Richland Creek Watershed Action Plan

Haywood County, NC

Prepared by:
Richland Creek Watershed Restoration Group

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Executive Summary

The purpose of the Richland Creek Watershed Action Plan (WAP) is to guide restoration efforts and improve surface water quality in the Richland Creek Watershed of Haywood County, North Carolina. It focuses on nonpoint source pollution and was created by the Richland Creek Restoration Group, which is composed of agencies, organizations, and individuals with skills and/or interest in nonpoint source water quality issues. The WAP is a living document that will be updated by watershed stakeholders as additional information and opportunities become available.

The Richland Creek Watershed is 43,638 acres and completely contained within the County. Much of the area is forested. Developed areas are mainly confined to the city of Waynesville and along the Richland Creek valley. Paved and unpaved roads are abundant. Agricultural uses are few.

The watershed has many high quality streams for drinking water, recreation, agriculture, and industry uses. However, there are long-term nonpoint source pollution impacts associated with urbanization, erosion and sedimentation. Several streams are on the NC list of impaired waterways.

The Division of Water Quality, Tennessee Valley Authority, Haywood Waterways Association, and other partners have been collecting water quality data for many years. This data provides evidence of the most significant problem areas, helps prioritize restoration efforts, identify data gaps, justify grant applications and demonstrate measurable results from watershed improvement projects.

The primary stressors affecting the watershed are sediment, bacteria, nutrients, and temperature. Other stressors include exotic/invasive species and litter. Sources include stormwater, eroding streambanks and unpaved roads, and inadequate riparian vegetation.

The WAP outlines management measures for addressing the water quality issues. The measures include monitoring, education, stormwater controls and treatment, stream work, riparian improvements, low impact development practices, greenways, and land use planning. It also includes information on technical and financial resources available to watershed groups and property owners.

If these measures are implemented, it is anticipated that Richland Creek and Raccoon Creek can be candidates for removal from the state list of impaired waterways within five years. They will also provide long-term protection of water quality throughout the watershed.

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SECTION 1. OVERVIEW

1.1 Purpose

The purpose of the Richland Creek Watershed Action Plan (WAP) is to guide water quality improvement and protection efforts in the Richland Creek watershed of Haywood County, NC. It focuses on nonpoint source pollution and was created by the Richland Creek Restoration Group. The WAP is a living document that will be updated by watershed stakeholders as additional information and opportunities become available.

1.2 Watershed Description

The Richland Creek Watershed is in southwest Haywood County (Figure 1) and is a major tributary in the Pigeon River Watershed (8-digit HUC = 06010106). Richland Creek is a fifth-order stream that is nearly thirteen miles long and has over 170 miles of perennial and intermittent tributaries. It originates on the southwestern boundary of the parent watershed and flows to the northeast through the most heavily developed portion of Haywood County. The watershed contains 43,638 acres (68 mi^2) and supports the Town of Waynesville, numerous industries, and agriculture. The current population of Waynesville is 9,922 (2011 census) and has experienced an average growth rate of about 4.0%. All water flows into Lake Junaluska, one of the most significant water resources in Haywood County.

Much of the watershed is forested (Figure 2). Developed areas in the watershed are mainly confined to the city of Waynesville along Richland Creek. Many commercial enterprises are present. Paved and unpaved roads are abundant with new ones being constructed to accommodate new residences, second-home communities, and a growing tourism industry. Agricultural use areas, though small, are primarily along Raccoon Creek and Ratcliff Cove Branch. There are nine subwatersheds in the Richland Creek Watershed (Table 1), each of varying land uses.

Haywood County has abundant productive soils (USDA 1997), and combined with a moderate climate and ample precipitation (Table 2), there is a great variety of vegetative growth. Many agricultural crops are grown in the area. The area lies in the Southern Blue Ridge Ecoregion, which is one of the most biologically significant in the United States.

Soils in this watershed are for the most part moderately deep to deep and loamy. Most areas are well drained. Land slope is a major limiting factor affecting land use. Soil instability, depth to soft bedrock, and the presence of mica in some soils are limiting factors to some of the more intensive land uses.

