Upper Neuse River Basin Association

Memorandum

To: Lick Creek Watershed Restoration Plan Partners and Stakeholders
Cc: Kimberly Nimmer, NC Division of Water Quality
From: Heather Saunders, Upper Neuse River Basin Association
Date: July 23, 2009
Re: Lick Creek Local Watershed Plan Demonstration Projects

Lick Creek was listed as "biologically impaired" by the NC Division of Water Quality (NCDWQ) on the 2006 NC 303(d) list (NCDWQ 2006). Lick Creek is also a tributary to Falls Lake, a state-designated nutrient-sensitive water (NSW) and a water-supply reservoir, providing drinking water to over 600,000 Wake County residents. Late in 2008, the Upper Neuse River Basin Association (UNRBA) began working with local stakeholders and community members to create a Local Watershed Plan (LWP) for Lick Creek that would identify sources of Lick Creek's impairment, identify restoration priorities, prioritize management strategies to address those sources, and aim to produce a demonstrable improvement in Lick Creek water quality by implementing the management strategies recommended in the LWP. Supporting documents for this effort can be found at http://www.unrba.org/lick/downloads.shtml.

Furthermore, the UNRBA aimed to use the Upper Neuse Site Evaluation Tool (SET), and other applicable calculation tools, to demonstrate the site-level pollutant removal potential that could be gained by implementing several of the high-priority restoration projects identified during the planning process (UNRBA 2007). UNRBA worked with community leaders, academia at NC State University (NCSU), local agencies such as the Durham County Soil and Water Conservation District (SWCD), NC Cooperative Extension (NCCE), and Baker Engineering to conduct a nutrient loading analysis of these projects before and after implementation, generate support for the projects, and foster incentives for the future procurement of funds to actually implement projects.

The SET, developed by Tetra Tech, Inc. (2006) for the UNRBA with funding from the NCDWQ Section 319 Non-Point Source (NPS) Grant program, is a tool used to asses the environmental impacts and costs of a site's stormwater design by predicting the following pre- and post-development stormwater quality and quantity effects:

- Total annual stormwater volume
- Total annual suspended solids (sediment)
- Total annual nitrogen
- Total annual phosphorous

The SET is an effective tool for measuring the pollutant removal potential of stormwater retrofits. For the Lick Creek LWP, restoration opportunities included stormwater retrofits, but also included stream and buffer restoration opportunities. In these cases, other calculation tools or resources, such as the Tar-Pamlico Nutrient Model (TPNM) (NCDWQ 2009) and Dave Rosgen's Bank Erosion Hazard Index (BEHI) (Rosgen 2001), were sourced and utilized for the purpose of calculating the nutrient removal potential or restoration projects.

Demonstrating the meaningfulness of implementation is crucial to both educating the community on the effectiveness and need for restoration and best management practices, as well as justifying the need for and procuring funding to actually implement restoration projects within the watershed. For this purpose, the UNRBA has assessed four "demonstration" projects for their nutrient removal potential including a stream restoration project, a buffer restoration, and two stormwater retrofit opportunities (Table 1). For a more detailed discussion about each site (Project ID) and project prioritization, please refer to Appendices 1 and 2 of the "Lick Creek Watershed Restoration Priorities" memorandum (UNRBA 2007). The remainder of this memorandum will describe each demonstration project in greater detail.

Table 1. Lick Creek Demonstration Projects.

Project ID*	Project Type	Area (acres) or Length (feet) Treated	Assessment Tool
IB**-350	Stream Restoration	3100 feet	BEHI
IB**-110	Buffer Restoration	1667 feet	Literature Review and NC Cooperative Extension Calculations
R**-300	Stormwater Retrofit	5.44 acres	SET and Tar-Pam Worksheet
R**-301	Stormwater Retrofit	8.08 acres	SET and Tar-Pam Worksheet

