Turkey Branch Subwatershed

3.23 Turkey Branch Stream Restoration and Stormwater Ponds

3.23.1 Introduction

Turkey Branch is part of the Lower Rock Creek watershed. Much of the watershed was developed without any stormwater management controls in place to manage runoff from this highly urbanized area of the County (***Figure 3.23.3***). Turkey Branch was rated as a high priority watershed to be restored based on the Rock Creek Watershed Feasibility Study (2001). The stream was so degraded that the U.S. Geological Survey (USGS) had difficulty locating a suitable site for a stream flow gage, one of the few times this has happened in locating stream flow gages in urban streams.

The Turkey Branch restoration project was completed in late 2007. Restoration associated with this project included the construction of two stormwater wetland pond complexes and retrofit of an existing dry stormwater pond to assist in controlling stormwater and associated erosional flows from within the watershed. In addition, stream restoration was also completed along the Turkey Branch mainstem to improve aquatic habitat and biological communities. ***Figures 3.23.1*** and ***3.23.2*** display examples of the restoration associated with the project.

Figure 3.23.1 – Stream Restoration at Lower Turkey Branch (site LRTB203A)

Figure 3.23.2 – Stormwater Management Site Matthew Henson I (dominant emergent species pictured include common three square, broadleaf cattail, and American water lotus)

Subwatershed facts

Subwatershed Drainage Area: 2,412 acres
Subwatershed Imperviousness: 32 percent

Project Facts

Project Area: Land use within the Turkey Branch subwatershed consists of residential and commercial properties with minimal, older stormwater designs to treat pollutant-enriched runoff during storms. In 1999, the Montgomery County Department of Environmental Protection (DEP) built a new stormwater pond to help treat approximately 44 acres of impervious surfaces (driveways, roads, rooftops, etc.) behind the Home Depot off of Georgia Avenue (MD 97). In 2007, to continue to improve the aquatic conditions and help protect the ecosystem within Turkey Branch, DEP undertook one of the largest stream restoration projects within Montgomery County.

The Turkey Branch Restoration Project included:

Upgrading a stormwater pond (Peppertree) in the upper Turkey Branch Subwatershed near the intersection of Bel Pre Road and Connecticut Avenue,

Building two new stormwater ponds just south of Georgia Avenue on either side of the stream (Matthew Henson I and II), and

Completing 3.6 miles of stream improvements along the Turkey Branch mainstem, from Georgia Avenue downstream to below Veirs Mill Road where the Turkey Branch subwatershed empties into Rock Creek mainstem.

The three ponds within this project capture and treat approximately 80 acres of impervious surfaces. In addition to these completed projects, DEP is proposing installation of additional stormwater controls within the Turkey Branch subwatershed by including rain gardens, bioretention facilities and other various Environmental Site Design (ESD) practices at the Aspen Hill Library, along roadways, and within private

properties. The location of all Turkey Branch Restoration Projects and the other proposed projects in the subwatershed can be found in ***Figure 3.23.4***.

Costs: Structural ($3,379,710), Reforestation ($104,771). Funded in part through the Maryland State Highway Administration TEA-21 Enhancement Program, administered by the Federal Highway Administration.
Completion Date: Late Winter, 2007
Property Ownership: Private, State of Maryland, and Maryland-National Capital Park and Planning Commission

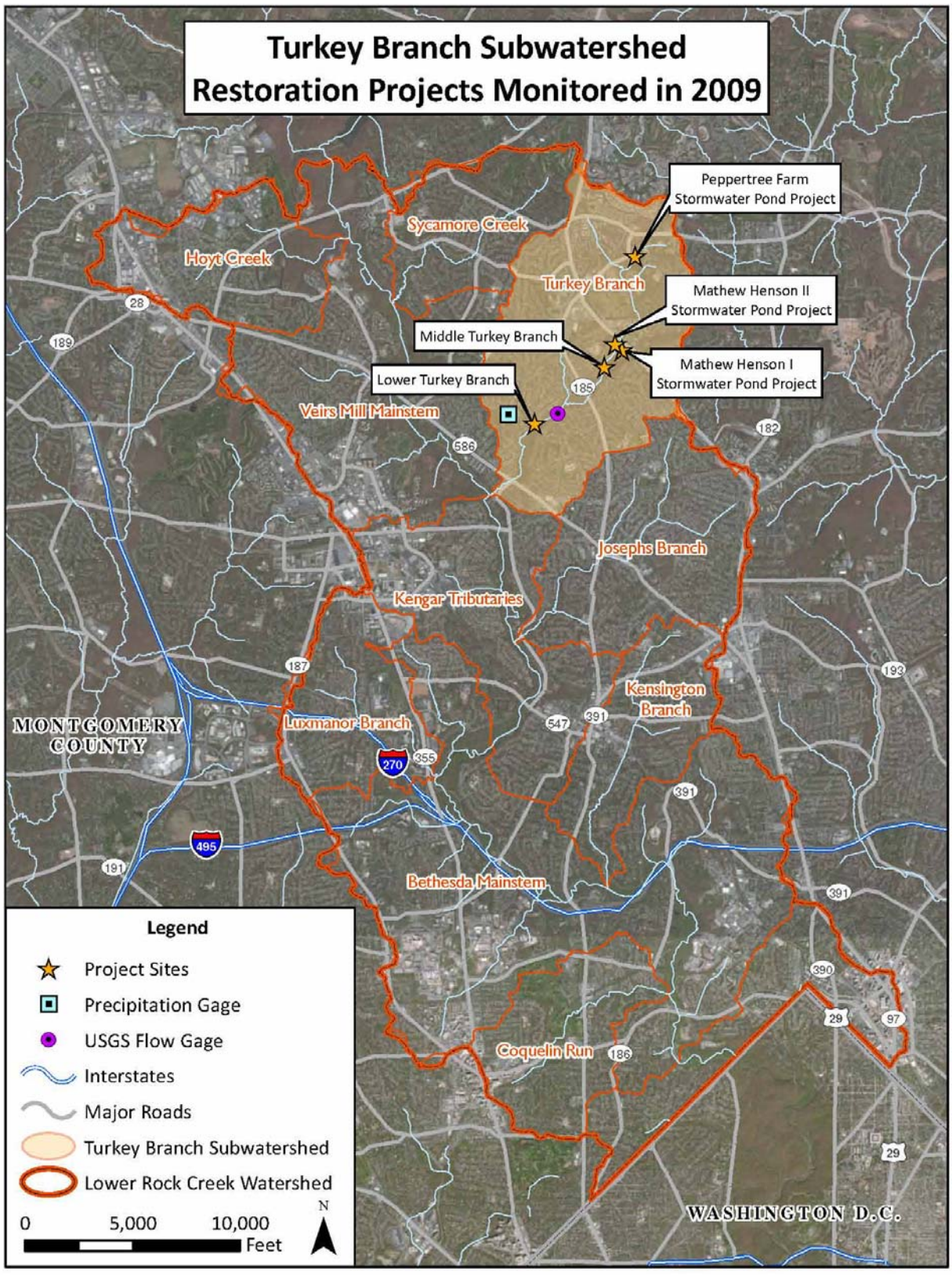


Figure 3.23.3 – Turkey Branch Subwatershed Restoration Projects Monitored in 2009

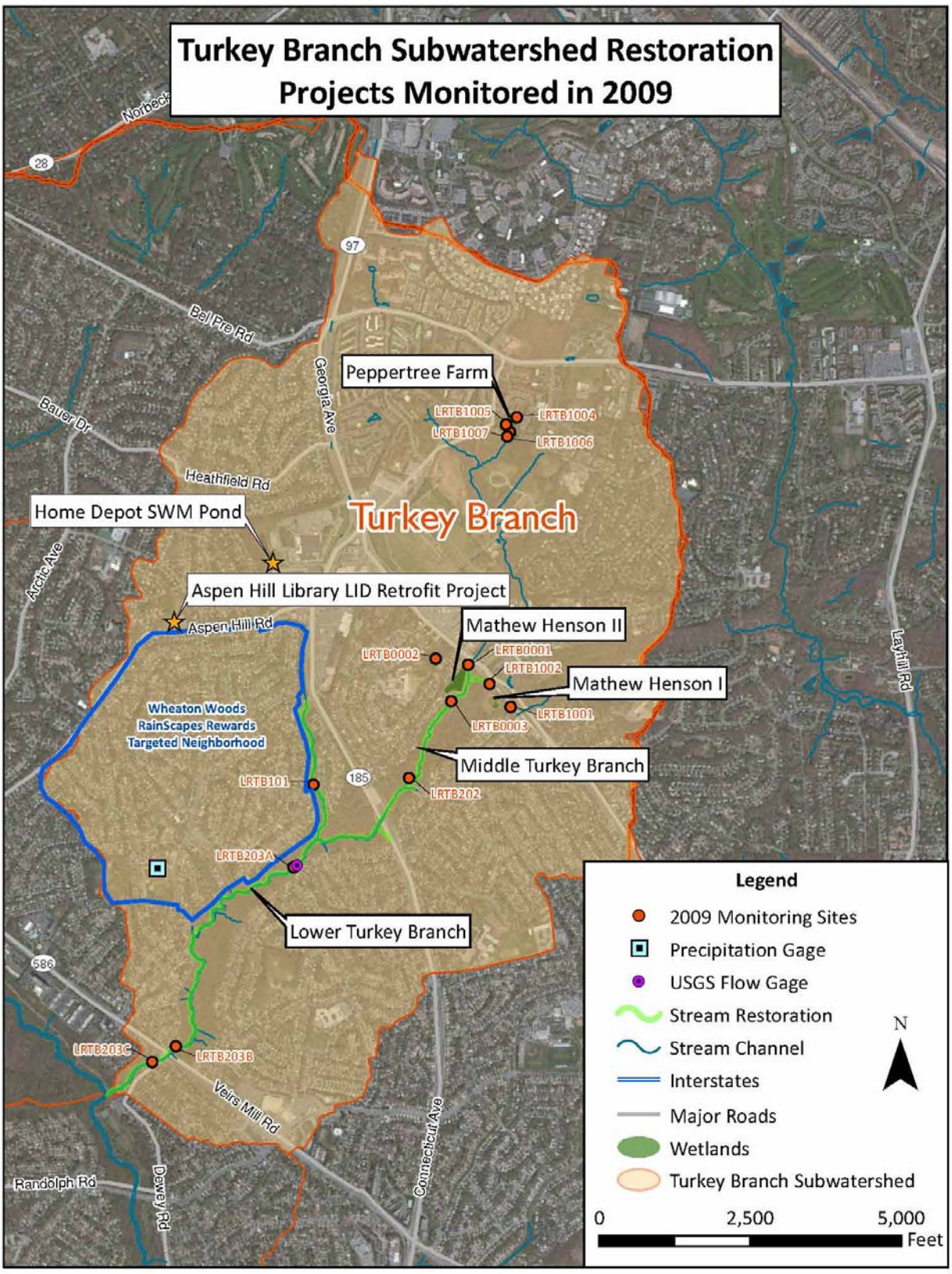


Figure 3.23.4 – Turkey Branch Subwatershed Restoration Projects Monitored in 2009 and Other Proposed Restoration Sites

Project Selection

In April 2001, the County evaluated over 14 miles of stream in the Rock Creek watershed and published the results in the Rock Creek Watershed Feasibility Study. Twenty-three stream restoration sites were identified and prioritized, based on stream habitat and water quality data. Sites were then ranked according to criteria such as cost of work needed, access to the site, impact on wetlands, reforestation potential, and extent of severe erosion. Turkey Branch was among those sites chosen for restoration.

Pre-Restoration Conditions

The Rock Creek Watershed Feasibility Study identified many impaired conditions in Turkey Branch. Uncontrolled stormwater created severely unstable banks, undercut trees, and damaged private property. Undercut trees fell into the stream and created debris jams that blocked the stream and caused further bank erosion.

Over time, the stream channel downcut and overwidened, limiting the stream's access to the original floodplain. The down-cutting and over-widening exposed sewer lines to damage and destroyed habitat necessary for diverse aquatic life. Large amounts of sediment from eroded banks and road grit accumulated in the stream, further degrading in-stream habitat conditions.

Restoration Actions Taken

In an effort to minimize impacts from uncontrolled runoff, the County constructed two new stormwater management ponds near Georgia Avenue (Matthew Henson I and II) and upgraded an existing pond east of Pear Tree Lane (Peppertree). These ponds provide water quality and channel protection volumes for 98 acres of impervious surfaces (381 total drainage area) ranging from 0.3380 to 6.5020 acre feet.

The stream restoration component of the Turkey Branch Project focused on protecting sewer crossings and stabilizing the eroded stream channel, thereby improving stream conditions and improving habitat for aquatic organisms. In-stream structures included rock and log vanes, which direct water away from unstable streambanks, form downstream scour pools, and provide stable and suitable habitat for fish. Rock cross vanes also work as grade controls, which slow the erosive process of stream downcutting.

Undercut and undermined trees were reinforced with supportive "rock packing". More seriously damaged trees were flush cut, allowing the root system to remain for stabilization of the bank. Other efforts to enhance riparian habitat and buffer include more than 15,000 native plantings on banks and in adjacent riparian areas.

As a result of direction received from the Montgomery County Council, DEP partnered with the USGS to install and maintain a real-time flow gage to better understand the relationship between rainfall and stream flow in the watershed. To view data from the gage, visit: http://waterdata.usgs.gov/nwis/uv?01647850. As a result of this major restoration and stabilization project, Washington Suburban Sanitary Commission (WSSC) was able to reline all sewer lines to prevent sewage from seeping out and contaminating the stream. The Maryland National Capital Park and Planning Commission (MNCPPC) constructed a paved hiker/biker path to encourage the surrounding communities to visit the Turkey Branch Tributary and hopefully become interested in watershed stewardship.

3.23.2 Restoration Goals

Restoration goals were defined during the planning and implementation of the Turkey Branch project. Pre- and post-restoration monitoring was conducted within the stream, up and downstream of each of the ponds, as well as within the stormwater ponds themselves. ***Table 3.23.1*** below presents the restoration goals, monitoring performed to evaluate the success of the goals, and when and where the monitoring occurred.

Table 3.23.1 – Summary of Restoration Project Goals and Associated Monitoring

Why: Restoration Goals	What: Monitoring Done to Evaluate Goal	When: Years Monitored	Where: Station or Location Monitored
• Improve aquatic habitat conditions in Turkey Branch • Improve water quality in Turkey Branch	• Aquatic Communities: ▪ Benthic macroinvertebrates ▪ Fish • Qualitative Habitat • In-situ Water Chemistry	2001, 2002, 2006 (pre-restoration) 2009, 2010[1] (post-restoration)	LRTB203A LRTB203B LRTB203C LRTB101 LRTB202
• Avoid introduction of new thermal impacts in Turkey Branch	• Stream temperature • Pond temperature • Precipitation gage	2006 (pre-restoration) 2009 (post-restoration)	LRTB0001, LRTB0002, LRTB0003, LRTB1001, LRTB1002, LRTB1004, LRTB1005, LRTB1006, LRTB1007
• Reduce stream erosion and sedimentation • Reduce erosive stream flows • Improve stormwater management quantity control	• Quantitative habitat (stream morphology surveys) • USGS Stream flow gage • Precipitation gage	2001, 2002, 2006 (pre-restoration) 2010, 2011[2] (post-restoration)	LRTB101, LRTB202, LRTB203A, LRTB203B, LRTB203C
• Create wetlands	• Wetland vegetation	2009 (post-restoration)	Matthew Henson I, Matthew Henson II, Peppertree Farm
• Reforest riparian zone	• Botanical survey	2009 (post-restoration)	LRTB203A, LRTB101, LRTB202

[1] This report includes 2010 benthic data for LRTB202, because the benthic sample for this site was missed in 2009.

[2] Quantitative habitat surveys were scheduled for 2009, but were delayed due to missing benchmarks. These benchmarks were located and survey work was performed in 2010 and 2011. 2010 and 2011 reports will include updates for this monitoring.

3.23.3 Methods to Measure Project Goals

The basic sampling design for most of the monitoring tasks was pre-restoration (before) and post-restoration (after) monitoring, located within stream restoration reaches and upstream and downstream of the ponds. Data were collected at 13 sites in the vicinity of this restoration project, nine of which were temperature logger sites monitored to detect temperatures in the stream, up and downstream of the stormwater ponds, and in the case of the Peppertree site, in the ponds themselves. (***Figures 3.23.5 – 3.23.7***). At the

remaining four sites, the County monitored the biological communities (benthic macroinvertebrates and fish), performed rapid habitat assessments (RHAB), and took in-situ water chemistry measurements to evaluate the aquatic habitat conditions and water quality during the pre- and post-restoration periods. All data collected prior to 2007 are considered pre-restoration data and all subsequent data are considered post-restoration.

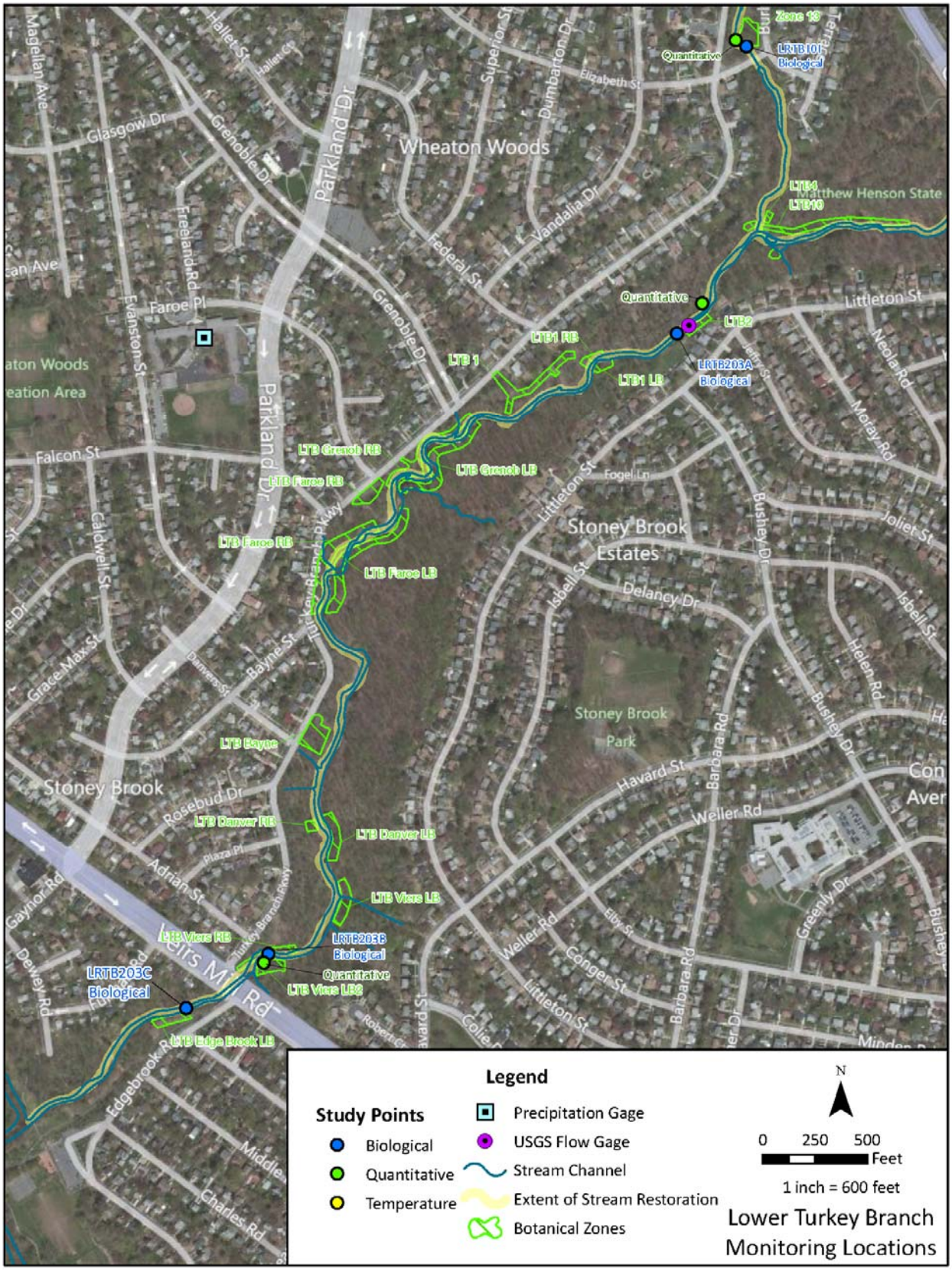


Figure 3.23.5 – Map of 2009 Monitoring Locations in Lower Turkey Branch

Figure 3.23.6 – Map of 2009 Monitoring Locations in Middle Turkey Branch

Figure 3.23.7 – Map of 2009 Monitoring Locations in the Vicinity of the Peppertree Stormwater Pond

Biological communities within Turkey Branch were assessed at sites LRTB101, LRTB202, LRTB203A, LRTB203B, and LRTB203C; botanical reforestation within the floodplain was also monitored at these sites.

