# National Park Service
# George Washington Memorial Parkway
# Stream Monitoring Program
# 2008 Annual Report

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**ABSTRACT**

Benthic macroinvertebrate data was collected in the summer of 2008 for the completion of a sixth year of stream water quality monitoring. Mine Run and Difficult Run consistently received "acceptable" year-round health scores according to the Virginia Save Our Streams (VASOS) protocol. The remaining seven monitored streams received "unacceptable" seasonal average scores. Dead Run and Windy Run received the lowest average rating during the entirety of the 2008 monitoring program. Spout Run, the most impacted stream, received the lowest average rating during the entirety of the six year monitoring program. Its highly urbanized watershed may be an indication that development and associated pollutants can have a significant effect on stream health.

Monitoring also included two streams, Donaldson Run and Gulf Branch, which were contaminated by a pesticide spill in 2001. Lack of appropriate data from past years prohibits a proper statistical analysis regarding the actual improvement of species density/ (richness). There is no data to support whether a recovery to pre-contamination conditions has occurred for Donaldson Run and Gulf Branch. The 2008 season also marked the second year of monitoring at Windy Run and Difficult Run. According to a statistical analysis of stream score trends, Difficult Run was the only stream to show a significant improvement between 2007 data and 2008 data. Continual monitoring will account for annual variation in health scores and aid in determining changes in stream water quality over time.

## INTRODUCTION

The George Washington Memorial Parkway (GWMP), a unit of the National Park Service (NPS), is responsible for preservation of natural and historic property along the Potomac River. This includes protection of the Potomac River shoreline and watersheds within park boundaries. The Natural Resource Management Division is responsible for all concerns regarding the relationship between wildlife and habitat within the park. This responsibility, coupled with concern for the Potomac River watershed, led to establishment of a program to monitor water quality of streams that feed into this important and historic waterway.

The Northern Virginia suburbs of Washington D.C., particularly Fairfax and Arlington Counties, have experienced remarkable urban and suburban development. Appendix 17 depicts the amount of square footage that has been added from 2002-2006 in Arlington County. Appendices 18 and 19 show the amount of land used and planned to be used as of 2004 in Fairfax County. Increased land development and associated impervious surface cover puts a strain on storm water management (Figure 28). Rainwater is not readily absorbed, increasing potential for destabilization of soils within watersheds and increased sediment runoff into streams (USEPA 1997). Sediment and pollutants carried by storm water runoff can adversely affect biological stream communities, and present the need for stream protection and restoration (Storm Water Management Branch 2001).

In response to this need, the Fairfax County Department of Public Works and Environmental Services established the Stream Protection Strategy in 2000, in cooperation with the Northern Virginia Soil and Water Conservation District (NVSWCD). NVSWCD established the Volunteer Stream Monitoring Program, a local, regional, and statewide effort of stream data consolidation. This program uses Virginia Save Our Streams (VASOS) protocol, developed by the Izaak Walton League of America and later modified by a two-year study at Virginia Tech. In an effort to share data and work cooperatively with local jurisdictions the GWMP stream monitoring program adopted the VASOS protocol and began contributing data to Fairfax County's Stream Monitoring Program database in 2001.

The VASOS protocol is a method of stream monitoring that evaluates stream health through collecting and identifying benthic macroinvertebrates, sampling water chemistry and basic water quality parameters, and conducting habitat assessments. Benthic macroinvertebrates are an important component of the freshwater stream ecosystem as they aid in decomposition of

organic material and are vital organisms in the food chain. Each order of benthic macroinvertebrates has a specific level of tolerance to environmental stresses. This, coupled with their quick response to environmental stressors, and relative ease of identification, makes benthic macroinvertebrates excellent indicators of water quality and environmental health (Storm Water Management Branch, 2001). VASOS protocol uses type and abundance of benthic macroinvertebrates found in each stream to calculate statistical metrics, from which a health score is determined based on a multimetric index. Beginning in 2007, the stream data collected was entered into the online VASOS multimetric index calculator, and was the tool used to derive the stream health ratings.

## PROJECT SITE

The GWMP's Surface Water Quality Monitoring Program was initiated to establish baseline water quality data that will aid in long-term protection of park streams. Monitoring efforts began in summer of 2001 and focused on seven of ten perennial piedmont streams running through park property: Mine Run, Pimmit Run, Gulf Branch, Turkey Run, Dead Run, Donaldson Run, and Spout Run (Figure 1). Monitoring continued in 2002, 2003, 2006, 2007, and 2008 focusing on the same seven streams sampled in 2001. In 2007 and 2008, Difficult Run and Windy Run were added to the stream monitoring program.

## METHODS

Stream monitoring was conducted from May 27, 2008 to July 29, 2008. A total of nine streams were monitored in the 2008 season (Figures 2-10). Three rounds were completed for Mine Run, Pimmit Run, Gulf Branch, Turkey Run, Dead Run, Donaldson Run, and Spout Run. Beginning in mid-July Difficult Run and Windy Run were monitored for a total of two rounds each. Global Positioning System (GPS) coordinates for each stream station are listed in Appendix 12. Each stream was sampled at three stations, with a minimum distance of twenty meters between each sample station. The time of day in which sampling took place remain consistent with previous sampling times to the extent possible. Sampling times for 2008 can be found in Appendix 10.

**Benthic Macroinvertebrate Collection**

At each station, sampling occurred in riffles. Riffles are a section of stream characterized by shallow, fast-moving water flowing over cobbles. The station furthest downstream was sampled first to prevent duplicate collection of macroinvertebrates and alterations in water chemistry. In accordance with VASOS protocol, benthic macroinvertebrate samples were taken using a 3'x 3' kick-seine net (1/16-inch mesh) placed perpendicular to water flow immediately downstream of the sampling area. The net was angled approximately forty-five degrees, or greater, to the streambed. Prior to disturbance, rocks were placed along the net bottom to prevent macroinvertebrates from escaping under the net. One member of the monitoring team held the net in place and recorded elapsed time while another member scrubbed and removed large rocks from the riffle within the designated sample area. The scrubbing team member then vigorously churned the streambed area in front of the net by shuffling their feet. Churning time depended on the area sampled: 90 seconds for a 3'x 3' area, 60 seconds for a 3'x 2' area, and 30 seconds for a 3'x 1' area.

When time expired, rocks that held the bottom of the net were scrubbed. The net was then carefully lifted out of the water in a scooping motion, to avoid sample loss, and laid on a table for sorting. The riffle was then returned to its original state prior to sampling. All macroinvertebrates were removed from the net with forceps and placed in ice cube trays filled with stream water. Each piece of detritus was carefully searched for clinging macroinvertebrates. Each benthic macroinvertebrate collected was identified by common name and tallied on the Virginia Save Our Streams Benthic Macroinvertebrate Tally Sheet (Appendix 1). After all macroinvertebrates were counted, they were released back into the stream. The process was repeated until at least 200 macroinvertebrates were identified or four net samples were taken. Total number of individuals present in each net was counted, regardless of whether or not the total exceeded 200. If specimens were unidentifiable, they were taken back to headquarters for positive identification. Merritt and Cummins (1996), and Thorp (1991) were used as identification guides.

