Rutherford Creek

Watershed-Based Plan

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Duck River Opportunities Project

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The Tennessee Environmental Council (TEC) is a 501(c)(3), conservation organization whose mission is *Helping People and Communities Improve Our Environment* as such TEC is the primary agency proposed to implement the Rutherford Creek Watershed Based Plan. TEC and its staff have been working in the Rutherford Creek and Duck River Watershed for more than 25 years. Rutherford Creek is located in southwestern Williamson and northern Maury counties and is a part of the Duck River Watershed.

The development of the WBP was originally funded in part, under an agreement with the Tennessee Department of Agriculture, Nonpoint Source Program and the U.S. Environmental Protection Agency, Assistance Agreement, C9994674-05-0. Grant contract # GR-06-17452-00. The current update is funded by the Tennessee Environmental Council.

The purpose of the WBP is to provide an overview of the water quality problems and way forward actions necessary to de list Rutherford Creek. While the plan goals are similar to the 2006 goals, there has been and will be less emphasis on monitoring and more emphasis on BMP implementation. TEC working with TDEC, Springhill and local agencies will carry out some monitoring, but it will be limited to finding specific problems, that can then be addressed through the implementation of BMPs or regulatory means. The WBP includes the following sections:

- Identification of causes and sources (or groups of causes/sources)
- Load Reduction Estimates
- Description of Non-point Source Management Measures (BMPs)
- Cost Estimates
- Information/education
- Schedule for implementation
- Watershed Restoration Milestones
- Criteria to determine if load reductions are being met
- Measures of success (are loading reduction estimates being met?)

1) Identification of Causes and Sources

The Tennessee Department of Environment and Conservation (TDEC) 2020 303(d) List identifies the cause of degradation in Rutherford, Crooked, McCutcheon Creeks and Grassy Branch (Rutherford Creek Watershed) as sedimentation/siltation, nutrients, and alteration of stream side or littoral vegetation. Pollutant sources include land development/clearing, municipal/high density and point sources and pasture grazing (Table 1). The Duck River Opportunities Project (DROP) has been working in and around Rutherford and McCutcheon Creek watershed collecting data as well as implementing best management practices for the past 20 years. One observation supporting TDEC findings are the presence of large areas of bank erosion along the main stem of Rutherford Creek and its tributaries including McCutcheon Creek and Grassy Branch. As well, the Springhill area has continued to develop rapidly and there continues to be agricultural activity in the area.

Table 1 (TDEC, 2020)

Waterbody ID	Stream Name	Length impacted	Cause	Source
TN06040003034_0300	McCutcheon Creek	12.27	Sedimentation/siltation	Site clearing, Grazing in Riparian zones
TN06040003034_0410	Grassy Branch	7.18	Alteration in streamside vegetation or littoral vegetation	Municipal (Urbanized High Density Area)
TN06040003034_0700	Crooked Creek	2.5	Sedimentation/siltation, Physical substrate habitat alteration	Grazing in riparian zone, Municipal (Urbanized high density areas)
TN06040003034_2000	Rutherford Creek	10	Alteration in streamside or littoral vegetation, nitrate/nitrite, phosphorus, sedimentation/siltation	Municipal (Urbanized high density and point sources)

2) Load Reduction Estimates

Load reduction and cost estimates are in Appendix I and are based on the best available data for the management practice and its ability to reduce pollutant loads as presented in the TDA 319 2022 RFP. Based on these estimates the most cost effective sediment reduction strategy is installing sediment and water retention control basins. While there are likely significant sources of sediment from outside the stream channel that this strategy would address, there are also instream sources of sediment (i.e. bank erosion) as has been experienced through the urban stream syndrome. Thus some bank erosion will need to be addressed. The area to be treated should be prioritized to include 1) long eroding banks on outside bends and 2) areas where significant roots and other vegetation can be protected from further degradation.

The most cost effective nutrient reduction strategy is to restore riparian zones. However this may be coupled with livestock exclusion, providing for alternative water supply or limited stream access watering points may also be necessary to restore riparian zones in more rural parts of the sub watershed. In the suburban - urban environments these practices would also be applied and may be coupled with lawn care education and erosion control programs, and sediment retention/detention/infiltration basins and bank stabilization work. Municipal point sources should be regulated through the NPDES permitting system managed by TDEC.