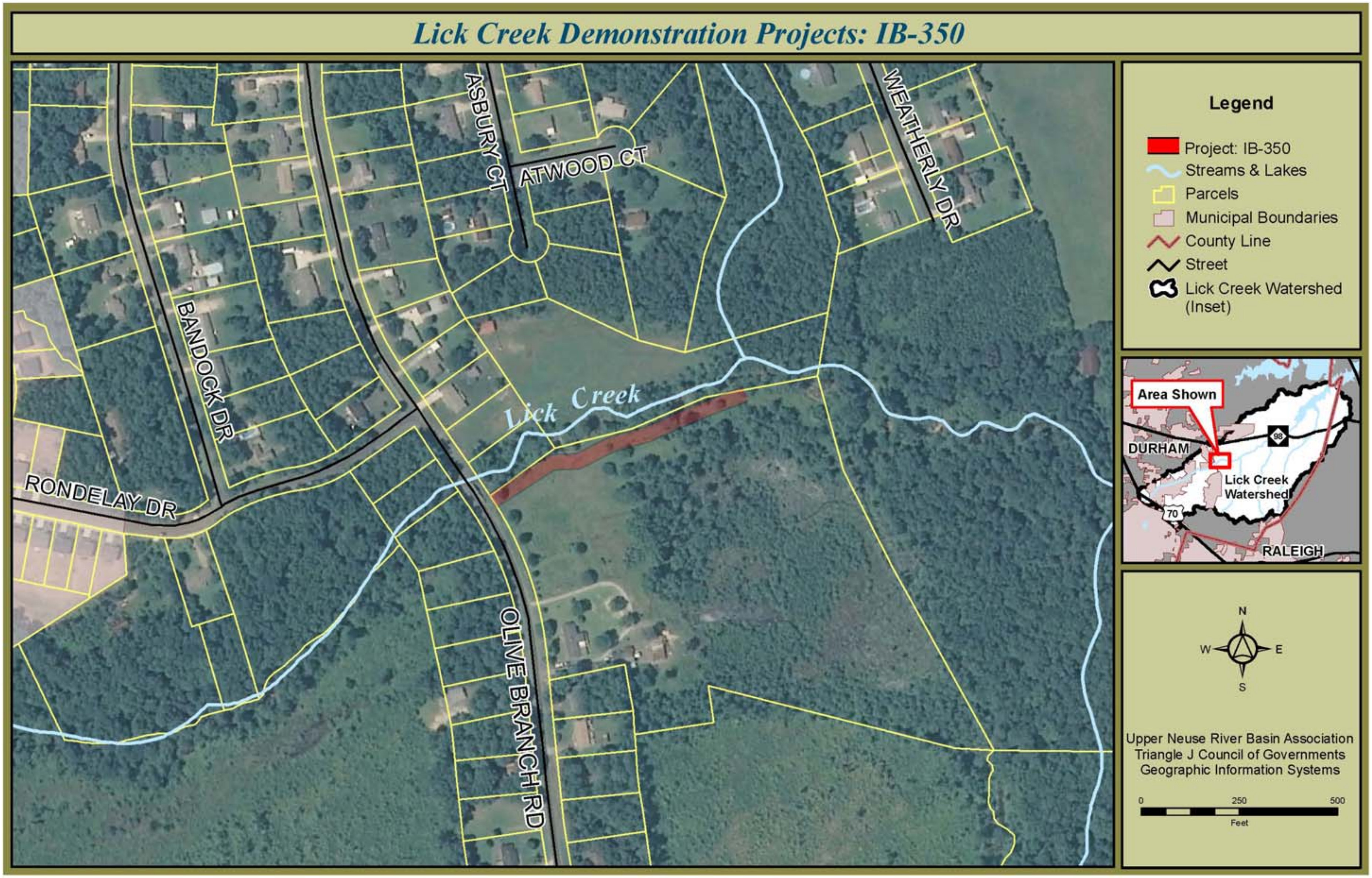
*Please refer to Appendices 1 and 2 of the ""Lick Creek Watershed Restoration Priorities" memorandum (UNRBA 2007) for project descriptions.
**IB=Impacted Buffer; R=Stormwater Retrofit

<u>IB-350: Lick Creek Stream Restoration/Enhancement</u>

Of all the major restoration projects identified during the development of the Lick Creek LWP, IB (Impacted Buffer)-350 was ranked the highest. For more information on restoration opportunities and prioritization, please refer to the "Lick Creek Watershed Restoration Priorities" memorandum (UNRBA 2007).

IB-350 is located along the main stem of Lick Creek, immediately downstream of Olive Branch Road (Figure 1). The Durham SWCD is currently engaging in a restoration project along this reach that includes restoration of approximately 1,500 linear feet of stream, enhancement of approximately 1600 linear feet of stream, and riparian reforestation of 7.1 acres (50-foot wide buffers) that will be placed in permanent conservation easements. This project will address the significant active bank erosion and channel widening that is currently occurring along this reach.

Figure 1. Lick Creek Demonstration Project IB-350.



Rosgen's BEHI (Rosgen 2001) was used to determine the annual sediment loss along this reach due to bank erosion by evaluating parameters such as bank height ratio, bank angle, root depth, root density, bank protection, and bank material at regular intervals along the stream reach. The assumption is that bank stabilization and riparian reforestation will prevent between 90% and 98% of that sediment loss due to changes in bank height, surface roughness, and bank angles (J. White, personal communication, June 3, 2009). Furthermore, sediment loss should decrease over time as streamside vegetation, including root mass and density, is established. For a more detailed discussion on BEHI methodology, please refer to Rosgen's paper "A Practical Method of Computing Streambank Erosion Rate" (2001).

The BEHI analysis indicates that the reach loses approximately 2,300 tons of sediment per year from the banks as a result of bank erosion along approximately 3900 linear feet of stream (Table 2 [NBS=Near Bank Stress]). If stream restoration practices do prevent bank degradation by between 90 and 98%, we can expect to see a reduction in sediment loss from 2,300 tons of sediment per year to as little as between 46 and 230 tons per year for the 3900 linear foot stretch (an average of 186 tons per linear mile of stream). To provide a point of reference, we may expect approximately 100 tons of sediment per year per linear mile of stream on stable banks approximately 5 feet high (G. Jennings, personal communication, June 16, 2009).

