Colvin Run– Forest Edge North and South

Fairfax County, Virginia

WSSI #20010, Task I2

Biological Monitoring Report- Year 1 (Post-Construction)

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Executive Summary

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

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

Biological stream monitoring was conducted along two[1] permanent biological monitoring reaches using benthic macroinvertebrate and habitat data. Fieldwork was conducted on May 25 and June 27, 2011. 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.

Our Year-1 post-construction results indicate that the habitat quality of the restored reaches of Forest Edge North and South has increased relative to pre-construction averages within both reaches. Overall benthic macroinvertebrate condition has shown little to no improvement from the pre-construction baseline conditions. Both benthic macroinverebrate communities within Biological Monitoring Reaches 2-A and 2-B remain listed under "Severe Stress" according to the VA-SCI, which is likely due to poor water quality and the short time since the initial disturbance from the restoration. As time progresses and further colonization by benthic macroinverebrates continues, a corresponding increase in VA-SCI condition scores is expected. In order to expedite and ensure this improvement, water quality enhancements will need to be undertaken within the watershed (by others).

Introduction

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

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

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

Project Area

The project area includes approximately 4,870 linear feet[3] of stream along Forest Edge North and South, an unnamed tributary of Colvin Run, as well as the adjacent riparian corridor. The project area is located between Baron Cameron Avenue (Route 606) and Lake Fairfax Park, in northern Fairfax County, Virginia. Exhibit 1 is a vicinity map that depicts the approximate location of the project area.

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

Overall Methodology

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

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

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

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

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

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

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

Biological Stream Monitoring

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

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

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

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

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

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

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

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

10 *Wetland Professional In-Training, Society of Wetland Scientists Certification Program, Inc. and North American Benthological Society (NABS) Certified Level 1 Taxonomist: All Taxa*

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

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

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

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

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

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

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

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

- Hilsenhoff Biotic Index (HBI). The Hilsenhoff Biotic Index is the abundance-weighted average tolerance of assemblage of organisms (Family taxonomic level). The HBI is expected to increase in response to environmental disturbance. The HBI can range from 3.2-10 for the VA-SCI.

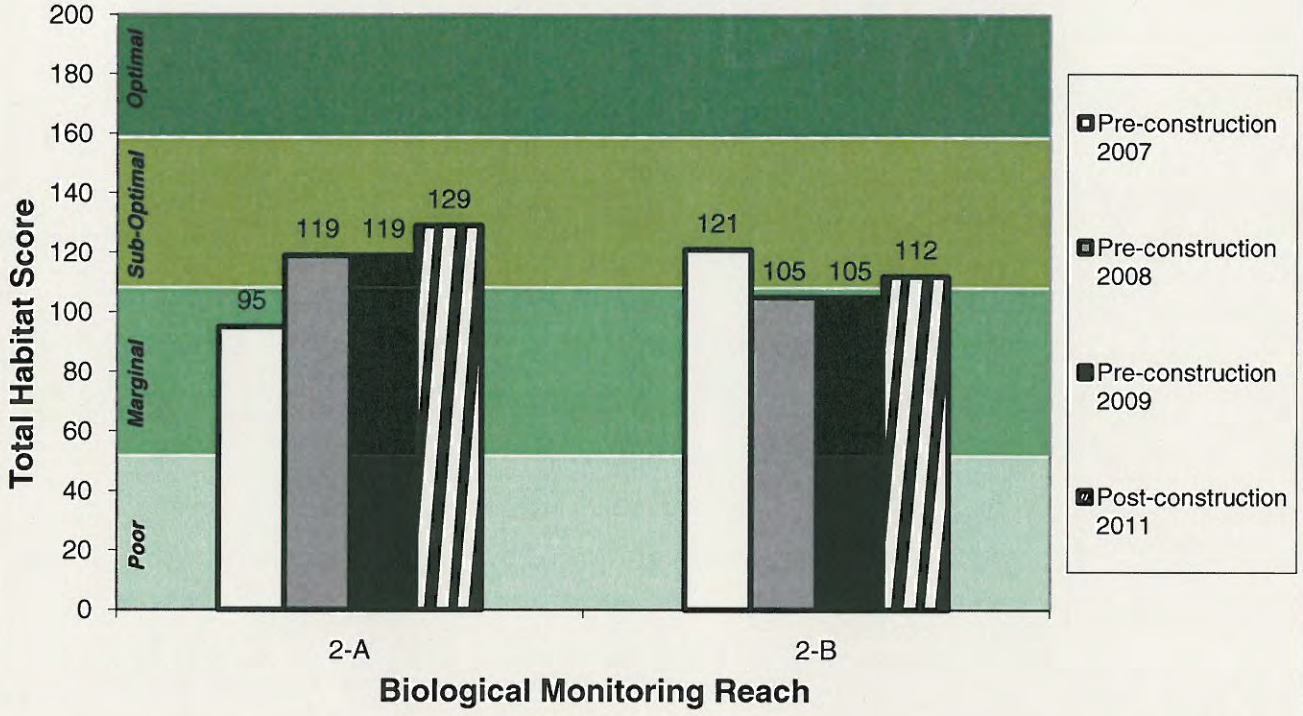
- The VA-SCI was calculated by taking the weighted average of the individual metric (and index) scores, with an VA-SCI range of 0-100. The weighting is as follows:

    - 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 2011 show that both restored biological monitoring stream reaches (2-A and 2-B) have "Sub-Optimal" habitat conditions. During the recent construction of Reach 2-B the water flow was diverted away from the reach to perform the restoration, however, flow was returned to the reach after construction, which was just prior to the benthic monitoring field work. Therefore, due to the construction activities and the fact that June exhibited below normal precipitation, Reach 2-B had a low water volume. Photographs (Exhibit 4) depict this unusual low water volume. The average habitat assessment score for the two restored stream reaches in 2011 was 120.5 out of 200. These results show improved habitat conditions following restoration, with scores exceeding the average pre-construction scores of 110 and 111 for Reaches 2-B and 2-A, respectively. Improved habitat scores relate to improved bank stability and vegetation, with little erosion or depositional zones present throughout the restored reaches. This trend is expected to continue over time as water flow fully reverts back to normal conditions following restoration work and the density of riparian vegetation increases.

Figure 1. Comparison of Habitat Assessment Scores from 2007-2011 for Forest Edge North and South



**Note that Reach 2-B post-construction exhibited a low water volume during the benthic monitoring field work due to recently completed restoration activities, which affected the habitat assessment scores.*

Benthic macroinvertebrates results indicate that 10 taxa[11] were collected between the two reaches (Table 1, Exhibit 4) during the 2011 post-construction benthic macroinvertebrate monitoring. Of all taxa collected, non-biting midge larvae (Chironomidae) and aquatic worms (Oligochaeta) comprised the majority of individuals in both reaches.

[11] *Although Table 2 lists 11 taxa, Oligochaeta was not included as part of the total taxa collected within the study area, because individuals were too young or too damaged to identify to the family-level.*

Table 1. 2011 Raw Benthic Macroinvertebrate Data at Forest Edge North and South			
TAXA	REACH		Total
	2-A	2-B	
Chironomidae	36	30	66
Ceratopogonidae	0	1	1
Culicidae	0	10	10
Corixidae	0	1	1
Dytiscidae	0	1	1
Hydropsychidae	2	0	2
Muscidae	0	1	1
Oligochaeta	49	44	93
Ostracoda	0	16	16
Simulidae	11	0	11
Tipulidae	1	0	1
Total	99	104	203

The above data collected for each reach were used to calculate the biotic metrics as shown in Table 2. The VA-SCI requires that these metrics be weighted to determine the VA-SCI, as shown in Table 3. The results of our data analysis indicate that the benthic macroinvertebrate community in both reaches (2-A and 2-B) were in "Severe Stress" in 2011 following stream restoration activities, based on their VA-SCI scores. The average VA-SCI numerical score for the two reaches assessed in 2011 is 29.76 ("Severe Stress"). These scores are the result of the low number of total taxa, low number of total EPT taxa, low percentage of Plecoptera and Trichoptera (excluding Hydropsychidae), low percentage of Scraper taxa, high percentage of Chironomidae, high percentage of top two dominant taxa, and high HBI found within the reaches assessed.

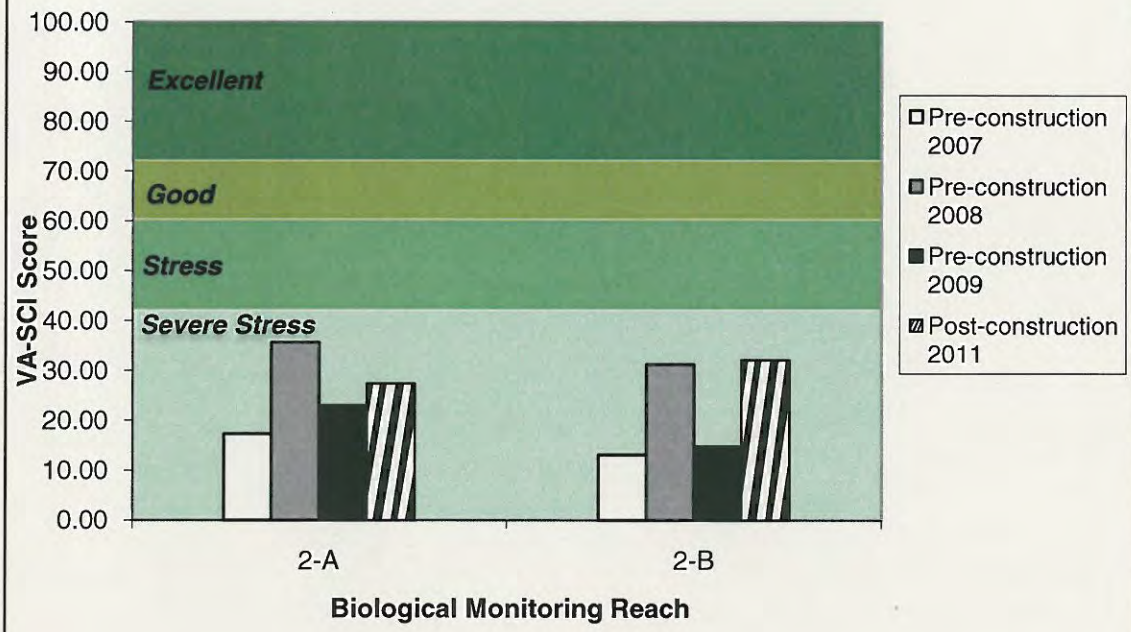
Table 2. Forest Edge North and South Biotic Metric Scores								
Reach	Total Taxa	Total EPT Taxa	Percent Ephemeroptera	Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)	Percent Scrapers	Percent Chironomidae	Percent Top Two Dominant	HBI[12]
2-A	5	1	0	0	0	36.36	36	2.98
2-B	8	0	0	0	0	28.85	29	2.66

