3.6 Lockridge Drive Stream Restoration

3.6.1 Introduction

The Lockridge Drive stream restoration project was constructed in late 2001. The stream restoration extends from the dead end of Lockridge Drive to the mainstem of the Northwest Branch (***Figures 3.6.1 – 3.6.2***).

A high percentage of impervious surfaces and a lack of stormwater management in the drainage area had degraded stream conditions in the Lockridge Tributary. The stream had become eroded and entrenched, with unstable storm drain outfalls and poor aquatic habitat. The project was initially designed as a stormwater pond opportunity, but due to community concerns and potential tree loss, the project evolved into a stream restoration, storm drain outfall stabilization (***Figure 3.6.3***), and wetland/vernal pool creation project. Stream restoration was limited to the stream channel and consisted of check dams (***Figure 3.6.4***) and rip rap bank stabilization (***Figure 3.6.5***) designed to avoid disturbance of the riparian trees. A wetland/vernal pool with wetland vegetation was created nearby for amphibians (***Figure 3.6.6***).

Figure 3.6.1 – Lockridge Drive Post-restoration (2001)

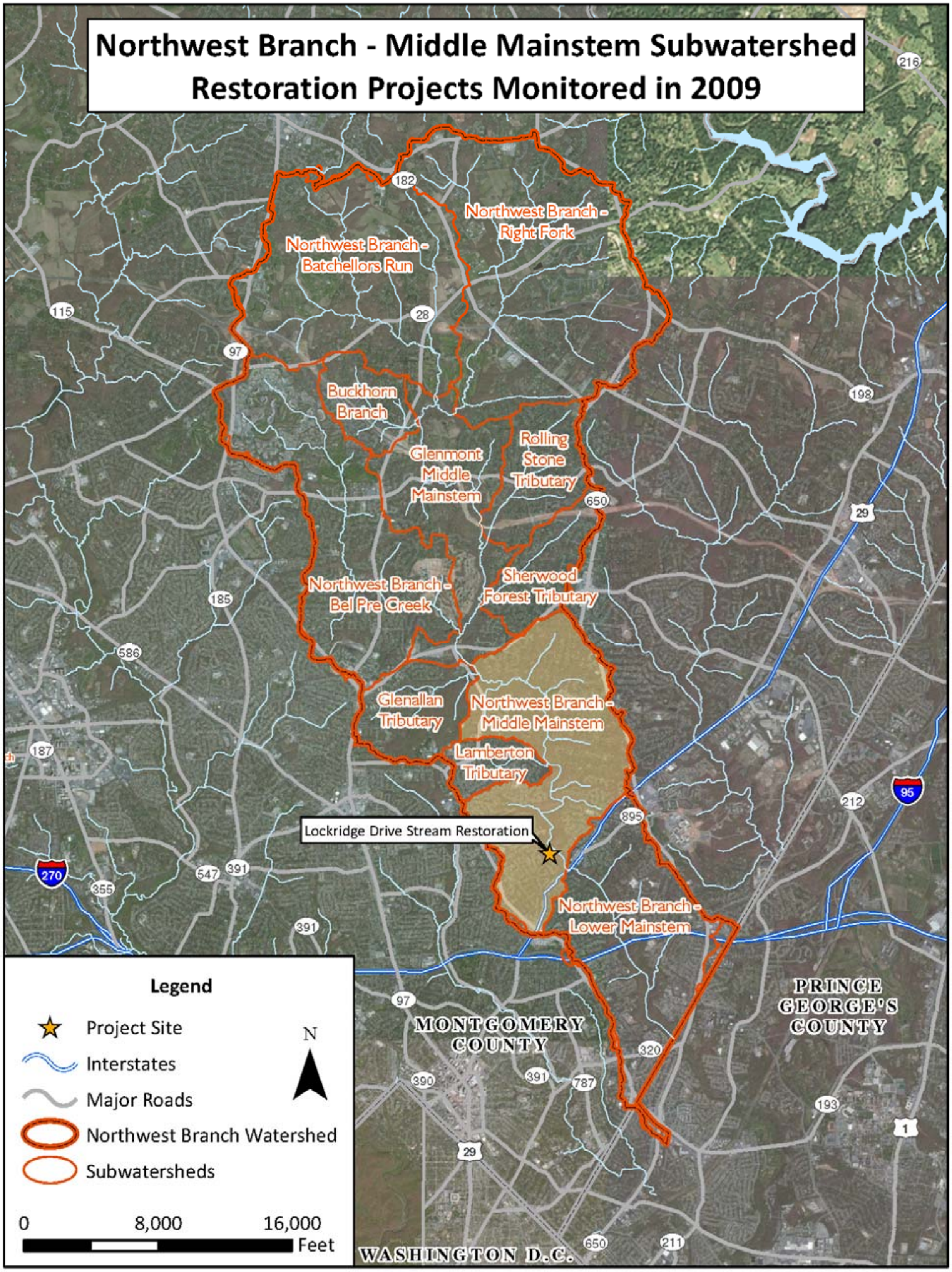

Figure 3.6.2 – Vicinity Map for Lockridge Drive Stream Restoration Project

Figure 3.6.3 – Lockridge Drive Storm Drain Outfall Stabilization (2001, View Upstream to Pedestrian Crossing)

Figure 3.6.4 – Lockridge Drive Check Dam Construction at Outfall Channel – During Construction (2001)

Figure 3.6.5 – Lockridge Drive Bank Stabilization Post-restoration (2005)

Figure 3.6.6 – Lockridge Drive Constructed Wetland (2009)

Subwatershed facts

Subwatershed Drainage Area: 158 acres
Subwatershed Imperviousness: 29 percent

Project Facts

Project Area: The Lockridge Drive stream restoration is located at the dead end of Lockridge Drive in the Northwest Branch Park. It captures drainage from the single family homes located to the east of University Boulevard and north of U.S. Route 29.
Costs: Construction $308,250 funded in part by U.S. Army Corps of Engineers (USACE)
Completion Date: Late 2001
Property Ownership: Maryland-National Capital Park and Planning Commission (M-NCPPC)

Project Selection

The USACE and six non-Federal sponsors (including Montgomery County) undertook a feasibility study to investigate restoration opportunities in the Anacostia Watershed. The feasibility study, which included an environmental impact statement, was completed in July 1994 and recommended sites for environmental restoration, including various projects within Northwest Branch of Montgomery County. The Lockridge Drive restoration project was initially identified as a new stormwater pond opportunity within the USACE study, but after public input and concern about tree loss, the project was adjusted to focus on stream restoration, wetland/vernal pool creation, and storm drain outfall stabilization.