Table 2. BEHI Worksheet as Completed for Stream Restoration Project IB-350.

Location : Lick Creek Site Durham, NC

Date: 5/22/009

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F
BEHI	NBS	BK HEIGHT	FEET/YR (from curve)	DISTANCE(note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)
Mod	Low	4.5	0.09	27	10.935
high	Low	8.0	0.18	85	83.52
high	Mod	8.0	0.3	183	235.2
high	extreme	8.0	1.5	285	1224
Mod	low	6.0	0.09	370	45.9
high	extreme	10.0	1.5	424	810
high	extreme	10.0	1.5	518	1410
v. high	mod	10.0	0.3	616	294
v. high	low	10.0	0.18	650	61.2
v. high	mod	10.0	0.3	716	198
v. high	extreme	10.0	1.5	818	1530
v. high	Mod	9.0	0.3	900	221.4
v. high	high	8.0	0.5	1041	564
v. high	high	10.0	0.5	1184	715
v. high	extreme	9.0	1.5	1253	931.5
v. high	Mod	9.0	0.3	1306	143.1
v. high	high	9.0	0.5	1991	3082.5
v. high	Mod	9.0	0.3	2061	189
v. high	extreme	9.0	1.5	2311	3375
v. high	Mod	9.0	0.3	2464	413.1
v. high	extreme	9.0	1.5	2632	2268
v. high	Low	9.0	0.18	2702	113.4
v. high	V. High	9.0	0.8	2836	964.8
v. high	Mod	9.0	0.3	2947	299.7
v. high	V. High	10.0	0.8	3121	1392
v. high	Low	10.0	0.18	3227	190.8
v. high	V. High	10.0	0.8	3487	2080
v. high	high	10.0	0.5	3670	915
v. high	high	10.0	0.5	3930	1300
				TOTAL FT³/YR	25,061.06
Divide FT³/yr by 27				TOTAL YD³/YR	928.19
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	1,206.64
				TOTAL TONS/YR/FOOT	0.31

RIGHT BANK

A	B	C	D	E	F
BEHI	NBS	BK HEIGHT	FEET/YR (from curve)	DISTANCE(note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)
high	low	4.5	0.18	29	23.49
high	mod	6.0	0.3	92	113.4
mod	mod	9.5	0.18	183	155.61
low	mod	4.0	0.068	249	17.952
v. low	low	4.0	0.02	285	2.88
v. high	v. high	10.0	0.8	424	1112
v. high	v. high	10.0	0.8	448	192
v. high	mod	10.0	0.3	518	210
v. high	mod	10.0	0.3	616	294
v. high	extreme	10.0	1.5	716	1500
v. high	mod	10.0	0.3	770	162
v. high	extreme	10.0	1.5	818	720
v. high	mod	9.0	0.3	41	-2097.9
v. high	high	11.0	0.5	1176	6242.5
mod	low	9.0	0.09	1253	62.37
v. high	high	9.0	0.5	1991	3321
v. high	extreme	9.0	1.5	2061	945
v. high	low	9.0	0.18	2145	136.08
v. high	mod	9.0	0.3	2311	448.2
v. high	extreme	9.0	1.5	2438	1714.5
v. high	mod	9.0	0.3	2632	523.8
v. high	extreme	9.0	1.5	2748	1566
v. high	low	9	0.18	2820	116.64
v. high	v. high	10	0.8	2947	1016
v. high	mod	10	0.3	3116	507
v. high	v. high	10	0.8	3227	888
v. high	low	10	0.18	3369	255.6
v. high	v. high	10	0.8	3487	944
v. high	high	10	0.5	3574	435
v. high	low	10	0.18	3670	172.8
low	high	10	0.14	3930	364
				TOTAL FT³/YR	22,063.92
				TOTAL YD³/YR	817.18
				TOTAL TONS/YR	1,062.34
				TOTAL TONS/YR/FOOT	0.30

IB-110: Lick Creek Buffer Restoration

Approximately 1667 feet of wetland buffer was cleared for the development of the Brightleaf Subdivision in eastern Durham (IB-110; UNRBA 2007). In addition, a sewer right-of-way runs the length of this section of stream. While the UNRBA does not advocate the procurement of funds to mitigate water quality impacts caused by recent construction projects, this site (Figure 2) was chosen in order to depict the pollutant removal potential lost as a result of deforestation.

Research conducted by Line et al. (2002) on pollutant export from various land uses in the Upper Neuse River Basin suggests that the total nitrogen (TN) export rate for "developing" lands can range from 11.9 to 36.3 kilograms per hectare (10.7 to 31.6 pounds per acre), while TN export rates under natural or forested conditions will range between just 2.5 and 11.4 kilograms per hectare (2.2 and 9.9 pounds per acre), with the greatest pollution and sediment loss occurring during the construction phases. In a similar study, Line and White (2007) evaluated the pollutant exports from two sites; one being developed, and an adjacent tract of predominately undeveloped forestland to study the effects of development on nutrient loading. The study revealed that the overall export rates of total suspended solids (TSS) was 95% greater than that of the undeveloped area, and that the export rates of TN and total phosphorous (TP) were 66 to 88% higher on the developed tract than on forestland. Tables 3 and 4 describe the export rates of various pollutants and TSS from the above-referenced studies.

