows, or urban and suburban land uses, the County's open space (including parkland and undeveloped land) supports many plant species now considered to be rare, threatened or endangered in the state or throughout their range. The County's forested tracts form a component of the Atlantic flyway, a wide flight path from Canada to South America used by migrating birds.

The condition of the forests varies widely depending

Forest Cover

Figure 2



upon stand location and maturity. The forests located on drier upland slopes and ridges are commonly oak/hickory forests with an understory of shrubs and sapling trees without a well-developed herbaceous component. The forests on lower slopes and bottomlands are tulip poplar/red maple forests with more species diversity and a more developed understory. The best of these areas support a variety of canopy species with a well-developed sub-canopy, including trees, shrubs and various herbaceous species. The bottomland forests are usually more mature areas and therefore contain a relatively small invasive species component. Invasive species are much more common in upland forests and may be a major component of early successional areas which are changing from meadow and old field to forest.

Most of the forested areas in eastern Montgomery County are associated with the stream valleys and the Rocky Gorge reservoir, including several significant forest stands associated with undeveloped properties in the northern part of eastern Montgomery County. These stands are important contributors to the protection and recharge of baseflow for wetlands, seeps and springs in the area.

The majority of eastern Montgomery County's park land is forested, but most of these parks were logged within the last 50 years. The forests on park property are generally young, second-growth or sapling woods of poor quality with a high incidence of weedy exotic species. However, Northwest Branch Stream Valley Park, Paint Branch Stream Valley Park and Fairland Recreational Park all support pockets of better quality forest which are primarily on steep slopes, wet areas or other locations that were difficult to log.

The forest and associated vegetation is unusual in the vicinity of McKnew Local Park south of Sandy Spring Road near the Prince George's County line. Due to the presence of the fall line, its vegetational profile is a peculiarly rich mixture of Coastal Plain, Piedmont and even normally Western Piedmont (or mountainous) species. This is the most extensive site of naturally occurring Coastal Plain species in Montgomery County. A great diversity of vegetation is found along the entire fall line from Fairland southwest to the Burnt Mills area of White Oak.

Rivers and Their Watersheds

Two major river system—the Potomac River and the Patuxent River—drain the Washington, D.C. metropolitan area (see Figure 3, page 11). Portions of each system are contained within eastern Montgomery County (see Figure 4, page 12). Three main watersheds of the Anacostia River system comprise the majority of eastern Montgomery County: Northwest Branch, Paint Branch and Little Paint Branch all flow northwest to southeast. Sligo Creek is a major subwatershed of Northwest Branch which covers a significant portion of the Four Corners planning area. Downstream of Montgomery County, they join and flow into the Anacostia River, which in turn empties into the Potomac River in the District of Columbia. The northern edge of eastern Montgomery County flows easterly to the Patuxent River watershed.

Northwest Branch drains a larger area (53.2 square miles) than any other Anacostia tributary. It flows 17.5 miles from its headwaters in Olney and Sandy Spring, southeast to Bladensburg downstream of eastern Montgomery County, where it meets the Northeast Branch to form the Anacostia River. This stream forms the western boundary of the eastern Montgomery County planning areas, running along the outer borders of Cloverly and White Oak. Its principal tributary is Sligo Creek. The Northwest Branch watershed, which lies mainly within the Piedmont geologic formations, is characterized by ridges and deep, narrow stream valleys, channels and floodplains created by moderate to high velocity streams flowing over moderate gradients.

Extensive stretches of undeveloped woodland and agricultural or low density areas surround the upper portions of the watershed in eastern Montgomery County. Although the upper reaches have stable, shaded banks and riffle/pool formations in the swift waters, the stream slows and widens in the downstream urbanized areas south of eastern Montgomery County. Publicly owned parkland borders the stream banks, with predominantly single-family residential use in the adjacent areas. The stream is known for its highly diverse riverscapes and scenic areas, particularly where it crosses the fall line. Its stream valley park extends for almost its entire length. Northwest Branch has a Use IV[1]

[1] Stream use designations as assigned by the Maryland Department of the Environment:

Use I and IP—Water Contact Recreation, Aquatic Life and Water Supply;

Use II—Shellfish Harvesting Waters;

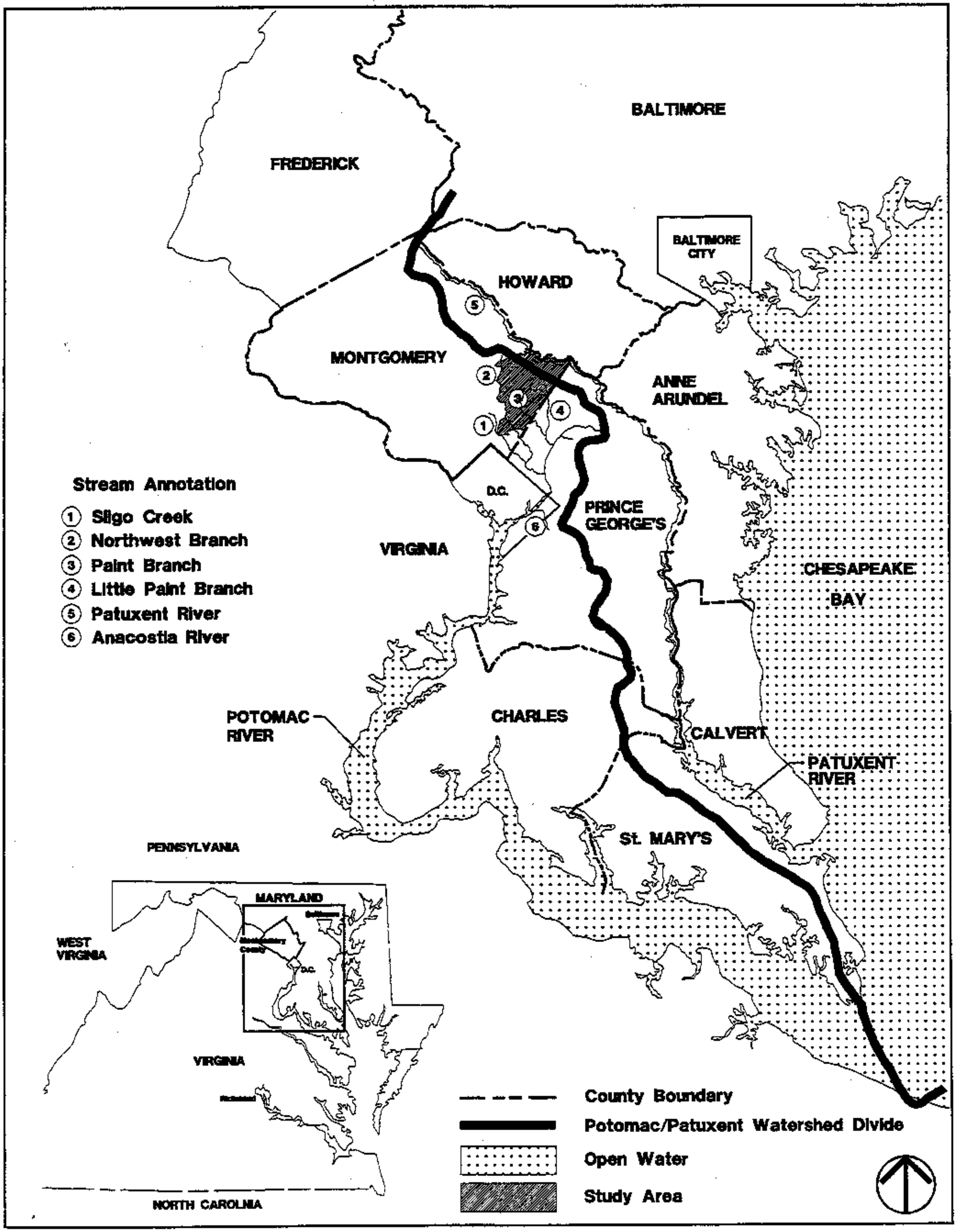
Use III and III-P—Natural Trout Waters, including those potentially or actually suitable for the growth and propagation of trout and capable of supporting natural trout populations and their associated food organisms;

Use IV and IV-P—Recreational Trout Waters, including those potentially or actually capable of supporting adult trout for put and take fishing; or managed as a special fishery by periodic restocking.

Each category has a corresponding set of standards, with Use III the most stringent designation. The 'P' designation indicates the water body is used as a public water supply and must meet toxic substance criteria to protect aquatic organisms as well as the standard criteria for Use I, III or IV waters. In eastern Montgomery County, only the Patuxent watershed has the 'P' designation.

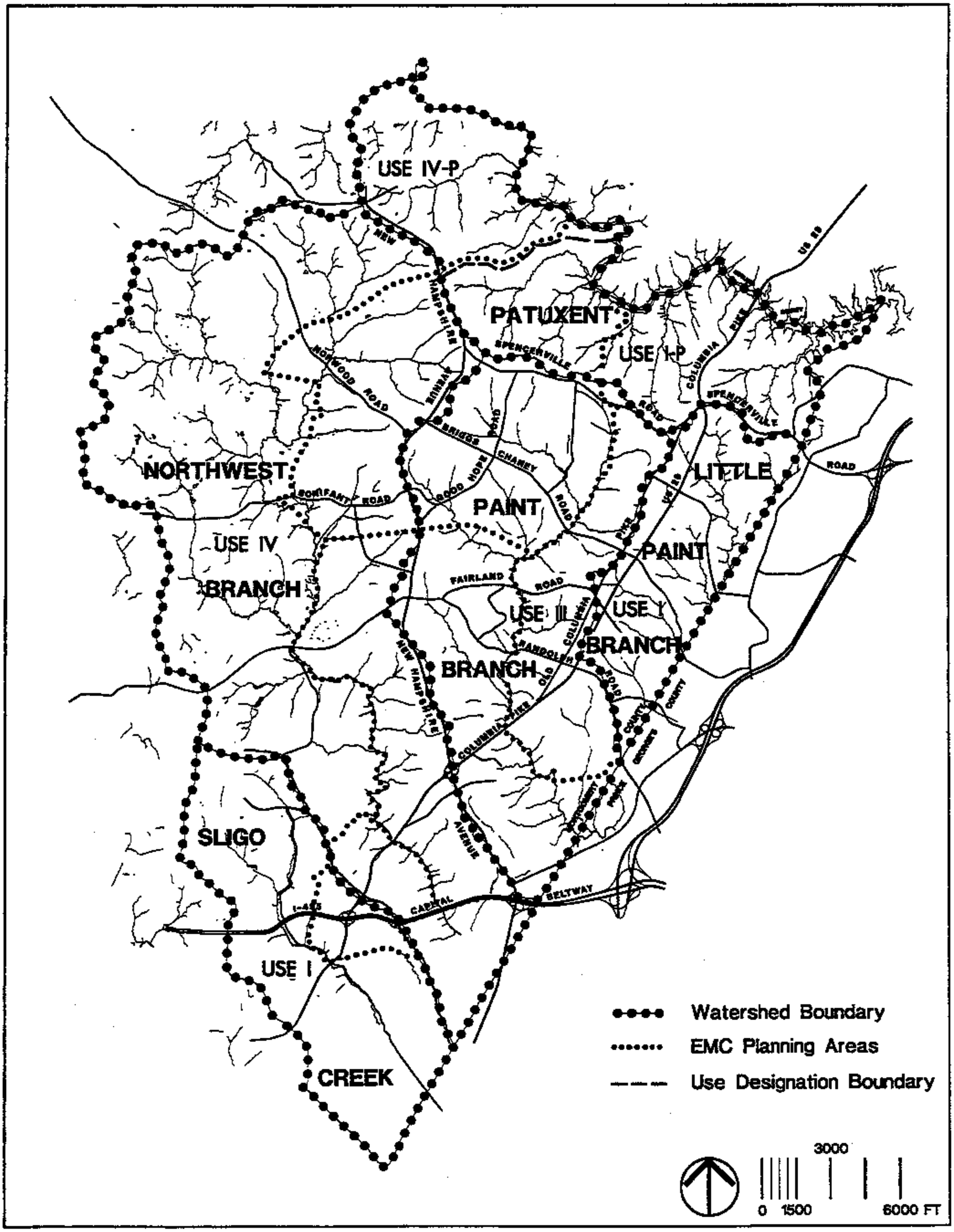
Chesapeake Bay Regional Map

Figure 3



Watersheds

Figure 4



designation, and trout are stocked on a put and take basis by the Maryland Department of Natural Resources (DNR).

Sligo Creek, a major tributary of Northwest Branch, drains an area of 13.3 square miles of dense commercial and residential development. The stream flows 8.2 miles beginning in Wheaton near the intersection of Ventura Avenue and Channing Drive to its juncture with the Northwest Branch in Hyattsville. Most of the stream is bordered by an almost continuous, narrow buffer of publicly owned parkland with many different species of trees shading its banks. However, there is little open space in the watershed outside this stream valley park, which harbors a variety of urban wildlife such as foxes, squirrels, opossums, groundhog and various bird species. It is designated as a Use I stream and because it is readily accessible; recreational use of the creek occurs throughout the year.

Paint Branch originates in the area south of Spencerville Road. It is 17 miles in length, draining a 31.5 square mile area. The mainstem of Paint Branch is a moderate-sized, fourth order stream which terminates at its confluence with Northeast Branch in the heart of Prince George's County. The upper portion, defined as being roughly north of Fairland Road in Montgomery County, flows through predominantly low-density residential areas interspersed with large tracts of undeveloped land. There is a particularly scenic area along the boulderstrewn gorge downstream from US 29, where the stream cuts through the fall line between the Piedmont and Coastal Plain geologic zones. This transitional area has also given rise to unusual forest communities composed of the diverse species of both geologic zones.

A wide variety of wildlife thrives in the watershed and several species of fish are found in the stream, the most notable being the brown trout, an indicator of very high water quality due to its requirements for cold, clean water and unsilted streambed conditions. The Paint Branch and its tributaries hold a special significance in Montgomery County, being among the very small number of naturally reproducing (Use III) trout streams in the County, and the only stream system with a proven, long term self-sustaining trout population. The brown trout fishery in Paint Branch extends from the upper reaches of the stream system near Spencerville Road (MD 198) into the mainstem as far as the Capital Beltway.

Besides the presence of high water quality, major contributing factors for supporting a self-sustaining trout population are a favorable physical habitat that supports the trout and aquatic macroinvertebrates (including insects that fish feed upon), low stream temperature and steady base flow. Headwater streams provide critical spawning grounds for the trout. A large part of the Paint Branch watershed's seeps, springs and wetlands occur here and contribute to the cold, steady, high quality baseflow of the system. Fingerlings and young-of-year are almost exclusively found in the Upper Paint Branch whereas adult trout are able to withstand the poorer conditions of the mainstem in lower Paint Branch. Management efforts over the past 20 years by various organizations including DNR, and Trout Unlimited have succeeded in protecting the trout population

Little Paint Branch headwaters originate at points along US 29 in the Fairland planning area and within the Fairland Regional Park. The mainstem of the stream is in Prince George's County where it flows into the Paint Branch near College Park. Its watershed is 10.8 square miles in area, mostly suburban development, with open space provided by Fairland Recreational Park, which straddles the Montgomery/Prince George's County line and Beltsville Agricultural Research Center in Prince George's County. The stream valley park and its facilities are the center of recreational activity in the suburbanized watershed.

The Little Paint Branch is located just east of the Fall Line where coastal sediments overlay the rocks of the piedmont. This leads to situations where the streams have cut through the shallow coastal soils into the edge of the piedmont. This provides conditions that support an unusual combination of vegetation and wildlife where the land is still undeveloped or protected as parkland.

Patuxent River is the largest river entirely contained within the state of Maryland. The state has designated it a "scenic river" which provides for its specific protection by the Department of Natural Resources as a river of unusual value to the state. The river, which is a primary source of local drinking water, begins at Paffs Ridge in north central Montgomery County and flows in a general southeasterly direction to the Chesapeake Bay. Its watershed includes parts of Howard, Montgomery, Anne Arundel, Prince George's, Calvert, St. Mary's and Charles Counties-a total of 910 square miles, 61 of which are within Montgomery County.

Two large reservoirs on this river provide drinking water for Howard, Montgomery and Prince George's counties. The Rocky Gorge Reservoir in eastern Montgomery County stores 6.4 billion gallons of water; the Triadelphia reservoir, upriver of eastern

Montgomery County, stores 6.5 billion gallons. The 4,714-acre portion of the Patuxent watershed within eastern Montgomery County drains into the Rocky Gorge reservoir. The natural resources of the Patuxent River watershed include high-quality.streams and wetlands, steep stream valleys and large forested areas that are partly on private land and partly protected through Washington Suburban Sanitary Commission (WSSC) land ownership. The reservoirs and their buffers are also environmentally significant'In providing aquatic and terrestrial wildlife habitats.

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Wetlands

The majority of wetlands in eastern Montgomery County are upland, fresh water wetlands with varying types of vegetation (see Table 1, page 15). Most occur in narrow bands along the streams or are associated with springs, seeps, farm ponds or stormwater management ponds. The frequency, size, distribution and diversity of wetlands is far less in the more urbanized areas than in the upper or headvvatet sections of the watersheds.

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Eastern Montgomery County Wetlands

Table 1

Subwatershed	Size Of Sub-watershed (acres)	Wetland Cover (% of sub-watershed)	Wetland Type (acres)				
			Lacustrine	Palustrine			
				Forested	Scrub-Shrub	Emergent	Open Water
PAINT BRANCH							
Left Fork	1,400	2.6		29.8	3.4		3.5
Right Fork	941	3.0		26.6		0.7	1.1
Good Hope	986	1.8		17.4			0.3
Gum Springs	624	0.4		1.3			1.1
Fairland Farms	198	1.3		1.2	1.2		0.3
Hollywood Br	996	0.2		2.3			
West Farm	727	0.3					2.0
Mainstem	3,828	2.3		69.9	8.2	0.6	7.2
LITTLE PAINT BRANCH							
Silverwood	1,295	0.7			3.2	0.9	5.5
Galway	622	0.5		2.7			0.4
Tanglewood	631	0.4		2.1			0.4
Greencastle	901	1.8		6.9			9.4
NW BRANCH							
Hampshire Greens Trib	709	1.3		8.0			1.0
Mainstem	5,147	1.5		56.2	10.4	4.6	6.2
Johnson Road	498	0.4			2.2		
Bryants Nursery Run	1,030	0.2					2.2
SLIGO CREEK	626	0.0					
PATUXENT							
Belle Cote	723	0.8	6.0				
Burtonsville Park	442	0.1				0.6	
Spencerville Road	449	3.5	15.6				0.2
Dustin Road	425	2.2	9.4				

Eastern Montgomery County Wetlands (cont.)

Subwatershed	Size Of Sub-watershed (acres)	Wetland Cover (% of sub-watershed)	Wetland Type (acres)					
			Lacustrine	Palustrine				
				Forested	Scrub-Shrub	Emergent	Open Water
Main East	293	3.2	9.5	2.7			
Rocky Gorge	963	1.9	16.1				2.9
Millgrove	1,161	2.3	24.2				2.0
Main West	190	2.9	5.2			0.3	

Source: MD DNR 1988 non-tidal wetlands data, based on aerial photography analysis. Wetlands may be more extensive based on field delineation techniques.

Lacustrine System - lakes, ponds and reservoirs with less than 30% coverage of wetland trees, shrubs or emergent vegetation

Palustrine System - nontidal wetlands including marshes, swamps, bogs and some small ponds or ponded areas. Usually dominated by trees, shrubs and persistent emergents.

Major Environmental Planning/Resources Management Issues

This section describes the current conditions of each natural resource, highlights issues to be dealt with in the master planning process, describes ongoing actions and policies that apply to that resource and describes the results of analysis done as part of the master planning process.

Water Quality

The health of streams and wetlands has been of primary environmental concern for the state of Maryland for at least the past 30 years (see Watershed Management, page 18). The conditions of the Chesapeake Bay and its many tributaries have dramatically benefitted from the actions of environmental programs that reduce both point and some non-point sources of pollution. Clean-up of sewage plant discharges, removal of obstacles to fish passage, construction of stormwater management and stream enhancement projects have all improved the water quality. At the same time, continuing population growth and the resulting development threatens to outstrip the progress that has been made. Efforts in Montgomery County are coordinated with federal, state and regional programs to reduce the impact of new development and repair the impact of past activity.

The Washington region has seen evidence of the effects of extensive development in its watersheds, particularly further downstream in the Anacostia River system where conditions are unfavorable to many aquatic species.[2] Development impacts include streams overflowing their banks more frequently and to a greater magnitude; increased stream velocity and consequent scouring, channel widening, and loss of the pools and riffles which provide habitat diversity; more sedimentation smothering aquatic insects in the streambed; increased levels of pollutants; higher water temperatures and loss of wetlands. Habitat loss, shifts in food webs or nutrient flows and direct mortality which follow result in lower species abundance and diversity.[3]

[2] Metropolitan Washington Council of Governments, 1990 State of the Anacostia: 1989 Status Report.

[3] Specific impacts in the Anacostia basin as a whole include: 1) loss of 70% of its non-tidal wetlands; 2) loss of 75% of the watershed's forest cover; 3) channelization of more than 25 miles of streams and estuary, resulting in the loss of aquatic habitat and stream bank erosion; and 4) loss of fish and macroinvertebrate species(Metropolitan Washington Council of Governments, 1990).

For the most part, effects will be felt in stream ecosystems long before they are experienced by human communities. It is therefore imperative that potentially haffnful factors are monitored, corrected or prevented while a feasible response is still possible, in order to ensure our health, protect our recreational areas fr4orm degradation and properly fulfill the role of stewards of the natural resources, both locally and regionally.

This report includes the findings of a recent MNCPPC planning-level study of imperviousness and stream system quality within the watersheds of eastern Montgomery County. The analysis assessed the current health of the streams, documented the degree to which existing land uses have impacted streams using, watershed imperviousness as a measure, and proved how buildout of land uses according to the 1981 Master Plan may affect stream health.

The methodology and technical approach for analyzing watersheds in eastern Montgomery County are presented in the Appendix. Eastern Montgomery County was divided into sub-watersheds of relatively homogeneous land uses, and limited stream monitoring was conducted in the 1993 summer season using the US EPA Rapid Bioassessment Protocol II. This monitoring, combined with monitoring results from various local and state agencies, aided in characterizing existing stream quality conditions. GIS data was used to calculate impervious cover by sub-watershed and project imperviousness for the ultimate land use pattern in the 1981 Eastern Montgomery County Master Plan. The acreages of impervious features on the M&NCPPC GIS data layers (roads, parking lots, rooftops, play areas, etc.) were compiled, and detailed calculations were made to add in the many sidewalks and

Watershed Management: Historical Account of Government Action

The priority placed on water quality and watershed protection is a long-established priority in the County. These are some of the policies for part or all of eastern Montgomery County that have dealt with environmental issues:

- 1974 - Paint Branch and all its tributaries upstream of the Capital Beltway were officially designated "Use III," or Natural Trout Waters (i.e., able to support the propagation and survival of natural trout populations and their associated food organisms), by the state of Maryland.
- The Maryland Scenic and Wild Rivers Act (amended 1978) which designated the Anacostia and Patuxent as "Scenic Rivers."
- 1980 - DNR, in cooperation with Trout Unlimited, designated the Paint Branch watershed upstream of Fairland Road as a "Special Trout Management Area." These regulations aimed at maximizing protection while maintaining recreational fishing.
- The 1980 Patuxent River Watershed Act, which directed the Department of State Planning to prepare the Patuxent River Policy Plan. This plan was a land management strategy, approved by the seven counties within the Patuxent watershed.
- 1981 Eastern Montgomery County Master Plan — Major emphasis on watershed protection. Watershed management, the brown trout fishery and water supply and distribution systems are the subjects of the first three of seven "major environmental issues" identified. The plan includes provisions to protect headwaters, especially sensitive spawning tributaries from development by down-zoning, stream valley park acquisition and imperviousness limits.
- 1984 - The Anacostia Watershed Restoration Agreement signed by Maryland and the District of Columbia. In 1987, Montgomery and Prince George's Counties joined in the effort to form the Anacostia River Watershed Restoration Committee (AWRC) under a new agreement to protect and restore the water quality, ecological integrity, wetlands, and forest cover of the Anacostia River system. An action plan developed by the AWRC to achieve those objectives by the turn of the century involves a coalition among local, state and federal agencies.
- 1992 - Metropolitan Washington Council of Governments and the AWRC produced a "Blueprint for the Restoration of the Anacostia Watershed" which laid out plans for individual restoration projects for 16 sub-watersheds, including stormwater retrofits, stream restoration, fish passage, reforestation and wetlands creation.
- 1993 - Functional Master Plan for the Patuxent River Watershed - recommended steps for developing and implementing water quality criteria, more restrictive stream buffers and more effective agricultural and urban BMPs.
- 1995 - Clinton Administration has designated the Anacostia River a priority ecosystem and the US EPA has established a Five-Point Action Plan to restore the watershed.
- 1995 - Limited Amendment to the Eastern Montgomery County Master Plan - Adds substantially to current park acquisition plans for the Paint Branch Stream Valley Park system to maintain low imperviousness levels, cool water temperatures and baseflow in the trout spawning reaches of upper Paint Branch.

