CHAPTER 5

SUMMARY & RECOMMENDATIONS

The overall goal of the SPS study was to provide comprehensive baseline information on stream conditions in Fairfax County through biological and physical habitat assessments, and based on these results, assign priorities for watershed management. This overall goal and the purpose for the study were achieved.

In summary, this SPS Baseline Study achieved the following:

- Enabled Fairfax County staff and the public to have a better understanding of the degree of stream degradation in the County.
- Established Watershed Management Categories that outlined strategies and measures that, if implemented, could be effective in reversing the negative trends of stream degradation and the protection of stream resources.
- Identified areas to be treated on a priority basis for the allocation of resources toward development of comprehensive watershed master plans.
- Demonstrated how SPS supports and integrates with other ongoing and future environmental policies, initiatives and regulations.
- Provided a basis for moving ahead with implementation of stream restoration and preservation efforts and assessing future conditions of County streams.
- Established working partnerships with citizens and provided the basis for continual environmental stewardship by supporting other monitoring efforts.

The methods and detailed results of the study were presented in Chapters 2 and 3. Priorities and recommendations for watershed management were presented in Chapter 4. This chapter provides a summary of the results and presents recommendations for future work to achieve and enhance water quality goals.

Streams within Fairfax County exhibit a diverse range of conditions. While field monitoring isolated numerous systems with high biological and habitat quality, it also highlighted many areas where substantial degradation has taken place (Figures 5, 6, and 7). Levels of drainage imperviousness are known to influence stream condition, and spatial analyses of land cover characteristics indicate that a large percentage of County watersheds currently have imperviousness levels that are within or above the range (10 – 20%) at which biological impairment is generally accepted to occur. (Figure 8).

The systems of high integrity that still exist within the County's boundaries are typically found only in largely undeveloped watersheds. Conversely, the most degraded streams are those that flow through areas of the most intensive development (Figure 10). This pattern is even more pronounced in drainages containing older developments that often lack the more recently developed and more efficient stormwater controls.

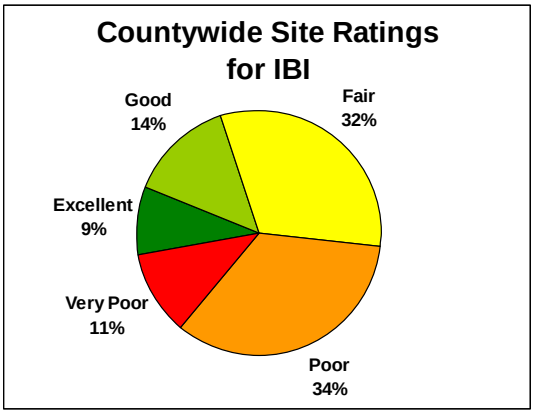

Figure 5. Percentage of SPS monitoring sites scoring in each of the five IBI quality categories.

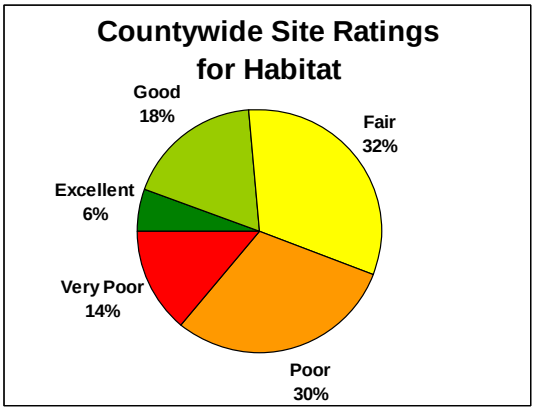

Figure 6. Percentage of SPS monitoring sites scoring in each of the five Habitat quality categories.