Table 3. Pollutant export rates for various land uses in the Upper Neuse River Basin (Line et al. 2002).

Land use	Period (a)	Rain (mm)	Runoff/rain	Pollutant export rate (kg/ha·a)					
				NO_3–N	TKN	NH_3–N	TN	TP	TSS
Residential	2.3	2204	0.57	3.2	20.7	2.4	23.9	2.3	387
Golf course	1.5	1845	0.47	4.8	26.4	3.0	31.2	5.3	658
Pasture	3.3	2385	0.26	1.2	5.5	0.4	6.7	4.3	143
Construction-I	1.0	1251	0.52	1.4	6.9	0.6	8.3	3.0	22 600
Construction-II	1.0	1031	0.70	7.3	29.0	4.1	36.3	1.3	6 560
Wooded	1.3	1517	0.32	3.6	7.8	0.3	11.4	1.0	986
Developed[a]	N/A[b]	N/A[b]	N/A[b]	5.1	25.4	3.2	30.5	3.0	2 535

[a] Average of residential, golf course, and construction-II sites.
[b] Not available.

Approximately 40 plots have been cleared for development on the southern upslope side of Lick Creek (Figure 2). More plots occur on the south side of Prospect Parkway (Figure 2), which will likely contribute to additional runoff; however, for the purposes of this analysis, we have confined our calculations to the 40 plots (approximately 22 acres) that occur adjacent to Lick Creek on the north side of Prospect Parkway (Figure 2). Along this stretch of Lick Creek in the Brightleaf Subdivision, many of the lots have been cleared and platted, but are yet to be built; therefore the area is currently predominantly un-vegetated with loose soil (Figures 3 and 4). For the purposes of this analysis, we will consider the land use along this stretch of Lick Creek to be characterized as Construction I and II phases (Table 3) and Clearing and Built 1 (Table 4).

Figure 2. Lick Creek Demonstration Project IB-110.