These policies have been supported and encouraged by legislation, regulation, inter-jurisdictional agreements and master plans at various levels, including:

driveways that did not appear in the GIS database.

Table 2 shows the estimated impervious cover for each of the subwatersheds in eastern Montgomery County, grouped by watershed for 1990. It also shows the proportion of each subwatershed in forest and wetland cover and an estimate of the propprtidnoft-he subwatershed that is developable. In addition, Table 2 summarizes the impervious cover 'Within each subwatershed if development build-out occurs under the 1981 Master Plan zoning. The Upper Paint Branch Watershed Planning Study, which is based on the Paint Branch portion of this analysis, offers more background information. It also describes healthy stream ecosystem characteristics, common sources of ecosystem degradation and how degradation of a stream system can be avoided or reduced; some of this is summarized in the Appendix.

Tables 3 through 7 summarize past and present conditions that have been documented by various agencies in eastern Montgomery County subwatersheds.

Water Quality and Habitat Conditions in the Anacostia Tributaries of Eastern Montgomery County

The Anacostia watershed has undergone two waves of change to its land use. In the 1800s, much of the original forest was cleared to support agricultural uses, particularly tobacco farming. Then in the 1950s, the area underwent major suburbanization, becoming a residential community of the expanding Washington metropolitan area. A USGS report (Yorke and Herb, 1978) indicated that suspended solids transported from the Anacostia Basin averaged 13,400 tons per year between 1962 - 1974. Development of the watershed

- The Federal Water Pollution Control Act of 1948 for regulating dumping and disposal into navigable waters.
- The Water Quality Act of 1965, which created ambient water quality standards for interstate waters.
- The 1972 Federal Clean Water Act and 1977, 1981 amendments, for preservation of fishable and swimmable waters of the U.S.
- The Maryland Water Resources Law.
- The Chesapeake Bay Agreement of 1983 is a commitment by the states of Pennsylvania, Maryland, and Virginia, the District of Columbia, and the U.S. EPA to restore and protect the Bay through correcting existing pollution problems and avoiding new ones.
- 1983 - Section 208 Water Quality Mangement Plan by the state, in compliance with that section of the Federal Clean Water Act.
- Montgomery County enacts stormwater management requirements for water quality and quantity control in 1983.
- Montgomery County Planning Board approves stream buffer guidelines in 1983 (updated in 1993) to protect streams from non-point source pollution.
- DEP continues to administer stream restoration and stormwater management retrofit projects through the County.
- The State Planning Act of 1992, in which one of the seven visions given states that stewardship of the Cheseapeake Bay is to be considered a universal ethic. The planning act also requires inclusion of a sensitive areas element protecting 100-year floodplains, streams and their buffers, habitats of threatened and endangered species and steep slopes in all master plans by July 1997. All master plans must be updated at least every five years after 1997.
- The 1992 Chesapeake Bay Agreement requires a 40 percent reduction in controllable nutrient loads (nitrogen and phosphorus) to the Bay from the 1985 level by the year 2000. The state initiates the tributary strategies program to customize nutrient reduction plans for different sub-watersheds. Montgomery County has two tributary plans (Middle Potomac and Patuxent) which will focus on a combination of urban and agricultural non-point source best management practices (BMPs) to reduce pollution from runoff.
- 1992 County Forest Conservation Law - provides for tree preservation and planting in new developments; forest is protected with conservation easements.
- 1993 General Plan Refinement - Three of the 14 environmental goals contained in that document were protection and improvement of water quality; conservation of County waterways, wetlands and sensitive parts of stream valleys; and, comprehensive stormwater management to minimize sedimentation.
- 1994 - Anacostia River was listed as a threatend river by American Rivers, a national conservation organization dedicated to protecting and improving American rivers. The designation is an upgrade over its 1993 status as endangered and reflects the extensive efforts of many jurisdictions to restore the river system.
- 1994 Clarksburg Master Plan & Hyattstown Special Study Area - first master plan to utilize the special protection area concept; designated the Little Seneca Creek and part of Ten mile Creek watershed as SPAs.
- The County creates regulations in 1995 for special protection area performance standards that are intended to maintain baseflow, wetland and aquatic habitat functions, and groundwater recharge.

1990 Land Cover Conditions

Table 2

Subwatershed	Size of Sub-watershed (Acres)	1990 % Imperviousness	1990 Existing + Pipeline % Imperviousness	% Imperviousness from Developable Land Under 1981 Zoning	Existing + Pipeline + Developable % Imperviousness Under 1981 Master Planned Zoning	% Imperviousness from Master Planned Roads[1]	1981 Master Plan Build-out % Imperviousness	Percent of Subwatershed in:		
								Developable Land	Forest Cover	Wetland Cover[2]
PAINT BRANCH										
Left Fork	1,400	12.1	12.4	2.2	14.6	N/A	14.6	25.2	19.9	2.6
Right Fork	941	9.6	10.4	4.4	14.8	N/A	14.8	46.9	21.7	3.0
Good Hope	986	9.8	10.4	2.4	12.8	1.7	14.5	30.6	54.4	1.8
Gum Springs	624	15.6	17.5	0.2	17.7	0.6	18.3	3.8	24.6	0.4
Fairland Farms	198	11.8	12.6	2.5	15.1	N/A	15.1	15.0	15.2	1.3
Hollywood Branch	996	24.1	24.3	0.0	24.3	N/A	24.3	0.0	13.6	0.2
West Farm	727	17.9	35.6	16.9	52.5	N/A	52.5	23.8	20.5	0.3
Mainstem	3,828	21.0	21.5	1.1	22.6	0.3	22.9	3.5	29.2	2.3
LITTLE PAINT BRANCH										
Silverwood	1,295	15.1	18.0	6.8	24.8	N/A	24.8	21.2	40.5	0.7
Galway	622	24.5	26.4	0.5	26.9	N/A	26.9	1.2	15.8	0.5
Tanglewood	631	23.5	23.8	8.1	31.9	1.9	33.8	24.4	31.5	0.4
Greencastle	901	29.7	32.6	5.7	38.3	0.6	38.9	14.6	20.1	1.8
NORTHWEST BRANCH										
Hampshire Greens	709	5.3	8.7	0.5	9.2	N/A	9.2	7.1	34.0	1.3
Mainstem	5,147	16.0	16.5	0.3	16.8	0.5	17.3	1.5	21.5	1.5
Johnson Rd	498	8.0	11.5	1.8	13.3	0.3	13.6	25.7	32.3	0.4
Bryants Nursery Run	1,030	7.9	11.2	1.7	12.9	2.1	15.0	23.4	39.4	0.2
SLIGO CREEK	626	31.3	N/C	N/C	N/C	N/A	N/C	N/C	10.5	0.0

1990 Land Cover Conditions (cont.)

Subwatershed	Size of Sub-watershed (Acres)	1990 % Imperviousness	1990 Existing + Pipeline % Imperviousness	% Imperviousness from Developable Land Under 1981 Zoning	Existing + Pipeline + Developable % Imperviousness Under 1981 Master Planned Zoning	% Imperviousness from Master Planned Roads[1]	1981 Master Plan Build-out % Imperviousness	Percent of Subwatershed in:		
								Developable Land	Forest Cover	Wetland Cover[2]
PATUXENT										
Belle Cote	723	9.5	9.5	2.7	12.2	N/A	12.2	44.8	47.7	0.8
Burtonsville Park	442	4.5	4.5	2.0	6.5	N/A	6.5	49.2	45.0	0.1
Spencerville Rd	449	5.6	6.5	1.3	7.8	N/A	7.8	26.7	55.2	3.5
Dustin Rd	425	8.4	8.4	1.3	9.7	N/A	9.7	36.3	41.7	2.2
Main East	293	5.3	5.3	0.6	5.9	N/A	5.9	13.6	61.8	3.2
Rocky Gorge	963	7.7	10.2	1.4	11.6	N/A	11.6	32.6	42.2	1.9
Millgrove	1,161	6.8	7.6	0.9	8.5	N/A	8.5	24.5	32.6	2.3
Main West	190	3.1	3.4	1.0	4.4	N/A	4.4	22.3	63.7	2.9

Source: Data based on GIS analysis of 1990 conditions
N/A - Not applicable N/C - Not calculated
1. Master planned roads include only Briggs Chaney Road realignment at MD 650, MD 28-MD 198 connector, and a 6-lane Intercounty Connector.

2. Wetlands coverage is based on MD DNR non-tidal wetlands data for 1988.

Summary of Northwest Branch Water Quality Monitoring

Table 3

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Northwest Branch Subwatersheds		
						Hampshire Greens Trib.	Bryants Nursery Trib.	Mainstem
Macro-invertebrates	1989	MWCOG (Kumble, 1990)	Surber, 2 sq. ft.	Modified RBP III; 6 metrics[1]	Good/Fair/Poor		•Norwood Rd (GOOD)	•Randolph Rd (GOOD) •Rt 29 (FAIR)
	1989	ICPRB (Stribling et.al., 1990)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/Fair/Poor		•Norwood Rd (EXCEL)	•Randolph Rd (FAIR) •Rt 29 (FAIR)
	1990	ICPRB (Cummins et.al., 1991)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/Fair/Poor			•Layhill Park (EXCEL)
	1993	M-NCPPC EPD (1993)	D-net, 300 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/Fair/Poor	•Old Orchard Rd (EXCEL)		•Bonifant Rd (FAIR) •Randolph Rd (FAIR) •Rt 29 (FAIR)
	1996	M-NCPPC EPD (1996)	D-net, 2 sq. meter	RBP II; qualitative assessment in field	Excellent/Good/Fair/Poor		•Duxbury Rd. (EXCEL)	•Johnson Rd. Trib. at Notley Rd. (EXCEL)
Fish (excludes MD. DNR data)	1988	MWCOG (Herson et.al., 1989) ICPRB (Cummins, 1989)	Seine hauls	Fish diversity comparisons. MWCOG ratings[3]	Excellent/Good/Fair/Poor		•Norwood Rd (EXCEL)	•Randolph Rd (GOOD) •Rt 29 (FAIR) •Rt 650 (GOOD)
	1990	ICPRB (Cummins et.al., 1991)	Electroshock	RBP V; IBI, 8 metrics[4]	Excellent/Good/Fair/Poor			•Layhill Park (EXCEL)
Chemical and Physical Water Quality	1972	MCDEP (1974)	Grab samples	9 parameters[5]	Excellent/Good/Fair/Poor			•Upper (GOOD) •Lower (FAIR) •Bel Pre Cr (GOOD)
	1973	MCDEP (1974)	Grab samples	9 parameters[5]	Excellent/Good/Fair/Poor			•Upper (GOOD) •Lower (FAIR) •Bel Pre Cr (GOOD)
	1974-1975	MCDEP (1976)	Grab samples	9 parameters[5]	Excellent/Good/Fair/Poor			•Upper (EXCEL) •Lower (GOOD) •Bel Pre Cr (EXCEL)
	1976	MCDEP (1977)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor			•Upper (FAIR) •Lower (FAIR) •Bel Pre Cr (FAIR)
	1977	MCDEP (1978)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor			•Upper (GOOD) •Lower (FAIR) •Bel Pre Cr (GOOD)
	1978	MCDEP (1979)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor			•Upper (FAIR) •Lower (FAIR) •Bel Pre Cr (FAIR)
	1979	MCDEP (1980)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor			•Upper (FAIR) •Lower (FAIR) •Bel Pre Cr (FAIR)

Summary of Northwest Branch Water Quality Monitoring (cont.)

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Northwest Branch Subwatersheds		
						Hampshire Greens Trib.	Bryants Nursery Trib.	Mainstem
	1980	MCDEP (1981)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor			•Upper (FAIR) •Lower (FAIR) •Bel Pre Cr (FAIR)
	1985	MWCOG (1987)	Grab samples	4 parameters[7]	Good/Fair/Poor			•Riggs Rd (FAIR TO GOOD)
	1986 & 1987	MWCOG (1989a)	Grab samples	5 parameters[8]	Excellent/Good/Fair/Poor			•Riggs Rd (GOOD)
	1988	ICPRB (Cummins, 1989)	Grab samples	4 parameters[9]	No rating provided		•Norwood Rd[9]	•Randolph Rd[9] •Rt 29[9] •Rt 650[9]
	1989	ICPRB (Stribling et.al., 1990)	Grab samples	10 parameters[10]	Good/Fair/Poor		•Norwood Rd (FAIR)	•Randolph Rd (GOOD) •Rt 29 (FAIR)
	1990	ICPRB (Cummins et.al., 1991)	Grab samples	6 parameters[11]	No rating provided			•Layhill Park[11]

1. RBP III (EPA's Rapid Bioassessment Protocol, level III) is a genus level study on the benthic macroinvertebrate (aquatic insect) community, which entails scoring 6 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent and standardized assessment of all sites throughout the study. MWCOG examined the RBP III data collected and analyzed by ICPRB in 1989 and then developed the stream condition characterization breakdown.

2. RBP II (EPA's Rapid Bioassessment Protocol, level II) is a family level study on the benthic macroinvertebrate (aquatic insect) community. The Environmental Planning Division analyzed data from the source indicated, which involved transposing a mix of genus and family level macroinvertebrate data into a consistent set of family level data for all the sites and then performed a RBP II (family level) analysis. The RBP II analysis entails scoring 7 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent and standardized assessment of all sites throughout the study.

3. Fish diversity comparisons involved comparing the diversity of fish communities from different stream sites throughout the Anacostia River basin. Ratings are based on a MWCOG breakdown: 0 - 5 fish species = POOR, 5 - 10 species = FAIR, 10 - 15 species = GOOD, and 15 - 25 species = EXCELLENT.

4. A RBP V (EPA's Rapid Bioassessment Protocol, level V) is a species level study of the fish community. An Index of Biological Integrity (IBI) is used as an analysis procedure, similar to RBP II & III, which involves assigning values for 8 different fish community attributes (metrics) for each site, and then comparing those values with a reference (best condition) site to get a consistent and standardized assessment for all sites throughout the study.

5. The 9 parameters assessed by MCDEP in the years 1972 through 1975 included; mean water temperature, mean dissolved oxygen, mean pH, mean biochemical oxygen demand (BOD), mean turbidity, mean total coliform, mean fecal coliform, mean total nitrate/nitrite, and mean total phosphates. Stream condition characterization for 1972 through 1975 was based on a combination of assessments and comparisons of the average values of the 9 water quality parameters for all the sites on each stream, which included; assessing violations of State water quality criteria, assessing sites which exhibited poor water quality, comparisons of the various parameters between streams, and professional judgement of DEP staff.

6. The 9 parameters assessed by MCDEP in the years 1976 through 1980 included; mean water temperatures, mean dissolved oxygen, mean pH, mean BOD, mean total phosphates, mean nitrate/nitrite, mean turbidity, mean total suspended solids, and mean fecal coliform bacteria concentrations. Stream condition characterization for 1976 through 1980 was based on a Water Quality Index (for further information and explanation see the MCDEP Environmental Reports for those years or see the EPA publication: EPA-907/9-74-001, Feb 1974).

Summary of Northwest Branch Water Quality Monitoring (cont.)

Table 3

7. The 4 parameters assessed by MWCOG in 1985 included; mean total suspended solids, mean fecal coliforms, mean nitrate, mean total phosphorous concentrations. Stream condition characterization was based on professional judgement.

8. The 5 parameters assessed by MWCOG in 1986 & 1987 included the mean values from May through September for; water temperature, pH, total suspended solids, fecal coliform, and nitrate. The stream condition characterization was based on a water quality index developed by ICPRB in 1979 which assigns a score for the mean for each parameter, and then based on this total score, assigns a rating for the particular sample site.

9. The 4 parameters collected by ICPRB in 1988 included; water temperatures, pH, dissolved oxygen, and conductivity. No stream rating or characterization was furnished in the study report, however a discussion of the relative significance of the values of the 4 parameters was provided in the report and is summarized in the following: Norwood Rd - all four parameters were within normal limits during spring, summer and fall sampling events; Randolph Rd - all four parameters were within normal limits during spring, summer and fall sampling events; Rt 29 - pH, DO, and conductivity were all normal during spring, summer, and fall sampling events, and water temperature was normal during spring and fall, but was unusually high in the summer; Rt 650 - all four parameters were within normal limits during spring, summer and fall sampling events.

10. The 10 parameters assessed by ICPRB in 1989 included; mean water temperature, mean dissolved oxygen, mean pH, mean turbidity, mean total suspended solids, mean total dissolved solids, mean ammonia, mean conductivity, mean total coliforms, and mean fecal coliform. Stream condition characterization was based on professional judgement.

11. The 6 parameters assessed by ICPRB in 1990 included; water temperature, pH, total dissolved solids, turbidity, dissolved oxygen, and coliform bacteria concentrations. No stream rating or characterization was furnished as part of the study report, however a discussion of the relative significance of the values of the parameters was provided in the report and is summarized in the following: the Layhill Rd site on the Northwest Branch had all parameters within acceptable limits except for the coliform concentrations which chronically exceeded the recommended limit set in State water quality standards.

the Anacostia Basin averaged 13,400 tons per year between 1962 - 1974. Development of the watershed has greatly altered the hydrology of the river and its tributaries. Point source pollution in the form of sewage and industrial discharges in the '50s, '60s and early '70s was a major culprit in stream degradation. Today, non-point source pollution in agricultural and urban stormwater runoff are the chief contributors. Lakes and ponds have also been affected with eutrophication[4], elevated water temperatures and accumulations of toxic hydrocarbons, PCBs and heavy metals.

The Anacostia Watershed Restoration Project is a regional effort to protect and enhance water quality in the Anacostia River including the Northwest Branch, Paint Branch, Silgo Creek and Little Paint Branch watersheds. This effort was initiated under the Anacostia Watershed Restoration Agreements of 1984 and 1987 and has involved local projects in the various Anacostia subwatersheds in Montgomery and Prince George's Counties and the District of Columbia. Currently in Montgomery County, the U.S. Army Corps Engineers is undertaking a feasibility study in cooperation with local and regional agencies to determine stream enhancement and water quality/quantity retrofit opportunities in the Northwest Branch watershed. MCDEP is studying potential improvements in the upper Paint Branch.

Northwest Branch

As with most of the Anacostia tributaries, Northwest Branch has varied water quality along its length, with the upper portions in better condition as a general rule. Its upper headwater streams in Cloverly and Sandy Spring/Ashton are generally of high quality. Although these headwater streams do not support naturally-reproducing trout populations, the streams still sustain diverse, environmentally-sensitive aquatic communities, including aquatic macroinvertebrates. These diverse macroinvertebrate communities indicate generally good to excellent stream conditions in upper Northwest Branch streams (see Table 3, page 22); M-NCPPC found healthy, diverse aquatic macroinvertebrate communities and high quality aquatic habitat in the very limited monitoring that was conducted in the summers of 1993 and 1996. As a Use IV stream system, the Northwest Branch in Montgomery County supports a put-and-take brown trout fishery. The trout population is continually stocked by DNR although there are some adult trout which survive for more than one year.

The headwaters area in Cloverly is defined as the Hampshire Greens, Bryants Nursery Run, Ednor Road, and Johnson Road sub-watersheds, as well as the mainstem at and upstream of Johnson Road (see Figure 5, page 26). Imperviousness for 1990 ranges from about 5 to 8 percent in these sub-watersheds (see Table 2, page 20). The headwater streams in Northwest Branch tend to be siltier and carry a higher sediment load than the headwater streams in Paint Branch. Some of the streams that appear to have moderate silt and sediment loading include those in the Bryants Nursery and Johnson Road subwatersheds. This is due to a combination of factors, including soils and geology. The Northwest Branch watershed contains more erodible soils than the Paint Branch watershed and may be particularly sensitive to changes in cover conditions: for example, in the upper headwater area of Northwest Branch within Cloverly (which includes the Johnson Road, Bryants Nursery Run, and Hampshire Greens subwatersheds), roughly 29 percent of the soils are defined as highly erodible using Soil Conservation Service criteria; and about 18 percent of the soils in upper Paint Branch (defined as the Good Hope, Gum Springs, Right Fork, Left Fork, and Fairland Farms subwatersheds) are defined as highly erodible. In addition, agricultural uses in the upper Northwest Branch, which typically involve ongoing land cover disturbances and create significant sediment loads to streams, cover a larger area than in upper Paint Branch.