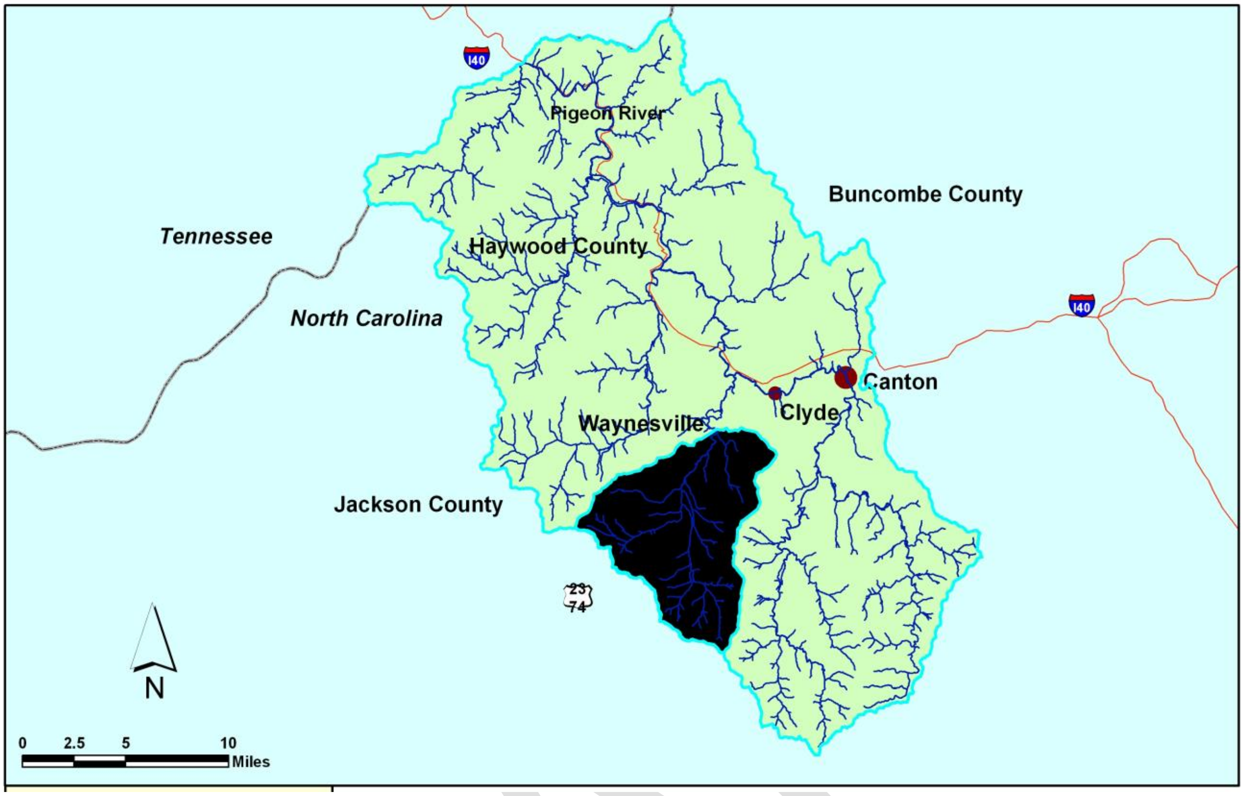

Figure 1. Richland Creek Watershed Location Map

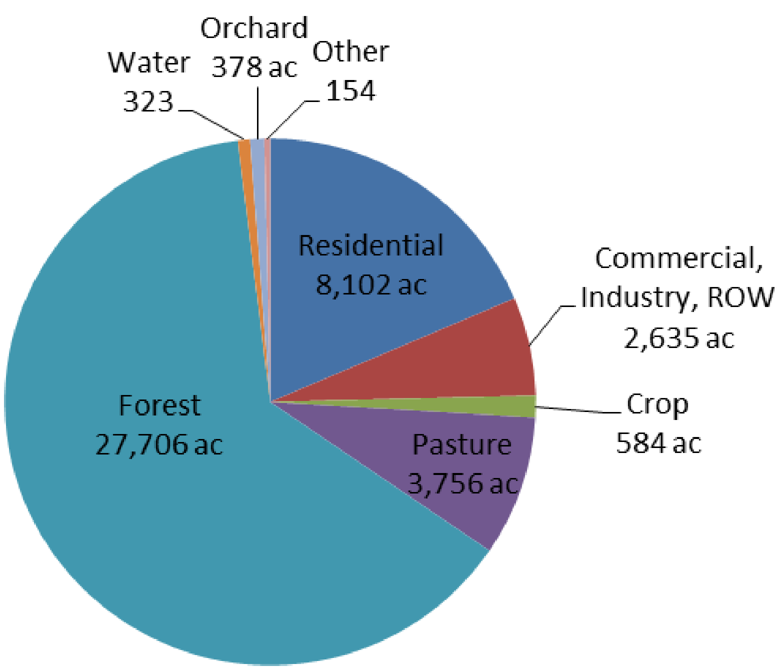

Figure 2. Land Uses in the Richland Creek Watershed

Table 1. Richland Creek Subwatersheds

Subwatershed	Size (acres)	Land Use[1]	Features
Richland Creek Watershed (Total)	43,638	Forest = 27,706 (63.5%) Agriculture = 4,723 (10.8%) Developed = 10,737 (24.6%)	
Allens Creek	10,846	Forest = 10,174 (93.8%) Agriculture = 145 (1.3%) Developed = 379 (3.5%)	Headwaters begin along Blue Ridge Parkway; Waynesville's water supply (WS-I, 8,400 acres); largest rock quarry in Haywood County;
Eaglesnest Creek	901	Forest = 465 (51.6%) Agriculture = 45 (4.9%) Developed = 391 (43.4%)	36% of land use is residential
Browning Branch	3,208	Forest = 2,168 (67.6%) Agriculture = 227 (7.1%) Developed = 774 (24.1%)	
Hyatt Creek	1,492	Forest = 772 (51.7%) Agriculture = 321 (21.5%) Developed = 398 (26.7%)	Class C waters;
Plott Creek	2,415	Forest = 1,808 (74.9%) Agriculture = 188 (7.8%) Developed = 419 (17.3%)	
Raccoon Creek	3,306	Forest = 1,676 (50.7%) Agriculture = 896 (27.1%) Developed = 716 (21.7%)	Class B waters;
Ratcliff Cove	2,504	Forest = 1,323 (52.8%) Agriculture = 757 (30.2%) Developed = 422 (16.9%)	Class B waters; subwatershed to Raccoon Creek
Richland Creek, Lower (downstream of Lake Junaluska)	4,172	Forest = 2,007 (48.1%) Agriculture = 1,150 (27.6%) Developed =991 (23.8%)	Class C waters;
Richland Creek, Middle (Lake Junaluska to Plott Creek)	7,566	Forest = 2,374 (31.4%) Agriculture = 338 (4.5%) Developed =4,615 (61.0%)	Class B, Tr waters; Lake Junaluska reservoir (200 acre) contributes $40 million annually for Haywood County; 44% of land use is residential
Richland Creek, Upper (Plott Creek to head)	7,228	Forest = 4,939 (68.3%) Agriculture = 657 (9.1%) Developed = 1,631 (22.6%)	Class B waters; Headwaters begin along the Blue Ridge Parkway, Nolen Creek (DWQ reference stream)

[1]Forest cover includes grassland, shrub, scrub, and wetlands; agriculture includes mix of crops and pasture; developed lands include a mix of residential, commercial, industry and right-of-ways.

Table 2. Waynesville Climate Summary, 1894 – 2010

Parameter	Annual Average
Rainfall (inches)	46
Snowfall (inches)	14
Average Minimum (°F)	39
Average maximum (°F)	67

Source: The Southeast Regional Climate Center.

1.3 Watershed Significance

The Richland Creek watershed has significant implications for Haywood County, the Town of Waynesville and the Lake Junaluska Assembly. Its' streams provide aesthetic value and high quality water for drinking, recreation, agriculture, and industry. Richland Creek flows through Waynesville and into Lake Junaluska, a popular recreation center and retreat that provides over $40 million per year to the local economy. Streams in the watershed support good populations of trout, which attracts thousands of visitors each year. Richland Creek is managed as Hatchery Supported Trout Waters and the Town of Waynesville has been designated as a "Mountain Heritage Trout Water" city by the NC Wildlife Resources Commission (WRC). The lower Richland Creek watershed also carries the NC Division of Water Quality's (DWQ) Tr classification (trout waters).

The Richland Creek watershed was identified by the NC Ecosystem Enhancement Program (2009) as one of 29 targeted local watersheds in the French Broad River basin with the greatest need and opportunity for stream and wetland restoration efforts. The Enhancement Program has given this watershed higher priority for implementation of restoration projects. Richland Creek is also one of the US Environmental Protection Agency (EPA) Region Four's Restoration Watersheds and is a priority stream for the Tennessee Valley Authority (TVA). TVA identifies Richland Creek as a sensitive waterbody with potential to ecologically improve; they support local organizations and encourage efforts to improve and maintain water quality.