LRTB101 is a station on an unnamed, first order tributary upstream of Elizabeth Street. The other four sites, LRTB202, LRTB203A, LRTB203B, and LRTB203C are on the Turkey Branch mainstem. LRTB202 (Middle Turkey Branch) is downstream of Georgia Avenue, below the Matthew Henson ponds, and upstream of Connecticut Avenue. LRTB203A, LRTB203B, and LRTB203C are within the Lower Turkey Branch project area. LRTB203A is downstream of Connecticut Avenue and the LRTB101 tributary. LRTB203B is further downstream, just above the Viers Mill Road crossing and LRTB203C is just downstream of Viers Mill Road.

The temperature effects from the Peppertree ponds, north of Peppertree Lane, were measured at sites LRTB1004, LRTB1005, LRTB1006, and LRTB1007. The first three sites mentioned above are located in each of the three Peppertree open water cells and loggers were deployed to document pond temperatures. Site LRTB1007 is located in the stream channel, downstream of the ponds; a logger was deployed here to determine if the ponds contributed to heated water downstream. Temperature monitoring at this site only occurred post-restoration.

To document the temperature effects of the creation of the Matthew Henson I stormwater pond, sites LRTB1001 and LRTB1002 were established. Site LRTB1001 is located upstream of the pond and LRTB1002 is located downstream. Temperature loggers were placed at LRTB1001 and LRTB1002 prior to construction (2006), to determine the pre-restoration temperature regime. In 2009, temperature loggers were deployed at both sites to determine if the pond affected the pre-restoration stream temperature regime. Stream temperature in the vicinity of Matthew Henson II stormwater pond was measured at sites LRTB0001, LRTB0002, and LRTB0003. LRTB0001 and LRTB0002 were established to monitor the temperature upstream of the pond and LRTB0003 was established to monitor the temperature effects of the pond downstream. These sites were only monitored after restoration, in 2009. A map showing the locations of the stormwater ponds and the monitoring sites is provided in ***Figures 3.23.5 – 3.23.7***.

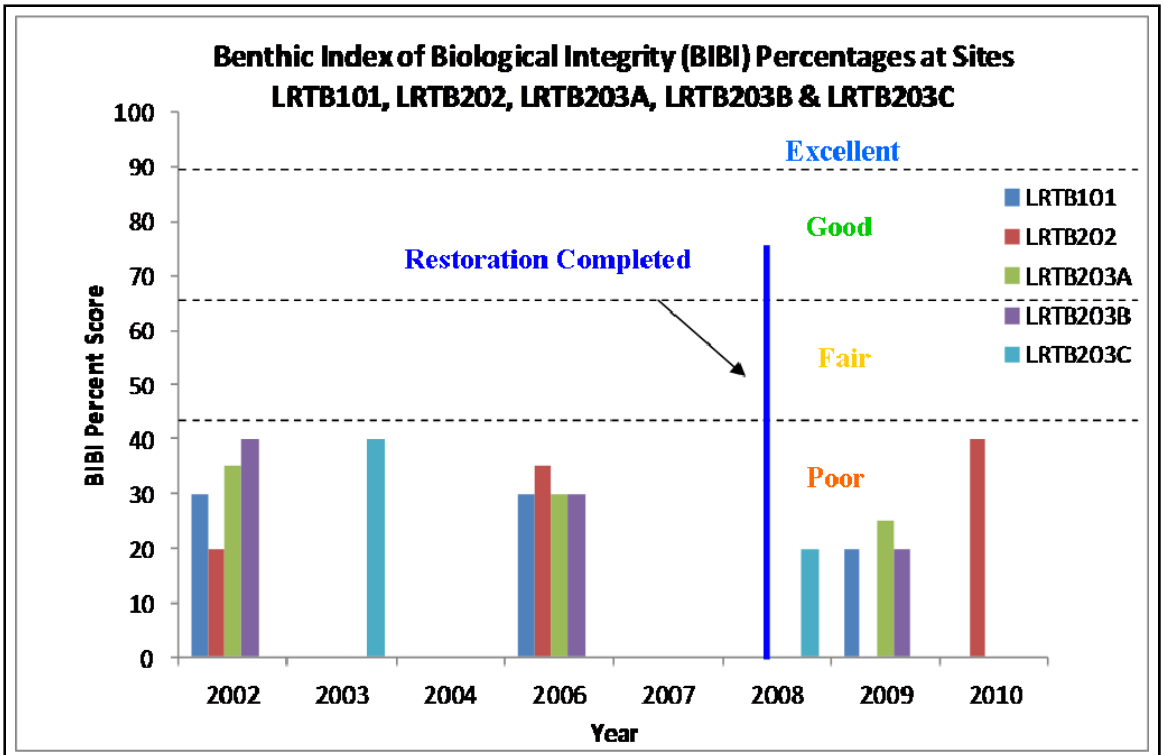
These data are presented in the results section below. For more information on how this monitoring is performed and used to measure stream health in the County, see the detailed Methods section above (***Section 2***).

3.23.4 Results and Analysis

Benthic Macroinvertebrates

BIBI (Benthic Index of Biological Integrity) Scores

As stated above, pre- and post-restoration monitoring was conducted at four monitoring sites within the Turkey Branch subwatershed. The benthic macroinvertebrate community in the Turkey Branch project area, as assessed by the MCDEP Benthic Index of Biological Integrity (BIBI), was Poor each monitoring year in both the pre- and post-restoration period from 2002 to 2010 (***Figure 3.23.8***). Most BIBI percentages declined after restoration, with the exception of LRTB202 which increased slightly.



Station ID	BIBI Percentages (Narrative Ranking)					
	2002	2003	2006	2008	2009	2010
LRTB101	30 (poor)	-	30 (poor)	-	20 (poor)	-
LRTB202	20 (poor)	-	35 (poor)	-	-	40 (poor)
LRTB203A	35 (poor)	-	30 (poor)	-	25 (poor)	-
LRTB203B	40, 30 (poor)	-	30 (poor)	-	20 (poor)	-
LRTB203C	-	40 (poor)	-	20 (poor)	-	-

Figure 3.23.8 – Pre- and Post-Restoration Benthic Index of Biological Integrity (BIBI) Percentages at LRTB203A, LRTB203B, LRTB203C, LRTB101, and LRTB202

The increase in BIBI percentage ranking at LRTB202 from 2002 to 2010 was due to an increase in taxa richness, a decrease in the biotic index, and an increase in the proportion of EPT taxa (ephemeroptera, plecoptera, and trichoptera). The decline in BIBI percentages at sites LRTB101 and LRTB203A were due to decreases in the ratios of scrapers. The decline in BIBI percentage at LRTB203B was due to a decrease in taxa richness, an increase in the proportion of dominant taxa, and a decrease in the ratio of scrapers. Site LRTB203C had declines in taxa richness and an increase in the biotic index, which contributed to the decline in BIBI percentages. Field data sheets from 2009 and 2010 benthic macroinvertebrate monitoring are included in ***Appendix D***.

Dominant Taxa

Both pre-and post-restoration communities of benthic macroinvertebrates in the Turkey Branch project area were generally dominated by Chironomidae (midges (subtribes

Orthocladiinae and Chironomini), Naididae and Enchytraeidae (aquatic worms), and *Physella sp*. (snails). The proportion of dominant taxa generally increased from the pre- to the post-restoration period, except for at site LRTB203A which showed a decline in the proportion of dominant taxa over time. Dominant taxa at all Turkey Branch sites comprised from 67 to 88 percent of the community prior to restoration and from 66 to 96 one year after restoration.

Tolerance Values

Three out of five sites in the Turkey Branch project area experienced an increase in the proportion of tolerant benthic macroinvertebrate taxa and a decrease in the proportion of intermediate taxa between the pre- and post-restoration period. This suggests a decline in this aspect of the benthic macroinvertebrate community over time. Additionally, sensitive taxa were present in minor proportions at LRTB101 and LRTB203B prior to restoration but they were completely absent at all sites one year after restoration. However, two sites (LRTB202 and LRTB203A) showed a decline in the number of individuals tolerant to urbanization after restoration and an increase in the number of individuals intermediate in sensitivity. ***Figures 3.23.9*** and ***3.23.10*** below present the tolerance value proportions at LRTB101 prior to and after restoration.

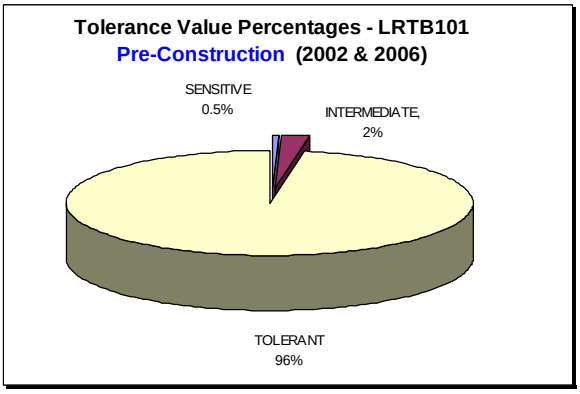


Figure 3.23.9 – Benthic Macroinvertebrate Tolerance Composition at LRTB101 Prior to Restoration

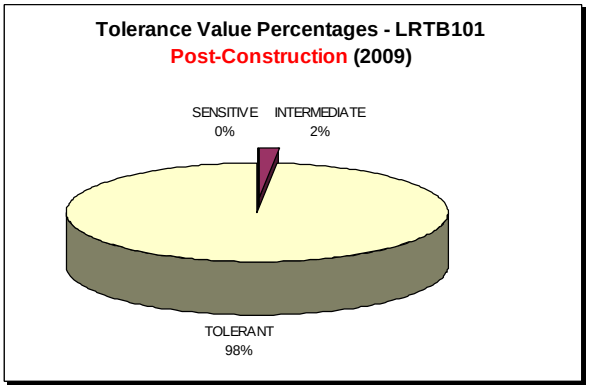


Figure 3.23.10 – Benthic Macroinvertebrate Tolerance Composition at LRTB101 After Restoration

The proportion of tolerant benthic macroinvertebrates at LRTB202 decreased from 83 to 68 percent between the pre- and post-restoration period. This suggests a slight improvement in the benthic macroinvertebrate community and is consistent with the BIBI results. ***Figures 3.23.11*** and ***3.23.12*** below present the tolerance value proportions at LRTB202 prior to and after restoration.

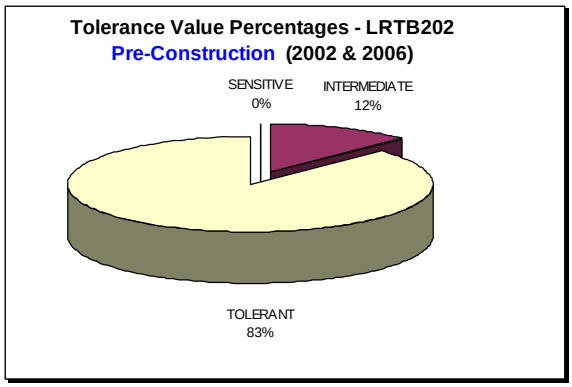


Figure 3.23.11 – Benthic Macroinvertebrate Tolerance Composition at LRTB202 Prior to Restoration

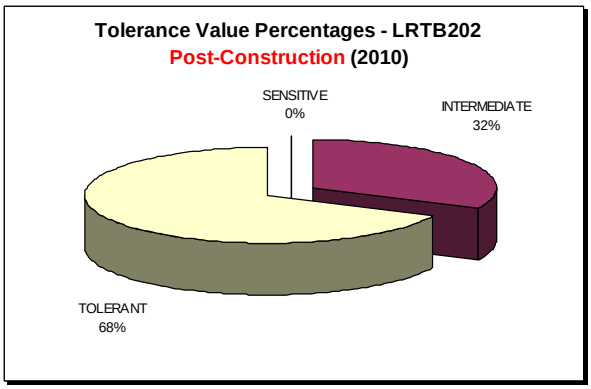


Figure 3.23.12 – Benthic Macroinvertebrate Tolerance Composition at LRTB202 After Restoration

At LRTB203A, the proportion of tolerance values within the benthic macroinvertebrate community did not vary much between the pre- and post-restoration period, with the percentage of tolerant individuals decreasing from 88 to 82 percent between monitoring periods. ***Figures 3.23.13*** and ***3.23.14*** below present the tolerance value proportions at LRTB203A prior to and after restoration.

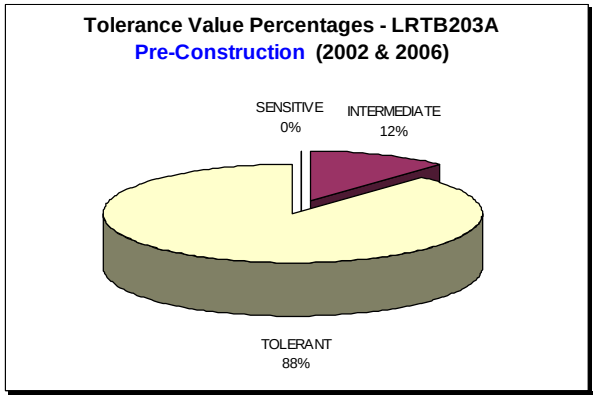


Figure 3.23.13 – Benthic Macroinvertebrate Tolerance Composition at LRTB203A Prior t Restoration

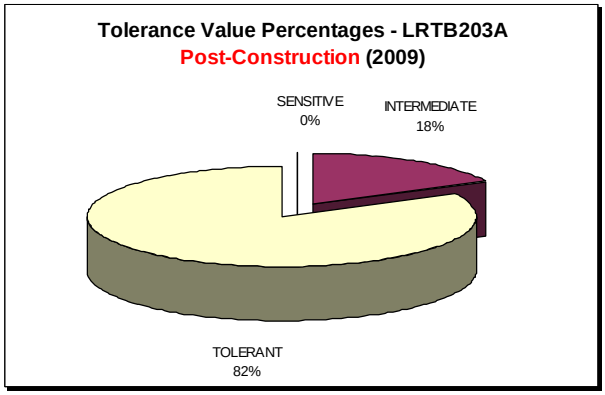


Figure 3.23.14 – Benthic Macroinvertebrate Tolerance Composition at LRTB203A After Restoration

At LRTB203B, the proportion of individuals tolerant to urbanization increased from 79 to 95 percent between the pre- and post-restoration period. Site LRTB203C also had and increase in the proportion of tolerant benthic macroinvertebrate individuals from 23 to 66 percent between the pre- and post-restoration periods. ***Figures 2.35.15 - 2.23.18*** below present the tolerance value proportions at LRTB203C and LRTB203C prior to and after restoration.

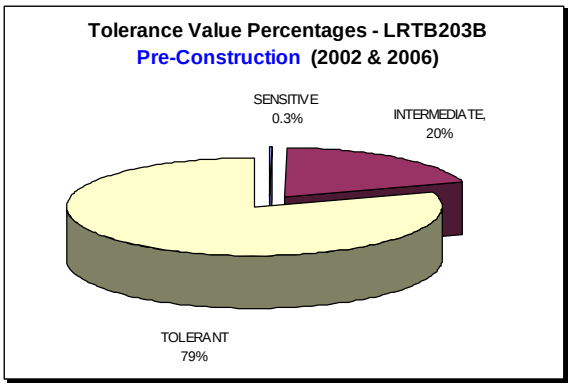
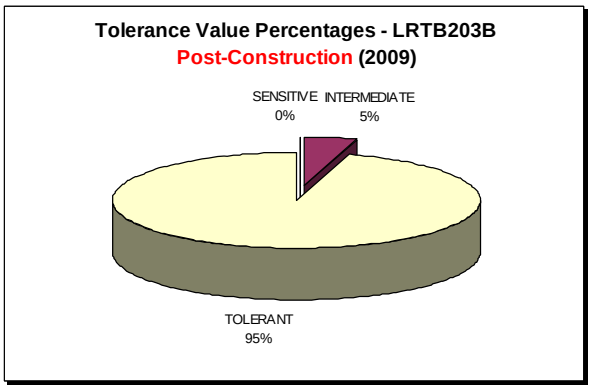


Figure 3.23.15 – Benthic Macroinvertebrate Tolerance Composition at LRTB203B Prior to Restoration



3.23.16 – Benthic Macroinvertebrate Toleran Composition at LRTB203B After Restoration

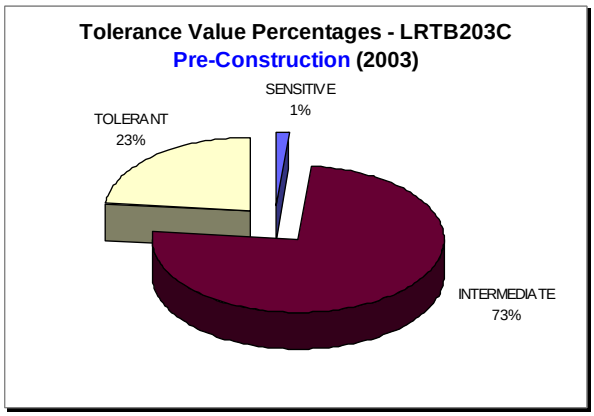


Figure 3.23.17 – Benthic Macroinvertebrate Tolerance Composition at LRTB203C Prior to Restoration

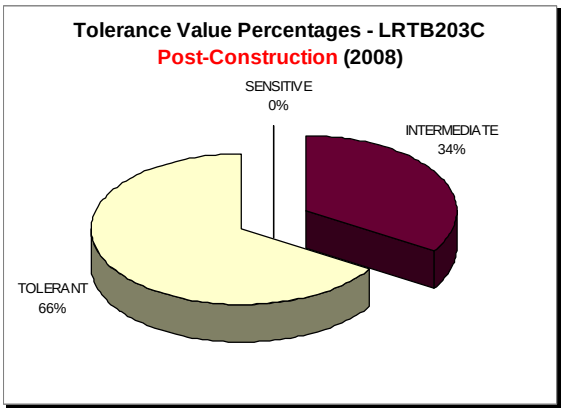


Figure 3.23.18 – Benthic Macroinvertebrate Tolerance Composition at LRTB203C After Restoration

Functional Feeding Groups

Collectors were the most dominant functional feeding group at all sites in the project area both prior to and after the Turkey Branch restoration occurred. More specialized feeders, including scrapers and shredders that require less degraded stream conditions or specific habitat features, were present in only minor amounts both before and after restoration, and most sites saw a decline within one year post-restoration. At LRTB101, scrapers represented five percent of the benthic community prior to restoration and were absent after restoration (***Figures 3.23.19*** and ***3.23.20***).

