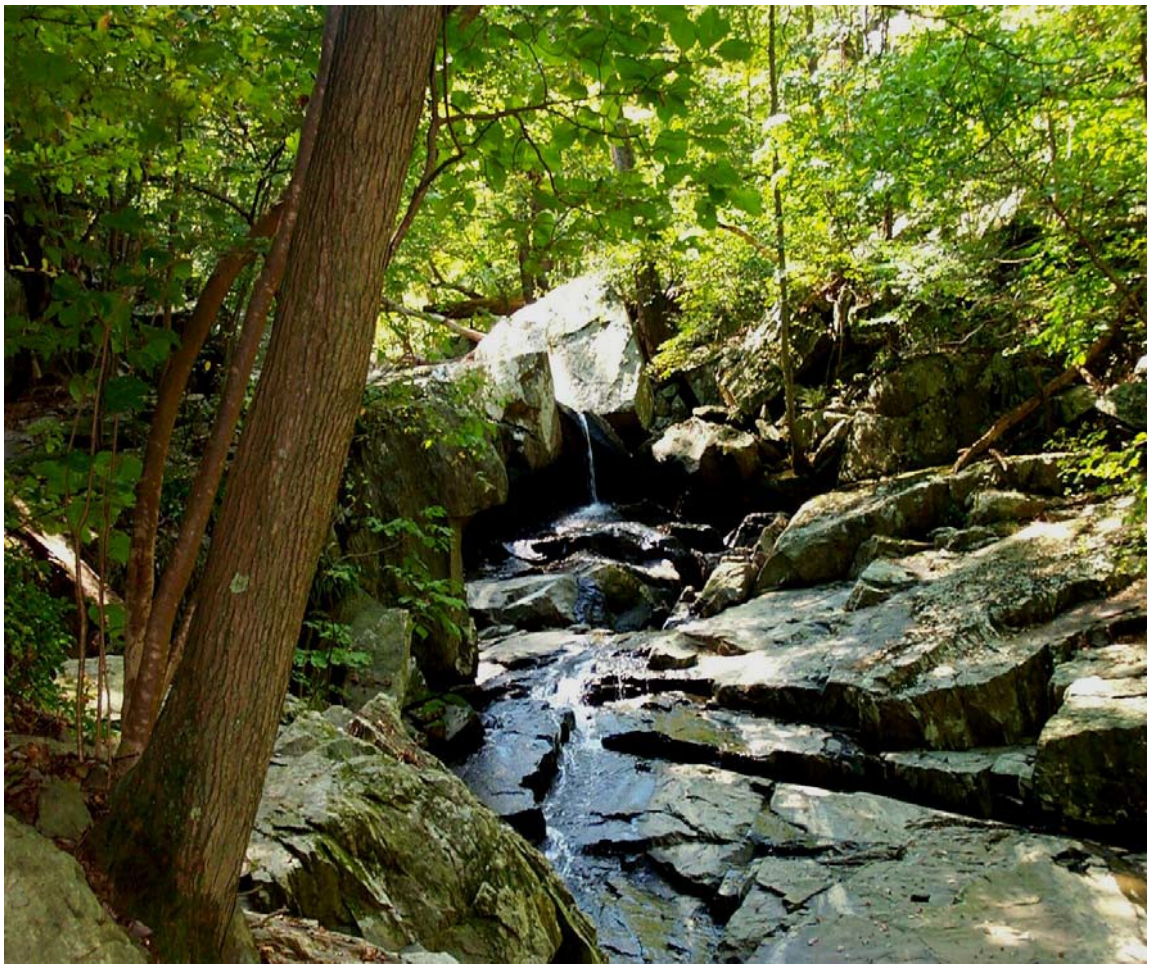
National Park Service
George Washington Memorial Parkway
Stream Monitoring Program

2006 Annual Report



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ACKNOWLEDGEMENTS

We would like to express our gratitude to Ann Brazinski for her devotion in creating the George Washington Memorial Parkway Stream Monitoring Program. We also thank Joanna Cornell who contributed her time to train and certify us as stream monitors. We would especially like to acknowledge Melissa Kangas and Brent Steury for continuing this project after Ann's absence, for their constant support and advice, and for all of the other accommodations they provided us. We truly appreciate the opportunity to participate in this project and would like to thank the entire staff of the George Washington Memorial Parkway for helping us have an enjoyable experience with the National Park Service.

ABSTRACT

Benthic macroinvertebrate data was collected in the summer of 2006 for the completion of a fourth year of stream water quality monitoring. Mine Run, the least impacted of the seven streams, consistently received "acceptable" year/round health scores according to the Virginia Save Our Streams (VASOS) protocol. The remaining streams consistently scored "unacceptable" yearly health scores. Spout Run, the most impacted stream, received the lowest average rating during the entirety of this monitoring program. This may be an indication that urban development, and associated pollutants, can have a significant effect on stream health.

Monitoring also focused on two streams, Donaldson Run and Gulf Branch, which were contaminated by a pesticide spill in 2001. Results indicate richness and density have improved since the impact; however, stream health scores have not recovered to pre-contamination conditions. 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. Increased land development and associated impervious surface cover puts a strain on stormwater management. Rainwater is not readily absorbed, increasing potential for destabilization of soils within watersheds and increased sediment runoff into streams (USEPA 1997 and Stormwater Management Branch 2001). Sediment and pollutants carried by stormwater runoff can adversely affect biological stream communities, and present the need for stream protection and restoration (USEPA, 1997 and Stormwater 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 (Stormwater 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.

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 (Figure 1). Difficult Run, Windy Run, and an unnamed tributary referred to as Wisteria Run, were not monitored due to unfavorable sampling conditions in 2001. Monitoring continued in 2002, 2003, and 2006 focusing on the same seven streams sampled in 2001. Monitoring staff were trained and certified in VASOS protocol by NVSWCD prior to data collection.

METHODS

Stream monitoring was conducted from June 20, to August 3, 2006. Seven streams were sampled in the order of Mine Run, Turkey Run, Dead Run, Gulf Branch, Pimmit Run, Donaldson Run, and Spout Run (Figures 2-8). Global Positioning System (GPS) coordinates for each stream station are listed in appendix 13. Each stream was sampled at three stations, with a minimum distance of twenty meters between each sample station. In 2006, three rounds of sampling occurred at Mine Run, while two rounds of sampling were conducted at the remaining streams.