1.4 Extent of Impairment

Even though the watershed contains streams of high quality water, there are long-term nonpoint source pollution impacts associated with urbanization, erosion and sedimentation (DWQ 2005). The stressors impacting the watershed are reducing the watershed's aesthetic and recreational quality, eroding agricultural land, degrading wildlife habitat, and incurring significant costs for downstream users.

There are several streams on the list of impaired waterways (Table 3). Streams in this category do not meet water quality standards and are identified as impaired by the State of North Carolina. Overall, Richland Creek is not supporting its uses due to impaired biological integrity (benthos, fish) and fecal coliform bacteria (DWQ 2011). Sources of bacteria include failing septic systems and livestock access to streams. There has been leaking sewer infrastructure in the Town of Waynesville but they have fixed those problems. Raccoon Creek is not supporting its uses due to impaired biological integrity (fish). The Lake Junaluska reservoir is not supporting its uses due to high pH, which has been partially attributed to eutrophication of the lake and subsequent algal blooms (DWQ 2011). There are also two streams on the "watch list", meaning there are several issues that if they become more significant could lead listing. One is Hyatt Creek, a formerly listed stream that was delisted in 2010.

Table 3. Impaired Waterways of the Richland Creek Watershed

Stream Section	Description	Length (miles)	Classification	Use	Reason for listing	Category
Richland Creek	Source to US Route 23	8.0	B, Tr	Recreation	Fecal coliform	5
Richland Creek	US Route 23 to Boyd Ave	2.3	B, Tr	Recreation	Fecal coliform	5
				Aquatic life	Biological integrity (fish, Poor)	4c
Richland Creek	Boyd Ave to Depot St	0.7	B	Recreation	Fecal coliform	5
				Aquatic life	Biological integrity (fish, Poor)	4c
Richland Creek	Depot St to Shelton Branch	0.9	B	Recreation	Fecal coliform	5
Richland Creek	Shelton Branch to Lake Junaluska backwater	2.0	B	Recreation	Fecal coliform	5
				Aquatic life	Biological integrity (fish, Fair)	4c
Richland Creek	Lake Junaluska	200 acres	B	Aquatic life	High pH	5
Richland Creek	Jones Cove Br to Pigeon River	0.7	C	Aquatic life	Biological integrity (benthos, Fair)	5
Raccoon Creek	Source to Richland Creek	4.7	B	Aquatic life	Biological integrity (fish, Poor)	4c
Watch List						
Hyatt Creek	Source to S R 1159	0.9	C	Aquatic life	Benthos	3a
Hyatt Creek	SR 1159 to Richland Creek	2.6	C	Aquatic life	Benthos	3a
Unnamed tributary to Hyatt Creek	Source to Hyatt Creek	0.6		Aquatic life	Benthos	3a
Richland Creek	Lake Junaluska	200 acres	B	Aquatic life	Chlorophyll a	3n

Many of the issues in the watershed are related to impervious surfaces and stormwater. There are 2,786.4 acres of impervious surfaces in the Richland Creek Watershed (Table 4), which is 6.4% of the total watershed. The Middle Richland Creek subwatershed has the greatest proportion of impervious surfaces (14.2%) due to the Town of Waynesville, which has several commercial areas with vast expanses of impervious surfaces. Studies have shown that when a watershed exceeds 10% imperviousness, water quality degradation is inevitable (Arnold and Gibbons 1996). Browning Branch is within the town and also has a high proportion (8.4%); it has dense residential land uses with some commercial properties.

Richland Creek has a high percentage of riparian areas along perennial streams that are considered insufficient; the IPSI classifies these as marginal or inadequate conditions (44%, Table 4). Although the right and left bank totals differ slightly, there are roughly 64 miles of riparian corridor in less than adequate condition. The subwatersheds with the highest percentages of riparian buffer in these conditions are Hyatt Creek, Ratcliff Cove Branch, Raccoon Creek, and Middle Richland Creek. Allens Creek has a very low proportion (7.6%).

Table 4. Land Uses Issues in the Richland Creek Watershed[1]

Subwatershed	Impervious Surfaces		Riparian Buffer Condition		Dump Sites
	Acres %,	**(% of total area**	*Marginal Inadequate (lf)*	*% of Total Buffer*	*#*
Allens Creek	236.6	2.0	11,653 7,712	7.6	6
Eaglesnest Creek	69.2	7.7	1,946 1,946	22.8	2
Browning Branch	270.2	8.4	21,177 26,409	57.5	7
Hyatt Creek	73.8	4.9	4,055 12,113	88.2	2
Plott Creek	115.5	4.8	2,726 17,448	43.7	6
Raccoon Creek	178.6	5.4	15,609 22,769	82.0	4
Ratcliff Cove Branch	92.0	3.7	6,462 4,698	83.4	5
Richland Creek, Lower (downstream of Lake Junaluska)	316.8	7.6	8,342 6,313	70.7	5
Richland Creek, Middle (Lake Junaluska to Plott Creek)	1,073.8	14.2	51,452 71,031	85.1	16
Richland Creek, Upper (Plott Creek to head)	359.9	5.0	24,103 22,787	37.1	5
Totals =	**2,786.4**	**6.4**	**149,470.1 lf** **191,280.5 lf**	**44.2**	**58**

[1] Source: TVA Integrated Pollutant Source Identification database.

There are many unregulated dump sites in the watershed (Table 4); 58 were identified with most in the Middle Richland Creek subwatershed. When it rains, these dump sites can leach hazardous chemicals into waterways and ground water. They can also transport trash, which can block storm drains and ditches and cause higher risk of flooding.

Lake Junaluska provides a good example of the impacts affecting the watershed. The 200-acre reservoir captures nearly all of the sediment carried by the Richland Creek Watershed. Unfortunately, the sediment loads being delivered to Lake Junaluska far exceed naturally occurring levels. Over the years, the Lake Junaluska Assembly has spent millions of dollars removing sediment from the Lake. The first sediment removal project was in 1964 when between 400,000 and 500,000 cubic yards were removed. However, sediment was arriving at an increasing rate, and in 1973 another 391,000 cubic yards were removed. There have been subsequent removals since that time. In recent years, the Assembly has been spending about $25,000 per year in an attempt to remove some of the most recent sediment. However, sediment is arriving at such a rate that this work does not begin to keep up with deposition. It is now estimated cost to removing a majority of the sediment will be between $2 and $3 million.

