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:

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

---

1 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.

2 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.3

**Project Area**

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. Exhibit 1 is a vicinity map that depicts the approximate location of the study area.

The study area is covered mostly by mixed-deciduous forest. 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 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 NVSRB4. 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.)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

---

3 Note that monitoring reports for the Snakeden Branch and Colvin Run watershed portions of the NVSRB are provided under separate cover.
4 Assessment reaches were established for every 2,000 linear feet of samplable streams, which includes perennial and intermittent streams containing enough flowing water to sample in the spring.
5 Note that the BioRecon was used to aid in the selection of permanent monitoring reaches during the first year of pre-construction monitoring and is not required in subsequent monitoring years. The results of the BioRecon are described in “Biological Monitoring Report #1, Pre-construction Monitoring, Northern Virginia Stream Restoration Bank, The Glade Watershed”, dated December 8, 2008.
6 This method is to be used in all monitoring years and is accompanied by a habitat assessment; following guidance established Virginia Department of Environmental Quality’s (DEQ) standard operating procedures for stream habitat assessment.
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**

**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 SOPs for stream habitat assessment (DEQ 2008)\(^7\) and the U.S. Environmental Protection Agency’s Rapid Bioassessment 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 three 300 linear foot reaches that were selected in Biological Monitoring Report #1 (Reach 1-A through 1-C).\(^9\) The locations of these three sampling reaches relative to Design Reaches 5 and 6 are depicted in the Biological Stream Monitoring Map (Exhibit 3). 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 (Exhibit 4 for each reach).

---

\(^7\) 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 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 Exhibit 4 for each reach.

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

Benthic macroinvertebrate data were analyzed by calculating the Stream Condition Index for Virginia Non-coastal Streams (VA-SCI), following guidance established in “A Stream 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
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 Chironomidae can range from 0-100 for the VA-SCI.

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

- Hilsenhoff Biotic Index (HBI). The Hilsenhoff Biotic Index is the abundance-weighted average tolerance of assemblage of organisms (Family taxonomic level). The HBI is expected to increase in response to environmental disturbance. The HBI can range from 0-10 for the VA-SCI.

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

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

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

**Biological Stream Monitoring Results and Discussion.** Habitat results for 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.
Benthic macroinvertebrate results show that individuals from 17 taxa were collected from all three reaches collectively (Table 2, Exhibit 4) 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.

Table 1. 2015 Total Habitat Assessment Scores

<table>
<thead>
<tr>
<th>BIOMONITORING REACH</th>
<th>Total Habitat</th>
<th>Narrative Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-A (10% Restored)</td>
<td>172</td>
<td>Optimal</td>
</tr>
<tr>
<td>1-B (50% Restored)</td>
<td>182</td>
<td>Optimal</td>
</tr>
<tr>
<td>1-C (100% Restored)</td>
<td>187</td>
<td>Optimal</td>
</tr>
<tr>
<td>Average</td>
<td>180</td>
<td>Optimal</td>
</tr>
</tbody>
</table>

*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."
The above data collected for each reach were used to calculate the biotic metrics as shown in Table 3. The VA-SCI requires that these metrics be weighted to determine the VA-SCI, as shown in Table 4. The results of our data analysis indicate that the benthic macroinvertebrate 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 2. The Glade 2015 Raw Data

<table>
<thead>
<tr>
<th>TAXA</th>
<th>REACH</th>
<th>1-A (10% Restored)</th>
<th>1-B (50% Restored)</th>
<th>1-C (100% Restored)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphipoda</td>
<td></td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Ceratopgonidae</td>
<td></td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Chironomidae</td>
<td></td>
<td>54</td>
<td>65</td>
<td>63</td>
<td>182</td>
</tr>
<tr>
<td>Coenagrionidae</td>
<td></td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Copepoda</td>
<td></td>
<td>-</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Elmidae</td>
<td></td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Empididae</td>
<td></td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Heptageniidae</td>
<td></td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Hydracarina</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hydropsychidae</td>
<td></td>
<td>17</td>
<td>7</td>
<td>7</td>
<td>31</td>
</tr>
<tr>
<td>Hydroptilidae</td>
<td></td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Isopoda</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Oligochaeta</td>
<td></td>
<td>3</td>
<td>12</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Planorbidae</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Philopotamidae</td>
<td></td>
<td>18</td>
<td>-</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Sphaenidae</td>
<td></td>
<td>1</td>
<td>4</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Tipulidae</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>108</strong></td>
<td><strong>104</strong></td>
<td><strong>114</strong></td>
<td><strong>326</strong></td>
</tr>
</tbody>
</table>