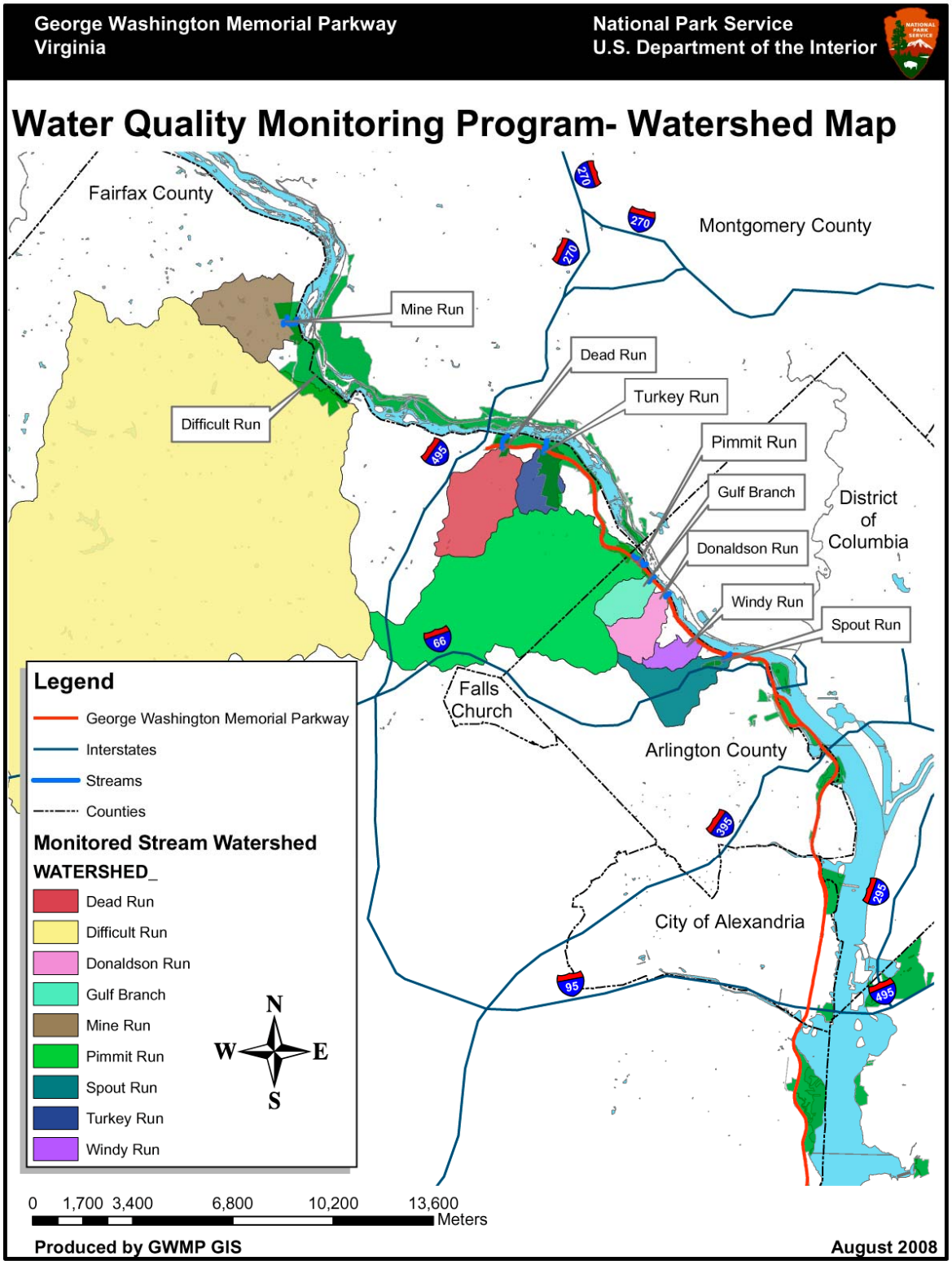



**Figure 1: Water Quality Monitoring Streams and Watersheds**

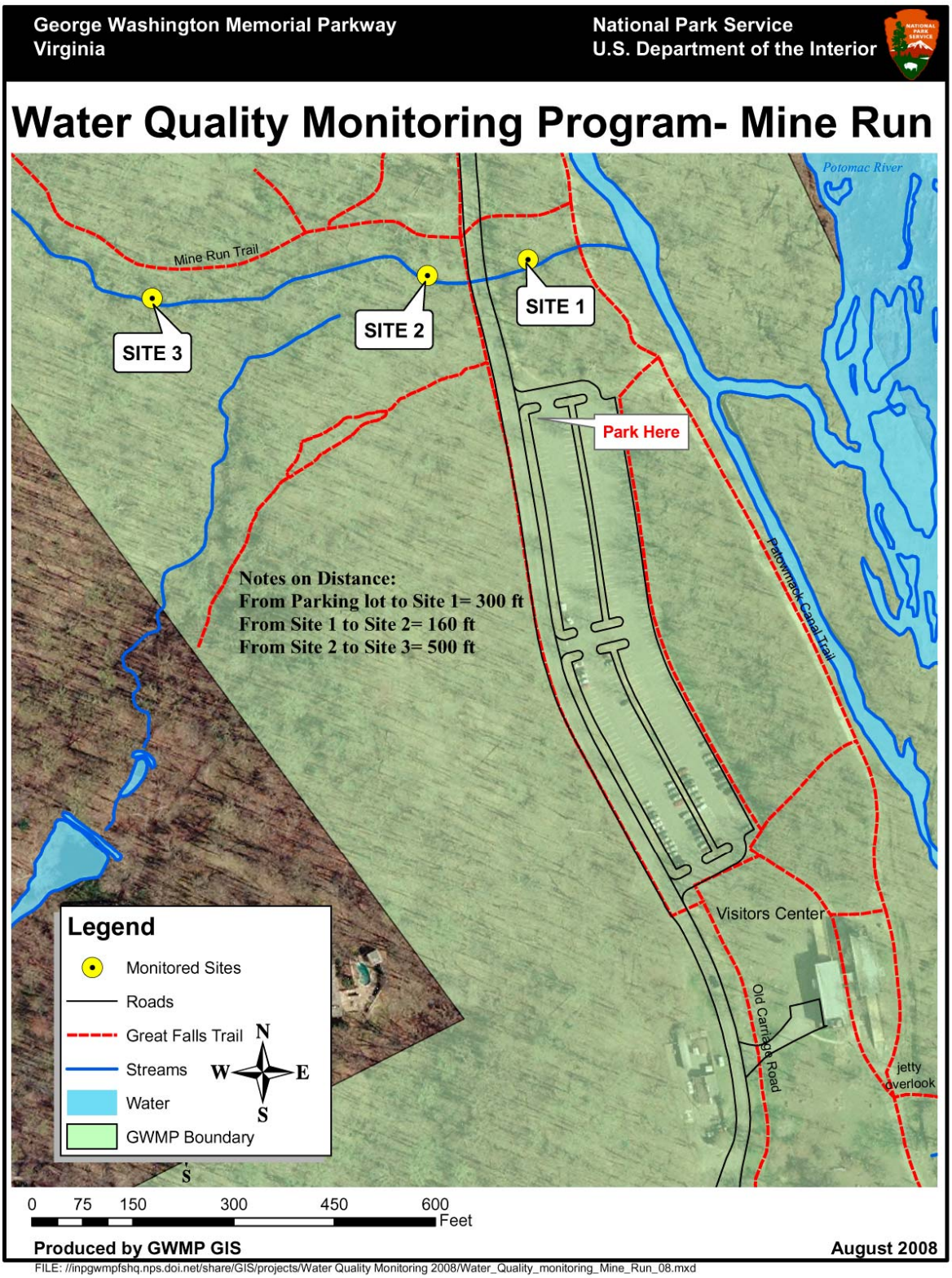



**Figure 2: Site Sampling Locations: Mine Run**

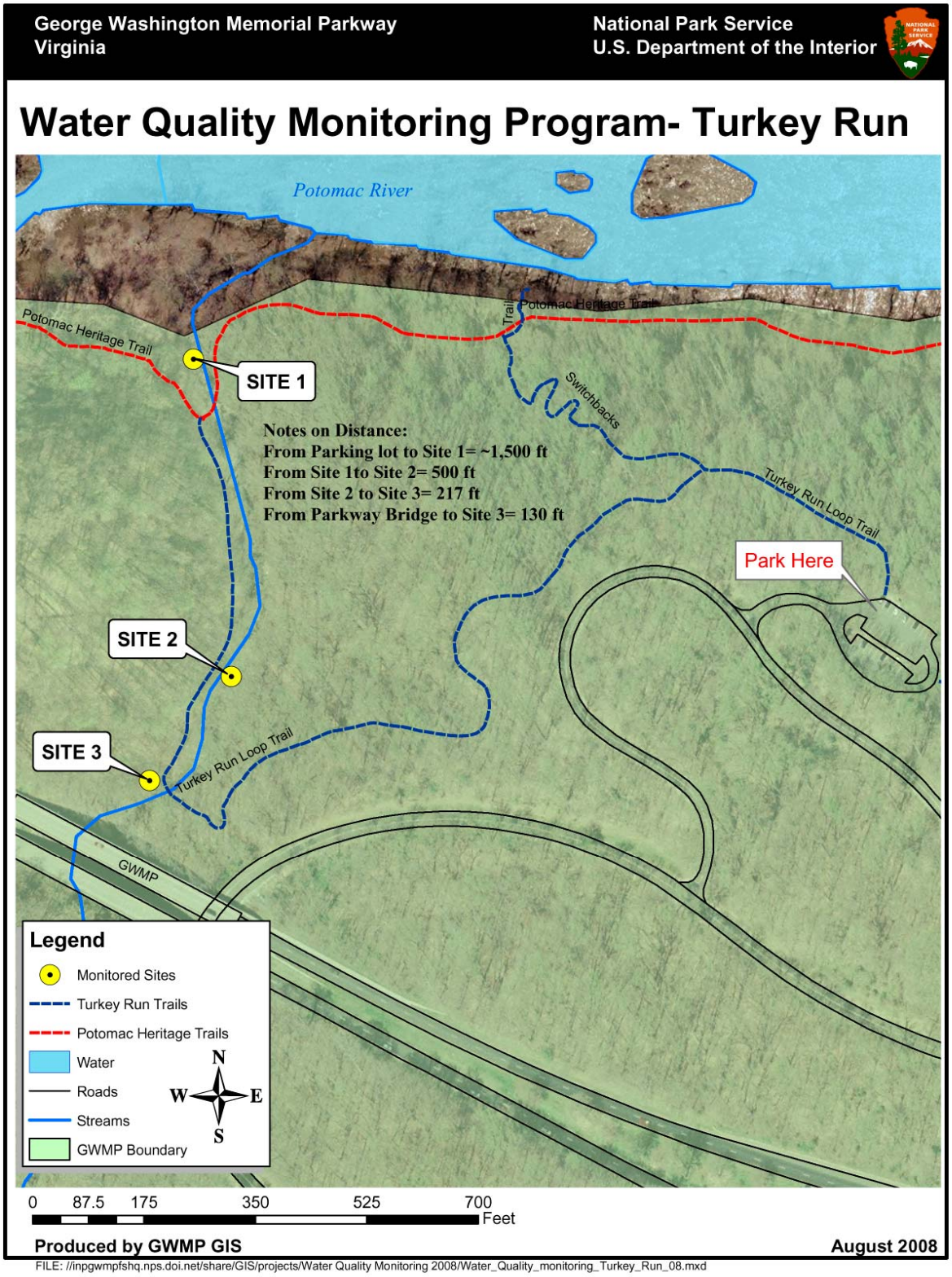



**Figure 3: Site Sampling Locations: Turkey Run**

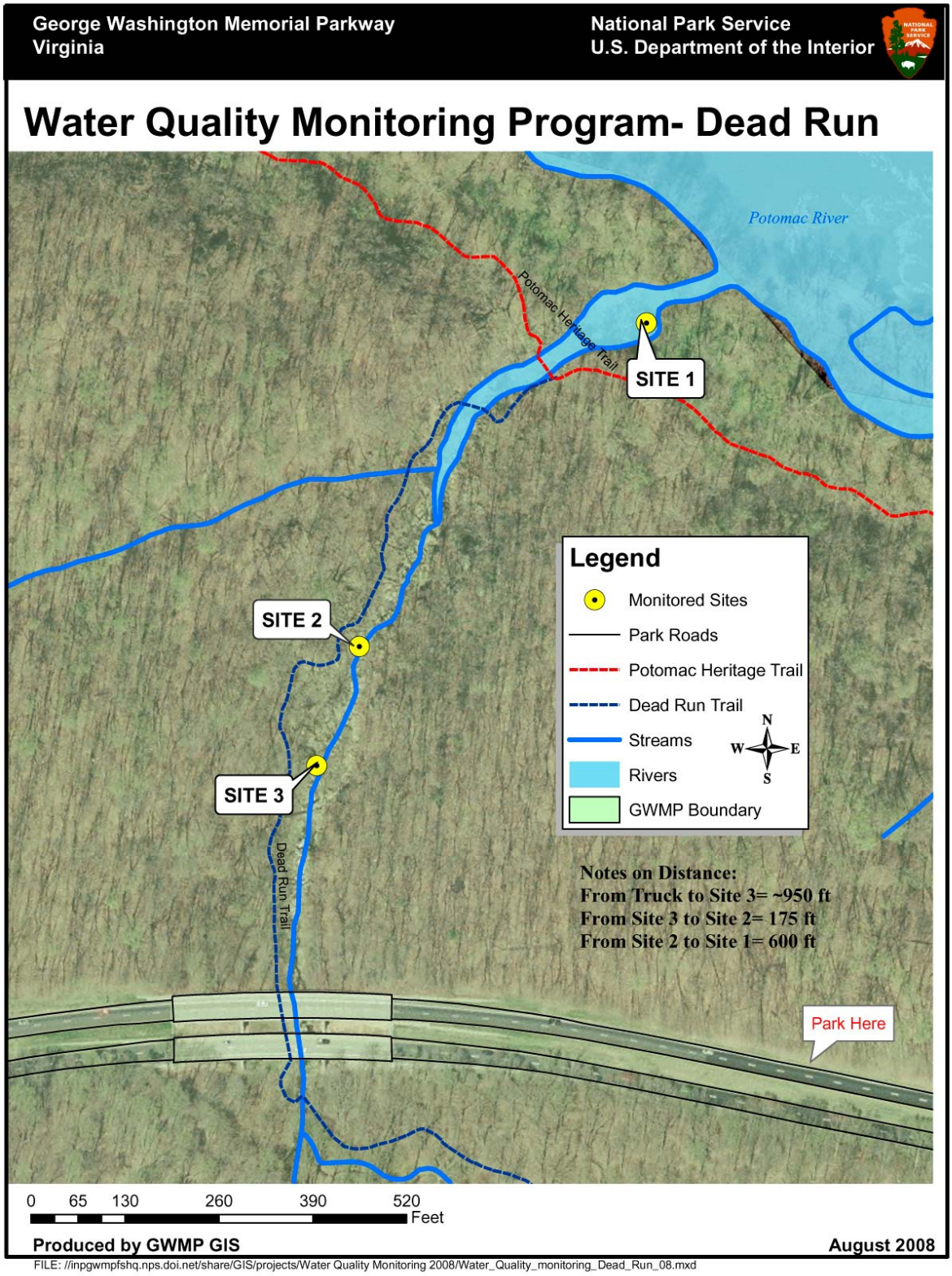



**Figure 4: Site Sampling Locations: Dead Run**

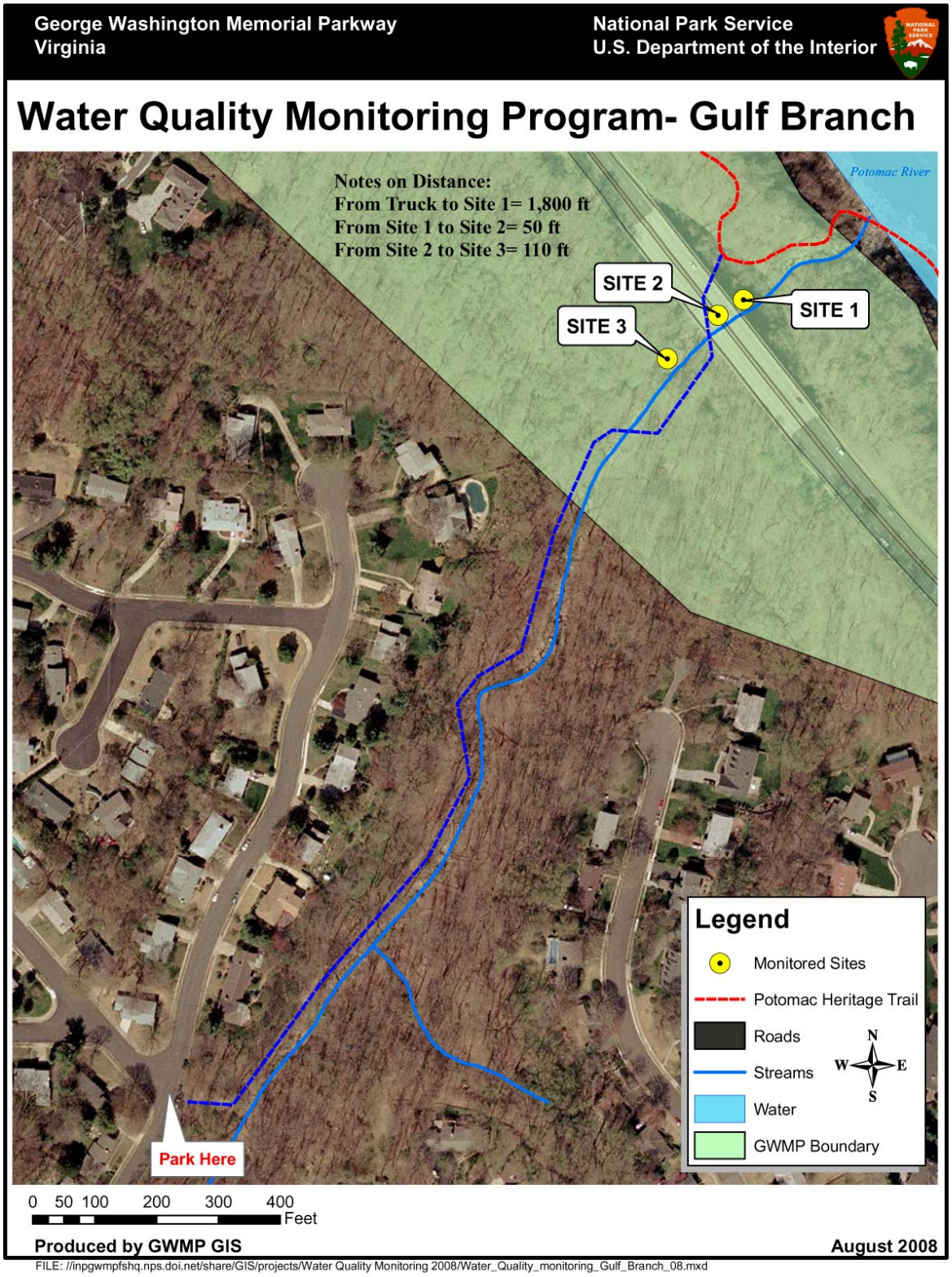



**Figure 5: Site Sampling Locations: Gulf Branch**

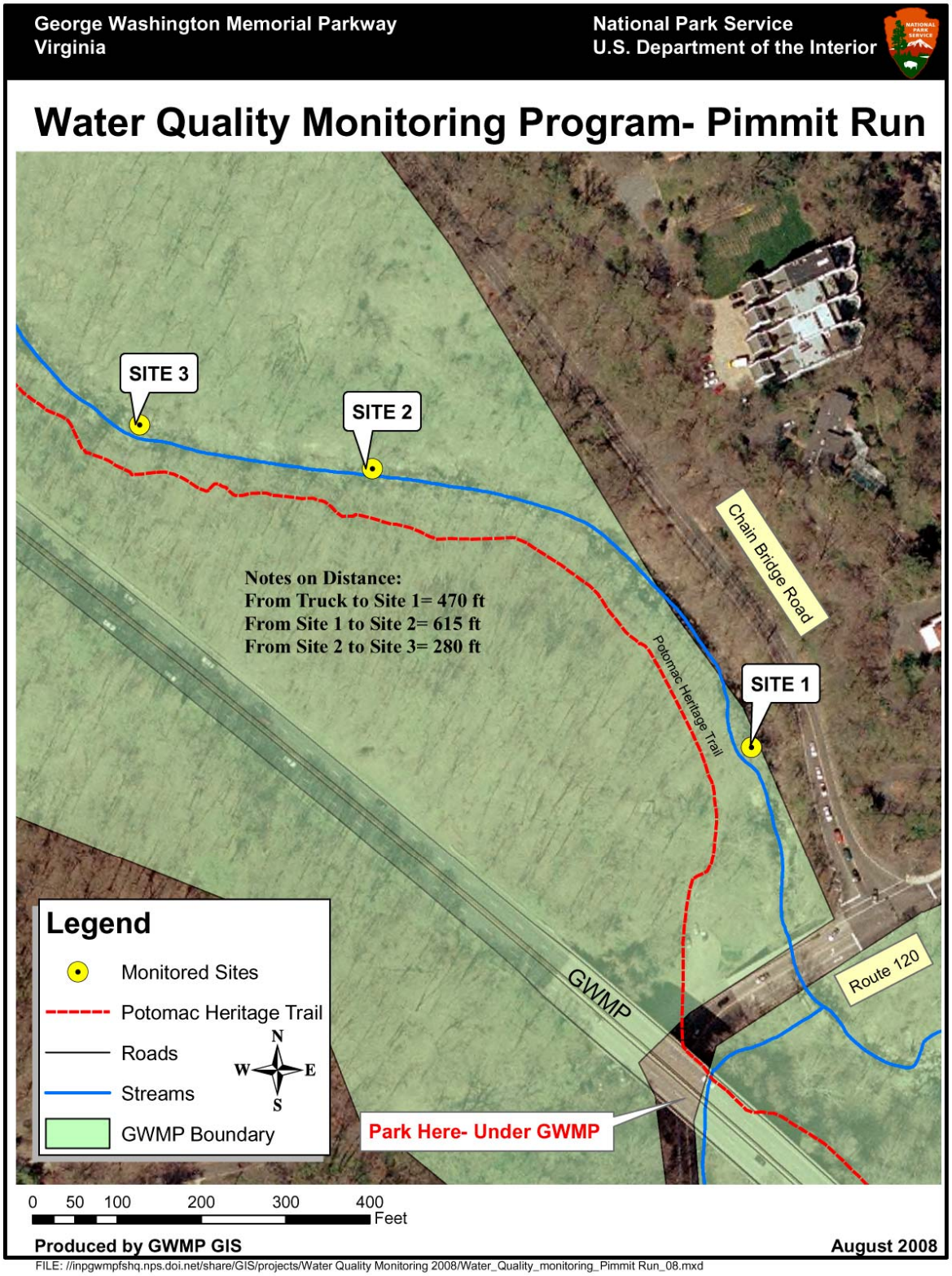



**Figure 6: Site Sampling Locations: Pimmit Run**

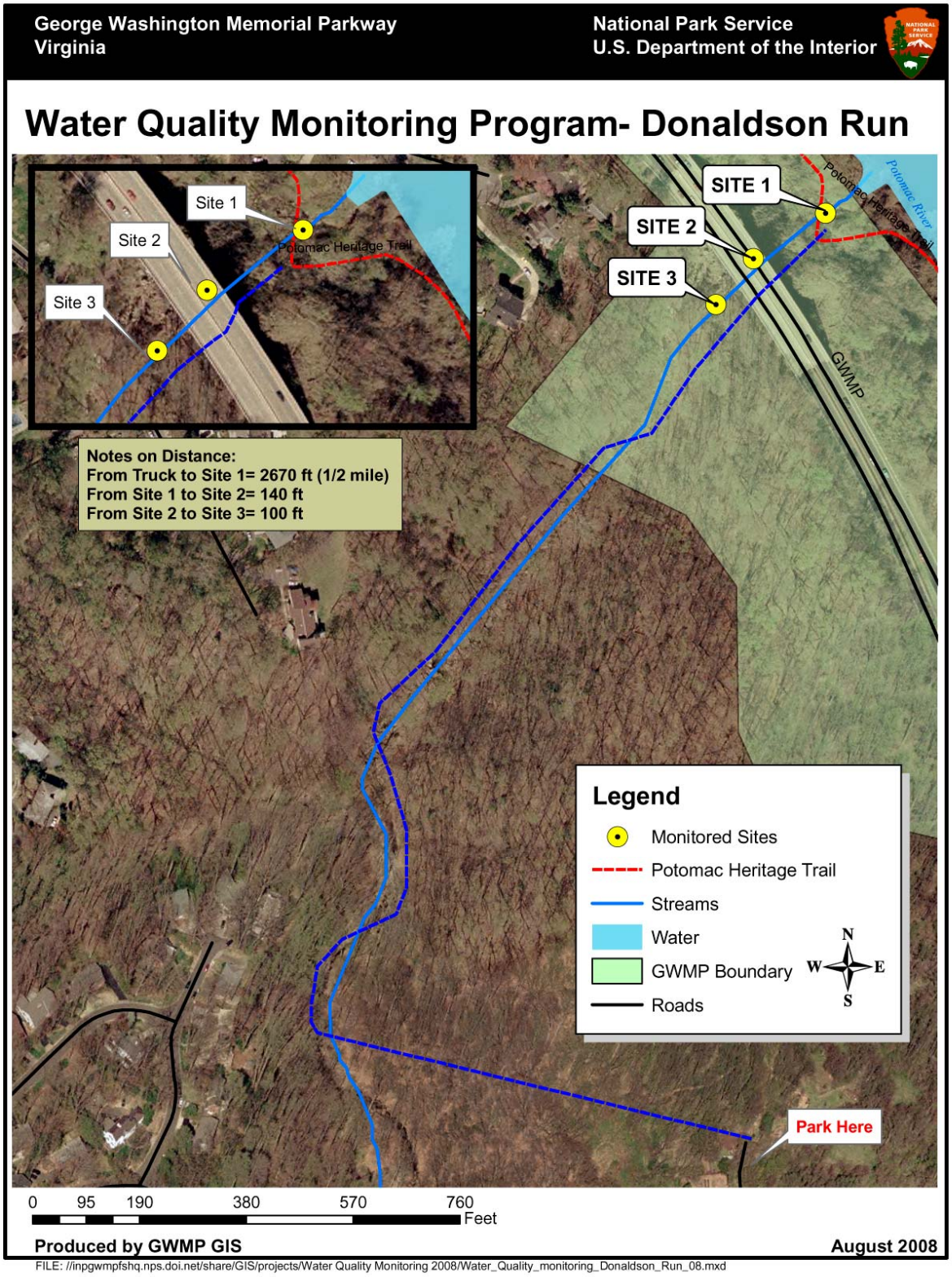



**Figure 7: Site Sampling Locations: Donaldson Run**

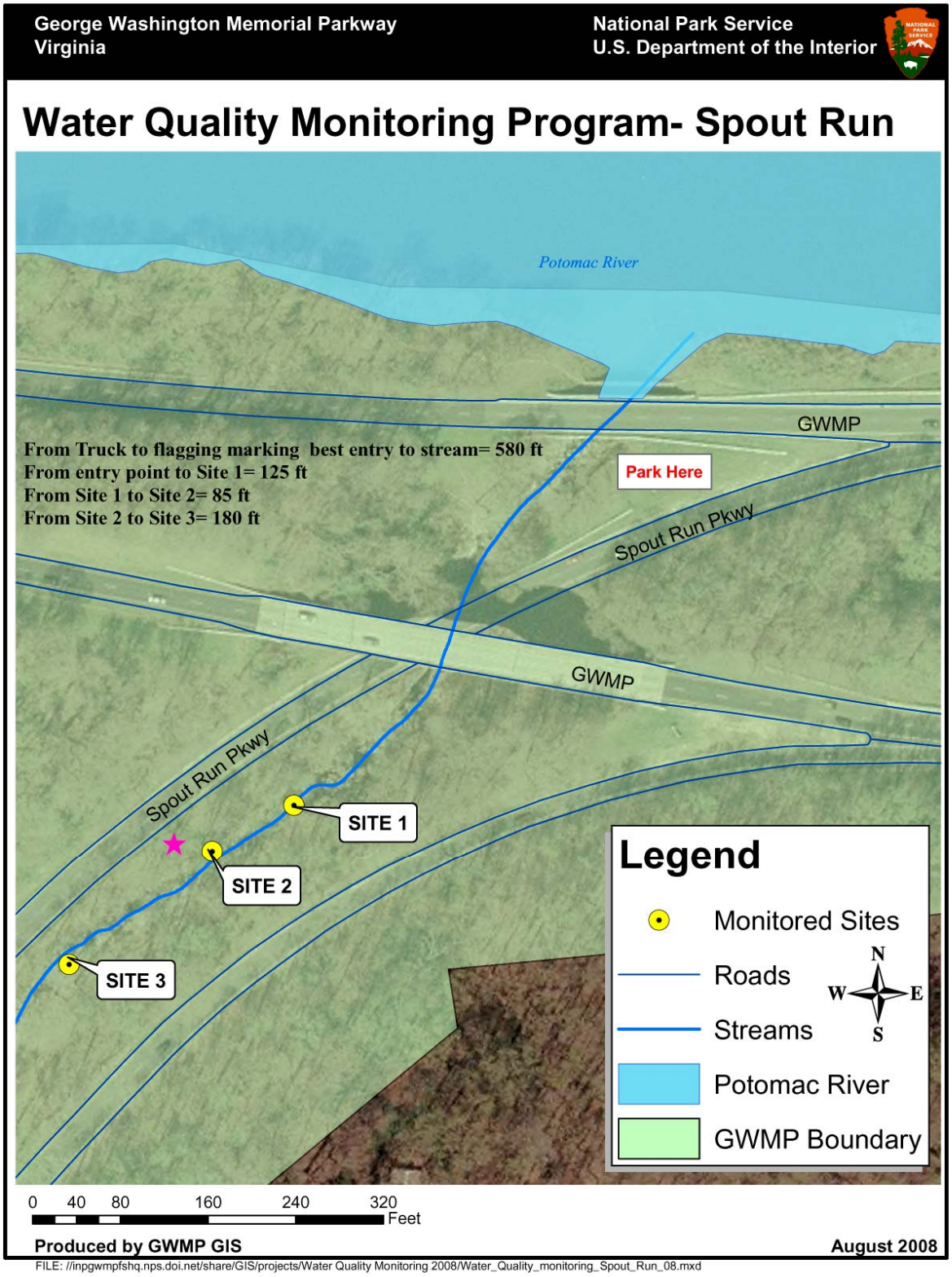



**Figure 8: Site Sampling Locations: Spout Run**

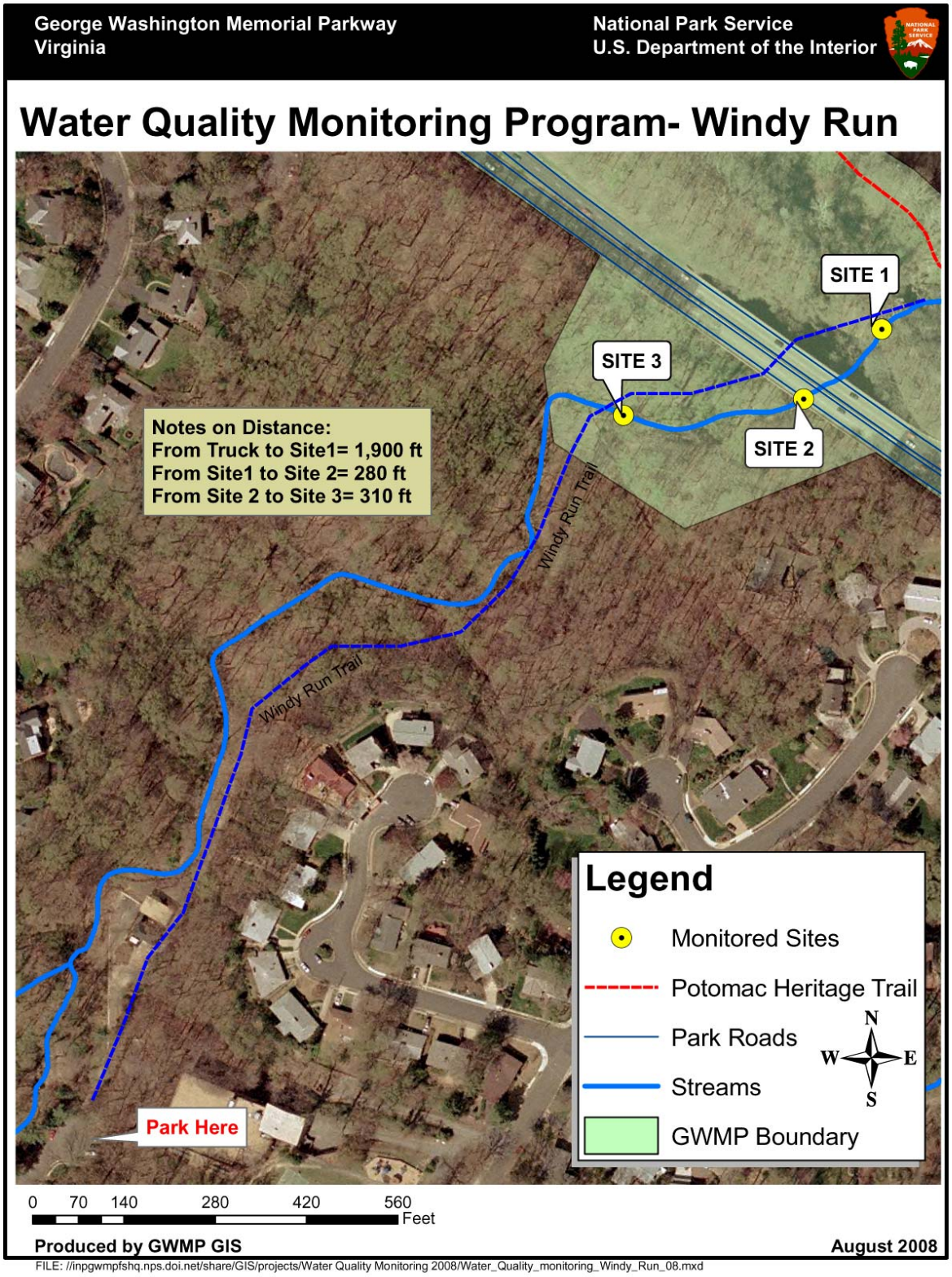



**Figure 9: Sampling Location- Windy Run**

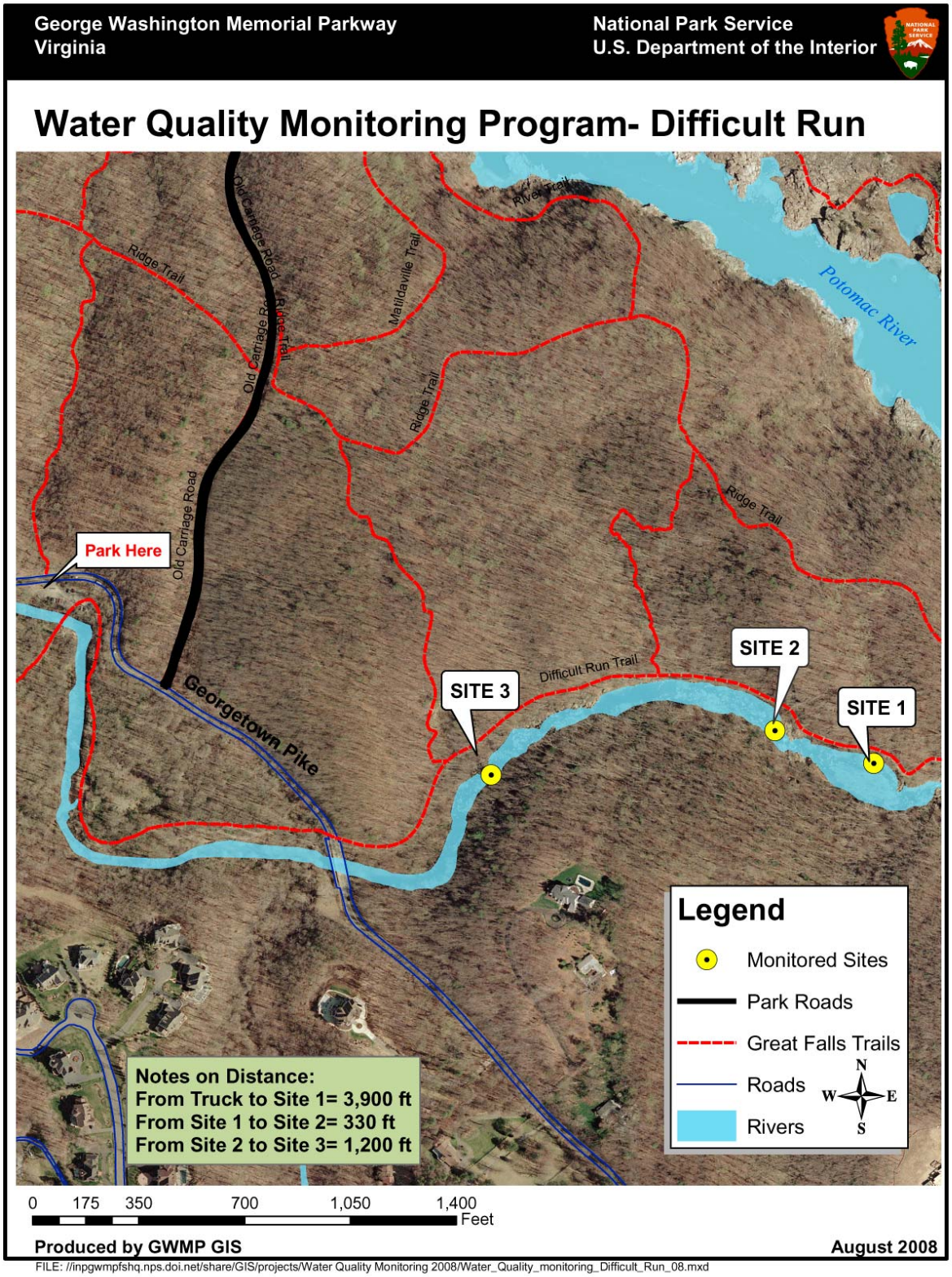



**Figure 10: Site Sampling Locations: Difficult Run**

In accordance with VASOS protocol, stream health scores were calculated using the new online (VASOS Data Entry) multimetric index score that compare proportion of pollution-tolerant species collected to proportion of pollution-intolerant species collected. Percentages of mayflies, stoneflies, caddisflies, common netspinners, lunged snails, beetles, non-insects, and tolerant species were calculated (Appendix 2) and assigned metric values based on their percentage value (Appendix 3). The metric values were then automatically added for each stream station and produced a score on a scale of zero to twelve. An "acceptable" rating received a score of 7.00 or greater, while an "unacceptable" rating was given for a score of 6.99 or less.

**Water Chemistry and Basic Water Quality Parameters**

Each station was tested for dissolved oxygen, conductivity, pH, nitrate, nitrite, water temperature, salinity, and turbidity. YSI Meter, model 85, was used to measure dissolved oxygen, water temperature, and conductivity (Appendix 4). Dissolved oxygen is the amount of oxygen freely available in water, necessary for aquatic life and oxidation of organic materials. Intolerant benthic macro-invertebrates require aquatic environments with high oxygen concentrations. Low dissolved oxygen can often be the result of various biotic and abiotic conditions, some of which may arise via human action. Prolonged exposure to low levels of dissolved oxygen will increase an aquatic organism's susceptibility to other environmental stresses. Organisms are especially susceptible during summer when warmer temperatures raise their metabolic rate, increasing their need for oxygen. The potential loss of canopy and runoff from warm, impervious surfaces upstream of the study sites will increase water temperature, decreasing available dissolved oxygen (USEPA 1997). Many physical, chemical, and biological characteristics of a waterway are directly linked to water temperature. Lower water temperatures hold more oxygen and higher water temperatures increase aquatic organism's metabolic rate and need for oxygen. Increased temperature from urban runoff can cause stress to stream organisms leaving them susceptible to other environmental stresses (USEPA 1997). Conductivity measures the ability of water to pass an electrical current and depends on the quantity of dissolved ions in water. High conductivity may indicate presence of elevated levels of metals or salts. High conductivity measurements could be indicative of runoff from a variety of sources, possibly anthropogenic (USEPA 1997).

YSI meter, model 60, was used to measure pH of stream water and water temperature (Appendix 5). The pH of stream water reflects hydrogen ion concentration, or how acidic or alkaline the water is. It is measured on a scale of one to fourteen. Acidic pH is less than seven, and an alkaline pH is greater than seven. Aquatic life is generally sustained at neutral pH levels of 6.5-8. Sources like acid rain can move stream pH levels outside this normal range and make pollutants more readily available for uptake, causing physiological damage to aquatic organisms (USEPA 1997).

LaMotte turbidity kit was used to measure turbidity (Appendix 6). Turbidity is a measure of suspended solids in a liquid, or clarity of water. Some sources of turbidity include soil erosion, waste discharge, urban runoff, and algal growth. Turbid water can absorb more heat, decrease light, and clog respiration apparatuses of aquatic organisms. As turbidity increases, water can lose its ability to support aquatic organisms (USEPA 1997).

Industrial Test Systems "Waterworks" water quality test strips were used to measure nitrate and nitrite levels (Appendix 7). Nitrogen is an important nutrient for plants and animals and is found naturally in waterways; however, excessive levels cause large amounts of algal growth and deplete available oxygen. Nitrogen was tested for in the form of nitrate ($NO_3$) and nitrite ($NO_2$). Common sources of nitrogen include sewage, fertilizer, agricultural waste, and nutrient runoff from soil (Storm Water Management Branch 2001).

**Stream Habitat Assessment and Physical Characteristics**

Stream habitat assessment involved surveying for presence of aquatic vertebrates including fish, salamanders, and eels. Other parameters assessed were: surface water and streambed appearance, streambed stability, presence of algae, odor, color, amount of stream channel shade and stream bank erosion, plant coverage of stream bank sides and top, and presence of trash. Physical characteristics of each stream such as: stream width, channel width, flow rate, riffle water depth, and average stream depth were measured and recorded on the Virginia Save Our Streams: Stream Quality Survey form (Appendix 8). Physical habitat characteristics can have influences on water chemistry, and is another link in the assessment of stream health scores.

## RESULTS

### Benthic Macroinvertebrates and Stream Health Scores

Water quality sampling occurred between May 27 and July 29 for the 2008 season. There was a 31% increase in sampling for the 2008 season compared to the 2007 season. The complete multimetric index scores and chemical data collected can be found in Appendix 10, and all other field data collected can be found in Appendix 9, including the type and abundance of macroinvertebrates. The multimetric scores for the 2008 season can also be seen in Figure 11. The average yearly health scores, as seen in Table 1 and Figure 12, show that Mine Run and Difficult Run were the only two streams to receive an average "acceptable" score of seven or greater for the season (Mine received an 8.56 and Difficult received a 9.33). Mine Run received acceptable scores for all sampled sites during all three rounds. Difficult Run was only sampled for two rounds, but it also received acceptable scores for all sampled sites. Turkey Run, Windy Run, Dead Run, Pimmit Run, Gulf Branch, Donaldson Run, and Spout Run all received "unacceptable" yearly average scores, with Dead Run being the only stream to receive consistent "unacceptable" scores for all sampled sites. Dead Run and Windy Run received the lowest average score for the 2008 season with a 4.67.

**Table 1: Average Yearly Health Scores**

| | Mine Run | Turkey Run | Dead Run | Pimmit Run | Gulf Branch | Donaldson Run | Spout Run | Windy Run | Difficult Run |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | 8.75 | 6.25 | 6.00 | 6.40 | 6.67 | 5.50 | 5.29 | | |
| 2002 | 8.00 | 2.83 | 4.00 | 3.30 | 4.17 | 4.20 | 3.50 | | |
| 2003 | 7.89 | 4.13 | 4.50 | 4.00 | 4.25 | 4.78 | 3.43 | | |
| 2006 | 8.83 | 5.83 | 4.50 | 5.30 | 5.00 | 4.17 | 3.50 | | |
| 2007 | 7.50 | 4.50 | 5.00 | 7.50 | 4.50 | 5.00 | 3.67 | 5.00 | 7.10 |
| 2008 | 8.56 | 4.89 | 4.67 | 5.44 | 5.22 | 5.67 | 5.11 | 4.67 | 9.33 |
| Average | 8.26 | 4.74 | 4.78 | 5.32 | 4.97 | 4.89 | 4.08 | 4.84 | 8.22 |

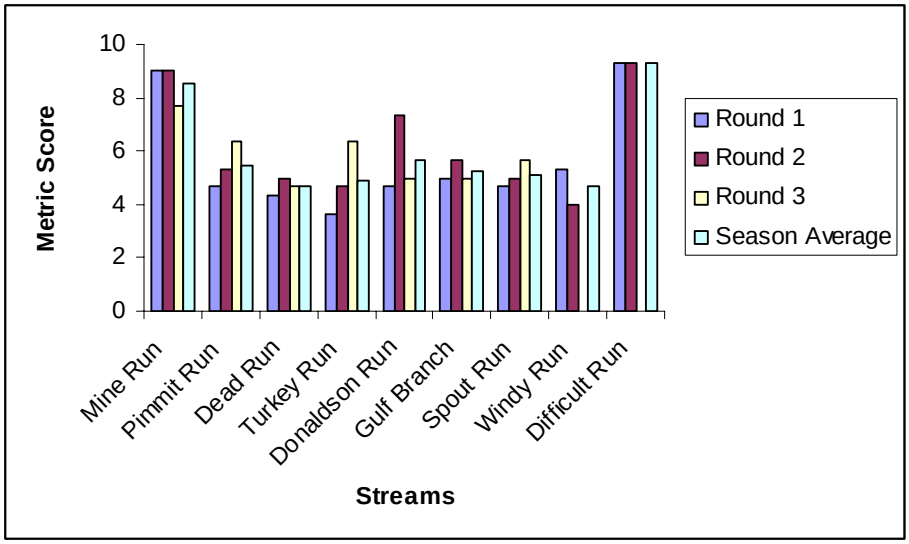



**Figure 11: Stream Health Score 2008**

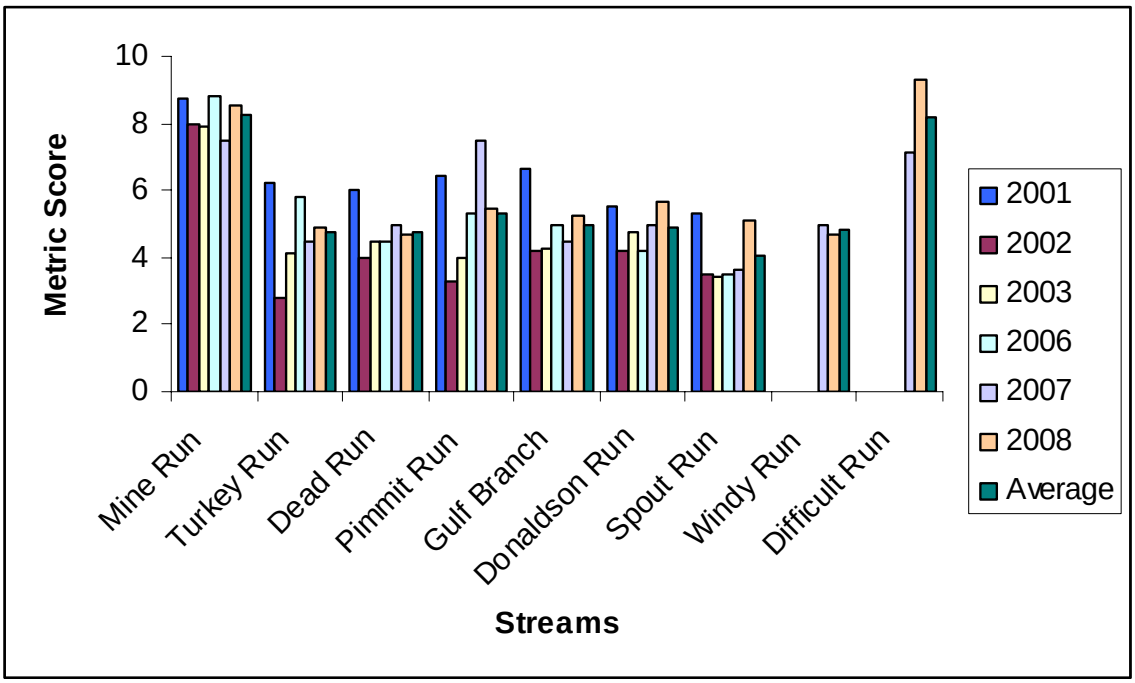



**Figure 12: Average Yearly Health Scores**

While the multimetric scores from 2008 seem to be improving, data collected in previous years statistical analysis shows that only Difficult Run has significantly improved:

> Trends in the Stream Health Scores were analyzed using a Daniels Test for Trend (Conover, 1999). In this test, each stream is analyzed separately. For each stream both the year that the stream was sampled and the stream health scores were converted to ranked data. The correlation between the rank of the year and the rank of the scores determines the trend in steam health. This correlation between two sets of ranked data is referred to as a "Spearman's ranked correlation" or a "Spearman's ρ (=rho)". A positive

correlation indicates an improving stream health while a negative correlation indicates declining stream health. The larger the absolute value of the correlation, the stronger the trend. A p-value of 0.05 or less is used to assess statistical significance. Windy Run and Difficult Run have only 2 years of data. While some stream showed improvement and others showed decline, only at Difficult Run, *with only two years of data*, was the trend were significant (Table 2). (John Paul Schmitt, Quantitative Ecologist, NPS Center for Urban Ecology).

**Table 2: Daniels Test for Trend (Conover, 1999)**

| Stream | Spearman's ρ | p-value |
|---|---|---|
| Mine Run | -0.078 | 0.62 (n.s.) |
| Dead Run | -0.077 | 0.64 (n.s.) |
| Turkey Run | 0.092 | 0.57 (n.s.) |
| Pimmit Run | 0.130 | 0.39(n.s.) |
| Gulf Branch | 0.169 | 0.35(n.s.) |
| Donaldson Run | 0.198 | 0.23(n.s.) |
| Spout Run | 0.126 | 0.43(n.s.) |
| Windy Run | -0.092 | 0.81 (n.s.) |
| Difficult Run | 0.702 | 0.011 |

As previously mentioned, both Mine Run and Difficult Run received the highest scores for the 2008 season. A statistical test was run between the streams in order to compare their scores:

A Kruskal-Wallis test was used on the Stream Health scores from 2008 to determine if stream health differs between streams. A significant difference in stream health among streams was detected (H=39031, df=8, p<0.0011, adjusted for ties). As illustrated in Figure 13, Difficult Run, Mine Run have higher health scores than the other 7 streams (John Paul Schmitt, Quantitative Ecologist, NPS Center for Urban Ecology).

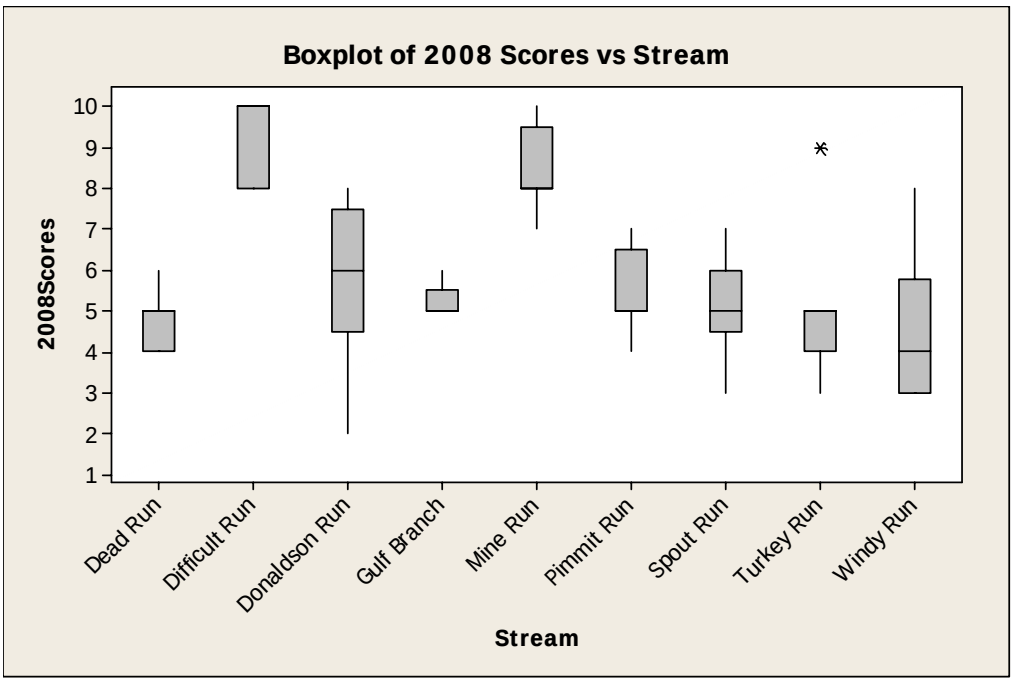



**Figure 13. Box-plot of Steam Health Scores from 2008.**

The multimetric scores are based on biological indications found by comparing the presence of pollution tolerant and intolerant macroinvertebrates. Figure 14 shows the percentage of intolerant benthic macroinvertebrates collected in 2008. Intolerant benthic macroinvertebrates are more sensitive to environmental stressors like increased turbidity, higher water temperatures, and lower dissolved oxygen, so they are unlikely to live in polluted streams. Percent intolerant data reflects VASOS metric data. VASOS metric data relies on relative proportion of all tolerance levels, and integrates tolerant and moderately tolerant taxonomic groups into final health scores.

Both Mine Run and Difficult Run have high percentages of pollution intolerant species. These streams also received the highest multimetric scores for the season. Pollution intolerant species include mayflies, stoneflies, beetles, gilled snails, hellgrammites, and most caddisflies. Other species such as common netspinners, crayfish, damselflies, dragonflies, scud, and sowbugs may be indicators of an "acceptable" stream as they are somewhat intolerant to pollution. However, aquatic and flat worms, black flies, clams, leeches, lunged snails, midges, and most true flies are tolerant to pollution. The presence of these species can alter data towards an "unacceptable" score. In turn, the presence of pollution intolerant species may shift towards an "acceptable" score. For example, during round one sampling of Windy Run, station two received a multimetric score of 8. This score seems high considering station one and three of round one received scores of 5 and 3 respectively. However looking at the percent of pollution intolerant species, station two had 40% intolerant species present. This percentage is greater than the amount found at either station one, with only 23% intolerant species or station three with 20% intolerant species. Also note that at station three, there were five lunged snails present. Lunged snails are pollution tolerant and indicators of a stressed environment, lowering the multimetric score.

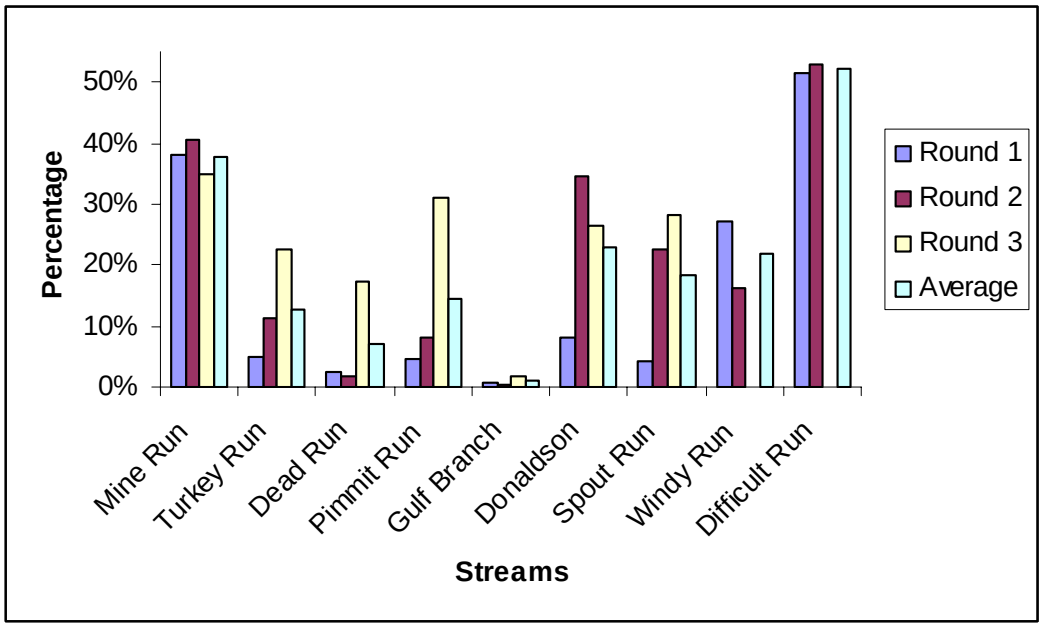



**Figure 14: Percent Pollution Intolerant Benthic Macroinvertebrates 2008**

**Water Chemistry and Basic Water Quality Parameters**

Water chemistry data collection is another form of water quality monitoring. During the 2008 season, basic water quality parameters and water chemistry data were collected. This data includes nitrates, pH, water temperature, conductivity, salinity, turbidity, and dissolved oxygen, and can be found in Appendix 10 for each sampled site. Nitrates and nitrites were tested for during the sampling process; however no nitrite was present in any of the testing sites. Figure 15 shows the variations of nitrate levels found for each round with Spout Run having the highest average of nitrate levels at 4.67 ppt.

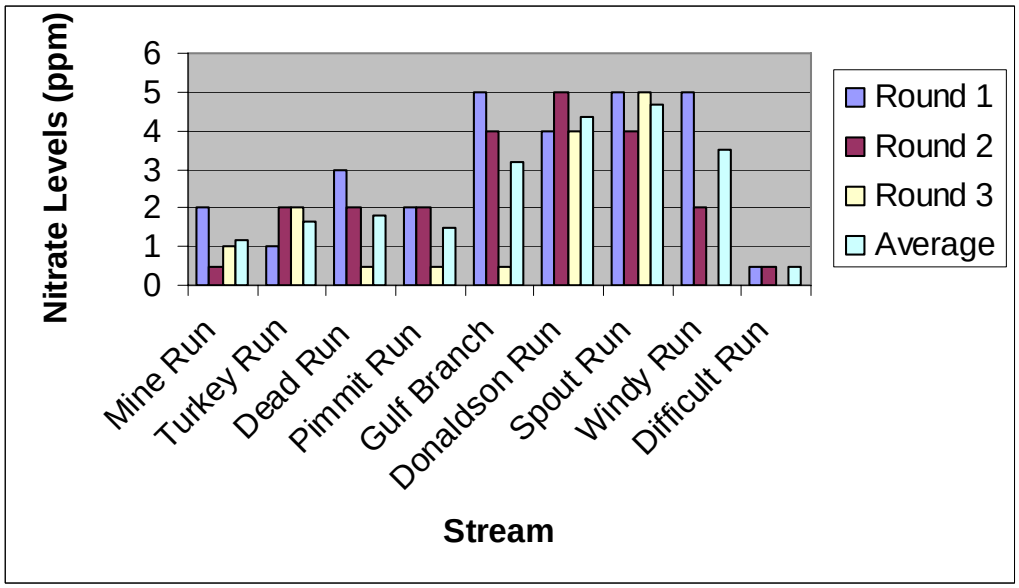



**Figure 15: 2008 Nitrate Levels in Streams**

Potential hydrogen (pH) was monitored for the 2008 season, with stream averages ranging from 7.42 (Gulf Branch) to 7.89 (Turkey Run). This range is within the basic measurement of pH. The pH values for each round and seasonal averages of the streams can be viewed in Figure 16.

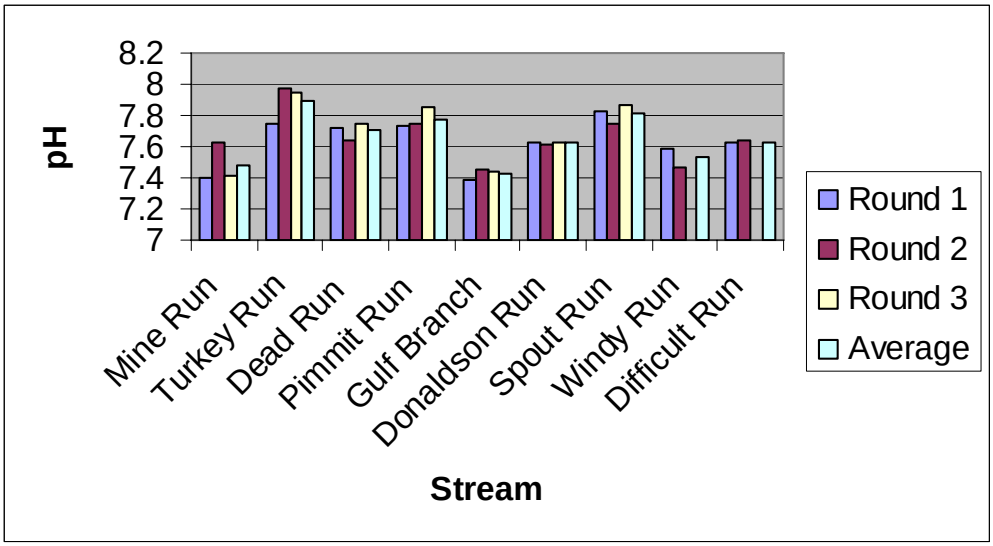



**Figure 16: 2008 pH Levels of Streams**

Water temperature is another important parameter to monitor in streams. The water temperatures of the monitored streams remained within a range of 18.9 $^{o}$C to 24.1 $^{o}$C. From looking at the average temperatures between the three rounds, there seems to be a slight increase from round one to round two, and from round two to round three. The temperatures for each round and the season average can be viewed in Figure 17.

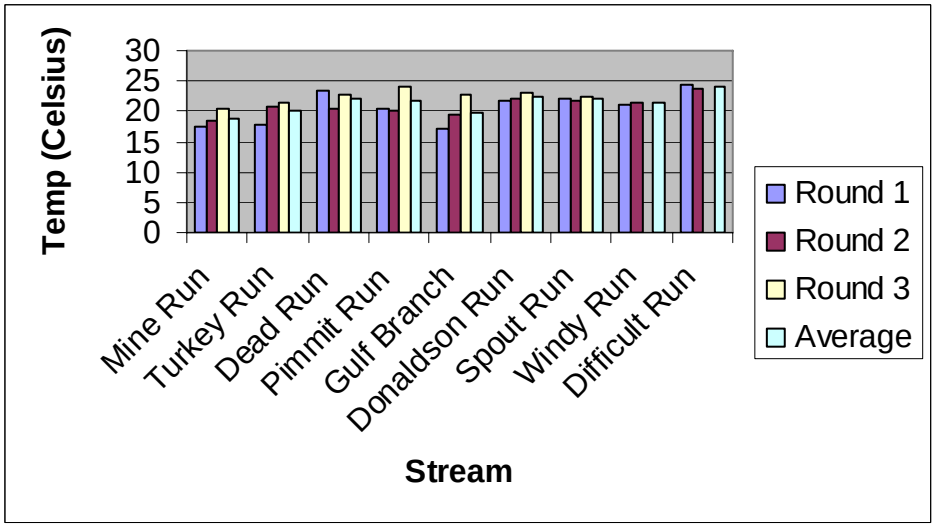



**Figure 17: 2008 Stream Water Temperatures**

The presence of dissolved oxygen is important in streams, and the amount can affect its biota in different ways. For the 2008 season, dissolved oxygen (DO) was measured by percentage and mg/L. This data can be viewed in Figures 18.1 and 18.2.

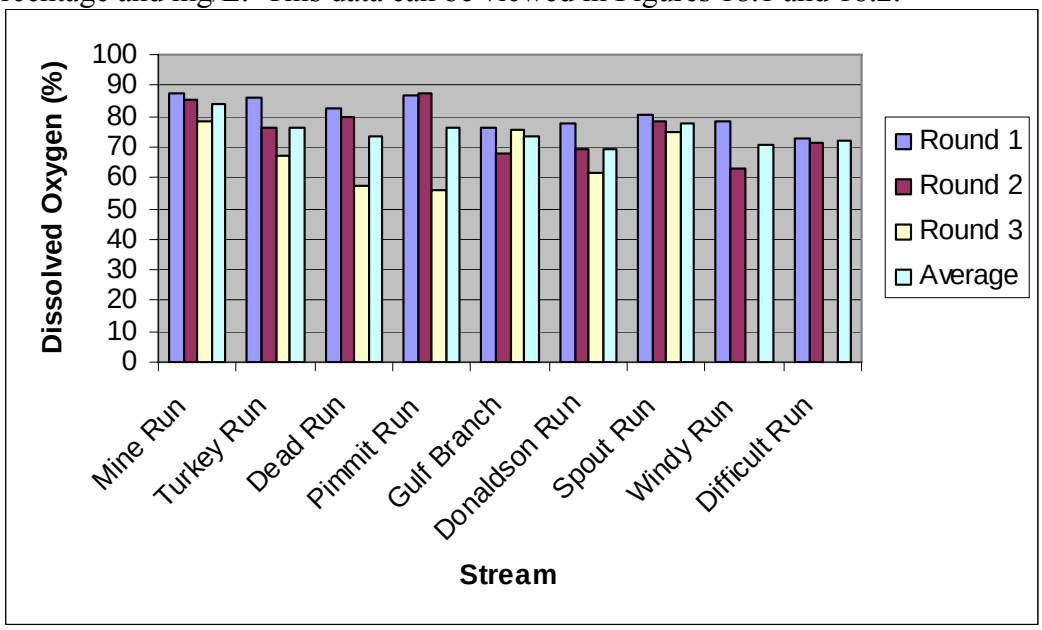



**Figure 18.1: 2008 Measurements of Dissolved Oxygen (%)**

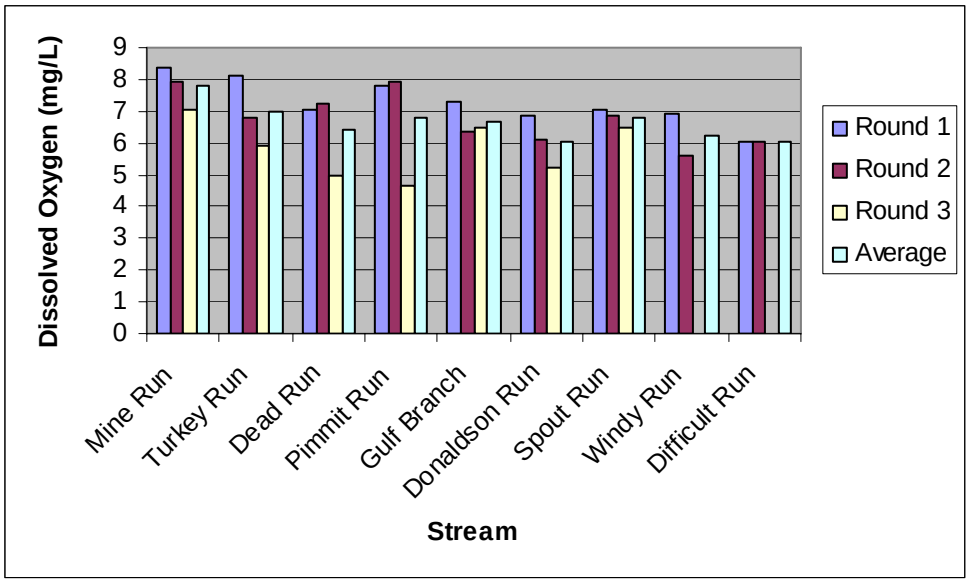



**Figure 18.2: 2008 Measurements of Dissolved Oxygen (mg/L)**

Conductivity is a measurement of the water's ability to conduct electrical current. Conductivity is measured in micro Siemens (uS). The highest conductivity measurements were taken at Spout Run with a seasonal average of 516.49 uS. The lowest conductivity measurements were taken at Mine Run with a seasonal average of 119.20 uS. The conductivity measurements at each round and the seasonal averages can be viewed in Figure 19.

