Colvin Run– Forest Edge North and South

Fairfax County, Virginia

WSSI #20010, Task I 5

Biological Monitoring Report- Year 5 (Post-Construction)

June 18, 2015

Prepared for:
Northern Virginia Stream Restoration, L.C.
c/o Wetland Studies and Solutions, Inc.
5300 Wellington Branch Drive, Suite 100
Gainesville, Virginia 20155

Prepared by:

Wetland Studies and Solutions, Inc.®
a DAVEY company
5300 Wellington Branch Drive, Suite 100
Gainesville, Virginia 20155
Tel: 703-679-5600 Email: contactus@wetlandstudies.com
www.wetlandstudies.com

Biological Monitoring Report – Year 5 (Post-Construction)

Colvin Run – Forest Edge North and South
WSSI #20010, Task I5

Executive Summary

In accordance with the "Northern Virginia Stream Restoration Bank Banking Instrument" (Banking Instrument), streams and drainage features within portions of the Colvin Run Watershed were restored and stabilized in 2010/2011. This stream restoration resulted in a direct improvement of in-stream habitat.

In the fifth year following restoration, Wetland Studies and Solutions Inc. (WSSI) conducted biological stream assessments along 4,870 linear feet of stream restoration in Colvin Run - Forest Edge North and South. This monitoring was conducted pursuant to the maintenance and monitoring requirements defined in the Banking Instrument, Section VI.B.2.(i). The assessed reaches were selected to be representative of the condition of an unnamed tributary of Colvin Run following the restoration. This report summarizes the 2015 Year 5 monitoring (post-construction), as compared to the 2007, 2008, and 2009 pre-construction baseline conditions and the Year 1 (2011) post-construction conditions.

Biological stream monitoring was conducted along two[1] permanent biological monitoring reaches using benthic macroinvertebrate and habitat data. Fieldwork was conducted on March 23, 2015. Habitat data was used to calculate the Total Habitat Score for each reach and benthic macroinvertebrate data was used to calculate a Stream Condition Index for Virginia Non-coastal Streams (VA-SCI).

Our Year 5 post-construction results indicate that the habitat quality of the restored reaches of Forest Edge North and South has increased relative to pre-construction averages within both reaches and has continued to improve following the Year 1 post-construction. Overall benthic macroinvertebrate condition has shown little to no improvement from the pre-construction baseline conditions. Both benthic macroinverebrate communities within Biological Monitoring Reaches 2-A and 2-B remain listed under "Severe Stress" according to the VA-SCI, which is likely due to poor water quality which was not addressed by the restoration. Due to the high percentage of impervious cover in the area, water quality enhancements will need to be undertaken within the watershed (by others) to cause a meaningful improvement in the benthic macroinvertebrate community.

Introduction

As set forth in the Banking Instrument, dated February 17, 2006 and prepared by WSSI, Northern Virginia Stream Restoration, L.C. will restore approximately 14 miles of streams and upland buffers, within portions of the Snakeden Branch, Colvin Run, and The Glade watersheds in Reston, Virginia. As required in Section VI.B.2.(i) of the Banking Instrument, biological monitoring will be conducted within restored streams within these watersheds. These stream restoration activities resulted in a direct improvement of in-stream habitat. Using benthic

[1] *Note that Biological Monitoring Reaches 1-A, 3-A, and 4-8A have not been restored and therefore were not sampled for this report.*

macroinvertebrate and habitat data, this Year 5 post-construction monitoring report characterizes the restored reaches within the Colvin Run Watershed portion of NVSRB in 2015, as compared to conditions described in Biological Monitoring Reports #1 (dated November 6, 2008), #2 (dated December 8, 2008), #3 (dated November 17, 2009), and #4 (dated September 20, 2011). With this data, and data from previous and subsequent monitoring reports, we propose to determine the effect of stream restoration on the condition of streams within the Colvin Run Watershed portion of the NVSRB[2].

Project Area

The project area includes approximately 4,870 linear feet[3] of stream along Forest Edge North and South, an unnamed tributary of Colvin Run, as well as the adjacent riparian corridor. The project area is located between the Dulles Access Road (Route 267) and Leesburg Pike (Route 7) to the northwest of Lake Fairfax Park, in northern Fairfax County, Virginia. Exhibit 1 is a vicinity map that depicts the approximate location of the project area.

The unnamed tributary to Colvin Run flows southeast and through a mostly forested area. The project area is gently to steeply sloping. The topography can be seen in the excerpt from the Vienna, Virginia-Maryland 1994 USGS topographical quadrangle map included as Exhibit 2.

Overall Methodology

Per maintenance and monitoring requirements defined in the Banking Instrument, Section VI.B.2.(i), biological stream assessment reaches are to be established for every 2,000 linear feet of stream restoration along samplable streams at the NVSRB[4]. Once established, these reaches are to be monitored prior to stream restoration, then in years 1, 5, and 10 after restoration. The following methods are to be employed:

- Biological Reconnaissance (BioRecon) following guidance established in the U.S. Environmental Protection Agency's "Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers" (EPA's RBP; Barbour et al. 1999.)[5],
- Biological stream assessment for Calculating the Stream Condition Index for Virginia Non-coastal Streams (VA-SCI), following guidance established in "A Stream Condition Index for Virginia Non-Coastal Streams" (Tetra Tech 2003) and "Using Probabilistic Monitoring Data to Validate the Non-Coastal Virginia Stream Condition Index" (DEQ 2006).[6]

---

[2] *Note that monitoring reports for the Snakeden and The Glade watershed portions of the NVSRB will be provided under separate cover.*

[3] *1,944 linear feet in Design Reach 2-A and 2,926 linear feet in Design Reach 2-B.*

[4] *Assessment reaches were established for every 2,000 linear feet of samplable streams, which includes perennial and intermittent streams containing enough flowing water to sample in the spring.*

[5] *Note that the BioRecon was used to aid in the selection of permanent monitoring reaches during the first year of pre-construction monitoring and is not required in subsequent monitoring years. The results of the BioRecon are described in "Biological Monitoring Report #1, Pre-construction Monitoring, Northern Virginia Stream Restoration Bank, Colvin Run Watershed", dated November 6, 2008.*

[6] *This method is to be used in all monitoring years and is accompanied by a habitat assessment, following guidance established Virginia Department of Environmental Quality's (DEQ) standard operating procedures for stream habitat assessment.*

Biological Stream Monitoring

Biological Stream Monitoring Methodology. The biological stream monitoring consisted of two components: 1) Stream habitat assessment and 2) benthic macroinvertebrate assessment. The stream habitat assessment was conducted using guidance established in the DEQ Standard Operating Procedures (SOPs) for stream habitat assessment (DEQ 2008) [7] and the U.S. Environmental Protection Agency's Rapid Bioasssessment Protocol for habitat (Barbour et al. 1999). The benthic macroinvertebrate assessment field work was conducted using guidance established in the SOPs for multi-habitat benthic macroinvertebrate sampling (DEQ 2008). [8]

WSSI assessed two 300-foot linear reaches, Biological Monitoring Reaches 2-A and 2-B. The locations of these two sample reaches relative to the restoration design reaches are depicted in the Biological Stream Monitoring Map (Exhibit 3). Photographs, Habitat, and Benthic Macroinvertebrate Field Data Sheets are included in Exhibit 4 for each reach. Benthic macroinvertebrate sampling and habitat assessment was conducted by WSSI environmental scientists Alison Robinson, PWS, PWD, CT[9] and Lauren Shaffer, WPIT, CT[10].

In accordance with the SOPs, habitat conditions were assessed by qualitatively rating ten habitat parameters, including Epifaunal Substrate/Available Cover, Embeddedness, Velocity/Depth Regime, Sediment Deposition, Channel Flow Status, Channel Alteration, Frequency of Riffles, Bank Stability, Vegetation Protection, and Riparian Vegetative Zone Width. The overall habitat quality of each reach was determined by adding together the individual metric scores to provide a Total Habitat Score at each reach, with a maximum of 200 points possible. Each reach was then assigned a narrative rating according to the total habitat score, where "Optimal" is 200-160, "Sub-optimal" is 159-107, "Marginal" is 106-54, and "Poor" is 53-0. Stream habitat data were recorded on the WSSI Benthic Macroinvertebrate and Habitat Field Data Sheets (Exhibit 4 for each reach).

To assess benthic macroinvertebrate condition, 60 linear feet of best-available habitat in each reach was sampled using a D-Framed Net. Habitat types sampled include cobble/gravel and snags/leafpacks. Benthic field data was recorded on WSSI Benthic Macroinvertebrate Field Data Sheets (Exhibit 4 for each reach).

The benthic macroinvertebrate samples were processed and subsampled by WSSI staff using guidance from the SOPs. Specifically, a fixed-count method was used, where organisms were randomly picked from a gridded (numbered) tray and the organisms were identified to the family level (if possible) using a dissecting microscope. Each individual (containing a head) found in a sample was recorded and enumerated on a WSSI Benthic Macroinvertebrate Bench Sheet (Exhibit 4 for each reach).