Table 3. The Glade 2015 Biotic Metric Scores

<table>
<thead>
<tr>
<th>Reach</th>
<th>Total Taxa</th>
<th>Total EPT Taxa</th>
<th>Percent Ephemeroptera</th>
<th>Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)</th>
<th>Percent Scrapers</th>
<th>Percent Chironomidae</th>
<th>Percent Top Two Dominant</th>
<th>HBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-A (10% Restored)</td>
<td>11</td>
<td>3</td>
<td>1.85</td>
<td>16.67</td>
<td>6.48</td>
<td>50.00</td>
<td>67</td>
<td>4.93</td>
</tr>
<tr>
<td>1-B (50% Restored)</td>
<td>10</td>
<td>1</td>
<td>0.00</td>
<td>0.00</td>
<td>4.81</td>
<td>62.50</td>
<td>74</td>
<td>4.88</td>
</tr>
<tr>
<td>1-C (100% Restored)</td>
<td>13</td>
<td>1</td>
<td>1.75</td>
<td>7.89</td>
<td>14.04</td>
<td>55.26</td>
<td>64</td>
<td>4.89</td>
</tr>
</tbody>
</table>
Table 4. 2015 Biotic Metric and Index Weighting and VA-SCI at The Glade.

<table>
<thead>
<tr>
<th>WEIGHTED METRIC</th>
<th>BIOLOGICAL MONITORING REACH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-A (10% Restored)</td>
</tr>
<tr>
<td>Total Taxa</td>
<td>50.00</td>
</tr>
<tr>
<td>EPT Taxa</td>
<td>27.27</td>
</tr>
<tr>
<td>Percent Ephemeroptera</td>
<td>3.02</td>
</tr>
<tr>
<td>Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)</td>
<td>46.82</td>
</tr>
<tr>
<td>Percent Scrapers</td>
<td>12.56</td>
</tr>
<tr>
<td>Percent Chironomidae</td>
<td>50.00</td>
</tr>
<tr>
<td>Percent Top Two Dominant</td>
<td>48.17</td>
</tr>
<tr>
<td>HBI</td>
<td>74.62</td>
</tr>
<tr>
<td>VA-SCI Numerical Score</td>
<td>39.06</td>
</tr>
<tr>
<td>VA-SCI Narrative Score</td>
<td>Severe Stress</td>
</tr>
<tr>
<td>Average VA-SCI Numerical Score</td>
<td>35.26</td>
</tr>
<tr>
<td>Average VA-SCI Narrative Score</td>
<td>Severe Stress</td>
</tr>
</tbody>
</table>

Figure 2. Comparison of Virginia Stream Condition Index Scores from 2007-2015 at The Glade Watershed
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

<table>
<thead>
<tr>
<th>REACH</th>
<th>Watershed Acres</th>
<th>Percent Impervious</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-A (10% Restored)</td>
<td>780</td>
<td>15</td>
</tr>
<tr>
<td>1-B (50% Restored)</td>
<td>668</td>
<td>15</td>
</tr>
<tr>
<td>1-C (100% Restored)</td>
<td>618</td>
<td>15</td>
</tr>
</tbody>
</table>

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” (Figure 2). 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 Snaeken 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).
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.