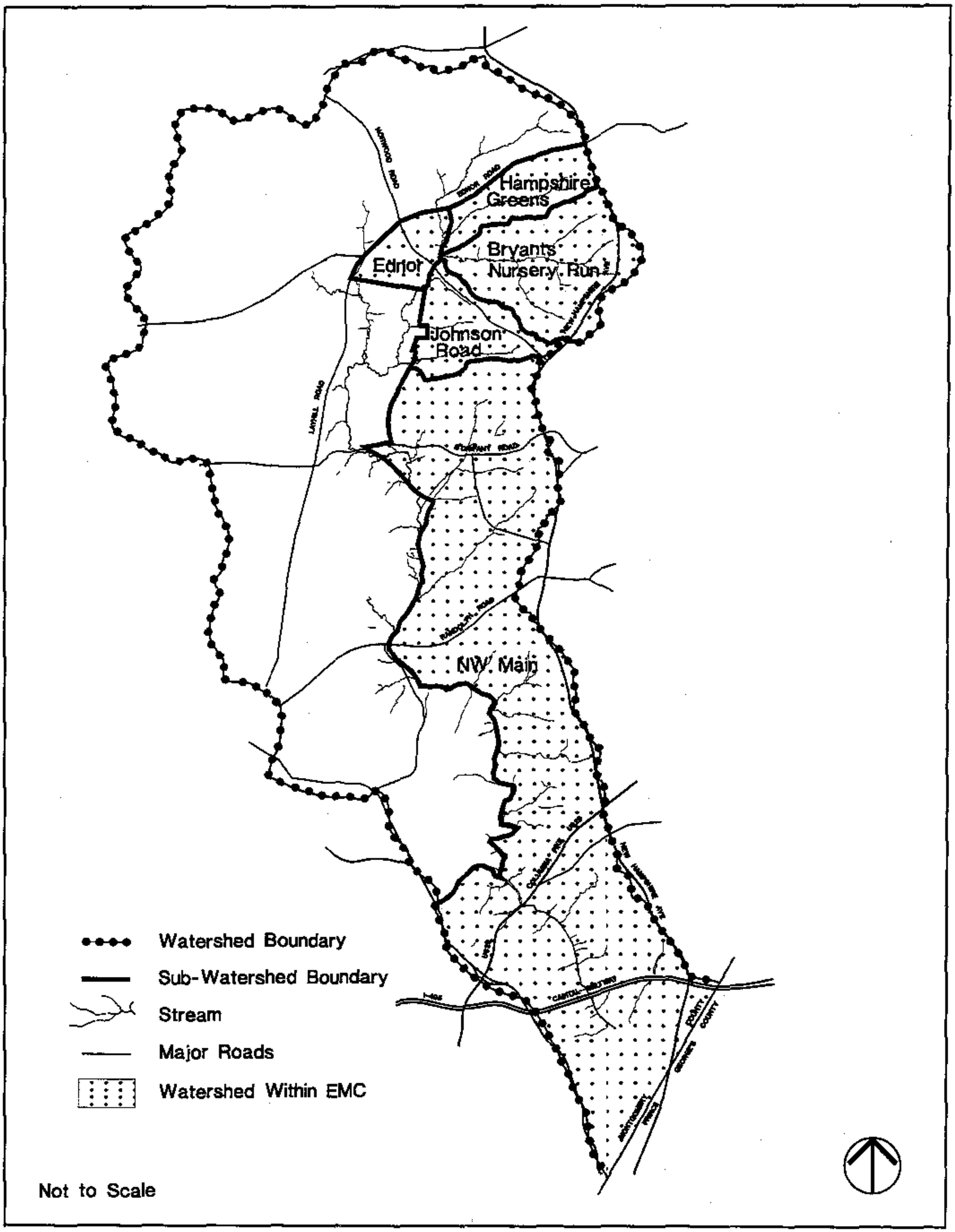
Efforts to protect the high quality conditions in the headwater streams of the Northwest Branch should focus on maintaining low density land uses, as well as providing stormwater management and sediment controls for new development consistent with the Use IV stream designation. This would include preserving stream and wetlands buffers, reforesting buffer areas where forest does not exist, and identifying and implementing retrofit projects and agricultural BMPs to reduce sedimentation and correct existing problems.

Farther downstream, in the vicinity of Randolph Road, where a greater proportion of the watershed is developed (see Table 2, page 20), the quality of Northwest Branch is not as high as in the upstream sections (see Table 3, page 22). Extensive sand bars occur on the inside of meanders as well as in mid-channel in the mainstem. Severe undercutting of stream banks and especially of outside meanders has made the banks essentially vertical, and lateral erosion and ongoing channel widening are evident. As with any

[4] Nutrient enrichment (especially of nitrogen and phosphorus) which promotes increased oxygen demand from the biological blooms it stimulates. When excessive, this can lead to rapid depletion of dissolved oxygen and turbidity, among other negative impacts.

Northwest Branch

Figure 5



streams, the mainstem channel is in a dynamic state, changing its shape and size in response to base and storm flow fluctuations resulting from development in the watershed. Stream banks therefore bear the marks of absorbing the energy of floods allowed little dissipation over floodplains.

Downstream conditions are further aggravated by the use of three-wheeled all-terrain vehicles, the presence of exposed (sometimes leaking) sewer lines and eroding trails, the dumping of trash and debris, and the removal of stabilizing streamside vegetation. Most of the time, fecal coliform counts exceed state standards (U.S. Army Corps of Engineers, 1994). Less diverse and more pollution tolerant aquatic life is supported in the lower sections of the stream especially in the slower, unshaded, channelized urban sections, and most of the fish species found there are tolerant of poor water quality and sedimentation.

As seen in Table 2, page 20, impervious cover within most of the Northwest Branch subwatersheds are projected under the 1981 master plan zoning to remain within the 10 to 15 percent range that is generally considered as the impervious cover limits for protecting coldwater streams in Maryland. Therefore, the 1981 master plan land uses, in combination with regulatory environmental requirements, standards, and guidelines, are expected to provide appropriate protection for Northwest Branch within Cloverly.

The mainstem subwatershed (roughly the area draining the mainstem downstream of Johnson Road) is estimated to have a subwatershed imperviousness of 16 percent in 1990. Because most of the land in this part of Northwest Branch has been developed, it is projected to increase by only about 1.3 percent (see Table 2, page 20). Since opportunities to significantly change the mainstem's subwatershed characteristics are very limited, given the small proportion of remaining developable land within the subwatershed, no changes in the 1981 master plan land uses are recommended. To enhance protection of the natural resources within the mainstem watershed, strict implementation and enforcement of regulatory environmental requirements and standards, and application of guidelines are recommended for any new development or redevelopment projects. In addition, programs and projects which identify and implement stormwater management retrofits and stream restoration in a timely manner should also be pursued.

Sligo Creek

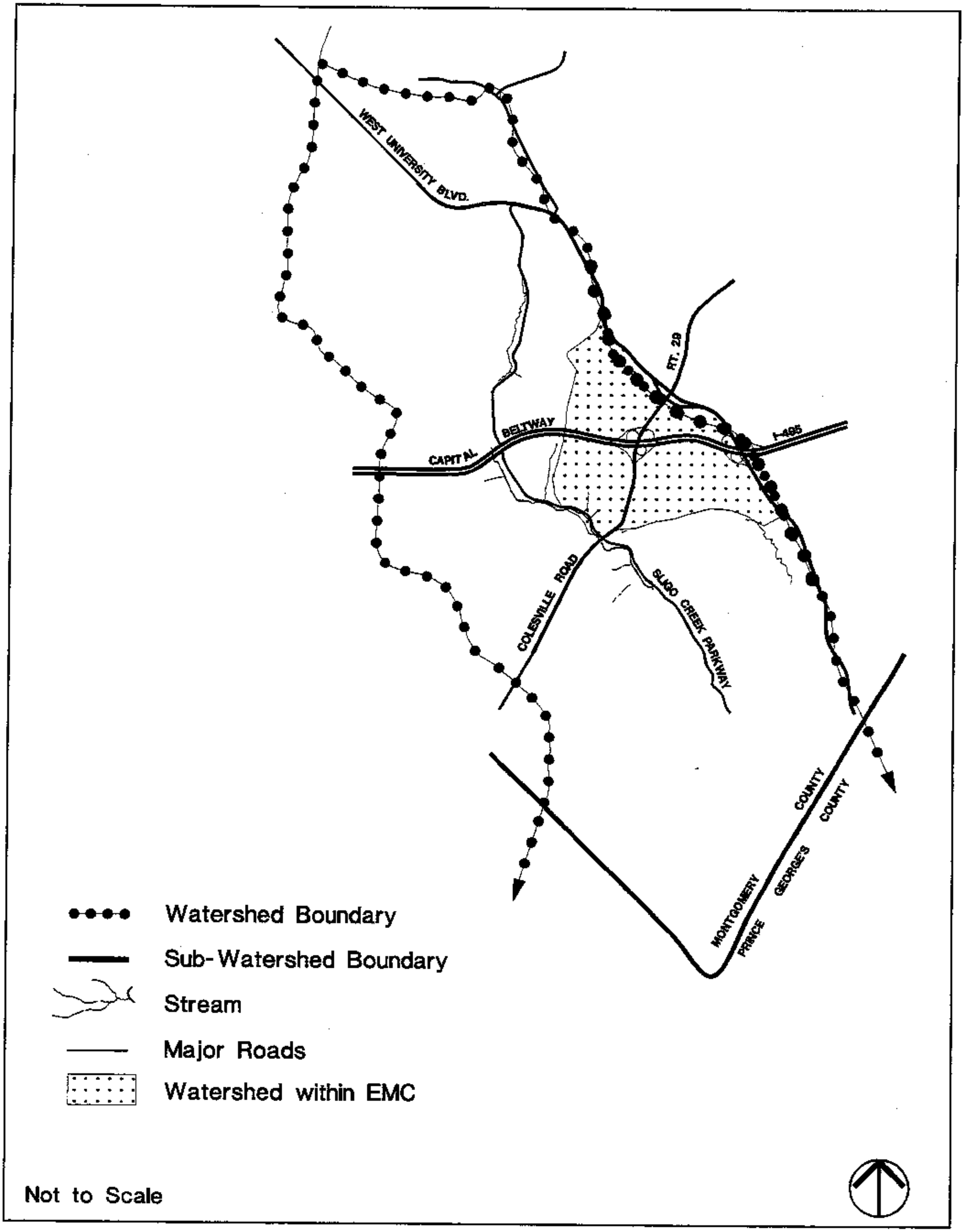
Only a small portion of the Sligo Creek watershed is within eastern Montgomery County (in the Four Corners planning area, see Figure 6, page 28). Ratings by different studies of Sligo Creek's overall quality range from poor to fair-good (see Table 4, page 29). Such ratings are typical of streams which drain relatively urbanized land that have relatively high impervious cover. The 1990 impervious cover for Sligo Creek within eastern Montgomery County is about 31.3 percent (see Table 2, page 20). Predominant commercial and suburban land uses have resulted in high overall imperviousness in the subwatershed. Many of its tributaries have disappeared, starved of their supply of rainwater. The majority of development took place prior to implementation of stormwater management controls. Storm water is typically conveyed directly into the stream by storm drains. Excessive stormwater runoff often alters the flow significantly, causing extensive bottom scouring and bank erosion and loss of trees, along with adverse fluctuations in biological and chemical conditions. Though temperature and dissolved oxygen levels have been within the Use I water quality standards, fecal coliform bacteria counts have been consistently high (probably due to contamination which commonly leaches from the adjacent sewer line), particularly during heavy flows (U.S. Army Corps of Engineers, 1994).

Sligo Creek, a Use I stream, was not capable of supporting a diverse fish community until recently when extensive restoration of the headwaters was undertaken by various agencies including MCDEP, MDE and M-NCPPC. The water quality is sufficiently high to permit survival of a variety of aquatic species but physical barriers to fish migration, in addition to erratic variations between baseflow and storm flow volumes and velocities, have limited Sligo Creek's fish community. These impacts on the fish population are the reason for its historical reputation as the worst tributary of the Anacostia. Very few macroinvertebrates or aquatic plants are resident, and the few species occurring are pioneer species (i.e., are tolerant of siltation, low water quality and/or low base flow).

Restoration of the creek is an ongoing effort, with over $2 million already invested by state and local government. Montgomery County DEP has constructed four major retrofit projects, including the innovative Wheaton Branch stormwater management retrofit facility that was constructed near Dennis Avenue (upstream of the Four Corners planning area), and has restocked part of the stream with native fish and

Sligo Creek

Figure 6



Summary of Sligo Creek Water Quality Monitoring

Table 4

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Condition of Sligo Creek Mainstem
Macro-invertebrates	1989	MWCOG (Kumble, 1990)	Surber, 2 sq. ft.	Modified RBP III; 6 metrics[1]	Good/Fair/Poor	•Near Sligo Park Golf Course (POOR) •Rt 650 (POOR)
	1989	ICPRB (Stribling et.al., 1990)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Near Sligo Park Golf Course (POOR)
	1990	ICPRB (Cummins et.al., 1991)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 650 (POOR)
	1993	M-NCPPC EPD (1993)	D-net, 300 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Rt 29 (POOR)
Fish - (excludes MD. DNR data)	1988	MWCOG (Herson et.al., 1989) ICPRB (Cummins, 1989)	Seine hauls	Fish diversity comparisons. MWCOG ratings[3]	Excellent/Good/ Fair/Poor	•Near Sligo Park Golf Course (POOR) •Rt 650 (POOR)
	1990	ICPRB (Cummins et.al., 1991)	Electro-shock	RBP V; IBI, 8 metrics[4]	Excellent/Good/ Fair/Poor	•University Blvd (POOR) •Rt 650 (Long Branch) (POOR)
Chemical and Physical Water Quality	1972	MCDEP (1974)	Grab samples	9 parameters[5]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 29 (FAIR) •Carroll Ave (FAIR)
	1973	MCDEP (1974)	Grab samples	9 parameters[5]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 29 (FAIR) •Carroll Ave (FAIR)
	1974-1975	MCDEP (1976)	Grab samples	9 parameters[5]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 29 (FAIR) •Carroll Ave (FAIR)
	1976	MCDEP (1977)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 29 (FAIR) •Carroll Ave (FAIR)
	1977	MCDEP (1978)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 29 (FAIR) •Carroll Ave (FAIR)
	1978	MCDEP (1979)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 29 (FAIR) •Carroll Ave (FAIR)
	1979	MCDEP (1980)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 29 (FAIR) •Carroll Ave (FAIR)
	1980	MCDEP (1980)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor	•University Blvd (FAIR) •Rt 29 (FAIR) •Carroll Ave (FAIR)
	1985	MWCOG (1987)	Grab samples	4 parameters[7]	Good/Fair/Poor	•Sligo Cr @ Carroll Ave (FAIR) •Long Br @ Carroll Ave (FAIR-GOOD)

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Condition of Sligo Creek Mainstem
	1986 & 1987	MWCOG (1989a)	Grab samples	5 parameters[8]	Excellent/Good/ Fair/Poor	•Carroll Ave (FAIR-GOOD)
	1988	ICPRB (Cummins, 1989)	Grab samples	4 parameters[9]	No rating provided	•Near Sligo Park Golf Course[9] •Rt 650[9]
	1989	ICPRB (Stribling et.al., 1990)	Grab samples	10 parameters[10]	Good/Fair/Poor	•Near Sligo Park Golf Course (FAIR) •Rt 650 (GOOD)
	1990	ICPRB (Cummins et.al., 1991)	Grab samples	6 parameters[11]	No rating provided	•Sligo Cr & Long Br confluence[11] •University Blvd[11]

1. RBP III (EPA's Rapid Bioassessment Protocol, level III) is a genus level study on the benthic macroinvertebrate (aquatic insect) community, which entails scoring 6 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent and standardized assessment of all sites throughout the study. MWCOG examined the RBP III data collected and analyzed by ICPRB in 1989 and then developed the stream condition characterization breakdown.

2. RBP II (EPA's Rapid Bioassessment Protocol, level II) is a family level study on the benthic macroinvertebrate (aquatic insect) community. The Environmental Planning Division analyzed data from the source indicated, which involved transposing a mix of genus and family level macroinvertebrate data into a consistent set of family level data for all the sites and then performed a RBP II (family level) analysis. The RBP II analysis entails scoring 7 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent and standardized assessment of all sites throughout the study.

3. Fish diversity comparisons involved comparing the diversity of fish communities from different stream sites throughout the Anacostia River basin. Ratings are based on a MWCOG breakdown: 0 - 5 fish species = POOR, 5 - 10 species = FAIR, 10 - 15 species = GOOD, and 15 - 25 species = EXCELLENT.

4. A RBP V (EPA's Rapid Bioassessment Protocol, level V) is a species level study of the fish community. An Index of Biological Integrity (IBI) is used as an analysis procedure, similar to RBP II & III, which involves assigning values for 8 different fish community attributes (metrics) for each site, and then comparing those values with a reference (best condition) site to get a consistent and standardized assessment for all sites throughout the study.

5. The 9 parameters assessed by MCDEP in the years 1972 through 1975 included; mean water temperature, mean dissolved oxygen, mean pH, mean biochemical oxygen demand (BOD), mean turbidity, mean total coliform, mean fecal coliform, mean total nitrate/nitrite, and mean total phosphates. Stream condition characterization for 1972 through 1975 was based on a combination of assessments and comparisons of the average values of the chemical water quality parameters for all the sites on each stream, which included; assessing violations of State water quality criteria, assessing sites which exhibited poor water quality, comparisons of the various parameters between streams, and professional judgement of DEP staff.

6. The 9 parameters assessed by MCDEP in the years 1976 through 1980 included; mean water temperatures, mean dissolved oxygen, mean pH, mean BOD, mean total phosphates, mean nitrate/nitrite, mean turbidity, mean total suspended solids, and mean fecal coliform bacteria concentrations. Stream condition characterization for 1976 through 1980 was based on a Water Quality Index (for further information and explanation see the MCDEP Environmental Reports for those years or see the EPA publication: EPA-907/9-74-001, Feb 1974).

7. The 4 parameters assessed by MWCOG in 1985 included; mean total suspended solids, mean fecal coliforms, mean nitrate, mean total phosphorous concentrations. Stream condition characterization was based on professional judgement.

8. The 5 parameters assessed by MWCOG in 1986 & 1987 included the mean values from May through September for; water temperature, pH, total suspended solids, fecal coliform, and nitrate. The stream condition characterization was based on a water quality index developed by ICPRB in 1979 which assigns a score for the mean for each parameter, and then based on the total score, assigns a rating for the particular sampling site.

Summary of Sligo Creek Water Quality Monitoring (cont.)

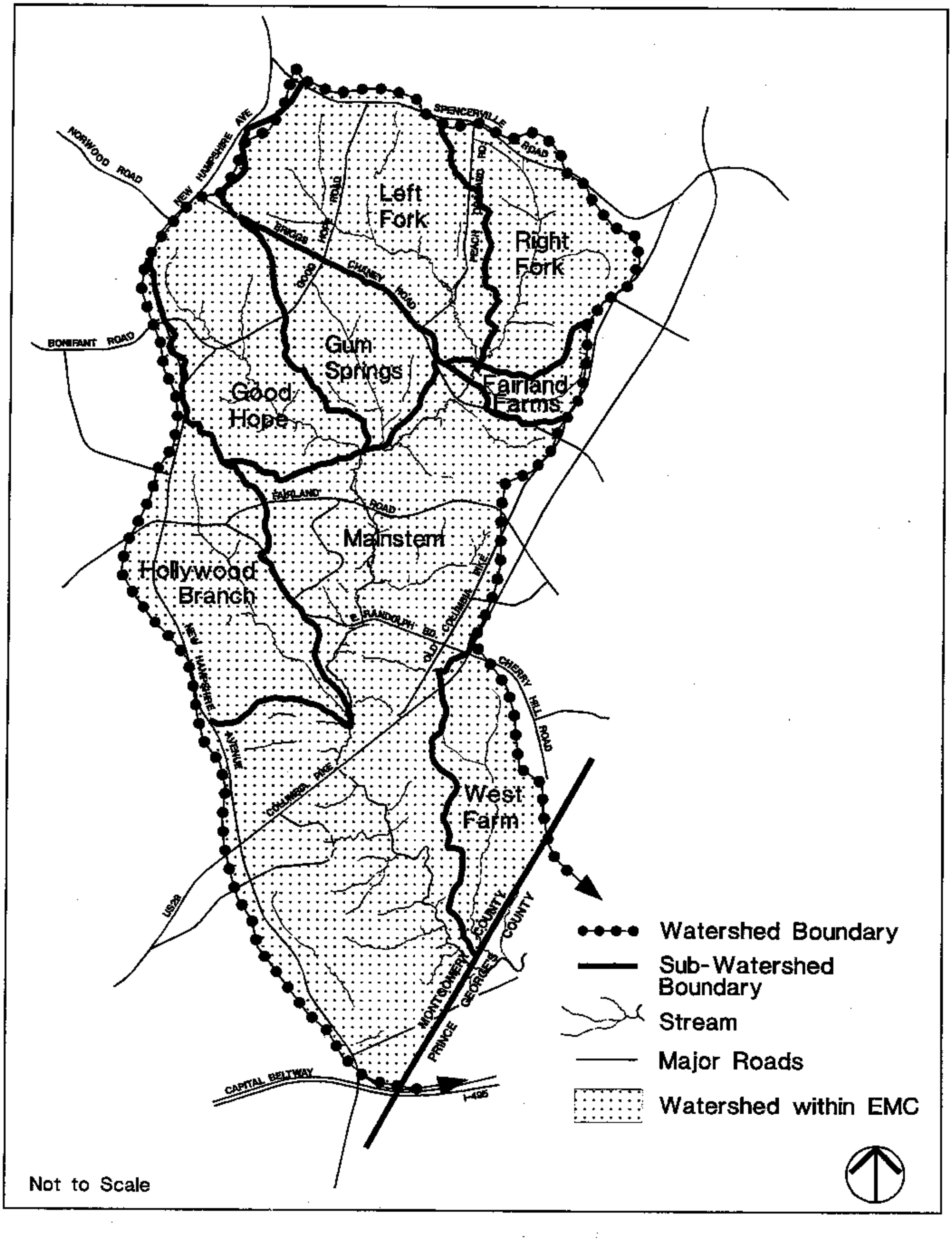
9. The 4 parameters collected by ICPRB in 1988 included; water temperatures, pH, dissolved oxygen, and conductivity. No stream rating or characterization was furnished in the study report, however a discussion of the relative significance of the values of the 4 parameters was provided in the report and is summarized in the following: Both the Rt 29 and Sligo Park Golf Course sites had pH, water temperatures, dissolved oxygen within normal limits during the spring, summer, and fall sampling events, however the conductivity levels at both sites were elevated in the spring and summer.

10. The 10 parameters assessed by ICPRB in 1989 included; mean water temperature, mean dissolved oxygen, mean pH, Mean turbidity, mean total suspended solids, mean total dissolved solids, mean ammonia, mean conductivity, mean total coliforms, and mean fecal coliform. Stream condition characterization was based on professional judgement.

11. The 6 parameters assessed by ICPRB in 1990 included; water temperature, pH, total dissolved solids, turbidity, dissolved oxygen, and coliform bacteria concentrations. No stream rating or characterization was furnished as part of the study report, however a discussion of the relative significance of the values of the parameters was provided in the report and is summarized in the following: the Sligo Creek site at University Blvd and the Sligo Creek & Long Branch confluence site both had all 6 parameters within acceptable limits except for the coliform concentrations which chronically met or exceeded the recommended limit in State water quality standards at both sites.

Paint Branch

Figure 7



macroinvertebrates. WSSC has taken steps to eliminate sewage overflow and leaks in the subwatershed.

These measures seem to be working, since the stream conditions for aquatic life have improved. Species monitoring immediately downstream of the Wheaton Branch SWM facility and in the stocked section of the stream in 1994 found sixteen species of fish, a significant improvement over a 1992 count of eight (U.S. Army Corps of Engineers, 1994), the 1988 count of two and a 1984 survey finding only one. In addition, several other aquatic species have become established in the self sufficient community now thriving in newly created vernal pools and wetlands. It is hoped these retrofit and restoration efforts continue to provide benefits to the stream system in the long term and are able to restore the stream's health on a permanent basis.

Table 2, page 20, shows that the Sligo Creek watershed within eastern Montgomery County is roughly 31.3 percent impervious. Because remaining developable land is very small, efforts to improve the quality of the stream system should continue to focus on identifying and implementing projects for stormwater management retrofits and stream restoration in a timely manner. Efforts to monitor and track the effectiveness of these projects over the long-term should also continue.

Paint Branch

The Paint Branch subwatershed lies mostly within Montgomery county (a small downstream portion lies within Prince Georges' County). Uses in eastern Montgomery County largely control what happens in the headwaters subwatersheds and a large portion of the mainstem (see Figure 7). Detailed characterization and evaluation of Paint Branch in eastern Montgomery County is provided in the Upper Paint Branch Watershed Study. The reader should refer to that study for detailed analysis and recommendations for preservation and protection of the high quality conditions and unique natural resource of the Paint Branch watershed.

The brown trout population serves as an indicator of high water quality in the subwatersheds of eastern Montgomery County. While the abundance of macroinvertebrates and other fish species has been measured , the trout is an easily recognized and well-established indicator. By virtue of its exceptional sensitivity to any adverse impacts, its presence signifies the high water and habitat quality of a stream; conditions which are likely to be more than adequate for the survival of species which form its food source, or are otherwise part of the cold water ecosystem. Likewise, the growth or decline of trout populations are an early indication of fluctuations in the health of the stream.

The relatively low impervious cover within the upper portions of the Paint Branch watershed has helped preserve the very high quality conditions in the important headwater streams (see Table 2, page 20).