Benthic macroinvertebrate data were analyzed by calculating the Stream Condition Index for Virginia Non-coastal Streams (VA-SCI), following guidance established in "A Stream

---

[7] *Note that the DEQ has revised their SOP for habitat. Thus, starting in 2010, WSSI is using the latest SOP for habitat (DEQ 2008).*

[8] *Note that the DEQ has revised their SOP for benthic macroinvertebrates. Thus, starting in 2010, WSSI is using the latest SOP for benthic macroinvertebrates (DEQ 2008).*

[9] *Professional Wetland Scientist #2532, Society of Wetlands Scientists Certification Program, Inc. VA Certified Professional Wetland Delineator #3402000147. Certified Taxonomist- Family Level- All Taxa, Society for Freshwater Science (SFS).*

[10] *Wetland Professional In Training, Society of Wetlands Scientists Certification Program, Inc. Certified Taxonomist- Family Level- All Taxa, Society for Freshwater Science (SFS).*

Condition Index for Virginia Non-Coastal Streams" (Tetra Tech 2003) and "Using Probabilistic Monitoring Data to Validate the Non-Coastal Virginia Stream Condition Index" (DEQ 2006). The VA-SCI is a multi-metric Index of Biotic Integrity developed for the DEQ to assess Streams of the Commonwealth. The VA-SCI uses seven biotic metrics and one biotic index including Total Taxa, EPT Taxa, Percent Ephemeroptera, Percent Plecoptera + Trichoptera (Excluding Hydropsychidae), Percent Scrapers, Percent Chironomidae, Percent Top Two Dominant Taxa, and Hilsenhoff Biotic Index. The individual metrics and index used are defined and described as follows:

- Total Taxa Richness. Total Taxa Richness represents the total number of taxa in a sample. Total Taxa Richness is expected to be relatively high in undisturbed streams and is expected to decrease in response to environmental disturbance. Total Taxa Richness can range from 0-22 for the VA-SCI.

- EPT Taxa Richness. EPT Taxa Richness represents the number of taxa from the aquatic insect orders Ephemeroptera, Plecoptera, and Trichoptera. EPT taxa are generally very sensitive to pollution. Total EPT Taxa Richness is expected to be relatively high in undisturbed streams, and it is expected to decrease in response to environmental disturbance. EPT Taxa Richness can range from 0-11 for the VA-SCI.

- Percent Ephemeroptera. The Percent Ephemeroptera represents the ratio of members of the aquatic insect order Ephemeroptera (mayflies) to the total number of individuals in a sample. Mayflies are generally very sensitive to pollution, thus Percent Ephemeroptera is expected to decrease in response to environmental disturbance. Percent Ephemeroptera can range from 0-61.3 for the VA-SCI.

- Percent Plecoptera + Trichoptera (Excluding Hydropsychidae). The Percent Plecoptera + Trichoptera (Excluding Hydropsychidae) represents the ratio of members of the aquatic insect orders Plecoptera (stoneflies) and Trichoptera (caddisflies) (excluding the those in the pollution tolerant family Hydropsychidae) to the total number of individuals in a sample. Percent Plecoptera + Trichoptera (Excluding Hydropsychidae) is expected to decrease in response to environmental disturbance. Percent Plecoptera + Trichoptera (Excluding Hydropsychidae) can range from 0-35.6 for the VA-SCI.

- Percent Scrapers. The Percent Scrapers represents the ratio of taxa adapted primarily for scraping food from a substrate to the total number of individuals in a sample. Percent Scrapers is expected to decrease in response to environmental disturbance. Percent Scrapers can range from 0-51.6 for the VA-SCI.

- Percent Chironomidae. The Percent Chironomidae represents the ratio of members of the aquatic insect family Chironomidae (non-biting midges) to the total number of individuals in a sample. Because chironomids are generally tolerant to pollution, Percent Chironomidae is expected to increase in response to environmental disturbance. Percent Chrionomidae can range from 0-100 for the VA-SCI.

- Percent Top Two Dominant. The Percent Top Two Dominant is the ratio of the top two most abundant taxa in a sample to the total number of individuals in a sample. Percent Top Two Dominant is expected to increase in response to environmental disturbance. Percent Top Two Dominant can range from 30.8-100 for the VA-SCI.

- Hilsenhoff Biotic Index (HBI). The Hilsenhoff Biotic Index is the abundance-weighted average tolerance of assemblage of organisms (Family taxonomic level). The HBI is

expected to increase in response to environmental disturbance. The HBI can range from 0-10 for the VA-SCI.

- The VA-SCI was calculated by taking the weighted average of the individual metric (and index) scores, with an VA-SCI range of 0-100. The weighting is as follows:

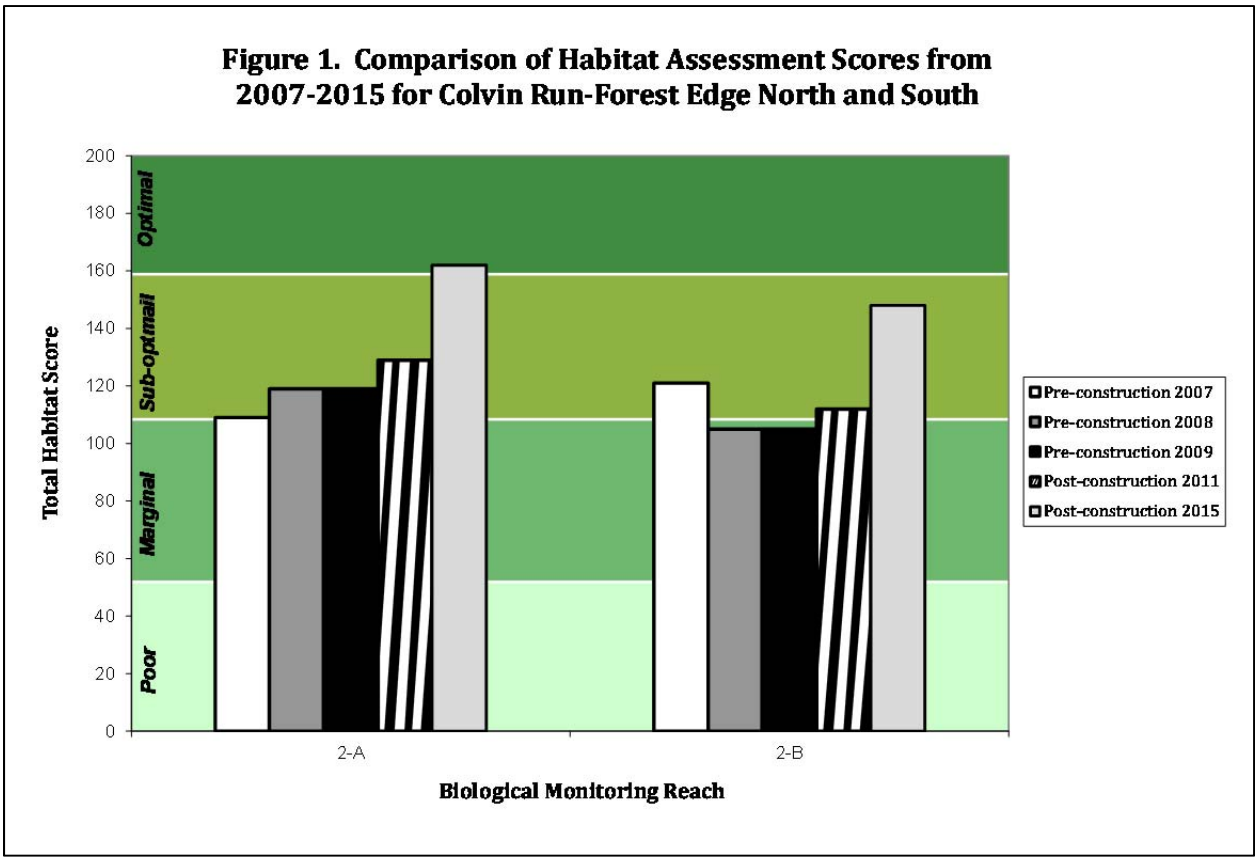
  - Total Taxa: Score = 100 x (X/22), where X = Metric Value
  - EPT Taxa: Score = 100 x (X/11), where X = Metric Value
  - Percent Ephemeroptera: Score = 100 x (X/61.3), where X = Metric Value
  - Percent Plecoptera + Trichoptera less Hydropsychidae: Score = 100 x (X/35.6), where X = Metric Value
  - Percent Scrapers: Score = 100 x (X/51.6), where X = Metric Value
  - Percent Chironomidae: Score = 100 x [(100-X) (100-0)], where X = Metric Value
  - Percent Top 2 Dominant: Score = 100 x [(100-X) (100-30.8)], where X = Metric Value
  - Hilsenhoff Biotic Index: Score = 100 x [(100-X) (100-3.2)], where X = Metric Value

Each reach was then assigned a narrative rating according to the calculated VA-SCI, where "Excellent" is >73, "Good" is 60-72, "Stress" is 43-59, and "Severe Stress" is <42.