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


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

Exhibit 1
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

Wetland Studies and Solutions, Inc.
a DAVEY company
Biomonitoring
Reach 1-A
(10% Restored)

Sopston Drive

Design Reach 5

Lake Audubon

Beaver Save Area

Design Reach 6

Biomonitoring Reach 1-B
(50% Restored)

Biomonitoring Reach 1-C
(100% Restored)

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

Scale 1" = 500'

Biomonitoring Reaches
Restored Streams
Stream Restoration Easements

Aerial Source: March 2013 Virginia Base Mapping Program (VBMP)

Wetland Studies and Solutions, Inc.
Exhibit 3

Northern Virginia Stream Restoration Bank
Glade Reaches 5 and 6
Reston, Virginia
THE GLADE –REACHES 5 AND 6
EXHIBIT 4
INDIVIDUAL BIOLOGICAL MONITORING REACH DATA

• REACH 1-A
  o Biological Stream Assessment Photographs
  o Benthic Macroinvertebrate and Field Data Sheet
  o Benthic Macroinvertebrate Bench Sheet

• REACH 1-B
  o Biological Stream Assessment Photographs
  o Benthic Macroinvertebrate and Field Data Sheet
  o Benthic Macroinvertebrate Bench Sheet

• REACH 1-C
  o Biological Stream Assessment Photographs
  o Benthic Macroinvertebrate and Field Data Sheet
  o Benthic Macroinvertebrate Bench Sheet
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.
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.
5. Looking south (upstream) at Reach 1-A of The Glade in the eastern portion of the study area. Photo taken March, 2015.
### Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

**Job # Task:** 20030, Task 15b

**Station ID:** Reach 1-A  
**Ecoregion:** Piedmont  
**Land Use:** Urban

**Field Team:** ABP / HC  
**Location:** Reston, VA  
**Start time:**

**Date:** 3/30/2015  
**Longitude:** 77°19'29"  
**Finish time:**

**Survey Reason:** Year 5 Biomonitoring

#### Stream Physiochemical Measurements

<table>
<thead>
<tr>
<th>Instrument ID number:</th>
<th>N/A</th>
<th>pH:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature:</td>
<td>N/A °C</td>
<td>Conductivity:</td>
<td>N/A uS/cm</td>
</tr>
<tr>
<td>Dissolved Oxygen:</td>
<td>N/A mg/L</td>
<td>Did instrument pass all post-calibration checks?</td>
<td>N/A</td>
</tr>
</tbody>
</table>

#### Benthic Macroinvertebrate Collection

<table>
<thead>
<tr>
<th>Method Used:</th>
<th>Single Habitat (Riffle)</th>
<th>Multi Habitat (Logs, Plants, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riffle Quality:</td>
<td>Good</td>
<td>X</td>
</tr>
<tr>
<td>Woody Debris</td>
<td>Poor</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitats Sampled:</th>
<th>Riffle</th>
<th>Woody Debris</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>#: Jabs</td>
<td>16</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Weather Observations

<table>
<thead>
<tr>
<th>Current Weather</th>
<th>Cloudy</th>
<th>Clear</th>
<th>Rain/Snow</th>
<th>Foggy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent Precipitation</td>
<td>Clear</td>
<td>X</td>
<td>Rain</td>
<td>Storms</td>
</tr>
<tr>
<td>Stream Flow</td>
<td>Low</td>
<td>Normal</td>
<td>X</td>
<td>Above Normal</td>
</tr>
</tbody>
</table>

#### Biological Observations

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

### High Gradient Habitat Data Sheet

#### Habitat Parameter

<table>
<thead>
<tr>
<th>Habitat Parameter</th>
<th>Condition Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Epifaunal Substrate/ Available Cover</strong></td>
<td>Optimal</td>
</tr>
<tr>
<td>Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat and at stage to allow full colonization potential (i.e. snags/logs that are not new fall and not transient).</td>
<td>40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization.</td>
</tr>
</tbody>
</table>

| Score | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 17 |

---

#### 2. Embeddedness

Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.  
Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.  
Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.  
Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

| Score | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 17 |

---

#### Velocity/Depth Regime

All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast shallow)(slow is <0.3m/s, deep is >0.5 m).  
Only 3 of the 4 regimes present (if fast-shallow is missing, score lower if missing other regimes).  
Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).  
Dominated by 1 velocity/depth regime (usually slow-deep).

| Score | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 15 |

---

#### 4. Sediment Deposition

Little or no enlargement of islands or point bars and <5% of the bottom affected by sediment deposition.  
Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected; slight deposition in pools.  
Moderate deposition of new gravel, sand, or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.

| Score | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 15 |
### Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