Pre-Restoration Conditions

The Lockridge Tributary had issues with loss of stream bed material (also called head-cutting) which causes the channel to degrade progressively upstream. This condition also creates stream entrenchment or down-cutting resulting in streambanks more vulnerable to erosion. A majority of the cause for the acceleration in streambank erosion is due to a lack of stormwater management within the developed land that drains to this tributary. Lack of native vegetation on the streambanks also contributed to the erosion problem.

Restoration Actions Taken

The Lockridge stream restoration project used natural channel restoration techniques and reforestation to help stabilize streambanks and enhance riparian habitat. To help reduce the erosive forces from the stormwater, plunge pools were created just below the stormdrain outfalls to help dissipate the stormwater energy prior to entering the tributary. In-stream structures included rock and log vanes, which direct water away from unstable streambanks and form downstream scour pools, which provide good habitat for fish. Rock cross vanes also function as grade controls, which slow the erosive process of stream down-cutting. In-stream root wad revetments were installed to help stabilize streambanks, and create scour holes and overhead cover for fish.

Boulder rock installed at the toe of streambank slopes stabilized the area of the stream channel subject to the greatest erosive forces or "shear" stress. The slopes above the reinforced toes were graded back to create new floodplain terraces, and planted with native trees and shrubs to further stabilize the banks. The project attempted to save undercut trees with supportive "rock packing." More seriously damaged trees were cut flush with the streambank, allowing the root systems to remain in the bank for stabilization. A large wetland/vernal pool was also created in the floodplain closer to the mainstem of Northwest Branch and was planted with various native wetland plants.

3.6.2 Restoration Goals

The initial restoration goal for the Lockridge Restoration Project was to construct a stormwater facility at the dead end of Lockridge Drive to control erosive storm flows prior to entering the mainstem of Northwest Branch. Per the initial public input, the stormwater facility was dropped due to expected tree impacts. Replacing the stormwater facility concept with a stream restoration project was more favorable to the surrounding community. ***Table 3.6.1*** below presents the restoration goals, monitoring performed to evaluate the success of the goals, and when and where the monitoring occurred.