1.5 Responsible Parties & Stakeholders

The WAP was created by the Richland Creek Restoration Group, a coalition of stakeholders with an interest in the health of the watershed (Table 5). Funds were provided through a grant from the DWQ 319 Program. The partnership already had experience working together through the Hyatt Creek Restoration Project, which ultimately resulted in the stream being removed from the state list of impaired waterways. The group decided to continue their partnership and focus on the Richland Creek watershed, to which Hyatt Creek is a tributary. The high degree of collaboration between local agencies, organizations, and all levels of government demonstrates what can be achieved when like-minded groups cooperate. It also provides the local support, stakeholder buy in and financial resources necessary to improve and protect degraded watersheds.

The long-term goals of the partnership are to: (1) improve water quality and restore uses to Haywood County's impaired waterways; (2) protect water quality for downstream landowner uses; (3) support fish populations; (4) reduce water quality and economic impacts to the Pigeon River and its' tributaries; and (5) provide clean water for recreation.

Table 5. Richland Creek Watershed Restoration Group

Partner	Role
Haywood County Commissioners	Stakeholder
Haywood County Cooperative Extension Service	Education, technical assistance
Haywood County Environmental Health Department	Wastewater treatment
Haywood Soil and Water Conservation District	Technical assistance, grant writing
Haywood Waterways Association, Inc.	Education, outreach, monitoring, grant writing
Lake Junaluska Assembly	Stakeholder
Landowners	Stakeholder, matching funds
NC DENR, Division of Water Quality	Monitoring, technical assistance
NC Department of Transportation	Technical assistance
NC State University	Technical assistance
NC Wildlife Resources Commission	Monitoring, technical assistance
Southwestern NC Resource Conservation & Development Council	Fiduciary agent, grant writing
Tennessee Valley Authority	Monitoring, funding agent
University of Tennessee-Knoxville	Monitoring, technical assistance
US Environmental Protection Agency	Technical assistance
USDA Natural Resources Conservation Service	Technical assistance, funding agent
Town of Waynesville	Stakeholder

SECTION 2. CAUSE & SOURCE IDENTIFICATION

According to DWQ's Basinwide Report (2005) and Aquifer Protection Section, there are multiple stressors affecting water quality, including:

- Increased sediment load from development and agriculture practices,
- Poor riparian buffers and lack of sufficient tree canopy to shade the stream,
- Channelization and alteration of the streams natural course,
- Stormwater runoff and the effects of heated stormwater,
- Untreated waste from animals and humans, and
- Fertilizers used in agriculture, home gardens, lawns, and golf courses.

In addition, DWQ's Basinwide report (2011) attributes high bacteria levels in the Richland Creek watershed to leaking sewer infrastructure, failing septic systems, and livestock with access to the creek.

There have also been multiple agencies and organizations collecting water quality information throughout the watershed, either as part of a long-term study or for specific projects (Figure 3). The results from each of these data sources are summarized in this section. Load estimates are provided where available.

Integrated Pollutant Source Identification (IPSI) - The IPSI database is a tool to help identify potential watershed restoration projects. It was created by TVA and Haywood Waterways acquired two of them in 2000 and 2007. It is a GIS-based dataset that includes such watershed features as land use/land cover, streams, impervious surfaces, eroding stream banks, riparian cover, livestock operations, and unpaved roads. The IPSI also estimates loads for sediment, nutrients, and other nonpoint source pollutants. Nutrient loads were estimated using the SIMPLE Method (Schueler 1987). The concentrations used in the model are from USEPA (2001) with values specific to North Carolina. The Universal Soil Loss Equation (USLE) was used to estimate pollutant loads from rural land uses and disturbed areas. The area District Conservationist (Natural Resources Conservation Service) provided factor values for each land use/land cover class. A factor of 0.7 was used to estimate TSS. Nutrient load estimates were made by applying soil pollution coefficients (lbs. of pollutant per ton of soil) to the USLE. Pollution coefficients were developed by TVA. Nutrient load estimates from animal operations were calculated based on the estimated number of livestock, typical daily nutrient production and a delivery factor.

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Volunteer Water Information Network (VWIN) – The VWIN Program is a volunteer-based water quality monitoring program managed by the Environmental Quality Institute (EQI). The program has sites throughout western NC. Haywood Waterways administers the program in Haywood County; they currently monitor ten sites on seven streams in the Richland Creek watershed. Samples are analyzed by EQI for pH, conductivity, alkalinity, turbidity, total suspended solids (TSS), metals (copper, lead, zinc), and nutrients (orthophosphate, nitrate/nitrite, ammonia). Sites are rated as Excellent, Good, Average, Below Average, and Poor. The ratings are based on regional averages, scientific merit, and DWQ water quality standards. The samples are not stormwater-dependent and primarily provide information from normal flow conditions.

In 2004, Haywood Waterways began monitoring stormwater-induced TSS loads in the Richland Creek Watershed. The main objective was to monitor sediment concentrations and to determine if ground disturbing activities were increasing loads. Although there is currently no standard to compare TSS readings, EQI considers any reading over 100 mg/L during normal flow as high. Sampling is focused in the Raccoon Creek and Hyatt Creek subwatersheds. Those are the subwatersheds determined by VWIN sampling to be contributing the greatest sediment loads. Samples are collected from bottles attached to a pole in the thalweg. Each site has between four and six bottles at varying heights but evenly spaced with each bottle representing a different discharge level. Stage A represents the lowest water level.