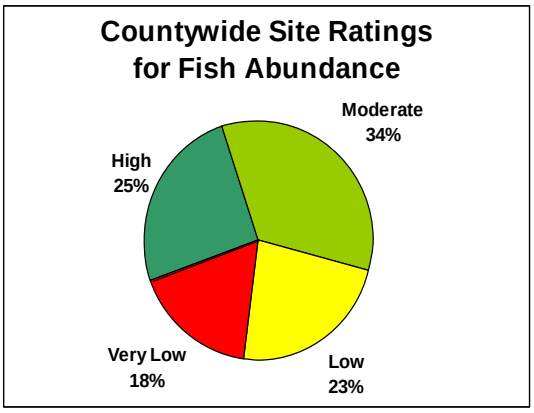

Figure 7. Percentage of SPS monitoring sites scoring in each of the four Fish abundance categories.

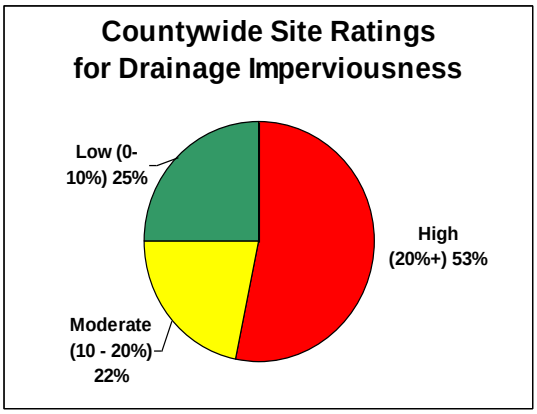

Figure 8. Distribution of Imperviousness at SPS monitoring sites.

The impact of land alteration on aquatic systems within the County is twofold: (1) widespread instream habitat degradation from channel incision and widening caused by high storm flows and (2) excessive sediment loading (with the associated high levels of deposition) from instream erosion and sometimes poorly installed and/or maintained controls at construction sites.

Consistent with what has been reported in the literature (Klein, 1979, Booth, 1991, Schueler et al, 1992, Booth et al, 1993, Booth and Jackson, 1994 and Boward et al, 1999) this study showed a statistically significant relationship between drainage area, imperviousness and biological quality at a site (see Appendix B for details on the statistical analyses). Figure 9 shows the relationship between biological integrity and drainage area imperviousness. The trend line shown in the figure is presented to highlight the fact that impervious area generated during development is correlated with declining stream quality as measured by macroinvertebrate community health. However, the relationship in its current form (linear) should not be used for predictive purposes since that would require a more detailed statistical analysis.

CHAPTER 5

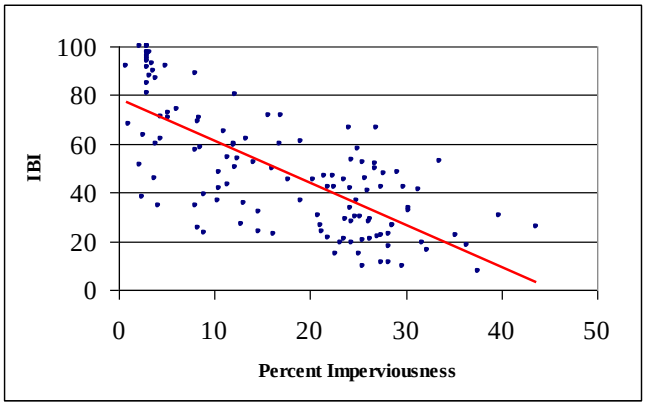

Figure 9. Trend line indicating that Biological integrity, as measured by an Index of Biotic Intetrity (IBI) for benthic macroinvertebrates, generally decreases with increasing percent imperviousness. Appendix B includes information on the statistical significance of the data presented.

To address the many issues of stream quality, an innovative approach will be needed, with the SPS program as the cornerstone. The County has already begun the process by improving the existing erosion and sediment inspection program, updating and enhancing the EQC policy and enforcing existing environmental regulations. These changes must continue with an attitude shift toward viewing streams as important natural resources and functioning ecosystems. Many new technologies are available in the field of stormwater management and bioengineering, which can be used to eliminate or substantially limit the impact of development on adjacent aquatic systems.

