# The Glade – Reaches 5 and 6

Fairfax County, Virginia WSSI #20030, Task I5b

# Biological Monitoring Report- Year 5 (Post-Construction)

April 27, 2015

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

Prepared by:

Studies and Solutions, In a **DAVEY** company

5300 Wellington Branch Drive, Suite 100 Gainesville, Virginia 20155 Tel: 703-679-5600 Email: contactus@wetlandstudies.com www.wetlandstudies.com

# **Biological Monitoring Report - Year 5 (Post-Construction)**

# The Glade – Reaches 5 and 6 WSSI #20003, Task I5b

# **Executive Summary**

As set forth in the "Northern Virginia Stream Restoration Bank Banking Instrument" (Banking Instrument), streams and drainage features within The Glade Watershed have been stabilized and restored. This stream restoration has resulted in a direct improvement of in-stream habitat.

In the fifth year following restoration, Wetland Studies and Solutions, Inc. (WSSI) conducted biological stream assessments along 7,165 linear feet of stream restoration in The Glade Design Reaches 5 and 6, as well as 1,175 linear feet of non-restored areas above and below Design Reach  $6^{11}$  (Exhibit 3). This monitoring was conducted pursuant to the maintenance and monitoring requirements defined in the Northern Virginia Stream Restoration Bank (NVSRB) Banking Instrument, Section VI.B.2.(i). This report summarizes the Year 5 monitoring (post-construction) in 2015, as compared to the baseline (pre-construction) conditions assessed from 2007-2009 and the post-construction conditions from 2011-2014.

Biological stream monitoring was conducted along three<sup>2</sup> biological monitoring reaches using benthic macroinvertebrate and habitat data. Fieldwork was conducted on March 30, 2015. 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 Total Habitat Score for each reach.

Our Year 5 post-restoration results indicate that on average the habitat quality of the stream has increased and is beginning to stabilize. 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., nutrient inputs, impervious areas, temperature fluctuations, etc.) are negatively affecting the benthic community.

# 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. 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

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<sup>&</sup>lt;sup>1</sup> Approximately 800 linear feet of stream between Designs Reaches 5 and 6 was not restored. In addition, 50 linear feet within Design Reach 6 and 325 linear feet at the downstream end of Design Reach 6 were not restored.

<sup>&</sup>lt;sup>2</sup> Note that biological monitoring reaches 1-D through 1-G, 2A and 3A were restored in 2010 and do not require monitoring in 2011.

benthic macroinvertebrate and habitat data, this fifth year post-construction monitoring report characterizes Design Reach 5 and 6 as well as portions non-restored stream in the Glade Watershed portion of the NVSRB in 2015, as compared to baseline conditions described in Biological Monitoring Reports #1 (dated December 8, 2008), #2 (dated December 17, 2008), and #3 (dated October 14, 2009), Year 1 (Post-Construction, dated August 23, 2011), and supplemental memos dated November 27, 2012, August 5, 2013, and October 9, 2014. With this data, we propose to evaluate the effect of stream restoration on the condition of streams within The Glade Watershed portion of the NVSRB.<sup>3</sup>

# <u>Project Area</u>

The study area includes approximately 7,164 linear feet of restored stream along Design Reaches 5 and 6 and 1,175 linear feet of non-restored stream in The Glade, as well as the adjacent riparian corridors. The study area is located north of Lawyers Road (Route 673) between Soapstone Drive and Twin Branches Road in Fairfax County, Virginia. <u>Exhibit 1</u> is a vicinity map that depicts the approximate location of the study area.

The study area is covered mostly by mixed-deciduous forest. The Glade flows in an easterly direction through the study area. An asphalt recreational trail, which crosses The Glade multiple times, is located parallel to the stream. 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 <u>Exhibit 2</u>.

# **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<sup>4</sup>. 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:

- 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.)<sup>5</sup>
- 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).<sup>6</sup>

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<sup>&</sup>lt;sup>3</sup> Note that monitoring reports for the Snakeden Branch and Colvin Run watershed portions of the NVSRB are provided under separate cover.

<sup>&</sup>lt;sup>4</sup> 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.

<sup>&</sup>lt;sup>5</sup> 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, The Glade Watershed", dated December 8, 2008.

<sup>&</sup>lt;sup>6</sup> This method is to be used in all monitoring years and is accompanied by a habitat assessment; following guidance established Virginia Department of Environmental Quality's (DEQ) standard operating procedures for stream habitat assessment.

Voluntary supplemental monitoring was undertaken in Year 2 (2012), Year 3 (2013) and Year 4 (2014) to better understand and document the effects of stream restoration on the benthic community within the Glade Watershed. This data is also included within this report.

# **Biological Stream Monitoring**

<u>Biological Stream Monitoring Methodology.</u> 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 SOPs for stream habitat assessment (DEQ 2008)<sup>7</sup> 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).<sup>8</sup>

WSSI assessed three 300 linear foot reaches that were selected in Biological Monitoring Report #1 (Reach 1-A through 1-C).<sup>9</sup> The locations of these three sampling reaches relative to Design Reaches 5 and 6 are depicted in the Biological Stream Monitoring Map (<u>Exhibit 3</u>). The assessed reaches were selected to be representative of the condition of The Glade and unnamed tributaries of The Glade. However, these biological monitoring reaches were selected before the restoration plans were designed for Design Reaches 5 and 6, and during the public review process, it was determined that portions of Design Reaches 5 and 6 need not be restored. These portions include a beaver save area, located between Design Reaches 5 and 6, a small stretch of stream within Design Reach 6, and the downstream end of The Glade (Design Reach 6), before it crosses under Twin Branches Road. The non-restored area downstream from Design Reach 6 includes biological monitoring Reach 1-A, approximately 10% of which was restored. Biological monitoring Reach 1-B is located at the upstream end of Design Reach 6 and approximately 50% of this reach was restored with portions of the biological monitoring reach located within the beaver save area. Since the biological monitoring reaches had already been established, WSSI decided not to shift the biological monitoring locations to completely restored areas to prevent a skew in the data so these areas could be used as reference data points. Photographs, Habitat and Benthic Macroinvertebrate Field Data Sheets are included in Exhibit 4 for each reach. Benthic macroinvertebrate sampling and habitat assessment field work was conducted by WSSI environmental scientist Alison Robinson, PWS, PWD, CT.

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 was recorded on the WSSI Benthic Macroinvertebrate and Habitat Field Data Sheets (<u>Exhibit 4</u> for each reach).

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<sup>&</sup>lt;sup>7</sup> Note that the DEQ has revised their SOP for habitat. Thus, starting in 2010, WSSI is using the latest SOP for habitat (DEQ 2008).

<sup>&</sup>lt;sup>8</sup> 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).

Note that biological monitoring reaches 1-D through 1-G, 2-A and 3-A were restored in 2010 and do not need to be assessed in post-construction Year 6.

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, snags/leafpacks, root-wads, and submerged vegetation. Benthic field data was recorded on WSSI Benthic Macroinvertebrate and Field Data Sheets (developed from the EPA's RBP Benthic Macroinvertebrate Field Data Sheets), which are included in <u>Exhibit 4</u> 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 (<u>Exhibit 4</u> 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" (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 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

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Scrapers is expected to decrease in response to environmental disturbance. Percent Scrapers can range from 0-51.6 for the VA-SCI.