Although upper Paint Branch is still of very high quality, long-term monitoring of the system, primarily by DNR-tracking of the brown trout fishery, is showing that the upper stream system is being stressed. These stressed conditions are being documented even at fairly low subwatershed imperviousness levels.

Downstream of Fairland Road, the streams in Paint Branch are generally of lower quality than upper Paint Branch (see Table 5, page 34). However, generally, conditions in lower Paint Branch are still of high enough quality to support adult trout. The lower quality in lower Paint Branch is largely due to the fact that a higher proportion of the lower watershed is developed, which is reflected in higher impervious cover (see Table 2, page 20). Much of the developed areas of lower Paint Branch pre-date stormwater management requirements, and surface water runoff from these areas flow largely uncontrolled and untreated to receiving streams.

The InterCounty Connector (ICC) master plan alignment currently crosses both the Good Hope and the Gum Springs tributaries, paralleling the Good Hope tributary for approximately 6000 feet. The draft environmental impact statement (EIS) for the proposed InterCounty Connector is considering the appropriate size, design and potential impact of locating this road at this and several other locations (in addition to no-build and upgrading of existing roads). The impact of the road on the protection of water quality will be evaluated during the draft EIS process.

Little Paint Branch

Many of the streams and the surrounding valleys in the Little Paint Branch have been degraded by surrounding development in the Route 29 corridor. Documented data on Little Paint Branch within Montgomery County indicate that the streams are generally in poor to fair condition (see Table 6, page 40). Most of the watershed within Montgomery County has relatively high impervious cover (see Table 2, page 20), reflecting fairly dense development that already exists. Some of this existing development, especially those areas built before the application of regulatory stream buffers, has resulted in a variety of adverse

Summary of Paint Branch Water Quality Monitoring

Table 5

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Paint Branch Subwatersheds					
						Left Fork Trib.	Right Fork Trib.	Good Hope Trib.	Gum Springs Trib.	Hollywood Branch	Mainstem
Macro-invertebrates	1979-1980	MD. DNR (Hughes, 1980)	Not given in source.	Macro-invertebrate Diversity Index	3.00 - 4.00 = Excellent 2.00 - 3.00 = Good 1.00 - 2.00 = Fair 0.00 - 1.00 = Poor	Range = 1.88 - 2.16 (FAIR TO GOOD) Mean = 2.00	Range = 2.27 - 3.77 (GOOD TO EXCEL) Mean = 3.14	Range = 2.42 - 3.01 (GOOD TO EXCEL) Mean = 2.80			•Briggs Chaney Rd: Range= 2.00 - 2.43 (GOOD) Mean = 2.16 •Fairland Rd: Range= 1.65 - 2.65 (FAIR TO GOOD) Mean = 2.21 •Rt. 29: Range= 1.38 - 2.25 (FAIR TO GOOD) Mean = 1.90
	1980-1984	MD. DNR (Gougeon, 1985)	Not given in source.	Macro-invertebrate Diversity Index	3.00 - 4.00 Excellent 2.00 - 3.00 = Good 1.00 - 2.00 = Fair 0.00 - 1.00 = Poor	Range = 1.83 - 2.83 (FAIR TO GOOD)	Range = 1.69 - 3.56 (FAIR TO EXCEL)	•Upper: Range = 1.83 - 3.56 (FAIR TO EXCEL) •Lower: Range = 1.41 - 3.13 (FAIR TO EXCEL)	Range = 1.61 - 3.62 (FAIR TO EXCEL)		•Briggs Chaney Rd: Range= 1.36- 3.03, for 1980 to 3/82 only (FAIR TO EXCEL) •Fairland Rd: Range= 1.17 - 2.86 (FAIR TO GOOD) •Rt. 29: Range= 0.71 - 2.40 (FAIR TO GOOD)
	1989	MWCOG (Kumble, 1990)	Surber, 2 sq. ft.	Modified RBP III; 6 metrics[1]	Good/Fair/Poor						•Fairland Rd (GOOD) •Rt. 29 (GOOD)
	1989	ICPRB (Stribling et.al., 1990)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor						•Fairland Rd (EXCEL) •Rt. 29 (GOOD)
	1990	ICPRB (Cummins et.al., 1991)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor						•Randolph Rd (EXCEL)
	1990	MD. DNR (1990)	D-net, 90 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Lower (GOOD)	•Upper (EXCEL)	•Upper (GOOD) •Lower (GOOD)	•Lower (FAIR)		•Fairland Rd (GOOD) •Rt. 29 (FAIR)
	1991	MD. DNR (1991)	D-net, 90 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Lower (EXCEL)	•Upper (EXCEL)	•Upper (EXCEL) •Lower (EXCEL)	•Lower (GOOD)		•Fairland Rd (EXCEL) •Rt. 29 (FAIR)

Summary of Paint Branch Water Quality Monitoring (cont.)

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Paint Branch Subwatersheds					
						Left Fork Trib.	Right Fork Trib.	Good Hope Trib.	Gum Springs Trib.	Hollywood Branch	Mainstem
	1992	MD. DNR (1992)	D-net, 90 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Lower (EXCEL)	•Upper (EXCEL)	•Upper (EXCEL) •Lower (EXCEL)	•Lower (GOOD)		•Fairland Rd (EXCEL) •Rt. 29 (GOOD)
	1993	MD. DNR (1993)	D-net, 90 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Lower (FAIR)	•Upper (EXCEL)	•Upper (GOOD) •Lower (GOOD)	•Lower (FAIR)		•Fairland Rd (GOOD) •Rt. 29 (POOR)
	1993	M-NCPPC EPD (1993)	D-net, 300 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor						•Above Randolph Rd (FAIR) •Below Randolph Rd (FAIR)
	1995	MCDEP	Kick, Seine net	Montgomery County protocol[3] compare to reference condition	Excellent/Good/ Fair/Poor	•Good	•Good to Excellent	•Good	•Good to Excellent		•Briggs Chaney (EXCELLENT) •Fairland Rd (GOOD)
Habitat Qualitative	1994-1995	MCDEP	Rapid assessment	Graph comparison	Optimal/Suboptimal /Marginal/Poor	•Suboptimal (1994)	•Suboptimal (1994)	•Suboptimal to Optimal (1994-1995)	•Suboptimal to Optimal (1994) •Optimal (1995)		•Briggs Chaney (SUBOPTIMAL 1994) •Fairland Rd (SUBOPTIMAL 1994-1995)
Habitat Quantitative	1994-1996	MCDEP	Mont. County protocol	Graph comparison	Flow, morphological description	To be published in Paint Branch SPA Conservation Plan					
Fish - (excludes MD. DNR data)	1988	MWCOG (Herson et.al, 1989) ICPRB (Cummins, 1989)	Seine hauls	Fish diversity comparisons. MWCOG ratings[4]	Excellent=15-25 species Good=10-15 species Fair = 5-10 species Poor = 0-5 species						•Rt. 29: 5-10 species (FAIR)
	1983, 1986, 1988	MWCOG (Kumble et.al., 1990)	Not given in source	Abundance of sensitive species	No rating provided			7 sensitive species out of 12 species collected, at 10% imperviousness		1 sensitive species out of 6 sps. collected at 25% imperv.	

Summary of Paint Branch Water Quality Monitoring (cont.)

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Paint Branch Subwatersheds					
						Left Fork Trib.	Right Fork Trib.	Good Hope Trib.	Gum Springs Trib.	Hollywood Branch	Mainstem
	1990	ICPRB (Cummins et.al., 1991)	Electro-shock	RBP V; IBI, 8 metrics[5]	Excellent/Good/ Fair/Poor						•Below Randolph Rd (GOOD)
	1994-1995	MCDEP	Electro-shock	Pop estimate, 3 pass removal, IBI-reference condition, Montgomery County protocols	Excellent/Good/ Fair/Poor	•Good (1994)	•Fair to Excellent (1994)	•Fair to Good (1994) •Fair to Excellent (1995)	•Fair to Excellent (1994) •Excellent (1995)		•Briggs Chaney (GOOD 1994) •Fairland Rd. (GOOD 1994) •Fairland Rd. (EXCEL 1995)
Chemical and Physical Water Quality	1972	MCDEP (1974)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor						•Fairland Rd (EXCEL) •Powdermill Rd (EXCEL)
	1973	MCDEP (1974)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor						•Fairland Rd (GOOD) •Powdermill Rd (GOOD)
	1974-1975	MCDEP (1976)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor						•Fairland Rd (EXCEL) •Powdermill Rd (EXCEL)
	1976	MCDEP (1977)	Grab samples	9 parameters[7]	Excellent/Good/ Fair/Poor						•Fairland Rd (GOOD) •White Oak NSWC (GOOD) •Powdermill Rd (GOOD)
	1977	MCDEP (1978)	Grab samples	9 parameters[7]	Excellent/Good/ Fair/Poor						•Fairland Rd (FAIR) •White Oak NSWC (FAIR) •Powdermill Rd (FAIR)
	1978	MCDEP (1979)	Grab samples	9 parameters[7]	Excellent/Good/ Fair/Poor						•Fairland Rd (FAIR) •White Oak NSWC (FAIR) •Powdermill Rd (FAIR)
	1979	MCDEP (1980)	Grab samples	9 parameters[7]	Excellent/Good/ Fair/Poor						•Fairland Rd (FAIR) •White Oak NSWC (FAIR) •Powdermill Rd (FAIR)

Summary of Paint Branch Water Quality Monitoring (cont.)

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Paint Branch Subwatersheds					
						Left Fork Trib.	Right Fork Trib.	Good Hope Trib.	Gum Springs Trib.	Hollywood Branch	Mainstem
	1980	MCDEP (1981)	Grab samples	9 parameters[7]	Excellent/Good/ Fair/Poor						•Fairland Rd (FAIR) •White Oak NSWC (FAIR) •Powdermill Rd (FAIR)
	1985	MWCOG (1987)	Grab samples	4 parameters[8]	Good/Fair/Poor						•Powdermill Rd (GOOD)
	1988	ICPRB (Cummins, 1989)	Grab samples	4 parameters[9]	No rating provided						•Rt. 29[9]
	1989	ICPRB (Stribling et.al., 1990)	Grab samples	10 parameters[10]	Good/Fair/Poor						•Fairland Rd (GOOD) •Rt. 29 (FAIR)
	1990	ICPRB (Cummins et.al., 1991)	Grab samples	6 parameters[11]	No rating provided						•Randolph Rd[10]
	1994-1996	MCDEP	Grab samples	4 parameters	Supports biological monitoring						

Summary of Paint Branch Water Quality Monitoring (cont.)

1. RBP III (EPA's Rapid Bioassessment Protocol, level III) is a genus level study on the benthic macroinvertebrate (aquatic insect) community, which entails scoring 6 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent assessment of all sites in the study. MWCOG examined the RBP III data collected and analyzed by ICPRB in 1989 and then developed the stream condition characterization breakdown.

2. RBP II (EPA's Rapid Bioassessment Protocol, level II) is a family level study on the benthic macroinvertebrate (aquatic insect) community. The Environmental Planning Division analyzed data from the source indicated, which involved transposing a mix of genus and family level macroinvertebrate data into a consistent set of family level data for all the sites and then performing a RBP II (family level) analysis. The RBP II analysis entails scoring 7 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent assessment of all sites throughout the study.

3. Montgomery County DEP established a Biological Monitoring Work Group in 1994. Monitoring protocols reviewed by this Group are used by various County agencies to monitor County streams.

4. Fish diversity comparisons involved comparing the diversity of fish communities from different stream sites throughout the Anacostia River basin. Ratings are based on a MWCOG breakdown: 0 - 5 fish species = POOR, 5 - 10 species = FAIR, 10 - 15 species = GOOD, 15 - 25 species = EXCELLENT.

5. RBP V is a species level analysis on the fish community. An Index of Biological Integrity (IBI) is an analysis procedure, similar to RBP II & III, which involves assigning values for 8 different fish community attributes (metrics) for each site, and then comparing those values to a reference (best condition) site to get a consistent and standardized assessment for all sites throughout the study.

6. The 9 parameters assessed by MCDEP in the years 1972 through 1975 included; mean water temperature, mean dissolved oxygen, mean pH, mean biochemical oxygen demand (BOD), mean turbidity, mean total coliform, mean fecal coliform, mean total nitrate/nitrite, and mean total phosphates. Stream condition characterization for 1972 through 1975 was based on a combination of assessments and comparisons of the average values of the 9 water quality parameters for all the sites on each stream, which included; assessing violations of State water quality criteria, assessing sites which exhibited poor water quality, comparisons of the various parameters between streams, and professional judgement of DEP staff.

7. The 9 parameters assessed by MCDEP in the years 1976 through 1980 included; mean water temperatures, mean dissolved oxygen, mean pH, mean BOD, mean total phosphates, mean nitrate/nitrite, mean turbidity, mean total suspended solids, and mean fecal coliform bacteria concentrations. Stream condition characterization for 1976 through 1980 was based on a Water Quality Index (for further information and explanation see the MCDEP Environmental Reports for those years or see the EPA publication: EPA-907/9-74-001, Feb 1974).

8. The 4 parameters assessed by MWCOG in 1985 included; mean total suspended solids, mean fecal coliforms, mean nitrate, mean total phosphorous concentrations. Stream condition characterization was based on professional judgement.

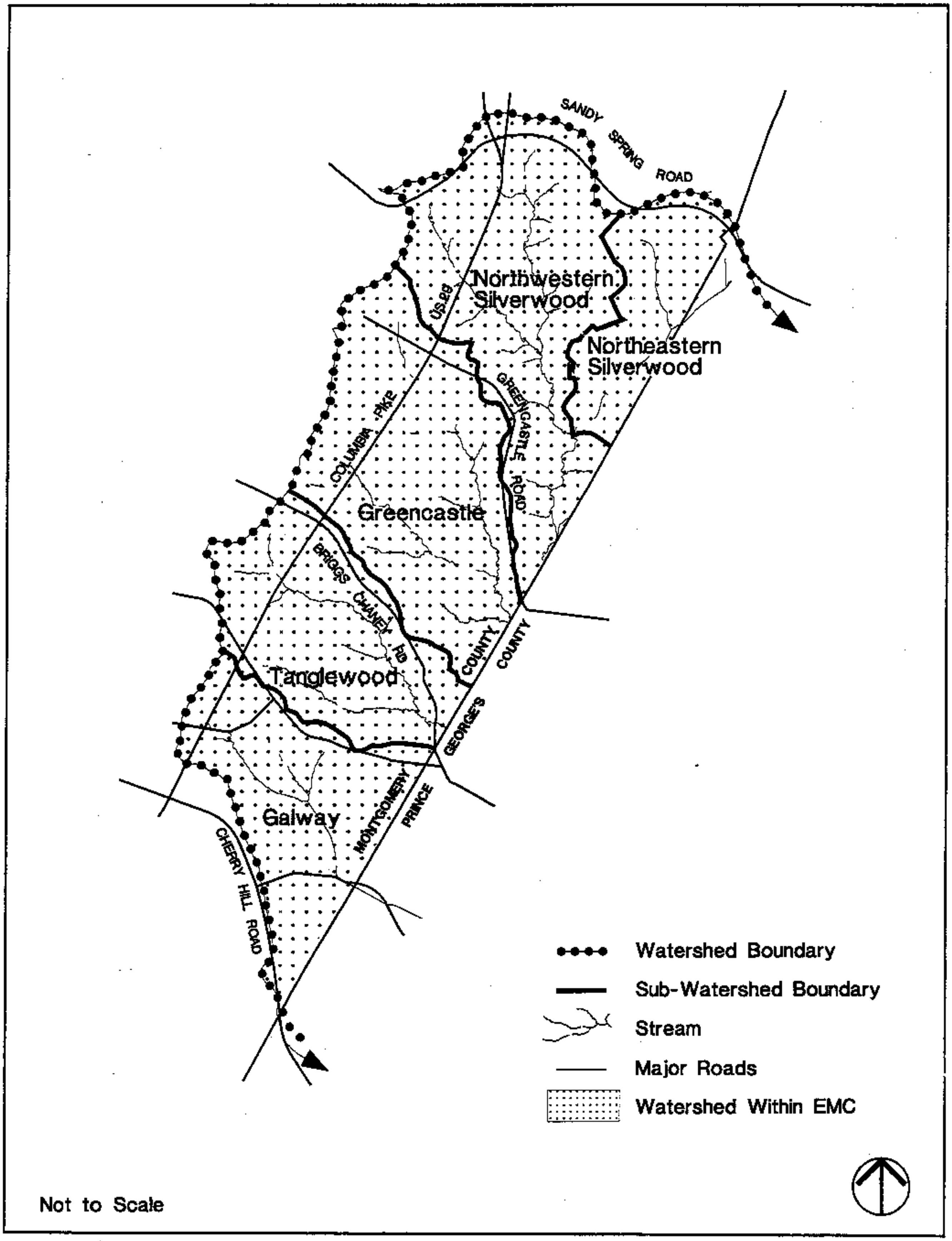
9. The 4 parameters collected by ICPRB in 1988 included; water temperatures, pH, dissolved oxygen, and conductivity. No stream rating or characterization was furnished in the study report, however a discussion of the relative significance of the values of the 4 parameters was provided in the report and is summarized in the following: the Rt 29 site had temperatures, pH, and conductivity levels which were normal in spring, summer, and fall, but the dissolved oxygen level was low in summer while normal in spring and fall.

10. The 10 parameters assessed by ICPRB in 1989 included; mean water temperature, mean dissolved oxygen, mean pH, mean turbidity, mean total suspended solids, mean total dissolved solids, mean ammonia, mean conductivity, mean total coliforms, and mean fecal coliform. Stream condition characterization was based on professional judgement.

11. The 6 parameters assessed by ICPRB in 1990 included; water temperature, pH, total dissolved solids, turbidity, dissolved oxygen, and coliform bacteria concentrations. No stream rating or characterization was furnished as part of the study report, however a discussion of the relative significance of the values was provided in the report and is summarized in the following; the Randolph Rd site had pH levels which were mostly normal throughout the year but high in July, the Total Dissolved Solid levels were normal all year, the turbidity levels were normal all year, the dissolved oxygen levels were normal all year, the temperature levels were normal all year, the coliform concentrations chronically met or exceeded the recommended limit set in State water quality standards.

Little Paint Branch

Figure 8



Summary of Little Paint Branch Water Quality Monitoring

Table 6

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Little Paint Branch Subwatersheds			
						Galway Trib.	Tanglewood Trib.	Greencastle Trib.	Mainstem
Macro-invertebrates	1989	MWCOG (Kumble, 1990)	Surber, 2 sq. ft.	Modified RBP III; 6 metrics[1]	Good/Fair/Poor				•Briggs Chaney Rd (FAIR)
	1990	ICPRB (Cummins et. al., 1991)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor		•Upstream of Briggs Chaney Rd (POOR)		
	1993	M-NCPPC EPD (1993)	D-net, 300 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Downstream of East Fairland/Calverton Park (POOR)	•Upstream of Briggs Chaney Rd (FAIR)	•Upstream of Pitcairn Place (FAIR)	
Fish - (excludes MD. DNR data)	1988	MWCOG (Herson et. al., 1989) ICPRB (Cummins, 1989)	Seine hauls	Fish diversity comparisons. MWCOG ratings[3]	Excellent/Good/ Fair/Poor				•Briggs Chaney Rd (FAIR)
	1990	ICPRB (Cummins et. al., 1991)	Electroshock	RBP V; IBI, 8 metrics[4]	Excellent/Good/ Fair/Poor		•Upstream of Briggs Chaney Rd (FAIR)		
Chemical and Physical Water Quality	1985	MWCOG (1987)	Grab samples	4 parameters[5]	Good/Fair/Poor				•Near Briggs Chaney Rd (FAIR)
	1986 & 1987	MWCOG (1989a)	Grab samples	5 parameters[6]	Excellent/Good/ Fair/Poor				•Near Briggs Chaney Rd (POOR-FAIR)
	1988	ICPRB (Cummins, 1989)	Grab samples	4 parameters[7]	No rating provided				•Briggs Chaney Rd[7]
	1989	ICPRB (Stribling et. al., 1990)	Grab samples	10 parameters[8]	Good/Fair/Poor				•Briggs Chaney Rd (FAIR)
	1990	ICPRB (Cummins et. al., 1991)	Grab samples	6 parameters[9]	No rating provided		•Upstream of Briggs Chaney Rd[9]		

1. RBP III (EPA's Rapid Bioassessment Protocol, level III) is a genus level study on the benthic macroinvertebrate (aquatic insect) community, which entails scoring 6 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent and standardized assessment of all sites throughout the study. MWCOG examined the RBP III data collected and analyzed by ICPRB in 1989 and then developed the stream condition characterization breakdown.

2. RBP II (EPA's Rapid Bioassessment Protocol, level II) is a family level study on the benthic macroinvertebrate (aquatic insect) community. The Environmental Planning Division analyzed data from the source indicated, which involved transposing a mix of genus and family level macroinvertebrate data into a consistent set of family level data for all the sites and then performed a RBP II (family level) analysis. The RBP II analysis entails scoring 7 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent and standardized assessment of all sites throughout the study.

3. Fish diversity comparisons involved comparing the diversity of fish communities from different stream sites throughout the Anacostia River basin. Ratings are based on a MWCOG breakdown: 0 - 5 fish species = POOR, 5 - 10 species = FAIR, 10 - 15 species = GOOD, and 15 - 25 species = EXCELLENT.

4. A RBP V (EPA's Rapid Bioassessment Protocol, level V) is a species level study of the fish community. An Index of Biological Integrity (IBI) is used as an analysis procedure, similar to RBP II & III, which involves assigning values for 8 different fish community attributes (metrics) for each site, and then comparing those values with a reference (best condition) site to get a consistent and standardized assessment for all sites throughout the study.

5. The 4 parameters assessed by MWCOG in 1985 included; mean total suspended solids, mean fecal coliforms, mean nitrate, mean total phosphorous concentrations. Stream condition characterization was based on professional judgement.

6. The 5 parameters assessed by MWCOG in 1986 & 1987 included the mean values from May through September for; water temperature, pH, total suspended solids, fecal coliform, and nitrate. The stream condition characterization was based on a water quality index developed by ICPRB in 1979 which assigns a score for the mean for each parameter, adds the scores to get a total score and then based on this total score assigns a rating for the particular sample site.

7. The 4 parameters collected by ICPRB in 1988 included; water temperatures, pH, dissolved oxygen, and conductivity. No stream rating or characterization was provided in the study report, however a discussion of the relative significance of the values of the parameters was provided in the report and is summarized for the Briggs Chaney Rd site in the following: water temperatures and conductivity were relatively normal in spring and summer; pH was low in spring, summer and fall; dissolved oxygen was very low in summer, but normal in spring, no fall reading.

8. The 10 parameters assessed by ICPRB in 1989 included; mean water temperature, mean dissolved oxygen, mean pH, mean turbidity, mean total suspended solids, mean total dissolved solids, mean ammonia, mean conductivity, mean total coliforms, and mean fecal coliform. Stream condition characterization was based on professional judgement.

9. The 6 parameters assessed by ICPRB in 1990 included; water temperature, pH, total dissolved solids, turbidity, dissolved oxygen, and coliform bacteria concentrations. No stream rating or characterization was provided in the study report, however a discussion of the relative significance of the values of the 6 parameters was provided in the study report and is summarized in the following: the Little Paint Branch tributary site which was upstream of Briggs Chaney Rd had water temperatures within normal limits during June through October; pH was generally within normal limits from June through October except for July when it was very high; total dissolved solids were within normal limits from June through October; turbidity was generally within normal limits from June through September, however in October it was slightly elevated; dissolved oxygen levels were within normal limits from June through October; total and fecal coliform concentrations were relatively normal during April, July and October but were excessively high during May, June, August and September.