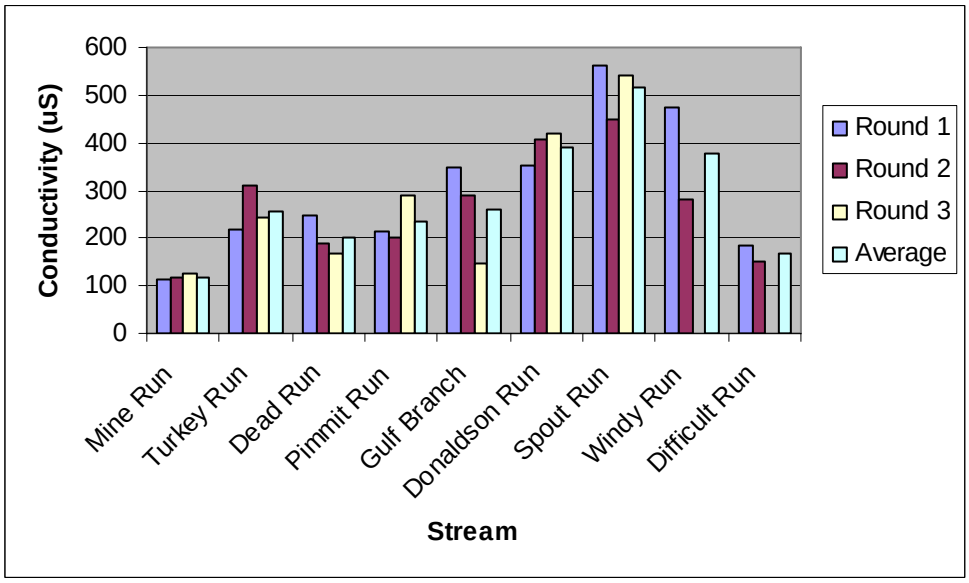



**Figure 19: 2008 Stream Conductivity Measurements**

Salinity is a measurement of the dissolved salt content of water. The highest measurements for salinity were found at Spout Run with an average of 0.27 ppt, and the lowest measurements were found at Mine Run, Dead Run, and Difficult Run with averages of 0.1 ppt. Salinity measurements of the three rounds and the seasonal average can be found in Figure 20.

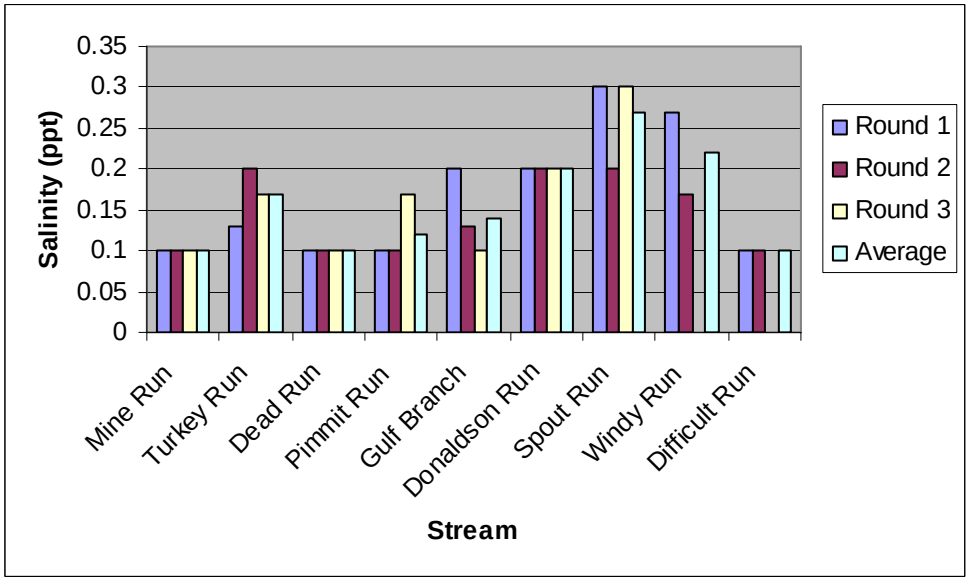



**Figure 20: 2008 Salinity Measurements**

Turbidity, written in Jackson Turbidity Units (JTUs), is a measurement of the suspended solids in water. Streams that are very turbid will often appear cloudy. For the 2008 season, the turbidity levels can be viewed in Figure 21.

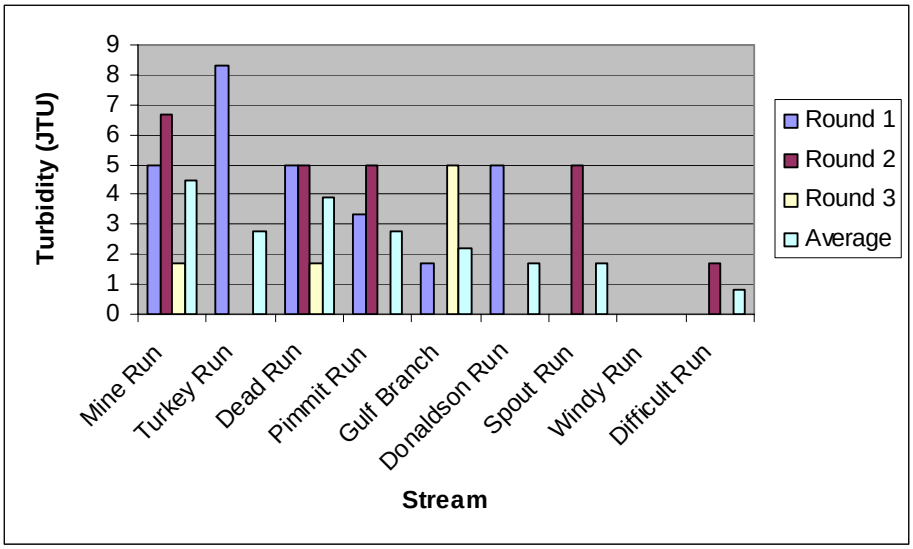



**Figure 21: 2008 Turbidity Measurements**

**Habitat Assessment and Physical Characteristics**

Appendix 9 shows habitat assessment and physical characteristics data. Barriers to fish movement, surface water appearance, stream bed deposit, odor, stability of stream bed, stream bank coverage, algae, algae color, stream channel shade, and stream bank erosion were visually assessed and categorized according to the Virginia Save Our Streams Stream Quality Survey Form (Appendix 8).

There were a number of wildlife sightings during the 2008 season. Fish were observed at seven of the nine monitored streams: Turkey Run, Dead Run, Donaldson Run, Difficult Run, Mine Run, Gulf Branch, and Pimmit Run. Waterfalls or large rocks were the main barriers to fish movement. Salamanders were observed at Turkey Run, Mine Run, and at Dead Run. Two eels were found this summer at Donaldson Run, which had historically been known as a tributary with eels. In 2001 a pesticide spill seemed to have eradicated the eels, and this may be the first written documentation of eel sightings on Donaldson since the spill. Also, at Donaldson there was a sighting of a groundhog near the bank of the stream. Horsehair worms (from the group Nemotomorpha) were found in Turkey Run, Gulf Branch, and Donaldson Run. Deer were spotted at Mine Run, Difficult Run, Pimmit Run, and Gulf Branch. There was also a snake spotted in the water at Difficult Run; however it was unable to be identified. It should be noted that copperheads are frequent in the Great Falls area, and that *all* snakes can swim (it is one method of thermoregulation).

Surface water appearance was described as "clear" at the majority of sample stations in 2008. The stream bed deposit was described as "brown/tan," "silty," "sandy," and "muddy" during all three rounds at the majority of sample stations. The stream bed was termed stable for all stream stations, except for Dead Run, Turkey Run, Donaldson Run, and Pimmit Run. There were a number of occurrences of a sewage odor at Spout Run, Mine Run, Pimmit Run, Dead Run, Turkey Run, and Donaldson Run. Both Pimmit Run and Mine Run have sewer lines running nearby which may account for the odor, but it remains unknown whether there are sewer lines near the remaining streams.

Erosion potential of the stream banks varied from stream to stream. Most sites had severe or high erosion potential (25%-49%). Difficult Run was seen as having only moderate erosion potential. It is difficult to compare the changes in erosion potential between the years, as there are no exact guidelines to what each category means. For the sampling of 2008, any sites

with large boulders and "beach" like areas, trees with roots partially or fully exposed, or steep undercut banks were deemed as "severe". Stream channel shade also varied from stream to stream. Most sites were moderately shaded (25%-49% of the channel was shaded), but Mine Run, Donaldson Run, Gulf Branch, Dead Run, Turkey Run, Spout Run, and Windy Run had one or more sites with high shade coverage (50%-74%). Difficult Run is the only stream to have been documented as having slight shade covering (1%-14%) for the 2008 season. Again, all data is subjective to human opinion. The shade may change depending on what time of day sampling is taken, and this is another reason maintaining a consistent sampling time is important.

Most sample stations contained some percentage of algae during all rounds of sampling. The algae were in the form of dark green, brown-coated, and/or matted on the stream bed. Difficult Run had the most algae of any stream, with documentation of having brown coated, dark green, and hairy algae. Water flow rates were noted as relatively normal, except for after storms when they would become high. This is another measurement which is difficult to remain precise over the years because of personal opinion as to what is seen as "normal" or "high".

**Land Use**

The USGS National Land Cover Data system was used to categorize land use in each of these watersheds (Figure 26a). The NLCD is a 21-class land cover classification system with a data resolution of thirty meters. Of the twenty-one land cover classifications fifteen were identified in the watersheds of these seven streams. In this report these fifteen land cover types were grouped into the following seven sets; Forest (evergreen forest, deciduous forest, mixed forest); Water Bodies (open water, emergent herbaceous wetlands, woody wetlands); Agriculture (pasture/hay, row crops); Urban Grasses (urban/recreational grasses); Other (transitional); Residential (low intensity residential, high intensity residential); Commercial (commercial/industrial/transportation); and rock (bare rock/sand/clay, quarries/strip mines/gravel pits). For a detailed description of these classifications see Appendix 13.

Figures 17-25 show land use in the watershed of each of the nine streams. Figure 26a shows the percentages of each type of land use as of 1993. Mine Run consists of 63.0% forested land and 28.8% agricultural land. Turkey Run watershed consists of 74.7% forested land and 18.4% residential/commercial land making it the most forested watershed and the second least residentially/commercially developed. Dead Run and Gulf Branch had similar percentages of

residentially/commercially developed land with 48.6% and 47.6% respectively. Donaldson had a smaller percentage of residential/commercial land development with 30.0%. Pimmit Run has the second highest percentage of residentially/commercially developed watershed land with 54.6%. Finally, Spout Run contains the highest percentage of residentially/commercially developed watershed land with 79.2%, thus being subject to large amount of runoff from impervious surfaces.

## DISCUSSION

The average health scores for each stream vary throughout the monitoring years. There does not seem to be a definite trend, with the exception of Difficult Run. As mentioned before, Difficult Run is the only stream to have seen significant improvement between last year (the first year it was monitored) and this year. It is important to also acknowledge the lack of data on the stream prior to 2007. The only alternative data obtained for this report on Difficult Run was listed in a 303(d) EPA document in which it was listed for PCBs in Fish Tissue, E. Coli, Benthic Macroinvertebrates, and Heptachlor Epoxide (US EPA 2006). Mine Run and Pimmit Run were also included on the 303(d) EPA document. Mine Run was listed for E. Coli, and Pimmit Run was listed for fecal coliform, PCBs in fish tissue, chlordane, and heptachlor epoxide. Mine Run remains with Difficult Run as being the only two streams at an "acceptable" level of health for the 2008 season.

Studies have shown that runoff from impervious surfaces is recognized as a significant cause of stream degradation (Stormwater, p.ES-8, 2001); therefore, it is crucial to note watershed land use in order to understand and thoroughly assess current and future impacts on stream health. Typically, watersheds with high percentages of impervious cover, such as buildings and paved surfaces, would contain streams with lower health scores than watersheds with less impervious surfaces, like forests or agricultural land. Mine Run contains the lowest percentage of highly impervious cover of the nine watersheds and, as expected, its health scores are among the highest with an average 8.56 in 2008 and a six year average ('01-'03, '06-'08) of 8.26. Turkey Run watershed is the most forested watershed and second least residentially/commercially developed, with a health score of 4.89 in 2008. Mine Run and Turkey Run have similar percentages of forested land but Mine Run has a larger percentage of agricultural coverage and

Turkey Run has a larger percentage of residential/commercial coverage. Even though there are similarities between these two watersheds, the scores of Turkey Run are very similar to the other five streams. This may be an indication that residential/commercial development may have a larger impact on stream health than agricultural development in this area. Dead Run and Gulf Branch had health scores of 4.67 and 5.22 respectively in 2008, and both have similar percentages of residentially/commercially developed land. Donaldson has a smaller percentage of residential/commercial land development and a stream health score of 5.67. Pimmit Run has the second highest percentage of residentially/commercially developed watershed land and received a score of 5.44 in 2008. Spout Run has the lowest average health score of 4.08 for the six year average, and contains the highest percentage of residentially/commercially developed watershed land (See Figures 24-33).

While the multimetric scores focus on the macroinvertebrates, the water chemistry data collected also plays an important role in identifying the health and concerns of the streams. Nitrate is an oxidized form of Nitrogen, and is an important nutrient in healthy environments. The presence of Nitrates can occur naturally in streams from eroding rocks, soils, and animal and plant wastes. Nitrate can also enter the stream through human activity from "wastewater treatment plants, runoff from fertilized agricultural lands, lawns, and golf courses, runoff from grazing animals, and commercial cleaning activities (*Heal the Bay*, 2008)." Increased nitrogen levels can cause algal blooms, which deplete the water of dissolved oxygen upon decay. The US EPA Maximum Contaminant Level (MCL) of Nitrate found in streams is 10.0 ppm. Throughout sampling season, the Nitrate tests for the all of the streams remained below the MCL with a range of 0.5 ppm to 5.0 ppm. Analysis of season averages for Nitrate levels shows that the streams near residential areas (Spout Run, Windy Run, Donaldson Run, and Gulf Branch) maintained average of 3.0 ppm and above, higher levels of Nitrate than the other streams.

Conductivity is the measure of how well water passes an electric current and indirectly measures the presence of inorganically dissolved solids (salts and metals such as nitrate and sodium). An increase in conductivity indicates an increase of the levels of dissolved solids. Too many dissolved solids cause water balance problems and decrease the level of dissolved oxygen. The healthy conductivity range for fresh waters is 10-500uS (Mackie, 2004). All streams, except for Spout Run, maintained a score in the range. The conductivity season average for Spout Run

is 516.49 uS. The high levels of nitrate found in Spout Run may attest for the higher conductivity reading (See Figure 22).

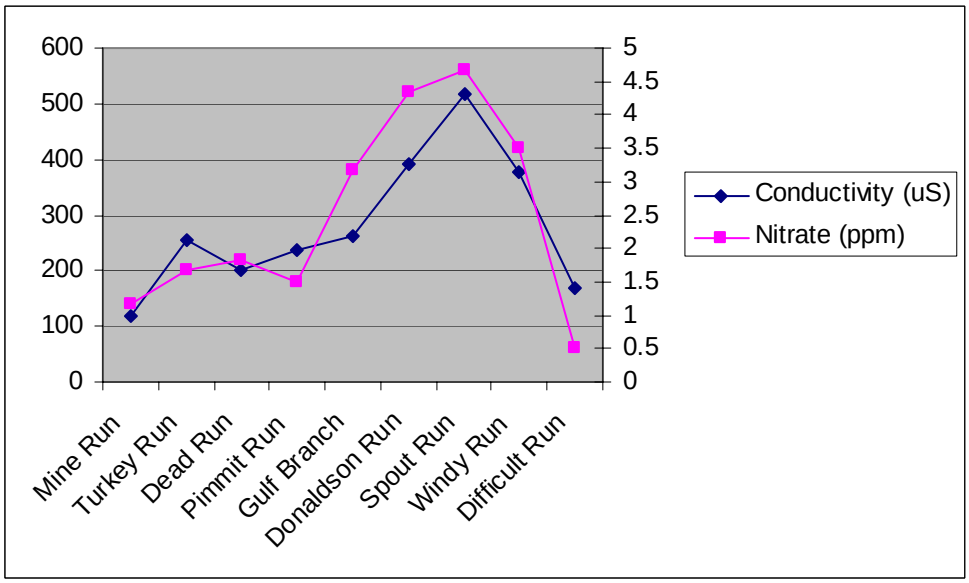



**Figure 22: 2008 Conductivity and Nitrate Comparison**

Salinity is a measurement of sodium found in the streams, and sodium is another inorganically dissolved compound that is measured by conductivity. Again, Spout Run contained the greatest average measurement of salinity, another possible explanation as to the high conductivity readings for the season (See Figure 23).

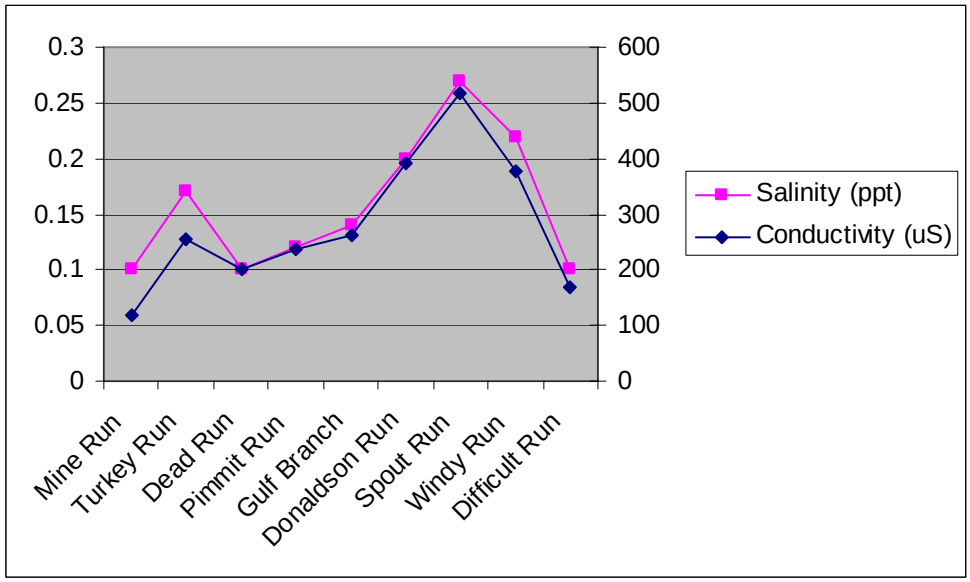



**Figure 23: 2008 Conductivity and Salinity Comparison**

For life to exist in streams, the water quality parameters must be within certain ranges. The optimal range of pH that aquatic organisms will tolerate is 6.5 to 8.2, all relatively neutral. Extreme alkalinity or acidity can disrupt biochemical reactions necessary for the life processes of organisms. In 2008, the pH at every site was slightly basic and fell in this range.

Dissolved Oxygen is essential for the survival of benthic macroinvertebrates. Levels less than 3mg/L are stressful for the organisms, and a healthy stream is considered to be 90-100% saturated (Murdock 2001). Dissolved oxygen levels are affected by temperature; stream flow, presence of aquatic plants, and dissolved or suspended solids. Stream shade also affects dissolved oxygen; more light increases the temperature of the water, which then decreases the dissolved oxygen. All dissolved oxygen levels measured in 2008 were below those of a healthy stream but all of the sites had adequate (3 or higher) levels in mg/L. Algae were present during the 2008 season in most of the streams, and may have affected the dissolved oxygen concentrations. "Green plants release oxygen underwater during photosynthesis. Maximum amounts of DO are produced with the energy of the late afternoon sun. (*Heal the Bay*, 2008)." Depending on the time of day the sample was taken, concentrations of DO may vary.

Turbidity is the measure of the amount of suspended solids in the water, or how cloudy the water is. Suspended solids can increase the temperature of water, block/absorb light, and clog the gills of organisms. The increase of temperature then depletes the amount of dissolved oxygen. Water becomes turbid because of plankton, soil as a result of erosion, and other solids in the water. These solids can carry nutrients and pesticides, which decrease the water quality. In 2008, turbidity was always low (See Appendix 9).