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

Figure 1: Water Quality Monitoring Streams and Watersheds

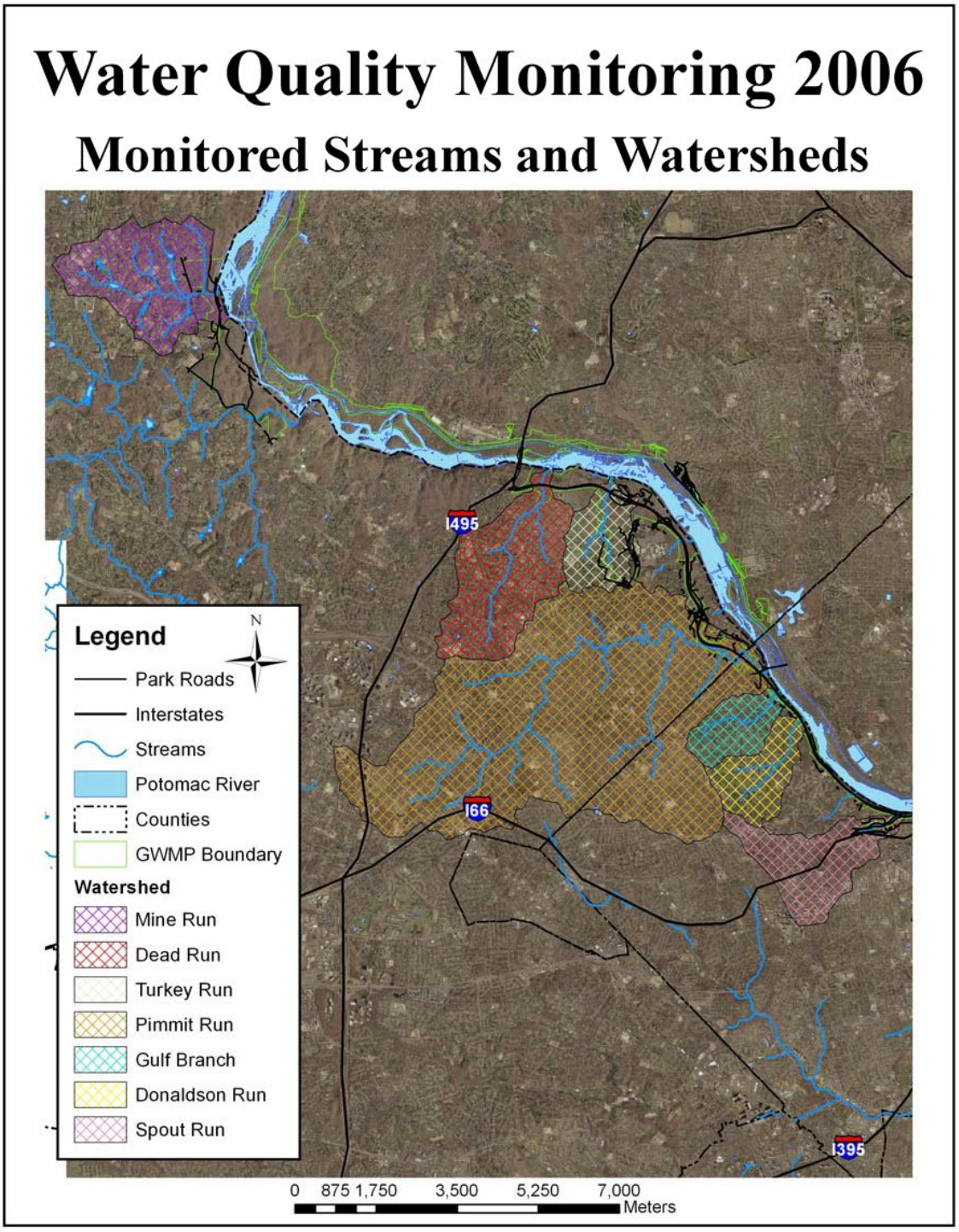


Figure 2: Mine Run

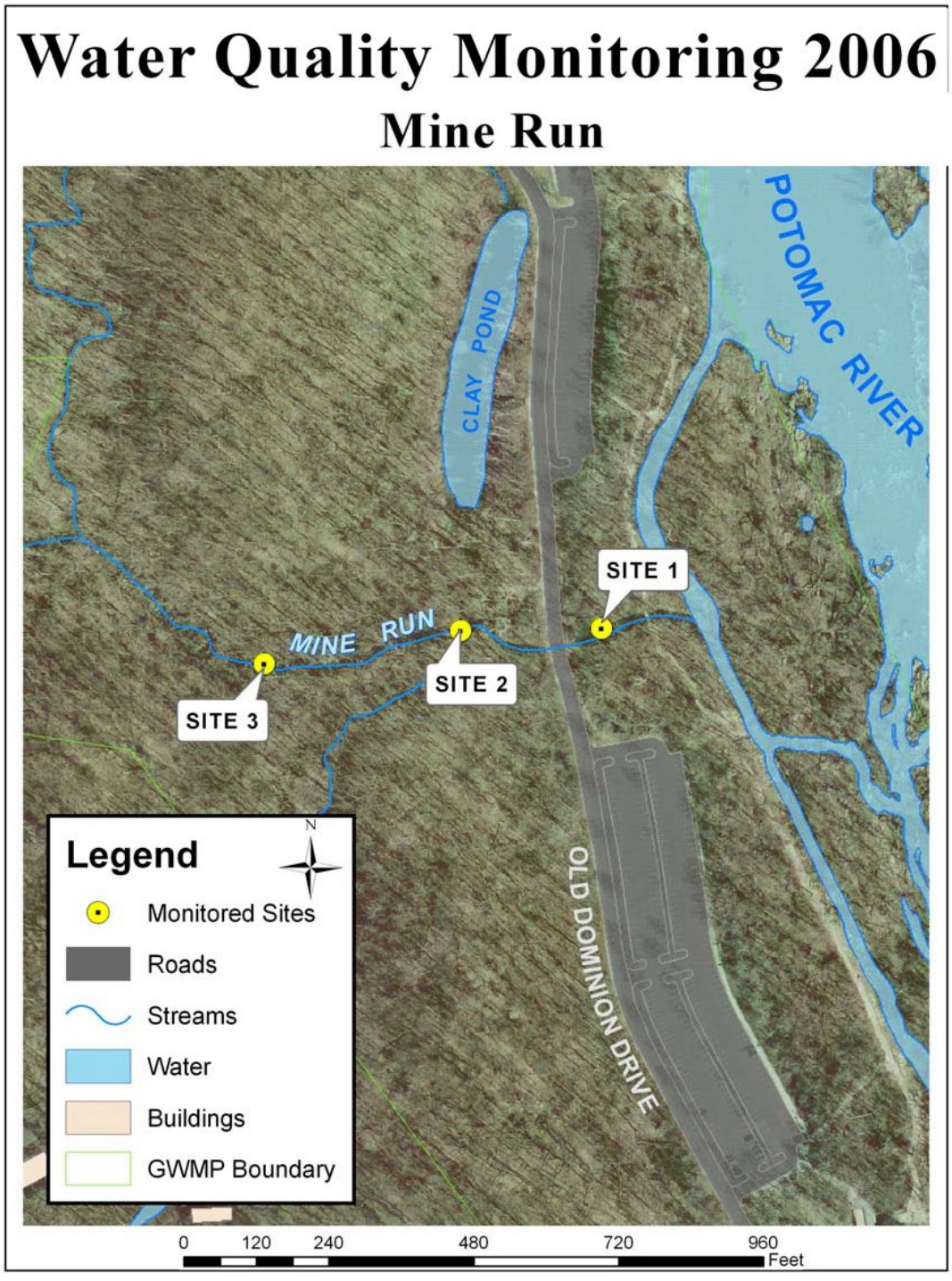


Figure 3: Turkey Run

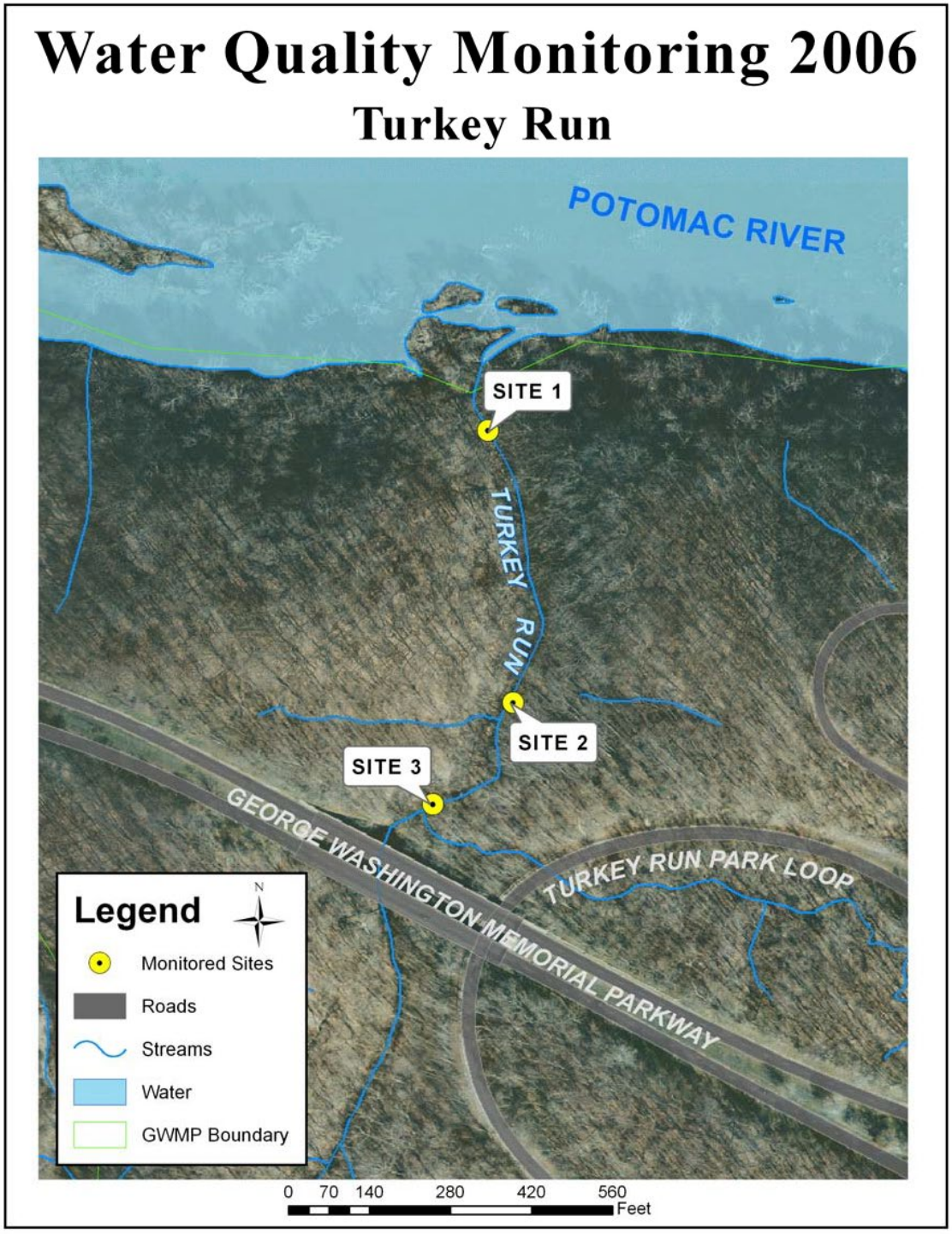


Figure 4: Dead Run

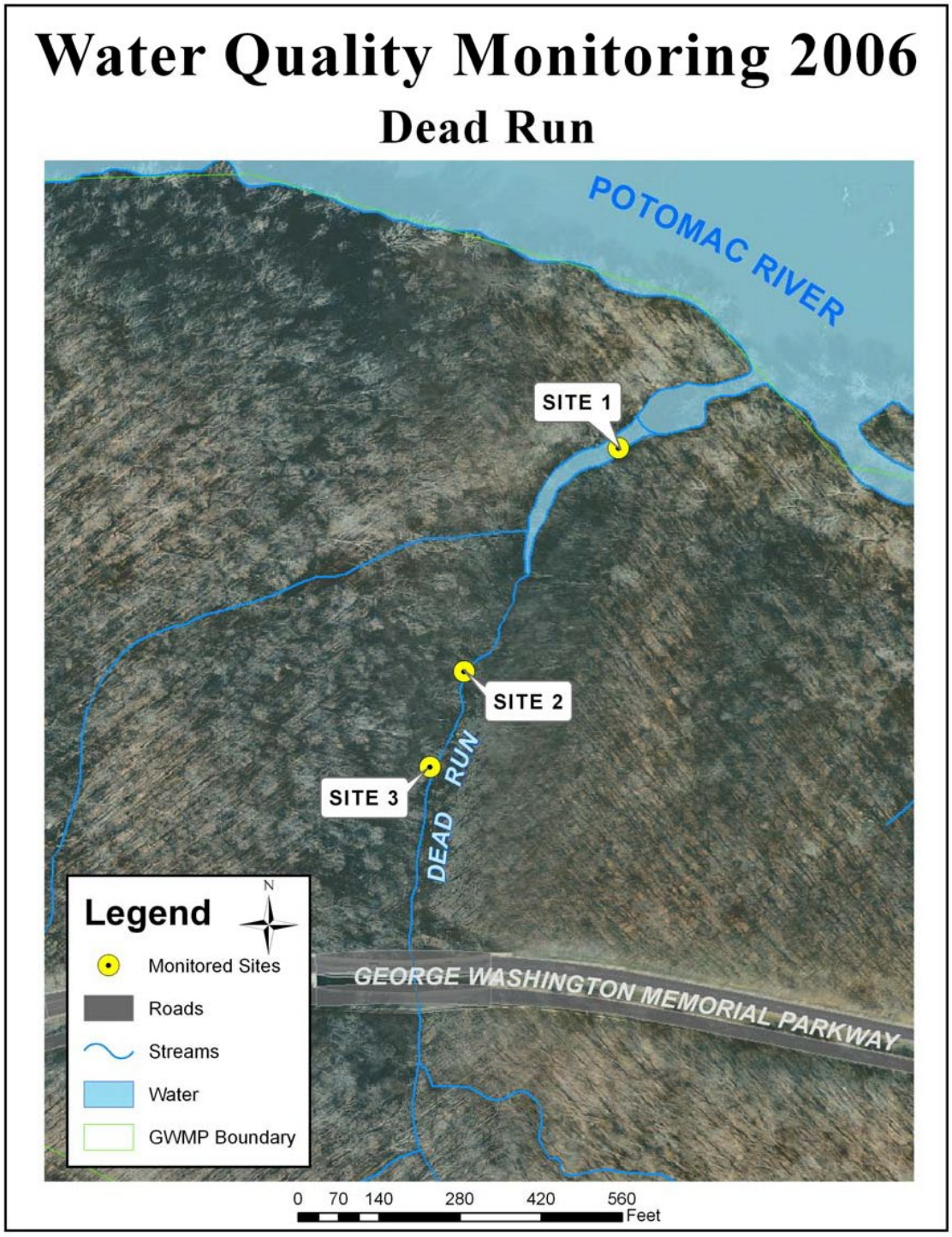


Figure 5: Gulf Branch

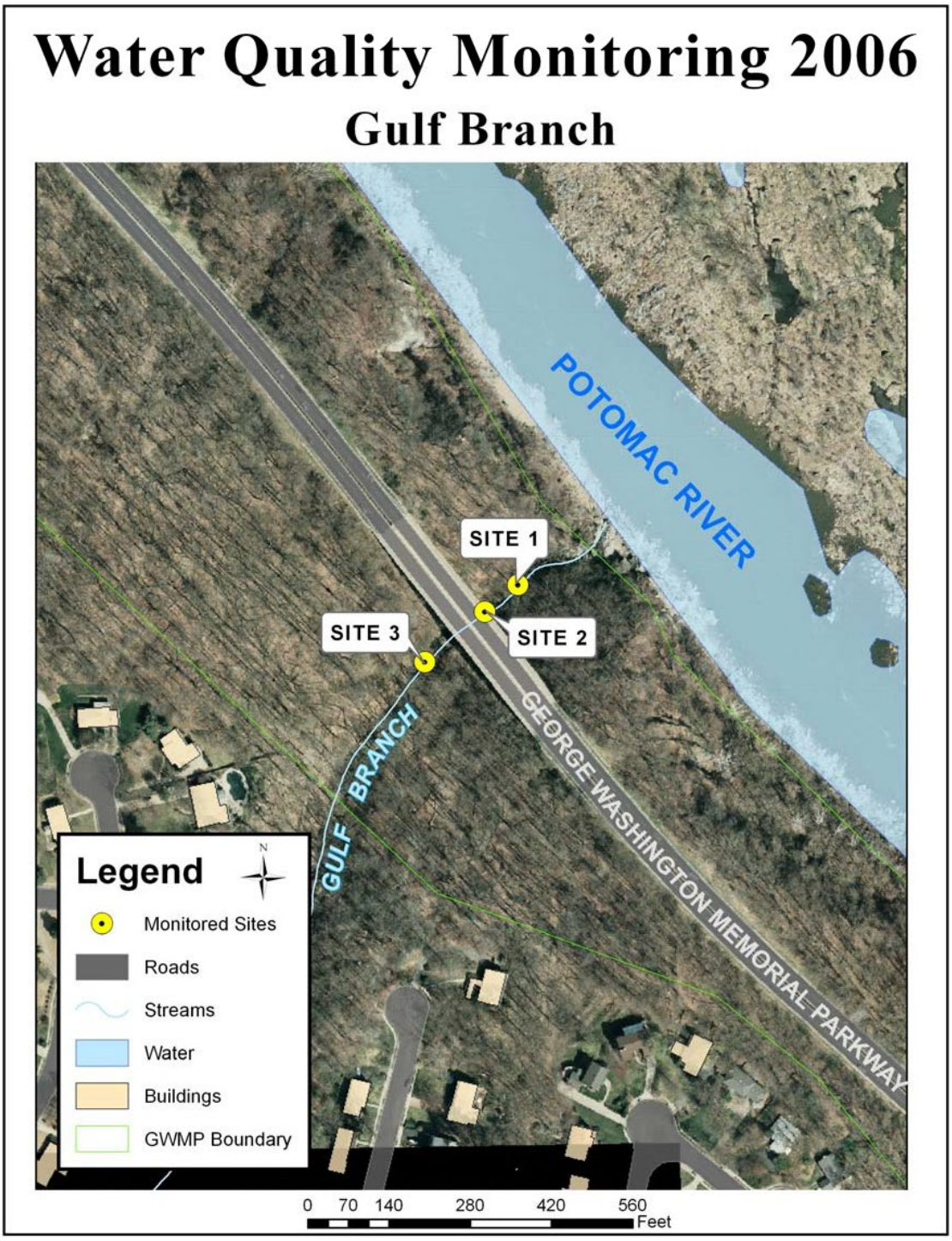


Figure 6: Pimmit Run

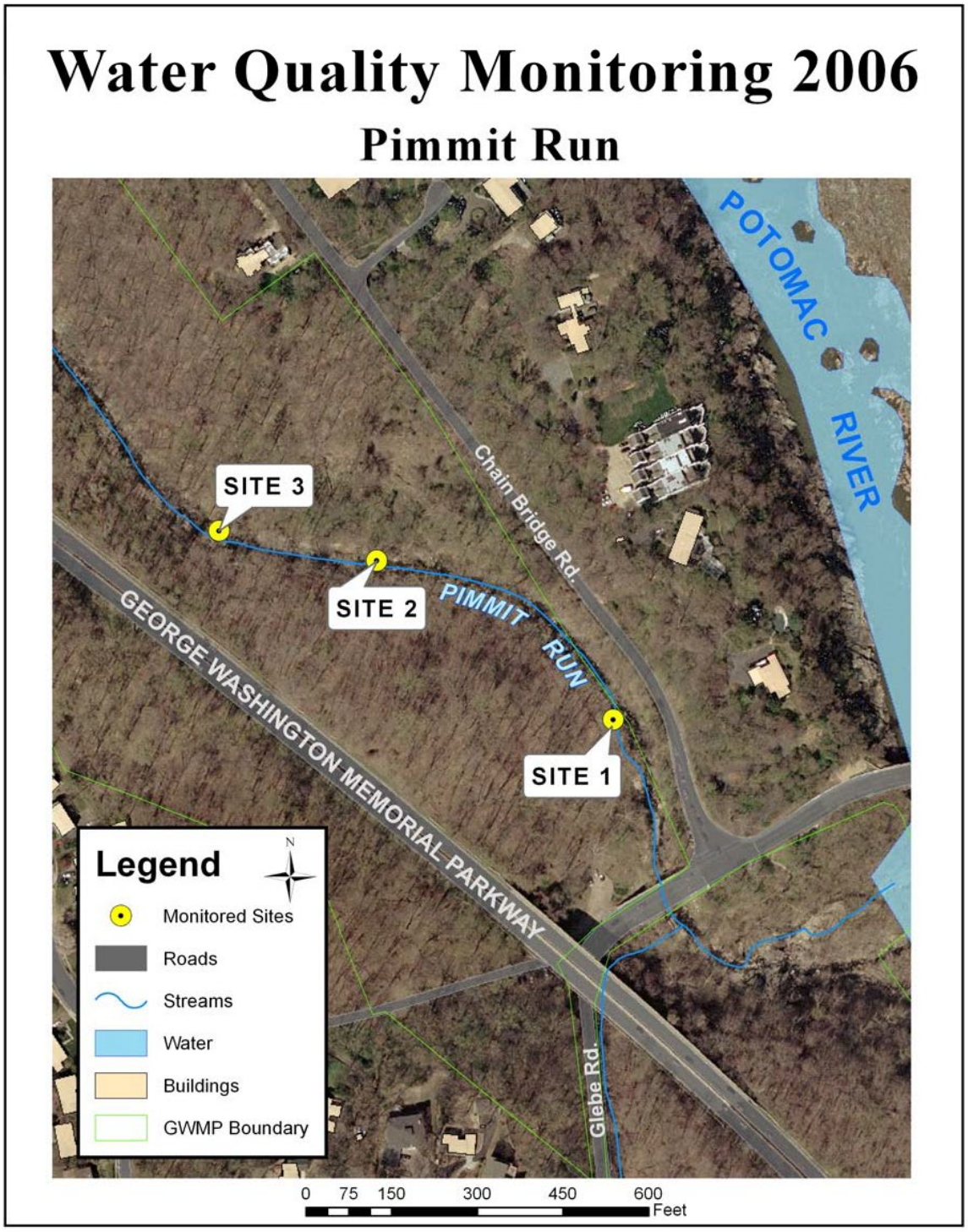


Figure 7: Donaldson Run

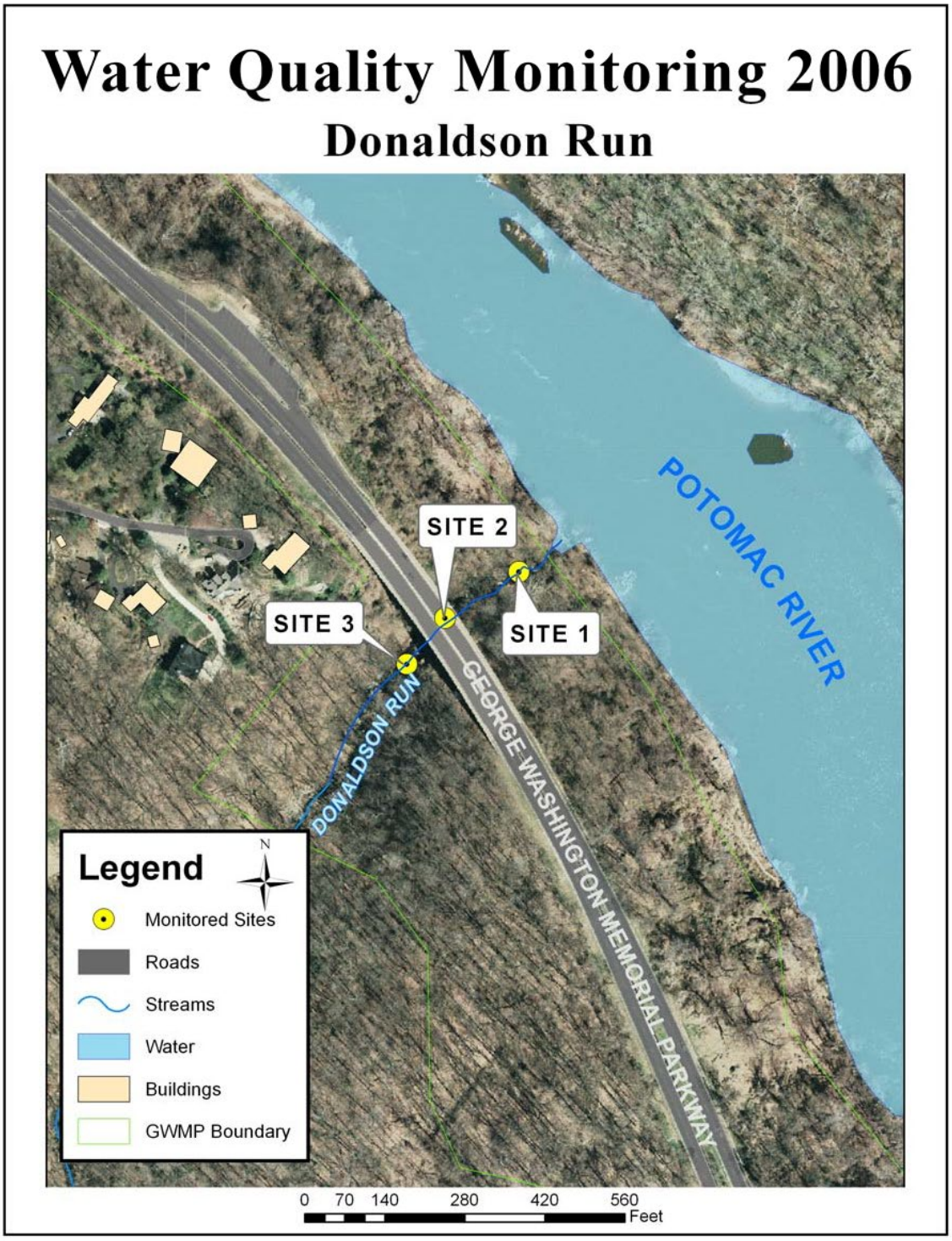
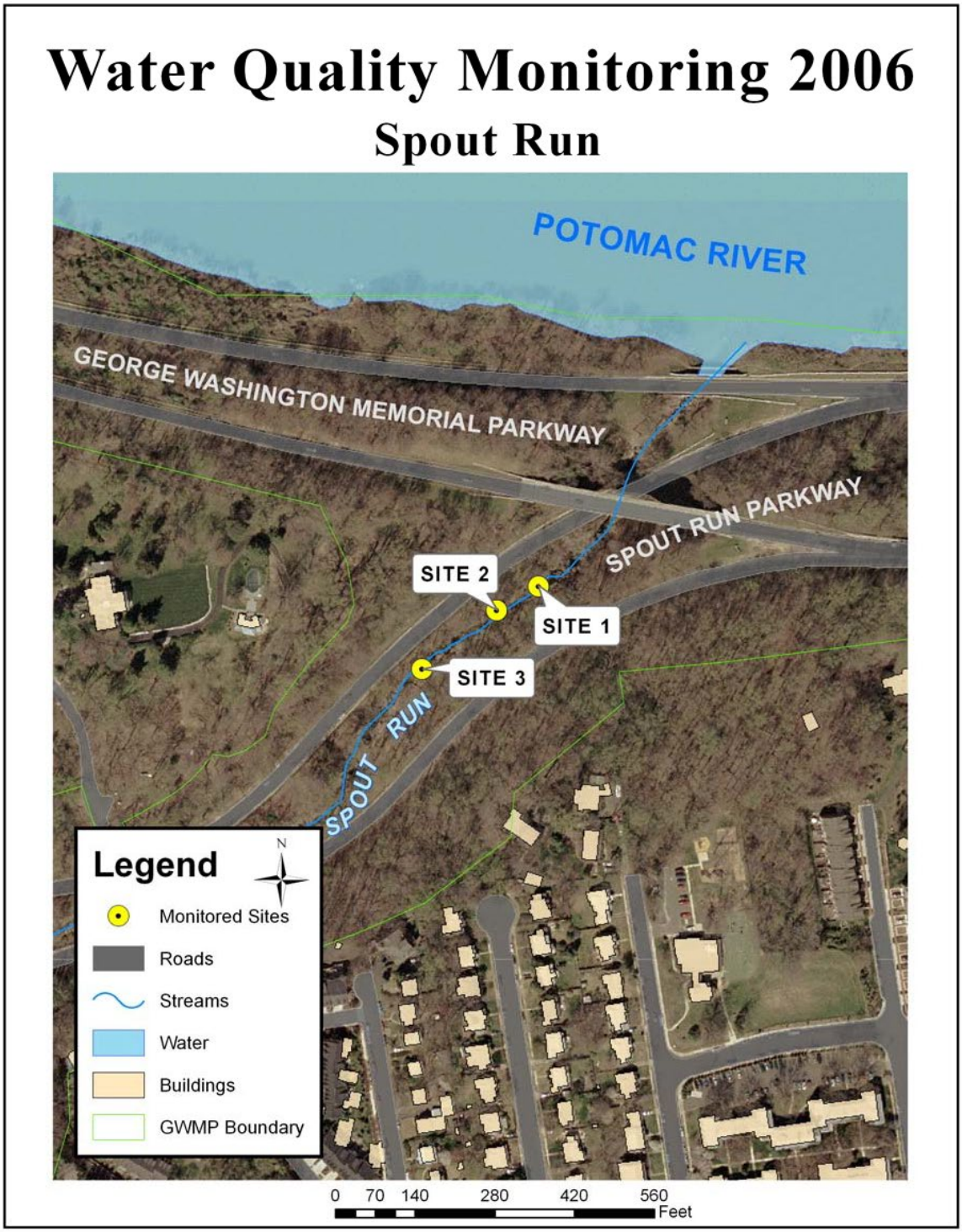


Figure 8: Spout Run



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 2'x 2' area, and 30 seconds for a 1'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. Unidentifiable specimens were taken back to headquarters for positive identification. Merritt and Cummins (1996), and Thorp (1991) were used as identification guides.

