State of the Streams Loudoun County: 2005

A Water Quality Assessment

Loudoun Watershed Watch and
Loudoun Wildlife Conservancy

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Executive Summary

The State of Loudoun Streams: 2005 report provides baseline water quality data and assessments of current conditions in Loudoun County streams. These data are taken from stream monitoring reports and water quality studies prepared by government, regional, county, and citizen groups. This report provides comprehensive analyses of data from several sources that cover the major streams in Loudoun County. The 2005 report updates the State of Loudoun Streams: 2002 report prepared by Loudoun Watershed Watch.

Purpose

The purpose of the assessments are to provide a point of reference on the severity of stream degradation that can be used by county and other officials to prioritize areas with the greatest need for protection and restoration. This report contributes useful information to support comprehensive watershed planning efforts in Loudoun County, and to inform citizens and educators of water resource stewardship needs.

The assessments of Loudoun streams examine the major human impacts that upset the natural balance found in less disturbed stream ecosystems. Human impacts are complex, and many small impacts can add up to cause major degradation problems. The conditions considered to assess human impacts are: (1) the chemical and bacteriological quality of the water, (2) changes in land use and impervious surfaces, (3) riparian buffers and stream habitat, and (4) the type and quantity of organisms living in the stream. The assessments attempt to provide a balanced consideration of these conditions.

Background

All Loudoun streams are impacted to some degree by human activities. Several are degraded to the degree that they do not meet both Federal Clean Water Act and Virginia Water Quality Standards for recreational use and aquatic life. These streams have been designated as impaired by the state. They include: Catoctin Creek and its tributaries, Goose Creek and its tributaries, Little River, Limestone Branch, Piney Run, Broad Run, and Sugarland Run. The Virginia Department of Environmental Quality (DEQ) and Department of Conservation Recreation (DCR) have conducted pollution source studies and issued reports (called Total Maximum Daily Load or TMDL) for Goose Creek, Catoctin Creek, Piney Run, and Limestone Branch. They have also prepared a plan for Catoctin Creek that identifies the best management practices that needed to be applied to reduce fecal contamination to acceptable levels and to allow the safe use of streams for recreation. The plan depends upon federal cost-share funds and voluntary actions by riparian property owners who are polluting the streams.

Monitoring Organizations

- **Loudoun Watershed Watch – LWW** is a citizen group that has a goal of developing a countywide stream monitoring program and encouraging citizens to protect the water resources of Loudoun County. It works

to enhance the contributions of participating groups by promoting the synergy that results from citizen, private organizations, County personnel, and Federal and State agencies working together to accomplish common goals.

- **Loudoun Wildlife Conservancy –** LWC is a 501(3) membership organization whose mission is to preserve aquatic and upland wildlife habitat. LWC is the largest unaffiliated conservation group in Loudoun County, and the principal partner with LWW in stream monitoring and educational outreach to the citizens of Loudoun County.

  Much of the stream data used in this report are collected by citizens. **Loudoun Stream Quality Project** is a countywide, stream monitoring program sponsored by LWC and the Audubon Naturalist Society (ANS). The project supports stream monitoring at 16 sites throughout Loudoun County. Monitoring is conducted by teams of citizen volunteers who receive training from the Audubon Naturalist Society in the sampling techniques and macroinvertebrate identification. Stream monitors follow a protocol based upon EPA's Rapid Bioassessment Protocol. Monitoring includes: (1) an annual comprehensive stream habitat assessment, and (2) sampling of benthic macroinvertebrates in May and September. In June 2005 LWW and LWC began a bacteria monitoring program in the Catoctin Creek watershed using the Coliscan Easygel method.

Major Findings

Stream monitoring data collected by DEQ, LWC, North Fork Goose Creek Watershed Committee (NFGC), and Loudoun Soil and Water Conservation District (LSWCD) indicate the following about the health of Loudoun streams.

- **Sources of Pollution –** Pollution from urban storm water runoff, agricultural and grazing activities, failing septic tank systems, and wildlife are degrading all Loudoun streams. The state rates the impact as "high" for 67% of the streams. The principal causes of the degraded conditions are the failure of riparian property owners to maintain natural stream buffers and floodplains; and to provide adequate storm water, agricultural, and grazing best management practices (BMPs).

- **Impervious Surfaces –** Increases in the amount of impervious surfaces in watersheds aggravate the impact of storm water runoff on stream erosion and water quality. Assessments in 2002 showed that 22% of Loudoun streams were highly to moderately impacted. The high rate of development since that time continues to increase the severity of the problem. It is doubtful that highly impacted streams can be fully restored to healthy conditions.

- **Chemical Quality –** The chemical quality of stream water is generally good throughout Loudoun. However, large quantities of sediment, caused by land disturbances and streambank erosion, are carried

from Loudoun streams into the Potomac River, and contribute to the severe sediment problems in the Chesapeake Bay.

- **Fecal Contamination** – The bacteriological quality of Loudoun streams are generally poor due to fecal bacteria contamination. The largest contributors of fecal bacteria are livestock that are allowed access to streams. Human sources are also substantial in some watersheds. High levels of fecal bacteria contamination have existed for several years, and recent monitoring by state authorities show no improvements. The high levels of fecal bacteria are a potential health hazard to people who use the streams for recreational purposes.

- **Stream Habitats** – The health of stream habitats varies considerably between streams and stream segments. Monitoring sites on most streams show marginal habitat conditions due to poor riparian buffers in agriculture areas, unstable banks caused by high runoff flows, and sediment deposition on stream bottoms. Stream habitat conditions have not improved over the last several years.

- **Aquatic Life** – Conditions of aquatic life are poor to fair in many streams. These streams show poor diversity of aquatic insects and have a majority of pollution- tolerant species such as midge larva. Biological conditions can fluctuate considerably from year to year.

Conclusions

In 2002 LWW made several recommendations to address water quality and stream health problems in Loudoun County. Unfortunately, little has been done in Loudoun County since 2002 to protect streams, with the exception of the "Goose Creek Source Water Protection Plan" developed by Loudoun County Sanitation Authority (LCSA). Many of the same needs and conditions exist in 2005.

- **Watershed Management Planning** – Loudoun County needs watershed management plans that will enable the county to implement the Federal Clean Water Act and the Chesapeake Bay Act requirements, and the Virginia Water Quality Standards. In order to accomplish this, the following are recommended.

- **Water Management Authority** – Loudoun County should create a water management authority to develop watershed management plans an d oversee the implementation of plans to restore the quality of Loudoun streams. A system of small subwatersheds should be identified that provide homogeneous management areas. Additional information regarding impervious cover and loss of forest will aid management planning. Collaboration with Loudoun Watershed Watch and Loudoun Wildlife Conservancy would help bring citizen stakeholders together to support this process.

- **Cost Sharing Incentives** – The practice of allowing livestock access to streams is severely degrading Loudoun streams. Loudoun needs more effective cost sharing and tax-incentive programs designed to

encourage landowners to install agriculture best management practices to protect streams. This needs to be supported by a countywide educational program conducted in cooperation with local and regional citizen water quality organizations.

- **Countywide Stream Monitoring Program –** Loudoun County needs a countywide stream monitoring program to assess changes in stream health and progress being made by state authorities to restore water quality. The monitoring is needed to supplement state efforts and efforts of citizen organizations engaged in stream stewardship activities, and to support the Chesapeake Bay Agreement. A countywide program will allow the county to play a leadership role in water resource protection and restoration.
- **Collaborative Monitoring Program –** Assessments of chemical, bacteriological, habitat, and biological parameters are needed to provide an accurate evaluation of water quality and stream health conditions. The program should coordinate monitoring by county, state, and citizen groups; and utilize low cost methods to conduct the assessments.
- **Probabilistic Monitoring Program –** To be most effective, the program should include a probabilistic sampling plan based on randomly selected monitoring sites in each watershed.

Chapter One

Introduction

Purpose

The Virginia Department of Environmental Quality (DEQ) (1999) explains that the purpose of a watershed assessment is to provide the best possible answer to specific questions about water quality and stream health. Data collected at a particular time from a variety of stations spread across the county can answer questions such as "How healthy are Loudoun streams?" or "How many steams are severely impacted by human activities?" Data collected at the same station over a number of years can reveal how conditions change and answers questions such as: "Has development activity and changing land use degraded our streams?"

The **State of Loudoun Streams: 2005** report provides stream assessments that answer these questions about Loudoun County, Virginia. The assessments are based on analyses of physical, chemical, bacterial, stream habitat, and aquatic insect data and water quality studies provided by government, regional, county, and citizen groups. The 2005 report updates the **State of Loudoun Streams: 2002** report prepared by Loudoun Watershed Watch.

The stream assessments in the **State of Loudoun Streams: 2005** report can be used by county and state officials and citizen groups. The report documents the need for comprehensive watershed planning in Loudoun County, and county officials can use the assessments to help prioritize streams with the greatest need for protection and restoration. County planners can use the report to help guide decisions on where and how to apply Loudoun's policies that protect stream corridors. Citizen groups can use information provided in the report to expand citizen stream monitoring, develop educational materials, and organize stream stewardship projects.

Erosion at storm drain outfall in Sugarland Run Watershed

Background

Loudoun County is rich in natural resources including a large network of streams forming three major watersheds and several smaller watersheds. A watershed is the area from which the surface and subsurface water drains into a particular stream. The watersheds in Loudoun are part of the Potomac River and Chesapeake Bay watersheds.

In the past ten years, Loudoun County has experienced tremendous residential and commercial growth, and a population that has almost tripled. Forest and farmlands have been converted to residential communities and industrial parks throughout the county, especially in eastern and central sections. Loudon has shifted away

from forested lands that allow rainwater to infiltrate into the ground to extensive developments with impervious surfaces that prevent infiltration and greatly increase rainfall runoff and peak stream flow volumes. Rainwater collects and flushes rapidly from rooftops, parking lots, and roadways; and is channeled via parking lot gutters, roadside ditches, and storm drains at high velocity into streams. The high runoff flows erode stream banks and cause downstream flooding. In addition, rainwater runoff from urban/suburban developments, industrial parks, and roadways picks up oil, grease, heavy metals, trash, sediment, pesticides, fertilizers, and fecal contamination. These pollutants enter our waterways and impact the aquatic life in streams and the environment as a whole.

Healthy Streams

The Federal Clean Water Act of 1972 guarantees citizens the right to be informed about the quality of their drinking and recreational waters, and to help keep these waters healthy. Water quality standards establish numerical criteria for the safe use of waters for aquatic life, drinking, swimming, fishing, and boating. The purpose is to establish pollutant limits that prevent degradation.

Headwater stream in Countryside that has been buffered from surrounding development.

A healthy stream has stream banks that are covered with plants that keep soils from eroding. There is a balanced supply of organic materials, or detritus, and other nutrients that fall into the stream from the stream banks. There are a variety of habitats, including waters in fast-moving riffles, slow-moving pools, and fallen trees and root masses along stream banks for aquatic organisms living in the stream. There is sufficient dissolved oxygen for organisms to breathe, shade to keep water temperatures low, and no toxic chemicals.

A healthy stream does not exist in isolation. Rather, it is the lowest point in an interconnected complex of upstream drainages, and is influenced by land uses around it. Keeping excessive sediments, nutrients, organic materials, harmful chemicals, and disease-causing bacteria out of streams requires the application of best management practices (BMPs). These BMPs need to be applied to the riparian zone along stream banks as well as throughout the upstream drainage area. Environmental stewardship includes encouraging the use of BMPs and educating the public about wise watershed management.

Water Quality Monitoring

Government – There are several state, county, and regional authorities that monitor water quality in Loudoun streams. Monitoring includes assessing physical, chemical, and bacteriological water quality parameters; and

collecting biosurvey information. The following authorities collect stream monitoring data in Loudoun County:

- **Virginia Department of Environmental Quality (DEQ) –** collects stream quality data at several stations in Loudoun as part of Virginia's ambient water quality monitoring network. The data consist primarily of physical, chemical, and bacteriological measurements. DEQ also collects stream habitat and macroinvertebrate data at 3 stations. The number of sampling stations and sampling frequency was reduced in 2001.

- **US Geological Survey (USGS) –** collects chemical, sediment, and stream flow data at stations in Goose and Catoctin Creeks. Seven stations were added in 2002 in other streams.

- **Loudoun County Sanitation Authority (LCSA) –** monitors wastewater and drinking water treatment discharges throughout the county. It does not routinely monitor stream waters, but has conducted a special study on Broad Run in planning for a new wastewater treatment facility. LCSA also conducted a special Source Water Protection Program study of the Goose Creek and Beaverdam Reservoir.

- **Loudoun County Building and Development (LCBD) –** oversees a water resources monitoring program in cooperation with the U.S. Geological Survey. The program provides rainfall, stream flow, and ground water monitoring data at a variety of sites throughout the county.

- **Loudoun Soil and Water Conservation District (LSWCD) –** is a state agency that works with landowners to install agricultural best management practices (BMP). They monitor streams at a variety of sites throughout Loudoun County for physical and nutrient parameters, fecal bacteria, and aquatic insects. LSWCD uses the Save Our Streams (SOS) protocol for their aquatic insect monitoring. The data are posted on their website.

- **Metropolitan Washington Council of Governments (COG) –** is a regional organization that conducts baseline studies of stream quality conditions at the invitation of local officials. In the past 10 years, COG has conducted studies of Sugarland Run, Broad Run, Goose Creek, Limestone Branch, Piney Run, and Dutchman's Creek.

- **Citizens –** The decline in healthy streams throughout Loudoun County can readily be seen, and many citizens have volunteered to support water monitoring activities that document problems and educate citizens. The following are the most active groups that have participated in stream monitoring and stream stewardship programs:

- **Audubon Naturalist Society (ANS) –** a regional environmental education and stewardship organization that operates the Rust Sanctuary in Leesburg. It has an active stream monitoring program in Maryland and

Fairfax County, Virginia using a modified EPA Rapid Bioassessment II methodology. ANS provides training, environmental stewardship education, and program support for the stream monitoring activities of the Loudoun Wildlife Conservancy in Loudoun County.

- **Loudoun Wildlife Conservancy (LWC)** – a 501(3)(3) membership organization whose mission is to preserve wildlife habitat. LWC is the largest unaffiliated conservation group in Loudoun County. LWC members and volunteers supply most of the manpower to the organization's citizen stream monitoring program, the Loudoun Stream Quality Project. In 2004 there were 49 LWC volunteers who monitored 26 different sites on 42 occasions. LWC monitors bottom-dwelling aquatic insects (benthic macroinvertebrates) and stream habitat using the EPA Rapid Bioassessment II methodology.

- **Loudoun Watershed Watch (LWW)** – LWW was formed in 2000 by citizen and county authorities concerned about protecting the water resources of Loudoun County. LWW seeks to address water quality problems on a countywide basis and educate citizens and county decision makers. LWW has been successful in providing comprehensive stream monitoring guidelines, organizing watershed stewardship activities, and developing citizen educational materials. LWW has also compiled baseline water quality data collected by state, regional, local, and citizen groups for streams throughout Loudoun County. LWW use these data to assess current stream quality conditions as well as long-term trends. In 2002 LWW published its first report titled, State of Loudoun Streams: 2002, to help inform the public about the status of the County's stream water resources.

- **Catoctin Watershed Project (CWP)** – In 2004 LWW collaborated with LWC and ANS to obtain grant funds to initiate several stream stewardship activities in the Catoctin Watershed. The purpose of the project is to support the Virginia Department of Conservation and Recreation (DCR) plan to reduce fecal pollution in the watershed so water quality can meet state standards for recreational use. It is CWP's goal to organize a local Friends of Catoctin Watershed group, provide a number of stream stewardship events, and work with LWC to collect and analyze bacteriological samples to help assess progress in reducing fecal pollution levels in the Catoctin Creek watershed.

Use of Stream Monitoring Data

DEQ uses local authority and citizen group stream monitoring data to help identify watersheds that are threatened by water pollution and by water quality problems that degrade aquatic life. DEQ uses these data along with their own monitoring data to prepare their biennial 305(b)/3-3(d) Integrated Report to the public, the U.S. Environmental Protection Agency (EPA), and the Congress on the status of water quality in Virginia. This integrated report provides a list of "impaired" streams; that is, streams that do not meet state water quality standards and the Federal Clean Water Act. The Loudoun streams that were listed by DEQ in their 2004 report as threatened based on citizen stream monitoring data is provided in **Table 1** on the next page.

Table 1. Loudoun County Streams That are Listed by DEQ as Being Threatened by Pollution in the 2004 Integrated Assessment Report.

Stream	Monitoring Station	Station Location	Citizen Group	Length (miles)
Piney Run	1ASDH-15-LWC	Blue Ridge Environmental Center	LWC	3.56
Catoctin Creek	1ACAX-3-LWC	Downstream of Taylorstown	LWC	Miles?[1]
North Fork Catoctin Creek	1ANOC-1-LWC	Near mouth	LWC	Miles?
South Fork Catoctin Creek	1ACSOC-4-LWC	Purcellville Nature Park	LWC	Miles?
Milltown Creek	1AMIH-11-LWC	Milltown Rd	LWC	2
Limestone Branch	1AXAQ-5-LWC	Temple Hall Regional Park	LWC	1.9
Limestone Branch	1AXGJ-16-LWC	Tutt Lane	LWC	4.97
Middle Goose Creek/Panther Skin	1APAE-12-LWC	Willisville Rd	LWC	3.71
North Fork Goose Creek/Crooked Run	1ACRF-6-LWC	Forest Mill Rd.	LWC	2.08
North Fork Goose Creek	1ANOG-7-LWC	Tranquility Rd.	LWC	2.56
North Fork Goose Creek	1ANOG-4-NFGC	Lincoln Rd	NFGC	2.47
North Fork Goose Creek	1ANOG-5-NFGC	Shelburne-Glebe Rd	NFGC	
North Fork Beaverdam Creek/Butchers Br.	1ABUS-10-LWC	Ebenezer Church Rd.	LWC	1.11
North Fork Beaverdam Creek	1ANOB-9-LWC	Jeb Stewart Rd.	LWC	2.89
Tuscarora Creek	1ATUS-2-LWC	Lawson Rd.	LWC	Miles?
Broad Run/Beaverdam Run	1ABEM-13-LWC	Old Ashburn Rd	LWC	0.45
Sugarland Run	1ASUG-14-LWC	Downstream of Heritage HS	LWC	3.5

[1] *Miles? – No distance is provided in DEQ report.*

Chapter Two

ASSESSING STREAM HEALTH

There are a number of Federal and State laws and programs designed to keep streams safe for use for drinking water, recreation, and aquatic life. Are these laws and programs being effectively applied to keep our streams healthy? Citizens want to know.

Assessing the health of streams involves measuring the cumulative changes caused by human activities that disturb the stream ecosystem. Human impacts on a watershed are complex, and small individual and cumulative impacts can add up to major degradation problems. Four principal factors are normally assessed to measure human impact on a stream - land use and impervious surfaces, chemical and bacteriological quality of the water, in-stream habitat conditions, and the health of aquatic organism populations in the stream.

Legal Base for Stream Assessment

Federal Clean Water Act – Virginia's DEQ has authority to enforce the Federal Clean Water Act, and U.S. EPA has responsibility to oversee the state's implementation. The State Water Control Law protects high-quality waters and provides for the restoration of other waters so they support reasonable public uses and aquatic life. Virginia has adopted water quality standards under Section 62.1-44.15(3a) to accomplish the law's purposes.

- **Water Quality Standards** – Water quality standards consist of narrative and numeric criteria. These statements and numbers describe the water quality necessary for designated uses such as swimming and other water-based recreation, public water supply, and the support of aquatic life. DEQ and EPA use these standards to regulate the amount of pollutants that can be safely discharged into surface waters.
- **Anti-Degradation Policy** – Virginia's water quality standards include an anti-degradation policy that provides additional protections. All existing in-stream water uses and the level of water quality to protect the existing uses must be maintained and protected. This means that, at a minimum, all waters in Loudoun County streams should meet adopted water quality standards.

Virginia's Tributary Strategy Program – Virginia's Tributary Strategy Program aims to reduce nutrient and sediment loads from tributaries that flow in the Potomac River and Chesapeake Bay. Current levels of erosion, sediments, and nutrients in the smaller creeks throughout the Bay watershed have led to water quality problems that affect the major rivers and the Bay. Such problems include low levels of dissolved oxygen, high sediment loads, declining numbers of pollution intolerant aquatic insects, and reduced size bed of submerged aquatic vegetation. The program is based on scientific data and is voluntary. It includes establishing goals for nutrient and sediment reductions, identifying cost-effective practices for achieving these reductions, and implementing these practices. Each watershed has distinct characteristics, and each requires an individualized approach with specific reduction targets.

Designated Use Standards - All streams in Loudoun County are designated for recreational uses including swimming and boating, and for the support of aquatic life and fishing. These designated uses determine the water quality criteria applicable to Loudoun streams. There are chemical and bacteriological criteria for temperature, pH, dissolved oxygen, ammonia, chloride, and fecal coliform bacteria. These standards are listed in **Table 2.1.** There are no standards for other parameters such as nitrogen, phosphorous, turbidity, suspended solids, or biological oxygen demand (BOD).

Table 2.1. DEQ's Water Quality Standards for Recreational Use in Piedmont Zones. (Source: 9 VAC 25-260-5 et seq. Water Quality Standards, 1/10/97)

Parameter	State Standard (Acute/Chronic)	Significance
Temperature	Maximum = 32^0C	Affects rates of chemical prosesses in cells and the water's dissolved oxygen content
pH	6.0 – 9.0	Level of acidity -- affects cell membrane functions
Dissolved Oxygen (DO)	Minimum = 4 mg/l	Affects biological metabolism
Ammonia	0.86 – 32 mg/l as N acute/ 0.19 – 3.02 chronic[1]	Form of nitrogen that in excess causes eutrophication and loss of dissolved oxygen; a toxin
Chloride	860/ 230 mg/l	Indication of salt content
Fecal Coliform Bacteria[2]	400 colonies/100ml	Common bacteria in animals' digestive tracts. Indicator of human sewage or animal droppings.

[1] *Standard varies with temperature and pH.*

[2] *In 2003 DEQ switched to an E. coli standard of 235 colonies/100 ml per single sample to assess fecal pollution. However, the previous 10 years of monitoring data used for this report are fecal coliform bacteria so this standard continues to be listed.*

Assessment Factors

Parameters used to measure human impacts that upset the balanced conditions found in a natural stream ecosystem and cause major degradation problems are: (1) physical and chemical quality of the stream water, (2) bacteriological quality of the stream water, (3) stream habitat, and (4) type of aquatic organisms in the stream.

Physical and Chemical Indicators – Stream monitoring programs have traditionally relied on physical, chemical, and bacterial indicators to assess water quality. This is because government programs have historically focused on controlling point discharges of pollutants such as the effluent from sewage treatment plants. Most data collected by DEQ in Loudoun Country are physical, chemical, and bacteriological data. Evaluating water quality by using key physical and chemical indicators can reveal degradation from nonpoint

pollution sources as well. The key physical and chemical indicators used in this assessment report are summarized in **Table 2.2**.

Table 2.2. Key Chemical Indicators of Water Quality.

Parameter	Description
Sediment	Sediments are materials that are dissolved, suspended or settled in stream water. They are measured as total suspended solids (TSS) (solids that can be filtered), total dissolved solids (TDS) (ions that are not filtered), and turbidity (suspended materials that affect water clarity by scattering light). There are no water quality standards in Virginia for total suspended and dissolved solids, and for turbidity, but sediments are a major factor that stress aquatic life in streams.
pH	pH identifies the acid/base balance of water. pH affects many chemical and biological processes in water. Most aquatic organisms prefer a range of 6.5 to 8.0. pH values outside this range cause stress to most organisms and reduce reproduction. Low pH values can indicate acid rain. The Virginia water quality standard for pH is 6.0 – 9.0.
Dissolved Oxygen (DO)	A small amount of oxygen, up to about ten molecules of oxygen per million of water, is dissolved in water and breathed by fish and zooplankton. Swiftly moving waters contains more dissolved oxygen than stagnant water, and cold water holds more oxygen than warm water. Bacteria also consume dissolved oxygen when digesting organic matter, such as septic system wastes and cow manure. Too much organic material in streams can cause oxygen-deficiency. The Virginia standard for dissolved oxygen is a minimum of 4 mg/l.
Phosphorus	Phosphorus is a plant nutrient in short supply in most fresh waters. It usually limits the growth of plants. Even modest increases can accelerate plant growth, cause lower dissolved oxygen, and lead to the death of fish and macroinvertebrates. There is no Virginia standard, but there is a screening value of 0.2 mg/l. The maximum level set by EPA is 1.0 mg/l. Sources include sewage discharges; runoff from lawns, golf courses, and croplands; manure; failing septic systems; and drained wetlands.
Nitrogen	Nitrogen is also an essential plant nutrient. Like phosphorus, excessive levels of nitrogen encourage the growth of plants. If phosphorus rises to high levels, then nitrogen becomes the limiting factor. There is no Virginia standard, and EPA has not set a maximum level. Sources include runoff and non-point pollution.

Bacteriological Indicators – Wastes from warm-blooded animals that include humans, livestock, and wildlife introduce disease-causing micro-organisms into streams. Fecal coliform bacteria are used to indicate the potential presence of human pathogens and the likelihood of a public health threat. Higher concentrations cause greater public health concerns. DEQ considers recreational waters to be impaired or unsuitable for use when more then 10% of the water samples collected over a 2-5 year period are greater than 400 fecal coliform colonies per 100 ml of sample (FC MFN/100ml). This level decreased from 1000 fecal coliform colonies in 2003 when DEQ changed their standard to 235 E. coli colonies/100 ml water for a single sample.

Habitat Indicators – Habitat conditions are an important indicator of stream health because aquatic insects and fish have specific habitat requirements. Stream habitats with balanced conditions are needed to preserve diverse and healthy biological communities. The habitat assessments used by DEQ and citizen groups are based upon EPA's Rapid Habitat Assessment Form (1997). This assessment measures the following in-stream characteristics:

- Pools, riffles, and runs including availability of attachment sites for macroinvertebrates;
- Channel alteration and changes in water flow that upset a stream's energy equilibrium and cause bank erosion;
- Composition of the stream bottom substrate including the amount of embeddedness and sediment deposition; and
- Condition of stream banks including the amount of bank vegetation and riparian vegetative zone protection.

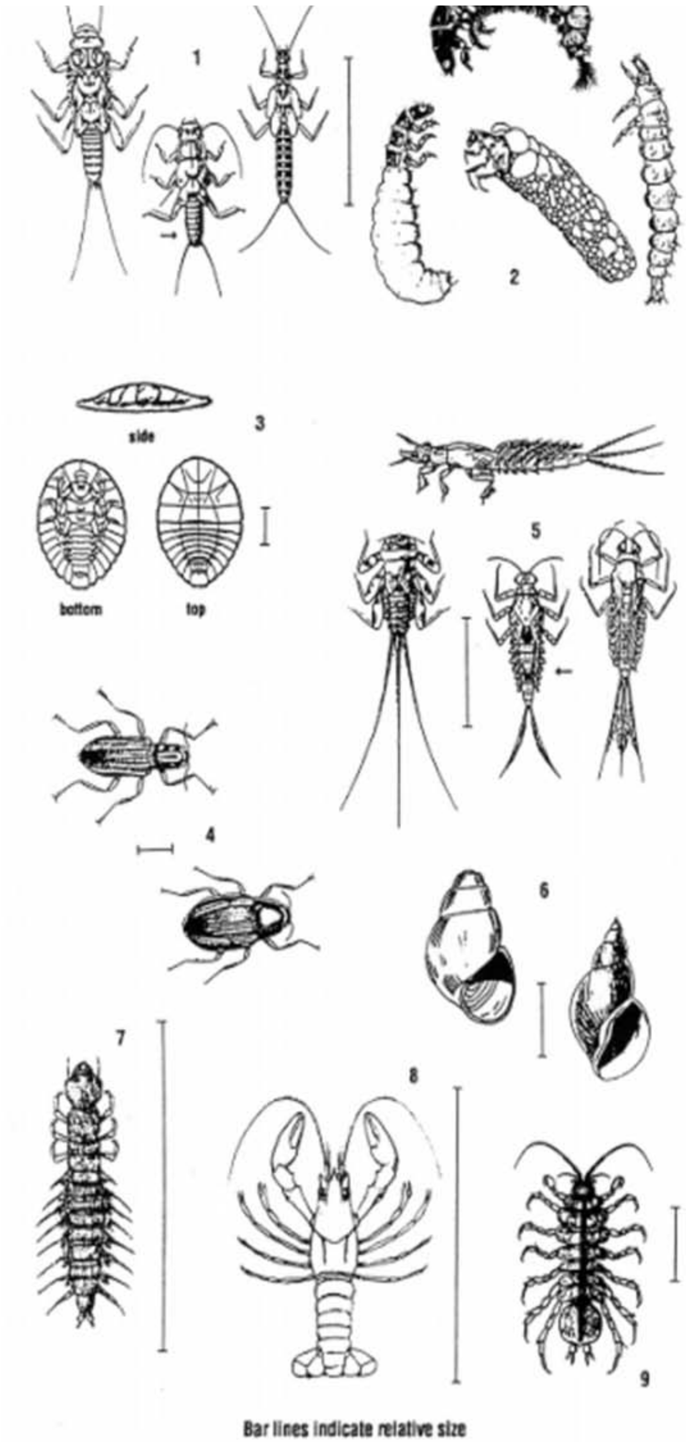
There are ten rating characteristics used in the assessment; each with a score ranging from 0 to 20. The scores are summed, and the sum is converted to a percent for the final habitat condition score. High score/percentages indicate healthy stream habitat conditions.

Biological Indicators – Biosurvey techniques are used to monitor pollutants that affect aquatic organisms, and to evaluate the relative seriousness of the impacts. Aquatic organisms (also called benthic macroinvertebrates) include the aquatic insects, crayfish and other crustaceans, clams and mussels, snails, aquatic worms, and other similar organisms. Insects comprise the largest diversity of these animals and include mayflies, stoneflies, caddisflies, and midges. They cycle nutrients, and are major food sources for fish and other aquatic animals. **Figures 2.1 and 2.2** illustrates the benthic macroinvertebrates commonly found in streams.

These organisms are excellent indicators for assessing streams because they cannot escape changes in water quality. Each insect has requirements the stream must provide for the insect to flourish. By determining the number and type of insects that live in a stream, the quality of the water and the health of the stream environment can be assessed. The number and type of macroinvertebrates will change depending on water quality and stream habitat conditions. For example, stonefly nymphs are sensitive to most pollutants and degraded habitat conditions. If chemical and habitat parameters, such as dissolved oxygen and sedimentation levels are good, a stream will support this type of insect and can be considered healthy. Conversely, if a stream has many pollution tolerant insects, such as midge and black fly larva, or few insects, then the biological assessment indicates that the habitat conditions are poor or "unhealthy."

Figure 2.1

Crustaceans



GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

1 ***Stonefly: Order Plecoptera.*** 1/2" - 1 1/2". 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)

2 ***Caddisfly: Order Trichoptera.*** Up to 1". 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on underside.

3 ***Water Penny: Order Coleoptera.*** 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs and fluffy gills on the other side. Immature beetle.

4 ***Riffle Beetle: Order Coleoptera.*** 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.

5 ***Mayfly: Order Ephemeroptera.*** 1/4" - 1", brown, moving, plate-like or feathery gills on sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.

6 ***Gilled Snail: Class Gastropoda.*** Shell opening covered by thin plate called operculum. When opening is facing you, shell usually opens on right.

7 ***Dobsonfly (Hellgrammite): Family Corydalidae.*** 3/4" - 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

GROUP TWO TAXA

Somewhat pollution tolerant organisms can be in good or fair quality water.

8 ***Crayfish: Order Decapoda.*** Up to 6", 2 large claws, 8 legs, resembles small lobster.

9 ***Sowbug: Order Isopoda.*** 1/4" - 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

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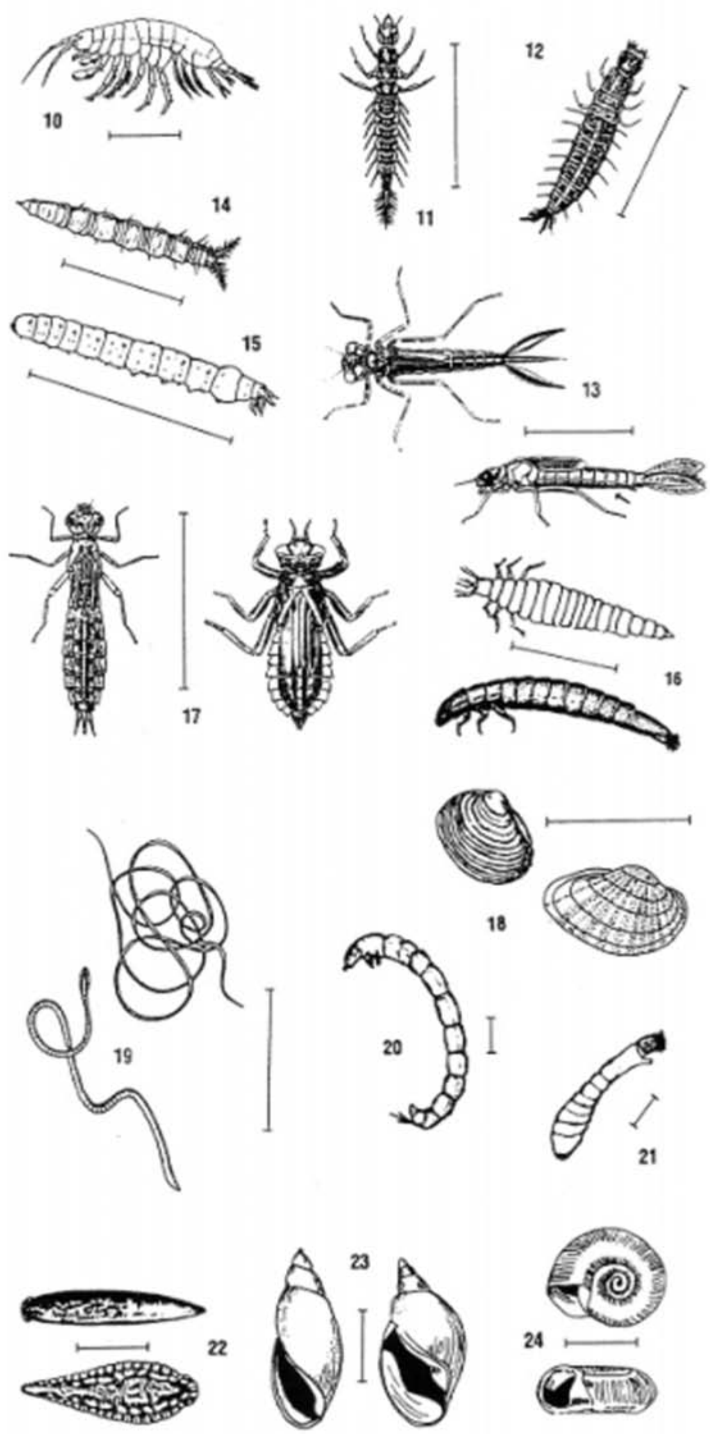
Figure 2.2 Stream Insects and Crustaceans



Bar lines indicate relative size

GROUP TWO TAXA CONTINUED

10 ***Scud: Order Amphipoda.*** 1/4", white to grey, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 ***Alderfly Larva: Family Sialidae.*** 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 ***Fishfly Larva: Family Corydalidae.*** Up to 1 1/2" long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

13 ***Damselfly: Suborder Zygoptera.*** 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 ***Watersnipe Fly Larva: Family Athericidae (Atherix).*** 1/4" - 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.

15 ***Crane Fly: Suborder Nematocera.*** 1/3" - 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 ***Beetle Larva: Order Coleoptera.*** 1/4" - 1", light-colored, 6 legs on upper half of body, feelers, antennae.

17 ***Dragon Fly: Suborder Anisoptera.*** 1/2" - 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 ***Clam: Class Bivalvia.***

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

19 ***Aquatic Worm: Class Oligochaeta.*** 1/4" - 2", can be very tiny; thin worm-like body.

20 ***Midge Fly Larva: Suborder Nematocera.*** Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.

21 ***Blackfly Larva: Family Simulidae.*** Up 1/4", one end of body wider. Black head, suction pad on other end.

22 ***Leech: Order Hirudinea.*** 1/4" - 2", brown, slimy body, ends with suction pads.

23 ***Pouch Snail and Pond Snails: Class Gastropoda.*** No operculum. Breathe air. When opening is facing you, shell usually opens on left.

24 ***Other Snails: Class Gastropoda.*** No operculum. Breathe air. Snail shell coils in one plane.

Biological Condition Metrics - Aquatic insect are collected to measure the "biological condition" of the stream being monitored. Four measurements or metrics described by EPA (1997) as "primary" are used in this report. The higher the score, the better the biological conditions. These metrics are listed in **Table 2.3**.