The goal of protecting and restoring stream quality is an achievable one, but the key to success will be found only in a diverse approach which includes an active and ongoing stream monitoring effort, community education, improving stormwater controls, and enhanced channels of communication with site developers. The SPS program is but one component of the larger effort that will be needed, but its initial creation and subsequent integration with many other existing programs is a vital first step.

CHAPTER 5

Countywide Conditions

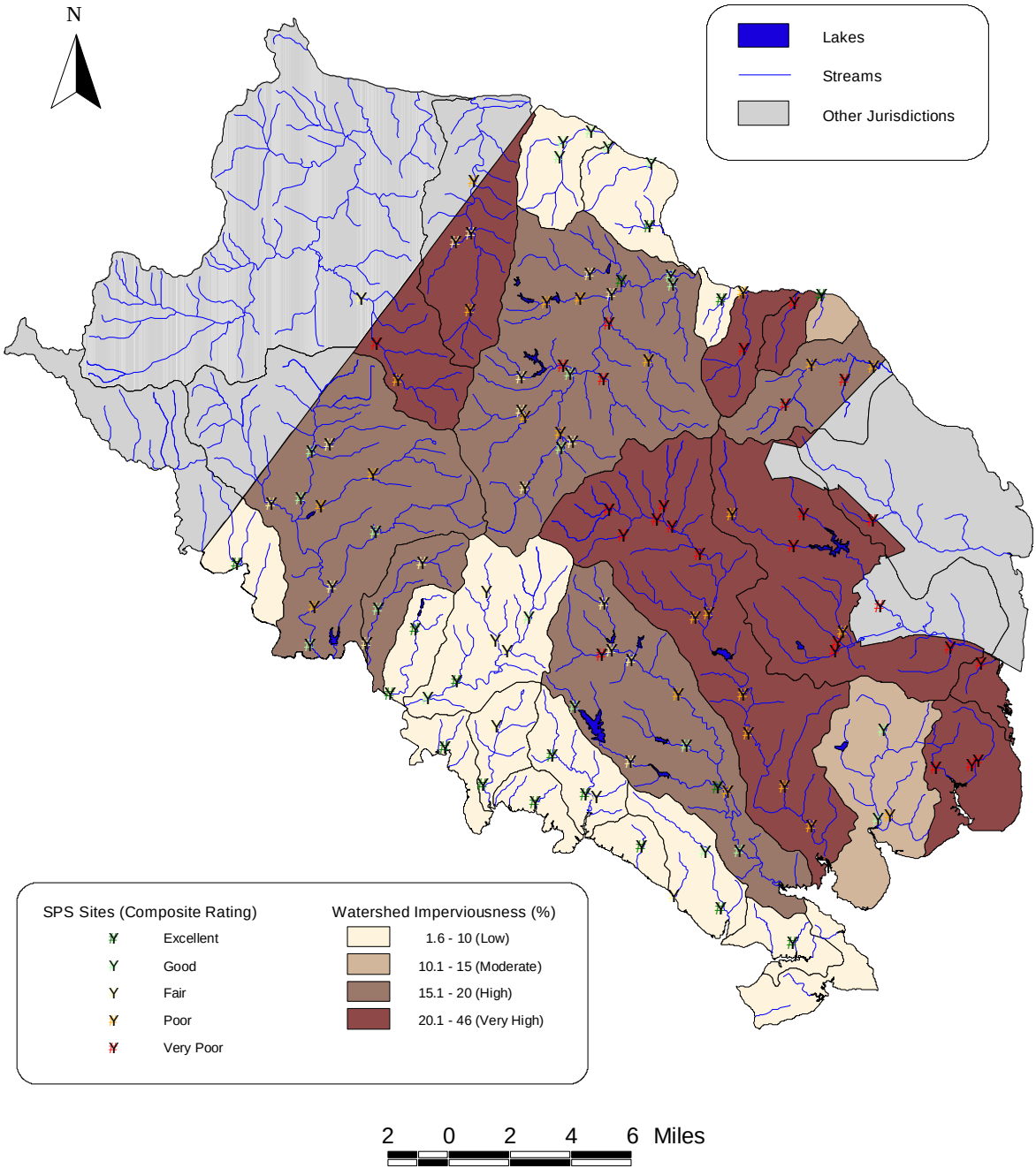

Figure 10. Relationship between imperviousness and overall stream condition.