In accordance with VASOS protocol, stream health scores were calculated using a 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 added for each stream station and produced a score on a scale of zero to twelve. An "acceptable" rating required a score of seven or greater, while a score of six or less was rated as being "unacceptable".

Water Chemistry and Basic Water Quality Parameters

Each station was tested for dissolved oxygen, conductivity, pH, nitrate, nitrite, air and water temperature, 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 macroinvertebrates 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 need for oxygen. The potential loss of canopy and runoff from warm, impervious surfaces 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).

Hanna Instruments pH Meter (Model 9025) was used to measure pH of stream water and air 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, with alkaline 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).

Hach 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). Nitrogen is present in sewage, fertilizer, agricultural waste, and nutrient runoff from soil (Stormwater Management Branch 2001).

Stream Habitat Assessment and Physical Characteristics

Stream habitat assessment involved surveying for presence of fish and salamanders, surface water and streambed appearance, stream bed stability, presence of algae, 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

Sampling occurred between June 20, 2006 and August 4, 2006. Appendix 9 shows the complete multimetric index scores along with type and abundance of macroinvertebrates collected at each sample station. In 2006, stream health scores ranged from a station score of eleven at Mine Run, to the lowest score of three at stations in Dead Run, Pimmit Run, Donaldson Run, and Spout Run. Health score by round and year are presented in figure 9. Three of seven streams (Gulf Branch, Donaldson Run, and Spout Run) received an unacceptable score at every sample station. Mine Run received an "acceptable" score of seven or greater during all nine samplings in 2006. Mine Run scores ranged from seven to eleven, Dead Run scores ranged from three to seven, Turkey Run scores ranged from four to eight, Pimmit Run scores ranged from three to eight, Gulf Branch scores ranged from four to six, Donaldson Run scores ranged from three to six, and Spout Run scores ranged from three to five. Figure 10 shows average health scores for each stream during each sampling year. Stream health scores were the highest for all streams in 2001. In 2006, health scores are greater than those of 2002 and 2003 in all streams with the exception of Donaldson Run. Six of the seven streams consistently scored "unacceptable", while Mine Run consistently scored "acceptable". Table 1 presents stream

Figure 9: Stream Health Score 2006

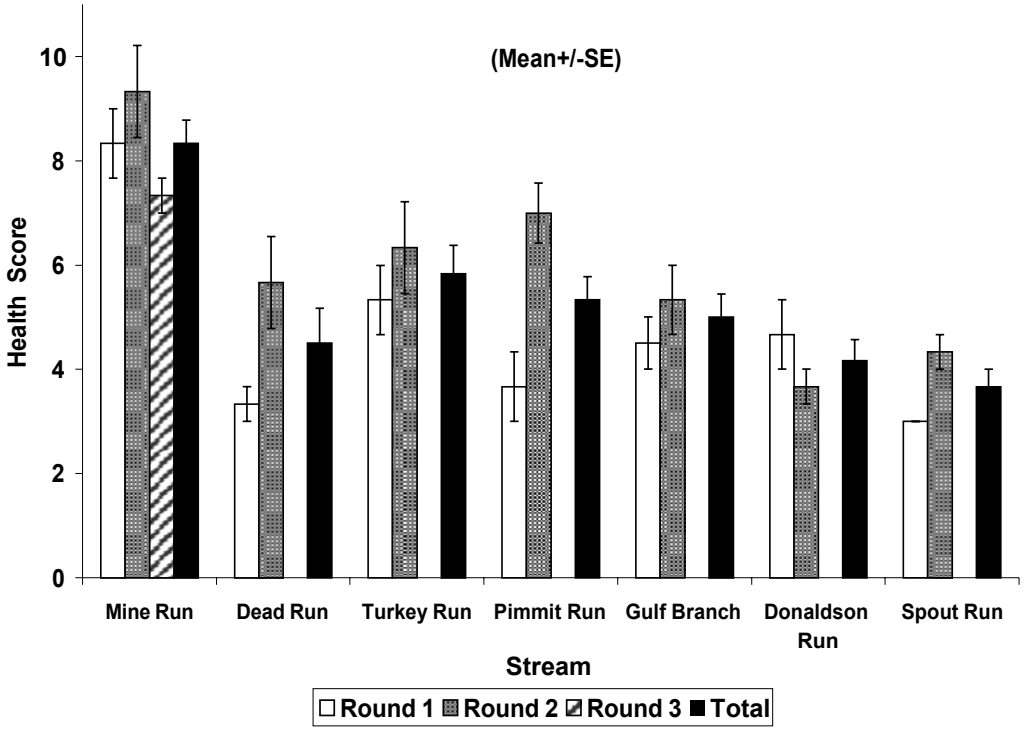


Figure 10: Yearly Health Scores

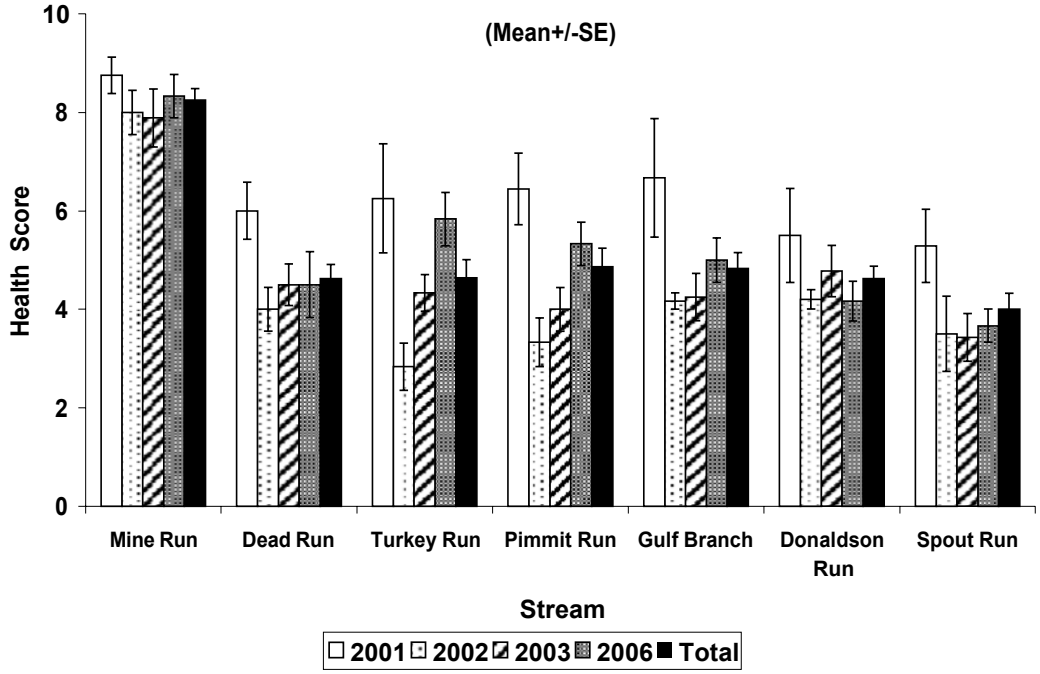


Table 1: Statistically Invalid Sampling Data (<200 Macroinvertebrates): 2001 to 2006				
2001				
of 63 Stations	**Stream Name**	**Round**	**Station Number**	**Total Number of Macroinvertebrates**
	Dead Run	1	1	174
	Dead Run	1	2	99
	Dead Run	1	3	175
	Turkey Run	1	1	175
	Turkey Run	1	2	175
	Dead Run	2	2	174
	Dead Run	2	3	144
	Turkey Run	2	3	91
	Gulf Branch	2	1	64
	Gulf Branch	2	2	84
	Gulf Branch	2	3	113
	Donaldson Run	2	2	70
	Donaldson Run	2	3	183
	Spout Run	2	3	24
	Mine Run	3	2	141
	Turkey Run	3	2	57
	Turkey Run	3	3	187
	Gulf Branch	3	1	41
	Gulf Branch	3	2	23
	Gulf Branch	3	3	42
	Donaldson Run	3	1	1
	Donaldson Run	3	2	2
	Donaldson Run	3	3	0
	Spout Run	3	1	154
2002				
of 45 Stations	**Stream Name**	**Round**	**Station Number**	**Total Number of Macroinvertebrates**
	Donaldson Run	2	2	81
2003				
of 63 Stations	**Stream Name**	**Round**	**Station Number**	**Total Number 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 Run	2	1	172
	Spout Run	2	2	188
	Dead Run	3	2	136
2006				
of 45 Stations	**Stream Name**	**Round**	**Station Number**	**Total Number of Macroinvertebrates**
	Gulf Branch	1	2	160

stations where the minimal number benthic macroinvertebrates (200) were not collected since the entirety of this monitoring program. Stream health scores calculated from these samplings were not used in analysis.

Figure 11 shows the percentage of intolerant benthic macroinvertebrates collected in 2006. 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. However, percent intolerant data revealed greater impacts to Gulf Branch compared to Dead Run, Donaldson Run, and Spout Run, whereas VASOS metric data scored Gulf Branch higher than the previous. VASOS metric data relies on relative proportion of all tolerance levels, and integrate tolerant and moderately tolerant taxonomic groups into final health scores.

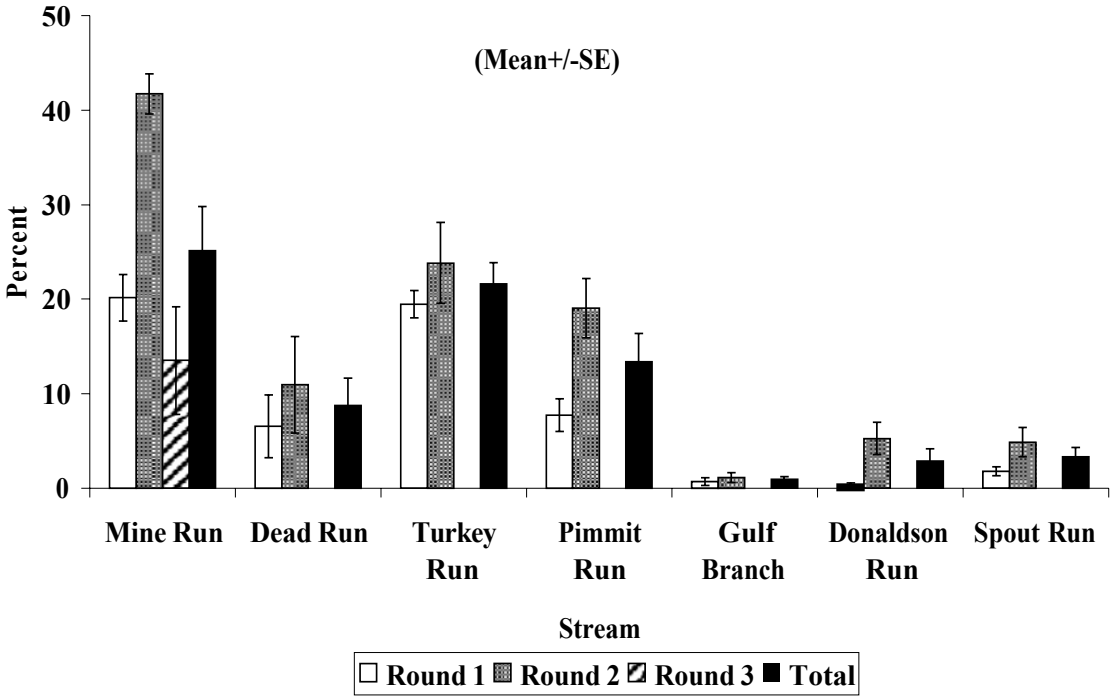
Statistical Analysis

Stream health scores collected from 2001 to 2006 were analyzed using Wilcoxon Matched-Pairs Signed-Ranks Test. A Bonferroni correction was made for multiple comparisons. With a selected alpha of 0.05 and n equaling the number of between-stream comparisons, p-values $\leq$ alpha / $n \leq 0.05 / 21 \leq 0.002$ were considered significant. Values used and a calculation example of the Wilcoxon Matched-Pairs Signed Ranks-Test are presented in Appendix 10. Matched pairs that contained statistically invalid data were omitted from the analysis. Since an alpha of ≤ 0.002 was considered significant, Wilcoxon Signed-Ranks critical value tables were not used due to the level of significance needed; exact p-values were calculated using an online statistical program (http://fonsg3.let.uva.nl/Service/Statistics/Signed_Rank_Test.html). Of the multiple comparison tests, Mine Run had significantly higher stream health scores than all other streams sampled in the George Washington Memorial Parkway, while the remaining six streams showed no differences in stream health.

Water Chemistry and Basic Water Quality Parameters

Appendix 11 shows water chemistry and basic water quality parameter data at each sample station. Water pH remained basic throughout the sampling period for all sampling points with an average of 7.63. A high of 8.71 was recorded at Pimmit Run during round one, and a low of 7.05 was recorded at Mine Run during round two. Dissolved oxygen ranged from 115.0% (9.52 mg/l at 24.9 ºC) at Spout Run during round two, to 82.3% (7.33 mg/l at 20.9 ºC) at Mine Run during round one. Conductivity ranged from 580.0 microSiemens (uS) at Spout Run during

Figure 11: Percent Intolerant



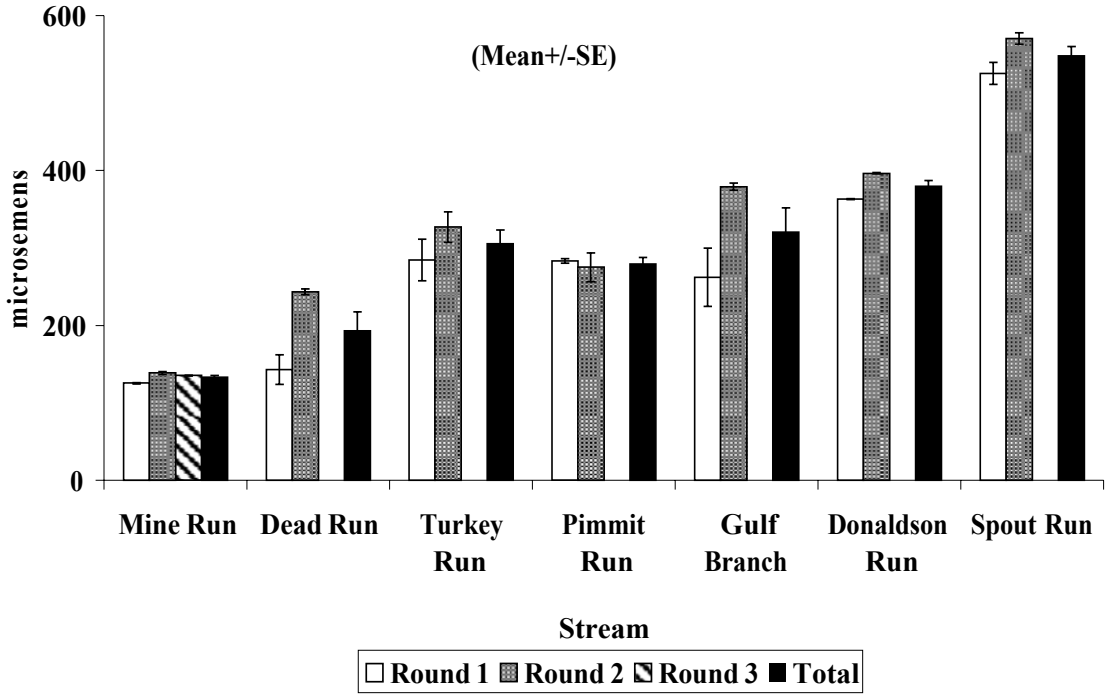
round two to 106.0 uS at Dead Run during round one. Mine Run registered the lowest average conductivity for 2006 at 133.13 uS, and Spout Run registered the highest average at 547.83 uS Figure 12. Average scores for pH and dissolved oxygen were similar among streams in 2006. Turbidity was equal to, or less than 2.5 Jackson Turbidity Units (JTU) in forty-four of forty-five samplings. The highest turbidity reading was 10 JTU taken at station three of Turkey Run in round one. In general, low levels nitrate and nitrite were detected at all stream stations with nitrate levels ranging from 0 ppm to 5 ppm. Nitrite readings were 0 ppm at every sample station in 2006.

Habitat Assessment and Physical Characteristics

Appendix 12 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).

Fish were observed at one or more stations in Dead Run and Turkey Run for both rounds of sampling and in Mine Run during all three rounds of sampling. Fish were also found at station

Figure 12: Conductivity



one of Donaldson Run in the second round of sampling. Waterfalls were the main barriers to fish movement occurring in every stream at one or more sample stations. Salamanders were only found in Mine Run, Dead Run, and Turkey Run. A total of eleven were collected at Mine Run with at least one caught in each round. Three salamanders were found at both Dead Run and Turkey Run during round one, for a total of seventeen collected for all streams during the 2006 monitoring season.

