Prepared for the Town of Black Mountain
160 Midland Avenue
Black Mountain, NC 28711

Upper Swannanoa River Watershed Management Plan

Buncombe County
North Carolina
Effective January 1, 2016

Prepared By:

EQUINOX
balance through proper planning

37 Haywood Street, Suite 100 • Asheville, North Carolina 28801

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Acknowledgements

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Erica Anderson of the Land-of-Sky Regional Council of Government for her initiative in obtaining matching money from the NCDWR 205(j) grant program.

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Key to Acronyms and Abbreviations

ACSP	Agricultural Cost Share Program
CCDAP	Community Conservation Assistance Program
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
DEQ	Department of Environmental Quality
EPA	Environmental Protection Agency
EQI	Environmental Quality Institute
EQIP	Environmental Quality Incentives Program
HUC	Hydrologic Unit Code
lb	Pound(s)
LOSRCOG	Land-of-Sky Regional Council of Government
MRA	Mountain Retreat Association
MSI	Municipal Sphere of Influence
NA	Natural Area
NCDNCR	North Carolina Department of Natural and Cultural Resources
NCDWR	North Carolina Division of Water Resources (effective 2014)
NCDWQ	North Carolina Division of Water Quality (pre-2014)
NCEEP	North Carolina Ecosystem Enhancement Program (renamed Division of Mitigation Services in 2015)
NCIBI	North Carolina Index of Biotic Integrity
NCNHP	North Carolina Natural Heritage Program
NCSRI	North Carolina Stream Restoration Institute
NCWRC	North Carolina Wildlife Resources Commission
NEMAC	National Environmental Modeling and Analysis Center
NPDES	National Pollution Discharge Elimination System
PARTF	Parks and Recreation Trust Fund
SCM	Stormwater Control Measure
SVM	Swannanoa Valley Museum
SMIE	Stream Monitoring Information Exchange
SR	Secondary Road
STEPL	Spreadsheet Tool for Estimation of Pollutant Load
TBM	Town of Black Mountain
TBD	To Be Determined
TLW	Targeted Local Watershed
TOM	Town of Montreat
TMDL	Total Maximum Daily Load
UNCA	University of North Carolina at Asheville
USCB	U.S. Census Bureau
USDA-NRCS	U.S. Department of Agriculture Natural Resource Conservation Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
USRW	Upper Swannanoa River Watershed
VWIN	Volunteer Water Information Network
WMP	Watershed Management Plan

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North Carolina 9-Element Plan Checklist

Watershed	Swannanoa River upstream of North Fork Swannanoa River
Applicant Name	Equinox Environmental Consultation & Design, Inc. on behalf of the Town of Black Mountain
Contact Person/Title	Josh Harrold – Town of Black Mountain Director of Planning and Development Services or Jim Borawa - Equinox
Address	160 Midland Avenue Black Mountain, NC 28711 or 37 Haywood Street, Suite 100 Asheville, NC 28801
Phone Number/Email	828-419-9370; josh.harrold@townofblackmountain.org Or 828-253-6856; jborawa@equinoxenvironmental.com
Date of Submittal	December 15, 2015

What plans will you be using to document the 9 Elements required for 319 funding? Please provide a full reference.	**Name of Plan(s)**	**Author/Developer**	**Year**	**Link/Location**
	French Broad Basinwide Water Quality Plan	N.C. Division of Water Quality	2011	http://portal.ncdenr.org/web/wq/ps/bpu/basin/frenchbroad/2011
	French Broad River Basin Restoration Priorities 2009	N.C. Ecosystem Enhancement Program	2009	http://portal.ncdenr.org/web/eep/rbrps/french-broad
	2014 Comprehensive Plan Update for the Town of Black Mountain	Town of Black Mountain Land-of-Sky Regional Council of Government	2014	http://www.townofblackmountain.org/Town-Government/Boards-and-Commissions/Planning-Board?folderId=121&view=gridview&pageSize=10

	Upper Swannanoa River Watershed Management Plaan	Town of Black Mountain/Equinox	2016	http://portal.ncdenr.org/web/wq/ps/nps/319program/nc-watershed-plans
	Black Mountain Wellhead Protection Planning Project	Land-of-Sky Regional Council of Government	1995	Land-of-Sky Regional Council of Government. Asheville, North Carolina. Not available on-line.
	Town of Black Mountain Stormwater Master Plan 2009	Town of Black Mountain McGill Associates, Inc.	2009	Report not available on-line; see Section 5.2 of the 2014 Master Plan cited above.
	Comprehensive Plan Alternatives for Montreat, North Carolina	Town of Montreat; University of North Carolina at Chapel Hill	2003	http://www.townofmontreat.org/downloads/comp_plan/CompPlan1.pdf
	The Upper Swannanoa River is a targeted local watershed for stream restoration by the NCDMS, but a local watershed plan has not been developed.	N.C. Division of Mitigation Services	N/A	See priorities planning map at: http://portal.ncdenr.org/web/eep/priorities-map
Once completed, please submit your checklist to Kim Nimmer at kimberly.nimmer@ncdenr.gov. DWR will conduct an internal review and notify you when the plan has been determined to meet all of the 9 Elements and is eligible for Section 319 Grant implementation funding. As they are approved they will be listed on DWR's list of 319 watershed plans at htpp://portal.ncdenr.org/wegb/wq/s/nps/319program/nc-watersehd-plans. If you are developing a plan that you are hoping to submit a 319 in the same year, please contact Kim Nimmer by email or by phone at (919)-807-6438. Your plan will need to be submitted for approval at least 45 days prior to the 319 Grant application due date				

1. Identification of the Causes and Sources Checklist	Yes	No	Notes	Identify location of information (include link or attach plan and identify section and page number)
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Does this plan identify stressors and sources in the watershed?	X			Element A, Page 22
OPTIONAL (Supplemental and/or supporting information)				
Was a GIS desktop analysis performed?	X		Potential stormwater retrofit sites and stream riparian areas in need of improvement were assessed and modeled in GIS using aerial photos and land use data	Element B, Pages 25, 26, and 53
Has existing water quality or biological data been reviewed? • Ambient water quality data • USGS data • Other?	X		NCDWR benthic macroinvertebrate survey data VWIN water quality data SMIE benthic invertebrate survey data	Watershed Characterization Water Quality, Page 18 Benthic Communities, Page 21 Fish Communities, Page 22
Does the plan(s) identify any water quality impairments in this watershed (303(d) list)?		X	Review of available data shows no exceedances of state standards	Watershed Characterization Water Quality, Page 18
Has a field assessment been conducted? • CWP (Center for Watershed Protection) Method • EEP (Ecosystem Enhancement Program) Manual • Other?	X		Field assessment of potential stormwater retrofits sites was conducted following Equinox established procedures.	Element B Management Measures Stormwater, Page 26 and Appendix A
Does the plan indicate if a TMDL has been developed for this watershed?	X		A TMDL has not been developed for this watershed.	Introduction, Page 6
Does the plan(s) include a map that shows where stressors and sources are concentrated?	X		Potential project site locations are identified	Element B Management Measures Potential Stormwater Control Projects, Figure 4 on Page 28 Potential Stream Improvement Projects, Figure 13 on Page 55

2. Description of the NPS Management Measures Checklist	Yes	No	Notes	Identify location of information (include link or attach plan and identify section and page number)
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Does the plan(s) identify management measures that address the stressors and sources identified in Element 1? (*note prioritization of projects would be considered to meet this element*)	X		Management measures applicable to this plan are described; a list of potential projects is presented, including priority by expected time frame for implementation.	Element B Management Measures Stormwater, Page 46 Stream Improvement, Page 57
3. Estimate of the load reductions expected for the management measures	**Yes**	No	Notes	**Identify location of information (include link or attach plan and identify section and page number)**
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Have potential indicators been identified for each management measure to determine success?	X		Indicators identified for each project type. Within project type indicators apply across management measures	Element H Pollutant Load Reduction Achievements Stormwater, Page 83 Stream Improvement, Page 83
Has it been roughly quantified how much each management measure will reduce one or more parameters identified in Element 1?	X		Reductions of TSS, N, P, and Zn are calculated for stormwater measures Reductions in sediment estimated for stream improvement measures.	Element X Estimate of Pollutant Load Reductions Stormwater, Table 15 Page 61 Stream Improvement, Table 16 Page 63
OPTIONAL (Supplemental and/or supporting information)				
Has a water quality, watershed or lake response model been developed for this watershed?		X		

4. Estimate of the technical and financial assistance needed	Yes	No	Notes	Identify location of information (include link or attach plan and identify section and page number)
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Have the potential costs associated with management activities listed in the plan(s) been identified?	X		Estimates for management measures and outreach and education activities have been estimated.	Element D Technical and Financial Assistance Needs Stormwater Management Measures Costs, Table 19 Page 55; Table 20 Page 67 Element E – Outreach and Education Plans, Pages 71-74
Has the technical assistance that may be required to help with design, construction, implementation and monitoring of management strategies listed in the plan(s) been identified?	X		Type of technical assistance and sources of assistance for each management action are listed	Element D Technical and Financial Assistance Needs Table 18 Page 65
OPTIONAL (Supplemental and/or supporting information)				
Have potential partners and funding sources to assist with implementation of the watershed plan(s) been identified and/or contacted?	X		Potential partners have been identified; some have been contacted or were part of the stakeholder group.	Element D Technical and Financial Assistance Needs Table 17 Page 64
Have potential partners and funding sources to assist in the maintenance and/or monitoring following completion been identified?	X		Monitoring Partners identified; management measure maintenance entity to be determined during project development	Element D Technical and Financial Assistance Needs Table 17 Page 64 Element I Watershed Monitoring Plan, Page 84

5. Information/Education component	Yes	No	Notes	Identify location of information (include link or attach plan and identify section and page number)
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Have a range of information and education options been identified in the watershed plan?	X		Four Categories Addressed - General outreach, Local Government Practices and Program, Outreach to the Business Community, Public Stormwater Management Practices	Element E Outreach and Education Action Plans, Pages 71-74
OPTIONAL (Supplemental and/or supporting information)				
Have resource agencies that can be integrated into the watershed planning process been identified and/or contacted?	X		Some participated in stakeholder group meetings; others listed as potential partners; will be asked to participate based on their area of expertise	Element E Outreach and Education Potential Partners, Page 64
6. Schedule for implementing management measures	Yes	No	Notes	**Identify location of information (include link or attach plan and identify section and page number)**
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Have the tasks and activities that are related to the implementation and monitoring of management recommendations been identified?	X		Standard project development activity list compiled; list of items for which costs cannot be predicted are also included	Element D Technical and Financial Assistance Needs Management Measures Costs, Pages 65-66
Has it been determined if these tasks and activities are short-term, medium, or long-term in nature (*note: prioritization of projects is acceptable for meeting this element)*?	X		Planned timeframe for stormwater control measures developed; stream improvement projects are based on linear footage of stream to be addressed, not individual project.	Element F Schedule for Implementation Stormwater Control Measures, Table 24 Page 78 Stream Improvement Projects, Table 25 Page 79
7. Description of interim, measurable milestones	Yes	No	Notes	**Identify location of information (include link or attach plan and identify section and page number)**
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Have interim, measurable milestones (things that you can track) that can help determine if management measures (in Element 2) are being implemented been identified?	X		Measureable milestones and accomplishment tracking tables are presented.	Element G – Measurable Milestones Tables 26-28 Pages 81-83

8. Criteria that can be used to determine if loading reductions are being achieved	Yes	No	Notes	**Identify location of information (include link or attach plan and identify section and page number)**
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Have criteria and/or indicators that can be used to determine if management strategies and activities listed in the plan(s) are being effective been identified?	X		Watershed response indicators are identified and presented.	Element H – Criteria of Pollutant Load Reduction Achievements Stormwater, Table 29 Page 83 Stream Improvement, Table 30 Page 83
9. Monitoring	Yes	No	Notes	**Identify location of information (include link or attach plan and identify section and page number)**
REQUIRED (This box(es) below must be checked Yes in order to be eligible as a 9 Element plan)				
Has a monitoring plan that includes each of the criteria and/or indicators identified in Element 8 been developed?	X		Implementation tracking tables and water quality/biological sampling tables will document watershed improvement achievements	Element G Measureable Milestones Implementation Tracking Tables 26-28 Pages 81-82 Element I – Watershed Monitoring Program, page XX
OPTIONAL (Supplemental and/or supporting information)				
Are there plans for conducting water quality monitoring? • Intensive/On-going • Field kits?	X		Ongoing monthly sampling to be conducted by the Environmental Quality Institute Volunteer Water Information Network Requests for benthic macroinvertebrate and fish sampling will be made for years 1, 5, and 10.	Element I – Watershed Monitoring Plan Table 31 Page 86
If water quality monitoring is expected to be conducted, have you contacted NCDWR?	X		NCDWR participated in the stakeholder group and is aware of the VWIN program; no NCDWR funded sampling is planned at this time.	

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EXECUTIVE SUMMARY

The Upper Swannanoa River Watershed (USRW), delineated as the seven mile portion of the Swannanoa River and tributaries upstream of its confluence with the North Fork Swannanoa River was placed on North Carolina's 303(d) impaired waters list in 2006 because of a degraded benthic macroinvertebrate community. Recent state planning documents for the French Broad River basin identified stormwater as a major cause of degraded conditions of the Swannanoa River. To address the impacts of stormwater runoff, the Town of Black Mountain (TBM) partnered with the Land-of-Sky Regional Council of Governments to obtain funding for development of an EPA compliant 9-element watershed management plan (WMP).

This document represents the culmination of a collaborative planning effort led by the TBM. The main objective of the planning process was to identify actions necessary to address existing stormwater runoff problems and lead to the removal of the Swannanoa River from the impaired waters list. It will complement the TBM's current efforts to upgrade its stormwater infrastructure and manage future construction under phase II stormwater regulations. Approval of this WMP will give the TBM access to grant funds to construct stormwater control features and improve riparian vegetation as well as implement an outreach and education program. Funding for such projects is available through the EPA 319(h) non-point source pollution abatement program and administered by the North Carolina Division of Water Resources.

Historically, the USRW was an Indian hunting ground and it remained isolated until after the Revolutionary War when the first road into the area was constructed; a rail line was completed in 1879. Today the towns of Black Mountain and Montreat, which make up much of the watershed, are thriving communities that are supported by tourism, religious retreats, outdoor recreation, and second home development. While much of the land at higher elevations is forested, flatter land at lower elevations has become urbanized. Although heavy industry and agriculture no long have a major presence in the watershed, commercial, institutional, and residential development associated with urbanization has accelerated. This development has significantly increased the amount of impervious surface, be it from buildings, roads, or parking lots. This has decreased the ability of the watershed to absorb stormwater. The removal of forest cover and the conversion of other land to open space consisting of turf and lawns also has contributed to the stormwater runoff problems. Stormwater runoff from these less pervious surfaces has increased the volume, peak flows, and peak flow frequencies of the USRW. This has resulted in the erosion of stream banks and the degradation of aquatic habitat. In addition, the loss of woody riparian vegetation associated with changes in land use adjacent to streams have contributed to streambank instability and increased erosion.

While development in the USRW has caused degradation of streams, it is a very environmentally conscious community. The residents value the benefits of clean water and ecologically functioning waterways. They also recognize that not only is a good environment beneficial to their health but it also serves as the basis for economic prosperity and social activities such as fishing, boating, crafts, and nature watching.

This watershed management plan (WMP) was developed with input from a stakeholder group whose members represent local and state government, educational institutions, and a conservation organization. They played an important role in developing the outreach and education program and

aided in the identification of potential stormwater retrofit sites. They also participated in a consensus modeling technique to determine the implementation schedule for stormwater projects.

Geographically, the USRW is located in eastern Buncombe County and drains 15 miles to the west where it joins the French Broad River. The watershed has three natural areas designated by the North Carolina Natural Heritage program. Some or all of these natural areas are contained on the 8,000 acres of land in the watershed that are managed for the conservation of natural resources. Two rare plants, four rare animals, and one rare natural community likely occur within the watershed. These occurrences along with a number of rare upland plants, animals, and natural communities reflect the biological diversity of the area.

Ecologically, the USRW water quality is good, having recovered from the clear-cut logging practices of the early 20th century. No pollutants are known to exceed state standards. The State of North Carolina has rated benthic communities in the upper part of the watershed as Good-Fair to Excellent. Lower in the watershed, however, those ratings decline to Fair and, as a consequence, the watershed is considered impaired. The condition of the fish community is not known, although wild trout have been documented in the mainstem Swannanoa River as far downstream as Black Mountain Recreational Park.

The effects of increased stormwater runoff cause increased peak flows, increased peak flow frequencies, and shortened peak flow duration. These changes in stream flow have resulted in increased streambank and channel scour, streambank instability, and, where woody riparian vegetation is sparse or lacking, increased water temperatures.

Potential stormwater retrofit and stream improvement sites were identified using a combination of GIS data, aerial photo interpretation, and field assessments (stormwater only). Once those sites were identified, appropriate management actions for the projects were selected.

Of the 31 potential stormwater retrofit sites identified, 21 were found to be feasible. All but seven sites are located in or near Black Mountain's town center. Conceptual plans for17 sites indicate it may be possible to construct 11 bioretention features, four wetland features, and one extended detention feature. There is also the potential to install one cistern and one underground detention chamber. Private landowners also are encouraged to install non-structural features such as rain barrels and backyard raingardens. The WMP includes descriptions and examples of each type of feature recommended.

The SIMPLE model was used to estimate pollutant reductions at the 21 proposed stormwater retrofit sites. Outputs from that model indicate annual reductions of 1.9 tons of suspended sediment, 14 pounds of phosphorus, 103 pounds of nitrogen, and 8 pounds of zinc. The stormwater features will also act to moderate runoff volumes, peak flows, and peak flow frequencies as they are designed to handle a 1-year 24-hour storm event.

Rain barrel and raingarden installations are estimated to cost from less than $100 to about $400 per unit. Estimated costs to design and construct structural stormwater control features range from $4.07 to $20.93 per square foot of treatment. Individual site costs are estimated to range from $11,600 to $615,825. These costs do not include land acquisition, utility relocations, street modifications, or legal fees, if necessary.

Sixteen potential stream improvement sites covering an estimated 31,000 feet of stream channel were identified with almost 19,000 feet of that occurring in the Tomahawk Branch subwatershed. The remaining 12,000 feet are scattered among 10 sites across the remainder of the USRW. Three

management action options, riparian revegetation, stream enhancement, and stream restoration are recommended. Assessment of parcel ownership and on-site conditions will be necessary to determine which management action will be necessary to improve stream channel and riparian vegetation. Although no landowner outreach has been conducted, several sites in the Tomahawk Branch subwatershed are on public land. It is recommended that those sites be pursued first as it is usually easier to gain approval from public agencies to implement stream improvement projects.

The STEPL model was used to estimate the reduction in sediment originating from streambanks lacking woody riparian vegetation. Implementation of all 16 projects would achieve an annual reduction of an estimated 1,014 tons of sediment to the USRW; 730 tons of that could be achieved by implementing projects in the Tomahawk Branch subwatershed alone.

Generalized costs for each of the stream improvement project types are: riparian revegetation - $80-100 per linear foot; channel enhancement - $100-$200 per linear foot; channel restoration - $200+ per linear foot. As with SCMs, these costs do not include land acquisition, utility relocation, road modification, or legal fees, if necessary.

Stakeholder group input provided the basis for the outreach and education strategy. It is aimed at informing the public about the work proposed in this plan and environmental education in general. The outreach and education strategy has four components – programmatic outreach, local government practices and programs, outreach to the business community, and public stormwater management practices. Key elements of this strategy include development of an active watershed group to guide implementation of the outreach action plan, environmental education of youth, education of elected officials, engagement of the business community to help with WMP implementation, and utilization of high visibility stormwater features to demonstrate how they work and the environmental benefits they provide.

Stormwater retrofit and stream improvement projects proposed in the WMP are scheduled for implementation over the 10-year life of the plan. For planning purposes projects were assigned to one of three implementation periods: short-term – 1-3 years; mid-term – 4-7 years; long-term – 8-10 years. Actual implementation will be opportunity driven primarily by landowner willingness to participate and the ability to acquire funding for individual projects. A project tracking and accomplishments table is included in the WMP so as to determine how well the plan is being implemented.

Potential funding sources are identified and include state, federal, and private entities. Technical assistance for the various types of projects are also described and include local, state, and federal agencies as well as private businesses.

Last, but most importantly, a watershed monitoring plan was prepared. It recommends water chemistry and benthic macroinvertebrate monitoring by local volunteers to track trends in watershed conditions. It also recommends that the North Carolina Division of Water Resources be requested to sample the fish and benthic macroinvertebrate community at five year intervals as a way to determine whether or not the USRW conditions are such that it is meeting its uses and can be removed from North Carolina's 303(d) impaired waters list.

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INTRODUCTION

Background and History

The portion of the Swannanoa River watershed in the Black Mountain area was originally known as Grey Eagle by the Cherokee and Catawba Indians (TBM 2015). Based on archaeological finds, the Swannanoa River valley has been inhabited for at least 12,000 years and served as hunting grounds for these tribes (SVM 2015). Due to the steepness of the slopes to the east the area was insulated from colonization until the middle 1700's when settlers began to arrive. After the revolutionary war, Europeans of Scot-Irish, German, and English descent began arriving, some bringing African slaves with them. Development of the Swannanoa River valley accelerated with the building of a road through the area in 1850 (Wikipedia® 2015) and the coming of the railroad in 1879. The improved access brought prosperity as tourists and land speculators arrived and farmers began to export livestock and crops.

The Town of Black Mountain, the principal municipality in the Upper Swannanoa River Watershed (USRW) was incorporated in 1893 (Figure 1). The area known today as Montreat, officially incorporated as a township in 1967 (Wikipedia 2015), was originally organized in 1897 as the Mountain Retreat Association (TOM 2015). The name was shortened to Montreat the same year. Into the early 1900s the upper Swannanoa River valley became a center for major religious retreat centers that included not only Montreat but also Ridgecrest and the YMCA Blue Ridge Assembly among others.

Early settlement of the Swannanoa River valley was dominated by agricultural activities. With the coming of the railroad and need for timber in the industrial north, loggers clear-cut the mountainsides during the 1910s and exposed mountainside soils. The exposed the soils were then subject to erosion, particularly that associated with the flood of 1916 that hit the Southern Appalachian Mountains. Between Asheville and Old Fort about 30 miles of railroad track were washed away or otherwise damaged. Heavy rains caused landslides that buried some tracks with up to 28 feet of soil (Williams 2013).

Today farmland has all but disappeared in the portion of the USRW encompassing Black Mountain and Montreat; manufacturing jobs, too have decreased significantly. While many of the religious retreats have survived, the area is now home to residential housing developments for workers commuting to Asheville and other parts of the county as well as seasonal residents. A major portion of the local economy is based on tourism. Montreat Normal School, now Montreat College, which opened in 1916, is located within the watershed.

The transition from an agricultural/industrial-based economy to one dominated by residential and tourism-based growth has brought with it changes in the impacts to the ecology of the watershed. Agricultural runoff (sediment, nutrients, and fecal coliform bacteria) and industrial discharges are no longer a major factor influencing water and habitat quality of the USRW. Despite this change, the upper Swannanoa River is on North Carolina's 303(d) list of impaired waters.

For the most part, headwater streams of the Upper Swannanoa River run much clearer. Much of the land surrounding those streams, damaged by past logging, is once again forested. During the mid-1900s some of those previous impacted streams were impounded to serve as drinking water supplies or provide recreation (Brown and Caldwell 2010a). The North Carolina Natural Heritage Program has also given some lands in the watershed a Moderate or High ratings as natural areas; some of those lands are protected by conservation easements or as registered heritage areas (NCNHP 2015a).

This watershed management planning (WMP) document focuses on the developed portions of the Swannanoa River watershed upstream of its confluence with the North Fork Swannanoa River (Figure 2). This portion of the watershed has been impacted by urban development that contributes to water quality and aquatic habitat degradation. Because of this development, almost the entire area is now subject to Environmental Protection Agency Phase II stormwater control regulations that are either under individual National Pollution Discharge Elimination (NPDES) permits or fall within the surrounding MSI (municipal sphere of impacts) area.

While the new regulations will influence stormwater impacts for future development projects, it does not address existing problems. As a result, the Town of Black Mountain, in cooperation with its partners, felt that a locally inspired WMP would be the most effective way to address existing problems. The objective of this WMP is to identify potential projects that address watershed impairment associated primarily with stormwater runoff and associated sediment. It will include watershed improvement measures that can be taken to improve watershed conditions to the point where the upper Swannanoa River can be removed from the 303(d) impaired waters list. The content of this watershed plan will address the Environmental Protection Agency's (EPA) required 9-elements that will make its sponsor, the Town of Black Mountain, eligible to apply for funding through EPA's 319(h) non-point source grant program that is administered through the North Carolina Department of Environmental (DEQ) Division of Water Resources (NCDWR).

