Northern Virginia Stream Restoration Bank – Snakeden Branch Watershed

Fairfax County, Virginia

WSSI #20003, Task I5

Biological Monitoring Report #4 – Post Construction Monitoring Year 5

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Biological Monitoring Report #4
Year 5 Monitoring

Northern Virginia Stream Restoration Bank
Snakeden Branch Watershed
(20,068 Linear Feet)
WSSI #20003

Executive Summary

In accordance with the "Northern Virginia Stream Restoration Bank Banking Instrument" (Banking Instrument), 20,068 linear feet of streams and drainage features within the Snakeden Branch Watershed were stabilized and restored from February 2008 to March 2009 and from June 2009 to October 2009.

In the fifth year following restoration, Wetland Studies and Solutions, Inc. (WSSI) conducted biological stream assessments along the Snakeden Branch Watershed portion of the Northern Virginia Stream Restoration Bank (NVSRB) in 2013 pursuant to the maintenance and monitoring requirements defined in the NVSRB Banking Instrument, Section VI.B.2.(i). The assessed reaches were selected to be representative of the condition of Snakeden Branch and unnamed tributaries of Snakeden Branch following the restoration. This report summarizes the 2013 Year 5 monitoring, as compared to the 2007 and 2008 pre-construction baseline conditions and the Year 1 through Year 4[1] post-construction conditions.

Biological stream monitoring was conducted along nine permanent biological monitoring reaches using benthic macroinvertebrate and habitat data. Fieldwork was conducted on March 28 and 29, 2013. Benthic macroinvertebrate data was used to calculate a Stream Condition Index for Virginia Non-coastal Streams (VA-SCI) and habitat data was used to calculate the percentage of best possible habitat for each reach.

Habitat assessment results indicate that the habitat of the streams within the Snakeden Branch watershed portion of the NVSRB during the post-construction Year 5 (2013) biological monitoring were "Optimal", with an average Total Habitat Score of 180 (out of 200) for the nine reaches assessed. The optimal habitat scores can be attributed to the successful establishment of the riparian vegetation, the continued stability of the bioengineered banks, and improved geomorphology.

Benthic macroinvertebrate results indicate that the benthic macroinvertebrate community within the Snakeden Branch watershed portion of the NVSRB was in "Severe Stress" during the post-construction Year 5 (2013) monitoring. Although stream habitat has improved following restoration (as shown in our habitat results), the VA-SCI score remains low. 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, oil leaks, impervious areas, temperature fluctuations, etc.) are affecting the benthic community.

[1] *Voluntary supplemental monitoring was conducted in Year 2(2010), Year 3(2011), and Year 4 (2012).*

Introduction

As set forth in the "Northern Virginia Stream Restoration Bank Banking Instrument" (Banking Instrument), dated February 17, 2006 and prepared by Wetland Studies and Solutions, Inc. (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. To date, Northern Virginia Stream Restoration, L.C. stabilized and restored 20,068 linear feet of streams and drainage features within the Snakeden Branch Watershed from February 2008 to March 2009 and from June 2009 to October 2009.

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 should result in a direct improvement of in-stream habitat. Using benthic macroinvertebrate and habitat data, this Year 5 post-construction monitoring report characterizes the restored streams within the Snakeden Branch Watershed portion of the NVSRB in 2012, as compared to baseline conditions described in Biological Monitoring Reports #1 (dated January 29, 2008), #2 (dated October 24, 2008), and #3 (dated October 2, 2009) and supplemental memos dated June 9, 2010, August 24, 2011, and November 27, 2012. With this data, and data from previous and subsequent monitoring reports, we propose to study the effect of stream restoration on the condition of streams within the Snakeden Branch Watershed portion of the NVSRB[2].

Project Area

The study area includes 20,068 linear feet of stream along Snakeden Branch and several unnamed tributaries of Snakeden Branch, as well as the adjacent riparian corridor. The study area is located southeast of Reston Parkway (Route 602) and immediately northwest of Lake Audubon in Fairfax County, Virginia. Exhibit 1 is a vicinity map that depicts the approximate location of the study area.

The study area is covered mostly by mixed-deciduous forest, as depicted on the Biological Stream Monitoring Map (Exhibit 4). Snakeden Branch flows in a southeasterly direction through the central portion of the study area. An asphalt recreational trail, which crosses Snakeden Branch multiple times, is located parallel to the stream and to several of its unnamed tributaries. The study area is gently to moderately 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. Once established, these reaches are to be monitored prior to stream restoration, then in years 1, 5, and 10. The following methods are to be employed:

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

- 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)[3].

- 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)[4].

Voluntary supplemental monitoring was undertaken in Year 2 (2010)[5], Year 3 (2011) and Year 4 (2012) to better understand and document the effects of stream restoration on the benthic community within the Snakeden Branch Watershed. This data is also included within this report.

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 habitat assessment field work was conducted using guidance established in the DEQ standard operating procedures for stream habitat assessment (SOPs; DEQ 2008) and the EPA's RBP 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).

WSSI assessed the nine permanent sampling reaches that were selected in Biological Monitoring Report #1 (Reaches 1-A through 1-F, 2-A, 2-B, and 3-A). The locations of these nine sampling reaches relative to the 17 restoration design reaches are depicted in Exhibit 3[6]. As required by the SOPs, each reach is 300 linear feet. The approximate location of each reach is depicted on the Biological Stream Monitoring Map (Exhibit 4). Photographs of each reach are included in Exhibit 6. Benthic macroinvertebrate sampling and habitat assessment field work

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[3] *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, Snakeden Branch Watershed", dated January 29, 2008.*

[4] *This method is to be used in all monitoring years and is accompanied by a habitat assessment, following guidance established in Virginia Department of Environmental Quality's (DEQ) standard operating procedures for stream habitat assessment (SOPs; DEQ 2008) and the EPA's RBP for habitat (Barbour et al. 1999).*

[5] *Monitoring was only conducted at biological monitoring reach 1-A, 1-B, 1-C and 1-E during the Year 2 (2010) fieldwork.*

[6] *Note that the nine permanent monitoring reaches correspond with reaches of the NVSRB-Snakeden Branch plan sets, as follows: Reach 1-F corresponds with Reach 1 of the May 2007 plan set; Reach 1-E corresponds with Reach 2 of the August 2007 plan set; Reach 3-A corresponds with Reach 4 of the October 2007 plan set; Reaches 1-D and 1-C correspond with Reaches 5 and 7, respectively of the November 2007 plan set; Reaches 2-A and 2-B correspond with Reaches 13 and 15, respectively of the July 2, 2008 plan set; and Reaches 1-A and 1-B correspond with Reaches 12 and 17, respectively of the July 10, 2008 plan set.*

was conducted by WSSI environmental scientists Alison Robinson, WPIT, CT[7] and Jessica Campo, WPIT[8] on March 28 and 29, 2013.

In accordance with the SOPs, habitat conditions were assessed by qualitatively rating ten habitat parameters, including Epifaunal Substrate/Available Cover, Pool Substrate Characterization, Pool Variability, Sediment Deposition, Channel Flow Status, Channel Alteration, Channel Sinuosity, Bank Stability, Vegetation Protection, and Riparian Vegetative Zone. The overall habitat quality of each reach was determined by calculating the percentage of the best possible score[9], where the best possible score for each reach equals 200. The following formula was used to determine the percentage of best possible score for each reach:

Percentage of Best Possible Score = (Total Habitat Score)/(200)*100

Each reach was then assigned a narrative rating according to the calculated percentage of best possible score, where "Excellent" is >90, "Good" is 75-88, "Fair" is 60-73, and "Poor" is <58. WSSI Benthic Macroinvertebrate and Habitat Field Data Sheets (developed from the EPA's RBP Habitat Assessment Field Data Sheets) for each reach are included as Exhibit 6.

To assess benthic macroinvertebrate condition, 60 linear feet of best-available habitat was sampled in each reach using a D-Framed Net. Habitat types sampled include cobble/gravel, snags/leafpacks, under-cut banks, root-wads, and submerged vegetation. Benthic field data was recorded on WSSI's Benthic Macroinvertebrate and Habitat Field Data Sheets (developed from the EPA's RBP Benthic Macroinvertebrate Field Data Sheets), which are included in Exhibit 6 for each reach.

Benthic macroinvertebrate samples were processed and subsampled by WSSI staff using guidance from the SOPs. Specifically, a fixed-count method was used, where one hundred and ten organisms plus or minus 10% (99-121 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, which are included in Exhibit 6 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 Condition Index for Virginia Non-Coastal Streams" and "Using Probabilistic Monitoring Data to Validate the Non-Coastal Virginia Stream Condition Index". 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:

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7 *Wetland Professional In-Training, Society of Wetland Scientists Certification Program, Inc.; North American Benthological Society (NABS) Certified Level 1 Taxonomist: All Phyla; ISA Certified Arborist MA-5179A.*

8 *Wetland Professional in Training, Society of Wetland Scientists Certification Program, Inc.*

9 *The SOPs indicate that overall habitat quality is determined by calculating the percent similarity to reference score. Since reference reaches were not available to assess, WSSI used the best possible score as the reference score.*

- 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

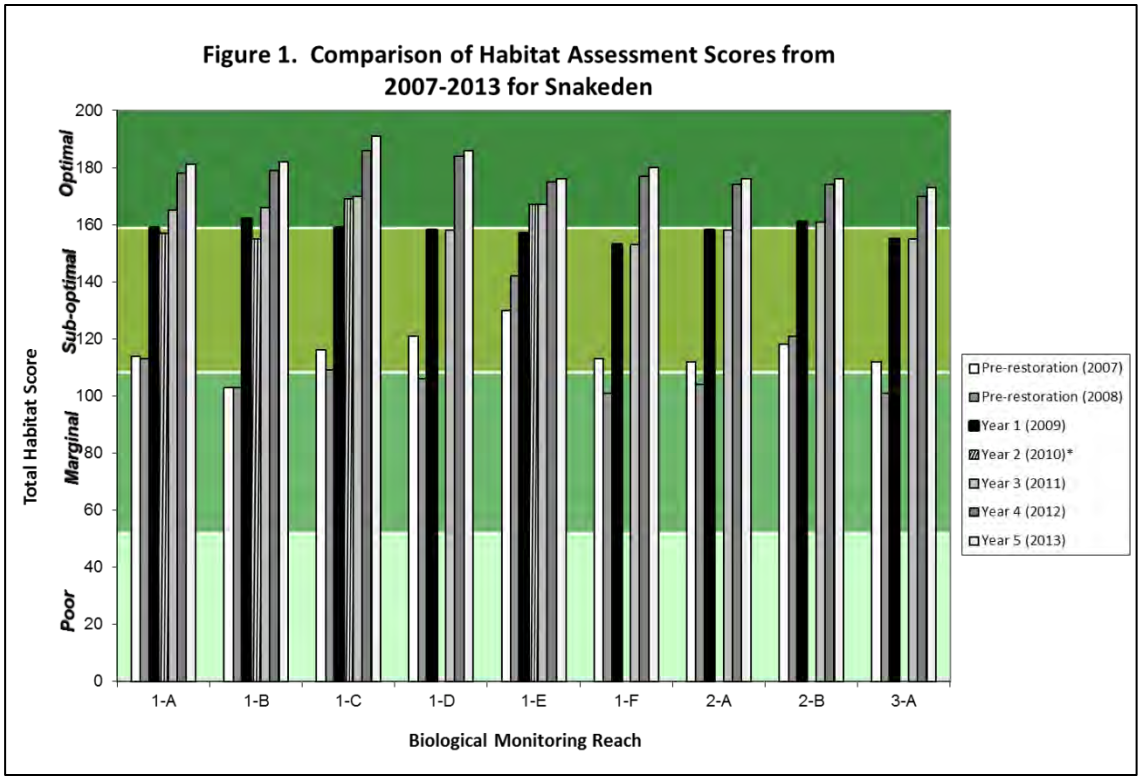
- EPT Taxa: Score = 100 x (X/11), where X = Metric Value
- Percent Ephemeroptera: Score = 100 x (X/61.3), where X = Metric Value
- Percent Plecoptera + Trichoptera less Hydropsychidae: Score = 100 x (X/35.6), where X = Metric Value
- Percent Scrapers: Score = 100 x (X/51.6), where X = Metric Value
- 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.