Table 2.3. EPA's Primary Biological Condition Metrics.

EPA Metric	Scope of Metric
Number of taxa	Number of families of organisms (taxa) present. A high number of taxa indicates a high diversity in the aquatic insect community and good stream health.
EPT Index	Number of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) compared to the total number of individuals in the sample. These three families of insects indicate good water quality because they are most susceptible to pollution.
Percent Dominant Taxon (PDT)	Proportion of individuals in the most dominant family (taxon) compared to the total number of organisms in the sample. The PDT should be less than 20% in headwater streams to indicate good conditions.
Modified Hilsenhoff Biotic Index (MHBI)	Each taxon is assigned a pollution sensitivity or tolerance value. The MHBI is calculated by multiplying the number of individuals in each taxon with the sensitive value for the taxon. The MHBI should be less than 2 in headwater streams to indicate good conditions.

Reference Stream – Virginia's water quality standards include a general requirement that all state waters are free of pollutants harmful to animal, plant, or aquatic life. This standard allows the state to consider stream habitat and aquatic insect populations as indicators of stream quality. To apply the standard, DEQ compares measurements from the stream of unknown quality with measurements from another stream of known good quality called a "reference stream." The reference stream represents the "natural," unimpaired conditions found in a stream of similar size and in the same geographic "ecoregion."

Two reference streams are used by DEQ to evaluate Loudoun County streams; the lower Rapidan River for muddy bottom streams and Catoctin Creek at Taylorstown for rocky bottom streams. Most streams in Loudoun County are rocky bottom streams. DEQ calculates the percent similarity between the stream being monitored and the reference stream for both habitat and biological conditions.

LWW used the DEQ reference streams to assess stream conditions in the 2002 report. However, LWW decided not to use this approach for the 2005 assessments because Catoctin Creek at Taylorstown Bridge (the DEQ monitoring site) is a larger, higher order stream with hydrologic and habitat characteristics dissimilar to the lower and middle order streams in Loudoun that are most often sampled by citizen groups. Instead, criteria to interpret stream habitat and biomonitoring results are taken from EPA's "Volunteer Stream Monitoring: A Methods Manual."

Loudoun Watershed Profiles

The assessments of individual streams are provided in a series of profiles in the following chapters. These profiles address specific questions concerning water quality and management of aquatic resources. These questions include:

- Does the watershed support aquatic life and meet designated standards for recreational uses?
- Has water quality changed significantly since previous assessments?
- What are the source, extent, and magnitude of the pollutants impacting water quality?
- What can be done to restore waters that are degraded and unhealthy?

The profile assessments also report on the level of monitoring in each watershed, the chemical and bacteriological quality of the water, and the stream habitat and biological conditions of the streams. A final, overall summary of stream health is provided.

IMPAIRED STREAM WATERS

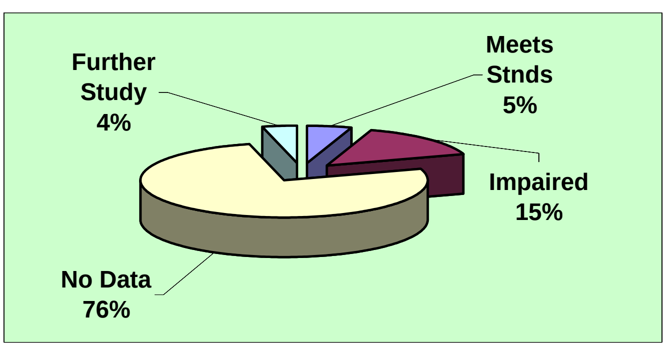
Impaired Waterways in Virginia

Section 305(b) of the Federal Clean Water Act and the Virginia Water Quality Monitoring, Information and Restoration Act require the state to report the water quality conditions in the state. Section 303(d) of the Federal Clean Water Act requires Virginia to submit a list of streams that are impaired (do not meet water quality standards) and need a pollution source and load study (Total Maximum Daily Load or TMDL study) in even years. In 2004 the 305(b) and 303(d) reports were to be submitted together in an Integrated Report. The Integrated Report also lists waters that have "observed effects" (formally called "threatened waters") and require further study.

2004 Statewide Findings — Virginia has approximately 50,300 miles of streams and rivers that are divided into nine major watershed basins. In 2004 DEQ reported that nearly 7,000 miles or about 14% of Virginia's rivers and streams are impaired. Only 2,200 miles or 4% have good water quality that supports all six categories of use: aquatic life, fishing, shellfishing, swimming, wildlife, and public water supplies. The rest of the waterways, which comprises 37,300 miles or 74%, either haven't been tested or the results of tests are inconclusive.

DEQ has not tested the vast majority of state waterways because it lacks the staff and funding for a more comprehensive monitoring program. In 2002, a study by the General Assembly's Joint Legislative Audit and Review Commission found that Virginia is last in the nation in spending for parks and protecting natural resources. DEQ advises that there is a lot of work to be done, but also believes that not every stream has to be monitored every year. The percentage distribution of unsampled, impaired, threatened, and waters that meet standards in Loudoun County is shown in **Chart 3.**

Chart 3. Summary of DEQ's 2004 Water Quality Assessments for Loudoun County Streams.



In 2002 DEQ added 235 rivers and streams to the impaired list. In 2004 358 more waterways were added to the impaired list. The total number of waterways on Virginia's impaired list is 1,257. Pollution responsible for the impairments is largely from non-industrial sources, such as farms and septic tanks. Finding polluted streams isn't the difficult part. Cleaning the waterways up will take many years and a significant amount of money.

Impaired Stream Waters in Loudoun County

A summary list of the impaired streams in Loudoun County is provided on **Table 3.1.** A more comprehensive list of the DEQ water quality assessment findings for each monitoring station in Loudoun County are provided in **ATTACHMENT B**.

Table 3.1. Impaired Waters in Loudoun County.

Stream Name	Cause	Data Source	First Listing
Beaverdam Creek	FC	DEQ	1998
Broad Run	FC	DEQ	2004
Catoctin Creek	FC	DEQ	1994
Cromwell's Run	FC	DEQ	1998
Goose Creek	FC, Benthic	DEQ	1998
Limestone Branch	FC	DEQ	2002
Little River	FC, Benthic	DEQ	1998
NF Catoctin Creek	FC	DEQ	1994
NF Goose Creek	FC	DEQ	1998
Piney Run	FC	DEQ	1998
SF Catoctin	FC, Benthic	DEQ, Citizen	1994
SF Sycolin Creek	FC	DEQ	2002
Sugarland Run	FC, Benthic	DEQ, Citizen	2002
Sycolin Creek	FC	DEQ	1996
Tuscarora Creek	FC	DEQ	2004

Benthic Impairments in Loudoun County Watersheds – A benthic impairment applies to streams that are degraded and do not support a healthy benthic macroinvertebrate community. Benthic impairments were first designated in the Goose Creek and Little River watersheds in 1998. In 2002 a benthic impairment was designated in Sugarland Run. In 2004 DEQ designated a new benthic impairment in a segment of the South Fork Catoctin Creek that include waters in Purcellville. In addition, DEQ designated waters in the mainstem of Catoctin Creek, the North Fork Catoctin Creek, and in Milltown Branch as having observed effects (threatened). These waters require further study by DEQ to determine if an actual impairment exists.

Total Maximum Daily Load Studies

In July 1992 EPA promulgated regulations requiring the states to develop a Total Maximum Daily Load (TMDL) for waterways not meeting water quality standards under the 1972 Federal Clean Water Act. In 1997 Virginia enacted regulations directing DEQ to develop a TMDL for all waters on Virginia's 303(d) list.

In 1998 the American Canoe Association and the American Littoral Society filed a complaint against EPA for failure to enforce the nonpoint pollution requirements of the Clean Water Act and require states to develop TMDL. EPA signed a Consent Degree, and worked with Virginia to develop a schedule for the development of 665 TMDL in Virginia by 2010. These TMDL are for impaired waters that were on Virginia's 1998 list. TMDL for state waters that have been listed since 1998 will be developed after 2010. The schedule for TMDL development for Loudoun streams is provided in **Table 3.2.**

Table 3.2. DEQ's TMDL Development Schedule and Accomplishments.

Stream	Type of TMDL	Date of TMDL	Status
Goose Creek	**Fecal & Benthic**	**2002/2003**	**Approved**
• **North Fork Goose Creek**	**Fecal**	**2002**	**Approved**
• **Beaverdam Creek**	**Fecal**	**2002**	**Approved**
• **Sycolin Creek**	**Fecal**	**2002**	**Approved**
• **Little River**	**Fecal & Benthic**	**2002/2003**	**Approved**
Catoctin Creek	**Fecal**	**2003**	**Approved**
Limestone Creek	**Fecal**	**2004**	**Approved**
Piney Run	**Fecal**	**2004**	**Approved**
Tuscarora Creek	**Fecal**	**Unscheduled**	
Broad Run	**Fecal**	**Unscheduled**	
Sugarland Creek	**Fecal & Benthic**	**Unscheduled**	

TMDL are developed to determine the pollution loads that a stream can assimilate and still provide reasonable assurance that water quality standards for the stream's designated uses will be met. The TMDL are based on a model that predicts the response of the stream to different pollution loads. These predictions are used to establish pollution load allocations between different sources of pollution impacting the stream.

Public Health Risks

There are public health risks associated with fecal contamination in stream water. The Center for Disease Control estimates at least 73,000 cases of illnesses and 61 deaths per year in the U.S. are caused by a fecal coliform pathogen identified as *E. coli* 0157:H7 bacteria. It is reported that cattle are an important reservoir for this type of *E. coli,* and 5-40% of cattle shed the bacteria at any time. The threat of these pathogens appears

more prevalent as human and cattle populations increase. EPA has assessed the risks the public is willing to accept, and established the water quality standards based on these acceptable risks. DCR has identified the control measures or "best management practices (BMPs)" needed to safeguard the public from these risks. Information provided by the State concerning public health risks is provided in **ATTACHMENT C.**

Public Benefits

The streams of Loudoun County are valuable public resources, and clean water in our streams benefits the entire community. These benefits include:

- Improved public health;
- Greater conservation of natural resources (e.g., soil and soil nutrients);
- Healthy aquatic communities;
- Improved riparian buffers and habitat;
- Reductions in flood damage;
- Increased recreational opportunities;
- Greater economic opportunities (e.g., agriculture production); and
- Enhanced real estate values for farms, homes and businesses near streams with good water quality.

The most important of these benefits are the following:

- Public Health Benefits–The incidence of infection from contact with contaminated surface waters should be reduced considerably.
- Agricultural Benefits–Exclusion of cattle from streams leads to the development of alternative water sources, and an opportunity for intensive pasture management and improved nutrient management.
- Habitat Benefits–Natural forested buffers along streams reduce sediment and nutrient transport to the stream, support healthy aquatic communities, and provide wildlife corridors.

Further information about public benefits of clean water is provided in **ATTACHMENT D.**

TMDL Implementation Plans

DCR is required under state law to develop plans that implement pollution reduction goals identified in approved TMDL studies. The implementation plans rely on voluntary action by riparian property owners, and are administered by state officials. DEQ provides stream monitoring data to track the effectiveness of pollution controls and implementation.

Catoctin Creek TMDL Implementation Plan (IP) – The approach adopted by DCR to control nonpoint pollution and clean up Virginia waters is exemplified in the Catoctin TMDL Implementation Plan (IP) that was approved in 2004. This is the first IP, and as of 2005, the only IP developed for an impaired stream in Loudoun County.

- **Stakeholder Input**–DCR has developed a guidance manual and adopted a standard format for the hundreds of TMDL IP's required under court order and state law. The specific number and type of control measures, and the estimated costs of controls are developed with extensive local input. Public participation takes place at three levels:
  - Public meetings are held to inform the public of the TMDL findings, the need for developing the IP, and the need for public input.
  - Working groups are formed to address the agriculture, residential, environmental, and government components of the IP. These working groups meet periodically during the IP development process and provide technical input to the IP.
  - A Steering Committee is formed with representatives of the working groups and other state and local stakeholders.
- **Nonpoint Pollution Load Reduction** – The TMDL study for the Catoctin Creek watershed recommended that substantial reductions are needed in nonpoint pollution if streams are to meet water quality standards for recreational use. Recommendations made in the TMDL included:
  - All livestock must be excluded from streams within all impaired segments;
  - All straight pipes must be identified and corrected within all impaired segments; and
  - All functional septic systems need to be maintained.
- **Estimated Costs** – Virginia's approach relies on encouraging voluntary participation through education and financial incentives. The primary responsibilities for implementation fall on riparian property owners who need to apply good agricultural and residential best management practices. The major costs associated with the plan are for excluding livestock from streams and replacing straight pipes with new septic systems. Costs are estimated based on the number of farms needing exclusion systems and homes without adequate septic systems. Technicians are hired to work with property owners to design and install these control practices. The estimated costs for the Catoctin Creek TMDL IP for a five-year period are shown in **Table 3.3.** Funding sources include: (1) Federal Clean Water Act Section 319 Increment Funds; (2) USDA Environmental Quality Incentives Program (EQIP); and (3) USDA Wildlife Habitat Incentive Fund (WHIP).

Table 3.3. Estimated Cost for Agricultural BMPs, Residential BMPs, and Technical Assistance for Catoctin Watershed TMDL IP.

Implementation Needs	Average Total Costs ($)
Livestock Exclusion BMPs	**913,000**
Residential BMPs	**430,000**
Technicians:	
• **Agricultural Programs**	**250,000**
• **Residential Programs**	**125,000**
Total	**$1,718,000**

- **Staged Implementation** – Implementation is planned in stages over a five-year period. The target is to accomplish a 20% reduction in livestock sources and straight pipes each year. It is estimated that this will decrease the percentage of the time water quality standard are exceeded from 30% to 5% in five years and zero percent in 10 years.
- **Community Education and Monitoring** – Educating the public to clarify the problems and solutions, and encourage public involvement is a key component. The ultimate success of the program depends on cultivating commitment and partnerships among government agencies, businesses, interest groups, and citizen groups in the watershed; and encouraging individual stewardship. Regrettably, DCR funding does not include an education technician position to coordinate community involvement and partnership initiatives. Instead, DCR is relying on unfunded, voluntary efforts by local citizen groups.
- **Will the Plan Succeed?** – There are numerous success stories across the country that demonstrate it is possible to protect healthy streams and restore degraded streams to more natural conditions. These actions will minimize manmade problems and health risks to the community. For this to happen, the community needs to recognize that there is a problem, and that the health of citizens, especially those who are least able to protect themselves (i.e., children), are an important consideration. It is imperative that local, state, and federal agencies authorize effective cost sharing programs and tax-credit incentives, and fund these programs to make BMPs installation economically attractive to riparian property owners.

Chapter Four

COUNTYWIDE MONITORING PROGRAM

Stream monitoring programs play a critical role in water resource protection. DEQ (1999) reports that intergovernmental agreements such as the Chesapeake Bay Preservation Act are demanding more of state and local monitoring programs. Monitoring is needed not only to provide baseline data, but also to assess stream health and to resolve degradation problems. These new focuses require a revised strategy and better organization of state and local monitoring efforts.

Current Gaps in Stream Monitoring Activities

2002 LWW Report – In The State of Loudoun Streams: 2002 report, LWW concluded that Loudoun County needs watershed management plans to help implement the Federal Clean Water Act, the Chesapeake Bay Act, the Virginia Water Quality Standards, and the policies of Loudoun's Green Infrastructure and River and Stream Corridor Overlay District in the Comprehensive Plan. The County needs to take action because DEQ's stream monitoring program has not been designed to support watershed management planning at the County and subwatershed level. This has created gaps in data collection, and insufficient data for Loudoun County to extrapolate to assess stream health over an entire stream length with known statistical confidence.

In addition, there is little joint planning or collaboration between state, regional, and county authorities, and citizen groups involved in stream monitoring in Loudoun County. Each entity has unique goals, protocols, sampling stations, and schedules.

LWW also concluded that an updated County stream monitoring strategy to supplement state efforts is particularly important because existing baseline data has already established that many streams are impaired. Restoring the health of streams will require protecting existing forested riparian buffer zones and installing best management practices along degraded stream corridors. Better control and natural treatment of stormwater runoff is also needed. A comprehensive, countywide monitoring program is needed to establish statistically valid baseline data for streams throughout the County, and then measure the effectiveness of these needed initiatives to restore water quality.

2003 LCSA Report – In September 2003 the Loudoun County Sanitation Authority (LCSA) issued the findings and draft recommendations regarding the development of a source water protection (SWP) program for drinking water in Loudoun County. The plan adopts a multi-barrier approach that will protect drinking water sources within the Goose Creek watershed. The SWP program includes a "risk monitoring & compliance" component that relies upon stream monitoring. Reports identifying stream protection needs in Loudoun County have also been issued by the Center for Watershed Protection and the Conference of Governments.

2004 DEQ Report – DEQ's 2004 (305(b)/303(d) Integrated Report identified six new (since 2002) stream segments in Loudoun County with water quality impairments. It also reported that approximately 75% of the waters in Loudoun County have not been assessed by DEQ because of the scarcity of monitoring stations and resources to collect monitoring data. These data suggest that little is actually known about the true extent of the pollution problems affecting Loudoun streams.

Stream Monitoring Program Strategy

It is the function of local governments and citizen watershed organization working in concert with state authorities to develop watershed management plans that incorporate national, regional, and state legislative commitments as well as community priorities. It is the vision of LWW and LWC that Loudoun County government and County Agencies become the principal authorities that collect water resource data and prepare and implement watershed management plans, with the support of citizen watershed organizations. Stream monitoring can best be achieved through the collaboration of government authorities and citizen watershed organizations working together to provide the most effective use of limited state, county, and volunteer resources.

A well-designed stream sampling plan will ensure that resulting data are adequately representative of the conditions in the target stream and are defensible for their intended use. There are two principal types of sampling design:

- Judgment sampling involves selecting monitoring sites on the basis of expert knowledge or professional judgment. Data from this type of design can be used to track trends in the water quality in a watershed.
- Probability-based design involves random selection of monitoring sites. Data from this design allow statistical inferences to be made about the sampled population. These data allow baseline assessments to be made with an efficient use of resources.

Stream Monitoring Goals

A countywide stream monitoring plan begins with stream monitoring goals. On March 6, 2003 Loudoun Watershed Watch sponsored the "Comprehensive County Stream Monitoring Plan Design Development Conference" that was attended by state, regional, and local stakeholders. Participants identified the following stream monitoring goals for Loudoun County:

Goal #1: Characterize and Assess Stream Health:

- Develop baseline data using probability sampling to characterize the health of county streams and determine whether water quality standards are being met;
- Provide data to develop watershed management plans and establish stream preservation and restoration priorities; and
- Identify problem streams that need special studies.

Goal #2: Provide Trend Assessments and Forecasts:

- Document water quality trends over time
- Provide data to develop watershed management plans

Goal #3: Evaluate TMDL Implementation and Watershed Management Plans:

- Determine whether TMDL implementation is working
- Determine if watershed management plans are effective

Goal #4: Provide Environmental Stewardship and Education:

- Provide data and documentation to support pollution prevention, stream restoration, and environmental stewardship
- Provide avenues for citizens to demonstrate concern regarding stream health

Goal #5: Coordinate State, County, and Citizen Resources:

- Divide monitoring responsibilities rationally between state, county, and citizen groups.

Design for Stream Monitoring Program

Once goals are established, agreement is needed on the components of a countywide stream monitoring plan. In May 2003 Loudoun Watershed Watch sponsored the "Loudoun County Stream Monitoring Strategy Workshop." At this two-day workshop, state, regional, and local stakeholders outlined a structure for an updated stream monitoring program. The following sampling designs were agreed upon to achieve the different monitoring goals.

- **Watershed Survey Design –** A watershed survey is needed to collect new and existing information on conditions and processes at the watershed level. This information can be used to identify the type of additional monitoring that may be needed, problem areas for corrective action, and to bolster watershed awareness and education at all levels. It has two parts:

- **Information Research Survey** - Existing information is compiled from reports, interviews, and public meetings regarding stream and watershed conditions and characteristics; and

- **Field Surveys -** Field data and visual observations are collected on various watershed conditions and characteristics.

- **Trend Monitoring Design –** Representative water quality data from any permanent monitoring station can be used to evaluate trends in water quality at the station. Documentation of short-term, mid-term, and long-term trends can be used to assess water quality and best management practices implemented to restore water quality. Trend sampling stations must be carefully selected based upon professional judgment to provide data to answer specific questions about water quality and stream health. Trend data from one monitoring site can be combined with other trend data to produce trend analyses for larger drainage areas. The sampling methods and laboratory analytical methods must be standardized to combine data from various stations or to compare trends in different streams.

- **Probabilistic Monitoring Design –** The probabilistic monitoring design is used to characterize the impact of nonpoint pollutants and other stress factors on the health of benthic communities and stream habitats. It provides comprehensive information about large geographic areas, while keeping costs reasonable. Loudoun County should follow the sample design recommended by DEQ and collect samples once at each probabilistic site. Sites should be stratified by stream orders to assure approximately equal representation among headwater, mid-watershed, and lower watershed streams.

- **TMDL Validation Monitoring Design –** A validation assessment is designed to document the effectiveness of the best management practices (BMPs) that have been installed to improve the water quality. The primary assessment conducted by DEQ will be limited to small stream segments currently designated as impaired. Supplemental assessments conducted by Loudoun County and citizen groups will target stream segments not monitored by DEQ. If data results suggest that the implemented management controls are not effective, recommendations on redesigning the management controls are considered by DEQ and DCR. Data collected through the trend monitoring designs will be used to validate TMDL implementation.

Collaborative Initiative Needed

A countywide stream monitoring plan that incorporates the contributions of federal, state, regional, and local authorities along with citizen watershed organizations will provide the most comprehensive coverage and effective use of limited state, county, and volunteer resources. The following contributions are needed to adopt a collaborative, countywide stream monitoring program.

State Agencies – DEQ and DCR have the legal mandate and professional staff to monitor streams and ensure that state water quality standards are met. DEQ and DCR should provide:

- Technical guidance, training and QA oversight;
- Laboratory support for bacteriological monitoring
- Laboratory support for benthic macroinvertebrate identification
- Utilization of county and citizen collected samples and DEQ analyzed results for documenting impaired waters and validating TMDL implementation.

County Government and Agencies – Loudoun County and County Agencies have laws and ordinances that protect stream corridors; and professional staff to provide safe drinking water, monitor and control point discharges of pollution, protect citizens from water related health hazards, and monitor and manage stormwater facilities, as resources permit. Loudoun County and County Agencies should provide:

- A full-time Water Resources Program Coordinator and part-time support positions to administer a countywide, collaborative, stream monitoring program; collect monitoring samples; ID macroinvertebrate samples; and provide educational programs
- Training and QA oversight of county operations
- Chemical test kits, mapping, GPS units, data management and reporting, and website support for a countywide stream monitoring program

Citizen Groups – Citizen watershed groups have trained volunteers who collect water samples for physical and chemical analyses, monitor benthic macroinvertebrates, and assess stream habitats. Environmental organizations have experienced staff to provide environmental education. These groups and organizations should collaborate with Loudoun County to promote environmental stewardship and stream habitat protection. Citizen groups should provide:

Chapter Five

RECOMMENDATIONS

The "State of Loudoun Streams: 2005" report provides updated baseline data and assessments of the health of Loudoun streams. The same conclusions can be drawn from these assessments as were previously published by LWW based on their 2002 stream assessments. This is because little has been done in the last three years to address the critical needs within the county to protect its water resources and restore water quality. It is hoped the next three years will be different.

Loudoun County has recently received grant funds to begin addressing water quality and watershed management needs, and it is hoped these funds will be used wisely. It is also expected that county authorities will use the assessments in this report to support both wise management initiatives and environmental stewardship programs. The following initiatives, first recommended in 2002, continue to be needed to protect and restore the valuable stream resources in Loudoun County.

Water Management Authority – The stream monitoring data analyses and the "State of Loudoun Streams: 2002" and "State of Loudoun Streams: 2005" reports were prepared by a volunteer citizen organization because Loudoun County does not have a watershed management program and staff. Instead, Loudoun County relies on DEQ to monitor and protect the quality of its streams. DEQ can not provide sufficient data to meet Loudoun's needs to document, plan for, and manage potential impacts on stream corridors.

There are many stakeholders in Loudoun that seek to support watershed management planning and the Total Maximum Daily Load (TMDL) Implementation Plan process. These stakeholders only lack a leadership authority that can organize a collaborative, data gathering program, and provide planning and management. It should also be considered that the management objectives of the larger Potomac River and Chesapeake Bay watersheds need to be incorporated into County watershed plans.

1. **Recommendation** – A county authority should be established with the responsibility and staff to develop watershed management plans. The watershed authority should provide the continuous, long-term management commitment necessary to implement these plans and assess their effectiveness.
2. **Recommendation** – A county authority should have responsibility and staff to oversee the development and implementation of TMDL plans for Loudoun streams in cooperation with DEQ and DCR. TMDL implementation is needed for every Loudoun watershed, and will require many years of oversight, coordination, and effective management to be successful.

3. **Recommendation** – Loudoun County should adopt all watershed management tools available under Virginia laws including civil penalty programs for violation of erosion, sediment, and stormwater best management practices (BMPs); and the Chesapeake Bay Protection Act.
4. **Recommendation** – Loudoun County should collaborate with LWW and Loudoun Wildlife Conservancy to encourage representatives of local, regional and state watershed stakeholder groups to support the development of watershed plans. Inter-governmental collaboration is a key component to successful watershed planning and management.

Subwatershed Plans – The "State of Loudoun Streams: 2002" and "State of Loudoun Streams: 2005" reports divide the larger Goose Creek and Catoctin Creek watersheds into subwatersheds. Such subwatersheds provide homogeneous management areas and are probably the best units to use to develop effective management plans. Small subwatersheds will also facilitate timely monitoring, mapping, and other management tasks.

5. **Recommendation** – A system of small subwatersheds in Loudoun should be defined for the purpose of watershed planning and management. Data on impervious surfaces, forest cover, land use, and hydrology should be used to define subwatersheds that provide homogeneous management areas.

Indicators of Land Use Change – There is little information available regarding the amount of impervious surfaces and forested lands in the subwatersheds in Loudoun County. The amount of impervious cover and forested land have been shown to be important measures for correlating development activity and stream degradation, and provides a powerful method to predict the future quality of streams based upon land use change.

6. **Recommendation** – An accurate measure of impervious cover and forested land should be developed for each subwatershed. This will provide a basis for dividing Loudoun streams into those that will likely support recreational use and aquatic life, and those that likely will not. Different management plans will be needed for each type, and borderline streams will need priority attention to prevent their becoming degraded to the non-supporting level.

Agricultural Sources of Nonpoint Source Pollution – TMDL reports for Loudoun streams establish that agricultural sources of nonpoint pollution are the major cause of fecal bacteria pollution in Loudoun streams. Past initiatives to encourage landowners to voluntarily install BMPs, such as fencing-off streams to livestock, have had limited success. All major Loudoun watersheds are impacted by pollution from agricultural activities.

7. **Recommendation** – Loudoun County should seek more effective state cost-share and tax-incentive programs to work cooperatively with landowners abutting streams to install agricultural BMPs to

prevent agricultural runoff and discharges that degrade streams. Continued state support for cost-share programs for septic tank repair and maintenance is also important.

Riparian Stream Buffers – TMDL reports on Little River and Goose Creek document that sediment from stream bank erosion and wash off from pastureland are a major problem in this watershed. DEQ estimates that 68,000 tons of sediment is flowing into the Potomac River from Goose Creek every year. A 6% increase in developed land in this watershed will increase sediment loads from stream bank erosion another 36%. Studies also show that Catoctin Creek contributes another 9,000 tons of sediment a year. All streams in Loudoun County are impacted by sediments from stream bank erosion.

8. **Recommendation** – Loudoun County should re-establish the River and Stream Corridor Resources Policies and River and Stream Corridor Overlay District (RSCOD) in the Comprehensive Plan to protect riparian buffers and substantially reduce stream bank erosion. The protections should include maintenance of natural forested floodplains by allowing only passive recreation (e.g., hiking trails), and adoption of conservation design ordinances that will implement green infrastructure elements on a site being developed.

Monitoring to Assess Impacts – The "Loudoun County Comprehensive Stream Monitoring Strategy: Plan and Guidelines" prepared by LWW in June 2004 provides guidelines for a comprehensive stream monitoring plan for Loudoun County. These guidelines includes both probabilistic stations and trend stations, and a sampling protocol that will ensure future monitoring data will be fully compatible with existing baseline data and state data. Data collected under these guidelines can provide timely feedback on how stream habitats and biological communities are responding to the management practices outlined in the watershed plans. The guidelines utilize low cost stream indicators that assess physical parameters, habitat quality, and biological diversity.

9. **Recommendation** – Loudoun County should fund and staff a stream monitoring program in collaboration with LWW and LWC to supplement DEQ's assessment of trends and progress in restoring the health of Loudoun streams. The program should focus on monitoring key parameters such as habitat and biological conditions, and bacteriological quality. The program should also monitor indicators of management performance such as number of best management practices installed and stream miles in compliance with TMDL.

Glossary

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

Benthic Macroinvertebrate - An aquatic animal that lacks a backbone, lives in or on the bottom of a stream, and generally is visible to the unaided eye.

Best Management Practice (BMP) - A structural or nonstructural practice that is designed to minimize the impact of urban, agricultural, and forest land use changes on surface and groundwater.

Biosurvey - The use of living organisms including phytoplankton, benthic macroinvertebrates, and fish to assess environmental conditions.

Clean Water Act - A Federal law enacted by the U.S. Congress in 1972 and enforced by the Environmental Protection Agency (EPA) at the national level and the Virginia Department of Environmental Quality (DEQ) at 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.

Degradation - A reduction in the quality of water, habitat, and/or biological conditions of a stream.

Designated Uses - The uses specified in water quality standards for each stream or stream segment. Different segments of a stream can have different designated uses. Full body contact recreation or water supply are uses specified for Loudoun streams.

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

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.

Embeddedness - The extent to which stream substrate (gravel, cobble, boulders and snags) is filled and/or covered with silt, sand, or mud; and is unavailable as microhabitats for benthic macroinvertebrates.

EPT Index - A measurement that uses three orders of insects — mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Tricoptera) - to help assess stream health based on their sensitivity to pollution.

Fecal Coliform Bacteria - A group of organisms common to the intestinal tracts of humans and other warm-blooded animals. The presence of fecal coliform bacteria in water is an indicator of pollution and the potential of pathogens being present.

Floodplain - The area of land adjoining a stream that is covered, temporarily, by water during a flood event.

Habitat - The environment in which an organism lives.

Impaired Stream - A stream in which the water quality is degraded to an extent that it is unfit for its designated uses, and/or the resident biological community lacks the diversity and/or abundance that would otherwise be present.

Impervious Surface - A land cover composed of any material that significantly impedes or prevents natural infiltration of water into soil (i.e., roads, houses, parking lots, etc.)

Imperviousness - The amount or percentage of impervious surfaces within a defined area.

Indicator - A measurable quantity that can be used to evaluate the relationship between pollutant sources and their impact on water quality.

Monitoring - The periodic or continuous surveillance or testing to determine the level of compliance with water quality standards.

Nonpoint Source Pollution (NPS) - Contaminants such as sediments, nitrogen and phosphorous, and fecal coliform bacteria whose sources cannot be pinpointed but rather are diffused or washed from the land surfaces by stormwater runoff.

Nutrients - Chemicals needed by plants and animals for growth (e.g., nitrogen and phosphorus). In water resources 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.

Point Source Pollution - Pollutants discharged at a specific location from pipes or outfalls often from waste treatment facilities.

Pollution -The presence of matter or energy whose nature, location, or quantity produces undesired effects on the physical, biological, or chemical integrity of water.

Probabilistic Monitoring - Using a randomly selected set of monitoring sites to provide unbiased data to characterize stream water quality over a basin-wide or geographic area.

Reference Conditions - Composite characteristics of several high quality streams reflecting chemistry, habitat, and biological conditions against which individual streams are compared in a given geographical area.

Reference Stream - Streams that exhibit highest water quality or least impaired conditions that are used as a standard against which other streams are compared.

Restoration - Improving conditions in a stream so that its functional characteristics are comparable to its original, unaltered state.

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

Riparian Buffer or Zone - A transitional area around a stream, pond, or wetland left in a natural state to impede the flow of runoff and protect the water body from nonpoint source pollution. Development is often restricted within such zones.

Runoff - The part of stormwater, snowmelt, or irrigation water that runs off the land into streams. It can carry pollutants from the land into receiving waters.

Stream Health - The degree to which the chemical quality, and habitat and biological conditions of a stream reflect the best characteristics possible for a given ecoregion.

Stream Restoration - Techniques used to replicate natural hydrological and ecological characteristics that have been lost in a stream because of human disturbance.

Subwatershed - A defined land area within a watershed drained by a tributary stream or drainage way, or a system of connecting streams or drainways, on which all surface water within the area flows through a specific point.

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

TMDL Implementation Plan A plan required by Virginia legislation to restore impaired waters. It includes the date of expected achievement, measurable goals, corrective actions necessary and the associated cost, benefits, and environmental impacts.

TMDL Study - The report of results of intensive investigation, stream surveys, and modeling characterizing the cause, extent, and severity of impairment to designated use in a particular stream.

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

Total Maximum Daily Load (TMDL) - The maximum amounts of a particular pollutant a 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 pollution source loads.

Trend Monitoring Stations - Water monitoring stations established to provide data for detecting and evaluating tendencies in long-term water quality changes.

Turbidity - A measure of the suspended solids in a stream; usually from sediments in runoff that discolor the water.

Urban Runoff - Stormwater from rooftops, driveways, residential streets, and commercial properties that carries nonpoint source pollutants of various kinds into the stormwater system and receiving waterways.

Water Quality - The biological, chemical, and physical conditions of a stream. It is a measure of a stream's ability to support beneficial uses.

Watershed - A discrete unit of land drained by a stream or drainage way, or a system of streams or drainage ways, on which all surface water within the area flows through a single outlet.

Wetland - Land that is saturated with water, and 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.

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Appendices

2005

State of the Streams
Loudoun County: 2005
A Water Quality Assessment

Appendix A: Watershed Profiles

Introduction

Robert Soltess (2002) in his assessment report on the Sugarland Run watershed explains that many local watershed groups have a good understanding of the policies and political issues at play in their watershed. However, they lack even the most basic environmental information about their watershed. Such information is not easily accessible to citizens groups because it is often fragmented and not generally organized by local small watershed boundaries. Local watershed groups need information about hydrology, geology, ecology, and physical characteristics of their watershed. This information can be used to assess the health of the watershed and communicate effectively about developing watershed plans and stewardship projects to restore degraded streams.

Watershed Profile – This report provides profiles of the major watersheds in Loudoun County with the following exceptions. One medium size watershed, Bull Run with 18,300 acres, and several other smaller watersheds (Clarks Run, Dutchman Creek, Quarter Branch, and small direct drainages to the Potomac River) have no monitoring data and are not profiled. Another larger watershed, Sugarland Run, is located mostly in Fairfax County where it is heavily impacted by urban development, and is not profiled. Broad Run is also not profiled because little monitoring data is available on this watershed. It is hoped that monitoring can be expanded in Loudoun County to include watersheds with little or no data, and that future stream reports can have more complete coverage.

Watershed Profile Model – Developing a watershed profile is a complex undertaking even for the smallest watersheds. Data analyses need to include several impacts, risks, and concerns. The Virginia Department of Environmental Quality (DEQ) (1999) suggests that watershed data should be analyzed to provide answers to

specific questions concerning water quality and management of aquatic resources that include:

- Does the watershed support designated uses at least 90% of the time?
- Has water quality changed significantly since previous assessments?
- What are the cause, extent, and severity of water use problems?
- What can be done to restore waters that are degraded and unhealthy?

The profiles in this Appendix address these questions, and provide an overall summary of stream health.