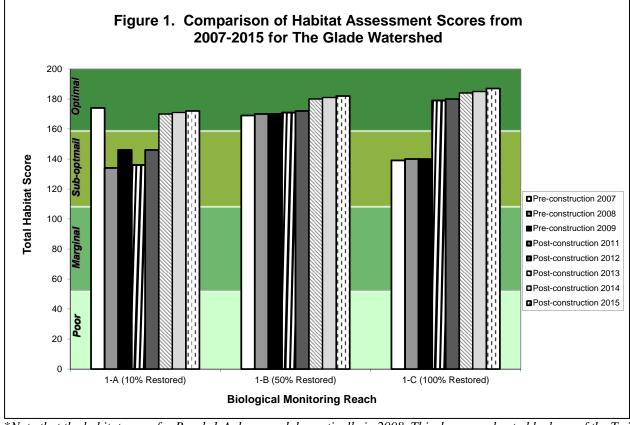
- Percent Chironomidae. The Percent Chironomidae represents the ratio of members of the aquatic insect family Chironomidae (non-biting midges) to the total number of individuals in a sample. Because chironomids are generally tolerant to pollution, Percent Chironomidae is expected to increase in response 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 =  $100 \times (X/11)$ , where X = Metric Value
  - Percent Ephemeroptera: Score =  $100 \times (X/61.3)$ , where X = Metric Value
  - Percent Plecoptera + Trichoptera less Hydropsychidae: Score =  $100 \times (X/35.6)$ , where X = Metric Value
  - Percent Scrapers: Score =  $100 \times (X/51.6)$ , 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 =  $100 \times [(100-X) (100-3.2)]$ , 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.

<u>Biological Stream Monitoring Results and Discussion.</u> Habitat results for Year 5 show that Reach 1-A, 90% of which was not restored, scored an "Optimal" habitat condition rating. Reach 1-B is 50% restored, with the upstream portion within the non-restored beaver save area, and scored in the "Optimal" category. Reach 1-C was the only fully restored reach in Design Reaches 5 and 6 and scored in the "Optimal" category (Table 1, Figure 1 and Exhibit 4 for each reach). The average habitat assessment score for all restored stream reaches assessed in 2015 is 180 out of 200 following restoration which falls in the "Optimal" category. These results show improved habitat conditions following restoration, with scores exceeding the pre-restoration scores with the exception of Reach 1-A which was not fully restored. 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. It is expected that this trend will continue and stabilize over time.

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Table 1. 2015 Total Habitat Assessment Scores								
BIOMONITORING Total REACH Habitat Narrative Rating								
-	Habitat	Ontimal						
1-A (10% Restored)	172	Optimal						
1-B (50% Restored)	182	Optimal						
1-C (100% Restored)	1-C (100% Restored) 187 Optimal							
Average	180	Optimal						



\*Note that the habitat score for Reach 1-A decreased dramatically in 2008. This drop was due to blockage of the Twin Branches culvert, located at the downstream end of the Glade, which caused sediment deposition and increased embeddedness of the substrate, a decrease in the velocity and depth regime, and a decrease in the frequency of riffles within Reach 1-A. This blockage has since been removed.

Benthic macroinvertebrate results show that individuals from 17 taxa were collected from all three reaches collectively (<u>Table 2</u>, <u>Exhibit 4</u>) during the 2015 post-construction benthic macroinvertebrate monitoring. Of all taxa collected, non-biting midge larvae (Chironomidae) and common net spinning caddisfly larvae (Hydropsychidae) comprised the majority of individuals in the reaches.

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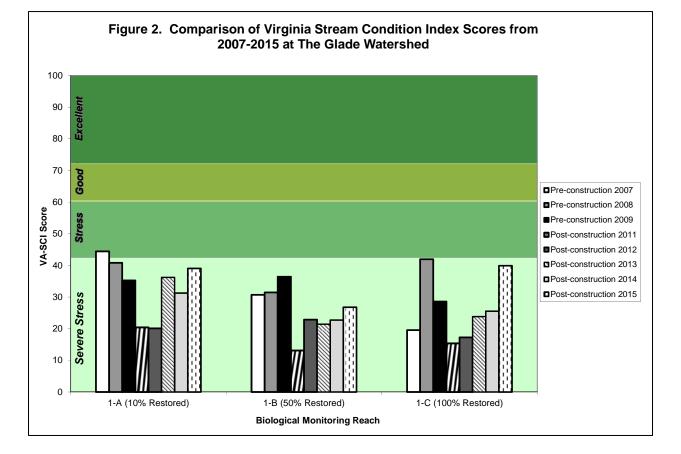
Та	ble 2. The G	lade 2015 Raw	Data	
		REAC	ж	
ΤΑΧΑ	1-A (10% Restored)	1-B (50% Restored)	1-C (100% Restored)	Total
Amphipoda	3	1	-	4
Ceratopgonidae	2	-	-	2
Chironomidae	54	65	63	182
Coenagrionidae	2	1	4	7
Copepoda	-	5	1	6
Elmidae	5	5	10	20
Empididae	-	3	-	3
Heptageniidae	2	-	2	4
Hydracarina	-	-	1	1
Hydropsychidae	17	7	7	31
Hydroptilidae	-	-	3	3
Isopoda	-	-	1	1
Oligochaeta	3	12	9	24
Planorbidae	-	-	1	1
Philopotamidae	18	-	6	24
Sphaeriidae	1	4	-	5
Tipulidae	1	1	6	8
Total	108	104	114	326

The above data collected for each reach were used to calculate the biotic metrics as shown in <u>Table 3</u>. The VA-SCI requires that these metrics be weighted to determine the VA-SCI, as shown in <u>Table 4</u>. The results of our data analysis indicate that the benthic macroinvertebrate communities at all three stream reaches (Reaches 1-A through 1-C) were in "Severe Stress" in 2015 following stream restoration activities, based on their VA-SCI scores. The average VA-SCI numerical score for all reaches assessed in 2015 is 35.26 ("Severe Stress"). These scores are the result of a low number of total EPT taxa, low percentage of Ephemeroptera, Plecoptera and Trichoptera (excluding Hydropsychidae), low percentage of Scraper taxa, moderate percentage of Chironomidae, moderate percentage of top two dominant taxa, and moderate HBI found within the reaches assessed.

Table 3. The Glade 2015 Biotic Metric Scores											
Reach	Total Taxa	Total EPT Taxa	Percent Ephemeroptera	Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)	Percent Scrapers	Percent Chironomidae	Percent Top Two Dominant	нві			
1-A (10% Restored)	11	3	1.85	16.67	6.48	50.00	67	4.93			
1-B (50% Restored)	10	1	0.00	0.00	4.81	62.50	74	4.88			
1-C (100% Restored)	13	1	1.75	7.89	14.04	55.26	64	4.89			

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Table 4. 2015 Biotic Metric an	d Index Weightii	ng and VA-SCI at	t The Glade.			
	BIOLOGICAL MONITORING REACH					
WEIGHTED METRIC	1-A	1-B	1-C			
	(10% Restored)	(50% Restored)	(100% Restored)			
Total Taxa	50.00	45.45	59.09			
EPT Taxa	27.27	9.09	36.36			
Percent Ephemeroptera	3.02	0.00	2.86			
Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)	46.82	0.00	22.18			
Percent Scrapers	12.56	9.32	27.20			
Percent Chironomidae	50.00	37.50	44.74			
Percent Top Two Dominant	48.17	37.52	51.97			
HBI	74.62	75.37	75.08			
VA-SCI Numerical Score	39.06	26.78	39.93			
VA-SCI Narrative Score	Severe Stress	Severe Stress	Severe Stress			
Average VA-SCI Numerical Score	35.26					
Average VA-SCI Narrative Score	Severe Stress					



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An analysis of land use within the watershed of each stream reach indicates that each watershed is highly developed, with all reaches having 15 percent impervious land cover as depicted in the Land Cover Map (Exhibit 5), and Table 5. It has been documented that even at low levels of imperviousness (~5-10%), stream degradation can begin to occur, which includes macroinvertebrate diversity (Schueler, Fraley-McNeal, and Cappiella, 2009). Runoff from the highly impervious land within these watersheds typically produces a high volume and velocity of flowing water and sediment in the stream channels during storm events. As a result, epifaunal substrate/available cover within these streams becomes highly mobile and benthic macrofauna cannot easily colonize the available substrate (Debrey and Lockwood 1990) or they can be 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 in the areas that were restored and it is anticipated that benthic condition could increase overtime if water quality enhancing measures were undertaken in the watershed by others.