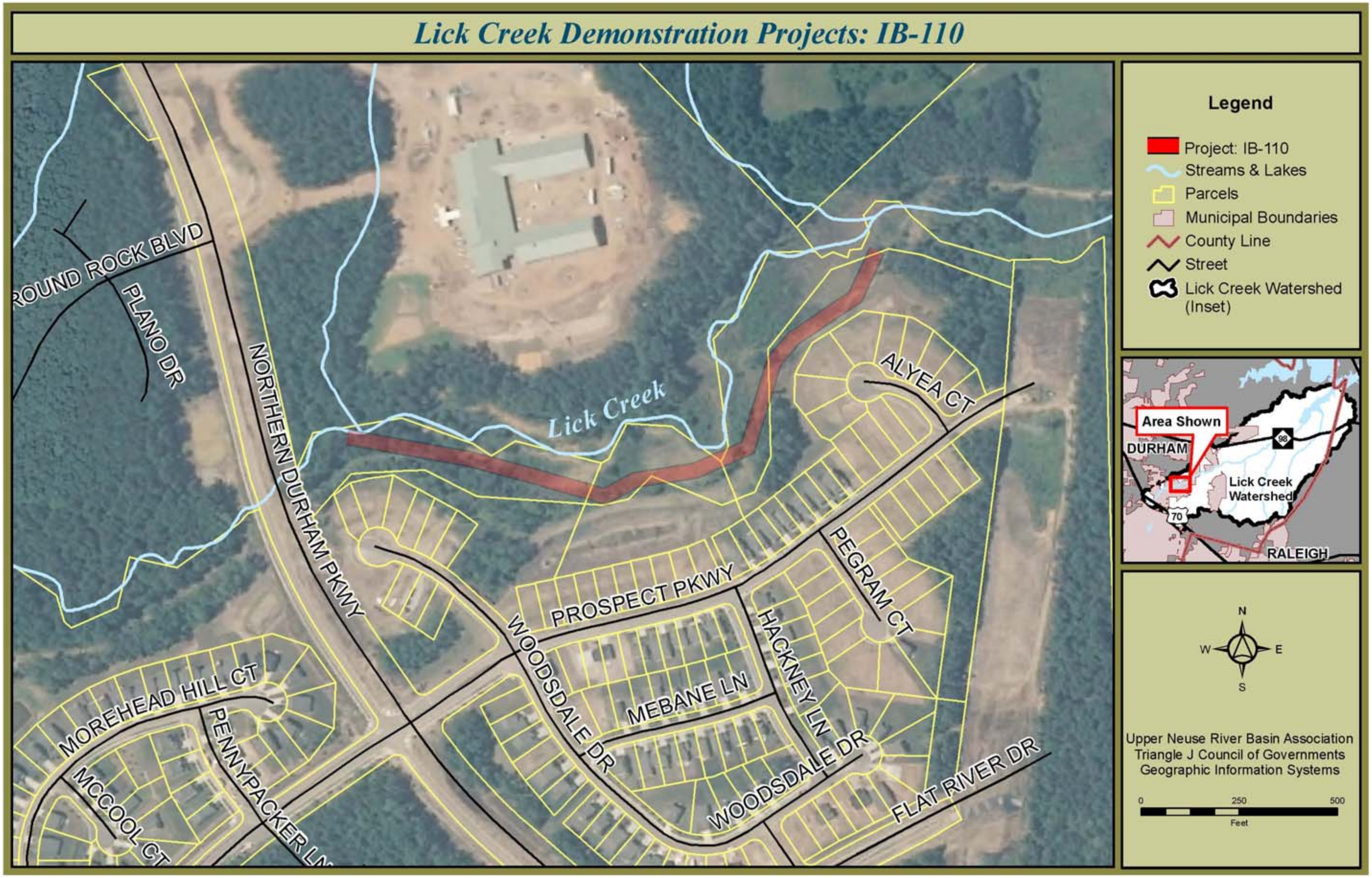


Figure 3. Land-clearing at IB-110.

Figure 4. Land-clearing at IB-110.

Table 4. Pollutant export rates for a developed and adjacent undeveloped tract in the Neuse River Basin (Line and White 2007).

Period	Duration (years)	Runoff/ total rain	TSS	Total phosphorus	NO_{3+2}-N	TKN	NH_3-N	Total nitrogen
				kg/ha-yr				
Developed								
clearing	0.7	0.50	29 250	2.8	2.0	8.4	0.7	10.4
Built1	1.4	0.60	6170	1.3	5.9	25.6	3.3	31.5
Built2	3.5	0.55	1958	1.7	1.8	16.2	1.7	18.0
Overall	5.6	0.55	6274	1.3	2.4	13.1	1.6	15.5
Undeveloped								
overall	5.6	0.21	349	0.5	1.0	5.3	0.2	6.3
Difference in LSM (%)	—	68	95	74	66	70	88	69

Table 5 shows the nutrient export rates predicted for Site IB-110 ("existing") based on recent research (Line et al. 2002 and Line and White 2007; Tables 3 and 4). Table 5 also provides a list of the nutrient export rates we may expect for an undeveloped or buffered site ("natural"); thereby illustrating the loss of nutrient removal potential lost as a result of land-clearing activities, or the nutrient removal potential that could be achieved by re-vegetating this section of streamside buffer. As shown in Table 5, the export rate of TN on developed land ("existing") is almost three times that of what we might expect under forested ("natural") conditions; TP is 1.3 to 3 times higher, and TSS ranges between almost 6 and 30 times higher on developed land.

Table 5. Expected nutrient export rates for IB-110.

TP (lbs per acre)		TN (lbs per acre)		TSS (lbs per acre)	
Existing	**Natural**	**Existing**	**Natural**	**Existing**	**Natural**
1.1-2.6	0.4-0.9	7.2-31.6	5.5-9.9	1702.6-25434.8	303.5-857.4

The analysis (Table 5) demonstrates the significant differences in nutrient and sediment export rates for developed and forested lands that may be expected at Site IB-110, based on the most recent literature on nutrient export rates in the Neuse River Basin. Clearly nutrient removal functions have been lost due to land-clearing activities along this reach of Lick Creek. Furthermore, construction at this site has lagged and many of the lots here have been cleared and graded, but not built, meaning that many of these lots can be categorized as “cleared” or “Construction I” lands, which have been shown to have the highest TSS and nutrient export rates of all land types in the Neuse River Basin (Tables 3 and 4). Using this same analysis, we can expect reforesting or buffering of this section of Lick Creek to reduce the TN export rate by up to 70%; the TP export rate by up to 65%, and the TSS export rate by up to 97%.

R-300 and R-301: Lick Creek Stormwater Retrofits

Five stormwater retrofit restoration opportunities were identified during the Lick Creek LWP planning process (UNRBA 2007). Of these, R-300 and R-301 were ranked the highest; therefore, these two retrofits were selected for nutrient removal potential analysis using the SET and the TPNM (NCDWQ 2009). Both R-300 and R-301 are generally located at the intersection of Mineral Springs Road, Miami Boulevard, and NC Highway 70 (Figures 5 and 7), one of the biggest and busiest intersections in all of Durham County. Land uses at and around this intersection include highway, roads, parking lots, fast-food restaurants, and light industrial/commercial businesses.

R-300

R-300 (proposed for a vegetated stormwater wetland) (Figure 5) would capture approximately 6.4 acres of stormwater runoff predominantly from roads, parking lots, and other impervious surfaces from one of the busiest intersections in Durham County. Approximately 84% (5.4 acres) of the drainage area is impervious cover, with only 15% (1 acre) being forested. Currently, the stormwater at this site is mostly bypassing a concrete conveyance built to accommodate storm flows, and is exiting to a poorly defined stream channel after passing through a low-lying area where commercial dumpsters are located.