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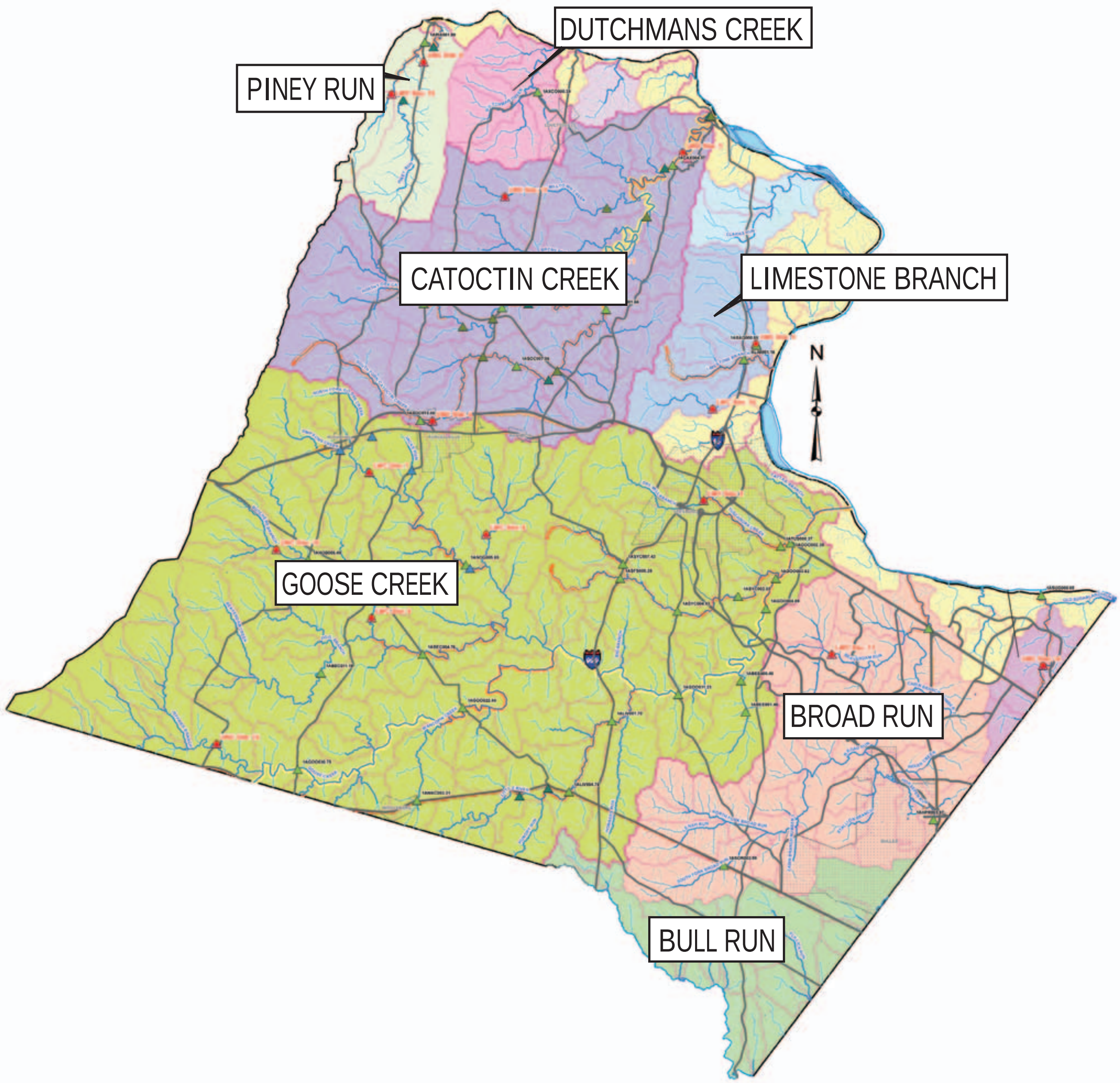
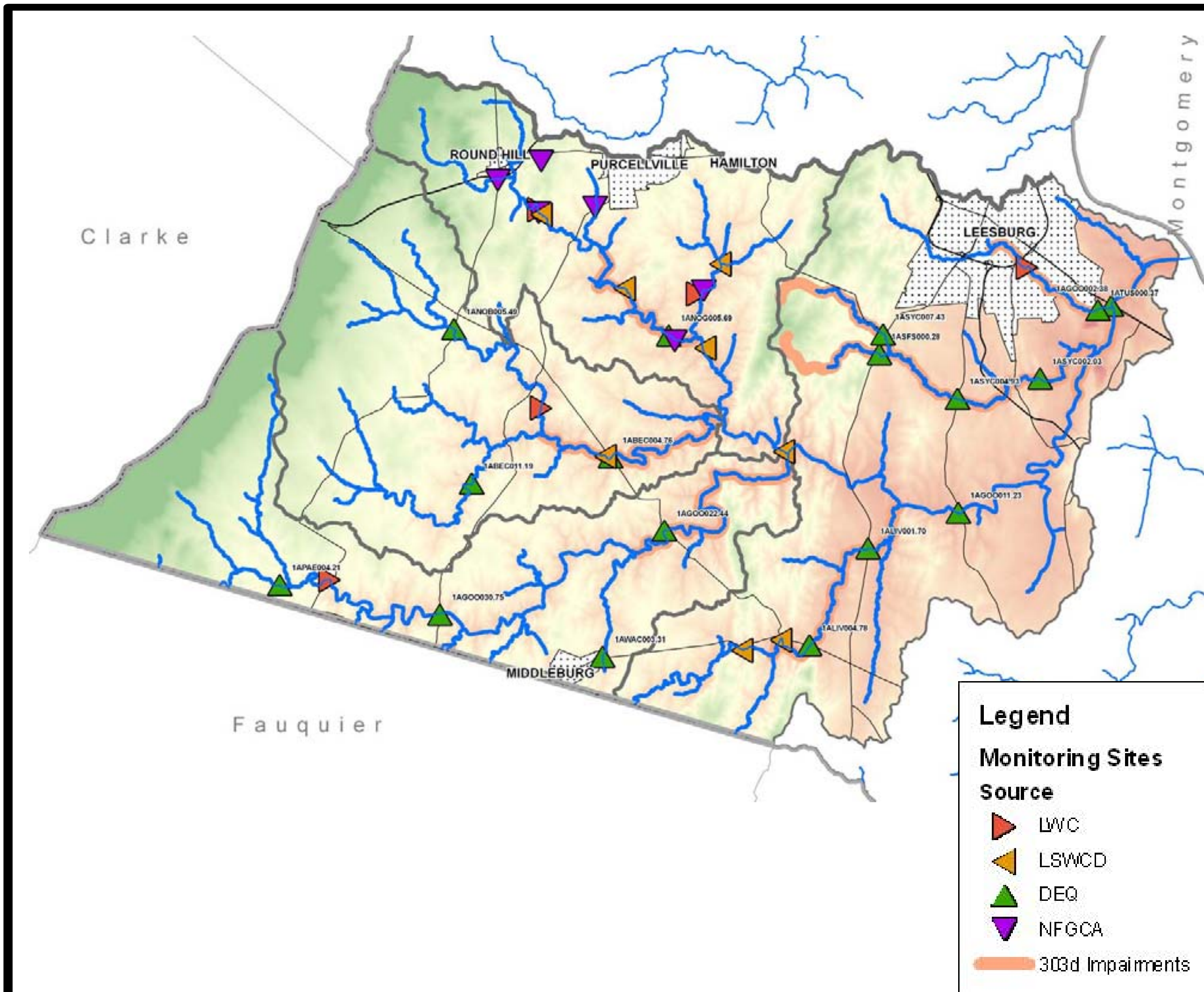
Loudoun Watersheds



Beaverdam Creek Watershed / 2005 Profile



Beaverdam Creek Watershed

QUICK REFERENCE .... Page

Watershed Description

North Fork Beaverdam Creek–LWC Monitoring Site

The Beaverdam Creek watershed is part of the larger North Fork Goose Creek Watershed, and drains 34,000 acres or 10% of the southwestern portion of Loudoun County. Major tributaries are the North Fork Beaverdam Creek, Butchers Branch, and Dog Branch.

Beaverdam Creek is located in the Blue Ridge and Piedmont geographic regions. The watershed has moderately well-drained silt and clay loam soils, and bedrock geology.

Rainfall and Streamflow–Rainfall in the watershed is monitored at Lincoln, VA. A summary of average monthly and annual precipitation is provided in **Table A.1**. The rainfall is fairly evenly distributed throughout the year, although it tends to be lower between December and February.

Table A.1. Summary of Average Monthly and Annual Rainfall Data (inches) at Lincoln, VA. in the North Fork Goose Creek Watershed.

J	F	M	A	M	J	J	A	S	O	N	D	Annual
3.02	2.63	3.63	3.40	4.09	3.84	3.87	4.11	3.56	3.16	3.17	3.12	41.59

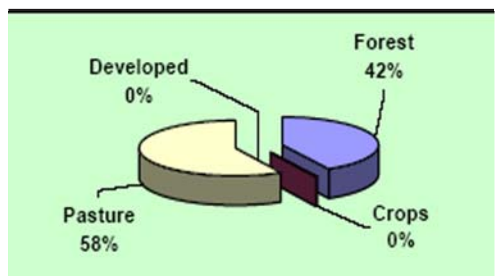
There is little stream flow data for the Beaverdam Creek watershed. The Virginia Department of Environmental Quality (DEQ) discontinued collecting stream flow data in the early 1990's. The Loudoun Soil and Water Conservation District (LSWCD) take sporadic stream flow readings at their monitoring stations. The US Geological Survey established a new stream flow gauge in 2001 on Beaverdam Creek at Rt. 734. Data from the USGS station is shown on **Table A.2**. There are insufficient data to establish any patterns for Beaverdam Creek. However, long term stream flow data for Goose Creek at Middleburg show that lowest flows usually occur between July and November.

Table A.2. USGS Stream Flow Data for Beaverdam Creek Watershed. Monthly Mean Stream Flow, in ft^3/s

	Monthly Mean Stream Flow, in ft^3/s											
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2001										6	7	9
2002	9	8	26	24	43	26	11	3	10	25	53	73
2003	113	91	180	83	237	197	69	28	181			
Mean	**61**	**50**	**103**	**53**	**140**	**111**	**40**	**15**	**96**	**15**	**30**	**41**

Land Use – Land use is predominately agricultural and forested lots. See **Chart A.1**. Riparian buffer zones are poor to marginal in several segments of the streams where the land is in agricultural use. Runoff of sediments into the stream is a problem in some of these segments.

Chart A.1. Land Use in Beaverdam Creek Watershed Based on 1997 Data.



Impervious Surfaces – Impervious surfaces include the roadways, driveways, rooftops and parking lots that do not allow infiltration of water from rainstorms and runoff into the ground. The Loudoun County Environmental Indicators Project (LEIP) included mapping impervious surfaces in the county using Lansat Imagery. They report that the amount of impervious surface over the entire Goose Creek watershed is 1.37%. Impervius surface coverage in the Beaverdam Creek subwatershed portion is likely similar. As a general rule, a watershed with less than 10% of its area in impervious surfaces will not experience a noticeable impact on the hydrological characterisitics.

Water Quality Studies

Water Quality Standards - DEQ is required under the Federal Clean Water Act and Virginia statutes to publish an assessment of the quality of state waters. This assessment includes a list of waters that do not meet state and federal water quality standards. These waters are designated as "impaired waters." The DEQ list of impaired waters includes a 6.32 mile segment of Beaverdam Creek that extends from its confluence with the

North Fork Goose Creek upstream to the confluence with the North Fork Beaverdam Creek. A summary of the information published by DEQ in their assessment report on North Fork Goose Creek is provided in **Table A.3.** This data infers that 75% of the watershed has not been monitored and assessed by DEQ because there are no data.

Table A.3. Assessment of Beaverdam Creek by DEQ in the 2004 303(d)/305(b) Integrated Report to EPA (data in river miles).

Watershed Monitoring Station	Meet Stnds	No Data	Insufficient Data	Citizen Data Show Problems	Citizen Data Show No Problems	Impaired
Beaverdam Creek/ Upper Beaverdam Creek	3.62	54.54	0	4.00	0	6.32

Water Quality Studies – Stream waters listed by DEQ that do not meet water quality standards are required to be studied. The purpose of the study is to identify the source(s) of the pollution and quantify the pollution load(s) to the stream. In addition, the Federal Safe Drinking Water Act requires states to assess the health of streams and watersheds that are used as a drinking water supply. Water from Goose Creek is used as a public drinking water supply. Two studies have been conducted in recent years because of these requirements, and they provide good information about the water quality and sources of pollution that degrade the North Fork Goose Creek.

- **TMDL Report –** DEQ published a report, "Bacterial TMDL for the Goose Creek Watershed," in February 2003 that included water quality information on the Beaverdam Creek subwatershed. The lower mainstem of Goose Creek and six tributary streams have elevated fecal coliform bacteria levels that exceed state water quality standards for safe use for recreation. The TMDL (Total Maximum Daily Load) study identified the sources of pollution affecting the Goose Creek watershed.

- **Goose Creek Source Water Protection Study –** The Loudoun County Sanitation Authority (LCSA) published a report, " Goose Creek Source Water Protection Program," in December 2003 that included water quality information on the North Fork Goose Creek. The purpose of the report was to provide a plan to protect drinking water supplies in the Goose Creek from pollution and stream habitat degradation that will affect the safety of drinking water supplies.

Findings – Fecal coliform bacteria pollution originates from a variety of sources in Beaverdam Creek. DEQ did special bacteria source tracking or BST studies to determine the type of warm-blooded animals that are contributing the fecal bacteria to the stream waters. They also used a Hydrological Simulation Program, Fortran (HSPF) to develop a model to simulate the fate and transport of fecal bacteria in the stream.

- **Point Sources of Pollution** - Point sources of fecal bacteria include the municipal and industrial plants that treat human wastes, and private residences that have non-septic tank systems that have a discharge requiring a permit. These permitted sources are listed in **Table A.4.**

Table A.4. Permitted Point Sources of Fecal Bacteria in the Beaverdam Creek Watershed.

Facility	City	Receiving Stream
St. Louis Community	St. Louis	Beaverdam Creek
US FEMA	Bluemont	Jeffries Branch
Bluemont Post Office	Bluemont	Butcher's Branch
Residence A	Round Hill	Jeffries Branch
Residence B	Middleburg	Dog Branch
Residence C	Bluemont	Butcher's Branch
Residence D	Bluemont	Butcher's Branch
Residence E	Bluemont	Butcher's Branch

- **Human Sources - Septic Systems** - Properly functioning septic systems allow treated human waste effluent to filter into the soil so it does not reach surface water. However, failing septic tank systems can allow bacteria to reach the surface and flow directly into a nearby stream, as runoff especially during a heavy rainfall. Failing systems can also allow the effluent to seep into the ground water if the system is located too close to a stream or pond.

  The special BST study conducted by DEQ showed that fecal bacteria from human sources are widespread in the Goose Creek watershed including Beaverdam Creek. Human sources can be the dominant source for some rainfall events. They estimate that there is a 5% failure rate of septic systems in the watershed, and that fecal bacteria from these systems are entering streams as stormwater runoff. Any system located within 50 feet of surface water is assumed to be directly discharging fecal bacteria to the stream.

  These estimates are based on surveys that have been conducted. For example, in 1992 the Loudoun County Health Department conducted a septic system survey of Bluemont in the North Fork Beaverdam Creek watershed and found 22 failing systems out of 52 systems surveyed. In 2002 the Health Department estimated there are 97 failing septic systems in the Beaverdam Creek watershed. A breakdown of the estimated failing systems is provided in **Table A.5.**

Table A.5. 2002 Estimate of Failing Septic Systems in the Beaverdam Creek Watershed.

Stream Segment	# Septic Systems	# Failing Systems	# Systems <50' from Stream
Beaverdam Creek	141	29	0
Upper Beaverdam Creek	1,188	59	9

- **Biosolids -** Class B biosolids (liquid or dewatered sludge from a sewage treatment plant) are applied on occasion to both cropland and pasture in the North Fork Beaverdam Creek watershed. Record keeping of applications is poor, and DEQ had to estimate application amounts. Application varies considerably by year and even more so by month. The only application recorded in the Beaverdam Creek watershed was in 1999 when 620 dry tons were applied.

- **Dairy and Beef Cattle -** In 2003 DEQ reported there are large numbers of dairy cattle and beef cattle pasturing in the Beaverdam Creek watershed. The number of beef cattle varies seasonally in the watershed, with the highest numbers in the summer and lowest in the winter (October to April). Cattle are generally pastured and have access to streams. Beef cattle normally spend a portion of each day in the streams, especially in the summer. Most farmers in the watershed do not use stream bank fencing. The estimated number of dairy and beef cattle are provided in **Table A.6.**

- **Horses -** Loudoun County has the largest horse population in Virginia, and many are located in the Beaverdam Creek watershed. However, most horses do not have access to streams, and horse manure is typically deposited on pasture land. Therefore, horses were not identified as a major source of pollution by DEQ. The estimated number of horses is also listed on **Table A.6.**

Table A.6. Estimated Livestock Populations in the Beaverdam Creek Watershed in 2002.

Stream Segment	Dairy Cattle	Beef Cattle	Horses
Beaverdam Creek		500	400
Upper Beaverdam Creek	650	3,000	2,500

- **Wildlife -** There are a wide variety and large number of wildlife in the watershed that contribute some fecal bacteria to the streams. It is estimated, for example, that there are 2,900 deer and 1,300 raccoon. However, there have been no wildlife surveys conducted in Loudoun County, and the Virginia Department of Game and Inland Fisheries (VDGIF) uses a model to estimate wildlife populations based on the various habitat types found in the watershed.

The study found that most wildlife are not a significant source of pollution to the streams because they spend little time in stream waters, and their wastes impact stream water quality only as part of stormwater runoff. Of all the wildlife species, DEQ estimates that deer and raccoon are the only wildlife species that impact water quality in Beaverdam Creek.

- **Average Daily Fecal Bacteria Load By Source** – DEQ combined the information from the various sources of fecal wastes to estimate the average, daily, fecal bacteria load to the streams in the watershed. These percent average daily loads are listed in **Table A.7.** This list shows that 92% of the fecal coliform bacteria in Beaverdam Creek come from the manure of cattle and other livestock.

Table A.7 Percent Average Daily Loads of Fecal Bacteria by Source in the Beaverdam Creek Watershed.

Source	Beaverdam Creek	Upper Beaverdam Creek
Livestock	92%	92%
Human	1%	1%
Wildlife	1%	1%
Other	6%	7%
Total All Sources	**100%**	**101%**

Water Quality Restoration – DCR and DEQ will use the TMDL study to develop an implementation plan for the voluntary reduction of pollution loads by riparian property owners. The needed pollution load reductions are substantial and are shown in **Table A.8.** DCR has not scheduled the development of a TMDL Implementation Plan for Goose Creek as of 6/1/2005.

Table A.8. TMDL Implementation Needs for Beaverdam Creek Watershed

Level of Reduction	Source of Nonpoint Pollution
98%	Reduction on in loads from pasture runoff
100%	Reduction on in direct deposition from cattle in streams
100%	Reduction on in loads from failing septic systems

Table A.9. Stream Monitoring Data for the Beaverdam Creek Watershed.

Monitoring Sites	Water Flow	Chemical	Bacterial	Habitat	Aquatic Insects
Beaverdam Creek					
Rt. 734, Snickersville Rd.	USGS (new)	DEQ 1976-2001	DEQ 1976-2001		
Rt. 731, Watermill Rd.		LSWCD 1999-2001	LSWCD 1999-2001		LSWCD 1999-2001
Rt. 626, Foxcroft Rd		DEQ 2001-2004	DEQ 2001-2004		
North Fork Beaverdam Creek					
Rt. 630, Jeb Steuart Rd				LWC 1997- 1998 NFGCA 2004	LWC 1997-1998 NFGCA 2004
Rt. 719, Airmont Rd		DEQ 2001-2004	DEQ 2001-2004		
Butchers Branch					
Rt. 831				LWC 1997-2002	LWC 997-2002

Watershed Monitoring

Stream Monitoring – DEQ has documented the chemical and bacteriological quality of Beaverdam Creek dating back to 1976. DEQ added two new stations in Beaverdam Creek and the North Fork Beaverdam Creek in 2001. The Loudoun Soil and Water Conservation District (LSWCD) has chemical, bacteriological, and aquatic insect data from 1999 to 2001 at one station in Beaverdam Creek. The Loudoun Wildlife Conservancy has a monitoring station on Butchers Branch with data from 1997-2002. The North Fork Goose Creek Association began monitoring the Butcher's Branch station again in 2004. A summary of the available data is provided in **Table A.9.**

Water Chemistry Conditions

The chemical quality of Beaverdam Creek is an important indicator used by DEQ to determine whether streams in the watershed are fit for aquatic life and recreational use. DEQ has collected chemical water quality data at one stations in Beaverdam Creek at Rt. 734, Snickersville Turnpike, since the 1970's. These data show that chemical parameters meet state standards and national guidelines. The key chemical parameters are summarized in **Table A.10**.

Table A.10. Summary of Key Chemical Parameters Based Upon DEQ Data from the Beaverdam Creek Watershed Between 1996 and 2001.

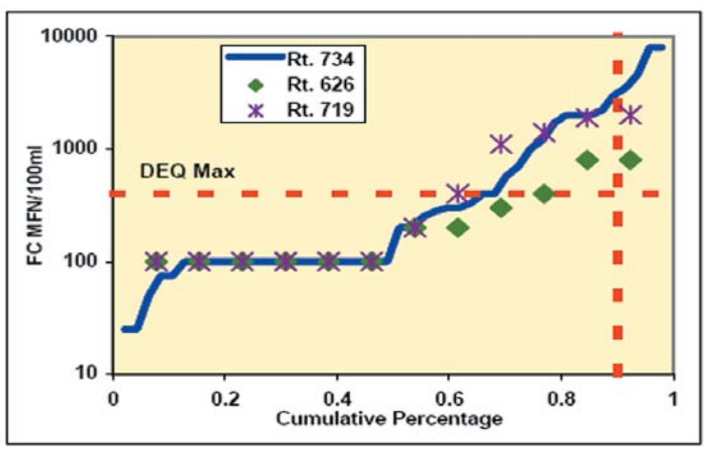
Parameter	Criteria	Observation	Condition
pH	DEQ sets a range of 6-9 for pH levels	Mean pH level is 7.2 and the range is 5.7 to 7.8. Levels are consistently between 6.5 and 7.5 which is good for aquatic life.	Criteria consistently met
DO (Dissolved Oxygen)	DEQ sets a minimum of 4 mg/l	Mean DO level is 9.4 with a range of 3.9 to 13.5 mg/l. Levels flucuate inversely with temperature and are consistently between 8 and 12 mg/l which is good for aquatic life.	Criteria consistently met
BOD (Biological Oxygen Demand)	No DEQ standard. EPA guildline is a maximum of 7 mg/L	Mean BOD level is 2 with a range of 0.7 to 4 mg/l. Levels are consistently about 2 mg/l suggesting low organic loads in stream water.	Criteria consistently met
Phosphorus	No DEQ standard. EPA set a guide of 1.0 mg/L for non-impaired waters	Mean level of 0.1 mg/l suggests there is no excessive run-off of fertilizers from agricultural and other operations affecting the watershed.	Criteria consistently met
Nitrogen (as Nitrate)	There are no state or EPA guide for nitrogen.	Mean level is 0.5 with a range of 0.2 to 1.2 mg/l. These low levels of nitrogen in combination with low levels of phosphorus keep growth of aquatic plants and algae in check.	Low levels

LSWCD has also collected chemical data at their station at Rt. 731 begining in 1997. These data are consistent with DEQ's data and support DEQ's finding that the chemical quality of the water in Beaverdam Creek is good.

Water Bacteriology Conditions

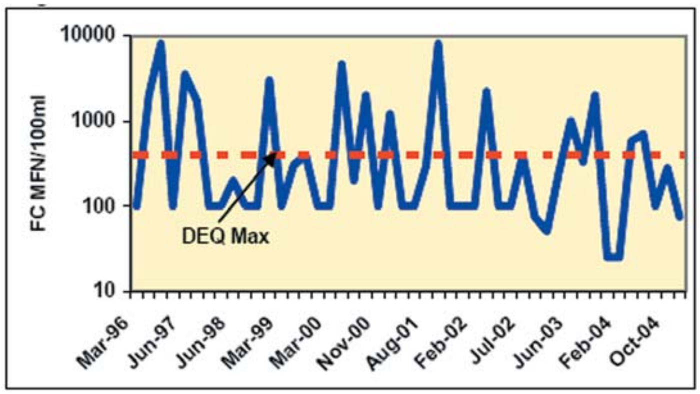
DEQ Data – DEQ's most recent 1996-2004 fecal coliform data at their three stations in the Beaverdam Creek watershed are shown in **Figure A.1.** The data are plotted as cumulative percentages and are compared with the DEQ water quality standard. The water quality at these stations do not meet state standards in that approximately 20-30 % of the samples are above 400 fecal coliform. **Figure A.2** shows the same data plotted over time to illustrate the characteristic spikes of pollution that occur. The trend line for these data suggest that fecal coliform levels are decreasing.

Figure A.1. DEQ Fecal Coliform Bacteria Data for Beaverdam Creek 1996-2004.



Loudoun Soil and Water Conservation District – LSWCD has also collected fecal coliform data at a site since 1999. These data show that approximately 30 % of the samples exceed 400 and that water quality standards are not met. Further these data show the same trend as the DEQ data.

FigureA.2. DEQ Fecal Coliform Bacteria Data for Beaverdam Creek 1996-2004.

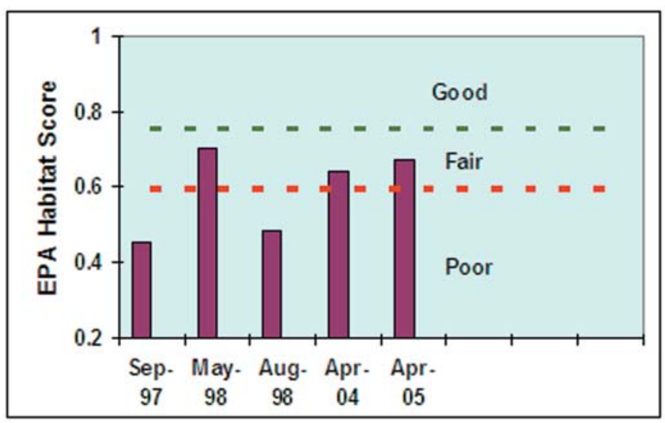


Future Fecal Impairments – DEQ's fecal coliform data from their two new stations at Rt. 626 on the main stem of Beaverdam Creek and Rt. 719 on the North Fork Beaverdam Creek support the TMDL findings that fecal coliform bacteria contamination is wide spread in the watershed. The existing 6-mile fecal impairment on the main stem should be extended to include all of Beaverdam Creek and the North Fork Beaverdam Creek.

Stream Habitat Quality

Loudoun Wildlife Conservancy – LWC has collect stream habitat data at one station in the North Fork Beaverdam Creek since 1997 using the Audubon Naturalist Society (ANS) protocol. LWC also collected stream habitat data at a station in Butcher's Branch, but discontinued this in 2003. The quality of the stream habitat is summarized in **Figure A.3.** These data show that the stream habitat is generally "poor" to "fair." The data indicates there has been a substantial loss of natural riparian stream buffer, and that streambank erosion is a major problem. Stream habitat is a limiting factor for a healthy biological community.

FigureA.3. Stream Habitat Conditions for North Fork Beaverdam Creek at Rt. 630, 1997-2004.

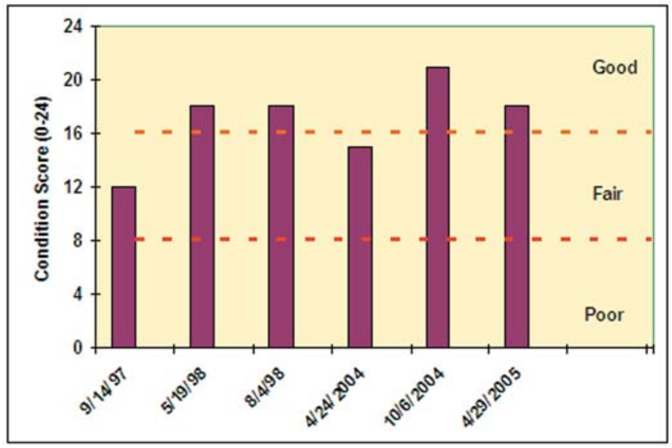


Aquatic Insect Populations

Loudoun Wildlife Conservancy – LWC has collected aquatic insect data in North Fork Beaverdam Creek and Butchers Branch since 1997. The Butchers Branch station was discontinued in 2003. The results showed "poor" to "fair" conditions using EPA metrics. The LWC aquatic life condition data for the North Fork

Beaverdam Creek station at Rt. 630 are provided in **Figure A.4.** These data show that the insect community conditions at this site are "fair to "good." This indicates that the composition and diversity of the aquatic insects are sometimes less than expected for a healthy stream in this ecological region.

Graph A.4. Aquatic Insect Condition Scores for Beaverdam Creek at Rt. 630 from 1997-2004.



Loudoun Soil and Water Conservation District and North Fork Goose Creek Association –
LSWCD has also monitored aquatic insect conditions in the Beaverdam Creek watershed since 1999 using the original SOS protocol. Results show fair to good conditions at their station on Rt. 731.

Overall Assessment of Stream Health

The water quality problems in the Beaverdam Creek watershed are well documented now that DEQ has completed their TMDL study and two new stations are being monitored. The fecal coliform bacteria monitoring and the TMDL study show that there is fecal contamination from nonpoint sources of pollution throughout the watershed. DEQ has designated a six-mile segment of Beaverdam Creek as impaired because it does not meet DEQ's standards for recreational use. This impairment should be extended to include the entire main stem and the North Fork Beaverdam Creek. DCR also needs to schedule a TMDL Implementation Plan for this watershed so efforts to restore the water quality to meet standards can begin.

The stream habitat and aquatic insect communities are less well documented. The stream habitat conditions have been assessed by LWC in Butchers Branch and the North Fork Beaverdam Creek. Conditions are "poor" to "fair" at both sites using the EPA criteria. This indicates there has been a moderate loss of good stream habitat, and that it is a limiting factor that impacts on the biological community. The assessment of the aquatic insect conditions at the two stations range from "fair" to "good" depending upon the monitoring site.

Overall, the assessments indicate that the Beaverdam Creek watershed is impacted by human activities and the health of the stream is stressed as a result. The results of various measurements of stream health are summarized on **Table A.11.**

Table A.11. Summary of North Fork Goose Creek Assessments.

Monitoring Site	Environmental Parameters					
	Water Flow	Chemical Quality	Bacteria Quality	Habitat Assessment	Aquatic Insect Score	Impervious Surfaces
Beaverdam Creek		Good	Impaired			Good
NF Beaverdam Creek					Fair-Good	Good
Butchers Branch		Good		Fair-Good	Fair	Good

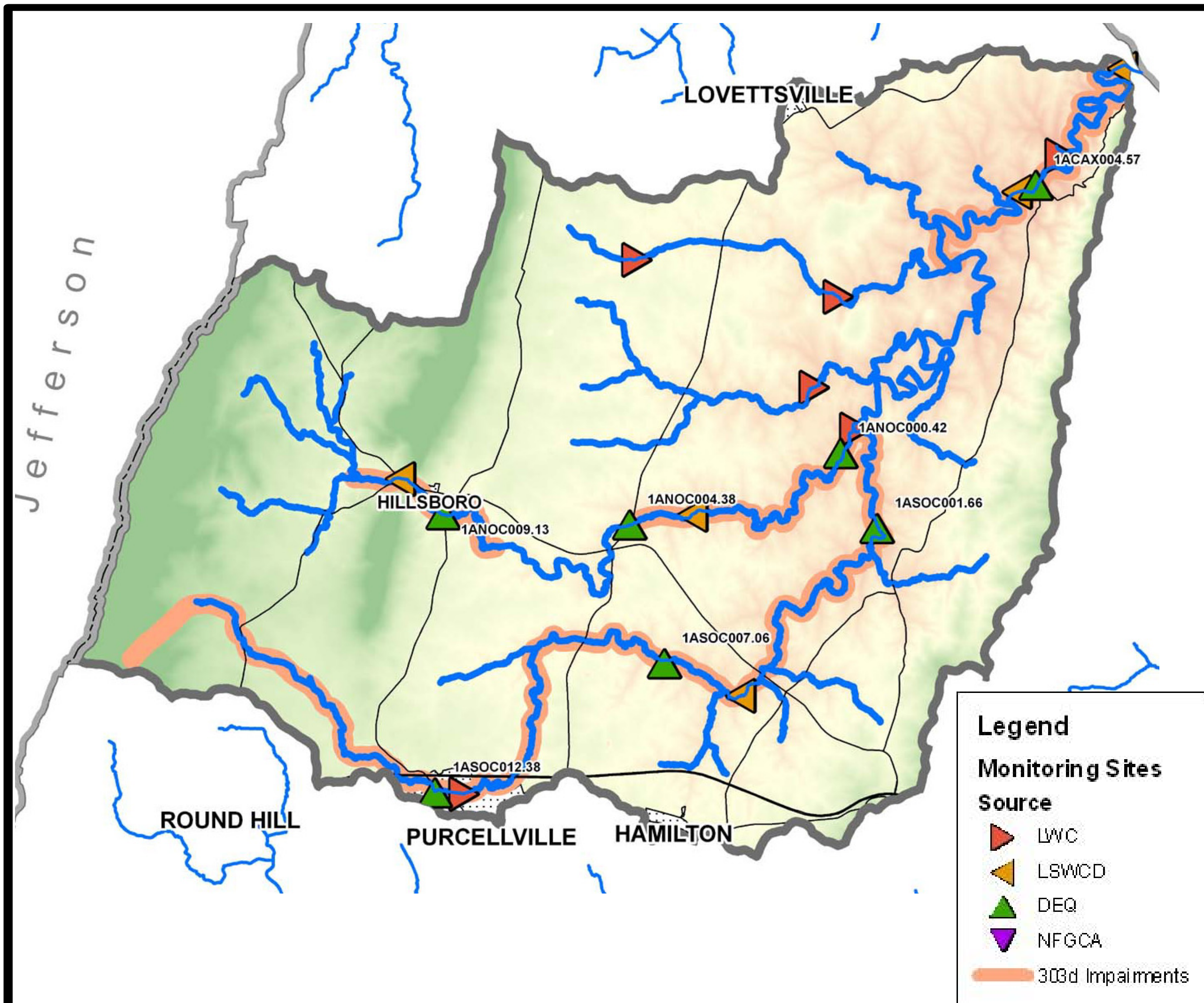
References

George Washington University. 2000. "Loudoun County Environmental Indicators Project (LEIP). Annual Report 2000. Ashburn, VA.

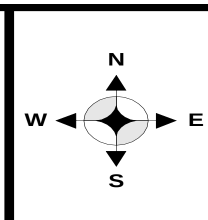
Interstate Commission on the Potomac River Basin. 2003. Bacteria TMDLs for the Goose Creek Watershed. Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation. February 2003.

Loudoun County Sanitation Authority. 2003. Goose Creek Source Water Protection Program. December 2003.

Catoctin Creek Watershed / 2005 Profile



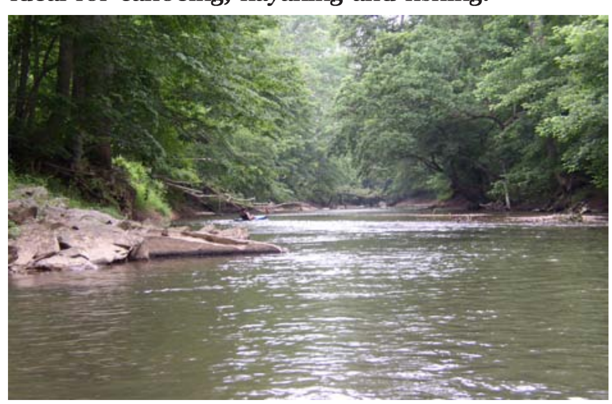
Catoctin Creek Watershed



Watershed Description

The Catoctin Creek watershed is located in Loudoun County, Virginia, immediately north of Purcellville and approximately five miles to the northwest of Leesburg, Virginia. The watershed flows into the Potomac River and the Chesapeake Bay. The South Fork of Catoctin Creek rises on the slopes of the Blue Ridge west of Purcellville and flows eastward toward Waterford. The North Fork rises on the Blue Ridge west of Hillsboro and flows eastward toward the confluence with the South Fork north of Waterford.

Mainstem Catoctin Creek has deeper waters ideal for canoeing, kayaking and fishing.

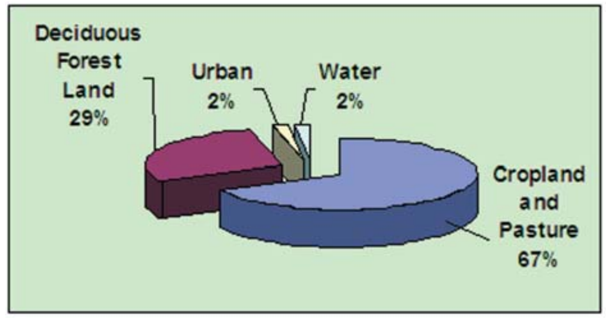


The primary tributary to Catoctin Creek is Milltown Creek which originates on the eastern slope of Short Hill Mountain and flows easterward to join the main stem of Catoctin Creek east of Milltown. The main stem of the creek turns north toward the Potomac. The steep rocky bluffs along the stream in the final miles from Taylorstown to Point of Rocks produce a destination for kayakers and canoeists, and contributes to Catoctin Creek's value as a recreational resource.