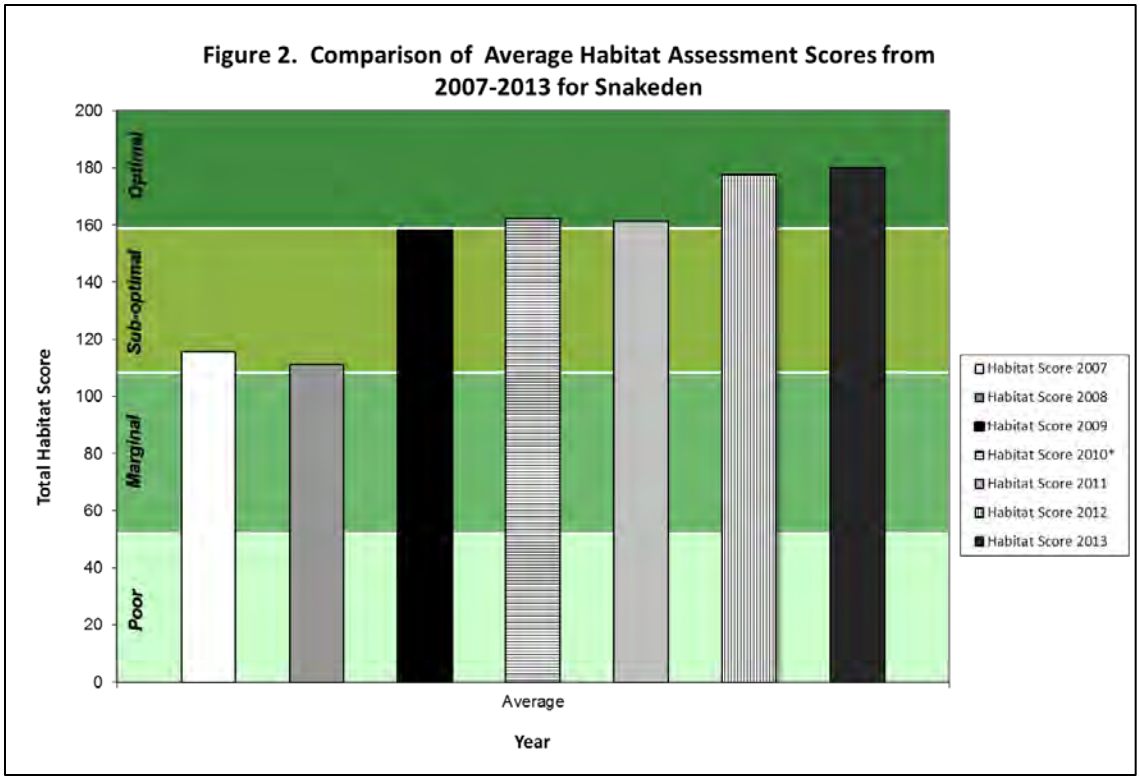
Biological Stream Monitoring Results and Discussion. Habitat results for 2013 show that all restored biological monitoring stream reaches (Reaches 1-A through 1-F, 2-A, 2-B and 3-A) have "optimal" habitat condition (Table 1, Figure 1) following restoration. The average habitat assessment score for all restored streams assessed within the Snakeden Branch Watershed portion of the NVSRB in 2013 is 180, which is 90 percent of the best possible score ("Good" to "Excellent"). These results show improved habitat conditions following restoration, with average scores exceeding the pre-restoration and the post-restoration scores (Figure 1 and Figure 2), 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. 2013 Total Habitat Assessment Scores

BIOMONITORING REACH	Total Habitat	Narrative Rating
1-A	181	Optimal
1-B	182	Optimal
1-C	191	Optimal
1-D	186	Optimal
1-E	176	Optimal
1-F	180	Optimal
2-A	176	Optimal
2-B	176	Optimal
3-A	173	Optimal
Average	**180**	**Optimal**



**In supplemental Year 2 (2010) only reaches 1-A, 1-B, 1-C, and 1-E were sampled.*



Benthic macroinvertebrate results show that individuals from 24 taxa were collected from all nine reaches collectively (Table 2, below) during the 2012 post-construction (Year 5) benthic macroinvertebrate monitoring. These 24 taxa include amphipods (Order Amphipoda), limpets (Family Ancylidae); copepods (Subclass Copepoda); Asian clams (Family Corbiculidae); leeches (Subclass Hirudinea); watermites (Hydracarina); an unknown moth larvae (Order Lepidoptera); lymnaid, ramshorn, and physid snails (Families Lymnaeidae, Planorbidae, and Physidae, respectively); oligochaete worms (Class Oligochaeta); deer fly, crane fly, biting midge, dance fly, and non-biting midge larvae (Families Tabanidae, Tipulidae, Ceratopogonidae, Empididae, and Chironomidae, respectively); common net-spinning caddisfly larvae (Family Hydropsychidae); riffle beetles, crawling water beetles, and water pennies (Families Elmidae, Haliplidae, and Psephenidae, respectively); and narrow-winged damselfly larvae (Family Coenagrionidae). Of all 24 taxa collected, non-biting midge larvae and oligochaete worms comprised the majority of individuals in each reach (Table 2, below).

Table 2. 2013 Raw Benthic Macroinvertebrate Data at Snakeden

TAXA	REACH									
	1-A	1-B	1-C	1-D	1-E	1-F	2-A	2-B	3-A	Total
AMPHIPODA	-	-	-	-		1	-	-	-	1
ANCYLIDAE	-	-	-	-	3	-	-	-	-	3
CERATOPOGONIDAE	-	-	3	-	2	-	-	-	1	6
CHIRONOMIDAE	20	12	28	17	26	3	65	14	7	192
COENAGRIONIDAE	4	1	-	-	-	-	1	-	-	6
COPEPODA	1	2	-	1	2	1	1	5	-	13
CORBICULIDAE	1	-	-	-	-	-	-	-	-	1
ELMIDAE	5	-	1	-	-	-	2	3	-	11
EMPIDIDAE	2	-	3	-	-	-	-	-	-	5
GASTROPODA	-	1	-	-	-	-	-	-	-	1
HALIPLIDAE	-	1	-	-	-	-	-	-	-	1
HIRUDINEA	-	-	-	-	-	-	1		-	1
HYDRACARINA	-	-	-	-	-	-	-	1	-	1
HYDROPSYCHIDAE	1	2	14	2	2	-	-	-	-	21
LEPIDOPTERA	-	-	-	-	-	-	1	-	-	1
LYMNAEIDAE	1	-	-	-	-	-	-	-	-	1
OLIGOCHAETA	63	72	53	74	57	88	21	59	80	567
PHYSIDAE	-	-	-	-	-	-	1	-	-	1
PLANORBIDAE	1	-	-	-	1	-	-	-	-	2
PSEPHENIDAE	-	-	-	-	-	-	1	-	-	1
SIMULIIDAE	2	-	-	-	-	-	3	-	-	5
SPHAERIDAE	-	-	1	-	1	-	1	3	-	6
TABANIDAE	-	-	-	-	-	-	-	1	-	1
TIPULIDAE	-	1	2	1	2	2	-	1	-	9
TOTAL	**101**	**92**	**105**	**95**	**96**	**95**	**98**	**87**	**88**	**559**

The above data collected for each reach were used to calculate the biotic metrics as shown in Table 3, below. The VA-SCI requires that these metrics be weighted to determine the VA-SCI, as shown in Table 4, below. The results of our data analysis indicate that the benthic macroinvertebrate community at all restored stream reaches (Reaches 1-A through 1-F, 2-A, 2-B, and 3-A) is in "Severe Stress" based on their VA-SCI scores (Table 4, below). The average VA-SCI numerical score for all streams assessed within the Snakeden Branch Watershed portion of the NVSRB in 2013 is 32.04 ("Severe Stress") (Figure 4, below).

Table 3. 2013 Snakeden Branch 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
1-A	11	1	0.00	0.00	6.93	19.80	82.18	2.25
1-B	8	1	0.00	0.00	0.00	13.04	91.30	1.10
1-C	8	1	0.00	0.00	0.95	26.67	77.14	2.78
1-D	4	0	0.00	0.00	0.00	17.89	95.79	1.21
1-E	9	1	0.00	0.00	4.17	27.08	86.46	2.26
1-F	5	0	0.00	0.00	0.00	3.16	95.79	0.25
2-A	11	0	0.00	0.00	4.08	66.33	87.76	4.61
2-B	8	0	0.00	0.00	3.45	16.09	83.91	1.51
3-A	3	0	0.00	0.00	0.00	7.95	98.86	0.55

These scores are the result of the low number of total taxa, low number of total EPT taxa, low number of Ephemeroptera taxa, low percentage of Plecoptera + Trichoptera (excluding Hydropsychidae taxa), low percentage of Scraper taxa, moderate percentage of Chironomidae, and the high percentage of top two dominant taxa found within the reaches assessed (Table 3).