3) Description of Non-point Source Management Measures (BMPs)

The two primary non-point source management measures necessary to abate the pollutant sources and causes associated with the State's 303 (d) listing of Rutherford Creek in the Duck River Watershed are riparian restoration coupled with minor bank stabilization and sediment basin installation.

3.1) Riparian restoration consists of two basic activities including 1) removal of the cause of degradation and 2) restoration of the vegetative community. In addition, some hydrologic conditions may need to be restored. Removal of the cause of degradation

includes livestock exclusion and provision for alternative water supply. Livestock exclusion will be accomplished by fencing riparian zones. Alternative water supply may be provided by one of two mechanisms, placement of trough or tank outside the livestock exclusion zone or a limited stable access point allowing livestock to enter the creek. Based on conversations with district conservationists, water supply should be provided every 2,000 feet. Once livestock are excluded from the riparian zone and alternative water supply provided riparian (buffer) restoration can occur.

The Natural Resources Conservation Service (NRCS) guidelines call for a minimum of a 35 foot wide buffer along rivers and streams, however other sources call for up to a 100 foot buffer (see Wenger, 1999). TEC will promote as wide a buffer as seemingly possible, based on land condition, landowner concerns and other factors that may apply. To leverage additional (NRCS) funds, buffers need to be a minimum of 35 feet wide. However, because TDEC biologist (personal communication with James R. Smith) and others have observed improvements in water quality associated with one row of trees along creek banks, and because landowner objections often have to do with loss of land to graze, crop etc. TEC will advocate for as much width as possible, but in some cases will work to reestablish minimal riparian zones. Revegetation may occur by two methods including active planting and/or natural "volunteer" revegetation. While the latter is more cost-effective, it may not provide as desirable a mix of biodiversity.

Finally, in some cases it may be necessary to restore natural hydrology to the riparian zone in cases where aquatic systems are severely down cut or where channels have formed through riparian zones. This would in effect bypass sheet flow and thus pollutant load reductions associated with the filtration/infiltration capacity of the riparian zone.

3.2) Stream bank stabilization maybe carried out along roughly 25% of stream banks. Stream bank erosion is a significant problem in the headwaters of Rutherford Creek and thus treating all stream banks is not cost-effective or practical. Stabilization projects will be prioritized based on protecting specific ecological assets and treating the most significant problem areas. For example, streams with one row or scattered trees on a highly erosive stream bank would be treated to protect and save those trees (ecological asset) providing shade and detrital material (habitat and food) to the system. Secondly, long, highly erosive segments may be treated. This should provide for the greatest load reductions at the least cost.

The primary method utilized to treat eroding stream banks will be placement of cedar revetments and/or coir logs, reshaping of banks as space allows back fill and revegetation. TEC has utilized this method to treat banks as high as 12 feet and generally found them effective in reducing erosion. The process is the same as that recommended by the NRCS, except cedar trees, if used should be wrapped in coir matting, prior to being attached to the stream bank. The matting helps capture more sediment by allowing cedar tree branches to be more compact/dense. In addition, the revetment can be backfilled and revegetated immediately following installation.

3.3) Sediment and water control basins are primarily utilized for pollutant reductions associated with residential and commercial development. As such they are a part of the regulatory / MS4 program in the communities of the watershed. Moreover, the regulatory agency and landowners need to continue to maintain and upgrade existing facilities as necessary. At a minimum these structures need to be inspected on a five year

cycle and upgraded as necessary. Because much of the watershed is already developed efforts should be made to "retrofit" existing developments with sediment and water control / infiltration basins. This can be done generally on a small scale. One must prioritize areas within sub watersheds and seek out locations that may be appropriate. These may include local parks, common spaces and individual yard's (landowner willing).

4) Cost Estimates

4.1) Technical and Financial Resource Estimates

DROP, NRCS and DROPs technical advisors will work with individual landowners to develop site-specific plans for stream restoration projects. Best management practice (BMP) cost estimates are generally based on experience and directly relate to stream miles impaired and causes and sources associated with the TDEC 303(d) listing. Thus, BMP cost estimates are for the entire subwatershed and presented in Appendix I along with load reductions.