Land Use – Catoctin Creek drains approximately 59,100 acres or 100 square miles, with agriculture and forest as the primary land uses. There are small areas of suburban development surrounding some of the oldest towns in the country. The proportion of land in these uses is shown in **Chart A.2**. The volcanic rocks from which the area

soils were derived have created productive farmland. In earlier times this area was known as the breadbasket of Loudoun. The southern edge of the watershed includes portions of the rapidly growing towns of Purcellville, Round Hill and Hamilton. Intensive suburban development is rapidly altering the nature of the land in the headwaters of Catoctin Creek.

Chart A.2 Land Use in Catoctin Creek Watershed 2000



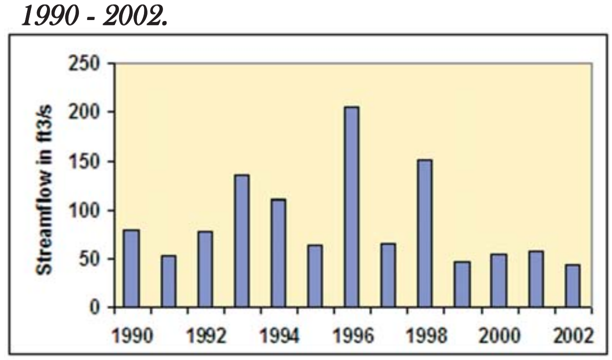
Impervious Surfaces – Impervious surfaces include the roadways, driveways, rooftops and parking lots that do not allow infiltration of water from rainstorms andrunoff. The Loudoun County Environmental Indicators Project (LEIP) includes mapping impervious surfaces in the county using Lansat Imagery. They report that the amount of impervious surface in Catoctin Creek as 0.36%. This is a modest amount and does not represent levels that would be expected to have a noticeable impact on the hydrological characterisitics of the watershed as a whole. However, imperviousness in towns such as Purcellville and Waterford, are much greater, and can be expected to impact stream health and water quality in the South Fork Catoctin Creek.

Impervious roadways and parking lots collect stormwater that flows directly into South Fork Catoctin Creek.

Precipitation and Stream Flow – Precipitation is measured at a station in Lincoln in Loudoun County. Analysis of data from 1968 to 2001 show there are differences in mean monthly precipitation. Precipitation in the spring-summer months of March through August tends to be higher than precipitation in the fall-winter months.

US Geological Survey (USGS) has been collecting stream flow data in the Catoctin watershed at Taylorstown since 1971. Average annual flows are shown in **Figure A.5.** Average stream flow is approximately 100 cubic feet per second which is adequate to maintain a healthy stream ecosystem. However, these data show that stream flows are highly variable. Stream flows in the summer and fall

Figure A.5. Annual Mean Stream flow for Catoctin Creek at Taylorstown Based on US Geological Survey Stream Monitoring Data, 1990 - 2002.



months tend to be lower than flows in the winter and spring months.

Water Quality Studies

Citizens are concerned about good water quality for a variety of reasons. Dip a paddle, run a rapid, cast a fishing line, hike along a stream, or just sit under a tree on a stream bank. Our streams provide special places for recreation and aesthetic enjoyment, essential habitat to wildlife, and a source of drinking water. They are a valuable resource that must be protected and managed wisely.

Milltown Creek tributary has fair to good quality riffles for aquatic insects at LWC monitoring site.

Water Quality Studies – Virginia Department of Conservation and Recreation (DCR) published a report on water pollution in the Catoctin watershed in March 2002 called the Total Maximum Daily Load or TMDL study. The study focused on four stream segments that violate the state and Federal water quality standard. Fecal coliform bacteria in these streams are consistently elevated above the standard. These stream segments are "impaired" which means the water quality does not support the stream's intended use for primary contact recreation (e.g. swimming, wading, and fishing).

Virginia Department of Environmental Quality (DEQ) added another stream segment in the North Fork Catoctin Creek to the impaired list in 2004 based on fecal coliform bacteria contamination. A second segment was added in the South Fork Catoctin Creek for violating the standard for aquatic life as revealed by benthic macroinvertebrate monitoring. These impairments and the status of other stream segments are summarized in **Appendix 1** to this profile.

Analyses of the water quality data show that there are high concentrations of fecal coliform bacteria at all flows and all months. There is no significant difference in monthly fecal concentrations within a year. Monthly mean concentrations at DEQ's monitoring station at Taylorstown on the mainstem are shown on **Table A.12**. The water quality standard is 400 fecal coliform bacteria/100 ml., and this level is exceeded more than 50% of the time every month. The public health risks associated with fecal contamination are discussed in statements issued by the DCR and Virginia Department of Health and provided in **ATTACHMENT C**.

Table A.12. Summary of Mean Monthly Fecal Coliform Concentrations at Catoctin Creek, Taylorstown Based on DEQ Stream Monitoring Data from 1973-2001.

Month	Mean (cfu/100 ml)	Minimum (cfu/100 ml)	Maximum (cfu/100 ml
January	1,792	93	8,000
February	689	3	3,900
March	1,577	43	24,000
April	546	0	2,500
May	1,849	100	9,200
June	2,066	100	24,000
July	532	23	4,100
August	1,759	43	16,000
September	1,909	100	9,200
October	1,794	100	24,000
November	911	100	4,600
December	2,709	43	24,000

Sources of Pollution

Point Sources – Four facilities are permitted to discharge treated wastewater through a pipe (point sources) into the Catoctin Creek watershed. They are the Hamilton Sewage Treatment Plant, Purcellville Water Treatment Plant, Waterford Sewage Treatment Plant, and 1 private residence. Permitted discharges may contain pathogens associated with fecal matter, and are required to maintain a fecal coliform concentration below 200 cfu/100ml. Monitoring of the point discharges from sewage treatment plants at Hamilton, Purcellville, and Waterford by the Loudoun County Sanitation Authority show these facilities are well designed and operated, and fecal coliform concentrations are reduced to levels well below the 200 cfu/100ml limit.

Nonpoint Sources – The principal sources of pollution causing the fecal coliform impairments in the Catoctin Creek watershed are from nonpoint sources. They include livestock, humans (from malfunctioning and failed septic systems), and wildlife. Analyses of pollution levels and stream flows showed that there are high levels of pollution from these sources under all conditions, but periods of low flow and less dilution water resulted in the worst pollution conditions. The proportion of fecal pollution from human sources ranges from as low as 4% to over 90%. These results are based on bacterial source tracking samples taken by DEQ in the Catoctin watershed.

- **Private Septic Tank Systems** - Typical private residential sewage treatment systems consist of a septic tank, distribution box, and a drainage field. Wastes from the septic tank are distributed to the drainage field, where it flows downward to groundwater, laterally to surface water, and/or upward to the soil surface

where water is evaporated. Removal of fecal coliform and pathogens is accomplished primarily by die-off in the soils. The Loudoun County Department of Health reports that fecal coliform can survive in soils for up to 50 days and move laterally up to 50 feet. These numbers might be higher or lower depending on soil moisture and temperature. A properly designed and functioning septic system provides sufficient retention to kill 99.9% of the fecal coliform bacteria.

A septic system fails when a drain field has inadequate drainage or a "break" that allows wastewater (effluent) to flow directly to the soil surface. In this situation the effluent can be flushed into surface waters during rain runoff events or flow directly into a nearby stream. Failures are more likely to occur in the winter-spring months than in the summer-fall months.

The LCHD reports that there are approximately 3100 septic systems in the Catoctin watershed. They estimate a failure rate of 5% with the majority of failures occurring at homes that are 20 years or more old. The estimated number of failing systems that are directly depositing sewage to streams is shown in **Table A.13.**

Table A.13. Estimated Number of Failing Septic Systems in Catoctin Watershed Based on 5% Failure Rate.

Stream Portion	Total Septic Systems	Failing Septic Systems	Straight Pipes
Catoctin Mainstem	1300	6	3
South Fork	470	2	1
North Fork	1340	7	4
Total	3110	15	8

- **Livestock –** The predominant types of livestock in the Catoctin Creek watershed are beef cattle and horses. Fecal pollution can enter surface waters from livestock both from direct deposited wastes from cows standing in a stream and from wash-off of manure from the pasture during a run-off producing rain. Direct deposits by beef cattle are the most serious. DEQ reports that 70% of the wastes of cattle with access to a stream will be deposited in the stream. Wash-off of wastes deposited on the land is especially important if there are poor natural riparian buffers and run-off is not filtered before it enters a stream. The estimated livestock populations are provided in **Table A.14.**

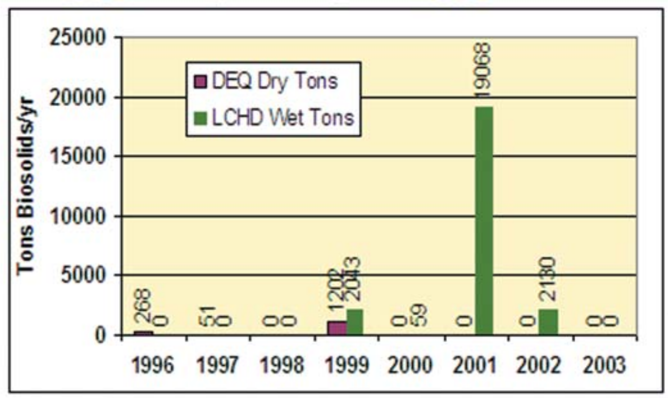
Table A.14. Livestock Populations in the Catoctin Creek Watershed Estimated by the Loudoun Soil and Water Conservation District

Animal Type	Number of Animals
Dairy Cows	170
Beef Heifer	5300
Horses	3100
Sheep	1180
Goats	75
Swine	315

■ **Biosolids –** The DEQ water pollution study considered several nonpoint pollution sources. The assessment of one source, biosolids, was developed from data covering the period 1999-2001. The DEQ report concluded that biosolids did not contribute to the water pollution problems.

However, more recent data obtained by Loudoun Watershed Watch from the LCDH reveal that the amount of biosolids applied since 2001 is several orders of magnitude greater than was considered by DEQ in the TMDL report. The annual application amount is shown in **Figure A.6.** There are also anecdotal reports of fish kills from biosolids, and evidence from the LCDH that biosolids have been applied in sinkholes and areas of "steep slopes". The potential significant loading contribution from biosolids is not included in the TMDL implementation plan designed to restore water quality. The DEQ report makes the assumption that the use of land applied fecal material (biosolids) will be maintained at current loadings or below current levels which is not supported by more recent data.

Figure A.6 . Amount of the Class "b" Biosolids Considered by DEQ (green bars) in the Catoctin TMDL Report Compared With More Recent Data From Loudoun County Dept of Health (red bars).



■ **Wildlife –** The most important species of wildlife impacting on water quality are muskrat and beaver because they deposit fecal wastes directly in the water. Other wildlife species, including deer, are less important because they deposit their wastes on land and it only enters the water in a diluted form in runoff. The Virginia Department of Game and Inland Fisheries (VDGIF) estimates there are 2800 muskrats and

Stream monitoring team collecting aquatic insects in headwater stream after flooding.

Aquatic insects picked out of sample and placed in ice cube tray for identification and counting.

200 beaver in Catoctin Creek. The high number of muskrat makes them the only wildlife species significantly impacting on water quality.

Stream Monitoring Activities

Water quality and stream health in the Catoctin watershed are monitored by DEQ, Loudoun Soil and Water Conservation District, and Loudoun Wildlife Conservancy. A summary of data for the Catoctin watershed is provided in **Table A.15** on the next page.

Table A. 15. Stream and Habitat Monitoring Data for Catoctin Creek.

Monitoring Sites	USGS Water Flow	Chemical	Bacterial	Habitat Assessment	Macro- invertebrate
Main Stem					
Rt 663	**USGS** 1972-2001	**DEQ** 1978-2004 **LSWCD** 1999-2004	**DEQ** 1978-2004 **LSWCD**1999-2004	**LSWCD** 1999-2001 **LWC** 1997-2001	**LSWCD** 1999-2004 **LWC** 1997-2004
South Fork					
Rt. 681				**LWC** 2004	**LWC** 2004
Rt 698	**USGS** 1972-2004	**DEQ** 1973-2004	**DEQ** 1973-2004		
Rt 738		**DEQ** 1977-2004	**DEQ** 1977-2004		
Rt. 611				**LWC** 1997-2004	**LWC** 1997-2004
Rt 690		***DEQ** 1973-2000*	***DEQ** 1973-2000*	**DEQ** 2001	**DEQ** 2001
Rt 711		**LSWCD** 1999-2003			
Rt. 719				**LWC** 2004	**LWC** 2004
Rt. 713				**LWC** 2004	**LWC** 2004
North Fork					
Rt 681		**DEQ** 1979-2001	**DEQ** 1979-2001	**LWC** 1997-2004	**LWC** 1997-2004
Rt 287		**LSWCD** 1999-2003 ***DEQ** 1974-2000*	**LSWCD** 1999-2003 ***DEQ** 1974-2000*	**LSWCD** 1999-2003	**LSWCD** 1999-2003
Rt 690		***DEQ** 1979-2000*	***DEQ** 1979-2000*		
Rt. 812		**DEQ** 2003 - 2004	**DEQ** 2003 - 2004		
Rt 719		**LSWCD** 1999-2003	**LSWCD** 1999-2003	**LSWCD** 1999-2003	**LSWCD** 1999-2003
Milltown Creek					
Rt. 673		**DEQ** 2003 - 2004	**DEQ** 2003 - 2004		
Rt. 682				**LWC** 2004	**LWC** 2004
Rt. 691				**LWC** 2002-2004	**LWC** 2002-2004
Unnamed Tributary (aka Richard Run)					
Cottage Grove Lane		**DEQ** 2003 - 2004	**DEQ** 2003 - 2004	**LWC** 2004	**LWC** 2004

DEQ Monitoring – Water quality was routinely monitored by DEQ at three permanent stations until 2001. In 2001 DEQ changed their monitoring program to a rotational plan in which every watershed is sampled 2 years out of every 6 years. In addition, the frequency of monitoring was reduced from monthly to bi- monthly so that within the six-year cycle, each monitoring station has only 12 sample results. At the same time, DEQ established four new stations for routine monitoring for a total of seven in the watershed. Three additional special study stations were sampled in 1999-2000 period during the TMDL study. DEQ's altered monitoring plan has two major impacts:

- **Limited Data Availability for Decision Making** - Every two years DEQ reviews the stream monitoring data to assess water quality. **Table A.16** shows that the number of samples making up the data set used for the assessment has decreased since the 2001 change in state monitoring. In addition, the same data set will be used to assess ambient stations for two to three consecutive assessments, decreasing the value of the assessment process.

Table A.16. Analysis of the Number of Samples Used in the 305(b)/03(d) Integrated Report by DEQ for Loudoun County Waters – 2000 through 2006.

Watershed Monitoring Station	Type of Station	Number of Samples Used for Assessment			
		2000	2002	2004	2006 (Projected)
Catoctin Creek A02					
1ACAX004.57	Trend[1]	49	51	38	35
North Fork Catoctin Creek A02					
1ANOC000.42	Ambient[2]	19	22	16	10
1ANOC004.38	Ambient		11	11	12
1ANOC009.13	Ambient		11	13	13
South Fork Catoctin Creek A02					
1ASOC001.66	Ambient	20	22	17	11
1ASOC007.06	Ambient		11	11	11
1ASOC0012.38	Ambient		12	12	12

[1] Trend Stations – monitored once every two months, every year
[2] Ambient Stations – monitored once every two months, two out of every six years.

- **Limited Data Available to Assess Catoctin TMDL** – The original bacterial source tracking (BST) done by MapTech, Inc. under contract with DEQ during the TMDL study was very limited. The TMDL report concluded that it was sufficient only to "provide insight into the likely sources of fecal contamination," and to "aid in distributing fecal loads from different sources during model calibration." The MapTech, Inc. data, in themselves, are not sufficient to identify hot spots of contamination because of the short duration of the MapTech, Inc. study and the resulting small number of observations. Further, the impairments and watershed characteristics found in the Catoctin Creek watershed are characterized as "highly complex"

under DCR guidelines. Field surveys, stream walks, and an expanded source assessment are needed in such situations, but have not been done.

County Agency Monitoring – LSWCD has monitored stream water quality in the Catoctin watershed at five (5) stations since 1999. Samples are analyzed for nutrient parameters, bacteriological quality, and aquatic life.

Citizen Monitoring – LWC has sampled benthic macroinvertebrates at four (4) stations since 1997. In 2004 the number of stations was increased to nine (9) to better assess aquatic life conditions that are largely not monitored by DEQ. In 2005 LWC plans to expand their monitoring to include bacteriological quality assessment. An example of the importance of citizen monitoring to identify problems is provided in **Appendix 2** to this profile.

Physical, Chemical, Nutrient, and Sediment Conditions

Physical and Chemical Parameters – DEQ has collected physical and chemical data on the main branch of the Catoctin Creek, and the North and South Forks sinc the 1970's. The status of these key physical and chemical parameters are summarized in **Table A.17.** The water quality standards are consistently met in Catoctin Creek.

Table A.17. Summary of Key Chemical Parameters Based Upon DEQ Data in the Catoctin Watershed Between 1996 and 2001.

Parameter	DEQ's Criteria	Observation	Condition
pH	6-9 units	The average pH is good.	**Criteria consistently met**
DO (Dissolved Oxygen)	Minimum of 4 mg/l	DO levels vary between 6 – 9 mg/l which is well above the DEQ minimum standard.	**Criteria consistently met**
BOD (Biological Oxygen Demand)	Maximum of 7 mg/l set by EPA	Occasional high BOD spikes are possibly related to large storm events -- fewer spikes in recent years.	**Criteria consistently met**

Chesapeake Bay Nutrient Reduction Goals – Government and citizen groups in the Chesapeake Bay watershed have worked together since 1987 to reduce the amount of nutrients flowing into the Bay from tributaries such as the Potomac River and its tributaries including Catoctin Creek. High nutrient levels threaten the delicate balance of the Bay ecosystem by causing the rapid growth of unhealthly algae and prohibiting light from reaching underwater grasses critical to the health of the Bay's fish and shellfish. Excess algae release oxygen as a byproduct of photosynthesis during the day, but during the night, they respire and consume oxygen. Their oxygen consumption can reduce dissolved oxygen concentrations below the levels necessary to support other life. Excess algae can also foul the substrate habitat of aquatic insects.

Nutrient Levels in Catoctin Creek – Virigina agreed in 2003 to reduce sediment loads into the Chesapeake Bay to help improve the water clarity that is necessary for underwater grasses to thrive. Turbidity due to suspended solids and particles in the water is a major factor that blocks light from reaching the grasses. Virginia is to reduce sediments loads in the Potomac River watershed by 617,000 tons/year.

DEQ has collected nutrient data on the North, South, and main branch of the Catoctin Creek since the 1970's. LSWCD also has been collecting nutrient data at four stations since 1999. Estimated nutrient loads flowing from Catoctin Creek into the Potomac River are provided in **Table A.18.**

Table A.18. Average Annual Nutrient and Sediment Loads (lbs/ac/yr) for Catoctin Creek Based on DEQ 305(b) Data.

	Total Nitrogen	Total Phosphorus	Total Dissolve Solids
lbs/ac/yr	7.64	0.86	0.22
Acres	59,000	59,000	59,000
Total	450760 lbs/yr	50,740 lbs/yr	12,980 lbs/yr

Analyses of the DEQ data provided in **Graphs A.7 and A.8** show that phosphorus levels have decreased over the last 10 years. However, nitrogen levels have remained about the same over this time period. It is critical to reduce nitrogen in order to raise the dissolved oxygen levels in Chesapeake Bay and eliminate the "dead zones" in the Bay where the lack of oxygen is killing fish, crabs, and shellfish.

Figure A.7 Total Phosphorus Levels in Catoctin Creek at Taylorstown, 1995-2004

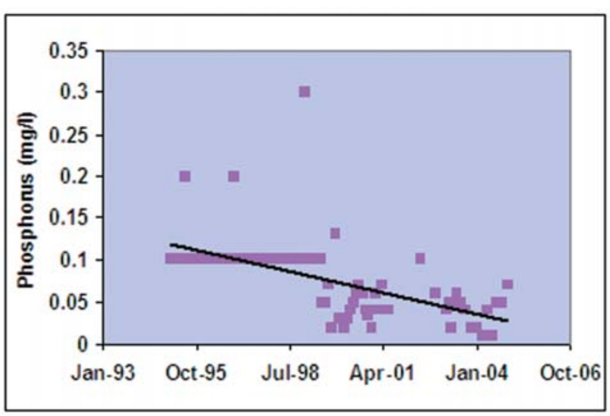
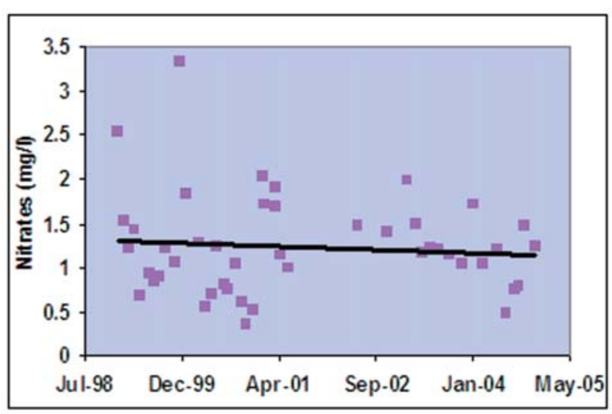


Figure A.8 Total Total Nitrogen Levels in Catoctin Creek at Taylorstown based on DEQ Data, 1999-2004.



Best Management Practices – There are four nonpoint pollution management practices recommended to reduce nutrient loads:

- Restore stream buffers on agriculture land to keep fertilizers and animal wastes out of the streams;
- Improve waste-water treatment to reduce nutrient loads
- Improve retention of urban storm water to better manage erosion, sediments and nutrients; and
- Utilize low impact residential development designs and nitrogen removing septic systems in rural areas.

Sediments – Sediments also impact Catoctin Creek. Aquatic insects live in the substrate and provide food for many game fish including bass. Fine particle sediment suspended in the stream water will settle out and fill in living spaces around gravel and cobble, and smother the aquatic organisms. Sediment also creates sand and mud bars in streams that shift after high flows. These unstable substrates provide unhealthy conditions for aquatic life.

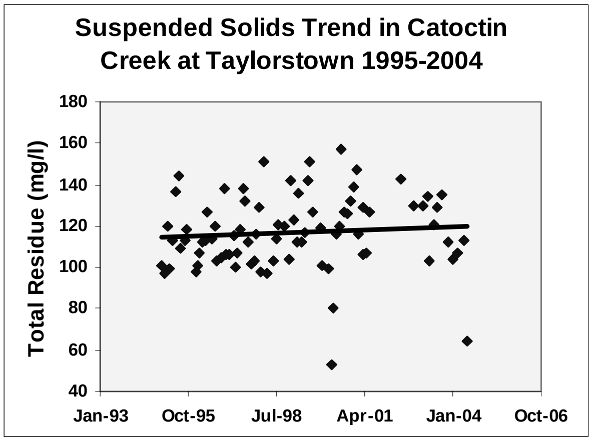
DEQ found that the primary sources of sediments in Catoctin Creek and the Potomac River are streambank erosion and runoff from agricultural lands used for pasture and crops with inadequate natural buffers along tributary streams. Sediment loads flowing into the Potomac River from Catoctin Creek are shown in **Table A.19.** The estimated load for 2001 is 8,800 tons. Remedies to restore healthy stream conditions include fencing livestock out of streams to decrease stream bank erosion and providing wider natural riparian buffers to stablize streambanks.

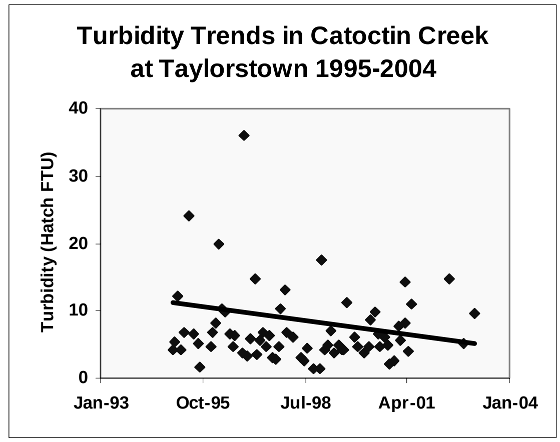
Table A.19. Average Annual Sediment Loads from Catoctin Creek by Source (in tons/year) for 2001.

Source	Loads	Percent
Construction	268	3.02%
Crops	1,335	15.03%
Forest	290	3.27%
Pasture	3,213	36.17%
Streambank Erosion	3,728	41.97%
Other	47	0.53%
Total	**8,882**	**100.00%**

DEQ has also collected turbidity and suspended solids data in the Catoctin Creek watershed since the 1970's. Analyses of DEQ data, provided in **Figures A.9 and A.10** on the next page, show that suspended solids levels have remained about the same over the last 10 years. Turbidity, which is a measure of the discoloration of water and the extent to which visibility is reduced, has decreased.

Figures A.9 and A.10 Suspended Solids and Turbidity Levels in Catoctin Creek at Taylorstown Based on DEQ Data, 1995-2004.





Bacteriological Water Quality Conditions

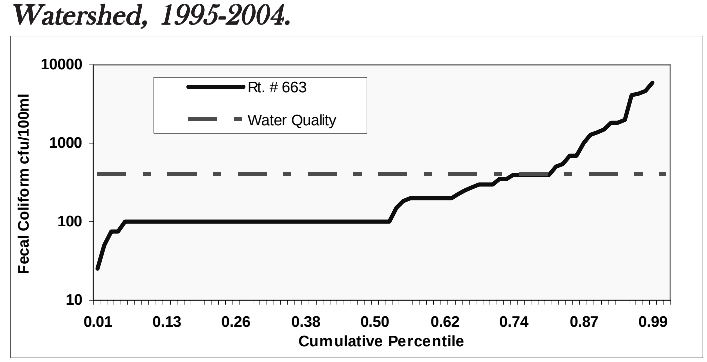
DEQ Data – Streams fit for recreational use must have low levels of fecal bacteria contamination. DEQ has collected fecal coliform data in the North Fork, South Fork, and the main stem of Catoctin Creek since the 1970's. The 1995-2004 fecal coliform bacteria levels for Catoctin Creek and the North and South Forks are shown in **Figures A.11, A.12 and A.13** below and on the next page. These data are plotted as cumulative percentages to show violation rates. The point at which the data line crosses the water quality standard line of 400 fecal coliform (mFC/100 ml) indicates the percentage of samples that meet the water quality standards. The difference between that percentage and 100% is the violation rate.

The DEQ data show the following:

- The data lines for the mainstem of Catoctin Creek at Taylorstown Bridge crosses the DEQ standard line at approximately 80% indicating that 20% of the samples exceed 400 mFC/100 ml and there is a 20% violation rate.

- The data lines for the North Fork Catoctin Creek stations indicate that water quality standards are met near the mouth of North Fork, but that water quality deteriorates upstream. The violation rate at the 4.38 stream mile point is 17% and at the 9.13 stream mile point it is 35%.

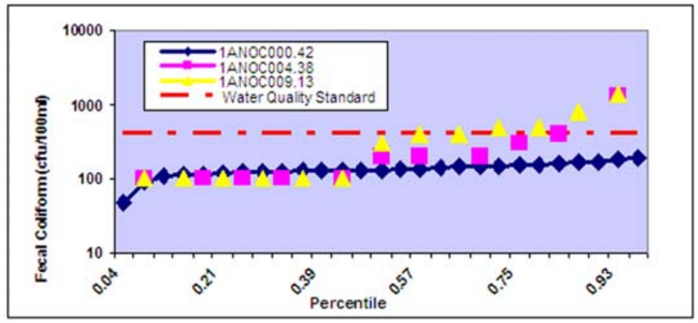
FigureA.11 Fecal Coliform Bacteria Concentrations Showing Water Quality Violation Rates for the Catoctin Watershed, 1995-2004.

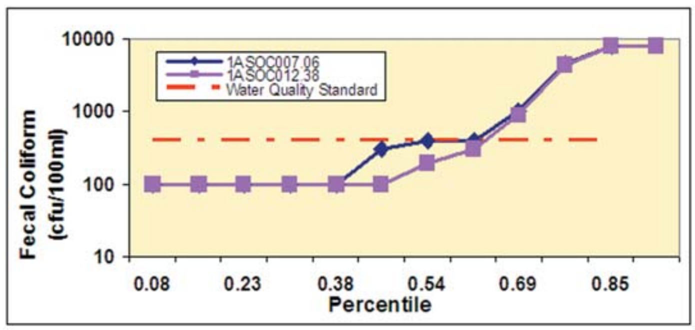


- The data lines for the South Fork Catoctin Creek stations indicate that water quality standards are exceeded 30 to 35% of the time at the two stations.

Loudoun Soil and Water Conservation District Data – LSWCD also collects fecal coliform data at four stations in the mainstem and North and South Forks Catoctin Creek. The monitoring data for the period 1999–2003 also show that a high percentage of samples violate the water quality standard at all stations.

Figures A.12 and A.13 Fecal Coliform Bacteria Concentrations Showing Water Quality Violation Rates for the Catoctin Watershed, 1995-2004.



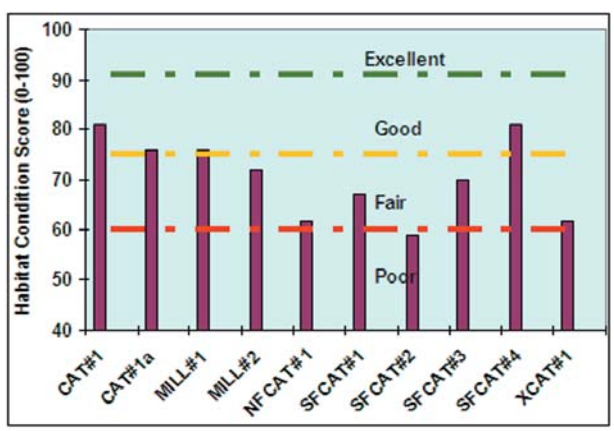


Stream Habitat Conditions

LWC Stream Habitat Data – LWC has collected stream habitat data since 1996 in the North and South Forks and at Taylorstown, and since 2002 in the Milltown Run tributary. LWC uses the EPA RBPII protocol and assesses the stream using ten parameters. Habitat scores for the 2004 assessments are shown in **Figure A.14**. The chart shows that the stream habitat at 60% of the monitoring stations is rated in the "Fair to Poor" range.

The habitat parameters that are most stressed or altered from what are natural conditions are:

Figure A.14 Stream Habitat Conditions in the Catoctin Creek Watershed Based on LWC Assessment Data.



- Narrow riparian buffers that reflect human impact along the immediate bank zone
- Unstable banks with eroded areas, bank scars, and bank sloughing.
- Stream banks poorly covered with natural vegetation leaving bare soils or low cut vegetation that are susceptible to erosion.
- Find sediments that surround and fill-in living spaces around and between gravel, cobble, and boulders creating poor conditions for aquatic life.

- Sediment deposition in the stream that fills in pools, and creates point bars at bends and mud banks along edges.

Aquatic Life Conditons

DEQ Aquatic Insect Data – DEQ has monitored aquatic insects in Catoctin Creek at Taylorstown for several years. DEQ considers the Taylorstown site to be comparable to the best condition to be expected in the ecological region. According to their data, there is an optimal and balanced aquatic insect population for a stream the size of Catoctin. The DEQ data are shown on the next page in **Figure A.15.**

LWC Aquatic Insect Data – LWC has monitored aquatic insect at four sites in the Catoctin Creek watershed since 1998. In 2004 the number of sites was increased to nine in order to develop more comprehensive data on the watershed. The 2004 data were analyzed to calculate an aquatic insect score for each monitoring station based on EPA recommended criteria. The results for the nine stations are shown on **Figure A.16.** These data show that the aquatic insect scores in the watershed generally are in the "fair" range. This means that there is only a moderate amount of species diversity, there are fewer sensitive species such as stoneflies and mayflies, and there are several species that are moderately tolerant of pollution such as caddisflies, true flies such as midge larvae, and aquatic beetle.

Figure A.15 DEQ Aquatic Insect Scores for Catoctin Creek at Taylorstown, 1997-2002.

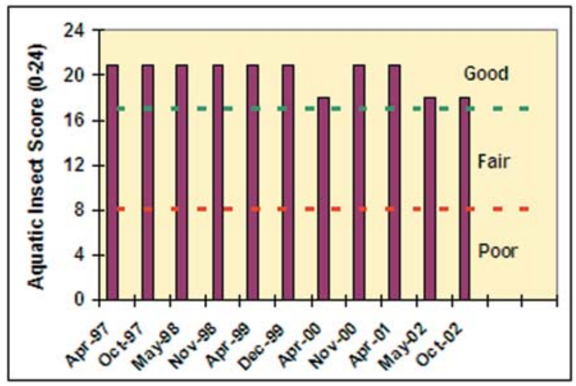
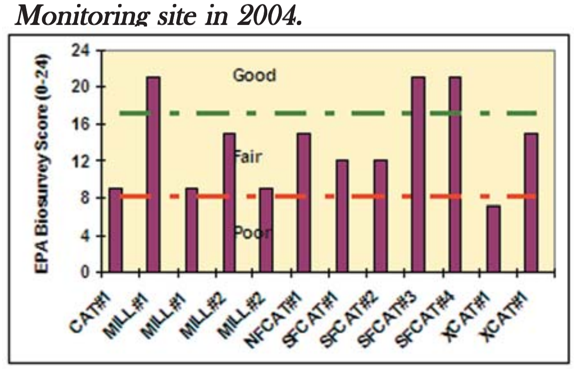


Figure A.16 LWC Aquatic Insect Scores for Nine Catoctin Creek Watershed Monitoring site in 2004.



Overall Assessment of Stream Health

The quality of the water and health of the stream ecosystem in the Catoctin watershed is well documented compared to most other streams in Loudoun. A summary of the various stream assessments can be found above in **Table A.20.** These assessments show that the health of the Catoctin Creek watershed is being significantly impacted by human activities. Large portions of the stream do not meet water quality standards and are designated as impaired because of fecal coliform bacteria contamination.

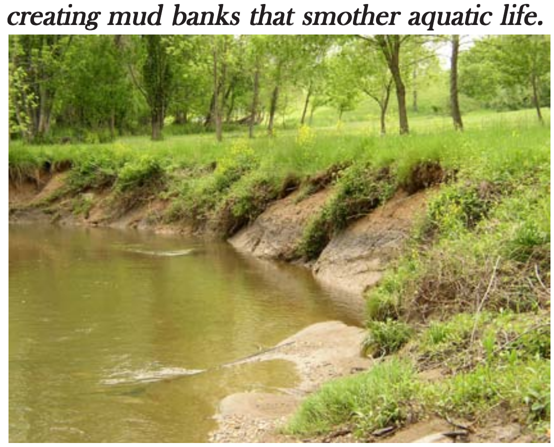
Table A.20. Summary of Catoctin Creek Water Quality and Stream Health Assessments.

Monitoring Site	Environmental Parameters					
	Chemical Quality	Nutrients/ Sediments	Bacteria Quality	Habitat Assessment	Aquatic Insect Score	Impervious Surfaces
Main Stem	Good	Marginal	Impaired	Good	Fair	Good
North Fork	Good		Impaired		Fair	Good
South Fork	Good		Impaired	Fair	Fair	Good
Milltown Creek	Good			Fair-Good	Fair	Good

Assessments of the stream habitat show generally "fair to poor" conditions. Narrow riparian buffers, unstable stream banks, and sediments that smother bottom substrates are common problems. The assessments of aquatic life show that the aquatic insect populations at all monitoring sites are generally in the "fair" range. The aquatic life assessments in the South Fork Catoctin Creek at Purcellville show a stressed aquatic insect community, and a stream segment has been designated as impaired.

Corrective Action Needed – Non-point sources of pollution are widespread in the watershed and are the cause of the poor water quality and aquatic life conditions. DCR has established limits on the pollution impacts that must be met to adhere to water quality standards. DCR also has worked with local stakeholders and developed a plan to limit these pollution loads and restore water quality by 2015. The pollution control plan targets cattle with access to streams and failing septic tank systems as the major problems which must be corrected to reduce fecal contamination. Farmers in the watershed are being offered cost-share and tax credits as incentives to exclude livestock from the streams. The most common exclusion method is to provide fencing and an alternative water supply. Homeowners are being asked to repair malfunctioning septic systems.

Absence of trees encourages stream bank erosion and sloffing of soils into stream creating mud banks that smother aquatic life.