Surface water appearance was described as "clear" at the majority of sample stations in 2006. The stream bed deposit was described as "brown/tan" during all three rounds at the majority of sample stations, with sample stations in Turkey Run and Dead Run additionally described as "silty" and with Dead Run also being described as "muddy". The stream bed was consistently termed stable for most stream stations. Dead Run, station one, was termed unstable during both rounds consisting of muddy deposits. Gulf Branch and Turkey Run were the only two streams that did not register an odor in the summer of 2006, with the most common odor being musky.

Stream bank side coverage was poor (<30%) at only two stations, station one of Gulf Branch and station one of Dead Run. Stream bank side coverage for the remaining stations were

divided between good (>70%) and fair (30-70%). Stream bank slope and floodplain coverage was good (>70%) for thirty-four of forty-five sample stations. All remaining sample stations were observed as having fair (30%-70%) stream bank slope and floodplain coverage in summer of 2006. Stream bank erosion recordings varied greatly within each run and round. The majority of stations recorded almost no erosion (<20%), given that stream bank substrate was primarily bedrock or boulders at most stations. Stream channel shade was high (50-80%) or excellent (>80%) at most sample stations.

All sample stations contained some percentage of algae during all rounds of sampling. Most algae was in the form of dark green, benthic algae. Water flow rates were normal for all streams during each round. Average stream depth ranged from 1.5 to 10.0 inches. Average sample depth was between 2 and 5 inches.

Land Use

The USGS National Land Cover Data system was used to categorize land use in each of these watersheds (Figure 13). The NLCD is a 21-class land cover classification system with a data resolution of thirty meters. Of the twenty-one land cover classifications thirteen were identified in the watersheds of these seven streams. In this report these thirteen 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). For a detailed description of these classifications see Appendix 13.

Figure 14 shows land use in the watershed of each of the seven streams as of 1992. Mine Run consists of 63.0% forested land and 28.8% agricultural land as of 1992. 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

Weather

Summer of 2006 had below average rainfall in the months of May, July and August. The month of June received 14.02 inches of rain, 10.89 inches above average (Figure 15). Reagan National Airport recorded 11.37 inches of rainfall in the days between June 22nd and June 28th alone (http://www.noaanews.noaa.gov/stories2006/s2663.htm). This irregular and extreme rainfall event caused major flooding in the Washington D.C. metropolitan area. Stream levels swelled and sampling was delayed until levels returned to normal. Increased stream flow rates and occasional flooding can alter stream morphology by moving stones, tree limbs, and associated sediment and pollutants. This habitat alteration can stress and kill benthic macroinvertebrates or wash them further downstream. It is difficult to determine immediate effects of major storm events; however, stream health scores recovered quickly and showed improvement during round 2 for most streams (Figure 9).

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 seven watersheds and, as expected, its health scores are the highest with an average 8.33 in 2006 and a four year average (’01-’03, ’06) of 8.18. Turkey Run watershed is the most forested watershed and second least residentially/commercially developed, scoring of 5.83 in 2006. 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

Figure 13: Watershed Land-Use

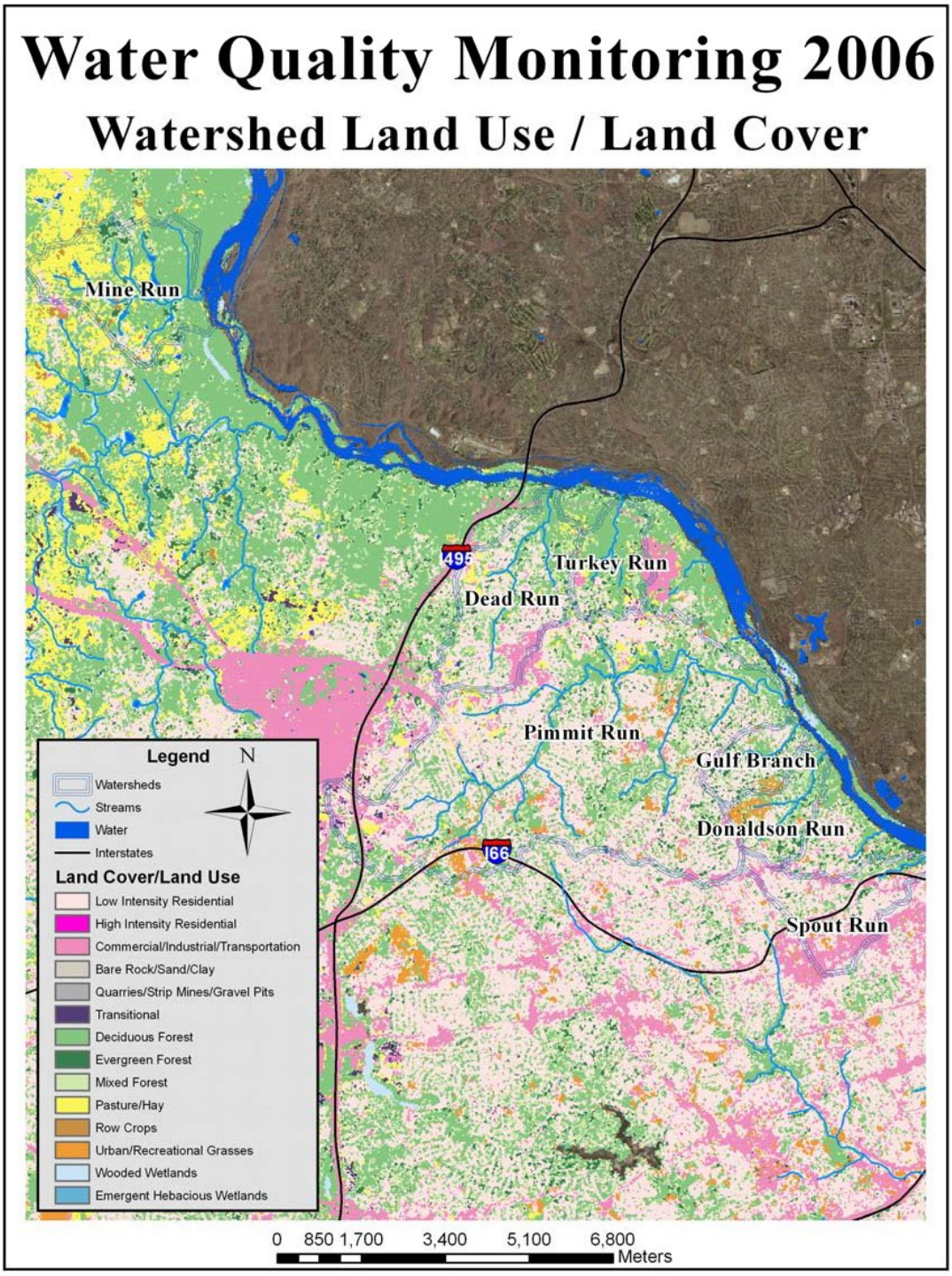
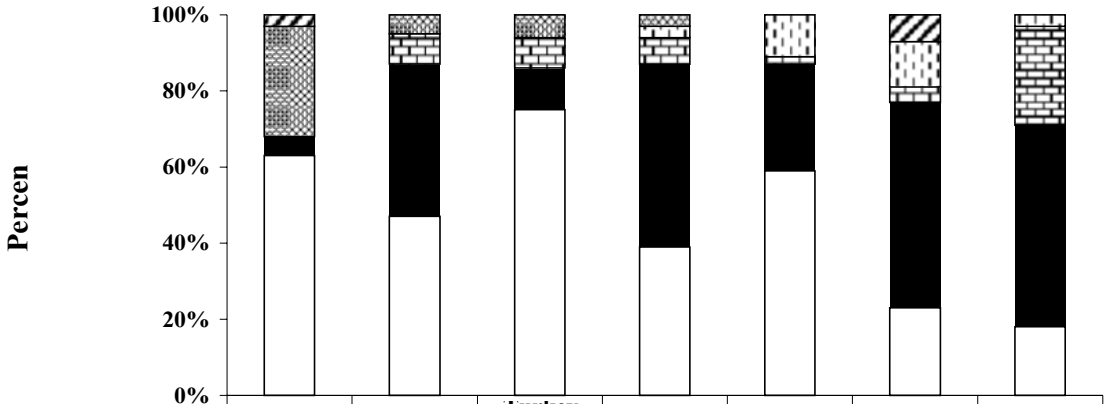


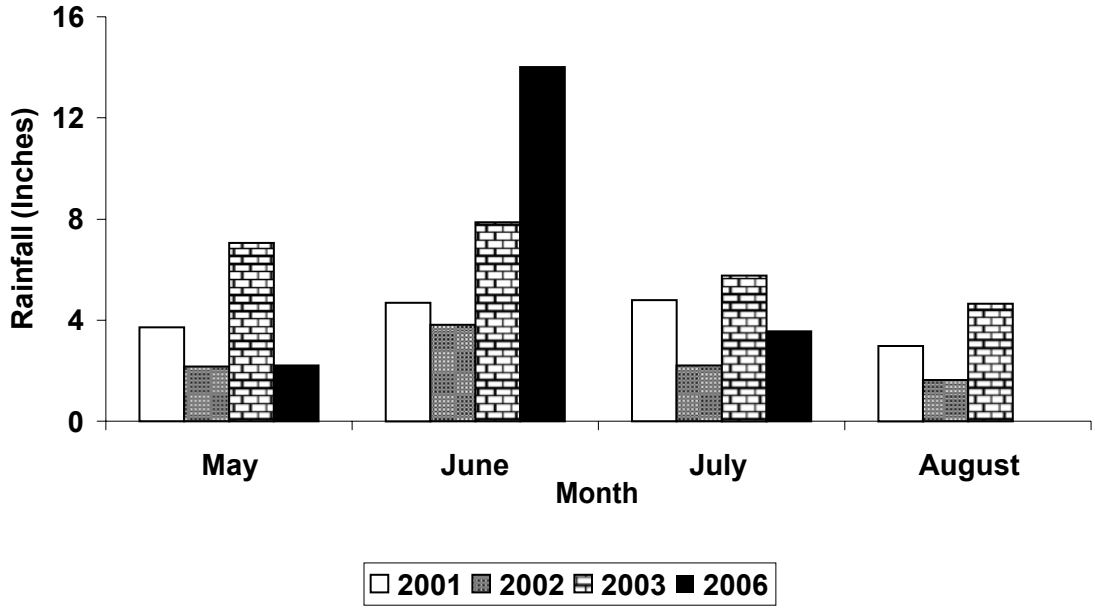
Figure 14: Watershed Land-Use



	Mine Run	Dead Run	Turkey Run	Pimmit Run	Donaldson Run	Gulf Branch	Spout Run
Water Bodies	3%	0%	0%	0%	0%	7%	0%
Agriculture	29%	5%	6%	3%	0%	0%	0%
Urban Grasses	0%	0%	0%	3%	11%	12%	3%
Commercial	0%	8%	8%	7%	2%	4%	26%
Residential	5%	40%	11%	48%	28%	54%	53%
Forest	63%	47%	75%	39%	59%	23%	18%

Stream Watershed

Figure 15: Monthly Rainfall at Ronald Reagan National Airport: 2001-2003, 2006.



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 4.50 and 5.00 respectively in 2006, 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 4.17. Pimmit Run has the second highest percentage of residentially/commercially developed watershed land yet received the third highest score of 5.33 in 2006. Spout Run had the lowest average health score of 3.67 in 2006 and contains the highest percentage of residentially/commercially developed watershed land.

From land-use data we would also predict that water chemistry parameters would reflect variation in land use. However, percent/concentration of dissolved oxygen, pH, nitrate, nitrite, and turbidity were not considerably altered in watersheds with high impacts verses watersheds with low impacts. High conductivity concentrations seem to have similarities between land-use data and stream health scores. Conductivity (Figure 12) was lowest for Mine Run, which produced the highest stream health score; and was highest for Spout Run, which produced the lowest stream health score in 2006. Remaining streams had average (for this data set) conductivity levels and health scores. Lack of direct reflection of stream health scores to most water chemistry and land-use data show the usefulness of benthic macroinvertebrates as biotic indicators of transient impacts. These impacts can occur but are not persistent and often missed when measuring water quality data but have lasting effects on stream biota.

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 1). 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 a health score of 5.00 for 2006.

The data show that macroinvertebrate richness has recovered to pre-contamination conditions for both Donaldson Run and Gulf Branch. Density varied with year and round but has not dropped to, or below, immediate post-contamination conditions. Stream health scores have been lower since the 2001 spill; however, this may be due to annual variation.

RECOMMENDATIONS

From the data collected we can see there is a possible link between increased development of watershed land 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 in order to inform local landowners on the health status of their watershed, making people aware of their environment and suggest

ways to improve its health status. Also, future renovation or development projects need to consider environmentally friendly stormwater management and land use practices to prevent or diminish impacts on these and other Potomac tributaries.

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. For example, Mine Run has been the only stream with a consistent "acceptable" health score among the seven monitored streams. 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.

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.

REFERENCES

Hach Company. 2001. Procedure for Use of Water Quality Test Strips. Hach Company, Loveland, Colorado.

Hanna Instruments. 1997. Instruction manual for portable waterproof pH meters. http://www.hannainst.com.

Jordan, B. M. 1997. Prince William Forest Park Resource Management Division Benthic Macroinvertebrate Reference Collection Guideline. Prince William Forest Park, Dumfries, Virginia.

LaMotte Company. 2000. Procedure for turbidity in water test kit. LaMotte Company, Chestertown, Maryland.

Merritt, R.W. and K.W. Cummins. 1996. An Introduction to the Aquatic Insects of North America, 3rd ed. Kendall/Hunt Publishing Company, Dubuque, IA.

McCafferty, P.W. 1981. Aquatic Entomology the Fisherman's Guide to Insects and Their Relatives. Jones and Bartlett Publishers, Boston, Massachusetts.

National Weather Service: Weather Forecast Office Baltimore/Washington. September 2003. http://www.erh.noaa.gov/er/lwx/climate.htm

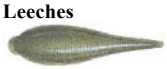
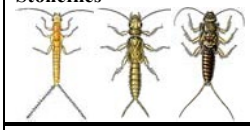
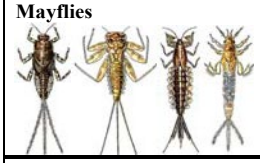
Stormwater Management Branch, Stormwater Planning Division, Department of Public Works and Environmental Services. 2001. Fairfax County Stream Protection Strategy Baseline Study.

Thorp, J. H. and A. P. Covich. 1991. Ecology and classification of North American freshwater invertebrates. Academic Press, Incorporated, New York.

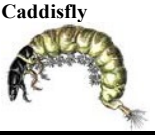
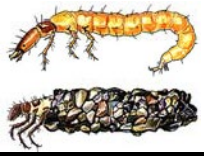
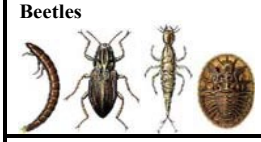
USEPA. 1997. Volunteer Stream Monitoring: A Methods Manual. EPA 841-B-97-003. November. http://www.epa.gov/owow/monitoring/volunteer/stream/

YSI Incorporated.1996. Handheld Oxygen, Conductivity, Salinity, and Temperature System Operations Manual. YSI Incorporated, Yellow Springs, Ohio.

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: Hanna Instruments pH Meter 9025 Instructions (Hanna, 1997)

pH Calibration

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

1. Pour small quantities of pH 7.01 and pH 4.01 (or pH 10.01 for alkaline measurements) into two clean beakers. For accurate calibration use two beakers for each buffer solution, the first one for rinsing the electrode and the second one for calibration. This minimized contamination of the buffers.

2. Immerse the pH electrode into a pH buffer solution (e.g. pH 7.01) and stir gently. The electrode should be submerged approximately 4 cm into the solution, with the temperature probe located as close to it as possible.

3. Press the **CAL** key. The **CAL** and a beaker symbol will be displayed.

4. One of the 5 buffers choices will be displayed (4.01, 6.86, 7.01, 9.18, 10.01). Press the ☒ºC or ☒ºC key until the display changes to the desired buffer.

5. Once the electrode is submerged in the buffer solution, the LCD will notify the user if the reading is not stable by an intermittent **NOT READY**. Only when the reading is stable, will it change to a blinking **READY** and **CON**.

6. Press the **CON** key to confirm the calibration. If the reading is not close to the selected buffer, **WRONG** will blink. If the reading is close to the selected buffer, the meter stores the reading (and adjusts the offset point). The buffer value is then displayed on the primary LCD and the secondary LCD will display another buffer value.

7. Immerse the pH electrode into the second buffer solution (10.01) and stir gently.

8. Select the second buffer value on the secondary display by pressing the ☒ºC or ☒ºC key. When **READY** and **CON** symbols blink on the display, the reading is stable and the calibration can be confirmed.

9. Press the **CON** key. If the reading is not close to the selected buffer solution **WRONG** will blink. If the reading is close to the selected buffer, the slope and the offset are calibrated. The values will be stored in memory and the meter will return to the operation mode.

Disposal: Disposal of the buffer solutions can be done by pouring them down the drain with running water.

pH Meter Operating Instructions

1. Connect the pH electrode and the temperature probe to the BNC and temperature sockets on the top of the instrument.

2. The temperature probe can be used independently to take temperature measurements, or it can be used in conjunction with the pH electrode to utilize the meter's ATC capability. If the probe is disconnected, temperature can also be set manually with the **UP** and **DOWN** keys

3. To switch the instrument on, press and hold the **ON/OFF** key for a second. The meter has a built-in protection against electromagnetic interference and the delayed response of the keys assures that the commands are not mistaken for stray signals.

4. Remove the protective cap and submerge the tip of the electrode and temperature probe 1 ½ inches (4cm) into the sample to be tested.