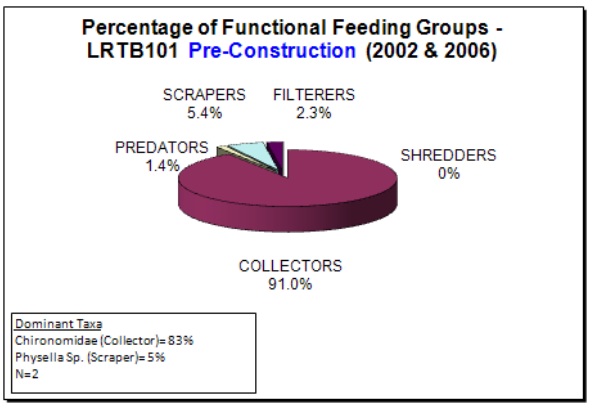


Figure 3.23.19 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB101 Prior to Restoration

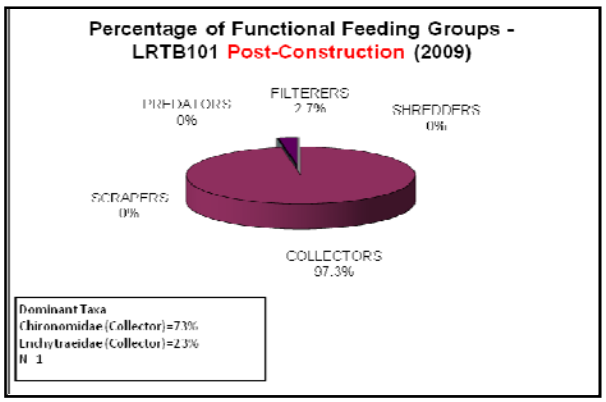


Figure 3.23.20 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB101 After Restoration

Site LRTB202 was comprised of seven percent predators and five percent scrapers in the pre-restoration period. The percentage of predators declined slightly to near six percent after restoration and the percentage of scrapers declined to less than one percent. The percentage of filterers increased during this time to over 25 percent, comprising the second most dominant feeding group after collectors. These changes indicate a decline in the quality of the benthic macroinvertebrate community over time. ***Figures 3.23.21*** and ***3.23.22*** show the percentages of each benthic macroinvertebrate functional feeding group at LRTB202 for the pre- and post-restoration monitoring periods, respectively.

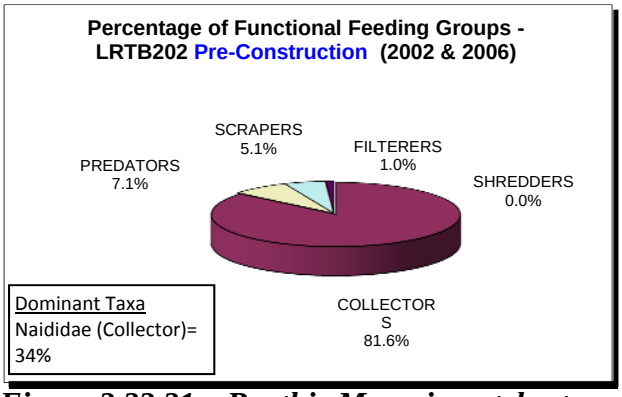


Figure 3.23.21 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB202 Prior to Restoration

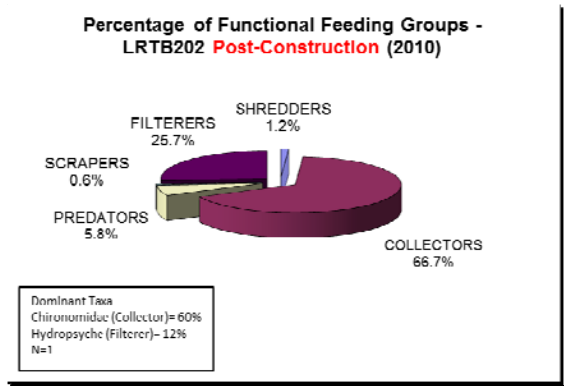


Figure 3.23.22 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species atLRTB202 After Restoration

The shift in composition of benthic macroinvertebrate functional feeding groups at LRTB203A and LRTB203B over time was similar to what occurred at LRTB101; the percentage of scrapers went from a fairly low proportion to zero between the pre- and post-restoration periods with the proportion of generalist feeders increasing over time to occupying nearly 100 percent of the community at both sites. ***Figures 3.23.23*** – ***3.23.28*** show the percentages of each benthic macroinvertebrate functional feeding group at LRTB203A and LRTB203B for the pre- and post-restoration monitoring periods.

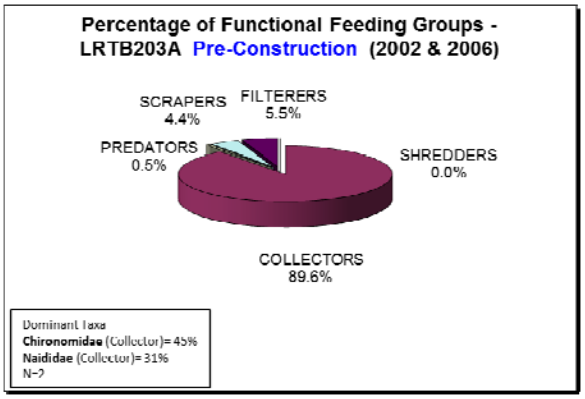


Figure 3.23.23 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB203A Prior to Restoration

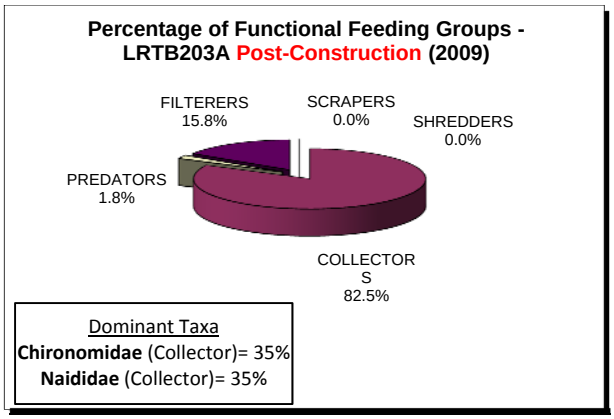


Figure 3.23.24 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB203A After Restoration

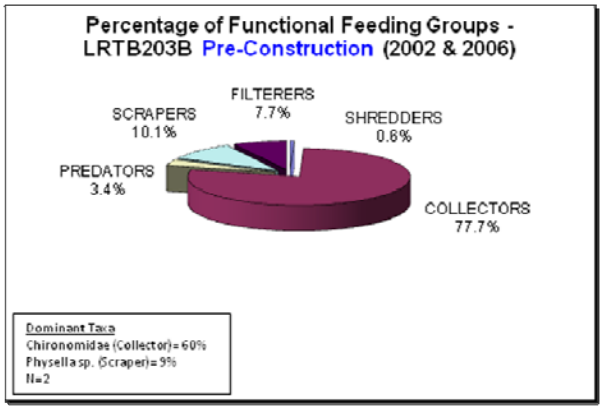


Figure 3.23.25 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB203B Prior to Restoration

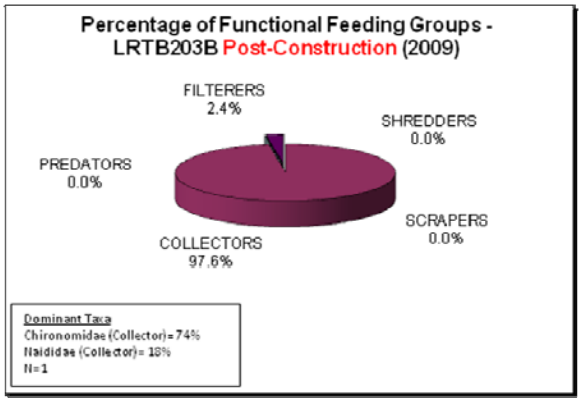


Figure 3.23.26 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB203B After Restoration

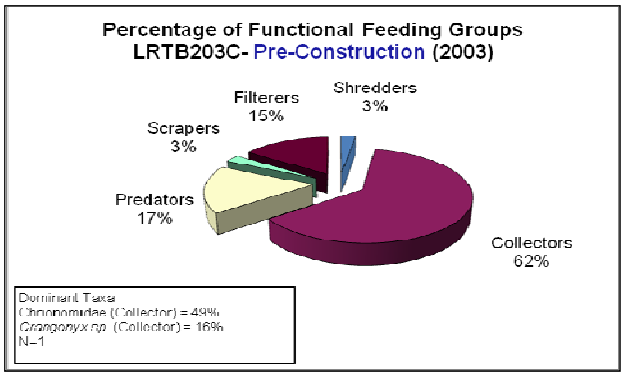


Figure 3.23.27 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB203C Prior to Restoration

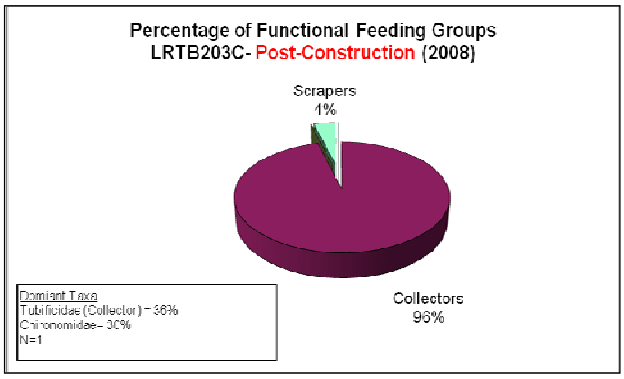


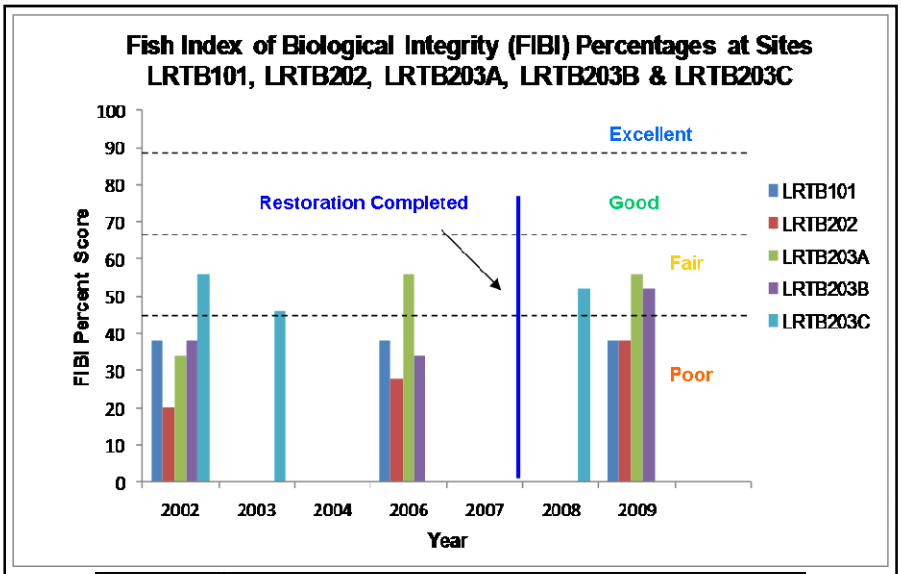
Figure 3.23.28 – Benthic Macroinvertebrate Functional Feeding Group Composition and Dominant Species at LRTB203C After Restoration

Fish

FIBI (Fish Index of Biological Integrity) Scores

The pre-restoration fish community in the Turkey Branch project area, as assessed by the MCDEP Fish Index of Biological Integrity (FIBI), was mostly Poor prior to restoration, with 70 percent of the sites scoring in the Poor range and the remaining 30 percent scoring in the Fair range. Specifically, site LRTB203C (Lower Turkey Branch) scored in the fair range in both assessed years (2002 and 2003), and LRTB203A (Lower Turkey Branch) scored in the Fair range in 2006 (***Figure 3.23.29***).

The fish community assessments conducted during the post-restoration period either maintained the same FIBI percentage from the pre-restoration period or showed an improvement. Sixty percent of the sites generally maintained similar FIBI percentages and 40 percent of the sites showed improvement in FIBI percentages. Site LRTB203B (Lower Turkey Branch) increased from a Poor to Fair FIBI ranking. LRTB202 (Middle Turkey Branch) remained in the Poor FIBI range pre- and post-restoration, however it did increase from 20 and 28 percent in the pre-restoration period to 38 percent in the post-restoration period. The slight increase in FIBI percentage at LRTB202 was due to an increase in the total number of fish species, an increase in minnow species, and a decrease in the proportion of individuals with disease or anomalies. Field data sheets from 2009 fish monitoring are included in ***Appendix D***.



Station ID	FIBI Percent Score (Narrative Ranking)				
	2002	2003	2006	2008	2009
LRTB101	38 (poor)	-	38 (poor)	-	38 (poor)
LRTB202	20 (poor)	-	28 (poor)	-	38 (poor)
LRTB203A	34 (poor)	-	56 (fair)	-	56 (fair)
LRTB203B	38 (poor)	-	34 (poor)	-	52(fair)
LRTB203C	56 (fair)	46 (fair)	-	52 (fair)	-

Figure 3.23.29 – Pre- and Post-Restoration Fish Index of Biological Integrity (FIBI) Percentages at LRTB203A, LRTB203B, LRTB203C, LRTB101, and LRTB202

Dominant Species

The fish community in the first order tributary above Elizabeth Street (LRTB101) remained similar between the pre- and post-restoration period; *Carassius auratus (*goldfish) was the only fish species collected at this site. The abundance of goldfish collected at this site increased over time from 3 to 17 to 135 individuals in 2002, 2006, and 2009, respectively. The fish community at LRTB202 was heavily dominated by *Rhinichthys atratulus* (blacknose dace) in both the pre- and post-restoration periods. The second most dominant fish species and only other species present in 2002 was *Catostomus commersoni* (white sucker). The second most dominant species in both 2006 and 2009 was *Semotilus atromaculatus* (creek chub) with white sucker being collected in nearly equal amounts.

At site LRTB203A, blacknose dace was the most dominant fish species in 2002 and 2009, and was second most dominant in 2006. White sucker was the most dominant species in 2006, second most dominant in 2002, and present in minor amounts in 2009. *Rhinichthys cataractae* (longnose dace) was the second most dominant fish species in 2009. The fish community at LRTB203B was heavily dominated by blacknose dace in both the pre- and post-restoration periods. Longnose dace was the second most dominant fish species at this site, but was much less dominant than blacknose dace.

Tolerance Values

Tolerant fish species heavily dominated all sites in the project area prior to and after restoration. Site LRTB101 was represented by 100 percent tolerant species in all years, since goldfish were the only species present. At site LRTB202, individuals with intermediate tolerance levels were present in a minor amount and were absent at this site one year after restoration. Longnose dace was the only species present at this site with an intermediate tolerance level and was only collected in 2006. ***Figures 3.23.30*** and ***3.23.31*** show the differences in tolerant fish species between pre- and post-restoration sampling periods at LRTB202.

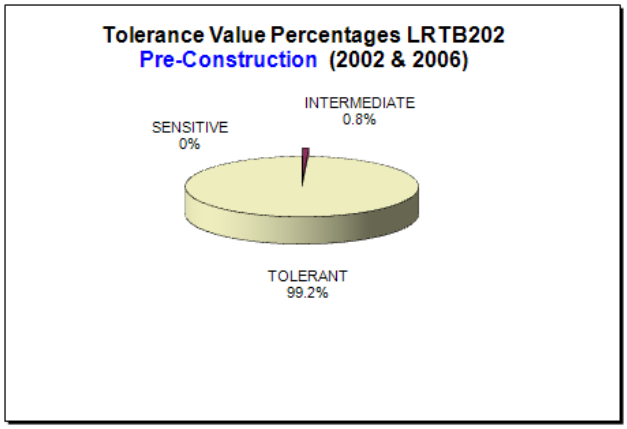


Figure 3.23.30 – Fish Tolerance Composition at LRTB202 Prior to Restoration

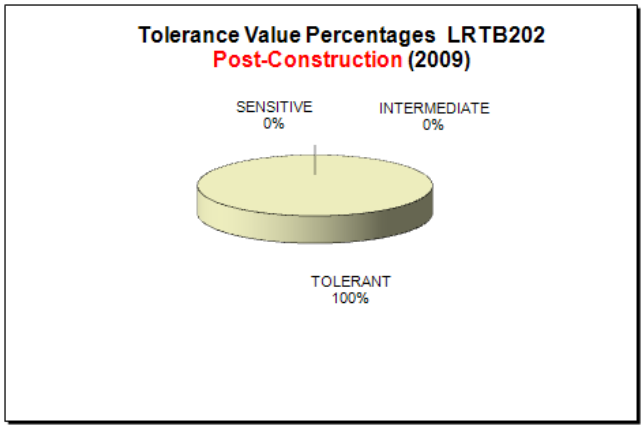


Figure 3.23.31– Fish Tolerance Composition at LRTB202 After Restoration

Site LRTB203A had a similar composition of tolerant fish species among years, with the percentage of intermediate species increasing by one percent between the pre- and post-restoration period. The dominant intermediate species at this site was longnose dace. ***Figures 3.23.32*** and ***3.23.33*** show the differences in tolerant fish species between pre- and post-restoration sampling periods at LRTB203A.

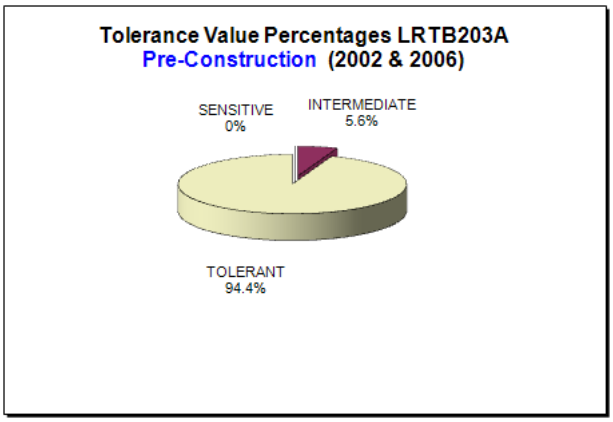


Figure 3.23.32 – Fish Tolerance Composition at LRTB203A Prior to Restoration

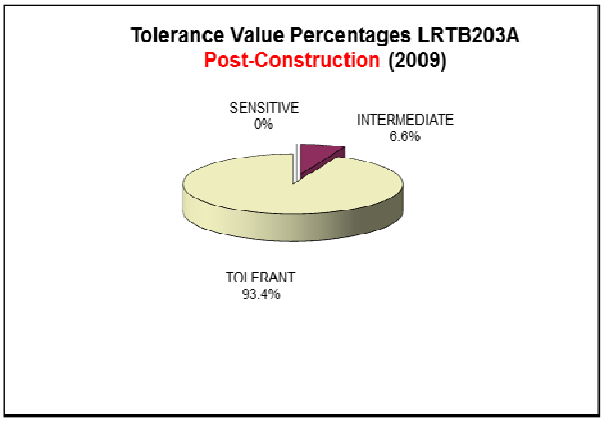


Figure 3.23.33 – Fish Tolerance Composition a LRTB203A After Restoration

The composition of fish tolerance percentages remained similar among years at LRTB203B. The proportion of individuals intermediate in sensitivity increased slightly after restoration. This increase in intermediate species was due to an increase in the proportion of longnose dace collected. ***Figures 3.23.34*** and ***3.23.35*** show the differences in tolerant fish species between pre- and post-restoration sampling periods at LRTB203B. The composition of fish tolerance percentages were similar between the pre- and post-restoration period at LRTB203C, with the percentage of individuals intermediate in sensitivity decreasing from eight to three percent. ***Figures 3.23.36*** and ***3.23.37*** show the differences in tolerant fish species between pre- and post-restoration sampling periods at LRTB203C.