Figure 1. Upper Swannanoa River Regional Overview

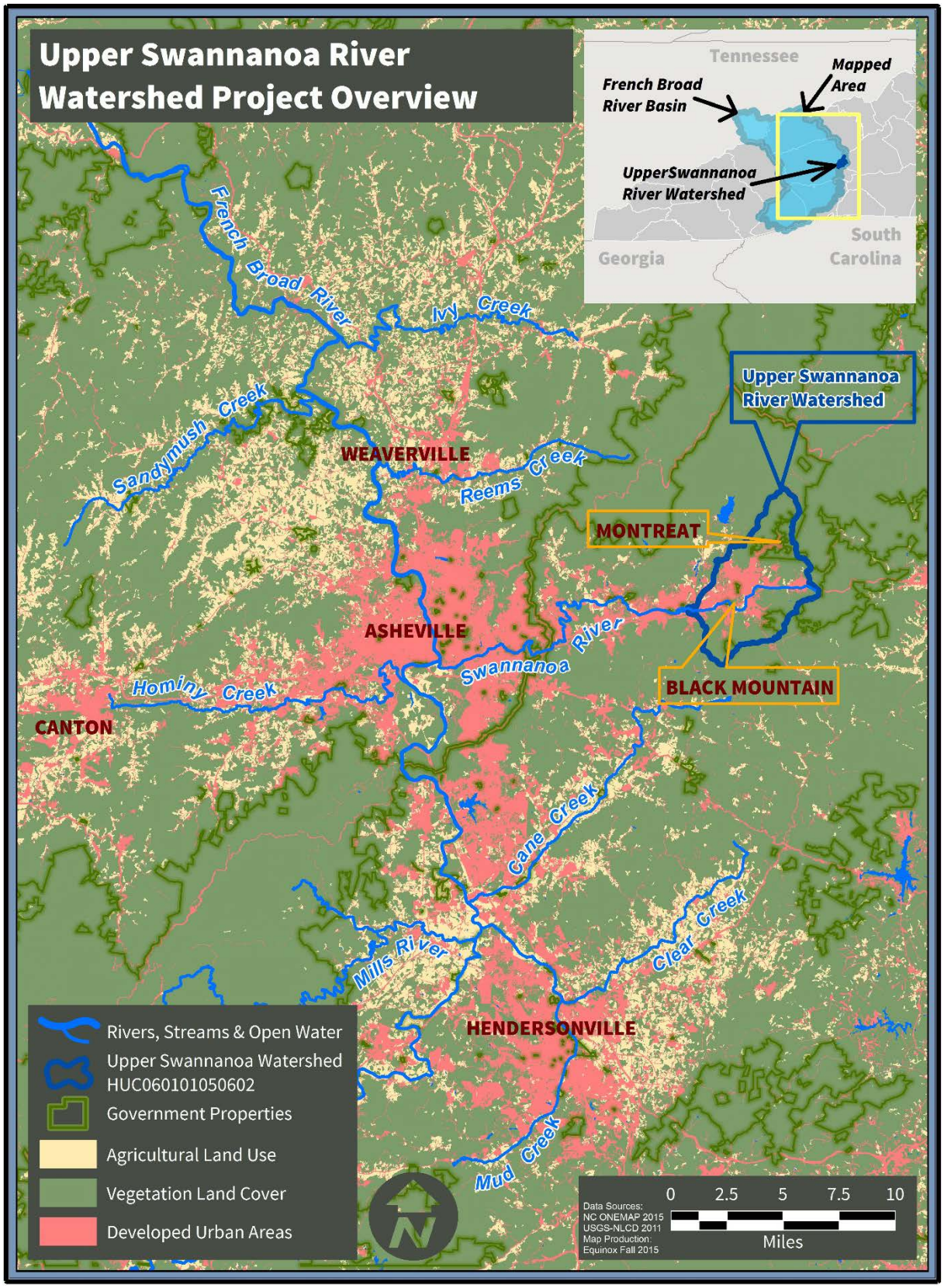
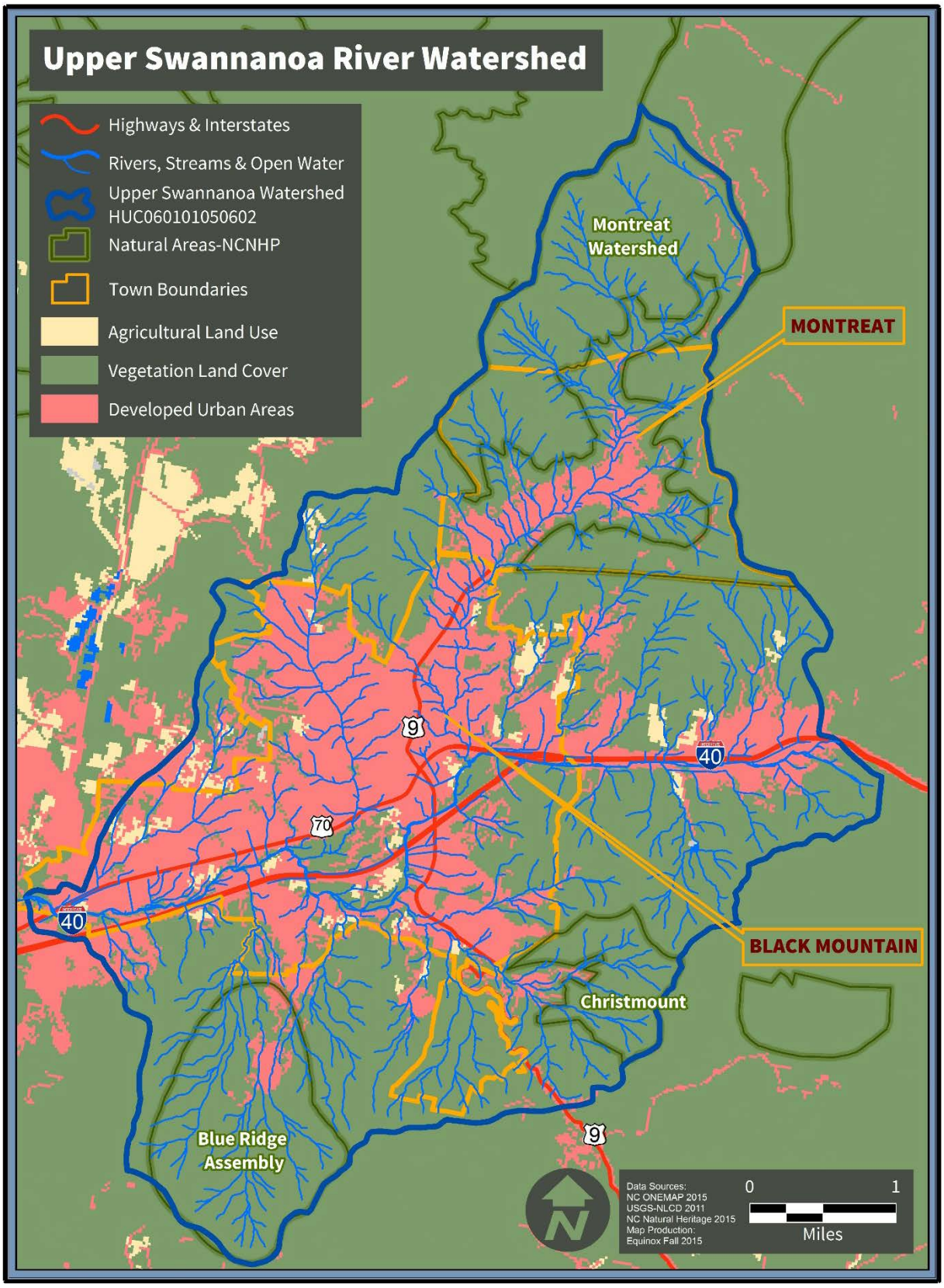


Figure 2. Upper Swannanoa River Watershed Planning Area



Why is the Upper Swannanoa River Impaired?

The seven mile reach of the Swannanoa River upstream of its confluence with the North Fork Swannanoa River has been on North Carolina's 303(d) list of impaired waters since 2006 (Figure 2; NCDWR 2014a). This portion of the Swannanoa River is not fully supporting its uses that include maintaining balanced fish and benthic macroinvertebrate communities. Those communities should be comprised of diverse indigenous species at population levels considered at least Good-Fair when compared to reference streams. Based on 2002-2003 benthic invertebrate community assessments, the upper Swannanoa River was rated as Fair (NCDWQ 2008, 2014b).

Under the integrated reporting classification, the upper Swannanoa River has been designated as Category 5, which means that available data indicates that at least one use is not being met and that a total maximum daily load (TMDL) must be calculated. A TMDL is a calculation of the maximum amount of pollutant that a waterbody can receive and still meet water quality standards. It is generally applied to pollutants with identifiable sources that can be readily remediated. Since that is not the case in the USRW, a TMDL has not been developed. In the USRW the biological community is being degraded primarily due to the impacts of stormwater runoff that include scouring of the stream channel and stream banks. Under this plan, the Town of Black Mountain has volunteered to sponsor the development of this watershed management plan and to implement watershed improvement projects that are expected to result in improvement of the biological community.

Why Care?

Why should citizens living, working, or recreating in the USRW concern themselves with the conditions of the river and its tributaries? Because there are a number of environmental, economic, and social factors that relate stream health to community health.

Environmental Factors

Streams are valuable resources that provide a variety of ecosystem services. Ecosystem services are natural processes that benefit the environment and, in turn, benefit people. A hydrologically functioning watershed provides flood control, which reduces property loss and damage during flood events. A healthy stream provides habitat for a variety of plants, fish, amphibians, and insects that prey on pests such as mosquitoes, black flies, and midges. A functioning aquatic ecosystem also provides surface water filtration, purification, and pollutant processing.

***Fact** – Due to the terrain, stormwater in mountainous areas have a greater propensity to erode soils and cause more widespread flooding than in non-mountainous regions.*

How the land we live on is utilized directly influences the health of streams. As it stands, while much of the land in the headwaters of the upper Swannanoa River is forested, stream banks along the less steep areas are urbanized and have less than ideal wooded riparian areas. This has led to increased stormwater runoff volumes that are eroding sediment deposited on stream banks during the early 20th century. As these stream banks are eroded sediment yields stay unnaturally high and degrade instream habitats by filling in riffles and pools with sand and fine sediment. Erosion of stream banks also threatens to damage adjacent property. As a result, the diversity of plants and animals living in the upper Swannanoa River is not as healthy as it could be.

Economic Factors

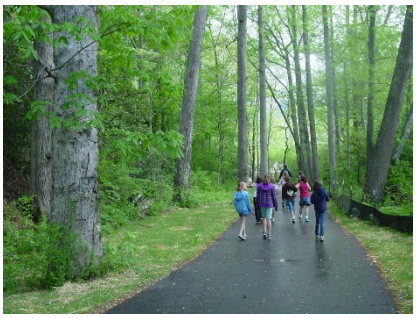
The condition of the USRW has significant economic implications for the towns of Black Mountain and Montreat as well as the surrounding portion of eastern Buncombe County. Tourism and outdoor recreation are important contributors to the local economy. Buncombe County ranked first in western North Carolina in total tourism expenditures ($662 million; NEMAC 2013). Add to that the number of church affiliated summer camps providing outdoor recreation and second home developments established in recent years and the importance of maintaining the environment of the watershed becomes clear. This development has helped offset and replace lost manufacturing jobs and wages. Outdoor recreation in North Carolina, exclusive of fishing, hunting, and wildlife viewing, is estimated to generate $19.2 billion in consumer spending (OIA 2011/2012).

Financial resources are required to mitigate the effects of poor water quality. Property damage due to unstable stream banks can be reduced through the implementation of watershed improvement projects. Additional costs are associated with repairing property, bridges, utilities, and other infrastructure due to flood damage and streambank erosion (Brown and Caldwell 2010b). In most instances, it requires less of a financial investment to protect natural resources and prevent damage to streams than it costs to restore impacted streams or treat polluted waters.

Enhanced stream corridors can be an attractive asset within a community. Greenways and parks along streams provide recreational opportunities and attract visitors who spend time and money in the area. Black Mountain (TBM Undated) and Montreat (TOM 2010?) have already developed greenways; Buncombe County has prepared a greenways and trails master plan (Buncombe County 2012) that envisions linking all communities within the county. Implementing the plan and BMPs to improve watershed health will employ local businesses, such as engineers, land graders, landscapers, and nurseries, to name a few. The residents and tourists that will use the facilities will provide a long-term economic benefit to the upper Swannanoa River.

Social Factors

Healthy streams provide recreational opportunities such as fishing, boating, swimming, or just getting your feet wet. Attractive stream corridors consist of clean-flowing water and lush vegetation that contribute to the livability and aesthetic benefits of a community. At risk communities such as the elderly, poor, and other minorities that disproportionately live within the floodway of streams are more directly affected by poor stream channel function and water quality. Some will derive spiritual benefits from the surroundings, whereas others may derive more creative benefits such as using natural materials to make crafts or other artistic products. Walking paths and greenways along streams provide hiking, biking, and nature-watching opportunities as well as provide health benefits. When a stream is impaired, however, it cannot fulfill these uses because the water may appear dirty and, therefore, deter public use. A healthy environment results in a healthy, thriving community, and investing in the environment is an investment in the community.

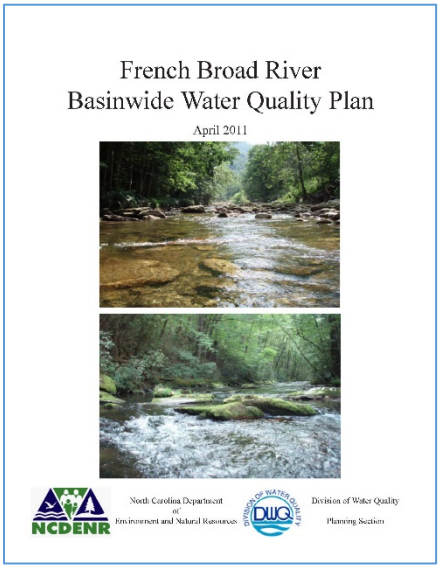


Watershed Partners and the Planning Process

Previous Planning Efforts

Over the last 10 years the French Broad River basin, of which the Swannanoa River is a tributary, has been the subject of many planning projects at both regional and local levels that have recognized the high quality natural resources that exist in the basin. These plans also describe threats to these resources as well as the need for projects that will improve water quality. The most significant of these plans include:

- *French Broad River Basinwide Water Quality Plan* (NCDWQ 2011) – Recommendations for the 8-digit HUC in which the Swannanoa River watershed resides include increasing efforts on stormwater management, erosion control and pesticide education. In addition, they encouraged the installation of stormwater control measures (SCMs) to manage stormwater and prevent associated pollutants from reaching surface waters.
- *French Broad River Basin Restoration Priorities* (NCEEP 2009) – The upper Swannanoa River watershed was identified as a targeted local watershed (TLW). Specific goals for the 8-digit HUC in which the Swannanoa River watershed resides include "working with local partners to improve management of stormwater runoff, controlling both stormwater volume and pollutants, and promote[ing] low impact



development techniques to lessen impacts of new development, especially in the expanding areas of Asheville, Black Mountain, Fletcher, and Hendersonville".

- *2014 Comprehensive Plan Update for the Town of Black Mountain* (TBM 2014) – Identifies stormwater as a primary source of pollution and impact to waterways. It describes five strategies to preserve the quality of water as it flows through Black Mountain.
- *Black Mountain Wellhead Protection Project: Planning Phase* (LOSRCOG 1995)– A planning document prepared by the Land-of-Sky Regional Council aimed at protecting the Town of Black Mountain's groundwater quality that serves wells used as the Town's drinking water supply.
- *Town of Black Mountain Stormwater Master Plan 2009* (TBM 2009) – Report prepared for the Town of Black Mountain that describes the state of the watershed and the need to protect water quality and stream channels from the impacts of stormwater. The plan describes 12 potential projects that would reduce stormwater impacts and, in some cases, provide recreational opportunities for residents and visitors.
- *Comprehensive Plan Alternatives for Montreat, North Carolina* (TOM 2003) – This plan describes steps the town can take to manage growth while maintaining environmental conditions important to the community. It clearly states that while much of the land within the town limits is in a natural state, it is at risk of being developed.
- *Natural Areas of Buncombe County, North Carolina: A Preliminary Inventory* (NCNHP 1995, 2015a) - The North Carolina Natural Heritage Program inventory identified several natural areas of state and regional significance in the upper Swannanoa River watershed. They also identified development and associated impacts as likely the greatest threat to the natural areas.
- *North Carolina Wildlife Action Plan* (NCWRC 2015) - Recognizes habitat degradation as the most widespread problem in the French Broad River basin. Large-scale developments and urbanization are identified as significant sources of non-point source pollution and sedimentation. Much of the sedimentation is attributed to poorly managed developments on steep slopes and within riparian areas along tributaries. Due to poor habitat conditions, the Swannanoa River watershed is not a priority watershed for aquatic species conservation activities.
- *Strategic Plan for the Partners for Fish and Wildlife Program 2012 - 2016, Southeast Region* (USFWS 2011) – The upper French Broad River subbasin, which includes the Swannanoa River watershed, is a designated focus area of the USFWS for riparian corridor and wetlands improvements that will benefit federally listed and rare aquatic species such as brook trout (*Salvelinus fontinalis*) and bog turtle (*Glyptemys muhlenbergii*).

These plans provide a firm foundation for preparation of a WMP that will address the causes of the impaired benthic community. Data from them will be used in identifying necessary management actions and implementation schedules that will lead to water quality and aquatic habitat improvements.

Public support for the Upper Swannanoa River improvement project is critical to achieving long-term success. A goal of this project is to motivate landowners, local businesses, and the general public to take ownership of the problems facing the watershed and commit to the mission of improving water quality. Public support for this plan will be achieved through a combination of efforts including a stakeholder group, their personal contacts, and a public open house.

Stakeholder and Public Inputs

The Town of Black Mountain as sponsor of the watershed planning effort, convened a group of stakeholders for the purposes of obtaining input on the WMP's content. More specifically, the group's purpose was to aid in the development of a list of potential watershed improvement projects and creation and implementation of an education and outreach program. The stakeholder group was comprised of representatives of various agencies and organizations with an interest in improving the upper Swannanoa River watershed (Table 1).

Two meetings of the stakeholder group were held in order to gain their views of problems in the watershed, to get feedback on potential stormwater control projects within the Black Mountain town limits, and to review and develop a proposed education and outreach program action plan.

Upon approval of the Upper Swannanoa River Watershed Management Plan, the Town of Black Mountain will host an open house with the purposes of gaining public support in implementing the WMP.

Table 1. Upper Swannanoa River Watershed Stakeholder Group Membership

Name	Organization
Josh Harrold, Planning Director and Chair Matt Settlemeyer, Town Manager Max Wlodarczak (Intern)	Town of Black Mountain
David Currie	Town of Montreat
Mark Brenner Geoffrey Habron	Warren Wilson College
Ed Williams Zan Price	N.C. Division of Water Resources
Karen Cragnolin Amy Anino Leah Hart Handwerger (Intern)	RiverLink
Mary Leonard-White	Resident; former Chair Swannanoa River Flood Risk Task Force and Town of Black Mountain Alderwoman
Erica Anderson	Land-of-Sky Regional Council of Government
Kim Williams Fred Grogan Jim Borawa James Rogers	Equinox (consultant and meeting facilitator)

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WATERSHED CHARACTERIZATION

Geographic Location and Attributes

Geography

The Upper Swannanoa River Watershed (USRW), the focus of this WMP and defined as being the portion of the Swannanoa River watershed upstream of its confluence with the North Fork Swannanoa River is 22.2 mi.^{2} in area and located at coordinates 35.60463 -82.36837 (Figure 2). It is identified as U.S. Geological Survey 12-digit Hydrologic Unit Code (HUC 12) 060101050602 (USGS 2012). It is located in eastern Buncombe County; the Towns of Black Mountain and Montreat lie almost entirely within its boundary. From this point the Swannanoa River flows downstream approximately 15 miles to its confluence with the French Broad River.

Geographically, the USRW is located in eastern Buncombe County, North Carolina and is part of the Southern Appalachian Mountains. The eastern boundary of the watershed is part of the Eastern Continental Divide. Rain falling on the west of the divide flows to the Gulf of Mexico, whereas rain falling to the east of the divide flows to the Atlantic Ocean. Flat Creek, Tomahawk Branch, Camp Branch, and Wolfpit Branch are the largest tributaries. Elevations of the USRW range from 5,408 above sea level to 2,227 feet above sea level at its confluence with the North Fork Swannanoa River. Highways I-40, US 70, and NC 9 run east-west through the southern portion of the watershed.

Geology

Geologically, the USRW is located within the Blue Ridge Mountain physiographic province that is underlain with bedrock comprised of felsic granites, gneisses, and schists. Soils are usually shallow on and near ridges, while in the valleys soils are more deeply weathered and formed mostly from alluvium and colluvium parent materials. The primary soils of the watershed are ultisols and inceptisols, which are typical of this region (USDA-NRCS 2009).

Climate

Climatologically the USRW is in the Southern Mountain portion of the Humid Subtropical zone. The average annual temperature is 54.4°F with average annual low and high temperatures of 43.4°F and 66.5°F. January has the lowest average daily low temperature at 24.4°F; July has the highest average daily high at 83.7°F. Climate normals for the period from 1981 to 2010 at Black Mountain (station GHCND: USC00310843; Arguez et al. 2012) reveal an average of 47.2 inches of precipitation per year, 7.3 inches of which is frozen precipitation. June is wettest month and October is driest month with 4.75 and 3.09 inches of precipitation.

Population and Land Use Characteristics

Population

With regard to human population, 10 US Census block groups overlap with the USRW. Based on the American Community Survey the estimated combined population of these ten block groups is 13,211 people (USCB 2015). The combined 2010 population of the towns of Black Mountain and Montreat was 8,604 (USCB 2010), a level that appears to have remained stable over the last five years. Combined, the population of these towns make up 3.6% of the 238,318 total population of Buncombe County.

Land Use

Land use and land cover within the USRW is typical for the Southern Appalachian region. The USGS National Land Cover Dataset(Homer et al. 2015; Xian 2011; Homer 2007; Yang 2002) revealed that in 2011 this watershed was 68.1% forested (9,654 acres) and 29.3% developed (4,149 acres) with the remaining 2.6% being classed as other non-developed or non-forested lands (Figure 2 and Table 2). Developed impervious surfaces such as roofs and paved parking lots, as well less pervious turf lawns, make up 4.03% (612.9 acres) of the watershed. The most developed areas are located along the lower elevation portions of stream valleys.

Land use and land cover changes between 2001 and 2011 reveal continued development within the watershed (Table 2) despite a stable population. Total forested and agricultural area has declined by about 30 acres, while total developed/urban area has increased by 11+ acres. Within the developed/urban group, a loss of developed open space (<20% impervious) was replaced by an increase in medium intensity developed area (50-70% impervious), which would contribute an increase in stormwater runoff. Herbaceous and shrub/scrub area increased by a combined 19 acres. Agriculture land use, which comprised 254 acres in 2001, decreased by about 11 acres between 2001 and 2011.

Table 2. Land Use/Land Cover Characteristics and 2001/2011 Comparisons

NLCD Land Use Class	2011 Acres	2011 Watershed %	Change between 2001 & 2011 (Acres)	% Change in Area	% Change From 2001 to 2011
Total Developed/Urban	4,149	29.27	11.3	0.08	
Developed, High Intensity (>80% Impervious)	87	0.61	9.3	0.07	12.02
Developed, Medium Intensity (50-79% Impervious)	276	1.95	59.0	0.42	27.13
Developed, Low Intensity (20-49% Impervious)	617	4.35	-1.9	-0.01	-0.29
Developed, Open Space (<20% Impervious)	3,169	22.35	-55.1	-0.39	-1.70
Total Forested	9,654	68.05	-19.6	-0.13	
Mixed Forest	214	1.51	-0.4	0.00	-0.20
Deciduous Forest	9,321	65.76	-18.7	-0.13	-0.19
Evergreen Forest	118	0.83	-0.4	0.00	-0.37
Agriculture (Hay/Pasture)	254	1.79	-10.4	-0.07	-3.94
Total Other	120	0.85	17.6	0.12	
Emergent Herbaceous Wetlands (only 2011 data)	1	0.01	NA	NA	NA
Herbaceous	65	0.46	8.9	0.06	15.81
Barren Land	4	0.03	0.0	0.00	0.01
Open Water	2	0.01	0.0	0.00	0.01
Shrub/Scrub	26	0.19	9.8	0.07	59.53
Woody Wetlands	22	0.15	-1.1	-0.01	-4.88
Grand Total	14,177				

Natural Resources

Protected Lands

The USRW is home to many unique and well-known features of biological and ecological significance. Areas containing populations of rare species, their habitats, and outstanding aquatic and terrestrial natural communities have been identified as Natural Areas (NAs) by the North Carolina Natural Heritage Program (NCNHP). The NCNHP also tracks other lands managed to conserve uniqueness, biological diversity, and ecological function (NCNHP 2015a).

The NCNHP has identified three NAs within the USRW covering a total of 3,554 acres (Figure 2, Table 3). These areas include some or all of such well-known features as Greybeard Mountain, Pinnacle Mountain, the Blue Ridge Assembly, the Montreat Watershed, and the Christmount Natural Area.

Table 3. Natural Heritage Program Natural Areas

Natural Area Name	Acres
Blue Ridge Assembly Natural Area	1,078
Christmount Natural Area	383
Montreat Watershed	2,093
Total	3,554

The above NAs are partially or wholly encompassed within a mix of privately and publicly owned lands managed for conservation purposes. These managed lands may be protected by fee simple ownership or be land on which a conservation easement exists or is otherwise managed to some degree for conservation of biological and ecological purposes (Figure 2, Table 4). Some of these lands are in public ownership and are used for recreation as well as for providing products such as timber and drinking water. Other areas are privately owned and are designated as conservation easements. Furthermore, some properties are not managed for conservation purposes, but are still of conservation interest because of the natural resources that they contain.

Table 4. Other Managed Lands

Landowner	Ownership Type	Acres
Buncombe County	Local Government	196
U.S. Forest Service	Federal	9
Conservation Trust of North Carolina	Private	3
Clean Water Management Trust Fund (NCDNCR)	State	2,855
Southern Appalachian Highlands Conservancy	Private	2,973
Montreat Watershed (Mountain Retreat; RHA)	Private	2,088
Total		8,124

Important Plant and Animal Species

The Upper Swannanoa River Watershed is home to two rare plant species, four rare animal species, and one rare natural community that are associated with streams and adjacent riparian

areas. According to state, and federal global rankings (Table 5; NCNHP 2015b) nearly all of these ecological components are considered at risk of being eliminated due to the current condition of their habitats.

Hellbender (amphibian), French Broad crayfish (crustacean), Superb jewelwing (damselfly), and bog turtle (reptile) are all considered animal species of concern by the State of North Carolina, U.S. Fish and Wildlife Service, and NatureServe (NCNHP 2015a). The most notable of these is the bog turtle, which is classified as Threatened and ranked as Imperiled by North Carolina as well as the Federal Government. Globally, the bog turtle is rare enough to be designated Vulnerable because of its highly restricted range as well as population decline due to illegal collection. Two vascular wetland plant species are known to occur within riparian areas of the USRW. Of these, the large purple fringed orchid is listed as Threatened and Imperiled by the State of North Carolina. One rare wetland natural community, the Rich Montane Seep, also occurs within the project area and is considered vulnerable to extinction by North Carolina as well as by NatureServe™ (2015).

Table 5. At-Risk Animal and Plant Species (Sheet 1 of 2)

Scientific Name	Common Name	State Status[1]	State Rank[2]	Federal Status[1]	Global Rank[2]	Habitat	Type
Amphibians							
Ambystoma talpoideum	Mole Salamander	SC	S2S3		G5	Upland	Animal
Cryptobranchus alleganiensis	Hellbender	SC	S3	FSC	G3G4	Wetland	Animal
Birds							
Aegolius acadicus pop. 1	Northern Saw-whet Owl - Southern Appalachian population	T	S2B,S2N	FSC	G5T3	Upland	Animal
Catharus guttatus	Hermit Thrush	SR	S2B,S5N		G5	Upland	Animal
Falco peregrinus anatum	American Peregrine Falcon	E	S1B,S2N		G4T4	Upland	Animal
Setophaga cerulea	Cerulean Warbler	SC	S2B	FSC	G4	Upland	Animal
Vireo gilvus	Warbling Vireo	SR	S2B		G5	Upland	Animal
Crustacean							
Cambarus reburrus	French Broad River Crayfish	SR	S2	FSC	G3	Aquatic	Animal
Dragonfly or Damselfly							
Calopteryx amata	Superb Jewelwing	SR	S1S2		G4	Aquatic	Animal

Table 5. At-Risk Animal and Plant Species (Sheet 2 of 2)

Scientific Name	Common Name	State Status[1]	State Rank[2]	Federal Status[1]	Global Rank[2]	Habitat	Type
Reptiles							
Crotalus horridus	Timber Rattlesnake	SC	S3		G4	Upland	Animal
Glyptemys muhlenbergii	Bog Turtle	T	S2	T(S/A)	G3	Wetland	Animal
Non-Vascular Plant							
Melanelia stygia	Alpine Camouflage Lichen	SR-D	S1S2		G5	Upland	Plant
Vascular Plants							
Hydrastis canadensis	Goldenseal	SR-O	S3		G3G4	Wetland	Plant
Lilium grayi	Gray's Lily	T	S3	FSC	G3	Upland	Plant
Platanthera grandiflora	Large Purple Fringed Orchid	T	S2		G5	Wetland	Plant
Robinia hispida var. kelseyi	Kelsey's Locust	SR-O	S1		G4T1	Upland	Plant
Scutellaria galericulata	Hooded Skullcap	SC-H	SH		G5	Upland	Plant
Thermopsis fraxinifolia	Ash-leaved golden banner	SC-V	S2?		G3?	Upland	Plant
Natural Communities							
Acidic Cove Forest (Typic Subtype)		n/a	S4		G5	Upland	Natural Community
Carolina Hemlock Forest (Typic Subtype)		n/a	S2		G2	Upland	Natural Community
High Elevation Red Oak Forest (Orchard Forest Subtype)		n/a	S2		G2	Upland	Natural Community
High Elevation Red Oak Forest (Typic Herb Subtype)		n/a	S3		G4	Upland	Natural Community
High Elevation Rocky Summit (Typic Subtype)		n/a	S2		G2	Upland	Natural Community
Low Elevation Rocky Summit (Acidic Subtype)		n/a	S2		G3?	Upland	Natural Community
Montane Oak--Hickory Forest (Acidic Subtype)		n/a	S4S5		G4G5	Upland	Natural Community
Northern Hardwood Forest (Typic Subtype)		n/a	S3		G3G4	Upland	Natural Community
Pine--Oak/Heath (Typic Subtype)		n/a	S3		G3	Upland	Natural Community
Rich Cove Forest (Montane Intermediate Subtype)		n/a	S4		G4	Upland	Natural Community
Rich Montane Seep		n/a	S3		G3	Wetland	Natural Community

[1] E = Endangered; T = Threatened; T-S/A = Similarity of appearance to a Threatened taxon; TSR = Significantly Rare, but at the periphery of its range; SC = Special Concern; SR-P = Significantly Rare-Peripheral; SC-V = Special Concern-Vulnerable (likely to become Threatened within the foreseeable future; SR-T = Significantly Rare throughout its range; FSC = Federal Species of Concern.

[2] See NCNHP (2015b) for definitions of the state and global rankings.