**Figure 24: Watershed Land-Use**

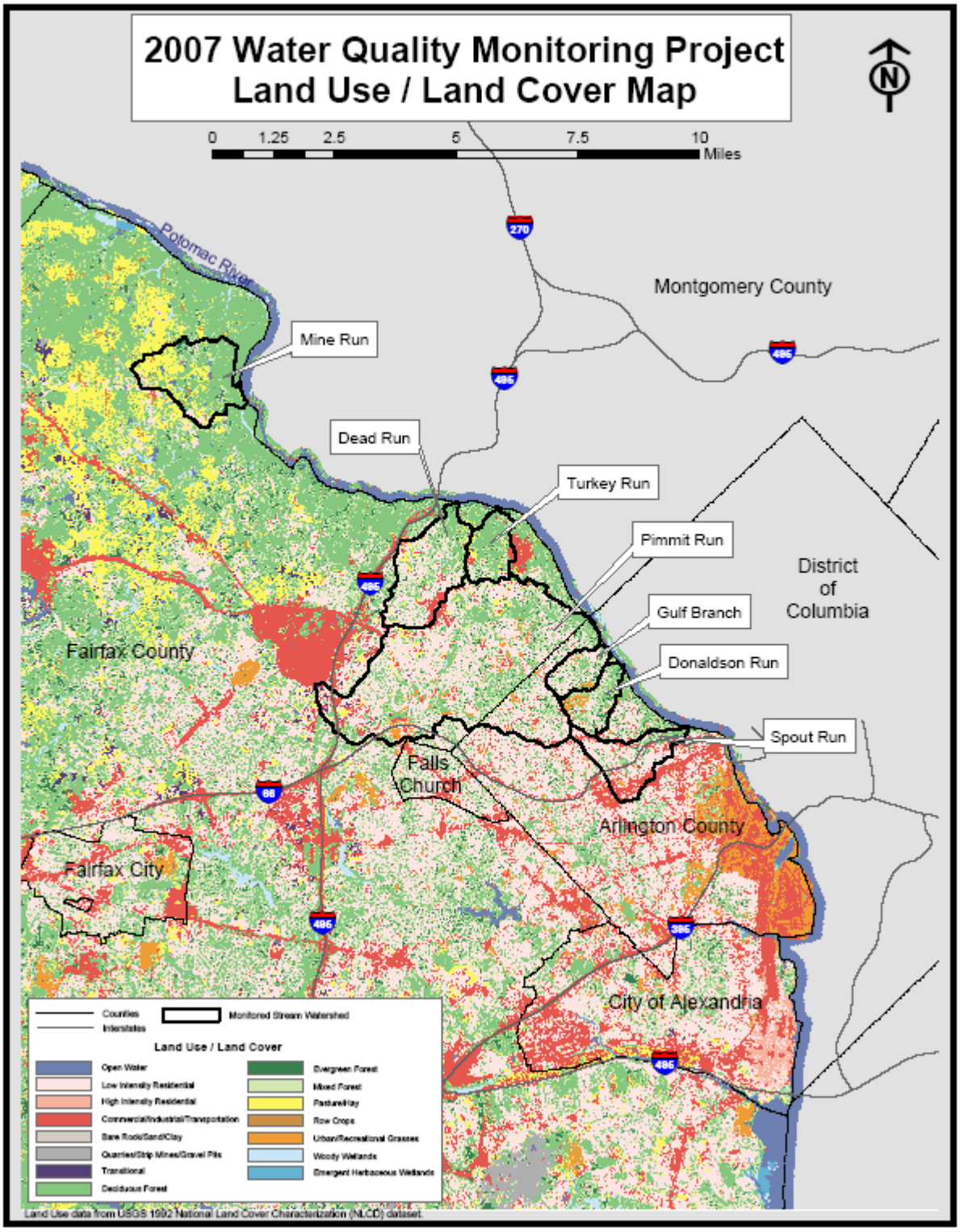


**Figure 25: Watershed Land-Use: Mine Run**

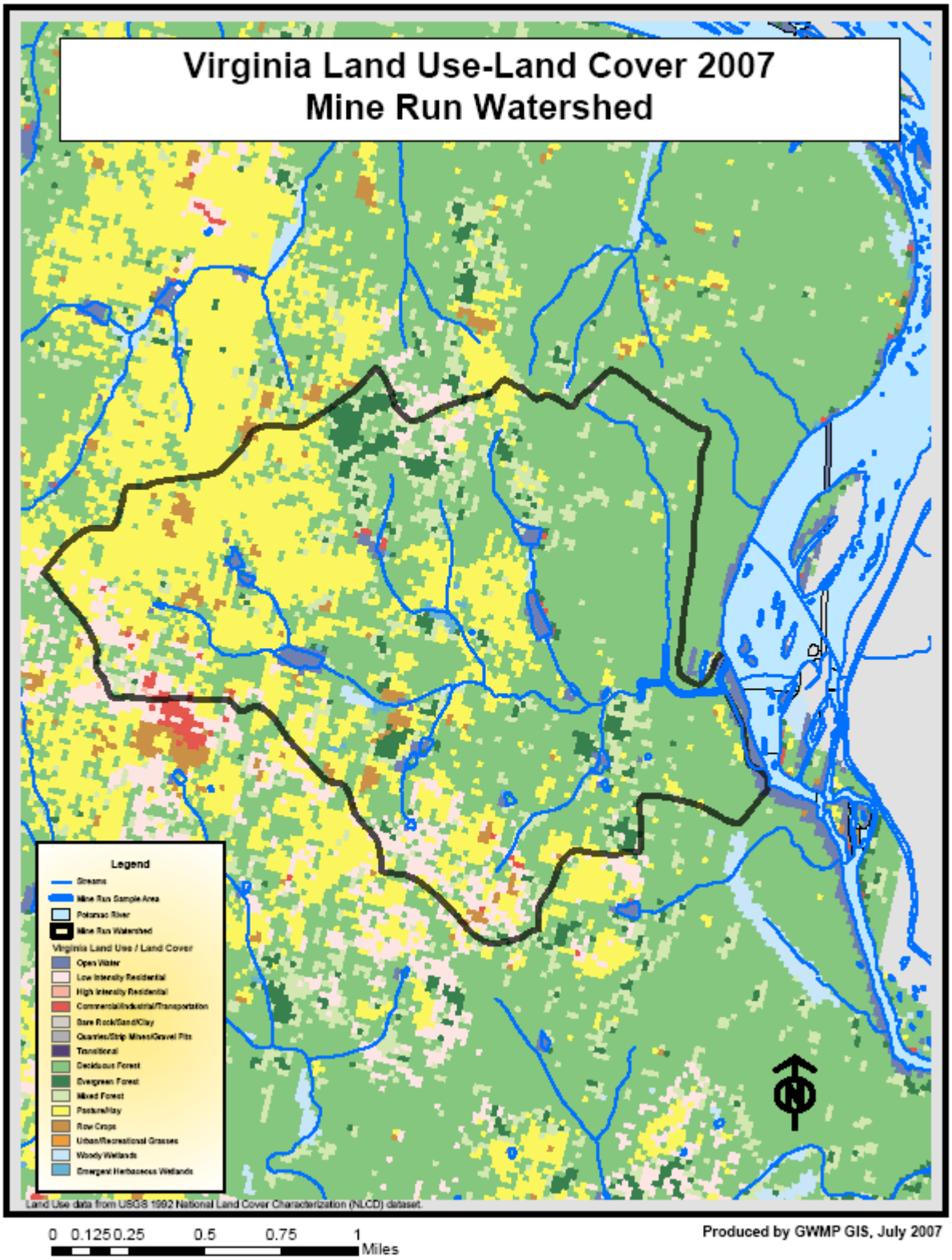


**Figure 26: Watershed Land Use: Turkey Run**

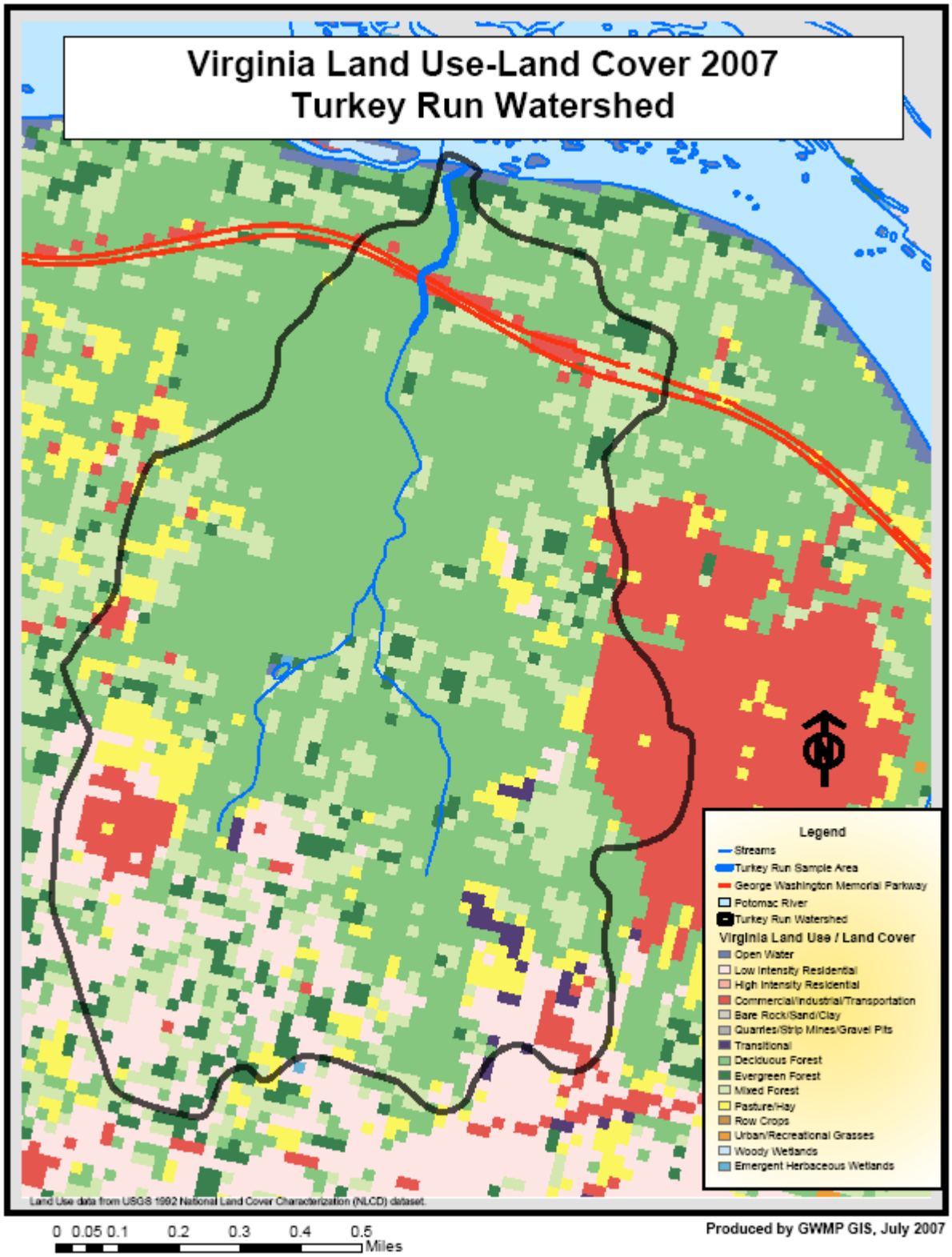


**Figure 27: Watershed Land Use: Dead Run**

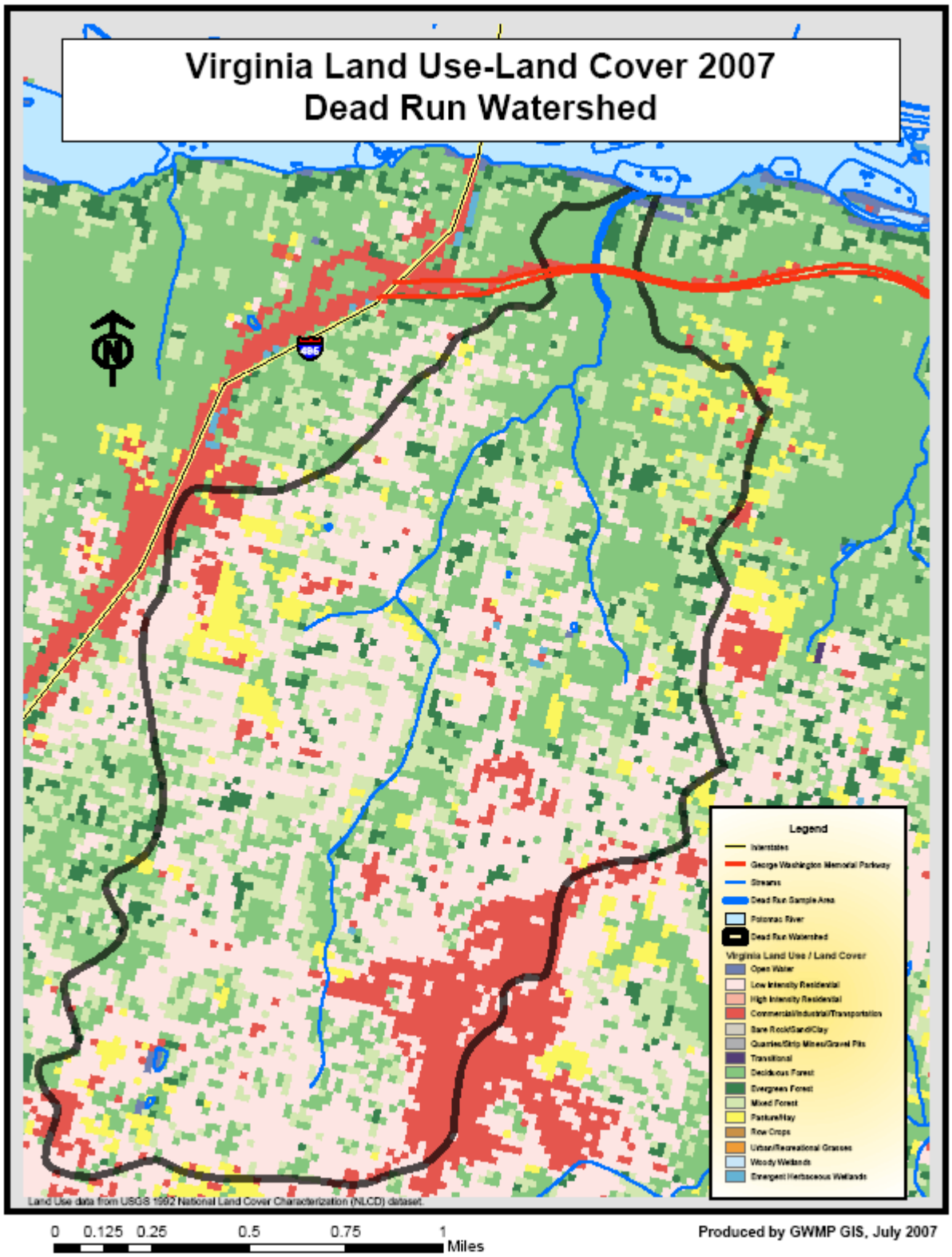


**Figure 28: Watershed Land Use: Pimmit Run**

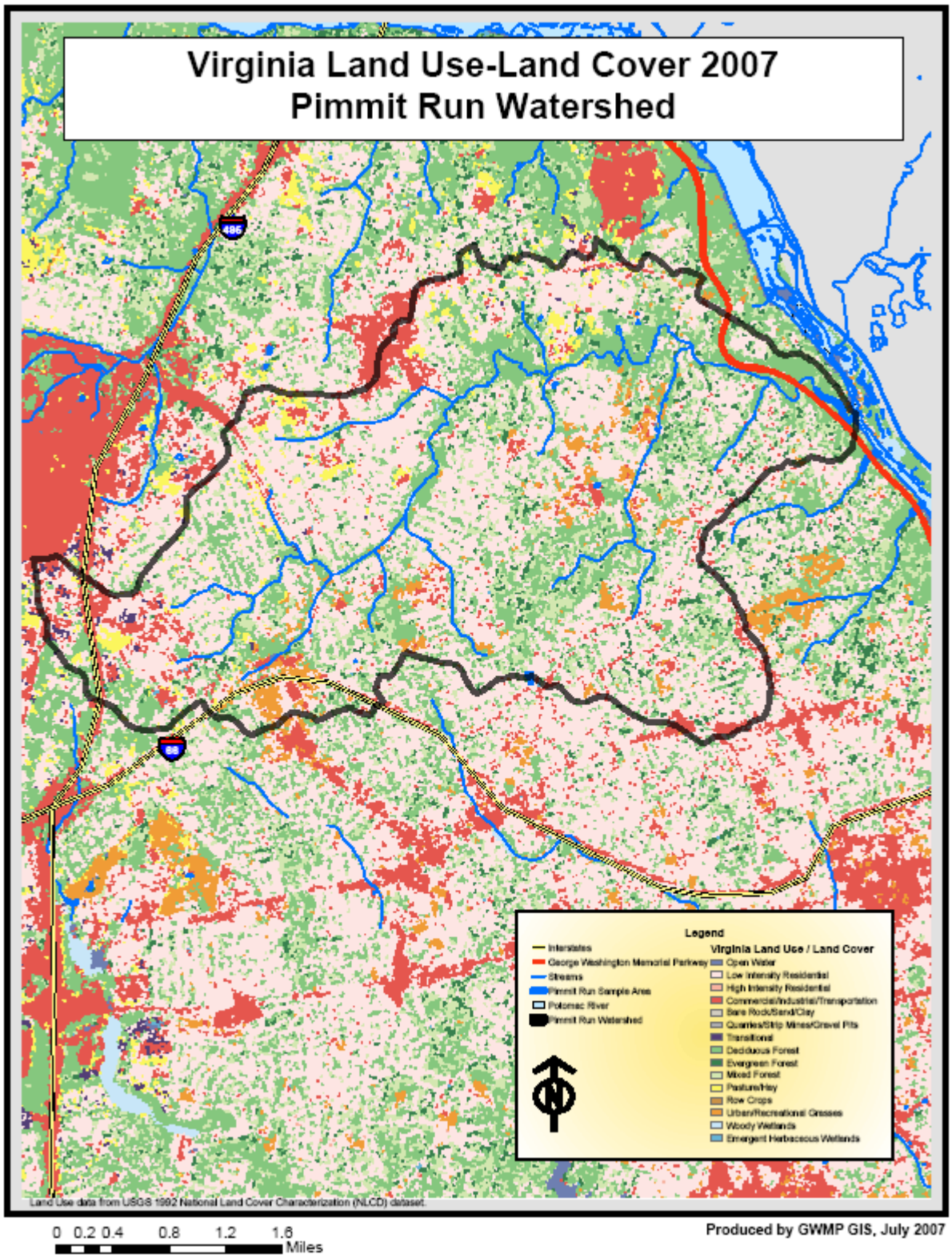


**Figure 29: Watershed Land Use: Gulf Branch**

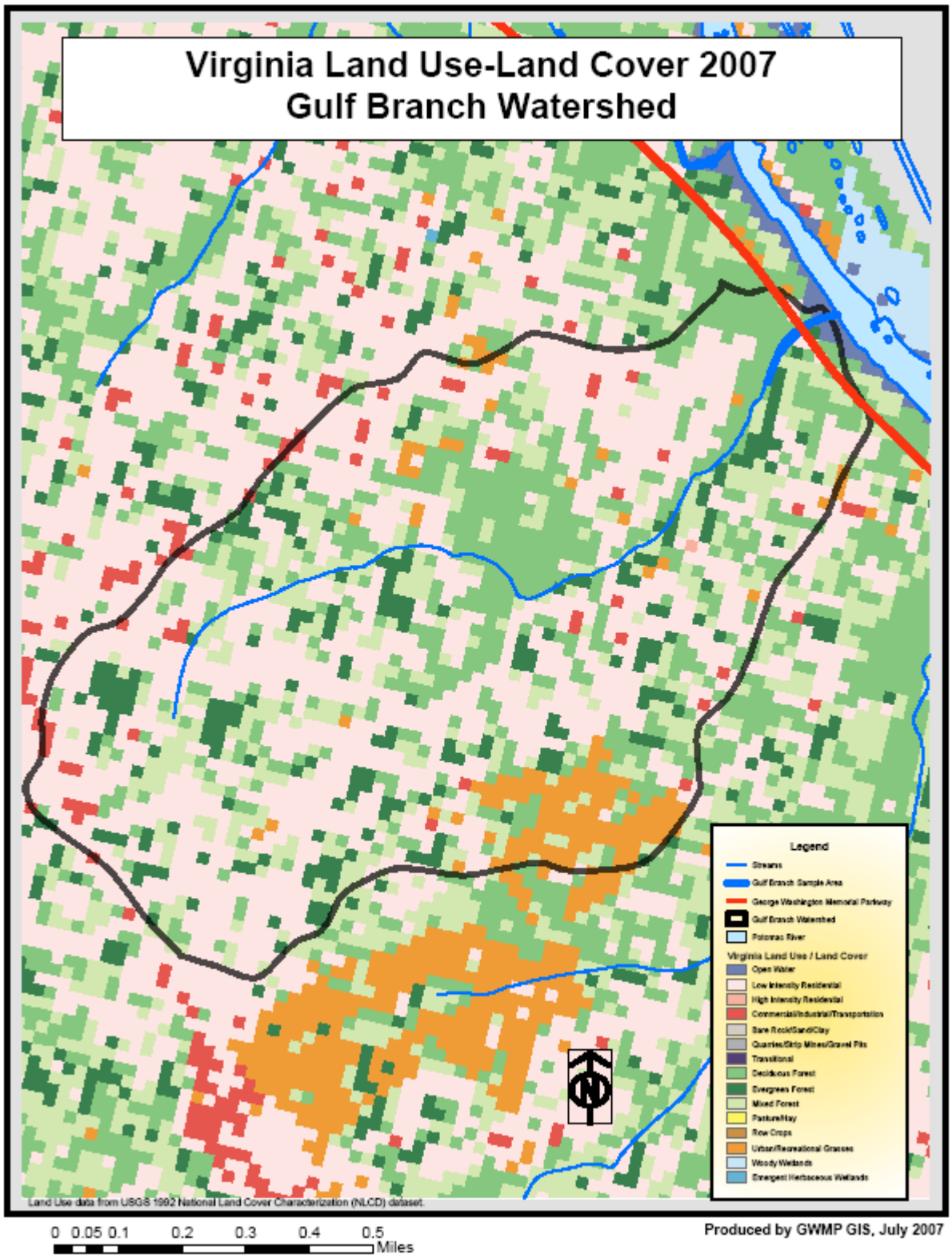


**Figure 30: Watershed Land Use: Donaldson Run**

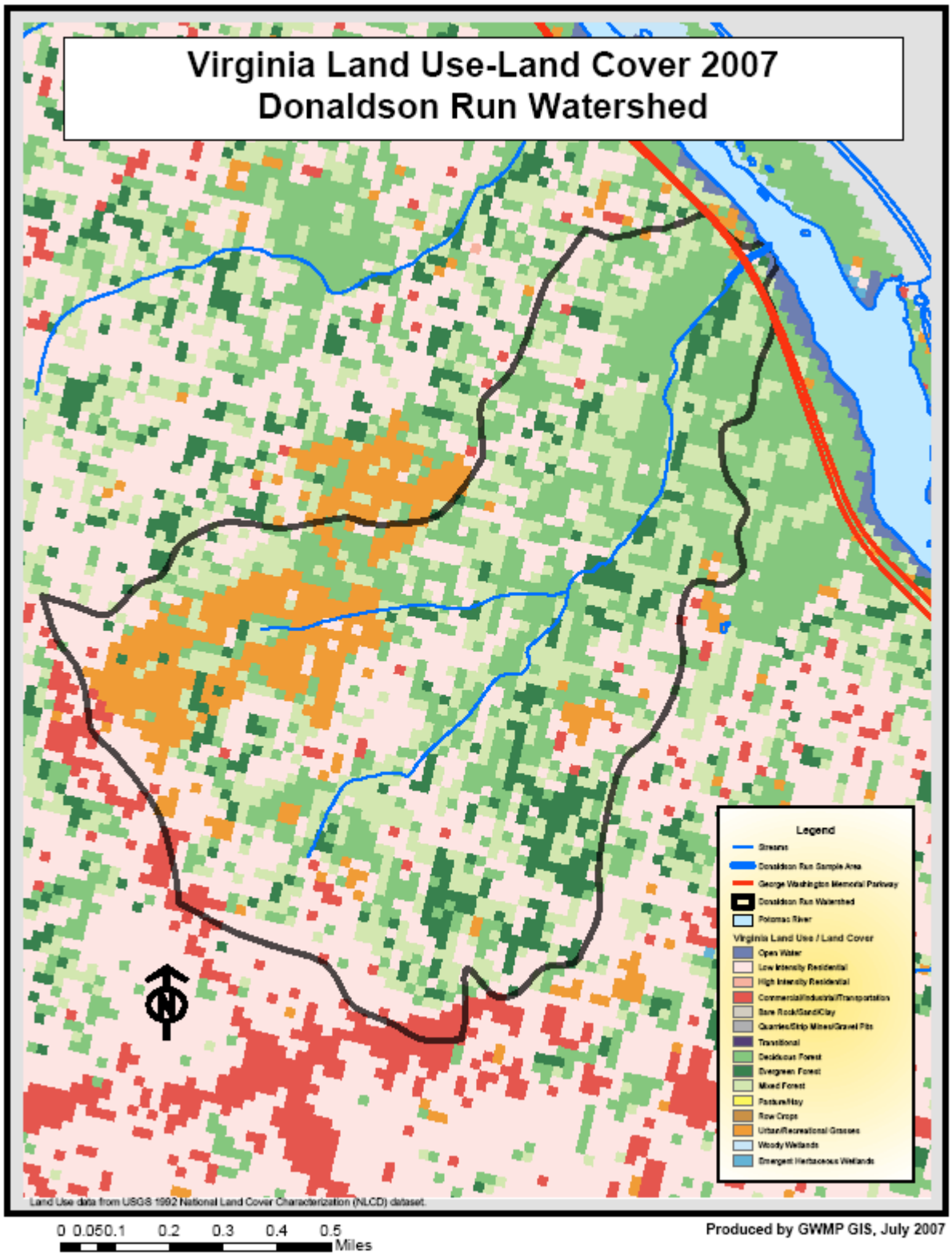


**Figure 31: Watershed Land Use: Spout Run**

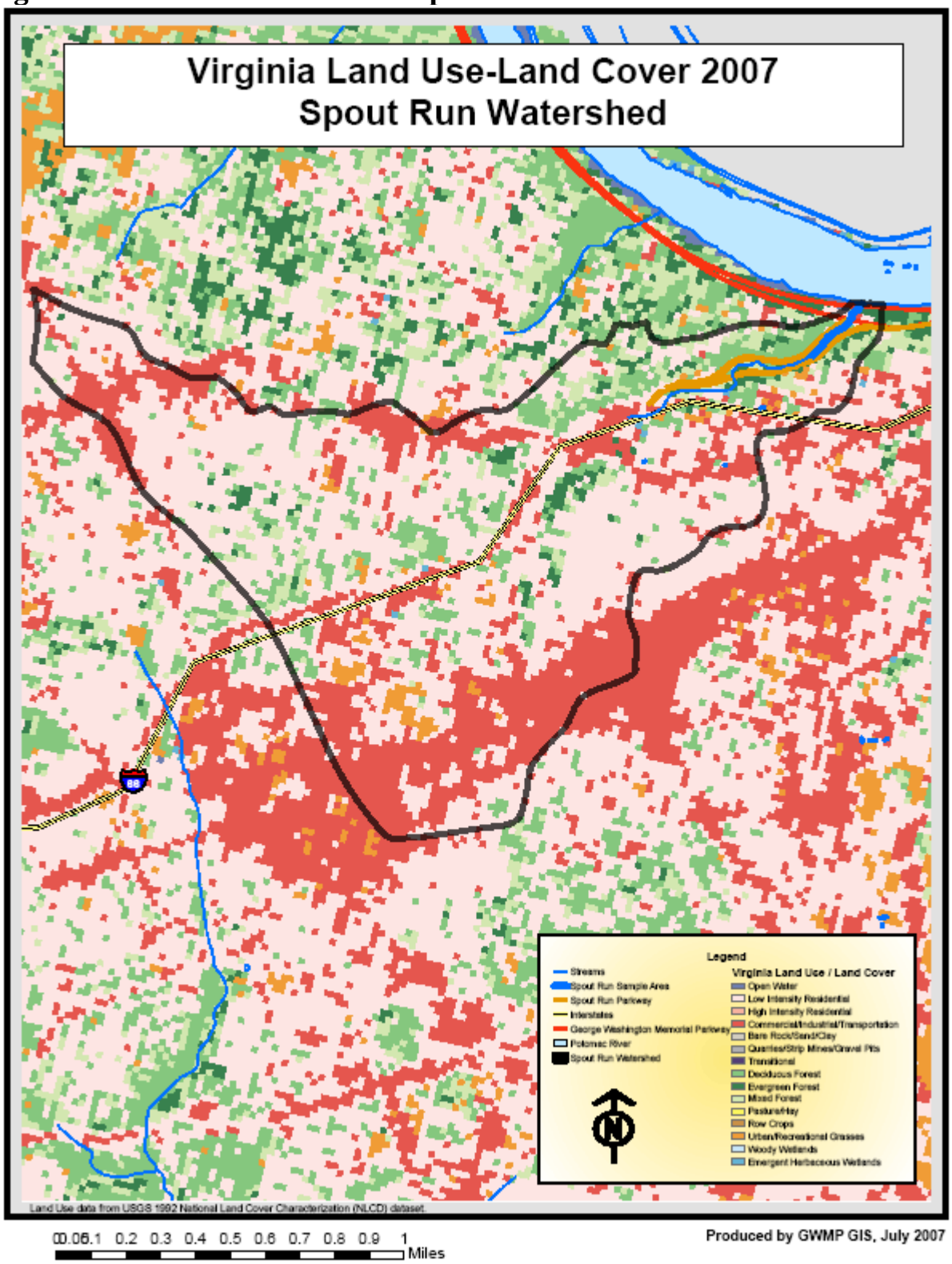


**Figure 32: Watershed Land Use: Windy Run**

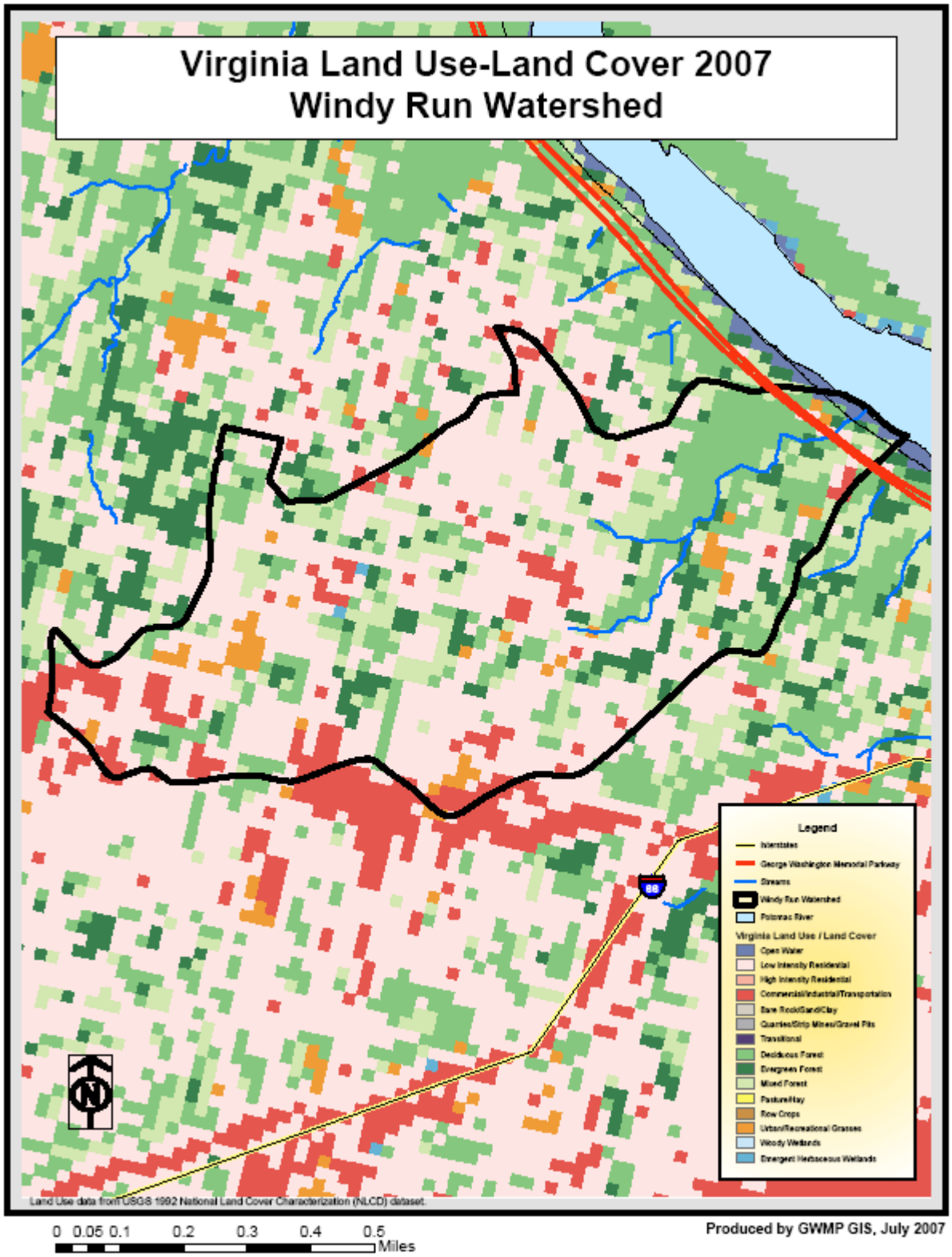


**Figure 33: Watershed Land Use: Difficult Run**

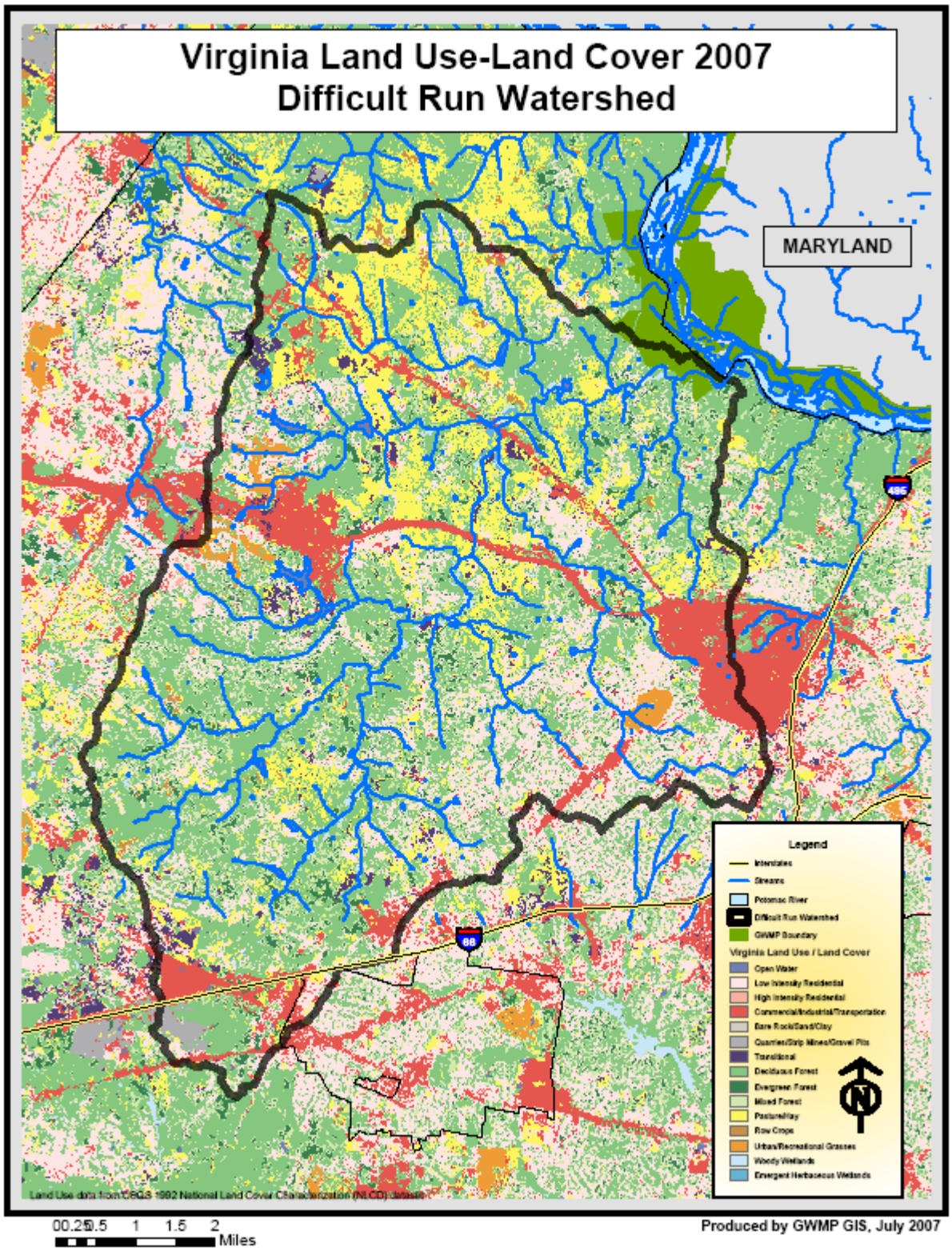


**Figure 34a: Watershed Land Use**

1993

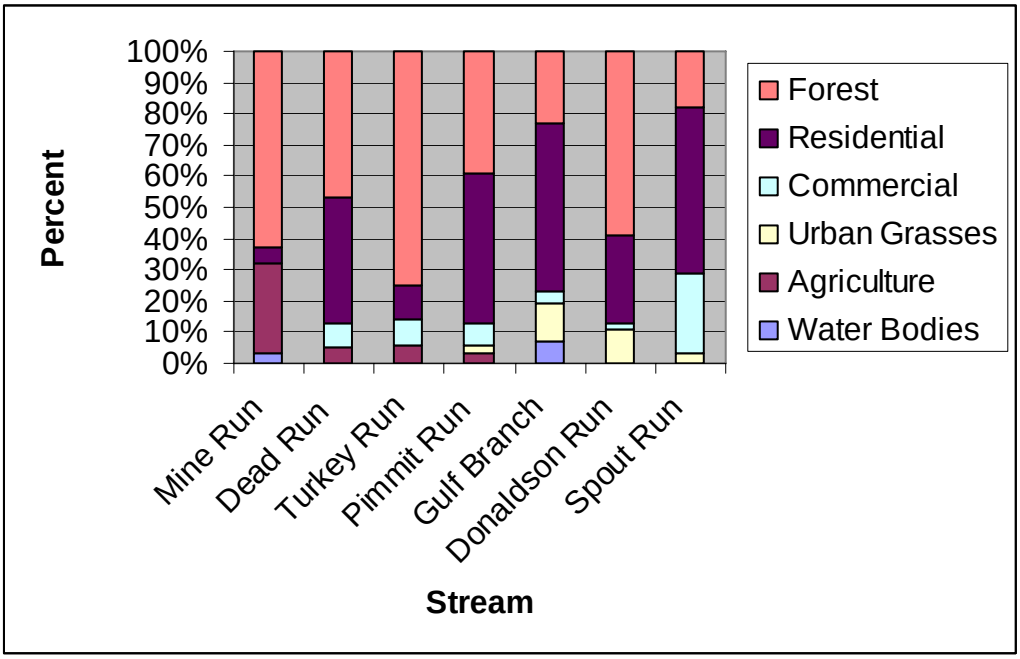



**Figure 34b: Watershed Land Use**

2001

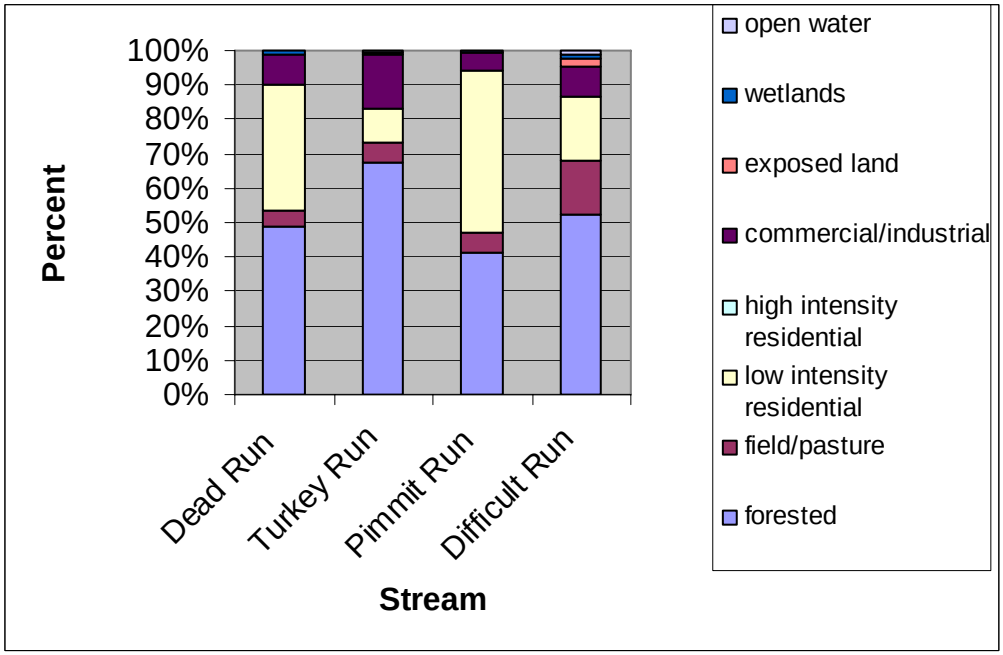
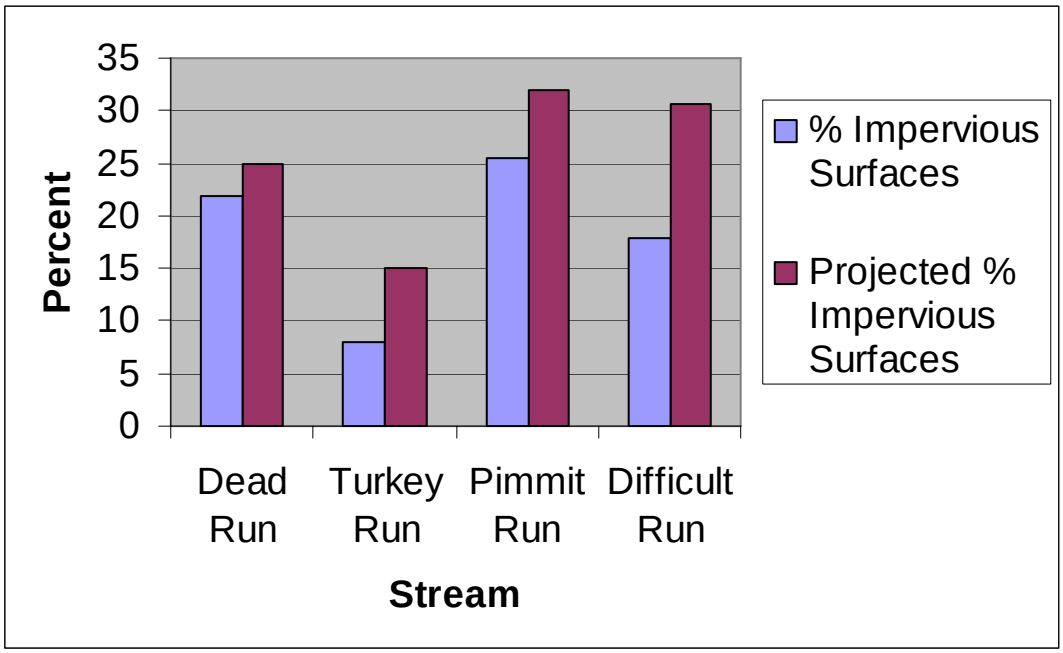


**Figure 35: Impervious Surfaces in Fairfax County Watersheds (2001)**




**Effects of 2001 Pesticide Spill on Gulf Branch and Donaldson Run**

On August 23, 2001 Donaldson Run and Gulf Branch were contaminated with pesticide runoff from a neighboring golf course, killing fish and macroinvertebrates. Two rounds of samples had been collected pre-contamination and one round post-contamination provided valuable data prior to and after impact. Data from rounds one and two, pre-contamination, for Donaldson Run revealed macroinvertebrate density / (richness) of 23.93 / (13) and 4.20 / (13). Round three, post-contamination, data revealed a density / (richness) of 0.03 / (2). The minimal number of macroinvertebrates (200) were not present at Donaldson Run during round two, stations two and three, and all stations in round three (Table 2). Gulf Branch recorded 20.80 / (14), 2.42 / (9), and 0.98 / (3) for density / richness per round in 2001. Only round one had statistically valid counts for Gulf Branch. Data from 2001 revealed significant impacts between sampling rounds, and of valid samplings, pre-contamination health scores were 5.50 and 6.67 for Donaldson Run and Gulf Branch respectively.

In 2002 density / (richness) were recorded as 26.17 / (11), and 17.85 / (10) for rounds one and two of Donaldson Run. Gulf Branch density / (richness) were 21.56 / (13) and 18.04 / (17). Donaldson Run round two, station two was the only sampling event that had less than the

required 200 macroinvertebrates. Stream health scores were 4.20 for Donaldson Run and 4.17 for Gulf Branch.

In 2003, Gulf Branch and Donaldson Run were monitored for three rounds, two years after pesticide contamination. Density / (richness) of benthic macroinvertebrates collected during 2003 at Donaldson Run was approximately 14.30 / (13), 26.30 / (10), and 28.37 / (13) during rounds one, two, and three, while Gulf Branch density / (richness) were 1.86 / (11), 3.54 / (9), and 13.84 / (11). In 2003, Donaldson Run received an average health score of 4.78, and Gulf Branch received an average health score of 4.25. At least 200 individuals were collected at Donaldson Run making all samples for Donaldson Run statistically valid. At Gulf Branch five of nine samplings produced less than 200 individuals.

Density / (richness) values for Donaldson Run in 2006 were 52.11/ (8) and 58.85 / (12) for rounds one and two, with an average health score of 4.17. Density / (richness) values for Gulf Branch were 16.53 / (12) and 113.86 / (12) for rounds one and two, with a health score of 5.00 for 2006.

Density / (richness) values (macroinvertebrates per square foot / (number of species found)) for Donaldson Run in 2007 were 59.4/ (12) and 42.23/ (13) for rounds one and two, with an average health score of 5. Density / (richness) values for Gulf Branch in 2007 were 11.67/ (12) and 26.795/ (11) for rounds one and two, with an average health score of 4.5.

Density/ (richness) values at Donaldson Run in 2008 were 28.94/ (11) [Round 1], 98.00/ (11) [Round 2], and 72.17/ (11) [Round 3]. The 2008 season average health score for Donaldson Run is 5.67. The density/ (richness) values at Gulf Branch in 2008 were 65.07/ (13) [Round 1], 82.00/ (10) [Round 2], and 145.67/ (10) [Round 3]. The 2008 season average health score for Gulf Branch is 5.22.

There is no data to support whether a recovery to pre-contamination conditions has occurred for Donaldson Run and Gulf Branch. Past species density / (richness) calculations were not explained in previous reports. Prior to the sampling season of 2007 the sampling technique used did not produce statistically valid results for many sampling sites because less than 200 macroinvertebrates were collected. Therefore, a statistical analysis comparing data collected for each season prior to 2007 would not be valid for most sites. It is impossible to statistically analyze the density/ (richness) data for the years 2001-2008, and therefore no claim can be made on whether the species density / (richness) has returned to pre-contamination levels.

## EDUCATION AND OUTREACH

During the summer of 2008, there were two educational programs given. The first education program was given on May 31st, 2008 during the Riverbend Festival located outside of the visitor center at Riverbend Park in Great Falls, VA. The Riverbend Festival was centered around water recreation and water quality. They had a number of programs such as fishing, kayaking, a puppet show teaching kids about the importance of healthy streams and animal habitats. There were also tables with representatives from REI, The Nature Conservancy, among others. John Callow of Fairfax County had asked Joanna Cornell to provide a water quality monitoring demonstration during the festival. She contacted us, and asked that we would lead the demonstration for the festival. We provided samples of benthic macroinvertebrates from the GWMP's collection, and led two groups of children and adults through the process of sampling in the stream. Each group was taught an overview of what a watershed is and how humans affect it, as well as how the watershed inversely affects humans. Approximately 25 people participated in this program.

The second educational program was on July 8th, 2008 at George Mason University. Beth Murphy, a teacher for a summer program for children at GMU, had asked for help with presenting a demonstration of water sampling techniques to children at the camp. The children who were attending the camp were between 10 and 12 years of age, 24 people total. The campers made connections with pollution and its effects on wildlife and human health. The camp is geared at having children understand the importance of water quality in their watershed. Techniques on sampling with the kick-seine net were shown, and two sample nets were taken from the small creek that ran through the campus. The samples were laid out on two portable tables, allowing the students to pick the macroinvertebrates from the net using tweezers and paint brushes. Three field microscopes and many viewing boxes were laid out for them to use. There were two species that the kids really enjoyed. The first was the snail, and the second a leech. The demonstration seemed to have made a lasting impression on some of the campers and focused them for the next section of the camp.

Over the 2008 season of the water quality monitoring program, a number of guests and volunteers were able to join us in the field. The first guest was Nick Horrock, a local Fairfax County newspaper reporter, who met with us at Gulf Branch in Arlington, VA. Nick Horrock

was interested in the water quality monitoring program for a series of articles on watersheds and water quality for *The Connection Newspapers*. He did write two articles which included information about the water quality monitoring program. Tyler Fox was the second guest to come into the field with us. Tyler worked for the Episcopalian Diocese in Virginia, and was interested in volunteering with us for a day at Mine Run to learn the process of sampling. By volunteering with us, he gained the knowledge of monitoring that he needed in order to incorporate a water monitoring program for a summer camp. The last guest we had in the field was Daniel Parr, a fellow Student Conservation Association intern who was interested in documenting our field work for the SCA headquarters. Daniel met with us on Difficult Run, and took a series of photographs as we shared stories about the SCA program and experiences in the field. Over the 2008 season, roving contacts were made during field days and amounted to over 125 people. Most roving contacts were met at Donaldson Run, Pimmit Run, Gulf Branch, Windy Run, and Turkey Run. There were no roving contacts at either Spout Run or Dead Run.

## SOURCES OF ERROR

In this study, there are many things that could have caused error in the data. The sites are not always the same from year to year. As water levels change, riffle positions also change. Some sites from previous years are no longer fit to be sampled, so other nearby riffles are chosen. Also, the amount of time between rounds at each site varied as well as the intensity of the shuffling for each sample. This could have had an effect on the data. These variants are very difficult to avoid because of weather and human inconsistencies.

There are also many sources for human error in this study. Human error is hard to prevent when using qualitative tests, for example when testing for nitrate/nitrite and evaluating turbidity. Both tests involve color comparisons, which introduce error because they are not exact measurements and may not be consistent. It is similar when it comes to judging stream flow rate; for example, what was considered “normal” this year may have been “low” last year. Without knowledge of stream-flow regularity, it remains difficult to assess the stream flow rate.