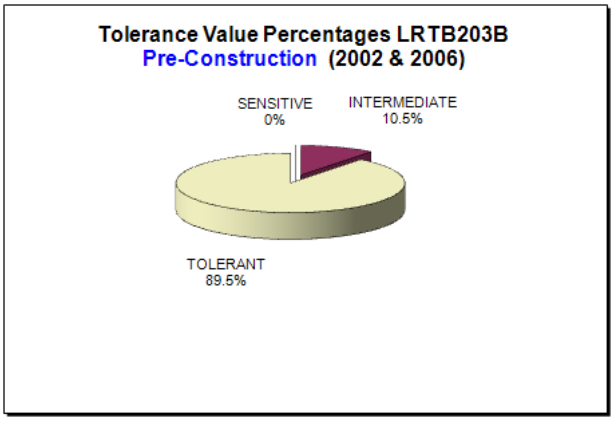


Figure 3.23.34 – Fish Tolerance Composition at LRTB203B Prior to Restoration

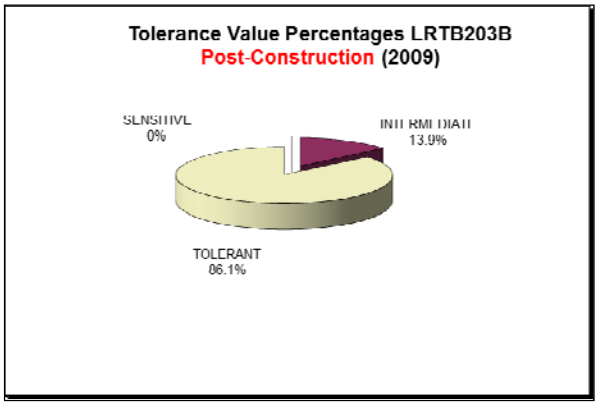


Figure 3.23.35 – Fish Tolerance Composition at LRTB203B After Restoration

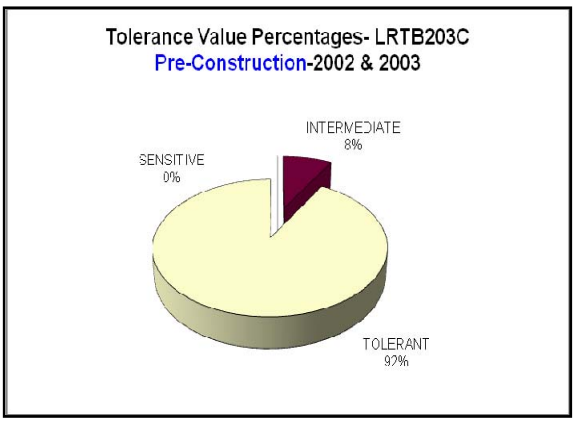


Figure 3.23.36 – Fish Tolerance Composition at LRTB203C Prior to Restoration

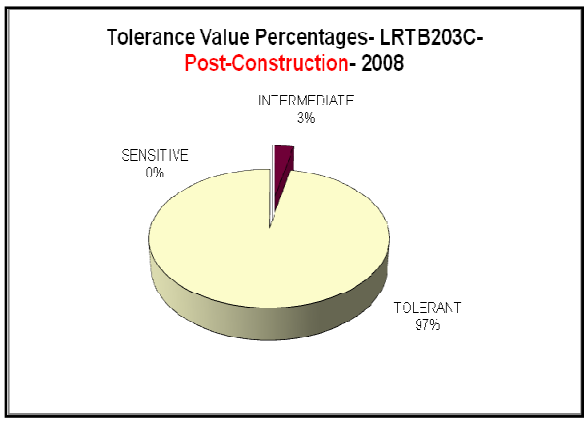


Figure 3.23.37 – Fish Tolerance Composition at LRTB203C After Restoration

Functional Feeding Groups

All sites in the Turkey Branch watershed were dominated by omnivorous fish species both pre- and post-restoration. Since goldfish was the only species found at LRTB101, the percentage of functional feeding groups remained at 100 percent omnivores in all monitored years. The percentage of omnivores at LRTB202 and LRTB203A increased from the pre- to post-restoration period. This was due to an increase in the proportion of blacknose dace, an omnivorous fish species. The percentage of generalists decreased between pre- and post-restoration at LRTB202 due to a decrease in the proportion of creek chub. A very small percentage of invertivores and predators were present at LRTB202 in the pre-restoration period, but were absent post-restoration. ***Figures 3.23.38*** and ***3.23.39*** show the percentages of each functional feeding group at LRTB202 for pre- and post-restoration monitoring periods, respectively. ***Figures 3.23.40*** and ***3.23.41*** show the percentages of each functional feeding group at LRTB203A for pre- and post-restoration monitoring periods, respectively.

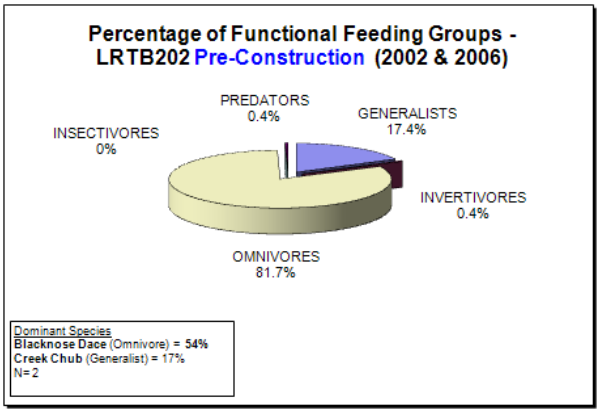


Figure 3.23.38 – Fish Functional Feeding Group Composition and Dominant Species at LRTB202 Prior to Restoration

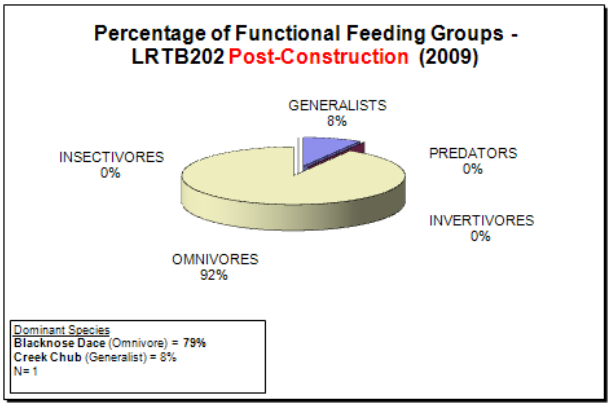


Figure 3.23.39 – Fish Functional Feeding Group Composition and Dominant Species at LRTB202 After Restoration

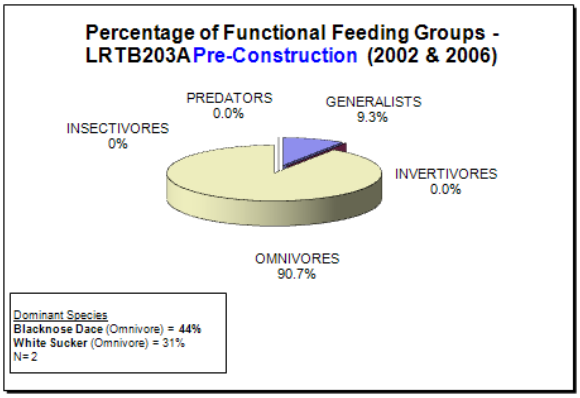


Figure 3.23.40 – Fish Functional Feeding Group Composition and Dominant Species at LRTB203A Prior to Restoration

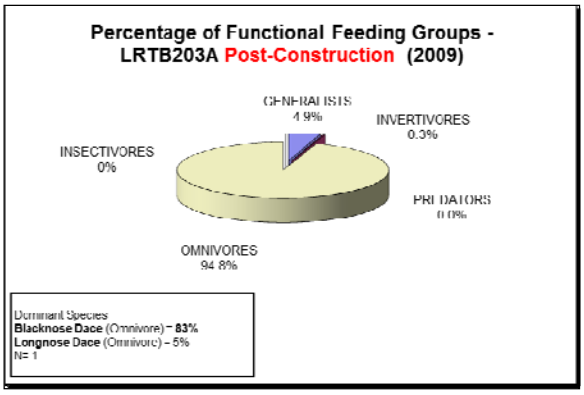


Figure 3.23.41 – Fish Functional Feeding Group Composition and Dominant Species at LRTB203A After Restoration

At LRTB203B, the percentage of omnivores increased slightly and the percentage of generalists decreased slightly between the pre- and post-restoration periods. This was due to an absence of creek chub, a generalist species, following restoration. ***Figures 3.23.42*** and ***3.23.43*** show the percentages of each functional feeding group at LRTB203B for the pre- and post-restoration monitoring periods, respectively.

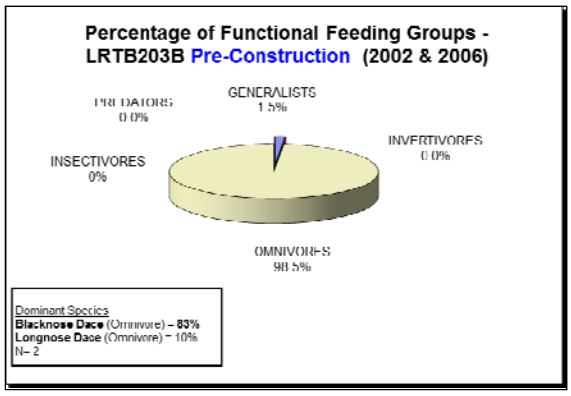


Figure 3.23.42 – Fish Functional Feeding Group Composition and Dominant Species at LRTB203B Prior to Restoration

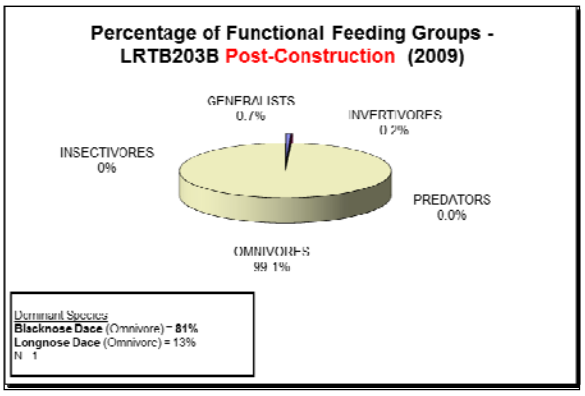


Figure 3.23.43 – Fish Functional Feeding Group Composition and Dominant Species at LRTB203B After Restoration

At site LRTB203C, the percentage of invertivores increased from the pre- to post-restoration monitoring period and the percentage of omnivores decreased from 93 to 87 percent. The increase in invertivore percentage was due to an increase in two species of sunfish, bluegill *(Lepomis macrochirus*) and pumpkinseed (*Lepomis gibbosus*), an increase in percentages of tessellated darter (*Etheostoma olmstedi*) and spotfin shiner (*Cyprinella spiloptera*), and the presence of both roseyside dace (*Clinostomus funduloides*) and eastern mosquitofish (*Gambusia holbrooki*) in the post-restoration period that were absent prior to restoration. ***Figures 3.23.44*** and ***3.23.45*** show the percentages of each functional feeding group at LRTB203C for the pre- and post-restoration monitoring periods, respectively.

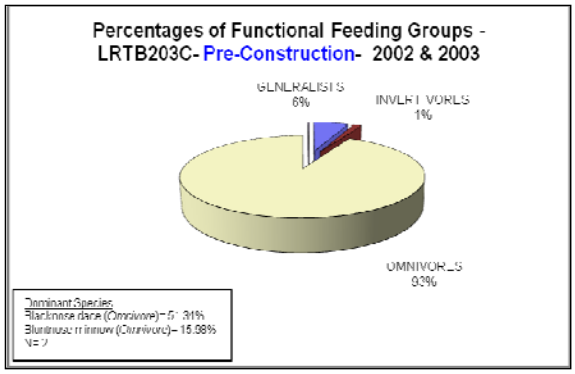


Figure 3.23.44 – Fish Functional Feeding Group Composition and Dominant Species at LRTB203C Prior to Restoration

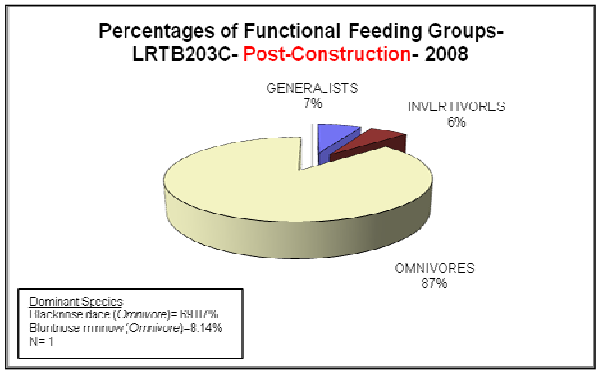
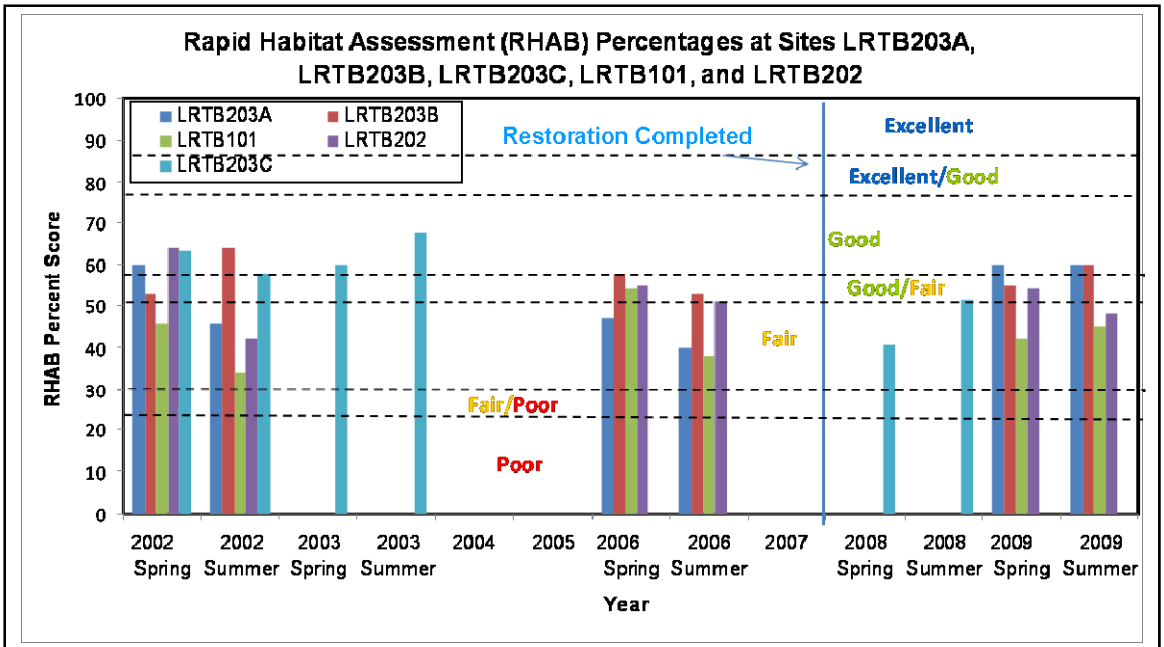


Figure 3.23.45 – Fish Functional Feeding Group Composition and Dominant Species at LRTB203C After Restoration

Qualitative Habitat

Pre-restoration aquatic habitat was evaluated at LRTB101, LRTB202, LTRB203A, and LRTB203B in the spring and summer in 2002 and 2006. Pre-restoration aquatic habitat was assessed at LRTB203C in 2002 and 2003. Scores were in the Fair, Fair/Good, and Good ranges in the pre-restoration periods, with 40 percent of the sites scoring in the Good range, 25 percent of the sites scoring in the Fair/Good ranges, and 35 percent of the sites scoring in the Fair range. Prior to restoration, Turkey Branch sites generally had suboptimal in-stream cover for fish, marginal epifaunal substrate for benthic macroinvertebrates, and moderate sediment deposition. Bank stability was variable among sites, but most sites had moderately unstable to unstable banks and marginal streambank vegetative protection. Embeddedness was also variable, but most sites were estimated to have between 50 and 75 percent embeddedness. Sites LRTB202, LRTB203B, and LRTB203C generally had higher scores for in-stream cover and LRTB203B and LRTB203C had higher epifaunal substrate scores. ***Figure 3.23.46*** shows aquatic habitat scores prior to and after restoration at all Turkey Branch sites.



Station ID	RHAB Percent Score (Narrative Ranking)									
	2002 Spring	2002 Summer	2003 Spring	2003 Summer	2006 Spring	2006 Summer	2008 Spring	2008 Summer	2009 Spring	2009 Sum-mer
LRTB101	45 (Fair)	34(Fair)	-	-	54 (Good/ Fair)	38 (Fair)	-	-	42 (Fair)	45 (fair)
LRTB202	64 (Good)	42 (Fair)	-	-	55 (Good/ Fair)	51 (Good/ Fair)	-	-	54 (Good/ Fair)	48 (Fair)
LRTB203A	60 (Good)	46 (Fair)	-	-	47 (Fair)	40 (Fair)	-	-	60 (Good)	60 (Good)
LRTB203B	53 (Good/ Fair)	64 (Good)	-	-	58 (Good)	53 (Good/ Fair)	-	-	55 (Good/ Fair)	60 (Good)
LRTB203C	64 (Good)	58 (Good)	60 (Good)	68 (Good)	-	-	40(Fair)	52 (Good/ Fair)		

Figure 3.23.46 – Pre- and Post-Restoration Rapid Habitat Assessment (RHAB) Percentages at LRTB203A, LRTB203B, LRTB203C, LRTB101, and LRTB202

Aquatic habitat percentages were similar at all Turkey Branch sites after restoration but showed a declining trend; 30 percent of the sites scored in the Good range, 20 percent scored in the Good/Fair range, and 40 percent scored in the Fair range. Sites LRTB101 and LRTB203C were rated slightly lower after restoration due to lower in-stream cover and epifaunal substrate scores. Site LRTB203A was rated slightly higher due to higher in-stream cover and epifaunal substrate scores, and LRTB202 and LRTB203B were rated similarly before and after restoration. At most sites, riffle frequency and bank stability improved after restoration.

Quantitative Habitat

Quantitative monitoring was scheduled to occur at sites LRTB101, LRTB202, LRTB203A, and LRTB203B in 2009, but was delayed due to problems locating the benchmarks. Data were collected in 2010 and 2011 and will be presented in the subsequent 2010 and 2011 reports.

Water Chemistry

With the exception of some dissolved oxygen readings, in-situ water quality parameters were in compliance with COMAR standards for Use I streams during the pre-restoration period (***Tables 3.23.2 – 3.23.6***). During the summer of 2002, dissolved oxygen readings fell below the 5 mg/L instantaneous State standard at three of five Turkey Branch sites (LRTB101, LRTB202, and LRTB203A). Only one site (LRTB202) fell below the dissolved oxygen standard during the summer of 2006. However, the dissolved oxygen readings approached the lower limit of the standard, but did not fall below it at both LRTB203A and LRTB203B during the summer of 2006.

Post-restoration in-situ water quality conditions were similar to pre-restoration conditions. Sites LRTB203A and LRTB203C were in compliance with COMAR standards in both the spring and summer seasons after restoration. Dissolved oxygen readings taken during the summer of 2009 fell below the minimum 5 mg/L standard at LRTB101, LRTB202, and LRTB203A.

Table 3.23.2 – Pre- and Post-Restoration in-situ Water Chemistry Data at LRTB101

Water Quality Parameter	2002		2006			2009	
	Spring	Summer	Spring	Summer	Fall	Spring	Summer
Dissolved oxygen (mg/L)	11.1	3.64	8.37	6.16	7.24	11.8	3.73
Dissolved oxygen (% saturation)	144	43	83	73	67	123	40
pH	8.17	7.08	7.53	7.86	8.49	7.32	7.3
Conductivity (µmhos)	579	535	758	562	463	462	460
Water temperature (ºF)	78.8	75.7	58.8	75.2	52.9	63.9	67.6

Table 3.23.3 – Pre- and Post-Restoration in-situ Water Chemistry Data at LRTB202

Water Quality Parameter	2002		2006		2009	2010
	Spring	Summer	Spring	Summer	Summer	Spring
Dissolved oxygen (mg/L)	5.3	3.38	9.76	2.79	3.98	15.42
Dissolved oxygen (% saturation)	72.9	40	94	37.2	44	132
pH	7.04	6.9	7.41	7.6	7.23	7.47
Conductivity (µmhos)	449	316	375	344	349	532
Water temperature (ºF)	73.4	79.2	55.8	76.3	69.8	51.3

Table 3.23.4 – Pre- and Post-Restoration in-situ Water Chemistry Data at LRTB203A

Water Quality Parameter	2002		2006		2009	
	Spring	Summer	Spring	Summer	Spring	Summer
Dissolved oxygen (mg/L)	10.54	1.87	10.91	5.02	12.91	4.68
Dissolved oxygen (% saturation)	132	24	109	56	131	53
pH	7.62	6.48	7.99	7.98	7.51	7.39
Conductivity (µmhos)	465	365	534	444	435	371
Water temperature (ºF)	75.2	72.5	59.7	72.1	62.2	71.2

Table 3.23.5 – Pre- and Post-Restoration in-situ Water Chemistry Data at LRTB203B

Water Quality Parameter	2002		2006			2009	
	Spring	Summer	Spring*	Summer	Fall	Spring	Summer
Dissolved oxygen (mg/L)	12.96	5.28	-	5.04	8.86	10.74	7.01
Dissolved oxygen (% saturation)	98	61	-	54	86	114	80
pH	6.83	6.76	-	8.13	7.69	7.73	7.43
Conductivity (µmhos)	448	202	-	382	218	572	341
Water temperature (ºF)	41	74.1	-	70.3	57.0	66.7	72.0

*probe malfunctioned

Table 3.23.6 – Pre- and Post-Restoration in-situ Water Chemistry Data at LRTB203C

Water Quality Parameter	2002		2003		2008	
	Spring	Summer	Spring	Summer	Spring	Summer
Dissolved oxygen (mg/L)	6.27	6.19	13.01	8.41	7.93	11.2
Dissolved oxygen (% saturation)	68	71	127	94	84	-
pH	7.01	7.03	7.64	7.07	8.19	7.80
Conductivity (µmhos)	461	142	540	431	410	405
Water temperature (ºF)	66.2	74.3	57.2	71.8	63.5	68.0

Wetland Vegetation

All three stormwater wetland ponds, Matthew Henson I, Matthew Henson II, and Peppertree Farm, were monitored post-restoration in 2009. Since both Matthew Henson ponds were created as part of the restoration, and Peppertree Farm was a dry pond prior to restoration, all ponds were only monitored after restoration.