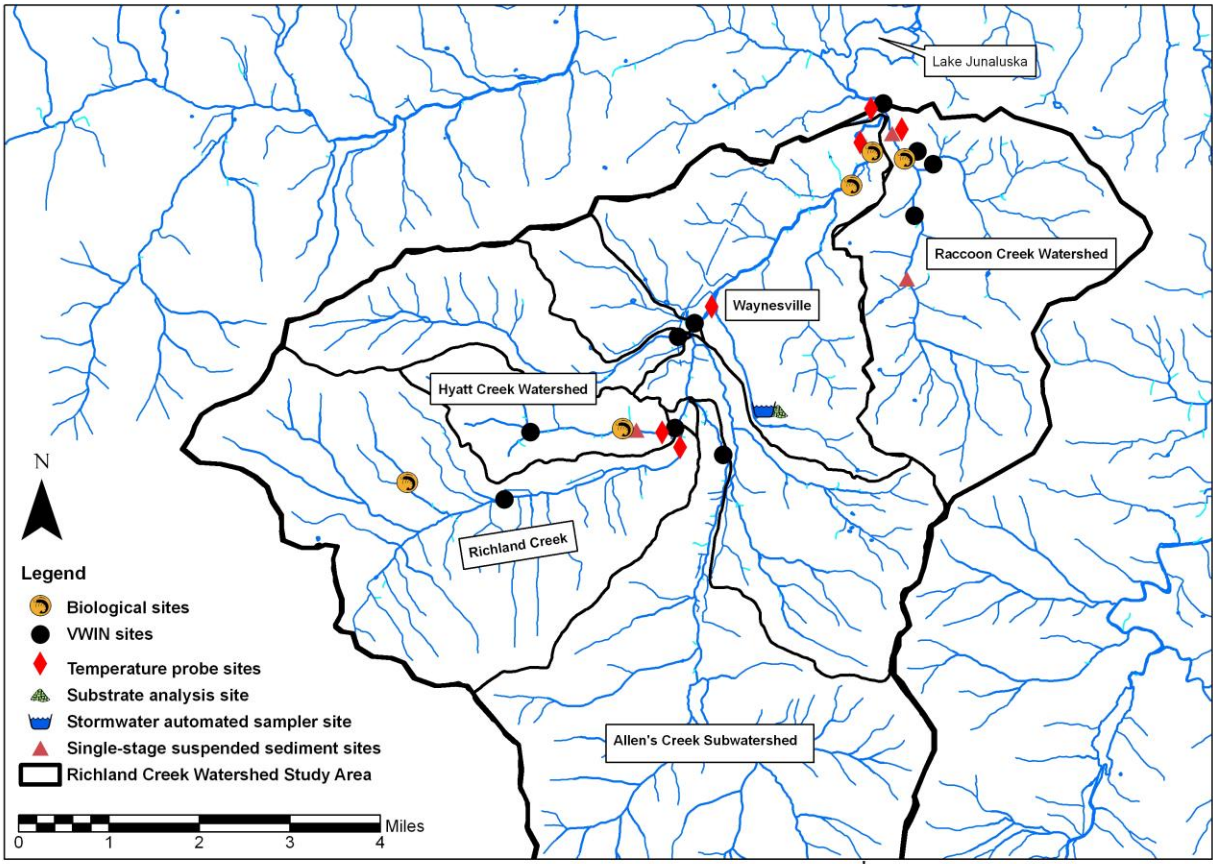

Figure 3. Monitoring Locations

Haywood Waterways are collecting temperature data in Richland Creek and Raccoon Creek near their confluence. Data loggers monitor hourly; data are reported from February 2011 to February 2013.

Between November 2011 and April 2012, Haywood Waterways maintained an ISCO automated stormwater sampler on Raccoon Creek. The location was part of an anticipated stream restoration project that did not occur. Eight samples were collected in that time period. Samples were analyzed for pH, conductivity, alkalinity, turbidity, TSS, and nutrients (orthophosphate, nitrates, and ammonia). The information provides an assessment of pollutant loadings from most of the Raccoon Creek subwatershed upstream of Ratcliff Cove Branch.

Researchers at Western Carolina University are using the headwaters of Allens Creek (also known as the Waynesville Watershed) and one site on Raccoon Creek as a natural laboratory for research and education. The university has installed multiple, water quality monitoring stations which allow for the collection of semi-continuous water quality data. They completed a study of the Raccoon Creek watershed in 2012 (Miller and Miller 2012). Parameters included pH, temperature, discharge, dissolved oxygen, TSS, and turbidity.

DWQ collected fecal coliform and benthic macro-invertebrate data as part of its ambient monitoring program as well as identifying sources of fecal coliform bacteria. Bacteria contamination is an ongoing problem; sources include failing or inadequate septic systems, degrading municipal sewer pipes, and animal access. DWQ sampled bacteria at 71 sites on 20 streams between December 2006 and September 2010. Many samples were simply snapshots of water quality but multiple samples were collected at sites with suspected problems; only the latter are presented in this WAP. Where available, only data from 2010 are presented as multiple improvements to wastewater treatment were made prior to 2010.

Watershed Science, Inc. collected benthic macroinvertebrate samples from five sites in the Richland Creek watershed and one reference site on Cataloochee Creek in the Great Smoky Mountains National Park. Collection protocols and analytical methods were selected to mimic those of the NC Division of Water Quality (DWQ 2006). Samples were collected in the fall between 2010 and 2012 as part of grants from DWQ's 319 Program and the NC Clean Water Management Trust Fund.

TVA has been sampling benthic macroinvertebrate communities since 1997; they base their ratings on number of EPT taxa (Ephemeroptera, Plecoptera, Trichoptera). TVA has also sampled fish communities since 1997 and uses the data to calculate an Index of Biotic Integrity similar to DWQ's rating system. WRC completed a fish community survey and habitat analysis in the Hyatt Creek watershed in 2006.

The Stream Monitoring Information Exchange Program is a volunteer-based system of collecting water quality information based on benthic macroinvertebrates. The macroinvertebrates are collected, identified and water quality is graded based on a scale of poor, fair, good, and excellent. The program uses several metrics but this report only includes results from the Izaak Walton League calculation, which combines both macroinvertebrate diversity and taxa specific to water quality tolerance.

Haywood Waterways coordinates an Adopt-A-Stream program that focuses on stream litter removal. The results give an indication of the amount of trash entering the streams and the potential risks for storm drain and water intake pipes becoming clogged.

2.1 Basic Chemistry

According to VWIN results, pH measurements were within the normal range of water (6.5 to 7.2; Table 6). Alkalinity could be an issue in Allens Creek, Plott Creek, and Richland Creek upstream. Streams in western NC typically have low alkalinity because of thin soils and the underlying granitic bedrock does not have much acid-neutralizing capacity (i.e., low calcium carbonate; Westphal et al. 2009). If acid rain or other acid-type substance were to increase in those subwatersheds, there would likely be limited buffering capacity and the impacts of low pH would be significant.

The conductivity data indicate frequently high concentrations of dissolved ions in the Hyatt Creek, Raccoon Creek, Ratcliff Cove Branch and Eaglesnest Creek subwatersheds (Table 6). The results are likely a result of clay and other dissolved solids (ex. chloride, nitrate, phosphate, calcium, iron) washing off the landscape. They are an indication of potential issues from erosion, wastewater discharge, and runoff, particularly in the Raccoon and Hyatt Creek watersheds (Westphal et al. 2009).