CHAPTER 5

This baseline study identifies and prioritizes areas with the greatest needs, and creates a foundation for implementing targeted monitoring and remediation efforts in the future. The recommended management classifications are each characterized by a set of goals and strategies that best suits each respective environment given our current level of understanding. The overall objective is to recommend measures to protect the highest quality streams and actively restore degraded streams to the most practical extent possible. The management categories are as follows:

Watershed Protection (31.5% of County)
Primary goal: Preserve biological integrity by taking measures to identify and protect, to the extent possible, the conditions responsible for current high quality rating of these streams. Watershed Protection Areas have the highest priority and require immediate attention to assure their current biological integrity is maintained.

Watershed Restoration Level I (7.2% of County)
Primary Goal: Re-establish healthy biological communities, where feasible, by taking measures to identify and remedy the cause(s) of stream degradation both broad scale and site specific. Watershed Restoration Level I Areas have the greatest opportunity for improvement based on current conditions and proposed development. Restoration plans should be developed and implemented for these watersheds first.

Watershed Restoration Level II (61.3% of County)
Primary Goal: Maintain areas to prevent further degradation and implement measures to improve water quality to comply with Chesapeake Bay Initiatives, Total Maximum Daily Load (TMDL) regulations and other water quality initiatives and standards. Areas designated as Watershed Restoration Level II will need to be prioritized based on stream order (headwater vs. mainstem), current and potential development, existing improvement projects, regulatory requirements and other initiatives.

CHAPTER 5

FUTURE ASSESSMENT

The results in this report are only intended to provide a snapshot of stream quality conditions as they exist today. As such, this baseline study should be seen only as the beginning phase of the permanent monitoring effort that will be needed for effective management of aquatic resources within the County. If appropriate decisions are to be made, trends in stream conditions will need to be identified and assessed over the long term. This will require expanding our base of understanding of streams, and components of any future SPS program should involve:

- Expanding analyses of existing spatial data sets
- Continuing to monitor existing SPS sites on a rotating basis
- Establishing a detailed visual assessment program at the subwatershed level
- Assessing variables influencing fish community composition and distribution
- Promoting the expansion of volunteer monitoring efforts
- Defining and identifying perennial stream networks within the County
- Assessing relative contribution of various sources of instream sediment
- Evaluating alternate site selection design to allow for more rigorous analyses
- Assisting with assessments of effectiveness of various BMP technologies
- Monitoring changes in imperviousness at the watershed and subwatershed levels
- Improving inter-agency cooperation regarding sediment control implementation and maintenance
- Fostering community interest in stream quality issues.

Spatial Analysis

Assessments of the relationship between land use and stream condition should be expanded to include other variables. Specifically, comparisons should be made between current site composite ratings and percent forest cover, proximity to upstream impoundments, extent of parkland and Resource Protection Areas, and age of development. Each of these examinations should be made with respect to the contributing drainage area of each SPS monitoring location.

Long Term Monitoring

All environmental monitoring relies on repeated observation to provide the most complete picture of environmental processes. In this vein, all County watersheds should be re-sampled in coming years to both highlight changes in conditions as well as develop a broader information base. Identification of ongoing trends, both on a large- and small-scale, will provide a basis for targeting management activities in the future. Annual re-sampling should include at least 20 – 25% of SPS sites each year. Areas of priority concern (i.e., those potentially reaching a threshold for integrity) should be

reassessed first and more frequently, potentially with an expansion of monitoring efforts within the respective subwatersheds.

Visual Assessments

Given the limited scope of this initial baseline study, many questions remain as to the actual extent of degradation within many watersheds. As a first step, County streams should be walked in full to identify areas of both large- and small-scale concern and to better understand factors influencing basin-wide patterns in stream condition. Such efforts would also be useful in highlighting otherwise undiscovered problems where property or other infrastructure requires maintenance or repair. Site-specific information should be collected using a GPS unit for use within a GIS environment. Given the amount of time required to complete such a task within all of the County's watersheds, areas of priority concern should be targeted first. This effort could be integrated with a comprehensive watershed master planning effort.