Matthew Henson I Stormwater Pond

The Matthew Henson I stormwater pond is located immediately south of Georgia Avenue about 500 feet east of the mainstem of Turkey Branch (***Figure 3.23.47***). This planned emergent wetland was monitored in 2009 using the *MDE Mitigation Site Scoring Method* (2007) in order to evaluate the success of planted wetland vegetation after restoration.

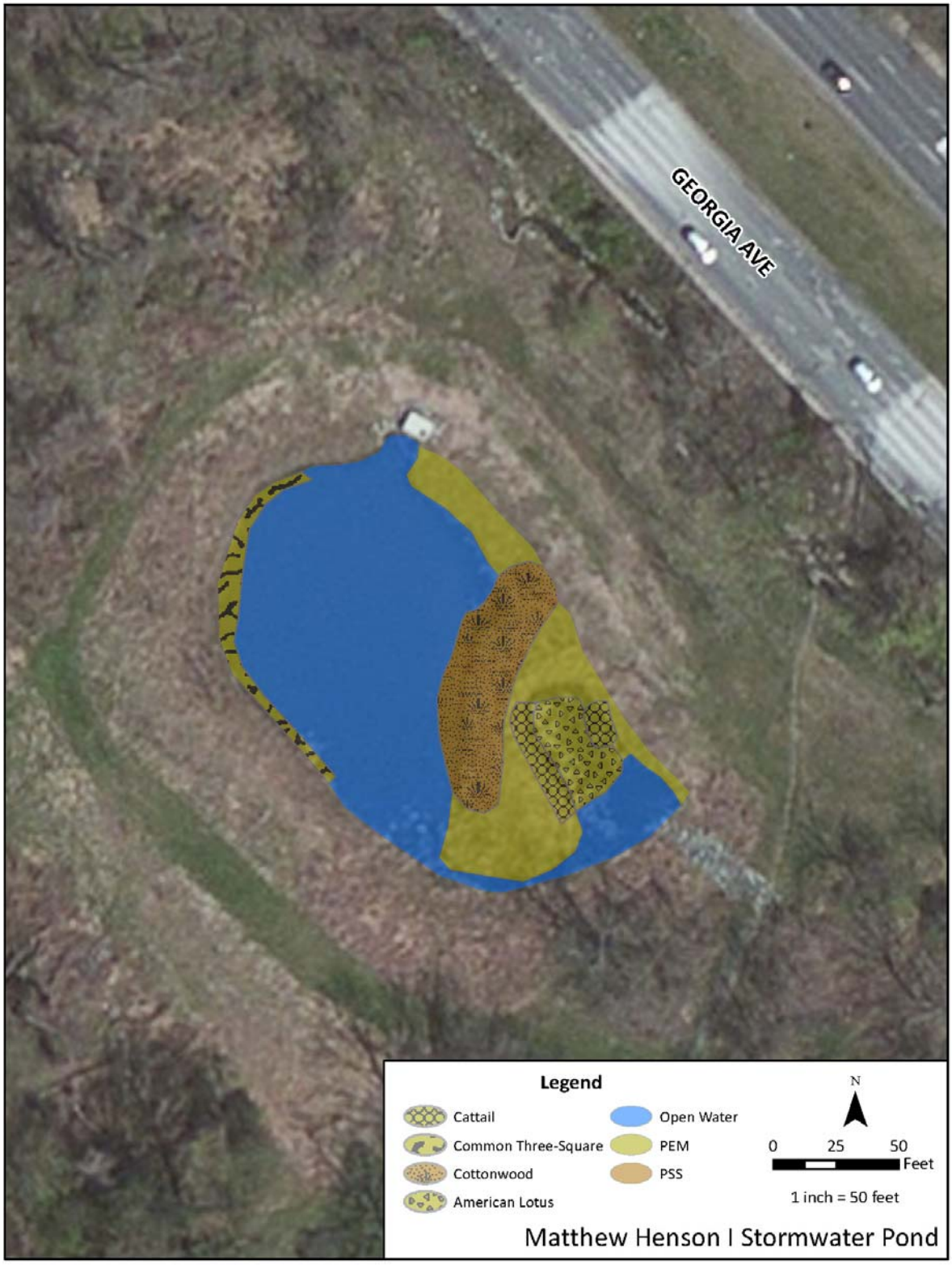


Figure 3.23.47 – Locations of the 2009 Monitored Wetland Zones at the Matthew Henson I Stormwater Pond

Vegetation

While open water was the dominant cover type site-wide, wetland vegetation was present within the southern half of the site as well as along the edges of the pond. ***Figures 3.23.48*** and ***3.23.49*** show images of the different cover types present during the 2009 vegetation monitoring. The cover types observed were characterized by 70 percent herbaceous cover and 30 percent palustrine scrub shrub. The scrub shrub area was dominated by small trees; however, as it grows, this cover type most likely will be classified as palustrine forested. Herbaceous vegetation in the wetland was characterized by *Schoenoplectus pungens* (common three square), *Typha latifolia* (broadleaf cattail), and *Nelumbo lutea* (American water lotus). Cover estimates for these species were 35, 15, and 10 percent, respectively. Woody species found growing around the edge of the pond consisted of relatively abundant *Populus deltoides* (eastern cottonwood) and *Salix nigra* (black willow). Woody plants were generally one to one-and-a-half feet tall, and did not appear stressed. Some deer browse was noticeable, but did not appear to be limiting the success of woody plants. The presence of eastern cottonwood is notable as this species was not included in the planting plan. A high density of desirable, native wetland vegetation at the site led to a vegetation score of 28.8 out of a possible 30, or 96 percent.

Figure 3.23.48 – Matthew Henson I Stormwater Pond 2009 (volunteer eastern cottonwood seedlings growing in herbaceous zone)

Figure 3.23.49 – Matthew Henson I Stormwater Pond 2009 (American water lotus plants near southern outlet)

Soils

Hydric soils were present at the time of the site visit, with redoximorphic features occupying 10 percent of the matrix. A clay layer was found at a depth of approximately 18 inches, which likely serves as a confining layer. The presence of surface water over much of the year combined with accumulated inputs of decomposing vegetation should lead to continued hydric soil development site-wide. These factors led to a soils score of 20 out of a possible 20, or 100 percent.

Hydrology

In November 2009, during a time of above average rainfall, about 70 percent of the wetland was inundated with up to 12 inches of surface water. Thirty percent was saturated due to an elevated water table. Other indicators of wetland hydrology present during the site visit included silt deposition and water marks. The source of hydrology to the pond is surface runoff. Furthermore, the pond is hydrologically connected to Turkey Branch, which is nearby to the west. The Matthew Henson I stormwater wetland received a hydrology score of 29 out of a possible 30, or 97 percent.

Wetland Functional Gains

The wetland complex was determined to provide several biological, hydrologic, and water quality functions, including 1) providing habitat for fish, reptiles, amphibians, and other wetland dependent and non-dependent wildlife, 2) furnishing organic material to aquatic food webs, 3) filtering sediments, pollutants, and excess nutrients, and 4) storing, slowing, or reducing headwater flow.

Overall Wetland Score

Overall, this restoration site appears to support highly functioning wetlands, based on a functional score of 17 out of a possible 20 points. The total score for the entire site was 94.8 out of a possible 100. Field data sheets for this task are included in ***Appendix D***.

Matthew Henson II Stormwater Pond

The Matthew Henson II stormwater pond is located south of Ralph Road and Georgia Avenue and is immediately adjacent to the right bank of Turkey Branch (***Figure 2.23.51***). This planned emergent wetland was monitored in 2009 using the *MDE Mitigation Site Scoring Method* (2007) in order to evaluate the success of planted wetland vegetation after restoration.

Vegetation

While open water was the dominant cover type site-wide, wetland vegetation was generally present around the periphery of the pond. This open area was planned to be vegetated with water smartweed, however no vegetation was observed in the open water area. ***Figure 3.23.50*** is an image of the pond at the time of wetland vegetation monitoring in 2009. Based on the dominant species observed, future vegetative cover was estimated to be 20 percent herbaceous and 10 percent forested, although at the time of the 2009 site visit this ten percent cover was assessed as a scrub shrub vegetation type since the tree species present were very small. The herbaceous community was characterized by *Pontedaria cordata* (pickerelweed), *Iris versicolor* (harlequin blueflag), and broadleaf cattail. Cover estimates for these species were five, two, and two percent, respectively. One to two foot tall black willow trees occurred across much of the western pond edge. These trees did not appear stressed despite their small size. Evidence of browsing by deer was not present at the time of the site visit. A relatively high density of desirable, native wetland vegetation around the edges of the pond led to a vegetation score of 17 out of a possible 30, or 57 percent. This score reflects the open water unvegetated portion of the wetland that was planned to be vegetated.

Figure 3.23.50 – Matthew Henson II Stormwater Pond 2009 (vegetated strip along western edge of pond, with pickerelweed and other herbaceous plants pictured)

Figure 3.23.51 – Locations of the 2009 Monitored Wetland Zones at the Matthew Henson II Stormwater Pond

Soils

Hydric soils were observed during the site visit, with redoximorphic features occupying 15 percent of the soil matrix. The presence of surface water over much of the year combined with accumulated inputs of decomposing vegetation should lead to continued hydric soil development site-wide. These factors led to a soils score of 20 out of a possible 20, or 100 percent.

Hydrology

In November 2009, during a time of above average rainfall, about 90 percent of the wetland was inundated with at least one inch of surface water. Ten percent was saturated due to an elevated water table. Other indicators of wetland hydrology present during the site visit included silt deposition and water marks. The source of hydrology to the pond is surface runoff. Furthermore, the pond is hydrologically connected to Turkey Branch, which is nearby to the east. The Matthew Henson II stormwater wetland received a hydrology score of 23 out of a possible 30, or 77 percent. This was due to a lack of planned vegetation within the open water area of the pond. The open water area seems to be too deep to support the planted emergent vegetation.

Wetland Functional Gains

The wetland complex was determined to provide several biological, hydrologic, and water quality functions, including 1) providing habitat for fish, reptiles, amphibians, and other wetland dependent and non-dependent wildlife, 2) furnishing organic material to aquatic food webs, 3) filtering sediments, pollutants, and excess nutrients, and 4) storing, slowing, or reducing headwater flow. Overall, this restoration site appears to support highly functioning wetlands, based on a functional score of 17 out of a possible 20 points.

Overall Wetland Score

The total score for the entire site was 77 out of a possible 100. Field data sheets for this task are included in ***Appendix D***.

Peppertree Farm Stormwater Pond

The Peppertree Farm stormwater pond is located east of Pear Tree Lane near the end of Peppertree Lane (***Figure 3.23.7***). Prior to the 2007 restoration activities, this area was a dry pond, having base flow running through concrete pilot channels. ***Figure 3.23.52*** shows an aerial view and ***Figure 3.23.53*** shows a ground view of the Peppertree site prior to restoration.

Figure 3.23.52 – Aerial View of the Peppertree Farm Dry Pond Prior to the Retrofit in 2007

Figure 3.23.53 – Ground View of the Peppertree Farm Dry Pond Prior to the Retrofit in 2007

After restoration, this planned scrub-shrub/emergent wetland was monitored in 2009 using the *MDE Mitigation Site Scoring Method* (2007) in order to evaluate the success of planted wetland vegetation after the retrofit in 2007. Two distinct vegetative zones were observed and assessed (herbaceous & scrub-shrub), the results of which are presented separately below (***Figure 3.23.55***).

Vegetation

Open water was the dominant cover type site-wide, however wetland vegetation was extensive both around the edges of the ponded areas as well as on slightly raised areas between the open water cells (***Figure 3.23.54***). Based on the dominant species observed, future vegetative cover was estimated to be 80 percent herbaceous and 20 percent scrub-shrub over the entire site. The herbaceous zone was characterized by *Ludwigia peploides* (floating primerose-willow), *Panicum virgatum* (switchgrass), broadleaf cattail, and pickerelweed. These species accounted for approximately 25, 25, 20, and 10 percent cover, respectively. *Betula nigra* (river birch) was the only dominant woody species, although a few *Cercis canadensis* (eastern redbud) and black willow individuals were also observed. These represent the only surviving planted trees in the herbaceous zone. Deer activity such as browsing and scraping may be limiting the success of the plantings in this zone.

The scrub-shrub zone was characterized by the presence of relatively abundant *Cephalanthus occidentalis* (common buttonbush) and *Alnus serrulata* (smooth alder) (***Figure 3.23.56***). These plants comprised 20 and five percent cover, respectively. Planted shrubs were generally about five feet tall and did not seem stressed. Some deer browse was noticeable, but the plantings did not appear to be significantly impacted. Herbaceous plants observed, including switchgrass, broadleaf cattail, and pickerelweed, constituted 25, 20, and 10 percent cover in the scrub-shrub zone, respectively. Due to a high density of desirable, native wetland vegetation in the palustrine scrub shrub (PSS) portion of the site, a vegetation score of 27.5 out of 30 (92 percent) was given. The palustrine Emergent (PEM) portion of the site, despite dense herbaceous growth, only scored a 24.2 out of 30 (81 percent) due to the presence of the non-native floating primerose-willow.

Figure 3.23.54 – Peppertree Farm Stormwater Pond 2009 (looking north at emergent portion of site from end of Peppertree Lane)

Figure 3.23.55 – Locations of the 2009 Monitored Wetland Zones at the Peppertree Farm Stormwater Pond

Figure 3.23.56 – Peppertree Farm Stormwater Pond 2009 (scrub shrub area in northern portion of created wetland Black willow, switchgrass, and broadleaf cattail among plants pictured)

Soils

Both the herbaceous and scrub-shrub portions of the site contained hydric soils at the time of the site visit, with redoximorphic features occupying 5 percent of the matrix. The presence of surface water over much of the year combined with accumulated inputs of decomposing vegetation should lead to continued hydric soil development site-wide. These factors led to a soils score, in both the PEM and PSS portion of the wetland, of 20 out of a possible 20, or 100 percent.

Hydrology

In November 2009, during a time of above average rainfall, about 95 percent of the wetland complex was inundated with up to 30 inches of surface water. Five percent was saturated due to an elevated water table. Other indicators of wetland hydrology present during the site visit included silt deposition, bent vegetation, and water marks. The source of hydrology to the wetland is surface runoff. Furthermore, the wetland serves as a hydrologic source to Turkey Branch, which is nearby to the south. The PEM portion of the wetland complex received a hydrology score of 29.5 out of a possible 30, or 98 percent and the PSS portion of the wetland received a score of hydrology score of 30.

Wetland Functional Gains

The wetland complex was determined to provide several biological, hydrologic, and water quality functions, including 1) providing habitat for fish, reptiles, amphibians, and other wetland dependent and non-dependent wildlife, 2) furnishing organic material to aquatic food webs, 3) filtering sediments, pollutants, and excess nutrients, 4) reducing erosion, 5) serving as a floodwater and headwater wetland (storing, slowing, or reducing floodwater flow), 6) discharging groundwater, and 7) providing recreational opportunities. The PSS portion of this restoration site appears to support highly functioning wetlands and was given a functional score

of 17; the PEM portion scored slightly higher at 19 out of 20 points. Field data sheets for this task are included in ***Appendix D***.

Overall Wetland Score

A total score for the entire site was calculated based on a weighting of the sub-scores determined by the area of each zone. The total score for the entire site was 89.3 out of a possible 100 (***Table 3.23.7***).

Table 3.23.7 – Post-Restoration Vegetation Assessment (2009)

Area #	Area Score	Portion of Total Credit (based on Sub-Area)	Sub-Score
PSS	94.5	0.1	9.5
PEM	88.7	0.9	79.8
Total		**1.0**	**89.3**

Botanical Reforestation

Riparian areas along numerous sections of the mainstem of Middle and Lower Turkey Branch were planted as a part of the restoration project. Each planting site and associated zone was located along a portion of the in-stream restoration area and was monitored to determine the success of the plantings (***Figures 3.23.5*** and ***3.23.6***). Tables comparing the number of plantings per area with the number of plants observed during the 2009 monitoring are shown below (***Tables 3.23.8*** and ***3.23.10***). Planting zones were not established until the 2009 monitoring period, so it is not possible to compare the number of original plantings per planting zone with post-restoration botanical observations per planting zone. However, plantings observed per planting zone in 2009 are presented in ***Tables 3.23.9*** and ***3.23.11*** and will be compared to future botanical monitoring at these sites.

The majority of planting occurred in 2007, however a lot of the planted material did not persist since the stock was small and most individuals were overtaken by invasive plants or browsed by deer. In 2008, the County planted additional trees and shrubs in the project area to supplement the lost plant stock. Except for plantings at site LRTB101 where few invasive plants were observed, planting survival at Turkey Branch sites was poor.

Middle Turkey Branch

Overall, reforestation success in Middle Turkey Branch was very poor. Only 0.7 percent of the plantings survived in this area (***Table 17.4.6***). *Cornus florida* (flowering dogwood) plantings were most successful, with 100 percent survival. *Populus deltoides* (eastern cottonwood), American sycamore, and *Liriodendron tulipifera* (tulip poplar or tuliptree) were the next most successful, with their survivability ranging from 6.4 to 7.5 percent. Most other planted trees and shrubs died, including all 666 *Salix purpurea* (purpleosier willow) and all but two of the 706 planted *Sambucus nigra* ssp. *Canadensis* (elderberry).