5. Allow for the electrode to adjust and stabilize.

6. The electrode must be always be kept wet and rinsed thoroughly with the sample to be measured before use.

The pH reading is directly affected by temperature, so the temperature probe and electrode must be located as close to each other as possible.

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: Hach 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_____ºF or ºC Air temp_____ºF or ºC

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? ϒ No ϒ Yes If yes, how many? _____

What types of pipes are they? ϒ Sewage treatment ϒ Runoff (field or stormwater) ϒ 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. _____

_____

HABITAT ASSESSMENT

NORTHERN VIRGINIA SOIL AND WATER CONSERVATION DISTRICT
VOLUNTEER STREAM MONITORING PROGRAM

Fish Water Quality Indicators:
ϒ scattered individuals
ϒ scattered schools
ϒ trout (pollution sensitive)
ϒ bass (somewhat sensitive)
ϒ catfish (pollution tolerant)
ϒ carp (pollution tolerant)

Barriers to Fish Movement:
ϒ beaver dams
ϒ man-made dams
ϒ waterfalls (>1ft)
ϒ other
ϒ none

Salamanders:
ϒ present
how many? _____
ϒ none

Stream:_____

Station #: _____

Date: _____

Surface Water Appearance:
ϒ clear
ϒ clear, but tea-colored
ϒ colored sheen (oily)
ϒ foamy
ϒ milky
ϒ cloudy/turbid
ϒ muddy
ϒ other_____

Stream Bed Deposit (Bottom):
ϒ gray
ϒ orange/red
ϒ yellow
ϒ black
ϒ brown/tan
ϒ silty/muddy
ϒ sandy
ϒ other_____

Odor:
ϒ rotten eggs
ϒ musky
ϒ oil
ϒ sewage
ϒ other_____
ϒ none

Stability of Stream Bed:
Bed sinks beneath your feet in:
ϒ no spots
ϒ a few spots
ϒ many spots

Coverage of Stream Bank by Plants, Rocks, Logs, etc. (vs. exposed soil):	Good	Fair	Poor
	(>70%)	(30-70%)	(<30%)
- Stream banks (sides)	ϒ	ϒ	ϒ
- Top bank (slope and floodplain)	ϒ	ϒ	ϒ

Algae Located:
ϒ everywhere
ϒ in spots
_____% of bed covered
ϒ none

Algae Color (if present):
ϒ light green
ϒ dark green
ϒ brown coated
ϒ matted on stream bed
ϒ hairy/filamentous

Describe Stream Bank sides and Top:
(Mostly shrubs or trees or paved or soil)
_____
_____
_____
_____
_____

Stream Channel Shade:
ϒ >80% excellent
ϒ 50% - 80% high
ϒ 20% - 49% moderate
ϒ <20% almost none
ϒ <20% winter/leaf off

Stream Bank Erosion:
ϒ >80% severe
ϒ 50% - 80% high
ϒ 20% - 49% moderate
ϒ <20% almost none

Pebble Count Results (optional)
100 pebble count
_____ # silt (< 1/4" grains)
_____ # sand (1/16" - 1/4" grains)
_____ # gravel (1/4" - 2" stones)
_____ # cobbles (2" - 10" stones)
_____ # boulders (>10" stones)

Land Uses in the Watershed: Look at a map. Walk your stream in your area. Record all land uses in the watershed area upstream and surrounding your site. Indicate whether these land uses have a High (H), Moderate (M), Slight (S), or No (N) potential (even if present) to impact the quality of your stream. If the land use is not present in your watershed, record NP for Not Present. Leave blank if unsure.

____ Housing Developments
____ Forest
____ Logging
____ Urban Uses (e.g., parking lots, highways, etc.)

____ Sanitary Landfill
____ Active Construction
____ Cropland
____ Recreation

____ Trash Dump
____ Fields
____ Livestock Pasture
____ Other _____
_____

Appendix 9: Benthic Macroinvertebrate and Metric Data

Biological Monitoring: Summer 2006: Round 1

Stream	Station	Date	Worms	Flat Worms	Leeches	Crayfish	Sowbugs	Scuds	Stoneflies	Mayflies
Mine Run	1	06/20/06	15	0	1	3	0	4	71	24
Mine Run	2	06/20/06	15	1	0	0	0	1	40	3
Mine Run	3	06/20/06	14	0	0	0	0	1	24	15
Dead Run	1	06/21/06	7	0	1	0	1	53	0	2
Dead Run	2	06/21/06	25	0	0	1	0	0	0	2
Dead Run	3	06/22/06	19	0	0	0	0	0	0	2
Turkey Run	1	06/22/06	5	0	0	0	3	72	2	27
Turkey Run	2	06/22/06	3	0	0	0	0	177	2	25
Turkey Run	3	06/23/06	20	0	0	3	2	39	1	15
Pimmit Run	1	07/17/06	31	3	0	0	1	0	0	21
Pimmit Run	2	07/17/06	19	2	0	0	0	0	0	8
Pimmit Run	3	07/13/06	10	0	0	0	1	0	0	6
Gulf Branch	1	06/23/06	23	4	0	0	1	6	0	2
Gulf Branch	2	07/03/06	5	0	0	0	1	3	0	1
Gulf Branch	3	07/10/06	23	0	0	0	0	0	0	0
Donaldson Run	1	07/10/06	9	0	0	0	0	0	0	1
Donaldson Run	2	07/11/06	7	0	0	0	0	0	0	5
Donaldson Run	3	07/11/06	20	0	0	0	0	3	0	1
Spout Run	1	07/13/06	55	1	0	0	1	1	0	2
Spout Run	2	07/17/06	15	0	0	0	0	0	0	6
Spout Run	3	07/17/06	90	0	0	2	0	5	0	3

Biological Monitoring: Summer 2006: Round 2

Stream	Station	Date	Worms	Flat Worms	Leeches	Crayfish	Sowbugs	Scuds	Stoneflies	Mayflies
Mine Run	1	07/18/06	10	0	0	1	1	0	9	23
Mine Run	2	07/18/06	0	0	0	1	0	0	24	29
Mine Run	3	07/18/06	0	0	0	1	0	0	9	58
Dead Run	1	07/19/06	7	0	0	0	0	3	0	2
Dead Run	2	07/20/16	7	0	0	1	0	0	0	0
Dead Run	3	07/20/16	5	1	0	1	0	0	0	2
Turkey Run	1	07/21/06	5	0	0	2	0	2	1	6
Turkey Run	2	07/21/06	3	0	0	1	0	1	1	1
Turkey Run	3	07/24/06	17	0	0	4	2	22	8	5
Pimmit Run	1	07/27/06	7	2	0	0	1	0	0	57
Pimmit Run	2	07/28/06	9	4	0	0	0	0	0	106
Pimmit Run	3	07/28/06	14	4	0	0	0	0	0	67
Gulf Branch	1	07/24/06	25	11	0	1	1	0	0	10
Gulf Branch	2	07/25/06	11	1	0	0	3	0	0	8
Gulf Branch	3	07/25/06	4	4	0	1	3	2	0	1
Donaldson Run	1	07/26/06	53	0	0	3	0	0	0	3
Donaldson Run	2	07/26/06	9	0	0	0	0	0	0	27
Donaldson Run	3	07/27/06	60	1	0	1	1	5	0	45
Spout Run	1	07/31/06	14	0	0	0	0	1	0	21
Spout Run	2	08/01/06	3	0	0	0	0	0	0	12
Spout Run	3	08/02/06	58	1	0	1	0	7	0	38

Biological Monitoring: Summer 2006: Round 3

Stream	Station	Date	Worms	Flat Worms	Leeches	Crayfish	Sowbugs	Scuds	Stoneflies	Mayflies
Mine Run	1	08/03/06	0	0	0	2	0	0	5	9
Mine Run	2	08/03/06	0	1	0	2	0	0	5	9
Mine Run	3	08/04/06	0	0	0	2	0	0	3	81

Appendix 9: Benthic Macroinvertebrate and Metric Data

Biological Monitoring: Summer 2006: Round 1

Stream	Station	Dragonflies, Damselflies	Hellgrammites, Fishflies, Alderflies	Common Netspinners	Most Caddisflies	Beetles	Midges	Black Flies
Mine Run	1	0	1	372	74	44	44	3
Mine Run	2	2	0	356	47	10	18	3
Mine Run	3	1	0	180	20	30	43	4
Dead Run	1	0	0	37	4	0	69	19
Dead Run	2	0	0	134	32	0	44	4
Dead Run	3	0	0	309	13	1	42	37
Turkey Run	1	0	0	159	61	9	40	1
Turkey Run	2	1	1	160	74	3	58	4
Turkey Run	3	0	0	172	58	7	85	8
Pimmit Run	1	0	0	105	2	1	52	2
Pimmit Run	2	0	0	109	1	2	54	2
Pimmit Run	3	0	0	93	11	0	80	1
Gulf Branch	1	0	0	20	1	1	104	31
Gulf Branch	2	0	0	14	0	0	117	3
Gulf Branch	3	0	0	8	0	0	361	46
Donaldson Run	1	0	0	4	0	1	224	1
Donaldson Run	2	0	0	17	0	0	736	9
Donaldson Run	3	0	0	9	0	1	348	0
Spout Run	1	0	0	8	1	0	125	0
Spout Run	2	0	0	24	0	0	164	1
Spout Run	3	0	0	5	0	0	108	1

Biological Monitoring: Summer 2006: Round 2

Stream	Station	Dragonflies, Damselflies	Hellgrammites, Fishflies, Alderflies	Common Netspinners	Most Caddisflies	Beetles	Midges	Black Flies
Mine Run	1	1	1	50	74	9	80	4
Mine Run	2	3	4	394	272	32	30	25
Mine Run	3	1	2	273	290	23	110	5
Dead Run	1	0	0	4	1	0	158	33
Dead Run	2	0	0	99	65	0	111	59
Dead Run	3	0	0	452	106	0	122	165
Turkey Run	1	0	0	30	41	1	166	55
Turkey Run	2	0	0	53	71	3	117	20
Turkey Run	3	0	0	74	61	2	46	5
Pimmit Run	1	0	1	203	57	1	480	31
Pimmit Run	2	0	0	196	50	0	297	50
Pimmit Run	3	0	0	299	136	2	243	68
Gulf Branch	1	0	1	112	0	0	266	84
Gulf Branch	2	0	0	103	0	0	375	122
Gulf Branch	3	0	0	44	0	0	334	119
Donaldson Run	1	0	0	87	4	0	157	38
Donaldson Run	2	0	0	226	9	0	251	70
Donaldson Run	3	0	0	107	5	0	365	24
Spout Run	1	0	0	80	0	0	545	22
Spout Run	2	0	0	52	3	0	246	6
Spout Run	3	0	0	30	0	0	267	8

Biological Monitoring: Summer 2006: Round 3

Stream	Station	Dragonflies, Damselflies	Hellgrammites, Fishflies, Alderflies	Common Netspinners	Most Caddisflies	Beetles	Midges	Black Flies
Mine Run	1	0	1	36	18	12	205	2
Mine Run	2	0	1	121	23	65	466	16
Mine Run	3	0	0	545	140	11	92	38

Appendix 9: Benthic Macroinvertebrate and Metric Data

Biological Monitoring: Summer 2006: Round 1

Stream	Station	Most True Flies	Gilled Snails	Lunged Snails	Clams	Other	Total
Mine Run	1	17	0	1	0	0	674
Mine Run	2	9	0	0	1	0	506
Mine Run	3	4	0	0	0	0	336
Dead Run	1	2	0	5	0	0	200
Dead Run	2	15	0	1	0	0	258
Dead Run	3	12	0	2	0	0	437
Turkey Run	1	26	0	1	0	0	406
Turkey Run	2	23	1	2	0	0	534
Turkey Run	3	14	0	0	1	4	429
Pimmit Run	1	0	0	1	0	2	221
Pimmit Run	2	1	0	0	0	2	200
Pimmit Run	3	2	0	1	0	1	206
Gulf Branch	1	4	0	7	0	0	204
Gulf Branch	2	12	0	0	0	4	160
Gulf Branch	3	2	0	1	0	0	441
Donaldson Run	1	0	0	1	0	2	243
Donaldson Run	2	0	0	2	0	0	776
Donaldson Run	3	2	0	6	0	0	390
Spout Run	1	2	0	20	0	1	217
Spout Run	2	7	0	2	0	0	219
Spout Run	3	4	0	26	0	0	244

Biological Monitoring: Summer 2006: Round 2

Stream	Station	Most True Flies	Gilled Snails	Lunged Snails	Clams	Other	Total
Mine Run	1	5	0	0	0	0	268
Mine Run	2	6	0	0	0	0	820
Mine Run	3	5	0	0	0	0	777
Dead Run	1	1	0	1	0	0	210
Dead Run	2	2	0	1	0	0	345
Dead Run	3	1	0	1	0	0	856
Turkey Run	1	2	0	0	0	0	311
Turkey Run	2	1	0	0	0	3	275
Turkey Run	3	4	0	1	0	0	251
Pimmit Run	1	28	0	2	0	11	881
Pimmit Run	2	28	0	0	0	13	753
Pimmit Run	3	16	0	2	0	17	868
Gulf Branch	1	5	0	0	0	0	516
Gulf Branch	2	1	0	1	0	0	625
Gulf Branch	3	0	0	0	0	1	513
Donaldson Run	1	2	0	0	0	0	347
Donaldson Run	2	11	0	2	0	4	609
Donaldson Run	3	4	0	19	0	0	637
Spout Run	1	22	0	72	0	24	801
Spout Run	2	6	0	15	0	16	359
Spout Run	3	11	0	31	0	36	488

Biological Monitoring: Summer 2006: Round 3

Stream	Station	Most True Flies	Gilled Snails	Lunged Snails	Clams	Other	Total
Mine Run	1	3	0	0	0	0	293
Mine Run	2	1	0	0	0	0	710
Mine Run	3	7	0	0	0	0	919

Appendix 9: Benthic Macroinvertebrate and Metric Data

Individual Category Metrics: 2006: Round 1

Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	% Lunged Snails	% Tolerant	% Non-insects	% Beetles
Mine Run	1	25.07	55.19	0.15	10.09	3.56	6.53
Mine Run	2	17.79	70.36	0.00	8.10	3.56	1.98
Mine Run	3	17.56	53.57	0.00	18.75	4.46	8.93
Dead Run	1	3.00	18.50	2.50	77.50	33.50	0.00
Dead Run	2	13.18	51.94	0.39	28.68	10.47	0.00
Dead Run	3	3.43	70.71	0.46	22.88	4.81	0.23
Turkey Run	1	22.17	39.16	0.25	30.05	19.95	2.22
Turkey Run	2	18.91	29.96	0.37	45.88	34.27	0.56
Turkey Run	3	17.25	40.09	0.00	36.13	15.15	1.63
Pimmit Run	1	10.41	47.51	0.45	40.72	16.29	0.45
Pimmit Run	2	4.50	54.50	0.00	38.50	10.50	1.00
Pimmit Run	3	8.25	45.15	0.49	45.15	5.83	0.00
Gulf Branch	1	1.47	9.80	3.43	86.27	20.10	0.49
Gulf Branch	2	0.63	8.75	0.00	80.63	5.63	0.00
Gulf Branch	3	0.00	1.81	0.23	97.73	5.44	0.00
Donaldson Run	1	0.41	1.65	0.41	96.71	4.12	0.41
Donaldson Run	2	0.64	2.19	0.26	97.16	1.16	0.00
Donaldson Run	3	0.26	2.31	1.54	96.67	7.44	0.26
Spout Run	1	1.38	3.69	9.22	93.55	35.94	0.00
Spout Run	2	2.74	10.96	0.91	83.11	7.76	0.00
Spout Run	3	1.23	2.05	10.66	94.26	50.41	0.00

Individual Category Metrics: 2006: Round 2

Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	% Lunged Snails	% Tolerant	% Non-insects	% Beetles
Mine Run	1	39.55	18.66	0.00	35.82	4.48	3.36
Mine Run	2	39.63	48.05	0.00	7.07	0.12	3.90
Mine Run	3	45.95	35.14	0.00	14.93	0.13	2.96
Dead Run	1	1.43	1.90	0.48	96.19	5.24	0.00
Dead Run	2	18.84	28.70	0.29	51.59	2.61	0.00
Dead Run	3	12.62	52.80	0.12	34.35	0.93	0.00
Turkey Run	1	15.43	9.65	0.00	73.31	2.89	0.32
Turkey Run	2	26.55	19.27	0.00	51.27	1.82	1.09
Turkey Run	3	29.48	29.48	0.40	37.05	18.33	0.80
Pimmit Run	1	12.94	23.04	0.23	59.36	1.36	0.11
Pimmit Run	2	20.72	26.03	0.00	47.81	1.73	0.00
Pimmit Run	3	23.39	34.45	0.23	38.13	2.30	0.23
Gulf Branch	1	1.94	21.71	0.00	75.00	7.36	0.00
Gulf Branch	2	1.28	16.48	0.16	82.08	2.56	0.00
Gulf Branch	3	0.19	8.58	0.00	90.84	2.73	0.00
Donaldson Run	1	2.02	25.07	0.00	71.47	16.14	0.00
Donaldson Run	2	5.91	37.11	0.33	54.52	1.81	0.00
Donaldson Run	3	7.85	16.80	2.98	74.57	13.66	0.00
Spout Run	1	2.62	9.99	8.99	81.65	10.86	0.00
Spout Run	2	4.18	14.48	4.18	75.21	5.01	0.00
Spout Run	3	7.79	6.15	6.35	76.23	20.08	0.00

Individual Category Metrics: 2006: Round 3

Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	% Lunged Snails	% Tolerant	% Non-insects	% Beetles
Mine Run	1	10.92	12.29	0.00	70.65	0.68	4.10
Mine Run	2	5.21	17.04	0.00	68.03	0.42	9.15
Mine Run	3	24.37	59.30	0.00	14.15	0.22	1.20