Table 3.6.1 – 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
• Stabilize storm drain outfalls and large head-cuts to improve aquatic habitat	• Aquatic Community: ▪ Benthic macroinvertebrates • Qualitative Habitat • Water Chemistry	1995 and 2001 (pre) 2002, 2004, 2005, 2007, 2009 (post)	NWLR102
• Stabilize streambanks and reduce stream erosion	• Quantitative habitat (stream morphology surveys)	2005, 2007, 2011[1](post)	NWLR102
• Create wetlands • Create amphibian habitat	• Wetland Vegetation • Vernal Pool	2005, 2007, 2009 (post)	NWLR102P

[1]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.

3.6.3 Methods to Measure Project Goals

Monitoring was performed pre and post-restoration at a stream site within the project limits as well as at the nearby created wetland/vernal pool (***Figure 3.6.7***). Pre-restoration monitoring occurred in 1995 and 2001, the project was completed in late 2001. Post-restoration monitoring was conducted in 2002, 2003, 2004, 2005, 2007, 2009, and 2011 (***Table 3.6.1***).

The County monitored biological communities (benthic macroinvertebrates and fish), performed rapid habitat assessments (RHAB), and collected in-situ water chemistry data to evaluate aquatic habitat and water quality conditions at the Lockridge site (NWLR102) pre- and post-restoration. Photo-documentation of the outfall and bank stabilization was conducted during construction and post-restoration. Quantitative surveys were conducted to measure stability of habitat features, streambanks, and bed material. Wetland vegetation and wetland herpetofauna monitoring was performed at site NWLR102P post-restoration to determine the success of the plantings, and the ability of the wetland to function as habitat for amphibians and other wetland fauna. For more information on how the various types of monitoring are performed and used to measure stream health in the County, see ***Section 2*** Methods.

Figure 3.6.7 – Map of Monitoring Locations for Lockridge Drive Stream Restoration

3.6.4 Results and Analysis

Benthic Macroinvertebrates

Benthic Index of Biological Integrity (BIBI) Scores

Benthic macroinvertebrate IBI scores were consistently Poor from pre-restoration (1995 and 2001) through post-restoration (2002-2009) (***Figure 3.6.8***). In 2002, the BIBI increased slightly, due to the presence of *Dolophilodes sp.*, a genus of caddisfly with the lowest (most sensitive) tolerance value, and an absence of two other relatively tolerant caddisfly genera (*Hydropsyche sp.* and *Cheumatopsyche sp.*). In 2004, *Dolophilodes sp.* was collected again, however the proportion of *Hydropsyche sp.* and *Cheumatopsyche sp.* to all other EPT (Ephemeroptera, Plecoptera, Trichoptera), which would include *Dolophilodes sp.* was much higher (80 percent) than in 2002 leading to a lower score for this individual metric and an overall lower BIBI score.