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Attachment 1: DEQ Assessment - Catoctin

part 1

DEQ Assessment of Water Quality Conditions in Catoctin Watershed 2004 DEQ Fact

Stream	Location	Assessment	Status
Catoctin Creek Mainstem	7.2 mile segment begins at the confluence of Milltown Creek to Catoctin Creek, approx. 1.2 rivermiles downstream of Rt. 673, and continues downstream to its confluence with the Potomac River.	DEQ ambient, biological, and fish tissue/sediment station 1ACAX004.57. Citizen monitoring stations 1ACAX-4.57-LWC and 1ACAX-3-LWC. Fish tissue/sediment sampling was conducted in August 2001. Citizen biological monitoring results indicate an area of medium probability of adverse conditions at 1ACAX-3-LWC located approximately 1 RM downstream from the DEQ location. However, the DEQ monitoring data indicates fully supporting for all uses. This segment was initially listed in 1994 for a swimming use impairment due to fecal coliform bacteria exceedances. A fecal coliform TMDL for the Catoctin Creek watershed was submitted to the U.S. EPA on April 29, 2002 and approved May 31, 2002. The sources of fecal coliform bacteria requiring reductions are livestock and wildlife waste delivered directly to the stream, and human contributions from straight pipes. This segment was assessed as fully supporting the swimming use during this assessment cycle.	Impaired for recreational use based upon fecal coliform bacteria exceedances during past assessment cycles.
Milltown Creek	2 mile stream segment not assessed by DEQ. Citizen Monitoring Station 1AMIH-11-LWC.	Six surveys: 6/6 Fair Rating. Area of medium probability of adverse conditions for biota.	Not assessed by DEQ
North Fork Catoctin Creek	4.12 mile segment begins at the confluence of x-trib to North Fork Catoctin Creek, approx. 0.2 rivermiles downstream from Rt. 287 bridge, downstream to its confluence to Catoctin Creek. DEQ AWQM and sediment station 1ANOC000.42. Citizen Monitoring Station 1ANOC-1-LWC.	6 of 16 (37.5%) samples exceeded the instantaneous fecal coliform standard. A fecal coliform TMDL for the Catoctin Creek watershed was submitted to the U.S. EPA on April 29, 2002 and approved May 31, 2002. The sources of fecal coliform bacteria requiring reductions are livestock and wildlife waste delivered directly to the stream, and human contributions from straight pipes. Sixteen surveys at citizen monitoring station 1ANOC-1-LWC: 13/16 Fair ; 3/16 Poor rating. Citizen station finds medium probability of adverse conditions for biota.	Impaired for recreational use based upon fecal coliform bacteria exceedances during past assessment cycles.

Attachment 1 part 2

DEQ Assessment of Water Quality Conditions in Catoctin Watershed 2004 DEQ Fact

Stream	Location	Assessment	Status
North Fork Catoctin Creek	3.16 mile segment begins at outlet from an unnamed impoundment, approx. 0.4 rivermiles upstream from the Rt. 611 bridge, downstream to confluence of x-trib and N.F. Catoctin Creek, approx. 0.2 rivermiles downstream from Rt. 287 bridge (start of segment NOC01A00). DEQ SS Monitoring Station 1ANOC004.38.	This segment was included in NOC01A00 in the 2000 cycle and was listed in the 1998 303 (d) report. SS Station 1ANOC04.38 was added as a special study based on the 1998 303(d) listing of North Fork Catoctin Creek. The segment is not considered part of the listed impaired section of North Fork Catoctin Creek as the special study monitoring station indicates full support of the swimming use.	Meets WQ standards
North Fork Catoctin Creek	2.45 mile segment begins at the confluence of an x-trib to North Fork Catoctin Creek, approx. 0.8 rivermile upstream of Rt. 719, near Hillsboro, downstream 2.45 rivermiles to an unnamed impoundment. DEQ SS Monitoring Station 1ANOC009.13.	This segment was included in NOC01A00 in the 2000 cycle and was listed in the 1998 303 (d) report for a swimming use impairment. SS Station 1ANOC09.13 was added as a special study based on the 1998 303(d) listing of North Fork Catoctin Creek. The segment was not listed in the 2002 303(d) report. However, with the lower fecal coliform instantaneous standard, it is considered impaired. 4 of 13 samples (30.8%) exceeded the instantaneous fecal coliform standard. A fecal coliform TMDL for the Catoctin Creek watershed was submitted to the U.S. EPA on April 29, 2002 and approved May 31, 2002. The sources of fecal coliform bacteria requiring reductions are livestock and wildlife waste delivered directly to the stream, and human contributions from straight pipes.	Impaired for recreational use based upon fecal coliform bacteria exceedances during past assessment cycles.
South Fork Catoctin Creek	5.77 mile segment begins at the confluence of an x-trib to South Fork Catoctin Creek, approx. 0.55 rivermile upstream of Rt. 9, downstream to its confluence to Catoctin Creek. DEQ AWQM Station 1ASOC001.66.	Eight of 17 samples (47.1%) exceeded the instantaneous fecal coliform standard. Two of 17 samples (11.8%) exceeded the screening value of 0.2 mg/L for total phosphorus. A fecal coliform TMDL for the Catoctin Creek watershed was submitted to the U.S. EPA on April 29, 2002 and approved May 31, 2002. The sources of fecal coliform bacteria requiring reductions are livestock and wildlife waste delivered directly to the stream, and human contributions from straight pipes.	Impaired for recreational use based upon fecal coliform bacteria exceedances during past assessment cycles.

DEQ Assessment of Water Quality Conditions in Catoctin Watershed 2004 DEQ Fact

Stream	Location	Assessment	Status
South Fork Catoctin Creek	2.97 mile segment begins at confluence of x-trib to S. Frk Catoctin Creek, approx 0.75 rivermiles upstream from Rt. 287 bridge, downstream to the confluence of x-trib to S. Frk Catoctin Creek, approx. 0.55 rivermiles upstream from Rt. 9 bridge (start of SOC01A00). DEQ SS Monitoring Station 1ASOC007.06.	This station was added as a special study based on the 1998 303(d) listing of South Fork Catoctin Creek. Three of 11 samples (27.3%) exceeded the instantaneous fecal coliform standard.	Impaired for recreational use based upon fecal coliform bacteria exceedances during past assessment cycles.
South Fork Catoctin Creek	3.4 mile segment begins at the Purcellville town limits and continues downstream to the confluence with x-trib to S. Frk Catoctin Creek, approx 0.75 rivermiles upstream from Rt. 287 bridge (start of segment SOC02A02). DEQ biological monitoring stations 1ASOC011.98 and 1ASOC012.60. DEQ SS station 1ASOC012.38. Citizen monitoring station 1ASOC-4-LWC.	Station 1ASOC012.38 was added as a special study based on the 1998 303(d) listing of South Fork Catoctin Creek. Four of 12 samples (33.3%) exceeded the instantaneous fecal coliform standard. A fecal coliform TMDL for the Catoctin Creek watershed was submitted to the U.S. EPA on April 29, 2002 and approved May 31, 2002. The sources of fecal coliform bacteria requiring reductions are livestock and wildlife waste delivered directly to the stream, and human contributions from straight pipes. This segment was included in VAN-A02R_SOC03A02 last cycle. It was segmented differently because of the biological monitoring performed in this assessment cycle. Both DEQ monitoring stations indicate moderate biological impairments. The citizen monitoring station indicates a high probability of adverse conditions for biota. The two DEQ surveys indicating moderate benthic impairment were confirmed in the summer of 2003.	Impaired for recreational use based upon fecal coliform bacteria exceedances during past assessment cycles. Impairment for aquatic life based upon moderately adverse conditions for biota.
South Fork Catoctin Creek	5.17 mile segment begins at the headwaters of S. Frk Catoctin Creek downstream to the Purcellville town limits, downstream from the Rt. 7 bridge crossing. DEQ biological monitoring station 1ASOC013.05.	Downstream DEQ SS station 1ASOC012.38 was used to perform the physical/chemical and pathological assessment. Station 1ASOC012.38 was added as a special study based on the 1998 303(d) listing of South Fork Catoctin Creek. 4 of 12 samples (33.3%) exceeded the instantaneous fecal coliform standard. This segment was included in VAN-A02R_SOC03A02 last cycle. It was segmented differently because of the biological monitoring performed in this assessment cycle. Biological monitoring results from station 1ASOC013.05 indicate a slight benthic impairment.	Impaired for recreational use based upon fecal coliform bacteria exceedances during past assessment cycles. Slight impairment for aquatic life based upon slight adverse conditions for biota.

Attachment 2: Why Monitor?

Why Should Citizens Monitor? – A Case Example

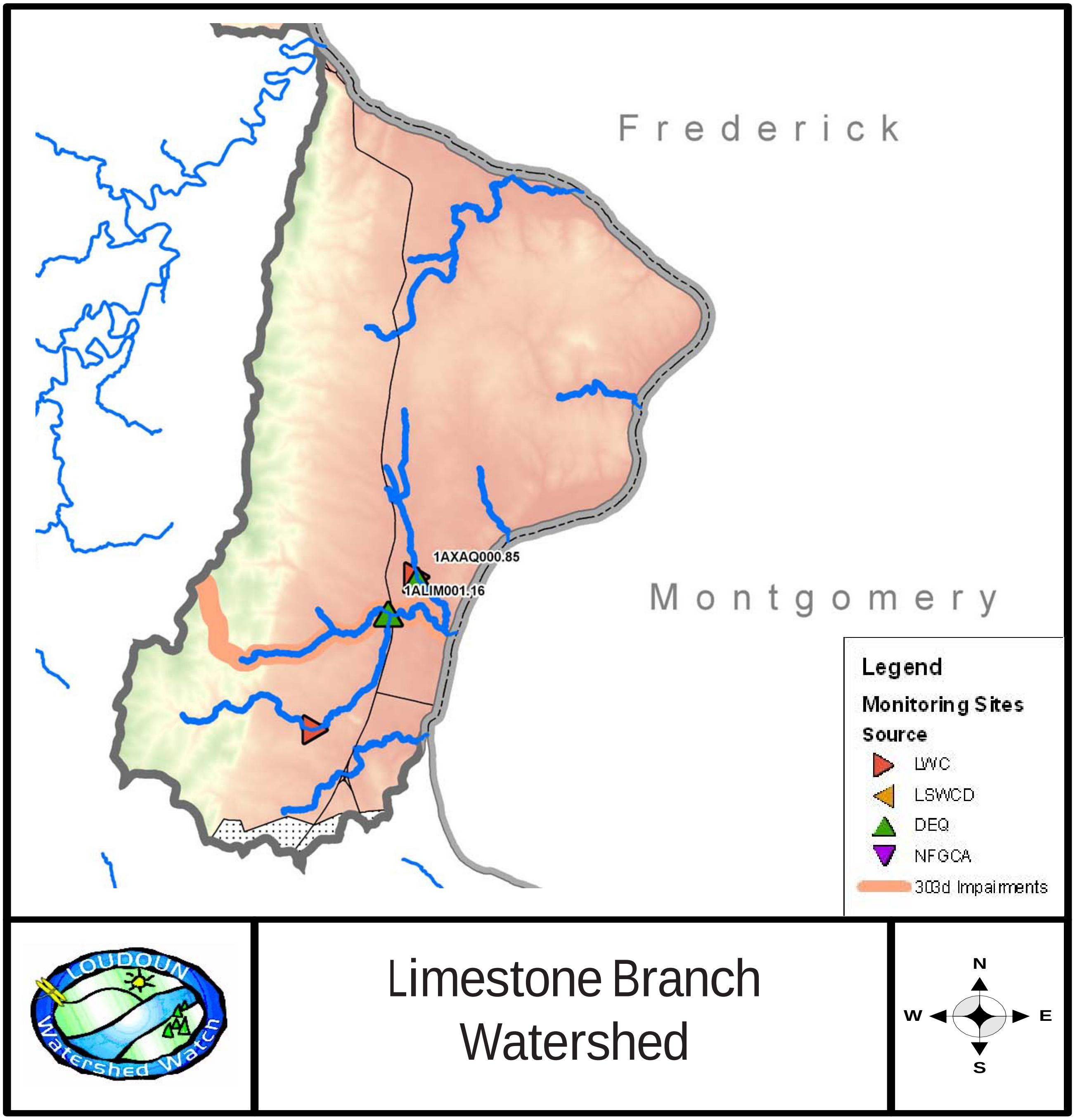
First Referral to DEQ – In November 2000 volunteer stream monitors filed a complaint with DEQ about water quality problems in the South Fork Catoctin Creek at Purcellville. The volunteers were concerned that the condition of the stream had deteriorated in the wake of two pollution-related incidents during the fall, including a tar spill. Fred W. Fox, a biologist and co-chairman of the Loudoun Wildlife Conservancy stream monitoring project, advised DEQ that fuel and chemicals from an industrial park were contaminating Catoctin Creek. "This stream segment is under assault from massive land-use changes in the watershed, and industrial and residential runoff are the main culprits." Stream monitoring records showed a decline in the number of aquatic insects. The number and type of insects indicates the overall quality of the water. At the same time a volunteer discovered tar oozing from a storm drain in an embankment directly beneath Valley Industrial Park.

DEQ Action – The Virginia Department of Environmental Quality (DEQ) had already started monitoring at a station upstream of the industrial park in July 1999 and continued until August 2000. This monitoring site, however, did not assess the impact of the problems at the industrial park on the downstream portion of the stream. DEQ began collecting aquatic insect samples downstream of the industrial park in June 2001 continuing to July 2002. DEQ did not collect these data in time, however, to be considered when they contracted with MapTech, Inc. in the fall of 2001 to begin studying water pollution problems in the Catoctin watershed. As a result, the TMDL study of Catoctin Creek did not include the aquatic life problems in the Purcellville portion of the South Fork Catoctin Creek.

Second Referral to DEQ – In June 2003 Loudoun Watershed Watch submitted a second referral to DEQ regarding the degraded conditions in the Purcellville section of the South Fork Catoctin Creek. The referral included LWC stream monitoring data and pictures that clearly demonstrated poor stream conditions.

Further Action Required – DEQ designated this section of the creek as impaired in 2004 based on the benthic survey they conducted in June 2001. Unfortunately, the impairment is not scheduled for study or restoration for at least ten years. In addition, the current fecal coliform TMDL implementation plan for the Catoctin Creek watershed does not include any funding to address the stormwater pollution problems in Purcellville that are the likely cause of the aquatic life impairment in the South Fork Catoctin Creek.

Limestone Branch Watershed



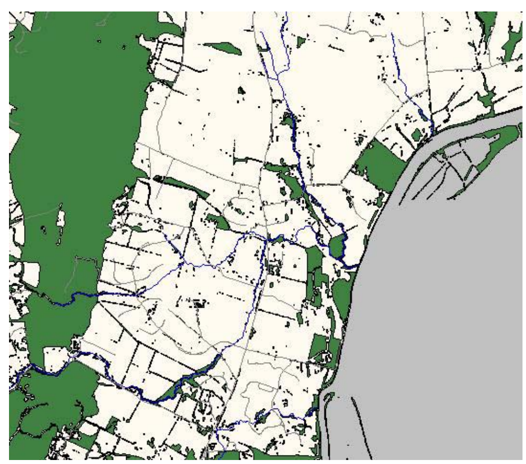
QUICK REFERENCE .... Page

Watershed Description

The Limestone Branch is a small watershed located in the eastern portion of the county north of Leesburg. The watershed runs from west to east, and is approximately 3.5 miles long and 7 miles wide covering an area of approximately 15.5 square miles. It drains less than 10,000 acres or 3% of the county. There are no major tributaries although three smaller unnamed drainages exist.

Limestone Branch is located within the Piedmont, and topography varies only slightly. Elevations range from 200 ft to 800 ft above sea levels. In general, soils with high infiltration rates and low runoff potential are located in the low areas, and soils with low infiltration rates and high runoff potential tend to be found in the higher elevations. The average annual rainfall is 42 inches. There is no stream flow data for the Limestone Branch watershed.

Limestone Branch watershed showing forest cover.



Land Use – Land use is predominately pasture (57%) and forest (39%). There are two major residential areas - Beacon Hill Estates and Golf Course, and Raspberry Falls Estates and Golf Course. The steeper slopes in the headwater portions of the watershed have remained forested, while the pasture land tends to be closer to the streams and in the lower elevations. Both residential developments and golf courses are located at the higher elevations where runoff potential is high. Riparian buffer zones are minimal to nonexistant in the residential-golf course sections of the stream, and marginal in many segments where the land is in pasture and crop use. Further conversion of agricultural land to residential use can be expected as residential communities in the nearby Leesburg continue to expand to accommodate Loudoun County’s high rate of growth.

Impervious Surfaces – Impervious surfaces include the roadways, driveways, rooftops and parking lots that do not allow infiltration of water from rainstorms and runoff. The Loudoun County Environmental Indicators Project (LEIP) includes mapping of impervious surfaces in the county using Lansat Imagery. They report that the amount of impervious surface in the Limestone Branch watershed is less than 1%. As a general rule, a watershed with less than 10% of its area in impervious surfaces will not experience a noticeable impact on the hydrological characterisitics of the watershed. However, lawns in residential areas and golf course fairways located in soils with high runoff potential can be an exception to this rule. High flows that cause downstream bank erosion and flooding are common in portions of the Limestone Branch watershed.

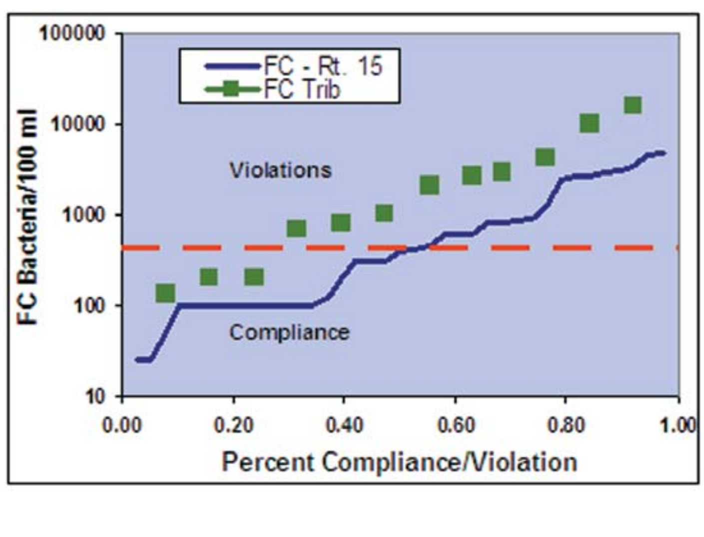
Turbid waters and streambank erosion downstream of residential-golf course development in Limestone Branch watershed.

Water Quality Studies

Water Quality Standards - Water samples collected by DEQ at Rt. 15 since the early 1970's show that water quality conditions in Limestone Branch are marginal. The state water quality standard for fecal coliform bacteria was being exceeded about 40% of the time. In 1998 DEQ listed 4.75 miles of Limestone Branch as "impaired." The stream segment does not meet state standards for recreational use because of fecal coliform bacteria pollution.

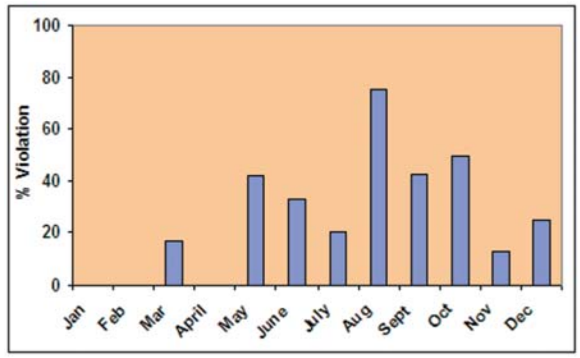
The 1995-2004 DEQ fecal coliform bacteria data, plotted as cumulative percentages to show the percent of samples that exceed the standard, are provided in **Chart A.17.** The water quality at the Rt. 15 station does not meet state standards in that about 50 % of the samples are above 400 fecal coliform. MapTech also collected fecal coliform data at a station on the unnamed tributary at Rt. 661. Seventy-five percent of the samples at this station exceeded the state standard, as well. These data are also shown on **Graph A.17.**

Figure A.17. Fecal Coliform Bacteria Levels in Limestone Branch 1995-2004.



DEQ also analyzed the water quality data to determine whether there is a seasonal pattern in violations. These results are shown in **Graph A.18.** The violation rate is highest from May to October when water flow is likely lowest and livestock have the greatest access to streams.

Figure A.18. Seasonal Distribution of Fecal Coliform Violations of the Water Quality Standard in Limestone Branch at Rt. 15.



TMDL Study – In 2002-2003 DEQ conducted a Total Maximum Daily Load or TMDL study and published the results in a 2004 report titled, "Bacteria TMDL for Limestone Branch, Loudoun County, Virginia." During the study MapTech, under contract with the Virginia Department of Conservation and Recreation (DCR), collected 24 water quality samples at two sites on a monthly basis from August 2002 through July 2003. The samples were analyzed for fecal coliform, E. coli bacteria, and their antibiotic resistance characteristics (a form of BST analysis). The latter analysis provides the identity of the species of warm blood animal that deposits the fecal wastes in the stream. There were four categories of sources identified: human, livestock, pet, and wildlife.

Assessment of Fecal Coliform Bacteria Sources – The TMDL study determined the relative contribution of bacteria by human, pet, livestock, and wildlife sources of fecal bacteria into the stream at two sampling stations. The results of these analyses are shown in **Table A.21.** Human sources are relatively small in the watershed, pet and livestock are about equal contributors in the mainstem of Limestone Branch, livestock is the main contributor in the unnamed tributary, with pets and wildlife a close second.

Table A.21. Bacteria Source Tracking Results for Limestone Branch Watershed.

Fecal Coliform cfu/100 ml (median)	E. coli cfu/100 ml (median)	Bacteria Source Tracking Distribution (average)			
		Human	Pet	Livestock	Wildlife
Limestone Branch at Rt. 15					
445	165	8%	32%	34%	26%
Unnamed Tributary at Rt. 661					
1500	450	8%	28%	37%	28%

The study also estimated the quantity or what they called "loading" of each of the four sources in the watershed. The load estimates where divided into point sources and nonpoint sources of pollution. Point sources of pollution are those discharges that come out of a pipe. Nonpoint sources of pollution are wastes that are discharged into streams in a diffused manner or flow over the land into streams in runoff from a rainfall.

- **Point Sources of Pollution –** Limestone Branch watershed has six small sewage treatment plants that have been issued state discharge permits for their treated effluent. The plants and their permitted discharges are listed on **Table A.22.** The permitted discharge loads are two to three orders of magnitude (1012 compared to 1014 or 1015) less than the estimated loads from human, pet, livestock and wildlife sources in the stream, and, therefore, are not a significant contributor. This remains true even in the event that the discharges increase to 4-times the current volume.

Table A.22. Annual Fecal Coliform Bacteria Discharges from the Permitted Waste Water Treatment Plants Discharging in the Limestone Branch Watershed.

Facility Name	Receiving Stream	Design Flow (MGD)	Fecal Coliform Discharge Limit (cfu/100ml)	Annual Fecal Coliform Discharge (Max permitted)
Lucketts Elem. School	Tributary to Limestone Br.	0.0063	126	1.10×10^{10}
Piedmont Behavioral Health Center	Tributary to Limestone Br.	0.0100	126	1.74×10^{10}
Hiway Mobile Home Community	Tributary to Limestone Br.	0.0120	126	2.09×10^{10}
Raspberry Falls	Limestone Br.	0.1000	126	1.74×10^{11}
Selma Plantation	Tributary to Limestone Br.	0.0150	126	1.83×10^{11}
Oakwoods	Tributary to Limestone Br.	0.0900	126	1.57×10^{11}
Existing Permitted Fecal Coliform Discharge				**5.63×10^{11}**
2 x Expansion				**1.13×10^{12}**
4 x Expansion				**2.82×10^{12}**

- **Human Non-Point Sources From Straight Pipes –** In 2000 Limestone Branch watershed had a population of approximately 1,600 people living in 531 households. Some of these properties have no known septic systems. The Virginia Department of Health (VDH) estimates that there are nine households located adjacent to perennial streams that have straight discharges of untreated sewage (straight pipes).

- **Human Non-Point Sources From Malfunctioning Septic Systems –** VDH estimated the number of households with malfunctioning septic systems based on the known drain field locations and age of the systems. They estimate there are potentially 64 failing septic tanks systems in the Limestone Branch watershed that are discharging partially treated or untreated wastes in perennial streams.

- **Livestock** – DEQ used 1997 agriculture data for Loudoun County to estimate the number of livestock. The Limestone Branch watershed contains approximately 3% of the total pastureland in the county. Wastes from livestock are deposited directly to the stream where livestock have stream access, and are deposited on the land where it is available for transport to streams in surface runoff. DEQ estimates there are approximately 1,200 cows, cattle and calves; and 100 horses in the watershed.

Livestock with stream access deposit wastes and erode stream banks.

- **Wildlife** – Wildlife most likely to contribute significant amounts of fecal coliform bacteria in wastes are deer and raccoons. The Virginia Department of Game and Inland Fisheries (DGIF) estimates there are approximately 1,650 deer and 230 raccoon in the watershed based on available habitat types.

- **Fecal Coliform Bacteria Loads from Non-Point Sources of Pollution** – DEQ used the estimated populations of human and animal sources to develop estimated fecal coliform bacteria loading from non-point sources in the Limestone Branch watershed. The population estimates were multiplied by the typical waste production rates and typical fecal coliform bacteria densities in the waste products of the different sources to get the estimated source loads. The annual fecal coliform loads from major sources are listed on **Table A.23.**

Table A.23. Estimated Fecal Coliform Production from Point and Nonpoint Pollution Sources in the Limestone Branch Watershed.

Source of Pollution	Population in Limestone Br	Waste Production (Average)	Annual Fecal Bacteria Load (cfu/yr)
Human – straight pipes	27 people	7.3×10^{11} cfu/yr/person	1.97×10^{13}
Human – failing septic systems	192 people	1.04×10^{6} 100 mL/yr/person	2.07×10^{14}
Livestock	49,317 cattle/cows + 15,800 horses + other livestock	47.5 lbs/animal/yr	1.02×10^{15}
Wildlife	1651 deer + 233 raccoon + other wildlife	1.3×10^{6} g/deer/yr & 1.05×10^{5} g/raccoon/yr	2.58×10^{14}
		Total	**1.5×10^{15}**

Stream Monitoring

Stream Quality and Habitat Monitoring– DEQ monitors water quality at one location, and Loudoun Wildlife Conservancy (LWC) monitors stream habitat and aquatic life at two locations in the Limestone Branch watershed. DEQ has collected chemical and bacteriological data at their station on the main stem at Rt. 15 dating back to 1974. LWC has collected habitat and aquatic insect data from a tributary station at Rt. 661 dating from 1997 and a tributary station at Rt. 740 dating from 2001. A summary of the available data is provided in **Table A.24.**

Table A.24. Stream Monitoring Data for the Limestone Branch Watershed.

Monitoring Sites	Water Flow	Chemical	Bacterial	Habitat	Aquatic Insects
Rt. 15		**DEQ** 1974-2004	**DEQ** 1974-2004		
RT. 661				**LWC** 1997-2004	**LWC** 1997-2004
Rt. 740				**LWC** 2001-2004	**LWC** 2001-2004

DEQ has designated Limestone Branch at Rt. 15 as a trend station which means it is sampled several times a year. In addition, MapTech collected 12 additional samples in 2003 during the TMDL special study under contract with the DCR.

Water Chemistry Conditions

The chemical quality of a stream is an important indicator in determining whether the stream is fit for recreational use. DEQ has collected chemical water quality data at one station on Limestone Branch since the 1970's. These data show that chemical parameters meet state standards and national guidelines. These key chemical parameters for the period 1996-2004 are summarized in **Table A.25** on the next page.

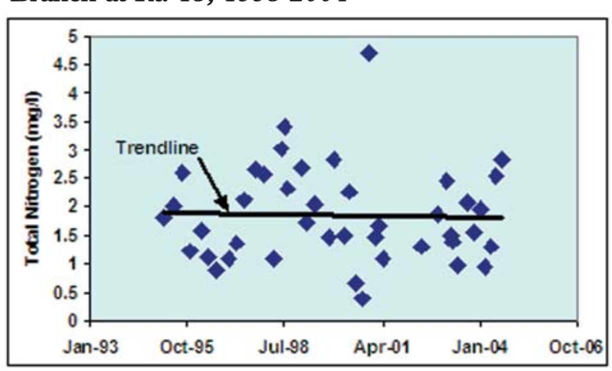
Mowed grass and hilly terrain results in high stormwater runoff flows, downstream erosion, and flooding.

Table A.25. Summary of Key Chemical Parameters Based Upon DEQ Data from the Limestone Branch Watershed Between 1996 and 2001.

Parameter	Criteria	Observation	Condition
pH	Range of 6-9 units	Mean pH level is 7.3 and range from 4.4 to 8.5. Levels fell below 6 during one period which is toxic to aquatic life.	Criteria generally met
DO (Dissolved Oxygen)	Minimum of 4 mg/l	Mean DO level is 10.4 with a range of 6 to 14.2 mg/l. Levels are consistently between 8 and 12 mg/l which is very good for aquatic life.	Criteria consistently met
BOD (Biological Oxygen Demand)	No DEQ standard – EPA guildline is a maximum of 7 mg/L	Mean BOD level is 2.1 with a range of 0.4 to 5 mg/l. Levels are consistently less than 2 mg/l indicating low organic loads.	Criteria consistently met
Phosphorus	No DEQ standard – EPA guideline is 1 mg/L for non-impaired waters	Mean level of 0.09 mg/l suggests there is not excessive run-off of fertilizers from agricultural and other operations affecting the watershed.	Criteria consistently met
Nitrogen (as Nitrate)	No DEQ or EPA guideline for nitrogen	Mean level of 0.5 with a range of 0.1 to 1 mg/l. These low levels of nitrogen in combination with low levels of phosphorus keep growth of aquatic plants in check.	Low levels

Chesapeake Bay Nutrient Reduction Goals –Government and citizen groups in the Chesapeake Bay watershed have working since 1987 to reduce the amou nt of nutrients flowing into the Bay from tributaries such as the Potomac River and its tributaries including Limestone Branch. An analysis of DEQ's nitrogen data for 1995-2004 is provided in **Figure A.19.** The trendline for these data show that nitrogen levels are not being reduced over this time period. It is critical to reduce nitrogen in order to raise the dissolved oxygen levels in Chesapeake Bay and eliminating the "dead zones" in the Bay where the lack of oxygen is killing fish, crabs, and shellfish.

Figure A.19. Total Nitrogen for Limestone Branch at Rt. 15, 1995-2004

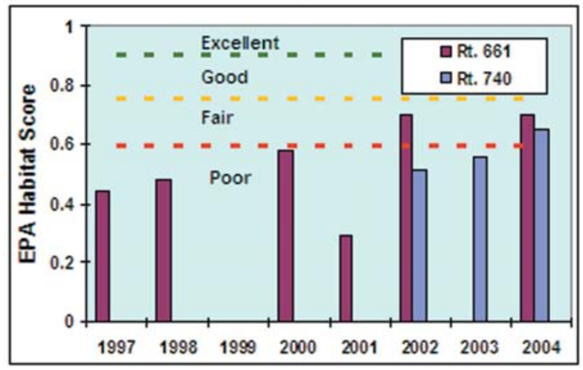


Stream Habitat Conditions

Loudoun Wildlife Conservancy – LWC has collected stream habitat data at two sites on tributaries in the watershed using the EPA RBPII protocol for several years. Monitoring at the Rt. 661 site was started in 1997, and monitoring at the Rt. 740 site started in 2001. The quality of the stream habitat is assessed using ten

parameters that are combine into a "habitat condition score." The results are summarized in **Figure A.20.**

Figure A.20. Stream Habitat Condition on Tributaries to Limestone Branch at Rt. 661and Rt. 740, 1997-2004



These data show that the stream habitat condition is generally in the "poor" to "fair" range of conditions. This indicates that the streamside habitat is being degraded by human activities, and that the health of aquatic life can be impacted. The greatest problems are loss of riparian buffers and natural vegetation that stabilizes the streambank and help prevent erosion. As a result aquatic insects that live in the cobble and gravel in the stream substrate are smothered by sediments from erosion and shifting substrates caused by high stormwater flows.

Aquatic Insect Populations

Loudoun Wildlife Conservancy – LWC has collected aquatic insect data at the Rt. 661 tributary site since 1997 and at the Rt. 740 tributary site since 2001. These data were analyzed using EPA metrics. The results for the station off of Rt. 740, Tutt Lane, are shown in **Figure A.21.** They indicate the conditions of the aquatic insect communities at this monitoring site are generally in "fair" range. There are a reduced number of different types of insects, fewer insects that are intolerant to pollution and sediments, and more insects, such as black flies, that are tolerant of pollution. The data also show that conditions are getting worse. This site is downstream of a large development that includes a golf course. There are few natural riparian buffers and high levels of runoff from the steep slopes on the golf course that contribute to streambank erosion problems.

Figure A.21. Aquatic Insect Conditions in Unnamed Tributary to Limestone Branch at Rt. 740, 2001 - 2005.

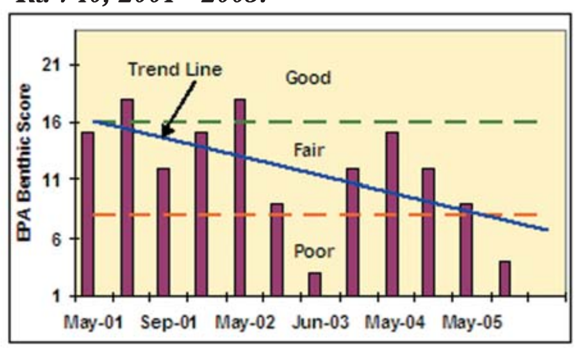
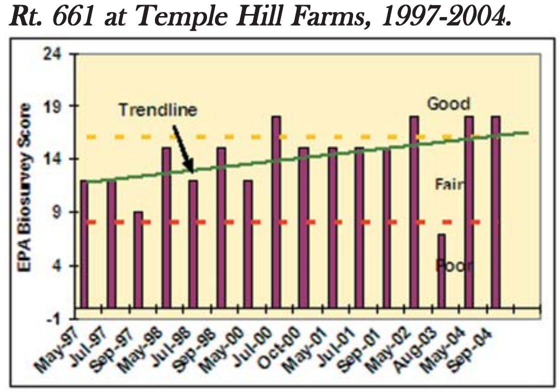


Figure A.22. Aquatic Insect Conditions in Unnamed Tributary of Limestone Branch at Rt. 661 at Temple Hill Farms, 1997-2004.



Aquatic life conditions in the other tributary at the Rt. 661 station where there is no large development and golf course in the headwaters are different as seen in **Figure A.22.** The conditions are generally in the "fair" to "good" range that

intolerant to pollution and sediments, and fewer that are pollution tolerant. Conditions also seem to be improving as shown by the trendline. This monitoring site is downstream of a regional park, and park authorities have fenced off the stream from livestock, planted trees, and allowed the natural vegetation to grow in the riparian buffer. This is greatly improving the stream habitat and stream conditions upstream of the monitoring site, and it may account for the improving aquatic life conditions at the downstream site.

Steep banks with active erosion and undercutting of trees from high flows along Rt. 740.

Conducting a habitat assessment at the Rt. 661 site where the riparian buffer is being restored.

Overall Assessment of Stream Health

Water quality and stream habitat conditions are documented at one DEQ and two LWC monitoring sites in the Limestone Branch watershed. The data show that although the water chemistry is good, fecal contamination from nonpoint sources of pollution affect the entire watershed. These waters do not meet DEQ's water quality standards for recreational use and the main stem has been classified as "impaired." DEQ currently does not have sufficient water quality data for the two unnamed tributaries to classify these waters, although samples taken during the TMDL study show high levels of fecal bacteria.

Stream habitat conditions are monitored by LWC at their two monitoring sites. Conditions are generally "poor" to "fair" due to poor riparian buffers, limited natural vegetation along the streams, and high stream bank erosion that contributes sediments to the streams and covers stream-bottom cobble and gravel. These conditions impact the biological community.