Appendix 9: Benthic Macroinvertebrate and Metric Data

Multimetric Index: 2006: Round 1

Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	% Lunged Snails	% Beetles	% Tolerant
Mine Run	1	1	0	2	2	2
Mine Run	2	1	0	2	0	2
Mine Run	3	1	0	2	2	2
Dead Run	1	0	2	1	0	0
Dead Run	2	0	0	0	0	2
Dead Run	3	0	0	0	0	2
Turkey Run	1	1	0	2	0	2
Turkey Run	2	1	1	0	0	2
Turkey Run	3	1	0	2	0	2
Pimmit Run	1	0	0	0	0	2
Pimmit Run	2	0	0	2	0	2
Pimmit Run	3	0	0	0	0	2
Gulf Branch	1	0	2	1	0	0
Gulf Branch	2	0	2	2	0	0
Gulf Branch	3	0	2	2	0	0
Donaldson Run	1	0	2	0	0	0
Donaldson Run	2	0	2	2	0	0
Donaldson Run	3	0	2	1	0	0
Spout Run	1	0	2	1	0	0
Spout Run	2	0	2	0	0	0
Spout Run	3	0	2	1	0	0

Multimetric Index: 2006: Round 2

Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	% Lunged Snails	% Beetles	% Tolerant
Mine Run	1	2	2	2	1	2
Mine Run	2	2	0	2	1	2
Mine Run	3	2	0	2	0	2
Dead Run	1	0	2	0	0	0
Dead Run	2	1	1	2	0	1
Dead Run	3	0	0	2	0	2
Turkey Run	1	0	2	2	0	0
Turkey Run	2	1	2	2	0	1
Turkey Run	3	1	1	0	0	2
Pimmit Run	1	0	1	2	0	1
Pimmit Run	2	1	1	2	0	1
Pimmit Run	3	1	1	2	0	2
Gulf Branch	1	0	1	2	0	0
Gulf Branch	2	0	2	2	0	0
Gulf Branch	3	0	2	2	0	0
Donaldson Run	1	0	1	2	0	0
Donaldson Run	2	0	0	0	0	1
Donaldson Run	3	0	2	1	0	0
Spout Run	1	0	2	1	0	0
Spout Run	2	0	2	1	0	0
Spout Run	3	0	2	1	0	0

Multimetric Index: 2006: Round 3

Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	% Lunged Snails	% Beetles	% Tolerant
Mine Run	1	0	2	2	1	0
Mine Run	2	0	2	2	2	0
Mine Run	3	1	0	2	0	2

Appendix 9: Benthic Macroinvertebrate and Metric Data

Multimetric Index: 2006: Round 1

Stream	Station	% Non-insects	Multimetric Index Score	Ecological Condition
Mine Run	1	2	9	Acceptable
Mine Run	2	2	7	Acceptable
Mine Run	3	2	9	Acceptable
Dead Run	1	0	3	Unacceptable
Dead Run	2	1	3	Unacceptable
Dead Run	3	2	4	Unacceptable
Turkey Run	1	1	6	Unacceptable
Turkey Run	2	0	4	Unacceptable
Turkey Run	3	1	6	Unacceptable
Pimmit Run	1	1	3	Unacceptable
Pimmit Run	2	1	5	Unacceptable
Pimmit Run	3	1	3	Unacceptable
Gulf Branch	1	1	4	Unacceptable
Gulf Branch	2	1	5	Unacceptable
Gulf Branch	3	1	5	Unacceptable
Donaldson Run	1	2	4	Unacceptable
Donaldson Run	2	2	6	Unacceptable
Donaldson Run	3	1	4	Unacceptable
Spout Run	1	0	3	Unacceptable
Spout Run	2	1	3	Unacceptable
Spout Run	3	0	3	Unacceptable

Multimetric Index: 2006: Round 2

Stream	Station	% Non-insects	Multimetric Index Score	Ecological Condition
Mine Run	1	2	11	Acceptable
Mine Run	2	2	9	Acceptable
Mine Run	3	2	8	Acceptable
Dead Run	1	2	4	Unacceptable
Dead Run	2	2	7	Acceptable
Dead Run	3	2	6	Unacceptable
Turkey Run	1	2	6	Unacceptable
Turkey Run	2	2	8	Acceptable
Turkey Run	3	1	5	Unacceptable
Pimmit Run	1	2	6	Unacceptable
Pimmit Run	2	2	7	Acceptable
Pimmit Run	3	2	8	Acceptable
Gulf Branch	1	1	4	Unacceptable
Gulf Branch	2	2	6	Unacceptable
Gulf Branch	3	2	6	Unacceptable
Donaldson Run	1	1	4	Unacceptable
Donaldson Run	2	2	3	Unacceptable
Donaldson Run	3	1	4	Unacceptable
Spout Run	1	1	4	Unacceptable
Spout Run	2	2	5	Unacceptable
Spout Run	3	1	4	Unacceptable

Multimetric Index: 2006: Round 3

Stream	Station	% Non-insects	Multimetric Index Score	Ecological Condition
Mine Run	1	2	7	Acceptable
Mine Run	2	2	8	Acceptable
Mine Run	3	2	7	Acceptable

Appendix 10: Wilcoxon Test Data and Example Calculation

Comparison		Wilcoxon Test Example			
Turkey Run	Gulf Branch	Xa-Xb	| Xa-Xb |	Rank	Rank w/sign
7	6	1	1	4.5	4.5
1	4	-3	3	14	-14
3	4	-1	1	4.5	-4.5
2	4	-2	2	11	-11
3	4	-1	1	4.5	-4.5
4	5	-1	1	4.5	-4.5
4	4	0	0	-	-
4	5	-1	1	4.5	-4.5
4	4	0	0	-	-
5	3	2	2	11	11
6	5	1	1	4.5	4.5
6	4	2	2	11	11
6	5	1	1	4.5	4.5
6	4	2	2	11	11
8	6	2	2	11	11
5	6	-1	1	4.5	-4.5
W+ and W- values are used to determine critical values and approximate					
				W+ = 57.5	W- = 47.5
significance levels based on N				N = 14	

Ranking System Calculations					
| Xa-Xb |	Rank 1 (Ties)	Rank 2 (Ties)	Rank 3 (No Ties)	Final Rank	Rank w/sign
1	1			4.5	4.5
3			14	14	-14
1	2			4.5	-4.5
2		9		11	-11
1	3			4.5	-4.5
1	4			4.5	-4.5
0				-	-
1	5			4.5	-4.5
0				-	-
2		10		11	11
1	6			4.5	4.5
2		11		11	11
1	7			4.5	4.5
2		12		11	11
2		13		11	11
1	8			4.5	-4.5
Sum	36	55			

Tied ranks are summed and averaged	Sum	# of Ties	Average
Rank 1 (Ties)	36	8	4.5
Rank 2 (Ties)	55	5	11
Average of Rank 1 (Ties) are assigned to all 1's			
Average of Rank 2 (Ties) are assigned to all 2's			
W+ = The sum of the ranks with a positive sign			
W- = The sum of the ranks with a negative sign			
N = The number of non-tied pairs			

Appendix 10: Wilcoxon Test Data and Example Calculation

	Data Set						
Year	Mine Run	Dead Run	Turkey Run	Pimmit Run	Gulf Branch	Donaldson Run	Spout Run
2001	9	-	-	6	9	4	7
	7	-	-	6	5	6	7
	10	-	7	4	6	8	7
	10	5	8	3	-	4	6
	8	-	7	6	-	-	2
	9	-	-	6	-	-	-
	9	5	3	9	-	-	-
	-	7	-	9	-	-	4
	8	7	-	9	-	-	4
2002	9	3	1	2	4	4	7
	9	5	3	2	4	4	2
	7	3	2	5	4	4	2
	9	3	3	3	4	4	4
	7	5	4	4	5	-	3
	7	5	4	4	4	5	3
2003	4	6	2	3	-	5	4
	6	5	5	5	-	2	5
	8	2	4	5	-	5	5
	9	4	5	5	-	3	-
	9	5	4	2	-	4	-
	9	5	4	2	5	5	3
	8	5	4	5	4	6	3
	9	-	5	5	3	7	2
	9	4	6	4	5	6	2
2006	9	3	6	3	4	4	3
	7	3	4	5	-	6	3
	9	4	6	3	5	4	3
	11	4	6	6	4	4	4
	9	7	8	7	6	3	5
	8	6	5	8	6	4	4

Appendix 11: Water Chemistry Data

Monitoring: Summer 2006: Round 1

Stream	Station	Nitrite (ppm)	Nitrate (ppm)	Turbidity JTU	pH	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	Conductivity (uS)
Mine Run	1	0	0-1	<2.5	7.41	82.3	7.33	123.7
Mine Run	2	0	0-1	<2.5	7.60	85.9	7.66	127.0
Mine Run	3	0	0-1	<2.5	7.52	87.0	7.78	125.5
Dead Run	1	0	0-1	~2.5	7.28	88.4	7.79	106.0
Dead Run	2	0	0-1	<2.5	7.40	86.0	7.41	154.1
Dead Run	3	0	0-1	<2.5	7.42	92.5	8.16	168.9
Turkey Run	1	0	0-1	<2.5	7.70	92.6	8.48	304.9
Turkey Run	2	0	0-1	<2.5	7.75	97.8	8.66	316.6
Turkey Run	3	0	0-1	10	7.45	94.5	8.51	231.5
Pimmit Run	1	0	0-1	<2.5	8.02	113.4	9.61	283.8
Pimmit Run	2	0	0-1	<2.5	8.71	114.9	9.40	288.0
Pimmit Run	3	0	0-1	<2.5	7.80	103.7	8.84	278.1
Gulf Branch	1	0	0-1	<2.5	7.30	92.6	8.19	206.8
Gulf Branch	2	0	2	<2.5	7.30	93.0	8.21	245.4
Gulf Branch	3	0	2	<2.5	7.34	91.0	8.35	333.8
Donaldson Run	1	0	2	<2.5	7.56	92.3	8.30	361.9
Donaldson Run	2	0	2	<2.5	7.75	105.1	9.35	362.8
Donaldson Run	3	0	2	<2.5	7.75	101.1	8.56	364.3
Spout Run	1	0	1-2	<2.5	7.81	95.2	8.07	503.0
Spout Run	2	0	2-5	<2.5	7.76	102.0	8.73	521.0
Spout Run	3	0	2	<2.5	7.84	108.7	8.99	552.0

Monitoring: Summer 2006: Round 2

Stream	Station	Nitrite (ppm)	Nitrate (ppm)	Turbidity JTU	pH	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	Conductivity (uS)
Mine Run	1	0	0-1	<2.5	7.05	91.8	7.90	135.4
Mine Run	2	0	0-1	<2.5	7.24	100.5	8.48	138.4
Mine Run	3	0	0-1	<2.5	7.56	103.2	8.54	141.7
Dead Run	1	0	0-1	<2.5	7.30	111.9	9.39	236.1
Dead Run	2	0	2	~2.5	7.64	114.0	8.63	247.6
Dead Run	3	0	2	~2.5	7.62	98.4	8.16	246.6
Turkey Run	1	0	1-2	<2.5	7.83	104.3	8.13	345.1
Turkey Run	2	0	0-1	<2.5	7.92	96.5	8.29	348.2
Turkey Run	3	0	0-1	<2.5	7.59	95.2	8.75	287.4
Pimmit Run	1	0	0-1	<2.5	7.83	97.7	7.81	238.1
Pimmit Run	2	0	0-1	<2.5	7.68	103.1	8.56	291.1
Pimmit Run	3	0	0-1	<2.5	7.87	102.5	8.24	295.7
Gulf Branch	1	0	2	<2.5	7.49	108.2	9.50	369.9
Gulf Branch	2	0	2	<2.5	7.49	97.2	8.61	381.2
Gulf Branch	3	0	2	<2.5	7.54	93.6	8.13	385.9
Donaldson Run	1	0	0-1	<2.5	7.71	104.6	8.06	397.7
Donaldson Run	2	0	2	<2.5	7.80	106.1	9.03	397.0
Donaldson Run	3	0	0-1	<2.5	7.69	97.3	8.34	394.6
Spout Run	1	0	5	<2.5	7.88	103.6	8.62	556.0
Spout Run	2	0	5	<2.5	7.88	114.4	8.45	580.0
Spout Run	3	0	2	<2.5	7.85	115.0	9.52	575.0

Monitoring: Summer 2006: Round 3

Stream	Station	Nitrite (ppm)	Nitrate (ppm)	Turbidity JTU	pH	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	Conductivity (uS)
Mine Run	1	0	0-1	<2.5	7.41	102.2	9.51	134.4
Mine Run	2	0	0-1	<2.5	7.41	100.5	8.30	136.3
Mine Run	3	0	0-1	<2.5	7.56	98.5	8.27	135.8

Appendix 12: Stream Habitat Assessment Data

Monitoring: Summer 2006: Round 1

Stream	Station	(water) Width (feet)	(bank-to-bank) Width (feet)	Stream Flow Rate	Riffle Depth (in.)	Stream Depth (in.)	Water Temperature (°C)	Air Temperature (°C)	Fish Water Quality Indicators
Mine Run	1	12.0	28.5	Normal	~2	~3	20.9	26.1	scattered individuals
Mine Run	2	13.0	24.0	Normal	~4	~3.5	20.9	25.4	none
Mine Run	3	12.0	36.0	Normal	~3	~3	20.8	24.2	scattered individuals
Dead Run	1	12.0	58.5	Normal	~2.5	~3.5	22.0	23.3	scattered individuals
Dead Run	2	11.0	39.0	Normal	~1.5	~5	23.1	27.2	none
Dead Run	3	8.0	32.0	Normal	~2.5	~5	21.2	22.4	none
Turkey Run	1	17.0	32.0	Normal	~3.5	~4	19.6	22.0	scattered individuals
Turkey Run	2	20.0	38.0	Normal	~1.5	~5	21.3	24.7	scattered individuals
Turkey Run	3	25.0	28.0	Normal	~2.5	~5	20.4	21.8	none
Pimmit Run	1	30.0	53.0	Normal	~5	~9	23.5	25.7	none
Pimmit Run	2	36.0	69.0	Normal	~5	~8	25.5	30.7	none
Pimmit Run	3	25.0	68.0	Normal	~6	~10	23.3	24.1	none
Gulf Branch	1	12.0	28.0	High	~2	~7	21.8	23.2	none
Gulf Branch	2	7.0	32.0	Normal	~3	~3.5	21.4	23.0	none
Gulf Branch	3	4.0	35.5	Normal	~3	~3	19.4	22.4	none
Donaldson Run	1	32.0	56.0	Normal	~1.5	~3.5	20.5	24.1	none
Donaldson Run	2	17.0	33.0	Normal	~4	~5	21.0	24.3	none
Donaldson Run	3	13.0	42.0	Normal	~2.5	~5	21.9	26.8	none
Spout Run	1	20.0	44.0	Normal	~7	~5	23.7	25.3	none
Spout Run	2	9.0	28.0	Normal	~5	~8	23.2	25.4	none
Spout Run	3	16.0	29.0	Normal	~ 4	~8	24.9	28.0	none

Monitoring: Summer 2006: Round 2

Stream	Station	(water) Width (feet)	(bank-to-bank) Width (feet)	Stream Flow Rate	Riffle Depth (in.)	Stream Depth (in.)	Water Temperature (°C)	Air Temperature (°C)	Fish Water Quality Indicators
Mine Run	1	10.5	25.0	Normal	~3	~2.5	22.6	25.9	scattered schools
Mine Run	2	6.0	25.5	Normal	~3.5	~3.5	23.9	27.9	scattered schools
Mine Run	3	41.0	58.0	Normal	~3	~6	24.9	28.0	none
Dead Run	1	9.0	88.0	Normal	~2.5	~3	24.1	36.3	scattered schools
Dead Run	2	11.5	34.0	Normal	~3.5	~8.5	23.7	26.2	none
Dead Run	3	11.0	46.0	Normal	~3	~4	24.6	26.3	none
Turkey Run	1	19.0	33.0	Normal	~2.5	~3	22.0	24.8	scattered schools
Turkey Run	2	11.0	34.0	Normal	~3	~3	22.8	28.4	scattered individuals
Turkey Run	3	30.0	38.0	Normal	~2	~4	19.3	22.6	none
Pimmit Run	1	46.0	78.0	Normal	~4.5	~6	26.5	29.8	none
Pimmit Run	2	37.0	68.0	Normal	~4.5	~6	24.8	26.7	none
Pimmit Run	3	33.0	58.0	Normal	~4	~9	26.2	29.0	none
Gulf Branch	1	10.0	37.0	Normal	~2.5	~3	21.6	28.9	none
Gulf Branch	2	7.5	34.0	Normal	~4	~4	22.9	26.0	none
Gulf Branch	3	4.5	33.0	Normal	~2.5	~6	22.2	28.1	none
Donaldson Run	1	36.0	63.0	Normal	~3	~5.5	22.3	27.4	scattered individuals
Donaldson Run	2	10.0	35.0	Normal	~3	~5.5	25.4	33.5	none
Donaldson Run	3	15.0	36.0	Normal	~3	~8	23.1	27.5	none
Spout Run	1	10.0	37.0	Normal	~5	~4	24.5	27.8	none
Spout Run	2	7.0	29.0	Normal	~3	~5.5	24.9	28.3	none
Spout Run	3	14.0	36.0	Normal	~3	~4.5	24.9	28.9	none

Monitoring: Summer 2006: Round 3

Stream	Station	(water) Width (feet)	(bank-to-bank) Width (feet)	Stream Flow Rate	Riffle Depth (in.)	Stream Depth (in.)	Water Temperature (°C)	Air Temperature (°C)	Fish Water Quality Indicators
Mine Run	1	8.0	27.0	Normal	~2.5	~1.5	24.4	27.6	scattered individuals
Mine Run	2	4.5	24.0	Normal	~2	~2	25	28.3	none
Mine Run	3	18.0	58.0	Normal	~2	~7	24.1	27.3	scattered individuals