<table>
<thead>
<tr>
<th>Habitat Parameter</th>
<th>Condition Category</th>
<th>Optimal</th>
<th>Suboptimal</th>
<th>Marginal</th>
<th>Poor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Channel Flow Status</td>
<td>Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.</td>
<td>20</td>
<td>19</td>
<td>18</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>6. Channel Alteration</td>
<td>Channelization or dredging absent or minimal; stream width normal pattern.</td>
<td>20</td>
<td>19</td>
<td>18</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>7. Frequency of Riffles</td>
<td>Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream &lt; 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.</td>
<td>20</td>
<td>19</td>
<td>18</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>8. Bank Stability (score each bank)</td>
<td>Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. &lt;5% of bank affected.</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>9. Vegetation Protection (score each bank)</td>
<td>More than 90% of the streambank surfaces covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetation disruption through grazing or moving minimal or not evident; almost all plants allowed to grow naturally.</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>10. Riparian Vegetative Zone Width (score each banks riparian zone)</td>
<td>Width of riparian zone &gt;18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

**Score Left Bank**

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

**Score Right Bank**

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

**Total Score**

The total score is 172.

**Notes:**
<table>
<thead>
<tr>
<th>Taxa Collected:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Porifera</strong></td>
<td>Metretopodidae</td>
</tr>
<tr>
<td>Spongilliidae</td>
<td>Neopneumoperidae</td>
</tr>
<tr>
<td><strong>Ostracoda</strong></td>
<td>Oligoneuridae</td>
</tr>
<tr>
<td><strong>Flatworms</strong></td>
<td>Psuedonirotidae</td>
</tr>
<tr>
<td>Ancylostomidae</td>
<td>Polymyricyidae</td>
</tr>
<tr>
<td><strong>Gastropoda</strong></td>
<td>Potamandridae</td>
</tr>
<tr>
<td><strong>Limpets</strong></td>
<td>Planorbididae</td>
</tr>
<tr>
<td><strong>Snails</strong></td>
<td>Planorbidae</td>
</tr>
<tr>
<td><strong>Bivalvia</strong></td>
<td>Planicidae</td>
</tr>
<tr>
<td>Immature</td>
<td>Protonuridae</td>
</tr>
<tr>
<td>Lymnaeidae</td>
<td>Psychomyiidae</td>
</tr>
<tr>
<td><strong>Flatworms</strong></td>
<td><strong>Planariidae</strong></td>
</tr>
<tr>
<td>Tricladida</td>
<td>Zygoptera</td>
</tr>
<tr>
<td><strong>Bivalvia</strong></td>
<td><strong>Acanthometropodidae</strong></td>
</tr>
<tr>
<td>Sphaeridae</td>
<td><strong>Nymphomyiidae</strong></td>
</tr>
<tr>
<td><strong>Oligochaeta</strong></td>
<td><strong>Lumbriculida</strong></td>
</tr>
<tr>
<td>Immature</td>
<td>Macromiidae</td>
</tr>
<tr>
<td>Lumbriculida</td>
<td>Lumbriculida</td>
</tr>
<tr>
<td><strong>Tubificida</strong></td>
<td><strong>Enchytraeidae</strong></td>
</tr>
<tr>
<td>Immature</td>
<td>Lepidoptera</td>
</tr>
<tr>
<td>Tubificida</td>
<td>Plecoptera</td>
</tr>
<tr>
<td>Naididae</td>
<td>Leuctridae</td>
</tr>
<tr>
<td><strong>Haplotaxida</strong></td>
<td>Lepidoptera</td>
</tr>
<tr>
<td>Hirudinea</td>
<td>Nemouridae</td>
</tr>
<tr>
<td>Hirudinidae</td>
<td>Perlidae</td>
</tr>
<tr>
<td>Erpobdellida</td>
<td>Perlidae</td>
</tr>
<tr>
<td>Glossiphoniida</td>
<td>Perlidae</td>
</tr>
<tr>
<td>Hirudinidae</td>
<td>Planorcaridae</td>
</tr>
<tr>
<td>Piscididae</td>
<td>Taeniopterygidae</td>
</tr>
<tr>
<td>Branchiobdellida</td>
<td>Branchiobdellida</td>
</tr>
<tr>
<td>Coepeoda</td>
<td>Belostomatidae</td>
</tr>
<tr>
<td>Decapoda</td>
<td>Belostomatidae</td>
</tr>
<tr>
<td>Shrimp</td>
<td>Gelasstoceridae</td>
</tr>
<tr>
<td>Palaemonidae</td>
<td>Gomphidae</td>
</tr>
<tr>
<td>Isopoda</td>
<td>Pachypodidae</td>
</tr>
<tr>
<td>Asellidae</td>
<td>Chironomidae</td>
</tr>
<tr>
<td>Amphipoda</td>
<td>3</td>
</tr>
<tr>
<td>Crangonycticida</td>
<td>Naucoridae</td>
</tr>
<tr>
<td>Gammaridae</td>
<td>Hymenopoetaidae</td>
</tr>
<tr>
<td>Tailridae</td>
<td>Velidae</td>
</tr>
<tr>
<td>Water Mites</td>
<td>Pleidae</td>
</tr>
<tr>
<td>Hydracarina</td>
<td>Pleidae</td>
</tr>
<tr>
<td><strong>Ephemeroptera</strong></td>
<td>Early Instar and/or damaged</td>
</tr>
<tr>
<td><strong>Trichoptera</strong></td>
<td>Early Instar and/or damaged</td>
</tr>
<tr>
<td>Caenidae</td>
<td>Branchycentridae</td>
</tr>
<tr>
<td>Ephemerellida</td>
<td>Branchycentridae</td>
</tr>
<tr>
<td>Ephemeridae</td>
<td>Branchycentridae</td>
</tr>
<tr>
<td>Heptagenidae</td>
<td>2</td>
</tr>
<tr>
<td>Leptophlebiidae</td>
<td>17</td>
</tr>
<tr>
<td>TOTAL: 9</td>
<td>TOTAL: 19</td>
</tr>
</tbody>
</table>
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.
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.
5. Looking west (upstream) at Reach 1-B of The Glade in the eastern portion of the study area. Photo taken March, 2015.
### Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