The condition of aquatic insects at the two sites are generally in the "fair" range. However, in one tributary with a large development and golf course in the headwaters, aquatic insects show a downward trend. In the other tributary without a development and golf course in the headwaters, aquatic life conditions appear to be improving. Recent restoration of

the riparian buffer upstream of the latter monitoring station has likely helped improve aquatic life conditions. The results of these measurements of the condition of the Limestone Branch watershed are summarized in **Table A.26.**

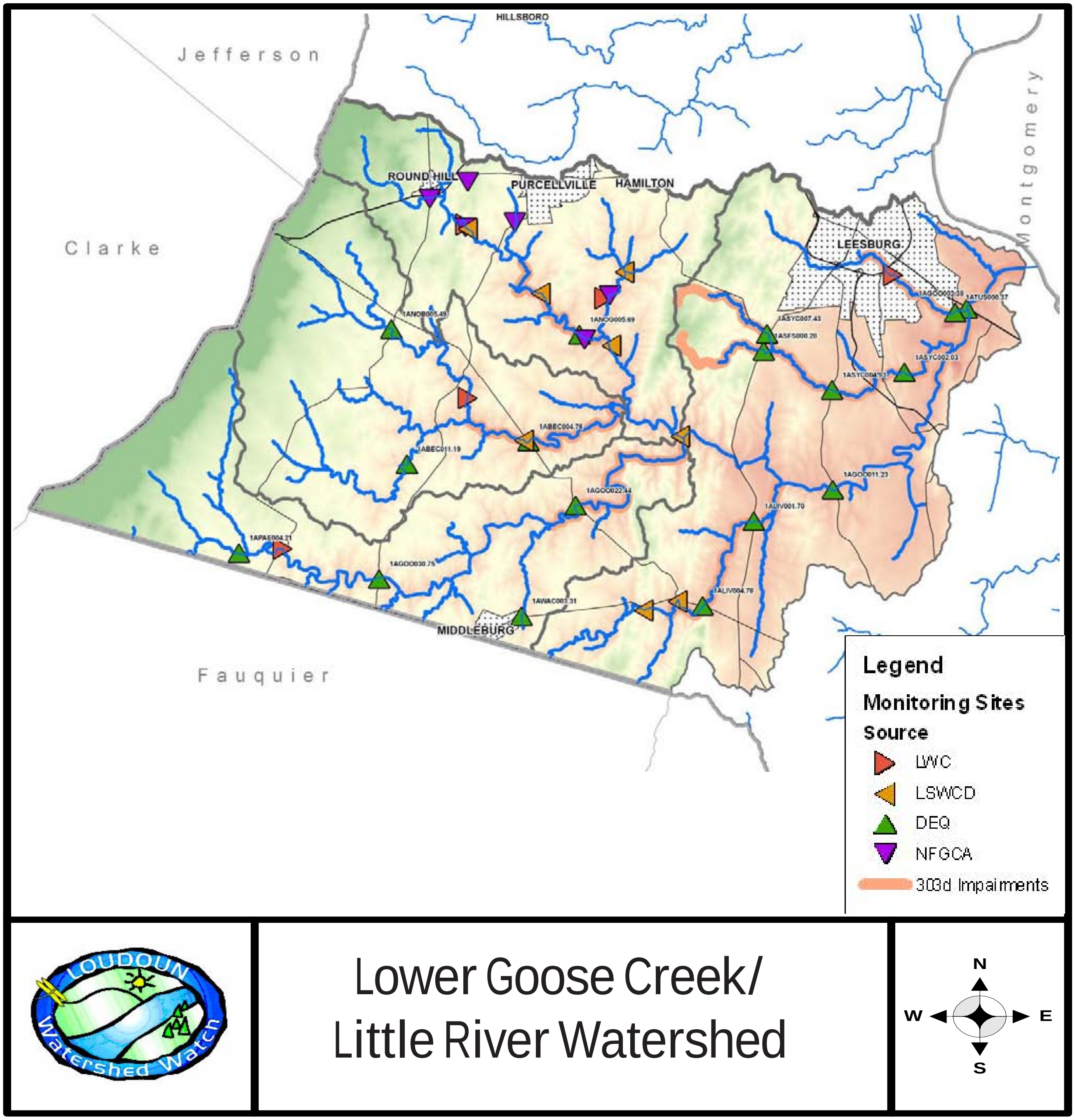
Table A.26. Summary of Limestone Branch Assessments that Measure Stream Health.

Monitoring Site	Environmental Parameters					
	Water Flow	Chemical Quality	Bacteria Quality	Habitat Assessment	Aquatic Insect Score	Impervious Surfaces
Rt. 15		Good	Impaired			Good
Rt. 661 Tributary				Poor -Fair	Fair	Moderate
Rt. 740 Tributary				Poor - Fair	Fair	Good

References:

Virginia Department of Environmental Quality. 2004. Draft Bacteria TMDL for Limestone Branch, Loudoun County, Virginia. March 2004.

Lower Goose Creek/Little River Watershed–2005



QUICK REFERENCE .... Page

Watershed Description

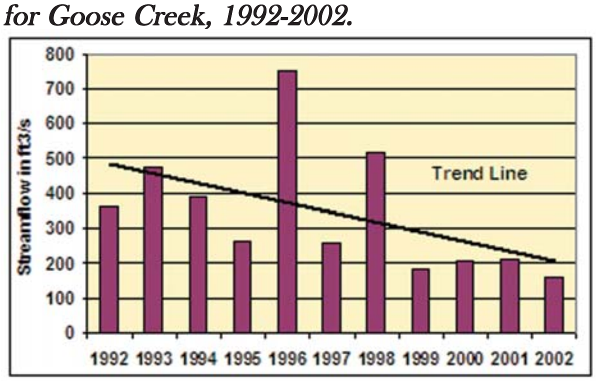
Goose Creek and its tributaries are part of the Potomac River Basin that flows into the Chesapeake Bay. The headwaters of Goose Creek begin near the Blue Ridge Mountains in northwestern Fauquier county and flow east and slightly north for approximately 53 miles toward its confluence with the Potomac River. The Lower Goose Creek subwatershed drains 57,000 acres in the middle portion of Loudoun County. Major tributaries are Little River, Tuscarora Creek, and Sycolin Creek. Tuscarora Creek flows through Leesburg and drains large urban residential and commercial areas.

The watershed is characterized by silt and clay loam soils derived from metamorphic and igneous bedrock. A large percentage of the soils in the lower portion of the watershed east of Leesburg are poorly-drained soils.

The entire portion of the mainstem of Goose Creek in Loudoun County have been designated a scenic river under Virginia's Scenic River Act. The City of Fairfax operates a water supply reservoir and intake on Goose Creek and maintains a second water supply reservoir on a small tributary.

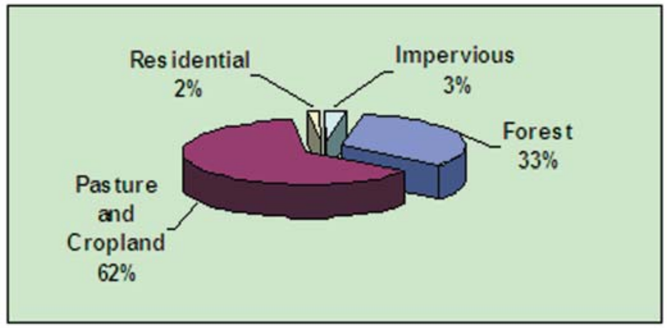
Stream Flow Rates – There are limited data on stream flow in the Lower Goose Creek watershed. DEQ discontinued collecting stream flow data in the early 1990's. US Geological Survey has stream flow data at Rt. 7 dating from 1910. The USGS data are shown in **Figure A.23.** These data show a declining trend of stream flow since 1992.

Figure A.23. USGS Annual Mean Streamflow for Goose Creek, 1992-2002.



Land Use – The Goose Creek watershed lies on the edge of the Washington, D.C. metropolitan area. The watershed includes the towns of Leesburg and Middleburg. Much of the watershed remains rural, although large portions around Leesburg and Beaverdam Creek and Reservoir are rapidly being developed. These areas are in the high density and moderate density development sections of the Loudoun County Comprehensive Plan. A breakdown of land uses in the watershed is shown in **Chart A.3.**

Chart A.3 Land Use in Lower Goose Creek Watershed Based on 1997 Data.



Impervious Surfaces – Impervious surfaces include the roadways, driveways, rooftops and parking lots that do not allow infiltration of water from rainstorms and runoff. DEQ used a 1997 EPA study to determine that the amount of impervious surface in the Lower Goose Creek and Little River subwatershed is 3%. As a general rule, a watershed with less than 10% of its area in impervious surfaces will not experience a noticeable impact on its hydrological characterisitics.

However, these same data shown that the Tuscarora Creek subwatershed has an imperviousness of 10%. Further, the lower Sycolin Creek subwatershed has an imperviousness of 17%. These streams drain large residential and comercial areas in Leesburg, and have poor riparian buffers along many segments. Streams having 10% or greater imperviousness will exhibit characteristics such as eroding banks, poor biological diversity, and high bacterial levels. In addition, the DEQ reports that the population of Loudoun County is expected to increase by 75% over the next 10 years, and a large portion of this growth will be in the Goose Creek watershed. Imperviousness can be expected to increase substantially.

Water Quality Studies

Water Quality Standards – Stream waters that are fit for recreational use must have low levels of fecal contamination. Virginia streams must also be fit to support aquatic life. DEQ has collected fecal coliform data at five stations in the Lower Goose Creek and Little River watersheds since the 1970's to determine whether these water quality standards are being met. DEQ also monitors aquatic life (benthic macroinvertebrates) in the Lower Goose Creek at Rt. 7 and in Little River.

The fecal coliform bacteria samples indicate that water quality at these stations do not meet the state fecal coliform bacteria standard of 400 fecal coliform. The 1995-2004 data on fecal coliform bacteria levels, plotted as cumulative percentages to show the level at which the water quality standard is exceeded, are

shown in **Figure A.24.** The percent violations at the different stations range from 20 to 55%.

The trend line for these data, when plotted by sampling date, suggest that fecal coliform concentrations have gradually decreased over time. The two exceptions are in Sycolin Creek and Tuscarora Creek where fecal concentrations have increased over the period of sampling. The Sycolin Creek data are shown in **Figure A.25.**

Loudoun Soil and Water Conservation District (LSWCD) – LSWCD has also collected fecal coliform data in Little River at two sites since 1999. These data support the DEQ data that over 10 % of the samples exceed 400 and that water quality standards are not being met, as shown in **Figure A.26.** These data also reveal that intermittent spikes of high concentrations of pollution occur, and that fecal coliform concentrations in the lower Goose Creek and Little River are either remaining constant or gradually decreasing over time.

Impaired Waters – Lower Goose Creek and little River are listed by DEQ as impaired for recreational use due to the violations of the Virginia water quality standards for fecal coliform bacteria. The impaired portions in Goose Creek extend from the Potomac River to Goose Creek Dam, all of Tuscarora Creek and Sycolin Creek, and most of Little River. "Impaired" means the water quality in these portion do not support the stream's intended use for recreation including swimming, wading, and fishing.

DEQ has also designated portions of the mainstem of Goose Creek from the Potomac River upstream to the Goose Creek Dam and Little River as being

Figure A.24. Fecal Coliform Concentrations in Goose Creek and Little River Showing Level of Violations.

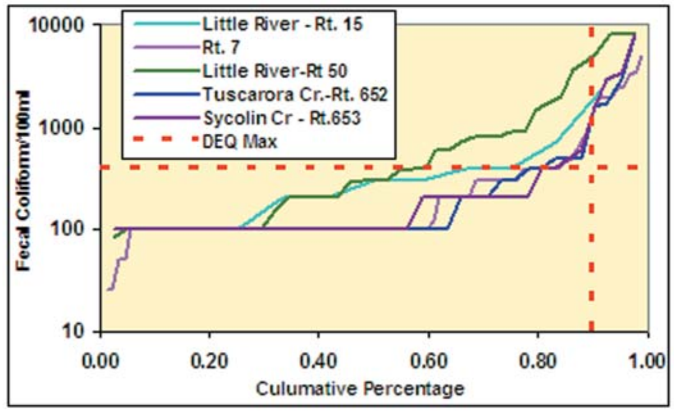


Figure A.25 F Fecal Coliform Bacteria Levels in Sycolin Creek Showing an Increasing Trend for 1995-2004

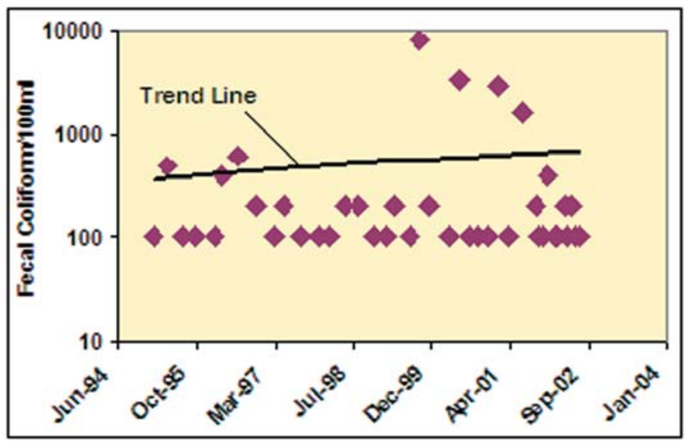
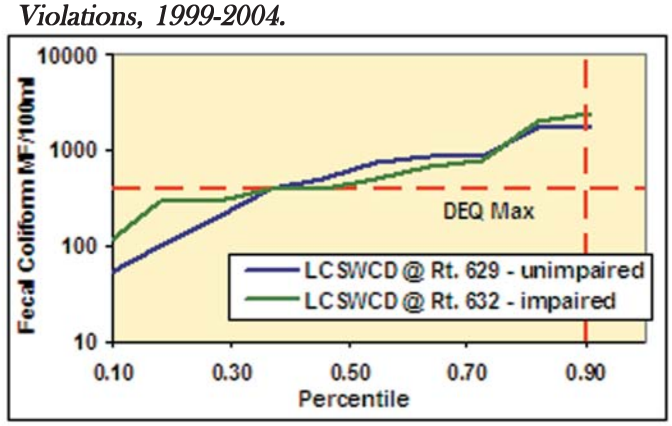


Figure A.26 Fecal Coliform Concentrations for Little River at Rt. 629 and Rt. 632 Showing level of Violations, 1999-2004.



impaired for violating this state water quality standards for the support of aquatic life. Further, in 2004 DEQ identified Tuscarora Creek as having a benthic macroinvertebrate community that is threatened (has "observed effects") based on citizen stream monitoring data.

TMDL Reports – DEQ is required to conduct studies of all waters that do not meet state water quality standards. The purpose of the study is to identify the sources of pollution and quantify the pollution loads to the stream. DEQ has published two reports on water quality in the Goose Creek watershed. The first report, "Bacteria TMDLs for the Goose Creek Watershed," was published in February 2003. The second report, "Benthic TMDLs for the Goose Creek and Little River Watersheds," was published in March 2004.

Sources of Pollution – There are two types of pollution impacting the Lower Goose Creek watershed. Point sources of fecal bacteria include municipal and industrial waste water treatment plants (WWTP) and private residences that have an above ground treatment system. Nonpoint sources of fecal bacteria include human sources, agricultural souces, and wildlife sources. In addition, the mainstem of Goose Creek is potentially impacted by nonpoint pollution loads delivered from upstream tributaries making nonpoint source pollution a watershed wide problem.

- **Point Sources** – There are four wastewater treatment facilities that discharge in the watershed: Aldie WWTP, Goose Creek Industrial Park WWTP; Rehau Plastics, Inc., and St. Louis Community treatment facility. These sources are permitted by the state and provide a high level of treatment. There is no evidence that they are contibuting any significant amounts of fecal bacteria pollution to Goose Creek.
- **Human Sources** – The most significant source of fecal pollution from humans is from failing septic systems that allow waste water to flow on the surface and into streams or ponds. Water quality samples showed that fecal coliforms from human sources are widespread in the watershed, and that human sources could even be the dominant source after storm events. Extensive field work shows septic systems that are more than 40 years old have an average failure rate of 40%, 20-40 year old systems have a 20% failure rate, and less than 20 years old systems have a 5% failure rate. Based on these studies, DEQ estimates there are 78 failing septic systems in the Lower Goose Creek and Little River subwatersheds.
- **Liverstock Sources** – Beef cattle and horses are the predominant livestock in the Goose Creek watershed. The DEQ study found that fecal coliform loads come from both pasture runoff and from direct deposites of manure by cattle in streams. Over 95% of the fecal

Cattle in Sycolin Creek

contamination to the streams comes from cattle. In most impaired stream segments, contamination from runoff from pastures is greater than contamination from direct deposites in the stream by cattle. This occurs despite the fact that most of the bacteria die off on the land surface and only a small portion are transported to the stream in runoff.

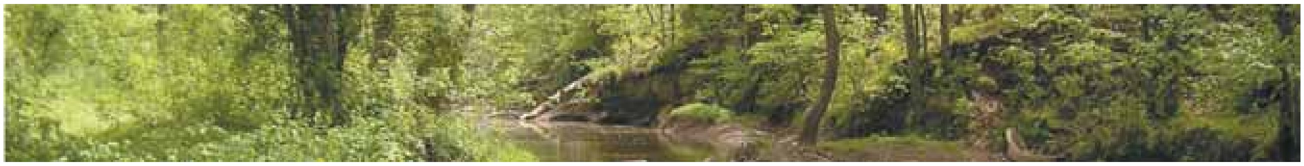
Wildlife in Goose Creek

- **Wildlife** – There are no wildlife population surveys available for the Goose Creek watershed. DEQ estimated the number of wildlife of different species based on the available habitat types. Beaver and muskrat are the most important species from a water quality aspect because 80-100% of their wastes are deposited directly into streams. However, wildlife populations and their fecal contributions are relatively small, and reductions are not necessary to meet water quality standards.

- **Average Daily Fecal Bacteria Load By Source** – DEQ combined the information on point sources, nonpoint sources, and direct disposition of fecal wastes and estimated the average daily fecal bacteria load in the watershed.   The percent of the average daily load from different sources are shown in **Table A.27**. Approximately 68% to 99% of the fecal coliform bacteria in the North Fork Goose Creek that comes from pasture runoff or direct disposition by cattle.

Table A.27. Percent of Average Daily Loads of Fecal Bacteria by Source in the Lower Goose Creek Watershed.

Source	Lower Goose Creek	Tuscarora Creek	Sycolin Creek	Little River
Direct Sources:				
• Point Sources	---	---	---	---
• Septic Systems	---	---	---	---
• Wildlife in Stream	0.8%	0.3%	0.3%	0.1%
• **Cattle in Stream**	**30.4%**	**25.3%**	**37.6%**	**23.3%**
Runoff Sources:				
• Forest - Wildlife	8.2%	1%	0.9%	0.3%
• Crop	12.4%	3.3%	0.5%	0.1%
• **Pasture - Livestock**	**37.2%**	**66%**	**60.1%**	**76%**
• Developed	11%	4%	0.7%	0.3%
Total All Sources	**100%**	**100%**	**100%**	**100%**



Stream Montoring

Stream water quality and habitat conditions are monitored in the Lower Goose Creek watershed by DEQ, LSWCD, and Loudoun Wildlife Conservancy (LWC). DEQ has chemical, nutrient, sediment, and bacterial data at stations in Goose Creek, Little River, Sycolin Creek, and Tuscarora Creek that date back to 1973. DEQ also has habitat and aquatic insect data for Goose Creek at Rt. 7 and Little River at Rt. 50. LSWCD has nutrient, bacterial, and aquatic insect data at two stations on Little River dating from 1999 to 2004. LWC has habitat and aquatic insect data from one station on Tuscarora Creek beginning in 1997, and a station in Sycolin Creek starting in 2004. A summary of the available data is provided in **Table A.28.**

Table A.28. Stream Monitoring Stations and Data Type for the Lower Goose Creek and Little River Watersheds.

Monitoring Sites	Water Flow	Chemical & Physical	Bacterial	Stream Habitat	Aquatic Insects
Main Stem					
– Rt. 7	USGS 1910 - 1999	DEQ 1973-2004	DEQ 1973-2004	DEQ 1996- 2004	DEQ 1996-2004
-- Rt. 621	USGSS	DEQ 2001-2004	DEQ 2001-2004		
Little River					
-- Rt. 15		DEQ 2001- 2002	DEQ 2001- 2002		
– Rt. 50		DEQ 1973-2002	DEQ 1973-2002	DEQ 1997-2004	DEQ 1997-2004
-- Rt. 629	LSWCD 1999-2001	DEQ 2003-2004 LSWCD 1999-2001	DEQ 2003-2004 LSWCD 1999-2001		LSWCD 1999-2001
-- Rt. 632	LSWCD 1999-2001	LSWCD 1999-2001	LSWCD 1999-2001		LSWCD 1999-2001
Sycolin Creek					
– Rt. 15		DEQ 1973-2000	DEQ 1973-2000		
– Rt. 652		DEQ 1973-2002	DEQ 1973-2001	LWC 2004	LWC 2004
– Rt. 621		DEQ 1973-2000	DEQ 1973-2000		
– Rt. 797		DEQ 1973-2000	DEQ 1973-2000		
Tuscarora Creek					
-- Golf Course		DEQ 2003-2004	DEQ 2003-2004		
– Rt. 653		DEQ 1973-2002	DEQ 1973-2002		
-- Lawson Rd.				LWC 1997-2004	LWC 1997-2004

Chemical, Nutrient, and Physical Water Quality Studies

DEQ monitored the chemical, nutrient, and physical conditions in the mainstem of Goose Creek and Little River in 2003 as part of their study on impacts to aquatic life. Earlier DEQ stream monitoring data indicates that aquatic life in the streams are slightly impaired. The study was conducted to identify the stress factors in the stream environment what were degrading aquatic life. Four potential stress factors were examined: (1) heavy metals and toxic chemicals; (2) alteration of water flow; (3) nutrients and excess algae; and (4) sediment. DEQ published their findings in their 2004 report, "Benthic TMDLs for the Goose Creek and Little River Watersheds."

Heavy Metals and Toxic Chemicals – DEQ did not identify any heavy metals or toxic chemicals in the water samples, the sediment samples, or fish tissue samples that are likely to cause the aquatic life impairment. Toxicity studies were conducted on the growth and survival of fathead minnows and the survival and reproduction of water fleas in an EPA laboratory to make this determination.

Altered Water Flow – Both Goose Creek and Little River have dams that can affect aquatic life downstream if sufficient stream flows are not maintained. Habitat assessments conducted by DEQ under low flow conditions indicate there is sufficient flow in both Goose Creek and Little River to support aquatic life. Water temperatures were also normal under low flow conditions.

Nutrients – Nitrogen and phosphorus concentrations in samples collected by DEQ were compared to concentrations in healthy streams. DEQ data from 1992 to 2002 show that nitrogen concentrations in the lower Goose Creek are considerably higher than those in healthy streams. Nitrogen levels in Little River, and phosphorus levels in both Goose Creek and Little River were comparable to levels in healthy streams. There are no water quality standards for nitrogen.

Government and citizen groups have worked together since 1987 to reduce the amount of nutrients flowing into the Chesapeake Bay from tributaries of the Potomac River including Goose Creek. High nutrient levels threaten the delicate balance of the Bay ecosystem by causing rapid growth of unhealthy algae thus prohibiting light from reaching underwater grasses critical to the Bay's fish and shellfish.

DEQ data for Goose Creek at Rt. 7 and Little River at Rt. 50 also show that total nitrogen and total phosphorus concentrations have remained relatively constant over the last 5-10 years. It is critical to reduce nitrogen levels in order to raise the dissolved oxgyen levels in Chesapeake Bay and eliminate the "dead zones" in the Bay where the lack of oxygen is killing fish, crabs, and shellfish.

Sediment Loads – DEQ found that sediment loads in excess of those found in healthy streams are the likely cause of the aquatic life impairments in Goose Creek and Little River. This is based on direct evidence from an examination of the aquatic insects and other macroinvertebrates found in Goose Creek and Little River compared to those found in healthy streams. Information on these findings are reported in the section on "Aquatic Life Conditions."

- **Sources of Sediment in Goose Creek** – The major source of sediment in Goose Creek is streambank erosion. It accounts for almost 70% of the total sediment load. Erosion from pasture is the second largest source, accounting for about 25% of the total load. Erosion from crops and construction sites are the next largest sources, but neither accounts for more than 3% of the total sediment load.

- **Sediment Trapping in the Goose Creek Reservoir and Beaverdam Reservoir** – The Goose Creek Reservoir is a major sink for sediment generated in the Goose Creek watershed. The reservoir, created in 1961, had to be dredged in 1998 because it had lost almost half its storage capacity. Studies estimate that sediment was deposited in the reservoir at a rate of approximately 10,000 tons/year.

- **Little River** – Erosion from pasture is the largest source of sediment load to Little River, accounting for 60%. Streambank erosion is not as dominant, and accounts for 30% of the sediment load.

- **Sediment Loads** – The sediment loading to Goose Creek and Little River from different sources are shown in **Table A.29.** The total for Goose Creek is 76,000 tons per year of which 7,600 tons is trapped in the Goose Creek reservoir. The total for Little River is 8,900 tons per year.

- **Impact of Development** – The impact of development is an important factor to consider in the Goose Creek watershed. The population in the Town of Leesburg doubled between 1990 and 2000, and the area surrounding Leesburg continues to grow at a rapid rate. This growth will especially impact the Tuscarora and Sycolin Creeks.

  As development in the watershed increases, the total sediment load

Table A.29. Average Annual Sediment Loads From Goose Creek and Little River By Source (tons/year).

Source	Goose Creek (tons/year)	Little River (tons/year)
Construction	1,542	268
Crops	1,843	**1,335**
Forest	998	290
Pasture	**15,481**	**3,213**
Developed Land	447	16
Streambank Erosion	**55,502**	**3,728**
Reservoir Trapping	-7,592	---
Total	**68,250 tons/yr**	**8,851 tons/yr**

changes. Increased development leads to an increase in sediment loads primarily through an increase in streambank erosion. **Table A.30** shows the projected impact of development on sediment loads in Goose Creek. The data show that an increase in developed land from 4% to 8% (projected by DEQ for 2015) increases the overall sediment load in Goose Creek by 36%.

Table A.30. Average Annual Sediment Loads to Goose Creek (tons/yr) Under Different Development Conditions.

Source	Current Load (tons/yr)	2015 Load (tons /yr)	Full Build-out Load (tons /yr)
Forest	1,000	1,000	1,000
Cropland	1,800	1,700	1,600
Pasture	15,500	14,200	13,300
Developed Land	500	1,000	1,400
Construction	1,000	800	500
Streambank Erosion	55,500	83,800	110,300
Other Sources	200	200	200
Reservoir Trapping	-7,500	-10,300	-12,900
Percent Developed	4%	8%	12%
Total Sediment Load	68,000	92,400	115,400
Required Reduction	38%	54%	63%

- **Meeting Water Quality Standards** – The annual sediment load that needs to be reduced to meet water quality standards is shown in **Table A.30.** The percentage changes from 38% under current conditions to 63% under full build-out conditions.

- **Chesapeake Bay Sediment Reduction Goals** – The high levels of sediment in Goose Creek impact the Chesapeake Bay Sediment Reduction Goals agreed to by Virginia in 2003. Reductions in sediment loading are needed to provide water clarity in the Chesapeake Bay necessary for underwater grasses to thrive. Virginia has agreed to reduce sediment loads in the Potomac River watershed by 617,000 tons/year.

Stream Habitat Conditions

The quality of stream habitats is assessed using ten parameters that are combine into a "habitat quality score." EPA provide criteria to use the habitat score to characterize stream habitat conditions as "poor," "fair," "good," or "excellent." DEQ, LCSA, and LWC use EPA's parameters and habitat score to assess stream habitats at their stream monitoring sites.

DEQ – DEQ has monitored stream habitat conditions on Goose Creek at Rt. 7 and Little River at Rt. 50 for several

years. The habitat condition scores are shown in **Figures A.27 & A.28.** The habitat conditions at the Goose Creek station appear to have a downward trend and are currently in the "fair" condition category. The scores show that habitat conditions at the Little River station are consistently "good" and will support healthy biological communities. These healthy conditions have existed for several years.

LCSA – LCSA has assessed stream habitats throughout the Goose Creek watershed as part of their "Goose Creek Source Water Protection Program" study. The stream habitats were assessed to determine whether they provided the necessary elements of a healthy aquatic system. Ten reaches in both the Lower Goose Creek watershed and the Little River watershed were assessed using the EPA RBP II protocol. These assessments provide the most extensive data on stream habitats in the Lower Goose Creek/Little River watershed.

The LCSA assessment scores, based on the same EPA criteria as used for the DEQ data, are shown in **Figures A.29 and A.30.** The stations progress from the mouth of each watershed to upstream reaches. These data show generally "poor to fair" conditions in each

Figure A.27. DEQ Habitat Scores for Goose Creek at Rt. 7, 1997-2000.

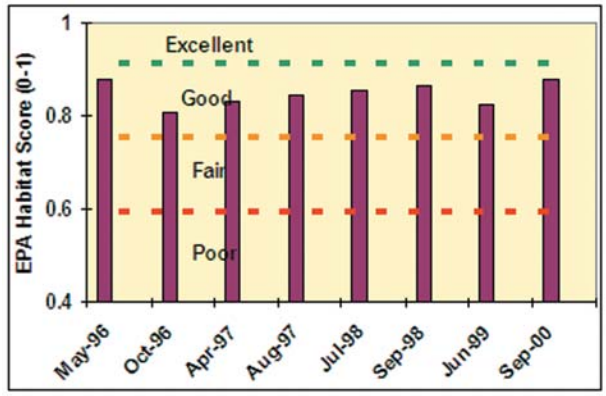


Figure A.28. DEQ Habitat Scores for Little River at Rt. 50, 1997-2000.

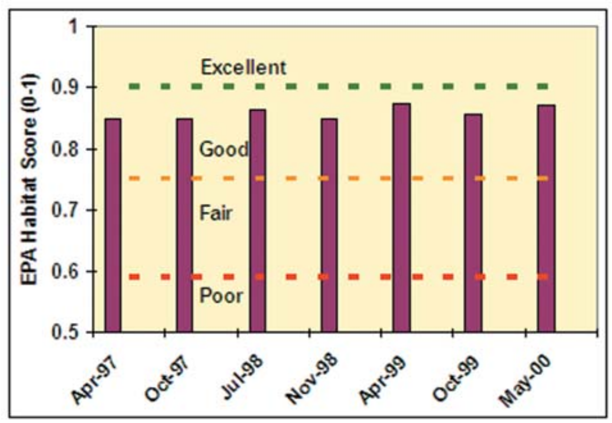


Figure A.29. LCSA Stream Habitat Scores, Lower Goose Creek Watershed, 2003.

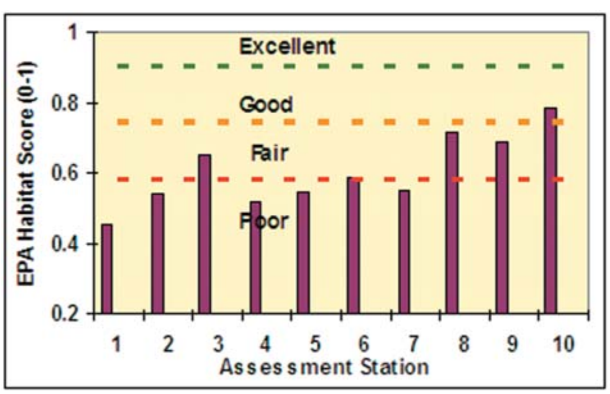
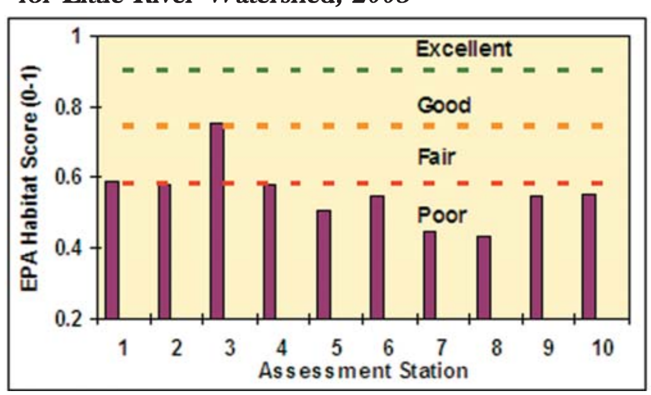


Figure A.30. LCSA Stream Habitat Scores for Little River Watershed, 2003



watershed. The lack of riparian buffers and active bank erosion contribute to these lower scores. The scores suggest that habitat is a limiting factor for healthy aquatic insect communities.

LWC – LWC has monitored Tuscarora Creek since 1997, and began monitoring Sycolin Creek in 2004. The monitoring results for Tuscarora Creek are shown in **Figure A.31.** The results show that stream habitat conditions are characterized as being "fair." The factors stressing the habitat are increased sediment deposits that reduce living spaces for aquatic life, reduced canopy cover, and stream channel alterations. Habitat conditions at the Sycolin Creek monitoring site are characterized as "good."

Aquatic Life Conditions

DEQ – DEQ has monitored aquatic insects at stations in Goose Creek and Little River for several years. They use EPA's RBP II protocol to assess whether there are healthy aquatic life communities, and to determine whether streams meet aquatic life water quality standards. The aquatic life conditions at DEQ stations in Goose Creek and Little River are shown in **Figures A32. & A.33.**

Goose Creek – The results for Goose Creek at Rt. 7 show that there are some insects such as mayflies and free living caddisflies that are commonly found in good water quality conditions. Goose Creek also does not have unusually high numbers of insects found in poor water quality conditions such as worms, clams, and midge fly larvae. However, overall there is a reduced number of insect species, particularly insects found in

Figure A.31. Habitat Conditions in Tuscarora Creek, 1997-2002.

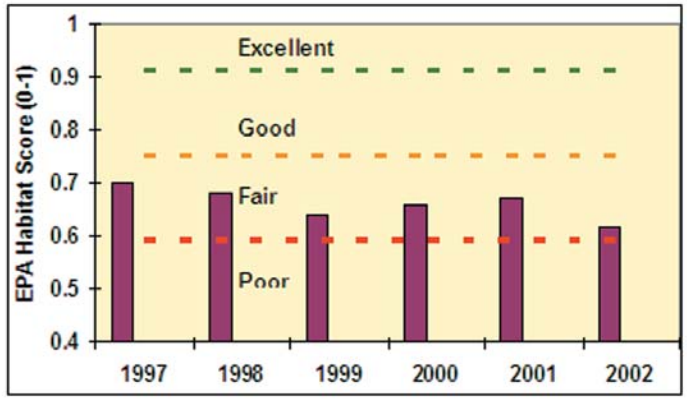


Figure A.32. Aquatic Insect Conditions in Goose Creek at Rt. 7, 1996-2002.

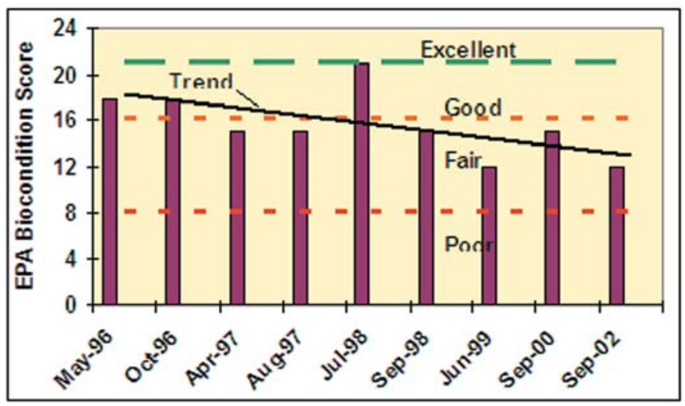
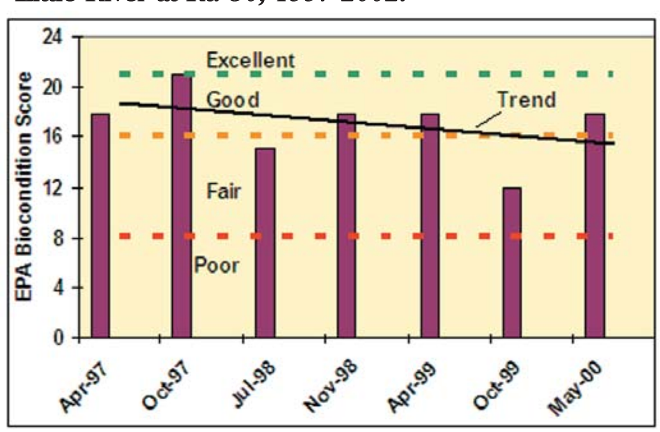


Figure A.33. Aquatic Insect Conditions in Little River at Rt. 50, 1997-2002.



DEQ concludes that:

- Goose Creek has more crayfish, which are sediment toleratant, than healthy streams;
- Goose Creek shows consistently higher numbers of water striders and whirligig beetles, and low numbers of riffle beetles, which taken together suggest slow moving water and less coarse substrate;
- Goose Creek has more narrow-winged damselflies, which may suggest some sediment desposition; and
- Goose Creek lacks some sediment intolerant aquatic insects including stoneflies and water pennies.

DEQ designated Goose Creek as slightly impaired based upon human impacts that are harmful to aquatic life. The aquatic insect community is stressed because of high sediment levels in the stream caused by streambank erosion as discussed in the section on "Physical, Chemical, and Nutrient Water Quality Studies."

Little River – The results of DEQ monitoring of aquatic insects in Little River show slightly better conditions than found in Goose Creek. Little River does contain a good abundance of riffle beettles, and does not contain a high abundance of poor water quality insects such as worm, midge fly lavae, and narrow-winged damselflies. However, monitoring data also show higher numbers of sediment tolerant insects than normally found in good water quality streams.