Fish Community Metrics

Many questions remain regarding fish communities in many County watersheds. Specifically, further study is needed of the factors influencing measures of relative abundance, composition, and distribution, with an eye toward developing a useful suite of metrics for broad-scale comparisons. Of specific concern are the compounding effects of instream fish barriers, stocking efforts, and the relative proximity of large rivers systems. Impoundments should also be assessed with regard to their impact on fish movement as well as their influence on stream temperature, sediment load, and nutrient content.

Volunteer Monitoring Efforts

Subwatersheds designated within this report as Assessment Priority Areas should be a primary focus of future biological sampling efforts. The expansion of the volunteer monitoring program, with the help of the NVSWCD and ANS, would be of great benefit in this regard. Reliable volunteer data could be used to help develop a broader information base, particularly in areas of priority concern where more detailed examinations are warranted. It is also recommended that volunteers receive training in identifying possible violations of County E&S regulations. Broader involvement of citizen volunteer monitors could promote greater environmental stewardship, heighten public awareness and provide support for public education.

CHAPTER 5

Stream Network Assessment

Perennial or "permanent" streams within the County were identified based upon the USGS 1:24,000 topographic maps, a standard source used by many resource management agencies at the federal, state, and local levels. It has been argued, however, that the resulting coverage is incomplete and inaccurate and that a more rigorous definition needs to be developed. Once this criteria is established, perennial streams within the County could be identified and inventoried as part of the ongoing visual assessment efforts detailed above. This would again require the use of GPS units so that the resulting information could be incorporated as part of land use analyses within a GIS environment. In this process, it is also recommended that the many unnamed tributary systems found in all watersheds be given title designations, a process that would allow for better referencing and serve to enhance citizen identification and ownership of streams.

Instream Sediment Studies

Since sediment is a serious pollutant in County streams, pilot studies should be undertaken to determine the relative contribution of specific sources (i.e., instream erosion versus site development) and to look at ways to mitigate the associated degradation. As an important step toward better voluntary compliance with the Chesapeake 2000 Agreement, attempts should also be made to quantify sediment loads leaving County streams. Any stream restoration activities will also require better estimates of current rates of erosion and bend migration to ensure viability. Controlling the amount of stream sediment loading must be a major priority for the SPS as well as other County environmental programs, particularly in light of recent issues surrounding the intake system for the Potomac River water supply. Additional training in stream classification and morphological assessment methodology is recommended for all County personnel with a stake in affecting stream restoration.

Study Designs Modifications

A re-evaluation of current SPS study site placement is recommended. Other, more statistically rigorous alternatives may be useful in allowing for more detailed analysis of data collected in the future. Specifically, the use of a more randomized sampling design would allow for more direct comparison of site characteristics both within stream orders and between subwatersheds and physiographic regions.

Stormwater Control Effectiveness

Assessments of new BMP technologies should be an ongoing process as recommended by the recent draft of the Infill and Residential Development Study. Detailed cost-benefit analyses and a better overall understanding of their applicability

within Fairfax County is needed. Both pre- and post-implementation monitoring should be conducted to determine overall effectiveness of various designs.

Impervious Cover Estimation

As a primary component of the overall ranking system detailed in this report, levels of imperviousness within all County watersheds will need to be regularly reassessed and compared with the results of subsequent biological habitat monitoring. Efforts should also be made to develop applications within a GIS environment to automate, as much as possible, the detailed, multi-step processes (point delineation, clipping of land use coverages, tabulation of areas) that are necessary to develop impervious cover estimates. This could be used to further refine the relationship of imperviousness to biological integrity of County watersheds. GIS will likely play an increasingly significant role in the future.