## RECOMMENDATIONS

From the data collected we can see there is a possible link between increased human development outside of GWMP and stream health scores. Most development occurs outside the park boundaries. Active communication and partnerships with the park and its watershed neighbors are needed to develop management strategies that reduce their impact on these streams. Public awareness programs could be implemented further in order to inform local landowners, community leaders and policy makers on the health status of their watershed, making people aware of their environment and suggesting ways to improve its health status. One way this could be done is by putting up signs indicating watershed boundaries and the presence of stream monitoring sites (Fairfax County Storm Water Planning Division, 2001). More specifically, hazardous waste collection and disposal methods could be publicized throughout communities within the watersheds and community stream cleanups could be organized. Also, future renovation or development projects need to consider environmentally friendly storm water management and land use practices, such as riparian revegetation and tree planting (Fairfax County, 2001). This would help to prevent or diminish impacts on these and other Potomac tributaries.

Water chemistry parameters are affected by the sunlight which drives the fluctuations of photosynthesis and respiration of the algae. These processes have affects on dissolved oxygen. For this reason it is suggested that the times of the water chemistry tests remain constant at each site, every round. If all times are constant and the readings are relatively constant every time at every site, then it is possible to identify changes taken place by something other than natural fluctuations.

Nitrate levels and conductivity levels may spike during rainy periods. For this reason it is a good idea to keep track of daily rainfall (Appendix 13). A storm the day before a sampling period may account for a spike in nitrate or conductivity levels. Otherwise, a spike in these parameters may indicate human interference.

To help identify more specific sources of pollution, sites could be added to upstream tributaries. In the case of Dead Run, adding site three up to a tributary south of the George Washington Memorial Parkway could help clarify the magnitude of the impact the parkway has on the stream. Adding site one of Pimmit Run south to the Glebe Road tributary could also help in the same way. Adding these new sites could be considered if time permits.

Collections of beetles, where present, were taken at each station during the 2008 season. This collection was the beginning of a Parkway-wide beetle survey. A comprehensive beetle survey is scheduled for the near future.

During the 2008 season, a strange discoloration of water entering Pimmit Run was noted. The discoloration may be due to a presence of red algae. It was recommended that water samples be taken in order to run an IC anion scan and to test for E. coli. The Aquatic Ecologists at the Center for Urban Ecology have suggested that the samples be sent to an independent lab (EnvioChem). Additional funds should be dedicated for laboratory testing of suspicious sites.

There is a concern about stream bank loss due to erosion for the GWMP. Stream bank erosion is monitored using the VASOS data protocol, however it is a subjective test and is not quantitative. To keep track of this stream bank loss more accurately, it is recommended that bank to bank measurements at each sampling station are conducted.

In regards to future water quality monitors, there are several recommendations we can offer to better the summer experience. Remain consistent with previous sampling times (Appendix 10). Also, because community outreach is vital to this program and its efforts, it may be wise to begin making contacts early on in the season. Joanna Cornell is a key contact, and should provide a source for more community opportunities and involvement. Perhaps a press release would be beneficial in addressing the outside community, and provide an invitation for volunteers to join the monitors in the field (Note that all press releases must go through Dana Dierkes/Public Relations). It would be beneficial to include an orientation/seminar session with *Bridging the Watershed* early on in the summer experience.

## CONCLUSIONS

The George Washington Memorial Parkway Stream Monitoring Program efforts have provided valuable baseline data and have proven to be useful in identifying health trends of the seven monitored streams. Unlike past seasons, no streams received consistent acceptable health scores. Furthermore, Dead Run, Turkey Run, Pimmit Run, Gulf Branch, Donaldson Run, and Spout Run have consistently been rated as “unhealthy” streams during all monitoring seasons. These monitoring efforts have also proven to be useful in identifying impacts; such as the case with the 2001 contamination of Gulf Branch and Donaldson Run. Gathering data from streams that have never been monitored is also important for evaluating the water quality in a large area.

Continuation of this stream monitoring program will account for annual variation and improve estimates of stream health. Furthermore, the data collected during the stream monitoring program will continue to be shared with local agencies to aid in future stream protection and restoration efforts. These efforts allow the George Washington Memorial Parkway to work with its upstream neighbors to better protect water resources, both inside and outside park boundaries.

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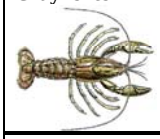
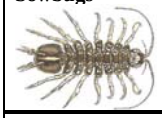
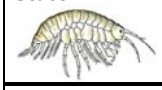
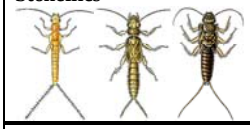
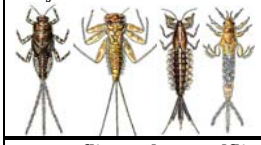
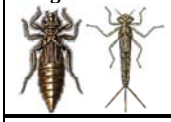
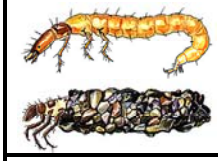
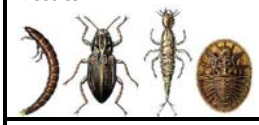
## Appendix 1: Virginia Save Our Streams Macroinvertebrate Tally Sheet

| Macroinvertebrates | Tally | Count |
|---|---|---|
| **Worms** | | |
| **Flat Worms** | | |
| **Leeches** | | |
| **Crayfishes**  | | |
| **Sowbugs**  | | |
| **Scuds**  | | |
| **Stoneflies**  | | |
| **Mayflies**  | | |
| **Dragonflies and Damselflies**  | | |
| **Hellgrammites, Fishflies, and Alderflies** | | |

Illustrations from: Voshell, J. R., Jr. 2001. Guide to the Common Freshwater Invertebrates of North America. MacDonald and Woodward Publishing Co. With permission of the author.

| Macroinvertebrates | Tally | Count |
|---|---|---|
| **Common Netspinner Caddisfly** | | |
| **Most Caddisflies**  | | |
| **Beetles**  | | |
| **Midges** | | |
| **Black Flies** | | |
| **Most True Flies** | | |
| **Gilled Snails** | | |
| **Lunged Snails** | | |
| **Clams** | | |
| **Other** | | |
| **Total number of organisms in the sample** | | |

## Appendix 2: Individual Category Metrics

| Metric | Number | | Total number of organisms in the sample | | Percent |
|---|---|---|---|---|---|
| **Mayflies + Stoneflies + Most Caddisflies** | | **Divide by** | | **Multiply by 100** | |
| **Common Netspinners** | | **Divide by** | | **Multiply by 100** | |
| **Lunged Snails** | | **Divide by** | | **Multiply by 100** | |
| **Beetles** | | **Divide by** | | **Multiply by 100** | |

### % Tolerant

| Taxon | Number |
|---|---|
| Worms | |
| Flatworms | |
| Leeches | |
| Sowbugs | |
| Scuds | |
| Dragonflies and Damselflies | |
| Midges | |
| Black Flies | |
| Lunged Snails | |
| Clams | |
| Total Tolerant | |
| Total Tolerant divided by the total number of organisms in the sample | |
| Multiply by 100 | |

### % Non-Insects

| Taxon | Number |
|---|---|
| Worms | |
| Flatworms | |
| Leeches | |
| Crayfish | |
| Sowbugs | |
| Scuds | |
| Gilled Snails | |
| Lunged Snails | |
| Clams | |
| Other non-insects (organisms without 6 jointed legs) | |
| Total Non-Insects | |
| Total Non-Insects divided by the total number of organisms in the sample | |
| Multiply by 100 | |

## Appendix 3: Save Our Streams Multimetric Index

Determine whether each metric should get a score of 2, 1, or 0. Write your metric value from the previous page in the 2nd column (Your Metric Value). Put a check in the appropriate boxes for 2, 1, or 0. Then calculate the subtotals and Save Our Streams Multimetric Index score and determine whether the site has acceptable or unacceptable ecological condition.

| **Metric** | **Your Metric Value** | **2** | **1** | **0** |
|---|---|---|---|---|
| % Mayflies + Stoneflies + Most Caddisflies | | Greater than 32.2 | 16.1 – 32.2 | Less than 16.1 |
| % Common Netspinners | | Less than 19.7 | 19.7 – 34.5 | Greater than 34.5 |
| % Lunged Snails | | Less than 0.3 | 0.3 – 1.5 | Greater than 1.5 |
| % Beetles | | Greater then 6.4 | 3.2 – 6.4 | Less than 3.2 |
| % Tolerant | | Less than 46.7 | 46.7 – 61.5 | Greater than 61.5 |
| % Non-Insects | | Less than 5.4 | 5.4 – 20.8 | Greater than 20.8 |
| | | Total # of 2s: | Total # of 1s: | Total # of 0s: |
| Subtotals: | | Multiply by 2: | Multiply by 1: | Multiply by 0: |

Now add the 3 subtotals to get the Save Our Streams Multimetric Index score:_____

_____Acceptable ecological condition (7 to 12) _____Unacceptable ecological condition (0 to 6)

## Appendix 4: YSI, Model 85, Meter Instructions (YSI, 1996)

When storing the YSI meter always **keep the probe in the storage chamber**. Always **keep the circular sponge damp** using three to six drops of distilled water to moisten it.

### *Calibrating for Dissolved Oxygen*

1. Calibrate for dissolved oxygen before each use.

2. Keep the small round sponge wet with three to six drops of distilled water. Put the sponge inside calibration/storage chamber. Insert the probe into the calibration chamber.

3. Turn the YSI on by pressing the **ON/OFF** button. Once the YSI is on, press **MODE** until dissolved oxygen is displayed in **mg/L** or **%**. Now wait ~15 minutes to allow the unit to warm up and for the readings to stabilize.

4. Find out the approximate altitude of the region in which you are located.

5. Press the **up** and **down arrow keys** simultaneously. Enter your altitude in hundreds of feet using the **up** and **down arrow keys** to increase or decrease the altitude. For example: Entering the number 2 indicates 200 feet. Once you have found the appropriate altitude hit **ENTER**.

6. The screen should now display CAL in the lower left corner of the display, the calibration value should be displayed in the lower right of the display and the current % reading (before calibration) should be on the main display. If the current % reading (large display) is stable, press **ENTER**. The YSI should read **SAVE**. Calibration of dissolved oxygen is now complete.

### *Calibrating for Conductivity*

1. Calibrate for conductivity every couple of months.

2. Turn the YSI on and allow it to warm up for ~15 minutes.

3. Fill a glass beaker with at least 3 inches of freshwater conductivity solution.

4. Push the **MODE** button until it displays a conductivity reading.

5. Insert the probe into the beaker so that the oval shaped hole in covered. Make sure to keep the probe at least ¼ inch above the bottom of the beaker.

6. Allow the temperature reading to stabilize.

7. Move the probe in the solution to dislodge any air bubbles.

8. Push the **UP** and **DOWN ARROW** buttons simultaneously until the **CAL** symbol appears at the bottom left corner.

9. Use the **UP** or **DOWN ARROW** button to adjust the reading until it matches the value of the calibration solution. Then hit the **ENTER** button. The word **SAVE** will flash across the screen and calibration for conductivity is complete.

## *Changing the Membrane Cap*

1. Change once a month if YSI is used frequently.
2. Unscrew and remove the probe sensor guard.
3. Unscrew and remove the old membrane cap.
4. Rinse the sensor tip with distilled water.
5. Prepare the electrolyte according to the direction on the KCL bottle.
6. Hold the membrane cap and fill it at least ½ full with the electrolyte solution.
7. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.
8. Screw the probe sensor guard on moderately tight.

YSI Meter Operating Instructions

1. After calibrating for dissolved oxygen, remove probe from calibration chamber.
2. Put probe in water making sure the entire probe must be covered in water, particularly the two holes at the top of the probe, which measure conductivity.
3. Scroll through options by pressing MODE. Dissolved oxygen is displayed in mg/L or %, conductivity is displayed in µS, specific conductivity is displayed with a flashing µS.

Take readings only when the YSI meter readings have stabilized.

# Appendix 5: YSI 60 Meter Instructions (YSI, 1998)

## *Instructions for a 1- point pH Calibration*

It is recommended to calibrate the instrument frequently, especially if high accuracy is required.

1. Turn the instrument on by pressing the on/off key. If the instrument was already on press the MODE key until pH is displayed.

2. Rinse the probe with deionized or distilled water, then carefully dry the probe (or rinse it with some of the pH buffer solution to be used with calibration).

3. Place 30-35 mL of pH buffer you have chosen to calibrate the system with (pH 7 or 6.86) in the 100 mL graduated cylinder (provided with the model 60). The graduated cylinder minimizes the amount of solution needed. Immerse the probe making sure that both the pH and temperature sensors are covered by the solution.

4. To enter the calibration menu, use two fingers to press and release the UP ARROW and DOWN ARROW keys at the same time. The model 60 display will show CAL at the bottom, STAND will be flashing and the main display will show 7.00 (the buffer to be used to adjust the offset).

5. Press the ENTER key. The model 60 display will show CAL at the bottom, STAND will stop flashing and the pH calibration value is shown with the middle decimal point flashing.

6. When the reading is stable (does not change by 0.01 pH in ten seconds), the decimal point will stop flashing. Press and hold the ENTER key to save the calibration point. The model 60 will flash SAVE on the display along with OFS to indicate the offset value has been saved.

7. SLOPE will now appear on the display and be flashing. This indicates that the slope is ready to be set using a second pH buffer. The system is now calibrated at a single point. Press the MODE key to return to normal operation.

8. Rinse the probe with deionized and distilled water, and then carefully dry the probe.

## *pH Meter Operating Instructions*

After the system has been set up and the pH has been calibrated, it is ready to make measurements. Simply insert the probe into the sample, shake gently to remove any trapped air bubbles, and wait for the readings to stabilize (approximately 60 seconds). The first reading after storage and buffers make take longer to stabilize (5-10 minutes), therefore, the probe should be stored in the transport chamber when making field measurements. It is important that the probe be inserted into sample far enough so that both the pH sensor and the temperature sensor be covered by the sample (Thank you Captain Obvious).

The Model 60 has 3 modes:
1. pH-- displays pH and temperature (degrees Celsius).
2. Recall-- allows previously stored data to be displayed.
3. Erase All-- allows all previously stored data to be deleted.

To change between the model 60 modes, press and release the MODE key.
NOTE: when the model 60 is first turned on, it is in the pH mode. To save data when on the pH mode hold down ENTER. To recall data, press MODE and then press ENTER.

## Appendix 6: Turbidity Kit Instructions (LaMotte, 2000)

Turbidity is the measure of the cloudiness of water. It is important because it is a measure of the sediment flow coming downstream after storms.

Remember: It is more accurate to perform the test immediately at streamside. To do so, you must take along a small bottle of tap water.

1. Fill one of the cylinders to the 50 mL mark with stream water and the other with tap water. If the water appears very turbid/cloudy, fill the cylinders only to the 25 mL mark.

2. SHAKE the bottle of Standard Turbidity Reagent vigorously to re-suspend the latex particles in the reagent.

3. To the cylinder containing TAP WATER, use the dropper to add Standard Turbidity Reagent in the 0.5 mL increments–(NOT drop-by-drop). Add 1 squirt of 0.5 mL Reagent, and then use the plastic stirring rod to mix.

4. Compare the fuzzy appearance of the black dot at the bottom of the tap water cylinder with the dot in the stream water cylinder (**DO NOT** try to match the color- the latex particles are white and will never match the brownish or greenish tint of most stream water). The goal is to add enough of the Standard to the tap water so that the cloudiness (as judged by the appearance of the black dots) of the tap water is made to match that of the stream water.

5. Count the number of squirts required to get a match. Read the turbidity (in units called JTU) off the chart on the kit's package insert/directions. Make sure you read off the correct column–one column is for use with a 50 mL volume, the other column is for a 25 mL volume.

6. On the reporting sheet, fill in the result and the number of squirts and test volume used. Examples: 15 JTU (3 squrts/50 mL) or 30 JTU (3 squirts/25 mL)

7. If the stream water looks just as clear as the tap water, report the result as "less than 2.5 JTU."

8. If the stream water looks a little cloudier than the tap water at the start, but when you add 1 squirt of turbidity reagent it looks like the tap water column becomes much cloudier than the stream water, report the result as "about 2.5 JTU."

Tip: If you are not sure if you have a match, add another squirt of turbidity reagent. If you can see that you've "gone over," you can feel sure that the previous number of squirts was indeed the correct number.

Note: Since the turbidity measurement is only an estimate, you may interpolate your result, if you wish. For example, if the match seems like it was between squirts 2 and 3 for a 50 mL volume, you could report the result as "~12.5 JTU" (which means "about half-way between 10 and 15 JTU".)

Disposal: The cylinders full of water and its accompanying turbidity reagent can be disposed of at the stream station.

## Appendix 7: Water Works Nitrate/Nitrite Test Strip Instructions

1. Dip a strip into the water for 2 seconds and remove. Do not shake excess water from the test strip.

2. Hold the strip level, with pad side up, for 60 seconds. Compare the NITRITE test pad, the pad closest to your fingers, to the color chart on the bottle.

3. Simultaneously compare the NITRATE test pad, the pad closest to the edge away from your fingers, to the color chart. Estimate results if the color on the test pad falls between two color blocks.

4. Note: The nitrate test actually measures the sum of both nitrate and nitrite nitrogen present in the sample.

*It is important to keep the cap on tightly between uses.

# Appendix 8: Stream Quality Survey Form
# Fairfax County Volunteer Stream Monitoring Program

Coordinated by the Northern Virginia Soil and Water Conservation District

***For Office Use Only***

Name of Reviewer_____

Date Reviewed_____

Data Sent To_____

## VA Save Our Streams
## Stream Quality Survey

Rocky Bottom Method

The purpose of this form is to aid you in gathering and recording important data about the health of your stream. By keeping accurate and consistent records of your observation and data from your macroinvertebrate count, you can document changes in water quality. When conducting rocky bottom sampling, select a riffle where the water is not running too fast, the water depth is between 3-12 inches, and the bed consists of cobble-sized stones (2 to 10 inches) or larger.

Stream_____ Station #_____ # of Participants_____

County_____ State_____ Latitude_____ Longitude_____

Location (please be specific)_____

Names of Participants_____

Name of Certified Monitor_____

Weather Conditions Last 72 Hours_____

Date_____ Stream (water) width_____ _____ft Channel (bank-to-bank) width_____ _____ _____ft

Start Time_____End Time_____Stream Flow Rate: High_____Normal_____Low_____Negligible_____

Water depth in riffle _____ in. Average stream depth_____in Water temp_____ °F or °C Air temp_____ °F or °C

### Biological Monitoring Collection Times

Collection Time:

**Net 1:_____sec** **Area sampled:_____**

**Net 2:_____sec** **Area sampled:_____**

**Net 3:_____sec** **Area sampled:_____**

**Net 2:_____sec** **Area sampled:_____**

Comments Related to Sampling:

_____

_____

_____

_____

_____

pH:_____ Conductivity_____µs Oxygen:_____ %, _____mg/l

**Chemical Tests** (refer to NVSWCD instructions as needed):

| **Nitrite/Nitrate** Test Strip Results (circle) | LaMotte Kit **Turbidity** Results, JTU (circle) |
|---|---|
| Nitrite Nitrogen, ppm (mg/L): 0 0-0.15 0.15 0.15-0.3 0.3 >0.3 | Vol: 25 or 50 mL <2.5 ~2.5 5 10 15 20 |
| Nitrate Nitrogen, ppm (mg/L): 0 0-1 1 1-2 2 2-5 5 >5 | # squirts: _____ 25 30 35 other: _____ |

**Are there any discharging pipes?** ☐ No ☐ Yes If yes, how many? _____

**What types of pipes are they?** ☐ Sewage treatment ☐ Runoff (field or stormwater) ☐ Industrial: type of industry _____

**Describe types of trash in and around the stream.**

_____

**Provide comments to indicate what you think are the current and potential future threats to your stream's health. Feel free to attach additional pages or photographs to better describe the condition of your stream.** _____

_____

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Latitude** | **Longitude** | **Description** | **Date** | **Certified Monitor** |
| Mine Run P1 | 38.99983 | 77.255833 | 5m downstream from road | 5/27/2008 | Rachel Buedel Megan Bauer |
| Mine Run P2 | 39 | 77.256 | 15m upstream from road | 5/27/2008 | Rachel Buedel, Megan Bauer |
| Mine Run P3 | 39.00001667 | 77.25633 | 25m upstream from road | 5/29/2008 | Rachel Buedel, Megan Bauer |
| Turkey Run P1 | 37.966 | 77.1567 | base of Switchback trail | 5/28/2008 | Rachel Buedel, Megan Bauer |
| Turkey Run P2 | 37.9648 | 77.1567 | 100m downstream from GW Pkwy | 6/5/2008 | Rachel Buedel, Megan Bauer |
| Turkey Run P3 | 37.9638 | 77.157 | 50m downstream from GW Pkwy | 6/10/2008 | Rachel Buedel, Megan Bauer |
| Dead Run P1 | 38.967 | 77.1725 | 15-20m upstream from mouth | 6/10/2008 | Rachel Buedel, Megan Bauer |
| Dead Run P2 | 38.96633 | 77.173167 | 50 m downstream | 6/10/2008 | Rachel Buedel, Megan Bauer |
| Dead Run P3 | 38.965167 | 77.173667 | 70m downstream of GW Pkwy bridge, below falls | 6/10/2008 | Rachel Buedel, Megan Bauer |
| Pimmit Run P1 | 38.92933 | 77.118667 | 30 meters upstream Glebe Road Route 123 Bridge | 6/2/2008 | Rachel Buedel, Megan Bauer |
| Pimmit Run P2 | 38.929833 | 77.118667 | 50 meters upstream Glebe Road, Route 123 Bridge | 6/2/2008 | Rachel Buedel, Megan Bauer |
| Pimmit Run P3 | 38.9301667 | 77.119 | 80 meters upstream Glebe Road, Route 123 Bridge | 6/2/2008 | Rachel Buedel, Megan Bauer |
| Gulf Branch P1 | 38.925167 | 77.113667 | 50m downstream from GW Pkwy | 5/30/2008 | Rachel Buedel, Megan Bauer |
| Gulf Branch P2 | 38.925 | 77.114167 | directly under bridge | 6/3/2008 | Rachel Buedel, Megan Bauer |
| Gulf Branch P3 | 38.9245 | 77.114667 | 15 m upstream from bridge | 6/3/2008 | Rachel Buedel, Megan Bauer |
| Donaldson P1 | 38.919836 | 77.1078389 | 10m upstream from mouth | 6/11/2008 | Rachel Buedel, Megan Bauer |
| Donaldson P2 | 38.919667 | 77.108167 | beneath GW Parkway bridge | 6/11/2008 | Rachel Buede, Megan Bauer |
| Donaldson P3 | 38.9195 | 77.10833 | 15m upstream from GW parkway | 6/13/2008 | Rachel Buedel, Megan Bauer |
| Spout Run P1 | 38.9013 | 77.0835 | next to drainage pipe, off Spout Run Pkwy, under GW | 6/16/2008 | Rachel Buedel, Megan Bauer |
| Spout Run P2 | 38.9003 | 77.0847 | 200 m upstream from P1 | 6/16/2008 | Rachel Buedel, Megan Bauer |
| Spout Run P3 | 38.8983 | 77.086 | below Spout Run, ~50 m upstream of 2nd drainage pipe | 6/16/2008 | Rachel Buedel, Megan Bauer |
| Windy Run P1 | N 38° 54' 20.34" | W 077° 05' 39.08" | After 2nd crossing of stream | 7/11/2008 | Rachel Buedel, Megan Bauer |
| Windy Run P2 | N 38° 54' 19.31" | W 077° 05' 40.62" | Below GWMP Bridge | 7/11/2008 | Rachel Buedel, Megan Bauer |
| Windy Run P3 | N 38° 54' 19.09" | W 077° 05' 44.13" | After GWMP bridge, located at the third crossing of the stream. | 7/11/2008 | Rachel Buedel, Megan Bauer |
| Difficult Run P1 | N 38° 58' 36.27" | W 077° 14' 23.40" | | 7/17/2008 | Rachel Buedel, Megan Bauer |
| Difficult Run P2 | N 38° 58' 37.42" | W 077° 14' 27.50" | | 7/17/2008 | Rachel Buedel, Megan Bauer |
| Difficult Run P3 | N 38° 58' 36.03" | W 077° 14' 39.40" | | 7/18/2008 | Rachel Buedel, Megan Bauer |

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Avg stream width** | **Average stream depth** | **Flow rate (High/Normal/Low/Negligible)** | **Weather last 72 hours** | **Water Temp** |
| Mine Run P1 | 12.7 | 2.2 | HIgh | Humid, cloudy, light rain | 18.5 |
| Mine Run P2 | 10 | 3.75 | high | hot, humid, light rain | 18.9 |
| Mine Run P3 | 13.3 | 2.95 | Normal | Day before Rainy in AM, Today cool | 14.8 |
| Turkey Run P1 | 23.75 | 2.6 | Normal | Light rain, cooler temps today, Yesterday was super humid and muggy | 16.1 |
| Turkey Run P2 | 10.1 | 3.8 | High | Severe Thunderstorms, Tornado Watch, Heavy Rain and Wind | 18 |
| Turkey Run P3 | 22.8 | 2.9 | High | Severe thunderstorms, tornado watch, heavy rain and wind | 19.3 |
| Dead Run P1 | 9.55 | 7.7 | Normal | Thunderstorms, hot, humid | 22.4 |
| Dead Run P2 | 12.9 | 7 | Normal | hot, humid | 23 |
| Dead Run P3 | 12.4 | 3.7 | Normal | Hot, Humid | 24.4 |
| Pimmit Run P1 | 33.9 | 8.91 | High | Heavy Rain and Thunderstorms | 18.3 |
| Pimmit Run P2 | 23.85 | 4.65 | High | Heavy Rain, Thuderstorms | 20.8 |
| Pimmit Run P3 | 40.9 | 6.4 | High | Heavy Rain, Thunderstorms | 22.6 |
| Gulf Branch P1 | 13.4 | 2.95 | normal | Cooler, Humid | 15.9 |
| Gulf Branch P2 | 13.9 | 3.7 | Normal | Light rain, windy, partly cloudy | 16.6 |
| Gulf Branch P3 | 11 | 4.05 | Normal | Light Rain, Windy, Partly Cloudy | 18.6 |
| Donaldson P1 | 35 | 7 | Normal | hot, humid, thunderstorms | 21.9 |
| Donaldson P2 | 35 | 5.6 | Normal | hot, humid, thunderstorms | 22.2 |
| Donaldson P3 | 15 | 8.4 | Normal | Humid, warm | 20.9 |
| Spout Run P1 | 11.6 | 7.4 | Normal | hot and humid | 23.1 |
| Spout Run P2 | 9.1 | 6.6 | Normal | Hot, humid | 21.2 |
| Spout Run P3 | 11.5 | 6.2 | Normal | hot humid | 22 |
| Windy Run P1 | 5.6 | 4.8 | Normal | Rain, Humid | 21.5 |
| Windy Run P2 | 6.6 | 4 | Normal | Hot, light rain, humid | 20.4 |
| Windy Run P3 | 13 | 1.7 | Normal | rain, hot temps | 21 |
| Difficult Run P1 | 52 | 7.4 | high | Sun | 24.4 |
| Difficult Run P2 | 81.7 | 9.4 | High | Sun | 25.3 |
| Difficult Run P3 | 58.3 | 15 | High | Hot & Humid | 23.8 |

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Collection Time (net1)** | **Collection Time (net2)** | **Collection Time (net3)** | **Collection Time (net4)** | **First Page Comments** |
| Mine Run P1 | | | | | 3x2 sample area |
| Mine Run P2 | | | | | We sampled an area of 3' x 2' because of previous data showing a large number of macroinvertebrates. |
| Mine Run P3 | 30 | | | | |
| Turkey Run P1 | 90 | 90 | | | Light/slow flow, hard to find a good site for sampling. A few big species present. but alot of little guys be careful when walking, very slippery and lots of spots. |
| Turkey Run P2 | 90 | | | | Sampled Directly across from flag |
| Turkey Run P3 | 90 | 30 | | | We saw a broad-winged hawk and two salamanders! |
| Dead Run P1 | 90 | 90 | | | |
| Dead Run P2 | 90 | 90 | | | |
| Dead Run P3 | 90 | 90 | | | Found a salamander |
| Pimmit Run P1 | 90 | | | | Right next to heavily used road |
| Pimmit Run P2 | 90 | 90 | | | Very little life |
| Pimmit Run P3 | 90 | | | | |
| Gulf Branch P1 | | | | | |
| Gulf Branch P2 | 90 | | | | |
| Gulf Branch P3 | 90 | | | | 3x2 Net |
| Donaldson P1 | 90 | 60 | | | |
| Donaldson P2 | 90 | | | | |
| Donaldson P3 | 90 | | | | |
| Spout Run P1 | 90 | | | | |
| Spout Run P2 | 90 | | | | |
| Spout Run P3 | 90 | | | | |
| Windy Run P1 | 60 | | | | |
| Windy Run P2 | 60 | | | | |
| Windy Run P3 | 60 | | | | |
| Difficult Run P1 | 30 | | | | We saw a deer on the hill and a snake in the water. |
| Difficult Run P2 | 30 | | | | |
| Difficult Run P3 | 30 | | | | |

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Worms** | **Flatworms** | **Leeches** | **Crayfish** | **Sowbugs** | **Scuds** | **Stoneflies** | **Mayflies** | **Dragonflies and Damselflies** |
| Mine Run P1 | 3 | 4 | 0 | 0 | 4 | 0 | 36 | 4 | 0 |
| Mine Run P2 | 22 | 8 | 0 | 2 | 8 | 4 | 71 | 12 | 2 |
| Mine Run P3 | 61 | 1 | 0 | 3 | 5 | 3 | 75 | 17 | 3 |
| Turkey Run P1 | 109 | 3 | | 4 | | 9 | 2 | 4 | |
| Turkey Run P2 | 130 | 0 | 0 | 1 | 2 | 0 | 1 | 1 | 0 |
| Turkey Run P3 | 50 | 1 | 1 | 5 | 0 | 1 | 3 | 3 | 0 |
| Dead Run P1 | 23 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Dead Run P2 | 69 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| Dead Run P3 | 43 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| Pimmit Run P1 | 33 | | | | 2 | 1 | | 4 | |
| Pimmit Run P2 | 51 | 0 | 0 | 0 | 14 | 1 | 0 | 17 | 0 |
| Pimmit Run P3 | 54 | 1 | 0 | 0 | 0 | 0 | 0 | 13 | 0 |
| Gulf Branch P1 | 78 | 3 | | | | 3 | | 1 | |
| Gulf Branch P2 | 40 | 6 | 1 | 1 | 0 | 0 | 0 | 3 | 0 |
| Gulf Branch P3 | 21 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Donaldson P1 | 63 | 1 | 0 | 0 | 0 | 2 | 0 | 15 | 0 |
| Donaldson P2 | 26 | 1 | 1 | 0 | 0 | 0 | 0 | 6 | 0 |
| Donaldson P3 | 48 | 5 | 0 | 0 | 0 | 0 | 0 | 51 | 0 |
| Spout Run P1 | 35 | 7 | 0 | 0 | 0 | 3 | 0 | 7 | 0 |
| Spout Run P2 | 24 | 2 | 0 | 0 | 0 | 0 | 0 | 25 | 0 |
| Spout Run P3 | 41 | 1 | 0 | 0 | 0 | 7 | 0 | 22 | 0 |
| Windy Run P1 | 70 | 14 | 0 | 0 | 0 | 0 | 0 | 27 | 0 |
| Windy Run P2 | 52 | 15 | 0 | 0 | 0 | 0 | 0 | 86 | 0 |
| Windy Run P3 | 88 | 1 | 0 | 0 | 0 | 0 | 0 | 52 | 0 |
| Difficult Run P1 | 6 | 56 | 2 | 0 | 0 | 5 | 0 | 32 | 1 |
| Difficult Run P2 | 8 | 20 | 1 | 0 | 0 | 4 | 0 | 42 | 0 |
| Difficult Run P3 | 9 | 53 | 1 | 2 | 0 | 1 | 0 | 21 | 0 |

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Hellgrammites, Fishflies, and Alderflies** | **Common Netspinners** | **Most Caddisflies** | **Beetles** | **Midges** | **Blackflies** | **Most True Flies** | **Gilled Snails** | **Lunged Snails** |
| Mine Run P1 | 2 | 177 | 22 | 103 | 54 | 68 | 24 | 0 | 0 |
| Mine Run P2 | 3 | 93 | 13 | 82 | 60 | 16 | 31 | 0 | 0 |
| Mine Run P3 | 1 | 48 | 8 | 46 | 87 | 2 | 8 | | |
| Turkey Run P1 | | 13 | | | 74 | 10 | 14 | | |
| Turkey Run P2 | 1 | 29 | 0 | 2 | 80 | 8 | 6 | 0 | 1 |
| Turkey Run P3 | 1 | 86 | 16 | 5 | 109 | 4 | 28 | 0 | 1 |
| Dead Run P1 | 0 | 8 | 5 | 0 | 165 | 3 | 8 | 0 | 0 |
| Dead Run P2 | 0 | 14 | 2 | 1 | 170 | 4 | 0 | 0 | 0 |
| Dead Run P3 | 0 | 9 | 2 | 1 | 148 | 4 | 9 | 0 | 1 |
| Pimmit Run P1 | | 8 | | | 174 | 8 | 1 | | |
| Pimmit Run P2 | 0 | 23 | 1 | 0 | 140 | 13 | 7 | | |
| Pimmit Run P3 | 0 | 19 | 2 | 0 | 207 | 17 | 6 | 0 | 0 |
| Gulf Branch P1 | 1 | | 3 | | 438 | 66 | 20 | | |
| Gulf Branch P2 | 1 | 2 | 0 | 0 | 551 | 178 | 3 | 0 | 1 |
| Gulf Branch P3 | 0 | 1 | 1 | 0 | 280 | 50 | 3 | | |
| Donaldson P1 | 0 | 111 | 4 | 0 | 222 | 12 | 3 | 0 | 1 |
| Donaldson P2 | 0 | 33 | 0 | 0 | 140 | 12 | 3 | 0 | 0 |
| Donaldson P3 | 0 | 27 | 0 | 0 | 160 | 3 | 4 | 0 | 1 |
| Spout Run P1 | 0 | 24 | 0 | 0 | 451 | 0 | 0 | 0 | 1 |
| Spout Run P2 | 0 | 14 | 0 | 0 | 292 | 0 | 4 | 0 | 0 |
| Spout Run P3 | 0 | 12 | 0 | 0 | 256 | 2 | 6 | 0 | 3 |
| Windy Run P1 | 0 | 71 | 47 | 0 | 74 | 12 | 1 | 0 | 0 |
| Windy Run P2 | 0 | 51 | 19 | 0 | 31 | 4 | 4 | 0 | 0 |
| Windy Run P3 | 0 | 53 | 4 | 0 | 58 | 23 | 0 | 0 | 5 |
| Difficult Run P1 | 0 | 268 | 373 | 165 | 63 | 3 | 0 | 0 | 0 |
| Difficult Run P2 | 1 | 32 | 29 | 55 | 62 | 1 | 3 | 0 | 0 |
| Difficult Run P3 | 2 | 323 | 169 | 125 | 9 | 11 | 7 | 0 | 0 |