**Job # Task:** 20030, Task 13b  
**Station ID:** Reach 1-B  
**Field Team:** ABR / HC  
**Site:** The Glade  
**Date:** 3/30/2015  
**Date:** 77°19'54"  
**Ecoregion:** Piedmont  
**Location:** Reston, VA  
**Latitude:** 38°55'25"  
**Longitude:** 77°19'54"  
**Land Use:** Urban  
**Start time:**  
**Finish time:**  

### Stream Physiochemical Measurements

<table>
<thead>
<tr>
<th>Instrument ID number:</th>
<th>N/A</th>
<th>pH:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature:</td>
<td>N/A</td>
<td>°C</td>
<td>N/A</td>
</tr>
<tr>
<td>Conductivity:</td>
<td>N/A</td>
<td>µS/cm</td>
<td>N/A</td>
</tr>
<tr>
<td>Dissolved Oxygen:</td>
<td>N/A</td>
<td>mg/L</td>
<td>N/A</td>
</tr>
<tr>
<td>Did instrument pass all post-calibration checks?</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Benthic Macroinvertebrate Collection

<table>
<thead>
<tr>
<th>Method Used:</th>
<th>Single Habitat (Riffle)</th>
<th>Multi Habitat (Logs, Plants, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riffle Quality:</td>
<td>Good</td>
<td>Marginal</td>
</tr>
<tr>
<td>Woody</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Debris</td>
<td>Riffle</td>
<td>X</td>
</tr>
<tr>
<td># Jabs:</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

### Weather Observations

<table>
<thead>
<tr>
<th>Current Weather</th>
<th>Cloudy</th>
<th>Clear</th>
<th>Rain/Snow</th>
<th>Foggy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent Precipitation</td>
<td>Clear</td>
<td>X</td>
<td>Rain</td>
<td>Storms</td>
</tr>
<tr>
<td>Stream Flow</td>
<td>Low</td>
<td>Normal</td>
<td>Above Normal</td>
<td>Flood</td>
</tr>
</tbody>
</table>