Freshwater Fish Collected in Little Paint Branch in Fairland Recreational Park, 1990-1991

Table 7

Fish Species	Trophic Level	Pollution Tolerance
Blacknose Dace *(Rhinichthys atratulus)*	Generalist	Tolerant
Rosyside Dace *(Clinostomus funduloidess)*	Insectivore	Intermediate
Longnose Dace *(Rhinichthys cataractae)*	Insectivore	Intolerant
Central Stoneroller *(campostoma anomalum)*	Herbivore	Intermediate
Cutlips Minnow *(Exoglossum maxillingua)*	Omnivore	Intermediate
Fallfish *(Semotilus corporalis)*	Generalist	Intermediate
Creek Chub *(Semotilus atromaculatus)*	Generalist	Tolerant
Common Shiner *(Luxilus cornutus)*	Insectivore	Intermediate
Spottail Shiner *(Notropus hudsonius)*	Insectivore	Intermediate
American Eel *(Anguilla rostrata)*	Piscivore	Intermediate
White Sucker *(Catostomus commersoni)*	Omnivore	Tolerant
Northern Hog Sucker *(Hypentelium nigricans)*	Insectivore	Intolerant
Margined Madtom (*Noturus insignis*)	Insectivore	Intermediate
Tessellated Darter *(Etheostoma olmstedi)*	Insectivore	Tolerant
Green Sunfish *(Lepomis cyanellus)*	Invertivore	Tolerant
Bluegill *(Lepomis macrochirus)*	Insectivore	Tolerant
Pumpkinseed *(Lepomis gibbosus)*	Invertivore	Tolerant
Rock Bass *(Ambloplites rupestris)*	Piscivore	Intermediate
Largemouth Bass *(Micropterus salmoides)*	Piscivore	Tolerant

Sources - M-NCPPC, Department of Park and Planning, Natural Resources Division
- Trophic level and pollution tolerance categories from information compiled by Keith Van Ness, MCDEP.

impacts that range from concrete channelization of a stream section within the older Calverton subdivision to inadequate or non-existent stormwater management and stream buffers and removal of much forest or vegetative cover during development.

There are, however, some streams in the Little Paint Branch watershed which are still of relatively good quality. The streams in the Silverwood subwatershed (including the small tributary that flows through McKnew Local Park and the northwestern Silverwood Tributary that traverses Fairland Recreational Park) appear to be of relatively good quality with the exception of the portion of the northeastern tributary below McKnew Local Park to the confluence with the northwestern tributary. This section has been degraded by existing land uses which have resulted in extensive sediment input, loss of undisturbed stream buffers, and in-stream wet ponds (see Figure 8, page 39). The Silverwood tributary sub-watershed has the lowest imperviousness (15.1 percent) of the Little Paint Branch subwatersheds in Montgomery County.

The good quality of some of the streams in the Silverwood subwatershed are not reflected in Table 6, page 40. Rather these conditions are indicated by some limited monitoring of the stream by M-NCPPC staff:

- Limited fish data collected by Parks staff in 1991, which showed a diverse fish community, and qualitative observations of the northwestern tributary and the mainstem between the confluence with the northwestern tributary to the County line, indicated that this tributary and the part of the mainstem below the tributary are high quality Use I streams. Table 7, page 42, lists the fish species that were collected. A summary of the aquatic resources identified through this monitoring effort can also be found in the Master Plan for Fairland Park. The high quality conditions of this tributary appear to still exist, based on a very limited quantitative sample of the macroinvertebrate community conducted in January 1996 at one station by M-NCPPC staff.
- The northeastern tributary (also known as the mainstem) appears to have high water quality in its upper section, from its origin in McKnew Local Park to roughly its intersection with the Columbia Gas Pipeline right-of-way. This evaluation was based on qualitative observations of the upper section of the tributary. A qualitative sample of the macroinvertebrate community in McKnew Local Park by M-NCPPC staff in January 1996, although very limited, supports staff's earlier evaluation: this part of the tributary has an unusually rich macroinvertebrate community, indicating high water quality.

Because some of the streams in the Silverwood subwatershed appear to be of good quality, these stream conditions should be preserved. A high level of protection is recommended for these streams to help maintain stream quality. Such measures could include, but would not be limited to, encouraging cluster development to protect environmentally-sensitive areas, park ownership of stream buffer areas and adjacent steep slopes, preservation of large high quality forest stands beyond the minimum required under the forest conservation law. In addition, land uses that minimize new impervious cover, given the existing land uses already in place, and that encourage clustering away from stream buffers, steep slopes, and forested areas should be put in place.

The degraded section of the northeastern tributary within the Silverwood subwatershed is one area of Little Paint Branch that should be identified for restoration and improvement to correct existing problems. New development in this area should incorporate stormwater retrofit and/or stream enhancement measures, as well as measures to comply with standard environmental protection requirements and guidelines.

In addition, the Little Paint Branch streams that drain land south of Greencastle Road are of lower quality. The relatively high impervious cover of the land that they drain (ranging from about 23.5 to 29.7 percent in 1990) reflect the higher level of stressed conditions that result in lower quality in these streams. The strategy for protecting these streams should focus on minimizing further degradation through stringent implementation and enforcement of regulatory environmental requirements, standards, and guidelines. In addition, timely identification and implementation of stormwater management retrofit and stream restoration projects within the watershed are needed.

Water Quality in the Patuxent River Basin

Data that documents the health and condition of the Patuxent watershed streams in eastern Montgomery County is sparse. Limited data on aquatic macroinvertebrate stream habitat data (Table 8, page 44), however, indicate that these streams are generally of high quality. The generally low density development that has occurred in the watershed, which is reflected in the low impervious cover (see Table 2, page 20), has aided in preserving the very good conditions of the streams (see Figure 9, page 45).

Areas of localized degradation do exist on some of the streams. For example, the headwaters of two streams that drain the northwest quadrant of the Burtonsville commercial area have been degraded. Much of the development in this commercial area predates stormwater management requirements and stormwater runoff from these uses is largely uncontrolled. This situation has resulted in severe channel erosion in the upper reaches of the tributary north of the elementary school and possibly degraded water quality in the upper reaches of these two streams.

The Rocky Gorge reservoir experiences some eutrophication due to nutrients and sediment trapped by settling action in the reservoir. Over time, the reservoir collects pollutants and sediments, decreasing its storage capacity, water quality and aquatic habitat.

The Patuxent River Commission and Maryland Department of State Planning in cooperation with all seven Patuxent watershed counties developed the Patuxent River Policy Plan in 1984. This plan arose from the need to restore water quality in the Patuxent and the Chesapeake Bay, to address non-point sources of pollution from a regional perspective and to protect the two reservoirs on the Montgomery-Howard County border. Approval of the plan by the seven counties and the General Assembly signified their agreement to accord special management and planning consideration to lands bordering watershed streams. The jurisdictions

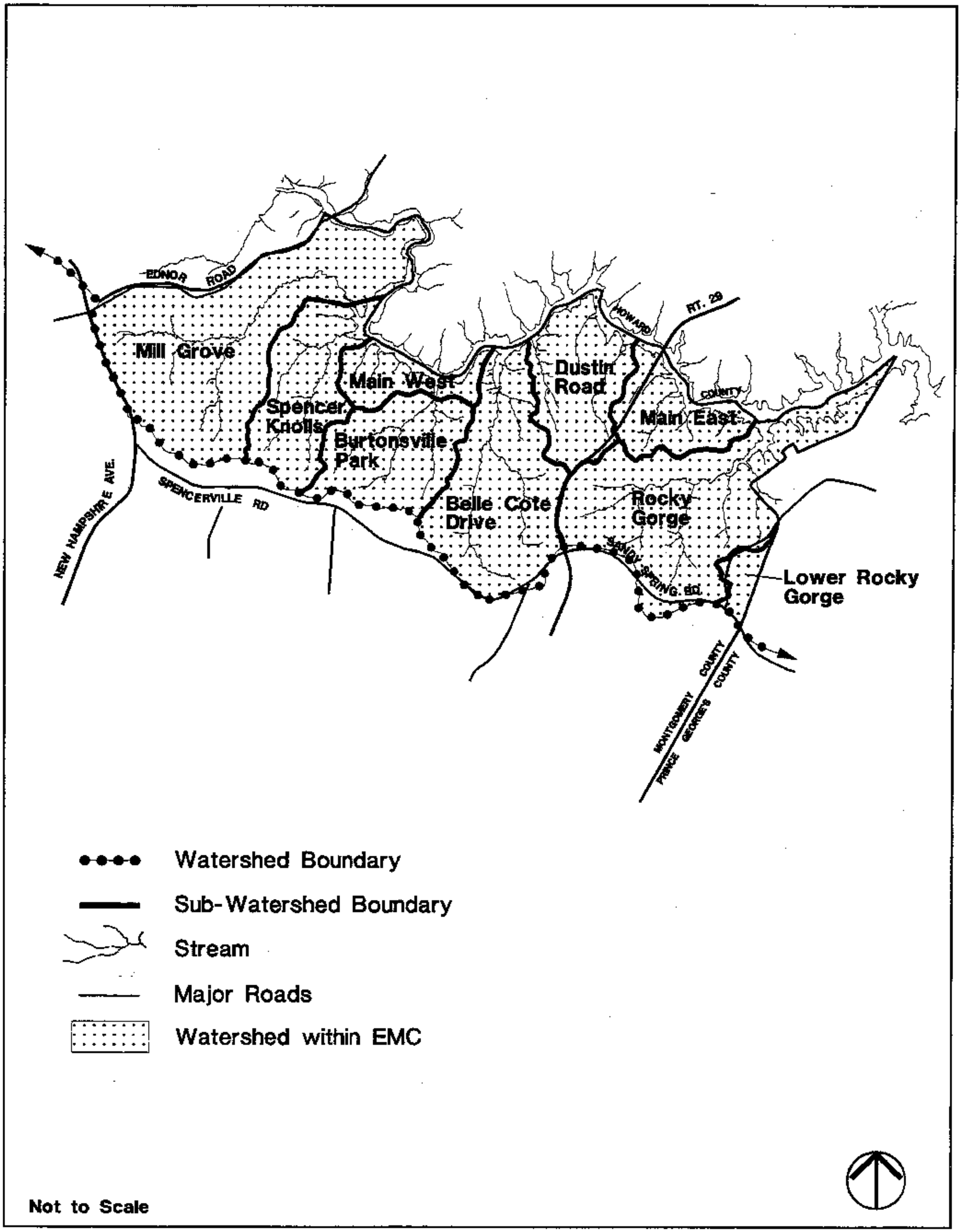
Summary of Patuxent River Watershed Studies

Table 8

Parameters Studied	Year of Data Collection	Agency (Source)	Condition of Various Tributaries to the Patuxent River
Macro-invertebrates and stream habitat	Summer 1993	M-NCPPC – EPD (1993)	• Oak Hill Road Tributary — (EXCEL) • Kruhm Road Tributary — (EXCEL) • Aitchson Lane Tributary — (EXCEL)
Sampling Method	**Analysis Method**	**Stream Condition Characterization**	
D-net 300 seconds	RBP II; 7 metrics. EPD analysis[1]	Excellent/Good/Fair, Poor with respect to a reference site	
Parameters Studied	**Year of Data Collection**	**Agency (Source)**	**Condition of Various Tributaries to the Patuxent River**
Macro-invertebrates, Stream Habitat, and Land Use habitat	Spring and Fall 1995	M-NCPPC – EPD (1996)	1. Kingdom Hall Tributary — Macroinvertebrates: spring/moderately impaired, fall/moderately impaired. Stream habitat: spring/slightly impaired, fall/slightly impaired. 2. Burtonsville Shopping Center Tributary — Macroinvertebrates: spring/severely impaired, fall/severely impaired. Stream habitat: spring/severely impaired, fall/severely impaired 3. Santini Road Tributary — Macroinvertebrates: spring/severely impaired, fall/moderately impaired. Stream habitat: spring/moderately impaired, fall/moderately impaired. 4. Magnolia Road Tributary — Macroinvertebrates: spring/slightly impaired, fall/moderately impaired. Stream habitat: spring/slightly impaired, fall/moderately impaired. 5. Ednor Park Tributary — Macroinvertebrates: spring/slightly impaired, fall/slightly imparied. Stream habitat: spring/non-imparied, fall/non-impaired. 6. Burtonsville Power Lines Tributary — Macroinvertebrates: spring/moderately impaired, fall/slightly impaired. Stream habitat: spring/slightly impaired, fall/slightly impaired 7. Foxes Branch Tributary (reference site) — Macroinvertebrates: spring/non-impaired, fall/non-impaired. Stream habitat: spring/non-imparied, fall/non-impaired.
Sampling Method	**Analysis Method**	**Stream Condition Characterization**	
D-net 300 seconds	RBP II; 7 metrics. EPD analysis[1]	Excellent/Good/Fair, Poor with respect to a reference site	

Patuxent River

Figure 9



also committed to develop and implement the primary management area approach in the Patuxent watershed. There are on-going efforts to protect and enhance water quality in the Patuxent through the efforts of the Patuxent Tributary Strategy as part of the Chesapeake Bay restoration effort, the U.S. Army Corps of Engineers Patuxent River Watershed Resources Study, the Patuxent Reservoir Group and the Patuxent Demonstration Project.

In the Patuxent watershed, the M-NCPPC environmental management guidelines call for a transition area beyond the regulatory stream buffer. Low zoning densities or conservation uses are recommended for this primary management area (PMA). Development will be accommodated in ways which minimize impacts on water quality and maximize the protection of existing environmental features. There is a 10 percent imperviousness limit for new development which contains the PMA. Also, the master plan recommends at least fifty feet of forest be maintained along all streams. If the achievement of other planning objectives necessitates a deviation from these policies, extraordinary protection measures should be implemented to mitigate the additional disturbance and development[5].

Under the 1981 master plan zoning, impervious cover of the subwatersheds of the Patuxent River within eastern Montgomery County are projected to lie between 4.4 and 12.2 percent. These projections fall within the generally accepted limits for coldwater streams in Maryland. These land uses, in combination with strict implementation of regulatory environmental requirements, standards, and guidelines, including the PMA, are expected to provide appropriate protection for the aquatic resources of the Patuxent.

[5] See the Functional Master Plan for the Patuxent Watershed (1993) and the Guidelines for Environmental Management of Development in Montgomery County, both of which are available from the Montgomery County Department of Park and Planning.

Sensitive Areas Protection

The Maryland Economic Development, Resource Protection, and Planning Act of 1992 established seven visions for the state, including the protection of sensitive areas. The Act requires the implementation of a "sensitive areas element" designed to protect streams and their buffers, one-hundred year floodplains, steep slopes and the habitats of threatened or endangered species, as well as any particular resources the locality deems appropriate.

The master plans take presence and amount of sensitive areas into account in their land use proposals. Many of these areas in eastern Montgomery County are already within parkland, and more are proposed for park acquisition. In areas where development is planned that includes sensitive areas, site-specific design and layout of a development project are addressed through the County development review process. This includes the application of M-NCPPC environmental guidelines, which provide for undisturbed stream buffers that include steep slopes,

Local Environmental Regulatory Responsibilities

Table 9

Agencies that review environmental issues for subdivision and site plan development in Montgomery County include:

MCDPS	Montgomery County Department of Permitting Services. Its role is to provide "one-stop-shop" for regulatory permitting and protection as part of development and growth activities. It handles permitting for stormwater management, floodplain management and sediment control from construction sites. The Well and Septic Section reviews and approves systems for private drinking water supplies (wells) and private sewage disposal systems (septic tanks and fields).
MCDEP	Montgomery County Department of Environmental Protection. MCDEP is responsible for implementing the County's water quality ordinance including monitoring water quality and pollutants from point and non-point sources, and is responsible for the County's stormwater discharge program under the NPDES provisions of the federal Clean Water Act. In Special Protection Areas, MCDEP assists MCDPS in setting performance goals for stormwater management associated with new development. MCDEP is also responsible for water and sewerage systems planning.
M-NCPPC	Maryland-National Capital Park and Planning Commission. The Environmental Planning Division (EPD) is part of the M-NCPPC Department of Park and Planning which provides staff for the County Planning Board. EPD oversees natural resource identification and protection through its environmental planning role at both the long-range master plan level and the short-term regulatory level. EPD arbitrates both the boundary and the permitted uses and encroachments into stream buffers as part of the M-NCPPC environmental guidelines. EPD also administers the county forest conservation law.
MCDPWT	Montgomery County Department of Public Works and Transportation. MCDPWT designs, constructs and maintains the county's public roads and public drainage systems and manages the County's solid waste program.
WSSC	Washington Suburban Sanitary Commission. This is a bi-county agency(Montgomery and Prince George's Counties) responsible for design, construction and maintenance of the pipes and facilities needed for providing public drinking water and sewage.

floodplains, wetlands and unique habitats, and DEP's County stormwater management and sediment/erosion control standards. Table 9 lists some of the local agencies who review development plans for environmentally related issues.

The U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service are all involved nationally in the protection of sensitive areas under various parts of the Clean Water Act; Maryland Department of the Environment administers state wetlands and water quality certification permits. These federal and state agencies also assist local governments in identifying suitable wetland restoration projects and conducting functional assessments of existing wetlands.

Habitat Preservation and Forest Conservation

The riparian system of streams, wetlands and stream valley forests is the major type of habitat in eastern Montgomery County. The stream valley areas already protected in parkland make up a considerable corridor spatially, but the extent to which this area adequately supports biological functions (and hence bio-diversity) of the habitat must also be considered. This involves protecting recharge areas and wetlands from development or other stress, while monitoring and improving physical, chemical and biological stream conditions on both public and private lands.

The health of stream valley habitats is influenced by conditions in upland areas. These areas have traditionally been subject to development pressures, first from agricultural uses, then from roads and crossroad communities located along the ridges. The major recharge areas for groundwater and wetlands are in the uplands where soils are most permeable. Upland forests also connect wildlife migration paths between the stream valleys. Additionally, upland meadows provide habitat for flora and fauna which can only thrive here, such as the Sedge Wren. These upland areas are particularly vulnerable because they are generally viewed as having the least environmental value and therefore are considered ideal for development disturbance.

The brown trout population is dependent upon upland recharge areas to support stream baseflow and temperature requirements, though the extent of its reliance is unknown at this stage. There are presently approximately 3,430 undeveloped acres in Montgomery County's Paint Branch watershed, 2,600 acres of which are forested. About 75 percent of this forested land is protected as parkland. Most of the forested land not in parkland is located north of Fairland Road.

The mature, mixed deciduous lowland forests, such as in parts of upper Paint Branch and McKnew Park, contain a diverse herbaceous layer which is matched in no other habitat. Hundreds of species can occur over small areas, and in places the soil is completely hidden by this lush growth. These areas where species diversity is high, offer the best opportunity for finding and preserving rare plant and animal species, and are instructive to natural resource managers in evaluating desirable conditions for fostering bio-diversity.

Forest conservation helps retain the natural beauty of the community and protects dependent ecosystems. Trees provide shade to ameliorate summer temperatures, to provide cover and food for a variety of wildlife and cleanse the air and runoff. Since 1992, Montgomery County has been requiring forest conservation as part of applications for land disturbance and development. The County's forest conservation law is required by and modeled after the Maryland Forest Conservation Act of 1991. Forest conservation recognizes the benefits of forest and trees in our increasingly urbanized environment and requires preservation and reforestation as part of the development process.

Urban forest and tree preservation often is intended to meet the needs of people as much as the environment. Frequently, woods in developed areas are isolated, invaded by exotic vegetation and in poor health. Some individual trees are worthy of preservation, but they can be difficult to save given site and layout constraints. The forest conservation law encourages retention of existing trees wherever possible, as well as appropriate maintenance to keep them viable. Street trees, which enhance neighborhoods and buffer road noise, are an important part of beautification in the down-county. The master plans support programs for expanding and improving street tree coverage.

Within the Suburban Taxing District, the County's Department of Public Works and Transportation (MCDPWT) offers street tree maintenance along County roads, including pruning, spraying for insect/disease control and tree removal and replacement. Outside the Suburban Taxing District, MCDPWT can provide low-level service for storm damage cleanup, hazardous tree removal and safety pruning around traffic control devices. The Suburban Taxing District includes all the Four Corners planning area and part of the White Oak planning area west of New Hampshire Avenue and south of Quaint Acres subdivision. The Fairland and Cloverly Planning Areas are outside the Suburban Taxing District.

Air Quality

Although there are various forms of air pollution, the major health concern in this region is ozone. Ozone is formed in the lower atmosphere when nitrogen oxides and volatile organic compounds (VOC) react in the presence of sunlight. These pollutants are largely attributable to gasoline fueling and combustion. Factors affecting ozone formation include VOC and oxides of nitrogen concentrations in the air, wind velocity, temperature, and sunlight. Ozone formation is greatest on hot, sunny, windless days. Adverse impacts of ozone include photochemical smog, vegetation damage, and health effects such as: coughing and chest pains, irritation of the eyes and throat, breathing difficulties, and greater susceptibility to infection.

The entire Washington Metropolitan Statistical Area (MSA), which includes all eastern Montgomery County, falls into the serious classification for ozone (0.160 - 0.180 ppm). The national ambient air quality standard for ozone is 0.120 part per million (ppm). On average, the region experiences 11 days per year during which this standard is exceeded. EPA permits only one such day per year. Although ozone affects all 3.9 million residents of the Washington metropolitan region, about one-third are especially at risk. This group includes children, the elderly, people with respiratory problems such as asthma, and a larger group that are ozone sensitive. EPA requires attainment of the federal standard by 1999, and more immediately, that the region achieve a 15 percent reduction of ozone precursors by 1996. If the region fails to achieve the standard, EPA may impose sanctions.

The Metropolitan Washington Air Quality Committee (MWAQC) is responsible for choosing the air pollution control measures to be implemented by the region and for preparing the region's air quality plans. It was formed under the combined authority of the mayor of Washington, D.C. and the governors of Maryland and Virginia. These plans are forwarded to the governors and the mayor for inclusion in the State Implementation Plans they submit to EPA.

On November 15, 1990, the Clean Air Act Amendments of 1990 became law. They embody fundamental legislative changes, and significantly alter the approach for meeting air quality standards in non-attainment areas. Control measures target two sources of pollution: mobile and stationary sources. Mobile sources are generally internal combustion engines. Stationary sources cover a wide range of structures such as smoke stacks, gaseous industrial exhaust and activities involving combustion or the use of highly volatile substances as in the use of aerosols, varnishes, incinerators and backyard barbecues.

Regulations that will reduce pollution from mobile sources are called transportation control measures (TCMs). Reduction of emissions from single occupancy vehicle (SOV) travel is the main focus of the County. One of the most effective measures is a balanced employer trip reduction program, which would require all employers or building owners to charge SOV drivers for parking. The proceeds would be used to fund incentives for employees that use alternative modes. Another measure would require the adoption of pedestrian- and transit-oriented design standards in all land use zones in order to improve access to alternative forms of transportation. The MWAQC has also identified several technological measures aimed at reducing automobile emissions. These include controls on gasoline formulation and enhanced inspection and maintenance of vehicles.

Public Utilities and Solid Waste

Water Supply

WSSC manages and supplies the principal sources of drinking water for eastern Montgomery County. Water is drawn from the Potomac and Patuxent rivers, treated and distributed throughout Montgomery and Prince George's Counties.

The water distribution system is divided into zones, which denote the pressurized system in which certain areas are served. The Four Corners area is served by the Montgomery County Main Zone. White Oak service is split between the Main and the High (Colesville service area) Zones. There is a pump/storage facility at Notley Road west of New Hampshire Avenue. Fairland is entirely within the High Zone (Colesville and Browns Corner service area). Cloverly is served entirely by the Browns Corner service area, part of the High Zone. Cloverly also has a standpipe at MD 198 and New Hampshire Avenue. There is presently a need for additional storage facilities in the High Zone. Two locations have been chosen on the Hampshire Greens property in Cloverly and on the WSSC Composting Facility Site in Fairland.