The SET was used to evaluate the difference of annual pollutant loads between existing land uses and a site design with one or multiple Best Management Practices (BMP). Stormwater treatment at this site would involve directing stormwater flows to a vegetated stormwater wetland with a small buffer of trees. The SET evaluated TN (pounds per year [lb/yr]), TP (lb/yr), and sediment (tons per year [ton/yr]). The SET analysis suggested that the installation of this retrofit would greatly reduce all three parameters (Figure 6), with reductions as high as 40% for TN, 35% for TP, and 85% for sediment (Table 6). Keep in mind that, for the purposes of this report, on the annual pollutant load and target summary were used to evaluate the potential effectiveness of retrofit installation.

Staff at the Department of Biological and Agricultural Engineering (BAE) at NCSU also evaluated the TN and TP removal potential of the R-300 retrofit project using the TPNM (NCDWQ 2009). Results from this analysis also revealed 40% and 35% reductions in TN and TP (Table 6), respectively; however, existing nutrient loads were assumed to be significantly lower in the TPNM (Table 6).

Table 6. Annual Pollutant Load of R-300 Under Existing Land Use and Design with BMP.

Total Site Annual Load	Existing Land Use		Design With BMP		Percent Reduction (%)	
	SET	TPNM	SET	TPNM	SET	TPNM
Total Nitrogen (lb/yr)	139	97	85	58	40	40
Total Phosphorous (lb/yr)	20	6.8	13.3	4.4	35	35
Sediment (ton/yr)	1.53	N/A*	0.23	N/A*	85	N/A*

*N/A=Not Applicable

Figure 5. Lick Creek Demonstration Project R-300.

Figure 6. SET Analysis for R-300.

Upper Neuse Site Evaluation Tool - Site Performance Analysis

LC Demonstration Projects
Durham County
R-300 Run 3

Land Use Summary

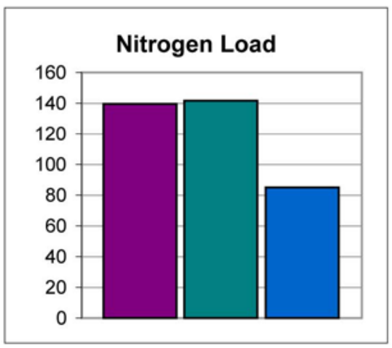
Total Site Area (acres)	6.44
Pre-development impervious percentage	84.5%
Post-development impervious percentage	84.5%

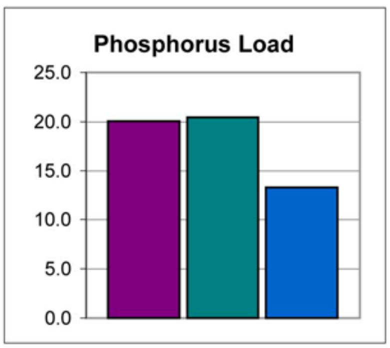
Annual Hydrology Summary

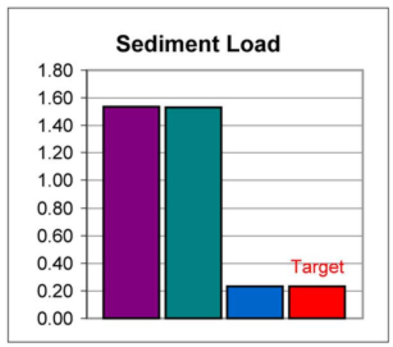
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	32.63	32.63	29.37
Annual Infiltration (inches/yr)	0.93	0.75	0.75

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	139	142	85		
Total Phosphorus (lb/yr)	20.0	20.4	13.3		
Sediment (ton/yr)	1.53	1.53	0.23	0.23	Yes

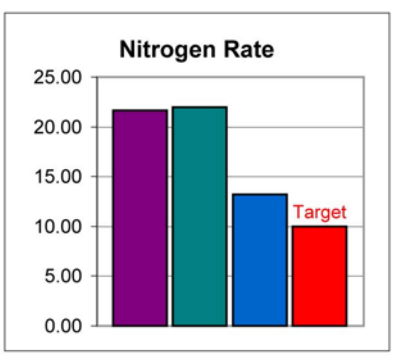


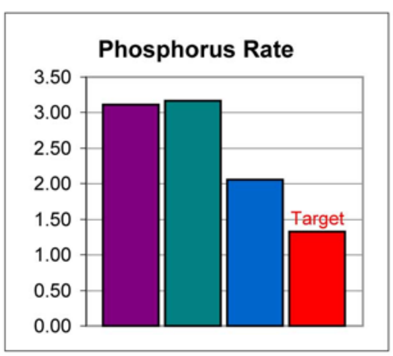


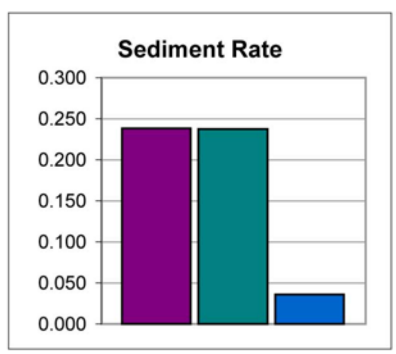


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	21.66	22.00	13.20	10.00	NO!
Total Phosphorus (lb/ac/yr)	3.11	3.17	2.06	1.33	NO!
Sediment (ton/ac/yr)	0.238	0.238	0.036		