Table 3.23.8 – 2009 Botanical Reforestation Summary for Middle Turkey Branch (Site LRTB202)

Common Name	Scientific Name	Number Planted	Number Observed (2009)	Percent Survival
blackgum	*Nyssa sylvatica*	2	0	0.0
flowering dogwood	*Cornus florida*	4	5	125.0
eastern cottonwood	*Populus deltoides*	40	3	7.5
eastern redbud	*Cercis canadensis*	40	0	0.0
American black elderberry	*Sambucus nigra* ssp. *canadensis*	706	1	0.1
American hornbeam	*Carpinus caroliniana*	41	0	0.0
pin oak	*Quercus palustris*	122	0	0.0
red maple	*Acer rubrum*	19	0	0.0
red oak	*Quercus rubra*	50	1	2.0
river birch	*Betula nigra*	40	0	0.0
sassafras	*Sassafras albidum*	40	0	0.0
serviceberry	*Amelanchier canadensis*	40	0	0.0
silky dogwood	*Cornus amomum*	667	0	0.0
southern arrowwood	*Viburnum dentatum*	40	0	0.0
northern spicebush	*Lindera benzoin*	40	1	2.5
purpleosier willow	*Salix purpurea*	666	0	0.0
American sycamore	*Platanus occidentalis*	58	4	6.9
tulip poplar (tuliptree)	*Liriodendron tulipifera*	47	3	6.4
white oak	*Quercus alba*	40	0	0.0
Total		**2702**	**18**	**0.7**

LRTB202

A summary of plantings observed at site LRTB202 in 2009 per zone can be found in ***Table 3.23.9*** below. Planting zones 16 and 17 are located just downstream of the outlet of Matthew Henson II stormwater pond on the right and left bank, respectively. Within planting zone 16, few living trees were observed. Those persisting included five flowering dogwoods, one northern red oak, and one tuliptree. Planting zone 17 was devoid of woody plantings, having been completely overtaken by the invasive species Japanese stiltgrass and *Persicaria perfoliata* (mile-a-minute). Planting zones TB-1, TB-2, and TB-3 are small areas located along the mainstem of Turkey Branch, downstream of zones 16 and 17 and northwest of May Street. Poor planting success was evident at planting zone TB-1, where virtually all planted trees and shrubs were dead with the exception of one American black elderberry specimen. The only woody plantings evident within planting zone TB-2 were two individuals of eastern cottonwood and one surviving American sycamore. Only one planted shrub, northern spicebush, was found in planting zone TB-3, yet some trees persisted, including one eastern cottonwood, three American sycamore specimens, and two tuliptrees. Despite widespread failure of many of the planted trees, those that were

observed in zones 16 and 17 did appear healthy at the time of the site visit. Both Japanese stiltgrass and mile-a-minute were pervasive in these planting zones.

Table 3.23.9 – Botanical Reforestation Data for Each Planting Zone for Middle Turkey Branch (Site LRTB202)

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
TB-1	American black elderberry	*Sambucus nigra* ssp. *canadensis*	1
TB-1 LB	none observed	none observed	0
TB-1 RB	none observed	none observed	0
TB-2 LB	eastern cottonwood	*Populus deltoides*	1
	American sycamore	*Platanus occidentalis*	1
TB-2 RB	eastern cottonwood	*Populus deltoides*	1
TB-3 LB	American sycamore	*Platanus occidentalis*	3
	tuliptree	*Liriodendron tulipifera*	2
	northern spicebush	*Lindera benzoin*	1
TB-3 RB	eastern cottonwood	*Populus deltoides*	1
16	flowering dogwood	*Cornus florida*	5
	northern red oak	*Quercus rubra*	1
	tuliptree	*Liriodendron tulipifera*	1
17	none observed	none observed	0
Total			**18**

Lower Turkey Branch

Botanical reforestation survival in Lower Turkey Branch was slightly better than in Middle Turkey Branch but was still very poor, with only 2.2 percent of the plantings surviving in this area (***Table 3.23.10***). *Quercus rubra* (northern red oak) was the most successful of all planted species in the area with 55.4 percent survivability, *Sassafras albidum* (sassafras) and flowering dogwood were the next most successful plantings at 40.4 and 31.8 percent, respectively. Several species planted in the Lower Turkey Branch were not found at all during the 2009 botanical reforestation monitoring including, but not limited to, *Juniperus virginiana* (eastern red cedar), eastern cottonwood, *Cornus amomum* (silky dogwood), and *Salix purpurea* (purpleosier willow). Overall, plantings at LRTB101 were more successful than at any other site in Lower Turkey Branch.

Table 3.23.10 – Botanical Reforestation Summary for Lower Turkey Branch (Sites LRTB101, LRTB203A, LRTB203B, LRTB203C)

Common Name	Scientific Name	Number Planted	Number Observed (2009)	Percent Survival
American holly	*Ilex opaca*	160	44	27.5
blackgum	*Nyssa sylvatica*	134	25	18.7
eastern red cedar	*Juniperus virginiana*	20	0	0.0
flowering dogwood	*Cornus florida*	22	7	31.8
eastern cottonwood	*Populus deltoides*	57	0	0.0
eastern redbud	*Cercis canadensis*	57	4	7.0
American black elderberry	*Sambucus nigra* ssp. *canadensis*	2227	5	0.2
American hornbeam	*Carpinus caroliniana*	57	12	21.1
paw-paw	*Asimina triloba*	29	0	0.0
pin oak	*Quercus palustris*	172	3	1.7
red maple	*Acer rubrum*	205	55	26.8
northern red oak	*Quercus rubra*	56	31	55.4
river birch	*Betula nigra*	57	5	8.8
sassafras	*Sassafras albidum*	57	23	40.4
silky dogwood	*Cornus amomum*	5190	0	0.0
southern arrowwood	*Viburnum dentatum*	57	1	1.8
northern spicebush	*Lindera benzoin*	57	9	15.8
purpleosier willow	*Salix purpurea*	3688	0	0.0
American sycamore	*Platanus occidentalis*	249	25	10.0
tuliptree	*Liriodendron tulipifera*	160	39	24.4
white maple	*Acer saccharum*	92	0	0.0
white oak	*Quercus alba*	57	0	0.0
Total		**12860**	**288**	**2.2**

LRTB101

As mentioned above, this planting area was the most successful of all in the Turkey Branch project area (***Figure 3.23.57***). A summary of plantings observed at this site in 2009 per zone can be found in ***Table 3.23.11*** below. Planting zone 12 is located on the right bank of an unnamed tributary to Turkey Branch between Connecticut Avenue and Turkey Branch Parkway, beginning near Independence Street and extending south for approximately 500 feet. This area was

characterized by relatively abundant *Ilex americana* (American holly) and *Acer rubrum* (red maple), of which 10 and eight individuals were observed, respectively. Four individuals of tuliptree were also identified, followed by only one observed specimen each of flowering dogwood and *Nyssa sylvatica* (blackgum). All surviving woody plants observed appeared healthy. The only invasive plant observed in this zone was *Alliaria petiolata* (garlic mustard). Planting zone 13 is just south of Planting zone 12, on the left bank of the unnamed tributary near Burlwood Drive. This area was comparatively more diverse, but had fewer surviving individuals. Only one or two trees of each of the following species occurred within the area: *Quercus rubra* (northern red oak), *Carpinus caroliniana* (American hornbeam), *Platanus occidentalis* (American sycamore), eastern redbud, *Sassafras albidum* (sassafras), *Sambucus nigra* var. *canadensis* (American black elderberry), *Viburnum dentatum* (southern arrowwood), and tuliptree. All surviving woody plants observed appeared healthy. Invasive plants found growing in this zone included garlic mustard and *Microstegium vimineum* (Japanese stiltgrass).

Figure 3.23.57 – Site LRTB101, Zone 13 (planted American sycamore)

Table 3.23.11 – Botanical Reforestation Data for Each Planting Zone at Lower Turkey Branch Site LRTB101

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
12	American holly	*Ilex opaca*	10
	blackgum	*Nyssa sylvatica*	1
	flowering dogwood	*Cornus florida*	1
	red maple	*Acer rubrum*	8
	tuliptree	*Liriodendron tulipifera*	4
13	American hornbeam	*Carpinus caroliniana*	2
	American sycamore	*Platanus occidentalis*	1
	eastern redbud	*Cercis canadensis*	1
	American black elderberry	*Sambucus nigra* ssp. *canadensis*	1
	northern red oak	*Quercus rubra*	2
	sassafras	*Sassafras albidum*	1

Table 3.23.11 – Botanical Reforestation Data for Each Planting Zone at Lower Turkey Branch Site LRTB101

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
	southern arrowwood	*Viburnum dentatum*	1
	tuliptree	*Liriodendron tulipifera*	1
Total			**34**

LRTB203A

This area consists of several planting zones north of Littleton Street, extending west along the mainstem of Turkey Branch from the Connecticut Avenue bridge crossing to just northwest of Jeffry Street. A summary of plantings observed at this site in 2009 per zone can be found in ***Table 3.23.12*** below. Few surviving woody plantings were observed in zones LTB-2 and LTB-3. Four American holly specimens and one blackgum occurred in these areas, respectively. Planting zones LTB-4, LTB-6 and LTB-7 were devoid of planted vegetation, which presumably were out-competed by non-native species. Zone LTB-8 contained a few healthy plantings including seven red maple and six sycamore, it also contained one damaged sycamore and one stressed red maple. Zone LTB-9 had one American sycamore and one blackgum. In contrast, planting zone LTB-10 was characterized by relatively abundant tuliptree, blackgum, American holly, red maple, and American sycamore. Counts for these species were 26, 21, 18, 16, and 10, respectively. Additionally, one sassafras, one flowering dogwood, and three *Betula nigra* (river birch) individuals were observed. Invasive exotic plants were extensive throughout LRTB203A, as they were observed in zones LTB-3, 6, 7, 8, 9, and 10. Japanese stiltgrass and mile-a-minute were dominant in these areas. ***Figure 3.23.58*** is an example of the botanical plantings found at site LRTB203A.

Table 3.23.12 – Botanical Reforestation Data for Each Planting Zone at Lower Turkey Branch Site LRTB203A

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
LTB-2	American holly	*Ilex opaca*	4
LTB-3	blackgum	*Nyssa sylvatica*	1
LTB-4	none observed	none observed	0
LTB-6	none observed	none observed	0
LTB-7	none observed	none observed	0
LTB-8	American sycamore	*Platanus occidentalis*	4
LTB-9	American sycamore	*Platanus occidentalis*	1
	blackgum	*Nyssa sylvatica*	2
LTB-10	American holly	*Ilex opaca*	18
	American sycamore	*Platanus occidentalis*	10
	blackgum	*Nyssa sylvatica*	21

Table 3.23.12 – Botanical Reforestation Data for Each Planting Zone at Lower Turkey Branch Site LRTB203A

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
	flowering dogwood	*Cornus florida*	1
	red maple	*Acer rubrum*	16
	tuliptree	*Liriodendron tulipifera*	26
LTB-10 RB	river birch	*Betula nigra*	3
	sassafras	*Sassafras albidum*	1
Total			**108**

Figure 3.23.58 – Site LRTB203A, LTB-8 2008 versus 2009 (planted American sycamore with stiltgrass covering herbaceous layer)

LRTB203B

This area consists of several planting zones that extend approximately 0.8 miles along the main stem of Turkey Branch, from near Federal Street and Turkey Branch Parkway south to Veirs Mill Road. A summary of plantings observed at this site in 2009 per zone can be found in ***Table 3.23.13*** below.

Zone LTB-1, which occurs on both banks, contained seven species. These included American holly, flowering dogwood, American sycamore, American hornbeam, sassafras, red maple, and tuliptree.

The Grenoble Drive planting zone also occupied both banks of Turkey Branch. In this area, woody planting success was marginal. A total of 25 individuals were counted representing the following species: sassafras, northern red oak, red maple, American black elderberry, eastern redbud, and American sycamore. Plantings in this zone were on the left and right banks, with most plantings occurring on the left bank.

Immediately downstream lies the Faroe Place planting zone, which was also characterized by marginal success of woody plantings. Plantings on both banks fared similarly, as 14 individuals were observed on both banks (28 cumulatively), representing 10 species collectively.

The Bayne Street planting zone is the largest, and is adjacent to the Faroe Place zone, extending approximately 750 feet downstream. This zone, despite its large size, contained the fewest number of surviving woody plantings in the LRTB203B area. No plantings persisted on the left bank, while the right bank contained 10 individuals, including five red maples, two sassafras, two northern spicebush, and one American sycamore.

Poor survival was also observed in the Danvers Street planting zone, which is found just east of Plaza Place and Turkey Branch Parkway. Only 11 individuals were observed on the left bank, most of which were red maples or northern spicebush. Only one specimen each of tuliptree and northern red oak were counted. On the right bank, one northern spicebush was the only woody planting found to persist.

The Veirs planting zones, LB, RB, and LB-2, are located just downstream of the aforementioned zones, extending south along Turkey Branch to the Veirs Mill Road bridge crossing (***Figure 3.23.59***). Planting success was marginal in these areas, given the relative success of red maple and northern red oak plantings, which numbered 12 and 15, respectively. Two eastern redbuds and two sassafras were observed, as well as one each of American hornbeam, northern spicebush, and tuliptree. These specimens appeared healthy at the time of the site visit; although invasive exotic plants occupied every assessed planting zone within LRTB203B, including Japanese stiltgrass and mile-a-minute.

Table 3.23.13 – Botanical Reforestation Data for Each Planting Zone at Lower Turkey Branch Site LRTB203B

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
LTB-1	American holly	*Ilex opaca*	12
	American sycamore	*Platanus occidentalis*	4
	flowering dogwood	*Cornus florida*	4
LTB-1 LB	tuliptree	*Liriodendron tulipifera*	1
LTB-1 RB	American hornbeam	*Carpinus caroliniana*	2
	red maple	*Acer rubrum*	1
	sassafras	*Sassafras albidum*	1
LTB-Grenob LB	American sycamore	*Platanus occidentalis*	1
	eastern redbud	*Cercis canadensis*	1
	American black elderberry	*Sambucus nigra* ssp. *canadensis*	2
	red maple	*Acer rubrum*	2
	red oak	*Quercus rubra*	7
	sassafras	*Sassafras albidum*	8
LTB-Grenob RB	American hornbeam	*Carpinus caroliniana*	1
	American black elderberry	*Sambucus nigra* ssp. *canadensis*	1

Table 3.23.13 – Botanical Reforestation Data for Each Planting Zone at Lower Turkey Branch Site LRTB203B

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
	red maple	*Acer rubrum*	1
	sassafras	*Sassafras albidum*	1
LTB-Faroe LB	American black elderberry	*Sambucus nigra* ssp. *canadensis*	1
	flowering dogwood	*Cornus florida*	2
	red maple	*Acer rubrum*	2
	northern red oak	*Quercus rubra*	4
	river birch	*Betula nigra*	1
	sassafras	*Sassafras albidum*	1
	tuliptree	*Liriodendron tulipifera*	3
LTB-Faroe RB	American hornbeam	*Carpinus caroliniana*	1
	American sycamore	*Platanus occidentalis*	1
	pin oak	*Quercus palustris*	3
	red maple	*Acer rubrum*	1
	northern red oak	*Quercus rubra*	2
	river birch	*Betula nigra*	1
	sassafras	*Sassafras albidum*	3
	tulip tree	*Liriodendron tulipifera*	2
LTB-Bayne RB	American sycamore	*Platanus occidentalis*	1
	northern spicebush	*Lindera benzoin*	2
	red maple	*Acer rubrum*	5
	sassafras	*Sassafras albidum*	2
LTB-Danver LB	northern spicebush	*Lindera benzoin*	5
	red maple	*Acer rubrum*	4
	northern red oak	*Quercus rubra*	1
	tulip tree	*Liriodendron tulipifera*	1
LTB-Danver RB	northern spicebush	*Lindera benzoin*	1
LTB-Viers LB	American hornbeam	*Carpinus caroliniana*	1
	eastern redbud	*Cercis canadensis*	2
	northern spicebush	*Lindera benzoin*	1
	red maple	*Acer rubrum*	7
	red oak	*Quercus rubra*	11
	sassafras	*Sassafras albidum*	2
	tulip tree	*Liriodendron tulipifera*	1

Table 3.23.13 – Botanical Reforestation Data for Each Planting Zone at Lower Turkey Branch Site LRTB203B

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
LTB-Viers RB	red maple	*Acer rubrum*	5
	red oak	*Quercus rubra*	4
Total			**134**

Figure 3.23.59 – Site LRTB203B, Viers LB Zone

LRTB203C

This area consists of a relatively small planting zone on the left bank of Turkey Branch just downstream of the Veirs Mill Road crossing, north of Edgebrook Road. A summary of plantings observed at this site in 2009 per zone can be found below in ***Table 3.23.14***. Five species were observed, totaling 14 individuals of American hornbeam, sassafras, red maple, American sycamore, and flowering dogwood. All of the observed planted trees appeared healthy at the time of the site visit. Mile-a-minute was the only dominant invasive plant observed in this area.

Table 3.23.14 Botanical Reforestation Data for Each Planting Zone in Lower Turkey Branch Site LRTB203C

Planting Zone	Common Name	Scientific Name	Number Observed (2009)
LTB-Edgebrook LB	American hornbeam	*Carpinus caroliniana*	5
	American sycamore	*Platanus occidentalis*	2
	flowering dogwood	*Cornus florida*	1
	red maple	*Acer rubrum*	3
	sassafras	*Sassafras albidum*	3
Total			**14**

Temperature

Temperature data were collected in the vicinity of the three stormwater ponds associated with the Turkey Branch restoration project (Matthew Henson I and II, and Peppertree Farm). Pre-restoration temperature data were only collected in the vicinity of Matthew Henson I. Post-restoration data were collected in 2009 at all three ponds. Each pond had its own set of temperature loggers to assess temperature regimes upstream and downstream of the pond(s) and in the case of the Peppertree ponds, within the ponds themselves. ***Figures 3.23.6*** and ***3.23.7*** show the locations of all temperature loggers and the rain gage. Temperature profiles associated with each pond were plotted together with precipitation data (post-restoration only) and are presented below in the section that corresponds to each pond. Precipitation data were obtained from the Turkey Branch rain gage installed at the Wheaton Wood Elementary School in the Lower Turkey Branch area, approximately one mile southwest of the Matthew Henson stormwater ponds.

Matthew Henson I Stormwater Pond

In 2006, pre-restoration temperature data were collected in the project area from sites LRTB1001 and LRTB1002. These two sites are located on a tributary to Turkey Branch, southwest of Georgia Avenue (MD 97). The logger at LRTB1001 was deployed upstream of the future site of Matthew Henson I stormwater pond and the logger at LRTB1002 was deployed downstream (***Figure 3.23.6***). The average temperatures were 69.8 ºF and 62.0 ºF at sites LRTB1001 and LRTB1002, respectively. No readings at either site exceeded the Use I COMAR temperature standard of 90 ºF. The maximum temperature at LRTB1001 (87.5ºF) was higher than the maximum temperature at LRTB1002 (75.6ºF). Temperature profiles from 2006 are plotted in ***Figure 3.23.60***.

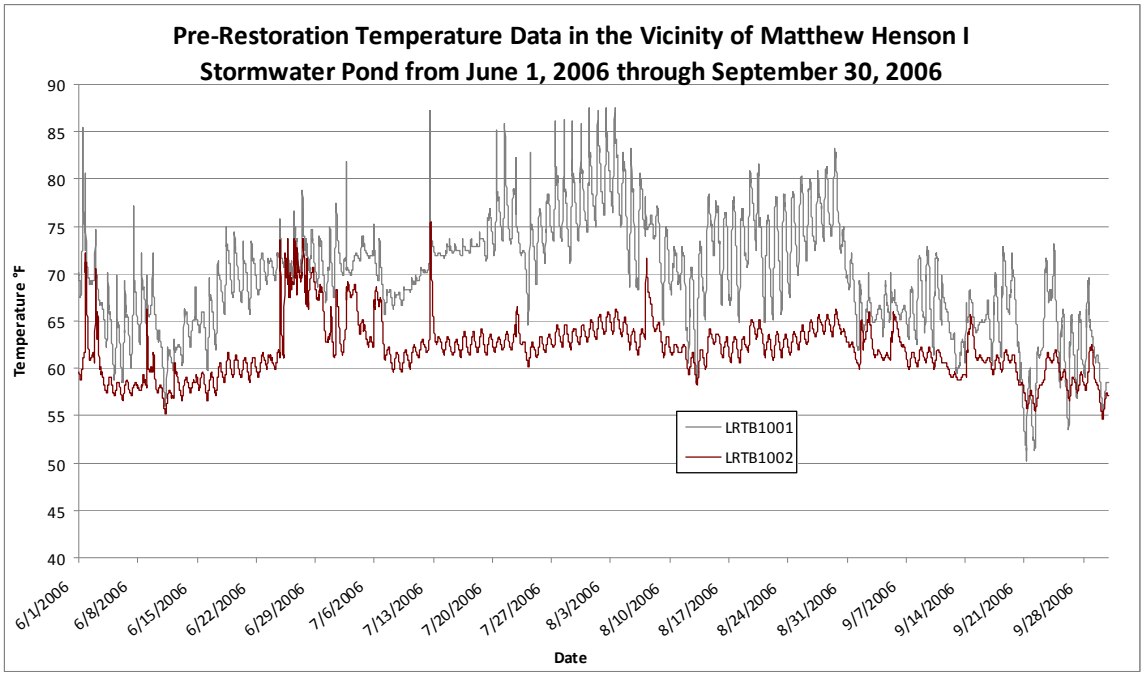


Figure 3.23.60 – Pre-restoration Stream Temperature Data from Matthew Henson I Stormwater Pond (Sites LRTB1001 and LRTB1002) from June 1 to September 30, 2006

Post-restoration temperature data were collected in 2009 at Matthew Henson I sites LRTB1001 (upstream) and LRTB1002 (downstream). Temperatures did not exceed the Use I temperature threshold at either of these sites. The average temperature upstream of the Matthew Henson I stormwater pond was 68.9°F. The average temperature downstream of the pond was 63.4°F, 5.5°F lower than the upstream site. ***Table 3.23.15*** shows the minimum, maximum, and average temperature at both Matthew Henson I sites, and the differences between these values. The maximum temperature in 2009 was also higher upstream (85.4°F) of the pond than downstream (75.9°F). In addition, a paired t-test performed on the 2009 data, comparing means between the upstream and downstream site, yielded a highly significant difference (p value <0.0001) between temperatures upstream and downstream of the pond. In this case, temperatures were significantly higher upstream of the pond than below. Post-restoration temperature profiles from all sites are plotted and presented below (***Figures 3.23.61*** and ***3.23.62***).