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Clams** | **Other Organisms** | **Define Other Organism** | **Total Organisms** | **Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies** | **Metric 2 - Percent Common Netspinners** | **Metric 3 - Percent Lunged Snails** | **Metric 4 - Percent Beetles** | **Metric 5 - Percent Tolerant** |
| Mine Run P1 | 1 | | | 502 | 12.350598 | 35.258964 | 0 | 20.517928 | 26.693227 |
| Mine Run P2 | 3 | 0 | | 430 | 22.325581 | 21.627907 | 0 | 19.069767 | 28.604651 |
| Mine Run P3 | | | | 368 | 27.173913 | 13.043478 | 0 | 12.5 | 44.021739 |
| Turkey Run P1 | | | | 242 | 2.4793388 | 5.3719008 | 0 | 0 | 84.710744 |
| Turkey Run P2 | 0 | | | 262 | 0.7633588 | 11.068702 | 0.3816794 | 0.7633588 | 84.351145 |
| Turkey Run P3 | 0 | | | 314 | 7.0063694 | 27.388535 | 0.3184713 | 1.5923567 | 53.184713 |
| Dead Run P1 | 0 | | | 214 | 2.3364486 | 3.7383178 | 0 | 0 | 90.186916 |
| Dead Run P2 | 0 | | | 263 | 1.5209125 | 5.3231939 | 0 | 0.3802281 | 92.775665 |
| Dead Run P3 | 0 | | | 221 | 2.7149321 | 4.0723982 | 0.4524887 | 0.4524887 | 88.687783 |
| Pimmit Run P1 | | | | 231 | 1.7316017 | 3.4632035 | 0 | 0 | 94.372294 |
| Pimmit Run P2 | | | | 267 | 6.741573 | 8.6142322 | 0 | 0 | 82.022472 |
| Pimmit Run P3 | 0 | 0 | | 319 | 4.7021944 | 5.9561129 | 0 | 0 | 87.460815 |
| Gulf Branch P1 | | | | 613 | 0.6525285 | 0 | 0 | 0 | 95.921697 |
| Gulf Branch P2 | 0 | | | 787 | 0.3811944 | 0.2541296 | 0.1270648 | 0 | 98.729352 |
| Gulf Branch P3 | | | | 357 | 0.280112 | 0.280112 | 0 | 0 | 98.59944 |
| Donaldson P1 | 0 | | | 434 | 4.3778802 | 25.576037 | 0.2304147 | 0 | 69.354839 |
| Donaldson P2 | 0 | | | 222 | 2.7027027 | 14.864865 | 0 | 0 | 81.081081 |
| Donaldson P3 | 0 | | | 299 | 17.056856 | 9.0301003 | 0.3344482 | 0 | 72.575251 |
| Spout Run P1 | 0 | 0 | 0 | 528 | 1.3257576 | 4.5454545 | 0.1893939 | 0 | 94.128788 |
| Spout Run P2 | 0 | 0 | | 361 | 6.9252078 | 3.8781163 | 0 | 0 | 88.088643 |
| Spout Run P3 | 0 | 0 | 0 | 350 | 6.2857143 | 3.4285714 | 0.8571429 | 0 | 88.571429 |
| Windy Run P1 | 0 | | | 316 | 23.417722 | 22.468354 | 0 | 0 | 53.797468 |
| Windy Run P2 | 0 | | | 262 | 40.076336 | 19.465649 | 0 | 0 | 38.931298 |
| Windy Run P3 | 0 | | | 284 | 19.71831 | 18.661972 | 1.7605634 | 0 | 61.619718 |
| Difficult Run P1 | 2 | | | 976 | 41.495902 | 27.459016 | 0 | 16.905738 | 14.139344 |
| Difficult Run P2 | 1 | | | 259 | 27.413127 | 12.355212 | 0 | 21.235521 | 37.451737 |
| Difficult Run P3 | 0 | | | 733 | 25.920873 | 44.065484 | 0 | 17.053206 | 11.459754 |

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Metric 5 - Percent Tolerant** | **Metric 6 - Percent Non-Insect** | **Score** | **Ecological Conditions** | **Fish Water Quality Indicators** |
| Mine Run P1 | 26.693227 | 2.3904382 | 8 | Gray Zone | |
| Mine Run P2 | 28.604651 | 10.930233 | 9 | Acceptable | No Fish |
| Mine Run P3 | 44.021739 | 19.836957 | 10 | Acceptable | |
| Turkey Run P1 | 84.710744 | 51.652893 | 4 | Unacceptable | Scattered Individuals |
| Turkey Run P2 | 84.351145 | 51.145038 | 3 | Unacceptable | Scattered Individuals |
| Turkey Run P3 | 53.184713 | 18.789809 | 4 | Unacceptable | Scattered Individuals |
| Dead Run P1 | 90.186916 | 11.682243 | 5 | Unacceptable | No Fish |
| Dead Run P2 | 92.775665 | 26.61597 | 4 | Unacceptable | No Fish |
| Dead Run P3 | 88.687783 | 19.909502 | 4 | Unacceptable | Scattered Individuals |
| Pimmit Run P1 | 94.372294 | 15.584416 | 5 | Unacceptable | no fish |
| Pimmit Run P2 | 82.022472 | 24.719101 | 4 | Unacceptable | No Fish |
| Pimmit Run P3 | 87.460815 | 17.241379 | 5 | Unacceptable | No Fish |
| Gulf Branch P1 | 95.921697 | 13.7031 | 5 | Unacceptable | |
| Gulf Branch P2 | 98.729352 | 6.2261753 | 5 | Unacceptable | No Fish |
| Gulf Branch P3 | 98.59944 | 6.162465 | 5 | Unacceptable | No Fish |
| Donaldson P1 | 69.354839 | 15.437788 | 4 | Unacceptable | Scattered Individuals/Scattered Schools |
| Donaldson P2 | 81.081081 | 12.612613 | 5 | Unacceptable | Scattered Individuals |
| Donaldson P3 | 72.575251 | 18.060201 | 5 | Unacceptable | Scattered Individuals |
| Spout Run P1 | 94.128788 | 8.7121212 | 5 | Unacceptable | No Fish |
| Spout Run P2 | 88.088643 | 7.2022161 | 5 | Unacceptable | No Fish |
| Spout Run P3 | 88.571429 | 14.857143 | 4 | Unacceptable | No Fish |
| Windy Run P1 | 53.797468 | 26.582278 | 5 | Unacceptable | No Fish |
| Windy Run P2 | 38.931298 | 25.572519 | 8 | Acceptable | No Fish |
| Windy Run P3 | 61.619718 | 33.098592 | 3 | Unacceptable | No Fish |
| Difficult Run P1 | 14.139344 | 7.2745902 | 10 | Acceptable | Scattered Individuals |
| Difficult Run P2 | 37.451737 | 13.127413 | 10 | Acceptable | Scattered Individuals |
| Difficult Run P3 | 11.459754 | 9.0040928 | 8 | Acceptable | Scattered Individuals |

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Stream** | **Barriers to Fish Movement** | **Surface-water appearance** | **Stream Bed Deposit** | **Odor** | **Stability of stream: Bed sinks beneath your feet** | **Algae Color(Light green/Dark green/Brown coated/Matted on streambed/Hairy)** |
| Mine Run P1 | No Barriers | Clear | Brown | No odor | no spots | none |
| Mine Run P2 | No Barriers | Clear | Brown/Rocky | no odor | no spots | |
| Mine Run P3 | No Barriers | Clear | Brown/Silt | No odor | No Spots | |
| Turkey Run P1 | No Barriers | Clear | Brown/silt | Other | Many Spots | |
| Turkey Run P2 | No Barriers | Clear but tea colored | Brown/Silt/Sand | No Odor | Many Spots | |
| Turkey Run P3 | No Barriers | Clear but tea-colored | brown/silty/sandy | No odor | A Few Spots | |
| Dead Run P1 | No Barriers | Clear | Brown/Sandy | No Odor | No Spots | |
| Dead Run P2 | Waterfalls | Clear | Brown/Sandy | Musky | No Spots | |
| Dead Run P3 | No Barriers | Clear | Brown/Silt/Sand | Musky | A few spots | |
| Pimmit Run P1 | No barriers | clear | brown,silt,sand | none | no spots | |
| Pimmit Run P2 | No Barriers | Clear | Brown, silt, sand | None | no spots | |
| Pimmit Run P3 | No Barriers | Clear | Brown, silt, sand | no odor | no spots | |
| Gulf Branch P1 | No Barriers | Clear | Brown | No odor | No spots | |
| Gulf Branch P2 | No Barriers | Clear | Brown,silt,sand | musky,sewage | no spots | |
| Gulf Branch P3 | No Barriers | Clear | Broan/Silty/Sand | Musky | No Spots | |
| Donaldson P1 | Waterfalls | Clear | Brown/Silt/Sand | Sewage and Rotting carcasses | A Few Spots | |
| Donaldson P2 | Waterfallas | Clear | Brown/Silty/Sandy | Sewage, rotting fish | A Few Spots | |
| Donaldson P3 | Waterfalls | Clear | Brown/Silt/Sand | No Odor | A Few Spots | Brown Coated/ Matted on streambed |
| Spout Run P1 | Rocks | Clear | Brown/Tan/Sandy | Sewage | No Spots | Dark Green |
| Spout Run P2 | Rocks | Clear | Brown/Tan/Sand | Sewage | No Spots | Dark Green |
| Spout Run P3 | Rocks | Clear | Brown/Tan/Sandy | Sewage | No Spots | Dark Green |
| Windy Run P1 | Waterfalls | Clear | Brown/Sandy | No Odor | No Spots | Dark Green, Brown Coated |
| Windy Run P2 | No Barriers | Clear | Brown, Sandy | No Odor | No Spots | Dark Green, Brown Coated |
| Windy Run P3 | No Barriers | Clear | Brown/ Sandy | No Odor | No Spots | Dark Green |
| Difficult Run P1 | Waterfalls | Clear | Brown/Tan | No Odor | No Spots | Brown Coated |
| Difficult Run P2 | Waterfalls | Clear | Brown/Tan | No Odor | No Spots | Brown Coated/Darkgreen/ Matted On Streambed/ Hairy |
| Difficult Run P3 | Waterfalls | Clear | Brown/tan | No Odor | No Spots | Dark Green/ Brown Coated/ Matted |

# Appendix 9: 2008 Data Collection

| Round 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Stream** | **Algae located(In Spots/Everywhere)** | **Percent algae** | **Stream channel shade** | **% Silt** | **% Sand** | **% Gravel** | **% Cobbles** |
| Mine Run P1 | | 0 | Full | 0 | 20 | 40 | 40 |
| Mine Run P2 | | | High | 2 | 3 | 35 | 60 |
| Mine Run P3 | | | Full | 15 | 20 | 45 | 20 |
| Turkey Run P1 | | | High | 30 | 5 | 50 | 15 |
| Turkey Run P2 | | | Moderate | 60 | 10 | 25 | 5 |
| Turkey Run P3 | | | High | 75 | 10 | 8 | 7 |
| Dead Run P1 | | | Full | 0 | 5 | 20 | 75 |
| Dead Run P2 | | | High | 0 | 5 | 20 | 75 |
| Dead Run P3 | | | High | 10 | 40 | 10 | 40 |
| Pimmit Run P1 | | | Moderate | 0 | 40 | 40 | 20 |
| Pimmit Run P2 | | | Full | 5 | 45 | 40 | 10 |
| Pimmit Run P3 | | | High | 5 | 40 | 15 | 40 |
| Gulf Branch P1 | | | Full | 0 | 0 | 35 | 45 |
| Gulf Branch P2 | | | Full | 0 | 10 | 20 | 70 |
| Gulf Branch P3 | | | Full | 0 | 10 | 50 | 40 |
| Donaldson P1 | | | Moderate | 10 | 10 | 50 | 30 |
| Donaldson P2 | | | Moderate | 10 | 50 | 20 | 20 |
| Donaldson P3 | In Spots | | High | 5 | 0 | 60 | 35 |
| Spout Run P1 | In Spots | 50 | Moderate | 0 | 15 | 45 | 40 |
| Spout Run P2 | In Spots | 50 | High | 0 | 10 | 45 | 45 |
| Spout Run P3 | In Spots | 40 | High | 0 | 25 | 30 | 45 |
| Windy Run P1 | In Spots | 60 | Moderate | 5 | 15 | 40 | 40 |
| Windy Run P2 | In Spots | 70 | High | 0 | 0 | 0 | 100 |
| Windy Run P3 | In Spots | 35 | Moderate | 0 | 20 | 30 | 50 |
| Difficult Run P1 | Everywhere | 100 | Moderate | 0 | 0 | 0 | 100 |
| Difficult Run P2 | Everywhere | 100 | Moderate | 0 | 0 | 0 | 100 |
| Difficult Run P3 | Everywhere | 100 | Moderate | 0 | 0 | 0 | 100 |

# Appendix 9: 2008 Data Collection

| **Round 1** | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Stream channel erosion potential** | **Area 1** | **Area 2** | **Area 3** | **Area 4** |
| Mine Run P1 | high | 2x3 | | | |
| Mine Run P2 | Severe to High | | | | |
| Mine Run P3 | High | 3x3 | | | |
| Turkey Run P1 | Severe | 3x3 | 3x3 | | |
| Turkey Run P2 | High | 3x3 | | | |
| Turkey Run P3 | High | 3X3 | 3X2 | | |
| Dead Run P1 | High | 3X3 | 3x3 | | |
| Dead Run P2 | Severe | 3x3 | 3x3 | | |
| Dead Run P3 | Severe | 3x3 | 3x3 | | |
| Pimmit Run P1 | Severe | 3x3 | | | |
| Pimmit Run P2 | Severe | 3x3 | 3x3 | | |
| Pimmit Run P3 | Severe | 3x3 | | | |
| Gulf Branch P1 | Severe | 3x3 | | | |
| Gulf Branch P2 | Severe | 3x3 | | | |
| Gulf Branch P3 | Severe | 3x2 | | | |
| Donaldson P1 | Severe | 3x3 | | | |
| Donaldson P2 | Severe | 3x3 | | | |
| Donaldson P3 | Severe | 3x3 | | | |
| Spout Run P1 | High | 3x3 | | | |
| Spout Run P2 | Severe | 3x3 | | | |
| Spout Run P3 | High | 3x3 | | | |
| Windy Run P1 | Severe | 3x2 | | | |
| Windy Run P2 | Severe | 3x2 | | | |
| Windy Run P3 | Severe | 3x2 | | | |
| Difficult Run P1 | Severe | 3x1 | | | |
| Difficult Run P2 | High | 3x1 | | | |
| Difficult Run P3 | Severe | 3x1 | | | |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Latitude** | **Longitude** | **Description** | **Date** | **Certified Monitor** |
| Mine Run P1 | 39 | 77.26 | 5m downstream from road | 6/19/2008 | Rachel Buedel, Megan Bauer |
| Mine Run P2 | 39 | 77.26 | 15m upstream from road | 6/19/2008 | Rachel Buedel, Megan Bauer |
| Mine Run P3 | 39 | 77.26 | 25m upstream from road | 6/20/2008 | Rachel Buedel, Megan Bauer |
| Turkey Run P1 | 38 | 77.16 | base of Switchback trail | 6/23/2008 | Rachel Buedel, Megan Bauer |
| Turkey Run P2 | 38 | 77.16 | 100m downstream from GW Pkwy | 6/23/2008 | Rachel Buedel, Megan Bauer |
| Turkey Run P3 | 38 | 77.16 | 50m downstream from GW Pkwy | 6/24/2008 | Rachel Buedel and Megan Bauer |
| Dead Run P1 | 39 | 77.17 | 15-20m upstream from mouth | 6/25/2008 | Rachel Buedel and Megan Bauer |
| Dead Run P2 | 39 | 77.17 | 50 m downstream | 6/25/2008 | Rachel Buedel and Megan Bauer |
| Dead Run P3 | 39 | 77.17 | 70m downstream of GW Pkwy bridge, below falls | 6/27/2008 | Rachel Buedel and Megan Bauer |
| Pimmit Run P1 | 39 | 77.12 | 30 meters upstream Glebe Road Route 123 Bridge | 6/17/2008 | Rachel Buedel and Megan Bauer |
| Pimmit Run P2 | 39 | 77.12 | 50 meters upstream Glebe Road, Route 123 Bridge | 6/20/2008 | Rachel Buedel, Megan Bauer |
| Pimmit Run P3 | 39 | 77.12 | 80 meters upstream Glebe Road, Route 123 Bridge | 6/17/2008 | Rachel Buedel, Megan Bauer |
| Gulf Branch P1 | 39 | 77.11 | 50m downstream from GW Pkwy | 6/20/2008 | Rachel Buedel, Megan Bauer |
| Gulf Branch P2 | 39 | 77.11 | directly under bridge | 6/25/2008 | Normal |
| Gulf Branch P3 | 39 | 77.11 | 15 m upstream from bridge | 6/24/2008 | Normal |
| Donaldson P1 | 39 | 77.11 | 10m upstream from mouth | 6/27/2008 | Rachel Buedel and Megan Bauer |
| Donaldson P2 | 39 | 77.11 | beneath GW Parkway bridge | 6/30/2008 | Rachel Buedel and Megan Bauer |
| Donaldson P3 | 39 | 77.11 | 15m upstream from GW parkway | 6/30/2008 | Rachel Buedel and Megan Bauer |
| Spout Run P1 | 39 | 77.08 | next to drainage pipe, off Spout Run Pkwy, under GW | 7/1/2008 | Rachel Buedel and Megan Bauer |
| Spout Run P2 | 39 | 77.08 | 200 m upstream from P1 | 7/1/2008 | Rachel Buedel and Megan Bauer |
| Spout Run P3 | 39 | 77.09 | below Spout Run, ~50 m upstream of 2nd drainage pipe | 7/1/2008 | Rachel Buedel and Megan Bauer |
| Windy Run P1 | N 38° 54' 20.34" | W 077 05' 39.08" | After 2nd crossing of stream | 7/24/2008 | Rachel Buedel and Megan Bauer |
| Windy Run P2 | N 38° 54' 19.31" | W 077 05' 40.62" | Below GWMP Bridge | 7/24/2008 | Rachel Buedel and Megan Bauer` |
| Windy Run P3 | N 38° 54' 19.09" | W 077 05' 44.13" | After GWMP bridge, located at the third crossing of the stream. | 7/24/2008 | Rachel Buedel and Megan Bauer |
| Difficult Run P1 | N 38° 58' 36.27" | W 077 14' 23.40" | | 7/28/2008 | Rachel Buedel and Megan Bauer |
| Difficult Run P2 | N 38° 58' 37.42" | W 077 14' 27.50" | | 7/28/2008 | Rachel Buedel and Megan Bauer |
| Difficult Run P3 | N 38° 58' 36.03" | W 077 14' 39.40" | | 7/28/2008 | Rachel Buedel and Megan Bauer |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Avg stream width** | **Average stream depth** | **Flow rate** | **Weather last 72 hours** | **Temp** | **Collection Time (net1)** | **Collection Time (net2)** | **Collection Time (net3)** | **Collection Time (net4)** |
| Mine Run P1 | 13 | 3.7 | High | cool temps, thunderstorms | 17.4 | 60 | | | |
| Mine Run P2 | 10 | 4 | High | cool temps, rain, thunderstorms | 18.5 | 30 | | | |
| Mine Run P3 | 15 | 3.2 | Normal | | 20 | 30 | | | |
| Turkey Run P1 | 24 | 2.2 | Normal | Rain, Thunderstorms, Overcast | 20.5 | 60 | | | |
| Turkey Run P2 | 18 | 4 | Normal | Rain, Thunderstorms, Overcast | 21.3 | 60 | | | |
| Turkey Run P3 | 16 | 5.4 | Normal | Humid, Thunderstorms | 20.3 | 60 | | | |
| Dead Run P1 | 10 | 8.4 | Normal | Hot and Humid | 19.4 | 90 | | | |
| Dead Run P2 | 14 | 3.8 | Normal | Hot and Humid | 20.4 | 90 | | | |
| Dead Run P3 | 18 | 3 | Normal | Hot and Humid | 21.9 | 90 | | | |
| Pimmit Run P1 | 37 | 11 | High | Rain and Thunderstorms | 23.1 | 90 | | | |
| Pimmit Run P2 | 24 | 5 | Normal | Rain, Cool temps, Cloudy | 18.5 | 90 | | | |
| Pimmit Run P3 | 34 | 7.5 | High | rain, thunderstorms, cool temps | 18.3 | 90 | | | |
| Gulf Branch P1 | 16 | 5.2 | Normal | Cool temps, Rain | 18 | 60 | | | |
| Gulf Branch P2 | | 3.1 | Normal | hot, humid | 21.2 | 60 | | | |
| Gulf Branch P3 | | 3.6 | Normal | Hot, Humid, Thunderstorms | 19.2 | 60 | | | |
| Donaldson P1 | 7 | 4.8 | Normal | Hot and Humid | 21.9 | 60 | | | |
| Donaldson P2 | 12 | 4 | High | Thunderstorms | 21.4 | 60 | | | |
| Donaldson P3 | 4 | 3.9 | High | Thunderstorms | 22.9 | 30 | | | |
| Spout Run P1 | 8 | 8.4 | Normal | Rain, Thunderstorms, Cool Temps | 20.9 | 60 | | | |
| Spout Run P2 | 9 | 6 | Normal | Rain, Thunderstorms, Cool Temps | 21.9 | 30 | | | |
| Spout Run P3 | 18 | 3.8 | Normal | Rain, Thunderstorms, Cool Temps | 22.6 | 60 | | | |
| Windy Run P1 | 7 | 4.7 | High | humid, heavy rain and thunderstorms | 20.9 | 90 | 90 | 60 | |
| Windy Run P2 | 8 | 6.3 | High | humid, heavy rain, thunderstorms | 21.6 | 90 | 90 | | |
| Windy Run P3 | 14 | 7 | High | humid, heavy rain, thunderstorms | 22 | 90 | | | |
| Difficult Run P1 | 44 | 8.8 | High | Thunderstorms, hot and humid | 23 | 30 | | | |
| Difficult Run P2 | 70 | 13.8 | High | Thunderstorms, hot and humid | 23.7 | 30 | 30 | | |
| Difficult Run P3 | 65 | 10.2 | High | thunderstorms, hot and humid | 24 | 30 | | | |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Worms** | **Flatworms** | **Leeches** | **Crayfish** | **Sowbugs** | **Scuds** | **Stoneflies** | **Mayflies** | **Dragonflies and Damselflies** |
| Mine Run P1 | 10 | 6 | 0 | 0 | 3 | 2 | 35 | 4 | 4 |
| Mine Run P2 | 44 | 11 | 0 | 0 | 2 | 2 | 33 | 1 | 0 |
| Mine Run P3 | 16 | 0 | 0 | 0 | 1 | 1 | 17 | 11 | 0 |
| Turkey Run P1 | 49 | 0 | 0 | 2 | 0 | 0 | 0 | 10 | 0 |
| Turkey Run P2 | 66 | 2 | 0 | 0 | 0 | 3 | 0 | 6 | 1 |
| Turkey Run P3 | 27 | 0 | 0 | 0 | 0 | 0 | 2 | 9 | 0 |
| Dead Run P1 | 17 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 |
| Dead Run P2 | 14 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 0 |
| Dead Run P3 | 159 | 1 | 0 | 0 | 0 | 0 | 0 | 7 | 0 |
| Pimmit Run P1 | 63 | 5 | 0 | 0 | 6 | 0 | 0 | 8 | 0 |
| Pimmit Run P2 | 40 | 0 | 0 | 0 | 1 | 0 | 2 | 22 | 0 |
| Pimmit Run P3 | 17 | 1 | 0 | 0 | 0 | 1 | 0 | 15 | 0 |
| Gulf Branch P1 | 55 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Gulf Branch P2 | 9 | 5 | 0 | 0 | 0 | 0 | 0 | 5 | 0 |
| Gulf Branch P3 | 16 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| Donaldson P1 | 72 | 4 | 0 | 0 | 0 | 0 | 0 | 61 | 0 |
| Donaldson P2 | 42 | 5 | 0 | 0 | 0 | 0 | 0 | 196 | 0 |
| Donaldson P3 | 23 | 1 | 0 | 0 | 0 | 0 | 0 | 131 | 0 |
| Spout Run P1 | 130 | 37 | 0 | 0 | 1 | 6 | 0 | 57 | 0 |
| Spout Run P2 | 23 | 2 | 0 | 0 | 0 | 0 | 0 | 72 | 0 |
| Spout Run P3 | 46 | 2 | 0 | 1 | 0 | 15 | 0 | 131 | 0 |
| Windy Run P1 | 70 | 5 | 0 | 0 | 3 | 0 | 0 | 45 | 0 |
| Windy Run P2 | 60 | 15 | 0 | 1 | 4 | 0 | 0 | 23 | 0 |
| Windy Run P3 | 94 | 1 | 0 | 0 | 3 | 0 | 0 | 23 | 0 |
| Difficult Run P1 | 2 | 11 | 0 | 0 | 0 | 7 | 0 | 124 | 0 |
| Difficult Run P2 | 5 | 22 | 2 | 2 | 0 | 9 | 0 | 70 | |
| Difficult Run P3 | | | | | | | | | |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Hellgrammites, Fishflies, and Alderflies** | **Common Netspinners** | **Most Caddisflies** | **Beetles** | **Midges** | **Blackflies** | **Most True Flies** | **Gilled Snails** | **Lunged Snails** |
| Mine Run P1 | 6 | 428 | 175 | 152 | 147 | 19 | 10 | 0 | 0 |
| Mine Run P2 | 0 | 198 | 179 | 87 | 51 | 3 | 1 | 0 | 0 |
| Mine Run P3 | 0 | 71 | 8 | 64 | 80 | 5 | 1 | 0 | 0 |
| Turkey Run P1 | 0 | 66 | 30 | 2 | 177 | 5 | 3 | 0 | 0 |
| Turkey Run P2 | 0 | 40 | 29 | 6 | 125 | 18 | 8 | 0 | 0 |
| Turkey Run P3 | 0 | 22 | 3 | 4 | 180 | 1 | 3 | 0 | 0 |
| Dead Run P1 | 0 | 2 | 0 | 0 | 214 | 1 | 0 | 0 | 0 |
| Dead Run P2 | 0 | 72 | 8 | 0 | 297 | 0 | 3 | 0 | 0 |
| Dead Run P3 | 0 | 52 | 4 | 0 | 324 | 3 | 6 | 0 | 0 |
| Pimmit Run P1 | 0 | | 31 | 1 | 342 | 59 | 4 | 0 | 0 |
| Pimmit Run P2 | 0 | 75 | 31 | 2 | 242 | 5 | 4 | 0 | 0 |
| Pimmit Run P3 | 0 | 20 | 3 | 0 | 336 | 3 | 0 | 0 | 0 |
| Gulf Branch P1 | 0 | 7 | 1 | 0 | 311 | 8 | 3 | 0 | 0 |
| Gulf Branch P2 | 0 | 4 | 0 | 0 | 369 | 110 | 3 | 0 | 0 |
| Gulf Branch P3 | 0 | 6 | 0 | 0 | 480 | 76 | 1 | 0 | 0 |
| Donaldson P1 | 0 | 186 | 49 | 0 | 154 | 64 | 9 | 0 | 1 |
| Donaldson P2 | 0 | 114 | 39 | 0 | 118 | 12 | 7 | 6 | 0 |
| Donaldson P3 | 0 | 78 | 25 | 0 | 58 | 9 | 4 | 1 | 0 |
| Spout Run P1 | 0 | 108 | 0 | 0 | 184 | 1 | 3 | 0 | 0 |
| Spout Run P2 | 0 | 26 | 0 | 0 | 107 | 0 | 1 | 0 | 0 |
| Spout Run P3 | 0 | 40 | 0 | 0 | 116 | 0 | 6 | 0 | 44 |
| Windy Run P1 | 0 | 77 | 12 | 0 | 26 | 12 | 6 | 0 | 1 |
| Windy Run P2 | 0 | 63 | 9 | 0 | 35 | 10 | 2 | 0 | 1 |
| Windy Run P3 | 0 | 67 | 3 | 0 | 24 | 5 | 3 | 0 | 0 |
| Difficult Run P1 | 0 | 191 | 83 | 70 | 23 | 0 | 0 | 0 | 0 |
| Difficult Run P2 | 3 | 35 | 52 | 82 | 25 | 0 | 2 | 0 | 2 |
| Difficult Run P3 | 1 | 108 | 41 | 18 | 22 | 1 | 3 | 0 | 0 |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Clams** | **Other Organisms** | **Define Other Organism** | **Total Organisms** | **Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies** | **Metric 2 - Percent Common Netspinners** | **Metric 3 - Percent Lunged Snails** | **Metric 4 - Percent Beetles** | **Metric 5 - Percent Tolerant** |
| Mine Run P1 | 2 | | | 1003 | 21.335992 | 42.671984 | 0 | 15.154536 | 19.242273 |
| Mine Run P2 | 7 | | | 619 | 34.410339 | 31.987076 | 0 | 14.054927 | 19.386107 |
| Mine Run P3 | 2 | | | 277 | 12.99639 | 25.631769 | 0 | 23.104693 | 37.906137 |
| Turkey Run P1 | 0 | | | 344 | 11.627907 | 19.186047 | 0 | 0.5813953 | 67.151163 |
| Turkey Run P2 | 0 | | | 304 | 11.513158 | 13.157895 | 0 | 1.9736842 | 70.723684 |
| Turkey Run P3 | 0 | | | 251 | 5.5776892 | 8.7649402 | 0 | 1.5936255 | 82.868526 |
| Dead Run P1 | 0 | | | 238 | 0.4201681 | 0.8403361 | 0 | 0 | 98.319328 |
| Dead Run P2 | 0 | 0 | 0 | 399 | 2.5062657 | 18.045113 | 0 | 0 | 78.696742 |
| Dead Run P3 | 0 | | | 556 | 1.9784173 | 9.352518 | 0 | 0 | 87.589928 |
| Pimmit Run P1 | 0 | 0 | | 614 | 6.3517915 | 15.472313 | 0 | 0.1628664 | 77.361564 |
| Pimmit Run P2 | 0 | | | 424 | 12.971698 | 17.688679 | 0 | 0.4716981 | 67.924528 |
| Pimmit Run P3 | 0 | | | 396 | 4.5454545 | 5.0505051 | 0 | 0 | 90.40404 |
| Gulf Branch P1 | 0 | | | 389 | 0.2570694 | 1.7994859 | 0 | 0 | 97.172237 |
| Gulf Branch P2 | 0 | | | 505 | 0.990099 | 0.7920792 | 0 | 0 | 97.623762 |
| Gulf Branch P3 | 0 | | | 582 | 0 | 1.0309278 | 0 | 0 | 98.797251 |
| Donaldson P1 | 0 | | | 600 | 18.333333 | 31 | 0.1666667 | 0 | 49.166667 |
| Donaldson P2 | 0 | | | 539 | 43.599258 | 21.150278 | 0 | 0 | 32.83859 |
| Donaldson P3 | 1 | | | 331 | 47.129909 | 23.564955 | 0 | 0 | 27.794562 |
| Spout Run P1 | 0 | | | 527 | 10.815939 | 20.493359 | 0 | 0 | 68.121442 |
| Spout Run P2 | 0 | | | 231 | 31.168831 | 11.255411 | 0 | 0 | 57.142857 |
| Spout Run P3 | 0 | | | 401 | 32.668329 | 9.9750623 | 10.972569 | 0 | 55.610973 |
| Windy Run P1 | 0 | | | 257 | 22.178988 | 29.961089 | 0.3891051 | 0 | 45.525292 |
| Windy Run P2 | 0 | | | 223 | 14.349776 | 28.251121 | 0.4484305 | 0 | 56.053812 |
| Windy Run P3 | 0 | | | 223 | 11.659193 | 30.044843 | 0 | 0 | 56.950673 |
| Difficult Run P1 | 0 | | | 511 | 40.508806 | 37.377691 | 0 | 13.69863 | 8.4148728 |
| Difficult Run P2 | 0 | | | 313 | 38.977636 | 11.182109 | 0.6389776 | 26.198083 | 21.405751 |
| Difficult Run P3 | 0 | | | 236 | 24.576271 | 45.762712 | 0 | 7.6271186 | 20.338983 |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | |
|---|---|---|---|---|
| **Stream** | **Metric 6 - Percent Non-Insect** | **Score** | **Ecological Conditions** | **Fish Water Quality Indicators** |
| Mine Run P1 | 2.2931206 | 9 | Acceptable | Scattered Individuals |
| Mine Run P2 | 10.662359 | 10 | Acceptable | Scattered Individuals |
| Mine Run P3 | 7.2202166 | 8 | Acceptable | Scattered Individuals |
| Turkey Run P1 | 14.825581 | 5 | Unacceptable | Scattered Individuals |
| Turkey Run P2 | 23.355263 | 4 | Unacceptable | Scattered Individuals/Scattered School |
| Turkey Run P3 | 10.756972 | 5 | Unacceptable | Scattered Individuals |
| Dead Run P1 | 8.4033613 | 5 | Unacceptable | Scattered Individuals |
| Dead Run P2 | 4.2606516 | 6 | Unacceptable | Scattered Individuals |
| Dead Run P3 | 28.776978 | 4 | Unacceptable | Scattered Individuals |
| Pimmit Run P1 | 12.052117 | 5 | Unacceptable | No Fish |
| Pimmit Run P2 | 9.6698113 | 5 | Unacceptable | No Fish |
| Pimmit Run P3 | 4.7979798 | 6 | Unacceptable | No Fish |
| Gulf Branch P1 | 15.167095 | 5 | Unacceptable | No Fish |
| Gulf Branch P2 | 2.7722772 | 6 | Unacceptable | No Fish |
| Gulf Branch P3 | 3.2646048 | 6 | Unacceptable | Scattered Individuals |
| Donaldson P1 | 12.833333 | 6 | Unacceptable | No Fish |
| Donaldson P2 | 9.8330241 | 8 | Acceptable | No Fish |
| Donaldson P3 | 7.8549849 | 8 | Acceptable | No Fish |
| Spout Run P1 | 33.017078 | 3 | Unacceptable | No Fish |
| Spout Run P2 | 10.822511 | 7 | Acceptable | No Fish |
| Spout Run P3 | 26.932668 | 5 | Unacceptable | No Fish |
| Windy Run P1 | 30.7393 | 5 | Unacceptable | No Fish |
| Windy Run P2 | 36.32287 | 3 | Unacceptable | No Fish |
| Windy Run P3 | 43.946188 | 4 | Unacceptable | No Fish |
| Difficult Run P1 | 3.9138943 | 10 | Acceptable | Scattered Individuals |
| Difficult Run P2 | 13.41853 | 10 | Acceptable | Scattered Individuals |
| Difficult Run P3 | 10.169492 | 8 | Acceptable | Scattered Individuals |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | | | |
|---|---|---|---|---|---|---|
| **Stream** | **Barriers to Fish Movement** | **Surface-water appearance** | **Stream Bed Deposit** | **Odor** | **Stability of stream** | **Algae Color** |
| Mine Run P1 | No Barriers | Clear | Brown/Tan | No Odor | No Spots | Brown Coated |
| Mine Run P2 | No Barriers | Clear | Brown/Tan | Sewage | No Spots | Brown Coated |
| Mine Run P3 | No Barriers | Clear | Brown/Tan/Sandy | No Odor | No Spots | Brown Coated |
| Turkey Run P1 | No Barriers | Clear | Brown/Tan/Silty | No Odor | A Few Spots | Dark Green/Brown Coated |
| Turkey Run P2 | No Barriers | Clear | Brown/Tan/Silty/Sandy | No Odor | A Few Spots | Dark Green/Brown Coated |
| Turkey Run P3 | No Barriers | Clear | Brown/Tan/Silty | No Odor | A Few Spots | Brown Coated |
| Dead Run P1 | Waterfalls | Clear | Brown/Tan/Sandy | No Odor | A Few Spots | Brown Coated |
| Dead Run P2 | Waterfalls | Clear | Black/Brown/Tan/Sandy | No Odor | No Spots | Brown Coated |
| Dead Run P3 | Waterfalls | Clear | Brown/Tan/Sandy | No Odor | A Few Spots | Brown Coated |
| Pimmit Run P1 | None | Clear | Brown/Tan/Sandy | No Odor | No Spots | Dark Green and Brown Coated |
| Pimmit Run P2 | No Barriers | Clear | Brown/Tan/Sandy | No Odor | No Spots | Brown Coated |
| Pimmit Run P3 | No Barriers | Clear | Brown/Tan/Sandy | No Odor | No Spots | Brown Coated |
| Gulf Branch P1 | Waterfalls | Clear | Brown/Tan/Sandy | No Odor | No Spots | Brown Coated |
| Gulf Branch P2 | No Barriers | Claer | Brown/Tan/Sandy | No Odor | No Spots | Brown Coated |
| Gulf Branch P3 | No Barriers | Clear | Brown/Tan/Sandy | No Odor | No Spots | Brown Coated |
| Donaldson P1 | Waterfalls | Clear | Brown/Tan | No Odor | A Few Spots | Brown Coated |
| Donaldson P2 | Waterfalls | Clear | Brown/Tan | No Odor | A Few Spots | Dark Green & Brown Coated |
| Donaldson P3 | Waterfalls | Clear | Brown/Tan | No Odor | No Spots | Dark Green & Brown Coated |
| Spout Run P1 | Waterfalls | Clear | Brown/Tan | No Odors | No Spots | Brown Coated |
| Spout Run P2 | None | Clear | Brown/Tan | No Odor | No Spots | Brown Coated |
| Spout Run P3 | No Barriers | Clear | Brown/Tan | No Odor | No Spots | Brown Coated |
| Windy Run P1 | Waterfalls | Clear | Brown/Tan/Sandy | No Odor | No Spots | No Algae |
| Windy Run P2 | Waterfalls | Clear | Brown/Tan | No Odor | No Spots | No Algae |
| Windy Run P3 | Waterfalls | Clear | Brown/Tan | No Odor | No Spots | None |
| Difficult Run P1 | Waterfalls | Cloudy/Turbid | Brown/Tan | No Odor | No Spots | Brown Coated |
| Difficult Run P2 | Waterfalls | Cloudy/Turbid | Brown/Tan | No Odor | No Spots | Dark Green/Hairy |
| Difficult Run P3 | Waterfalls | Cloudy/Turbid | Brown/Tan | No Odor | No Spots | Brown Coated |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | | | |
|---|---|---|---|---|---|---|
| **Stream** | **Algae located** | **Percent algae** | **Stream shade** | **% Silt** | **% Sand** | **% Gravel** |
| Mine Run P1 | In Spots | 30 | Moderate | 0 | 0 | 30 |
| Mine Run P2 | In spots | 30 | Moderate | 0 | 0 | 30 |
| Mine Run P3 | In Spots | 20 | Moderate | 0 | 10 | 70 |
| Turkey Run P1 | In Spots | | Moderate | 30 | 30 | 15 |
| Turkey Run P2 | In Spots | 45 | Moderate | 30 | 35 | 20 |
| Turkey Run P3 | In Spots | 10 | Moderate | 25 | 5 | 20 |
| Dead Run P1 | In Spots | 60 | Moderate | 0 | 10 | 20 |
| Dead Run P2 | Everywhere | | Moderate | 0 | 0 | 0 |
| Dead Run P3 | In Spots | 30 | Moderate | 0 | 0 | 50 |
| Pimmit Run P1 | In Spots | 50 | Full | 0 | 10 | 25 |
| Pimmit Run P2 | In Spots | 45 | Moderate | 0 | 10 | 45 |
| Pimmit Run P3 | in spots | 30 | Full | 0 | 10 | 60 |
| Gulf Branch P1 | In Spots | 40 | Moderate | 0 | 25 | 40 |
| Gulf Branch P2 | In Spots | 50 | Moderate | 0 | 0 | 0 |
| Gulf Branch P3 | In Spots | 50 | Moderate | 0 | 10 | 50 |
| Donaldson P1 | In Spots | 20 | Moderate | 0 | 0 | 10 |
| Donaldson P2 | In Spots | 60 | Moderate | 0 | 0 | 50 |
| Donaldson P3 | In Spots | 50 | High | 0 | 35 | 35 |
| Spout Run P1 | In Spots | 50 | High | 0 | 0 | 10 |
| Spout Run P2 | In Spots | 50 | High | 0 | 0 | 5 |
| Spout Run P3 | In Spots | 70 | Moderate | 0 | 0 | 10 |
| Windy Run P1 | | | High | 0 | 10 | 70 |
| Windy Run P2 | | | Full | 0 | 5 | 10 |
| Windy Run P3 | | | Full | 0 | 0 | 0 |
| Difficult Run P1 | Everywhere | | High | 0 | 0 | 0 |
| Difficult Run P2 | In Spots | 50 | Slight | 0 | 0 | 0 |
| Difficult Run P3 | Everywhere | | Slight | 0 | 0 | 100 |