Biological Stream Monitoring Results and Discussion. Habitat results for 2015 show that both restored biological monitoring stream reaches 2-A and 2-B have "Optimal" and "Sub-Optimal" habitat conditions, respectively (Table 1, Figure 1). The average habitat assessment score for the two restored stream reaches in 2015 was 155 out of 200. These results show improved habitat conditions following restoration, with average scores exceeding the pre-restoration and the post-restoration Year 1 scores (Figure 1), and it is expected that this trend will continue and stabilize over time. Improved habitat assessment scores relate to the success of the well vegetated and stabilized banks, with little erosion or depositional zones present throughout the restored reaches.

Table 1. 2015 Total Habitat Assessment Scores

Biomonitoring Reach	Post-Constuction Year 5 Habitat Score	Narrative Rating
2-A	162	Optimal
2-B	148	Sub-Optimal
Average	**155**	**Sub-Optimal**



Benthic macroinvertebrates results indicate that 11 taxa[11] were collected between the two reaches (Table 2, Exhibit 4) during the 2015 post-construction benthic macroinvertebrate monitoring. Of all taxa collected, non-biting midge larvae (Chironomidae) and aquatic worms (Oligochaeta) comprised the majority of individuals in both reaches.

[11] *Although Figure 2 lists 12 taxa, Diptera was not included as part of the total taxa collected within the study area, because the individual was too damaged to identify to the family-level.*

Table 2. 2015 Raw Benthic Macroinvertebrate Data at Forest Edge North and South			
TAXA	REACH		TOTAL
	2-A	2-B	
CERATOPGONIDAE	4	1	5
CHIRONOMIDAE	72	96	168
COPEPODA	2	-	2
DIPTERA (UNKNOWN)	-	1	1
HYDRACARINA	1	-	1
HYDROPSYCHIDAE	5	-	5
OLIGOCHAETA	20	7	27
PHILOPOTAMIDAE	1	-	1
PHYSIDAE	-	1	1
PLANORBIDAE	-	1	1
STRATIOMYIDAE	-	1	1
TIPULIDAE	-	1	1
TOTAL	105	109	214

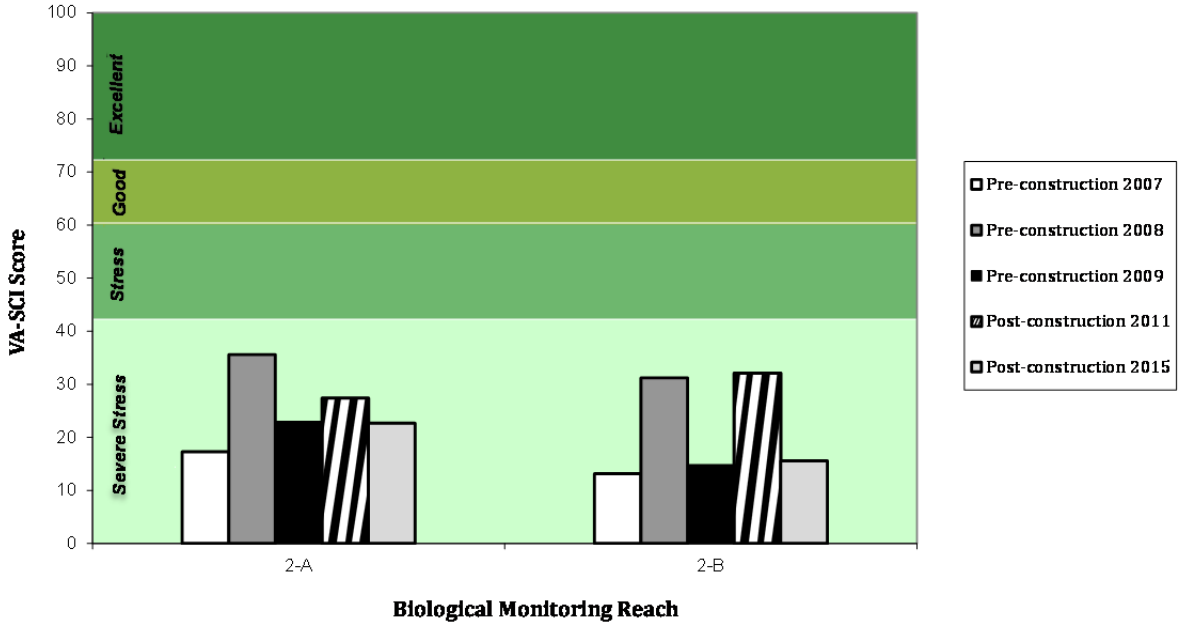
The above data collected for each reach were used to calculate the biotic metrics as shown in Table 3. The VA-SCI requires that these metrics be weighted to determine the VA-SCI, as shown in Table 4. The results of our data analysis indicate that the benthic macroinvertebrate community in both reaches (2-A and 2-B) were in "Severe Stress" in 2015 following stream restoration activities, based on their VA-SCI scores. The average VA-SCI numerical score for the two reaches assessed in 2015 is 19.11 ("Severe Stress") (Figure 2; Table 4 below). These scores are the result of the low number of total taxa, low number of total EPT taxa, low percentage of Plecoptera and Trichoptera (excluding Hydropsychidae), low percentage of Scraper taxa, high percentage of Chironomidae, and high percentage of top two dominant taxa found within the reaches assessed (Table 3).

Table 3. 2015 Forest Edge North and South Biotic Metric Scores								
Reach	Total Taxa	Total EPT Taxa	Percent Ephemeroptera	Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)	Percent Scrapers	Percent Chironomidae	Percent Top Two Dominant	HBI
2-A	7	2	0	0.95	0	68.57	88	4.61
2-B	8	0	0	0	1.83	88.07	94	5.6

These results depict little to no improvement from the 2007-2009 preconstruction monitoring or the Year 1 post-construction monitoring, where the benthic macroinverebrate community at both reaches was also listed in "Severe Stress" (Figure 2). Although the disturbance from restoration can temporarily reduce benthic condition, and recovery of the benthic community can be slow (Muatka 2002), it is WSSI's opinion that water quality and the high amount of impervious area within the Colvin Run - Forest Edge watershed will need to be addressed in order for the benthic macroinvertebrate community to improve.

Table 4. 2015 Biotic Metric and Index Weighting and VA-SCI at Forest Edge North and South		
WEIGHTED METRIC	**BIOLOGICAL MONITORING REACH**	
	2-A	**2-B**
Total Taxa	31.82	36.36
EPT Taxa	18.18	0.00
Percent Ephemeroptera	0.00	0.00
Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)	2.68	0.00
Percent Scrapers	0.00	3.56
Percent Chironomidae	31.43	11.93
Percent Top Two Dominant	17.89	7.95
HBI	79.27	64.76
VA-SCI Numerical Score	22.66	15.57
VA-SCI Narrative Score	Severe Stress	Severe Stress
Average VA-SCI Numerical Score	**19.11**	
Average VA-SCI Narrative Score	**Severe Stress**	

Figure 2. Comparison of Virginia Stream Condition Index Scores from 2007-2015 for Colvin Run-Forest Edge North and South



An analysis of land use within the watershed of each stream reach indicates that each watershed is highly developed, with Reach 2-A having 24 percent impervious land cover and Reach 2-B having 26 percent impervious land cover, as depicted in the Land Cover Map (Exhibit 5), and Table 5. It has been documented that even at low levels of imperviousness (~5-10%), stream degradation can begin to occur, which includes macroinvertebrate diversity (Schueler, Fraley-McNeal, and Cappiella, 2009). Runoff from the highly impervious land within these watersheds typically produces a high volume and velocity of flowing water and sediment in the stream channels during storm events. As a result, epifaunal substrate/available cover within these streams becomes highly mobile and benthic macrofauna could not easily colonize the available substrate (Debrey and Lockwood 1990) or they were buried and killed by high sediment deposition (Wood and Armitage 1997). However, because the restored streams within our study area have been engineered to accommodate high volume flows, future habitat degradation should be minimized and it is anticipated that benthic condition could increase overtime if water quality enhancing measures were undertaken in the watershed.

Table 5. Impervious Land Cover for Each Reach

REACH	Watershed Acres	Percent Impervious
2-A	176	24
2-B	100	26

Nutrients, pesticides, and other chemical pollutants that enter the streams through runoff can also have a negative effect on the macroinvertebrate community (Wright et al 1995; O'Halloran et al. 1996; Kiffney and Clements 1994). Sources for such pollutants within the streams we assessed likely include residential lawns, roads, wildlife, and stormwater runoff. High amounts of such pollutants into streams inevitably result in a shift in macroinvertebrate community composition, where pollutant tolerant taxa such as non-biting midge larvae and oligochaete worms out-compete sensitive taxa such as EPT (Shueler 1994).