Table 4. 2013 Biotic Metric and Index Weighting and VA-SCI at Snakeden Branch.									
WEIGHTED METRIC	BIOLOGICAL MONITORING REACH								
	1-A	1-B	1-C	1-D	1-E	1-F	2-A	2-B	3-A
Total Taxa	50.00	36.36	36.36	18.18	40.91	22.73	50.00	36.36	13.64
EPT Taxa	9.09	9.09	9.09	0.00	9.09	0.00	0.00	0.00	0.00
Percent Ephemeroptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent Scrapers	13.43	0.00	1.85	0.00	8.07	0.00	7.91	6.68	0.00
Percent Chironomidae	80.20	86.96	73.33	82.11	72.92	96.84	33.67	83.91	92.05
Percent Top Two Dominant	25.75	12.57	33.03	6.08	19.57	6.08	17.69	23.25	1.64
HBI	114.01	130.91	106.16	129.26	113.82	143.34	79.23	124.92	139.04
VA-SCI Numerical Score	36.56	34.49	32.48	29.45	33.05	33.62	23.56	34.39	30.80
VA-SCI Narrative Score	Severe Stress	Severe Stress	Severe Stress	Severe Stress	Severe Stress	Severe Stress	Severe Stress	Severe Stress	Severe Stress
Average VA-SCI Numerical Score	**32.04**								
Average VA-SCI Narrative Score	**Severe Stress**								

Figure 3. Comparison of Virginia Stream Condition Index Scores from 2007-2013 at Snakeden

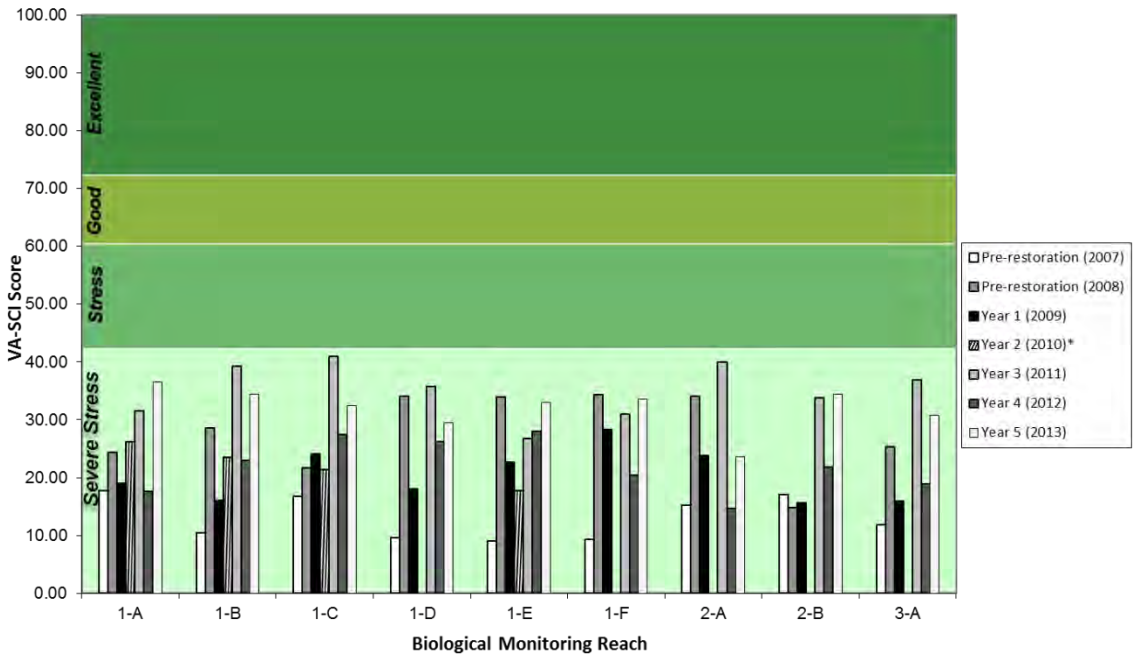
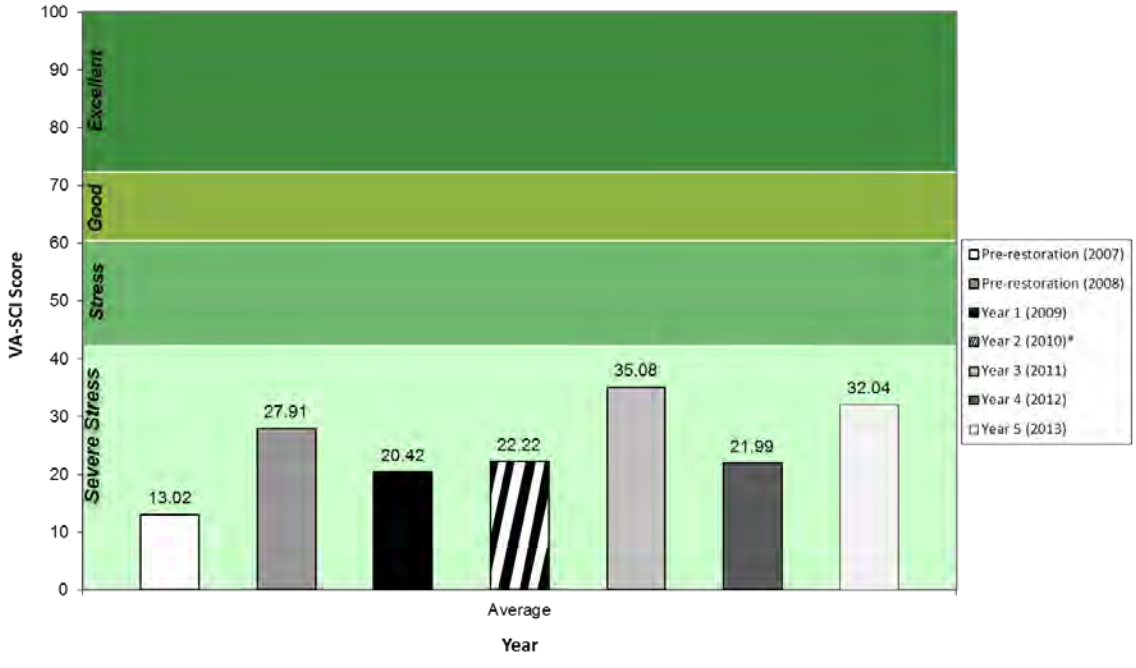


Figure 4. Comparison of Average Virginia Stream Condition Index Scores from 2007-2013 at Snakeden



An analysis of land use within the watershed of each stream reach indicates that each watershed is highly developed, with all reaches having greater than 25 percent impervious land cover (with a watershed average of 41 percent), as depicted in the Land Cover Map (Exhibit 5 and Table 5, below). 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 can not easily colonize the available substrate (Debrey and Lockwood 1990) or get 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
1-A	863	38
1-B	540	45
1-C	386	46
1-D	291	45
1-E	77	50
1-F	55	47
2-A	256	26
2-B	169	25
3-A	75	49

Nutrients, pesticides, and other chemical pollutants that enter the streams through runoff, stormwater pipes, or other sources can also have a negative effect on water quality and 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, the Reston National Golf Course, waterfowl, and oil spills and leaks. Evidence of nutrient pollution input into Snakeden Branch can be found in the DEQ Draft 2012 305(b)/303(d) Water Quality Assessment Integrated Report (Integrated Report), released March 26, 2012 (DEQ 2012). In this report the DEQ identified Snakeden Branch as an impaired water body, based on the impairment to aquatic life according to the benthic macroinvertebrate bioassessments.

In addition, in September 2009, both a waste cooking oil spill and a continuous diesel fuel leak were discovered just above biomonitoring Reach 1-E in two separate incidents. The incidents are since being remediated by the Reston Association and Fairfax County (Bellezza, 2013). High amounts of such pollutants entering streams inevitably results in a shift in macroinvertebrate community composition, where pollution tolerant taxa such as non-biting midges and oligochaete worms out-compete pollution sensitive taxa such as EPT (Shueler 1994).

It is WSSI's opinion that there have been no significant changes to the VA-SCI scores as a result of the Snakeden Branch restoration. However, because the restoration has provided a

stable substrate for colonization by benthic macroinvertebrates, it is possible that an increase in benthic condition may occur over time through colonization. Note that in order to accomplish a significant improvement of the benthic community within these streams, water quality enhancements will need to be undertaken within the watershed by others (i.e. residents, Reston Association, or Fairfax County).

Conclusions

The above results indicate that the habitat of the streams within the Snakeden Branch watershed portion of the NVSRB on average has increased following restoration but the overall benthic macroinvertebrate condition has not significantly changed since the restoration. 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, oil leaks, 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, WPIT, CT
Project Environmental Scientist

Mark Headly, PWS, PWD, LEED® AP
Executive Vice President

abr\L:\20000s\20003\Admin\05-ENVR\Biomonitoring\Postcon Year 5- 2013\BioRpt_Year 5.docx

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EXHIBIT 1

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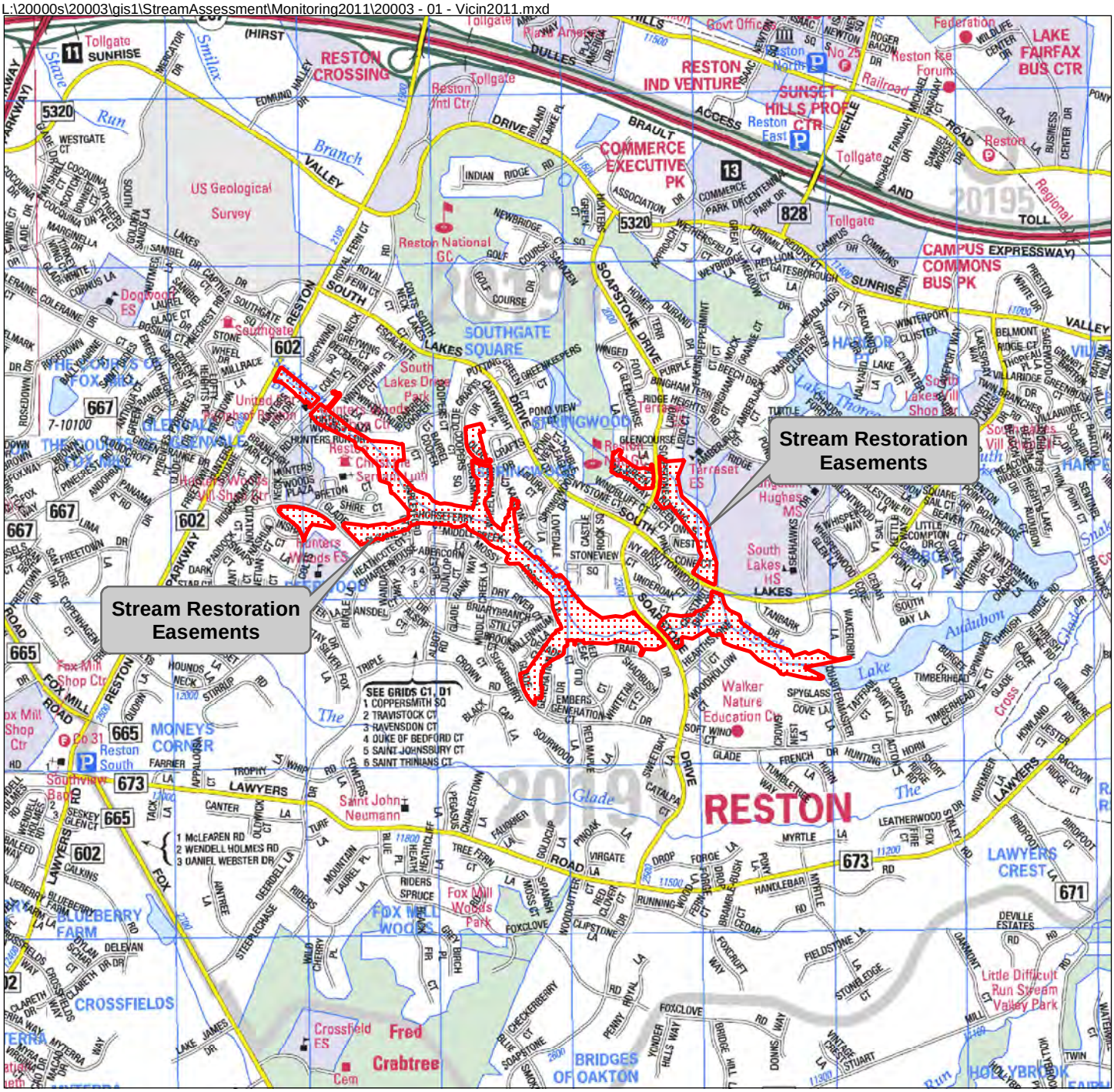

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Vicinity Map
Snakeden Branch
WSSI #20003
Scale: 1" = 2000'