Ecology

Ecologically, the USRW is part of the Blue Ridge Level III Ecoregion; with portions of the watershed in the Southern Crystalline Ridges and Mountains, the Broad Basins, and the High Mountains Level IV Ecoregions (Griffeth et al. 2002). The wide variety in geology, soils, and climate makes the Blue Ridge one of the most floristically diverse ecoregions. Forest communities include Appalachian oak, northern hardwoods, and, at the highest elevations, Southeastern spruce-fir forests. Cove hardwoods and oak-pine communities are also prevalent.

Water Quality

No NCDWR ambient water quality monitoring sites exist in the USRW; however, the Environmental Quality Institute (EQI) through its Volunteer Water Information Network (VWIN) maintains a sample location just above the confluence with the North Fork Swannanoa River (Figure 3). They collect monthly water samples to monitor the following water quality parameters:

- Nutrients as:
  - Ammonia nitrogen (NH_3)
  - Nitrate-nitrite nitrogen (NO_3)
  - Phosphorus (PO_4)
- Turbidity (nephelometric units; NTUs)
- Total suspended solids (mg/L)
- Conductivity (µS/cm)
- Alkalinity (mg/L $CaCO_3$)
- pH

The raw data are then evaluated to create an index of water quality. The 2012-2014 VWIN data and analysis (Table 6; UNCA-EQI 2009; EQI-VWIN2015 and unpublished data) show that the median values of all parameters fall below the regional average median. Based on these data, water quality of the Swannanoa River at its confluence with the North Fork Swannanoa River was rated as Good. The metric value for sediment was lower than that for nutrients and indicates that eroded soil from stream banks and uplands is being transported downstream. Some of this is likely the result of changes in stream flow and timing from stormwater runoff.

Figure 3. Water Quality and Biological Sampling Sites

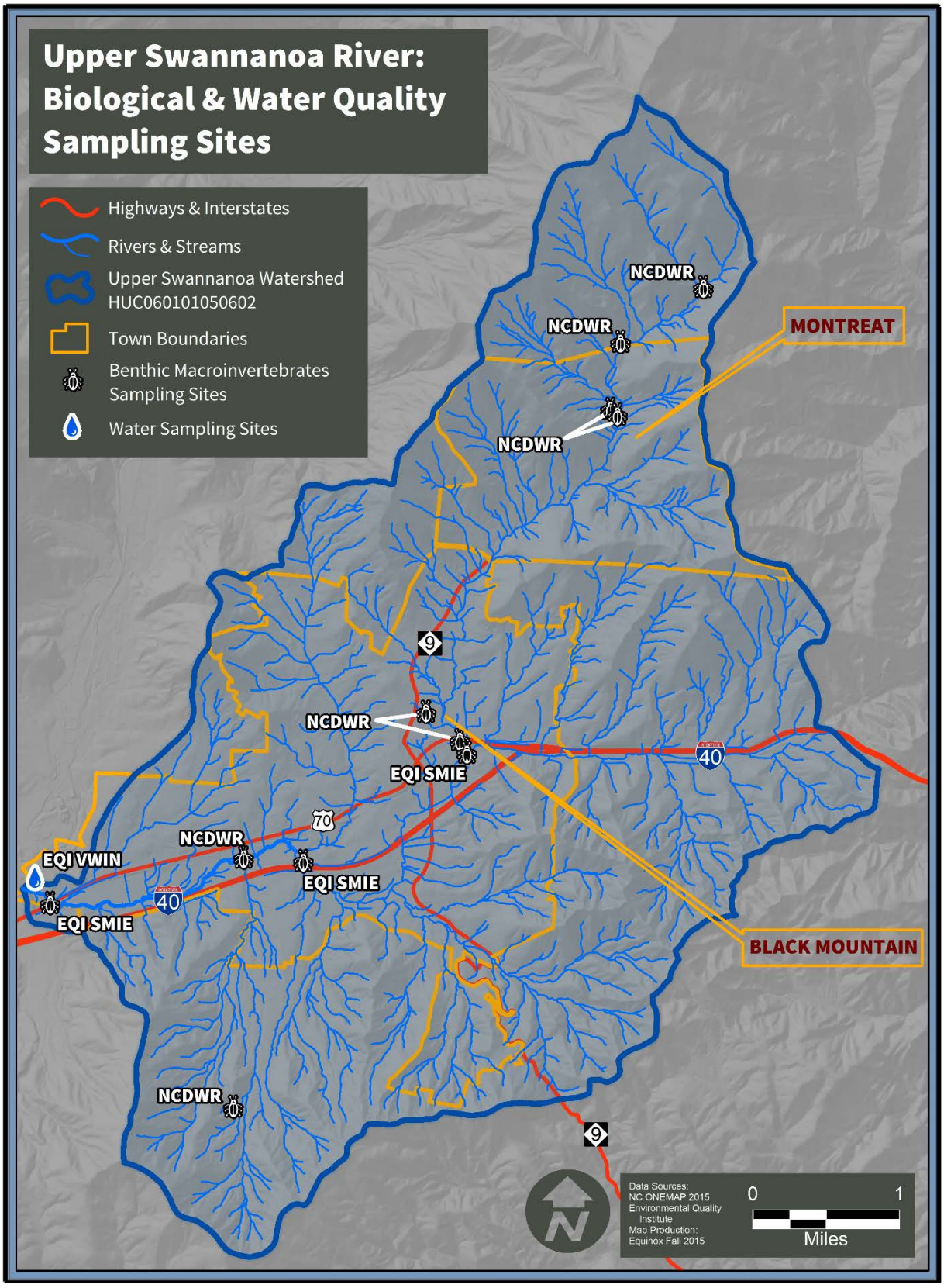

Table 6. Upper Swannanoa River VWIN Water Quality Data, 2012-2015[1]

Year	Month		NH_3	NO_3	PO_4	Turbidity (NTUs)	Total Suspended Solids (mg/L)	Conductivity (µS/cm)	Alkalinity	pH
2012	January		0.04	0.3	0.05	1.2	0.4	43.4	14.0	6.8
	February		0.04	0.3	0.03	2.6	0.8	41.8	16.0	6.8
	March		0.14	0.2	0.04	23.0	12.8	68.9	17.0	6.8
	April		0.08	0.2	0.09	4.6	3.2	40.3	17.0	6.8
	May		0.07	0.2	0.07	1.9	5.2	41.6	12.0	6.9
	June		0.06	0.2	0.09	4.2	4.8	38.0	10.0	6.8
	July		0.19	0.1	0.04	17.0	14.8	42.8	22.0	7.0
	August		0.19	0.1	0.06	50.0	37.2	36.2	20.0	7.0
	September		0.14	0.2	0.09	4.8	6.8	45.0	17.0	7.0
	October		0.06	0.3	0.16	1.5	1.2	43.8	14.0	7.0
	November		0.05	0.2	0.07	0.6	0.8	47.0	15.0	7.0
	December		0.04	0.2	0.05	1.1	1.2	40.2	19.0	7.1
2013	January		0.05	0.2	0.06	1.2	0.8	37.3	16.0	6.9
	February		0.07	0.2	0.08	5.5	4.4	32.9	12.0	6.8
	March		0.03	0.2	0.08	1.2	0.8	33.3	13.0	6.8
	April		0.04	0.3	0.03	2.1	3.6	35.2	9.0	7.0
	May		0.03	0.2	0.07	4.5	6.0	31.9	10.0	6.8
	June		0.06	0.2	0.04	3.5	4.0	31.0	10.0	6.9
	July		0.12	0.2	0.08	10.0	18.4	27.2	9.0	6.7
	August		0.14	0.2	0.14	4.4	6.8	31.2	17.0	6.9
	September		0.07	0.2	0.15	2.7	2.4	35.0	20.0	7.0
	October		0.07	0.2	0.04	1.5	2.4	37.9	25.0	7.0
	November		0.20	0.1	0.06	1.3	0.8	39.6	27.0	7.1
	December		0.10	0.2	0.04	2.2	1.6	38.4	20.0	7.0
2014	January		0.08	0.3	0.04	1.1	0.4	32.6	17.0	6.9
	February		0.06	0.2	0.02	1.2	0.4	35.1	14.0	6.8
	March		0.03	0.1	0.03	1.1	0.8	34.4	15.0	7.0
	April		0.05	0.2	0.04	1.2	2.8	34.7	16.0	6.8
	May		0.07	0.2	0.03	2.3	3.2	34.4	15.0	7.0
	June		0.09	0.3	0.06	4.1	4.0	37.6	19.0	6.8
	July		0.06	0.5	0.05	4.0	3.6	39.9	14.0	6.9
	August		0.06	0.2	0.06	3.2	2.4	42.3	14.0	6.8
	September		0.09	0.1	0.05	35.0	4.0	44.4	14.0	7.0
	October		0.06	0.1	0.04	2.5	0.8	42.3	14.0	7.0
	November		0.06	0.2	0.02	1.2	0.8	41.6	13.0	7.0
	December		0.07	0.2	0.05	2.7	2.4	40.1	10.0	7.0
	Minimum		0.03	0.10	0.02	0.6	0.4	27.2	9.0	6.7
	Median		0.07	0.20	0.05	2.5	2.6	38.2	15.0	6.9
	Maximum		0.20	0.50	0.16	50.0	37.2	68.9	27.0	7.1
Regional Average Median			0.09	0.50	0.08	6.0	4.8	62.0	22.0	7.0

[1]Sample location is at the US 70 crossing just upstream of the confluence of the Swannanoa River and North Fork Swannanoa River (EQI-VWIN 2015)...

Benthic Communities

Benthic communities have been monitored at several sites in the USRW by the NCDWQ (renamed the Division of Water Resources in 2014) and the EQI Stream Monitoring Information Exchange (SMIE) program (Table 7). The most recent samples taken by the NCDWR on Flat Creek upstream of Black Mountain have all produced Good-Fair or better benthic community ratings and likely continue to be less impacted by recent development. The most recent (2002-2003) NCDWR data taken at the SR 2500 (Blue Ridge Road) site were used as the basis for listing the upper Swannanoa River on North Carolina's 303(d) list of impaired streams because it was rated as Fair. The SMIE data from three other sites within the USRW indicate Good and Good-Fair benthic communities (EQI 2014), but cannot be directly compared to the NCDWR ratings. The NCDWR methods (NCDWR 2013a) are more rigorous as to the identification of individual organisms and their tolerances to pollutants. However, the SMIE index (EQI 2014) is useful for evaluating trends in ecological conditions of the stream.

Table 7. Benthic Macroinvertebrate Community Ratings by Site, 1987-2015

Waterbody (Organization[1])	Location Detail	Month or Season and Year Sampled	NC/SMIE IBI Ratings	Aquatic Habitat Rating
Big Slaty Branch (Flat Creek?) (NCDWR)	Near NC 9 (Greybeard Trail?)	December 1991	Excellent	
(Little) Slaty Branch (NCDWR)	Near NC 9 (Greybeard Trail)	December 1991	Excellent	
Big Piney Creek (Branch?) (NCDWR)	Near NC 9 (Greybeard Trail?)	December 1991	Excellent	
Flat Creek (NCDWR)	(Big) Piney Branch Above US 70 At US 70	October 1987 December 1991 December 1999	Fair Excellent Good-Fair	
Swannanoa River (EQI-SMIE)	At Flat Creek	Spring 2013 Fall 2013 Spring 2014 Fall 2014	Good-Fair Excellent Good Good-Fair	
Swannanoa River (NCDWR)	SR 2500; Blue Ridge Road	October 1987 August 2002 August 2003	Fair Fair[2] Fair[2]	
Swannanoa River (EQI-SMIE)	At Black Mountain Recreation Park	Spring 2011 Spring 2013 Fall 2013 Spring 2014 Fall 2014	Good-Fair Good Good-Fair Good-Fair Fair	
Swannanoa River (EQI-SMIE)	At Kearfott Plant	Spring 2013 Fall 2013 Spring 2014 Fall 2014	Good-Fair Good-Fair Good-Fair Good-Fair	

[1]NCDWR - North Carolina Division of Water Resources; EQI-SMIE - Environmental Quality Institute Stream Monitoring Information Exchange.

[2]Sample data used as a basis for listing the USRW on North Carolina's 303(d) list of impaired waters.

Fish Communities

No fish community assessments have been made by NCDWR in the USRW. The nearest sample was taken near the Swannanoa community approximately 3 miles downstream from its confluence with the North Fork Swannanoa River (NCDWR Unpublished data). At that location three fish community assessments taken from between 1997 and 2012 revealed Good-Fair or Good ratings (Table 8). The aquatic habitat rating at that site was rated at 73; fish and benthic communities can be affected when habitat ratings are below 70 (B. Tracy, NCDWR, Personal Communication).

The only other fish data available for the USRW was collected by the North Carolina Wildlife Resources Commission during a survey to identify the distribution of wild trout in the Swannanoa River watershed. Their records (A. Bushon, NCWRC, Personal Communication) indicate that wild trout are present as far downstream as Black Mountain Recreation Park.

Table 8. Swannanoa River Fish Community Ratings by Site, 1997-2015

Waterbody (Organization[1])	Location Detail	Month/Year Sampled	NCIBI Ratings[2]	Aquatic Habitat Rating
Swannanoa River (NCDWR)	SR 2435; Old US Highway 70	September 1997 June 2002 July 2012	Good-Fair Good Good-Fair	73

[1]NCDWR = North Carolina Division of Water Resources.

[2]NCIBI – North Carolina Fish Community Index of Biotic Integrity (NCDWR 2013b)

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PLANNING ELEMENTS

Element A: Causes and Sources of Impairment

As stated in the introduction, the seven mile reach of the Swannanoa River upstream of its confluence with the North Fork Swannanoa River is on North Carolina's 303(d) list of impaired waters. The reason for this designation is a degraded benthic invertebrate community (NCDWR 2014a). Urban related land uses generally have negative impacts on stream biota. In the case of the USRW, it is also related to logging and agricultural activities of the early 20th century. As urban development intensifies, fish and benthic macroinvertebrate abundance, species richness and diversity, and quality of biotic indices have been shown to decrease (EPA 2012). In addition, numbers of more pollutant tolerant species tend to increase.

Ecological conditions in the USRW River have been degraded primarily due to the transition of the watershed from one dominated by agriculture to one now being urbanized. With urbanization, stormwater controls become more important to prevent further stream degradation. To partially address this issue, local ordinances allow the use of "Green Streets" in combination with other Low Impact Development design elements. Both the towns of Black Mountain and Montreat also are required to control runoff from new construction under National Pollution Discharge Elimination System (NPDES) stormwater permits issued by the North Carolina Division of Energy, Lands, and Mineral Resources (Table 9). These permits require the towns to ensure that stormwater control measures are maintained following construction of new or upgraded facilities. It does not require existing facilities to be retrofitted; however, the Town of Black Mountain is currently developing an inventory of their stormwater infrastructure so as to address deficiencies. Three corporations are also required to control stormwater runoff under NPDES permits.

Table 9. Permitted Stormwater Dischargers

Permittee	Type of Operation/Permit	Receiving Stream
Town of Black Mountain	Stormwater; MS-4	Swannanoa River and tributaries
Town of Montreat	Stormwater; MS-4	Flat Creek and tributaries
Ingles Markets, Inc.	Transportation facility	Swannanoa River
Kearfott Corporation	Metals fabrication	Swannanoa River
Southern Concrete Materials, Inc.	Ready-mix concrete stormwater/wastewater discharge	Swannanoa River

Urbanization brings with it changes to stream ecosystems described as "urban stream syndrome" (EPA 2012) that effect water quality, hydrology, and physical habitat. In the case of the Upper Swannanoa River, the single largest source of stream impacts has been the increase in impervious surface area and the stress factors associated with runoff from those areas (Table 10). Not only does the increase in impervious area increase the volume of runoff, but it changes the peak volumes and timing of that runoff. Those factors combined contribute to the destabilization of downstream channels. In addition, stormwater from parking lots transports vehicle contaminants (e.g. brake lining dust and petroleum products) to receiving streams and increases in runoff water temperatures.

An important, but less prevalent contributor to stream degradation in the USRW is the lack of riparian vegetation, which enables stream banks to resist scour from the increased peak stream flows and frequencies, and filters pollutants and sediment from upland areas. Most of those locations identified in this WMP have riparian vegetation that is comprised of turf grass or lawns with limited amounts of woody vegetation. While some agricultural operations are adjacent to streams, most of which consists of row crop farming. There are virtually no livestock within the project area, which are often the cause of bank destabilization and increased nutrient and fecal coliform bacteria levels.

Table 10. Sources, Stressors, and Stress Indictors

Impairment Sources	Potential Stressors	Stress Indicators
Increased impervious surfaces • Commercial buildings • Warehouses • Roads and streets • Parking areas • Residential development on steep slopes	• Increased peak flow • Increase peak flow frequency • Shortened peak flow duration • Eroded stream banks • Reduced pool depth	• Channel scour • Stream bank instability • Sediment deposits • Aquatic habitat rating
Contaminants on impervious surfaces	• Increased contaminant levels (metals, petroleum products, nutrients) • Increase water temperatures	• Altered benthic community index
Reduced riparian vegetation	• Eroding stream banks	• Stream bank instability and scour • Increased temperature variation

Management measures that reduce the impacts of non-point pollutant sources will result in improved water quality, stream channel stability, and improved aquatic habitat conditions. Implementation of management measures described in Element B are expected to achieve such improvements and lead to an improved benthic macroinvertebrate community that will result in the Upper Swannanoa River being removed from North Carolina's impaired waters list.

Element B: Potential Projects and Management Measures

Watershed Management Goals

The ultimate goal of the WMP is to provide strategies leading to water quality and ecological improvements of the USRW such that it can be removed from North Carolina's 303(d) list of impaired waters. The focus of the WMP is on reducing the impacts of stormwater runoff on water quality and stream channel stability as well as enhancing riparian vegetation. Doing so will allow aquatic habitat of the Swannanoa River to improve, leading to improved fish and benthic macroinvertebrate communities and enabling the river to fully support its designated uses.

In the process of developing this WMP, goals and objectives from previous planning efforts were recognized and included as part of this plan. All of these plans describe stormwater as the main factor affecting water quality and stream function and suggest that a locally led effort in implementing watershed improvement projects is needed. More specifically those plans recommend pursuing the following actions:

- Implement projects that support water quality improvement needs and objectives as described in the following planning documents:
  - *2014 Comprehensive Plan Update for the Town of Black Mountain* (TBM 2014)
  - *French Broad River Basinwide Water Quality Plan* (NCDWQ 2011)
  - *French Broad River Basin Restoration Priorities* (NCEEP 2009)
  - *Town of Black Mountain Stormwater Master Plan 2009* (TBM 2009)
- Engage the community in water quality awareness and education.
- Develop additional partnerships to implement projects that improve water quality by engaging the business community and private citizens.
- Stimulate economic opportunities in the community and create jobs by using local businesses when management measures are implemented.

The following sections describe potential stormwater and stream improvement projects that were identified by this study for the USRW. In addition to maps showing the location of each potential project, a table describing some characteristics of each site is presented. Implementation of management measures that support the achievement of these goals will continue the process of improving water quality in the watershed.

Stormwater Impacts

During a rain event, stormwater flows across impervious surfaces and carries pollutants with it into streams. Since these impervious areas do not provide a mechanism to slow the water down, the result is often increased water velocities that scour receiving stream channels. These factors combine to cause increased turbidities and sediment loads from the degraded banks and subsequently impact aquatic habitat and fish and benthic communities.

The area of land within the USRW, including both the Towns of Montreat and Black Mountain, is regulated under EPA's Phase II stormwater regulations. Under this designation, new development is required to provide stormwater control features to manage runoff from the impervious surfaces of newly developed property. One approach local governments have taken to address this issue has been the adoption of ordinances allowing the use of Low Impact Development designs that can include the use of "Green Streets". Although this approach serves

to reduce further degradation of water quality, it does not provide mechanisms to remediate impacts caused by older developments. Impacts from these developments will continue unless the sites are retrofitted with stormwater control features.

This WMP focuses on two types of watershed improvements. The first deals with sites having conditions suitable for the installation of stormwater retrofit projects. The second targets improving stream channels and riparian areas that either have been degraded by stormwater runoff or lack adequate riparian vegetation to maintain stream bank integrity. Such stormwater retrofit practices and stream improvements will be designed not only provide water quality benefits, but improve aesthetics of the watershed. Both types of watershed improvement projects will also serve as models that can be utilized for educational purposes.

Potential Stormwater Control Projects

A GIS and aerial interpretation effort was conducted to identify potential SCM sites (Appendix A). These sites were then ground-truthed, and analyzed spatially to determine both feasibility and need. Several potential sites initially identified were found to be either inconsequential in treatment potential, constrained by existing conditions, or were newer developments where evidence of existing stormwater treatments were observed (cleanout pipes, monitoring wells) implying that they are already in compliance with phase II requirements. Thirty-one sites were identified as potential retrofits sites (Figure 4 and Table 11). After field work and further analysis that considered visually apparent conflicts such as land use, utilities, and topography, and then also consolidating some of the sites, 21 were determined to be viable projects that could be implemented within the 10-year WMP planning period.

Implementation of these stormwater control measures will help offset the impacts of impervious cover by mimicking the natural processes of forest ground cover. These processes slows runoff, giving the stormwater an opportunity to infiltrate into the ground and helping recharge the water table. Furthermore, by slowly releasing stormwater from a developed site, discharge rates of large events are reduced to match natural effluent contributing to stream flow. Some stormwater structures are effective in not only removing sediment, but also in reducing the levels of pollutants such as nutrients (nitrogen and phosphorus) and heavy metals. Once stormwater is captured by the treatment, pollutants are removed by aerobic and anaerobic processes. In addition to reducing the potential for downstream bank erosion, SCMs also can provide improved wildlife habitat by enhancing open space, reducing water temperatures, which are often elevated by heat-absorbing pavement, and to beautify the landscape by the addition of water features and vegetation.

Surface area estimated for each treatment is based on the maximum percent of contributing drainage area that can be treated. Detailed sizing calculations will be necessary when designing individual treatment locations and can be referenced in the NCDWQ BMP manual (NCDWQ 2007). Deficiencies in available treatment areas are most commonly a result of available land to implement the SCMs. However, these spatially deficient SCMs will still have treatment benefits, and will still provide benefits such as habitat uplift and public awareness.

Although beyond the timeline of the WMP, the 10 sites considered not viable were retained in the report for future consideration should unforeseen circumstances such as land donations, change of land use, structure removal, or parallel projects provide opportunity for their pursuit.

Conceptual studies of 17 of the 21 final sites are included to help both aid in communicating with landowners, and to convey intent when more detail design is pursued (Figure 5, Sheets 1-13). Due to the cursory nature of the concepts, they are not intended to be used for implementation, and should not be construed as detailed drawings because factors such as, but not limited to, site features, utility conflicts, land uses, and topography may vary.

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Figure 4. Distribution of Potential Stormwater Control Projects

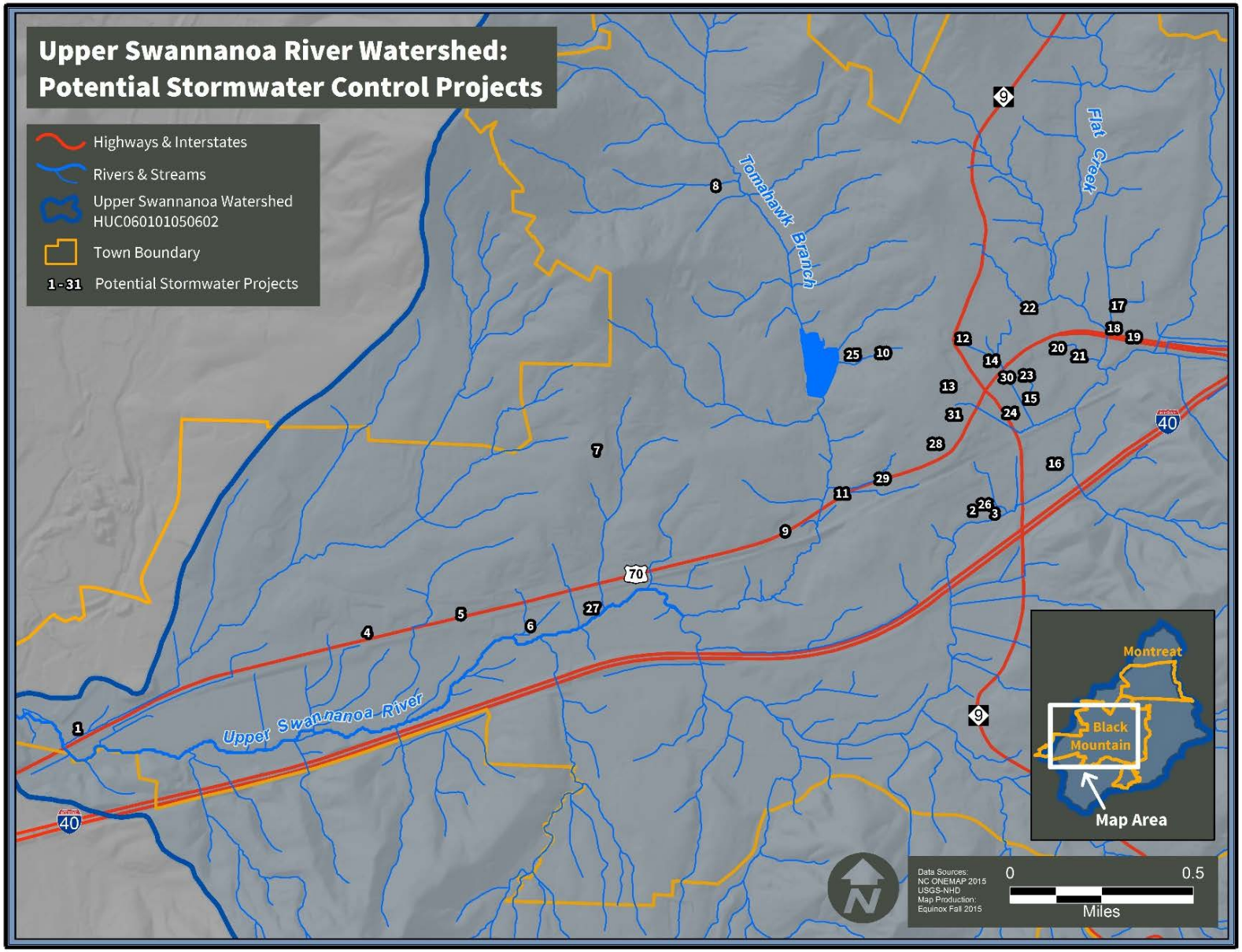

Table 11. Potential Stormwater Control Retrofit Projects (Sheet 1 of 2)

Site	Property Name	Type of SCM	Was The Site Observed	Public Land	Land Use	Drainage Area (acres)	Impervious Area (Acres)	Percent Impervious	Surface Area REQUIRED for SCM(s) (square feet)	Surface Area IDENTIFIED for SCM(s) (square feet)
1	Kearfott	Wetlands	Yes	No	Industrial	4.8	3.7	77	10,454	21,965
2, 3, 26	Foam and Fabric/Terry Estate Dr.	Bioretention	Yes	No	Commercial	1.9	0.9	46	8,700	5,404
4	Hopey, Dollar General, Goodwill	Bioretention, Tree Islands	Yes	No	Commercial	3	3	100	13,060	11,188
5	WNC Shopping Center	Bioretention	Yes	No	Commercial	1.0	1.0	100	870	2,005
6	Black Mountain Commerce Park	Wetlands	Yes	No	Commercial/ Industrial	23	13	60	50,094	49,233
7	Carver Center	Cistern	No	Yes	Institutional	0.4	0.4	100	*1500 GAL.	N/A
8	Golf Course Parking	Bioretention, Stream restoration	Yes	Yes	Government/ Golf Course	0.6	0.6	100	2,613	1,365
9	Apple Blossom Motel	Bioretention	Yes	No	Commercial	Has been confirmed on-site that filled in pool conversion not likely feasible, or effective				
10	Laurel Circle (ROW Storage)	Extended Detention	Yes	No	Transportation	8.1	1.4	17	10,585	3,416
11	CVS/US 70	Underground Detention Chamber	No	Partial	Commercial	28.5	15	50	**N/A 850	888
12	First Baptist Church	Bioretention	Yes	No	Religious	1.0	0.9	90	900	722
13	Church Street	Bioretention	Yes	Yes	Government	3.0	2.0	67	1,500	1,750
14	Police Station	Bioretention	Yes	Yes	Transportation	Constrained vehicle circulation				
15	Richardson	Bioretention	Yes	Yes	Transportation	Limited opportunities due to traffic volume, limited parking, and steep grade.				
16	Bi-Lo	Bioretention	No	No	Commercial	Existing storm treatment in place. Grassed area is on high point, and is likely being held for future development.				