Thus, given the factors listed above, it is not a surprise that our benthic macroinvertebrate data show low VA-SCI scores and pollution-tolerant taxa such as non-biting midges and aquatic worms as the dominant taxa. However, restoration has improved in-stream habitat, thus providing a stable substrate for colonization of benthic macroinvertebrates. Thus it may be possible in the future for benthic macroinvertebrates to re-colonize these reaches and in order to expedite colonization, and influence the species composition, water quality enhancing measures will need to be undertaken in the watershed (by others).

Conclusions

The above results indicate that the habitat of Biological Monitoring Reaches 2-A and 2-B of Colvin Run on average are "Sub-Optimal" and the benthic macroinverebrate community of the streams is in "Severe Stress". Improved habitat assessment scores following restoration relate to the success of the well vegetated and stabilized banks, with little erosion or depositional zones present throughout the restored reaches. These scores are expected to continue to improve as the riparian vegetation becomes more mature and stabilize over time. The low VA-SCI are likely due to several abiotic factors, including highly impervious land cover, high nutrient, toxicant and sediment input from adjacent land use, and large temperature fluctuations. These results suggest that although the restoration has provided a stable substrate for colonization, other

water quality measures not directly addressed through the restoration (i.e., nutrients, stormwater runoff, impervious areas, etc.) are affecting the benthic community.

Limitations

This study is based on examination of the conditions on the site at the time of our review and does not address conditions in the future. Such conditions may change over time and will be addressed in subsequent monitoring reports. Our biological monitoring report has been prepared in accordance with generally accepted guidelines for the conduct of such evaluations. We make no other warranties, either expressed or implied, and our report is not a recommendation to buy, sell or develop the property.

We offer no opinion and do not purport to opine on the possible application of various building codes, zoning ordinances, other land use or platting regulations, environmental or health laws and other similar statutes, laws, ordinances, code and regulations affecting the possible use and occupancy of the property for the purpose for which it is being used, except as specifically provided above. The opinions set forth above are rendered only and exclusively for the benefit of the addressees, the COE, the DEQ, and no other parties, successors or assigns. The foregoing opinions are based on applicable laws, ordinances, and regulations in effect as of the date hereof and should not be construed to be an opinion as to the matters set out herein should such laws, ordinances or regulations be modified, repealed or amended.

This document is solely for your benefit and is not to be quoted in whole or in part or otherwise referred to in any statement or document (except for purposes of identification) nor is it to be filed with any governmental agency or other person (other than the COE and DEQ), without the prior written consent of this firm, unless required by law.

WETLAND STUDIES AND SOLUTIONS, INC.

Alison Robinson, PWS, PWD, CT
Project Environmental Scientist

Benjamin N. Rosner, PWS, PWD, CE, CT
Manager – Environmental Science

Literature Cited

Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C. 339 pp.

Debrey, L. D. and J.A. Lockwood. 1990. Effects of sediment and flow regime on the aquatic insects of a high mountain stream. Regulated Rivers: Research & Management. 5 (3): 241-250.

Kiffney, P. M. and W. H. Clements. 1994. Effects of metals on a macroinvertebrate assemblage from a Rocky Mountain stream in experimental microcosms. Journal of the North American Benthological Society. 13: 511-523.

Muatka, T., R. Paavola, A. Haapala, M. Novikmec, P. Laasonen. 2002. Long-term recovery of stream habitat structure and benthic invertebrate communities from in-stream restoration. Biological Conservation. 105: 243-253.

O'Halloran, S. L., K. S. Liber, K.L. Schmude, and T. D. Corry. 1996. Effects of diflubenzuron on benthic macroinvertebrates in littoral enclosures. Archives of Environmental Contamination and Toxicology. 30(4):444-51.

Shueler, T. 1994. The importance of imperviousness. Watershed Protection Techniques. 1(3): 100-111.

Schueler, T., Fraley-McNeal, L., and Cappiella, K. 2009 "Is Impervious Cover Still Important? Review of Recent Research." *Journal of Hydrologic Engineering*. 14(4): 309-315

Tetra Tech, Inc. 2003. A Stream Condition Index for Virginia Non-Coastal Streams. Tetra Tech, Inc. Owings Mills, Maryland. Prepared for Virginia Department of Environmental Quality, Richmond, Virginia. 163 pp.

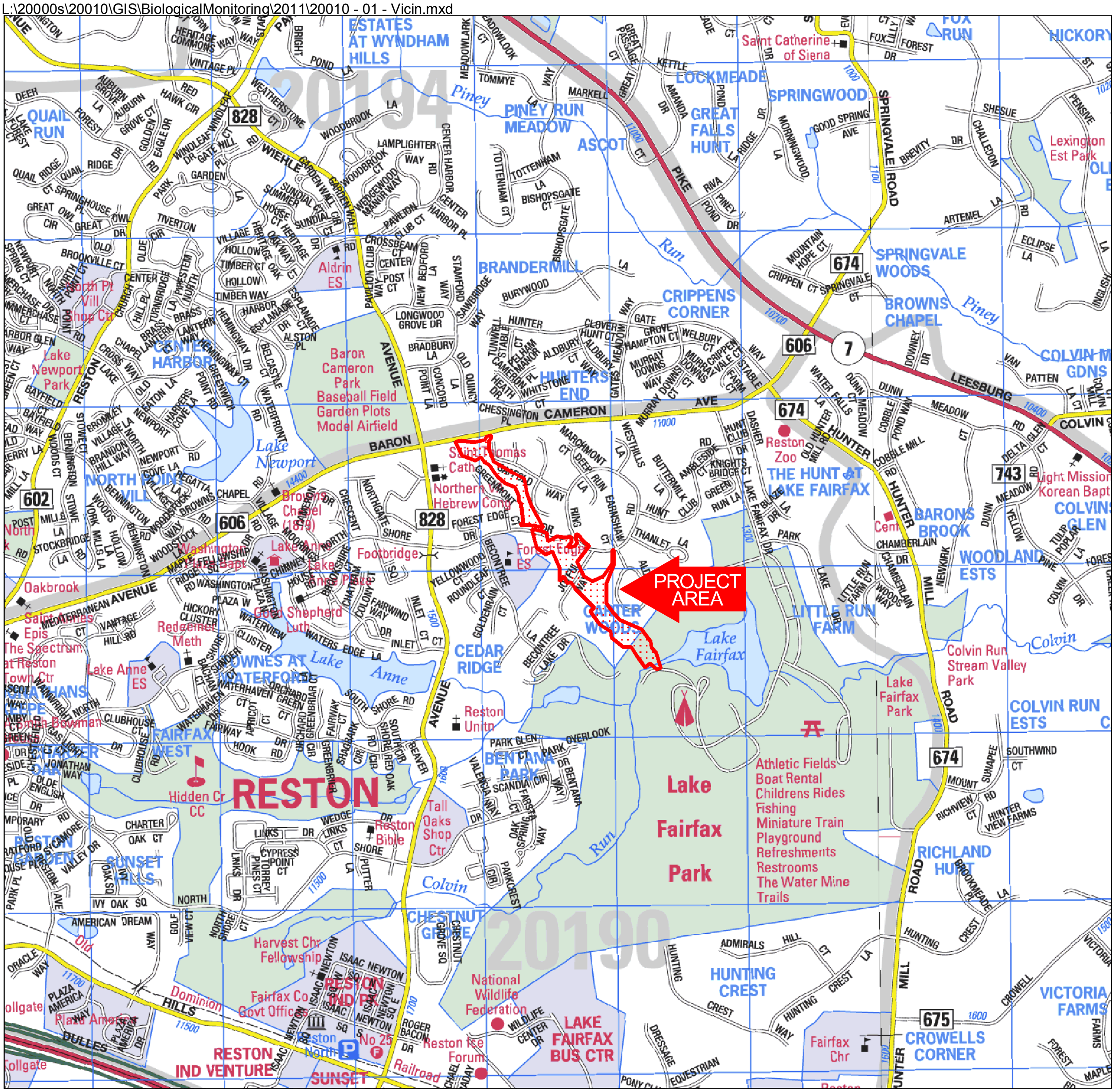
Virginia Department of Environmental Quality (DEQ) 2006. Using Probabilistic Monitoring Data to Validate the Non-Coastal Virginia Stream Condition Index. Division of Water Quality. Biological Monitoring Program. Richmond, Virginia. 54 pp.

DEQ. 2008. Biological Monitoring Program Quality Assurance Project Plan for Wadable Streams and Rivers. 43pp.

Wood, P. J. and P. D. Armitage. 1997. Biological effects of fine sediment in the lotic environment. Environmental Management. 21(2):203-217

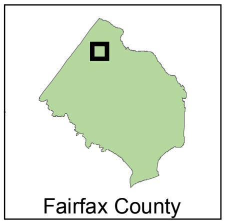
Wright I. A., B. C. Chessman, P.G. Fairweather, and L. J. Benson 1995. Measuring the impact of sewage effluent on the macroinvertebrate community of an upland stream: the effect of different levels of taxonomic resolution and quantification. Australian Journal of Ecology. 20, 142–149.