N
W E
S

EXHIBIT 2

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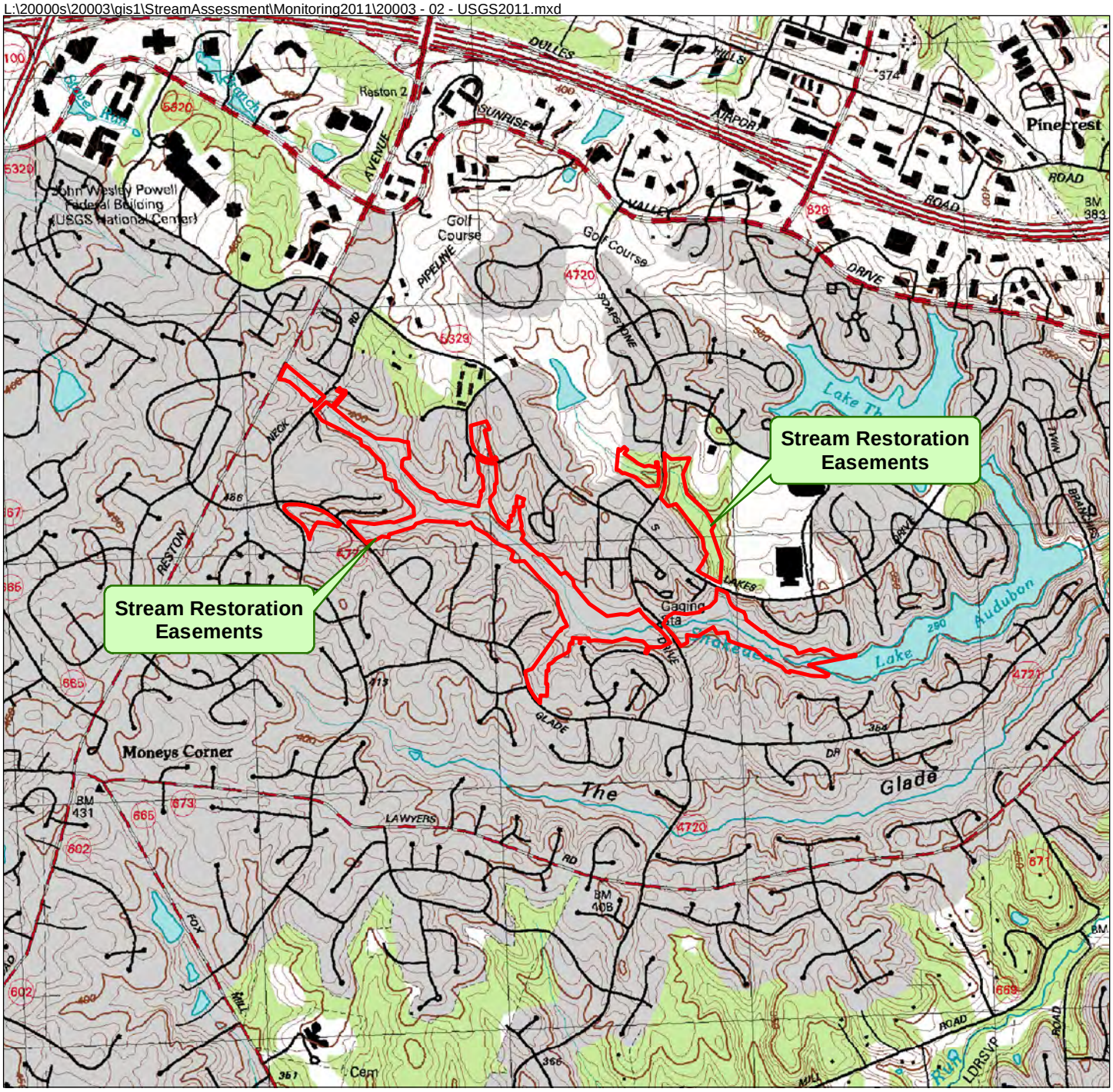

USGS Quad Map
Vienna, VA-MD 1994
Snakeden Branch
WSSI #20003
Scale: 1" = 2000'

N
W E
S

Latitude: 38°55'59" N
Longitude: 77°21'00" W
Hydrologic Unit Code (HUC): 02070008
Stream Class: III
Name of Watershed: Snakeden Branch

EXHIBIT 3

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Stream Reach Location Map
Snakeden Branch
WSSI #20003
Scale: 1" = 600'

N
W E
S

Design Reach 1
Design Reach 2
Design Reach 3
Design Reach 4
Design Reach 5
Design Reach 6
Design Reach 6A
Design Reach 6B
Design Reach 7
Design Reach 8
Design Reach 8A
Design Reach 9
Design Reach 10
Design Reach 11
Design Reach 12
Design Reach 13
Design Reach 14
Design Reach 15
Design Reach 16
Design Reach 17

Sampling Reach 1F
Sampling Reach 1E
Sampling Reach 3A
Sampling Reach 1D
Sampling Reach 1C
Sampling Reach 1B
Sampling Reach 1A
Sampling Reach 2B
Sampling Reach 2A

Wetland Studies and Solutions, Inc.

Exhibit 3

EXHIBIT 4

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Biological Stream Monitoring Map 2013

Northern Virginia Stream Restoration Bank

Snakeden Branch Watershed

Reston, Virginia

77°21'40"W 77°21'20"W 77°21'0"W 77°20'40"W 77°20'20"W

38°56'0"N 38°55'40"N

Sampling Reach 1F
Photo
Design Reach 1
Reston Parkway
Sampling Reach 1E
Photo
Design Reach 2
Colts Neck Road
Design Reach 3
Design Reach 6B
South Lakes Drive
Design Reach 6A
Design Reach 6
Design Reach 8A
Design Reach 8
Design Reach 7
Glade Drive
Design Reach 4
Photo
Sampling Reach 3A
Photo
Sampling Reach 1D
Photo
Sampling Reach 1C
Design Reach 5
Snakeden Branch
Design Reach 9
Design Reach 11
Design Reach 10
Hunters Woods Elementary School
Glade Drive
Photo
Sampling Reach 2B
Design Reach 13
Terraset Elementary School
Design Reach 14
Soapstone Road
Design Reach 15
Sampling Reach 2A
Photo
Langston Hughes Middle School
South Lakes High School
South Lakes Drive
Design Reach 16
Design Reach 12
Photo
Sampling Reach 1B
Design Reach 17
Sampling Reach 1A
Photo
Soapstone Road
Lake Thoreau
Lake Audubon

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Key Map
Map Area
Fairfax

Virginia Coordinate System of 1983
(VCS NAD 83), North Zone, U.S. Survey Foot

0 250 500 1,000 Feet

Scale 1" = 250'

Legend

- 300 LF Biological Sampling Reaches
- Restored Streams (Bankfull)
- Stream Restoration Easements

April 2011 Aerial Imagery Source: Wetland Studies and Solutions, Inc.

Exhibit 4

EXHIBIT 5

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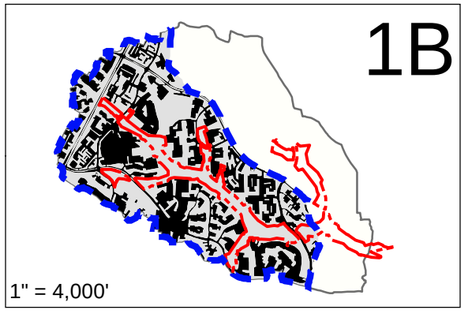
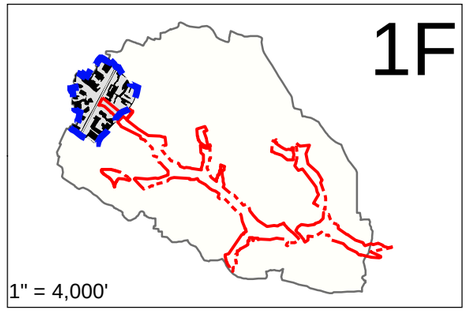
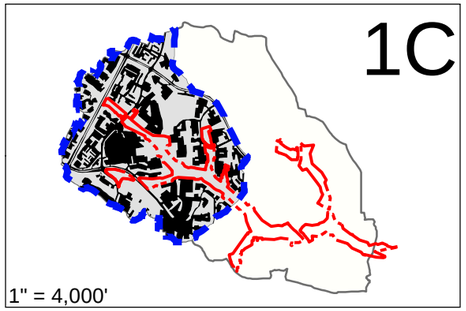
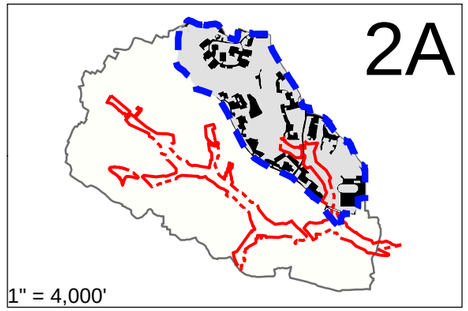




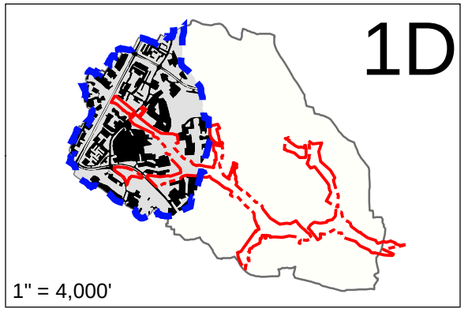


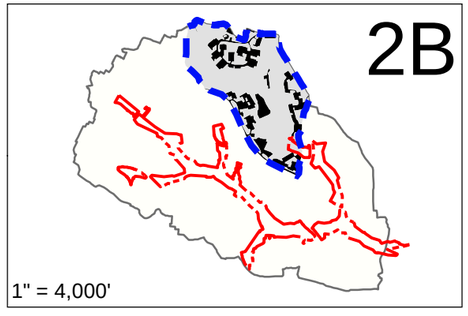


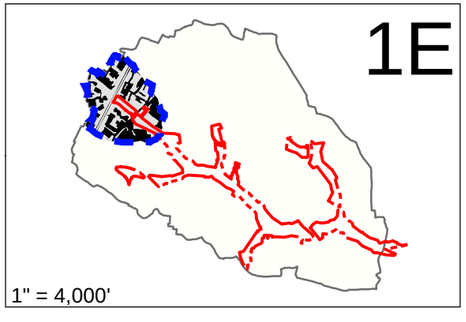
Land Cover Map

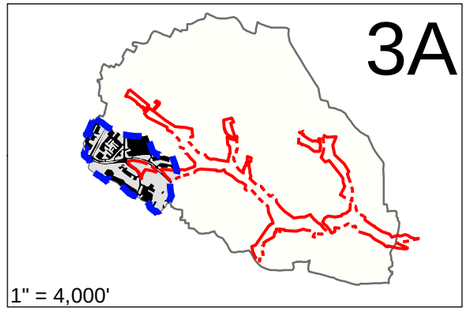
Snakeden Branch

Scale as Noted









Stream ID	Impervious Percent	Total Acres
1A	38%	863
1B	45%	540
1C	46%	386
1D	45%	291
1E	50%	77
1F	47%	55
2A	26%	256
2B	25%	169
3A	49%	75

STREAM RESTORATION EASEMENTS

DRAINAGE BOUNDARIES

IMPERVIOUS AREAS

PERVIOUS AREAS

EXHIBIT 6

EXHIBIT 6: HABITAT ASSESSMENT FIELD DATA SHEET - SUMMARY WORKSHEET

Project Name and WSSI Number: Northern Virginia Stream Restoration Bank: Snakeden (WSSI # 20003)

Stream ID: Snakeden and Unnamed Tributaries of Snakeden

Date: 3/28/13 through 3/29/13

Evaluators: ABR/JMC

HUC: 02070008

Assessment Period: **Post-construction - Year 5**

Assessment Reach Name		Condition Category										TOTAL SCORE	Condition	Reach Length	Stream Type
		Substrate	*Embedded-ness*	*Velocity*	*Sediment Depostion*	*Flow Status*	*Channel Alteration*	*Frequency of Riffles*	*Bank Stability**	*Vegetation Protection**	*Riparian Zone**				
Stream 1	1-A	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	181	Optimal	300	R3
	1-B	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	182	Optimal	300	R3
	1-C	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	191	Optimal	300	R3
	1-D	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	186	Optimal	300	R3
	1-E	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	176	Optimal	300	R3
	1-F	Suboptimal	Optimal	Suboptimal	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	180	Optimal	300	R4/RE**
Stream 2	2-A	Suboptimal	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	176	Optimal	300	R3
	2-B	Optimal	Optimal	Suboptimal	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	176	Optimal	300	R3
Stream 3	3-A	Suboptimal	Optimal	Suboptimal	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	173	Optimal	300	R3
											Average	180	**Total**	2,700	

* The score for Bank Stability, Vegetation Protection and Riparian Zone combines the left and right bank scores.