Project partners should work with local officials on the implementation of the erosion control and lawn care education program (LCEP). The LCEP should be carried out utilizing public service announcements in conjunction with the WaterWorks! program at MTSU. The erosion and sediment control program should be funded through participating municipalities, such as Spring Hill who is a part of the state MS4 program and as such required to establish an effective erosion and sediment control program.

4.2) Sources of Technical and Financial Resources

Project partners should seek funds from multiple sources. Sources include State/EPA 319 grants, NRCS farm conservation programs such as Environmental Quality Incentives program (EQIP), private foundations such as the Fish and Wildlife Foundation, private business and individual donors. Many non profits have been successful in incorporating NRCS farm programs into agricultural BMP implementation costs and seen as much as 75% of costs covered by those programs. However, limitations exist for these programs, mainly limited funding and NRCS ability to deliver the programs in a timely manner. Thus, while this is an excellent source of cost share dollars, its limitations must be considered. Most if not all site-specific BMP implementation will require a diverse source of funding. In the suburban – urban environments NRCS funds may not be available and thus other sources of financial resources must be sought. These include local governments, public and private foundations, private business and individual donors.

4.3) Plan Implementation Authorities

The Tennessee Environmental Council in partnership with local governments (Williamson and Maury County, Spring Hill) and Natural Resources Conservation Service will be the primary agency's responsible for the implementation of the plan. In addition, DROP will work with any other agency or individuals identified with potential to impact the Rutherford Creek Watershed.

Established in 1999, DROP is a science and technically based watershed conservation project that has historically focused on protecting and restoring the ecological health of the respective river systems. Work has focused on river restoration, education and

outreach that promote proactive, cooperative efforts to improve long-term conservation of Tennessee's vast water resources. Our work leverages scientific and technical experience of staff and advisors in additon to efforts of a diverse corps of volunteers who represent a crucial link in every aspect of DROP program work.

Some accomplishments include work funded by two 319 grants (and HRWA work) to focus on reduction in nonpoint source pollution. One project lead by McFadden for HRWA Visual Stream Assessment (VSA) in which 25 volunteers, logged over 550 hours, surveying 217 sites on 303(d) segments in the watershed. Data, including 800 photographs, included in an Access database and report produced, which is now used by staff to drive restoration program.

With a second 319 grant in 2002, DROP, in cooperation with HRWA, launched the Volunteer River Restoration Corps, an ongoing effort to engage citizens, schools, municipalities, farmers and others to improve long-term water quality of the Rutherford Creek and Duck River Watersheds by improving stream and riparian habitat on a site by site basis. DROP/HRWA completed over 20 stream and riparian restoration projects, planting over 25,000 seedlings, and stablizing close to 1700' (+/-) of stream bank. This could not have been accomplished without volunteers. The 2002 319 grant also included the gathering of field data, something DROP had been doing since 1999 to assess the effectiveness of restoration on water quality.

5) Information/Education/Outreach

Project Partners in conjunction with NRCS, may carry out field education days for citizens, and agricultural operators, and will work to have participating farmers present to and help recruit other farmers into the program for conservation. In addition, DROP will continue to work with educators and youth groups utilizing the Protecting Our Watersheds or similar curriculum in an effort to 1) add to information provided by TDEC and others and 2) get students involved in identifying and implementing restoration projects. The core of the educational programs will be related to gathering and training local citizens to speak for restoration and implement projects.

Secondly, and perhaps most importantly, DROP will work with local officials and staff to help determine the best ways to meet water quality load reductions called for in the sediment TMDL on the Duck River. Our approach will be to utilize the basics of watershed science to help local officials and staff develop effective short and long-term programs to protect watershed quality. One example might be to utilize the watershed treatment model to help engineering staff understand the importance of maintaining less than 10 % imperviousness within a subwatershed or increasing practices that decrease sediment (siltation) from development sites.