Table 5. Impervious Land Cover for Each Reach										
	Watershed Percent									
REACH	Acres	Impervious								
1-A (10% Restored)	780	15								
1-B (50% Restored)	668	15								
1-C (100% Restored)	618	15								

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 untreated stormwater. 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).

The Year 5 results show an overall increase in SCI figures since the restoration. However, the benthic community within all of the sampled reaches is still in "Severe Stress" (<u>Figure 2</u>). It was expected that the VA-SCI scores immediately following construction would not improve due to disturbance from construction. Such disturbances can temporarily reduce benthic condition, and recovery of the benthic community can be slow (Muatka 2002). WSSI noticed a similar decrease in the benthic community in the Snakeden Watershed immediately following restoration. However, given the factors discussed above, it is WSSI's opinion that the VA-SCI will remain low and pollution-tolerant taxa, such as non-biting midges and aquatic worms, will remain the dominant taxa. However, restoration has improved in-stream habitat, thus providing a stable substrate for colonization by benthic macroinvertebrates and it may be 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).

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# **Conclusions**

The above results indicate that the habitat of Design Reaches 5 and 6 of The Glade has improved following restoration which relates to the success of the well vegetated and stabilized banks (in the restored portions of the monitoring reaches) as well as the continued stability of the non-restored portions of the Glade. However, the overall benthic macroinvertebrate community has not changed significantly 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, stormwater, impervious areas, etc.) are negatively 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.

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WETLAND STUDIES AND SOLUTIONS, INC.

Alison Robinson, PWS, PWD, CT Project Environmental Scientist

Benjamin Rosner, PWS, PWD, CT, CE Manager – Environmental Scientist

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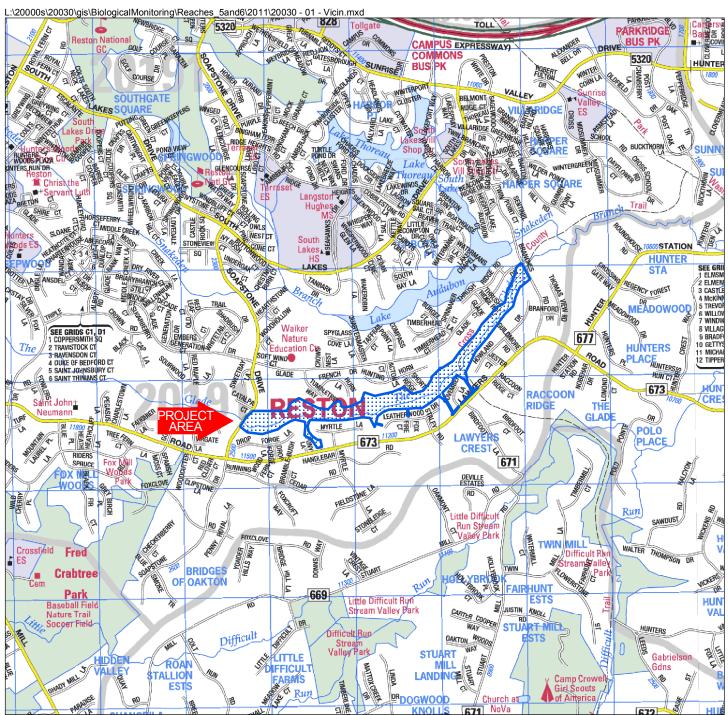
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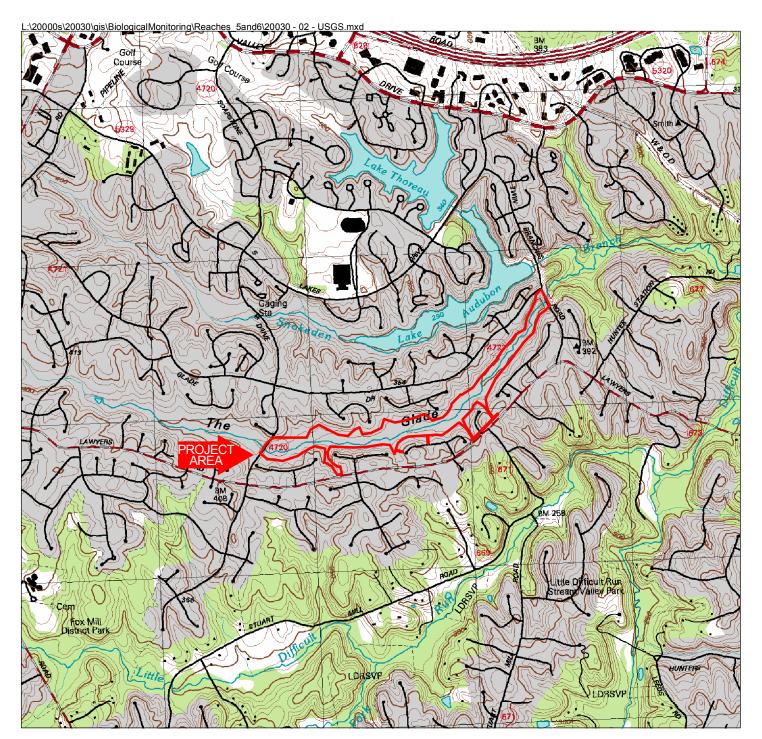
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Vicinity Map The Glade Reaches 5 and 6 WSSI #20030 Scale: 1" = 2000'



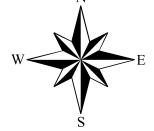
Wetland Studies and Solutions, Inc. a **DAVEY** company