Table 11. Potential Stormwater Control Retrofit Projects (Sheet 2 of 2)

Site	Property Name	Type of SCM	Was The Site Observed	Public Land	Land Use	Drainage Area (acres)	Impervious Area (Acres)	Percent Impervious	Surface Area REQUIRED for SCM(s) (square feet)	Surface Area IDENTIFIED for SCM(s) (square feet)
17	Outparcel	Bioretention, Channel enhancement, swales	Yes	No	Commercial	Although no significant pollutant treatment benefit would be realized, this site is currently experiencing localized flooding. An SCM could improve this issue and would be highly visible location adjacent to a school potentially providing educational benefits.				
18	Outparcel	Bioretention, Channel enhancement, swales	Yes	No	Commercial	1.2	0.8	70	4,150	3,000
19	Tractor Supply	Bioretention, Swales	Yes	No	Commercial	3.0	2.6	85	9,370	3,972
20	Robo Oil	Filters	Yes	No	Commercial	0.5	0.4	85	N/A	N/A
21	Tong Sing	Wetlands	Yes	No	Commercial	2.2	1.5	70	14,374	4,887
22	Black Mountain Primary	Swales, Bioretention	Yes	Yes	Institutional	Spatial constraints with utilities and vehicular circulation. Also, no significant treatment benefit would be realized.				
23	Fresh Parking	Bioretention	Yes	No	Commercial	0.2	0.2	100	780	900
24	Right of Way	Bioretention	Yes	Yes	Transportation	Buildings immediately adjacent, spatially constrained.				
25	Lake Tomahawk Parking	Bioretention	Yes	Yes	Parking	0.3	0.2	75	1,000	2,073
27	Montreat College (vacant land)	Wetlands	No	No	Institutional	97.5	52.5	54	111,250	76,500
28	Library	Bioretention	Yes	Yes	Institutional	0.2	0.2	100	2,150	1,500
29	Residential parcel	Extended Detention	Yes	No	Residential	Likely a use conflict.				
30	Post Office/Dry Cleaner	Riparian Restoration, Extended Detention	Yes	No	Commercial (for Sale)	Water quality concern of dry cleaning effluent. Volume concerns (increased velocity at outfall) as the stream enters a piped network under the Post Office.				
31	Methodist Church Parking	Bioretention/ Swales	Yes	No	Religious	Possibly using open space between trees. Treatment would have to be non-invasive as space is likely used for function gatherings. Treatment opportunity from parking area is minimal.				

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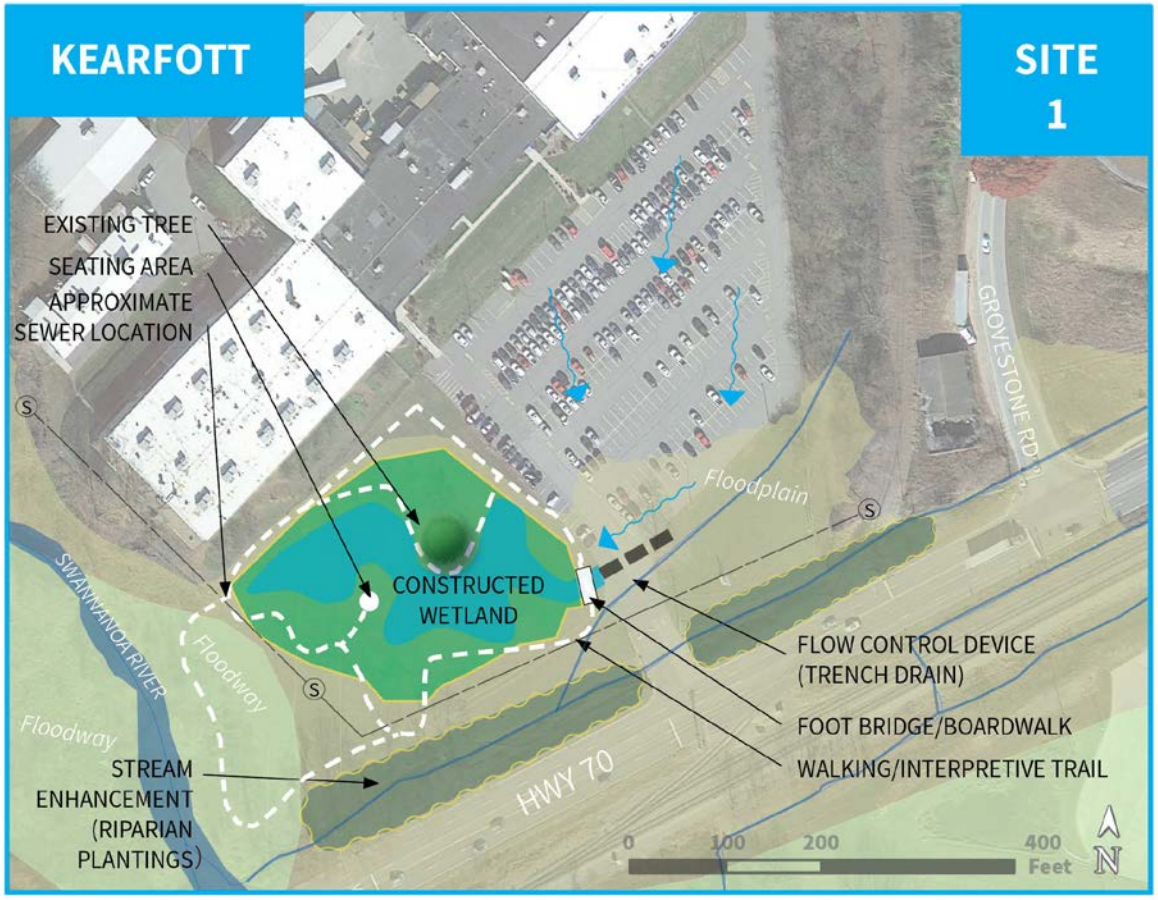
A holistic approach was taken to determine the appropriate SCMs for each individual site. Factors considered included slopes, soils, contributing hydrology, depth to bedrock, depth to the seasonably high water table, targeted pollutants, and available space. It is important to recognize that the siting and design of SCMs is as much of an art as a science (NCDWQ 2007). Appropriately fitting treatments into the natural features of a site can not only help reduce impacts to water quality, but address community concerns, safety issues, community acceptance, and wildlife benefits (Table 12).

Table 12. Stormwater Control Measure Characteristics[1]

SCM Type	Construction Cost	Maintenance Level	Safety Concerns	Community Acceptance	Wildlife Habitat
Bioretention	Medium-High	Medium-High	No	Medium-High	Medium
Wetlands	Medium	Medium	Yes	Medium	High
Wet Detention Basin	Medium	Medium	Yes	Medium	Medium
Sand Filter	High	High	No	Medium	Low
Filter Strip	Low	Low	No	High	Medium
Grassed Swale	Low	Low	No	High	Low
Restored Riparian Buffer	Medium	Low	No	High	Medium-High
Infiltration Devices	Medium-High	Medium	No	Medium-High	Low
Dry Extended Detention Basin	Low	Low-Medium	Yes	Medium	Low
Permeable Pavement System	Medium-High	High	No	Medium	None
Rooftop Runoff Management	Medium	Medium	No	High	Low

[1]Source: NCDWQ Stormwater BMP Manual (NCDWQ 2007)

Figure 5. Conceptual Site Information Sheets (Sheet 1 of 13)



Site Notes:

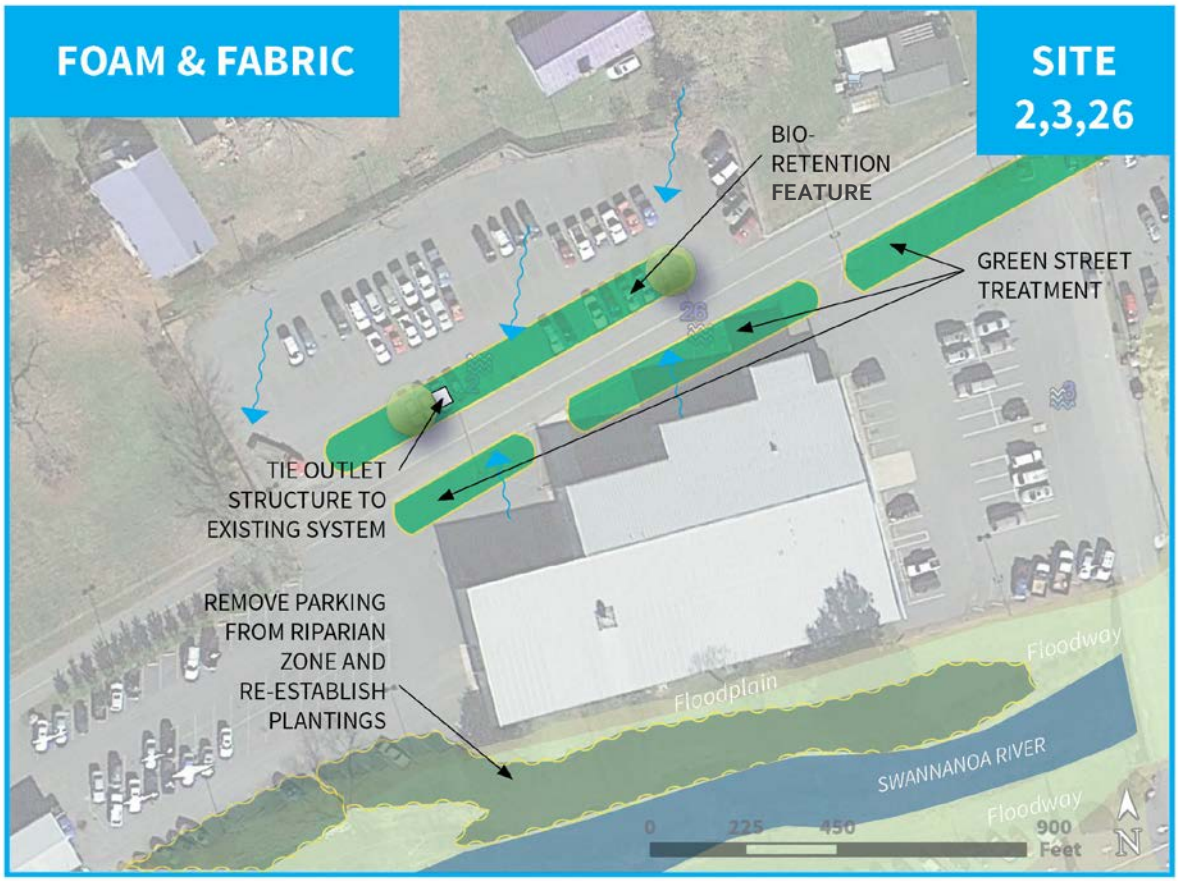
Adjacent stream (possibly in DOT ROW) is heavily incised. Potential wetland will be located in floodplain and should be able to treat the entire parking area.

Area is currently maintained lawn and is possibly used for company events, but design could provide walking/interpretive trails promoting employee break use.

Sewer line (and associated easement) will be considered with layout.

Example of a constructed wetland.

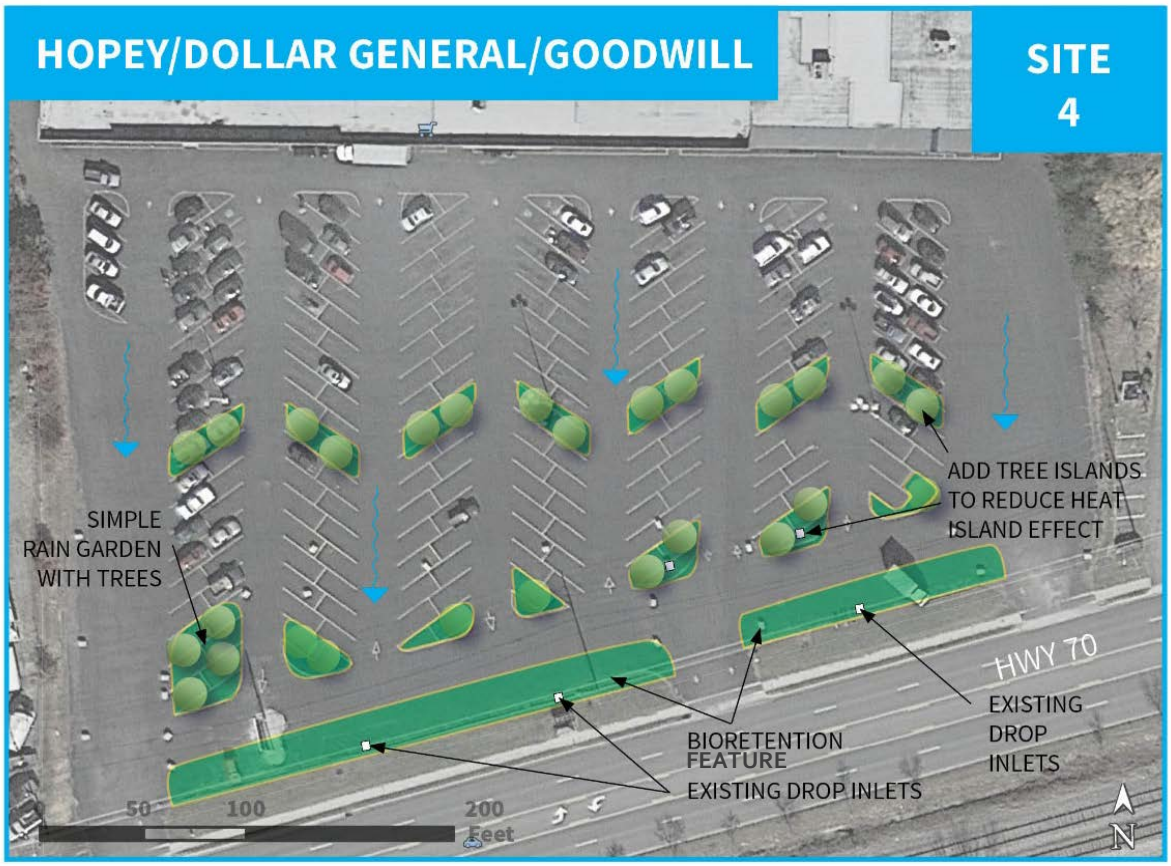
Figure 5. Conceptual Site Information Sheets (Sheet 2 of 13)



Site Notes:

Provides beautification opportunities along roadway. Landscape enhancements could be visible from Black Mountain Ave, Hwy 9, and Vance.

Figure 5. Conceptual Site Information Sheets (Sheet 3 of 13)

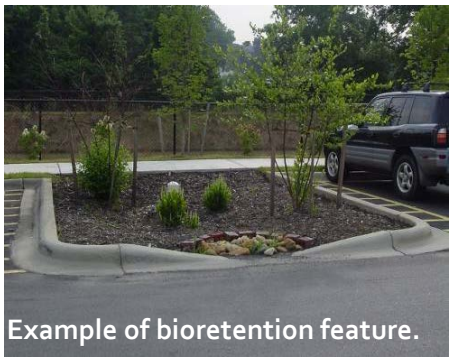


Site Notes:

Would require parking reconfiguration, although the concept considers existing concrete blocks located throughout parking. Existing infrastructure (perimeter inlets) would be used in bioretention cells.

SCMS would be visually appealing & reduce heat island effect. Maintaining visibility to businesses needs to be considered with plantings.


Existing site conditions.


Example of bioretention feature.

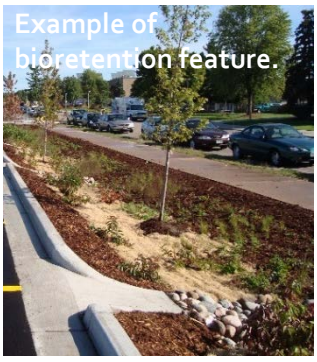
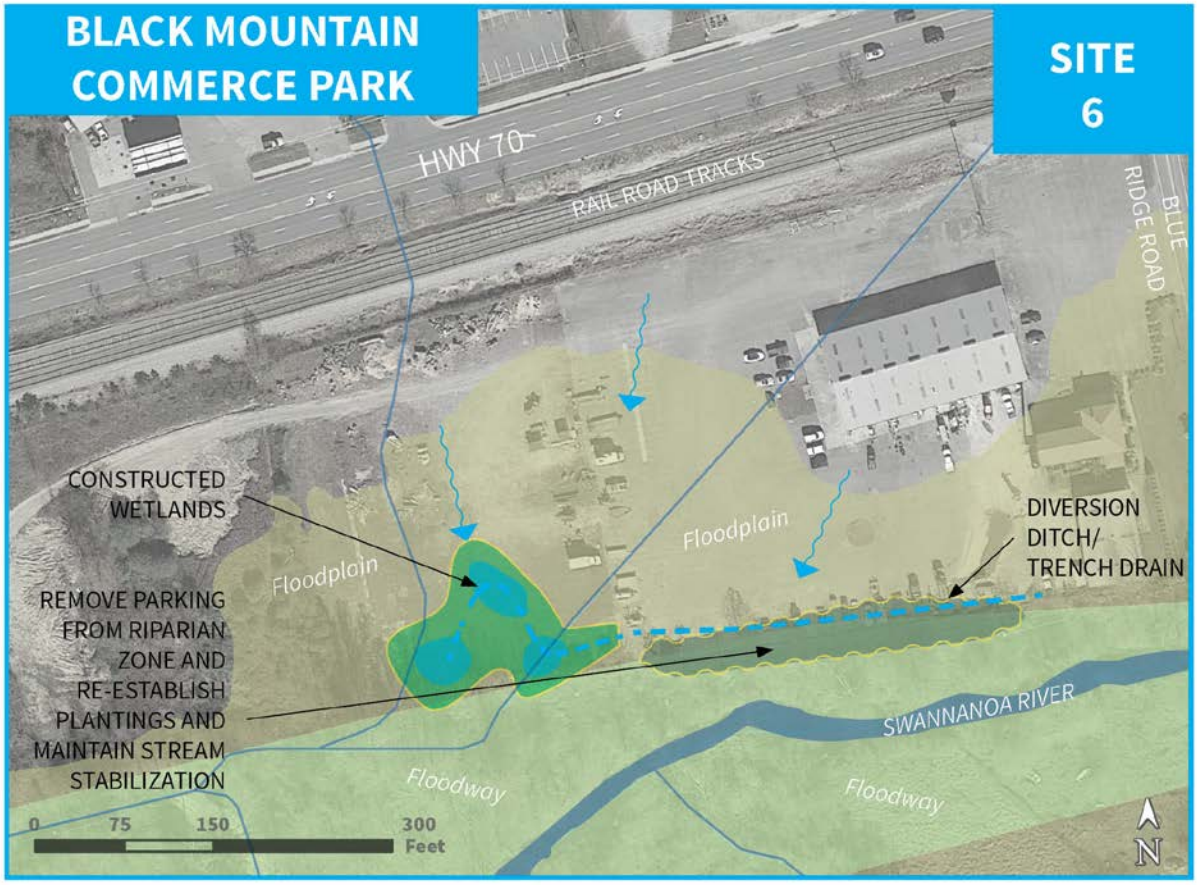

Example of bioretention feature.

Figure 5. Conceptual Site Information Sheets (Sheet 4 of 13)

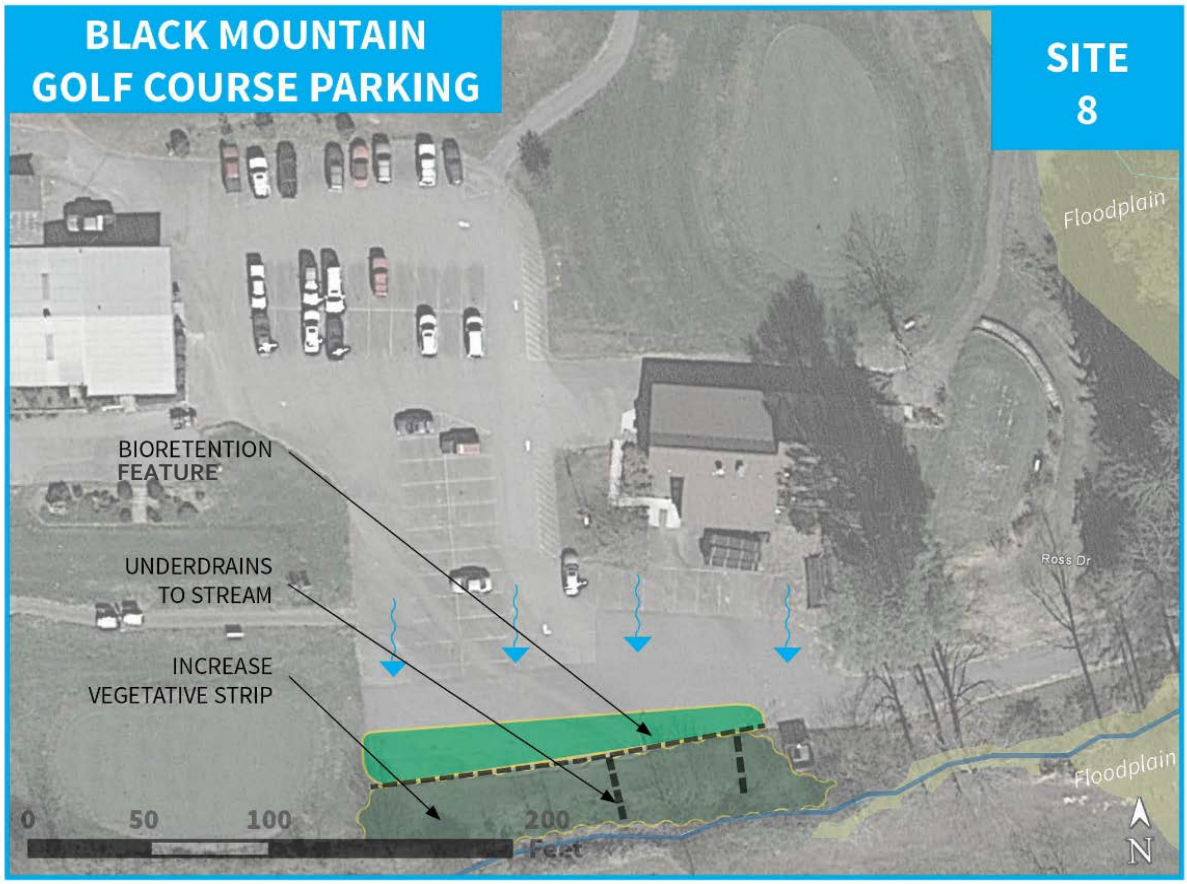


Site Notes:

Back paved area is expansive and could likely be reduced without affecting function. Lidar indicates on-site streams which are likely piped. Daylighted streams could support wetland hydrology. Close dialogue with property owner would be necessary to ensure existing uses for property (storage yard) is maintained.

Example of constructed wetland.

Figure 5. Conceptual Site Information Sheets (Sheet 5 of 13)



Site Notes:

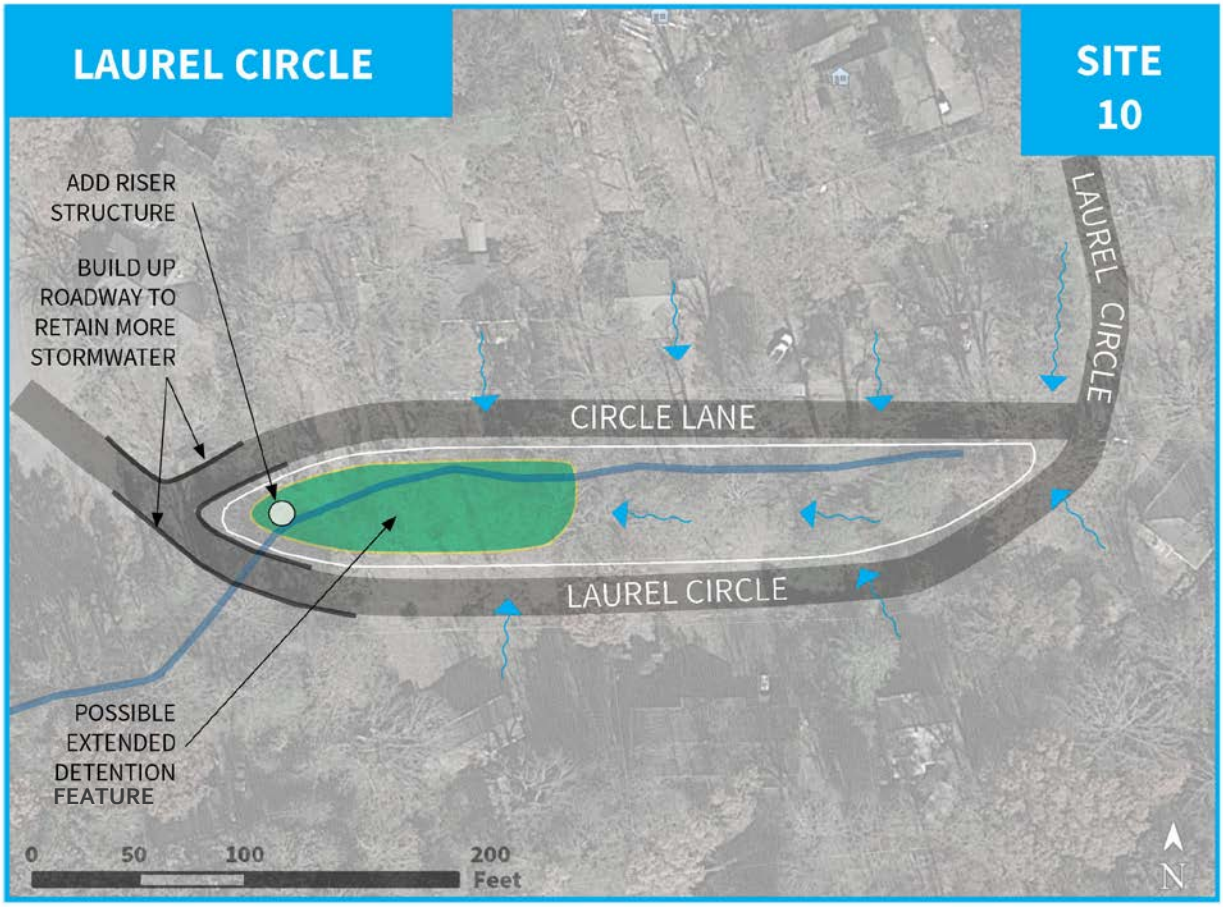
Reduction of parking (already limited) would be required. Bioretention would rely on surface overflow, and underdrains would daylight into stream corridor. Depth would be limited to underdrain daylight elevation and depth to water table. It is possible to increase a vegetated strip within the bioretention.

Example of vegetated strip.

Example of bioretention feature.

Example of vegetated strip.

Figure 5. Conceptual Site Information Sheets (Sheet 6 of 13)



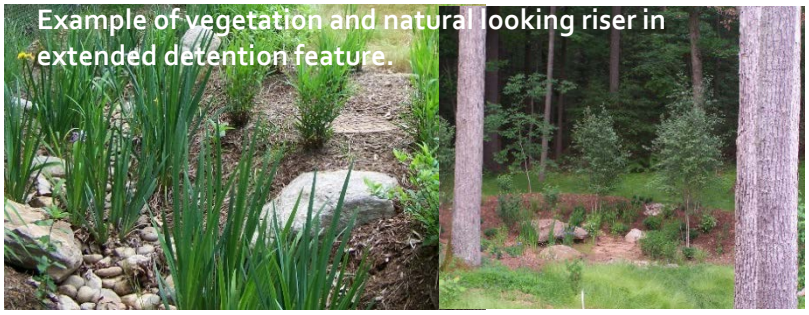
Site Notes:

Would require building up roadway on low end of drainage area and accommodating a drive that is connected. Potential volume achieved needs further analysis.

SCM primarily addresses velocities draining to channel by playground, so treatment potential is nominal.