2.2 Temperature

Temperatures are frequently at or above the upper thresholds for coldwater fisheries ($\geq$ 70°F; Table 7). Higher temperatures were observed between May and October, which may overlap with some fish spawning periods. The data indicated an illicit discharge upstream on Richland Creek. Between 3:00 pm and 5:00 pm over a period of ten days (9/29 to 10/8/2011), temperatures suddenly increased seven to 15 degrees within an hour, including one day that reached 80°F. While organisms can tolerate gradual temperature fluctuations, dramatic temperature swings such as these are a concern.

Temperature data were also collected by Haywood Waterways as part of the Hyatt Creek Restoration Project. The results from October 2006 to June 2009 indicate temperatures in the lower reaches of the watershed frequently exceeded 70°F and sometimes reached as high as 80°F.

Table 6. VWIN Classification Grades Based on Parameters and Ranges[1, 2]

Site	pH	Alkalinity	Turbidity	TSS	Conductivity	Ortho P	Ammonia-N	Nitrate-N	Copper	Lead	Zinc
8-Eaglenest Creek	A	B	B	B	C	B	A	B	B	A	A
9-Plott Creek	A	D	A	B	B	B	A	B	A	A	A
10-Richland Creek at West Waynesville	A	D	B	B	B	B	A	A	A	A	A
11-Richland Creek at Lake Junaluska	A	B	B	A	C	B	A	B	B	A	A
13-Allens Creek	A	D	A	A	B	B	B	A	A	A	A
21-Hyatt Creek upstream	A	B	C	D	C	C	A	C	C	A	B
22-Hyatt Creek downstream	A	B	D	D	C	C	B	C	B	A	B
23-Ratcliff Cove Branch	A	B	C	D	C	C	A	B	A	A	A
24-Raccoon Creek upstream	A	B	B	B	C	C	A	C	A	A	A
25-Raccoon Creek downstream	A	A	B	A	C	C	A	C	B	A	A
28-Hyatt Creek left branch	A	A	D	D	D	B	A	B	B	A	B
29-Hyatt Creek Owl Ridge Branch	A	B	D	D	C	C	A	B	C	A	B
30-Hyatt Creek Green Valley Branch	A	A	D	C	D	D	D	C	B	A	D

[1]Metals data collected from 2006 to 2009; all other data collected 2008 to 2012.

[2]Grade scales:

pH: Grade A = never less than 6.0

Alkalinity: Grade A = median greater than 30 mg/L and little vulnerability to acidic inputs; Grade B = median 20-30 mg/L; Grade D = median less than 15 ppm

Turbidity: Trout standard = 10 NTU, general standard = 50 NTU; Grade A = median <5 NTU, >10 NTU in less than 10% of samples, never >50 NTU; Grade B = median <7.5 NTU, never >50 NTU; Grade C = median <10 NTU and >50 NTU in less than 10% of samples; Grade D = median >10 NTU or >50 NTU in more than 10% of samples

TSS: No standard but values <30.0 mg/l generally considered low and values >100 mg/l considered high; Grade A = median <5 mg/L and maximum <100 mg/L, land not measurably disturbed; Grade B = median <7.5 mg/L and >100 mg/L in less than 10% of samples, land disturbance low – moderate; Grade C = median <10 mg/L and >100 mg/L in less than 10% of samples, land disturbance moderate – high; Grade D = median >10 mg/L or maximum >100 mg/L in more than 10% of samples, high land disturbance

Conductivity: Grade A = median <30 uhmos/cm, never >100 umhos/cm; Grade B = median <50 umhos/cm, >100 umhos/cm in less than 10% of samples; Grade C = median >50 umhos/cm, >100 umhos/cm in less than 10% of samples; Grade D = >100 umhos/cm in more than 10% of samples

Orthophosphate: No legal standard but concentrations should be below 0.05 mg/L to prevent algal growths; Grade B = median >0.05 mg/L but <0.10 mg/L; Grade C = median >0.10 mg/L but <0.20 mg/L; Grade D = median >0.20 mg/L

Ammonia Nitrogen: Proposed standard to protect trout waters = 1.0 mg/l in summer and 2.0 mg/l in winter; Grade A = never >0.50 mg/L; Grade B = never >of 1 mg/L (proposed ambient standard for trout waters in the summer); Grade C = >1 mg/L in less than 10% of samples, but never >2 mg/L

Nitrate Nitrogen: Standard = 10mg/L; Grade A = median <0.3 mg/L, no sample >1 mg/L; Grade B = less than 10% of samples >1 mg/L, none >5 mg/L; Grade C = no samples >5 mg/L

Copper: Standard = 7 ppb; Grade A = never > 7 ppb; Grade B = >7 ppb in less than 10% of samples; Grade C = >7 ppb in 10 to 20% of samples

Lead: Standard = 10 ppb; Grade A = never >10 ppb

Zinc: Standard = 50 ppb; Grade A = median <5 ppb, never >50 ppb; Grade B = median <10 ppb, >50 ppb in less than 10% of samples; Grade D = median >10 ppb or concentration >50 ppb in more than 20% of samples

Table 7. Temperature Data

Site	Period	Range (°F)	Days ≥ 70°F	First and last day > 70 °F
Richland Creek[1]	2/2011 – 2/2012 2/2012 – 2/2013	33.6 - 80.1 36.3 - 75.9	91 53	5/30, 10/17 5/28, 9/08
Raccoon Creek[2]	2/2011 – 2/2012 2/2012 – 2/2013	33.2 - 76.3 35.6 - 76.0	78 51	5/22, 9/04 5/02, 9/07
Historical Data – 2006-2009			*Average*	*General trend*
Hyatt Creek[3]		32.49 – 76.42°F	70/yr	5/28 – 9/24
Hyatt Creek[4]		34.03 – 80.54°F	63/yr	5/29 – 9/24
Hyatt Creek[5]		33.83 – 74.12°F	21/yr	6/28 – 8/30
Hyatt Creek[6]		33.88 – 69.94°F	0/yr	None

[1]At confluence with Raccoon Creek
[2]At confluence with Richland Creek
[3]At confluence with Richland Creek
[4]Upstream of package treatment plant
[5]Oxner Cove Br at confluence with Owl Ridge Branch
[6]Entrance to residential subdivision in upper reaches

2.3 Sediment (TSS, Turbidity)

According to the IPSI, sediment loadings are an estimated 14,113 tons per year (Table 8). The primary sources are unpaved roads, road banks, and stream banks (Figure 5).