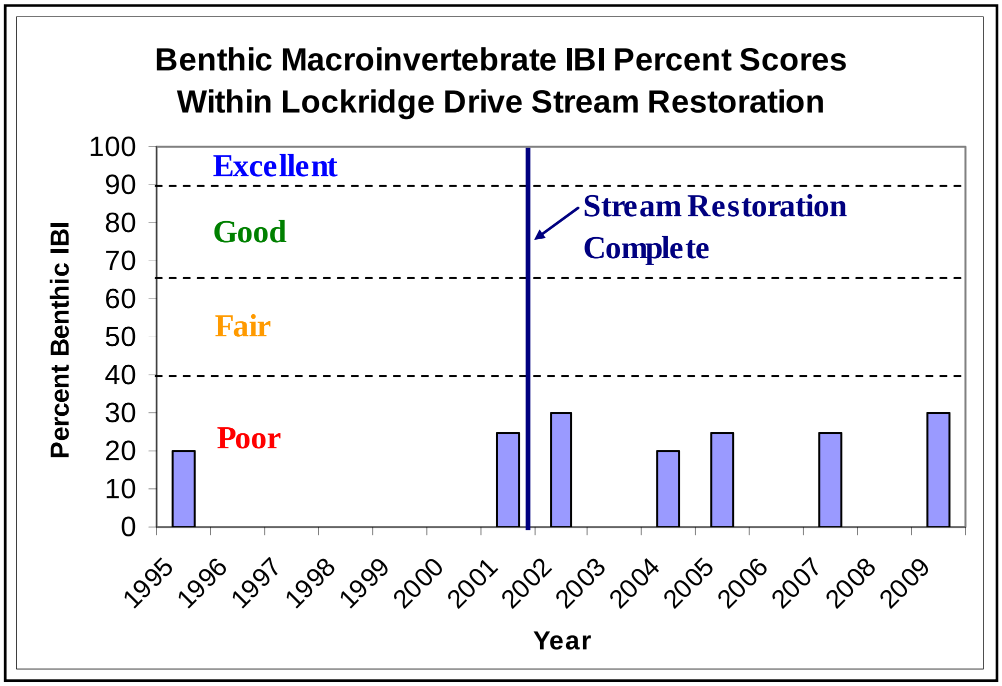

Figure 3.6.8 - Pre- and Post-restoration Benthic Index of Biological Integrity (BIBI) Percent Scores at NWLR102

Dominant Taxa

The pre-restoration benthic macroinvertebrate community was dominated by Chironomidae (midges); 88 percent of the community was comprised of this pollution tolerant family. The second most dominant taxa at NWLR102 was *Cheumatopsyche sp.* (a net-spinning caddisfly), one of the more tolerant genera of caddisfly. After restoration, midges were again the most dominant taxon, but their dominance decreased slightly to 84 percent. The second most dominant taxon after restoration was Nadidae, a family of aquatic worms, having the highest possible tolerance value.

Tolerance Values

Tolerant individuals dominated the benthic macroinvertebrate pre-restoration community, comprising 90 percent; individuals intermediate in sensitivity made up the remaining community (***Figure 3.6.9***). After restoration, tolerant individuals were again dominant (91 percent), individuals intermediate in sensitivity were second most dominant (6 percent) and individuals sensitive to urbanization comprised one percent of the community (***Figure 3.6.10***).

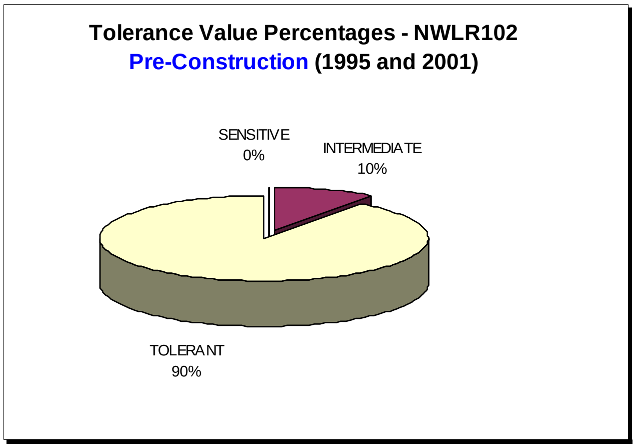

Figure 3.6.9 – Benthic Macroinvertebrate Tolerance Composition at NWLR102 Prior to Restoration

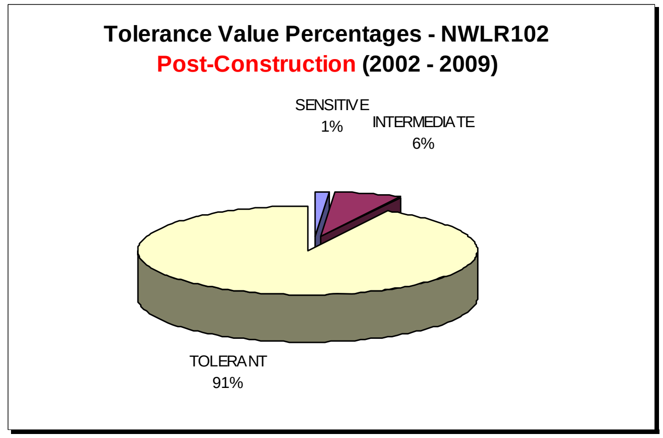

Figure 3.6.10 – Benthic Macroinvertebrate Tolerance Composition at NWLR102 After Restoration

<u>Functional Feeding Groups</u>

The pre-restoration community composition based on functional feeding groups was dominated (77 percent) by collectors, with specialized feeding groups including shredders and scrapers comprising only three percent of the community (***Figure 3.6.11***). After restoration, the proportion of collectors increased from 77 to 89 percent while the proportion of specialized feeding groups declined to two percent (***Figure 3.6.12***).