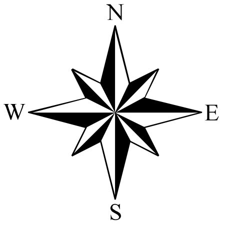
L:\20000s\20010\GIS\BiologicalMonitoring\2011\20010 - 01 - Vicin.mxd

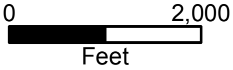


Copyright ADC The Map People
Permitted Use Number 20711184

Vicinity Map
Colvin Run - Reaches 2-A & 2-B
WSSI #20010
Scale: 1" = 2000'



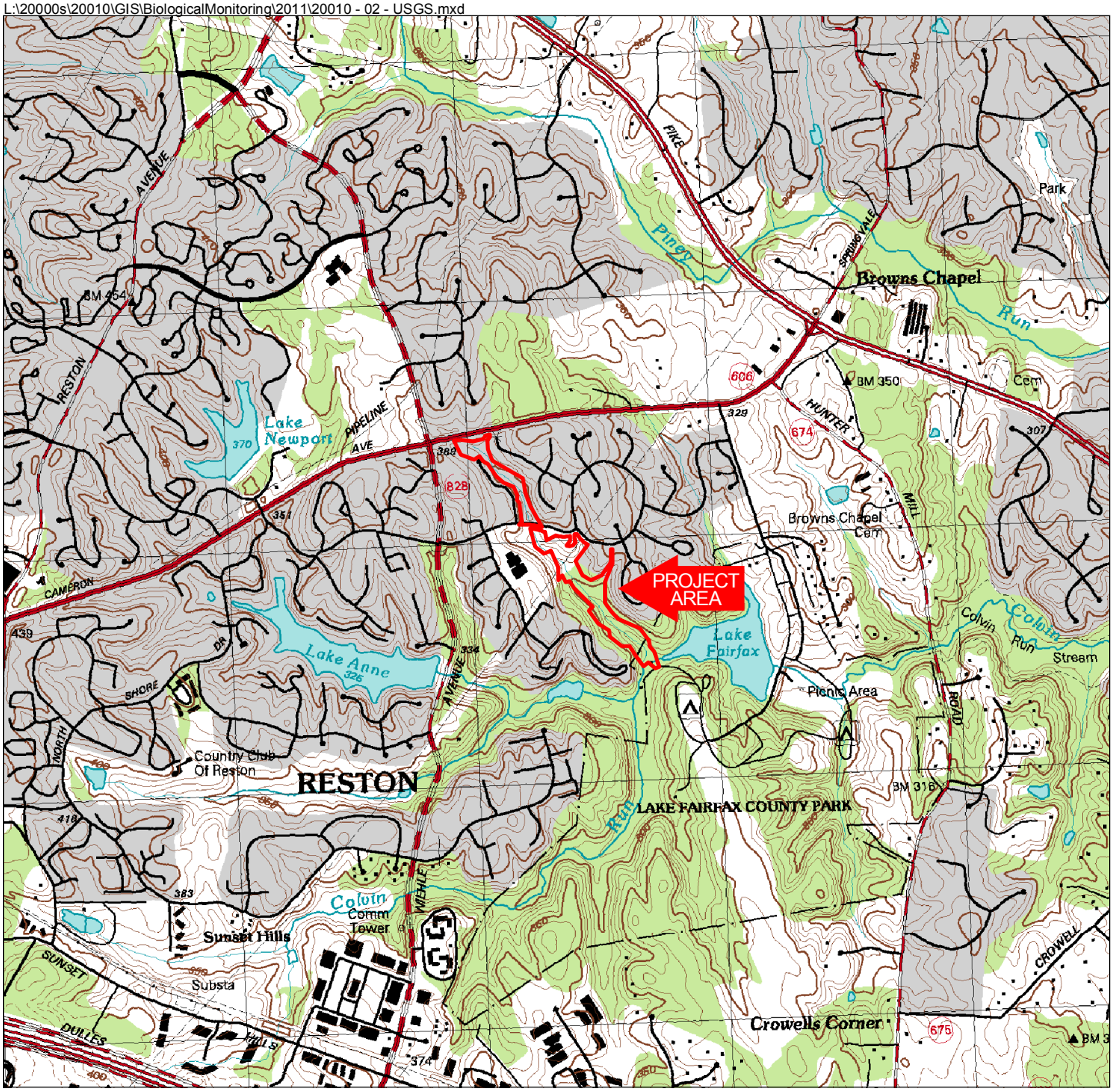




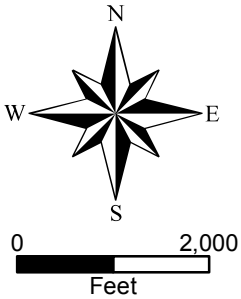
Wetland Studies and Solutions, Inc.
a DAVEY company

Exhibit 1

L:\20000s\20010\GIS\BiologicalMonitoring\2011\20010 - 02 - USGS.mxd



USGS Quad Map
Vienna, VA-MD 1994
Colvin Run - Reaches 2-A & 2-B
WSSI #20010
Scale: 1" = 2000'

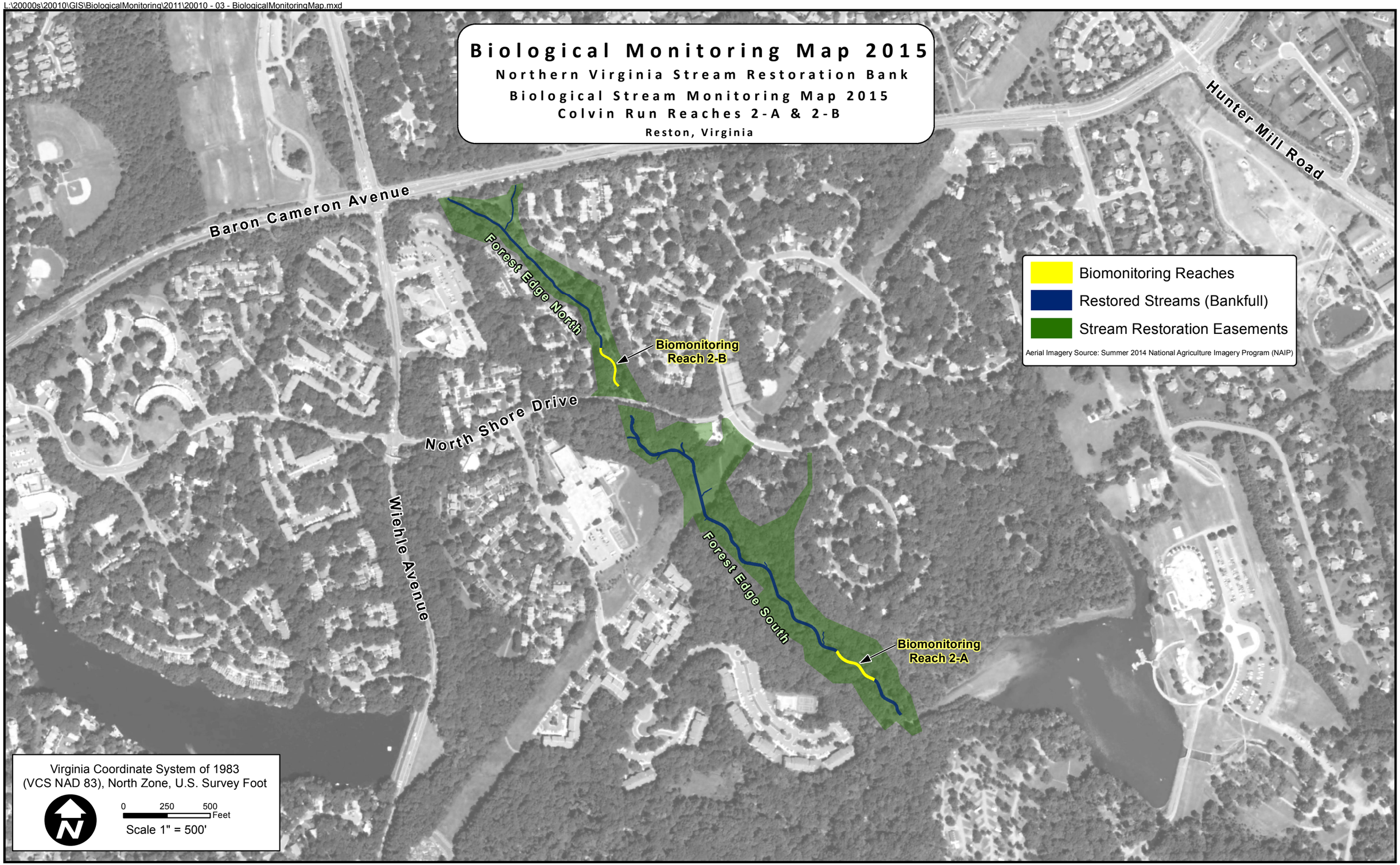


Latitude: 38°58'08" N
Longitude: 77°19'37" W
Hydrologic Unit Code (HUC): 020700081004
Stream Class: III
Name of Watershed: Colvin Run
COE Region: Eastern Mountains and Piedmont

Wetland Studies and Solutions, Inc.
a DAVEY company

Exhibit 2

L:\20000s\20010\GIS\BiologicalMonitoring\2011\20010 - 03 - BiologicalMonitoringMap.mxd



Wetland Studies and Solutions, Inc.
a DAVEY company

Exhibit 3

EXHIBIT 4
BIOLOGICAL STREAM MONITORING PHOTOGRAPHS
NORTHERN VIRGINIA STREAM RESTORATION BANK
COLVIN RUN-FOREST EDGE SOUTH
WSSI #20010

1. **Looking southeast (downstream) at Reach 2-A at an unnamed tributary to Colvin Run within the Forest Edge South project area. Photo taken during pre-construction Year 1 (2007) monitoring.**

2. **Looking southeast (downstream) at Reach 2-A at an unnamed tributary to Colvin Run within the Forest Edge South project area. Photo taken during pre-construction Year 2 (2008) monitoring.**

EXHIBIT 4
BIOLOGICAL STREAM MONITORING PHOTOGRAPHS
NORTHERN VIRGINIA STREAM RESTORATION BANK
COLVIN RUN-FOREST EDGE SOUTH
WSSI #20010

3. Looking southeast (downstream) at Reach 2-A at an unnamed tributary to Colvin Run within the Forest Edge South project area. Photo taken during pre-construction Year 3 (2009) monitoring.