[12] *Due to the large number of oligochaeta found within these reaches the HBI has fallen below the HBI range because oligochaeta do not have a tolerance value number. However, if oligochaeta are not figured in with the HBI calculations the HBI's would be 5.90 and 4.62 for Reaches 2-A and 2-B, respectively. The HBI of these reaches are expected to fall within the HBI range in future monitoring years because more time would allow a wider variety of benthic macroinvertebrates to become established within these reaches.*

Table 3. 2011 Biotic Metric and Index Weighting and VA-SCI at Forest Edge North and South		
METRIC	**BIOLOGICAL MONITORING REACH**	
	2-A	**2-B**
Total Taxa	22.73	36.36
EPT Taxa	9.09	0.00
Percent Ephemeroptera	0.00	0.00
Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)	0.00	0.00
Percent Scrapers	0.00	0.00
Percent Chironomidae	63.64	71.15
Percent Top Two Dominant	20.44	41.69
HBI	103.24	107.89
VA-SCI Numerical Score	27.39	32.14
VA-SCI Narrative Score	Severe Stress	Severe Stress
Average VA-SCI Numerical Score	**29.76**	
Average VA-SCI Narrative Score	**Severe Stress**	

These results depict marginal to no improvement from the 2007-2009 preconstruction monitoring, where the benthic macroinverebrate community at both reaches was also listed in "Severe Stress" (Figure 2). Due to the high levels of disturbance in 2010/2011 from restoration construction, it is expected that the VA-SCI scores would not immediately improve. Such disturbances temporarily reduce benthic condition, and recovery of the benthic community can be slow (Muatka 2002).

Figure 2. Comparison of Virginia Stream Condition Index Scores from 2007-2011



An analysis of land use within the watershed of each stream reach indicates that each watershed is highly developed, with Reach 2-A having 24 percent impervious land cover and Reach 2-B having 26 percent impervious land cover, as depicted in the Land Cover Map (Exhibit 5), and Table 4. It has been documented that increases in watershed imperviousness reduce macroinvertebrate diversity, such that when imperviousness exceeds 10 to 15 percent, macroinvertebrate diversity becomes low (Klein 1979). Runoff from the highly impervious land within these watersheds typically produces a high volume and velocity of flowing water and sediment in the stream channels during storm events. As a result, epifaunal substrate/available cover within these streams becomes highly mobile and benthic macrofauna could not easily colonize the available substrate (Debrey and Lockwood 1990) or they were buried and killed by high sediment deposition (Wood and Armitage 1997). However, because the restored streams within our study area have been engineered to accommodate high volume flows, future habitat degradation should be minimized.

Table 4. Impervious Land Cover for Each Reach

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

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

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

Conclusions

The above results indicate that the habitat of Biological Monitoring Reaches 2-A and 2-B of Colvin Run on average are "Sub-Optimal" and the benthic macroinverebrate community of the streams is in "Severe Stress". Improved habitat assessment scores following restoration relate to continued success of the well vegetated and stabilized banks, with little erosion or depositional zones present throughout the restored reaches. These habitat scores are expected to continue to improve as water volume returns entirely from recent, June 2011, restoration construction and as riparian vegetation continues to grow and stabilze banks. The low VA-SCI are likely due to several abiotic factors, including highly impervious land cover, high nutrient, toxicant and sediment input from adjacent land use, and recent disturbance from restoration. It will take time for benthic macroinvertebrates to re-colonize these reaches and in order to expedite colonization, water quality enhancing measures will need to be undertaken in the watershed (by others).

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.

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