** The stream is characterized as non-perennial by Fairfax County and is thus either intermittent or ephemeral.

REACH 1-A
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking northwest (upstream) at Reach 1-A of Snakeden Branch on the eastern portion of the study area during the 2007 preconstruction fieldwork. Photograph taken April 2007.**

2. **Looking northwest (upstream) at Reach 1-A of Snakeden Branch on the eastern portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 1-A
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. **Looking northwest (upstream) at Reach 1-A of Snakeden Branch on the eastern portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken May 2009.**

4. **Looking northwest (upstream) at Reach 1-A of Snakeden Branch on the eastern portion of the study area during the 2013 post construction, Year 5, fieldwork. Photograph taken March 2013.**

Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 1-A	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/29/2013	Latitude:	38°55'58"	Longitude	77°21'01"

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	Snags	X	Sediment		Vegetation
# Jabs:		17		3			

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	1	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	0		

Notes

High Gradient Habitat Data

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 maintainance 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	17
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
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	17
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 pools prevalent.	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	16

Wetland Studies and Solutions, Inc.

Benthic Macroinvertebrate and Habitat Field Data Sheet

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 availible channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the availible 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	17
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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
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 riperian 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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	9
Total Score					181

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	ABR, BNR		
Station ID:	Reach 1-A	Date Subsorted:	5/23/13		
Stream Name:	Snakeden	# of Grids subsorted	7		
Date Sampled:	3/29/13	Total # of subsorted insects:	101	Total # identified:	101
Sampling Method:	Multihabitat	Sample Identified by:	ABR, BNR	Date Identified:	5/23/13

Taxa Collected:

				Metretopodidae			Lepidostomatidae	
Porifera	Spongillidae			Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
Flatworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Gastropoda	Unknown			Potamanthidae			Philopotamidae	
Limpets	Ancylidae			Siphlonuridae			Phryganeidae	
Snails	Immature			Tricorythidae			Polycentropodidae	
	Lymnaeidae	1	Zygoptera	Early Instar and/or damaged			Psychomyiidae	
	Physidae			Calopterygidae			Ryacophilidae	
	Planorbidae	1		Coenagrionidae	4		Sericostomatidae	
	Hydrobiidae			Lestidae			Uenoidae	
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged	
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae	
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged	
	Corbiculidae	1		Cordulegastridae			Chrysomelidae	
	Sphaeriidae			Corduliidae			Curculionidae	
	Unionidae			Gomphidae			Dryopidae	
Oligochaeta	Unknown	63		Libellulidae			Dytiscidae	
Lumbriculida				Macromiidae			Elmidae	5
	Lumbriculidae			Petaluridae			Gyrinidae	
Tubificida				Cordullidae/Libelluidae			Haliplidae	
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae	
	Naididae			Capniidae			Helophoridae	
	Tubificidae			Chloroperlidae			Hydraenidae	
Haplotaxida				Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
Leeches	Hirudinea			Peltoperlidae			Limnichidae	
	Erpobdellidae			Perlidae			Noteridae	
	Glossiphoniidae			Perlodidae			Psephenidae	
	Hirudinidae			Pteronarcyidae			Ptilodactylidae	
	Pisciolidae			Taeniopeterygidae			Scirtidae	
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged	
Copepoda	Unknown	1		Belostomatidae			Athericidae	
Decapoda	Cambaridae			Corixidae			Blephariceridae	
	Portunidae			Gelastocoridae			Canaceidae	
Shrimp				Gerridae			Ceratopogonidae	
	Palaemonidae			Hebridae			Choaboridae	
Isopoda				Hydrometridae			Chironomidae	20
	Asellidae			Mesoveliidae			Culicidae	
Amphipoda				Naucoridae			Dixidae	
	Crangonyctidae			Nepidae			Dolichopodidae	
	Gammaridae			Notonectidae			Empididae	2
	Talitridae			Veliidae			Ephydridae	
Water Mites				Pleidae			Muscidae	
	Hydracarina		Neuroptera				Nymphomyiidae	
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae	
	Acanthometropodidae		Megaloptera				Psychodidae	
	Ameletidae			Corydalidae			Ptychopteridae	
	Baetidae			Sialidae			Sciomyzidae	
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae	2
	Behningiidae			Branchycentridae			Stratiomyidae	
	Caenidae			Calamoceratidae			Syrphidae	
	Ephemerellidae			Glossosomatidae			Tabanidae	
	Ephemeridae			Goeridae			Tanyderidae	
	Heptageniidae			Heliicopsychidae			Thaumaleidae	
	Isonychiidae			Hydropsychidae	1		Tipulidae	
	Leptophlebiidae			Hydroptilida		TOTAL:		29
TOTAL:		67	TOTAL:		5			

REACH 1-B
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking west (upstream) at Reach 1-B of Snakeden Branch on the eastern portion of the study area during the 2007 preconstruction fieldwork. Photograph taken April 2007.**

2. **Looking west (upstream) at Reach 1-B of Snakeden Branch on the eastern portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 1-B
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. **Looking west (upstream) at Reach 1-B of Snakeden Branch on the eastern portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken May 2009.**

4. **Looking west (upstream) at Reach 1-B of Snakeden Branch on the eastern portion of the study area during the 2012 post construction, Year 5, fieldwork. Photograph taken March 2013.**

Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 1-B	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/29/2013	Latitude:	38°55'58"	Longitude	77°21'01"

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	Snags	X	Sediment		Vegetation	
# Jabs:		19		1				

Weather Observations

Current Weather:	Cloudy	X	Clear		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 - 2
Filamentous Algae	2	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	0		

Notes

High Gradient Habitat Data

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 maintainance 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	18
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	18
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	16
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 pools prevalent.	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	16

Wetland Studies and Solutions, Inc.

Benthic Macroinvertebrate and Habitat Field Data Sheet

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 availible 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	17
8. Bank Stability (score each bank)	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	9
9. Vegetation Protection (score each bank) Note: Determine left or right side by facing downstream.	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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
10. Riparian Vegetative Zone Width (score each bank 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 riperian 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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
Total Score					182

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	MSJ		
Station ID:	Reach 1-B	Date Subsorted:	5/24/13		
Stream Name:	Snakeden	# of Grids subsorted	6		
Date Sampled:	3/29/13	Total # of subsorted insects:	111	Total # identified:	92
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	5/29/13

Taxa Collected:

				Metretopodidae			Lepidostomatidae		
Porifera	Spongillidae			Neoephemeridae			Leptoceridae		
Ostracoda	Unknown			Oligoneuridae			Limnephilidae		
Flatworms	Tricladida			Psuedironidae			Molannidae		
	Planariidae			Polymitarcyidae			Odontoceridae		
Gastropoda	Unknown	1		Potamanthidae			Philopotamidae		
Limpets	Ancylidae			Siphlonuridae			Phryganeidae		
Snails	Immature			Tricorythidae			Polycentropodidae		
	Lymnaeidae		Zygoptera	Early Instar and/or damaged			Psychomyiidae		
	Physidae			Calopterygidae			Ryacophilidae		
	Planorbidae			Coenagrionidae	1		Sericostomatidae		
	Hydrobiidae			Lestidae			Uenoidae		
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged		
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae		
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged		
	Corbiculidae			Cordulegastridae			Chrysomelidae		
	Sphaeriidae			Corduliidae			Curculionidae		
	Unionidae			Gomphidae			Dryopidae		
Oligochaeta	Unknown	72		Libellulidae			Dytiscidae		
Lumbriculida				Macromiidae			Elmidae		
	Lumbriculidae			Petaluridae			Gyrinidae		
Tubificida				Cordullidae/Libelluidae			Haliplidae	1	
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae		
	Naididae			Capniidae			Helophoridae		
	Tubificidae			Chloroperlidae			Hydraenidae		
Haplotaxida				Leuctridae			Hydrochidae		
	Haplotaxidae			Nemouridae			Hydrophilidae		
Leeches	Hirudinea			Peltoperlidae			Limnichidae		
	Erpobdellidae			Perlidae			Noteridae		
	Glossiphoniidae			Perlodidae			Psephenidae		
	Hirudinidae			Pteronarcyidae			Ptilodactylidae		
	Pisciolidae			Taeniopeterygidae			Scirtidae		
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged		
Copepoda	Unknown	2		Belostomatidae			Athericidae		
Decapoda	Cambaridae			Corixidae			Blephariceridae		
	Portunidae			Gelastocoridae			Canaceidae		
Shrimp				Gerridae			Ceratopogonidae		
	Palaemonidae			Hebridae			Choaboridae		
Isopoda				Hydrometridae			Chironomidae	12	
	Asellidae			Mesoveliidae			Culicidae		
Amphipoda				Naucoridae			Dixidae		
	Crangonyctidae			Nepidae			Dolichopodidae		
	Gammaridae			Notonectidae			Empididae		
	Talitridae			Veliidae			Ephydridae		
Water Mites				Pleidae			Muscidae		
	Hydracarina		Neuroptera				Nymphomyiidae		
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae		
	Acanthometropodidae		Megaloptera				Psychodidae		
	Ameletidae			Corydalidae			Ptychopteridae		
	Baetidae			Sialidae			Sciomyzidae		
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae		
	Behningiidae			Branchycentridae			Stratiomyidae		
	Caenidae			Calamoceratidae			Syrphidae		
	Ephemerellidae			Glossosomatidae			Tabanidae		
	Ephemeridae			Goeridae			Tanyderidae		
	Heptageniidae			Heliicopsychidae			Thaumaleidae		
	Isonychiidae			Hydropsychidae	2		Tipulidae	1	
	Leptophlebiidae			Hydroptilida		TOTAL:		14	
TOTAL:		75	TOTAL:		3				

REACH 1-C
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking northwest (upstream) at Reach 1-C of Snakeden Branch on the central portion of the study area during the 2007 preconstruction fieldwork. Photograph taken April 2007.**

2. **Looking northwest (upstream) at Reach 1-C of Snakeden Branch on the central portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 1-C
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. **Looking northwest (upstream) at Reach 1-C of Snakeden Branch on the central portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken May 2009.**