4. Looking southeast (downstream) at Reach 2-A at an unnamed tributary to Colvin Run within the Forest Edge South project area. Photo taken during post-construction Year 1 (2011) monitoring.

EXHIBIT 4
BIOLOGICAL STREAM MONITORING PHOTOGRAPHS
NORTHERN VIRGINIA STREAM RESTORATION BANK
COLVIN RUN-FOREST EDGE SOUTH
WSSI #20010

5. Looking southeast (downstream) at Reach 2-A at an unnamed tributary to Colvin Run within the Forest Edge South project area. Photo taken during post-construction Year 5 (2015) monitoring.

L:\20000s\20010\Admin\05-ENVR\BIO Assessment\Postcon Year 5 - 2015 Monitoring\Photos-ForestEdge South 2.docx

Wetland Studies and Solutions, Inc.®

Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

Job # Task	Forest Edge South, 20010, Task I5				
Station ID:	Reach 2-A	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/LLS	Location:	Reston, VA	Start time:	1:00
Site:	Unnamed trib to Colvin Run	Latitude:	38°57'58"	Finish time:	2:00
Date:	3/23/2015	Longitude:	77°19'27"	Survey Reason:	Year 5 Biomonitoring

Stream Physiochemical Measurements

Instrument ID number: N/A

pH: N/A

Temperature: N/A °C

Conductivity: N/A uS/cm

Dissolved Oxygen: N/A mg/L

Did instrument pass all post-calibration checks? N/A

If NO- which parameter(s) failed and action taken: N/A

Benthic Macroinvertebrate Collection

Method Used: Single Habitat (Riffle) ____ Multi Habitat (Logs, Plants, etc.) X

Riffle Quality: Good X Marginal ____ Poor ____ None ____

Habitats Sampled: Riffle X Woody Debris ____ Banks ____ Vegetation ____

Jabs: 20

Weather Observations

Current Weather: Cloudy ____ Clear X Rain/Snow ____ Foggy ____

Recent Precipitation: Clear X Showers ____ Rain ____ Storms ____

Stream Flow: Low ____ Normal X Above Normal ____ Flood ____

Biological Observations

Periphyton	2	Salamanders	0	Other....	Iron Oxidizing Bacteria: 1
Filamentous Algae	3	Warmwater Fish	2	0= Not observed	
Submerged Macrophytes	0	Coldwater Fish	0	1= Sparse	
Emergent Macrophytes	0	Beavers	0	2= Common to Abundant	
Crayfish	0	Muskrats	0	3= Dominant-	
Corbicula	0	Ducks/Geese	0	Abnormally high density where other taxa are insignificant in relation to the dominant taxa. There can be situations where multiple taxa are dominant such as algae and snails	
Unionidae	0	Snakes	0		
Operculate Snails	0	Turtles	0		
Non-operculate Snails	0	Frogs/Tadpoles	1		

High Gradient Habitat Data Sheet

Habitat Parameter	Condition Category				
	Optimal	Suboptimal	Marginal	Poor	Score
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat and at stage to allow full colonization potential (i.e. snags/logs that are not new fall and not transient).	40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization.	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	15
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	16
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast shallow)(slow is <0.3m/s, deep is >0.5 m).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	15
4. Sediment Deposition	Little or no enlargement of islands or point bars and <5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand, or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	13

Wetland Studies and Solutions, Inc.®

Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

Habitat Parameter	Condition Category				
	Optimal	Suboptimal	Marginal	Poor	Score
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	19
6. Channel Alteration	Channelization or dredging absent or minimal; stream width normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging, may be present, but recent channelization is not present.	Channeliztion may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	20
7. Frequency of Riffles	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distances between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	13
8. Bank Stability (score each bank) Note: Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	9
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	7
9. Vegetation Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetation disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	8
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	8
10. Riparian Vegetative Zone Width (score each banks riparian zone)	Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	9
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
Total Score					162

Notes:

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Colvin (Forest Edge)-20010	Sample subsorted by:	ABR/BNR		
Station ID:	Reach 2-A	Date Subsorted:	4/16/15		
Stream Name:	Unnamed Trib to Colvin Run	# of Grids subsorted	10		
Date Sampled:	3/23/15	Total # of subsorted insects:	105	Total # identified:	105
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	4/16/15

Taxa Collected:

Porifera	Spongillidae	
Ostracoda	Unknown	
Flatworms	Tricladida	
	Planariidae	
Gastropoda	Unknown	
Limpets	Ancylidae	
Snails	Immature	
	Lymnaeidae	
	Physidae	
	Planorbidae	
	Hydrobiidae	
	Pleuroceridae	
	Viviparidae	
Bivalvia	Immature	
	Corbiculidae	
	Sphaeriidae	
	Unionidae	
Oligochaeta	Unknown	20
Lumbriculida		
	Lumbriculidae	
Tubificida		
	Enchytraeidae	
	Naididae	
	Tubificidae	
Haplotaxida		
	Haplotaxidae	
Leeches	Hirudinea	
	Erpobdellidae	
	Glossiphoniidae	
	Hirudinidae	
	Pisciolidae	
Branchiobdellida	Branchiobdellidae	
Copepoda	Unknown	2
Decapoda	Cambaridae	
	Portunidae	
Shrimp		
	Palaemonidae	
Isopoda		
	Asellidae	
Amphipoda		
	Crangonyctidae	
	Gammaridae	
	Talitridae	
Water Mites		
	Hydracarina	1
Ephemeroptera	Early Instar and/or damaged	
	Acanthometropodidae	
	Ameletidae	
	Baetidae	
	Baetiscidae	
	Behningiidae	
	Caenidae	
	Ephemerellidae	
	Ephemeridae	
	Heptageniidae	
	Isonychiidae	
	Leptophlebiidae	
TOTAL:		23

	Metretopodidae	
	Neoephemeridae	
	Oligoneuridae	
	Psuedironidae	
	Polymitarcyidae	
	Potamanthidae	
	Siphlonuridae	
	Tricorythidae	
Zygoptera	Early Instar and/or damaged	
	Calopterygidae	
	Coenagrionidae	
	Lestidae	
	Protoneuridae	
Anisopteera	Early Instar and/or damaged	
	Aeshnidae	
	Cordulegastridae	
	Corduliidae	
	Gomphidae	
	Libellulidae	
	Macromiidae	
	Petaluridae	
	Cordullidae/Libelluidae	
Plecoptera	Early Instar and/or damaged	
	Capniidae	
	Chloroperlidae	
	Leuctridae	
	Nemouridae	
	Peltoperlidae	
	Perlidae	
	Perlodidae	
	Pteronarcyidae	
	Taeniopeterygidae	
Hemiptera	Early Instar and/or damaged	
	Belostomatidae	
	Corixidae	
	Gelastocoridae	
	Gerridae	
	Hebridae	
	Hydrometridae	
	Mesoveliidae	
	Naucoridae	
	Nepidae	
	Notonectidae	
	Veliidae	
	Pleidae	
Neuroptera		
	Sisyridae	
Megaloptera		
	Corydalidae	
	Sialidae	
Trichoptera	Early Instar and/or damaged	
	Branchycentridae	
	Calamoceratidae	
	Glossosomatidae	
	Goeridae	
	Heliicopsychidae	
	Hydropsychidae	5
	Hydroptilidae	
TOTAL:		5