### Biological Observations

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

### High Gradient Habitat Data Sheet

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

<table>
<thead>
<tr>
<th>Habitat Parameter</th>
<th>Condition Category</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5. Channel Flow Status</strong></td>
<td>Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>20 19 18 17 16</td>
<td>19</td>
</tr>
<tr>
<td><strong>6. Channel Alteration</strong></td>
<td>Channelization or dredging absent or minimal; stream width normal pattern.</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>20 19 18 17 16</td>
<td>19</td>
</tr>
<tr>
<td><strong>7. Frequency of Riffles</strong></td>
<td>Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream &lt;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.</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>20 19 18 17 16</td>
<td>18</td>
</tr>
<tr>
<td><strong>8. Bank Stability (score each bank)</strong></td>
<td>Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. &lt;5% of bank affected.</td>
<td></td>
</tr>
<tr>
<td>Note: Determine left or right side by facing downstream.</td>
<td>Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.</td>
<td></td>
</tr>
<tr>
<td>Score Left Bank</td>
<td>10 9 8 7 6</td>
<td>9</td>
</tr>
<tr>
<td>Score Right Bank</td>
<td>10 9 8 7 6</td>
<td>9</td>
</tr>
<tr>
<td><strong>9. Vegetation Protection (score each bank)</strong></td>
<td>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 moving minimal or not evident; almost all plants allowed to grow naturally.</td>
<td></td>
</tr>
<tr>
<td>Score Left Bank</td>
<td>10 9 8 7 6</td>
<td>10</td>
</tr>
<tr>
<td>Score Right Bank</td>
<td>10 9 8 7 6</td>
<td>10</td>
</tr>
<tr>
<td><strong>10. Riparian Vegetative Zone Width (score each banks riparian zone)</strong></td>
<td>Width of riparian zone &gt;18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.</td>
<td></td>
</tr>
<tr>
<td>Score Left Bank</td>
<td>10 9 8 7 6</td>
<td>9</td>
</tr>
<tr>
<td>Score Right Bank</td>
<td>10 9 8 7 6</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td>182</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- 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.
- Channelization 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.

- Width of riparian zone >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 <8 meters; little or no riparian vegetation due to human activities.
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.
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.
5. Looking east (downstream) at Reach 1-C of The Glade in the eastern portion of the study area. Photo taken March, 2015.
## Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

### Stream Physiochemical Measurements

<table>
<thead>
<tr>
<th>Instrument ID number:</th>
<th>N/A</th>
<th>pH:</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature:</td>
<td>N/A</td>
<td>°C</td>
<td>Conductivity:</td>
</tr>
<tr>
<td>Dissolved Oxygen:</td>
<td>N/A</td>
<td>mg/L</td>
<td>Did instrument pass all post-calibration checks?</td>
</tr>
</tbody>
</table>

### Benthic Macroinvertebrate Collection

<table>
<thead>
<tr>
<th>Method Used:</th>
<th>Single Habitat (Riffle)</th>
<th>Multi Habitat (Logs, Plants, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rifflle Quality:</th>
<th>Good</th>
<th>Marginal</th>
<th>Poor</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woody</td>
<td>Debris</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitats Sampled:</th>
<th>Riffle</th>
<th>X</th>
<th>Marginal</th>
<th>Poor</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Jobs:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Weather Observations

<table>
<thead>
<tr>
<th>Current Weather</th>
<th>Cloudy</th>
<th>Clear</th>
<th>Rain/Snow</th>
<th>Foggy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent Precipitation</td>
<td>Clear</td>
<td>X</td>
<td>Rain</td>
<td>Storms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stream Flow</th>
<th>Low</th>
<th>Normal</th>
<th>X</th>
<th>Above Normal</th>
<th>Flood</th>
</tr>
</thead>
</table>