DEQ concludes that:

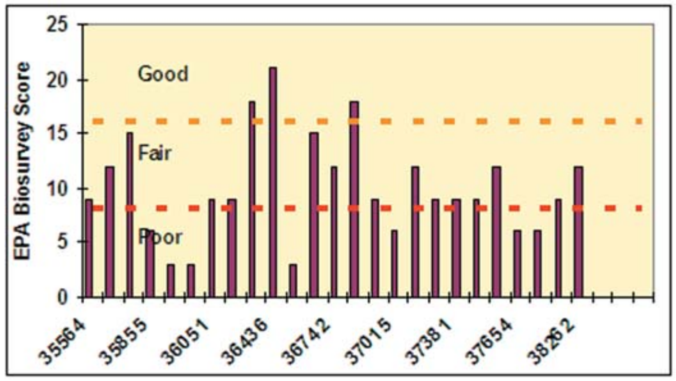
- Little River has high numbers of burrowing and sprawling mayflies, and increasing abundance of crayfish, and many Asian clams, which suggest sediment desposition
- Little River has few water pennies and almost no stoneflies

DEQ's assessments of these data have changed over the years. Prior to 1998, Little River was classified as being moderately impaired for aquatic life. DEQ reported that "rural development and an upstream impoundment impact the water quality." In November 1998, DEQ changed their assessment of the aquatic insect population from "moderately impaired" to "non-impaired." In August 2000, the aquatic life designation for Little River was changed again to "slightly impaired."

Tuscarora Creek – LWC has monitored Tuscarora Creek since 1997 using the same EPA protocol as DEQ. The aquatic insect scores for Tuscarora Creek are shown in **Figure A.34.** The graph shows dramatic fluctuations in the condition of the aquatic insect community with scores ranging from a low of 3 to a high of 21. Low aquatic insect scores are correlated with low species diversity and high numbers of insects tolerant to pollution. Impact from urban runoff is most likely causing these conditions. The high insect population scores

21. Low aquatic insect scores are correlated with low species diversity and high numbers of insects tolerant to pollution. Impact from urban runoff is most likely causing these conditions. The high insect population scores demonstrates the potential that can be achieved if human impact can be better controlled and stream conditions stabilized.

Figure A.34 . LWC Aquatic Insect Conditions for Tuscarora Creek, 1997-2004.



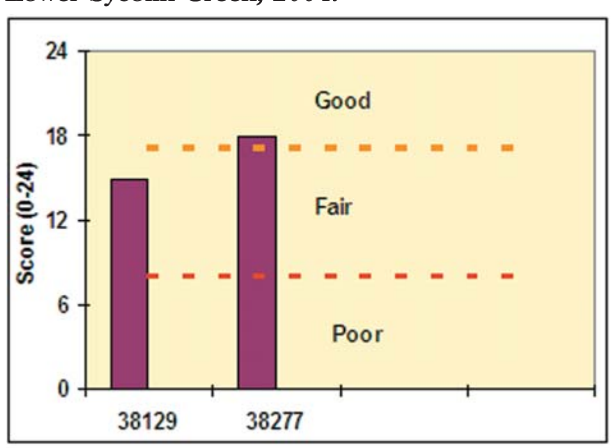
Sycolin Creek - LWC began monitoring Sycolin Creek in 2004. The results, shown in **Figure A.35,** indicate that aquatic life conditions are in the "good" range. LWC has used Sycolin Creek for a training site because of the good diversity of aquatic insects. However, increased streambank erosion, shifting sand and gravel bars in the stream channel, and increased sediments in the substrate indicate that agricultural activities and increased development upstream are having a negative impact on the stream.

Overall Assessment of Stream Health

The water quality and stream habitat conditions are well documented in the Lower Goose Creek and Little River watersheds. The data show that water quality is impacted by human activities, and the overall health of streams in the watershed is marginal. Stream waters throughout the watershed are impaired for recreational use due to high fecal coliform levels. On the positive side, stream flows are adequate, and the chemical quality of stream waters is good. There are no point sources of pollution that are degrading the water quality.

A Total Maximum Daily Load (TMDL) study has been conducted by DEQ that identifies livestock, failing septic tank systems, and wildlife as the major sources of pollution impacting on water quality. The report includes recommendations regarding the level of reductions in nonpoint pollution needed to restore water quality.

Figure A.35. LWC Aquatic Insect Conditions in Lower Sycolin Creek, 2004.



In addition, aquatic insect monitoring data show only "fair" aquatic life conditions because of a reduced number of insect species than would be expected without human stresses. DEQ has identified portions of

LWC monitoring site in Sycolin Creek showing good habitat conditions.

A Sycolin Creek section with severe streambank erosion and gravel bar in stream channel.

impaired for aquatic life, and portions of Turcarora Creek where aquatic life conditions are "threatened." DEQ conducted a study in 2003 and identified sediment from active streambank erosion as being the primary cause of stress on aquatic life. These finding were supported by stream habitat assessments conducted by Loudoun County Sanitation Authority as part of a source water protection study. They found problems with active streambank erosion at several stations in the Lower Goose Creek and Little River watersheds.

The assessments of various environmental parameters that show the impacts on water quality and stream health are summarized on **Table A.31.**

Table A.31. Summary of Lower Goose Creek / Little River Water Quality and Stream Health Assessments.

Monitoring Site	Environmental Parameters					
	Chemical Quality	Nutrients/ Sediments	Bacteriological Quality	Habitat Assessment	Aquatic Insect Score	Impervious Surfaces
Main Stem	Good	Marginal-Poor	Impaired	Fair-Poor	Fair	Good
Little River	Good	Marginal-Poor	Impaired	Fair-Poor	Fair - Good	Good
Sycolin Creek	Good		Impaired		Fair-Good	Good
Tuscarora Creek	Good		Impaired	Fair	Fair-Poor	Poor

References

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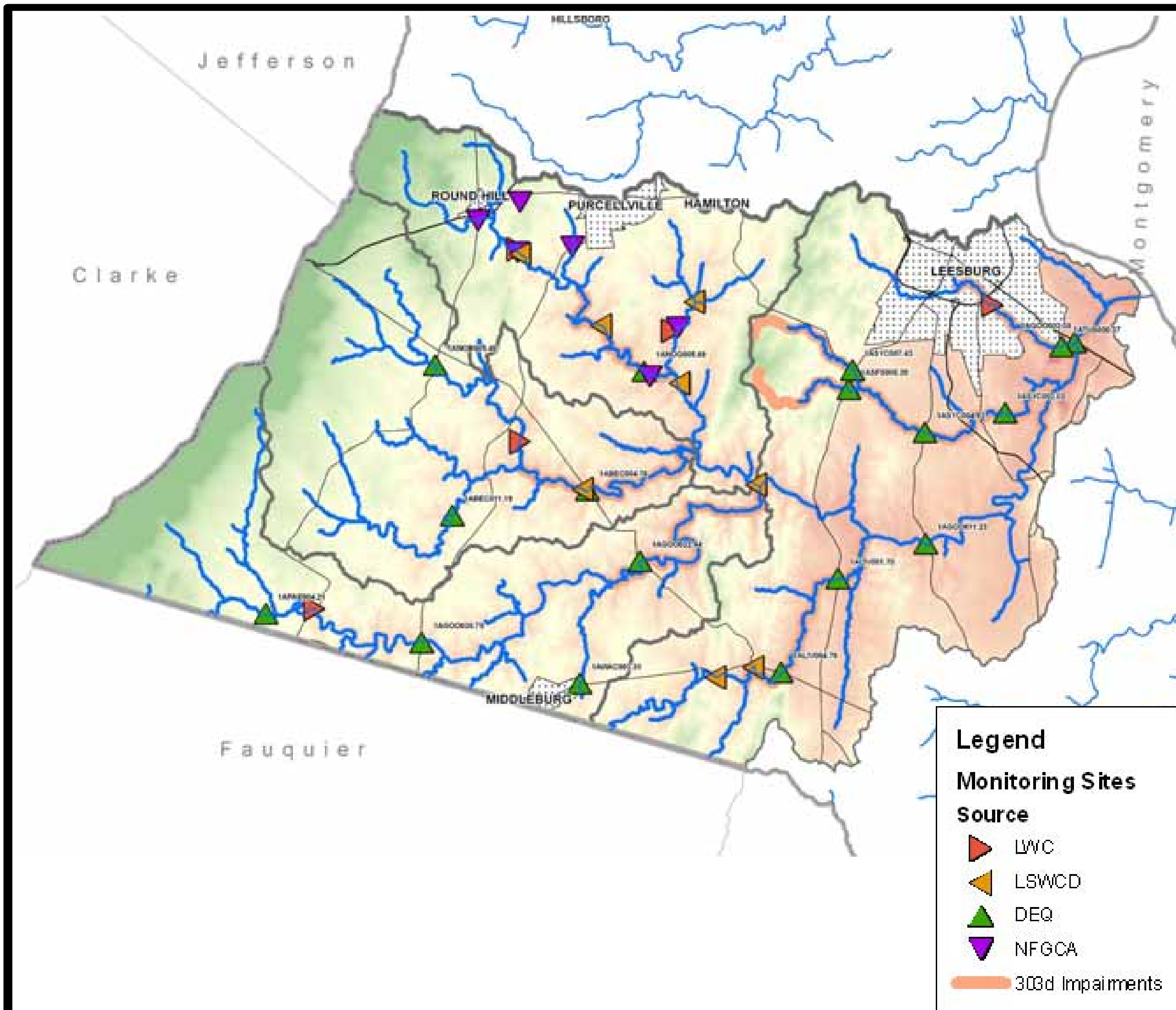


Lower Goose Creek/
Little River Watershed

Watershed Description

The North Fork Goose Creek watershed is in the middle portion of Loudoun County, and drains 28,500 acres or about 8.5% of the land in the county. The major tributaries include Crooked Run that drains the village of Lincoln, Jacks Run that drains a portion of Purcellville, and Sleeter Lake and Simpsons Creek that drain the village of Round Hill. Water from the North Fork Goose Creek flows into Goose Creek at about the 16 river-mile point, and then into the Potomac River and down to the Chesapeake Bay.

North Fork Goose Creek monitoring site below Sleeter Lake.

Several sections of the streams in the upper portions of the watershed have natural forested buffers, healthy stream valleys, and scenic vistas. There are wooded floodplains with wildflowers in the spring, homes for beaver and wood duck, forested corridors for wildlife, and trees that shade the water and provide important nutrients for aquatic life. Examples of such sections are provided in the pictures below.

The topography in the watershed is generally rolling hills with elevations less then 1,000 feet above sea level. The watershed is characterized mostly by moderately well-drained soils. The topography includes many moderate and very steep slopes, especially along the stream courses.

Hydrograph–Rainfall in the watershed is monitored at Lincoln, VA. A summary of average monthly and annual precipitation is provided in **Table A.32.** The rainfall is fairly evenly distributed throughout the year, although it tends to be lower between December and February.

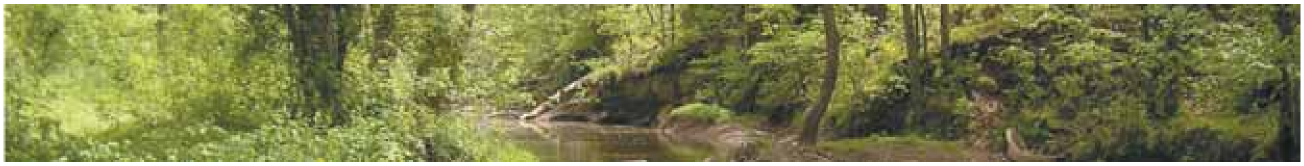


Table A.32. Summary of Average Monthly and Annual Rainfall Data (inches) at Lincoln, VA. in the North Fork Goose Creek Watershed.

J	F	M	A	M	J	J	A	S	O	N	D	Annual
3.02	2.63	3.63	3.40	4.09	3.84	3.87	4.11	3.56	3.16	3.17	3.12	41.59

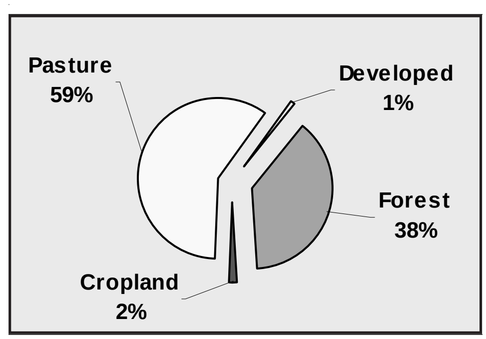
There is little stream flow data for the North Fork Goose Creek watershed. The Virginia Department of Environmental Quality (DEQ) discontinued collecting stream flow data in the early 1990's. The North Fork Goose Creek Association (NFGC) and Loudoun Soil and Water Conservation District (LSWCD) take sporadic stream flow readings at their monitoring stations. The US Geological Survey has a new stream flow gauge on Beaverdam Creek at Rt. 734 that was established in 2001. Data from the USGS station is shown on **Table A.33.** There are insufficient data to establish any patterns for the North Fork. However, long term stream flow data for Goose Creek at Middleburg show that the lowest flows usually occur between July and November.

Table A.33. USGS Stream Flow Data for North Fork Goose Creek Watershed.

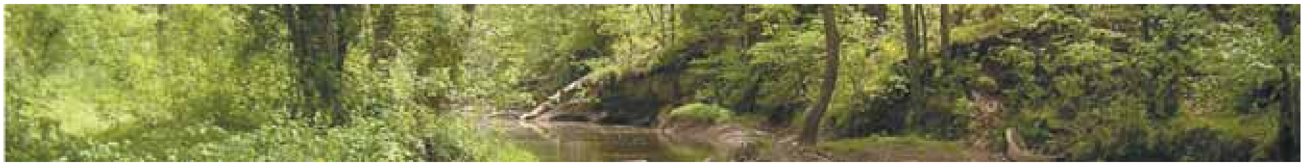
YEAR	Monthly Mean Stream Flow, in ft^3/s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001										6.1	7.22	9.04
2002	9	8	26	24	43	26	11	3	10	25	53	73
2003	113	91	180	83	237	197	69	28	181			
Mean of Monthly Stream Flows	61	50	103	53	140	111	40	15	96	15	30	41

Land Use – Land use is predominately agricultural and forested lots. There are residential and commercial areas in the towns of Hamilton, Purcellville, and Round Hill. **Chart A.4** shows the land-use patterns based on 1997 data published by EPA and provided in DEQ's 2002 TMDL report. The impact of pasture land use on stream buffers is seen in the following picture.

Chart A. 4 Land Use in North Fork Goose Creek Watershed Based on 1997 Data.



Impervious Surfaces - Impervious surfaces include the roadways, driveways, rooftops and parking lots that do not allow water from rainstorms and runoff to infiltration into the ground. The Loudoun County Environmental Indicators Project (LEIP)



The lower mainstem of Goose Creek and six tributary streams have elevated fecal coliform bacteria levels and the water quality does not meet state water quality standards for the safe use for recreation. The TMDL (Total Maximum Daily Load) study identified the sources of pollution affecting the Goose Creek watershed.

North Fork Goose Creek at Rt. 729 showing affects of use as pasture land.

- **Goose Creek Source Water Protection Study** – The Loudoun County Sanitation Authority (LCSA) published a report, " Goose Creek Source Water Protection Program," in December 2003 that included water quality information on the North Fork Goose Creek. The purpose of the report was to provide a plan to protect drinking water supplies in the Goose Creek from pollution and stream habitat degradation that will affect the safety of drinking water supplies.

Findings – Fecal coliform bacteria pollution originates from a variety of sources in North Fork Goose Creek. DEQ did special bacteria source tracking or BST studies to determine the type of warm-blooded animals that are contributing the fecal bacteria to the stream waters. They also used a Hydrological Simulation Program, Fortran (HSPF) to develop a model to simulate the fate and transport of fecal bacteria in the stream.

- **Point Sources of Pollution** – Point sources of fecal bacteria include the municipal and industrial plants that treat human wastes, and private residences that have non-septic tank systems that have a discharge requiring a permit. These permitted sources are listed in **Table A.35.**

Table A.35. Permitted Point Sources of Fecal Bacteria in the North Fork Goose Creek Watershed.

Facility	City	Receiving Stream
Purcellville STP	Purcellville	NF Goose Creek -Tributary
Round Hill WWTP	Round Hill	NF Goose Creek
Residence A	Purcellville	Jack's Run
Residence B	Round Hill	Simpson Creek

- **Human Sources–Septic Systems** - Properly functioning septic systems allow treated human waste effluent to filter into the soil so it does not reach surface water. However, failing septic tank systems can allow bacteria to reach the surface and flow directly into a nearby stream, especially as runoff during a

mapped impervious surfaces in the county using Lansat Imagery. They reported that the amount of impervious surface in the Goose Creek watershed is 1.37%. As a general rule, a watershed with less than 10% of its area in impervious surfaces will not experience a noticeable impact on the hydrological characterisitics of the watershed.

Crooked Run stream monitoring site.

Water Quality Studies

Water Quality Standards – DEQ is required under the Federal Clean Water Act and Virginia statutes to publish an assessment the quality of state waters. The assessment report includes a list of waters that do not meet state and federal water quality standards. These waters are designated as “impaired waters.” The list of impaired waters includes a 4.3 mile segment of the North Fork Goose Creek from its confluence with Crooked Run upstream past the Rt. 611 New Guinea Bridge.

It is important to note that DEQ has only one stream monitoring station in the North Fork Goose Creek watershed. Consequently, other portions of the watershed are not assessed. A summary of the information published by DEQ in their assessment report on North Fork Goose Creek is provided in **Table A.34.**

Table A.34. Assessment of North Fork Goose Creek by DEQ in the 2004 303(d)/305(b) Integrated Report to EPA.

Watershed Monitoring Station	Meet Stnds	No Data	Citizen Data Show Problems	Citizen Data Show No Problems	Impaired
NF Goose Creek/Crooked Run	0	41.29	4.64	0	4.29

Pollution Source Studies – Stream waters listed by DEQ that do not meet water quality standards are required to be studied. The purpose of the study is to identify the source(s) of the pollution and quantify the pollution load(s) to the stream. In addition, the Federal Safe Drinking Water Act requires states to assess the health of streams and watersheds that are used as a drinking water supply. Water from Goose Creek is used as a public drinking water supply. Two studies have been conducted in recent years because of these requirements and they provide good information about the water quality and sources of pollution that degrade the North Fork Goose Creek.

- **TMDL Report** – DEQ published a report, “ Bacterial TMDL for the Goose Creek Watershed,” in February 2003 that included water quality information on the North Fork Goose Creek subwatershed.

rainfall. Failing systems can also allow the effluent to seep into the ground water if the system is located too close to a stream or pond.

The special BST study conducted by DEQ showed that fecal bacteria from human sources are widespread in the North Fork Goose Creek watershed, and that human sources can be the dominant source during some rainfall events. They estimate that there is a 5% failure rate of septic systems in the watershed, and that fecal bacteria from these systems are entering streams as stormwater runoff. Any system located within 50 feet of surface water is assumed to be directly discharging fecal bacteria to the stream. The estimated number of failing septic systems is provided in **Table A.36.**

Table A.36. Estimated Failing Septic Systems in the North Fork Goose Creek Watershed.

Stream Segment	# Septic Systems	# Failing Systems	# Systems <50' from Stream
NF Goose Creek	818	66	3
Upper NF Goose Creek	957	48	5

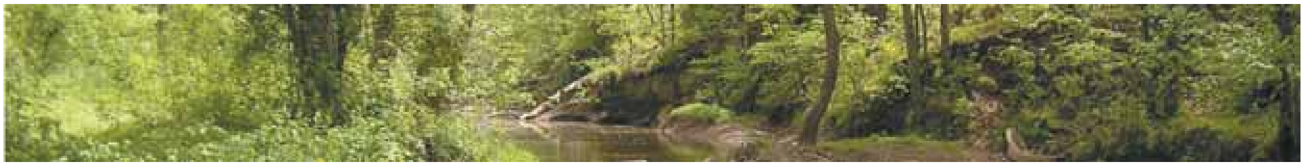
- **Biosolids** – Class B biosolids (liquid or dewatered sludge from a sewage treatment plant) are applied to both cropland and pasture in the North Fork Goose Creek watershed. Record keeping of applications is poor, and DEQ had to estimate application amounts. Application varies considerably by year and even more so by month. **Table A.37** provides an estimate of biosolids application based on data provided by the biosolids industry.

Table A.37. Estimated Annual Biosolid Application Rates (dry tons/yr) in the North Fork Goose Creek Watershed.

Stream Segment	1996	1997	1998	1999	2000	Annual Average
NF Goose Creek		51	105			**31**
Upper NF Goose Creek				1,383		**277**

- **Dairy and Beef Cattle** – In 2003 DEQ reported there was one dairy cattle operation in the Crooked Run portion of the North Fork Goose Creek watershed. The dairy operation hauls cow wastes daily and spreads it on cropland from September through April and on pasture the remainder of the year.

  The number of beef cattle in the watershed varies seasonally, with the highest numbers in the summer and lowest in the winter (October to April). Cattle are generally pastured, although LSWCD reports there is



one operation in the watershed that confines their cattle. Beef cattle generally have access to streams, and spend a portion of each day in the streams, especially in the summer. Most farmers in the watershed do not use stream bank fencing. The estimated number of dairy and beef cattle are provided in **Table A.38.**

- **Horses** – Loudoun County has the largest horse population in Virginia, and many are located in the North Fork Goose Creek watershed. However, most horses do not have access to streams, and horse manure is typically deposited on pasture land. Therefore, horses were not identified as a major source of pollution by DEQ. The estimated number of horses is also listed on **Table A.38.**

Table A.38. Estimated Livestock populations in the North Fork Goose Creek Watershed in 2002.

Stream Segment	Dairy Cattle	Beef Cattle	Horses
NF Goose Creek	200	1,000	500
Upper NF Goose Creek	244	2,000	1,500

- **Wildlife** – There are a wide variety and large number of wildlife in the watershed that contribute fecal bacteria to the streams. It is estimated, for example, that there are 2,300 deer. There have been no wildlife surveys conducted in Loudoun County, and the Virginia Department of Game and Inland Fisheries (VDGIF) use a model to estimate the wildlife populations in the various habitat types found in the watershed.

  Most wildlife are not a significant source of pollution to the streams because they spend little time in stream waters, and their wastes impact stream water quality only as part of stormwater runoff. Muskrat and beaver populations are two exceptions. They spend 90-100% of their time in the water, and almost all wastes are directly deposited in streams. Of these two species, VDGIF estimates there are 2,800 muskrats in the watershed making this the only wildlife species that has an impact on water quality.

- **Average Daily Fecal Bacteria Load By Source** – DEQ combined the information on point sources, nonpoint sources, and direct and indirect disposition of fecal wastes to estimate the average daily fecal bacteria load to the streams in the watershed. The percent distribution of the average daily loads by sources is listed in **Table A.39.** This list shows that over 95% of the fecal coliform bacteria in the North Fork Goose Creek come from pasture runoff or direct disposition of manure by cattle.

Table A.39. Average Daily Loads of Fecal Bacteria by Source in the North Fork Goose Creek Watershed.

Source	NF Goose Creek	Upper NF Goose Creek
Direct Sources:		
• Point Sources	---	---
• Septic Systems	---	---
• Wildlife in Stream	0.2%	0.2%
• Cattle in Stream	**35%**	**42.5%**
Runoff Sources:		
• Forest - Wildlife	0.3%	---
• Crop	2.5%	---
• Pasture - Livestock	**61%**	**57%**
• Developed	0.8%	0.4%
Total All Sources	100%	100%

Watershed Monitoring

Stream Quality and Habitat Monitoring – The North Fork Goose Creek watershed has one DEQ monitoring station that assesses 4.29 miles or 8% of the 50.22 creek miles in the watershed. DEQ has chemical and bacteriological data from this site (located at the 5.69 river mile) dating back to 1970. The remaining 92% of the watershed is unassessed.

There is also stream quality data collected by LSWCD, LWC, and North Fork Goose Creek Association (NFGCA) at several monitoring stations. LSWCD has chemical, bacteriological, and aquatic insect data at four stations in the main stem and one station in Crooked Run dating from 1999 to 2004. LWC has collected stream habitat and aquatic insect data since 1997 at two stations in the main stem and a station in Crooked Run. NFGCA collects chemical and aquatic insect data at four stations in the main stem dating back to 1998, and a single station in Crooked Run. A summary of the data available for the North Fork Goose Creek watershed is provided in **Table A40.**

Table A.40. Stream Monitoring Data for the North Fork Goose Creek Watershed.

Monitoring Sites	Water Flow	Chemical	Bacterial	Habitat	Aquatic Insects
North Fork Goose Creek					
Rt. 733		LSWCD 1999-2004	LSWCD 1999-2004		LSWCD 1999-2004
RT. 722		NFGC 1996-2004	DEQ 1970-2004		NFGC 2000-2004
Rt. 794, Rt 611		LSWCD 1999-2004	LSWCD 1999-2004		LSWCD 1999-2004
Rt. 782 (Tranquility Rd)		*NFGC 1996-2003* LSWCD 1999-2004	LSWCD 1999-2004	LWC 1997-2004	LWC 1997-2004 *NFGC 2000-2003* LSWCD 1999-2004
Rt. 729 (Iron Bridge)	USGS 2001-2004	*NFGC 1998-2003* LSWCD 1999-2004	LSWCD 1999-2004		*NFGC 2000-2003* LSWCD 1999-2004
Villages at Round Hill		*NFGC 1996-2003*			*NFGC 2000-2003*
Crooked Run					
Rt. 727		*NFGC 1996-2003*		LWC 1997-2001	LWC 1997-2004 *NFGC 2000-2003*
Rt. 725		LSWCD 1999-2001	LSWCD 1999-2001		LSWCD 1999-201
Jacks Run					
Rt. 690				NFGCA 2004	NFGCA 1996 – 2004
Simpsons Creek					
Rt. 719				**NFGCA** 2004	**NFGCA** 1996 – 2004

The table shows that there has been some duplicate sampling at the same site by different groups in this watershed. In 2003 the Loudoun Watershed Watch held a series of meetings to develop a comprehensive monitoring plan for Loudoun County that included Goose Creek. LWC and NFGCA participated in this initiative, and modified their monitoring in line with the new monitoring plan. In 2004 NFGCA discontinued monitoring for benthic macroinvertebrates at Rt. 729 (Iron Bridges), Rt. 782 (Tranquility Rd), the Villages at Round Hill, and Rt. 727 on Crooked River. This allowed NFCGA to begin monitoring new stations on Beaverdam Creek and in the Catoctin Creek watershed. NFGCA also collaborated with LWC and modified their monitoring protocol to begin identifying macroinvertebrates to the family level so EPA metrics can be applied to their data. In addition they began conducting habitat assessments based on the EPA RBP II protocol. These data are used in the LWW assessment of stream health provided in this report.

Water Chemistry Conditions

Chemical quality is an important indicator used to determine whether streams are fit for aquatic life and recreational uses. DEQ has collected chemical water quality data at one station in the North Fork Goose Creek watershed since the 1970's. These data show that chemical parameters meet state standards. The key chemical data are summarized in **Table A.41.**

Table A.41. Summary of Key Chemical Parameters Based Upon DEQ Data from the North Fork Goose Creek Watershed Between 1996 and 2001.

Parameter	Criteria	Observation	Condition
pH	DEQ sets a range of 6-9 for pH levels	Mean pH level is 7.3 with a range of 5.6 to 8. Levels are consistently between 6.5 and 7.5 which is good for aquatic life.	**Criteria consistently met**
DO (Dissolved Oxygen)	DEQ sets a minimum of 4 mg/l	Mean DO level is 9.9 with a range of 5.8 to 14.8 mg/l. Levels flucuate inversely with temperature and are consistently between 8 and 12 mg/l which is good for aquatic life.	**Criteria consistently met**
BOD (Biological Oxygen Demand)	No DEQ standard. EPA guildline is a maximum of 7 mg/L	Mean BOD level is 2 with a range of 0.7 to 7 mg/l. Levels are consistently about 2 mg/l suggesting low organic loads in stream water.	**Criteria consistently met**
Phosphorus	No DEQ standard. EPA set a guide of 1.0 mg/L for non-impaired waters	Mean level of 0.13 mg/l suggests there is not excessive run-off of fertilizers from agricultural and other operations affecting the watershed.	**Criteria consistently met**
Nitrogen (as Nitrate)	There are no state or EPA guide for nitrogen.	Mean level is 0.6 with a range of 0.2 to 1.6 mg/l. These low levels of nitrogen in combination with low levels of phosphorus keep growth of aquatic plants and algae in check.	**Low levels**

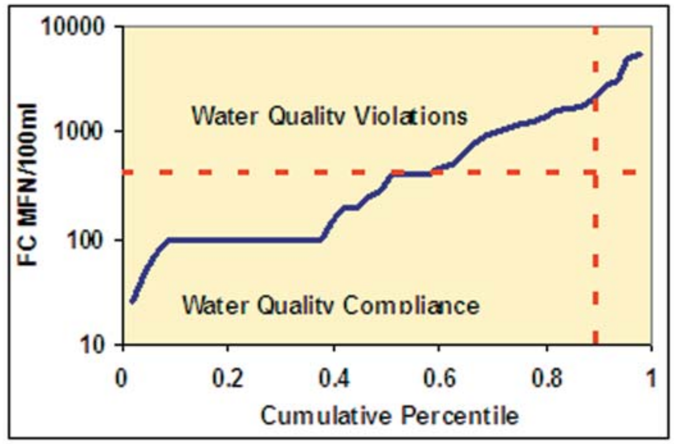
LSWCD and NFGCA have also collected chemical data at several stations in the watershed begining in 1997. These data are consistent with DEQ's data, and support DEQ's finding that the chemical quality of the water in North Fork Goose Creek is good.

Water Bacteriology Conditions

Water Quality Violations - Stream waters that are suitable for recreational use must have low levels of fecal contamination. DEQ has monitored one station in the North Fork watershed for fecal coliform bacteria since the 1970's. The 1996-2004 fecal coliform bacteria data, plotted as cumulative percentages to show the level at which the water quality standard is exceeded, are shown in **Figure A.36.**

The water quality at this station does not meet the state standard of 400 fecal coliform approximately 40 % of the time. As a result DEQ has designated 4.29 miles of the stream as impaired or unsuitable for recreational use. In 2003 DEQ began analyzing the water samples to enumerate E. coli bacteria - a type of fecal coliform bacteria more directly associated with human disease. An analysis of these data show a good correlation between the fecal coliform bacteria counts and the E. coli bacteria counts. Both sets of data have a median of 400 cfu/100 ml, and ranges between 25 and 2000 cfu/100 ml for the fecal coliform and 20 and 1800 cfu/100 ml for the E. coli bacteria.

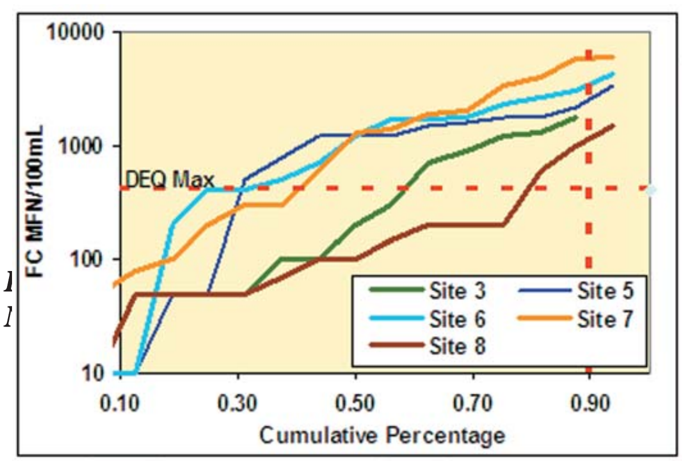
Figure A.36. DEQ Fecal Coliform Bacteria Levels for North Fork Goose Creek at Rt. 722 from 1996-2004.



Loudoun Soil and Water Conservation District – LSWCD has also collected fecal coliform data at five sites throughout the watershed since 1999. **Figure A.37** shows that 40% to 70% of the samples at these sites exceed the water quality standard of 400 cfu/100 ml. This indicates that poor water quality conditions are widespread in the North Fork Goose Creek and its tributaries.

Future Impairments – LSWCD fecal coliform monitoring at three stations in unimpaired segments downstream and upstream of the impaired segment in the North Fork Goose Creek, and in Crooked Run show there are poor water quality conditions similar to those in the impaired segment. The following additional stream segments should be classified by DEQ as having observed affects for fecal coliform:

Figure A.37. LSWCD Fecal Coliform Data for N.F. Creek Watershed 1999-2003.



- North Fork Goose Creek from its mouth at Goose Creek upstream to the confluence of Crooked Run and the current impairment.
- North Fork Goose Creek from its current impairment approximately 0.25 m upstream from the Rt. 611 Bridge to Sleeter Lake.
- Crooked Run from its mouth to its headwaters.

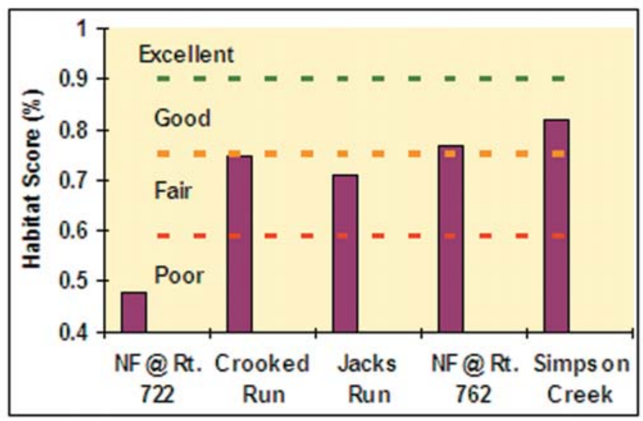
This is consistent with the finding of the TMDL study that water quality is poor throughout the Goose Creek watershed in Loudoun County.

Severe bank erosion and mud bars at the Rt. 722 monitoring site along NF Goose Creek.

Stream Habitat Quality

Loudoun Wildlife Conservancy – LWC has collected stream habitat data at six sites in the watershed using the EPA RBP II protocol since 1997. The quality of the stream habitat is assessed using ten parameters that are combine into a "habitat condition score." The results are summarized in **Figure A.38.** These data show that stream habitat conditions range from poor to good. This indicates there has been a moderate loss of natural habitat, and that habitat in some portions of the watershed is a limiting factor for a health biological community. For example, the following pictures show the reason conditions are poor at the Rt. 722 site. There are no natural riparian buffers and cattle have access to the stream. This has led to severe bank erosion, and mud and sand banks in the stream channel.

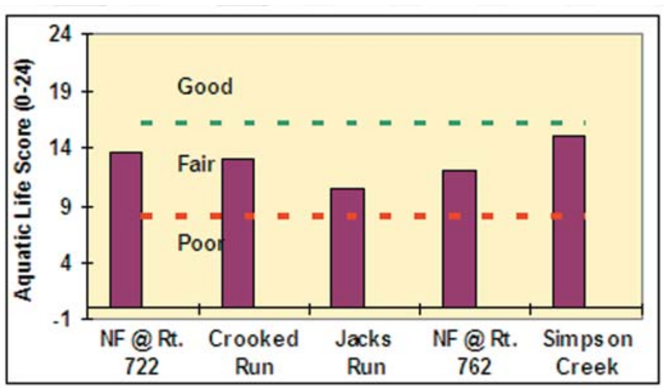
Figure A.38. LWC Benthic Macroinvertebrate Scores for North Fork Goose Creek Watershed - 2004.



Aquatic Insect Populations

Loudoun Wildlife Conservancy - LWC has collected aquatic insect samples in North Fork Goose Creek and Crooked Run since 1997. These data were analyzed using EPA metrics, and the results are shown in **Figure A.39.** The condition of the aquatic insect community at the North Fork monitoring site is in the "fair" range. This means that the composition and diversity of the aquatic insect community is generally lower than what is expected if the stream was not being degraded. Many of the insects found are moderately tolerant of pollution. For example, the Netspinner Caddisfly (Hydropsychidae) was the most common insect found at

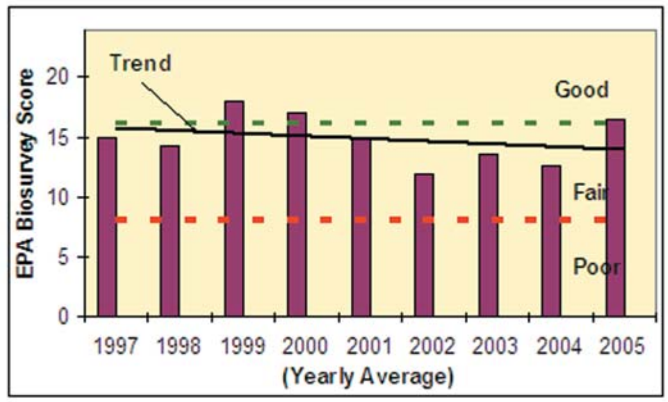
Figure A.39. LWC Benthic Macaroinvertebrate Scores for North Fork Goose Creek Watershed - 2004



the Rt. 762 site below Sleeter Lake. At the Crooked Run site, fewer than 50 insects were found in the spring sample and less than 100 in the fall sample. Over 200 insects per sample are common at good sites.