	Lepidostomatidae	
	Leptoceridae	
	Limnephilidae	
	Molannidae	
	Odontoceridae	
	Philopotamidae	1
	Phryganeidae	
	Polycentropodidae	
	Psychomyiidae	
	Ryacophilidae	
	Sericostomatidae	
	Uenoidae	
Lepidoptera	Early Instar and/or damaged	
	Pyralidae	
Coleoptera	Early Instar and/or damaged	
	Chrysomelidae	
	Curculionidae	
	Dryopidae	
	Dytiscidae	
	Elmidae	
	Gyrinidae	
	Haliplidae	
	Helodidae	
	Helophoridae	
	Hydraenidae	
	Hydrochidae	
	Hydrophilidae	
	Limnichidae	
	Noteridae	
	Psephenidae	
	Ptilodactylidae	
	Scirtidae	
Diptera	Early Instar and/or damaged	
	Athericidae	
	Blephariceridae	
	Canaceidae	
	Ceratopogonidae	4
	Choaboridae	
	Chironomidae	72
	Culicidae	
	Dixidae	
	Dolichopodidae	
	Empididae	
	Ephydridae	
	Muscidae	
	Nymphomyiidae	
	Pelecorhynchidae	
	Psychodidae	
	Ptychopteridae	
	Sciomyzidae	
	Simuliidae	
	Stratiomyidae	
	Syrphidae	
	Tabanidae	
	Tanyderidae	
	Thaumaleidae	
	Tipulidae	
TOTAL:		77

EXHIBIT 4
BIOLOGICAL STREAM MONITORING PHOTOGRAPHS
NORTHERN VIRGINIA STREAM RESTORATION BANK
COLVIN RUN-FOREST EDGE NORTH
WSSI #20010

1. **Looking south (downstream) at Reach 2-B of an unnamed tributary to Colvin Run within the Forest Edge North project area. Photo taken during the pre-construction Year 1 (2007) monitoring.**

2. **Looking south (downstream) at Reach 2-B of an unnamed tributary to Colvin Run within the Forest Edge North project area. Photo taken during the pre-construction Year 2 (2008) monitoring.**

EXHIBIT 4
BIOLOGICAL STREAM MONITORING PHOTOGRAPHS
NORTHERN VIRGINIA STREAM RESTORATION BANK
COLVIN RUN-FOREST EDGE NORTH
WSSI #20010

3. Looking south (downstream) at Reach 2-B of an unnamed tributary to Colvin Run within the Forest Edge North project area. Photo taken during the pre-construction Year 3 (2009) monitoring.

4. Looking south (downstream) at Reach 2-B of an unnamed tributary to Colvin Run within the Forest Edge North project area. Photo taken during the post-construction Year 1 (2011) monitoring.

EXHIBIT 4
BIOLOGICAL STREAM MONITORING PHOTOGRAPHS
NORTHERN VIRGINIA STREAM RESTORATION BANK
COLVIN RUN-FOREST EDGE NORTH
WSSI #20010

5. Looking south (downstream) at Reach 2-B of an unnamed tributary to Colvin Run within the Forest Edge North project area. Photo taken during the post-construction Year 5 (2015) monitoring.

L:\20000s\20010\Admin\05-ENVR\BIO Assessment\Postcon Year 5 - 2015 Monitoring\Photos-ForestEdgeNorth.docx

Wetland Studies and Solutions, Inc.®

Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

Job # Task	Forest Edge North, 20010, Task I5				
Station ID:	Reach 2-B	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR / LLS	Location:	Reston, VA	Start time:	11:00
Site:	Unnamed Trib to Colvin Run	Latitude:	38°58'14"	Finish time:	12:00
Date:	3/23/2015	Longitude:	77°19'44"	Survey Reason:	Year 5 Biomonitoring

Stream Physiochemical Measurements

Instrument ID number: N/A

pH: N/A

Temperature: N/A °C

Conductivity: N/A uS/cm

Dissolved Oxygen: N/A mg/L

Did instrument pass all post-calibration checks? N/A

If NO- which parameter(s) failed and action taken: N/A

Benthic Macroinvertebrate Collection

Method Used:			Single Habitat (Riffle)				Multi Habitat (Logs, Plants, etc.)	X
Riffle Quality:	Good		Marginal	X	Poor		None	
Habitats Sampled:	Riffle	X	Woody Debris		Banks		Vegetation	X
	# Jabs:	15						5

Weather Observations

Current Weather	Cloudy		Clear	X	Rain/Snow		Foggy	
Recent Precipitation	Clear	X	Showers		Rain		Storms	
Stream Flow	Low		Normal	X	Above Normal		Flood	

Biological Observations

Periphyton	2	Salamanders	0	Other....	
Filamentous Algae	0	Warmwater Fish	0	0= Not observed	
Submerged Macrophytes	0	Coldwater Fish	0	1= Sparse	
Emergent Macrophytes	0	Beavers	0	2= Common to Abundant	
Crayfish	0	Muskrats	0	3= Dominant-	
Corbicula	0	Ducks/Geese	0	Abnormally high density where other taxa are insignificant in relation to the dominant taxa. There can be situations where multiple taxa are dominant such as algae and snails	
Unionidae	0	Snakes	0		
Operculate Snails	0	Turtles	0		
Non-operculate Snails	0	Frogs/Tadpoles	2		

High Gradient Habitat Data Sheet

Habitat Parameter	Condition Category				
	Optimal	Suboptimal	Marginal	Poor	Score
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat and at stage to allow full colonization potential (i.e. snags/logs that are not new fall and not transient).	40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization.	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	15
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	14
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast shallow)(slow is <0.3m/s, deep is >0.5 m).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	11
4. Sediment Deposition	Little or no enlargement of islands or point bars and <5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand, or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	18

Wetland Studies and Solutions, Inc.®

Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

Habitat Parameter	Condition Category				
	Optimal	Suboptimal	Marginal	Poor	Score
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	17
6. Channel Alteration	Channelization or dredging absent or minimal; stream width normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging, may be present, but recent channelization is not present.	Channeliztion may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	20
7. Frequency of Riffles	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distances between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	5
8. Bank Stability (score each bank) Note: Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
9. Vegetation Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetation disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	9
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	9
10. Riparian Vegetative Zone Width (score each banks riparian zone)	Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	5
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	5
Total Score					148

Notes:

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Colvin (Forest Edge)-20010	Sample subsorted by:	ABR / BNR		
Station ID:	Reach 2-B	Date Subsorted:	4/10/15		
Stream Name:	Unnamed Trib to Colvin Run	# of Grids subsorted	7		
Date Sampled:	3/23/15	Total # of subsorted insects:	109	Total # identified:	9
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	4/10/15

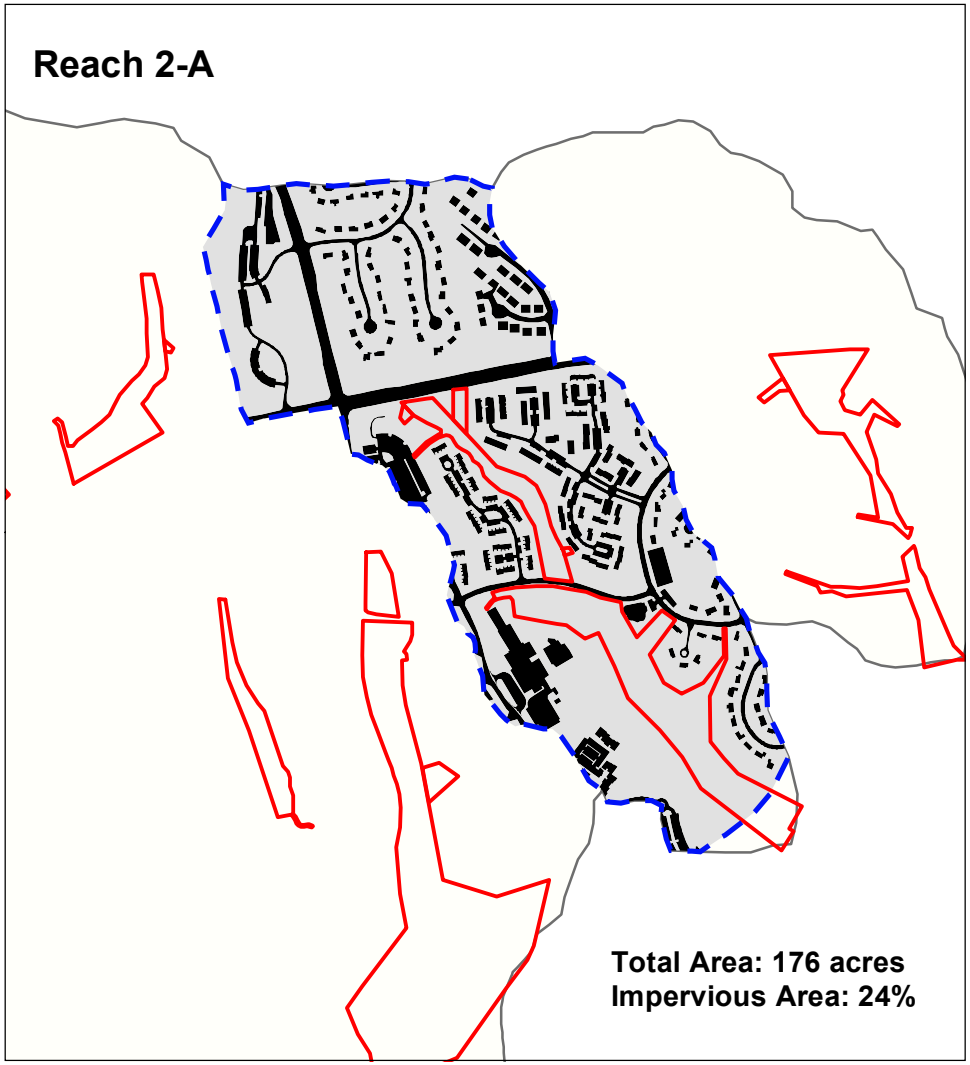
Taxa Collected:

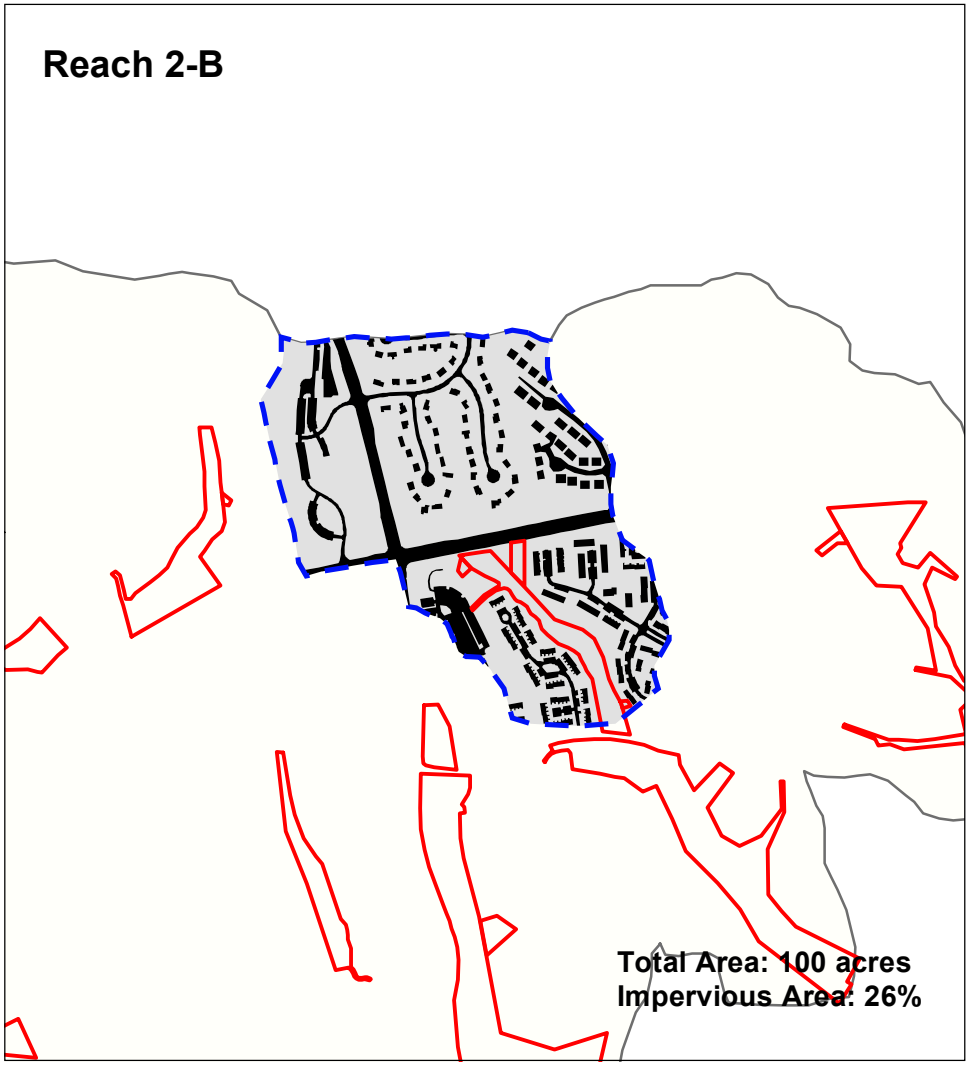
Porifera	Spongillidae	
Ostracoda	Unknown	
Flatworms	Tricladida	
	Planariidae	
Gastropoda	Unknown	
Limpets	Ancylidae	
Snails	Immature	
	Lymnaeidae	
	Physidae	1
	Planorbidae	1
	Hydrobiidae	
	Pleuroceridae	
	Viviparidae	
Bivalvia	Immature	
	Corbiculidae	
	Sphaeriidae	
	Unionidae	
Oligochaeta	Unknown	7
Lumbriculida		
	Lumbriculidae	
Tubificida		
	Enchytraeidae	
	Naididae	
	Tubificidae	
Haplotaxida		
	Haplotaxidae	
Leeches	Hirudinea	
	Erpobdellidae	
	Glossiphoniidae	
	Hirudinidae	
	Pisciolidae	
Branchiobdellida	Branchiobdellidae	
Copepoda	Unknown	
Decapoda	Cambaridae	
	Portunidae	
Shrimp		
	Palaemonidae	
Isopoda		
	Asellidae	
Amphipoda		
	Crangonyctidae	
	Gammaridae	
	Talitridae	
Water Mites		
	Hydracarina	
Ephemeroptera	Early Instar and/or damaged	
	Acanthometropodidae	
	Ameletidae	
	Baetidae	
	Baetiscidae	
	Behningiidae	
	Caenidae	
	Ephemerellidae	
	Ephemeridae	
	Heptageniidae	
	Isonychiidae	
	Leptophlebiidae	
TOTAL:		9

	Metretopodidae	
	Neoephemeridae	
	Oligoneuridae	
	Psuedironidae	
	Polymitarcyidae	
	Potamanthidae	
	Siphlonuridae	
	Tricorythidae	
Zygoptera	Early Instar and/or damaged	
	Calopterygidae	
	Coenagrionidae	
	Lestidae	
	Protoneuridae	
Anisopteera	Early Instar and/or damaged	
	Aeshnidae	
	Cordulegastridae	
	Corduliidae	
	Gomphidae	
	Libellulidae	
	Macromiidae	
	Petaluridae	
	Cordullidae/Libelluidae	
Plecoptera	Early Instar and/or damaged	
	Capniidae	
	Chloroperlidae	
	Leuctridae	
	Nemouridae	
	Peltoperlidae	
	Perlidae	
	Perlodidae	
	Pteronarcyidae	
	Taeniopeterygidae	
Hemiptera	Early Instar and/or damaged	
	Belostomatidae	
	Corixidae	
	Gelastocoridae	
	Gerridae	
	Hebridae	
	Hydrometridae	
	Mesoveliidae	
	Naucoridae	
	Nepidae	
	Notonectidae	
	Veliidae	
	Pleidae	
Neuroptera		
	Sisyridae	
Megaloptera		
	Corydalidae	
	Sialidae	
Trichoptera	Early Instar and/or damaged	
	Branchycentridae	
	Calamoceratidae	
	Glossosomatidae	
	Goeridae	
	Heliicopsychidae	
	Hydropsychidae	
	Hydroptilidae	
TOTAL:		0

	Lepidostomatidae	
	Leptoceridae	
	Limnephilidae	
	Molannidae	
	Odontoceridae	
	Philopotamidae	
	Phryganeidae	
	Polycentropodidae	
	Psychomyiidae	
	Ryacophilidae	
	Sericostomatidae	
	Uenoidae	
Lepidoptera	Early Instar and/or damaged	
	Pyralidae	
Coleoptera	Early Instar and/or damaged	
	Chrysomelidae	
	Curculionidae	
	Dryopidae	
	Dytiscidae	
	Elmidae	
	Gyrinidae	
	Haliplidae	
	Helodidae	
	Helophoridae	
	Hydraenidae	
	Hydrochidae	
	Hydrophilidae	
	Limnichidae	
	Noteridae	
	Psephenidae	
	Ptilodactylidae	
	Scirtidae	
Diptera	Early Instar and/or damaged	1
	Athericidae	
	Blephariceridae	
	Canaceidae	
	Ceratopogonidae	1
	Choaboridae	
	Chironomidae	96
	Culicidae	
	Dixidae	
	Dolichopodidae	
	Empididae	
	Ephydridae	
	Muscidae	
	Nymphomyiidae	
	Pelecorhynchidae	
	Psychodidae	
	Ptychopteridae	
	Sciomyzidae	
	Simuliidae	
	Stratiomyidae	1
	Syrphidae	
	Tabanidae	
	Tanyderidae	
	Thaumaleidae	
	Tipulidae	1
		100
TOTAL:		

Land Cover Map
Colvin Run Biological Monitoring - Reaches 2-A & 2-B
WSSI #20010





L:\20000s\20010\GIS\BiologicalMonitoring\2011\20010 - 05 - LandCover.mxd

SITE
DRAINAGE BOUNDARIES
IMPERVIOUS AREAS
PERVIOUS AREAS

0 0.125 0.25 0.5 Miles

N W E S

Wetland Studies and Solutions, Inc.
a DAVEY company

Exhibit 5