Site is located in Urban Non-Residential Nutrient Zone
TN loading rate is higher than the buy-down range of 3.6 to 10 lb/ac/yr







R-301

R-301 (proposed for a vegetated stormwater wetland) (Figure 7) would capture approximately 8.08 acres of stormwater runoff predominantly from roads, parking lots, and other impervious surfaces from one of the busiest intersections in Durham County. Approximately 90% (7.3 acres) of the drainage area is impervious cover, with only 10% (< 1 acre) being forested. Currently, the stormwater at this site is running directly off impervious surfaces. In addition, a 42-inch outfall pipe is directing stormflow directly into a pasture area sparsely vegetated, compacted scrub/shrub area.

The SET was used to evaluate the difference of annual pollutant loads between existing land uses and a site design with a BMP(s). Stormwater treatment at this site would involve a retrofit where water would be directed to a vegetated stormwater. The SET evaluated TN, TP, and sediment for annual pollutant loading. The SET analysis suggested that the installation of this retrofit would greatly reduce all three parameters (Figure 8), with reductions as high as 40% for TN, 35% for TP, and 85% for sediment (Table 7). Again, please note that for the purposes of this report, on the annual pollutant load and target summary were used to evaluate the potential effectiveness of retrofit installation.

Once again, NCSU BAE staff evaluated the TN and TP removal potential of the R-301 retrofit project using the TPNM (NCDWQ 2009). Results from this analysis also revealed 40% and 35% reductions in TN and TP (Table 7), respectively; however, existing nutrient loads were again assumed to be significantly lower in the TPNM (Table 7).

Table 7. Annual Pollutant Load of R-301 Under Existing Land Use and Design with BMP.

Total Site Annual Load	Existing Land Use		Design With BMP		Percent Reduction (%)	
	SET	**TPNM**	**SET**	**TPNM**	**SET**	**TPNM**
Total Nitrogen (lb/yr)	185	119.7	112	71.8	40	40
Total Phosphorous (lb/yr)	26.5	9.0	17.5	5.8	35	35
Sediment (ton/yr)	2.0	N/A*	0.3	N/A*	85	N/A*

*N/A=Not Applicable

Figure 7. Lick Creek Demonstration Project R-301.

Figure 8. SET Analysis for R-301.

Upper Neuse Site Evaluation Tool - Site Performance Analysis

LC Demonstration Projects
Durham County
R-301 Run 3

Land Use Summary

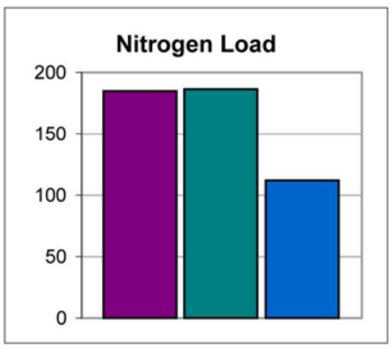
Total Site Area (acres)	8.08
Pre-development impervious percentage	89.9%
Post-development impervious percentage	89.9%

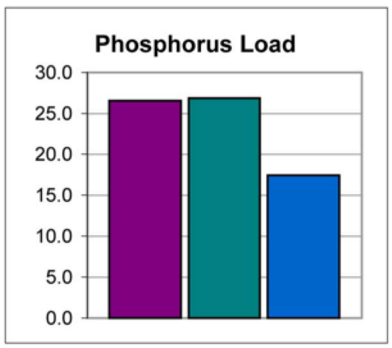
Annual Hydrology Summary

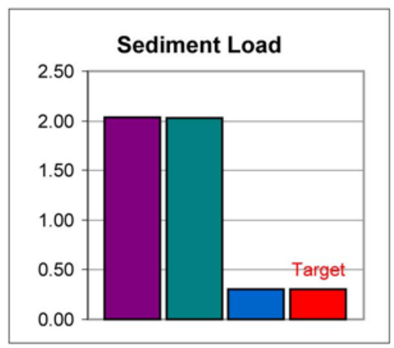
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	34.58	34.58	31.12
Annual Infiltration (inches/yr)	0.61	0.49	0.49

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	185	187	112		
Total Phosphorus (lb/yr)	26.5	26.9	17.5		
Sediment (ton/yr)	2.04	2.03	0.30	0.30	Yes