# Appendix 9: 2008 Data Collection

| Round 2 | | | | | |
|---|---|---|---|---|---|
| | % Cobbles | Stream channel erosion potential | Area 1 | Area 2 | Area 3 |
| Mine Run P1 | 70 | Moderate | 3x2 | | |
| Mine Run P2 | 70 | Moderate | 3x1 | | |
| Mine Run P3 | 20 | High | 3x1 | | |
| Turkey Run P1 | 25 | High | 3x2 | | |
| Turkey Run P2 | 15 | High | 3x2 | | |
| Turkey Run P3 | 50 | High | 3x2 | | |
| Dead Run P1 | 70 | High | 3x3 | | |
| Dead Run P2 | 70 | High | 3x3 | | |
| Dead Run P3 | 50 | High | 3x3 | | |
| Pimmit Run P1 | 65 | Severe | 3x3 | | |
| Pimmit Run P2 | 45 | Severe | 3x3 | | |
| Pimmit Run P3 | 30 | Severe | 3x3 | | |
| Gulf Branch P1 | 35 | High | 3x3 | | |
| Gulf Branch P2 | 100 | High | 3x2 | | |
| Gulf Branch P3 | 40 | High | 3x2 | | |
| Donaldson Run P1 | 90 | Severe | 3x2 | | |
| Donaldson Run P2 | 50 | Severe | 3x2 | | |
| Donaldson Run P3 | 30 | High | 3x1 | | |
| Spout Run P1 | 90 | Severe | 3x2 | | |
| Spout Run P2 | 95 | Severe | 3x1 | | |
| Spout Run P3 | 90 | Severe | 3x2 | | |
| Windy Run P1 | 20 | High | 3x3 | 3x3 | 3x2 |
| Windy Run P2 | 85 | Severe | 3x3 | 3x3 | |
| Windy Run P3 | 100 | High | 3x3 | | |
| Difficult Run P1 | 100 | High | 3x1 | | |
| Difficult Run P2 | 100 | High | 3x1 | 3x1 | |
| Difficult Run P3 | 100 | High | 3x1 | | |

# Appendix 9: 2008 Data Collection

| Round 3 | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Latitude** | **Longitude** | **Description** | **Date** | **Name of Certified Monitor** |
| Mine Run P1 | 39 | 77.26 | 5m downstream from road | 7/2/2008 | Rachel Buedel, Megan Bauer |
| Mine Run P2 | 39 | 77.26 | 15m upstream from road | 7/2/2008 | Rachel Buedel and Megan Bauer |
| Mine Run P3 | 39 | 77.26 | 25m upstream from road | 7/7/2008 | Rachel Buedel and Megan Bauer |
| Turkey Run P1 | 38 | 77.16 | base of Switchback trail | 7/15/2008 | Rachel Buedel and Megan Bauer |
| Turkey Run P2 | 38 | 77.16 | 100m downstream from GW Pkwy | 7/15/2008 | Rachel Buedel and Megan Bauer |
| Turkey Run P3 | 38 | 77.16 | 50m downstream from GW Pkwy | 7/15/2008 | Rachel Buedel and Megan Bauer |
| Dead Run P1 | 39 | 77.17 | 15-20m upstream from mouth | 7/16/2008 | Rachel Buedel and Megan Bauer |
| Dead Run P2 | 39 | 77.17 | 50 m downstream | 7/16/2008 | Rachel Buedel and Megan Bauer |
| Dead Run P3 | 39 | 77.17 | 70m downstream of GW Pkwy bridge, below falls | 7/29/2008 | Rachel Buedel and Megan Bauer |
| Pimmit Run P1 | 39 | 77.12 | 30 meters upstream Glebe Road Route 123 Bridge | 7/22/2008 | Rachel Buedel and Megan Bauer |
| Pimmit Run P2 | 39 | 77.12 | 50 meters upstream Glebe Road, Route 123 Bridge | 7/29/2008 | Rachel Buedel and Megan Bauer |
| Pimmit Run P3 | 39 | 77.12 | 80 meters upstream Glebe Road, Route 123 Bridge | 7/29/2008 | Rachel Buedel and Megan Bauer |
| Gulf Branch P1 | 39 | 77.11 | 50m downstream from GW Pkwy | 7/14/2008 | Rachel Buedel and Megan Bauer |
| Gulf Branch P2 | 39 | 77.11 | directly under bridge | 7/14/2008 | Rachel Buedel and Megan Bauer |
| Gulf Branch P3 | 39 | 77.11 | 15 m upstream from bridge | 7/14/2008 | Rachel Buedel and Megan Bauer |
| Donaldson P1 | 39 | 77.11 | 10m upstream from mouth | 7/21/2008 | Rachel Buedel and Megan Bauer |
| Donaldson P2 | 39 | 77.11 | beneath GW Parkway bridge | 7/21/2008 | Rachel Buedel and Megan Bauer |
| Donaldson P3 | 39 | 77.11 | 15m upstream from GW parkway | 7/21/2008 | Rachel Buedel and Megan Bauer |
| Spout Run P1 | 39 | 77.08 | next to drainage pipe, off Spout Run Pkwy, under GW | 7/25/2008 | Rachel Buedel and Megan Bauer |
| Spout Run P2 | 39 | 77.08 | 200 m upstream from P1 | 7/25/2008 | Rachel Buedel and Megan Bauer |
| Spout Run P3 | 39 | 77.09 | below Spout Run, ~50 m upstream of 2nd drainage pipe | 7/25/2008 | Rachel Buedel and Megan Bauer |

# Appendix 9: 2008 Data Collection

| Round 3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Avg stream width** | **Average stream depth** | **Flow rate** | **Weather last 72 hours** | **Water Temp** | **Collect. Time (net1)** | **Collect. Time (net2)** | **Collection Time (net3)** | **Collection Time (net4)** |
| Mine Run P1 | 12 | 1.9 | Normal | Rain, today very pleasant and sunny | 19.5 | 30 | | | |
| Mine Run P2 | 10 | 3.4 | Normal | Rain | 20.6 | 30 | | | |
| Mine Run P3 | 16 | 2.8 | High | humid, thunderstorms | 21.6 | 30 | | | |
| Turkey Run P1 | 24 | 1.7 | Normal | Rain two days ago, now nice weather | 20.1 | 60 | | | |
| Turkey Run P2 | 8 | 2.4 | Normal | rain heavy on 7/13; now sunny and cool temps | 22.3 | 30 | | | |
| Turkey Run P3 | 13 | 3.3 | Normal | Rain heavy 7/13; today sunny with cool temps | 22 | 30 | | | |
| Dead Run P1 | 9 | 6.2 | High | Sun | 22 | 60 | 90 | | |
| Dead Run P2 | 15 | 3.7 | Normal | Sun | 23.7 | 90 | | | |
| Dead Run P3 | 3 | 3 | Normal | hot, humid, light rain | 22.2 | 90 | | | |
| Pimmit Run P1 | 26 | 7.1 | Normal | hot, humid | 24.3 | 30 | | | |
| Pimmit Run P2 | 22 | 5 | Normal | hot, humid, light rain | 23.6 | 30 | | | |
| Pimmit Run P3 | 29 | 6.2 | Normal | hot, humid, light rain | 24.8 | 30 | | | |
| Gulf Branch P1 | 14 | 5.4 | High | Rain, Thunderstorms | 22.5 | 30 | | | |
| Gulf Branch P2 | 9 | 3 | High | Rain, Thunderstorms | 22.6 | 30 | | | |
| Gulf Branch P3 | 8 | 5.2 | High | Rain, Thunderstorms | 23.2 | 30 | | | |
| Donaldson P1 | 31 | 5 | Normal | Hot & Humid | 23.1 | 30 | | | |
| Donaldson P2 | 9 | 5.3 | Normal | hot & Humid | 23 | 30 | | | |
| Donaldson P3 | 4 | 3.9 | Normal | Hot and Humid | 23.5 | 60 | | | |
| Spout Run P1 | 12 | 8.2 | Normal | Humid, heavy rain & thunderstorms | 21.4 | 90 | | | |
| Spout Run P2 | 10 | 5.2 | Normal | humid, heavy rain, thunderstorms | 22.4 | 30 | 60 | | |
| Spout Run P3 | 18 | 6.6 | Normal | humid, heavy rain and thunderstorms | 23.8 | 90 | 90 | | |

# Appendix 9: 2008 Data Collection

| Round 3 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **First Page Comments** | **Worms** | **Flatworms** | **Leeches** | **Crayfish** | **Sowbugs** | **Scuds** | **Stoneflies** | **Mayflies** | **Dragonflies and Damselflies** |
| Mine Run P1 | | 15 | 11 | 0 | 0 | 1 | 2 | 10 | 13 | 3 |
| Mine Run P2 | Salamanders! | 7 | 4 | 0 | 2 | 2 | 1 | 37 | 12 | 6 |
| Mine Run P3 | Downstream from Flag; salamander | 56 | 5 | 0 | 1 | 1 | 6 | 28 | 19 | 3 |
| Turkey Run P1 | | 34 | 1 | 0 | 0 | 0 | 2 | 1 | 26 | 0 |
| Turkey Run P2 | | 48 | 0 | 0 | 3 | 0 | 6 | 1 | 33 | 0 |
| Turkey Run P3 | | 7 | 0 | 0 | 2 | 0 | 2 | 3 | 18 | 0 |
| Dead Run P1 | | 47 | 0 | 0 | 0 | 1 | 2 | 0 | 57 | 0 |
| Dead Run P2 | | 45 | 0 | 0 | 1 | 0 | 1 | 0 | 7 | 0 |
| Dead Run P3 | | 42 | 1 | 0 | 0 | 1 | 0 | 0 | 4 | 0 |
| Pimmit Run P1 | | 131 | 70 | 0 | 0 | 3 | 1 | 0 | 83 | 0 |
| Pimmit Run P2 | | 27 | 12 | 0 | 0 | 1 | 0 | 0 | 36 | 0 |
| Pimmit Run P3 | | 18 | 23 | 0 | 0 | 4 | 1 | 0 | 22 | 0 |
| Gulf Branch P1 | | 26 | 8 | 0 | 0 | 2 | 1 | 0 | 19 | 0 |
| Gulf Branch P2 | Horsehair worm found in net | 31 | 23 | 0 | 0 | 6 | 1 | 0 | 3 | 0 |
| Gulf Branch P3 | | 33 | 12 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Donaldson P1 | | 83 | 7 | 0 | 1 | 0 | 0 | 0 | 59 | 0 |
| Donaldson P2 | Horse hair worms collected; and when cleaning net a dragonfly nymph swam into net | 43 | 30 | 0 | 1 | 0 | 2 | 0 | 94 | 0 |
| Donaldson P3 | Saw a really big eel under the waterfall! | 87 | 8 | 0 | 0 | 0 | 2 | 0 | 29 | 0 |
| Spout Run P1 | | 61 | 68 | 0 | 0 | 2 | 2 | 0 | 136 | 0 |
| Spout Run P2 | | 41 | 46 | 0 | 0 | 0 | 8 | 0 | 38 | 0 |
| Spout Run P3 | | 14 | 2 | 1 | 0 | 2 | 1 | 0 | 85 | 0 |

# Appendix 9: 2008 Data Collection

| Round 3 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Hellgrammites, Fishflies, and Alderflies** | **Common Netspinners** | **Most Caddisflies** | **Beetles** | **Midges** | **Blackflies** | **Most True Flies** | **Gilled Snails** | **Lunged Snails** | **Clams** | **Other Organisms** |
| Mine Run P1 | 3 | 202 | 81 | 58 | 45 | 53 | 6 | 0 | 1 | 0 | |
| Mine Run P2 | 8 | 145 | 25 | 59 | 6 | 3 | 3 | 0 | 1 | 5 | |
| Mine Run P3 | 8 | 63 | 8 | 35 | 87 | 0 | 8 | 0 | 0 | 0 | |
| Turkey Run P1 | 0 | 320 | 41 | 3 | 52 | 2 | 9 | 0 | 0 | 0 | |
| Turkey Run P2 | 0 | 90 | 9 | 6 | 142 | 0 | 3 | 0 | 0 | 0 | |
| Turkey Run P3 | 0 | 74 | 126 | 1 | 78 | 37 | 6 | 0 | 0 | 0 | |
| Dead Run P1 | 0 | 46 | 4 | 4 | 137 | 2 | 10 | 0 | 6 | 0 | |
| Dead Run P2 | 0 | 36 | 1 | 0 | 140 | 8 | 1 | 0 | 0 | 0 | |
| Dead Run P3 | 0 | 70 | 57 | 0 | 29 | 9 | 4 | 0 | 2 | 0 | |
| Pimmit Run P1 | 1 | 100 | 101 | 0 | 40 | 22 | 3 | 0 | 0 | 0 | |
| Pimmit Run P2 | 0 | 186 | 32 | 1 | 7 | 0 | 5 | 0 | 1 | 0 | |
| Pimmit Run P3 | 0 | 196 | 112 | 2 | 12 | 0 | 3 | 0 | 0 | 0 | |
| Gulf Branch P1 | 0 | 5 | 0 | 0 | 133 | 15 | 5 | 0 | 0 | 0 | |
| Gulf Branch P2 | 0 | 8 | 0 | 0 | 376 | 52 | 3 | 0 | 1 | 0 | |
| Gulf Branch P3 | 0 | 18 | 0 | 0 | 379 | 149 | 0 | 0 | 1 | 0 | |
| Donaldson P1 | 0 | 103 | 27 | 0 | 21 | 16 | 4 | 0 | 0 | 0 | |
| Donaldson P2 | 0 | 56 | 19 | 0 | 33 | 0 | 4 | 0 | 0 | 0 | |
| Donaldson P3 | 0 | 50 | 2 | 0 | 47 | 0 | 6 | 0 | 32 | 0 | 0 |
| Spout Run P1 | 0 | 183 | 1 | 0 | 50 | 0 | 5 | 0 | 1 | 0 | |
| Spout Run P2 | 0 | 44 | 0 | 0 | 25 | 0 | 3 | 0 | 0 | 0 | |
| Spout Run P3 | 0 | 61 | 0 | 0 | 33 | 1 | 4 | 0 | 2 | 0 | |

# Appendix 9: 2008 Data Collection

| Round 3 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Define Other Organism** | **Total Organisms** | **Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies** | **Metric 2 - Percent Common Netspinners** | **Metric 3 - Percent Lunged Snails** | **Metric 4 - Percent Beetles** | **Metric 5 - Percent Tolerant** | **Metric 6 - Percent Non-Insect** | **Score** | **Ecological Conditions** |
| Mine Run P1 | | 504 | 20.634921 | 40.079365 | 0.1984127 | 11.507937 | 25.992063 | 5.952381 | 8 | Acceptable |
| Mine Run P2 | | 326 | 22.699387 | 44.478528 | 0.3067485 | 18.09816 | 10.736196 | 6.7484663 | 7 | Acceptable |
| Mine Run P3 | | 328 | 16.768293 | 19.207317 | 0 | 10.670732 | 48.170732 | 21.036585 | 8 | Acceptable |
| Turkey Run P1 | | 491 | 13.849287 | 65.173116 | 0 | 0.610998 | 18.533605 | 7.5356415 | 5 | Unacceptable |
| Turkey Run P2 | | 341 | 12.609971 | 26.392962 | 0 | 1.7595308 | 57.478006 | 16.715543 | 5 | Unacceptable |
| Turkey Run P3 | | 354 | 41.525424 | 20.903955 | 0 | 0.2824859 | 35.028249 | 3.1073446 | 9 | Acceptable |
| Dead Run P1 | | 316 | 19.303797 | 14.556962 | 1.8987342 | 1.2658228 | 61.708861 | 17.721519 | 4 | Unacceptable |
| Dead Run P2 | | 240 | 3.3333333 | 15 | 0 | 0 | 80.833333 | 19.583333 | 5 | Unacceptable |
| Dead Run P3 | | 219 | 27.853881 | 31.96347 | 0.913242 | 0 | 38.356164 | 21.004566 | 5 | Unacceptable |
| Pimmit Run P1 | | 555 | 33.153153 | 18.018018 | 0 | 0 | 48.108108 | 36.936937 | 7 | Acceptable |
| Pimmit Run P2 | | 308 | 22.077922 | 60.38961 | 0.3246753 | 0.3246753 | 15.584416 | 13.311688 | 5 | Unacceptable |
| Pimmit Run P3 | | 393 | 34.096692 | 49.872774 | 0 | 0.5089059 | 14.75827 | 11.704835 | 7 | Acceptable |
| Gulf Branch P1 | | 214 | 8.8785047 | 2.3364486 | 0 | 0 | 86.448598 | 17.28972 | 5 | Unacceptable |
| Gulf Branch P2 | | 504 | 0.5952381 | 1.5873016 | 0.1984127 | 0 | 97.222222 | 12.301587 | 5 | Unacceptable |
| Gulf Branch P3 | | 593 | 0 | 3.0354132 | 0.1686341 | 0 | 96.964587 | 7.925801 | 5 | Unacceptable |
| Donaldson P1 | | 321 | 26.791277 | 32.087227 | 0 | 0 | 39.563863 | 28.34891 | 6 | Acceptable |
| Donaldson P2 | | 282 | 40.070922 | 19.858156 | 0 | 0 | 38.297872 | 26.950355 | 7 | Acceptable |
| Donaldson P3 | 0 | 263 | 11.787072 | 19.011407 | 12.1673 | 0 | 66.920152 | 49.04943 | 2 | Unacceptable |
| Spout Run P1 | | 509 | 26.915521 | 35.952849 | 0.1964637 | 0 | 36.149312 | 26.32613 | 5 | Unacceptable |
| Spout Run P2 | | 205 | 18.536585 | 21.463415 | 0 | 0 | 58.536585 | 46.341463 | 5 | Unacceptable |
| Spout Run P3 | | 206 | 41.262136 | 29.61165 | 0.9708738 | 0 | 27.184466 | 10.679612 | 7 | Acceptable |

# Appendix 9: 2008 Data Collection

| Round 3 | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Fish Water Quality Indicators** | **Barriers to Fish Movement** | **Surface-water appearance** | **Stream Bed Deposit** | **Odor** |
| Mine Run P1 | Scattered Individuals | No Barriers | Clear | Brown/Tan | Sewage off and on |
| Mine Run P2 | Scattered Individuals | No Barriers | Clear | brown/tan | occasional sewage |
| Mine Run P3 | Scattered Individuals | No Barriers | Clear | Brown/Tan | No Odor |
| Turkey Run P1 | Scattered Individuals | None | Clear | Brown/Tan/Silty/Muddy | None |
| Turkey Run P2 | Scattered Individuals/ Scattered Schools | No Barriers | Clear | Brown/Tan/Sandy | No Odor |
| Turkey Run P3 | Scattered Individuals | No Barriers | Clear | Brown/Tan/Sandy | No Odor |
| Dead Run P1 | Scattered Individuals | None | Clear, but tea-colored | Brown/Tan/Sandy | None |
| Dead Run P2 | Scattered Individuals | No Barriers | Clear But Tea Colored | Brown/tan/Black/Silty/Muddy | No Odor |
| Dead Run P3 | Scattered Individuals | Waterfalls | Clear but tea-colored | Brown/Tan/Sandy | No Odor |
| Pimmit Run P1 | Scattered Individuals | No Barriers | Clear | Brown/Tan | No Odor |
| Pimmit Run P2 | Scattered Individuals | No Barriers | Clear | Brown/Tan/Sandy | No Odor |
| Pimmit Run P3 | Scattered Individuals | No Barriers | Clear | Brown/Tan/Sandy | No Odor |
| Gulf Branch P1 | No Fish | Waterfalls | Clear but tea-colored | Brown/Tan | No Odor |
| Gulf Branch P2 | No Fish | Waterfalls | Clear but tea-colored | Brown/Tan | No Odor |
| Gulf Branch P3 | No Fish | Waterfalls | Clear but tea colored | Brown/Tan | No Odor |
| Donaldson P1 | Scattered Individuals | Waterfalls | Clear | Brown/Tan | No Odor |
| Donaldson P2 | Scattered Individuals | Waterfalls | Clear | Brown/Tan | No Odor |
| Donaldson P3 | Scattered Individuals | Waterfalls | Clear | Brown/Tan/Sandy | No Odor |
| Spout Run P1 | No Fish | Waterfalls | Clear | Brown/Tan | No Odor |
| Spout Run P2 | No Fish | Waterfalls | Clear | Brown/Tan | No Odor |
| Spout Run P3 | No Fish | No Barriers | Clear | Brown/Tan | Sewage |

# Appendix 9: 2008 Data Collection

| Round 3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Stability of stream** | **Algae Color** | **Algae located** | **Percent algae** | **Stream shade** | **% Silt** | **% Sand** | **% Gravel** | **% Cobbles** |
| Mine Run P1 | No Spots | | | | High | 0 | 0 | 25 | 75 |
| Mine Run P2 | no spots | brown coated | everywhere | | Full | 0 | 0 | 30 | 70 |
| Mine Run P3 | No Spots | Brown Coated | Everywhere | 100 | Moderate | 0 | 0 | 50 | 50 |
| Turkey Run P1 | A Few Spots | Brown Coated | In Spots | 35 | High | 0 | 30 | 40 | 30 |
| Turkey Run P2 | A Few Spots | Brown Coated | In Spots | 10 | Moderate | 0 | 0 | 70 | 30 |
| Turkey Run P3 | A Few Spots | Matted on Stream Bed/Brown Coated | In Spots | 25 | High | 0 | 0 | 50 | 50 |
| Dead Run P1 | A Few Spots | Brown Coated | In Spots | 40 | High | 0 | 0 | 30 | 70 |
| Dead Run P2 | A Few Spots | Brown Coated | Everywhere | 100 | High | 0 | 20 | 70 | 10 |
| Dead Run P3 | A Few Spots | Brown Coated | In Spots | 70 | High | 0 | 30 | 20 | 50 |
| Pimmit Run P1 | No Spots | Brown Coated | In Spots | 30 | Moderate | 0 | 0 | 20 | 80 |
| Pimmit Run P2 | A Few Spots | Brown Coated | Everywhere | 80 | High | 0 | 10 | 40 | 50 |
| Pimmit Run P3 | A Few Spots | Brown Coated | Everywhere | 70 | High | 0 | 0 | 20 | 80 |
| Gulf Branch P1 | No Spots | Dark Green | In Spots | 20 | High | 0 | 0 | 0 | 100 |
| Gulf Branch P2 | No Spots | Dark Green | In Spots | 35 | High | 0 | 0 | 40 | 60 |
| Gulf Branch P3 | No Spots | Dark Green | In Spots | 20 | High | 0 | 0 | 0 | 100 |
| Donaldson P1 | No Spots | Brown Coated | In Spots | 10 | High | 0 | 0 | 30 | 70 |
| Donaldson P2 | No Spots | Brown Coated | In Spots | 10 | High | 0 | 0 | 60 | 40 |
| Donaldson P3 | A Few Spots | Brown Coated | In Spots | 5 | High | 0 | 0 | 80 | 20 |
| Spout Run P1 | No Spots | Brown Coated | In Spots | 50 | Full | 0 | 0 | 0 | 100 |
| Spout Run P2 | No Spots | Brown Coated | In Spots | 95 | Full | 0 | 0 | 20 | 80 |
| Spout Run P3 | No Spots | Brown Coated | Everywhere | 100 | HIgh | 0 | 0 | 50 | 50 |

# Appendix 9: 2008 Data Collection

| **Round 3** | | | | | |
|---|---|---|---|---|---|
| **Stream** | **Stream channel erosion potential** | **Area 1** | **Area 2** | **Area 3** | **Area 4** |
| Mine Run P1 | Severe | 3x1 | | | |
| Mine Run P2 | Severe | 3x1 | | | |
| Mine Run P3 | Severe | 3x1 | | | |
| Turkey Run P1 | Severe | 3x2 | | | |
| Turkey Run P2 | Severe | 3x1 | | | |
| Turkey Run P3 | Severe | 3x1 | | | |
| Dead Run P1 | Severe | 3x2 | 3x3 | | |
| Dead Run P2 | Severe | 3x3 | | | |
| Dead Run P3 | High | 3x3 | | | |
| Pimmit Run P1 | Severe | 3x1 | | | |
| Pimmit Run P2 | Severe | 3x1 | | | |
| Pimmit Run P3 | Severe | 3x1 | | | |
| Gulf Branch P1 | high | 3x1 | | | |
| Gulf Branch P2 | Severe | 3x1 | | | |
| Gulf Branch P3 | High | 3x1 | | | |
| Donaldson P1 | Severe | 3x1 | | | |
| Donaldson P2 | Severe | 3x1 | | | |
| Donaldson P3 | Severe | 3x2 | | | |
| Spout Run P1 | Severe | 3x3 | | | |
| Spout Run P2 | Severe | 3x1 | 3x2 | | |
| Spout Run P3 | Severe | 3x3 | 3x3 | | |

# Appendix 10: Water Chemistry Data
# Round 1, Summer 2008

| Stream Site | Day | Time | Nitrate | Nitrite | pH | Temp | DO % | DO mg/L | Cond. uS | Salinity (ppt) | Turbidity (JTU) | Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mine P1 | 5/27/08 | 9:00 AM | 2.0 | 0 | 7.36 | 18.5 | 86.1 | 8.06 | 117.9/ 134.5 | 0.1 | 5 | 8 |
| Mine P2 | 5/27/08 | 1:20 PM | 2.0 | 0 | 7.38 | 18.9 | 84.7 | 7.81 | 118.2/ 132.7 | 0.1 | 5 | 9 |
| Mine P3 | 5/29/08 | 7:30 AM | | | 7.47 | 14.8 | 91.9 | 9.31 | 107.7/ 133.8 | 0.1 | 5 | 10 |
| Pimmit P1 | 6/2/08 | 7:45 AM | 2.0 | 0 | 7.66 | 18.3 | 86.8 | 8.16 | 219.6/ 252.0 | 0.1 | 5 | 5 |
| Pimmit P2 | 6/2/08 | 10:00 AM | 2.0 | 0 | 7.78 | 20.8 | 85.8 | 7.68 | 234.2/ 254.8 | 0.1 | 5 | 4 |
| Pimmit P3 | 6/2/08 | 12:30 PM | 2.0 | 0 | 7.75 | 22.6 | 86.7 | 7.49 | 192.9/ 202.1 | 0.1 | 0 | 5 |
| Dead P1 | 6/9/08 | *8:40 AM | 5.0 | 0 | 7.79 | 22.4 | 84.4 | 7.33 | 244.7/ 257.9 | 0.1 | 5 | 5 |
| Dead P2 | 6/10/08 | 7:50 AM | 2.0 | 0 | 7.73 | 23 | 81.0 | 6.94 | 247.0/ 256.6 | 0.1 | 5 | 4 |
| Dead P3 | 6/10/08 | 11:15 AM | 2.0 | 0 | 7.63 | 24.9 | 82.8 | 6.92 | 253.4/ 256.4 | 0.1 | 5 | 4 |
| Turkey P1 | 5/28/08 | 1:00 PM | 2.0 | 0 | 7.88 | 16.1 | 86.3 | 8.37 | 290.2/ 350.8 | 0.2 | 5 | 4 |
| Turkey P2 | 6/5/08 | **8:00 AM | 0.5 | 0 | 7.65 | 18 | 89.4 | 8.45 | 172.9/ 199.3 | 0.1 | 10 | 3 |
| Turkey P3 | 6/5/08 | **11:30 AM | 0.5 | 0 | 7.69 | 19.3 | 82.4 | 7.56 | 188.4/ 210.4 | 0.1 | 10 | 4 |
| Donald.P1 | 6/11/08 | 8:00 AM | 5.0 | 0 | 7.62 | 21.9 | 75.4 | 6.60 | 329.5/ 350.5 | 0.2 | 5 | 4 |
| Donald.P2 | 6/11/08 | 11:30 AM | 2.0 | 0 | 7.61 | 22.2 | 73.3 | 6.38 | 335.9/ 355.1 | 0.2 | 5 | 5 |
| Donald.P3 | 6/13/08 | 8:00 AM | 5.0 | 0 | 7.64 | 20.9 | 84.7 | 7.56 | 390.0/ 423.5 | 0.2 | 5 | 5 |
| Gulf P1 | 5/30/08 | 8:30 AM | 5.0 | 0 | 7.42 | 15.9 | 78.5 | 7.76 | 335.9/ 406.8 | 0.2 | 5 | 5 |
| Gulf P2 | 6/3/08 | 8:00 AM | 5.0 | 0 | 7.36 | 16.6 | 74.6 | 6.97 | 353.9/ 403.9 | 0.2 | 0 | 5 |
| Gulf P3 | 6/3/08 | 11:30 AM | 5.0 | 0 | 7.37 | 18.6 | 76.1 | 7.12 | 351.4/ 400.6 | 0.2 | 0 | 5 |
| Spout P1 | 6/13/08 | 11:30 AM | 5.0 | 0 | 7.88 | 23.1 | 82.4 | 7.04 | 570.0/ 591.0 | 0.3 | 0 | 5 |
| Spout P2 | 6/16/08 | 8:30 AM | 5.0 | 0 | 7.74 | 21.2 | 78.4 | 6.95 | 551.0/ 595.0 | 0.3 | 0 | 5 |
| Spout P3 | 6/16/08 | 11:30 AM | 5.0 | 0 | 7.84 | 22.0 | 81.0 | 7.06 | 563.0/ 596.0 | 0.3 | 0 | 4 |
| Windy P1 | 7/9/08 | 9:00 AM | 5.0 | 0 | 7.66 | 21.5 | 74.3 | 6.55 | 458.1/ 491.3 | 0.2 | 0 | 5 |
| Windy P2 | 7/11/08 | 8:00 AM | 5.0 | 0 | 7.60 | 20.4 | 82.4 | 7.32 | 479.0/ 524.0 | 0.3 | 0 | 8 |
| Windy P3 | 7/11/08 | 11:00 AM | 5.0 | 0 | 7.52 | 21.0 | 77.4 | 6.90 | 484.0/ 525.0 | 0.3 | 0 | 3 |
| Difficult P1 | 7/17/08 | 9:00 AM | 0.5 | 0 | 7.81 | 24.4 | 78.5 | 6.56 | 184.3/ 186.7 | 0.1 | 0 | 10 |
| Difficult P2 | 7/17/08 | 12:30 PM | 0.5 | 0 | 7.76 | 25.3 | 81.1 | 6.66 | 188.8/ 187.7 | 0.1 | 0 | 10 |
| Difficult P3 | 7/18/08 | 8:00 AM | 0.5 | 0 | 7.30 | 23.8 | 57.8 | 4.88 | 184.6/ 188.9 | 0.1 | 0 | 8 |

# Appendix 10: Water Chemistry Data
# Round 2, Summer 2008

| Stream Site | Day | Time | Nitrate | Nitrite | pH | Temp | DO % | DO mg/L | Cond. uS | Salinity ppt | Turbidity (JTU) | Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mine P1 | 6/19/08 | 7:30 AM | 0.5 | 0 | 7.44 | 17.4 | 85.0 | 8.15 | 112.4/ 131.4 | 0.1 | 10 | 9 |
| Mine P2 | 6/19/08 | 11:00 AM | 0.5 | 0 | 7.66 | 18.5 | 83.8 | 7.84 | 116.0/ 132.2 | 0.1 | 10 | 10 |
| Mine P3 | 6/20/08 | 1:00 PM | 0.5 | 0 | 7.77 | 20.0 | 86.4 | 7.86 | 123.6/ 136.7 | 0.1 | 0 | 8 |
| Pimmit P1 | 6/17/08 | 1:30 PM | 2.0 | 0 | 7.73 | 23.1 | 85.8 | 7.34 | 164.0/ 170.1 | 0.1 | 10 | 5 |
| Pimmit P2 | 6/20/08 | 11:00 AM | 2.0 | 0 | 7.80 | 18.5 | 91.4 | 8.56 | 250.9/ 286.4 | 0.1 | 0 | 5 |
| Pimmit P3 | 6/18/08 | 8:00 AM | 2.0 | 0 | 7.69 | 18.3 | 84.9 | 7.97 | 187.9/ 215.2 | 0.1 | 5 | 6 |
| Dead P1 | 6/25/08 | 8:00 AM | 2.0 | 0 | 7.69 | 19.4 | 76.5 | 7.07 | 168.3/ 188.4 | 0.1 | 5 | 5 |
| Dead P2 | 6/25/08 | 11:00 AM | 2.0 | 0 | 7.64 | 20.4 | 84.3 | 7.63 | 172.1/ 188.9 | 0.1 | 5 | 6 |
| Dead P3 | 6/27/08 | 12:00 PM | 2.0 | 0 | 7.60 | 21.9 | 79.0 | 6.92 | 227.9/ 242.5 | 0.1 | 5 | 4 |
| Turkey P1 | 6/23/08 | **8:00 AM | 2.0 | 0 | 7.97 | 20.5 | 83.8 | 7.54 | 312.7/ 342.2 | 0.2 | 0 | 5 |
| Turkey P2 | 6/23/08 | **11:00 AM | 2.0 | 0 | 8.03 | 21.3 | 73.5 | 6.51 | 326.8/ 351.7 | 0.2 | 0 | 4 |
| Turkey P3 | 6/24/08 | **1:00 PM | 2.0 | 0 | 7.91 | 20.3 | 71.9 | 6.42 | 288.9/ 317.4 | 0.2 | 0 | 5 |
| Donald. P1 | 6/27/08 | 8:00 AM | 5.0 | 0 | 7.53 | 21.9 | 54.0 | 4.72 | 412.2/ 437.8 | 0.2 | 0 | 6 |
| Donald. P2 | 6/30/08 | 8:30 AM | 5.0 | 0 | 7.64 | 21.4 | 73.0 | 6.45 | 399.5/ 428.6 | 0.2 | 0 | 8 |
| Donald. P3 | 6/30/08 | 12:30 PM | 5.0 | 0 | 7.65 | 22.9 | 80.8 | 7.06 | 408.6/ 433.8 | 0.2 | 0 | 8 |
| Gulf P1 | 6/20/08 | 8:30 AM | 5.0 | 0 | 7.57 | 18.0 | 82.2 | 7.78 | 360.3/ 416.3 | 0.2 | 0 | 5 |
| Gulf P2 | 6/25/08 | 2:00 PM | 5.0 | 0 | 7.41 | 21.2 | 58.5 | 5.38 | 281.5/ 304.3 | 0.1 | 0 | 6 |
| Gulf P3 | 6/24/08 | 9:50 AM | 2.0 | 0 | 7.36 | 19.2 | 63.5 | 5.86 | 221.7/ 249.2 | 0.1 | 0 | 6 |
| Spout P1 | 7/1/08 | 8:15 AM | 2.0 | 0 | 7.69 | 20.9 | 80.3 | 7.16 | 408.5/ 442.8 | 0.2 | 5 | 3 |
| Spout P2 | 7/1/08 | 11:15 AM | 5.0 | 0 | 7.76 | 21.9 | 77.5 | 6.79 | 483.0/ 513.0 | 0.2 | 5 | 7 |
| Spout P3 | 7/1/08 | 1:00 PM | 5.0 | 0 | 7.78 | 22.6 | 77.3 | 6.67 | 451.0/ 473.2 | 0.2 | 5 | 5 |
| Windy P1 | 7/24/08 | 8:30 AM | 2.0 | 0 | 7.50 | 20.9 | 72.7 | 6.49 | 205.0/ 222.6 | 0.1 | 0 | 5 |
| Windy P2 | 7/24/08 | 11:30 AM | 2.0 | 0 | 7.54 | 21.6 | 70.6 | 6.22 | 299.9/ 230.9 | 0.2 | 0 | 3 |
| Windy P3 | 7/24/08 | 1:30 PM | 2.0 | 0 | 7.38 | 22.0 | 46.0 | 4.02 | 343.9/ 364.8 | 0.2 | 0 | 4 |
| DifficultP1 | 7/28/08 | 8:00 AM | 0.5 | 0 | 7.74 | 23.0 | 59.3 | 5.08 | 112.7/ 117.2 | 0.1 | 0 | 10 |
| DifficultP2 | 7/28/08 | 11:00 AM | 0.5 | 0 | 7.74 | 23.7 | 75.4 | 6.37 | 170.2/ 174.4 | 0.1 | 0 | 10 |
| DifficultP3 | 7/28/08 | 1:45 PM | 0.5 | 0 | 7.44 | 24.0 | 79.4 | 6.69 | 171.1/ 174.7 | 0.1 | 5 | 8 |