5.1) Erosion and Sediment Control Program

The Erosion and Sediment Control program is primarily a function of local municipalities. DROP will focus attention on the town of Spring Hill (McCutcheon Creek) in a effort to educate local leaders, developers and contractors about the need for an effective erosion and sediment control program. In addition, DROP will continue working with developers on implementation of short term practices to control sediment.

5.2) Lawn Care Education Program

DROP will work with the Middle Tennessee State University's Center for Environmental Education's WaterWorks! program on lawn care education (LCEP). The majority of public education outreach will be accomplished via radio and secondly through public speaking engagements with rotary, church groups, etc. The message will be targeted toward homeowners and their lawn fertilization practices.

6) Schedule for implementation - Total implementation time is estimated to be 20 years.

Activity	Year(s)
1) Identify and meet with project partners, landowners, homeowners' associations	1 - 10
2) Identify willing landowners, homeowners' associations., developers, etc.	1 - 18
3) Develop LCEP outreach information in conjunction w/ MTSU	1 - 3
4) Work with city and county to develop protocol to educate developers and disseminate LCEP information	1 - 3
5) Identify and train willing youth groups, scouts, schools, etc.	1 - 20
6) Carry out pre BMP information collection	1, 3, 5, 7, 9, 11, 13, as needed.
7) Develop site specific BMP implementation plans	2 - 18
8) Implementation of BMPs	2 – 20
9) Carry out post BMP information collection / assessment	4, 6, 8, 10, 12, 14, 16, 18, 20
10) Final report	19, 20

7) Watershed Restoration Milestones

Milestones	Year(s)
1) Site specific BMP plan development	2-18
2) Youth groups collecting information in the watershed	1 - 20
3) One community meeting per year, articles to local newspaper (4/year)	1-20
4) Develop LCEP outreach information in conjunction w/ MTSU	1 - 3
5) Work with city and county to develop protocol to educate developers	1 - 3
6) Collect information prior to BMP implementation	1, 3, 5, 7, 9, 11, 13, as needed.
7) Site specific BMP implementation	2 – 20
8) BMP implementation assessment / analysis (survival, structure integrity)	4, 6, 8, 10, 12, 14, 16, 18, 20
9) Final report and public meeting	19, 20

8) Measures of Success

The long-term success of the program will be measured utilizing TDEC watershed data. TDEC is in the watershed every five years collecting data through their watershed cycle. Data include benthic macroinvertebrate inventories (BMI) and habitat and physical/chemical measures. Ecological health is defined as the inclusion of benthic macroinvertebrate communities that are deemed by TDEC as fully supporting the fish and aquatic life use of waters of the state as compared to the appropriate ecoregional reference site.

DROP and other partners should utilize TDEC data in addition to other data collected by professional and volunteers to determine if the plan (or TMDL) needs revising. The main criteria will be BMI collections as many organizations, including TDEC and U.S. EPA consider this the primary characteristic of healthy aquatic systems. However, based on individual sampling plan data (i.e. TSS) associated with localized site work, it maybe determined that a specific practice, in a specific application situation is not functioning as predicted. The practice may then be modified and or excluded from the suite of practices being recommended.

DROP may utilize the Watershed Treatment Model or other methods to make basic watershed load reduction predictions to make site level predictions as allowed. This may be followed up with actual data collection to verify predictions. If predictions are not verified, then the plan (or TMDL) will be revised to increase the effectiveness of load reductions.

9) Monitoring Component to Evaluate Effectiveness

Three basic monitoring components will be utilized including 1) benthic macroinvertebrate (BMI) data collected on the five year cycle by TDEC (sentinel data) and possibly collected by DROP and/or local municipalities 2) physical habitat data collected on specific sites and 3) practice implementation data, such as stream miles fenced off from livestock, trees planted/survival rates and stream banks stabilized.