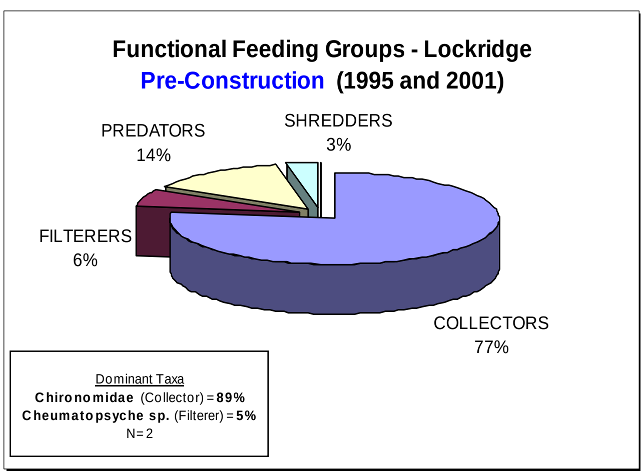

Figure 3.6.11 – Benthic Macroinvertebrate Functional Feeding Group Composition at NWLR102 Prior to Restoration

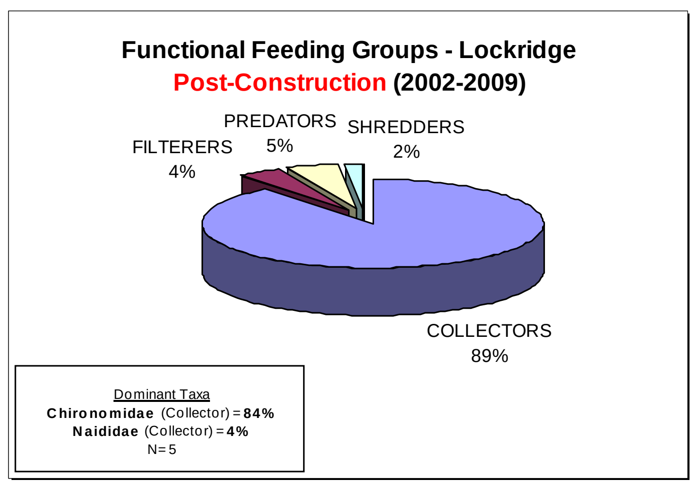

Figure 3.6.12 – Benthic Macroinvertebrate Functional Feeding Group Composition at NWLR102 After Restoration

Qualitative Habitat

Spring rapid habitat (RHAB) scores for the Lockridge Drive site (NWLR102) were rated as Good prior to restoration (1995 and 2001), Good/Fair for the first year post-restoration (2002), Good in 2004, Excellent/Good in 2005, and Good for 2007 and 2009 (***Figure 3.6.13***). Most aquatic habitat parameters were similar pre- and post-restoration although a few parameters improved and some declined. In-stream habitat, sediment deposition, and channel flow status parameters improved after restoration. Bank vegetative protection and riparian buffer width generally declined after restoration.