Wetland Monitoring

Methods for monitoring coastal wetland areas with variable drainages, such as the entire High Point Watershed, will need to be developed. These areas cannot currently be sampled under the RBP protocol, which requires clearly defined stream systems. The value of various indicators, such as macroinvertebrates, amphibians, and even plants, will need to be assessed with regard to their utility in highlighting degradation in wetland environments.

SPS monitoring can be incorporated into the new countywide wetland delineation and evaluation study currently being undertaken jointly with George Mason University personnel.

Inter-Agency Cooperation

With regard to monitoring for and responding to violations of E&S regulations at sites under development, SPS should work to strengthen its relationship with the Office of Site Inspection. Cross training of staff from both agencies should be encouraged.

Promoting Public Awareness

A major goal of the SPS program has been and will continue to be increasing community involvement and awareness in water resource issues. To this end, further developments of the SPS site on the World Wide Web are needed. This should include adding summaries of the information detailed in this current report, as well as periodic updates on monitoring efforts and management activities aimed at restoration and overall stream quality improvement. It is also recommended to develop an online GIS server, which would enable County residents to obtain information on stream health in their own neighborhoods on a continual basis.

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GLOSSARY

A

Andrews Curve - A graphical approach to viewing patterns of similarity or dissimilarity based on multi-dimensional data.

Anthropogenic - Effects or processes that are derived from human activity.

B

Base Flow - The sustained portion of stream discharge that is drawn from natural storage sources and not affected by human activity or regulation.

Baseline Monitoring - Data collection intended to define existing biological conditions and to set up a framework for long-term study.

Benthic - That portion of the aquatic environment inhabited by organisms which live permanently in or on the bottom.

Benthic Macroinvertebrate - An aquatic animal lacking a backbone and generally visible to the unaided eye.

Best Management Practice (BMP) - Structural or nonstructural practice that is designed to minimize the impacts of change in land use on surface and groundwater systems.

Biomonitoring - The use of living organisms to assess environmental conditions.

Bioretention Basin - Water quality BMP engineered to filter the water quality volume through an engineered planting bed, consisting of a vegetated surface layer (vegetation, mulch, and ground cover), planting soil, and sand bed (optional), and into the in-situ material. Also called a Rain Garden.

C

Channelization - Strengthening, widening, deepening, clearing, or lining of existing stream channels.

Clean Water Act - A law enacted by the United States Congress in 1972 and enforced by the Environmental Protection Agency on the national level and the Georgia Environmental Protection Division on the local level. The Clean Water Act established three main goals: "zero discharge" or the elimination of polluting discharges to the nation's waters by 1985; "fishable and swimmable waters" or the restoration and protection of water quality and wildlife habitat; and "no toxins in toxic amounts" or the prohibition of the discharge of toxic pollutants in amounts that are toxic to the environment or life.

Clingers - An aquatic macroinvertebrate that is able to cling to substrates and maintain itself in fast flowing water.

Coastal Plain - The physiographic province that lies along the Atlantic coast and extends inland to the Piedmont physiographic province. This area is generally characterized by low gradient, meandering streams with mobile sand/silt or gravel substrates.

Confluence - A flowing together of two or more streams.

D

Dissolved Oxygen - The amount of oxygen freely available in water and necessary for aquatic life and the oxidation of organic materials.

GLOSSARY

E

Ecoregion - A physical area that is defined by ecological factors such as meteorology, elevation, plant and animal speciation, landscape aspect, and soils.

Ecosystem - All of the component organisms of a community and their environment that, together, form an interacting system.

Electrofishing - Fish sampling method using electrical currents to temporarily stun fish to facilitate capture.

Embeddedness - Refers to the extent to which stream substrate (gravel, cobble, boulders and snags) is filled and/or covered with silt, sand, or mud.

Epifaunal Substrate - The variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna.

EPT - A group of three orders of insects: mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) which are used to determine stream health based on their sensitivity to pollution.

F

Family Biotic Index (FBI) - The general tolerance/intolerance of an assemblage that considers the numbers of individuals in each tolerance class at the family level taxonomic resolution.

Fecal Coliform Bacteria - A group of organisms common to the intestinal tracts of humans and of animals. The presence of fecal coliform bacteria in water is an indicator of pollution and of potentially dangerous bacterial contamination.