Appendix I

TN06040003034_0300 - McCutcheon Creek –
Sediment Reduction

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	Sed. reduction factor (tons/ft/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	12.27	9.2025	48,589.20	0.002	97.18	$8.00	$388,713.60
Streambank/Shoreline protection**	580	12.27	3.0675	16,196.40	0.047	761.23	$60.00	$971,784.00
Water and Sediment control Basin***	638	12.27	0.6135	3,239.28	6.109	19,788.76	$205.00	$664,052.40
Critical Area planting	342	12.27	6.135	32,392.80	0.055	1,781.60	$33.00	$1,068,962.40
Total Sediment reduction in tons per year/total cost						**22,428.77**		**$3,093,512.40**

TN06040003034_0410 - Grassy Branch

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	Sed. reduction factor (tons/ft/yr)	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	7.18	5.385	28,432.80	0.002	56.87	$8.00	$227,462.40
Streambank/Shoreline protection**	580	7.18	1.795	9,477.60	0.047	445.45	$60.00	$568,656.00
Water and Sediment control Basin***	638	7.18	0.359	1,895.52	6.109	11,579.73	$205.00	$388,581.60
Critical Area planting	342	7.18	3.59	18,955.20	0.055	1,042.54	$33.00	$625,521.60
Total Sediment reduction in tons per year/total cost						**13,124.58**		**$1,810,221.60**

TN06040003034_0700 - Crooked Creek –
Sediment reductions (Cont.)

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	Sed. reduction factor (tons/ft/yr)	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	2.5	1.875	9,900.00	0.002	19.80	$8.00	$79,200.00
Streambank/Shoreline protection**	580	2.5	0.625	3,300.00	0.047	155.10	$60.00	$198,000.00
Water and Sediment control Basin***	638	2.5	0.125	660.00	6.109	4,031.94	$205.00	$135,300.00
Critical Area planting	342	2.5	1.25	6,600.00	0.055	363.00	$33.00	$217,800.00
Total Sediment reduction in tons per year/total cost						**4,569.84**		**$630,300.00**

TN06040003034_2000 - Rutherford Creek

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	Sed. reduction factor (tons/ft/yr)	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	10	7.5	39,600.00	0.002	79.20	$8.00	$316,800.00
Streambank/Shoreline protection**	580	10	2.5	13,200.00	0.047	620.40	$60.00	$792,000.00
Water and Sediment control Basin***	638	10	0.5	2,640.00	6.109	16,127.76	$205.00	$541,200.00
Critical Area planting	342	10	5	26,400.00	0.055	1,452.00	$33.00	$871,200.00
Total Sediment reduction in tons per year/total cost						**18,279.36**		**$2,521,200.00**

* Assumes 35' width both sides bank

** Assumes bank failure rate of 25%

***Treating 0.5 miles of impaired waters located in urban/suburban areas of watershed

****Estimate based on TDA NPS projected

TN06040003034_0300 - McCutcheon Creek – N Reductions

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	N reduction factor (lbs N/unit/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	12.27	9.2025	48,589.20	308.4	3,784.07	$8.00	$388,713.60
Streambank/Shoreline protection**	580	12.27	3.0675	16,196.40	1.75	21.47	$60.00	$971,784.00
Water and Sediment control Basin***	638	12.27	0.6135	3,239.28	199.41	2,446.76	$205.00	$664,052.40
Critical Area planting	342	12.27	6.135	32,392.80	100.04	1,227.49	$33.00	$1,068,962.40
Total Sediment reduction in tons per year/total cost						**7,479.79**		**$3,093,512.40**

TN06040003034_0410 - Grassy Branch

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	N reduction factor (lbs N/unit/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	7.18	5.385	28,432.80	308.4	2,214.31	$8.00	$227,462.40
Streambank/Shoreline protection**	580	7.18	1.795	9,477.60	1.75	12.57	$60.00	
Water and Sediment control Basin***	638	7.18	0.359	1,895.52	199.41	1,431.76	$205.00	$388,581.60
Critical Area planting	342	7.18	3.59	18,955.20	100.04	718.29	$33.00	$625,521.60
Total Sediment reduction in tons per year/total cost						**4,376.93**		**$1,241,565.60**

TN06040003034_0700 - Crooked Creek – N reductions (Cont.)