# Appendix 10: Water Chemistry Data
# Round 3, Summer 2008

| Stream Site | Day | Time | Nitrate | Nitrite | pH | Temp | DO % | DO mg/L | Cond. uS | Salinity ppt | Tubidity (JTU) | Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mine P1 | 7/2/08 | 8:00 AM | 2.0 | 0 | 7.54 | 19.5 | 80.6 | 7.41 | 123.5/ 138.1 | 0.1 | 0 | 8 |
| Mine P2 | 7/2/08 | 12:30 PM | 0.5 | 0 | 7.60 | 20.6 | 78.0 | 7.02 | 126.3/ 138.1 | 0.1 | 0 | 7 |
| Mine P3 | 7/7/08 | **8:00 AM | 0.5 | 0 | 7.09 | 21.6 | 76.8 | 6.76 | 127.2/ 135.9 | 0.1 | 5 | 8 |
| Pimmit P1 | 7/22/08 | 8:00 AM | 0.5 | 0 | 7.92 | 24.3 | 48.3 | 4.04 | 310.1/ 314.2 | 0.2 | 0 | 7 |
| Pimmit P2 | 7/29/08 | 11:30 AM | 0.5 | 0 | 8.00 | 23.6 | 56.5 | 4.78 | 250.5/ 257.2 | 0.1 | 0 | 5 |
| Pimmit P3 | 7/29/08 | 12:45 PM | 0.5 | 0 | 7.63 | 24.8 | 62.2 | 5.17 | 309.1/ 311.8 | 0.2 | 0 | 7 |
| Dead P1 | 7/16/08 | 10:00 AM | 0.5 | 0 | 7.76 | 22.0 | 46.3 | 4.04 | 162.4/ 172.1 | 0.1 | 0 | 4 |
| Dead P2 | 7/16/08 | 1:00 PM | 0.5 | 0 | 7.72 | 23.7 | 80.3 | 6.79 | 174.7/ 178.9 | 0.1 | 0 | 5 |
| Dead P3 | 7/29/08 | 8:00 AM | 0.5 | 0 | 7.76 | 22.0 | 46.3 | 4.04 | 162.4/ 172.1 | 0.1 | 5 | 5 |
| Turkey P1 | 7/15/08 | 8:00 AM | 2.0 | 0 | 7.78 | 20.1 | 42.4 | 3.86 | 209.8/ 231.9 | 0.1 | 0 | 5 |
| Turkey P2 | 7/15/08 | 10:30 AM | 2.0 | 0 | 8.04 | 22.3 | 83.6 | 7.39 | 299.1/ 321.2 | 0.2 | 0 | 5 |
| Turkey P3 | 7/15/08 | 1:30 PM | 2.0 | 0 | 8.02 | 22.0 | 74.6 | 6.51 | 308.5/ 326.5 | 0.2 | 0 | 9 |
| Donald. P1 | 7/21/08 | 8:00 AM | 5.0 | 0 | 7.47 | 23.1 | 56.5 | 4.83 | 418.7/ 434.5 | 0.2 | 0 | 6 |
| Donald. P2 | 7/21/08 | 9:30 AM | 5.0 | 0 | 7.68 | 23.0 | 60.0 | 5.14 | 417.1/ 433.5 | 0.2 | 0 | 7 |
| Donald. P3 | 7/21/08 | 11:05 AM | 2.0 | 0 | 7.73 | 23.5 | 67.1 | 5.70 | 419.1/ 431.5 | 0.2 | 0 | 2 |
| Gulf P1 | 7/14/08 | 8:00 AM | 0.5 | 0 | 7.52 | 22.5 | 75.4 | 6.52 | 126.3/ 132.6 | 0.1 | 5 | 5 |
| Gulf P2 | 7/14/08 | 10:30 AM | 0.5 | 0 | 7.40 | 22.6 | 77.4 | 6.68 | 147.5/ 154.6 | 0.1 | 5 | 5 |
| Gulf P3 | 7/14/08 | 12:30 PM | 0.5 | 0 | 7.41 | 23.2 | 73.2 | 6.25 | 171.2/ 177.1 | 0.1 | 5 | 5 |
| Spout P1 | 7/25/08 | 8:30 AM | 5.0 | 0 | 7.81 | 21.4 | 73.2 | 6.45 | 526.0/ 564.0 | 0.3 | 0 | 5 |
| Spout P2 | 7/25/08 | 10:30 AM | 5.0 | 0 | 7.87 | 22.4 | 76.9 | 6.67 | 540.0/ 568.0 | 0.3 | 0 | 5 |
| Spout P3 | 7/25/08 | 12:30 PM | 5.0 | 0 | 7.92 | 23.8 | 74.7 | 6.30 | 556.0/ 569.0 | 0.3 | 0 | 7 |
| Windy P1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Windy P2 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Windy P3 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Difficult P1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Difficult P2 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Difficult P3 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

(*) Were times that we couldn't agree on an estimated time, but the time was taken from sampling done in 2007.

(**) Were times that were not written down, but were able to be estimated.

## Appendix 11: Land Cover Classification Description

1. *Open Water* – all areas of open water, generally with less than 25% cover of vegetation/land cover.
2. *Low Intensity Residential* – Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.
3. *High Intensity Residential* – Includes highly developed areas where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80 to100 percent of the cover.
4. *Commercial/Industrial/Transportation* – Includes infrastructure (e.g. roads, railroads, etc.) and all highly developed areas not classified as High Intensity Residential.
5. *Transitional* – Areas of sparse vegetative cover (less than 25 percent of cover) that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.).
6. *Deciduous Forest* – Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.
7. *Evergreen Forest* – Areas dominated by trees where 75 percent or more of the tree species `maintain their leaves all year. Canopy is never without green foliage.
8. *Mixed Forest* – Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.
9. *Pasture/Hay* – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
10. *Row Crops* – Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.
11. *Urban/Recreational Grasses* – Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.
12. *Woody Wetlands* – Areas where forest or shrubland vegetation accounts for 25-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.
13. *Emergent Herbaceous Wetlands* – Areas where perennial herbaceous vegetation accounts for 75-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

## Appendix 12: Location Data

| Monitoring: Summer 2008 | | | | | |
|---|---|---|---|---|---|
| Stream | Station | County | State | Latitude | Longitude |
| Turkey | 1 | Fairfax | VA | N 38 57.56.15 | W 77 9.24.91 |
| Turkey | 2 | Fairfax | VA | N 38 57.51.20 | W 77 9.24.25 |
| Turkey | 3 | Fairfax | VA | N 38 57.49.60 | W 77 9.25.9 |
| Dead | 1 | Fairfax | VA | N 38 58.00.955 | W 77 10.20.20 |
| Dead | 2 | Fairfax | VA | N 38 57.56.62 | W 77 10.25.34 |
| Dead | 3 | Fairfax | VA | N 38 57.54.98 | W 77 10.26.11 |
| Pimmit | 1 | Fairfax | VA | N 38 55.46.92 | W 77 7.5.49 |
| Pimmit | 2 | Fairfax | VA | N 38 55. 50.26 | W 77 7.11.12 |
| Pimmit | 3 | Fairfax | VA | N 38 55.50.81 | W 77 7.14.59 |
| Gulf Branch | 1 | Arlington | VA | N 38 55.29.00 | W 77 6.50.86 |
| Gulf Branch | 2 | Arlington | VA | N 38 55.20.07 | W 77 6.52.44 |
| Gulf Branch | 3 | Arlington | VA | N 38 55.29.76 | W 77 6.51.39 |
| Donaldson | 1 | Arlington | VA | N 38 55.11.84 | W 77 6.27.20 |
| Donaldson | 2 | Arlington | VA | N 38 55.11.06 | W 77 6.28.84 |
| Donaldson | 3 | Arlington | VA | N 38 55.10.26 | W 77 6.29.71 |
| Mine | 1 | Fairfax | VA | N 38 59.59.47 | W 77 15.22.95 |
| Mine | 2 | Fairfax | VA | N 38 59.59.25 | W 77 15.24.85 |
| Mine | 3 | Fairfax | VA | N 38 59.58.98 | W 77 15.30.06 |
| Spout | 1 | Arlington | VA | N 38 54.4.46 | W 77 5.1.73 |
| Spout | 2 | Arlington | VA | N 38 54.4.05 | W 77 5.2.69 |
| Spout | 3 | Arlington | VA | N 38 54.3.05 | W 77 5.4.36 |
| Difficult | 1 | Fairfax | VA | N 38 58.36.27 | W 77 14.23.40 |
| Difficult | 2 | Fairfax | VA | N 38 58.37.42 | W 77 14 27.50 |
| Difficult | 3 | Fairfax | VA | N 38 58.36.03 | W 77 14.39.40 |
| Windy | 1 | Arlington | VA | N 38 54.20.34 | W 77 5.39.08 |
| Windy | 2 | Arlington | VA | N 38 54.19.31 | W 77 5.40.62 |
| Windy | 3 | Arlington | VA | N 38 54.19.09 | W 77 5.44.13 |

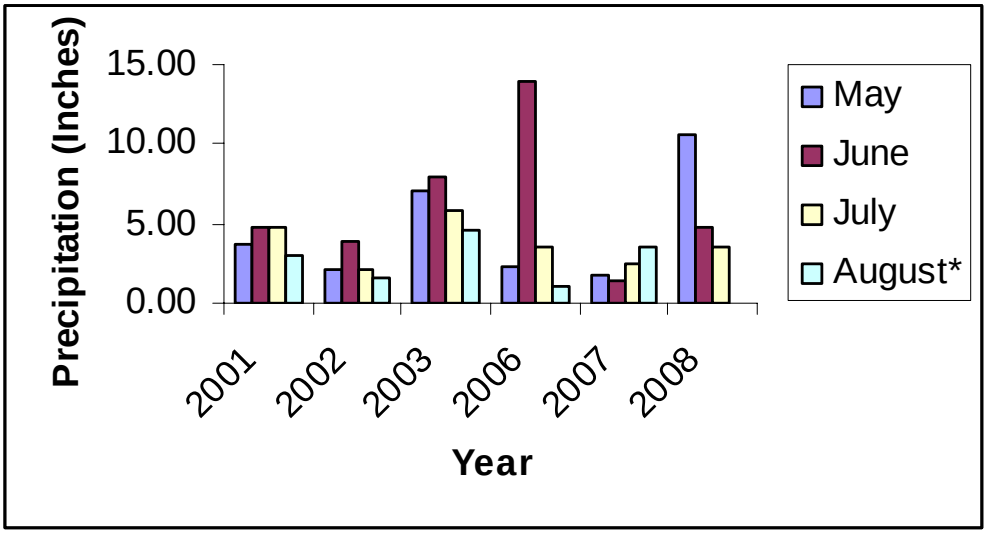
| Monitoring: Summer 2008 | | |
|---|---|---|
| Stream | Station | Location |
| Turkey | 1 | at the base of the switchback trail |
| Turkey | 2 | 100m downstream from GWMP, 40m upstream from site 1 |
| Turkey | 3 | 50m downstream from GWMP, 20m upstream from site 2 |
| Dead | 1 | 15-20m upstream from mouth |
| Dead | 2 | 50m upstream from site 1, 10-20m upstream from large waterfalls |
| Dead | 3 | 70-80 downstream of GWMP bridge, below waterfalls |
| Pimmit | 1 | 70m upstream of Glebe Rd (123 bridge) |
| Pimmit | 2 | 90m upstream of Glebe Rd (123 bridge) |
| Pimmit | 3 | 120m upstream of Glebe Rd, at start of a bend in the run |
| Gulf Branch | 1 | 20m downstream of GWMP, the edge of the GW closest to Potomac |
| Gulf Branch | 2 | Directly below GWMP on edge closest to Potomac |
| Gulf Branch | 3 | 20m upstream of site 2, 10-15m from GWMP's inland edge |
| Donaldson | 1 | 10m upstream from mouth |
| Donaldson | 2 | beneath GWMP bridge |
| Donaldson | 3 | 15m upstream from GWMP, below the 6ft waterfalls |
| Mine | 1 | 5m downstream from road |
| Mine | 2 | 15m upstream from road |

| | | |
|---|---|---|
| Mine | 3 | 25m upstream from road |
| Spout | 1 | next to drainage pipe off Spout Run Parkway |
| Spout | 2 | 100m upstream from site 1 |
| Spout | 3 | 50m upstream of second drainage pipe |
| Difficult | 1 | Near island,. When stream widens |
| Difficult | 2 | by a brush pile on large rocks (probably wont be there next season) |
| Difficult | 3 | |
| Windy | 1 | Upstream near the large dropoff |
| Windy | 2 | Right under GWMP |
| Windy | 3 | Right near the stream crossing |

**Appendix 13: Daily Rainfall: Summer 2008**

| Date | rainfall | Date | Rainfall | Date | Rainfall | Date | Rainfall | Date | Rainfall |
|---|---|---|---|---|---|---|---|---|---|
| May 26th | -- | June 9th | 0.00 | June 23rd | 0.14 | July 7th | 0.00 | July 21st | 0.00 |
| May 27th | -- | June 10th | 0.33 | June 24th | 0.00 | July 8th | 0.00 | July 22nd | 0.04 |
| May 28th | -- | June 11th | 0.00 | June 25th | 0.00 | July 9th | 0.01 | July 23rd | 1.09 |
| May 29th | -- | June 12th | 0.00 | June 26th | 0.00 | July 10th | 0.00 | July 24th | 0.00 |
| May 30th | -- | June 13th | 0.00 | June 27th | 0.09 | July 11th | 0.00 | July 25th | 0.00 |
| June 2nd | 0.00 | June 16th | 0.88 | June 30th | 0.16 | July 14th | 0.00 | July 28th | 0.01 |
| June 3rd | 0.79 | June 17th | 0.00 | July 1st | 0.09 | July 15th | 0.00 | July 29th | 0.00 |
| June 4th | 1.49 | June 18th | 0.00 | July 2nd | 0.00 | July 16th | 0.00 | | |
| June 5th | 0.04 | June 19th | 0.00 | July 3rd | 0.00 | July 17th | 0.00 | | |
| June 6th | 0.00 | June 20th | 0.00 | July 4th | 0.07 | July 18th | 0.00 | | |

**Figure 28: Monthly Rainfall at Ronald Reagan National Airport: 2001-2003, 2006-2008.**




*Monthly precipitation total for August 2008 could not be determined as data was unavailable.

## Appendix 14:Net New Development 2002-2006

*Arlington County, VA*

| Year | Office SF | Retail SF | Other SF | Residential Units | Hotel Rooms |
|---|---|---|---|---|---|
| 2002 | 956,983 | 195,595 | 8,184 | 1,959 | 350 |
| 2003 | 330,029 | 88,723 | 148,562 | 1,092 | 0 |
| 2004 | -3,628 | 7,934 | 471,547 | 432 | 0 |
| 2005 | 524,613 | 114,422 | 72,104 | 1,121 | 0 |
| 2006 | 1,321,168 | 75,481 | 193,588 | 1,339 | 4 |
| Total | 3,129,165 | 482,155 | 893,985 | 5,943 | 354 |

Source: Arlington County Department of Community Planning Housing and Development, Planning Research and Analysis Team.
All data is reported in Square Feet (SF) unless noted.

## Appendix 15: Acres of Land by General Land Use Category

Fairfax County, January 2004

| Existing Land Use | Total Acres | Percent of Total |
|---|---|---|
| Residential | 130,903 | 57.5 |
| Industrial | 9,389 | 4.1 |
| Commercial | 9,990 | 4.4 |
| Parks and Recreation | 28,108 | 12.3 |
| Public | 23,657 | 10.4 |
| Vacant and Natural Uses | 25,712 | 11.3 |
| Fairfax County | 227,759 | 100 |

## Appendix 16: Acres of Land by Planned Land Use Category

Fairfax County, January 2004

| Planned Land Use | Total Acres | Percent of Total |
|---|---|---|
| Residential | 143,496 | 63 |
| Industrial | 8,290 | 3.6 |
| Commercial/Retail Office | 5,259 | 2.3 |

| | | |
|---|---|---|
| Public Facilities and Mixed Use | 26,725 | 11.7 |
| Parks, Recreation, and Floodplains | 43,852 | 19.3 |
| Fairfax County | 227,622 | 100 |

## Appendix 17: Percent Impervious Surfaces, Stream Protection Strategy, January 2001

| Stream | % Impervious Surfaces | Projected % Impervious Surfaces |
|---|---|---|
| Dead Run | 21.9 | 25 |
| Turkey Run | 8 | 15 |
| Pimmit Run | 25.53 | 32 |
| Difficult Run | 17.89 | 30.58 |

## Appendix 18: Statistically Invalid Sampling Data ’01-‘07

**Table 2: Statistically Invalid Sampling Data (<200 macroinvertebrates): 2001-2007**

| | | | | |
|---|---|---|---|---|
| 2001 | | | | |
| Of 63 Stations | Stream | Round | Station | Total # of macroinvertebrates |
| | Dead | 1 | 1 | 174 |
| | Dead | 1 | 2 | 99 |
| | Dead | 1 | 3 | 175 |
| | Turkey | 1 | 1 | 175 |
| | Turkey | 1 | 2 | 175 |
| | Dead | 2 | 2 | 174 |
| | Dead | 2 | 3 | 144 |
| | Turkey | 2 | 3 | 91 |
| | Gulf Branch | 2 | 1 | 64 |
| | Gulf Branch | 2 | 2 | 84 |
| | Gulf Branch | 2 | 3 | 113 |
| | Donaldson | 2 | 2 | 70 |
| | Donaldson | 2 | 3 | 183 |
| | Spout | 2 | 3 | 24 |
| | Mine | 3 | 2 | 141 |
| | Turkey | 3 | 2 | 57 |
| | Turkey | 3 | 3 | 187 |
| | Gulf Branch | 3 | 1 | 41 |
| | Gulf Branch | 3 | 2 | 23 |
| | Gulf Branch | 3 | 3 | 42 |
| | Donaldson | 3 | 1 | 1 |
| | Donaldson | 3 | 2 | 2 |
| | Donaldson | 3 | 3 | 0 |
| | Spout | 3 | 1 | 154 |
| 2002 | | | | |
| Of 45 Stations | Stream | Round | Station | Total # of macroinvertebrates |
| | Donaldson | 2 | 2 | 81 |
| 2003 | | | | |
| Of 63 Stations | Stream | Round | Station | Total # of macroinvertebrates |
| | Gulf Branch | 1 | 1 | 32 |
| | Gulf Branch | 1 | 2 | 109 |
| | Gulf Branch | 1 | 3 | 66 |
| | Gulf Branch | 2 | 1 | 105 |
| | Gulf Branch | 2 | 2 | 74 |
| | Spout | 2 | 1 | 172 |
| | Spout | 2 | 2 | 88 |
| | Dead | 3 | 2 | 136 |
| 2006 | | | | |
| Of 45 Stations | Stream | Round | Station | Total # of macroinvertebrates |
| | Gulf Branch | 1 | 2 | 160 |
| 2007 | | | | |
| Of 57 Stations | Stream | Round | Station | Total # of macroinvertebrates |
| | Dead | 1 | 2 | 130 |

# Appendix 19: Driving Directions

**Mine Run**

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take I-495 South exit
3. Stay in right lane merging onto I-495 and take Langley/Great Falls exit
4. Turn right at 1st light onto west 193 and go approximately 4 miles
5. Turn right at 1st light onto Old Dominion
6. Continue straight to pay booth and into Great Falls Park
7. Pass visitor center and proceed to the end of the first long parking lot and park closest to the road
8. Mine Run will be in the forested gap between the two parking lots

Comments: green signs also present for direction to Great Falls Park

*To Return to Headquarters:*

1. Take Old Dominion back towards 193
2. Turn left at stoplight onto 193 and proceed approximately 4 miles
3. Go through first stoplight and stay in the left lane
4. Turn left at second stoplight onto I-495 North
5. Stay in right-most lane and take first exit onto GWMP
6. Turn left into parkway headquarters

**Dead Run**

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Drive past Turkey Run Park sign
3. Drive past 1st I-495 North/South exit sign
4. At 2nd I-495 South sign turn on hazard lights and slow
5. Turn off the parkway and onto the shoulder immediately after white arrow signs, park on grass just before Dead Run sign
6. Walk towards bridge and down the slope, stream is at the bottom of the hill

Comments: use caution when walking down the hill, it's a steep grade covered in loose dirt

*To Return to Headquarters:*

1. Turn on hazard lights and wait for an opening in traffic
2. Merge in to traffic headed North and merge immediately into the left lane
3. At a service road on the left, turn hazard lights on again and complete a U-turn
4. Proceed Southbound on GWMP
5. Turn left into parkway headquarters

**Turkey Run**

1. Exit through back entrance of parkway headquarters
2. Turn left at bottom of hill
3. Drive past parking lot C-3 (on left) and C-2 (on right) and enter lot C-1 (on right)
4. Park by interpretive wayside in near left corner
5. Follow trail downhill towards Potomac River, stay to the right
6. At the trailhead at the bottom of the hill, turn left
7. Turkey Run will be about 300 yards down the trail

*To Return to Headquarters:*

1. Hike back up trail
2. Turn left out of the parking lot
3. Follow loop back to headquarters

**Pimmit Run**

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Take 123 North exit (Chain Bridge/Washington exit)
5. Take right at light (onto North Glebe)
6. Go straight under bridge and park behind "Dead End" sign
7. Hiking back the way you drove, find trail on left shoulder
8. Follow trail to the left towards Pimmit Run

*To Return to Headquarters:*

1. Follow trail back up the hill
2. Turn left/straight out of parking lot onto Glebe Rd (towards Chain Bridge)
3. Turn left onto Chain Bridge Rd
4. Turn right onto GWMP North
5. Turn right into parkway headquarters

**Gulf Branch**

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Take 123 North exit (Chain Bridge/Washington exit)
5. Take right at light (onto North Glebe)
6. Take Military Road exit
7. Follow signs to Military Road (2 left's after exit)
8. Turn left onto 36th Road (not 36 Street)
9. Drive approximately 0.1-0.2 miles and park at trail head (across Nelson Street intersect)
10. Hike to bottom of stairs and turn left onto trail
11. Proceed to station locations

*To Return to Headquarters:*

1. Hike trail back to vehicle
2. Turn around, back towards Military Rd
3. Watch for sign for 120 North and turn right toward Chain Bridge
4. Merge on to N. Glebe Rd. heading down the hill
5. At the bottom of the hill, turn left onto Chain Bridge Rd
6. Turn right onto GWMP West
7. Turn right into parkway headquarters

**Donaldson Run**

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Take 123 North exit (Chain Bridge/Washington exit)
5. Take right at light (onto North Glebe Rd)
6. Take Military Road exit
7. Follow signs to Military Road (2 left's after exit)
8. Turn left onto Marcey Road
9. Drive back to Donaldson Run Park HQ and park just beyond HQ building, if full then park in lot outside HQ driveway entrance
10. Walk to the end of the paved road and find trail heading downhill

11. At the trailhead at the bottom of the hill, take the trail to the right
12. Proceed to station locations

*To Return to Headquarters:*

1. Hike back to vehicle
2. Drive out on Marcey Rd
3. Turn right onto Military Rd
4. Watch for sign for 120 North and turn right toward Chain Bridge
5. Merge on to N. Glebe Rd. heading down the hill
6. At the bottom of the hill, turn left onto Chain Bridge Rd
7. Turn right onto GWMP West
8. Turn right into parkway headquarters

**Spout Run**

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Take GWMP (South) to Ronald Reagan National Airport, go into Airport and fallow signs for GWMP North toward Washington (This may seem far to drive, but it is very simple and less stressful.)
5. Merge into left lane near TRI, and turn on hazard lights just after 1st Spout Run Parkway exit sign
6. Take Spout Run Parkway exit, slowing to prepare to pull off the road.
7. Enter exit in the right lane and park on grassy shoulder just behind the exit sign
8. Walk up side of road and cross when it is safe to do so
9. There is a storm drain just beyond the bridge on the left side of the road
10. Carefully walk through the brush and vegetation over the storm drain down into the stream

Comments: This is the most dangerous of the streams to sample. Be sure to wear orange vests when walking along the road and be sure to watch your footing while climbing down into the stream

*To Return to Headquarters:*

1. Return to vehicle as safely as possible
2. Turn on hazard lights and merge on to Spout Run Parkway
3. Stay in right lane of parkway and turn right at stoplight on Lorcom Ln
4. Turn right at the bottom of the hill onto Nelly Custis Dr
5. Nelly Custis Dr. becomes Military Rd
6. Watch for sign for 120 North and turn right toward Chain Bridge
7. Merge on to N. Glebe Rd. heading down the hill
8. At the bottom of the hill, turn left onto Chain Bridge Rd
9. Turn right onto GWMP North
10. Turn right into parkway headquarters

**Difficult Run**

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take I-495 South exit
3. Stay in right lane merging onto I-495 and take Langley/Great Falls exit
4. Turn Right at the light onto 193.
5. Take a left into the gravel parking lot of Difficult Run Valley Park.
6. Hike downstream (to the left) to sites.

*To Return to Headquarters:*

7. Turn Right onto 193.
8. Go through first stoplight and stay in the left lane
9. Turn left at second stoplight onto I-495 North
10. Stay in right-most lane and take first exit onto GWMP
11. Turn left into parkway headquarters

**Windy Run**

1. Turn Right out of Parkway Headquarters
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Stay in the right lane and take the exit for 123 Chain Bridge Rd. North
5. Turn right at the light onto Glebe rd.
6. Take exit for Military road and turn left onto Military Road.
7. Follow Military Road and keep left onto Nelly Custis Drive
8. Turn Left onto Lorcom Ln.
9. Take the next left onto Kenmore St. Follow it down to the end and park.
10. Follow sign to Potomac Heritage Trail and proceed to sites.

*To Return to Headquarters:*

1. Turn Right onto Lorcom Ln.
2. Turn Right onto Nelly Custis Drive. This becomes Military Road.
3. Watch for sign for Chain Bridge. Turn right onto ramp and merge onto N. Glebe road (120).
4. Turn Left at the light onto Chain Bridge Road
5. Turn right at sign for GWMP West.
6. Turn right into Parkway Headquarters.

**Dick's Sporting Goods** (For uniform)

1. Turn right from parkway headquarters front entrance onto GWMP
2. Take I-495 South exit towards Richmond/Alexandria
3. Take exit #49 onto I-66 West toward Front Royal/Manassas
4. Take exit #55/VA-7100 onto John F Herrity PKY(VA-7100) toward Herndon/Reston
5. Turn right on Fair Lakes PKY
6. Turn right on Fair Lakes Cir
7. Arrive at, Fairfax, on the left

Pants-Convertible Zip-off Quick Dry pants ~$20-30.

Shirts-2 or 3 navy blue T-shirts (previously purchased at Wal-Mart) ~$20 for 3.

*To Return to Headquarters:*

1. Turn right out of the parking lot
2. Turn right onto Fair Lakes Pkwy
3. Turn left onto West Ox Rd. / VA 608 N
4. Merge on to 50 East towards I-66
5. Merge left onto I-66 East towards Washington
6. Merge onto I-495 North towards Baltimore
7. Merge onto GWMP
8. Turn left into parkway headquarters

**Closest Wal-Mart**

1. Start out going WEST on GEORGE WASHINGTON MEMORIAL PKWY N / GW PKWY N.
2. Start out going WEST on GEORGE WASHINGTON MEMORIAL PKWY N / GW PKWY N.
3. Merge onto I-66 W via EXIT 49 toward MANASSAS / FRONT ROYAL.
4. Take the FAIRFAX CO PKY / VA-7100 exit- EXIT 55- toward RESTON / HERNDON / SPRINGFIELD.
5. Merge onto VA-7100 N / FAIRFAX COUNTY PKWY / JOHN F JACK HERRITY PKWY via EXIT 55B toward RESTON / HERNDON.
6. Turn LEFT onto FAIR LAKES PKWY.
7. Turn LEFT onto FAIR LAKES SHOPPING CTR.
8. Turn RIGHT to stay on FAIR LAKES SHOPPING CTR.
9. End at Wal-Mart:
   13059 Fair Lakes Shopping Ctr, Fairfax, VA 22033, US

Total Est. Time**:** 25 minutes  Total Est. Distance: 19.02 miles

**REI sporting goods**

1. Start out going WEST on GEORGE WASHINGTON MEMORIAL PKWY N / GW PKWY N.
2. Merge onto I-495 S / CAPITAL BELTWAY toward ALEXANDRIA / RICHMOND.
3. Merge onto I-66 W via EXIT 49 toward MANASSAS / FRONT ROYAL.
4. Merge onto US-50 E / LEE JACKSON MEMORIAL HWY via EXIT 57A toward FAIRFAX.
5. Keep RIGHT at the fork to continue on US-50 E / LEE JACKSON MEMORIAL HWY.
6. Turn RIGHT onto WAPLES MILL RD / VA-665 S.
7. Turn RIGHT onto RANDOM HILLS RD.
8. Turn LEFT onto RANDOM WALL WAY.
9. Turn RIGHT onto GRAND COMMONS AVE.
10. End at REI: 11950 Grand Commons Ave, Fairfax, VA 22030, US

Total Est. Time: 24 minutes  Total Est. Distance: 17.82 miles

# Appendix 20: Supplies

Always consult report for previous year's notes on the sample stations.
(i.e. Number of Macro- invertebrates, location of site, etc.)

1. Motorola Hand-held Radio ( For emergency contact and weather updates)
2. 3'x 3' kick-seine net (1/16-inch mesh)
3. Waders
4. Two backpacks
5. Collapsible table
6. Uniform
7. Two collapsible seats
8. Timer
9. Field first aid kit
10. Meter stick
11. Magnifying glass
12. Collection vial
13. Pens/Pencils
14. Measuring tape (100ft)
15. Brush
16. Forceps
17. Two ice cube trays
18. Virginia Save Our Streams benthic macroinvertebrate tally sheets (Appendix 1)
19. YSI meter, model 85
20. YSI meter, model 60
21. LaMotte turbidity kit
22. Squirt bottle
23. Water bottle
24. Hand sanitizer
25. Flagging
26. Cell phone for emergencies
27. Sunscreen and bug spray
28. Hach water quality test strips
29. Virginia Save Our Streams stream quality survey form (Appendix 8)
30. Digital Camera
31. Laminated Map Set

Calibration Chemicals Ordering Information:

YSI Meter
YSI Inc.: 937-767-7241 Fax: 937-767-9353
1700/1725 Brannum Lane
Yellow Springs, OH 45387

Nitrate.Nitrite Strips
Industrial Test Systems Inc.: 803-329-9712 Fax: 803-329-9743
1875 Langston St.
Rock Hill, SC 29730

# Appendix 21: Sampling Procedure

1. At each station, as a team, choose the sample area with best sampling conditions:
    a. Riffle of desired area (e.g. 3'x 3', 3'x 2', or 3'x 1').
    b. Mixture of small, medium, and moderately large cobbles with moderate flow, approximately 3-5 inches deep.
    c. Area with directional flow of water, or construct boundaries to direct flow.
2. Place kick-seine net perpendicular to water flow immediately downstream of sampling area.
3. Angle the net approximately 45 degrees, or greater, to streambed to allow capture of dislodged macroinvertebrates.
4. Place rocks along net bottom to prevent loss of macroinvertebrates.
5. The holding team member of the monitoring team keeps net in place and records elapsed time while the kicking team member scrubs and removes large rocks from the sample area.
6. When ready, the kicking team member vigorously churns the designated sample area by shuffling their feet.
7. Churning time depends on area of sample: 90 seconds for a 3'x 3' net, 60 seconds for a 3'x 2' net, and 30 seconds for a 3'x 1' net.
8. When time expires, rocks that held the bottom of the net are scrubbed and removed.
9. The net is then carefully lifted out of the water in a scooping motion to avoid sample loss.
10. The holding team member lays out the net on a table for sorting, while the kicking team member returns the riffle back to its original state.
11. All visible macroinvertebrates are removed from the net with forceps and placed in ice cube trays filled with stream water.
12. Each piece of detritus is carefully searched for clinging macroinvertebrates.
13. The net is picked until macroinvertebrates become difficult to find.
14. The net is then rolled from each side while the side facing the table is checked for macroinvertebrates.
15. Once the net is rolled up it is placed aside.
16. Macroinvertebrates on the table are then tallied and table is washed.
17. The net is then placed back on the table and steps 11-16 are repeated once.
18. At the end of the tally the net and table are washed clean for the next sample.

# Appendix 22: Orientation Duties

1. Acquire and organize sampling equipment
2. Conduct calibration of water chemistry devices
3. Review previous report
4. Become certified as stream monitor
   Contact: Joanna A. Cornell (jcornell@gmu.edu)
5. Obtain uniform
6. Complete online security training
7. Obtain login/password information for use of office computers
8. Complete first-aid/CPR training
9. Navigate to stream stations (same stations as previous years) using
   GPS unit and flag for future sampling
10. Attend a Bridging the Watershed orientation/seminar
11. Visit the Center for Urban Ecology and meet with the Water Resource Specialists

# Appendix 23: Points of Interest

All directions from Brookmont housing:
6201 Broad St.
Bethesda, MD 20816

Safeway Food and Drug

1. Head Northwest from Broad St. (go 0.2 mi.)
2. Turn right at Maryland Ave. (go 0.1 mi.)
3. Turn right at MacArthur Blvd. (go 0.2 mi.)
4. Turn hard left at Sangamore Rd. (go 353 ft.)
5. Continue on Brooks Ln. (go 0.3 mi.)
6. Arrive at Safeway

U.S. Post Office

1. Head Northwest from Broad St. (go 0.2 mi.)
2. Turn right at Maryland Ave. (go 0.1 mi.)
3. Turn right at MacArthur Blvd. (go 0.6 mi.)
4. Bear left at MacArthur Blvd. NW (go 0.3 mi.)
5. Turn left at Loughboro Rd. NW (go 1.1 mi.)
6. Bear left at Nebraska Ave. NW (go 1.0 mi.)
7. Turn right at Van Ness St. NW (go 0.2 mi.)
8. Turn right at Wisconsin Ave. NW (go 0.2 mi.)
9. Arrive at U.S. Post Office *(4005 Wisconsin Ave. NW, Washington D.C, 20016)*

Gas Station

1. Head Northwest from Broad St. (go 0.2 mi.)
2. Turn right at Maryland Ave. (go 0.1 mi.)
3. Turn right at MacArthur Blvd. (go 0.4 mi.)
4. Arrive at Hilltop Exxon

Sibley Memorial Hospital

1. Head Northwest from Broad St. (go 0.2 mi.)
2. Turn right at Maryland Ave. (go 0.1 mi.)
3. Turn right at MacArthur Blvd. (go 0.6 mi.)
4. Bear left at MacArthur Blvd. NW (go 0.3 mi.)
5. Turn left at Loughboro Rd. NW (go 0.1 mi.)
6. Arrive at Sibley Memorial Hospital (*5255 Loughboro Rd NW, Washington, DC 20016)*