Fish Barrier - An obstacle in a stream or river, such as a dam or elevated culvert, that prevents the up and downstream movement of fish and other aquatic species.

Flood Plain - For a given flood event, that area of land adjoining a continuous water course which has been covered temporarily by water.

Functional Feeding Group (FFG) - A categorization of a biological community based on its trophic or feeding level within its environment (shredder, predator, scraper…).

G

Gabion - A wire basket or cage that is filled with gravel and generally used to stabilize stream banks and improve degraded aquatic habitat.

Geographic Information System (GIS) - A method of overlaying spatial land and land use data of different kinds. The data are referenced to a set of geographical coordinates and encoded in a computer software system. GIS is used by many localities to map utilities and sewer lines and to delineate zoning areas.

Glide - Section of a stream with a relatively high velocity and with little or no turbulence on the surface of the water.

Global Positional System (GPS) - Network of satellites that emit continuous location-finding radio signals; GPS receivers use the signals from multiple satellites to determine their exact three-dimensional coordinates (latitude, longitude, and height).

H

Habitat - The environment in which an organism lives.

Headcut - A place with an abrupt change in a stream profile, generally formed by the presence of a rock layer resistant to erosive force of the stream flow.

Hilsenhoff Biotic Index (HBI) - The general tolerance/intolerance of the assemblage which considers the number of individuals in each tolerance class.

I

Impaired Stream - An aquatic system in which the water quality is degraded to an extent such that resident biological communities lack the diversity and/or abundance that would otherwise be present.

Impervious Cover - A surface composed of any material that significantly impedes or prevents natural infiltration of water into soil (i.e. sidewalks, houses, parking lots...).

Imperviousness - The percentage of impervious cover within a defined area.

Impoundment - A body of water contained by a barrier, such as a dam.

Instream Erosion - Erosion of stream banks caused by high flow rates.

Incised Channel Evolution Model (ICEM) - ICEM defines the stages through which stream channel morphology progresses after disturbance and can act as a useful predictor of future conditions.

Index of Biotic Integrity (IBI) - A stream assessment tool that evaluates biological integrity based on characteristics of the fish and benthic assemblage at a site.

Infiltration - The portion of rainfall or surface runoff that moves downward into the subsurface rock and soil.

Insectivore - An animal that feeds primarily on insects.

Intermittent Streams - Streams flowing temporarily or periodically rather than continuously throughout the year.

Intolerant Species - Populations of animals and/or plants that are adversely affected even at low levels of degradation.

Invertivore - An animal that primarily feeds on invertebrates.

L

Lentic - A non-flowing or standing body of fresh water, such as a lake or pond.

M

Metric - A characteristic of a habitat or biological community structure that changes in some predictable way with increased disturbance or divergence from normal, natural conditions.

N

National Pollutant Discharge Elimination System (NPDES) - Mandated by Congress under the Clean Water Act, a two-phased national program to address nonagricultural sources of stormwater discharge and prevent harmful pollutants from being washed into local water bodies by stormwater runoff.

Nonpoint Source Pollution - Contaminants such as sediment, nitrogen and phosphorous, hydrocarbons, heavy metals, and toxins whose sources cannot be pinpointed but rather are washed from the land surface in a diffuse manner by

stormwater runoff.

Nutrients - Chemicals that are needed by plants and animals for growth (e.g., nitrogen, phosphorus). In water resources, if other physical and chemical conditions are optimal, excessive amounts of nutrients can lead to degradation of water quality by promoting excessive growth, accumulation, and subsequent decay of plants, especially algae. Some nutrients can be toxic to animals at high concentrations.

O

Outfall – Site of discrete water and/or effluent discharge.

P

Peak Flow - Refers to a specific period of time when the discharge of a stream or river is at its highest point.

Perennial Streams - A body of water that normally flows year-round in a defined channel or bed, and is capable, in the absence of pollution or other manmade stream disturbances, of supporting bottom dwelling aquatic animals.