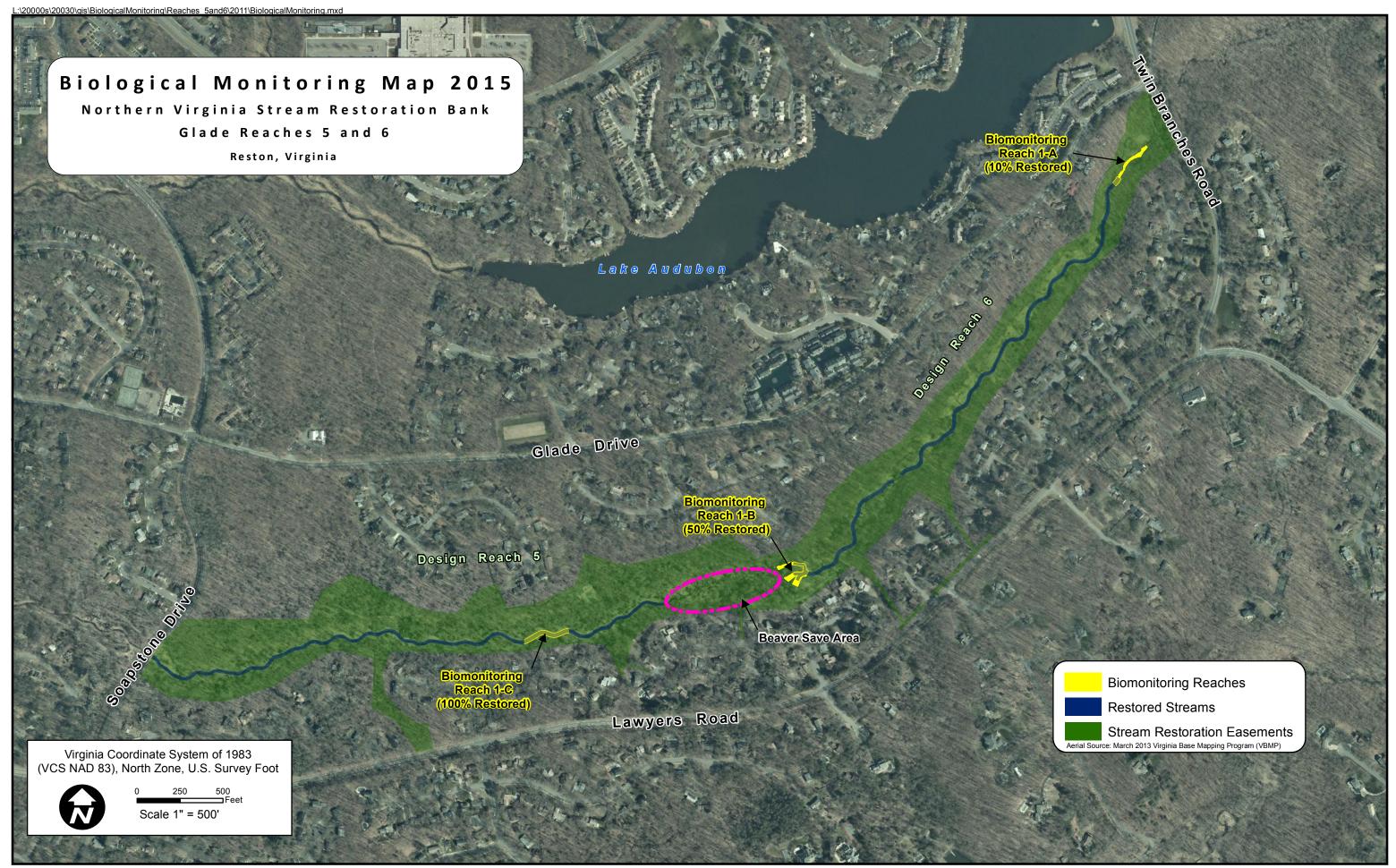


USGS Quad Map Vienna, VA-MD 1994 The Glade Reaches 5 and 6 WSSI #20030 Scale: 1'' = 2000'

Latitude: 38°55'25" N Longitude: 77°20'02" W Hydrologic Unit Code (HUC): 020700081004 Stream Class: III Name of Watershed:The Glade

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Exhibit 3

# THE GLADE –REACHES 5 AND 6 EXHIBIT 4 INDIVIDUAL BIOLOGICAL MONITORING REACH DATA

# • <u>REACH 1-A</u>

- o Biological Stream Assessment Photographs
- o Benthic Macroinvertebrate and Field Data Sheet
- Benthic Macroinvertebrate Bench Sheet

# • <u>REACH 1-B</u>

- Biological Stream Assessment Photographs
- Benthic Macroinvertebrate and Field Data Sheet
- Benthic Macroinvertebrate Bench Sheet

# • <u>REACH 1-C</u>

- o Biological Stream Assessment Photographs
- o Benthic Macroinvertebrate and Field Data Sheet
- o Benthic Macroinvertebrate Bench Sheet

L:\20000s\20030\Admin\05-ENVR\Biomonitoring\Reaches 5 and 6\PostCon Yr 5 - 2015\Exhibit 4 cover.doc

# REACH 1-A BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



1. Looking south-southwest (upstream) at Reach 1-A of The Glade in the eastern portion of the study area. Photo taken April, 2007.



2. Looking south-southwest (upstream) at Reach 1-A of The Glade in the eastern portion of the study area. Photo taken May, 2008.

# REACH 1-A BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



3. Looking south-southwest (upstream) at Reach 1-A of The Glade in the eastern portion of the study area. Photo taken March, 2009.



4. Looking south (upstream) at Reach 1-A of The Glade in the eastern portion of the study area. Photo taken March, 2011.

#### REACH 1-A BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



5. Looking south (upstream) at Reach 1-A of The Glade in the eastern portion of the study area. Photo taken March, 2015.

 $L: \label{eq:label} L: \label{eq:label} L: \label{eq:label} 20030 \label{eq:label} Admin \label{eq:label} 05-ENVR \label{eq:label} Biomonitoring \label{eq:label} Reaches 5 and 6 \label{eq:label} PostCon Yr 5 - 2015 \label{eq:label} 1-A \label{eq:label} PostCon Yr 5 - 2015 \label{eq:label} 1-A \label{eq:label} PostCon Yr 5 - 2015 \label{eq:label} 1-A \label{eq:label} PostCon Yr 5 - 2015 \label{eq:label} L: \label{eq:label} L: \label{eq:label} L: \label{eq:label} PostCon Yr 5 - 2015 \label{eq:label} PostCo$ 

Wetland Studies and Solutions, Inc a DAVEY 😤 company Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient loh # Task 20030, Task I5b Station ID: Reach 1-A Ecoregion: Piedmont Land Use: Urban Field Team: ABR / HC Location: Reston, VA Start time: Site: The Glade 38°55'49" Latitude: Finish time: Date: 3/30/2015 Longitude: 77°19'29" Survey Reason: Year 5 Biomonitoring **Stream Physiochemical Measurements** N/A Instrument ID number: N/A pH: Temperature: N/A °C Conductivity: N/A uS/cm Dissolved Oxygen: N/A Did instrument pass all post-calibration checks? mg/L N/A If NO- which parameter(s) failed and action taken: N/A **Benthic Macroinvertebrate Collection** Single Habitat (Riffle) Method Used: Multi Habitat (Logs, Plants, etc.) х Riffle Quality: Marginal Good х Poor None Woody Riffle Habitats Sampled: Debris Х Banks Х Vegetation 16 1 # Jabs: Weather Observations Current Weather Cloudy Clear Х Rain/Snow Foggy **Recent Precipitation** Clear Х Showers Rain Storms Stream Flow Normal Х Above Normal Flood Low **Biological Observations** Periphyton 2 Salamanders Other.... 0 **Filamentous Algae** Warmwater Fish 2 0= Not observed 2 Submerged Macrophytes 1 Coldwater Fish 0 1= Sparse **Emergent Macrophytes** 0 Beavers 0 2= Common to Abundant 0 Crayfish Muskrats 3= Dominant-Corbicula 0 Ducks/Geese 1 Abnormally high density where other taxa are Unionidae 0 Snakes 0 insignificant in relation to the dominant taxa. There can be situations where multiple taxa **Operculate Snails** 0 Turtles 0 are dominant such as algae and snails Non-operculate Snails 0 Frogs/Tadpoles 1 **High Gradient Habitat Data Sheet** Condition Category Habitat Parameter Poor Optimal Suboptimal Marginal Score Greater than 70% of substrate 40-70% mix of stable favorable for epifaunal habitat: well suited for full colonization and fish cover; mix colonization potential; 20-40% mix of stable 1. Epifaunal Less than 20% stable of snags, submerged logs, adequate habitat for habitat: habitat availability habitat: lack of habitat is Substrate/ Available undercut banks, cobble, or other maintenance of less than desirable; obvious; substrate stable habitat and at stage to populations: presence of substrate frequently Cover unstable or lacking. allow full colonization potential additional substrate in the disturbed or removed. (i.e. snags/logs that are not new form of newfall, but not yet fall and not transient) prepared for colonization. Score 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 17 avel cobble, and b Gravel, cobble, and Gravel, cobble, and Gravel, cobble, and particles are 0-25% surrounded boulder particles are 25boulder particles are 50boulder particles are more 2. Embeddedness by fine sediment. Layering of 50% surrounded by fine 75% surrounded by fine than 75% surrounded by cobble provides diversity of niche sediment. sediment. fine sediment 10 9 8 7 6 Score 20 19 18 17 16 15 14 13 12 11 4 3 2 17 0 All four velocity/depth regimes Only 3 of the 4 regimes Only 2 of the 4 habitat present (slow-deep, slow-Dominated by 1 Velocity/Depth present (if fast-shallow is regimes present (if fastshallow, fast-deep, fast velocity/depth regime Regime missing, score lower than shallow or slow-shallow shallow)(slow is <0.3m/s, deep i (usually slow-deep). if missing other regimes). are missing, score low). >0.5 m). Score 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 4 3 2 0 15 Moderate deposition of Heavy deposits of fine Some new increase in bar new gravel, sand, or fine material, increased bar Little or no enlargement of formation, mostly from sediment on old and new development; more than 4. Sediment islands or point bars and <5% of gravel, sand, or fine bars: 30-50% of the 50% of the bottom the bottom affected by sediment sediment; 5-30% of the bottom affected; sediment changing frequently; pools Deposition deposits at obstructions, almost absent due to deposition. bottom affected: slight deposition in pools. constrictions, and bends: substantial sediment