Well water is primarily used in the northern portions of Cloverly and Fairland, although there may be isolated users in areas currently eligible for WSSC service. It is not mandatory for well users to obtain WSSC service; however, many choose to receive the service over time.

Sewerage Systems

Sewer service in eastern Montgomery County is primarily provided via WSSC. Sewage is collected and transported to the Blue Plains regional wastewater treatment facility in the District of Columbia. Septic systems are primarily used in the northern portions of both Cloverly and Fairland, although there may be isolated users in areas currently served by WSSC. It is not mandatory for septic system users to obtain WSSC service within the service area, but many do eventually connect to community sewer lines.

All eastern Montgomery County on community sewer is served by two main service basins: Northwest Branch and Paint Branch. White Oak and Cloverly are served by both basins. Fairland is served by Paint Branch and Little Paint Branch—a sub-basin that also serves Prince George's County. All the service in Fairland, White Oak and Cloverly is via gravity.

Future service will also be extended via gravity in these basins. There are no WSSC sewer facilities in the Patuxent basin and none are planned. It is possible that sewer relief may be necessary in Paint Branch downstream of Colesville Road. The Northwest Branch trunk sewer between Randolph Road and Colesville is expected to have capacity constraints in the future.

WSSC's *Rock Creek Wastewater Facility Plan* is currently underway and will investigate alternatives for eliminating future capacity limitations in the wastewater conveyance system for the Rock Creek basin. One of the plan's possible alternatives is to pump flows from the Rock Creek sewer basin into Northwest Branch's sewer lines. This would significantly increase the number of Northwest Branch lines that will have future wastewater capacity constraints, as well as possibly accelerate the need for projects to address these contraints. The actual nature, extent and timing of any projects in these basins will be determined through the County's *Comprehensive Water Supply and Sewerage Systems Plan* and WSSC's CIP.

Solid Waste Management

Montgomery County's waste management system is founded on the four part preference of reduce, recycle/re-use, incinerate and landfill, as recommended by the U.S. Environmental Protection Agency and the Maryland Department of the Environment. The major components of the system are contained in the County's *Ten Year Solid Waste Plan*. This functional plan sets forth the goals and objectives of the County with regard to solid waste management. The goal most relevant to eastern Montgomery County is that of 50 percent waste recycling by the year 2000. This recycling goal will be largely met through establishment of a yard trim program, now underway, and expansion of the existing recycling program to include low-grade paper. This expansion will aid in achievement of the 50 percent goal.

Noise

The Department of Park and Planning defines noise simply as unwanted sound. Although this definition would suggest that the effects of noise vary based on an individual's sensitivity to, or feelings about a sound, medical evidence has shown that long-term exposure to excessive noise can have serious physical health effects regardless of the perception. Between 55 and 65 dBA[6] Ldn[7], humans experience increased levels of interference with speech and communication.

In Montgomery County, government agencies have the authority to control two of the most prevalent types of noise, stationary and mobile (i.e., transportation-related) sources. The Montgomery County Noise Ordinance regulates stationary noise sources such as heating and air conditioning units, construction activity and neighborhood noise annoyances. The Planning Department, through Master Plan and regulatory review of plans, tries to protect residential properties from mobile source noise.

In 1983 the Planning Board adopted the "Staff Guidelines For The Consideration Of Transportation Noise Impacts In Land Use Planning And Development." This document was developed to assure consistency in master plan recommendations and noise analysis of regulatory reviews, and to promote greater

[6] A measure of decibel levels, weighted (using "A" weighting) for sounds that affect the human ear.

[7] Decibel levels measured over a 24-hour period, with nighttime noise weighted more heavily.

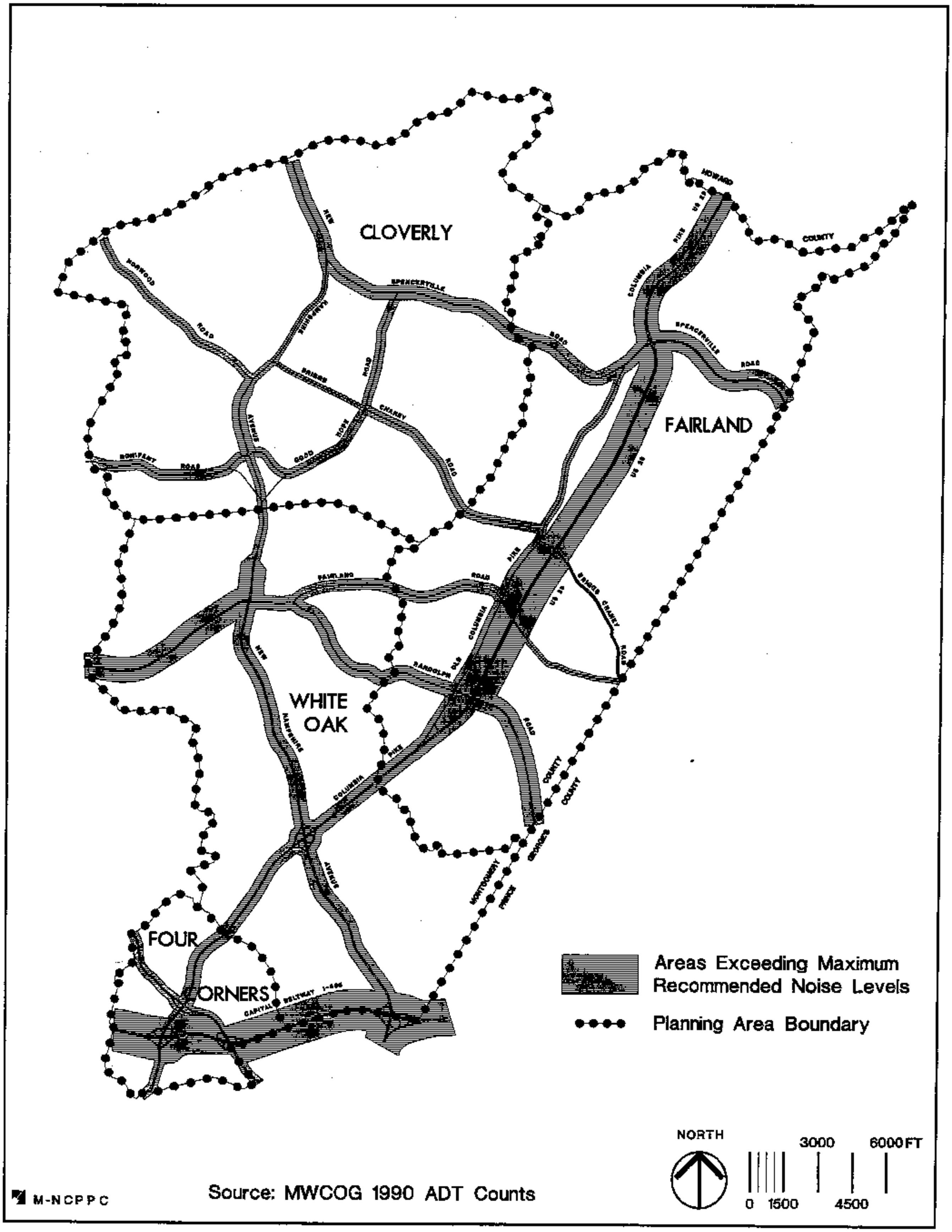
understanding of this issue by developers and planners alike. Unlike the County Noise Ordinance, these are guidelines only and are used to identify areas where transportation noise impacts may affect planning, and site design. The guidelines identify appropriate noise level goals based upon population density and traffic volumes within the County. A goal of 65 dBA was determined to be an achievable goal for the higher population density areas in the urban core. In the suburban "ring" around the urban core, staff determined that the 60 dBA level was an achievable goal, given lower traffic volumes and lower population densities. In the rural areas of the County where traffic volumes are much lower and lot sizes are larger, the 55 dBA level guideline is applied.

During the preparation of the Eastern Montgomery County Master Plans, major roadways were analyzed in an attempt to identify those properties with potential excessive noise levels. Existing and proposed noise levels illustrated in Figures 10 and 11, pages 51 - 52, are shown as a worst case scenario; the actual area of impact is lessened by berms, hilly topography, buildings and other physical barriers. The guidelines identify several measures to alleviate traffic noise problems for those properties, including:

1) Noise-compatible land use,
2) Distancing the receiver from the source,
3) Blocking the path from source to receiver,
4) Sensitive site design, and
5) Acoustical treatment of buildings.

1990 Traffic Noise Impact Areas

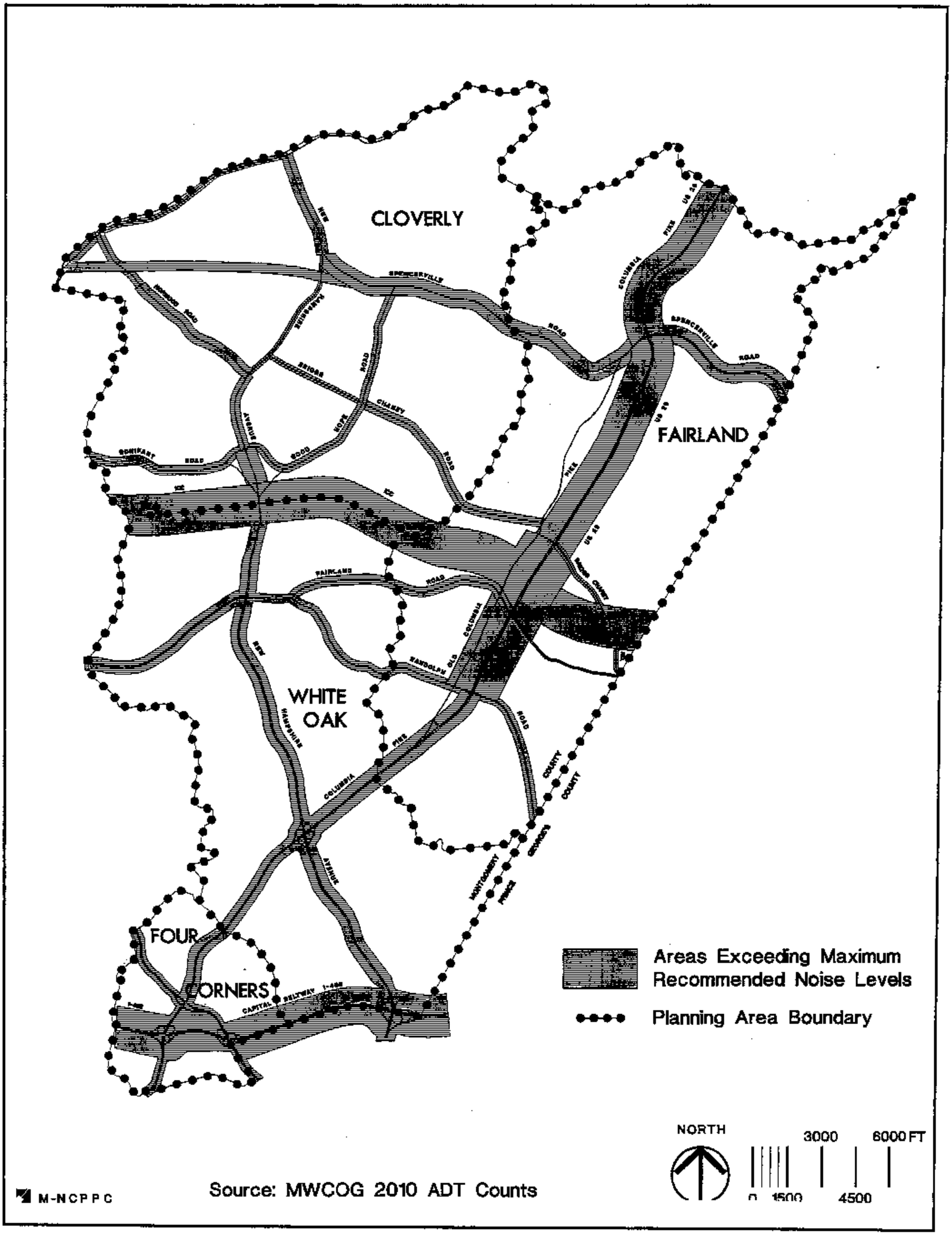
Figure 10



Source: MWCOG 1990 ADT Counts

Projected Traffic Noise Impact Areas

Figure 11



Source: MWCOG 2010 ADT Counts

Environmental Protection In Eastern Montgomery County

The general environmental goal for all the Eastern Montgomery County master plans is:

Protect and enhance the planning area's natural resources for the enjoyment of residents and sustain a stable and healthy biological environment for native plant and animal communities.

Approach to Water Resource Protection in Master Planning

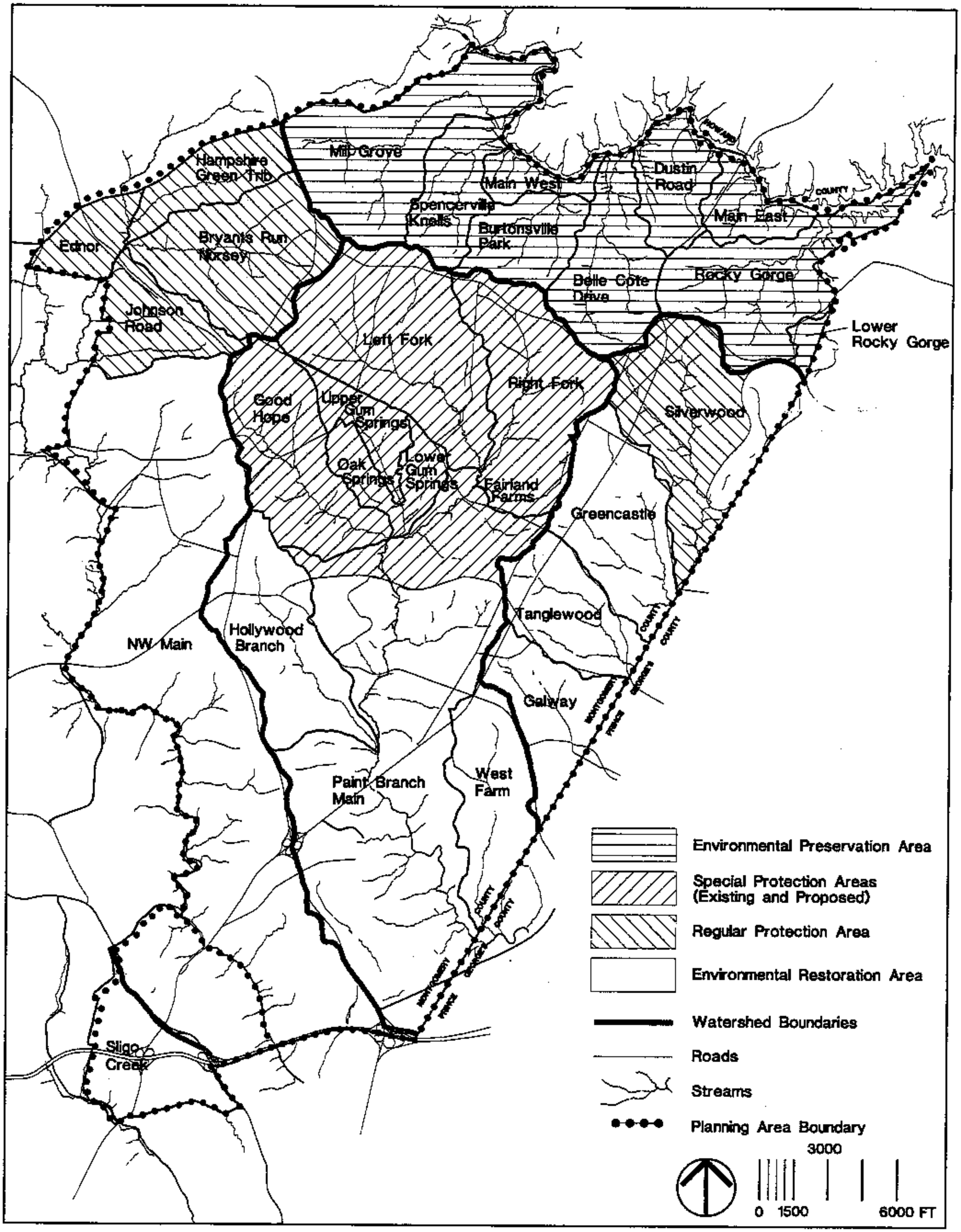
The resilience of natural resources vary based on environmental characteristics, the degree of disturbance, the effectiveness of mitigation and other factors. The need for development in various areas of the County differ as well. Development is generally concentrated in areas served by public infrastructure and limited to preserve agriculture, open space, and environmentally-sensitive areas. Given the established pattern of zoning in Montgomery County, and the accompanying extensions of roads and community water and sewer service, environmental protection goals need to reflect both current and future conditions.

The management strategy employed in the Eastern Montgomery County master plans is a four-tiered system that relates environmental conditions to land use (see Figure 12, page 54). These approaches are implemented on the sub-watershed scale because most of the County's natural resources are connected in some way to the stream systems. This management strategy offers a more detailed level of scrutiny than the state's water use designation system and provides consistency in setting management objectives for a given set of resources. Table 10 shows the conceptual relationship between the quality/sensitivity of the resource and the intensity of planned land uses. Of these approaches, the special protection area is the only one which requires action by the County Council due to the additional regulatory and monitoring requirements. As such, it has a legal definition and associated regulations and guidelines.

Today's environmental laws, regulations and

Environmental Protection Approach

Figure 12



guidelines are designed to minimize development-related impacts on the natural resources. The standard environmental protection measures are assumed to suffice in most developing areas of the County, which are designated in the master plans as 'Regular Protection Areas.' However, it has been recognized that more sensitive natural resources in the County require special protection where substantial development is planned. This was first acknowledged in the *Clarksburg Master Plan* and codified in the 1995 special protection area law. This law provides for additional environmental protection measures and monitoring of streams and best management practices to better evaluate and manage the effects of development. The purpose is to set performance goals for development in sensitive, high-quality watersheds in an effort to promote environmentally-friendly development. The goals focus on environmental functions such as baseflow maintenance, wetland and groundwater recharge and aquatic habitat protection that are typically not addressed through standard requirements. Executive regulations have been adopted and amendments to the Planning Department's *Environmental Guidelines* are being prepared to detail the requirements for environmental Protection in these 'Special Protection Areas.'

In some areas of the County, many high quality and sensitive resources are present. Generally, they are protected by virtue of the low-intensity land use chosen for both environmental and other planning purposes. These areas are considered 'Environmental Preservation Areas.' These areas have limited public infrastructure, and no significant extensions of service are proposed.

Decision Matrix for Applying Environmental Categories — Table 10

	Degraded Systems	Non-Degraded, Healthy Systems: Robust/ Resilient	Non-Degraded, Healthy Systems: Fragile/ Sensitive
Low Impervious/ Low Density	Environmental Restoration Area	Regular Protection Area	Environmental Preservation Area
Medium Impervious/ Medium Density	Environmental Restoration Area	Regular Protection Area	Special Protection Area
High Impervious/ High Density	Environmental Restoration Area	Regular Protection Area	Special Protection Area

Environmental Preservation Area: A geographic area where existing environmental resources are of such high quality and/or sensitive nature that they shall be protected through a combination of predominantly low-density residential and agricultural land uses and conservation easements/public acquisition.

Special Protection Area: A geographic area where existing water resources or other environmental features directly relating to those water resources are of high quality or unusually sensitive and proposed land uses would threaten the quality or preservation of those resources or features in the absence of special water quality protection measures which are closely coordinated with appropriate land use controls.

Regular Protection Area: A geographic area where current environmental protection measures are expected to maintain the quality of environmental resources, given planned land uses.

Environmental Restoration Area: A geographic area where, in general, past practices have significantly degraded environmental resources. Restoration efforts are required to assure a minimum quality or to achieve stated goals, standards or policies of federal, state or local government.

The Montgomery County Soil Conservation Service and the Chesapeake Bay Restoration Program (a federal, state, regional and local cooperative effort) work with agricultural interests in an ongoing attempt to reduce the impacts of agricultural practices on water quality and habitat.

In the older, built-up areas of the County, the focus is on environmental restoration to improve water quality and habitat conditions. While some stream segments may have higher quality, these watersheds generally suffer from degradation caused by intense development prior to the establishment of environmental controls. Land use decisions will have a limited effect on water quality of streams in these built-up areas. Therefore, the focus of the County's efforts are on restoration. These watersheds can be described as 'Environmental Restoration Areas' which need public funding to improve environmental conditions. New development taking place in the built-up areas must employ regular environmental protection measures, which may be supplemented with public funds to jointly address impacts from existing development upstream.

Funding sources, agency responsibilities and even best management practices change—over time. These realities require more timely input than is allowed by the ten-year review process associated with the Master Plans. Also, citizen participation during site selection and design stages has become standard for projects administered by the County Department of Environmental Protection (DEP). Therefore, the master plan will identify the environmental restoration areas in conjunction with DEP and state general support for corrective efforts by the implementing agencies.

Environmental Preservation Areas

The intent of master planning in Environmental Preservation Areas is to preserve as much of the natural resources (stream buffers, wetlands, forests) and surrounding area as possible in an undisturbed, stable condition.

Although the Regular Protection Area guidelines (i.e., all current environmental controls) will apply to new development in these areas, certain environmental practices often are not applicable to small subdivisions in low density or agricultural zones. For example, very low-density residential development do not usually require stormwater management control structures. Therefore, nonstructural BMPs are as important as wet ponds and detention basins. Important issues are:

- Protection of stream buffers, wetland buffers and forest conservation areas.
- Offseting agriculture and low density development effects through applicable BMPS.
- Maintain low intensity land uses as the most effective method for preserving large amounts of undisturbed open space.

Special Protection Areas

The intent of master planning is these areas is to protect the continued functioning of high-quality and/or sensitive environmental resources in an area where planned development threatens those resources. This protection is accomplished by using innovative planning or additional mitigation measures that are required or recommended under the Special Protection Area law, regulations, and guidelines. Certain environmental factors are exacerbated or stressed by the effects of development and can reduce or change the ability of natural resources to function properly. The Special Protection Area designation documentation identifies those factors, and their related natural features, which are most disturbed by development. In addition to the objectives of the Regular Protection Area requirements that are applied to all new development, the Special Protection Area approach is used to identify the desirable features or conditions that lead to a high quality environmental system, then to find mitigation methods to best approximate normal functions for these features. Each sensitive system may have unique elements or priorities; however, the following general approach applies to all Special Protection Areas. New development in Special Protection Areas must prepare a water quality plan addressing the following goals:

- Stream/aquatic life protection.
- Maintain stream baseflow.
- Protect seeps, springs, and wetlands.
- Maintain natural on-site stream channels.
- Minimize storm flow increases.
- Identify and protect stream banks prone to erosion and slumping.
- Minimize increases to ambient water temperature.
- Minimize sediment loadings.
- Minimize nutrient loadings.
- Control insecticides, pesticides and toxic substances.

In addition, requirements of the Special Protection Area include:

- Monitoring the effectiveness of stormwater management measures in achieving the objectives.
- Monitoring the conditions in the stream system to assess the impact of development.
- Revising requirements for future development approvals based on the results of monitoring.

Regular Protection Areas

The intent of master planning in these areas is to use current environmental requirements for new development to maintain the quality of natural resources.

The Regular Protection Area requirements are listed in the various County and Planning Department environmental regulations and guidelines. They include objectives for stormwater management, erosion and sediment control, forest conservation, stream buffers, and wetlands preservation. Restoration efforts would be targeted to areas with existing problems.