Physiographic Provinces - A region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Piedmont Upland - This physiographic province bordered by the Atlantic Coastal Plain to the east and the Appalachian Mountains to the west and is generally characterized by rolling terrain with streams of moderate gradient and cobble/gravel substrates.

Q

Quality Assurance/Quality Control (QA/QC) - A system of procedures, checks, audits, and corrective actions to ensure that research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

R

Rain Gardens - See Bioretention Basin.

Rapid Bioassessment Protocol (RBP) - A synthesis of techniques and methodologies for quickly assessing habitat and biological conditions in stream systems.

Rapid Stream Assessment Technique (RSAT) - A stream monitoring protocol for visually assessing instream and localized watershed conditions.

Reference Conditions - Conditions (i.e. habitat, chemical, biological) that reflect least impaired or best attainable conditions in a given area.

Reference Streams - Streams which exhibit highest quality or least impaired habitat conditions that are used as a standard to which all other streams are compared.

Resource Management Area (RMA) - That component of the Chesapeake Bay Preservation Area that is not classified as the Resource Protection Area. RMAs include land types that, if improperly used or developed, have the potential for causing significant water quality degradation or for diminishing the functional value of the Resource Protection Area.

Resource Protection Area (RPA) - That component of the Chesapeake Bay Preservation Area comprised of lands at or near the shoreline of water bodies that have an intrinsic value due to the ecological and biological processes they perform or are sensitive to impacts which may result in significant degradation to

the quality of state waters. All other land outside RPAs within Fairfax County is considered RMAs.

Restoration - Improving conditions within a natural system so that its functional characteristics are comparable to its original, unaltered state.

Retrofit - The modification of stormwater management systems through the construction and/or enhancement of wet ponds, wetland plantings, or other BMPs designed to improve water quality.

Riffle - A reach of stream that is characterized by shallow, fast moving water broken by the presence of rocks and boulders.

Riparian Buffer - A transitional area around a stream, lake, or wetland left in a natural state to protect the waterbody from runoff pollution. Development is often restricted within such zones.

S

Shannon-Wiener Index - A measure of general richness and composition of a biological community.

Shredder - Macroinvertebrate functional feeding group in which the individuals feed off of large pieces of plant material (i.e. leaves, twigs and bark) that have fallen into the stream.

Silt Fence - Temporary sediment barrier consisting of filter fabric, sometimes backed with wire mesh, attached to supporting posts and partially buried.

Stormwater Runoff - That portion of precipitation that is discharged across the land surface or through conveyances to one or more waterways.

Subwatershed - A defined land area within a watershed drained by a river, stream or drainage way, or system of connecting rivers, streams, or drainage ways such that all surface water within the area flows through a specific point.

T

Taxon (plural - Taxa) - A taxonomic category or group, such as a phylum, order, family, genus, or species.

Tolerant Species - Animals and/or plants that can withstand high levels of degradation.

Total Maximum Daily Load (TMDL) - The maximum levels of a particular pollutant water body can receive in a given day without violating pre-established water quality standards. Total Maximum Daily Loads are the sum of point and nonpoint source loads.

Triassic Basin - This physiographic province is a subprovince of the Piedmont Upland. The geology consists largely of red sedimentary (sandstone, siltstone, shale, and conglomerate) rocks characterized by wide and gently rolling hilltops, with long gently sloping sideslopes and nearly level areas.

Turbidity - A measure of the suspended solids in a liquid.

U

Urban Runoff - Stormwater from city streets and adjacent domestic or commercial properties that carries nonpoint source pollutants of various kinds into the sewer systems and receiving waters.

W

Watershed - A discrete unit of land drained by a river, stream, drainage way or system

of connecting rivers, streams or drainage ways such that all surface water within the area flows through a single outlet.

Watershed Restoration - Improving current conditions of watersheds to restore degraded fish habitat and provide long-term protection to aquatic and riparian resources.

Wetland - Land that is saturated with water and which contains plants and animals that are adapted to living on, near, or in water. Wetlands have hydric soils and are usually located between a body of water and land.