Table 3.23.15 – Min, Max, and Average Stream Temperatures in the Vicinity of the Matthew Henson I Stormwater Pond in 2009

Site (Location)	LRTB1001 (US)	LRTB1002 (DS)	Δ*
Average (°F)	68.9	63.4	-5.5
Min (°F)	50.4	57.9	7.5
Max (°F)	85.4	75.9	-9.5
Percentage of readings exceeding Use I standard (90 °F)	0	0	0

* the delta symbol (Δ) is used to represent change in temperature from upstream to downstream

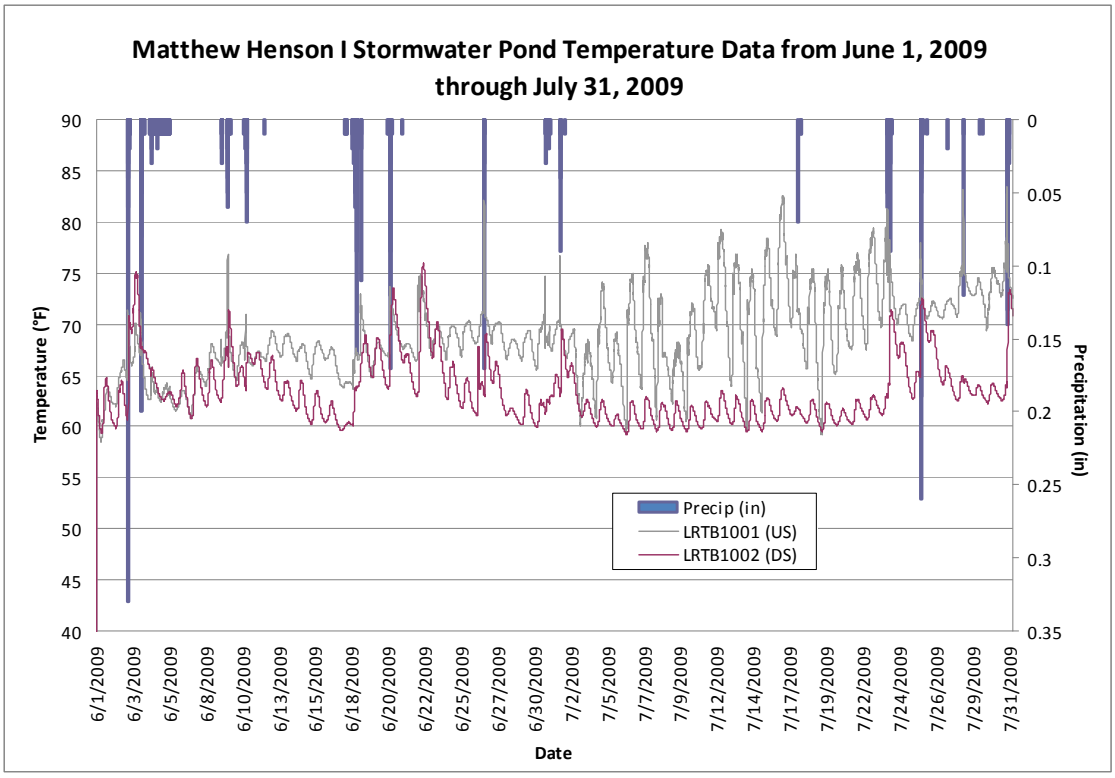


Figure 3.23.61 – Stream Temperature in the Vicinity of the Matthew Henson I Stormwater Pond at Sites LRTB1001 (US) and LRTB1002 (DS), from June 1 to July 31, 2009

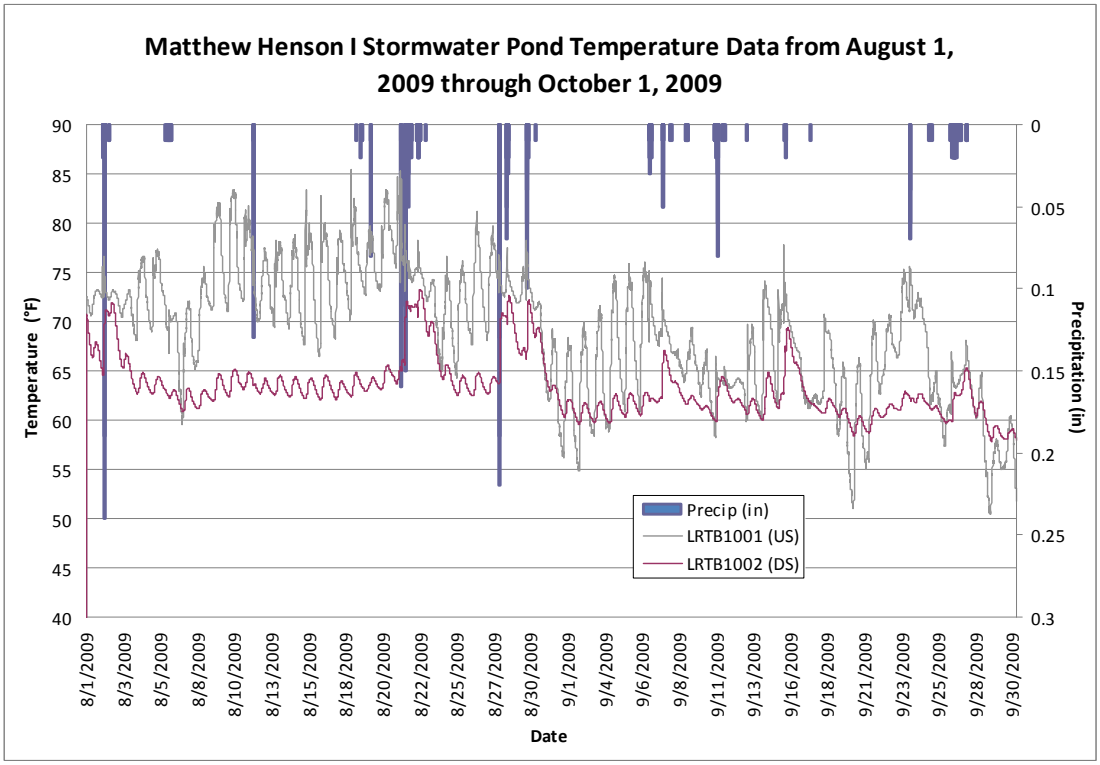


Figure 3.23.62 – Stream Temperature in the Vicinity of the Matthew Henson I Stormwater Pond at Sites LRTB1001 (US) and LRTB1002 (DS), from August 1 to September 30, 2009

Matthew Henson II Stormwater Pond

Sites LRTB0001 and LRTB0002 are located upstream of Matthew Henson II stormwater pond and LRTB0003 is located downstream of the pond (***Figure 3.23.6***). The stream LRTB0002 is on a separate tributary to Matthew Henson II than LRTB0001 and carries stormwater runoff from the neighborhood roads. The average temperature upstream of the Matthew Henson II stormwater pond was 69.0°F at LRTB0001 and 69.6°F at LRTB0002. ***Table 3.23.16*** shows the minimum, maximum, and average temperature at each site, and the differences between these values at the up and downstream sites.

The average temperature below the pond at site LRTB0003 was 70.9°F, 1.9°F and 1.3°F higher than the two upstream sites. The maximum temperature in 2009 was also higher downstream of the stormwater pond than upstream, with maximum temperatures ranging from 3.2 to 4.2 degrees higher downstream of the pond. At the time of temperature logger retrieval, the stream at site LRTB0002 was dry; this stream is thought to have only intermittent or ephemeral flow. Therefore, data from this logger may often have been collecting air temperatures instead of stream temperatures and data should be used carefully. As a result, a paired t-test was not performed comparing the means between this site (LRTB0002) and the downstream site, LRTB0003. A paired t-test was performed on the 2009 data, comparing the means between the other upstream site (LRTB0001) and the downstream site (LRTB0003) yielding a highly significant difference (p value <0.0001), with the stream temperatures downstream having a statistically higher mean than upstream of the pond. Post-restoration temperature profiles from all Matthew Henson II sites are presented below (***Figures 3.23.63*** and ***3.23.64***).

Table 3.23.16 – Min, Max, and Average Stream Temperatures in the Vicinity of the Matthew Henson II Stormwater Pond in 2009

Site (Location)	LRTB0001 (US)	Δ*	LRTB0002 (US)	Δ	LRTB0003 (DS)
Average (°F)	69.0	1.9	69.6	1.3	70.9
Min (°F)	60.2	-6.9	60.1	-6.8	53.3
Max (°F)	81.2	4.2	82.2	3.2	85.4
Percentage of readings exceeding Use I standard (90 °F)	0	0	0	0	0

* the delta symbol (Δ) is used to represent change in temperature from upstream to downstream

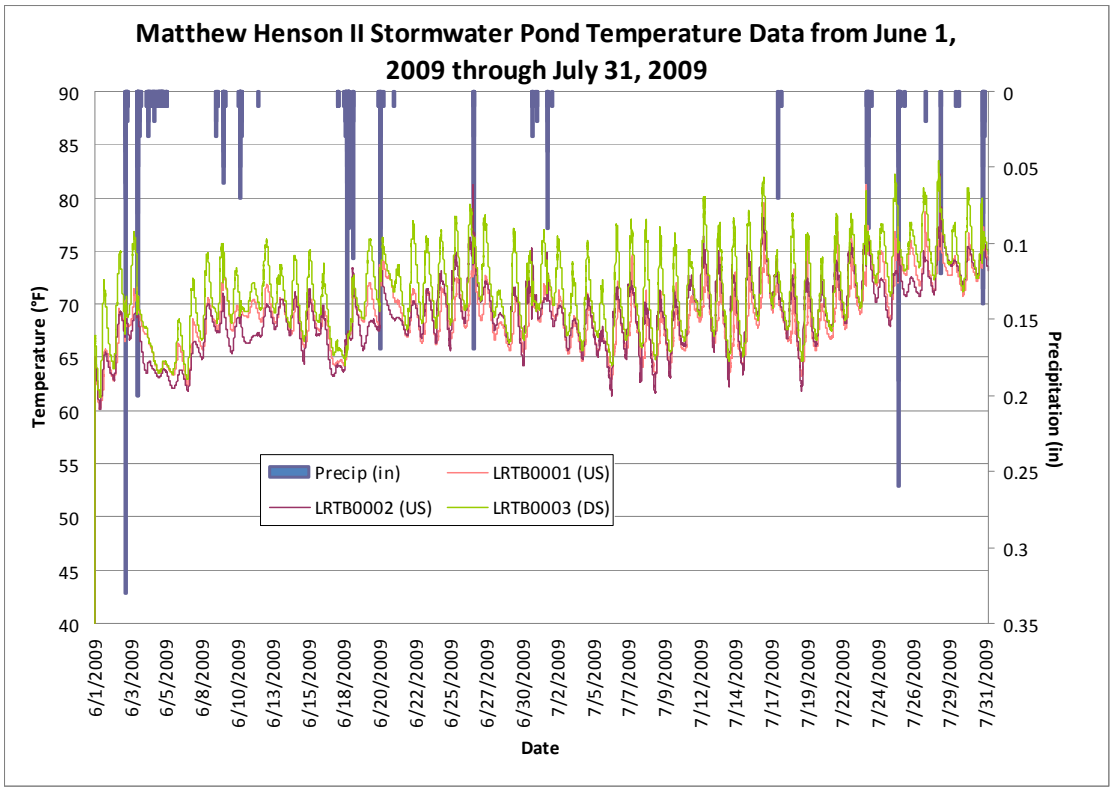


Figure 3.23.63 – Stream Temperature in the Vicinity of the Matthew Henson II Stormwater Pond at Sites LRTB0001 (US), LRTB0002 (US), LRTB0003 (DS), from June 1 to July 31, 2009

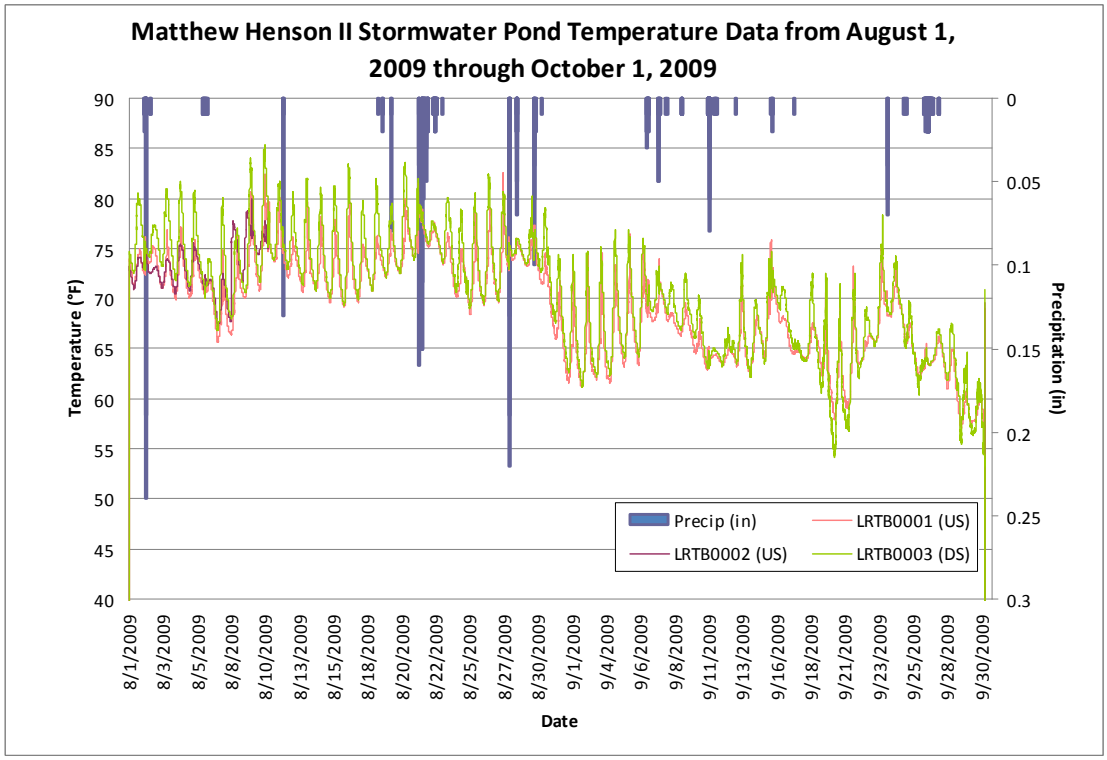


Figure 3.23.64 – Stream Temperature in the Vicinity of the Matthew Henson II Stormwater Pond at Sites LRT0001 (US), LRTB0002 (US), and LRTB0003 (DS), from August to September 30, 2009

Peppertree Farm Stormwater Pond

Sites LRTB1004, LRTB1005, LRTB1006 are located in three open water cells of the Peppertree Farm stormwater pond complex and LRTB1007 is located downstream of the pond. Average temperatures from within the three Peppertree stormwater ponds ranged from 73.0°F to 74.7°F. The average stream temperature downstream of the stormwater ponds was lower than in any of the ponds at 72.3°F. However, it is apparent from the hydrographs below, that the pond loggers were often dewatered and recording air temperatures due to a large fluctuation in pond water levels. Therefore temperature data from the ponds should be used very carefully. ***Table 3.23.17*** shows the minimum, maximum, and average temperature at each site, and the differences between these values at the pond sites and downstream site.

Table 3.23.17 – Min, Max, and Average Stream Temperatures in the Vicinity of the Peppertree Farm Stormwater Pond in 2009

Site (Location)	LRTB1004 (Pond)	Δ*	LRTB1005 (Pond)	Δ	LRTB1006 (Pond)	Δ	LRTB1007 (DS)
Average Temperature (°F)	73.0	-0.7	73.4	-1.1	74.7	-2.4	72.3
Min Temperature (°F)	47.6	11.4	45.0	14.0	42.5	16.5	59.0
Max Temperature (°F)	124.9+	-41.4+	119.6+	-36.1+	121.6+	-38.1+	83.5
Percentage of readings exceeding Use I standard (90 °F)	8.6	-8.6	13.3	-13.3	17.9	-17.9	0

* the delta symbol (Δ) is used to represent change in temperature from upstream to downstream

+ loggers deployed in the ponds were often dewatered and likely collecting sun exposed air temperatures, data should be used carefully

None of the temperature values downstream of the ponds exceeded the Use I threshold of 90°F. The minimum temperatures from within the ponds were much lower than measured in the stream below the ponds, ranging from 11.4 to 16.5°F lower, and the maximum temperatures within the ponds were much higher than measure in the stream, ranging from 36.1 to 41.1 degree higher. Maximum summer temperatures within the pond were extremely high, ranging from 120 to 125°F, nearly 35°F above the Use I temperature standard. Between 8.6 and 17.9 percent of the readings taken from within the ponds exceeded the Use I temperature standard of 90°F. Yet, it is clear that the loggers were often dewatered, recording air temperatures; these data should not be used to document thermal impacts from the ponds. Therefore, paired t-tests comparing mean temperatures between each of the ponds and the stream temperature downstream were not possible. At the time of installation, the loggers were deployed as deep as possible; however, when they were retrieved, all three pond loggers were dewatered. An improved methodology has been developed to prevent this from happening in the future.

Figures 3.23.65 and ***3.23.66*** show the temperature profiles of all Peppertree Farm stormwater pond loggers.