Appendix 12: Stream Habitat Assessment Data

Monitoring: Summer 2006: Round 1

Stream	Station	Barriers to fish movement	Salamanders	Surface water appearance	Stream bed deposit	Odor
Mine Run	1	none	1	clear	brown/tan, sandy	none
Mine Run	2	none	1	clear	brown/tan, sandy	sewage
Mine Run	3	none	none	clear	brown/tan, sandy	none
Dead Run	1	waterfall (>1ft.)	none	clear	brown/tan, sandy	none
Dead Run	2	waterfall (>1ft.)	2	clear	brown/tan	musky
Dead Run	3	waterfall (>1ft.)	1	clear/tea-colored	brown/tan, sandy	none
Turkey Run	1	waterfall (>1ft.)	1	clear	brown/tan, silty/muddy	none
Turkey Run	2	waterfall (>1ft.)	2	clear	brown/tan, silty/muddy, sandy	none
Turkey Run	3	waterfall (>1ft.)	none	cloudy/turbid	brown/tan, silty/muddy	none
Pimmit Run	1	none	none	clear	brown/tan	none
Pimmit Run	2	waterfall (>1ft.)	none	clear	brown/tan	none
Pimmit Run	3	waterfall (>1ft.)	none	clear	brown/tan	none
Gulf Branch	1	waterfall (>1ft.)	none	clear	brown/tan	none
Gulf Branch	2	waterfall (>1ft.)	none	clear	brown/tan, sandy	none
Gulf Branch	3	waterfall (>1ft.)	none	clear	brown/tan	none
Donaldson Run	1	waterfall (>1ft.)	none	clear	brown/tan	musky
Donaldson Run	2	waterfall (>1ft.)	none	clear	brown/tan	musky
Donaldson Run	3	waterfall (>1ft.)	none	clear	brown/tan	none
Spout Run	1	waterfall (>1ft.)	none	clear	brown/tan	musky
Spout Run	2	waterfall (>1ft.)	none	clear	brown/tan	musky
Spout Run	3	waterfall (>1ft.)	none	clear	brown/tan, sandy	musky

Monitoring: Summer 2006: Round 2

Stream	Station	Barriers to fish movement	Salamanders	Surface water appearance	Stream bed deposit	Odor
Mine Run	1	none	none	clear	gray	none
Mine Run	2	none	5	clear	brown/tan	musky
Mine Run	3	waterfall (>1ft.)	none	clear	brown/tan	none
Dead Run	1	waterfall (>1ft.)	none	celar	brown/tan, sandy	musky
Dead Run	2	waterfall (>1ft.)	none	clear	brown/tan, gray	none
Dead Run	3	waterfall (>1ft.)	none	clear	brown/tan, sandy	none
Turkey Run	1	none	none	clear	brown/tan, sandy	none
Turkey Run	2	waterfall (>1ft.)	none	clear	brown/tan, sandy	none
Turkey Run	3	none	none	clear	brown/tan, sandy, bedrock	none
Pimmit Run	1	none	none	clear	gray	musky/oil/sewage
Pimmit Run	2	none	none	clear	brown/tan, sandy	none
Pimmit Run	3	none	none	clear	gray, arange/red	none
Gulf Branch	1	waterfall (>1ft.)	none	clear	brown/tan, sandy	none
Gulf Branch	2	waterfall (>1ft.)	none	clear	gray	none
Gulf Branch	3	waterfall (>1ft.)	none	clear	brown/tan, sandy	none
Donaldson Run	1	waterfall (>1ft.)	none	clear	gray	none
Donaldson Run	2	waterfall (>1ft.)	none	clear	brown/tan, sandy	none
Donaldson Run	3	waterfall (>1ft.)	none	clear	gray	none
Spout Run	1	waterfall (>1ft.)	none	clear	brown/tan	none
Spout Run	2	waterfall (>1ft.)	none	clear	brown/tan	musky
Spout Run	3	waterfall (>1ft.)	none	clear	brown/tan	musky/old paint

Monitoring: Summer 2006: Round 3

Stream	Station	Barriers to fish movement	Salamanders	Surface water appearance	Stream bed deposit	Odor
Mine Run	1	none	3	clear	brown/tan	none
Mine Run	2	none	1	clear	brown/tan	sewage
Mine Run	3	waterfall (>1ft.)	none	clear	brown/tan	none

Appendix 12: Stream Habitat Assessment Data

Monitoring: Summer 2006: Round 1					
Stream	**Station**	**Stability of stream bed: Bed sinks beneath your feet in:**	**Coverage of Stream Bank (sides)**	**Coverage of Stream Bank (slope and floodplain)**	**Algae Located**
Mine Run	1	no spots	>70% (good)	>70% (good)	in spots
Mine Run	2	no spots	>70% (good)	>70% (good)	in spots
Mine Run	3	no spots	>70% (good)	>70% (good)	in spots
Dead Run	1	many spots	>70% (good)	30-70% (fair)	in spots
Dead Run	2	no spots	>70% (good)	>70% (good)	in spots
Dead Run	3	no spots	>70% (good)	>70% (good)	in spots
Turkey Run	1	no spots	30-70% (fair)	>70% (good)	in spots
Turkey Run	2	a few spots	>70% (good)	30-70% (fair)	in spots
Turkey Run	3	no spots	>70% (good)	>70% (good)	in spots
Pimmit Run	1	no spots	>70% (good)	30-70% (fair)	in spots
Pimmit Run	2	no spots	>70% (good)	>70% (good)	in spots
Pimmit Run	3	no spots	30-70% (fair)	>70% (good)	in spots
Gulf Branch	1	no spots	<30% (poor)	30-70% (fair)	in spots
Gulf Branch	2	no spots	30-70% (fair)	30-70% (fair)	in spots
Gulf Branch	3	no spots	>70% (good)	>70% (good)	in spots
Donaldson Run	1	no spots	30-70% (fair)	30-70% (fair)	in spots
Donaldson Run	2	no spots	>70% (good)	>70% (good)	in spots
Donaldson Run	3	a few spots	>70%(good)	>70%(good)	in spots
Spout Run	1	no spots	>70% (good)	30-70% (fair)	in spots
Spout Run	2	no spots	30-70% (fair)	>70% (good)	in spots
Spout Run	3	no spots	>70% (good)	30-70% (fair)	in spots
Monitoring: Summer 2006: Round 2					
Stream	**Station**	**Stability of stream bed: Bed sinks beneath your feet in:**	**Coverage of Stream Bank (sides)**	**Coverage of Stream Bank (slope and floodplain)**	**Algae Located**
Mine Run	1	no spots	>70% (good)	>70% (good)	in spots
Mine Run	2	no spots	30-70% (fair)	30-70% (fair)	in spots
Mine Run	3	no spots	>70% (good)	>70% (good)	in spots
Dead Run	1	many spots	<30% (poor)	30-70% (fair)	in spots
Dead Run	2	no spots	30-70% (fair)	>70% (good)	in spots
Dead Run	3	no spots	>70% (good)	>70% (good)	in spots
Turkey Run	1	no spots	30-70% (fair)	>70% (good)	in spots
Turkey Run	2	no spots	>70% (good)	>70% (good)	in spots
Turkey Run	3	no spots	>70% (good)	>70% (good)	in spots
Pimmit Run	1	no spots	30-70% (fair)	>70% (good)	in spots
Pimmit Run	2	no spots	30-70% (fair)	>70% (good)	in spots
Pimmit Run	3	no spots	30-70% (fair)	>70% (good)	in spots
Gulf Branch	1	no spots	30-70% (fair)	>70% (good)	in spots
Gulf Branch	2	no spots	30-70% (fair)	>70% (good)	in spots
Gulf Branch	3	no spots	30-70% (fair)	>70% (good)	in spots
Donaldson Run	1	a few spots	>70% (good)	>70% (good)	in spots
Donaldson Run	2	no spots	>70% (good)	>70% (good)	in spots
Donaldson Run	3	a few spots	30-70% (fair)	>70% (good)	in spots
Spout Run	1	no spots	>70% (good)	>70% (good)	in spots
Spout Run	2	no spots	30-70% (fair)	>70% (good)	in spots
Spout Run	3	no spots	30-70% (fair)	>70% (good)	in spots
Monitoring: Summer 2006: Round 3					
Stream	**Station**	**Stability of stream bed: Bed sinks beneath your feet in:**	**Coverage of Stream Bank (sides)**	**Coverage of Stream Bank (slope and floodplain)**	**Algae Located**
Mine Run	1	no spots	30-70% (fair)	>70% (good)	in spots
Mine Run	2	no spots	30-70% (fair)	>70% (good)	in spots
Mine Run	3	no spots	30-70% (fair)	30-70% (fair)	in spots

Appendix 12: Stream Habitat Assessment Data

Monitoring: Summer 2006: Round 1			
Stream	**Station**	**Algae color**	**% of bed covered with algae**
Mine Run	1	dark green	~40
Mine Run	2	dark green	~30
Mine Run	3	dark green	~20
Dead Run	1	dark green	~10
Dead Run	2	brown coated, matted on stream bed	~40
Dead Run	3	dark green	~30
Turkey Run	1	dark green, light green matted on stream bed	~60
Turkey Run	2	dark green, light green matted on stream bed	~40
Turkey Run	3	dark green	~20
Pimmit Run	1	dark green, brown coated, matted on stream bed	~20
Pimmit Run	2	dark green	~10
Pimmit Run	3	dark green, hairy/filamentous	~30
Gulf Branch	1	dark green, light green	~20
Gulf Branch	2	dark green	~20
Gulf Branch	3	dark green	~10
Donaldson Run	1	dark green	~10
Donaldson Run	2	dark green	~10
Donaldson Run	3	dark green, matted on stream bed	~60
Spout Run	1	dark green	~30
Spout Run	2	dark green	~10
Spout Run	3	dark green, light green matted on stream bed	~20
Monitoring: Summer 2006: Round 2			
Stream	**Station**	**Algae color**	**% of bed covered with algae**
Mine Run	1	light green	~20
Mine Run	2	dark green	~10
Mine Run	3	dark green	~15
Dead Run	1	dark green, light green, and filamentous	~30
Dead Run	2	dark green	~40
Dead Run	3	dark green, brown colored	~30
Turkey Run	1	dark green	~30
Turkey Run	2	dark green	~15
Turkey Run	3	dark green	~20
Pimmit Run	1	light green, dark green	~25
Pimmit Run	2	dark green	~20
Pimmit Run	3	light green	~40
Gulf Branch	1	dark green	~10
Gulf Branch	2	light green	~10
Gulf Branch	3	dark green	~10
Donaldson Run	1	light green	~5
Donaldson Run	2	dark green	~10
Donaldson Run	3	light green	~20
Spout Run	1	light green, dark green ,hairy/filamentous	~80
Spout Run	2	light green, dark green, hairy/filamantous	~80
Spout Run	3	light green, dark green, hairy/filamantous	~80
Monitoring: Summer 2006: Round 3			
Stream	**Station**	**Algae color**	**% of bed covered with algae**
Mine Run	1	dark green	~10
Mine Run	2	dark green	~30
Mine Run	3	dark green	~30

Appendix 12: Stream Habitat Assessment Data

Monitoring: Summer 2006: Round 1			
Stream	**Station**	**Stream channel shade**	**Stream Bank erosion**
Mine Run	1	>80% (excellent)	20-49% (moderate)
Mine Run	2	>80% (excellent)	<20% (almost none)
Mine Run	3	50-80% (high)	<20% (almost none)
Dead Run	1	50-80% (high)	<20% (almost none)
Dead Run	2	20-49% (moderate)	<20% (almost none)
Dead Run	3	50-80% (high)	<20% (almost none)
Turkey Run	1	50-80% (high)	50-80% (high)
Turkey Run	2	50-80% (high)	50-80% (high)
Turkey Run	3	>80% (excellent)	<20% (almost none)
Pimmit Run	1	50-80% (high)	50-80% (high)
Pimmit Run	2	20-49% (moderate)	<20% (almost none)
Pimmit Run	3	50-80% (high)	20-49% (moderate)
Gulf Branch	1	>80% (excellent)	50-80% (high)
Gulf Branch	2	20-49% (moderate)	<20% (almost none)
Gulf Branch	3	50-80% (high)	<20% (almost none)
Donaldson Run	1	50-80% (high)	20-49% (moderate)
Donaldson Run	2	50-80% (high)	<20% (almost none)
Donaldson Run	3	>80% (excellent)	50-80% (high)
Spout Run	1	20-49% (moderate)	20-49% (moderate)
Spout Run	2	>80% (excellent)	<20% (almost none)
Spout Run	3	20-49% (moderate)	<20% (almost none)
Monitoring: Summer 2006: Round 2			
Stream	**Station**	**Stream channel shade**	**Stream Bank erosion**
Mine Run	1	>80% (excellent)	20-49% (moderate)
Mine Run	2	>80% (excellent)	20-49% (moderate)
Mine Run	3	50-80% (high)	<20% (almost none)
Dead Run	1	20-49% (moderate)	>80% (severe)
Dead Run	2	50-80% (high)	<20% (almost none)
Dead Run	3	50-80% (high)	20-49% (moderate)
Turkey Run	1	>80% (excellent)	20-49% (moderate)
Turkey Run	2	>80% (excellent)	<20% (almost none)
Turkey Run	3	>80% (excellent)	<20% (almost none)
Pimmit Run	1	50-80% (high)	>80% (severe)
Pimmit Run	2	50-80% (high)	20-49% (moderate)
Pimmit Run	3	50-80% (high)	>80% (severe)
Gulf Branch	1	50-80% (high)	20-49% (moderate)
Gulf Branch	2	50-80% (high)	50-80% (high)
Gulf Branch	3	50-80% (high)	50-80% (high)
Donaldson Run	1	>80% (excellent)	20-49% (moderate)
Donaldson Run	2	50-80% (high)	<20% (almost none)
Donaldson Run	3	50-80% (high)	50-80% (high)
Spout Run	1	50-80% (high)	<20% (almost none)
Spout Run	2	>80% (excellent)	<20% (almost none)
Spout Run	3	50-80% (high)	<20% (almost none)
Monitoring: Summer 2006: Round 3			
Stream	**Station**	**Stream channel shade**	**Stream Bank erosion**
Mine Run	1	>80% (excellent)	20-49% (moderate)
Mine Run	2	50-80% (high)	20-49% (moderate)
Mine Run	3	50-80% (high)	20-49% (moderate)

Appendix 13: 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 clear-cuts, 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 14: Location Data

Monitoring: Summer 2006					
Stream	**Station**	**County**	**State**	**Latitude**	**Longitude**
Mine Run	1	Fairfax	VA	N 38 59.99'	W 77 15.35'
Mine Run	2	Fairfax	VA	N 39 0.00'	W 77 15.36'
Mine Run	3	Fairfax	VA	N 39 0.001'	W 77 15.38'
Dead Run	1	Fairfax	VA	N 38 58.02'	W 77 10.35'
Dead Run	2	Fairfax	VA	N 38 57.98'	W 77 10.39'
Dead Run	3	Fairfax	VA	N 38 57.91'	W 77 10.42'
Turkey Run	1	Fairfax	VA	N 38 57.96'	W 77 9.40'
Turkey Run	2	Fairfax	VA	N 38 57.89'	W 77 9.4'
Turkey Run	3	Fairfax	VA	N 38 57.83'	W 77 9.42'
Pimmit Run	1	Fairfax	VA	N 38 55.76'	W 77 7.12'
Pimmit Run	2	Fairfax	VA	N 38 55.79'	W 77 7.12'
Pimmit Run	3	Fairfax	VA	N 38 55.81'	W 77 7.14'
Gulf Branch	1	Arlington	VA	N 3855.51'	W 77 6.82'
Gulf Branch	2	Arlington	VA	N 38 55.50'	W 77 6.85'
Gulf Branch	3	Arlington	VA	N 38 55.47'	W 77 6.88'
Donaldson Run	1	Arlington	VA	N 38 55.21'	W 77 6.45'
Donaldson Run	2	Arlington	VA	N 38 55.18'	W 77 6.49'
Donaldson Run	3	Arlington	VA	N 38 55.17'	W 77 6.50'
Spout Run	1	Arlington	VA	N 38 54.05'	W 77 5.01'
Spout Run	2	Arlington	VA	N 38 54.02'	W 77 5.08'
Spout Run	3	Arlington	VA	N 38 53.99'	W 77 5.16'

Monitoring: Summer 2006		
Stream	**Station**	**Location**
Mine Run	1	~ 5m downstream from road
Mine Run	2	~ 15m upstream from road
Mine Run	3	~ 25m upstream from road
Dead Run	1	~ 15-20m upstream from mouth
Dead Run	2	~ 50m upstream from site 1, ~ 10-20m upstream from large waterfalls
Dead Run	3	~ 70-80m downstream of GWM Parkway bridge, below waterfalls
Turkey Run	1	At the base of Switchback trail
Turkey Run	2	~ 100m downstream from GWM Parkway, ~ 40m upstream from site 1
Turkey Run	3	~ 50m downstream from GWM Parkway, ~ 20m upstream from site 2
Pimmit Run	1	~ 70m upstream of Glebe Rd/123 Bridge
Pimmit Run	2	~ 90m upstream of Glebe Rd/123 bridge
Pimmit Run	3	~ 120m upstream of Glebe Rd/123 bridge; at start of a bend in the run
Gulf Branch	1	~20m downstream from GW Pkwy, the edge of GW closest to the Potomac
Gulf Branch	2	Directly below GWM Parkway, on the edge of GW closest to the Potomac
Gulf Branch	3	~ 20m upstream from P2; ~ 10-15m from GWM Parkway edge away from Potomac
Donaldson Run	1	~ 10m upstream from mouth
Donaldson Run	2	Beneath GWM Parkway bridge
Donaldson Run	3	~ 15m upstream from GWM Parkway; below 6ft waterfalls
Spout Run	1	Next to drainage pipe; off of Spout Run Parkway
Spout Run	2	~ 100m upstream from P1
Spout Run	3	~ 50m upstream of 2nd drainage pipe