### Biological Observations

<table>
<thead>
<tr>
<th>Periphyton</th>
<th>3</th>
<th>Salamanders</th>
<th>0</th>
<th>Other...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filamentous Algae</td>
<td>2</td>
<td>Warmwater Fish</td>
<td>1</td>
<td>0= Not observed</td>
</tr>
<tr>
<td>Submerged Macrophytes</td>
<td>0</td>
<td>Coldwater Fish</td>
<td>0</td>
<td>1= Sparse</td>
</tr>
<tr>
<td>Emergent Macrophytes</td>
<td>0</td>
<td>Beavers</td>
<td>0</td>
<td>2= Common to Abundant</td>
</tr>
<tr>
<td>Crayfish</td>
<td>0</td>
<td>Muskrats</td>
<td>0</td>
<td>3= Dominant-</td>
</tr>
<tr>
<td>Corbicula</td>
<td>0</td>
<td>Ducks/Geese</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Unionidae</td>
<td>0</td>
<td>Snakes</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Operculate Snails</td>
<td>0</td>
<td>Turtles</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Non-operculate Snails</td>
<td>0</td>
<td>Frogs/Tadpoles</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

### High Gradient Habitat Data Sheet

#### Habitat Parameter

<table>
<thead>
<tr>
<th>Habitat Parameter</th>
<th>Condition Category</th>
<th>Optimal</th>
<th>Suboptimal</th>
<th>Marginal</th>
<th>Poor</th>
<th>Score</th>
</tr>
</thead>
</table>

1. **Epifaunal Substrate/ Available Cover**

- Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat and at stage to allow full colonization potential (i.e. snags/logs that are not new fall and not transitory).
- 40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization.
- 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.
- Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

| Score | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|       | 18 |

2. **Embeddedness**

- Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.
- Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.
- Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.
- Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

<table>
<thead>
<tr>
<th>Score</th>
<th>20</th>
<th>19</th>
<th>18</th>
<th>17</th>
<th>16</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. **Velocity/Depth Regime**

- All four velocity/depth regimes present (slow-deep, slow-shallow; fast-deep, fast-shallow) (slow is <0.3 m/s, deep is >0.5 m).
- Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).
- Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).
- Dominated by 1 velocity/depth regime (usually slow-deep).

<table>
<thead>
<tr>
<th>Score</th>
<th>20</th>
<th>19</th>
<th>18</th>
<th>17</th>
<th>16</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. **Sediment Deposition**

- Little or no enlargement of islands or point bars and <5% of the bottom affected by sediment deposition.
- Some new increase in bar formation, mostly from gravel, sand, or fine sediment.
- Moderate deposition of new gravel, sand, or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.

<table>
<thead>
<tr>
<th>Score</th>
<th>20</th>
<th>19</th>
<th>18</th>
<th>17</th>
<th>16</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Benthic Macroinvertebrate and Habitat Field Data Sheet - High Gradient

<table>
<thead>
<tr>
<th>Habitat Parameter</th>
<th>Condition Category</th>
<th>Score</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Channel Flow Status</td>
<td>Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.</td>
<td>20 19 18 17 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water fills &gt;75% of the available channel; or &lt;25% of channel substrate is exposed.</td>
<td>15 14 13 12 11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.</td>
<td>10 9 8 7 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very little water in channel and mostly present as standing pools.</td>
<td>4 3 2 1 0</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td></td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>6. Channel Alteration</td>
<td>Channelization or dredging absent or minimal; stream width normal pattern.</td>
<td>20 19 18 17 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>15 14 13 12 11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.</td>
<td>10 9 8 7 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.</td>
<td>5 4 3 2 1 0</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td></td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>7. Frequency of Riffles</td>
<td>Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream &lt;7:1; variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.</td>
<td>20 19 18 17 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.</td>
<td>15 14 13 12 11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occasional riffle or bend; bottom contours provide some habitat; distances between riffles divided by the width of the stream is between 15 to 25.</td>
<td>10 9 8 7 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of &gt;25.</td>
<td>5 4 3 2 1 0</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td></td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>8. Bank Stability (score each bank) Note: Determine left or right side by facing downstream.</td>
<td>Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. &lt;5% of bank affected.</td>
<td>20 19 18 17 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.</td>
<td>15 14 13 12 11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderately unstable; 30-60% of bank reach has areas of erosion; high erosion potential during floods.</td>
<td>10 9 8 7 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of &gt;25.</td>
<td>5 4 3 2 1 0</td>
<td></td>
</tr>
<tr>
<td>Score Left Bank</td>
<td>10 9</td>
<td>8 7 6</td>
<td>5 4 3</td>
</tr>
<tr>
<td>Score Right Bank</td>
<td>10 9</td>
<td>8 7 6</td>
<td>5 4 3</td>
</tr>
<tr>
<td>9. Vegetation Protection (score each bank)</td>
<td>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 moving minimal or not evident; almost all plants allowed to grow naturally.</td>
<td>20 19 18 17 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>15 14 13 12 11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>10 9 8 7 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>5 4 3 2 1 0</td>
<td></td>
</tr>
<tr>
<td>Score Left Bank</td>
<td>10 9</td>
<td>8 7 6</td>
<td>5 4 3</td>
</tr>
<tr>
<td>Score Right Bank</td>
<td>10 9</td>
<td>8 7 6</td>
<td>5 4 3</td>
</tr>
<tr>
<td>10. Riparian Vegetative Zone Width (score each banks riparian zone)</td>
<td>Width of riparian zone &gt;18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.</td>
<td>20 19 18 17 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.</td>
<td>15 14 13 12 11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.</td>
<td>10 9 8 7 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width of riparian zone &lt;8 meters; little or no riparian vegetation due to human activities.</td>
<td>5 4 3 2 1 0</td>
<td></td>
</tr>
<tr>
<td>Score Left Bank</td>
<td>10 9</td>
<td>8 7 6</td>
<td>5 4 3</td>
</tr>
<tr>
<td>Score Right Bank</td>
<td>10 9</td>
<td>8 7 6</td>
<td>5 4 3</td>
</tr>
</tbody>
</table>