15 14 13 12 11

20 19 18 17 16

moderate deposition of

7

6

10 9 8

deposition

0

15

4 3 2



a **DAVEY** company

Benthic	Macroinvertebrate		Id Data Sheet -		
Dentino					
Habitat Parameter			tion Category	_	_
<u>Hastar alameter</u>	Optimal	Suboptimal	Marginal	Poor	Score
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	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.	extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and	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	543210	19
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	543210	14
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	876	543	2 1 0	10
9. Vegetation Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non- woody macrophytes; vegetation disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well- represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	9
Score Right Bank	10 9	876	5 4 3	2 1 0	9
10. Riparian Vegetative Zone Width (score each banks riparian zone)	Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear- cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12- 18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.	
Score Left Bank	10 9	876	5 4 3	2 1 0	10
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	9
Notos:		Total Score			172
Notes:					

Job Name/#		Glade - 2003	0	Sample subsorted by:	ABR	/ BNR		
Station ID:		Reach 1-A	-	Date Subsorted:		1/15	(Wetland)	)
				-			Studies and Solutions, In	c.
Stream Name:		The Glade		# of Grids subsorted	1	10	-	
Date Sampled:		3/30/15		Total # of subsorted insects	3:	108	Total # identified:	108
Sampling Meth	nod:	Multihabitat		Sample Identified by:	ABR	/ BNR	Date Identified:	3/31/1
Taxa Collecte	əd.							
	<u>50.</u>			Metretopodidae		1	Lepidostomatidae	
Porifera	Spongillidae		1	Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
Flatworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Gastropoda	Unknown		1	Potamanthidae		1	Philopotamidae	18
Limpets	Ancylidae		1	Siphlonuridae		1	Phryganeidae	
Snails	Immature		1	Tricorythidae		1	Polycentropodidae	
	Lymnaeidae		Zygoptera	Early Instar and/or damaged		1	Psychomyiidae	
	Physidae			Calopterygidae			Ryacophilidae	
	Planorbidae		l	Coenagrionidae	2	l	Sericostomatidae	
	Hydrobiidae		l	Lestidae		l	Uenoidae	
	Pleuroceridae			Protoneuridae		Lepidoptera	Early Instar and/or damaged	
	Viviparidae		Anisopteera	Early Instar and/or damaged		l	Pyralidae	
Bivalvia	Immature		l	Aeshnidae		Coleoptera	Early Instar and/or damaged	
	Corbiculidae		l	Cordulegastridae		l	Chrysomelidae	
	Sphaeriidae	1		Corduliidae			Curculionidae	
	Unionidae			Gomphidae			Dryopidae	
Oligochaeta	Unknown	3		Libellulidae			Dytiscidae	
_umbriculida				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	Hereiter Alter	_		Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
Leeches	Hirudinea			Peltoperlidae			Limnichidae	
	Erpobdellidae	_		Perlidae Barla di da s			Noteridae	
	Glossiphoniidae	_		Perlodidae			Psephenidae	
	Hirudinidae Dia sistista s			Pteronarcyidae			Ptilodactylidae	
Branchiobdellida	Pisciolidae			Taeniopeterygidae Early Instar and/or damaged		Distant	Scirtidae Early Instar and/or damaged	
Copepoda	Branchiobdellidae Unknown	_	Hemiptera	Belostomatidae		Diptera	Athericidae	
	Cambaridae	_		Corixidae			Blephariceridae	
Decapoda	Portunidae	_		Gelastocoridae			Canaceidae	
Shrimp	Fortunidae							2
Shrimp	Palaemonidae	+		Gerridae Hebridae			Ceratopogonidae Choaboridae	2
Isopoda		+	1	Hydrometridae		1	Chironomidae	54
	Asellidae		1	Mesoveliidae		1	Culicidae	7
Amphipoda		3	1	Naucoridae		1	Dixidae	
piipodd	Crangonyctidae		1	Nepidae		1	Dolichopodidae	
	Gammaridae	-	1	Notonectidae		1	Empididae	
	Talitridae		1	Veliidae		1	Ephydridae	
Water Mites			1	Pleidae		1	Muscidae	
	Hydracarina		Neuroptera			1	Nymphomyiidae	
Ephemeroptera	Early Instar and/or damage	d	louiopioid	Sisyridae		1	Pelecorhynchidae	
	Acanthometropodidae	-	Megaloptera			1	Psychodidae	
	Ameletidae		Jacoptora	Corydalidae		1	Ptychopteridae	
	Baetidae		1	Sialidae		1	Sciomyzidae	
	Baetiscidae	+	Trichoptera	Early Instar and/or damaged		1	Simuliidae	
	Behningiidae			Branchycentridae		1	Stratiomyidae	
	Caenidae		1	Calamoceratidae		1	Syrphidae	
	Ephemerellidae	+	1	Glossosomatidae		1	Tabanidae	
	Ephemeridae		1	Goeridae		1	Tanyderidae	
	Heptageniidae	2	1	Heliicopsychidae		1	Thaumaleidae	
	Isonychiidae	-	1	Hydropsychidae	17	1	Tipulidae	1
	Leptophlebiidae	+	1	Hydroptilidae	.7	1	npalludo	80
TOTAL:		9	TOTAL		19	TOTAL		00

# REACH 1-B BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



1. Looking northeast (downstream) at Reach 1-B of The Glade in the eastern portion of the study area. Photo taken March, 2007.



2. Looking northeast (downstream) at Reach 1-B of The Glade in the eastern portion of the study area. Photo taken May, 2008.

# REACH 1-B BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



**3.** Looking northeast (downstream) at Reach 1-B of The Glade in the eastern portion of the study area. Photo taken March, 2009.



4. Looking east (downstream) at Reach 1-B of The Glade in the eastern portion of the study area. Photo taken March, 2011.