Appendix 15: Miscellaneous Data

Monitoring: Summer 2006: Round 1			
Stream	**Station**	**Name(s) of certified Monitor(s)**	**Weather (last 72 hours)**
Mine Run	1	Darin Grulkowski and Rob Moreton	warm, sunny, heavy rain last night
Mine Run	2	Darin Grulkowski and Rob Moreton	warm, sunny, heavy rain last night
Mine Run	3	Darin Grulkowski and Rob Moreton	warm, sunny, heavy rain last night
Dead Run	1	Darin Grulkowski and Rob Moreton	warm and sunny
Dead Run	2	Darin Grulkowski and Rob Moreton	warm and sunny
Dead Run	3	Darin Grulkowski and Rob Moreton	sunny and warm, cloudy today with high humidity
Turkey Run	1	Darin Grulkowski and Rob Moreton	sunny and warm, cloudy today with high humidity
Turkey Run	2	Darin Grulkowski and Rob Moreton	partly sunny, humid with some light rain
Turkey Run	3	Darin Grulkowski and Rob Moreton	partly sunny, thunderstorms and high humidity
Pimmit Run	1	Rob Moreton and Darin Grulkowski	warm, sunny, humid
Pimmit Run	2	Rob Moreton and Darin Grulkowski	warm, sunny, humid
Pimmit Run	3	Rob Moreton and Darin Grulkowski	warm, hazy w/ some rain
Gulf Branch	1	Rob Moreton and Darin Grulkowski	partly sunny, thunderstorms and high humidity
Gulf Branch	2	Rob Moreton and Darin Grulkowski	warm, sunny, some showers
Gulf Branch	3	Rob Moreton and Darin Grulkowski	warm, partly sunny
Donaldson Run	1	Rob Moreton and Darin Grulkowski	warm, partly cloudy
Donaldson Run	2	Rob Moreton and Darin Grulkowski	warm and sunny
Donaldson Run	3	Rob Moreton and Darin Grulkowski	warm and sunny
Spout Run	1	Rob Moreton and Darin Grulkowski	warm, hazy w/ some rain
Spout Run	2	Rob Moreton and Darin Grulkowski	hot and sunny
Spout Run	3	Rob Moreton and Darin Grulkowski	hot and sunny
Monitoring: Summer 2006: Round 2			
Stream	**Station**	**Name(s) of certified Monitor(s)**	**Weather (last 72 hours)**
Mine Run	1	Darin Grulkowski and Rob Moreton	hot, sunny
Mine Run	2	Darin Grulkowski and Rob Moreton	hot, sunny
Mine Run	3	Darin Grulkowski and Rob Moreton	hot, sunny, humid
Dead Run	1	Darin Grulkowski and Rob Moreton	hot, sunny, humid
Dead Run	2	Darin Grulkowski and Rob Moreton	sunny, humid, very hot
Dead Run	3	Darin Grulkowski and Rob Moreton	hot, sunny
Turkey Run	1	Darin Grulkowski and Rob Moreton	hot, sunny
Turkey Run	2	Darin Grulkowski and Rob Moreton	hot, sunny
Turkey Run	3	Darin Grulkowski and Rob Moreton	warm, sunny
Pimmit Run	1	Rob Moreton and Darin Grulkowski	warm, partly cloudy
Pimmit Run	2	Rob Moreton and Darin Grulkowski	sunny, hot, humid
Pimmit Run	3	Rob Moreton and Darin Grulkowski	sunny, hot, humid
Gulf Branch	1	Rob Moreton and Darin Grulkowski	warm, sunny
Gulf Branch	2	Rob Moreton and Darin Grulkowski	warm, sunny
Gulf Branch	3	Rob Moreton and Darin Grulkowski	sunny, cloudy, humid
Donaldson Run	1	Rob Moreton and Darin Grulkowski	sunny, light sprinkles, warm
Donaldson Run	2	Rob Moreton and Darin Grulkowski	sunny, humid, warm, light sprinkling
Donaldson Run	3	Rob Moreton and Darin Grulkowski	sunny, warm, hazy
Spout Run	1	Rob Moreton and Darin Grulkowski	hot, partly sunny
Spout Run	2	Rob Moreton and Darin Grulkowski	warm, humid, partly cloudy
Spout Run	3	Rob Moreton and Darin Grulkowski	hot, humid
Monitoring: Summer 2006: Round 3			
Stream	**Station**	**Name(s) of certified Monitor(s)**	**Weather (last 72 hours)**
Mine Run	1	Darin Grulkowski and Rob Moreton	hot and sunny
Mine Run	2	Darin Grulkowski and Rob Moreton	hot and sunny
Mine Run	3	Darin Grulkowski and Rob Moreton	hot and sunny

Appendix 15: Miscellaneous Data

Monitoring: Summer 2006: Round 1								
Stream	**Station**	**Date**	**Stream Flow Rate**	**Number of Nets**	**Net 1-Area**	**Net 2-Area**	**Net 3-Area**	**Net 4-Area**
Mine Run	1	06/20/06	Normal	1	3*3	-	-	-
Mine Run	2	06/20/06	Normal	1	2*2	-	-	-
Mine Run	3	06/20/06	Normal	1	1*1	-	-	-
Dead Run	1	06/21/06	Normal	1	2*2	-	-	-
Dead Run	2	06/21/06	Normal	1	2*2	-	-	-
Dead Run	3	06/22/06	Normal	1	3*3	-	-	-
Turkey Run	1	06/22/06	Normal	1	3*3	-	-	-
Turkey Run	2	06/22/06	Normal	1	3*3	-	-	-
Turkey Run	3	06/23/06	Normal	1	2*2	-	-	-
Pimmit Run	1	07/17/06	Normal	2	3*3	1*1	-	-
Pimmit Run	2	07/17/06	Normal	2	3*3	3*3	-	-
Pimmit Run	3	07/13/06	Normal	1	3*3	-	-	-
Gulf Branch	1	06/23/06	High	2	3*3	3*3	-	-
Gulf Branch	2	07/03/06	Normal	4	3*3	3*3	3*3	3*3
Gulf Branch	3	07/10/06	Normal	2	3*3	2*2	-	-
Donaldson Run	1	07/10/06	Normal	1	3*3	-	-	-
Donaldson Run	2	07/11/06	Normal	1	3*3	-	-	-
Donaldson Run	3	07/11/06	Normal	1	3*3	-	-	-
Spout Run	1	07/13/06	Normal	1	3*3	-	-	-
Spout Run	2	07/17/06	Normal	2	3*3	3*3	-	-
Spout Run	3	07/17/06	Normal	1	3*3	-	-	-
Monitoring: Summer 2006: Round 2								
Stream	**Station**	**Date**	**Stream Flow Rate**	**Number of Nets**	**Net 1-Area**	**Net 2-Area**	**Net 3-Area**	**Net 4-Area**
Mine Run	1	07/18/06	Normal	1	2*2	-	-	-
Mine Run	2	07/18/06	Normal	1	3*3	-	-	-
Mine Run	3	07/18/06	Normal	1	2*2	-	-	-
Dead Run	1	07/19/06	Normal	2	3*3	2*2	-	-
Dead Run	2	07/20/16	Normal	1	3*3	-	-	-
Dead Run	3	07/20/16	Normal	1	3*3	-	-	-
Turkey Run	1	07/21/06	Normal	1	2*2	-	-	-
Turkey Run	2	07/21/06	Normal	1	2*2	-	-	-
Turkey Run	3	07/24/06	Normal	1	2*2	-	-	-
Pimmit Run	1	07/27/06	Normal	1	3*3	-	-	-
Pimmit Run	2	07/28/06	Normal	1	2*2	-	-	-
Pimmit Run	3	07/28/06	Normal	1	2*2	-	-	-
Gulf Branch	1	07/24/06	Normal	1	3*3	-	-	-
Gulf Branch	2	07/25/06	Normal	1	2*2	-	-	-
Gulf Branch	3	07/25/06	Normal	1	2*2	-	-	-
Donaldson Run	1	07/26/06	Normal	1	3*3	-	-	-
Donaldson Run	2	07/26/06	Normal	1	3*3	-	-	-
Donaldson Run	3	07/27/06	Normal	1	3*3	-	-	-
Spout Run	1	07/31/06	Normal	1	2*2	-	-	-
Spout Run	2	08/01/06	Normal	1	2*2	-	-	-
Spout Run	3	08/02/06	Normal	1	1*1	-	-	-
Monitoring: Summer 2006: Round 3								
Stream	**Station**	**Date**	**Stream Flow Rate**	**Number of Nets**	**Net 1-Area**	**Net 2-Area**	**Net 3-Area**	**Net 4-Area**
Mine Run	1	08/03/06	Normal	1	2*2	-	-	-
Mine Run	2	08/03/06	Normal	1	2*2	-	-	-
Mine Run	3	08/04/06	Normal	1	2*2	-	-	-

Appendix 15: Miscellaneous Data

Monitoring: Summer 2006: Round 1					
Stream	**Station**	**Net 1-Time**	**Net 2-Time**	**Net 3-Time**	**Net 4-Time**
Mine Run	1	90	-	-	-
Mine Run	2	60	-	-	-
Mine Run	3	30	-	-	-
Dead Run	1	60	-	-	-
Dead Run	2	60	-	-	-
Dead Run	3	90	-	-	-
Turkey Run	1	90	-	-	-
Turkey Run	2	90	-	-	-
Turkey Run	3	60	-	-	-
Pimmit Run	1	90	30	-	-
Pimmit Run	2	90	90	-	-
Pimmit Run	3	90	-	-	-
Gulf Branch	1	90	90	-	-
Gulf Branch	2	90	90	90	90
Gulf Branch	3	90	60	-	-
Donaldson Run	1	90	-	-	-
Donaldson Run	2	90	-	-	-
Donaldson Run	3	90	-	-	-
Spout Run	1	90	-	-	-
Spout Run	2	90	90	-	-
Spout Run	3	90	-	-	-
Monitoring: Summer 2006: Round 2					
Stream	**Station**	**Net 1-Time**	**Net 2-Time**	**Net 3-Time**	**Net 4-Time**
Mine Run	1	60	-	-	-
Mine Run	2	90	-	-	-
Mine Run	3	60	-	-	-
Dead Run	1	90	60	-	-
Dead Run	2	90	-	-	-
Dead Run	3	90	-	-	-
Turkey Run	1	60	-	-	-
Turkey Run	2	60	-	-	-
Turkey Run	3	60	-	-	-
Pimmit Run	1	90	-	-	-
Pimmit Run	2	60	-	-	-
Pimmit Run	3	60	-	-	-
Gulf Branch	1	90	-	-	-
Gulf Branch	2	60	-	-	-
Gulf Branch	3	60	-	-	-
Donaldson Run	1	90	-	-	-
Donaldson Run	2	90	-	-	-
Donaldson Run	3	90	-	-	-
Spout Run	1	60	-	-	-
Spout Run	2	60	-	-	-
Spout Run	3	30	-	-	-
Monitoring: Summer 2006: Round 3					
Stream	**Station**	**Net 1-Time**	**Net 2-Time**	**Net 3-Time**	**Net 4-Time**
Mine Run	1	60	-	-	-
Mine Run	2	60	-	-	-
Mine Run	3	60	-	-	-

Appendix 15: Miscellaneous Data

Monitoring: Summer 2006: Round 1		
Stream	**Station**	**Briefly describe litter**
Mine Run	1	none
Mine Run	2	none
Mine Run	3	none
Dead Run	1	cans
Dead Run	2	none
Dead Run	3	plastic bottles and cans
Turkey Run	1	none
Turkey Run	2	none
Turkey Run	3	none
Pimmit Run	1	wrappers, rubber tubing
Pimmit Run	2	plastic bottles and cans
Pimmit Run	3	plastic bottles and bags
Gulf Branch	1	none
Gulf Branch	2	plastic bottles and cans
Gulf Branch	3	none
Donaldson Run	1	plastic bottles, bags, pop cans, and other misc. material
Donaldson Run	2	plastic bottles and bags
Donaldson Run	3	
Spout Run	1	a lot of plastic bottles, bags, pop cans, and other misc. material
Spout Run	2	a lot of plastic bottles, bags, pop cans, and other misc. material
Spout Run	3	a lot of plastic bottles, bags, pop cans, and other misc. material
Monitoring: Summer 2006: Round 2		
Stream	**Station**	**Briefly describe litter**
Mine Run	1	none
Mine Run	2	none
Mine Run	3	none
Dead Run	1	plastic bottles
Dead Run	2	tennis ball
Dead Run	3	plastic bottles, plastic bags
Turkey Run	1	none
Turkey Run	2	tire and rim
Turkey Run	3	none
Pimmit Run	1	none
Pimmit Run	2	plastic bottles, plastic bags
Pimmit Run	3	plastic bags, paper, plastic sign
Gulf Branch	1	cans, plastic bags
Gulf Branch	2	cans, plastic bags
Gulf Branch	3	plastic bottles
Donaldson Run	1	plastic bag, plastic bottle, aluminum can
Donaldson Run	2	plastic bottle, plastic bags
Donaldson Run	3	none
Spout Run	1	lots of plastic bags, metal, other trash
Spout Run	2	lots of trash
Spout Run	3	foil, lots of plastic bags, paper, metal
Monitoring: Summer 2006: Round 3		
Stream	**Station**	**Briefly describe litter**
Mine Run	1	rubber hose
Mine Run	2	plastic stuff
Mine Run	3	lots of plastics

Appendix 15: Miscellaneous Data

Monitoring: Summer 2006: Round 1		
Stream	**Station**	**Brief Comments**
Mine Run	1	many macroinvertebrates
Mine Run	2	none
Mine Run	3	none
Dead Run	1	couldn't do a 3*3 net, no adequate sample area
Dead Run	2	sample area selection small
Dead Run	3	none
Turkey Run	1	none
Turkey Run	2	none
Turkey Run	3	none
Pimmit Run	1	none
Pimmit Run	2	none
Pimmit Run	3	many very small invertebrates, mostly small midges and black flies
Gulf Branch	1	low numbers of invertebrates
Gulf Branch	2	few invertebrates
Gulf Branch	3	none
Donaldson Run	1	none
Donaldson Run	2	none
Donaldson Run	3	none
Spout Run	1	none
Spout Run	2	none
Spout Run	3	none
Monitoring: Summer 2006: Round 2		
Stream	**Station**	**Brief Comments**
Mine Run	1	very good sampling area
Mine Run	2	very good sampling area
Mine Run	3	a lot of bedrock
Dead Run	1	poor sampling area, very sandy, difficult to count small invertebrates
Dead Run	2	poor riffle selection to choose from
Dead Run	3	only one or two riffles to choose from
Turkey Run	1	riffle just under the trail intersection, heavy foot traffic
Turkey Run	2	good riffle, quite a bit of bedrock
Turkey Run	3	a lot of bedrock, trail intersection with foot traffic
Pimmit Run	1	great deal of midges
Pimmit Run	2	great deal of midges
Pimmit Run	3	lots of invertebrates
Gulf Branch	1	mostly midges and black flies
Gulf Branch	2	mostly midges and black flies
Gulf Branch	3	almost all midges and black flies
Donaldson Run	1	easier sampling than first round
Donaldson Run	2	very few sampling spots
Donaldson Run	3	about 6 eels spotted in pool beneath waterfall
Spout Run	1	almost all midges
Spout Run	2	almost all midges
Spout Run	3	terrible smell, very humid
Monitoring: Summer 2006: Round 3		
Stream	**Station**	**Brief Comments**
Mine Run	1	none
Mine Run	2	none
Mine Run	3	none

Appendix 16: 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 across 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 for 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 120/123 North and turn right
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 North
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 for 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 120/123 North and turn right
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 North
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) past Theodore Roosevelt Island (TRI), past Ronald Reagan/Washington National Airport to Washington Sailing Marina
5. Conduct U-turn and proceed North on GWMP
6. Merge into left lane near TRI, and turn on hazard lights just after 1st Spout Run Parkway exit sign
7. Take Spout Run Parkway exit, slowing to prepare to pull off the road.
8. Enter exit in the right lane and park on grassy shoulder just behind the exit sign
9. Walk up side of road and cross when it is safe to do so
10. There is a storm drain just beyond the bridge on the left side of the road
11. 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 left 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 120/123 North and turn right
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

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 Kohl's next to Dick's) ~$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

Appendix 17: Supplies

1. 3’x 3’ kick-seine net (1/16-inch mesh)
2. Waders
3. Two backpacks
4. Collapsible table
5. Uniform
6. Two collapsible seats
7. Timer
8. Field first aid kit
9. Meter stick
10. Magnifying glass
11. Collection vial
12. Pens/Pencils
13. Measuring tape (100ft)
14. Brush
15. Forceps
16. Two ice cube trays
17. Virginia Save Our Streams benthic macroinvertebrate tally sheets (Appendix 1)
18. YSI meter, model 85 and associated calibration chemicals
19. Hanna Instruments pH meter (model 9025) and associated calibration chemicals
20. LaMotte turbidity kit
21. Squirt bottle
22. Water bottle
23. Hand sanitizer
24. Flagging
25. Cell phone for emergencies
26. Sunscreen and bug spray
27. Hach water quality test strips
28. Virginia Save Our Streams stream quality survey form (Appendix 8)

Appendix 18: 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', 2'x 2', or 1'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 2'x 2' net, and 30 seconds for a 1'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 19: 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. Tour Arlington cemetery
11. Tour Clara Barton House
12. Tour Dyke Marsh
13. Tour Theodore Roosevelt Island
14. Become familiar with Turkey Run trails

Appendix 20: 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)*