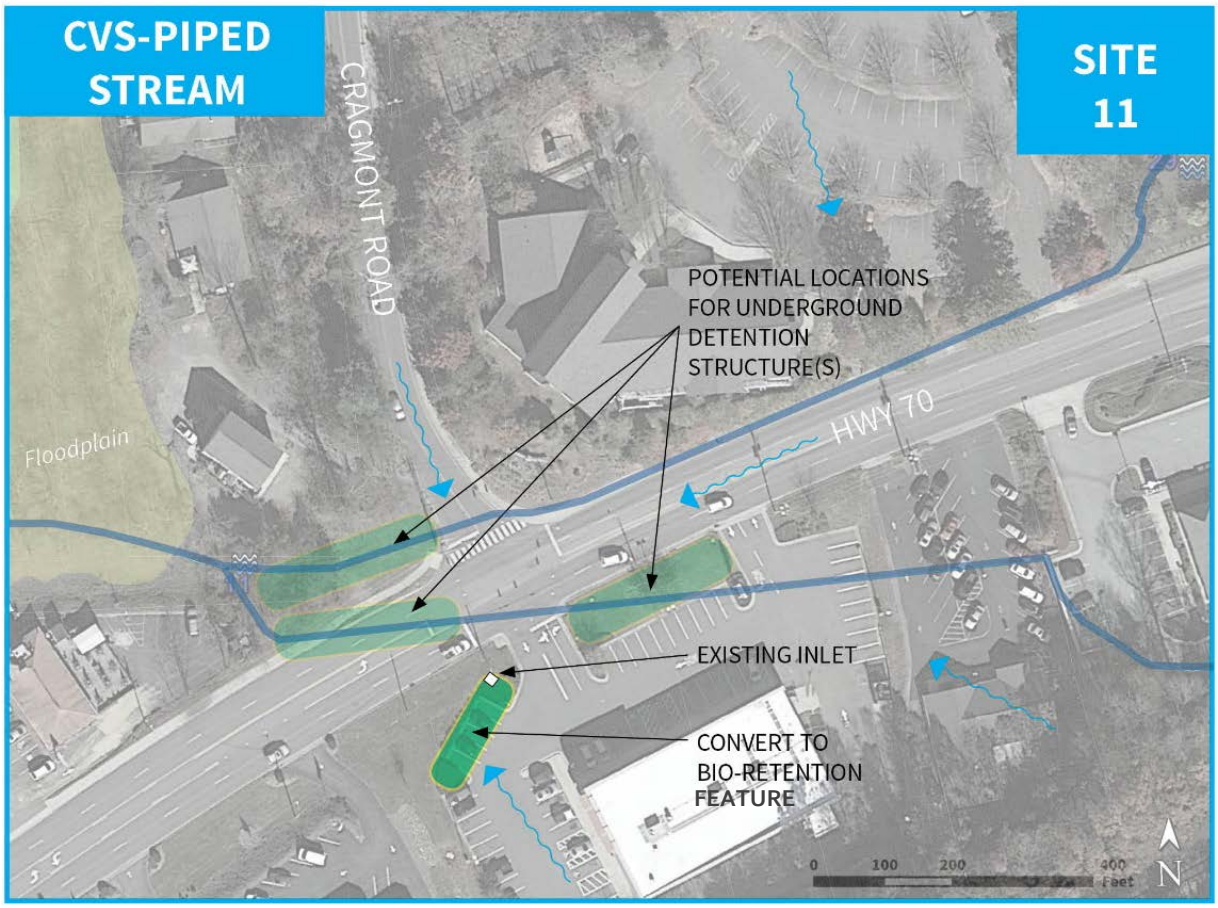
Perennial stream determination is needed and may limit options for concept.

Existing site conditions (bottom of Laurel Circle).



Example of vegetation and natural looking riser in extended detention feature.

Figure 5. Conceptual Site Information Sheets (Sheet 7 of 13)

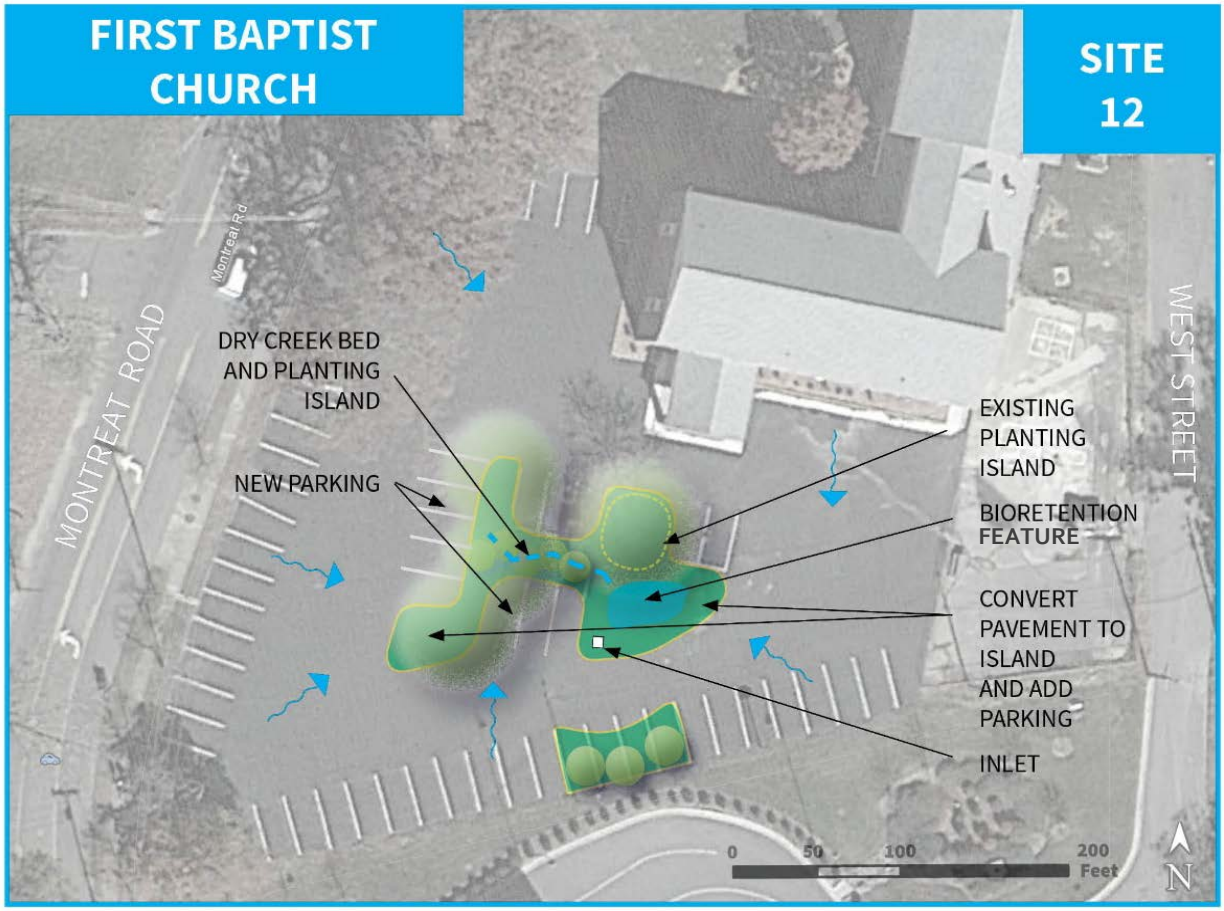


Site Notes:

Tomahawk Branch receives outfall of two underground pipe systems. Velocity reduction is the goal. Cost will likely be significant. Coordination with NCDOT is critical. There should be no implications with USACE/permitting since stream is already piped.

Examples of underground detention structures

Figure 5. Conceptual Site Information Sheets (Sheet 8 of 13)



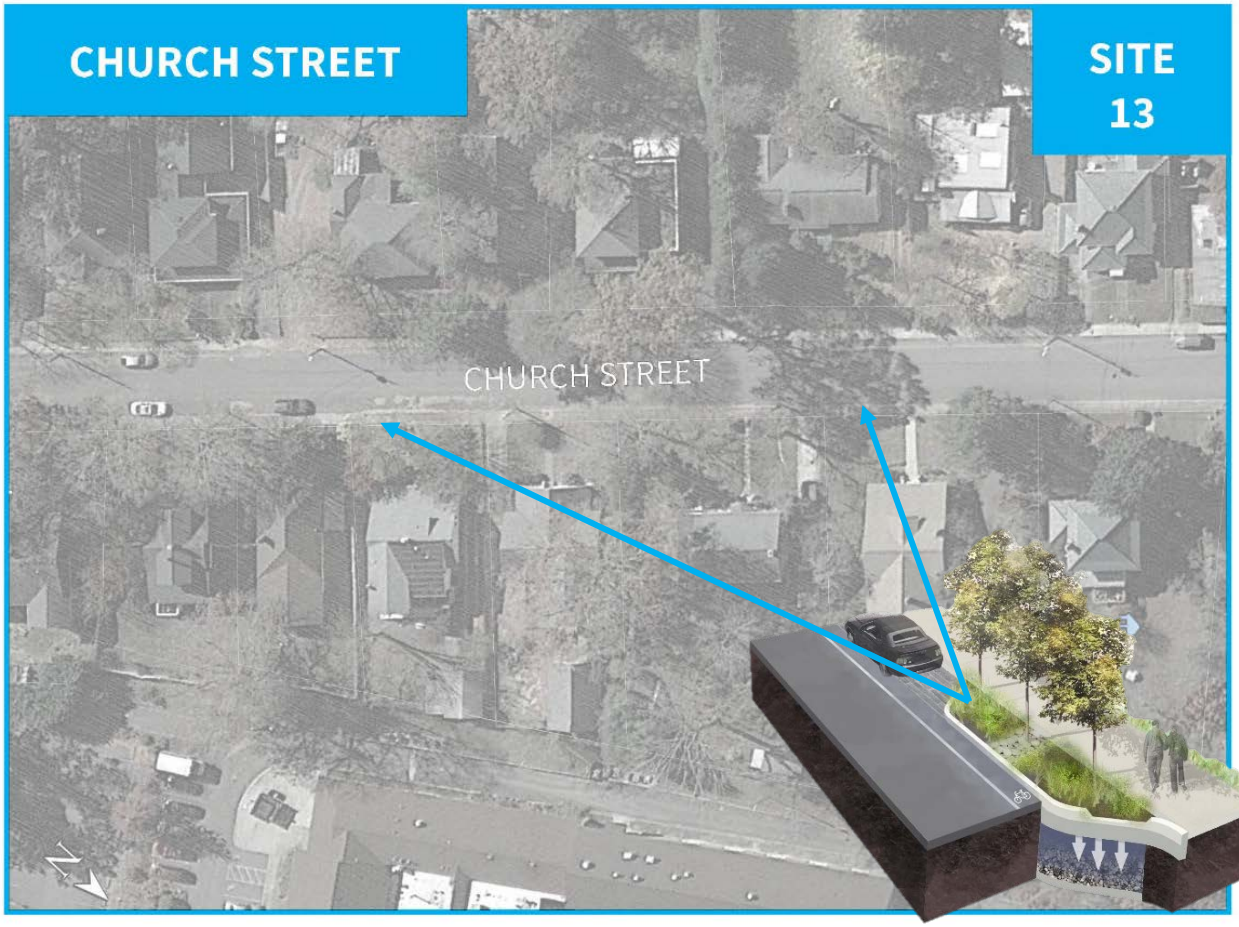
Site Notes:

Parking reconfiguration maintains current number of parking spaces. Proposed bioretention would utilize existing storm infrastructure. Tree islands added to define circulation and provide shade.

Existing site conditions (view from Montreat Road).

Example of a bio-retention feature.

Figure 5. Conceptual Site Information Sheets (Sheet 9 of 13)

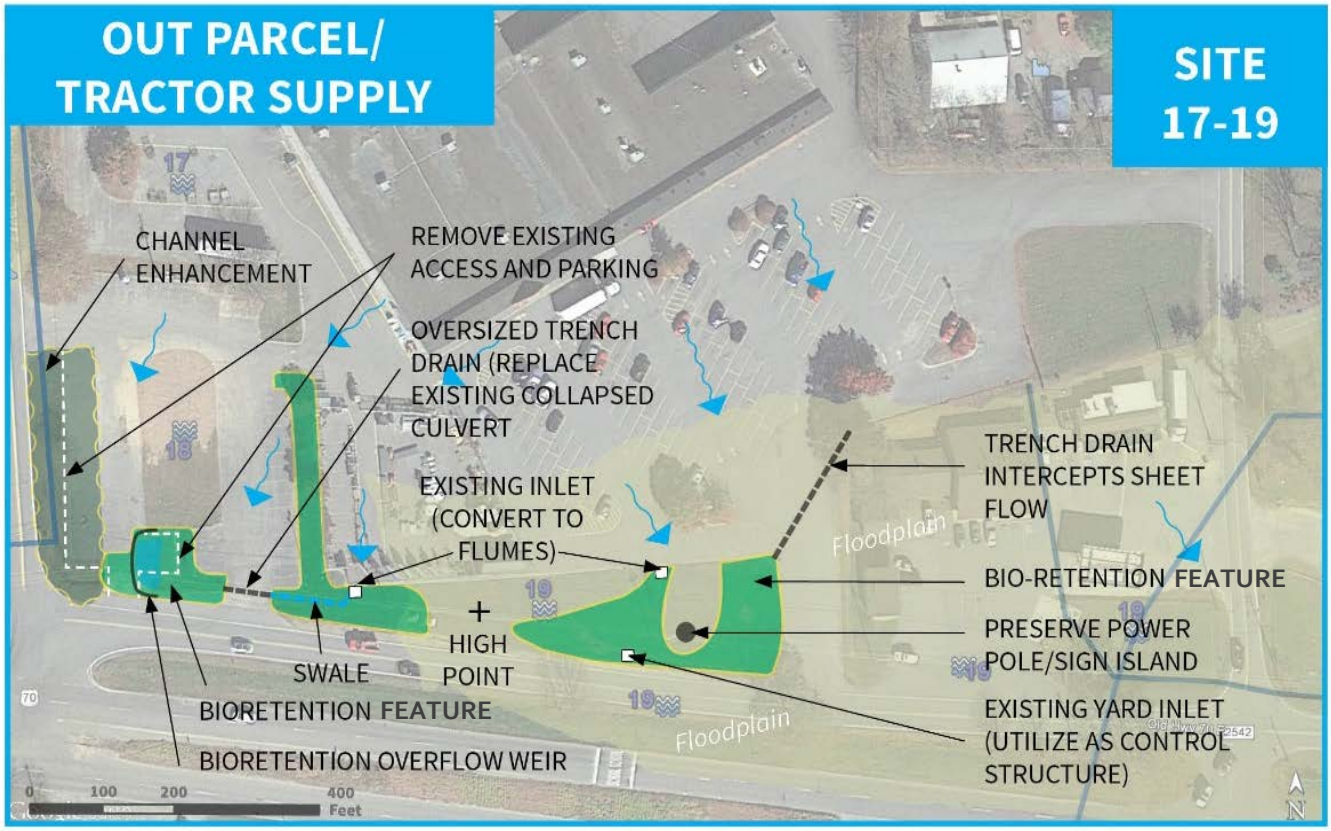


Site Notes:

Top of watershed contributing to downtown infrastructure issues. Greenstreet treatments to accommodate driveways, and on-street parking. Use traffic calming techniques with integrated stormwater treatment.

Examples of green street options.

Figure 5. Conceptual Site Information Sheets (Sheet 10 of 13)



Site Notes:

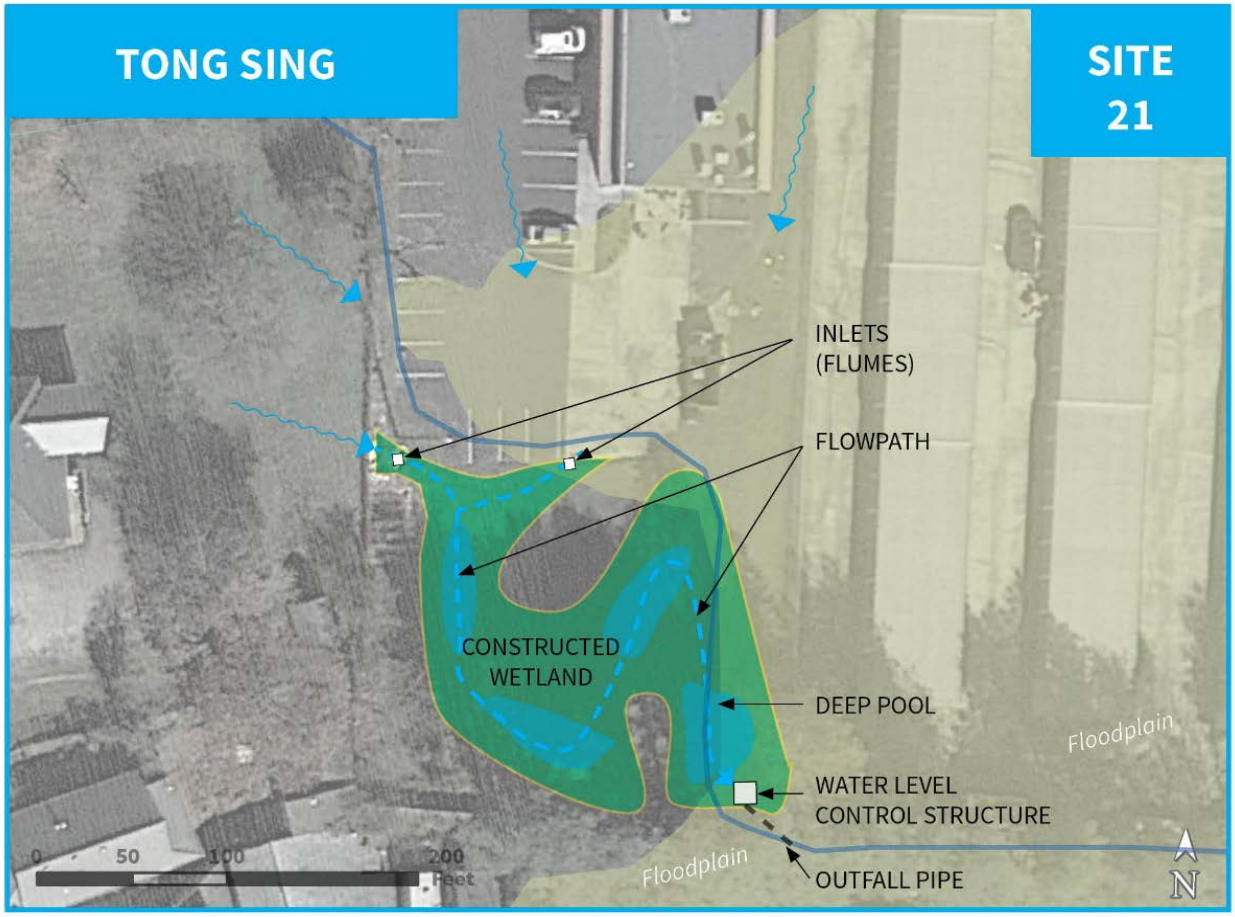
Utilize open space with existing infrastructure to treat stormwater. The presence of utilities are likely. Additional studies are recommended concerning adjacent gas station surface draining directly to inlets near waterway. Tanks are also buried immediately adjacent to waterway. Around five bioretention cells are anticipated.

(Above) example of a trench drain.

Example of a bioretention feature.

Site conditions on a rainy day of US 70 at the Tractor Supply entrance.

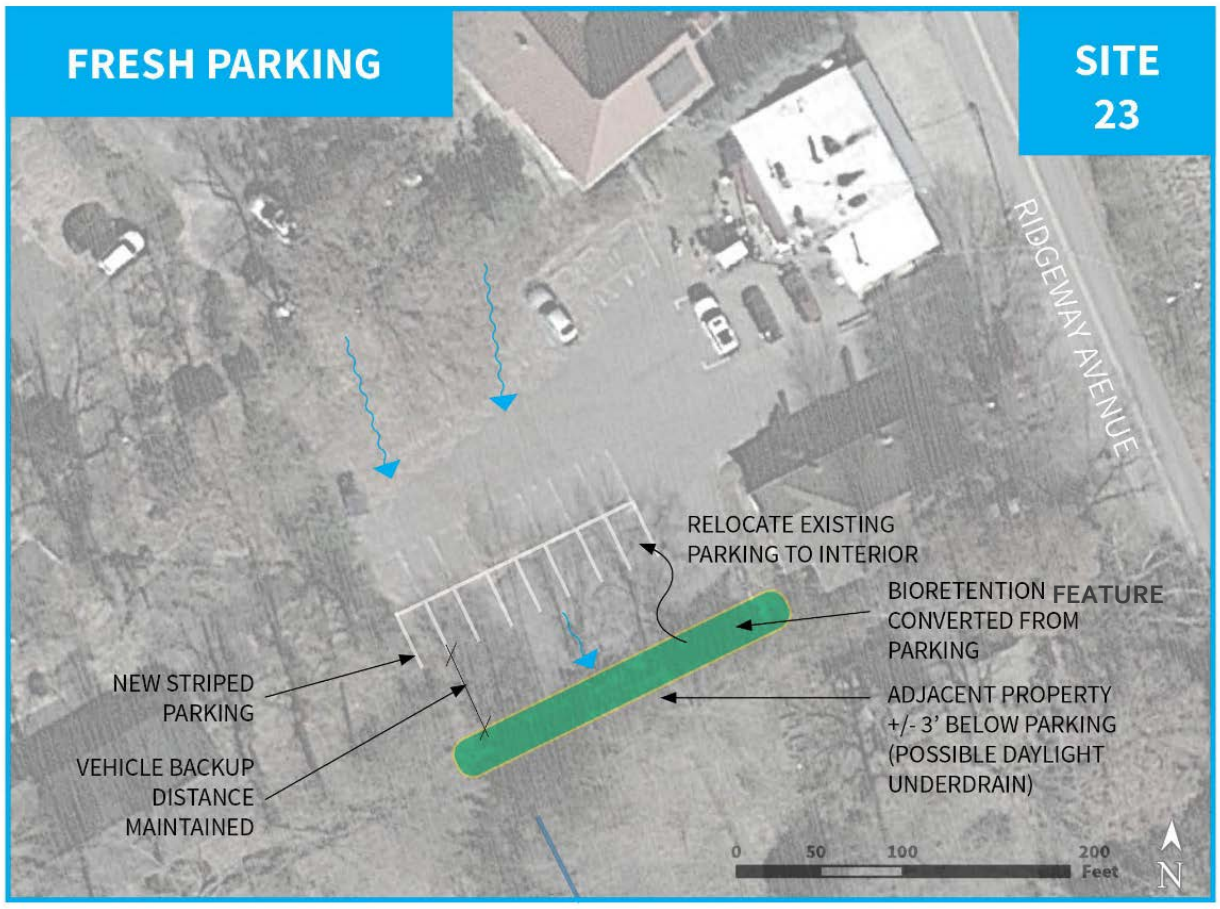
Figure 5. Conceptual Site Information Sheets (Sheet 11 of 13)



Site Notes:

Groundwater hydrology likely present to support constructed wetland. Also receives runoff from site 20.

Figure 5. Conceptual Site Information Sheets (Sheet 12 of 13)



Site Notes:

Possibly need to involve two parcels/landowners to reconfigure parking.

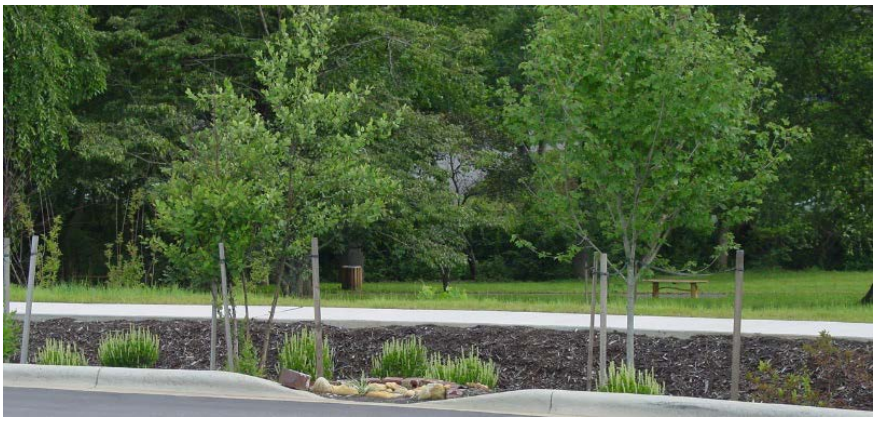
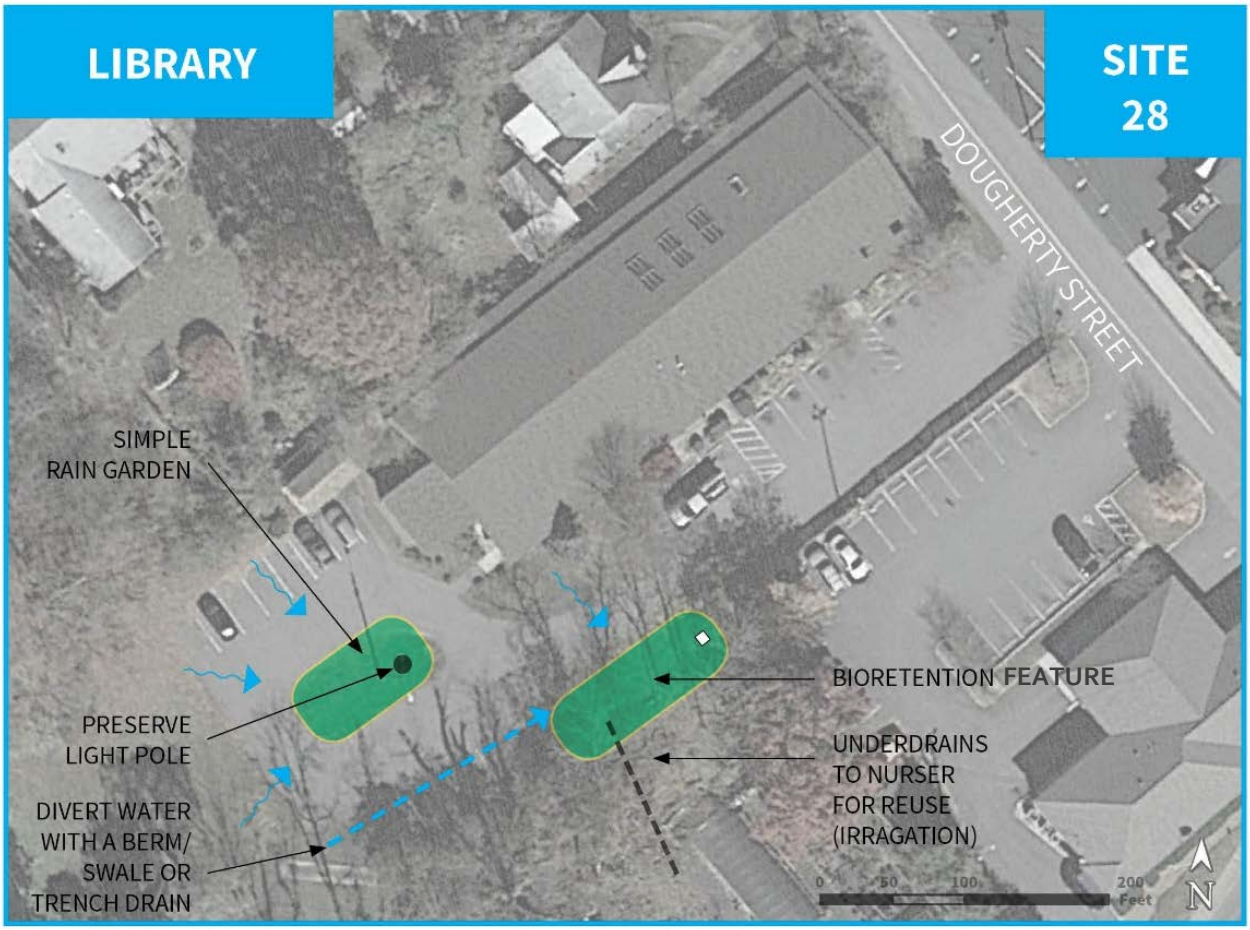


Figure 5. Conceptual Site Information Sheets (Sheet 13 of 13)



Site Notes:

Informal grass parking area to be converted to bioretention. Existing yard inlet can receive overflow, but is too shallow to tie to underdrain. Underdrains can potentially provide treated stormwater for irrigation re-use (although quantity of effluent will be nominal).