4. **Looking northwest (upstream) at Reach 1-C of Snakeden Branch on the central portion of the study area during the 2013 post construction, Year 5, fieldwork. Photograph taken March 2013.**

Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 1-C	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/29/2013	Latitude:	38°55'58"	Longitude	77°21'01"

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	Snags		Banks		Vegetation	X
# Jabs:	18							1

Weather Observations

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

Biological Observations

Periphyton	2	Salamanders	1	Other....	Iron Oxidizing Bacteria - 2
Filamentous Algae	2	Warmwater Fish	1	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	
unionidae	0	Snakes	0	are insignificant in relation to the dominant	
Operculate Snails	0	Turtles	0	taxa. There can be situations where multiple	
Non-operculate Snails	0	Frogs/Tadpoles	0	taxa are dominant such as algae and snails	

Notes

High Gradient Habitat Data

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 maintainance 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	19
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	19
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 pools prevalent.	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	19

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Benthic Macroinvertebrate and Habitat Field Data Sheet

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 availible 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	20
8. Bank Stability (score each bank)	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) Note: Determine left or right side by facing downstream.	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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
10. Riparian Vegetative Zone Width (score each bank 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 riperian 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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
Total Score					191

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	ABR		
Station ID:	Reach 1-C	Date Subsorted:	5/31/13		
Stream Name:	Snakeden	# of Grids subsorted	6		
Date Sampled:	3/29/13	Total # of subsorted insects:	105	Total # identified:	105
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	8/8/13

Taxa Collected:

				Metretopodidae			Lepidostomatidae	
Porifera	Spongillidae			Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
Flatworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Gastropoda	Unknown			Potamanthidae			Philopotamidae	
Limpets	Ancylidae			Siphlonuridae			Phryganeidae	
Snails	Immature			Tricorythidae			Polycentropodidae	
	Lymnaeidae		Zygoptera	Early Instar and/or damaged			Psychomyiidae	
	Physidae			Calopterygidae			Ryacophilidae	
	Planorbidae			Coenagrionidae			Sericostomatidae	
	Hydrobiidae			Lestidae			Uenoidae	
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged	
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae	
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged	
	Corbiculidae			Cordulegastridae			Chrysomelidae	
	Sphaeriidae	1		Corduliidae			Curculionidae	
	Unionidae			Gomphidae			Dryopidae	
Oligochaeta	Unknown	53		Libellulidae			Dytiscidae	
Lumbriculida				Macromiidae			Elmidae	1
	Lumbriculidae			Petaluridae			Gyrinidae	
Tubificida				Cordullidae/Libelluidae			Haliplidae	
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae	
	Naididae			Capniidae			Helophoridae	
	Tubificidae			Chloroperlidae			Hydraenidae	
Haplotaxida				Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
Leeches	Hirudinea			Peltoperlidae			Limnichidae	
	Erpobdellidae			Perlidae			Noteridae	
	Glossiphoniidae			Perlodidae			Psephenidae	
	Hirudinidae			Pteronarcyidae			Ptilodactylidae	
	Pisciolidae			Taeniopeterygidae			Scirtidae	
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged	
Copepoda	Unknown			Belostomatidae			Athericidae	
Decapoda	Cambaridae			Corixidae			Blephariceridae	
	Portunidae			Gelastocoridae			Canaceidae	
Shrimp				Gerridae			Ceratopogonidae	3
	Palaemonidae			Hebridae			Choaboridae	
Isopoda				Hydrometridae			Chironomidae	28
	Asellidae			Mesoveliidae			Culicidae	
Amphipoda				Naucoridae			Dixidae	
	Crangonyctidae			Nepidae			Dolichopodidae	
	Gammaridae			Notonectidae			Empididae	3
	Talitridae			Veliidae			Ephydridae	
Water Mites				Pleidae			Muscidae	
	Hydracarina		Neuroptera				Nymphomyiidae	
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae	
	Acanthometropodidae		Megaloptera				Psychodidae	
	Ameletidae			Corydalidae			Ptychopteridae	
	Baetidae			Sialidae			Sciomyzidae	
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae	
	Behningiidae			Branchycentridae			Stratiomyidae	
	Caenidae			Calamoceratidae			Syrphidae	
	Ephemerellidae			Glossosomatidae			Tabanidae	
	Ephemeridae			Goeridae			Tanyderidae	
	Heptageniidae			Heliicopsychidae			Thaumaleidae	
	Isonychiidae			Hydropsychidae	14		Tipulidae	2
	Leptophlebiidae			Hydroptilida		TOTAL:		37
TOTAL:		54	TOTAL:		14			

REACH 1-D
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking southwest (upstream) at Reach 1-D of Snakeden Branch on the central portion of the study area during the 2007 preconstruction fieldwork. Photograph taken April 2007.**

2. **Looking southwest (upstream) at Reach 1-D of Snakeden Branch on the central portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 1-D
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. **Looking southwest (upstream) at Reach 1-D of Snakeden Branch on the central portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken May 2009.**

4. **Looking southwest (upstream) at Reach 1-D of Snakeden Branch on the central portion of the study area during the 2013 post construction, Year 5, fieldwork. Photograph taken March 2013.**

Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 1-D	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/28/2013	Latitude:	38°55'58"	Longitude	77°21'01"

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	Snags	X	Banks:		Vegetation
# Jabs		19		1			

Weather Observations

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

Biological Observations

Periphyton	3	Salamanders	1	Other....	Iron Oxidizing Bacteria - 1
Filamentous Algae	2	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	0		

Notes

High Gradient Habitat Data

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 maintainance 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	18
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	19
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 pools prevalent.	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	17

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Benthic Macroinvertebrate and Habitat Field Data Sheet

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 availible 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	18
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	19
8. Bank Stability (score each bank)	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) Note: Determine left or right side by facing downstream.	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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
10. Riparian Vegetative Zone Width (score each bank 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 riperian 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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
Total Score					186

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	ABR, NG		
Station ID:	Reach 1-D	Date Subsorted:	6/13/13		
Stream Name:	Snakeden	# of Grids subsorted	8		
Date Sampled:	3/28/13	Total # of subsorted insects:	101	Total # identified:	95
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	8/8/13

Taxa Collected:

				Metretopodidae			Lepidostomatidae		
Porifera	Spongillidae			Neoephemeridae			Leptoceridae		
Ostracoda	Unknown			Oligoneuridae			Limnephilidae		
Flatworms	Tricladida			Psuedironidae			Molannidae		
	Planariidae			Polymitarcyidae			Odontoceridae		
Gastropoda	Unknown			Potamanthidae			Philopotamidae		
Limpets	Ancylidae			Siphlonuridae			Phryganeidae		
Snails	Immature			Tricorythidae			Polycentropodidae		
	Lymnaeidae		Zygoptera	Early Instar and/or damaged			Psychomyiidae		
	Physidae			Calopterygidae			Ryacophilidae		
	Planorbidae			Coenagrionidae			Sericostomatidae		
	Hydrobiidae			Lestidae			Uenoidae		
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged		
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae		
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged		
	Corbiculidae			Cordulegastridae			Chrysomelidae		
	Sphaeriidae			Corduliidae			Curculionidae		
	Unionidae			Gomphidae			Dryopidae		
Oligochaeta	Unknown	74		Libellulidae			Dytiscidae		
Lumbriculida				Macromiidae			Elmidae		
	Lumbriculidae			Petaluridae			Gyrinidae		
Tubificida				Cordullidae/Libelluidae			Haliplidae		
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae		
	Naididae			Capniidae			Helophoridae		
	Tubificidae			Chloroperlidae			Hydraenidae		
Haplotaxida				Leuctridae			Hydrochidae		
	Haplotaxidae			Nemouridae			Hydrophilidae		
Leeches	Hirudinea			Peltoperlidae			Limnichidae		
	Erpobdellidae			Perlidae			Noteridae		
	Glossiphoniidae			Perlodidae			Psephenidae		
	Hirudinidae			Pteronarcyidae			Ptilodactylidae		
	Pisciolidae			Taeniopeterygidae			Scirtidae		
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged		
Copepoda	Unknown	1		Belostomatidae			Athericidae		
Decapoda	Cambaridae			Corixidae			Blephariceridae		
	Portunidae			Gelastocoridae			Canaceidae		
Shrimp				Gerridae			Ceratopogonidae		
	Palaemonidae			Hebridae			Choaboridae		
Isopoda				Hydrometridae			Chironomidae	17	
	Asellidae			Mesoveliidae			Culicidae		
Amphipoda				Naucoridae			Dixidae		
	Crangonyctidae			Nepidae			Dolichopodidae		
	Gammaridae			Notonectidae			Empididae		
	Talitridae			Veliidae			Ephydridae		
Water Mites				Pleidae			Muscidae		
	Hydracarina		Neuroptera				Nymphomyiidae		
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae		
	Acanthometropodidae		Megaloptera				Psychodidae		
	Ameletidae			Corydalidae			Ptychopteridae		
	Baetidae			Sialidae			Sciomyzidae		
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae		
	Behningiidae			Branchycentridae			Stratiomyidae		
	Caenidae			Calamoceratidae			Syrphidae		
	Ephemerellidae			Glossosomatidae			Tabanidae		
	Ephemeridae			Goeridae			Tanyderidae		
	Heptageniidae			Heliicopsychidae			Thaumaleidae		
	Isonychiidae			Hydropsychidae	2		Tipulidae	1	
	Leptophlebiidae			Hydroptilida				18	
TOTAL:		75	TOTAL:		2	TOTAL:			

REACH 1-E
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking northwest (upstream) at Reach 1-E of Snakeden Branch on the western portion of the study area during the 2007 preconstruction fieldwork. Photographs taken April 2007.**

2. **Looking northwest (upstream) at Reach 1-E of Snakeden Branch on the western portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 1-E
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. Looking northwest (upstream) at Reach 1-E of Snakeden Branch on the western portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken May 2009.

4. Looking northwest (upstream) at Reach 1-E of Snakeden Branch on the western portion of the study area during the 2013 post construction, Year 5, fieldwork. Photograph taken March 2013.

Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 1-E	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/28/2013	Latitude:	35°55'58"	Longitude	77°21'01"

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	Snags	X	Banks		Vegetation
# Jabs:		19		1			

Weather Observations

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

Biological Observations

Periphyton	3	Salamanders	1	Other….	
Filamentous Algae	3	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	1		

Notes

High Gradient Habitat Data

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 maintainance 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	16
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	19
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 pools prevalent.	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	16

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Benthic Macroinvertebrate and Habitat Field Data Sheet

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 availible 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	19
8. Bank Stability (score each bank)	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	9
9. Vegetation Protection (score each bank) Note: Determine left or right side by facing downstream.	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 bank 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 riperian 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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	8
Total Score					176

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	ABR		
Station ID:	Reach 1-E	Date Subsorted:	5/30/13		
Stream Name:	Snakeden	# of Grids subsorted	19		
Date Sampled:	3/28/13	Total # of subsorted insects:	102	Total # identified:	96
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	5/30/13

Taxa Collected:

				Metretopodidae			Lepidostomatidae	
Porifera	Spongillidae			Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
Flatworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Gastropoda	Unknown			Potamanthidae			Philopotamidae	
Limpets	Ancylidae	3		Siphlonuridae			Phryganeidae	
Snails	Immature			Tricorythidae			Polycentropodidae	
	Lymnaeidae		Zygoptera	Early Instar and/or damaged			Psychomyiidae	
	Physidae			Calopterygidae			Ryacophilidae	
	Planorbidae	1		Coenagrionidae			Sericostomatidae	
	Hydrobiidae			Lestidae			Uenoidae	
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged	
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae	
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged	
	Corbiculidae			Cordulegastridae			Chrysomelidae	
	Sphaeriidae	1		Corduliidae			Curculionidae	
	Unionidae			Gomphidae			Dryopidae	
Oligochaeta	Unknown	57		Libellulidae			Dytiscidae	
Lumbriculida				Macromiidae			Elmidae	
	Lumbriculidae			Petaluridae			Gyrinidae	
Tubificida				Cordullidae/Libelluidae			Haliplidae	
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae	
	Naididae			Capniidae			Helophoridae	
	Tubificidae			Chloroperlidae			Hydraenidae	
Haplotaxida				Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
Leeches	Hirudinea			Peltoperlidae			Limnichidae	
	Erpobdellidae			Perlidae			Noteridae	
	Glossiphoniidae			Perlodidae			Psephenidae	
	Hirudinidae			Pteronarcyidae			Ptilodactylidae	
	Pisciolidae			Taeniopeterygidae			Scirtidae	
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged	
Copepoda	Unknown	2		Belostomatidae			Athericidae	
Decapoda	Cambaridae			Corixidae			Blephariceridae	
	Portunidae			Gelastocoridae			Canaceidae	
Shrimp				Gerridae			Ceratopogonidae	2
	Palaemonidae			Hebridae			Choaboridae	
Isopoda				Hydrometridae			Chironomidae	26
	Asellidae			Mesoveliidae			Culicidae	
Amphipoda				Naucoridae			Dixidae	
	Crangonyctidae			Nepidae			Dolichopodidae	
	Gammaridae			Notonectidae			Empididae	
	Talitridae			Veliidae			Ephydridae	
Water Mites				Pleidae			Muscidae	
	Hydracarina		Neuroptera				Nymphomyiidae	
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae	
	Acanthometropodidae		Megaloptera				Psychodidae	
	Ameletidae			Corydalidae			Ptychopteridae	
	Baetidae			Sialidae			Sciomyzidae	
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae	
	Behningiidae			Branchycentridae			Stratiomyidae	
	Caenidae			Calamoceratidae			Syrphidae	
	Ephemerellidae			Glossosomatidae			Tabanidae	
	Ephemeridae			Goeridae			Tanyderidae	
	Heptageniidae			Heliicopsychidae			Thaumaleidae	
	Isonychiidae			Hydropsychidae	2		Tipulidae	2
	Leptophlebiidae			Hydroptilida				30
TOTAL:		64	TOTAL:		2	TOTAL:		

REACH 1-F
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking northwest (upstream) at Reach 1-F of Snakeden Branch on the western portion of the study area during the 2007 preconstruction fieldwork. Photograph taken April 2007.**

2. **Looking northwest (upstream) at Reach 1-F of Snakeden Branch on the western portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 1-F
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. Looking northwest (upstream) at Reach 1-F of Snakeden Branch on the western portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken May 2009.

4. Looking northwest (upstream) at Reach 1-F of Snakeden Branch on the western portion of the study area during the 2013 post construction, Year 5, fieldwork. Photograph taken March 2013.

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Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 1-F	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/28/2013	Latitude:	38°55'58"	Longitude	77°21'01"

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	Snags		Banks	X	Vegetation	X
# Jabs:		18				1		1

Weather Observations

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

Biological Observations

Periphyton	3	Salamanders	0	Other....	Iron Oxidizing Bacteria - 2
Filamentous Algae	3	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	0		

Notes

High Gradient Habitat Data

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 maintainance 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	19
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	14
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 pools prevalent.	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	19

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Benthic Macroinvertebrate and Habitat Field Data Sheet

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 availible 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	15
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	19
8. Bank Stability (score each bank)	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) Note: Determine left or right side by facing downstream.	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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
10. Riparian Vegetative Zone Width (score each bank 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 riperian 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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	9
Total Score					180

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	JMC		
Station ID:	Reach 1-F	Date Subsorted:	3/28/13		
Stream Name:	Snakeden	# of Grids subsorted	7		
Date Sampled:	3/28/13	Total # of subsorted insects:	106	Total # identified:	95
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	5/28/13

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Taxa Collected:

				Metretopodidae			Lepidostomatidae	
Porifera	Spongillidae			Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
Flatworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Gastropoda	Unknown			Potamanthidae			Philopotamidae	
Limpets	Ancylidae			Siphlonuridae			Phryganeidae	
Snails	Immature			Tricorythidae			Polycentropodidae	
	Lymnaeidae		Zygoptera	Early Instar and/or damaged			Psychomyiidae	
	Physidae			Calopterygidae			Ryacophilidae	
	Planorbidae			Coenagrionidae			Sericostomatidae	
	Hydrobiidae			Lestidae			Uenoidae	
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged	
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae	
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged	
	Corbiculidae			Cordulegastridae			Chrysomelidae	
	Sphaeriidae			Corduliidae			Curculionidae	
	Unionidae			Gomphidae			Dryopidae	
Oligochaeta	Unknown	88		Libellulidae			Dytiscidae	
Lumbriculida				Macromiidae			Elmidae	
	Lumbriculidae			Petaluridae			Gyrinidae	
Tubificida				Cordullidae/Libelluidae			Haliplidae	
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae	
	Naididae			Capniidae			Helophoridae	
	Tubificidae			Chloroperlidae			Hydraenidae	
Haplotaxida				Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
Leeches	Hirudinea			Peltoperlidae			Limnichidae	
	Erpobdellidae			Perlidae			Noteridae	
	Glossiphoniidae			Perlodidae			Psephenidae	
	Hirudinidae			Pteronarcyidae			Ptilodactylidae	
	Pisciolidae			Taeniopeterygidae			Scirtidae	
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged	
Copepoda	Unknown	1		Belostomatidae			Athericidae	
Decapoda	Cambaridae			Corixidae			Blephariceridae	
	Portunidae			Gelastocoridae			Canaceidae	
Shrimp				Gerridae			Ceratopogonidae	
	Palaemonidae			Hebridae			Choaboridae	
Isopoda				Hydrometridae			Chironomidae	3
	Asellidae			Mesoveliidae			Culicidae	
Amphipoda				Naucoridae			Dixidae	
	Crangonyctidae	1		Nepidae			Dolichopodidae	
	Gammaridae			Notonectidae			Empididae	
	Talitridae			Veliidae			Ephydridae	
Water Mites				Pleidae			Muscidae	
	Hydracarina		Neuroptera				Nymphomyiidae	
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae	
	Acanthometropodidae		Megaloptera				Psychodidae	
	Ameletidae			Corydalidae			Ptychopteridae	
	Baetidae			Sialidae			Sciomyzidae	
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae	
	Behningiidae			Branchycentridae			Stratiomyidae	
	Caenidae			Calamoceratidae			Syrphidae	
	Ephemerellidae			Glossosomatidae			Tabanidae	
	Ephemeridae			Goeridae			Tanyderidae	
	Heptageniidae			Heliicopsychidae			Thaumaleidae	
	Isonychiidae			Hydropsychidae			Tipulidae	2
	Leptophlebiidae			Hydroptilida		TOTAL:		5
TOTAL:		90	TOTAL:		0			

REACH 2-A
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking northwest (upstream) at Reach 2-A of an unnamed tributary of Snakeden Branch on the eastern portion of the study area during the 2007 preconstruction fieldwork. Photograph taken April 2007.**

2. **Looking northwest (upstream) at Reach 2-A of an unnamed tributary of Snakeden Branch on the eastern portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 2-A
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. **Looking northwest (upstream) at Reach 2-A of an unnamed tributary of Snakeden Branch on the eastern portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken May 2009.**

4. **Looking northwest (upstream) at Reach 2-A of an unnamed tributary of Snakeden Branch on the eastern portion of the study area during the 2012 post construction, Year 5, fieldwork. Photograph taken March 2013.**

Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 2-A	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/29/2013	Latitude:	38°55'58"	Longitude	77°21'01"

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	Snags		Banks		Vegetation	X
# Jabs:		17						2

Weather Observations

Current Weather	Cloudy	X	Clear		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	2	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	0		

Notes

High Gradient Habitat Data

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 maintainance 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	17
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 pools prevalent.	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	16

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Benthic Macroinvertebrate and Habitat Field Data Sheet

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 availible 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	18
8. Bank Stability (score each bank)	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) Note: Determine left or right side by facing downstream.	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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
10. Riparian Vegetative Zone Width (score each bank 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 riperian 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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	8
Total Score					176

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	ABR, NG, MSJ		
Station ID:	Reach 2-A	Date Subsorted:	6/24/13		
Stream Name:	Snakeden	# of Grids subsorted	12		
Date Sampled:	3/29/13	Total # of subsorted insects:	101	Total # identified:	98
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	8/8/13

Taxa Collected:

				Metretopodidae			Lepidostomatidae	
Porifera	Spongillidae			Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
Flatworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Gastropoda	Unknown			Potamanthidae			Philopotamidae	
Limpets	Ancylidae			Siphlonuridae			Phryganeidae	
Snails	Immature			Tricorythidae			Polycentropodidae	
	Lymnaeidae		Zygoptera	Early Instar and/or damaged			Psychomyiidae	
	Physidae	1		Calopterygidae			Ryacophilidae	
	Planorbidae			Coenagrionidae	1		Sericostomatidae	
	Hydrobiidae			Lestidae			Uenoidae	
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged	1
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae	
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged	
	Corbiculidae			Cordulegastridae			Chrysomelidae	
	Sphaeriidae	1		Corduliidae			Curculionidae	
	Unionidae			Gomphidae			Dryopidae	
Oligochaeta	Unknown	21		Libellulidae			Dytiscidae	
Lumbriculida				Macromiidae			Elmidae	2
	Lumbriculidae			Petaluridae			Gyrinidae	
Tubificida				Cordullidae/Libelluidae			Haliplidae	
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae	
	Naididae			Capniidae			Helophoridae	
	Tubificidae			Chloroperlidae			Hydraenidae	
Haplotaxida				Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
Leeches	Hirudinea	1		Peltoperlidae			Limnichidae	
	Erpobdellidae			Perlidae			Noteridae	
	Glossiphoniidae			Perlodidae			Psephenidae	1
	Hirudinidae			Pteronarcyidae			Ptilodactylidae	
	Pisciolidae			Taeniopeterygidae			Scirtidae	
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged	
Copepoda	Unknown	1		Belostomatidae			Athericidae	
Decapoda	Cambaridae			Corixidae			Blephariceridae	
	Portunidae			Gelastocoridae			Canaceidae	
Shrimp				Gerridae			Ceratopogonidae	
	Palaemonidae			Hebridae			Choaboridae	
Isopoda				Hydrometridae			Chironomidae	65
	Asellidae			Mesoveliidae			Culicidae	
Amphipoda				Naucoridae			Dixidae	
	Crangonyctidae			Nepidae			Dolichopodidae	
	Gammaridae			Notonectidae			Empididae	
	Talitridae			Veliidae			Ephydridae	
Water Mites				Pleidae			Muscidae	
	Hydracarina		Neuroptera				Nymphomyiidae	
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae	
	Acanthometropodidae		Megaloptera				Psychodidae	
	Ameletidae			Corydalidae			Ptychopteridae	
	Baetidae			Sialidae			Sciomyzidae	
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae	3
	Behningiidae			Branchycentridae			Stratiomyidae	
	Caenidae			Calamoceratidae			Syrphidae	
	Ephemerellidae			Glossosomatidae			Tabanidae	
	Ephemeridae			Goeridae			Tanyderidae	
	Heptageniidae			Heliicopsychidae			Thaumaleidae	
	Isonychiidae			Hydropsychidae			Tipulidae	
	Leptophlebiidae			Hydroptilida		TOTAL:		72
TOTAL:		25	TOTAL:		1			

REACH 2-B
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking northwest (upstream) at Reach 2-B of an unnamed tributary of Snakeden Branch on the eastern portion of the study area during the 2007 preconstruction fieldwork. Photograph taken April 2007.**

2. **Looking northwest (upstream) at Reach 2-B of an unnamed tributary of Snakeden Branch on the eastern portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 2-B
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. Looking northwest (upstream) at Reach 2-B of an unnamed tributary of Snakeden Branch on the eastern portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken September 16, 2009.