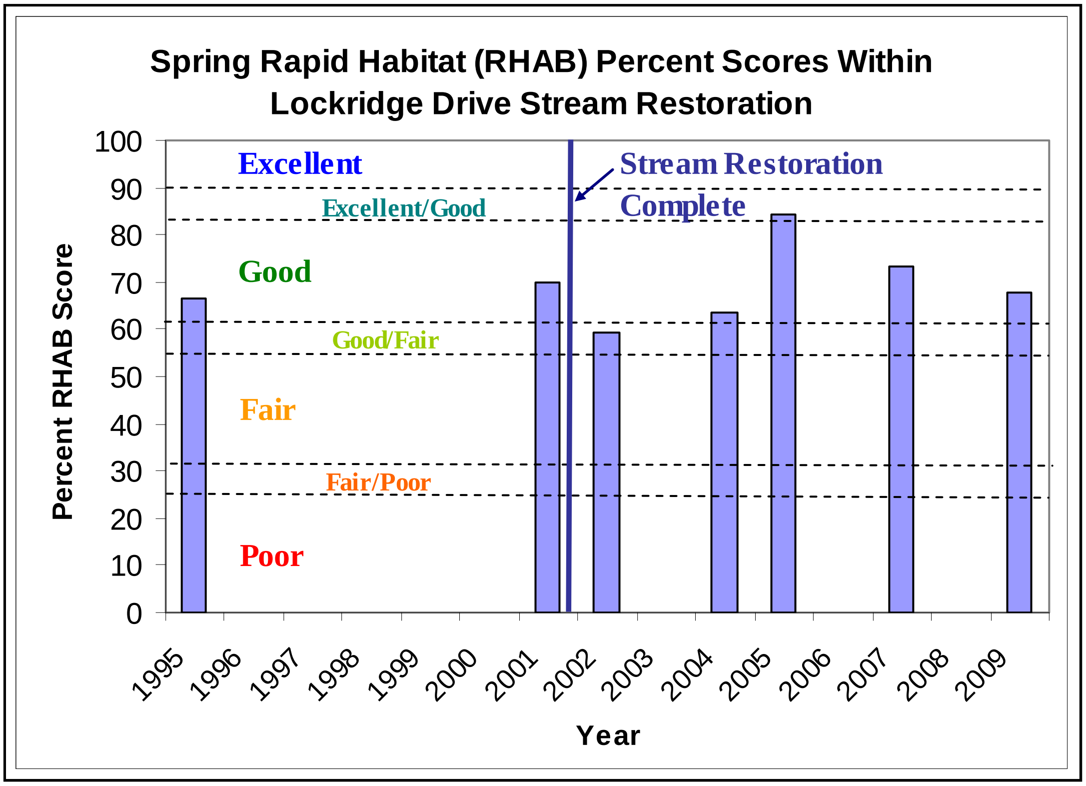

Figure 3.6.13 – Pre- and Post-restoration Spring Rapid Habitat (RHAB) Percent Scores at Site NWLR102

Water Chemistry

In-situ water chemistry readings were taken every time a site was sampled for benthic macroinvertebrates. There were no instances pre- or post-restoration when in-situ readings were out of compliance with COMAR Use I standards (***Table 3.6.2***).

Table 3.6.2 – Pre- and Post-restoration in-situ Water Chemistry at Site NWLR102

Parameter	1995	2001	2002	2004	2005	2007	2009
Dissolved oxygen (mg/L)	9.14	10.6	7	11.57	9.99	12.98	9.63
Dissolved oxygen (% saturation)	-	-	78	99	103	116	91
pH	7.02	7.60	6.94	7.20	7.89	8.12	7.16
Conductivity (µmhos)	280	245	302	341	396	470	686
Water temperature (°F)	54.5	43.7	69.4	48.6	62.0	50.7	50.9

Vernal Pool

A new wetland was constructed where the Lockridge tributary enters the mainstem of the Northwest Branch (***Figure 3.6.7***). This wetland is also considered a vernal pool since it is isolated from the stream, lacks fish, and dries up at least occasionally. Herpetofauna (amphibian and reptile) monitoring was performed post-restoration within the wetland in 2005, 2007, and 2009. In addition, wetland characteristics, plants, and invertebrates were also noted.

In the spring of 2005, the created vernal pool was measured to be 82 feet long, 26 feet wide, and two feet deep. Air temperature was 83°F and water temperature was 61°F. Emergent vegetation and *Typha latifolia* (broadleaf cattail) were present. Obligate wetland species *Lithobates sylvaticusi* (wood frog) egg masses and tadpoles were observed in mass quantities (***Figure 3.6.14***). In addition, four adult *Lithobates palustris* (pickerel frog), a facultative vernal pool species, were found in the pool in 2005. A *Dryocopus pileatus* (pileated woodpecker) was also observed around the pool (***Figure 3.6.15***). In the spring of 2007, the vernal pool measured 98 feet long, 30 feet wide, and two feet deep, with emergent vegetation and cattails present. More than 500 *Lithobates sylvaticusi* (wood frog) tadpoles and approximately 100 *Lithobates catesbiana* (American bullfrog) tadpoles were found.

Figure 3.6.14 – Lithobates sylvaticusi (wood frog) egg masses in Lockridge Created Vernal Pool in 2005

Figure 3.6.15 – Dryocopus pileatus (pileated woodpecker) observed nearby Lockridge Created Vernal Pool in 2005

The Lockridge vernal pool was sampled for a final time in the summer of 2009. The pool dimensions were measured as 130 feet long, 78 feet wide, and approximately 1.5 feet deep. Herbaceous, emergent, and submerged wetland vegetation was observed, including *Symplocarpus foetidus* (skunk cabbage), *Sagittaria latifolia* (broadleaf arrowhead), cattails, rushes, *Salix nigra* (black willow), *Impatiens capensis* (jewel weed), and *Vitis sp.* (grapevine). Invasive plants included *Rosa multiflora* (multiflora rose), *Persicaria perfoliata* (mile-a-minute), and *Microstegium vimineum* (Nepalese browntop or Japanese stilt grass).