# REACH 1-B BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



5. Looking west (upstream) at Reach 1-B of The Glade in the eastern portion of the study area. Photo taken March, 2015.

	Bonthic	Macroiny	ortobrato	and Ha	aitat Eio	Id Data Sk	Nont -	High Gradient	
Job # Task			entebrate	апи па		iu Dala Si	ieel -	nigh Gradient	
Station ID:	20030, Task I3b Reach 1-B		Fooragion	Piedmont		Land Use:	Urban		
Field Team:	ABR / HC		Ecoregion: Location:			Start time:	Ulball		
Site:	The Glade		Latitude:	Reston, VA 38°55'25"		Finish time:			
							Voor E D	iomonitoring	
Date: Stream Phys	3/30/2015 siochemical M		Longitude:	77°19'54"		Survey Reason:	rear 5 B	lomonitoring	
· · ·	ment ID number:		s I/A		pH:	N/A			
institu	Temperature:		°C	•	Conductivity:		uS/cm		
г	)issolved Oxygen:	•	mg/L			ment pass all pos	-	ion checks? N/A	
L	Jissolveu Oxygen.	NA	iiig/ L			th parameter(s) fa			-
Benthic Ma	croinvertebrat	e Collection			in NO wind				-
Method Used:			Single Ha	bitat (Riffle)		Multi H	labitat (Lo	ogs, Plants, etc.) X	
Riffle Quality:		Good	x	Marginal		•			-
				Woody		-			-
Habitats Sampl	ed:	Riffle	Х	Debris		Banks		Vegetation X	-
		# Jabs:	16			-		4	-
Weather Ob	oservations								-
Current Weath	er	Cloudy				Rain/Snow		Foggy	-
Recent Precipit	ation	Clear	Х			Rain		Storms	-
Stream Flow		Low		Normal	Х	Above Normal		Flood	-
Biological O	bservations								
	Periphyton	2			Salamanders		-	Other	
	ilamentous Algae				rmwater Fish		-	0= Not observed	
Submer	ged Macrophytes	1		C	oldwater Fish		-	1= Sparse	
Emerg	ent Macrophytes	0			Beavers		-	2= Common to Abundant	
	Crayfish	0			Muskrats		-	3= Dominant-	
	Corbicula				Ducks/Geese		-	Abnormally high density wh	ere other taxa are
	Unionidae				Snakes		-	insignificant in relation to th	
	Operculate Snails	0		_	Turtles		-	There can be situations whe are dominant such as alg	
Non-	operculate Snails	0			ogs/Tadpoles				
			High Gr	adlent F		Data Sheet			
Habitat I	Parameter					tion Catego			
		-	timal		ptimal	Margin	al	Poor	Score
			'0% of substrate for epifaunal		ix of stable suited for full				
1 En	ifaunal		nd fish cover; mix		n potential;	20-40% mix of	f stable	Less than 20% stable	
-			bmerged logs,		habitat for	habitat; habitat a		habitat; lack of habitat is	
	/ Available		and at stage to		nance of presence of	less than des substrate free		obvious; substrate	
Co	over		nization potential		bstrate in the	disturbed or re		unstable or lacking.	
			that are not new		all, but not yet				
			ot transient).	1	colonization.	40.0.0		5 4 9 9 4 9	10
S	core		18 17 16 le, and boulder		13 12 11	10 9 8		5 4 3 2 1 0	18
			25% surrounded	,	bble, and ticles are 25-	Gravel, cobbl		Gravel, cobble, and boulder particles are more	
2. Embe	ddedness		ent. Layering of	50% surrou	nded by fine	boulder particle 75% surrounde		than 75% surrounded by	
			diversity of niche ace.		ment.	sedimen		fine sediment.	
Sc	core		18 17 16	15 14	13 12 11	10 9 8	76	5 4 3 2 1 0	17
		All four velocit	y/depth regimes	Only 2 of th	e 4 regimes	Only 2 of the 4	hobitot		
Velocit	ty/Depth		w-deep, slow-		ast-shallow is	Only 2 of the 4 regimes presen		Dominated by 1	
	gime		st-deep, fast <0.3m/s, deep is		re lower than	shallow or slow		velocity/depth regime	
			s <0.3m/s, deep is 5 m).	if missing ot	ner regimes).	are missing, sco	ore low).	(usually slow-deep).	
Sc	core		18 17 16	15 14	13 12 11	10 9 8	76	5 4 3 2 1 0	16
						Moderate depo		Heavy deposits of fine	
		1.501			crease in bar	new gravel, san		material, increased bar	
4. Se	diment		nlargement of bars and <5% of		mostly from nd, or fine	sediment on old bars; 30-50%		development; more than 50% of the bottom	
	sition		cted by sediment		5-30% of the	bottom affected;			
Debc			osition.		ected; slight	deposits at obst		almost absent due to	
				depositio	n in pools.	constrictions, an		substantial sediment	
Se	core	20 19	18 17 16	15 14	13 12 11	moderate depo		deposition.	18

Habitat Damanata		Condi	tion Category		
Habitat Parameter	Optimal	Suboptimal	Marginal	Poor	Score
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	543210	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	543210	19
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	543210	18
8. Bank Stability (score each bank) Note: Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30- 60% of bank reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	9
9. Vegetation Protection (score each bank)	10 9 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.	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	5 4 3 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.	2 1 0 Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation of streambank vegetation has been removed to 5 centimeters or less in average stubble height.	9
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	10
Score Right Bank	10 9	8 7 6	543	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 riparian zone <6 meters; little or no riparian vegetation due to human activities.	
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	9
Score Right Bank	10 9	8 7 6	5 4 3	2 1 0	10
Score Right Bank		Total Score			182

	WSSI BENTHIC MACROINVERTEBRATE BENCH SHEET									
Job Name/#	Glade - 20030	Sample subsorted by:	ABR/BNR	Watland						
Station ID:	Reach 1-B	Date Subsorted:	4/8/15	Studies and Solutions, I	mc.					
Stream Name:	The Glade	# of Grids subsorted	8							
Date Sampled:	3/30/15	Total # of subsorted insects:	104	Total # identified:	104					
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	4/8/15					

Taxa Collected:

				Metretopodidae			Lepidostomatidae	
Porifera	Spongillidae			Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
latworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Bastropoda	Unknown			Potamanthidae			Philopotamidae	
impets	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		Lopidoptord	Pyralidae	
ivalvia	Immature		, anooptoora	Aeshnidae		Coleoptera	Early Instar and/or damaged	
ivalvia	Corbiculidae			Cordulegastridae		Coleoptera	Chrysomelidae	
		4		-			Curculionidae	
	Sphaeriidae	4		Corduliidae				
	Unionidae			Gomphidae			Dryopidae	
ligochaeta	Unknown	12	4	Libellulidae			Dytiscidae	
umbriculida			1	Macromiidae			Elmidae	5
	Lumbriculidae			Petaluridae			Gyrinidae	
ubificida			L	Cordullidae/Libelluidae			Haliplidae	
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae	
	Naididae			Capniidae			Helophoridae	
	Tubificidae			Chloroperlidae			Hydraenidae	
aplotaxida				Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
eeches	Hirudinea			Peltoperlidae			Limnichidae	
	Erpobdellidae			Perlidae			Noteridae	
	Glossiphoniidae			Perlodidae			Psephenidae	
	Hirudinidae			Pteronarcyidae			Ptilodactylidae	
	Pisciolidae			Taeniopeterygidae			Scirtidae	
ranchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged	
copepoda	Unknown	5	. iomptora	Belostomatidae		Diptora	Athericidae	
ecapoda	Cambaridae	U		Corixidae			Blephariceridae	
ccapoda	Portunidae			Gelastocoridae			Canaceidae	
hrimp	Fortunidae			Gerridae				
mmp	Dalaamanidaa						Ceratopogonidae Choaboridae	
	Palaemonidae			Hebridae				05
opoda	A			Hydrometridae			Chironomidae	65
	Asellidae			Mesoveliidae			Culicidae	
mphipoda		1		Naucoridae			Dixidae	
	Crangonyctidae			Nepidae			Dolichopodidae	
	Gammaridae			Notonectidae			Empididae	3
	Talitridae			Veliidae			Ephydridae	
/ater Mites				Pleidae			Muscidae	
	Hydracarina		Neuroptera				Nymphomyiidae	
phemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae	
	Acanthometropodidae		Megaloptera				Psychodidae	
	Ameletidae			Corydalidae			Ptychopteridae	
	Baetidae		1	Sialidae			Sciomyzidae	
	Baetiscidae		Trichoptera	Early Instar and/or damaged			Simuliidae	
	Behningiidae		1	Branchycentridae			Stratiomyidae	
	Caenidae		1	Calamoceratidae			Syrphidae	
	Ephemerellidae		1	Glossosomatidae			Tabanidae	
	Ephemeridae		1	Goeridae			Tanyderidae	
			1				-	
	Heptageniidae		4	Heliicopsychidae	-		Thaumaleidae	4
	Isonychiidae		1	Hydropsychidae	7		Tipulidae	1
	Leptophlebiidae			Hydroptilidae	1			74