4. Looking northwest (upstream) at Reach 2-B of an unnamed tributary of Snakeden Branch on the eastern portion of the study area during the 2013 post construction, Year 5, fieldwork. Photograph taken August 2013.

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Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 2-B	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/29/2013	Latitude:	38°55'58"	Longitude	77°21'01"

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	Snags		Banks		Vegetation	X
# Jabs:		17						1

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	1	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	
unionidae	0	Snakes	0	are insignificant in relation to the dominant	
Operculate Snails	0	Turtles	0	taxa. There can be situations where multiple	
Non-operculate Snails	0	Frogs/Tadpoles	1	taxa are dominant such as algae and snails	

Notes

High Gradient Habitat Data

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 maintainance 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	17
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 pools prevalent.	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

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 availible 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	15
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	18
8. Bank Stability (score each bank)	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) Note: Determine left or right side by facing downstream.	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 bank 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 riperian 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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	9
Total Score					176

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	ABR, BNR		
Station ID:	Reach 2-B	Date Subsorted:	6/28/13		
Stream Name:	Snakeden	# of Grids subsorted	17		
Date Sampled:	3/29/13	Total # of subsorted insects:	101	Total # identified:	87
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	8/8/13

Taxa Collected:

				Metretopodidae			Lepidostomatidae	
Porifera	Spongillidae			Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
Flatworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Gastropoda	Unknown			Potamanthidae			Philopotamidae	
Limpets	Ancylidae			Siphlonuridae			Phryganeidae	
Snails	Immature			Tricorythidae			Polycentropodidae	
	Lymnaeidae		Zygoptera	Early Instar and/or damaged			Psychomyiidae	
	Physidae			Calopterygidae			Ryacophilidae	
	Planorbidae			Coenagrionidae			Sericostomatidae	
	Hydrobiidae			Lestidae			Uenoidae	
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged	
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae	
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged	
	Corbiculidae			Cordulegastridae			Chrysomelidae	
	Sphaeriidae	3		Corduliidae			Curculionidae	
	Unionidae			Gomphidae			Dryopidae	
Oligochaeta	Unknown	59		Libellulidae			Dytiscidae	
Lumbriculida				Macromiidae			Elmidae	3
	Lumbriculidae			Petaluridae			Gyrinidae	
Tubificida				Cordullidae/Libelluidae			Haliplidae	
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae	
	Naididae			Capniidae			Helophoridae	
	Tubificidae			Chloroperlidae			Hydraenidae	
Haplotaxida				Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
Leeches	Hirudinea			Peltoperlidae			Limnichidae	
	Erpobdellidae			Perlidae			Noteridae	
	Glossiphoniidae			Perlodidae			Psephenidae	
	Hirudinidae			Pteronarcyidae			Ptilodactylidae	
	Pisciolidae			Taeniopeterygidae			Scirtidae	
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged	
Copepoda	Unknown	5		Belostomatidae			Athericidae	
Decapoda	Cambaridae			Corixidae			Blephariceridae	
	Portunidae			Gelastocoridae			Canaceidae	
Shrimp				Gerridae			Ceratopogonidae	
	Palaemonidae			Hebridae			Choaboridae	
Isopoda				Hydrometridae			Chironomidae	14
	Asellidae			Mesoveliidae			Culicidae	
Amphipoda				Naucoridae			Dixidae	
	Crangonyctidae			Nepidae			Dolichopodidae	
	Gammaridae			Notonectidae			Empididae	
	Talitridae			Veliidae			Ephydridae	
Water Mites				Pleidae			Muscidae	
	Hydracarina	1	Neuroptera				Nymphomyiidae	
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae	
	Acanthometropodidae		Megaloptera				Psychodidae	
	Ameletidae			Corydalidae			Ptychopteridae	
	Baetidae			Sialidae			Sciomyzidae	
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae	
	Behningiidae			Branchycentridae			Stratiomyidae	
	Caenidae			Calamoceratidae			Syrphidae	
	Ephemerellidae			Glossosomatidae			Tabanidae	1
	Ephemeridae			Goeridae			Tanyderidae	
	Heptageniidae			Heliicopsychidae			Thaumaleidae	
	Isonychiidae			Hydropsychidae			Tipulidae	1
	Leptophlebiidae			Hydroptilida		TOTAL:		19
TOTAL:		68	TOTAL:		0			

REACH 3-A
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

1. **Looking west (upstream) at Reach 3-A, an unnamed tributary of Snakeden Branch on the western portion of the study area during the 2007 preconstruction fieldwork. Photograph taken April 2007.**

2. **Looking west (upstream) at Reach 3-A, an unnamed tributary of Snakeden Branch on the western portion of the study area during the 2008 preconstruction fieldwork. Photograph taken February 2008.**

REACH 3-A
BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS
SNAKEDEN BRANCH WATERSHED
WSSI #20003

3. **Looking west (upstream) at Reach 3-A, an unnamed tributary of Snakeden Branch on the western portion of the study area during the 2009 post construction, Year 1, fieldwork. Photograph taken May 2009.**

4. **Looking west (upstream) at Reach 3-A, an unnamed tributary of Snakeden Branch on the western portion of the study area during the 2013 post construction, Year 5, fieldwork. Photograph taken August 2013.**

Wetland Studies and Solutions, Inc.

Benthic Macroinvertebrate and Habitat Field Data Sheet

Station ID:	Reach 3-A	Ecoregion:	Piedmont	Land Use:	Urban
Field Team:	ABR/JMC	Survey Reason:	Year 5 Biomonitoring	Start time:	
Stream Name:	Snakeden	Location:	Reston, Virginia	Finish time:	
Date:	3/28/2013	Latitude:	38°55'58"	Longitude	77°21'01"

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	Snags		Banks		Vegetation	X
# Jabs:		19						1

Weather Observations

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

Biological Observations

Periphyton	3	Salamanders	0	Other....	Iron Oxidizing Bacteria - 1
Filamentous Algae	2	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	
unionidae	0	Snakes	0	are insignificant in relation to the dominant	
Operculate Snails	0	Turtles	0	taxa. There can be situations where multiple	
Non-operculate Snails	0	Frogs/Tadpoles	0	taxa are dominant such as algae and snails	

Notes

High Gradient Habitat Data

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 maintainance 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	14
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
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	13
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 pools prevalent.	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	17

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Benthic Macroinvertebrate and Habitat Field Data Sheet

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 availible 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	16
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	19
8. Bank Stability (score each bank)	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) Note: Determine left or right side by facing downstream.	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	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
10. Riparian Vegetative Zone Width (score each bank 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 riperian 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	9
Total Score					173

WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET

Job Name/#	Snakeden-20003	Sample subsorted by:	ABR, NG		
Station ID:	Reach 3-A	Date Subsorted:	6/21/13		
Stream Name:	Snakeden	# of Grids subsorted	7		
Date Sampled:	3/28/13	Total # of subsorted insects:	101	Total # identified:	88
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	8/8/13

Taxa Collected:

				Metretopodidae			Lepidostomatidae		
Porifera	Spongillidae			Neoephemeridae			Leptoceridae		
Ostracoda	Unknown			Oligoneuridae			Limnephilidae		
Flatworms	Tricladida			Psuedironidae			Molannidae		
	Planariidae			Polymitarcyidae			Odontoceridae		
Gastropoda	Unknown			Potamanthidae			Philopotamidae		
Limpets	Ancylidae			Siphlonuridae			Phryganeidae		
Snails	Immature			Tricorythidae			Polycentropodidae		
	Lymnaeidae		Zygoptera	Early Instar and/or damaged			Psychomyiidae		
	Physidae			Calopterygidae			Ryacophilidae		
	Planorbidae			Coenagrionidae			Sericostomatidae		
	Hydrobiidae			Lestidae			Uenoidae		
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged		
	Viviparidae		Anisopteera	Early Instar and/or damaged			Pyralidae		
Bivalvia	Immature			Aeshnidae		Coleoptera	Early Instar and/or damaged		
	Corbiculidae			Cordulegastridae			Chrysomelidae		
	Sphaeriidae			Corduliidae			Curculionidae		
	Unionidae			Gomphidae			Dryopidae		
Oligochaeta	Unknown	80		Libellulidae			Dytiscidae		
Lumbriculida				Macromiidae			Elmidae		
	Lumbriculidae			Petaluridae			Gyrinidae		
Tubificida				Cordullidae/Libelluidae			Haliplidae		
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae		
	Naididae			Capniidae			Helophoridae		
	Tubificidae			Chloroperlidae			Hydraenidae		
Haplotaxida				Leuctridae			Hydrochidae		
	Haplotaxidae			Nemouridae			Hydrophilidae		
Leeches	Hirudinea			Peltoperlidae			Limnichidae		
	Erpobdellidae			Perlidae			Noteridae		
	Glossiphoniidae			Perlodidae			Psephenidae		
	Hirudinidae			Pteronarcyidae			Ptilodactylidae		
	Pisciolidae			Taeniopeterygidae			Scirtidae		
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged		
Copepoda	Unknown			Belostomatidae			Athericidae		
Decapoda	Cambaridae			Corixidae			Blephariceridae		
	Portunidae			Gelastocoridae			Canaceidae		
Shrimp				Gerridae			Ceratopogonidae	1	
	Palaemonidae			Hebridae			Choaboridae		
Isopoda				Hydrometridae			Chironomidae	7	
	Asellidae			Mesoveliidae			Culicidae		
Amphipoda				Naucoridae			Dixidae		
	Crangonyctidae			Nepidae			Dolichopodidae		
	Gammaridae			Notonectidae			Empididae		
	Talitridae			Veliidae			Ephydridae		
Water Mites				Pleidae			Muscidae		
	Hydracarina		Neuroptera				Nymphomyiidae		
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae		
	Acanthometropodidae		Megaloptera				Psychodidae		
	Ameletidae			Corydalidae			Ptychopteridae		
	Baetidae			Sialidae			Sciomyzidae		
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae		
	Behningiidae			Branchycentridae			Stratiomyidae		
	Caenidae			Calamoceratidae			Syrphidae		
	Ephemerellidae			Glossosomatidae			Tabanidae		
	Ephemeridae			Goeridae			Tanyderidae		
	Heptageniidae			Heliicopsychidae			Thaumaleidae		
	Isonychiidae			Hydropsychidae			Tipulidae		
	Leptophlebiidae			Hydroptilida		TOTAL:		8	
TOTAL:		80	TOTAL:		0				