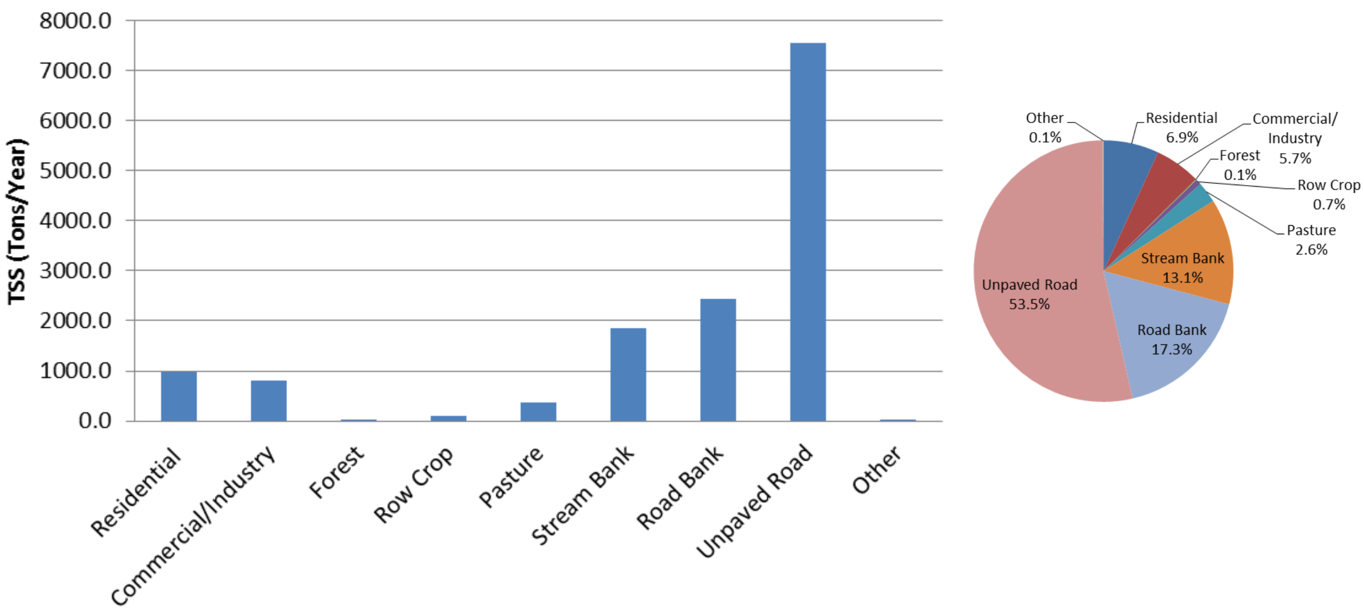

Figure 4. Total Suspended Solid Load Estimates

Table 8. Total Suspended Sediment Loadings by Subwatershed

Subwatershed	All Uses	Unpaved Road	Eroding Road Banks	Eroding Stream Bank	Fair/Poor/Overgrazed Pasture Condition		Animal Operations Adjacent to Stream
	Tons/Year	*Miles* *Tons/Year*	*Linear Feet* *Tons/Year*	*Linear Feet* *Tons/Year*	*Acres* *Tons/Year*	*% of* *Land Use*	*# /Linear Feet* *Tons/Year*
Allens Creek[1]	3,062.9	98.1 2,496.9	93,944 377.5	3,222 118.1	138.6 14.2	1.3	3/0 0.0
Eaglesnest Creek	323.9	3.4 87.4	34,082 136.9	1,320 35.8	24.1 2.6	2.7	2/0 0.0
Browning Branch	1,306.7	29.8 757.2	48,883 196.4	7,150 194.0	207.7 26.1	6.5	4/27 0.1
Hyatt Creek	545.4	11.0 280.3	11,075 44.5	4,812 130.6	309.3 32.8	20.1	7/231 1.3
Plott Creek	1,406.2	22.0 559.9	127,688 513.1	9,672 262.5	151.5 15.5	6.3	2/100 0.6
Raccoon Creek	1,331.7	24.5 623.0	47,711 191.7	8,085 301.4	463.7 61.5	14.0	8/136 0.8
Ratcliff Cove Branch	1,076.9	17.0 431.8	40,766 163.8	12,215 344.9	537.7 59.1	21.5	10/609 3.4
Richland Creek, Lower (downstream of Lake Junaluska)	1,385.9	23.9 608.9	77,879 312.9	5,094 138.2	608.7 100.7	14.5	3/348 1.9
Richland Creek, Middle (Lake Junaluska to Plott Creek)	1,904.0	23.1 588.2	64,035 257.3	8,240 223.6	541.9 22.5	7.2	4/232 1.3
Richland Creek, Upper (Plott Creek to head)	1,769.3	43.6 1,109.9	62,757 252.2	3,487 102.8	327.4 34.5	4.5	3/17 0.1
Totals =	**14,112.9**	**296.4** **7,543.5**	**608,820** **2,446.2**	**63,297** **1,852.0**	**3,310.6** **369.7**	**7.6**	**46 / 1,700** **9.5**

[1]Allens Creek – most unpaved roads in Waynesville Watershed; sedimentation most likely not as severe as model indicates due to predominantly forested land use, reservoir capture, or roads not in active use, or combination of these factors.

Approximately 7,543.5 tons TSS/yr originate from unpaved roads (Table 8). There are 625 miles of roads in the watershed with 310 miles of those unpaved. The IPSI model estimates most sediment originates from the Allens Creek subwatershed. However, those unpaved roads are within the protected Waynesville Watershed, the water supply watershed for the Town of Waynesville. While some level of erosion is occurring, the model very likely overestimates because the surrounding land use is entirely forested and the roads are historical logging roads that currently receive only minimal use. Also, any soil washing off the landscape settles behind the water supply dam and does not impact downstream reaches. The subwatershed that most likely contributes the highest TSS loads from unpaved roads is Upper Richland Creek (1,109.9 tons/yr), which has 43.6 miles of unpaved roads (Figure 6).

Approximately 38% of roads have eroding banks. Eroding road banks contribute 17.3% of TSS loads to the watershed (2,446.2 tons/yr). The Plott Creek subwatershed has the most issues with 127,688 linear feet of eroding banks; most of this watershed is residential.