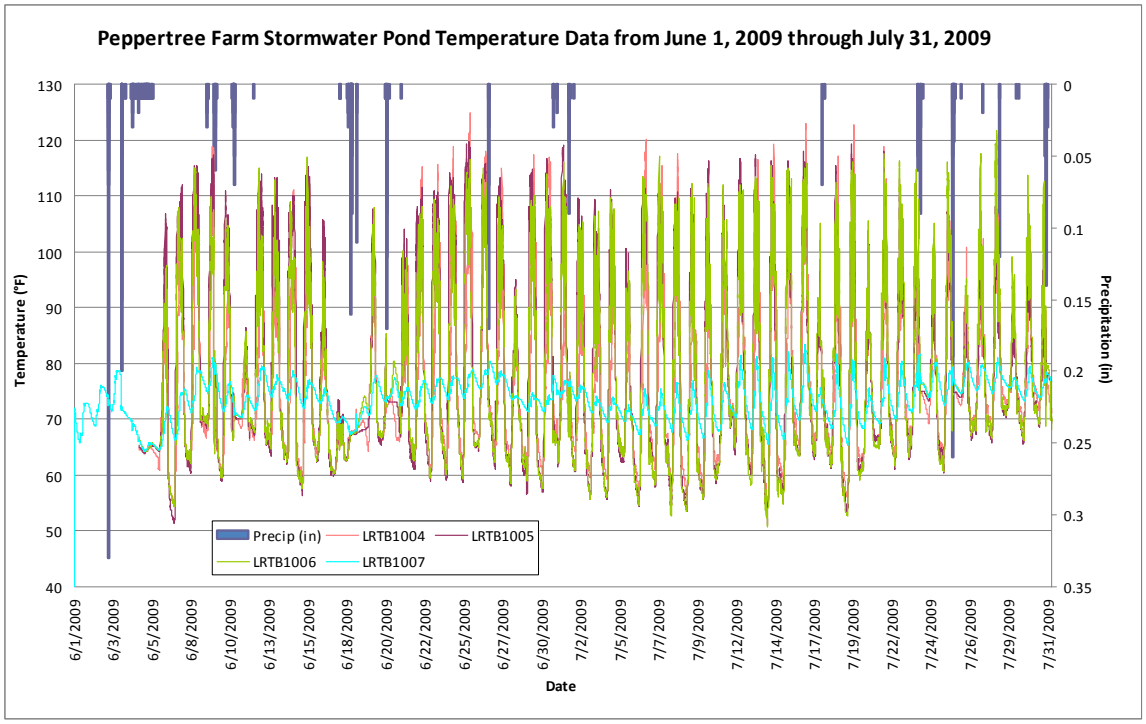


Figure 3.23.65 – Stream Temperature in the Vicinity of the Peppertree Stormwater Pond at Sites LRTB1004,LRTB1005, LRTB1006, and LRTB1007, from June 1 to July 31, 2009

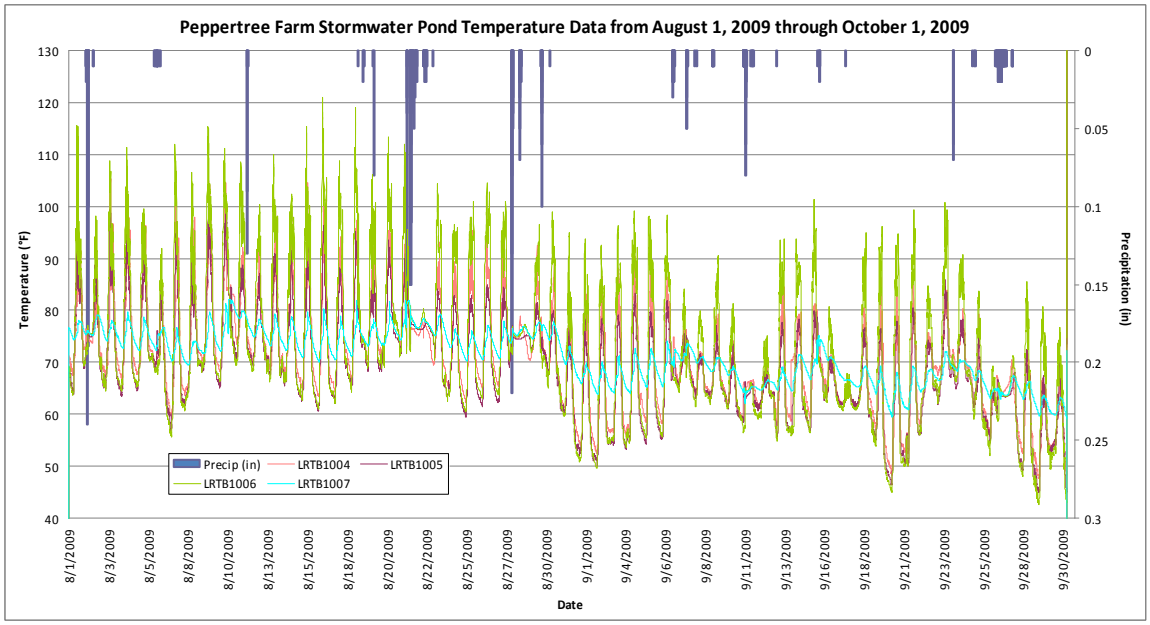


Figure 3.23.66 – Stream Temperature in the Vicinity of the Peppertree Stormwater Pond at Sites LRTB1004,LRTB1005, LRTB1006, and LRTB1007, from August 1 to September 30, 2009

3.23.5 Discussion

Table 3.23.18 below provides a summary of project goals, the results of post-restoration monitoring, and whether each project goal has been met by the restoration actions as assessed by the first year of post-restoration monitoring. One of the project goals was successfully met and

four were partially met, and two project goals could not be evaluated in 2009 and will be assessed in 2010.

Table 3.23.18 – Summary of Project Goal Results

Goal	Result
Improve aquatic habitat conditions in Turkey Branch	Partially successful – frequency of riffles improved at all sites; some sites had improved fish and benthic habitat and others had a decline
Improve water quality in Turkey Branch	Partially successful – increasing trend in the fish community, general declining trend in the benthic macroinvertebrate community
Avoid introduction of new thermal impacts in Turkey Branch	Partially successful – no thermal impacts were observed downstream of Matthew Henson I or Peppertree stormwater ponds but were observed downstream of Matthew Henson II
Reduce stream erosion and sedimentation	Unable to determine – quantitative survey data from 2010 will suggest if these goals have been met
Reduce erosive stream flows	Unable to determine – quantitative survey data from 2010 will suggest if these goals have been met
Improve stormwater management quantity control	Unable to determine – quantitative survey data from 2010 will suggest if these goals have been met
Create wetlands	Successful - open water, emergent and scrub shrub wetlands now exist in the restoration area that was previously open field
Reforest riparian zone	Partially successful – trees have been planted and allowed to grow in the restoration area that was previously sparsely vegetated; however, many plantings have died and most planted areas have extensive invasive species present

Partially Successful – Aquatic Habitat

All sites had improved riffle frequency and increased streambank stability after restoration. Aquatic habitat scores did not change much after restoration; some sites saw a decline in in-stream cover and epifaunal substrate scores while others saw an improvement. Future monitoring will assess aquatic habitat conditions throughout the project area to evaluate the effectiveness of the stream restoration.

Partially Successful – Water Quality

Overall, the fish community generally remained similar pre- and one year post-restoration. Slight improvements were observed at a few of the sites, mostly due to an increase in the proportion of longnose dace, an intermediately tolerant fish species. An increase in the percentage of invertivores, a specialized feeding group, was also observed at site LRTB203C,

indicating an improvement in the fish community at this site. Generally these sites in all years were dominated by tolerant and omnivorous fish species, including blacknose dace, creek chub, and goldfish, with a smaller proportion of longnose dace. However, at least two fish blockages have been identified downstream of the project area on Turkey Branch. Therefore, re-colonization of fish following restoration may have been hindered. Future monitoring in the project area will determine if fish communities have improved. If only slight improvements are observed, it may be advisable to re-stock native fishes historically known to occupy Turkey Branch. Re-stocking of resident fish has been successful at other restoration projects within the County, in nearby Sligo Creek, for example. Removal of all downstream fish blockages is also recommended to allow for natural re-colonization of resident fish species.

Assessments of benthic macroinvertebrate communities did not show large improvements. Most metrics reflected a decline in the benthic macroinvertebrate community after restoration, including a decline in the percentage of specialized feeding groups like scrapers and predators, and an increase in the proportion of dominant taxa. All sites showed a decrease in BIBI percentages, except for LRTB202, which showed an improvement. Three sites had a small percentage of sensitive taxa in the pre-restoration period, but in the post-restoration period sensitive taxa were absent at all sites, suggesting an additional community decline. With the exception of the improvement in BIBI percentage at LRTB202, the overall benthic community appears to be declining at all other sites in the Turkey Branch project area. However, recruitment of benthic macroinvertebrate communities takes time after stream disturbances have occurred, including disturbances such as stream dewatering that was performed during the restoration of this stream. The County will continue to monitor benthic macroinvertebrate communities in the restoration area biennially to see if conditions improve with additional time for benthic macroinvertebrate recruitment.

In-situ water chemistry remained similar prior to and after restoration. During the summer, many sites fell below the COMAR lower limit for dissolved oxygen in all sampled years. Low dissolved oxygen levels in the project area may also be limiting the biological communities.

Partially Successful – Thermal Impacts

The goal of not introducing new thermal impacts from the creation of new stormwater ponds as part of this restoration project has been partially met. All in-stream temperature values collected within Turkey Branch were below the 90°F COMAR temperature standard for Use I streams. The three loggers placed within stormwater ponds did have values that exceeded 90°F, from over eight to nearly 18 percent of the summer; however, it is clear that these loggers were often dewatered and were collecting air temperatures in dry ponds exposed to full sunlight. Matthew Henson I stormwater pond did not contribute to elevated temperatures in downstream waters; in fact, stream temperatures were lower downstream of the pond than upstream. After most rain events, temperatures spiked at both the upstream and downstream sites but were generally not higher downstream of the pond than upstream. Higher temperatures were also reported at LRTB1001 (upstream) than at LRTB1002 (downstream) in the pre-restoration period. At Matthew Henson II stormwater pond, stream temperatures were significantly higher downstream of the pond than upstream, although stream temperatures were just over one degree higher below the pond, on average. Temperature readings at all logger locations for the Matthew Henson II pond did not exceed the Use I temperature standards.

Temperature readings within the Peppertree stormwater pond were extremely high in 2009 but temperatures downstream of the pond were significantly lower than within the pond cells. It is apparent, however, that the loggers within the pond were often dewatered and collecting air temperatures. A new methodology for pond logger deployment will be implemented in the future and will hopefully aid in collection of pond water temperatures instead of air temperatures. It is not possible to determine whether the Peppertree pond is affecting pre-existing water temperature regime, since no pre-restoration data exists demonstrating the baseline temperature regime. Also, it is not feasible to determine whether the Peppertree pond is affecting downstream water temperatures, because the ponds are in the headwaters of the tributary and it is impossible to place a logger upstream of the pond. What is apparent from this temperature study is that stream temperature below the pond in the summer of 2009 was well below the Use I temperature standard.

It is recommended that two more loggers be placed in the vicinity of the Peppertree stormwater pond on the Turkey Branch mainstem, one upstream and one downstream of its confluence with the Peppertree tributary. These data would provide a little more information on whether the Peppertree tributary is contributing heated water to Turkey Branch or, if possible, warm temperatures observed in the ponds are being attenuated by baseflow. However, this may not be necessary since this stream is considered Use I, the least stringent of all COMAR uses, and temperatures from within the stream were well below the Use I standard of 90°F.

The temperature regimes at each of the stormwater ponds will continue to be monitored biennially (every two years) for the next four years to determine if these patterns persist over time.

Successful – Wetlands

All three sites (Matthew Henson I, Matthew Henson II, and Peppertree Farm) scored above 75 out of a possible 100 in a cumulative assessment of wetland quality based on vegetation, soils, hydrology, and functional capacity. The mean score for the three sites was 87. The sites were generally characterized by relatively dense growth of native, desirable vegetation. Deer browse appeared to be a factor only at the Peppertree Farm site; however, this site is a planned emergent/scrub-shrub wetland that currently contains many healthy shrubs. Both Matthew Henson sites are projected to contain forested cover in the near future. All three sites currently appear to be receiving the necessary hydrologic inputs to ensure continued development of hydrophytic vegetation as well as hydric soils.

Partially Successful – Riparian Reforestation

Many areas that were sparsely vegetated prior to construction have been planted for this restoration project and the riparian zone is relatively improved. However, many of the plantings have died and are being out-competed by invasive species.

3.23.6 Conclusions

Overall, the Turkey Branch restoration has met or partially met most of the project goals within two years of restoration. This report is the first of three reports for the Turkey Branch restoration project; post-restoration monitoring and evaluation of restoration success will be performed biennially over the next four years. One year post-construction, the restoration has created wetlands/stormwater ponds that treat runoff from an urbanized watershed, helped reforest the stream buffer, and slightly improved aquatic habitat and fish communities within Turkey Branch.

The goal of not introducing thermal impacts from the created stormwater ponds to downstream waters has been partially met. Two of the stormwater pond complexes, Matthew Henson I and Peppertree Farm, did not contribute heated water downstream, but Matthew Henson II did have higher temperatures downstream of the pond than upstream. Additionally, extremely high temperatures were observed within the Peppertree stormwater pond complex, but loggers were determined to be periodically dewatered during the monitoring period. Since this is only the first year of temperature monitoring in a five year monitoring period, it is recommended to closely look at temperature regimes in the later monitoring years to see if patterns persist. If temperatures remain significantly higher below the pond, recommendations will be made. The results of the first year of post-restoration monitoring for the quantitative survey tasks and analysis of the associated goals will be presented in the 2010 and 2011 reports. At this time, a more comprehensive assessment of how well the Turkey Branch restoration has met project goals will be made.

3.23.7 Cumulative Watershed Improvements

Additional post-restoration monitoring over the course of five years will provide additional data to assess cumulative watershed improvements in Turkey Branch. During this time, other Turkey Branch subwatershed restoration projects may be completed and assessed as well.

So far, cumulative watershed effects have been mixed. Fish communities have shown a slight improvement and benthic macroinvertebrate communities have shown a decline (***Figure 3.23.67***).

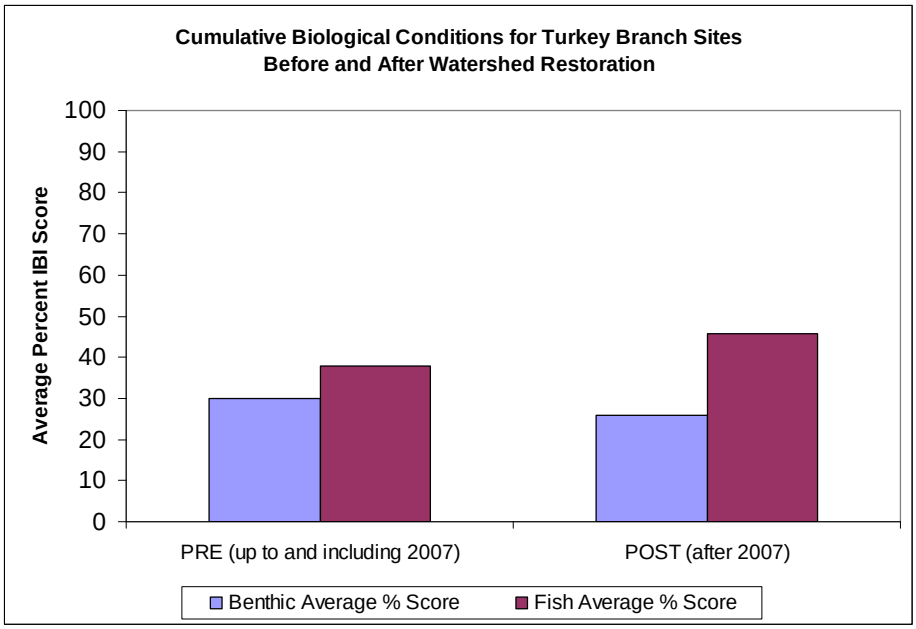


Figure 3.23.67 – Cumulative Biological Conditions for Turkey Branch Sites Prior to and After Restoration

Other measures of benthic macroinvertebrate community composition have shown mixed results, with most indices pointing to community decline. Sensitive taxa, although not abundant prior to restoration, were present, but were completely absent from the community after restoration (***Figures 3.23.68*** and ***3.23.69***). Tolerant taxa declined after restoration and intermediate taxa increased suggesting an improvement in the community; however, changes in laboratory

protocol are most likely the reason for the perceived shifts in tolerance. Additionally, declines in specialized benthic macroinvertebrate feeders such as scrapers and shredders occurred after restoration, while generalist feeders such as filterers and collectors increased, also suggesting declines in benthic macroinvertebrate community quality (***Figures 3.23.70*** and ***3.23.71***).

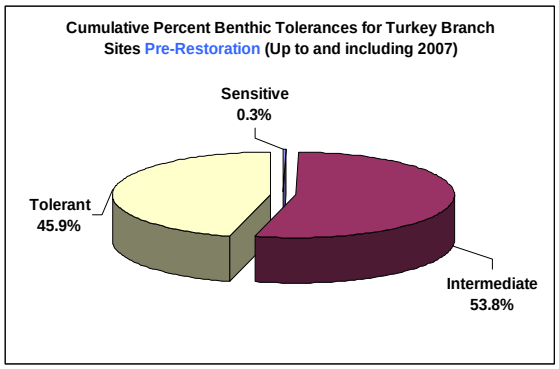


Figure 3.23.68 – Cumulative Benthic Macroinvertebrate Tolerance Composition for Turkey Branch Sites Prior to Restoration

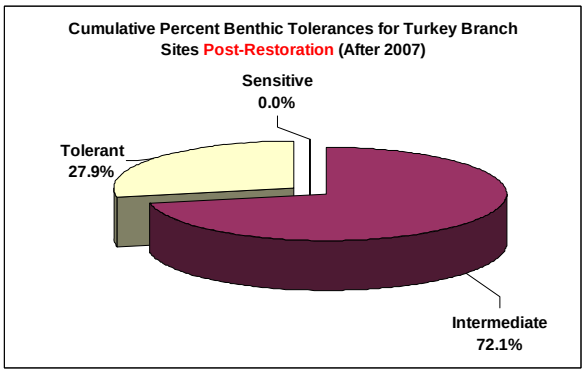


Figure 3.23.69 – Cumulative Benthic Macroinvertebrate Tolerance Composition for Turkey Branch Sites After Restoration

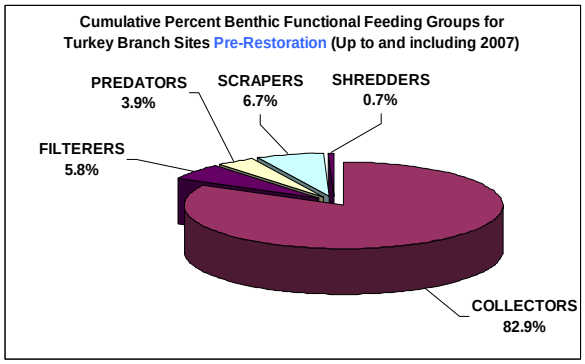


Figure 3.23.70 – Cumulative Benthic Macroinvertebrate Feeding Group Composition for Turkey Branch Sites Prior to Restoration

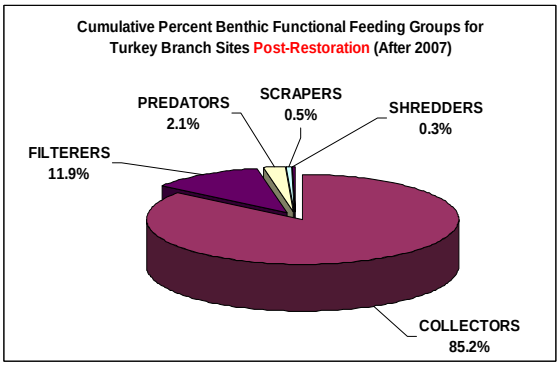


Figure 3.23.71 – Cumulative Benthic Macroinvertebrate Feeding Group Composition for Turkey Branch Sites After Restoration

Cumulative fish community data in the Turkey Branch also showed mixed results. In addition to the improvement in FIBI after restoration, the percentage of pioneer fish present in the community declined slightly after restoration, suggesting a community improvement. However, the proportion of tolerant fish present in the post-restoration period (94 percent) was slightly higher than in the pre-restoration period (93 percent), suggesting a slight decline in the quality of the fish community. Since this is only the first year of monitoring planned to occur biennially for a five year period, future monitoring will provide more insight on the cumulative biological improvement in the Turkey Branch watershed associated with this restoration project. If continued monitoring does not show improvements or only slight improvements in the biological condition, the County may wish to consider re-introducing, native, more sensitive species to the Turkey Branch. Re-introduction of more sensitive fish species following stream restoration has been successful in neighboring watersheds within Montgomery County.

In addition to the restoration projects that were monitored in 2009 for Turkey Branch

Subwatershed, MCDEP constructed a new stormwater pond in 1999 capturing approximately 44 acres of impervious surfaces behind the Home Depot off of Georgia Avenue. This wet pond provides stormwater control for the residential neighborhood to the north as well as the Home Depot's impervious surfaces.

Another restoration project in Turkey Branch is the Wheaton Woods RainScapes Rewards Targeted Neighborhood, where the County offers incentives for residents to capture stormwater runoff on private property. The County is also currently in the design phase of capturing stormwater runoff through Low Impact Development (LID) techniques at the Aspen Hill Library.