The Crooked Run site data are also an example of the degrading trend that is occurring in portions of the watershed. **Figure A.40** shows the downward trend of aquatic insects scores at the site over the last five years. Stream habitat conditions are characterized by increasing bank erosion, deposits of sediment in the stream bed, and poor substrate for aquatic insects (which accounts for the low numbers of insects).

Figure A.40. LWC Benthic Macroinvertebrate Scores for Crooked Run With Trend Line–1997–2004.



Overall Assessment of Stream Health

The water quality and stream conditions are well documented in the North Fork Goose Creek watershed. The DEQ and LSWCD data show that the water chemistry is good in the watershed. However, fecal coliform bacteria contamination from nonpoint sources of pollution is widespread. Pollution source studies conducted by DEQ indicate that cattle are the largest contributor to fecal coliform bacteria pollution in the watershed. DEQ has designated one section of the North Fork as not meeting DEQ's standards. However, several additional segments should be classified as impaired for recreational use based on the findings of the TMDL report and collaborating data collected by LSWCD.

The stream habitats conditions at the monitoring sites are generally rated in the "fair" category. This indicates there has been a moderate loss of habitat, and that habitat conditions may be a limiting factor to supporting a health biological community. The condition of aquatic insect communities are also generally in the "fair" range. The health of the insects communities in Crooked Run show a downward trend.

Cattle with stream access destroy riparian buffers and contribute to stream bank erosion.

Overall, the assessments indicate that the North Fork Goose Creek watershed is impacted by human activities and the health of the

Overall, the assessments indicate that the North Fork Goose Creek watershed is impacted by human activities and the health of the streams are being stressed as a result. The results of various measurements of stream health are summarized in **Table A.42.**

Table A.42. Summary of North Fork Goose Creek Stream Health Conditions Based on State and Local Stream Assessment Data.

Monitoring Site	Environmental Parameters					
	Water Flow	Chemical Quality	Bacteria Quality	Habitat Assessment	Aquatic Insect Score	Impervious Surfaces
NF Goose Creek	USGS 2001-2004	Good	Impaired	Poor-Good	Fair	Good
Crooked Run			Impaired	Fair-Good	Fair	Good
Jacks Run				Fair	Fair	Good
Simpson Creek				Good	Fair	Good

References

Environmental Protection Agency. 1997. Volunteer Stream Monitoring: A Methods Manual. November, 1997.

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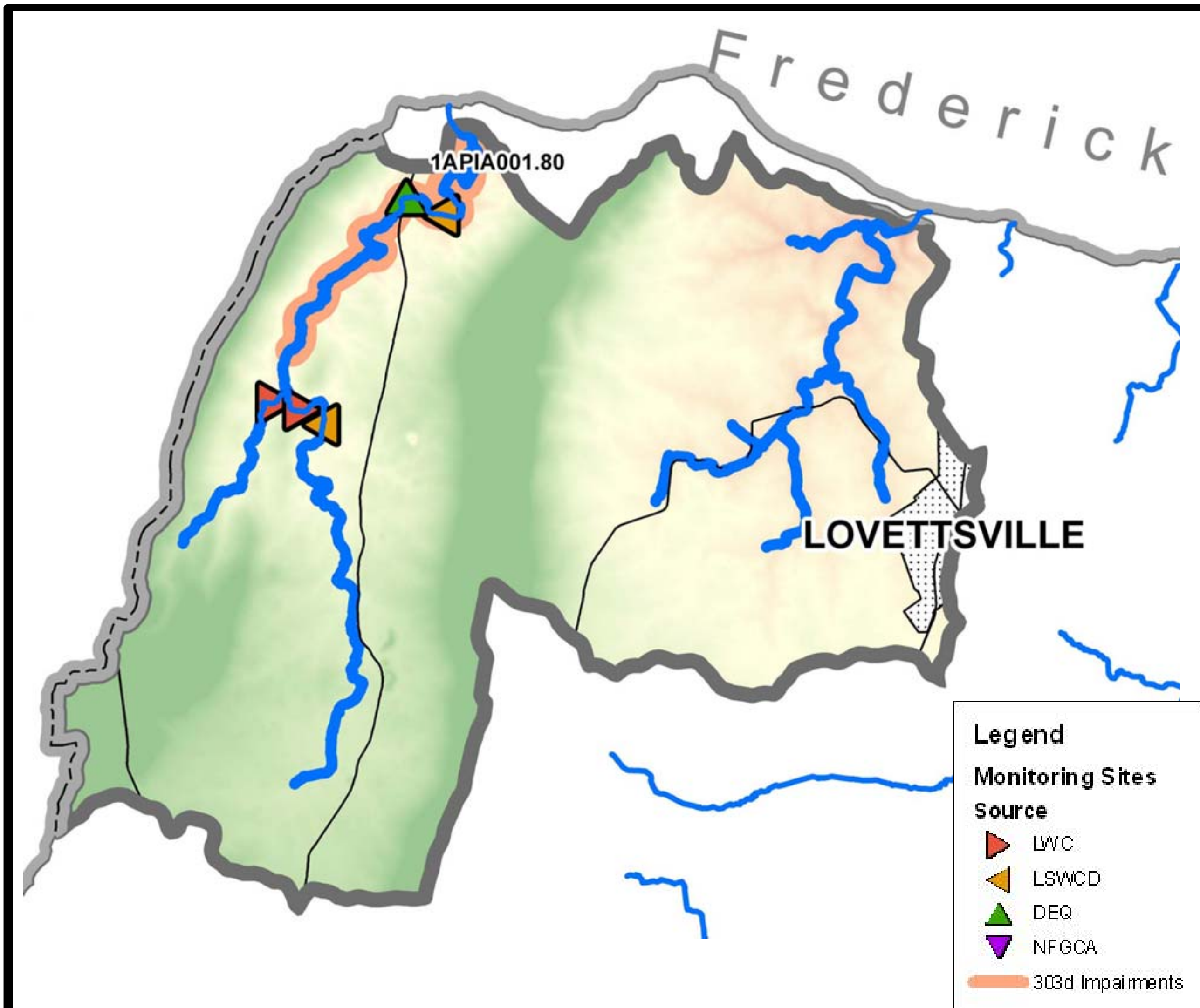


Piney Run Watershed

QUICK REFERENCE .... Page

Watershed Description

Sweet Run tributary monitoring site on BRCES property.

Piney Run is a small, first and second order stream in the northwestern portion of Loudoun County. The watersheds drains 9,700 acres or 15.2 square miles and includes the Sweet Run tributary. It is approximately 3 miles long and 6 miles wide, and runs from south to north. It flows into the Potomac River just downstream of Harpers Ferry, WV. There is a small waterfall at its confluence with the Potomac River that is near a takeout point for rafters and other boaters. In the summer months, hundreds of people, mostly youth, cool off in the Piney Run waters.

Piney Run flows in a valley between ridgelines to the west and east. In general, soils in the valley have high infiltration rates and low runoff potential, and soils at the higher elevations have low infiltration rates and high runoff potential. The average annual rainfall is 42.4 inches.

Land Use – Piney Run drains a rural area that is predominately mountain and valley basin. Land use type in the watershed is primarily forest (71%) and pasture (27%). The pasture land tends to be located closer to the stream, and the forest land along the ridge further from the stream. The steeper slopes along the ridge lines have remained largely forested. **Figure A.43** shows forested lands (in green) and pasture lands (in white).

Impervious Surfaces – Impervious surfaces include the roadways, driveways, rooftops and parking lots that do not allow infiltration of water from rainstorms and runoff. LEIP includes mapping impervious surfaces in

the county using Lansat Imagery. They report that the amount of impervious surface in the piney Run watershed is 0.08%. As a general rule, a watershed with less than 10% of its area in impervious surfaces will not experience a noticeable impact on its hydrological characterisitics.

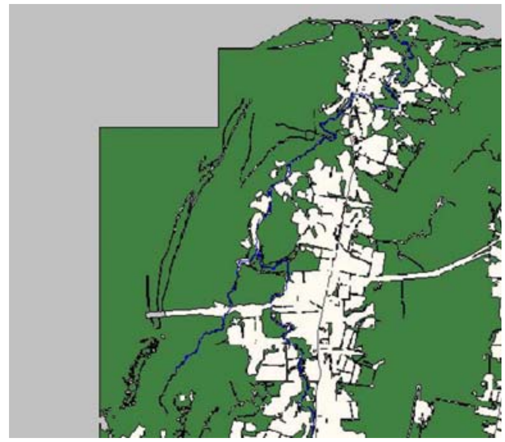


Figure A.43. Forest cover in the Piney Run watershed.

Water Quality Studies

Water Quality Standards - Piney Run is listed by the Virginia Department of Environmental Quality (DEQ) as impaired for recreational use due to violations of the State's water quality standard for fecal coliform bacteria. DEQ has one monitoring station at the 1.8 mile point in the stream. The impairment extends from the mouth at the Potomac River upstream to the 3.5 mile point and the confluence with Sweet Run. The remaining 32 miles of stream waters are not sampled by DEQ, and are not classified. A summary of DEQ's assessment of Piney Run is provided in **Table A.44.**

Table A.44. Assessment of Piney Run in DEQ's 2004 303(d)/305(b) Integrated Report to EPA.

Watershed Monitoring Station	Meet Stnds	No Data	Citizen Data Show Problems	Citizen Data Show No Problems	Impaired
Piney Run	0	31.9	0	0	3.52
Sweet Run	0	3.56	3.56	0	0

Table A.44 indicates that citizen data for Sweet Run show a problem that needs follow-up by DEQ. This is based on macroinvertebrate data collected by LWC. Loudoun Soil and Water Conservation District (LSWCD) also collects bacteria stream monitoring data at Rt. 685 (stream mile 4.2) upstream of DEQ's impaired section. The LSWCD data show excessive fecal coliform bacteria concentrations in this upstream segment similar to the downstream segment. Unfortunately, these data have not been accepted by DEQ and, consequently, this stream segment is not listed as showing problems.

Water Quality Studies – DEQ is required to conduct studies of all stream waters that do not meet water quality standards. The purpose of the study is to identify the source(s) of the pollution and quantify the pollution load(s) to the stream. DEQ studied the stream in 2003, and their report, "Bacterial TMDL Piney Run, Loudoun County, Virginia" was published in March 2004.

Piney Run monitoring site on Blue Ridge Center for Environmental Stewardship property.

DEQ used Bacteria Source Tracking (BST) and the Antibiotic Resistance Analysis (ARA) method to determine the relative contribution of bacteria by human, pet, livestock, and wildlife sources. Estimates were made of the numbers of these sources in order to calculate the annual pollution load contributed by each source.

- **Point Sources of Pollution** – There are two point sources that discharge under permit to Piney Run. Both sources discharge less than 1,000 gallons per day, and do not make a significant contribution to the stream pollution.

- **Humans and Pets** – 2000 Census data indicates there are 626 residents living in approximately 242 households in the Piney Run watershed. Bacteria from humans can enter the stream from straight sewage pipes and failing septic systems that discharge effluent to the perennial tributaries. The Department of Health estimates there are 9 straight pipes and 44 failing septic systems in the watershed. It is estimated that these homes have 900 dogs and 1,115 cats. Pollution from pets, especially dogs, can enter the stream through stormwater runoff.

- **Livestock** – Fecal wastes from livestock can be deposited directly in the stream if livestock have stream access, or transported to the stream in surface runoff from grazing or pastureland. LSWCD estimates there are 500 cattle and calves, 225 beef cows, and 350 horses in the Piney Run watershed.

- **Wildlife** – Like livestock, fecal wastes from wildlife can be deposited directly in the stream (muskrat, beaver, and geese), or it can be transported to the stream in surface runoff. The Department of Game and Inland Fisheries (DGIF) estimates that the biggest wildlife contributors are 1,600 deer and 120 raccoon.

- **Relative Yearly Fecal Bacteria Loads by Source** – DEQ combined the information on sources of pollution and estimated the average yearly fecal bacteria load contributed by different sources in the watershed. These relative loads are shown in **Table A.45**. It is seen that approximately 70% of the fecal bacteria in Piney Run watershed come from cattle and horses.

- **Estimated Load Reductions to Meet Water Quality Standards** – DEQ estimates that fecal coliform bacteria loads to Piney Run need to be reduced by 94% in all cases except for wildlife (18% reduction) if water quality standards are to be attained. This can be accomplished by repairing failing septic systems and straight pipes, fencing cattle out of streams and ponds draining into Piney Run, and allowing a natural riparian buffer to become established along the stream to help filter land runoff into the stream.

Table A45. Estimated Relative Contribution of Fecal Bacteria in Piney Run by Different Sources.

Source	Number of Units	Contribution	Reduction Needed
Human	9 straight pipes, 44 failing systems	2.6%	94%
Pet	411 dogs	11%	94%
Livestock	725 cattle, 350 horses	68.9%	94%
Wildlife	1,611 deer, 119 raccoon	17.5%	18%

Watershed Monitoring

Stream Quality and Habitat Monitoring - Water quality and stream health in the Piney Run watershed is marginally documented. DEQ has one chemical and bacteriological station that has been sampled since 1974. LSWCD has collected chemical, fecal, and aquatic insect data at two stations dating from 1999. LWC has collected aquatic insect data from one station on the Sweet Run tributary since 2001 and one station on Piney Run since 2003. A summary of the reportable data in the Piney Run watershed is provided in **Table A.46.**

Table A.46. Stream and Habitat Monitoring Data for the Piney Run Watershed.

Monitoring Sites	Water Flow	Chemical	Bacterial	Habitat	Aquatic Insects
Main Stem – Rt. 671		**DEQ** 1990-2004	**DEQ** 1990-2004		
Main Stem – Rt. 683		**LSWCD** 1999-2004	**LSWCD** 1999-2004		**LSWCD** 1999-2004
Main Stem – Rt. 685		**LSWCD** 1999-2004	**LSWCD** 1999-2001		**LSWCD** 1999-2001
Main Stem – Above Sweet Run				**LWC** 2004	**LWC** 2004
Sweet Run Tributary				**LWC** 2001-2004	**LWC** 2001-2004

Water Chemistry Conditions

The chemical quality of Piney Run is the major indicator used to determine whether the stream is fit for aquatic life and recreational uses. DEQ has collected chemical water quality data at the Rt. 671 bridge on Piney Run since 1990. These data show that chemical parameters meet state standards. Key chemical parameters are summarized in **Table A.47.**

Table A.47. Summary of Key Chemical Parameters Based Upon DEQ Data from Piney Run Between 1996 and 2001.

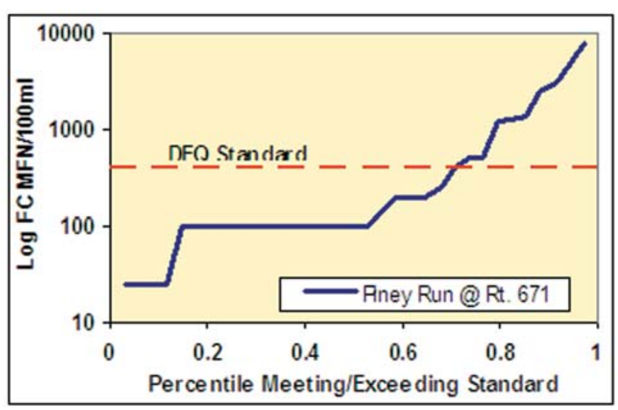
Parameter	Criteria	Observation	Condition
pH	Range of 6-9 units	Median pH level is 7.2	**Criteria met**
DO (Dissolved Oxygen)	Minimum of 4 mg/l	Median DO level is 10.1with a range of 5.8 to 13.8 mg/l. Levels are consistently between 8 and 14 mg/l which is good for aquatic life.	**Criteria consistently met**
BOD (Biological Oxygen Demand)	No DEQ standard -- EPA guildline is a maximum of 7 mg/L	Median BOD is 2 with a range of 0.6 to 6 mg/l. Levels are consistently at or below 2 mg/l suggesting low organic loads affecting stream water.	**Criteria consistently met**
Phosphorus	No DEQ standard -- EPA guideline of 1.0 mg/L	Median level of 0.1 mg/l suggests there is not excessive run-off of fertilizers from agricultural and other operations affecting the watershed.	**Criteria consistently met**
Nitrogen (as Nitrate)	No DEQ or EPA guideline	Median levels of 0.4 with a range of 0.1 to 4.6 mg/l. Trend towards increasing levels. These low levels of nitrogen in combination with low levels of phosphorus keep growth of aquatic plants and algae in check.	**Low levels**

LSWCD also had collected chemical data two stations upstream and downstream from Rt. 671 beginning in 1999. These data show consistently good results. These data support DEQ's finding that the chemical quality of Piney Run is good.

Water Bacteriology Conditions

DEQ Data – Streams that are fit for use as recreational waters must have low levels of fecal contamination. DEQ has collected fecal coliform data in Piney Run since 1990. The most recent 1996-2004 fecal coliform bacteria levels are shown in **Figure A.41**. The water quality does not meets state standards in that over 25% of the samples exceed 400 fecal coliform. There are periods when fecal coliform reach levels as high as 8000 cfu/100ml.

Figure A.41 DEQ Fecal Coliform Data for Piney Run Showing % Samples Exceeding Standard.



Loudoun Soil and Water Conservation District – LSWCD has collected fecal coliform data in Piney Run

at two sites upstream and downstream from the DEQ site since 1999. The data, plotted as cumulative percentages, are shown in **Figure A.42.** These data also show that 40% to 50% of the samples exceed 1000, and that water quality standards are not being met even in the upstream area not classified by DEQ.

Stream Habitat Quality

Loudoun Wildlife Conservancy - LWC has collected stream habitat data in Sweet Run since 2002 and Piney Run starting in 2004. The LWC monitoring sites are on the Blue Ridge Center for Environmental Stewardship (BRCES) property. The property is largely hardwood forested with wide natural forested riparian buffers, and unaltered, meandering stream courses. Habitat conditions are very good as shown in **Figure A.43.**

Aquatic Insect Populations

Loudoun Wildlife Conservancy - LWC has collected aquatic insect samplse at two stations using the ANS protocol. These data suggest that the condition of the aquatic insect communities at the sampling sites are in the "fair" category. The type of insects present are predominately those that are moderately tolerant of pollution such as caddisflies, midge larvae, black flies, and flathead mayflies. There are only a few species sensitive to pollution, and those present are normally in low numbers. Aquatic insect conditions at Piney Run are shown in **Figure A.44.**

Figure A.42. LSWCD Fecal Coliform Data for Piney Run Showing % Samples Exceeding Standard.

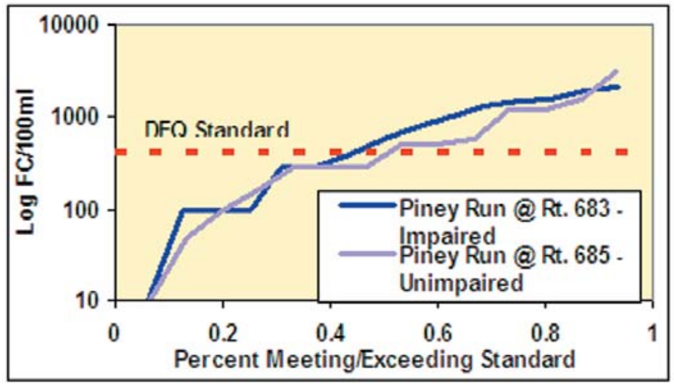
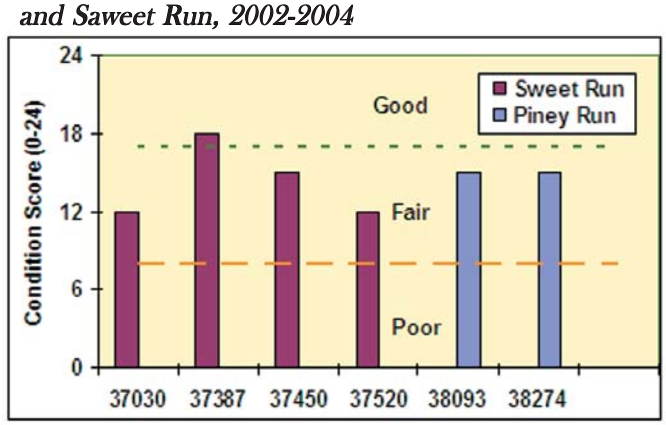


Figure A.43. Stream Habitat Conditions in Piney Run and Sweet Run. 2002-2004

Figure A.44. Aquatic Insect Conditons in Piney Run and Saweet Run, 2002-2004



Overall Assessment of Stream Health

DEQ's TMDL report on Piney Run provides good information on water quality conditions and sources of pollution affecting the watershed. These data are supplemented by bacteriological, stream habitat, and aquatic insect data collected by LSWCD and LWC.

The fecal coliform bacteria data for Piney Run show that the stream is impaired for use as recreational waters. The principal sources of pollution are cattle with access to the stream, deer and raccoons, pet dogs, and failing septic tanks systems. DEQ and LSWCD chemical data suggest that the water quality is otherwise good. The very limited stream habitat data are restricted to the Blue Ridge Environmental Center property that is all hard wood forest. The limited aquatic insect data suggest that the stream is marginally healthy. The results of various measurements of stream health are summarized on **Table A.48**.

Table A.48. Summary of Piney Run Stream Assessments that Measure Stream Health.

Monitoring Site	Environmental Parameters					
	Water Flow	Chemical Quality	Bacteria Quality	Habitat	Aquatic Insect	Impervious Surfaces
DEQ Rt. 734		Good	Poor-Impaired			Excellent
LSWCD Rt. 683		Good	Poor-Impaired			Excellent
LSWCD Rt. 685		Good	Poor-Impaired			Excellent
BREC-Piney Run				Good	Fair	Excellent
BREC-Sweet Run				Good	Fair	Excellent

References:

George Washington University. 2000. "Loudoun County Environmental Indicators Project (LEIP). Annual Report 2000. Ashburn, VA.

Virginia DEQ. 2004. "Bacteria TMDL for Piney Run, Loudoun County, Virginia."

Appendix B : DEQ Assessments - by Station

APPENDIX B part 1

DEQ's Station by Station Assessment of Loudoun Waters

Pink=Impaired, Yellow=Threatened/Observed Effects, Green=Meets Standards, Italics=New in catagory since 2001 Assessment,

NA=river segment overlaps with another segment

Watershed Monitoring Station	Monitoring Location	Type Data	River Miles	Categories (Number of River Miles)								
				2A – Meet Stnds	2B-Exceed Screening Value	3A – No Data	3B-Insufficient DEQ Data	3C-Citizen Data Show Problems	3D-Citizen Data Show No Problems	4A-Impaired with TMDL	5A-Impaired TMDL Needed	5D-TMDL Needed for Benthic
Piney Run/Dutchman Creek A01			**38.98**			**31.90**						
1APIA001.80	Rt. 671	DEQ									3.52	
New 1ASDH-15-LWC	Unnamed Tributary	Citizen						3.56				
Catoctin Creek A02			**132.91**			**96.67**						
1ACAX004.57	Rt. 663	DEQ								7.20		
New 1ACAX-3-LWC		Citizen						(NA)				
North Fork Catoctin Creek A02												
1ANOC000.42	Rt. 681	DEQ								4.12		
1ANOC004.38	Rt. 287	DEQ		3.16								
New 1ANOC009.13	Rt. 812	DEQ								2.45		
New 1ANOC-1-LWC		Citizen						(NA)				
South Fork Catoctin Creek A02												
1ASOC001.66	Rt. 698	DEQ								5.77		
1ASOC007.06	Rt. 738	DEQ								2.97		
New 1ASOC0011.98	Rt. 611	DEQ										(3.40)
1ASOC0012.38		DEQ								5.17		
New 1ASOC012.60	Rt. 690	DEQ										(NA)
1ASOC013.05	Rt. 7	DEQ										(NA)
1ACSOC-4-LWC	Rt. 611	Citizen						(NA)				
Milltown Creek A02												
New 1AMIH-11-LWC		Citizen						2.00				
Limestone Branch A03			**61.33**			**49.71**						
1ALIM001.16	Rt. 15	DEQ									4.75	
New 1AXAQ-5-LWC	Rt. 661	Citizen						1.90				

APPENDIX B part 2

DEQ's Station by Station Assessment of Loudoun Waters

Watershed Monitoring Station	Monitoring Location	Type Data	River Miles	Categories (Number of River Miles)								
				2A – Meet Stnds	2B- Exceed Screening Value	3A – No Data	3B- Insufficient DEQ Data	3C- Citizen Data Show Problems	3D- Citizen Data Show No Problems	4A- Impaired with TMDL	5A- Impaired TMDL Needed	5D- TMDL Needed for Benthic
New 1AXGJ-16-LWC	Tutt Lane	Citizen						4.97				
Middle Goose Creek/Panther Skin A05			**120.52**			**102.78**						
New 1AGOO022.44	Rt. 734	DEQ								7.20		
1AGOO030.75	Rt. 611	DEQ		**2**								
New 1APAE-12-LWC	Rt. 623	Citizen						3.71				
Non-Loudoun Waters		DEQ		3.22						3.61		
North Fork Goose Creek/Crooked Run A06			**60.43**			**41.29**						
1ANOG005.69	Rt. 722	DEQ								4.29		
New 1ACRF-6-LWC	Rt. 727	Citizen						2.08				
1ANOG-7-LWC	Rt. 762	Citizen						2.56				
1ANOG-1-NFGC		Citizen							(NA)			
1AJAC-2-NFGC		Citizen							2.89			
1ACRF-3-NFGC		Citizen							(NA)			
New 1ANOG-4-NFGC		Citizen						2.47				
New 1ANOG-5-NFGC		Citizen						(NA)				
1ANOG-6-NFGC		Citizen							3.82			
1ASIM-8-NFGC		Citizen							1.03			
Beaverdam Creek A07			**73.08**			**54.54**						
1ABEC004.76	Rt. 734	DEQ								6.32		
1ABEC011.19	Rt. 626	DEQ		1.17								
1ANOB005.49	Rt. 719	DEQ		2.45								
1ANOB007.97	Rt. 831	DEQ			4.60							
New 1ABUS-10-LWC	Rt. 779	Citizen						1.11				
1ANOB-9-LWC	Rt. 630	Citizen						2.89				
Lower Goose Creek A08			**161.58**			**121.54**						
1AGOO002.38	Rt. 7	DEQ								4.77		(NA)
1AGOO003.18		DEQ										(NA)
1AGOO011.23	Rt. 621	DEQ		**3.00**								

APPENDIX B part 3

DEQ's Station by Station Assessment of Loudoun Waters

Pink=Impaired, Yellow=Threatened/Observed Effects, Green=Meets Standards, Italics=New in catagory since 2001 Assessment,

NA=river segment overlaps with another segment

Watershed Monitoring Station	Monitoring Location	Type Data	River Miles	Categories (Number of River Miles)								
				2A – Meet Stnds	2B- Exceed Screening Value	3A – No Data	3B- Insufficient DEQ Data	3C- Citizen Data Show Problems	3D- Citizen Data Show No Problems	4A- Impaired with TMDL	5A- Impaired TMDL Needed	5D- TMDL Needed for Benthic
1644000.00		USGS			3.20							
Little River A08												
1ALIV001.70	Rt. 15	DEQ								(NA)		(NA)
1ALIV004.78	Rt. 50	DEQ								6.13		(NA)
Sycolin Creek A08												
New 1ASYC002.03	Rt. 653	DEQ								2.85		
1ASYC004.93	Rt. 621	DEQ								3.51		
1ASYC007.43	Rt. 797	DEQ								3.59		
1ASFS000.28	Rt. 15	DEQ								3.31		
Tuscarora Creek A08												
New 1ATUS000.37	Rt. 653	DEQ								3.55		
1ATUS-2-LWC		Citizen						(NA)				
Broad Run/Horsepen Run A09			**128.54**			**113.87**						
New 1ABRB002.15	Rt. 7	DEQ									2.88	
1AHPR003.87	Dulles Rd	DEQ		6.38								
1ASOR002.99	Rt. 616	DEQ		4.96								
New 1ABEM-13-LWC	Rt. 641	Citizen						0.45				
Sugarland Run A10			**4.42**			**0**						
1ASUR004.42	Rt. 7	DEQ									4.42	
New ASUG-14-LWC		Citizen						(NA)				
County Totals			**774**	**30**	**8**	**612**	**0**	**30**	**8**	**104**	**16**	**(3)**

Appendix C

Fecal Bacteria in Stream Water: Public Health Considerations

Are streams in Loudoun County safe for recreational use? - The Virginia Department of Environmental Quality (DEQ), Department of Conservation and Recreation (DCR), Department of Health (VDH), and Federal EPA provide information on their websites regarding the health risks associated with fecal bacteria in drinking and recreational waters.

What is Fecal Coliform? – When DEQ monitors stream water, they test for the presence of fecal coliform bacteria. These bacteria live in the intestinal tracts of humans and other warm-blooded animals. The presence of fecal coliform bacteria in stream waters is an indicator of pollution from fecal wastes, and the potential for human pathogens, or disease causing organisms, being present.

Do People Get Sick From Bacteria in Fecal Wastes? – The answer is YES. One particular kind of fecal coliform bacteria, *Escherichia coli (E. coli) O157:H7*, is an emerging cause of foodborne and waterborne illness. These bacteria produce a powerful toxin and can cause severe illness. This is of special concern because it is reported that cattle are a reservoir for this type of *E. coli*, and five to forty percent of cattle shed the bacteria at any given time.

The disease causing affects of bacteria in fecal wastes have been documented time and again in food, water supplies, and recreation waters used for swimming. An example of an outbreak associated with drinking water occurred in May 2000, in Walkerton, Ontario, a town of approximately 5000 people. There were seven confirmed deaths with four other deaths under investigation, and over 2000 poisonings all attributed to drinking water polluted by *E. coli Type 0157:H7*. The source of the pollution was probably runoff from a feedlot located more than 5 miles from the wells used for the town's water supply.

Livestock are the number one source of fecal bacteria pollution to Loudoun streams.

An example of an outbreaks associated with swimming water occurred on August 8, 1994 in Virginia. VDH was notified of campers and counselors at a Shenandoah Valley summer camp developing bloody diarrhea. *E. coli 0157:H7* was confirmed as the causative agent. Another outbreak occurred in Franklin County Virginia, in 1997. Illnesses

involving 3 children were attributed to *E. coli 0157:H7* in Smith Mountain Lake. The children were exposed to the bacteria while swimming in the lake and a two year old hospitalized almost died as a result of the exposure.

Are These Isolated cases? – The answer is NO. The Center for Disease Control estimates at least 73,000 cases of illnesses and 61 deaths per year throughout the U.S. caused by *E. coli 0157:H7* bacteria. In addition, other bacterial and viral pathogens are indicated by the presence of fecal coliform. Further, the threat of these pathogens appears more prevalent in more populated areas and areas with more cattle.

Are Water Quality Standards Important? – EPA is responsible for assessing the risk the public is willing to accept and then establishing water quality standards that reflect these acceptable risks. DEQ and DCR are responsible for implementing measures to safeguard the public from these risks. Water quality standards are society's method of protecting citizens from unacceptable risks.

What Does the Virginia Department of Health Say? – VDH urges citizens who use river, stream and lake water for recreational purposes to be cautious and to use common sense about contact with recreational water. Although the cleanliness and quality of Virginia's surface waters continually improves, it is impossible to guarantee that any natural body of water is free of risk from disease causing-organisms or injury.

Can't We Test Stream Waters for Pathogens? – Testing water for viruses, parasites, and bacteria that cause illnesses are difficult, time consuming, and costly. For these reasons, tests for fecal coliform bacteria and *E. coli* are the national standards used as an indicator of possible contamination from human waste. The higher the fecal coliform level, the more likely it is that sewage is present, and the greater the risk of disease causing organisms being present. On the other hand, water that tests negative for fecal coliform bacteria is not necessarily risk free.

What Precautions Should Citizens Take When Using Streams for Recreation? – Most of the organisms in Virginia's rivers and lakes probably do not cause human illness or are in such low levels they will not make anyone sick, but there is no way to be sure. Most of the waterborne organisms that cause disease affect the digestive tract and therefore are acquired by ingesting contaminated water. Less commonly, skin, ear and eye infections can result from contact with surface water. Although recreational water users may inadvertently swallow water, deliberately drinking from rivers, streams or lakes is never recommended. Persons whose immune systems are compromised should be very careful to avoid swallowing water from any river, stream or lake.

Where Do I Get Further Information? – More information is available from VDH regarding Risks of Recreational Water Use on there website at: www.vdh.state.va.us.

Appendix D

Clean Stream Water: What are the Public Benefits?

Are Clean Streams Waters Important? - The primary benefit of reducing pollution loads in Virginia streams to meet water quality standards is cleaner waters. The state believes this is so important that they are conducting pollution studies and developing plans to reduce pollution levels throughout the state. The studies are called Total Maximum Daily Load (TMDL) and the plans are called TMDL Implementation Plans (IP's).

How Will Citizens and the Community Benefit? – Benefits of clean water to citizens include:

- Improved public health,
- Conservation of natural resources (e.g., soil and soil nutrients),
- Improved aquatic life,
- Improved riparian habitat,
- Reductions in the amount of flood damage,
- Improved recreational opportunities, and
- Greater direct economic opportunities (e.g., improved agricultural production, tourism, etc.), and
- Ancillary economic benefit including enhanced real estate values for farms, homes, and businesses located near water bodies with good water quality.

How Will Costs Be Controlled? - In many instances water quality is impacted by several sources of pollution. TMDL IP's are designed to provide best management practices (BMPs) that allow multiple pollutant problems to be handled at the same time. For example, excluding livestock from streams is an important management practice to reduce fecal bacteria in a stream. Livestock are excluded by fencing off the stream. Fencing also helps restore a riparian buffer of 25 to 35 feet by allowing grasses and trees to grow. A healthy riparian buffer also benefits the aquatic habitat and the aquatic life in the same stream. The vegetated buffers that are established reduce sediment and nutrient transport to the stream from upslope locations. If fences were only placed at the top of the stream bank without the riparian buffer, the additional benefit of reducing sediment and nutrient loadings from the upland would be lost.

What is the Public Health Benefit? –The majority of TMDLs being developed in Virginia are to reduce fecal bacteria in streams. It is hard to gage the impact that reducing fecal bacteria contamination will have on public health, as most cases of waterborne infection are not reported or are falsely attributed to other sources. However,

the incidence of infection from pollutant sources, through contact with surface waters, should be reduced considerably, and this should be noted.

Is There a Benefit for the Chesapeake Bay?– On a larger scale, for watersheds located within the Chesapeake Bay watershed, reducing sediment and nutrients loads as a result of BMPs that are installed to improve benthic and bacteria water quality impairments will help obtain implementation goals in the Tributary Strategies.

What is the Economic Benefit to the Community? – The main objective of TMDL implementation is restoring water quality in our streams. Additional benefits will likely include continued economic vitality and strength. Healthy waters can improve economic opportunities for Virginians, and a healthy economic base can provide the resources and funding necessary to pursue restoration and enhancement activities. The agricultural, residential, or urban implementation actions recommended in the Implementation Plan (IP) will often provide economic benefits to the landowner, along with the expected environmental benefits. For example, exclusion of cattle from streams leads to the development of alternative (clean) water sources. This provides an opportunity for intensive pasture management and improved nutrient management. Additionally, money spent by landowners, government agencies, and non-profit organizations in the process of implementing the IP will stimulate the local economy.

What is the Economic Benefit to the Home Owner? – Human waste can carry with it human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry. In terms of economic benefits to homeowners, an improved understanding of private sewage systems, including knowledge of what steps can be taken to keep them functioning properly and the need for regular maintenance, will give homeowners the tools needed for extending the life of their systems and reducing the overall cost of ownership. The average septic system will last 20-25 years if properly maintained. Proper maintenance includes; knowing the location of the system components and protecting them by not driving or parking on top of them, not planting trees where roots could damage the system, keeping hazardous chemicals out of the system, and pumping out the septic tank every three to five years. The cost of proper maintenance, as outlined here, is relatively inexpensive in comparison to repairing or replacing an entire system.

Why is Citizen Support for Clean Water Needed? – Cleaner waters in Virginia will result in improved public health, conservation of natural resources, improved aquatic habitat, and greater economic opportunities for Virginians. These benefits add up to a better quality of life in the Commonwealth of Virginia; the recognition of these effects and their applicability in watersheds will help to ensure a successful implementation.

However, success of the TMDL implementation Plans depends on community support and voluntary actions by streamside property owners. Citizens need to take advantage of cost-sharing and tax incentive programs to restore stream buffers and exclude livestock from streams. Homeowners with improperly operating septic tank systems need to repair these systems.

How Do I get More Information?

Information in this attachment was taken from the DCR and DEQ, 2003, "Guidance Manual for Total Maximum Daily Load Implementation Plans." This document is available on the DEQ website at www.deq.virginia.gov. Additional information about how Loudoun streams can benefit from improved pollution source management practices is available from the following local organizations: