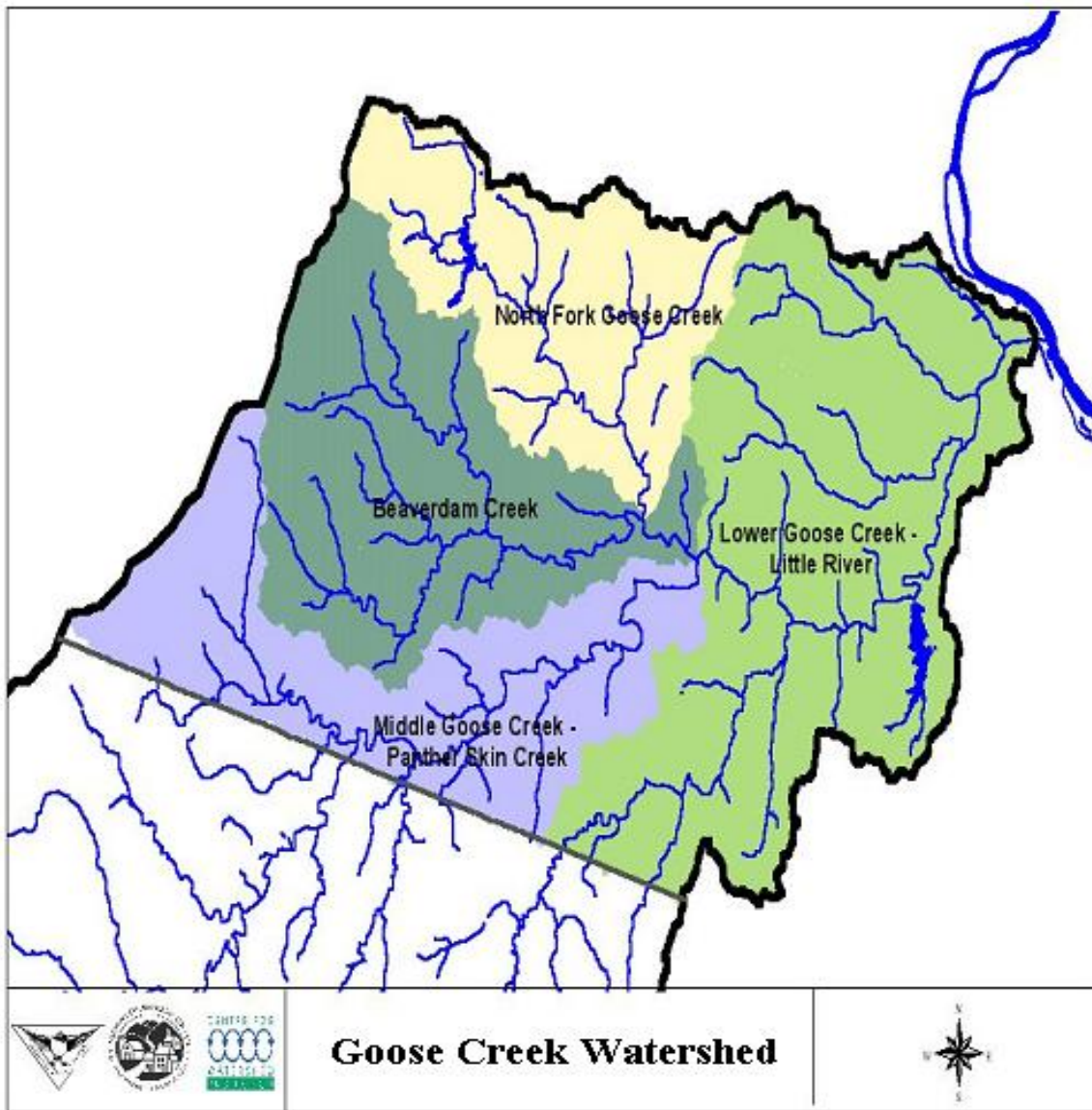


NORTH FORK GOOSE CREEK WATERSHED 2005 PROFILE



Watershed Description	
Water Quality Studies	
Water Chemistry Studies	
Stream Monitoring	
Stream Habitat Conditions	
Aquatic Life Conditions	
Overall Assessment of Stream Health	

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.

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.



North Fork Goose Creek monitoring site below Sleeter Lake.



Crooked Run stream monitoring site.

The topography in the watershed is generally rolling hills with elevations less than 1,000 feet above sea level. The watershed is characterized by mostly 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 1**. The rainfall is fairly

evenly distributed throughout the year, although it tends to be lower between December and February.

Table 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 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 2**. 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 2. 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

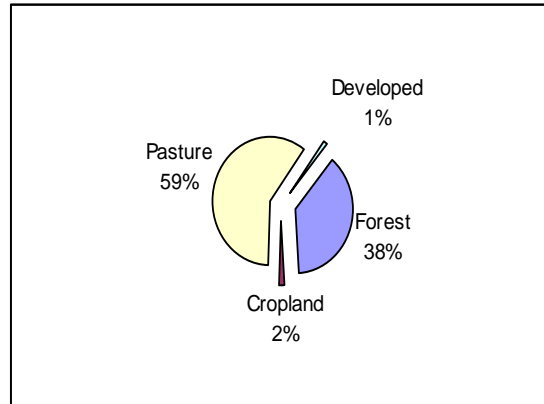
Land Use -- Land use is predominately agricultural and forested lots. There are residential and commercial areas in the towns of Hamilton, Purcellville, and Round Hill. **Figure 1** shows the land-use patterns based on 1997 data published by EPA and provided in DEQ's 2002 TMDL report. The impact of land use on stream quality is seen in the following pictures.



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

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) 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 characteristics of the watershed.

Figure 1. Land Use in North Fork Goose Creek Watershed Based on 1997 Data.



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 because DEQ has no monitoring data on these portions. A summary of the information published by DEQ in their assessment report on North Fork Goose Creek is provided in **Table 3.**

Table 3. 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. The lower mainstem of Goose Creek and six tributary streams have elevated fecal coliform bacteria levels and the water quality exceeds 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.
- **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 4**.

Table 4. 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 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 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. The estimated number of failing septic systems is provided in **Table 5**.

Table 5. 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 6** provides an estimate of biosolids application based on data provided by the biosolids industry.

Table 6. 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 7**.

- **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 7**.
- **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

Table 7. 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

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 8**. 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 8. 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 approved and unapproved data available for the North Fork Goose Creek watershed is provided in **Table 9**.

Table 9. 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)		<i>NFGC 1996-2003</i> LSWCD 1999-2004	LSWCD 1999-2004	LWC 1997-2004	LWC 1997-2004 <i>NFGC 2000-2003</i> LSWCD 1999-2004
Rt. 729 (Iron Bridge)	USGS 2001-2004	<i>NFGC 1998-2003</i> LSWCD 1999-2004	LSWCD 1999-2004		<i>NFGC 2000-2003</i> LSWCD 1999-2004
Villages at Round Hill		<i>NFGC 1996-2003</i>			<i>NFGC 2000-2003</i>
Crooked Run					
Rt. 727		<i>NFGC 1996-2003</i>		LWC 1997-2001	LWC 1997-2004 <i>NFGC 2000-2003</i>
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 NFGCA 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 10**.

LSWCD and NFGCA have also collected chemical data at several stations in the watershed beginning 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.

Table 10. 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 fluctuate 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 guideline 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

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 2**.

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.

Loudoun Soil and Water Conservation District –LSWCD has also collected fecal coliform data at five sites spread throughout the watershed since 1999. **Figure 3** 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.

Figure 2. DEQ Fecal Coliform Bacteria Levels for North Fork Goose Creek at Rt. 722 from 1996-2004.