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	N reduction factor (lbs N/unit/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	2.5	1.875	9,900.00	308.4	771.00	$8.00	$79,200.00
Streambank/Shoreline protection**	580	2.5	0.625	3,300.00	1.75	4.38	$60.00	$198,000.00
Water and Sediment control Basin***	638	2.5	0.125	660.00	199.41	498.53	$205.00	$135,300.00
Critical Area planting	342	2.5	1.25	6,600.00	100.04	250.10	$33.00	$217,800.00
Total Sediment reduction in tons per year/total cost						**1,524.00**		**$630,300.00**

TN06040003034_2000 - Rutherford Creek

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	N reduction factor (lbs N/unit/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	10	7.5	39,600.00	308.4	0.00	$8.00	$316,800.00
Streambank/Shoreline protection**	580	10	2.5	13,200.00	1.75	23,100.00	$60.00	$792,000.00
Water and Sediment control Basin***	638	10	0.5	2,640.00	199.41	526,442.40	$205.00	$541,200.00
Critical Area planting	342	10	5	26,400.00	100.04	2,641,056.00	$33.00	$871,200.00
Total Sediment reduction in tons per year/total cost						**3,190,598.40**		**$2,521,200.00**

* Assumes 35' width both sides bank

** Assumes bank failure rate of 25%

***Treating 0.5 miles of impaired waters located in urban/suburban areas of watershed

****Estimate based on TDA NPS projected

TN06040003034_0300 - McCutcheon Creek – P reductions

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	P reduction factor (lbs N/unit/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	12.27	9.2025	48,589.20	22.6	207.98	$8.00	$388,713.60
Streambank/Shoreline protection**	580	12.27	3.0675	16,196.40	0.17	0.52	$60.00	$971,784.00
Water and Sediment control Basin***	638	12.27	0.6135	3,239.28	33.92	20.81	$205.00	$664,052.40
Critical Area planting	342	12.27	6.135	32,392.80	13.56	83.19	$33.00	$1,068,962.40
Total Sediment reduction in tons per year/total cost						**312.50**		**$3,093,512.40**

TN06040003034_0410 - Grassy Branch

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	P reduction factor (lbs N/unit/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	7.18	5.385	28,432.80	22.6	121.70	$8.00	$227,462.40
Streambank/Shoreline protection**	580	7.18	1.795	9,477.60	0.17	0.31	$60.00	$568,656.00
Water and Sediment control Basin***	638	7.18	0.359	1,895.52	33.92	12.18	$205.00	$388,581.60
Critical Area planting	342	7.18	3.59	18,955.20	13.56	48.68	$33.00	$625,521.60
Total Sediment reduction in tons per year/total cost						**182.86**		**$1,810,221.60**

TN06040003034_0700 - Crooked Creek – P
Reductions (Cont.)

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	P reduction factor (lbs N/unit/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	2.5	1.875	9,900.00	22.6	42.38	$8.00	$79,200.00
Streambank/Shoreline protection**	580	2.5	0.625	3,300.00	0.17	0.11	$60.00	$198,000.00
Water and Sediment control Basin***	638	2.5	0.125	660.00	33.92	84.80	$205.00	$135,300.00
Critical Area planting	342	2.5	1.25	6,600.00	13.56	33.90	$33.00	$217,800.00
Total Sediment reduction in tons per year/total cost						**161.18**		**$630,300.00**

TN06040003034_2000 - Rutherford Creek

Practice	Code	Total Miles impacted	Miles treated (projected)	Ft treated	P reduction factor (lbs N/unit/yr)****	tons/yr	Costs ($/ft)	Total Cost
Riparian Forest Buffer*	391	10	7.5	39,600.00	22.6	169.50	$8.00	$316,800.00
Streambank/Shoreline protection**	580	10	2.5	13,200.00	0.17	0.43	$60.00	$792,000.00
Water and Sediment control Basin***	638	10	0.5	2,640.00	33.92	16.96	$205.00	$541,200.00
Critical Area planting	342	10	5	26,400.00	13.56	67.80	$33.00	$871,200.00
Total Sediment reduction in tons per year/total cost						**254.69**		**$2,521,200.00**

* Assumes 35' width both sides bank

** Assumes bank failure rate of 25%

***Treating 0.5 miles of impaired waters located in urban/suburban areas of watershed

****Estimate based on TDA NPS projected