# REACH 1-C BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



1. Looking southwest (upstream) at Reach 1-C of The Glade in the eastern portion of the study area. Photo taken March, 2007.



2. Looking southwest (upstream) at Reach 1-C of The Glade in the eastern portion of the study area. Photo taken May, 2008.

# REACH 1-C BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



**3.** Looking southwest (upstream) at Reach 1-C of The Glade in the eastern portion of the study area. Photo taken March, 2009.



4. Looking west (upstream) at Reach 1-C of The Glade in the eastern portion of the study area. Photo taken March, 2011.

# REACH 1-C BIOLOGICAL STREAM ASSESSMENT PHOTOGRAPHS THE GLADE WATERSHED WSSI #20030



5. Looking east (downstream) at Reach 1-C of The Glade in the eastern portion of the study area. Photo taken March, 2015.

L:\20000s\20030\Admin\05-ENVR\Biomonitoring\Reaches 5 and 6\PostCon Yr 5 - 2015\1-C\Photos 1-C.docx

Wetland Studies and Solutions, Inc a **DAVEY** Company Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient Job # Task 20030, Task I3b Station ID: Reach 1-C Ecoregion: Piedmont Land Use: Urban Field Team: ABR / HC Location: Reston, VA Start time: The Glade 38°55'22" Site: Latitude: Finish time: Date: 3/30/2015 Longitude: 77°20'12" Survey Reason: Year 5 Biomonitoring **Stream Physiochemical Measurements** N/A Instrument ID number: N/A pH: Temperature: N/A °C Conductivity: N/A uS/cm Dissolved Oxygen: N/A Did instrument pass all post-calibration checks? mg/L N/A If NO- which parameter(s) failed and action taken: N/A **Benthic Macroinvertebrate Collection** Single Habitat (Riffle) Method Used: Multi Habitat (Logs, Plants, etc.) х Riffle Quality: Marginal Good х Poor None Woody Riffle Habitats Sampled: Debris Х Banks Vegetation # Jabs: 16 Weather Observations Current Weather Cloudy Clear Х Rain/Snow Foggy **Recent Precipitation** Clear Х Showers Rain Storms Stream Flow Normal Х Above Normal Flood Low **Biological Observations** Periphyton 3 Salamanders Other.... 0 **Filamentous Algae** 2 Warmwater Fish 0= Not observed 1 Submerged Macrophytes 0 Coldwater Fish 0 1= Sparse **Emergent Macrophytes** 0 Beavers 0 2= Common to Abundant 0 Crayfish 0 Muskrats 3= Dominant-Corbicula 0 Ducks/Geese 0 Abnormally high density where other taxa are Unionidae 0 Snakes 0 insignificant in relation to the dominant taxa. There can be situations where multiple taxa **Operculate Snails** 0 Turtles 0 are dominant such as algae and snails Non-operculate Snails 0 Frogs/Tadpoles 0 **High Gradient Habitat Data Sheet** Condition Category Habitat Parameter Poor Optimal Suboptimal Marginal Score Greater than 70% of substrate 40-70% mix of stable favorable for epifaunal habitat: well suited for full colonization and fish cover; mix colonization potential; 20-40% mix of stable 1. Epifaunal Less than 20% stable of snags, submerged logs, adequate habitat for habitat: habitat availability habitat: lack of habitat is Substrate/ Available undercut banks, cobble, or other maintenance of less than desirable; obvious; substrate stable habitat and at stage to populations: presence of substrate frequently Cover unstable or lacking. allow full colonization potential additional substrate in the disturbed or removed. (i.e. snags/logs that are not new form of newfall, but not yet fall and not transient) prepared for colonization. Score 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 18 avel cobble, and b Gravel, cobble, and Gravel, cobble, and Gravel, cobble, and particles are 0-25% surrounded boulder particles are 25boulder particles are 50boulder particles are more 2. Embeddedness by fine sediment. Layering of 50% surrounded by fine 75% surrounded by fine than 75% surrounded by cobble provides diversity of niche sediment. sediment. fine sediment. Score 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 4 3 2 1 19 0 All four velocity/depth regimes Only 3 of the 4 regimes Only 2 of the 4 habitat Dominated by 1 present (slow-deep, slow-Velocity/Depth present (if fast-shallow is regimes present (if fastshallow, fast-deep, fast velocity/depth regime Regime missing, score lower than shallow or slow-shallow shallow)(slow is <0.3m/s, deep i (usually slow-deep). if missing other regimes). are missing, score low). >0.5 m). Score 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 4 3 2 0 16 Moderate deposition of Heavy deposits of fine Some new increase in bar new gravel, sand, or fine material, increased bar Little or no enlargement of formation, mostly from sediment on old and new development; more than 4. Sediment islands or point bars and <5% of gravel, sand, or fine bars: 30-50% of the 50% of the bottom the bottom affected by sediment sediment; 5-30% of the bottom affected; sediment changing frequently; pools Deposition deposits at obstructions, deposition. bottom affected: slight almost absent due to deposition in pools. constrictions, and bends: substantial sediment

15 14 13 12 11

20 19 18 17 16

moderate deposition of

6

10 9 8 7

deposition.

0

18

4 3 2



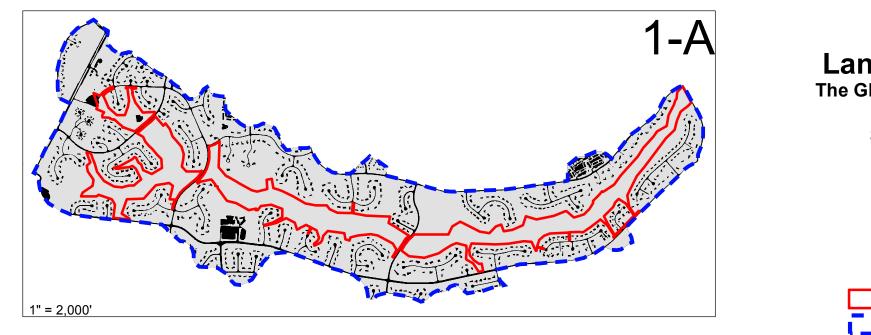
a **DAVEY** company

Benthic	Macroinvertebrate		Id Data Sheet -		
Dentine					
Habitat Parameter			tion Category		
<u>Habitat i arameter</u>	Optimal	Suboptimal	Marginal	Poor	Score
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.	
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	19
6. Channel Alteration	Channelization or dredging absent or minimal; stream width normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging, may be present, but recent channelization is not present.	extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and	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	543210	19
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	543210	18
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	876	543	2 1 0	10
9. Vegetation Protection (score each bank)	10 9 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.	8 7 6 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.	5 4 3 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.	2 1 0 Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation fas been removed to 5 centimeters or less in average stubble height.	10
Score Left Bank	10 9	876	543	2 1 0	10
Score Right Bank 10. Riparian Vegetative Zone Width (score each banks riparian zone)	10 9 Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear- cuts, lawns, or crops) have not impacted zone.	8 7 6 Width of riparian zone 12- 18 meters; human activities have impacted zone only minimally.	5 4 3 Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	2 1 0 Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.	10
Score Left Bank	10 9	8 7 6	5 4 3	2 1 0	10
Score Right Bank	10 9	876	543	2 1 0	10
		Total Score			187
Notes:					