**Total Score**: 187

Notes:
### Taxa Collected:

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Class</th>
<th>Order</th>
<th>Suborder</th>
<th>Family</th>
<th>Subfamily</th>
<th>Genus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porifera</td>
<td></td>
<td></td>
<td></td>
<td>Metretopodida</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Neochephepodidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ostracoda</td>
<td></td>
<td></td>
<td></td>
<td>Oligoneuridae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flatworms</td>
<td></td>
<td></td>
<td></td>
<td>Polysethila</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastropoda</td>
<td></td>
<td></td>
<td></td>
<td>Ostracoda</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limpets</td>
<td></td>
<td></td>
<td></td>
<td>Oligoneuridae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limnephilida</td>
<td></td>
<td></td>
<td></td>
<td>Planorbidida</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Planorbida</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Planorbida</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Lepidoptera</td>
<td></td>
<td></td>
<td></td>
<td>Lepidoptera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bivalvia</td>
<td></td>
<td></td>
<td></td>
<td>Bivalvia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oligochaeta</td>
<td></td>
<td></td>
<td></td>
<td>Oligochaeta</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumbriculida</td>
<td></td>
<td></td>
<td></td>
<td>Lumbriculida</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Tubificida</td>
<td></td>
<td></td>
<td></td>
<td>Tubificida</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tubificida</td>
<td></td>
<td></td>
<td></td>
<td>Tubificida</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haplotaxida</td>
<td></td>
<td></td>
<td></td>
<td>Haplotaxida</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leeches</td>
<td></td>
<td></td>
<td></td>
<td>Leeches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hirudinea</td>
<td></td>
<td></td>
<td></td>
<td>Hirudinea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erpobdellida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glossiphoniida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hinudiniida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pisciolida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brachiobdellida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copepoda</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decapoda</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shrimp</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopoda</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amphipoda</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Mites</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ephemeroptera</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acanthometropodida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ameletida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baelida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baetida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behningniida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caeleniida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ephemerellida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ephemerida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heptagenida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isonychiida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leptophlebida</td>
<td></td>
<td></td>
<td></td>
<td>Early Instar and/or damaged</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL:** 15

**TOTAL:** 14

**TOTAL:** 85
**Land Cover Map**

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

<table>
<thead>
<tr>
<th>Stream ID</th>
<th>Impervious</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-A</td>
<td>15%</td>
<td>780</td>
</tr>
<tr>
<td>1-B</td>
<td>15%</td>
<td>668</td>
</tr>
<tr>
<td>1-C</td>
<td>15%</td>
<td>618</td>
</tr>
</tbody>
</table>

1" = 2,000'