Spring and summer herpetofauna activity differs and observations from spring to summer are not expected to be the same. Wood frogs are most active in the early spring and were not found in the summer of 2009, but other frogs were found, including adult *Lithobates clamitans melanota* (northern green frog) (***Figure 3.6.16***), American bullfrog, and *Hyla versicolor/chrysoscelis* *complex* (unknown gray treefrog) tadpoles (***Figure 3.6.17***). Other herpetofauna was active as well, including a number of reptiles, such as *Terrapene carolina carolina* (eastern box turtle), and *Thamnophis sirtalis sirtalis* (eastern gartersnake). There were a variety of birds observed around the pool, including *Picoides pubescens* (downy woodpecker), *Molothrus ater* (brown-headed cowbird), *Vireo olivaceus* (red-eyed vireo), *Turdus migratorius* (American robin), *Passerina cyanea* (indigo bunting), *Carduelis tristis* (american goldfinch), and *Thryothorus ludovicianus* (Carolina wren).

Figure 3.6.16 – Adult Lithobates clamitans melanota (Northern Green Frog) Found in the Lockridge Drive Constructed Wetland in July 2009

Figure 3.6.17 – Tadpole of Unknown Gray Treefrog Species (Hyla versicolor/chrysoscelis complex) found in the Lockridge Drive Constructed Wetland in July 2009

Wetland Vegetation

Vegetation at the created wetland was assessed post-restoration to determine the success of plantings and the overall success of the wetland. Between 2003 and 2009, wetland vegetation has flourished (***Figures 3.6.18 and 3.6.19***).

Figure 3.6.18 – Lockridge Drive Wetland Vegetation (Spring 2003)

Figure 3.6.19 – Lockridge Drive Wetland Vegetation (Summer 2009)

The Lockridge Drive wetland was monitored in 2005, 2007, and 2009 to evaluate the success of the planted wetland vegetation after construction. Methodologies differed between years. In 2005 and 2007, a point-intercept sampling procedure (Federal Interagency Committee for Wetland Delineation 1989) was performed and a Prevalence Index (PI) was calculated to indicate wetland vegetation success. Based on the 1989 manual, the mean PI value must be less than 3.0 to meet the hydrophytic vegetation criteria. In 2009, the *MDE Mitigation Site Scoring Method* (2007) was used. Site scores were assigned points, which could be equated to letter grades (A = 90-100 points, B = 80-90 points, C = 70-80 points, D = 60-70 points, and E = less than 60 points). More details about the wetland vegetation monitoring methods can be found in ***Section 2***.

In September 2005, two-thirds of the pool was dry. One transect was sampled on the edge of the pool and two transects in tandem were sampled within the pool. The most common plants found were *Sagittaria latifolia* (broadleaf arrowhead), *Polygonum sagittatum* (arrowleaf tearthumb), and invasive species *Microstegium vimineum* (Nepalese browntop or Japanese stilt grass). The average PI value for the site was 1.61 (***Table 3.6.3***).

Table 3.6.3 – Lockridge Constructed Wetland Prevalence Index (PI) Results for 2005 and 2007

Year	Prevalence Index (PI) Value				Standard Error
	Transect 1	Transect 2	Transect 3	Average	
2005	1.800	1.444	1.571	1.605	0.104
2007	1.990	1.539	1.431	1.653	0.297

In August 2007, there was even less standing water in the center of the pool than in 2005. The predominant plants were *Polygonum sagittatum* (arrowleaf tearthumb) and *Microstegium vimineum* (Nepalese browntop or Japanese stilt grass). The average PI value was 1.65, but the standard error was 0.297 (***Table 3.6.3***). The MDE manual states that the standard error should not exceed 0.20. If the standard error is exceeded, additional transects should be monitored until the value is less than 0.20. Field notes indicate that vegetation was either lacking or lacking in diversity to measure additional transects.

In October 2009, the wetland area had approximately 35 percent open water, and 65 percent Palustrine Emergent Wetland (PEM). The dominant emergent species found were *Scirpus cyperinus* (woolgrass), *Leersia oryzoides* (rice cutgrass), and *Iris versicolor* (harlequin blueflag). The site received an overall MDE wetland score of 94 out of 100, or a grade of "A" (***Table 3.6.4***).