Environmental Restoration Areas

The intent of master planning to the degree possible, is to protect and enhance environmental resources. The County has ongoing programs that focus on these areas. Master planning considerations include:

- Using current environmental requirements and guidelines to mitigate effects of new development.
- Implementing restoration programs through appropriate agencies and with citizen participation and education to address the most severe environmental effects of existing development.

Applying the Approach in Eastern Montgomery County

In eastern Montgomery County, all four of these approaches are used, as Figure 12 illustrates. The Patuxent watershed is considered to be an Environmental Preservation Area because of the need to protect the drinking water reservoir and the existing low density land uses and extensive public lands. The upper Paint Branch watershed was recently designated as a Special Protection Area by the County Council. Upper Northwest Branch and a portion of the Silverwood Tributary are shown as Regular Protection Areas. The down-county portions of Northwest Branch, Paint Branch and Little Paint Branch as well as the northeastern tributary of the Silverwood subwatershed between McKnew Park and its confluence with the northwestern tributary are considered Environmental Restoration Areas, given the intense urban development (much of it pre-dating stormwater management requirements) and ongoing interagency efforts to improve environmental conditions.

County-wide Stream Protection Strategy

The County-wide Stream Protection Strategy (CSPS) is currently under development to assess stream quality throughout all the county watersheds in order to develop management categories and tools, and set priorities for watershed preservation, protection and restoration. The CSPS will define watershed management categories based on the existing stream resource conditions, existing and planned land uses in the watersheds, and the types of management tools available to protect or restore each watershed. The management categories as presently envisioned roughly coincide with those defined in the eastern Montgomery County master plans. The CSPS will provide a consistent process for identifying stream preservation, protection and restoration needs county-wide.

The Department of Environmental Protection (DEP) and the M-NCPPC are cooperating to draft the initial CSPS and will continue to refine the report and the priority rankings as new steam quality data becomes available. This strategy is closely tied to the county's biological monitoring program and will be updated on a regular basis to incorporate new monitoring results. The initial CSPS categorization of subwatersheds and related management tools should be completed by January, 1997. Recommendations, if any, for new management tools such as the designation of Special Protection Areas, should await completion of the initial CSPS. This report will discuss the characteristics of each subwatershed within the planning area, but final management recommendations will be made after January, 1997.

Water Resources Issues by Watershed

Some of the watersheds in eastern Montgomery County will be protected (i.e. their recognized state water use designations will be maintained), with the intensity of development anticipated from the land use and zoning patterns established in the 1981 master plan and amendments, along with the application of current environmental guidelines and regulations for new development. However, in some cases they fall short of their objective of protecting the streams. The individual master plans describe specific recommendations to address the need for improved protection on a planning area scale.

Northwest Branch

In the Northwest Branch it is important to protect headwater streams by assuring that ultimate subwatershed imperviousness remains within the 10 to 15 percent range. This range is considered to be the generally acceptable limits for coldwater stream systems in Maryland. New development in the upper Northwest Branch should minimize imperviousness and stormwater waivers should be avoided to the greatest extent possible. Efforts to protect the high quality conditions in the headwater streams of the Northwest Branch should focus on maintaining low density land uses, preserving stream and wetlands buffers, reforesting buffer areas where forest does not exist, and identifying and implementing retrofit projects and agricultural BMPs to reduce sedimentation and correct existing problems.

The remaining natural stream channels should be protected from urban pressures including thermal effects, erosion/sedimentation and the impacts of potential sewer construction.

Sligo Creek

The approach to protection and enhancement of Sligo Creek involves protecting the remaining natural stream channels from urban pressures (including thermal effects and erosion/sedimentation), and continuing the restoration and management activities as part of the Anacostia Restoration effort.

Paint Branch

To preserve the high quality conditions, watershed imperviousness should be maintained as close to existing levels as possible within the upper Paint Branch watershed (north of Fairland Road) by minimizing new imperiousness and reducing, where possible, existing imperviousness. Fragile and sensitive natural resources and features of the watershed (such as spring, seeps, wetlands, and large forested areas) should be preserved. Downstream of Fairland Road, impacts from urban development and potential sewer construction should be minimized. Enhancement and restoration efforts should continue to address the impacts of existing development. For more specific strategies, see the *Upper Paint Branch Watershed Study* (M-NCPPC, 1995).

Little Paint Branch

To maintain the good quality conditions of the northwestern tributary of the Silverwood subwatershed and the northeastern tributary in McKnew Local Park, land uses in the Silverwood subwatershed should minimize additional imperviousness in the subwatershed and allow substantial clustering of developed areas away from streams and wetlands, steep slopes, and forest. Throughout the watershed, adverse impacts from new development should be minimized. Restoration and enhancement activities should be undertaken in cooperation with the Anacostia Watershed Restoration efforts.

Patuxent River

The high water quality of the Patuxent River watershed is important to its use as a public drinking water supply and the high quality aquatic communities currently found in the streams. Continuation of low-density land use patterns and enforcement of the guidelines for the Primary Management Area are necessary to maintain this quality. Restoration and enhancement activities should be undertaken through the existing programs.

Habitat Preservation

The natural areas within the public parks represent a high percentage of the County's remaining forests. The 1995 amendment to increase park acquisition recognizes that water quality, aquatic ecosystems and terrestrial biodiversity are all interdependent. As the eastern Montgomery County park forests mature into older, second-growth woods, they will preserve and even create new habitat for an increasingly complex ecosystem. Long term protection, management and resource conservation are therefore essential for maintaining eastern Montgomery County's biodiversity.

Important resources to preserve include stream valley/wetland areas, brown trout aquatic habitat, scenic river gorge areas, Piedmont/Coastal Plain fall-line transition area habitats, large upland and riparian forested tracts and urban forests. Greenways can be used to promote integrated protection and enhancement for habitats and water quality.

Forest Conservation

Forest conservation begins with preservation of existing trees and forest wherever possible, and ends with planting additional trees to compensate for unavoidable loss. Environmentally sensitive areas are targeted for retention and replanting. The requirements for reforestation apply when any forest on a tract of land is cleared and become more stringent if clearing takes place beyond certain thresholds determined by zoning. Tracts which have less than a specified percentage of existing forest are also required to plant forest. Unforested stream buffers are the first priority for forest planting. Forest planting may be done off-site if there are no appropriate areas within the developing tract. Easements and other forms of long-term protection are used to ensure that designated forest areas are maintained. Off-site plantings, where necessary, should be located as close to the area being disturbed as possible. These plantings should take place in unforested stream buffers and areas that enlarge existing forest.

Greenways

Greenways are linear open spaces set aside for recreation and conservation uses. Greenways link people, communities and the natural environment. The greenway concept is not a regulatory or specific land acquisition program. It is a unifying approach to use existing regulatory and voluntary programs to create a network of green spaces that will provide for protection of stream valley habitats and provide linkages for humans and natural resources throughout the County. Greenways can be on public or on private lands. Private land in greenways may be protected through a conservation easement to provide visual open space and wildlife habitat, and in some cases, where, the property owner has given special permission, public access. Greenways on public land provide differing levels of public access depending on the sensitivity of the natural resources and the physical constraints imposed by steep slopes, wet soils or floodplains.

The Department of Park and Planning will be preparing a plan for greenways as part of the update of the *Park, Recreation and Open Space Plan*. This plan will provide a system of interlinked green corridors. It will facilitate the protection of parks and open spaces in order to preserve and enhance natural resources and accommodate, in some areas, a system of complementary regional and local pedestrian, equestrian and bicycle trails.

Although there are no specific guidelines, identification of potential greenways entails careful inventories of existing natural resources as well as existing recreational needs and opportunities within an area. A gap analysis studies the degree of existing or potential physical connection of green space. It then identifies opportunities to protect or enhance an existing ecological system, such as a series of stream valleys. These gaps can be large or small, depending on the natural resource to be protected and existing conditions, and become the basis for potential greenway additions.

Wherever possible, trails and/or bikeways are planned to provide connections between neighborhoods, schools, institutions, commercial areas and workplaces as well as between other parts of the County and the region. Sometimes, publicly-owned land in greenways provide vital links in an interconnected transportation network. This network encourages alternative modes of transportation and knits communities together.

In eastern Montgomery County, the major components of the greenways system include the stream valleys, specifically the mainstems of Northwest Branch, Paint Branch, Little Paint Branch and the Patuxent (see Figure 13, page 61). As the greenways plan is further refined, it is anticipated that areas will be identified that link the stream valleys together.

Air Quality

The main approach taken in master plans to improve air quality is to enhance access to community facilities, transit and alternative modes of transportation (bikeways, sidewalks, etc.).

The General Plan clearly recognizes the need to concentrate development in areas served by public infrastructure and transit, and the land use patterns of eastern Montgomery reflect this direction.

Public Utilities and Solid Waste

Community water and sewerage services are provided by the Washington Suburban Sanitary Commission (WSSC). Water and sewerage planning is done through the *Montgomery County Comprehensive Water Supply and Sewerage Systems Plan* (known as the

Comprehensive Water and Sewerage Plan), administered by DEP, which sets forth the policies and procedures that govern provision of water and sewerage service for the County. The proposed master plan land-use densities, in conjunction with the Comprehensive Water and Sewerage Plan policies, should drive the provision of service.

Subsequent to the County Council adoption of the Eastern Montgomery County master plans, DEP will initiate a comprehensive update to the Comprehensive Water and Sewerage Plan for the planning areas to ensure that water and sewer extensions are consistent with zoning decisions of the master plans. Generally, community water and sewer systems may be provided to properties zoned for densities of one dwelling unit per half acre or denser. Water service on a case-by-case basis also may be considered for lots in PD-1 and RE-2 Zones.

Noise Attenuation

The master plan can recommend noise-compatible, non-residential land uses for those properties where the Planning Board finds such uses to be suitable. Commercial, industrial and other uses where human contact to noise levels is generally limited to an eight-hour workday, are acceptable. If residential uses are preferred on a given property, the "Staff Guidelines for the Consideration of Transportation Noise Impacts in Land Use Planning and Development" recommend a number of alternatives to reduce exterior noise levels. The alternatives are typically applied at the time of subdivision. Noise impact maps are then used to assist staff and the development community to identify potential noise problems on a given parcel. At the development stage, noise attenuation measures, site design standards or acoustical treatment of the affected structures would be implemented to meet the goals within the guidelines.

Civic Involvement

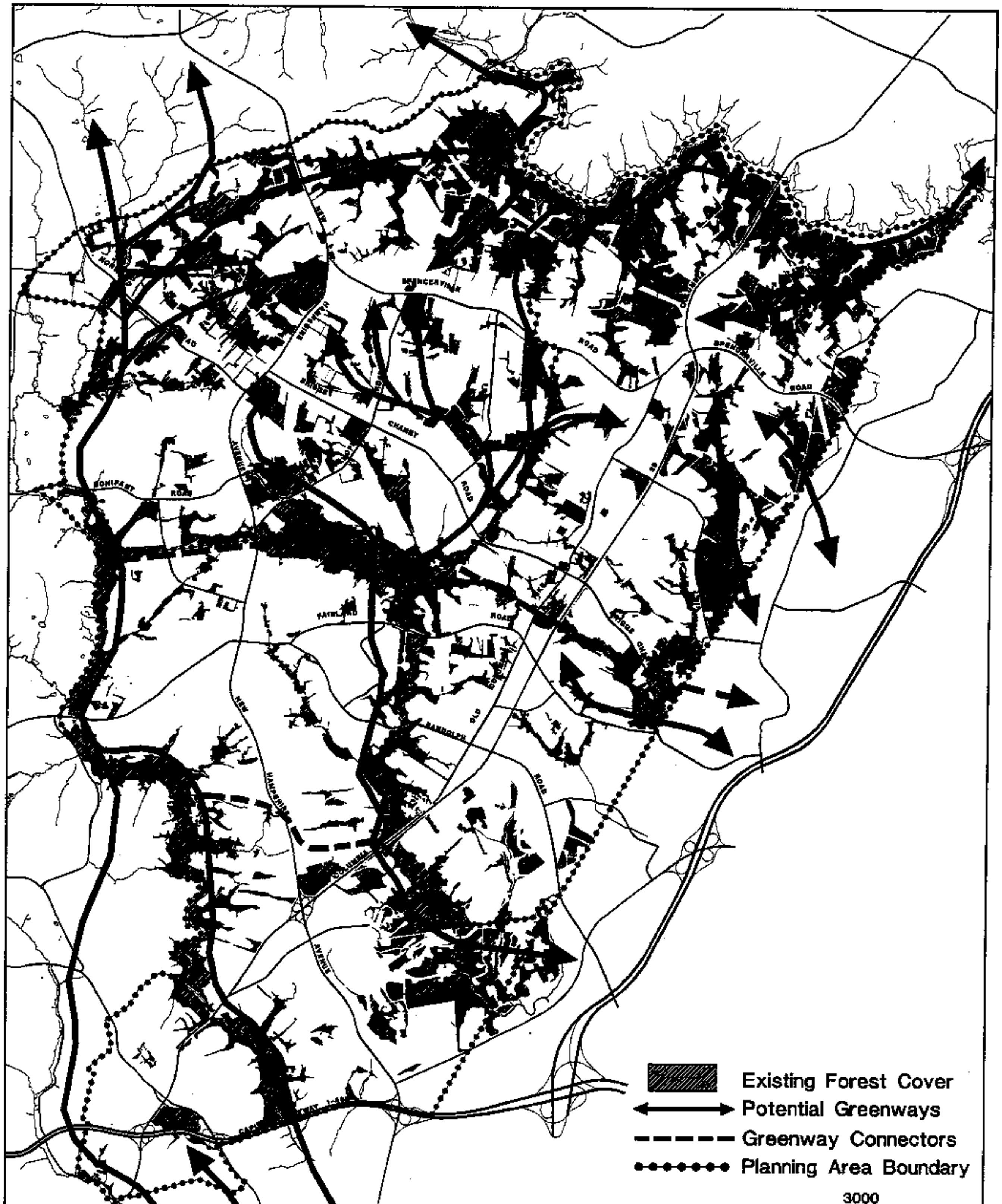
Popular support and participation is a significant element in effective implementation of environmental policy. This is particularly important in intensely developed areas since there are fewer options for retrofits, acquisition or enhancement. These measures can be financially impossible if the impetus and initiative for implementing public policy lies solely with government personnel. Because government enforcement and maintenance staff are limited, citizens can be very effective in the role of "watchdogs" or "boosters" for the environment.

In addition, the lifestyles and daily activities of individuals greatly influences pollutant levels. For example, the preference to drive (especially in single occupancy trips) rather than use mass transit, gasoline-powered lawnmowers and all-terrain vehicles, and the use of household aerosols or lighter fluids affect air pollution. The primary concern of water quality would benefit from more careful "urban housekeeping." Practices such as overuse of garden fertilizers and pesticides, improper disposal of household chemicals and motor oil, and illegal dumping of trash or yard trim introduce nutrients and toxic substances into stormwater. These eventually find their way into streams as non-point source pollution, a major cause of the physical and biological stress upon these waterways, and the cumulatively adverse conditions further downstream and in the Chesapeake Bay.

If members of the public are motivated to bring about change, then the goals of environmental improvement are more attainable. Therefore, public education, cooperation and consensus should be encouraged, especially in densely populated, developed areas.

Potential Greenways

Figure 13



Excerpted from the Preliminary Draft, "The Upper Paint Branch Watershed Planning Study," September, 1995.

Factors that Contribute to the Degradation of a Stream System

The cover and uses of the land that drains to a stream greatly influences the quality and health of that stream. Uses that involve extensive land disturbance, the elimination of vegetative cover, especially forest cover, and the replacement of pervious surfaces with impervious surfaces result in the degradation of the receiving stream system.

1. Change In Land Use

When a piece of land is cleared of trees, graded and developed, several features of the land change. The natural surface water runoff storage capacity is lost by removing the protective canopy of trees, grading of natural depressions, and removal of spongy topsoil and leaf litter. With the compaction of soil and placement of impervious materials on the land (e.g., buildings, roads, sidewalks, driveways, parking lots), the natural feature of the land that enables rainfall to percolate into the soil is lost. Essentially, all the water from rainfall and other precipitation events become surface runoff that travels directly to receiving streams.

If the development of land covers a significant portion of a watershed, the receiving stream system will be adversely affected. Clearing and grading of land can generate sediment that enters the stream, even with sediment and erosion control measures in place. Loss of forest cover within and around the stream valley increases the potential for unstable and eroding soils, exposes the stream to sunlight and raises water temperatures in the summer months, and eliminates the main energy source for the stream system. With the loss of forest material as an energy source, the stream system must rely on other sources, such as sunlight and algae; and the aquatic organisms that depend on leaf litter and woody material disappear.

2. Impervious Surfaces

The placement of extensive impervious surfaces in the watershed eliminates recharge areas for groundwater that feeds stream baseflow. Since impervious surfaces cover up the natural recharge areas for groundwater, more water from precipitation events (e.g., rainfall and snowfall) enters the stream as surface stormwater runoff and less as groundwater-derived baseflow. Stream baseflow becomes irregular and can be very small or eliminated during dry weather periods. Decreased baseflow reduces the ability of small streams to dilute and "neutralize" the effects of pollutants.

During warm weather (e.g., summer), extensive impervious surfaces can elevate the temperature of stormwater that travels over these surfaces prior to entering the stream, even with the use of stormwater management controls; this is because impervious surfaces absorb and reflect heat, and water travelling over these surfaces will pick up this heat. Warm stormwater runoff can adversely increase the temperatures of the receiving stream waters.

3. Stormwater Runoff

Stormwater runoff entering the streams may also be erosive and carry adverse levels of pollutants and trash, even with stormwater management controls in place. Increased land development and urbanization in a watershed usually results in increased pollutant-generating activities, such as motor vehicle uses (which generate oils and greases, metals, salts, sand, etc.), care and maintenance of lawns and other landscaped areas (which generate pesticides, fertilizers, etc.), use and disposal of various material (which generates trash), and care of pets (which generates animal waste).

To adjust to increases in stormflows due to increased impervious surfaces in the watershed, a stream will widen its channel, creating higher sediment loads and severely disturbing the stream bank area through undercutting, treefall, and slumping. Much of the sediment forms sandbars and silt deposits in the channel; these bars and deposits are constantly shifting and adds to the streambank erosion process by deflecting stream flows into erodible bank areas.

4. Sediment Loads

The increased sediment load in the stream can severely degrade or eliminate the natural runs, riffles, and pools that are present in healthy streams. This change in the stream morphology greatly reduces the diversity and availability of habitat for aquatic organisms.

The sediment may also be deposited within the small spaces between cobbles and gravels in riffle areas. This is known as embedding. Embedding greatly limits the quality and availability of spawning areas for fish, especially trout. It also reduces the circulation of water, organic matter, and oxygen to the filter-feeding aquatic insect larvae that live among and under the riffle areas.

5. Species Diversity and Composition of the Stream Community

The significant changes in the stream's morphology, hydrology, and water quality that occur when land development increases in a watershed degrades the health and viability of the biological community in the stream. The number and variety of species found in the stream community typically drops when the physical and chemical features of the stream degrade. Species that need steady, cold, clean, relatively silt-free stream flow often cannot go through parts or all of their life cycles in degraded streams; these species, which have relatively narrow ranges of tolerances of stream conditions, may be greatly reduced in numbers or disappear altogether in a degraded stream.

Species that have narrow tolerances for degraded stream conditions are often used as indicators or "markers" for the overall good health of a stream. Examples of these indicator species include certain aquatic insect larvae such as stoneflies (Plecoptera family[8]) and certain species of mayflies (Ephemeroptera family) and caddis flies (Trichoptera family). Fish have also been used as indicators of long-term (i.e., several years) stream health because they are relatively long-lived and mobile. In Maryland Piedmont streams, trout are often used as indicators of a healthy stream.

Assessing Urbanization Impacts on a Stream System

1. Stream Monitoring

The health of a stream system can be documented in various ways. The ideal way is to methodically and consistently quantify the physical, chemical, and biological conditions within the streams over time. Such a monitoring program would be able to document the water chemistry; physical features of the stream channel's shape, size and stream bottom characteristics; and the size, composition and diversity of the entire biological community in the stream. If the stream system degrades, the ideal monitoring program would be able to document the declining changes within the streams' physical, chemical and biological conditions. In addition, the ideal monitoring program would also be able to track specific changes to the land uses in the watershed and pinpoint the causes of degradation to the streams.

In reality, stream systems within Montgomery County rarely have been or can be monitored in a truly comprehensive manner. This is because monitoring resources are always limited, compared to the numerous streams that should be monitored because of their potential for declining quality. Often, only certain components of the stream system are monitored, such as limited water chemistry parameters or certain groups of organisms (e.g., fish or aquatic macroinvertebrates). And the monitoring program usually is set up so that only a very limited number of widely-spaced monitoring stations can be put in place, with very limited time periods available for collecting data. Because of limited resources, monitoring programs usually include methods to identify the presence or absence of species or groups of species that have small tolerance ranges for "unhealthy" stream conditions (i.e., indicator species); these methods enable the health of a stream to be documented fairly accurately without having to implement an extensive monitoring program. However, such monitoring programs usually do not include methods to track or identify the specific causes of degradation of the streams.

If stream monitoring resources are limited, one way of assessing the health or changing conditions of a stream system and the factors that affect its health is to examine all available data on the streams' conditions, in conjunction with characterizing the watershed's impervious cover.

2. Level of Watershed Imperviousness

Impervious cover in a watershed can be viewed as an easily quantified, planning-level measure of human impact on the aquatic resources in the watershed, including the stream system. The proportion of a watershed covered in impervious surfaces can indicate the degree to which stream and wetlands baseflows, water temperatures, water quality and stream morphology are adversely altered. It can also signify the susceptibility of the watershed to unstable and erodible

[8] This and other scientific names referenced in this study are part of a standardized scientific system for plants and animals. This classification system categorizes plants and animals into a hierarchy of groups. The major types of taxonomic categories are as follows, listed in order of decreasing inclusiveness (e.g., a phylum includes a wider range of organisms than a species): phylum, class, order, suborder, family, subfamily, genus, species.

soil conditions, and loss of vegetative cover (e.g., due to grading and construction activities).

In general, the greater the proportion of a watershed covered in impervious surfaces, the lower the quality and health of the stream system found in the watershed. The absolute imperviousness levels tolerated by different stream systems vary. This is because many variables affect how well a stream is buffered from the negative effects of urbanization. These variables include the characteristics of the soils, geology, and topography in the watershed, the size and configuration of the stream, the extent, location, and type of vegetation cover in the watershed, the importance of baseflow in the stream's overall flow patterns, and the extent and location of urban land uses with respect to the stream.

A study of 27 small watersheds in the Maryland Piedmont region found a direct relationship between stream quality and watershed imperviousness (Klein, 1979). The study concluded that generally, stream quality impairment is observed when watershed imperviousness reaches between 12 and 15 percent. Severe degradation occurs when watershed imperviousness is at about 30 percent. For more sensitive stream systems, such as those supporting naturally-reproducing trout populations, the study recommends that watershed imperviousness should not exceed 10 percent to maintain the quality and integrity of these streams.

Since the Klein study, other studies have been conducted to determine the relationship of stream quality and watershed imperviousness and urbanization. These studies cover a variety of physiographic areas in the United States and one area in Canada; their findings and conclusions are clearly summarized in a research article on impervious cover (Schueler, 1994).

Although these studies cover a wide range of stream systems (for example, ranging from the Jones and Clark study [1987], which looked at several streams draining to the Potomac River in northern Virginia, to streams in the state of Washington [Booth and Reinelt, 1993]), they lead to the same general conclusion: Few, if any, streams with moderate to high levels of watershed imperviousness (25 percent or more) can support diverse, healthy insect communities. With respect to a stream's ability to support pollution-sensitive fish such as trout and salmon, the Schueler article found that the general upper limits of trout or salmon streams are in the range of 10 to 15 percent watershed imperviousness; and declines in trout spawning success are evident above 10 percent imperviousness.