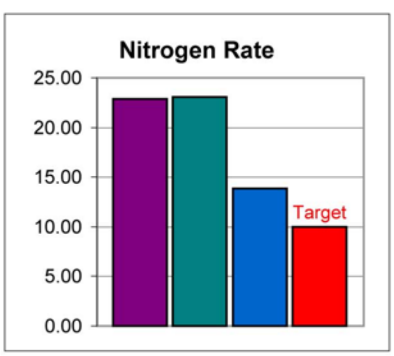


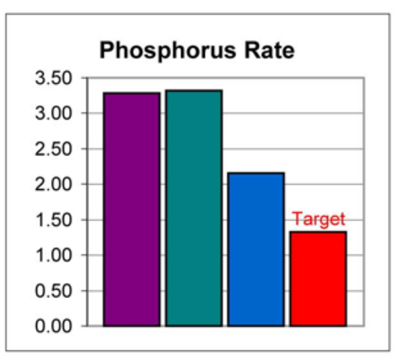


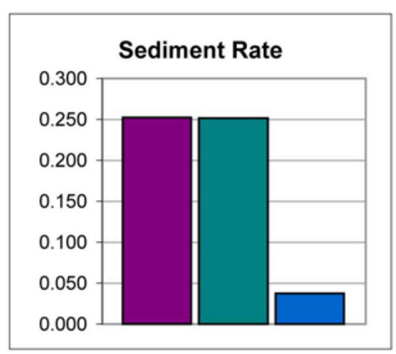


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	22.86	23.08	13.85	10.00	NO!
Total Phosphorus (lb/ac/yr)	3.28	3.32	2.16	1.33	NO!
Sediment (ton/ac/yr)	0.252	0.251	0.037		

Site is located in Urban Non-Residential Nutrient Zone
TN loading rate is higher than the buy-down range of 3.6 to 10 lb/ac/yr







Summary

Analyses of the four potential restoration projects demonstrate that all four projects would produce significant water quality benefits. The analysis showed potential reductions to both TN and TP for IB-110, R-300, and R-301 (IB-350 was not evaluated for TN or TP), and all four projects were projected to substantially decrease sediment loss as a result of restoration activities. Indeed, projected reductions in sediment loss ranged from 85% to upwards of 97%. Projected reductions were consistent for R-300 and R-301, with projected reductions of 40%, and 35% of TN and TP, respectively. This suggests nutrient loading models for the Piedmont assume similar loading rates for existing land uses and that 40% TN removal and 35% TP removal are accepted standards for BMP efficiencies. Removal efficiencies using recent literature suggested a higher TN and TP removal efficiency when applied to IB-110, with TN and TP reductions projected at 70% and 65%, respectively.

With the continuing development of the Lick Creek watershed (TJCOG 2007), the expansion of the Durham Urban Growth Boundary, and the degrading water quality conditions already being documented in the Lick Creek Watershed (Line 2009 and Woolfolk 2009), implementation of restoration activities identified during the local watershed planning effort will be nothing short of critical for maintaining baseline water quality conditions, in addition to their potential to improve them. These analyses provide evidence that these projects would be effective at reducing nutrients and in-stream sediment transport, and can be used to strengthen funding requests for project implementation.

Implementation of demonstration projects on the ground will also serve as irreplaceable education opportunities to local communities, county and city staff, and elected officials, by demonstrating the pollutant reduction potential of water quality improvement projects identified during local watershed planning efforts. Furthermore, the NCDWQ is currently developing a nutrient management strategy for Falls Lake (to which Lick Creek is a direct tributary). A result of this strategy will be a set of rules and reduction targets that the City of Durham, and Durham County will have to achieve. The four projects chosen for demonstration during this analysis demonstrate that restoration may be one tool with which municipalities and jurisdictions may meet this goal.

UNRBA has already been working with community members, academia, extension groups, local agencies, and consulting firms to evaluate the potential of these projects and develop buy-in and interest in pursuing and acquiring funding to implement restoration activities on the ground in Lick Creek. Durham SWCD is currently engaged in stream restoration activities along Lick Creek (IB-350), and developers for the Brightleaf Subdivision have expressed interest in becoming better aligned with water quality interests in Lick Creek (e.g. possibly re-buffering impacted buffers such as IB-110). Furthermore, UNRBA has visited sites R-300 and R-301 twice with staff from NCSU's BAE and Stream Restoration Programs to talk about potential retrofit design. UNRBA and Bill Hunt from NCSU's BAE department are currently conducting a feasibility analysis for retrofitting R-301 with a stormwater wetland.

The UNRBA has also partnered with the NC Ecosystem Enhancement Program (NCEEP) to pursue restoration activities that have been identified during the Lick Creek LWP planning process. Part of this strategy involves the development of a project atlas that will include a list (with accompanying maps) of restoration projects in the Lick Creek watershed that may be of interest to NCEEP or other agencies such as Durham SWCD or local land trusts for implementation. The UNRBA has committed to using this process as a way to also educate and inform the local communities and governments about the importance, need, and effectiveness of restoration to help reduce nutrient loading in Lick Creek and its receiving waters.

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