Stormwater Control Management Measures

> ***Runoff Volume***
>
> *One inch of precipitation falling on 1,200 square feet of roof produces approximately 750 gallons of runoff.*

Non-structural Control Measures - Simple SCMs include small, low cost measures that cumulatively can add up to significantly reduce stormwater runoff impacts. Homeowners and small businesses can easily implement simple SCMs on their properties and usually at low cost. Done properly these simple practices will beautify a property, protect basements and foundations from water seepage, and reduce water consumption and money that property owners spend on water utilities. Each property is unique. Prior to implementing any of these solutions, property owners should assess their site to ensure that their runoff will not cause or worsen storm runoff problems for neighbors or create or add to erosion and flooding conditions on their properties. Even though these solutions are referred to as 'simple', professional assistance with design and construction may be needed. Landowners will be encouraged to install these features through the education and outreach program.

Downspout Disconnects - As the name implies, in cases that roof drains are tied into a closed system, downspouts are physically disconnected from these systems. Downspouts from rooftop gutter systems can be re-routed to lawns and wooded areas to reduce runoff volume and stream velocity. People interested in helping streams through these practices should expect minimal investment in time and money. A homeowner with just a few downspouts will not incur as much cost as those who manage a large commercial facility. The site to which the downspout is re-routed should be assessed for its infiltration and erosion potential. Rerouting downspouts to steep slopes or clay soil areas may cause erosion or flooding. When these site conditions are unavoidable, use of stone, erosion control fabric and vegetation can help control erosion and promote infiltration. The more complicated a site, the more likely assistance of a design professional is necessary. Many homeowners will find this solution easy and inexpensive to implement and can likely undertake such a project on their own.

Rain Barrels and Cisterns - Rain barrels and cisterns (Figure 6) provide a storage device to capture rooftop drainage for later use on the site. Many people capture and reuse this water for their gardens and landscape plantings. Rain barrels come in a variety of sizes, shapes, and colors. It has become fairly commonplace to find 50 to 75 gallon barrels that make attractive additions to the landscape, while cisterns tend to be much larger and may even be designed to be used for non-potable indoor plumbing. A simple, 50 gallon plastic rain barrel will typically cost $100 or less. Users of this practice will need to make sure that they have screens over openings to keep mosquitoes from using the reservoir as a breeding ground. They will also need to direct overflow to a suitable location to keep it from seeping into foundations and basements.

Figure 6. Rain Barrel and Cistern Setup

A rain barrel is attached to a downspout and collects rain water.

An above ground cistern located at the City of Morganton Parks and Recreation maintenance building catches runoff from the roof. The water is used to clean equipment.

Dry Creek Beds - Dry creek beds (Figure 7) can be an attractive landscape amenity that can serve the function of routing storm runoff from impervious rooftops, driveways, and parking lots into a yard area where infiltration can occur.

The rough edges of the stones and the open spaces in between the rocks slow down runoff and allow it to be absorbed by the ground. Landscape plantings within and surrounding the dry creek bed also slow the water and promote infiltration. The stones and plants can also work together to create natural habitat for birds and small mammals.

Figure 7. Dry Creek Beds in a Residential Setting

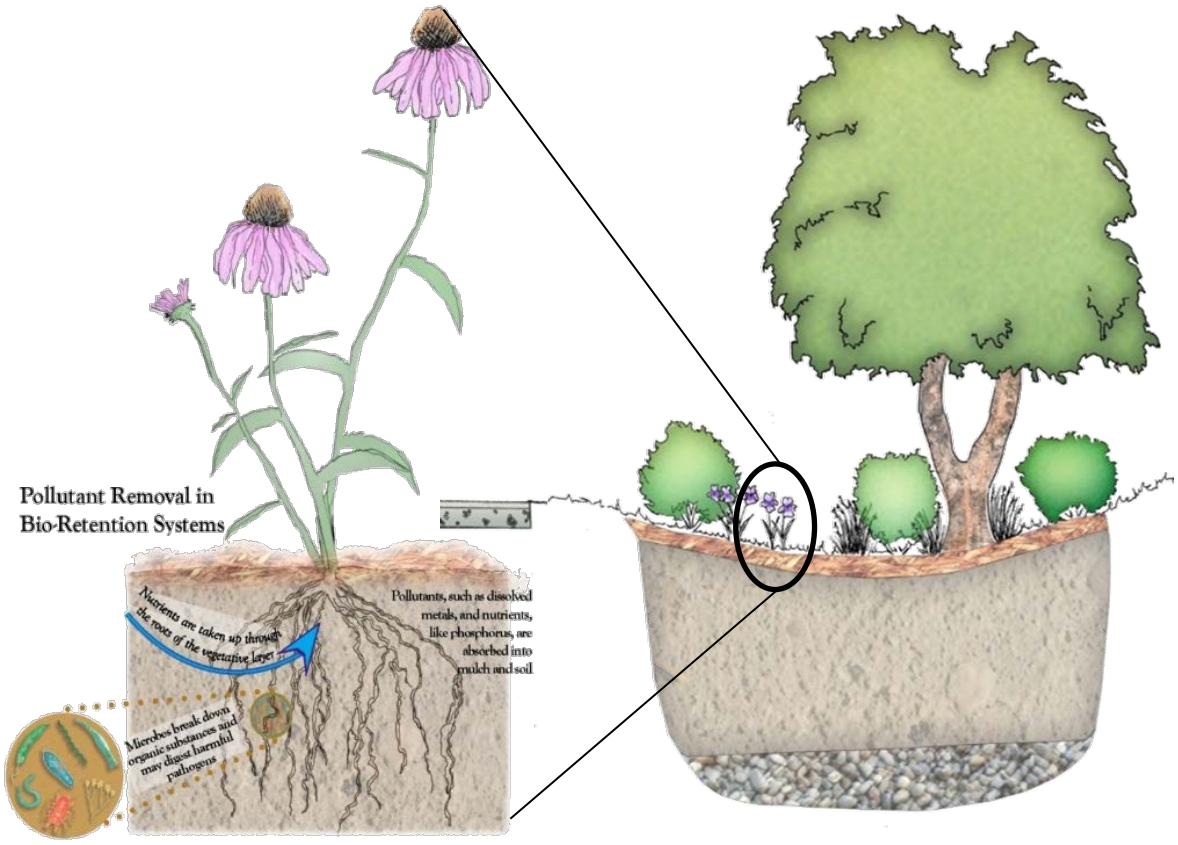
Raingardens - Raingardens are often simply excavated areas located in low points of a property where stormwater accumulates. They are intended to slow, treat, percolate, and promote evapotranspiration of stormwater. They rely primarily on a specified mix of medium placed with the treatment cell and planted with native species. They usually do not include underdrains and inlet structures.

Because they lack drainage structures, soils in raingardens need to be highly permeable to function correctly. It is important to test the composition of existing soil to ensure the raingarden is able to "draw down" between rain events.

Structural Stormwater Control Measures - Structural SCMs typically treat larger areas of imperviousness and "are intended to remove pollutants from stormwater runoff, reduce downstream erosion, provide flood control, and promote groundwater recharge" (NCDWR 2007). Design professionals and precise installation parameters are most often needed when implementing structural SCMs. They vary greatly in size, complexity, and function, often incorporating plant material, soil mixes, and diversions that filter pollutants by natural processes. Common examples of structural SCMs include bioretention, constructed wetlands (also known as stormwater wetlands), wet ponds, and sand filters. Less common and often more expensive solutions include permeable paving, regenerative stormwater conveyances, underground storage chambers, and green roofs.

Bioretention - Bioretention features are depressions that use soils and plants to treat storm runoff, using many of the water storage and pollutant-removal mechanisms that operate in healthy forests. During storms, water temporarily ponds on the surface of a sand/soil bed and then infiltrates through the bed. Nutrients are taken up by plants while microbes break down organic substances (Figure 8).

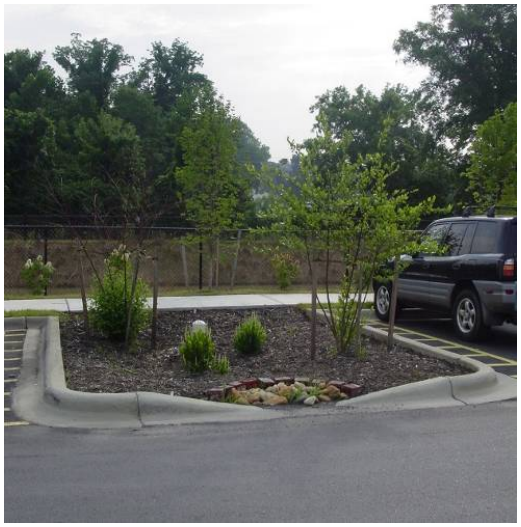
Figure 8. Plant Uptake and Pollutant Removal Processes



Bioretention cells are intended to "draw down" or empty within 24-48 hours following a rain event, alleviating stagnant water and mosquito breeding concerns. Cells can be designed to infiltrate water directly into native soils, if these soils are sufficiently permeable. If not, underdrain systems may be necessary. To reduce the sizing requirements of bioretention features, use of a structure can be installed to limit the amount of water the bioretention receives to the first inch of rain. Larger storm volumes bypass the bioretention cells protecting them from receiving amounts of water beyond what they are capable of treating. Overflow structures are typically installed within the bioretention cell, especially when a bypass structure, such as a curb cut in a parking lot, is not feasible. Bioretention can be used in a variety of topographic conditions, and can generally treat runoff from areas of one acre or less (Figure 9).

Figure 9. Bioretention Features in Residential and Commercial Applications

A bioretention area effectively captures runoff, preventing large volumes of polluted runoff from entering a stream.



Swales - Swales are utilized to convey water often in lieu of storm pipes. Simple grass lined swales have limited pollutant removal benefits, but are often utilized in conjunction with other SCMs. For example, in the case of the proposed Church Street retrofit, simple, dry swales may need to be utilized in conjunction with bioretention cells in locations where pipe networks do not exist.

Constructed Wetlands (also known as stormwater wetlands) - Constructed wetlands are shallow depressions constructed to mimic the functions of natural wetlands (Figure 10). They are intended to increase the flow paths of the stormwater and temporarily store stormwater in pools of varying depths that contain diverse wetland vegetation. The wetland uses physical, chemical, and biological processes to filter pollutants. They can also be designed to provide stormwater volume control. However, because they are shallow, stormwater wetlands require more surface area than similar wet detention ponds, but provide much greater habitat due to the undulations in topography.

Sediments that accumulate in the forebay of a constructed wetland need to be removed every 5 years or when the depth of the forebay diminishes by 50%. Wetlands should also be monitored for the invasion of exotic plant species that should be removed promptly when found. Other maintenance requirements include periodic inspection of the flow delivery mechanisms upstream of the wetland to ensure that stormwater is able to get to the wetland as designed. Otherwise, the wetland plant species may die. Trash and other debris removal may also be needed periodically.

Figure 10. Examples of Constructed Wetlands

A constructed wetland at a city park captures stormwater runoff from a residential development and a parking lot. It also serves as a water feature in the park and provides wildlife habitat.

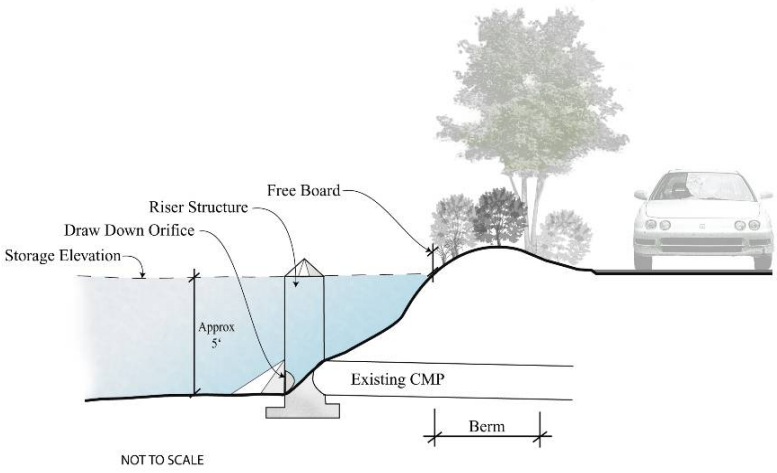
Constructed wetland after one growing season.

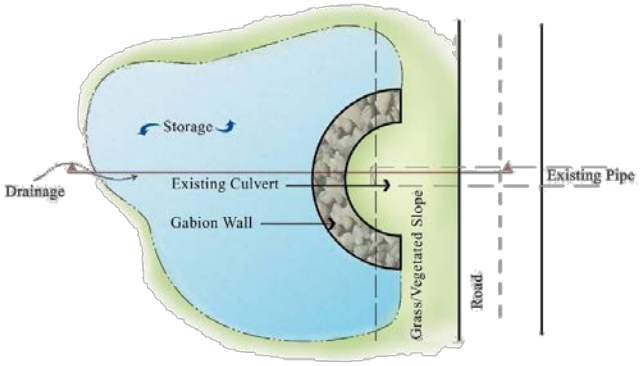
Wet Ponds - Wet retention ponds (Figure 11) are typically the most efficient use of land to meet stormwater volume requirements. Like wetlands, wet detention basins can handle runoff from large areas. In contrast to constructed wetlands, wet detention basins are usually deep and other than a perimeter planting shelf, do not utilize vegetation for the treatment of pollutants or to provide habitat diversity. Because of the safety issues posed by the pond depth, perimeter fencing is often required.

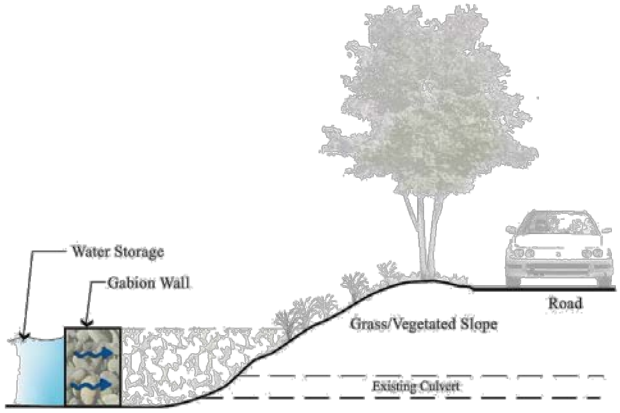
Figure 11. Examples of Wet Ponds

Dry Ponds - Dry ponds, most commonly in the form of extended detention, are intended to capture stormwater and temporarily store it for 12-24 hours promoting sediment and other pollutants to settle out while releasing effluent at a controlled rate, which reduces peak discharge to receiving streams (Figure 12). Since there is no long-term storage of the water, extended detention facilities do not increase outflow water temperature as do wet detention ponds. Furthermore, creative application of these features can accommodate alternate uses, such as parks or playing fields, between storm events. In a retrofit scenario, a structure such as a riser or gabion wall is simply installed upstream of an existing culvert. Because of the flexible nature of these features they make ideal flood mitigation opportunities, although water fluctuations create a harsh environment for plant establishment. Debris may also be a concern depending on the conditions in watershed upstream.

Figure 12. Examples of Extended Detention Retrofit Solutions







Maintenance - Maintenance of SCMs is critical not only for them to function effectively, but to maintain aesthetically pleasing landscapes. Currently Buncombe County, the Town of Black Mountain and Montreat, require Operation and Maintenance Agreements upon approval of stormwater facilities. Easements are also typically required to be included in the property deed to provide the regulating entity access to the site for periodic inspection. Due to existing physical constraints often associated with retrofits, maintenance access should be given special consideration during the design phase.

Inspections of the SCM should occur yearly. Stormwater treatment methods, particularly structural features, should be inspected by certified professionals that have a sound understanding of the intended functions of the SCMs and the complexities of the infrastructure involved. Certification programs such as those conducted by North Carolina State University require individuals to satisifactorily complete a training workshop and pass a written examination. Once certified, inspectors are required to attend continuing education workshops.

Potential Stream Improvement Projects

Based on GIS and aerial photo assessments and limited field observation, most stream channels in the developed portion of the Upper Swannanoa River watershed are moderately incised. Less steep portions of stream channel that were originally in agricultural use also show evidence of having been straightened. The condition of the riparian area was considered sufficiently degraded such that it would not function fully to reduce overland flow, filter sediment or be resistant to erosion and associated bank failure. A modest number of stream reaches at least 500 feet in length have riparian areas that are sparsely wooded or entirely lacking woody vegetation on one or both sides. Where riparian woody vegetation is sparse or lacking, stream channels show evidence of instability. These conditions have resulted in erosion, sedimentation, and degraded aquatic habitat. Incised and historically straightened streams are particularly vulnerable to erosion as they are detached from their adjacent floodplains, which eliminates the ability of the floodplain to mitigate storm flow velocities. Increased stormwater runoff from developed areas only exacerbates this problem. Restoration of meandering stream channels with established flood plains would be the ideal solution to this problem; however, in many cases that will not be possible.

Approximately 31,000 feet of stream channel at 16 locations were identified as having some level of degraded riparian areas on one or both sides of the stream channel (Figure 13 and Table 13). The degradation ranges from stream banks lined with only turf or manicured lawns to that of having few mature trees or woody shrubs. Tomahawk Branch has the most significant length of stream channel that could benefit from reestablishment of a healthy native plant community in the riparian area.

Approximately 18,800 feet (61%) of the stream channel with degraded riparian vegetation is located in the Tomahawk Branch subwatershed. For this reason and because some of the reaches are in public ownership, the Tomahawk Branch subwatershed should be given priority for stream improvement projects. Improvement of riparian areas in that subwatershed alone would not only improve overall watershed conditions but it would also reduce the maintenance requirements of sediment catch basins constructed upstream of Lake Tomahawk and lower water temperatures downstream of the lake. This condition may be the reason why no wild trout were captured in the Swannanoa River downstream of its confluence with Tomahawk Branch (Amanda Bushon, NCWRC, Personal Communication).

The remaining degraded stream improvement reaches are widely distributed throughout the USRW. Three are located near the middle portion of the Flat Creek subwatershed and one is in the Camp Branch subwatershed. The remaining five sites are within unnamed subwatersheds most of which are on private lands. No effort was made to determine the number of parcels involved or landownership. That will have to be done as part of the project development process.

Figure 13. Potential Stream Improvement Projects

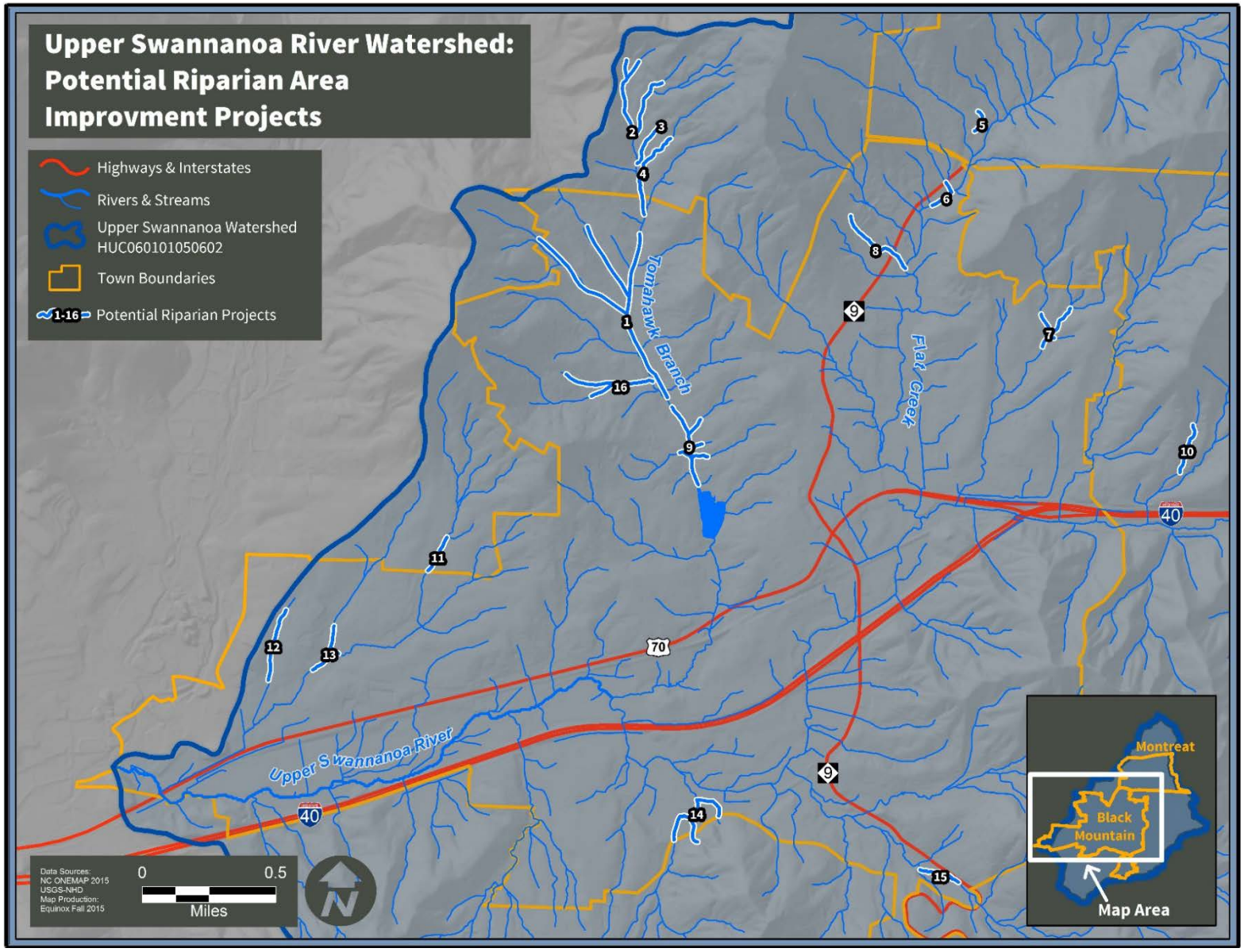


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Table 13. Potential Stream Improvement Projects

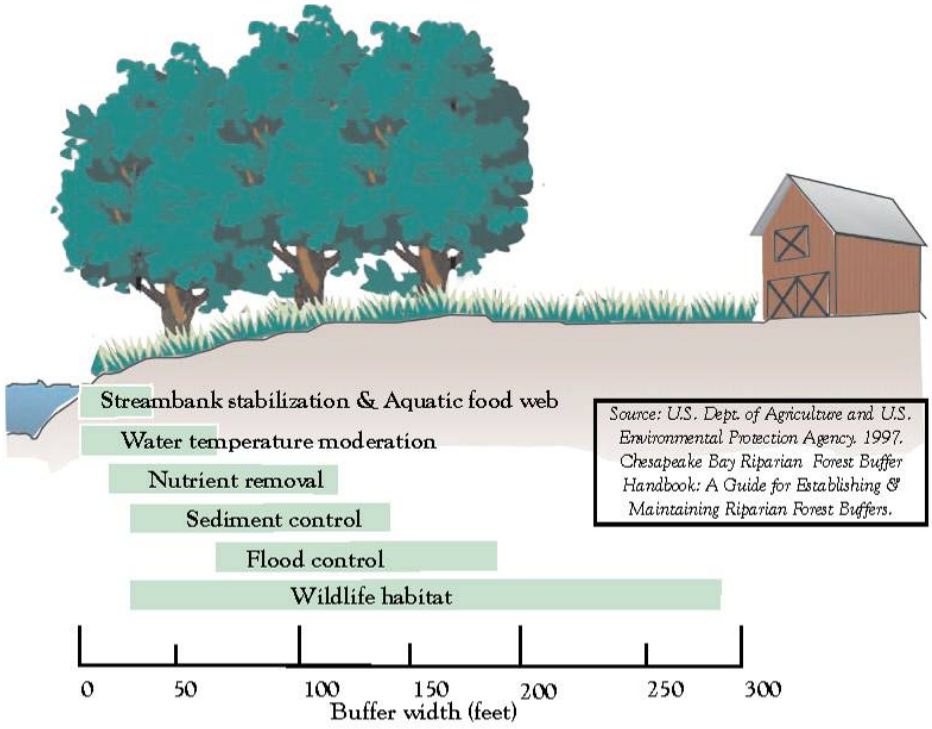
Site Number	Subwatershed / Location Description	Stream Channel Length (feet)	Ownership	Site Condition Descriptor from Aerial Photos
1	Tomahawk Branch	7,457	Public	Turf and lawn
2	Tomahawk Branch	3,318	Public	Lawn
3	Tomahawk Branch/ Walker Cove Road	991	Private	Lawn
4	Tomahawk Branch	1,844	Public	Adjacent to roadway
5	Assembly Drive/ Flat Creek	502	Private	Landscaped
6	Flat Creek	692	Private	Landscaped
7	Avena Road/ Unnamed Tributary	1,544	Private	Lawn/landscaped
8	Mountain View Avenue Flat Creek	1,638	Private	Lawn
9	Tomahawk Branch	2,896	Private	Turf and lawn
10	Old Toll Circle/ Unnamed Tributary	1,020	Private	Lawn/landscaped
11	Frances Avenue/ Unnamed Tributary	761	Private	Lawn/landscaped
12	Hospital Road/ Unnamed Tributary	1,458	Private	Adjacent agriculture
13	Tabernacle Road/ Unnamed Tributary	1,335	Private	Lawn
14	Armory Road/ Unnamed Tributary	2,367	Private	Turf and lawn
15	Llama Vista Court/ Camp Branch	844	Private	Lawn
16	Tomahawk Branch/ Chapel Road	2,291	Private	Lawn
	Total	30,958		

Stream Improvement Management Measures

Three options for stream improvement projects are proposed – riparian revegetation, stream enhancement, and stream restoration. The main difference among them is the degree of stream channel disturbance involved in their implementation. Simple definitions are as follows:

In all three categories of stream improvement, restoring vegetation within the riparian area plays a vital role to the long-term stability of the stream channel, its ability to filter out pollutants and sediment, and to the ecological function of the aquatic community (Figure 14).

Figure 14. Functions of Woody Riparian Vegetation



Riparian Revegetation – This is the simplest type of stream improvement management measure. It can be used where riparian vegetation is sparse or lacking but stream banks are relatively stable and at slight risk of being undercut or eroded. This activity basically involves the planting of a combination of native trees, shrubs, and herbaceous plants whose roots will bind the soil (Figure 15). In addition, the developing canopy provides shade resulting in lowered stream temperatures. The herbaceous vegetation is effective at reducing soil erosion and filters sediment and nutrients from upland areas.

Figure 15. Simple Riparian Revegetation Project Example

Before Planting – 2003

After Planting - 2009

Riparian vegetation management must consist of two phases – control of non-native invasive plant species (if present) and reestablishment of a functioning riparian vegetation community (Figure 15) comprised of primarily native tree, shrub, and herbaceous species (Table 14).

Table 14. Recommended Native Plants for Use in Stream Restoration and Enhancement

Plant Type	Common Names of Recommended Species
Trees	*River Birch, Bitternut Hickory, Shagbark Hickory, Sugarberry, Persimmon, Green Ash, Blackgum, Sycamore, Black Cherry, Swamp Chestnut Oak, Water Oak, Shumard Oak, Black Willow, White Basswood*
Small Trees & Shrubs	*Southern Sugar Maple, Painted Buckeye, Tag Alder, Service Berry, Red Chokeberry, Common Paw, Sweet Shrub, Ironwood, Buttonbush, Alternate Leaf Dogwood, Silky Dogwood, Hazelnut, Deciduous Holly, Winterberry, Virginia Willow*
Herbs	*Jack-in-the-Pulpit, Swamp Milkweed, Fringed Saxifrage, Bladder Sedge, Hop Sedge, Lurid Sedge, Broom Sedge, Tussock Sedge, Fox Sedge, Turtlehead, Umbrella Sedge, Bottlebrush Grass, Joe Pye Weed, Boneset, Jewel Weed, Soft Rush, Rice Cutgrass*

Stream Enhancement – This level of stream improvement is applied in areas where relatively small sections of the stream bank are moderately unstable and woody riparian vegetation is sparse. Generally bank reshaping of the unstable areas and revegetation is all that is required (Figure 16). This approach also can be used where physical constraints such as roads, structures, and utilities preclude a full restoration project.