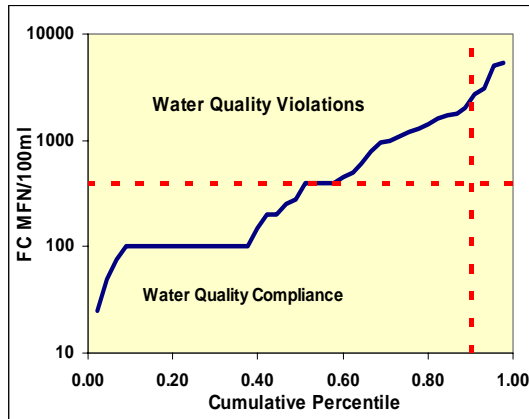
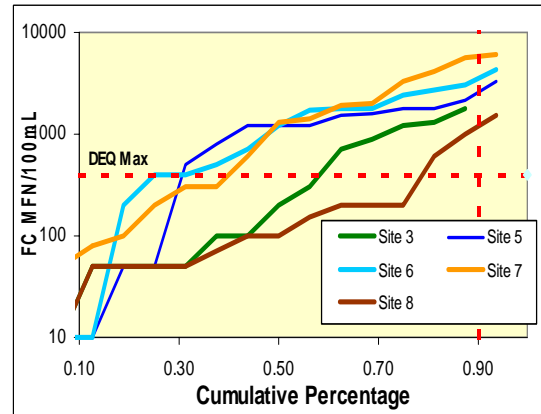


Figure 3. LSWCD Fecal Coliform Data for N.F. Goose Creek Watershed 1999-2003.



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:

- 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; and

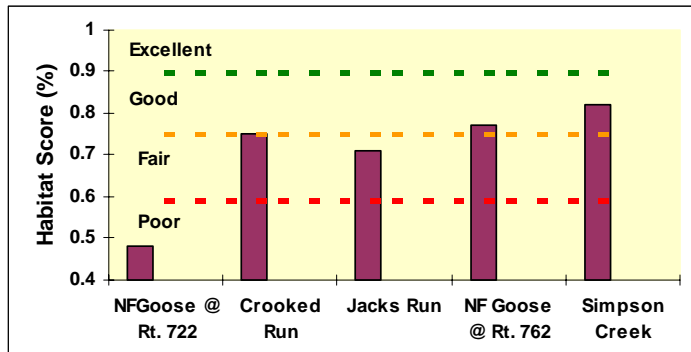
- Crooked Run from its mouth to its headwaters.

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

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 4**. 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 4. LWC Stream Habitat Scores for North Fork Goose Creek Watershed – 2004.



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



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

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 5**. 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 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 6** 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 5. LWC Benthic Macroinvertebrate Scores for North Fork Goose Creek Watershed – 2004.

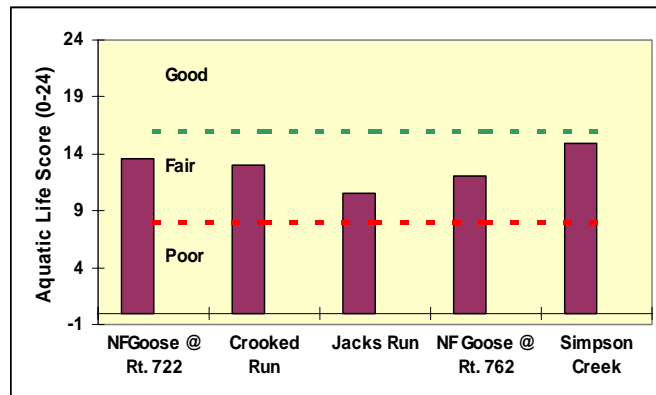
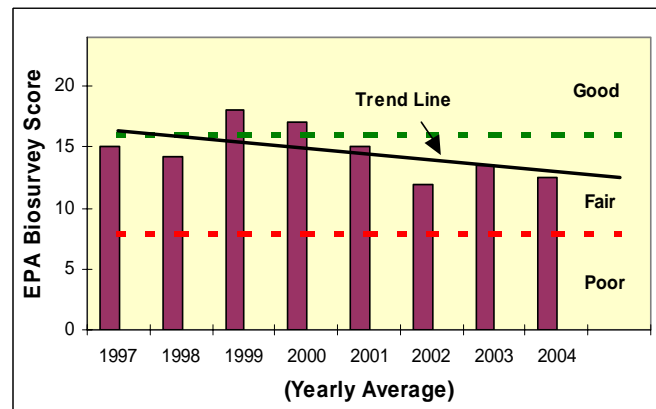


Figure 6. LWC Benthic Macroinvertebrate Scores for Crooked Run With Trend Line – 1997 – 2004.



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.

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 11**.

Table 11. 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

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