Table 3.6.4 – Lockridge Constructed Wetland Scores for 2009

Wetland Parameter	Score
Vegetation (out of 30)	27
Soil (out of 20)	20
Hydrology (out of 30)	29
Wetland Functional Gains (out of 20)	18
Bonus (up to 10)	-
Total Score (out of 100)	94

3.6.5 Discussion

The Lockridge Drive stream restoration and wetland creation project was successful or partially successful in achieving its project goals. The goals of stabilizing streambanks and reducing erosion could not be evaluated in 2009 and will be assessed in 2011. A summary of project goal results can be found below in ***Table 3.6.5***, followed by more detailed discussion.

Table 3.6.5 – Summary of Project Goal Results for the Lockridge Drive Stream Restoration and Wetland Creation Project

Goal	Result
Stabilize storm drain outfalls and large head-cuts to improve aquatic habitat and the aquatic community	Partially Successful – photo documentation post-restoration shows stabilized outfalls and head-cuts. However, benthic macroinvertebrate scores have not shown noticeable improvement. Qualitative habitat received a high score of Excellent/Good in 2005, but overall post-restoration scores did not differ greatly from pre-restoration scores of Good.
Stabilize streambanks and reduce erosion	Unable to determine – quantitative survey data from 2011 will determine if these goals have been met
Create a wetland for wetland obligate species	Successful – constructed wetland meets wetland criteria and is colonized by obligate and facultative herpetofauna species and several species of wetland plants, despite minor issues with deer browse and invasive plants.

Partially Successful – Aquatic Habitat

Post-restoration site photographs show stabilized storm drain outfalls and streambanks (***Figure 3.6.20***), and qualitative habitat scores are either Good or Excellent/Good. However, benthic macroinvertebrate scores and community structure analysis show little improvement, with scores remaining in the Poor range. It is not clear why the benthic scores are not improving. Possible explanations include water quality impacts and/or limitations to re-colonization.

Figure 3.6.20 – Lockridge Rip-Rap Bank Stabilization, Upstream View, 2011

Stable and vegetated banks, wide, sinuous stream channels with coarse substrates, and ample and diverse cover and substrate are associated with high biological condition and diverse community structure. Conversely, unvegetated and eroding banks, and deep channels with predominantly fine substrates are associated with lower biological condition (Pedersen and Perkins 1986; Jones and Clark 1987; Heitke et al. 2006; Moerke and Lamberti 2006). Photo-documentation shows vegetated banks with diverse cover (***Figure 3.6.21***), and water chemistry readings were within acceptable ranges.

Figure 3.6.21 – Lockridge Cross Section Riffle, Upstream View, 2011

Successful – Wetland Creation

The Lockridge restoration project was successful in creating a functional wetland (***Figure 3.6.22***). Emergent wetland vegetation has successfully colonized this site (hydrophytic vegetation criteria met), and obligate and facultative wetland animals have moved in and are reproducing. Isolated from predatory fish, the wetland is actually a vernal pool that dries occasionally, providing excellent habitat for amphibians, reptiles, invertebrates, and birds. Micro-habitat such as woody debris in the pool offers places for reproducing amphibians to attach eggs to and seek cover. Amphibian habitat could be improved if more shade trees were planted adjacent to the pool to cool water temperatures.

Figure 3.6.22 – Lockridge Constructed Wetland, June 2011

3.6.6 Conclusions

The Lockridge Drive stream restoration and wetland creation project was successful in accomplishing streambank and storm drain outfall stabilization, and in creating a successful wetland habitat for obligate wetland plants and animals.

The created wetland was well-established and colonized by many wetland species. Amphibian habitat could be improved if shade trees were planted adjacent to the pool to cool wetland water temperatures. However, the created wetland had evidence of deer browse and invasive plants in 2009. Treatment of the floodplain for invasives is recommended.

Despite apparent visual assessment of good quality aquatic habitat, benthic macroinvertebrate scores have not shown much improvement in eight years. Some studies indicate that large-scale and long-term disturbances in a watershed limit the recovery of stream communities for many decades (Harding et al. 1998). Also, physical limits to benthic macroinvertebrate re-colonization could be preventing improvement. Perhaps artificial re-introduction of benthics and/or continued biological monitoring may eventually show recovery in this urban stream.