Figure 16. Stream Enhancement Project Example

Stream Restoration – This management measure can be used at sites where there is significant streambank instability (Figure 17). Stream channels would be fully restored (NCSRI 2013) by reestablishing proper channel dimension (cross-section area), pattern (sinuosity), and profile (slope). Stream restoration designs must take into account watershed size, stream slope, and soils among other geomorphological characteristics. Restoration not only will lead to reduced erosion, but improve sediment transport, and over the long term result in better in-stream habitat conditions. As with stream enhancement, restoration requires revegetation of the riparian area with native shrubs, trees, and herbaceous plants as described above. Doing so will maximize the riparian area's ecological function and ability to filter sediment and other pollutants originating from upland areas.

Each potential project will need to be assessed so as to determine the stream improvement management measure that should be applied. Matching the level of restoration to existing conditions will be the most effective and cost efficient way to improve the USRW.

The following criteria should be considered in determining the stream improvement management measure to be applied:

- Landowner(s) willingness to participate in implementing stream improvements on their land; including, if necessary, entering into a conservation easement or other maintenance agreement
- Number of landowners involved
- Location – is it in an area with significant amount of channel instability?
- Size of stream – smaller streams are easier and less costly to improve than larger streams
- Protection status of upstream area; risk of development
- Current condition of stream banks and channels (eroding, undercut, sloughing, etc.)
- Condition of riparian vegetation (sparse, bare, turf, non-native species present, etc.)
- Potential for providing habitat for aquatic species (hellbender, freshwater mussels, etc.)

Figure 17. Stream Restoration Project Example

Strait Incised Channel Prior to Restoration

Meandering Vegetated Channel Three Years After Restoration

Element C: Estimates of Pollutant Load Reductions

Field data and generalized predictive models were used to determine the potential pollutant load reductions from SCM retrofits and streambank improvements (Appendices A and B). While sediment reduction loads were estimated for both categories of projects, nutrient reductions were estimated only for SCMs.

Stormwater Control Measures

The 21 individual SCM retrofit opportunities identified for implementation during the 10-year planning period of the WMP (Table 10) will be tailored to individual site conditions. Cumulatively, these features have the potential to reduce runoff volume and velocity as much as 100 acres of existing impervious surfaces. While most SCM types are very efficient at removing suspended solids, they also reduce nitrogen, phosphorus, and metals. Based on the conceptual designs and pollutant removal efficiencies, it is estimated the proposed SCMs will result in an estimated annual reduction of 1.8 tons of suspended sediment, 14 pounds of phosphorus, 106 pounds of nitrogen, and 2.5 pounds of zinc (Table 15).

While the potential pollutant reductions from SCM retrofits appear to be small, the cumulative benefits and value of reducing impervious surface area are significant. These benefits include reducing stormwater volume and velocity and peak flow frequency, which contribute to streambank erosion, improving aquatic wildlife habitat, and beautifying the landscape. Additionally, the proposed SCM projects will be valuable demonstration tools in informing the public about stormwater runoff and the ability of SCMs to remove sediment and nutrients.

Furthermore, implementing SCMs can achieve other goals stated in this WMP, particularly mutual cooperation and collaboration among landowners, local governments, and nonprofit groups. Such collaboration is necessary in order to achieve SCM implementation. As private landowners learn about BMPs from demonstration projects on public land, they will consider installing SCMs on their property. Finally, SCM installation requires professional services for design, construction, and maintenance, thus employing contractors and stimulating the local economy. The implementation of the SCMs, combined with other management measures, will lead to improved ecological function of the Upper Swannanoa River Watershed.

Table 15. Estimated Pollutant Load Reductions from Stormwater Control Measures (Sheet 1 of 2)

Site Number	Type of Stormwater Control Measure (SCM)	Total Phosphorus				Total Nitrogen			
		Annual Load (lb)	Post Treatment Load (lb)	SCM Pollutant Removal Efficiency	Load Removed by SCM (lb/year)	Annual Load (lb)	Post Treatment Load (lb)	SCM Pollutant Removal Efficiency	Load Removed by SCM (lb/year)
1	Wetland	1.0	0.7	0.35	0.4	8.3	5.0	0.40	3.3
2, 3, 26	Bioretention	0.4	0.2	0.45	0.2	2.9	1.9	0.35	1.0
4	Bioretention	0.7	0.4	0.45	0.3	5.1	3.3	0.35	1.8
5	Bioretention	0.2	0.1	0.45	0.1	1.7	1.1	0.35	0.6
6	Wetland	4.7	2.6	0.45	2.1	36.4	21.8	0.40	14.6
7	Cistern	0.1	0.1		0.0	0.5	0.5		0.0
8	Bioretention	0.1	0.1	0.45	0.1	1.0	0.7	0.35	0.4
10	Extended Detention	1.5	1.2	0.20	0.3	11.9	5.4	0.55	6.6
11	Detention	5.7	1.8	0.68	3.9	44.4	20.0	0.55	24.4
12	Bioretention	0.2	0.1	0.45	0.1	1.3	0.8	0.35	0.4
13	Bioretention	0.5	0.3	0.45	0.2	3.7	2.4	0.35	1.3
18	Bioretention	0.2	0.1	0.45	0.1	1.9	1.3	0.35	0.7
19	Bioretention	0.6	0.4	0.45	0.3	4.9	3.2	0.35	1.7
20	Filter	0.1	0.0	0.60	0.1	0.8	0.6	0.30	0.2
21	Wetland	0.5	0.3	0.35	0.2	3.5	2.1	0.40	1.4
23	Bioretention	0.0	0.0	0.45	0.0	0.3	0.2	0.35	0.1
25	Bioretention	0.1	0.0	0.45	0.0	0.5	0.3	0.35	0.2
27	Wetland	14.8	9.6	0.35	5.2	118.3	71.0	0.40	47.3
28	Bioretention	0.0	0.0	0.45	0.0	0.3	0.2	0.35	0.1
	Totals	31.4	18.0		13.5	247.9	141.8		106.1

Table 15. Estimated Pollutant Load Reductions from Stormwater Control Measures (Sheet 2 of 2)

Site Number	Type of Stormwater Control Measure (SCM)	Total Suspended Solids				Total Zinc as Representative Metal			
		Annual Load (lb)	Post Treatment Load (lb)	SCM Pollutant Removal Efficiency	Load Removed by SCM (lb/year)	Annual Load (lb)	Post Treatment Load (lb)	SCM Pollutant Removal Efficiency	Load Removed by SCM (lb/year)
1	Wetland	145.6	21.8	0.85	123.7	0.5	0.5		0.0
2, 3, 26	Bioretention	51.4	7.7	0.85	43.7	0.2	0.2		0.0
4	Bioretention	88.4	13.3	0.85	75.2	0.3	0.3		0.0
5	Bioretention	29.5	4.4	0.85	25.1	0.1	0.1		0.0
6	Wetland	636.5	95.5	0.85	541.0	2.2	2.2		0.0
7	Cistern	9.1	9.1		0.0	0.0	0.0		0.0
8	Bioretention	17.7	2.7	0.85	15.0	0.1	0.1		0.0
10	Extended Detention	208.5	29.2	0.86	179.3	0.7	0.7		0.0
11	Detention	775.9	108.6	0.86	667.3	2.7	0.3	0.90	2.4
12	Bioretention	22.4	3.1	0.86	19.3	0.1	0.1		0.0
13	Bioretention	64.9	9.7	0.85	55.2	0.2	0.2		0.0
18	Bioretention	33.7	5.1	0.85	28.7	0.1	0.1		0.0
19	Bioretention	86.4	13.0	0.85	73.4	0.3	0.3		0.0
20	Filter	14.4	2.2	0.85	12.2	0.1	0.0	0.90	0.0
21	Wetland	61.9	9.3	0.85	52.6	0.2	0.2		0.0
23	Bioretention	5.9	0.9	0.85	5.0	0.0	0.0		0.0
25	Bioretention	8.5	1.3	0.85	7.2	0.0	0.0		0.0
27	Wetland	2,065.6	309.8	0.85	1,755.8	5.6	5.6		0.0
28	Bioretention	4.6	0.7	0.85	3.9	0.0	0.0		0.0
	Totals	4,330.9	647.3		3,683.6	13.4	10.9		2.5

Stream Improvements

Sediment loading estimates for the 16 locations identified as needing some level of streambank and riparian area improvements (one or both sides) were calculated using the USEPA's Spreadsheet Tool for Estimation of Pollutant Load (STEPL) model (Appendix C). The current condition of the potential riparian enhancement locations were assessed using recent aerial photographs. No field assessments of these sites were conducted.

The desktop analysis revealed that estimated sediment load reductions of up to 1,014 tons per year could be achieved by implementing stream improvement projects at those locations (Table 16).

Table 16. Estimated Sediment Reductions from Streambanks

Site Number	Location Description and Subwatershed	Stream Channel Length (feet)	Channel Migration Rate	Estimated Load Production (tons/year)	Estimated Potential Load Reduction (tons/year)
1	Tomahawk Branch	7,457	Severe	526	421
2	Tomahawk Branch	3,318	Moderate	49	39
3	Tomahawk Branch/ Walker Cove Road	991	Moderate	14	11
4	Tomahawk Branch	1,844	Moderate	27	22
5	Assembly Drive/ Flat Creek	502	Moderate	7	6
6	Flat Creek	692	Moderate	12	10
7	Avena Road/ Unnamed Tributary	1,544	Severe	106	85
8	Mountain View Avenue Flat Creek	1,638	Moderate	24	19
9	Tomahawk Branch	2,896	Severe	140	112
10	Old Toll Circle/ Unnamed Tributary	1,020	Severe	46	37
11	Frances Avenue/ Unnamed Tributary	761	Moderate	12	9
12	Hospital Road/ Unnamed Tributary	1,458	Severe	69	55
13	Tabernacle Road/ Unnamed Tributary	1,335	Moderate	30	25
14	Armory Road/ Unnamed Tributary	2,367	Moderate	35	28
15	Llama Vista Court/ Camp Branch	844	Moderate	13	11
16	Tomahawk Branch/ Chapel Road	2,291	Severe	157	125
	Totals	30,958		1,268	1,014

Element D: Technical and Financial Assistance Needs

Partners

Successful implementation of any WMP necessitates local entities work as a team with assistance from State and Federal agencies (Table 17). Western North Carolina has a very high level of environmental consciousness that aims to maintain or improve its natural resources. Local non-profit organizations have cooperated with local government agencies and private individuals to successfully address environmental problems. Some of these partners can provide not only technical knowledge, but can provide funding and in-kind matches to enhance the strength of grant applications. The following table describes potential partners and the role they may play in the implementation of the Upper Swannanoa River WMP.

Table 17. Potential Watershed Plan Implementation Partners

Organization	Type	Assistance		
		Technical	Funding	In-Kind
Town of Black Mountain	Local Government	X	X	X
Town of Montreat	Local Government	X	X	X
RiverLink	Non-Profit	X	X	X
Environmental Quality Institute	Non-Profit	X		X
Warren Wilson College	Educational			X
Montreat College	Educational			X
Private Citizen	Private		X	X
Watershed Work Group (to be established)	Non-Profit	X (Volunteers)	X	X (Volunteers)
Businesses (being recruited)	Private		X	X
Buncombe County	Local Government	X	X	
Buncombe County Soil and Water Conservation District	Local Government	X	X	X
Natural Resources Conservation Service	Federal Government	X	X	X
N.C. Division of Water Resources	State Government	X		
N.C. Wildlife Resources Commission	State Government	X		
U.S. Fish and Wildlife Service	Federal Government	X	X	
TVA	Quasi-Federal Government	X	X	

Technical Assistance

Technical assistance with all aspects of implementing the management measures will ensure their success. While technical assistance in designing and constructing individual management measures is necessary (Table 18), the importance of reaching out to landowners cannot be understated. It is important to get their participation because in some cases they may be asked to forgo some uses or values of their property. Because landowner interactions also may include legal negotiations for easements, we also have identified some technical assistance needs for landowner outreach. Technical and financial assistance needs for the Outreach and Education program are presented in Element E.

Table 18. Technical Assistance Needs to Implement Management Measures

Management Measure	Technical Assistance Provider
Landowner outreach	Local conservation organizations Outreach specialist (RiverLink, local watershed group, Southern Appalachian Highlands Conservancy) Experienced conservation easement specialist (attorney, if needed)
Residential SCMs	
Rain barrels	Local Cooperative Extension Office
Rain gardens	Local conservation organization (RiverLink)
Stormwater Control Measures:	
Wetlands	Stormwater design specialist
Bioretention feature	Civil engineer
Cistern Installation	Plant specialist
Filter	Permitting – local/state agencies
Maintenance	To be determined during project development
Stream Enhancement	
Stream bank shaping	Experienced stream restoration specialist and equipment operator
Permitting	Town of Black Mountain, Town of Montreat, Buncombe County, Division of Water Resources, Division of Energy, Land, and Mineral Resources, U.S. Army Corps of Engineers
Riparian revegetation	Native plant specialist
Stream Restoration	
Channel modification	Stream restoration designer (engineer if needed)
Permitting	Town of Black Mountain, Town of Montreat, Buncombe County, Division of Water Resources, Division of Energy, Land, and Mineral Resources, U.S. Army Corps of Engineers
Stream construction	Experienced construction supervisor and equipment operators
Monitoring	Experienced monitoring consultant Survey channel dimension, pattern and profile Conduct pebble counts Conduct vegetation plot surveys Conduct fish and macroinvertebrate surveys

Management Measure Costs

Costs for two categories of SCMs, structural and non-structural, and a generalized cost of stream improvements are presented. Costs for SCMs were developed using information from DSWC (Undated) and CWP (2007) that was adjusted based on experience for constructing similar projects in western North Carolina. Costs for implementing stream improvement management measures are generalized because site specific needs will have to be determined. Due to the unknowns at individual sites and funding limitations, the following items were not considered in developing the project cost estimates:

- Landowner outreach
- Land acquisition costs (right-of-way costs, fee simple purchase, easements)
- Surveying or special studies (engineering)
- Attorneys' fees
- Fencing
- Utility relocations and additional storm infrastructure
- Road and street modifications (curbing)

The activities involved in developing a project's cost and with the exceptions noted above included the following:

- Site assessment and survey
- Conceptual design drawings for landowner review
- Full design drawings
- Construction drawings
- Permitting
- Contracting (bid documents and administration)
- Construction
- Revegetation (seed, plants, and labor to install
- Maintenance
- Monitoring

Non-Structural SCM Costs - Non-structural SCM are considered ones that homeowners can install on their own. They include rain barrels and raingardens that do not involve installation of underdrains. It is expected that residential landowners will bear the cost of the materials and, if necessary, installation (Table 19). Oftentimes, local non-profit conservation organizations or local governments may subsidize the cost of the rain barrels to encourage landowners to install them for the environmental benefits they provide. No specific non-structural projects are proposed as part of the WMP. Non-structural SCMs will be promoted as part of the Outreach and Education part of this plan.

Homeowner installed rain barrels can cost as little as $100 or less for materials. Installation by a service provider can cost significantly more when labor charges are involved.

Table 19. Estimated Costs to Implement Non-structural SCMs

Feature Type	Cost Range
Rain barrels	$100-$380
Raingardens	Less than $100

Structural SCM Costs – Estimated costs to design and construct the 21 SCM features identified in this plan varies from $4.07 to $20.93 per square foot of treatment area (Table 20). Estimated total costs for individual sites ranges from about $11,600 to $615,825. Although some smaller SCMs appear to be relatively inexpensive, when contractor mobilization is required the historic cost for individual projects usually starts at about $50,000. It may be possible to reduce the costs for some projects by bundling them with upcoming water and sewer rehabilitation projects being planned by the Town of Black Mountain.

Table 20. Estimated Costs to Implement Structural SCMs[1]

Site Number	Type of Stormwater Control Measure	Estimated Treatment Size (square feet)	Cost per Square Foot of Treatment Area	Estimated Cost for Treatment[2]
1	Wetland	21,965	$4.07	$89,399
2, 3, 26	Bioretention	8,700	$12.88	$90,096
4	Bioretention, Tree Islands	11,500	$20.93	$215,585
5	Bioretention	2,005	$12.88	$25,824
6	Wetland	49,233	$8.05	$396,326
7	Cistern	2,500 gallon	N/A	$2,500
8	Bioretention	1,365	$12.88	$17,581
10	Bioretention	3,416	$7.47	$25,519
11[3]	Detention, Bioretention	888	N/A	$386,400
12	Bioretention	722	$12.88	$9,299
13	Bioretention	1,750	$12.88	$22,540
18	Bioretention	3,000	$12.88	$38,640
19	Bioretention	3,972	$12.88	$51,159
20[3]	Filter		N/A	$64,400
21	Wetland	4,877	$8.05	$39,340
23	Bioretention	900	$12.88	$11,592
25	Bioretention	2,073	$12.88	$26,700
27	Wetland	76,500	$8.05	$615,825
28	Bioretention	1,500	$12.88	$19,320

[1]Source – Stormwater BMP Costs. (DSWC Undated).
[2]Combines proposed SCM and paving removal cost, a 15% contingency, and 12% of construction costs anticipated for design.
[3]indicates surface area in CVS parking for bioretention only. Cost should be considered a rough estimate. Installation of underground chambers varies greatly depending on complexity and size.

Stream Improvement Costs

Because the 16 potential stream improvement projects were not field surveyed as to their condition or extent of needed improvements, individual cost estimates for each site could not be calculated. In addition, costs associated with acquiring sites are highly variable due to the fact that the projects are linear and often involve negotiating with multiple landowners. Instead, we provide a range of costs for three categories of stream improvement – riparian revegetation, enhancement, and restoration (Table 21). These categories reflect the amount of work necessary to stabilize the stream channels and reestablish riparian vegetation.

Table 21. Estimated Costs to Implement Stream Improvement Projects

Improvement Category	Stream Condition	Actions Required	Cost per Linear Foot of Stream Channel
Riparian Area Revegetation	•Stream bank stable, small risk of failure •Woody vegetation sparse or absent •Herbaceous vegetation dominant with or without significant bare areas •Non-native invasive plant species often present	• Inventory existing plant community • Assess soil conditions • Control on-native plant species • Amend soils as needed • Prepare planting plan • Install plants w/stem protectors if needed • Monitor plant survival and replace as needed	$80-$100
Stream Enhancement	•Stream bank eroding in discrete areas, moderate risk of failure •Woody vegetation sparse or absent •Herbaceous vegetation dominant with or without significant bare areas •Non-native invasive plant species often present	• Regrade stream banks to eliminate erosion and to adjust channel cross-section dimensions • Inventory existing plant community • Assess soil conditions • Control on-native plant species • Amend soils as needed • Prepare planting plan • Install plants w/stem protectors if needed • Monitor plant survival and replace as needed	$100-$200
Stream Restoration	•Stream bank moderately to severely eroding over large percentage of channel; active bank failures present •Evidence of stream channelization •Channel entrenched such that stream cannot access floodplain •Woody vegetation sparse or absent •Herbaceous vegetation dominant with or without significant bare areas •Non-native invasive plant species often present	• Regrade channel to restore proper sinuosity, slope, and cross-sectional area • Restore stream access to floodplain • Inventory existing plant community • Assess soil conditions • Control on-native plant species • Amend soils as needed • Prepare planting plan • Install plants w/stem protectors if needed • Monitor plant survival and replace as needed	$200+

Funding Sources

Without funding, implementation of the USRW plan will not be possible (Table 22). A variety of potential funding sources are available to implement the Upper Swannanoa River Watershed Management Plan. Because grant requirements, allowable uses, matching requirements, and funding cycles often change, up-to-date details should be obtained from the agency before starting the application process. This list does not include loan programs that may be available to local government agencies.

Table 22. Potential Funding Sources for Watershed Improvement Projects

Funding Source	Programs
Buncombe County Soil and Water Conservation District	Agricultural Cost Share Program (ACSP) Community Conservation Assistance Program for urban waters (CCAP)
Clean Water Management Trust Fund	Legislated funding for stream restoration
Conservation Trust of North Carolina	Provides grants to local land trusts to advance land conservation goals
Duke Energy Foundation Water Resources Fund	Program to support improved water quality, quantity, and conservation; enhance fish and wildlife habitats, expand public use of waterways; increase citizen awareness about their roles in protecting water resources.
Environmental Protection Agency	Multiple grant programs. For example - Five Star Grants, Urban Waters Small Grants, See http://www2.epa.gov/grants for funding opportunities.
Local Governments – Town of Black Mountain, Town of Montreat, Buncombe County	Utilize funds from these agencies to meet required matches for State and Federal grants.
National Fish and Wildlife Foundation	Multiple lists of grant opportunities. See http://www.nfwf.org/whatwedo/programs/Pages/home.aspx#.VBrOUZRdWSp for details.
N.C. Department of Justice	Environmental Enhancement Grants
N.C. Department of Transportation	Non-mitigation funding associated with road improvement projects Special projects
N.C. Division of Parks and Recreation	Adopt-a-Trail Program Parks and Recreation Trust Fund (PARTF)
N.C. Division of Water Resources	USEPA 319(h) nonpoint source pollution watershed management and Implementation Funds USEPA 205(j) – Source Water Protection Planning Grants
N.C. Division of Mitigation Services	Stream and wetland mitigation funding in targeted watersheds
N.C. Forest Service	Forest Management Plan Program for private landowners (free) Urban and Community Forestry Grants
N.C. Wildlife Resources Commission	Green Growth Grant. Technical assistance with habitat management plans and providing fish sampling assistance. Value of some assistance may be useable as match for other grants.
Private Entities – Developers, businesses, and individuals	Property owners with potential projects will be recruited for In-kind donations that may include conservation easements, land, equipment, materials, supplies, or labor
Trout Unlimited	Embrace-A-Stream Grants to engage local TU chapter with other partners
USDA Natural Resource Conservation Service	Federal Farm Bill Programs – Environmental Quality Improvement Program (EQIP), Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP)
U.S. Fish and Wildlife Service	Partners for Fish and Wildlife (PARTF); Shade Your Stream Program; Endangered Species Program, Wetlands Conservation Act Program
U.S. Forest Service	Challenge Cost Share Projects (can conduct projects within administrative boundary than can include private lands)
Z. Smith Reynolds Foundation	Provides funding for projects that improve air and water quality and preserve natural landscapes, but not land purchases, greenways, or plant species preservation.

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Element E: Outreach and Education Strategy

Outreach and education is a critical element to obtaining local support for and success in implementing the Upper Swannanoa River WMP. As such, the outreach and education strategy is presented as a standalone element that includes the management actions, implementation schedule, and needed financial and technical resources as well as qualitative success indicators. With input from the stakeholder group, the strategy is composed of the following four components:

- Overall Programmatic Outreach
- Local Government Practices and Programs
- Outreach to the Business Community
- Public Stormwater Management Practices

The main objective of the education and outreach plan is to continue to improve watershed conditions that lead to heightened public awareness about water quality within the USRW. It also is believed that by using outreach and education activities, individual landowners will be motivated to implement management actions on their own and thus add to the watershed improvements identified in this plan.

Action Plans

The action plans (Table 23) on the following pages include the following:

- Management Action – What is to be done
- Targets – Quantification of how much of the action is proposed for the planning period
- Responsible Party – Who will take the lead in implementing the management action
- Schedule for Implementation – When the management action will begin or occur
- Financial Resources – How much funding will be required
- Potential Funding Resources – Where funding to implement the management action is likely to be obtained
- Technical Resources Needed – What types of expertise will help facilitate getting management option implemented
- Qualitative Success Indicators – What will be measured or documented to show success in implementing the management action

Table 23. Outreach and Education Action Plans (Sheet 1 of 4)

Overall Outreach

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Develop an Upper Swannanoa River Watershed Group to Implement the Outreach Action Plan	Organizing meeting; 2-4 meetings per year	Town of Black Mountain, Town of Montreat, RiverLink, Warren Wilson, DEQ	Year 1	Startup costs ($1,000)	TBD	None	Working group established
Overall Outreach-Youth: *Environmental Education with Kids*	1-2 classroom visits per year per school- depends on teacher interest/response	RiverLink	Year 1-2	TBD based on participation	Pigeon River Fund, Duke Energy Foundation	None at this time; use existing resources	Teacher interest; number of students educated / year
Overall Outreach-Youth and General Public: *BMP Education Tours—Existing and Proposed Sites*	1 annual organized event, self-guided option throughout year	RiverLink	Initiate guided events Summer 2016; annually thereafter; create self-guided information brochure	TBD	TBD	None at this time; use existing resources	Number of people on guided tours; brochures distributed

Table 23. Outreach and Education Action Plans (Sheet 2 of 4)

Local Government Practices and Programs

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Ongoing Education of Elected Officials: ***Work to Educate Elected Officials On Goals and Projects of the Watershed Plan***	Once, in the near term, and then ongoing when new officials come on-board	Towns of Black Mountain and Montreat in partner with RiverLink	Year 1/2; then as needed	TBD	TBD	None	Number of presentations and feedback
Ongoing Education of Elected Officials: ***Work to Educate Elected Officials On What Share of Pollutants Come From Montreat and Black Mountain***	Implement as a future assessment is completed	Towns work with Warren Wilson and DENR to get data that can be easily communicated to officials	As assessments are completed	TBD	TBD	Landscape Architect, Engineering; Warren Wilson College; DEQ	Actions taken by local officials to address watershed problems

Table 23. Outreach and Education Action Plans (Sheet 3 of 4)

Outreach to the Business Community

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Developers and Business Recognition: ***Develop a Recognition Effort for Those Working to Improve the Watershed***	1 individual, business or group per year	Towns of Black Mountain and Montreat	Annually beginning 2017	Minimal	TBD	None	Number of businesses allied with Towns to improve water quality
Outreach to Landowners: ***Work With Landowners/Businesses That May Be Willing to Install Stormwater SCMs***	1-2 landowners per year, prioritize those with the most impervious surface	Towns of Black Mountain and Montreat	As opportunities arise	TBD Depends on project design	DEQ-DWR; CWMTF	Outreach specialist; stormwater specialist	Number of stormwater control measure projects installed, number of pollutants removed
Outreach to Commercial Landowners: ***Work With Landowners/Businesses That May Be Willing to Donate Stormwater or Conservation Easement***	1-2 landowners per year, prioritize conference centers/major landowners	RiverLink with input from the Towns of Black Mountain and Montreat	Year 1 - Initial Meeting in January to discuss outreach strategy	TBD	RiverLink; Towns	Outreach specialist; stormwater specialist	Acres of land conserved
Outreach to Chamber of Commerce: ***Presentation to Gain Support from the Business Community***	1 presentation/year	Town of Black Mountain and RiverLink	Year 1 - Initial Meeting in January to discuss outreach strategy; as needed to maintain support	TBD	TBD	None	Number of new business interested in partnering to improve the watershed

Table 23. Outreach and Education Action Plans (Sheet 4 of 4)

Public Stormwater Management Practices

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Stormwater Management Practices: ***Develop Demonstration Projects (At Schools or Parks)***	2 projects in a 5-year period	Towns of Black Mountain, and Montreat, RiverLink	Years 1-5, depending on opportunities	Project dependent	Pigeon River Fund; DEQ-DWR; Duke Energy Foundation	Landscape Architect, Engineer	Number of BMPs implemented
Stormwater Management Practices: ***Educational Signage Installation***	2 signs in a 5-year period	RiverLink	Installed upon completion of construction	$2,500 per sign, $5,000 total	Duke Energy Foundation	Graphic Designer	Number of visitors to BMPs and signs

Implementation Schedule and Accomplishments Tracking

The Outreach and Education program implementation schedule for the Upper Swannanoa River WMP presents the timeline over which each management action will be achieved during the 10-year planning period (Table 23). Target numbers for each management action are taken from the management action plan tables in the previous section. The tables are also designed to compare actual versus planned accomplishments for each management action. The planned accomplishment numbers will serve as interim milestones against which progress in implementing the management measures will be evaluated. Significant deviations from the planned accomplishments will be an indicator that the action plan may need revision.