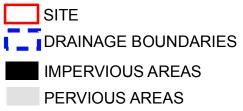
	WSSI BENTHIC	MACROINVERTEBRA	TE BENCH SHE	ET	
Job Name/#	Glade - 20030	Sample subsorted by:	ABR/BNR	Watland	
Station ID:	Reach 1-C	Date Subsorted:	4/7/15	Studies and Solutions,	mc.
Stream Name:	The Glade	# of Grids subsorted	4		
Date Sampled:	3/30/15	Total # of subsorted insects	s: 114	Total # identified:	114
Sampling Method:	Multihabitat	Sample Identified by:	ABR	Date Identified:	4/7/15

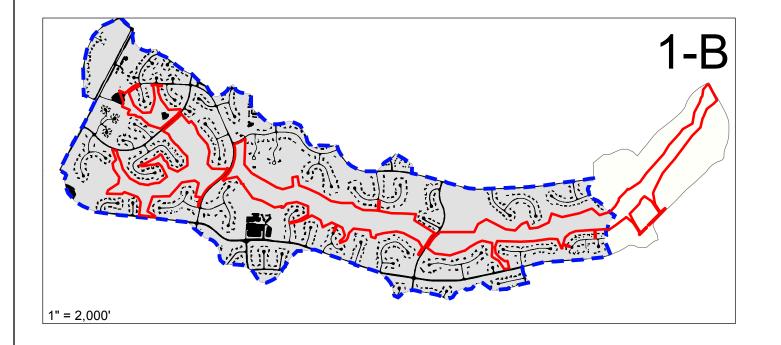
Taxa Collected:

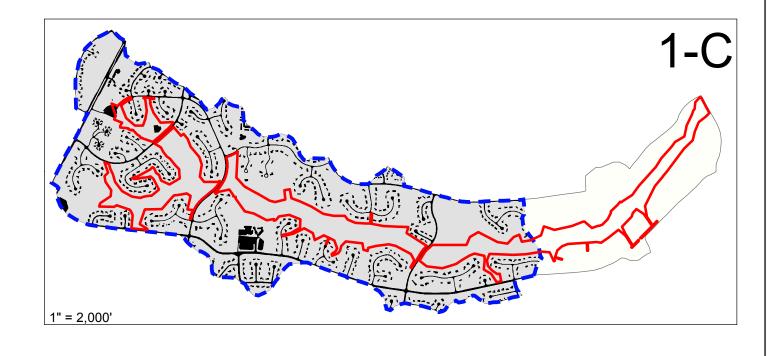
			3	Metretopodidae		1	Lepidostomatidae	
Porifera	Spongillidae			Neoephemeridae			Leptoceridae	
Ostracoda	Unknown			Oligoneuridae			Limnephilidae	
latworms	Tricladida			Psuedironidae			Molannidae	
	Planariidae			Polymitarcyidae			Odontoceridae	
Gastropoda	Unknown			Potamanthidae			Philopotamidae	6
impets	Ancylidae			Siphlonuridae			Phryganeidae	
Snails	Immature			Tricorythidae			Polycentropodidae	
	Lymnaeidae		Zygoptera	Early Instar and/or damaged		1	Psychomyiidae	
	Physidae			Calopterygidae		1	Ryacophilidae	
	Planorbidae	1		Coenagrionidae	4	1	Sericostomatidae	
	Hydrobiidae			Lestidae		1	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		oolooptola	Chrysomelidae	
	Sphaeriidae		-	Corduliidae			Curculionidae	
	Unionidae			Gomphidae			Dryopidae	
Olizaahaata		0	-					
Dligochaeta ₋umbriculida	Unknown	9	-	Libellulidae		4	Dytiscidae	40
Lumbriculida	Lumphriquido e		-	Macromiidae			Elmidae	10
T	Lumbriculidae			Petaluridae		ł	Gyrinidae	
Tubificida	-	-		Cordullidae/Libelluidae			Haliplidae	<u> </u>
	Enchytraeidae		Plecoptera	Early Instar and/or damaged			Helodidae	
	Naididae			Capniidae			Helophoridae	
	Tubificidae			Chloroperlidae			Hydraenidae	I
laplotaxida				Leuctridae			Hydrochidae	
	Haplotaxidae			Nemouridae			Hydrophilidae	
_eeches	Hirudinea			Peltoperlidae			Limnichidae	
	Erpobdellidae			Perlidae			Noteridae	
	Glossiphoniidae			Perlodidae		1	Psephenidae	
	Hirudinidae			Pteronarcyidae		1	Ptilodactylidae	
	Pisciolidae			Taeniopeterygidae		1	Scirtidae	
Branchiobdellida	Branchiobdellidae		Hemiptera	Early Instar and/or damaged		Diptera	Early Instar and/or damaged	
Copepoda	Unknown	1		Belostomatidae			Athericidae	
Decapoda	Cambaridae			Corixidae			Blephariceridae	
boodpoud	Portunidae		-	Gelastocoridae			Canaceidae	
Shrimp			-	Gerridae			Ceratopogonidae	
Jump	Palaemonidae		-	Hebridae			Choaboridae	
aanada	raiaemoniuae	1	-				Chironomidae	63
sopoda		1	-	Hydrometridae				63
	Asellidae			Mesoveliidae			Culicidae	
Amphipoda	-		-	Naucoridae			Dixidae	
	Crangonyctidae		-	Nepidae			Dolichopodidae	
	Gammaridae			Notonectidae			Empididae	I
	Talitridae			Veliidae			Ephydridae	
Water Mites				Pleidae			Muscidae	
	Hydracarina	1	Neuroptera				Nymphomyiidae	
Ephemeroptera	Early Instar and/or damaged			Sisyridae			Pelecorhynchidae	
	Acanthometropodidae		Megaloptera			1	Psychodidae	
	Ameletidae			Corydalidae		1	Ptychopteridae	
	Baetidae			Sialidae		1	Sciomyzidae	
	Baetiscidae		Trichoptera	Early Instar and/or damaged		1	Simuliidae	
	Behningiidae			Branchycentridae		1	Stratiomyidae	
	Caenidae		1	Calamoceratidae		1	Syrphidae	
	Ephemerellidae		-	Glossosomatidae			Tabanidae	
			-			1		
	Ephemeridae	0	-	Goeridae			Tanyderidae	
	Heptageniidae	2		Heliicopsychidae		1	Thaumaleidae	
	Isonychiidae			Hydropsychidae	7	l	Tipulidae	6
	Leptophlebiidae			Hydroptilidae	3			85



# Land Cover Map The Glade Reaches 5 and 6 WSSI #20030 Scale as Noted









Stream	Impervious	Total	
ID	Percent	Acres	
1-A	15%	780	
1-B	15%	668	
1-C	15%	618	