The Interstate Commission on the Potomac River Basin (ICPRB) has noted that, in general, stream quality is "impaired when urbanization (developed areas) reaches 10 percent of a watershed. Normally, a stream is severely impaired" when at least 25 percent of the area it drains is impervious. (ICPRB, Spring 1992).

A Metropolitan Washington Council of Governments (MWCOG) study of water temperature impacts of urbanization and stormwater management (SWM) facilities on small headwater streams in the eastern Montgomery County area revealed that summer stream temperatures increase linearly with increasing watershed imperviousness. The study showed that watershed imperviousness has a negative effect on stream temperatures under both baseflow and stormflow conditions, regardless of whether SWM controls are present or absent in the watershed. Stream temperature regime changes occur when watershed imperviousness exceeds about 12 percent. The results of the study strongly suggest that coldwater organisms, such as trout, will most likely be lost when watershed imperviousness exceeds 12 to 15 percent (Galli, 1990).

The Anacostia Watershed Restoration Committee's (AWRC) Upper Paint Branch Work Group recognized the lack of specific watershed imperviousness "thresholds" to establish limits in which stream degradation will definitely occur. The work group references a range of upper limits for watershed imperviousness (between 10 and 15 percent) beyond which Coldwater stream systems in Maryland become severely degraded or are destroyed (AWRC, 1994).

In addition to the amount of impervious cover, the location of the impervious surfaces in the watershed is important in determining the degree with which such land cover will adversely impact the stream system. For example, paved surfaces located adjacent to or within the regulatory stream buffer will have a greater adverse affect on the stream than the same paved areas located 200 feet uphill of the stream buffer. As another example, paved surfaces located in the extreme headwaters of a stream system will create greater adverse impacts on the system than paved surfaces located further down in the watershed of the stream system.

Techniques for Reducing Urbanization Impacts on Streams

1. Land Use Controls

The control or management of land uses placed in a watershed is generally considered the most effective tool in influencing the health of a stream system.

Management of land uses that maximizes retention of vegetation cover, especially forest, and minimizes disturbance and modification of soils and topography is the most effective method to protect the high quality conditions of a stream system. Preservation of a watershed's vegetation cover is especially important in that part of a watershed that drains to small streams (i.e., commonly defined as first to third order streams) because of the limited ability of these streams to withstand and counter adverse impacts. Retention of vegetation cover, especially forest, is also crucial in the area surrounding a stream channel.

The tools to manage land cover and uses in a watershed include zoning, overlay zoning, performance criteria for land development and the use of legally-protected conservation areas in and around sensitive natural features. If urbanization or suburbanization is to take place in a watershed, and the preservation of the stream system is a goal, land use tools that greatly limit the overall impervious cover should be implemented in those areas of the watershed that drain to small streams. Urban and suburban uses that result in high impervious cover should be located in areas that drain to larger streams and rivers (fourth order streams or larger), although the overall watershed imperviousness should still be relatively small. In addition, areas in and around streams should be placed in protected conservation areas throughout the watershed.

2. Best Management Practices

When a land use will result in significant clearing of vegetation, disturbance of soils, modification of the natural topography and/or creation of impervious surfaces, stormwater management and sediment and erosion control measures are usually required by State and County laws to be put in place. Such measures are termed best management practices (BMP) and are designed to reduce the adverse impacts of land disturbance and land development on aquatic resources. A best management practice (BMP) is a method or measure considered to be the most effective and practicable means available to prevent or reduce the amount of pollutants or other detrimental water resource impacts generated from non-point sources[9]. BMPs vary in their effectiveness in protecting water resources.

This limited effectiveness is due to various factors: inherent limitations of engineering designs to completely replicate natural conditions and features, limitations of performance efficiencies of the control measures, poor construction of these measures and/or poor inspection and maintenance of these measures after they are put in place and are operational.

In a research article on impervious cover, Schueler (1994) notes that many types of water quality pollutants generated from urban land uses can be lowered by the use of a variety of stormwater management practices. However, he also points out that "even when effective practices are widely applied, we eventually cross a threshold of imperviousness, beyond which we cannot maintain predevelopment water quality" (Schueler, 1994).

A study of sediment control measures in Maryland showed that the sediment traps and basins used at the time of the study were not very effective (Schueler and Lugbill, 1990). The study found that only a 46 percent sediment removal rate could be considered to be a representative estimate of the effectiveness of existing sediment control designs in Maryland. No sediment control measures were found to be 100 percent effective over the entire length of time they were in operation. In addition, it was found that small-sized sediments (i.e., extremely fine clays and colloids) may be very difficult, if at all possible, to trap within the control measures. It should be noted that the Maryland and Montgomery County sediment and erosion control design standards have been revised to increase sediment-trapping efficiencies, because of the results of the study; it is not known how much improvement has occurred on land development sites with these changes in design standards. Even with improved designs, however, the success of sediment control measures are highly dependent on proper construction, inspection and maintenance of these measures on the site.

Some characteristics of healthy stream systems that are typically diminished or eliminated by extensive land development in the watershed cannot be mitigated by engineered measures. Reduced stream baseflow due to impervious surfaces covering groundwater recharge areas cannot be brought back to pre-development flow patterns with current engineered best management practices. Several types of stormwater management facilities can generate warm water discharges, including those that previously were thought to be thermally neutral (e.g., infiltration-dry ponds) (Galli, 1990).

Some engineered best management practices are effective at mitigating some of the impacts resulting

[9] Non-point source pollution is that which originates from diffuse sources and not from discernible, confined or discrete sources. For example, fertilizers or pesticides on a lawn that are carried in surface water runoff to a stream are non-point source pollutants. In contrast, nitrogen and phosphorus compounds discharged into a stream from a wastewater treatment plant outfall pipe are point source pollutants.

from urbanization, but may exacerbate or create other adverse conditions. A well-known example of this is the SWM retention facility (i.e., wet pond). This type of facility can be effective at trapping many water quality pollutants, but it introduces warm water discharges into the stream.

Methodology and Technical Approach of Study

The study of water quality and imperviousness was performed in three steps: The staff compiled stream quality data from various sources, conducted limited baseline stream quality and stream habitat sampling and estimated and evaluated impervious cover and land uses for the Paint Branch watershed within eastern Montgomery County.

The assumption underlying analysis of watershed imperviousness is that the higher the level of land development in a watershed, the greater the degradation in stream quality. As has been summarized above, this relationship between stream quality and watershed imperviousness has been well documented in other studies and is widely accepted in the water resources field. Factors such as stormwater management measures, improved sediment and erosion controls and best management practices do help reduce the frequency and severity of impacts, but their effectiveness is limited. In watersheds where the biological communities in the streams contain pollution-intolerant indicator species, the limited effectiveness of engineered measures may not be enough to maintain and protect the high quality and healthy conditions of these streams. The watershed's land cover and use, in and of itself, is still the overriding factor in predicting impacts to a stream system at the master planning level.

Defining Subwatersheds

For the purposes of this study, the watersheds within eastern Montgomery County were divided into subwatersheds. A subwatershed is defined in such a way so that, in most cases, it contains at least one first- or second-order[10] stream and the land uses and/or potential for change in land use throughout the subwatershed are relatively similar.

[10] The size of a stream can be characterized in a relative manner according to where it fits within the larger system of streams. A first-order stream is one in which no other stream drains to it. A second-order stream is a stream which is formed by the joining of at least two first-order streams.

Compiling Stream Quality Data

Within the subwatersheds, the study has collected limited information on aquatic macroinvertebrate communities and stream habitat conditions in areas where no consistent monitoring has been done in the past in order to better characterize existing conditions. Environmental Planning Division staff collected data on macroinvertebrates and stream habitat conditions at two stations using the Rapid Bioassessment Protocol II developed by the U.S. Environmental Protection Agency (Plafkin et al., 1989). A modified and more rigorous version of this methodology for assessing stream quality is being used by MCDEP in their stream monitoring program.

The original intent of this stream monitoring effort was to collect data for at least three seasons and, ideally, for a longer time period However, because of staff time limitations, only one season, the 1993 summer season, could be sampled; therefore, the macro-invertebrate and stream habitat data collected by staff is limited in nature and must be used with caution in characterizing existing stream quality conditions.

The stream sampling stations set up by the Environmental Planning Division for the 1993 summer monitoring is shown in Figure 2. Stream sampling stations within the eastern Montgomery County portion of Paint Branch that have been set up as part of past or present monitoring programs by other agencies are also shown in Figure 2.

Data on stream quality collected by other agencies have been compiled in order to comprehensively characterize as best as possible the past and present conditions of the various streams and any changes in the quality and health of these streams since the adoption of the 1981 *Eastern Montgomery County Master Plan*.

Calculating Existing Subwatershed Imperviousness

This study estimates subwatershed imperviousness for current conditions and projects the impervious cover assuming buildout conditions under the 1981 Master Plan zoning. The methodology in this study used GIS data to estimate impervious cover for current conditions and added on estimated impervious cover by zoning category to project subwatershed imperviousness for future conditions.

The first step in estimating impervious cover was to define subwatershed boundaries. These boundaries were drawn on 1" = 200' topographic maps and clipped to each of the GIS planimetric layers (i.e., files) for buildings, roads, streets and parking lots, cultural features and sidewalks. These planimetric layers form the foundation of the County's geographic information system (CGIS). The information was entered into digital format from aerial photos by the Technology and Research Center of the M-NCPPC Montgomery County Department of Park and Planning.

For the study, the layers that represented current conditions reflected 1990 conditions. There has been a relatively small amount of development in the eastern Montgomery County area since 1990 due to traffic moratorium conditions, so that land use conditions reflected by the 1990 planimetric data were assumed to closely represent present existing conditions. That is, 1990 planimetric data were used to characterize existing conditions with respect to land uses and land cover. GIS was used to measure all paved surfaces and building rooftops that are shown in the planimetric layers for each subwatershed. These layers include all features that are considered to be impervious surfaces except for sidewalks and driveways for single-family detached houses (see below for the estimating impervious surface area attributable to sidewalks and residential driveways). This method of measuring impervious surfaces differs from past studies (i.e., staff analysis of imperviousness in upper Paint Branch for the 1981 *Eastern Montgomery County Master Plan* work [M-NCPPC 1981], staff analysis of imperviousness in Paint Branch due to proposed development in 1979 (Gresh, 1979) and the "Anacostia: Technical Watershed Study" [CH2M Hill, 1982]) in that previous methods relied largely on imperviousness factors by land use or development category to estimate subwatershed imperviousness under "current" or "existing" conditions; to calculate imperviousness within a given subwatershed, the factor would be multiplied by the amount of corresponding land use or development category occurring in the subwatershed, and the estimated impervious surfaces for the various land use or development categories would be summed.

The actual measure of impervious surface on the land, which has only recently become possible due to the development of GIS technology, provides a more accurate measure of imperviousness for "current" or "existing" conditions. It can also provide a reference against which to evaluate past and present methods of estimating imperviousness by land use category.

As part of this study, the GIS layers were compared to 1993 aerial photographs to check and verify the accuracy of the data. This comparison revealed that substantial paved area exists in the form of driveways on single-family detached residential lots which are not included in the planimetric database. In order to calculate the area of driveways not already accounted for, the building, road/street and parking layers were evaluated and an approximate count obtained of the number of buildings (primarily residential single family in subdivisions; rear yard structures assumed to be sheds and the like were not counted) for which a driveway existed but did not appear in the planimetric layer. This number was then multiplied by the average area for a driveway in each subwatershed, which was obtained from the required front-yard setback for the predominant residential zones within the watershed multiplied by an assumed width of 15 feet.

Sidewalks are a feature in the GIS data that are shown as lines and not as polygons. The area of sidewalks was determined by multiplying the length (taken from the planimetric layer) by an assumed width of four feet.

In addition to the GIS layers for paved features (buildings, driveways, roads, streets and parking, cultural and sidewalks), the "impervious" contribution of non-paved land cover was calculated, based on the assumption that these surfaces also contribute to surface water runoff for some precipitation events. Remaining non-paved land was categorized as either forested or non-forest, non-paved. Non-forest, non-paved land includes lawn, pasture and crop fields and is referred to as meadow. Forest cover is assigned an imperviousness factor of 1 percent; non-forest green cover is assigned a factor of 3 percent. A 1 percent imperviousness factor for forest cover has been used in other studies that focus on land use imperviousness (Northern Virginia Planning District Commission, 1980; Gall, 1983; CH2M Hill, 1982). For non-forested green cover, a wider range of imperviousness factors have been used (i.e., 0 to 7 percent). This study uses 3 percent imperviousness factor for non-forested green cover because it is roughly the middle of the range of values that have been used in other studies, it is the factor used in the Paint Branch compendium (Gall, 1983) and it reflects the greater benefits of forest cover compared to meadow or grass cover on streams.

Projecting Subwatershed Imperviousness

To estimate the effects of the 1981 Master Plan zoning recommendations on the ultimate subwatershed imperviousness levels, the study projected imperviousness by zoning.

For each subwatershed, properties were identified according to their development status as of 1990:

already developed, developable, committed or pipeline (i.e., properties that have an approved development plan, preliminary plan, or site plan, or are recorded lots, but were not constructed as of 1990). Developable and committed/pipeline properties were further characterized by zoning. For land in each category of zoning and development status, the amounts of forest and non-forest cover and associated impervious surfaces under 1990 conditions were calculated through the use of M-NCPPC Montgomery County Department of Park and Planning Arc/Info layers and databases. The projected impervious covers on a category of land, if or when it develops under either the master plan zoning or an approved plan, was calculated using imperviousness factors by zones. To estimate the total subwatershed impervious cover assuming 1981 Master Plan buildout, the projected impervious covers for all categories of land were added to the 1990 calculated impervious coverage and 1990 impervious surfaces for developable and committed/pipeline land were subtracted.

Imperviousness factors by zone were primarily derived from estimates of percent impervious cover by land use type that were compiled as part of a study of nonpoint pollution from uncontrolled urban and rural-agricultural land uses in northern Virginia (Northern Virginia Planning District Commission, 1980). These land use types are comparable to the zones found in Montgomery County. In addition, the eastern Montgomery County watershed study calculated impervious cover for selected residential subdivisions that have been constructed in eastern Montgomery County using data on the GIS system. The calculated impervious cover for these subdivisions are comparable to the impervious cover estimates in the northern Virginia study.

Table 1 presents the imperviousness factors by zones that have been used to Project the total subwatershed imperviousness under the 1981 Master Plan buildout. These imperviousness factors by zone have also been used to project subwatershed imperviousness under various buildout scenarios that deviate from the 1981 Master Plan zoning recommendations for specific subwatersheds to determine how changes to the 1981 Master Plan may affect impervious cover.

Imperviousness Factors by Zone

Table 1

Zoning Category	Imperviousness Factor (Percent)
RC	6
RE-2	9
RE-2C	9
RE-1	11
R-200	19
R-90	20
R-200/TDR 5	35
R-150/TDR 5	35
R-90/TDR 5 TO 8	37
R-60/TDR 8 TO 9	40
R-20	60
PD-2	20
C-1, C-2, C-3	90
O-M	90
I-1	60
I-2	80
I-3	60
I-4 in West Farm	60

Anacostia Restoration Team, Department of Environmental Programs, Metropolitan Washington Council of Governments. A Commitment to Restore Our Home River: A Six-Point Action Plan to Restore the Anacostia River. November 1991.

Anacostia Watershed Restoration Committee. "Upper Paint Branch Work Group Recommendations for Protecting the Good Hope Tributary," October 1994.

Booth, Derek B. and Lorin E. Reinelt. "Consequences of Urbanization on Aquatic Systems — Measured Effects, Degradation Thresholds, and Corrective Strategies." In: Proceedings Watershed '93, A National Conference on Watershed Management, pp. 545-550. March 21 -24, 1993. Alexandria, Virginia.

CH2M Hill. "Anacostia: Technical Watershed Study." Prepared for the M-NCPPC Montgomery County Planning Board. May 1982.

CH2M Hill. "Paint Branch: Recommendations for the Preservation of a Unique Trout Resource." Prepared for M-NCPPC. April 1980.

Chesapeake Environmental Mangement, Inc. "Hydrogeological Controls of Stream Water Quality, Selected Watersheds of Eastern Montgomery County, Md." Prepared for the Montgomery County Department of Park and Planning, June, 1996.

Cummins, James D. ICPRB. "1988 Survey and Inventory of the Fishes in the Anacostia River Basin, Maryland." ICPRB Report # 89-2. Contract #F-128-88-008, Md. DNR. January 1989.

Cununins, James D., James Stribling, Peter Thaler. ICPRB. "1990 Maryland Anacostia River Basin Study, Parts I and 11." ICPRB Report # 91-2. Contract #F-196-90-008, Md. DNR. January 1991.

Eastern Montgomery County Paint Branch Technical Work Group. Preliminary Draft, "The Upper Paint Branch Watershed Planning Study." July 1995

Galli, John. MWCOG. Presentation of Right Fork Tributary stream assessment work as part of the Paint Branch Technical Work Group. June 1995.

Galli, John. MWCOG. "Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices." December 1990.

Galli, John. M-NCPPC Environmental Planning Division. "A Compendium of the Water Resources for Paint Branch, Montgomery County, Maryland." April 1983.

Galli, John and Lori Herson. MWCOG. "Volume II. Anacostia River Basin, Montgomery County Stormwater Retrofit Inventory, 1988: Paint and Little Paint Branch Subwatersheds." Prepared for the Montgomery County Department of Environmental Protection. October 1988.

Gougeon, Charles R. Md.DNR. Personal communication, January 1995.

Gougeon, Charles R. Md.DNR. "Paint Branch — Overview." Unpublished summary. November 6, 1994.

Gougeon, Charles R. Md.DNR. "Paint Branch, Final Report." Federal Aid in Fish Restoration Project F-36-R. 1991.

Gougeon, Charles R. Md.DNR. "Paint Branch, Final Report." Federal Aid in Fish Restoration Project F-36-R, Job I. 1985.

Greenhome and O'Mara, Inc. "Patuxent Watershed Management Study, Technical Report," prepared for M-NCPPC. February 1990.

Gresh, John S. M-NCPPC. "An Inventory of Proposed Development and Associated Imperviousness in the Paint Branch Basin." August 1979.

Gries, William. M-NCPPC Dept. of Parks. Personal communication, January 1995.

Hau, Stephanie. Letter to Mr. Keith Bowers, Biohabitats, on the hydrogeological analysis of spring areas in the upper Paint Branch watershed. June 28, 1995.

Hughes, David M. Md.DNR. "Paint Branch, Final Report." Federal Aid in Fish Restoration Project F-36-R, Job I. 1985.

Interstate Commission on the Potomac River Basin. In the Anacostia Watershed, Volume V, No.2. Spring 1992.

Jones, R. Christian and Christopher Clark. "Impact of Watershed Urbanization on Stream Insect Communities." In: American Water Resources Association Water Resources Bulletin, Volume 23, No. 6 pp. 1047–1055, December 1987.

Klein, Richard D. "Urbanization and Stream Quality Impairment." In: American Water Resources Association Water Resources Bulletin, Volume 15, No.4, pp. 948–963. August 1979.

Kumble, Peter A. MWCOG. 'The State of the Anacostia: 1989 Status Report." August 1990.

Maryland Department of Natural Resources, Freshwater Fisheries Division. Unpublished summary by staff of relative abundances of brown trout in Paint Branch from 1985 through part of 1995. July 1995.

Maryland Department of Natural Resources. Unpublished macroinvertebrate data for the Paint Branch watershed. Collected by Susan Rivers, 1993.

Maryland Department of Natural Resources. Unpublished macroinvertebrate data for the Paint Branch watershed. Collected by Susan Rivers, 1992.

Maryland Department of Natural Resources. Unpublished macroinvertebrate data for the Paint Branch watershed. Collected by Susan Rivers, 1991.

Maryland Department of Natural Resources. Unpublished macroinvertebrate data for the Paint Branch watershed. Collected by Susan Rivers, 1990.

M-NCPPC. Public Hearing (Preliminary) Draft of the "Limited Amendment to the Master Plan for the Eastern Montgomery County Planning Area, Expanded Park Acquisition for Resource Management and Protection of the Paint Branch Watershed." May 1995.

M-NCPPC. "Approved and Adopted Master Plan for Eastern Montgomery County Planning Area: Cloverly, Fairiand, White Oak." November 1981.

M-NCPPC. 1993, Functional Master Plan for the Patuxent River Watershed. Silver Spring, MD.

M-NCPPC Envirorunental Planning Division. Unpublished data from stream assessments in eastern Montgomery County watersheds. Collected by Gregory Fick, Candy Bunnag, and Pamela Rowe. Summer 1993.

M-NCPPC Environmental Planning Division. Unpublished data from stream assessments in Northwest Branch watersheds. Collected by Gregory Fick and Brenda Sandberg. Spring 1996.

M-NCPPC Environmental Planning Division. Unpublished data from stream assessments in the Patuxent River watershed. Collected by Gregory Fick and Katherine Nelson. Spring and Summer 1995.

M-NCPPC Montgomery County Planning Department. "Environmental Guidelines: Guidelines for Environmental Management of Development in Montgomery County." Approved by the Montgomery County Planning Board. January 1993 (as corrected in June 1994).

M-NCPPC. Master Plan for Fairland Park. November, 1991.

Metropolitan Washington Council of Govemments, Department of Envirorunental Programs. "Anacostia Water Quality Conditions, 1986 and 1987." February 1989A.

Metropolitan Washington Council of Governments, Department of Environmental Programs. "Potomac River Water Quality—1985: Conditions and Trends in Metropolitan Washington." April 1987.

Metropolitan Washington Council of Govemments, Department of Environmental Programs. "The State of The Anacostia: 1988 Status Report." June 1989.

Montgomery County Department of Envionmental Protection. "Water Quality of Streams in Montgomery County, Maryland, January–December 1980." December 1981.

Montgomery County Department of Environmental Protection. "Water Quality of Streams in Montgomery County, Maryland, January–December 1979." December 1980.

Montgomery County Department of Environmental Protection. "Water Quality of Streams in Montgomery County, Maryland, January–December 1978." July 1979.

Montgomery County Department of Environmental Protection. "Water Quality of Streams in Montgomery County, Maryland, January–December 1977." October 1978.

Montgomery County Department of Environmental Protection. "Water Quality of Streams in Montgomery County, Maryland, January–December 1976." December 1977.

Montgomery County Department of Environmental Protection. "Water Quality of Streams in Montgomery County, Maryland, January–June 1974 and July–December 1975." November 1976.

Montgomery County Department of Environmental Protection. "Water Quality of Montgomery County Streams and Sewage Treatment Plant Effluents, December 1969–January 1974." August 1974.

Northern Virginia Planning District Commission. Guidebook for Screening Urban Nonpoint Pollution Management Strategies. A Final Report Prepared for the Metropolitan Washington Council of Governments. April 1980.

Plafkin, James L., Michael Barbour, Kimberly Porter, Sharon Gross, and Robert Hughes. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA Publication EPA/440/4-89/001. U.S. Environmental Protection Agency. May 1989.

Schueler, Thomas, editor. "The Importance of Imperviousness." In: Watershed Protection Techniques, Volume 1, No. 3, pp. 100–111. Fall 1994.

Yorke, Thomas H. and William J. Herb. U.S. Department of the Interior, U.S. Geological Survey. Effects of Urbanization on Streamflow and Sediment Transport in the Rock Creek and Anacostia River Basins, Montgomery County, Maryland, 1962–74. Geological Survey Professional Paper 1003. U.S. Government Printing Office, Washington, D.C.: 1978.