Table 24. Upper Swannanoa River Outreach and Education Implementation Schedule (Sheet 1 of 2)

Management Action	Year	Short-Term			Mid-Term			Long-Term				Targets
		1	2	3	4	5	6	7	8	9	10	
Overall Outreach												
Watershed Group – Establish an Upper Swannanoa River Watershed Group to Implement the Outreach Action Plan	Planned	3	3	3	3	3	3	3	3	3	3	Establish working group year 1; meet 2-4 times/year
	Actual											
Children's Programs - Environmental Education Program with Kids	Planned	3	3	3	3	3	3	3	3	3	3	Black Mtn. Primary & Elementary, Montessori School
	Actual											
Youth & General Public - BMP Education Tours of existing and proposed sites	Planned	1	1	1	1	1	1	1	1	1	1	10 guided tours
	Actual											
Local Government Practices and Programs												
Education of Elected Officials: Work to Educate Elected Officials On Goals and Projects of the Watershed Plan	Planned	1		1		1		1		1		5 presentations; 1 in year 1, as needed thereafter
	Actual											
Education of Elected Officials: Work to Educate Elected Officials On What Share of Pollutants Come From Montreat and Black Mountain	Planned	Implement as Assessment Data Collected and Ready for Presentation										3 presentations
	Actual											

Table 24. Upper Swannanoa River Outreach and Education Implementation Schedule (Sheet 2 of 2)

Management Action	Year	Short-Term			Mid-Term			Long-Term				Targets
		1	2	3	4	5	6	7	8	9	10	
Outreach to the Business Community												
Developers and Business Recognition: Develop a Recognition Effort for Those Working to Improve the Watershed	Planned	1	1	1	1	1	1	1	1	1	1	10 presentations
	Actual											
Outreach to Landowners: Work With Landowners/Businesses That May Be Willing to Install Stormwater SCMs	Planned	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	15 contacts
	Actual											
Outreach to Commercial Landowners: Work With Landowners/Businesses That May Be Willing to Donate Stormwater or Conservation Easement	Planned	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	15 contacts
	Actual											
Outreach to Chamber of Commerce: Presentation to Gain Support from the Business Community	Planned	1	1	1	1	1	1	1	1	1	1	10 presentations
	Actual											
Public Stormwater Management Practices												
Stormwater Management Practices: Develop Demonstration Projects	Planned	2					1	1	1	1	1	2 projects within first 5 years
	Actual											
Stormwater Management Practices: *Educational Signage Installation*	Planned	2										2 signs within first 5 years
	Actual											

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Element F: Schedule for Implementation

Stormwater Control Measures

The timeframe to implementation of SCMs included in this plan was determined using stakeholder input and a decision-making matrix (Table 25) that considered the following factors:

- Landowner willingness
- Constructability
- Cost
- Treatment area
- Pollutant load reduction and flow attenuation
- Public benefit and visibility

Because the length of time it may take to develop individual projects, it was decided to assign them to three time periods within the 10-year life of the WMP – 1-3 years (short-term); 4-7 years (medium-term), and 8-10 years (long-term). The stakeholder group discussed the favorability rating assigned to each of the individual projects and then, through a weighted voting process, each project was assigned to an implementation time period. During this process, it was determined that nine of the SCM projects could not be implemented during this planning period due to the amount of work that would be required to bring them to fruition or because there were concerns that the projects may not be feasible. The stakeholder group felt those projects were important enough to keep in the planning document for consideration if site conditions change or when the WMP is revised.

Table 25. Stormwater Control Measures Implementation Schedule[1]

Site	Property Name	Landowner Willingness/On Public Land[2]	Constructability and Cost	Benefit to Stormwater Treatment/ Reduction	Public Benefit and Visibility	Implementation Time Period[2] (Years)[3]		
						1-3	4-7	5-10
1	Kearfott	TBD				X		
2, 3, 26	Foam and Fabric/Terry Estate Dr.	TBD					X	
4	Hopey/Dollar General/Goodwill	TBD					X	
5	WNC Shopping Center	N/A	N/A	N/A	N/A			X
6	Black Mountain Commerce Park	TBD					X	
7	Carver Center	N/A	N/A	N/A	N/A	X		
8	Golf Course Parking					X		
9	Apple Blossom Motel	N/A	N/A	N/A	N/A	Future		
10	ROW Storage					X		
11	CVS/Hwy 70	TBD						X
12	First Baptist Church	TBD				X		
13	Church Street						X	
14	Police Station	N/A	N/A	N/A	N/A	Future		
15	Richardson	N/A	N/A	N/A	N/A	Future		
16	Bi-Lo	N/A	N/A	N/A	N/A	Future		
17	Outparcel – US 70 Tractor Supply	TBD				Future		
19							X	
18	Outparcel	TBD					X	
20	Robo Oil	N/A	N/A	N/A	N/A		X	
21	Tong Sing	TBD				X		
22	Black Mtn. Primary	N/A	N/A	N/A	N/A	Future		
23	Fresh Parking	TBD						X
24	Road Right-of-Way	N/A	N/A	N/A	N/A	Future		
25	Lake Tomahawk						X	
27	Montreat College (vacant land)	TBD					X	
28	Library					X		
29	Residential parcel					Future		
30	Post Office/Dry Cleaner	TBD					X	
31	Methodist Church Parking	N/A	N/A	N/A	N/A		X	

[1]Color key: Favorable; Moderately Favorable; Unfavorable.

[2]For most projects landowner willingness is not known and will be obtained during outreach efforts (TBD); public lands were considered favorable for development; landowner willingness for projects marked N/A was either not applicable because they involve public right-of-ways.

[3]Potential project marked as "Future" projects were considered important, but have constraints that do not make them practical to consider for this planning period.

Stream Improvement Projects

Of the 16 stream improvement projects identified as needing channel and riparian vegetation enhancements, the largest ones are located within the Tomahawk Branch subwatershed (Table 14). Those portions of stream on public land will be targeted for implementation first (Table 25); efforts will be made to include those on private lands as part of the overall approach to improving the Tomahawk Branch subwatershed. Since no on-site assessments or landowner contacts have been made and the costs for the needed stream improvements could be significant, depending on site conditions, the first projects will likely not occur until mid-term of the planning cycle.

Although projects outside of Tomahawk Branch are not targeted for this planning period, efforts to recruit those landowners into participating will occur as part of the Outreach and Education Program. If those landowners are found to be willing to implement projects on their properties, funding for design and construction will be pursued.

Table 26. Implementation Schedule for Stream Improvement Projects

Site Number	Location Description and Subwatershed	Ownership	Implementation Time Period		
			1-3	4-7	8-10
1	Tomahawk Branch	Public		X	
2	Tomahawk Branch	Public		X	
3	Tomahawk Branch/ Walker Cove Road	Private			X
4	Tomahawk Branch	Public		X	
5	Assembly Drive/ Flat Creek	Private	TBD		
6	Flat Creek	Private	TBD		
7	Avena Road/ Unnamed Tributary	Private	TBD		
8	Mountain View Avenue Flat Creek	Private	TBD		
9	Tomahawk Branch	Private			X
10	Old Toll Circle/ Unnamed Tributary	Private	TBD		
11	Frances Avenue/ Unnamed Tributary	Private	TBD		
12	Hospital Road/ Unnamed Tributary	Private	TBD		
13	Tabernacle Road/ Unnamed Tributary	Private	TBD		
14	Armory Road/ Unnamed Tributary	Private	TBD		
15	Llama Vista Court/ Camp Branch	Private	TBD		
16	Tomahawk Branch/ Chapel Road	Private			X

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Element G: Measurable Milestones

The USRW WMP accomplishments tracking tables presented below provide a timeline over which each management action will be achieved during the 10-year planning period (Tables 26-28). Target numbers for each management action are taken from the management action plan tables in Element F and distributed across years based on stakeholder input. The tables also are designed to compare actual versus planned accomplishments for each management action. The planned accomplishment numbers will serve as interim milestones against which progress in implementing the management measures will be evaluated. Significant deviations from the planned accomplishments will be an indicator that the action plan may need revision.

Table 27. Measurable Milestones and Implementation Tracking for Stormwater Control Measures

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	2	3	4	5	6	7	8	9	10	
Install bioretention SCMs	Planned		2			10			2			14 features installed
	Actual											
Install extended detention structures	Planned		1			1			1			3 features installed
	Actual											
Install cisterns	Planned		1									1 feature installed
	Actual											
Install filter system	Planned					1						1 feature installed
	Actual											
Install wetland system	Planned		3			1						4 features installed
	Actual											

Table 28. Measurable Milestones and Implementation Tracking for Stream Improvement Projects

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	2	3	4	5	6	7	8	9	10	
Stream Improvement Projects: • Conduct landowner outreach & field assessments	Planned		16 sites		3-5	3-5	3-5	3-5	3-5	3-5	3-5	Contact landowners at 16 identified sites
	Actual											
Stream Improvement Projects: • Restore riparian area vegetation & stabilize stream channels	Planned		1,000			3,000 feet			3,000 feet			7,000 feet
	Actual											

Table 29. Measurable Milestones and Implementation Tracking for Monitoring and Maintenance

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	2	3	4	5	6	7	8	9	10	
Water chemistry Ambient (VWIN)	Planned	X12	X12	X12	X12	X12	X12	X12	X12	X12	X12	See Table 7.6 for details
	Actual											
Biological Monitoring Benthic macroinvertebrates (NCDWR)	Planned	X				X					X	Sample established site at 5-year intervals
	Actual											
Biological Monitoring Benthic macroinvertebrates (SMIE)	Planned	X2	X2	X2	X2	X2	X2	X2	X2	X2	X2	Spring and fall samples at 3 established sites
	Actual											
Biological Monitoring Fish Community (NCDWR)	Planned	X				X					X	Establish baseline in year 1; repeat at 5-year intervals
	Actual											
Stewardship monitoring	Planned	X	X	X	X	X	X	X	X	X	X	Monitor installed projects annually
	Actual											
Watershed Management Plan Review, Update and Revision	Planned					X					X	Review watershed plan at 5-year intervals; revise as needed or at year 10
	Actual											

Element H: Criteria of Pollutant Load Reduction Achievements

Stormwater Control Measures

The main pollutant issue affecting downstream stream channel stability and benthic communities is the volume and frequency of stormwater runoff from existing impervious surfaces. The number of SCMs installed and their effect on water quality and pollutant reductions will be used to assess how well pollutant reduction objectives are being achieved (Table 30). Pollutant reduction objectives should be achieved for rainfall events that do not significantly exceed the 1-year 24-hour design storm of the SCMs. In addition, a portion of the sediment, nutrients, and metals will be filtered from the runoff. These changes will result in improved water quality and lower stream sediment loads that should lead to an improved benthic community.

Table 30. SCM Pollutant Load Reduction Achievement Criteria

Pollutant Issue	Management Action	Target Criteria
Stormwater runoff	Installation of stormwater control features	• Number of SCM features installed • Impervious surface area treated • Reduction in volume of runoff • Reduction in frequency of runoff • Sediment captured • Reduction in nutrients • Reduction in metals

Stream Improvement Measures

Pollutant load reduction criteria achievements will be determined by the linear footage of stream channel and acreage of riparian area revegetated (Table 30).

Table 31. Stream Improvement Pollutant Load Reduction Achievement Criteria

Pollutant Issue	Management Action	Target Criteria
Streambank erosion	Stream improvements: • Streambank enhancement • Stream channel restoration • Riparian area revegetation	• Linear feet of stream channel improved o Feet of bank reshaping o Feet of channel restoration • Acres of riparian area revegetated o Number of native plants installed o Survival of plants

Element I: Watershed Monitoring Plan

To determine the effectiveness of management measures being implemented, the physical and ecological conditions of the watershed should be monitored over time. As specific management actions are completed, particularly those to control stormwater, stream channels are expected to stabilize, leading to an improvement in ecological function and aquatic habitat conditions. Secondary indicators of improved water quality conditions include improvements in the benthic macroinvertebrate and fish communities. A standard suite of water chemistry parameters should also be monitored to ensure that other water quality is being maintained.

Monitoring activity, frequencies, benchmark levels, and target levels have been developed and are presented in Table 32. Benchmarks for fish and benthic macroinvertebrate communities and aquatic habitat are based on metric scoring methods, whereas water quality parameters are measured against NCDWR and EPA standards.

The following monitoring program is designed to assess overall watershed conditions. Subwatershed or site specific monitoring may be necessary to determine water quality and ecological improvements at localized levels or associated with specific watershed improvement projects.

Water Chemistry

A suite of water chemistry parameters is measured monthly by VWIN volunteers at a point near the lower boundary of the project watershed (Figure 3, Table 32). To ensure that pollutants are not becoming a problem in the upper Swannanoa River Watershed, the monthly sampling for these parameters should continue for the life of the WMP.

Ecological

To determine if there are ecological effects from the installation of watershed improvement projects, benthic macroinvertebrate and fish communities as well as aquatic habitats should be monitored on a regular basis.

Benthic Macroinvertebrates – The NCDWR has one established benthic macroinvertebrate sample site (Figure 3 and Table 7) that was sampled to establish a biotic integrity rating that was used as a basis for listing the USWR on the 303(d) impaired waters list. This activity follows rigorous sampling protocols and QA/QC procedures (NCDWR 2013); organisms are identified by highly trained biologists. Sampling for those assessments has typically been conducted every five years. This site should be monitored on a 5-year schedule to determine trends in the benthic community as the WMP is implemented.

In 2013, the EQI SMIE program (EQI 2014) established three benthic macroinvertebrate sites in the upper Swannanoa River watershed. Each site is sampled twice per year, spring and fall, using trained volunteers (Figure 3 and Table 7; EQI 2014). While not quite as rigorous as the NCDWR sample efforts, the higher frequency of SMIE sampling will provide a greater chance to detect short-term effects of watershed changes. The established sites should be sampled two times per year throughout the life of the WMP. Where concentrations of projects are planned, it may be necessary to establish monitoring sites at the catchment level.

Fish Community – The NCDWR does not have a fish community monitoring site within the upper Swannanoa River watershed. A request to collect baseline samples fall 2015 or spring 2016 could not be accommodated. However, it is recommended that the NCDWR be asked to establish at least one fish sample in 2016 (baseline), 2020, and 2025 for purposes of obtaining fish Index of Biotic Integrity ratings. The sample should be taken at or near the existing benthic macroinvertebrate site and conducted at the same time as the benthic community sampling occurs.

Aquatic Habitat – As with the biological communities, the NCDWR also assesses aquatic habitats following standard procedures (NCDWR 2013). It is recommended that an aquatic habitat assessment be conducted concurrently with the fish and benthic community sampling. Habitat assessments at these sites should be conducted on the same schedule as recommended for biological communities.

Stewardship Monitoring

Stewardship is an important component of this WMP. All watershed improvements, be they physical improvements, SCMs, riparian revegetation, or land conservation, require stewardship to ensure that they are maintained and protected for the long term. This is necessary not only to maintain their effectiveness but to protect the community's investment in improving the watershed. As management measures are implemented throughout the watershed, it is necessary to monitor them on a regular basis. Monitoring, in this sense, will be to ensure that structures are functioning properly, lands are being managed appropriately, and encroachments into areas under legal protection (e.g., conservation easements) are not occurring. Ideally, responsibility for these activities should be assigned to a "Watershed Coordinator" that is a part of a local organization or agency associated with the sponsor of this plan.

Watershed stewardship *ensures that investments in watershed conservation practices are protected and managed for purposes of maintaining water quality, wildlife habitat, and community awareness.*

Monitoring activities, frequencies, benchmark levels, and target levels have been developed and are presented in Table 31. Benchmarks for fish and benthic macroinvertebrate communities and aquatic habitat are based on metric scoring methods developed by the NCDWR and SMIE, whereas water quality parameters are measured against NCDWR and USEPA standards (NCDWR 2013).

Table 32. Watershed Monitoring Plan

Parameter	Sites	Frequency or Years	Benchmark Levels	Target Levels
Water Chemistry				
pH Alkalinity Turbidity Total Suspended Solids Conductivity Nutrients Orthophosphate (PO_4^{3-}) Ammonia-Nitrogen (NH_4^+/NH_3) Nitrate/Nitrite-Nitrogen (NO_3^-/NO_2^-)	Swannanoa River at railroad bridge adjacent to US 70 (VWIN)	Monthly	Comparison with historic data	Maintain Below State Standards
Biological				
Benthic macroinvertebrate community[1]	NCDWR monitoring site: SR 2500, Blue Ridge Road	2016, 2020, 2024	Comparison with historic data	Good-Fair or better ratings based on NCDWR IBI Scoring
Benthic macroinvertebrate community	SMIE Swannanoa R. monitoring sites: At Flat Creek At Black Mountain Recreation Park At Kearfott Plant	Annually	Comparison with historic data	Good-Fair or better ratings based on SMIE BI Scoring
Fish Community[2]	Establish NCDWR monitoring site at benthic location	Establish in 2016; repeat in, 2020 and 2024	Comparison with historic data	Establish baseline rating Maintain Good-Fair or better rating (NCDWR Fish IBI score ≥40)
Physical				
Aquatic habitat	At NCDWR benthic and fish monitoring sites	2016, 2020, 2024	Comparison with historic data	All sites with metric scores ≥80
Stewardship				
Project structures and properties	Completed sites	Annually	Post-project conditions	Stream stability, reduced erosion, no encroachments

[1]This sampling effort has been discussed with NCDWR staff; however, no commitment to conduct it has been made as they do not know if the resources will be available. A formal request for assistance should be made.

[2]NCDWR was not able to accommodate sampling in 2015; a follow-up request will be necessary to obtain sampling in 2016.

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APPENDICES

Appendix A. Stormwater Assessment

Potential Project Identification

Preliminary Desktop GIS Analysis - Opportunities for potential stormwater control measure (SCM) projects were explored using a combination of GIS and field reconnaissance. Commercial, institutional, and industrial land uses were identified. Those containing large expanses of impervious surface and poor land use practices were flagged for field evaluation to assess potential impacts and opportunities for SCMs. This analysis resulted in 28 potential SCM project sites being identified. An additional three sites were provided by members of the stakeholder group.

Field Assessment - During the field assessment, observations were made on the land use draining to the site, existing stormwater management practices, and site constraints to determine whether SCMs are feasible. A field data form was completed for each site (Appendix Table A-1) and photographs taken to document existing conditions. If necessary, site sketches were made of the site.

Data Analysis and Results – Field data were digitized for analysis. Of the 31 site assessed, 10 were screened from further analysis due to constraints that would not allow them to be constructed under current conditions. For the remaining 21 locations, the type of potential SCM was identified. Conceptual plans were prepared for 13 of the sites. These plans depict the site, stormwater flow patterns, type and location of SCM that may be possible.

Once the potential sites were identified, their constructability, benefit to stormwater treatment/reduction, and public benefit and visibility were characterized as Favorable, Moderately Favorable, or Unfavorable by the stakeholder group using a "traffic light" (green, yellow, red) assessment procedure as recommended by NEMAC. The overall ratings were used to determine the time period in which it would be likely that the project could be constructed (Near-term, 1-3 years; Mid-term, 4-7 years, or Long-term, 8-10) over the life of the planning document (Element F, Table 24).

Pollutant Load Reduction

An estimate of pollution reduction potential was calculated based on pollutant removal efficiencies of the individual SCMs, the percent of impervious surfaces draining to each SCM, the pollutant concentration in runoff based on land use, and the area of land draining to the SCM using the SIMPLE method (Schueler 1987). It should be noted that the calculations in this model are rough approximations of actual pollutant reductions. An in depth study of each site is required to accurately estimate pollutant reductions. Results of this analysis are presented in Element C.

Appendix Table A-1. Stormwater Control Measure Site Evaluation Form

Subwatershed: _____ BMP (desktop) ID Type: _____ Staff:_____
Date_____ Site Location (Road):_____

Tracking Information

Waypoint _____ Lat_____ Long_____
Photo number(s) and description_____

Reason for Assessment (check one; describe if further details are deemed appropriate)

☐ Large developed area (e.g. mall, large strip development, industrial complex, large mixed use area)
_____

☐ Large area of land clearing or disturbance (note nature if obvious)_____

☐ Pollution potential (list if any are observed, e.g. storage tanks, trash receptors, etc.)
_____

Nature of Site

Name of Facility/Area (if obvious)_____
(Check all that apply)

☐ Commercial ☐ Gov't ☐ Pasture ☐ Land disturbance ☐ Institutional
☐ Transport-related ☐ Row crops ☐ Animal operation ☐ Other_____ ☐ Industrial
☐ Golf course ☐ Nursery ☐ Residential

Site Concerns (check all that apply):

Developed uses:
Vehicle Operations (circle): Fueled Washed Maintained Repaired Stored Sold None No Observation
Uncovered Outdoor Material Storage: ☐Yes ☐No ☐Unknown ☐ No Observation
Describe: _____
Waste Management: ☐Garbage ☐Construction ☐Hazardous ☐None ☐Other_____☐ No Observation
Dumpsters: ☐Leaking ☐Near storm drain ☐OK ☐ No Observation
Impervious Surface Condition: ☐Clean ☐Stained ☐Debris/Dirty ☐Breaking Up ☐ No Observation
☐ Other_____
Impervious Surface Size: ☐<1 acre ☐1-5 acres ☐5-10 acres ☐>10 acres
Type of impervious surface: ☐ Parking lot ☐ Rooftop ☐ Roadway ☐ Other…
☐ Open space between outfall and property boundary
☐ Area drains directly to storm sewers
☐ Area drains directly to adjacent property
☐ Area in immediate proximity to stream or drainageway (with / with no controls)-circle one

Site Constraints:

Possible conflicts with other site functions (e.g., traffic flow) ☐No ☐Yes
(describe)_____
Conflicts with existing utilities ☐ None

Yes	Possible	
☐	☐	Sewer
☐	☐	Water
☐	☐	Gas
☐	☐	Electric
☐	☐	Overhead utilities
☐	☐	Other_____

Access Constraints (construction and maintenance) ☐No ☐Yes (describe-slopes, structures)
Possible Conflicts with Adjacent Land Use ☐No ☐Yes
describe)_____

ST Potential☐1 ☐2 ☐3 ☐4 ☐ 5 ☐6 ☐7 ☐ 8-specifically ☐ Other-explain on back

Appendix B. Riparian Area Assessment

Potential Project Identification

The primary objective of the riparian area analysis was to assess the general condition of vegetation in the corridor of land near and adjacent to streams. Vegetated, woody riparian areas of less than 30 feet in width from the tops of both stream banks and have been documented as too narrow to effectively filter sediment, nutrients, and fecal coliform bacteria. It is also documented that riparian zones help stabilize stream banks and slow stream bank erosion. The identification of potential stream improvement projects in the USRW was completed entirely by using GIS.

This analysis included all streams within the USRW. These potential riparian sites were identified using NC OneMap's 2010 Orthoimagery (NCCGIA 2011) provided by the State of North Carolina. Healthy vegetated riparian areas were defined as areas that were predominantly forested over the entire riparian area. Streams were identified by using the North Carolina Stream Mapping Program (NCSMP) GIS stream data layer based on 2007 LiDAR data (NCGIA Undated), a 60-foot buffer was generated and centered on each stream line (30 feet to either side of the stream) within the study area. Starting at each downstream line segment of and moving upstream, imagery were visually examined and each stream segment in the GIS stream dataset were analyzed in determination for good potential for a riparian restoration project. Land use classification was also taken into account (Appendix Table B-1). In an attempt to maintain consistency, this imagery were initially examined at 1:1000, zooming in if necessary to verify classification. The NC Onemap 2010 orthoimagery in the USRW is "leaf-off"; in some cases making identification of forested areas difficult. When necessary, additional imagery was used -- primarily ESRI World Imagery (ESRI 2015) -- in order to verify the presence of, "leaf-on" forested areas within the buffer. Quality control was performed by a second staff member who examined and verified imagery and good riparian restoration potential classifications at a 1:3000 scale.

Stream reaches with riparian zones having widths of less than 30 feet (from top of one or both stream banks) and greater than 500 feet in length were identified as potential stream improvement projects. In addition to riparian vegetation condition, whether or not the stream had been channelized or otherwise straightened and the relative extent of entrenchment also were characterized to the extent possible from the aerial photos. No field surveys of these sites were made. No parcel ownership analysis was conducted other that identifying public vs. private lands. Due to the inherent subjectivity associated with visual analysis of aerial imagery, these data should be viewed as being a screening tool for site identification. Further assessment will be necessary to determine on the ground conditions; landowner outreach must be a part of that effort.

Lengths of sites with good riparian area restoration potential were individually calculated for each potential site. Output from the GIS dataset was exported to a Microsoft Excel® format for further analysis. A total of 5.86 miles (30,958 feet) of stream at 16 location were identified as having good potential for improvement. Of those sites, 61% of the total stream lengths are either Tomahawk Branch or tributaries to Tomahawk Branch. Four locations show signs of channelization or significant entrenchment; two of those sites are in the Tomahawk Branch subwatershed. Results of this analysis are presented in the section titled Potential Stream Improvement Projects.

Pollutant Load Reduction Modeling

Sediment loads related to streambank erosion were modeled using data collected by visually analyzing remotely sensed images and the USEPA's Spreadsheet Tool for the Estimation of Pollutant Load (STEPL) model. The STEPL model is comprised of a spreadsheet that uses simple algorithms to calculate nutrient and sediment loads. For purposes of this WMP, STEPL was used to estimate annual sediment load contributed from streambank erosion, based on estimated bank condition and length of eroding bank, and the potential load reductions if banks were stabilized (Appendix Table B-1). Technical information regarding calculations of sediment loading can be found in the STEPL User's Guide (USEPA 2006).

The required STEPL model inputs include length of bank (feet), height of bank (feet), rate of lateral recession (feet per year), efficiency of the stream improvement measure, and soil textural class. A separate model was run for each site. Within each model, the values were partitioned by potential project reach. Based on a "heads up" process stream widths were measured using 2015 aerial imagery. Bank heights were estimated by determining a statistical relationship between banks full widths and bankfull heights from observed published data (Harman et al. 2000). The bankfull heights were estimated using the regression equation: y= 0.0282x + 1.2288. Where Y equals the estimated bankfull height and X equals the observed bankfull width. These bank height estimates were then used in the model for each identified reach. Identified higher, more entrenched, channel bank heights were multiplied by 1.5 the modeled height. Reach lengths were doubled to account for both the right and left bank lengths within the STEPL model. Bank stability score for each site was used to determine the lateral recession rate. All sites were categorized as having moderate recession rates except for sites with obvious entrenched reaches and/or land use that indicate adjacent impervious surfaces, which were categorized as severe. In these instances the recession rates were considered severe. The STEPL model categorizes lateral recession into four categories with:

- Slight - Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
- Moderate - Bank is predominantly bare, with some rills and vegetative overhang.
- Severe - Bank is bare, with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features, such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.
- Very Severe - Bank is bare, with gullies and severe vegetative overhang. Many fallen trees, drains, and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross-section is U-shaped and the streamcourse or gully may be meandering.

Only stream bank improvements were included in the model. Pollutant removal, expressed as percent removal of the targeted pollutants present, is required to estimate the total pollutant load reduction to be achieved. In this case, it is the reduction in sediment due to bank stabilization. Some level of background erosion is present in any natural stream system; however, erosion will be significantly less than that of an impacted stream system. For this model, we used an efficiency of 80% to account for "natural" background erosion even with a successful project. The last input for the STEPL model is soil textural class, which can greatly affect the amount of soil loss due to differences in cohesion. A review of Natural Resources Conservation Service (NRCS) soil survey data

indicated that most of the study area consisted of a mixture of loams and sandy clay loams. The results of the load reduction model are presented Element C.

Appendix Table B-1. Stream Improvement Project Migration Rates

Site Number	Location Description	Stream Channel Length (feet)	Migration Rate	Observed Site Condition based on NLCD Classification
1	Tomahawk Branch	7,457	Severe	100% developed open pace
2	Tomahawk Branch	3,318	Moderate	60% agricultural 10% developed open space
3	Walker Cove Road	991	Moderate	30% agricultural 10% developed open space
4	Tomahawk Branch	1,844	Moderate	30% developed open space 10% agricultural
5	Assembly Drive	502	Moderate	100% developed open space
6	Flatt Creek	692	Moderate	100% developed open space
7	Avena Road	1,544	Severe	80% developed open space
8	Mountain View Avenue	1,638	Moderate	70% developed open space 10% low intensity developed
9	Tomahawk Branch	2,896	Severe	100% developed open space
10	Old Toll Circle	1,020	Severe	80% developed open space
11	Frances Avenue	761	Moderate	50% developed open space 50% agricultural
12	Hospital Road	1,458	Severe	80% developed open space 10% agricultural
13	Tabernacle Road	1,335	Moderate	60% agricultural 10% developed open space
14	Armory Road	2,367	Moderate	50% agricultural 20% developed open space
15	Llama Vista Court	844	Moderate	80% developed open space
16	Chapel Road	2,291	Severe	100% developed open space
	Totals	30,958		

[1]Site condition is based on the National Land Cover Database classifications.