There are 63,297 linear feet of eroding stream bank. Hundreds of properties are faced with this problem. In the Richland Creek watershed, Ratcliff Cove Branch has the largest amount with 12,215 lf (Figure 7), which contributes about 345 tons TSS/yr. That is part of the Raccoon Creek system, which has a total of 20,300 lf of eroding stream bank contributing 646.3 tons TSS/yr. Plott Creek and Middle Richland Creek also have high TSS loads.

Pasture condition and animal access points don't contribute large amounts of sediment compared to other sources. Pasture classified as fair, poor, or overgrazed comprise 7.6% (3,311 acres) of the total watershed area; Ratcliff Cove Branch and Hyatt Creek have the greatest percentage with 21.5 and 20.7%, respectively. Overall, pasture contributes 370 tons TSS/yr. Most sediment is coming from the Lower Richland, Upper Richland, Raccoon Creek, Ratcliff Cove Branch and Hyatt Creek subwatersheds.

There are 46 clearly identified animal access points that contribute 9.5 tons TSS/yr. Most of them are concentrated in the Raccoon Creek and Ratcliff Cove Branch subwatersheds.

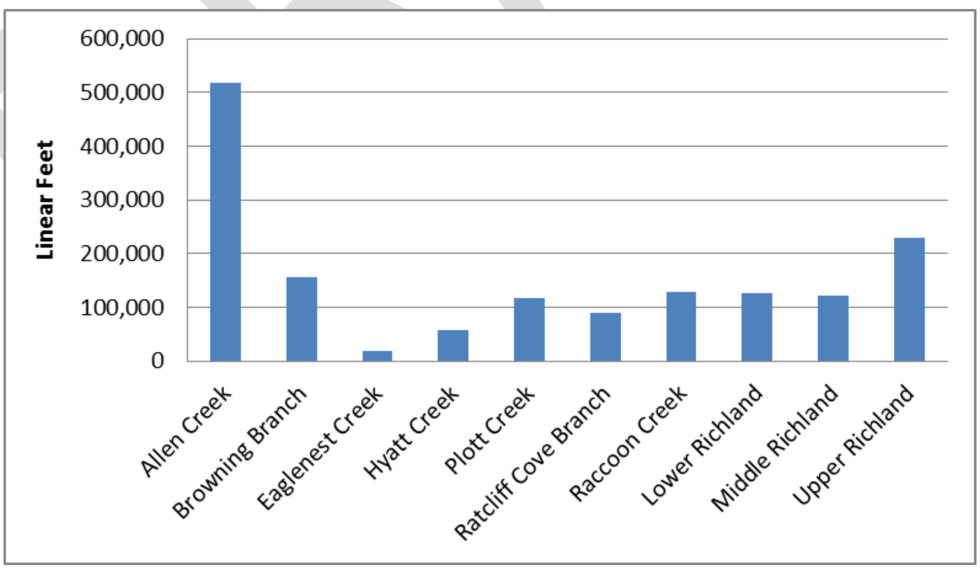

Figure 5. Length of Unpaved Roads

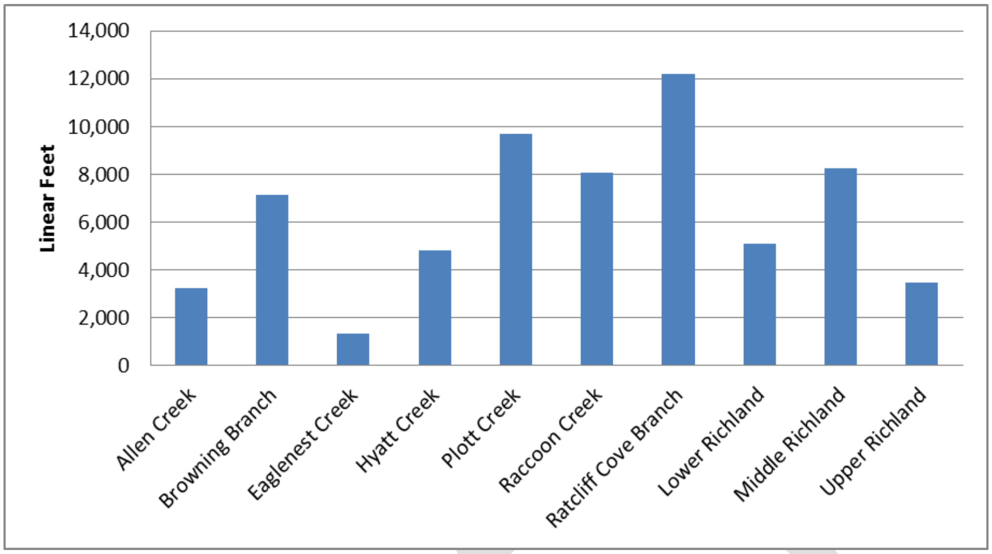

Figure 6. Length of Eroding Streambanks

The VWIN, single-stage stormwater sediment, and ISCO data support the information from the IPSI model. Erosion and sedimentation are issues in each subwatershed, but the highest TSS loads are coming from the Hyatt Creek and Ratcliff Cove Branch subwatersheds (Tables 9, 10, and 11). Upper Raccoon Creek and Eaglesnest Creek subwatersheds are also contributing significant loads.

According to the VWIN turbidity results, all sites had some samples that exceeded the 10 NTU trout standard and many were above the 50 NTU general standard. These same results were observed in the ISCO samples in lower Raccoon Creek.

The study completed by Western Carolina University provides additional evidence that high sediment loads are originating in the Raccoon Creek subwatershed. They found Raccoon Creek to have very high sediment loads compared to the Waynesville Watershed. The mean TSS was 288 but reached as high as 5,880 mg/L. For comparison, TSS concentrations from much larger flow events in the Waynesville Watershed rarely exceeded 500 mg/L. Turbidity values during base flow conditions often exceeded 10 NTUs in Raccoon Creek, and during larger floods turbidity exceeded 800 NTUs. Many areas along Raccoon Creek are dominated by sand and silt. Tens of centimeters of sediment would often form bars during flood events. Land-use maps and field observations suggest much of the sediment originates from Ratcliff Cove Branch. The stream bed is dominated by fine material, and qualitative observations suggest the channel bed sediment along Raccoon Creek changes upstream of Ratcliff Creek.

Table 9. VWIN Results by Subwatershed

Site	Years Sampled		Rating[1]	Sediment Rating	% samples exceeding 10 NTU	Metals Rating	Nutrients Rating	Issues[2]
Regional Average	1996-2012	2009 -	Good (82)	74	--	86	85	
		2012 -	Average (79)	72	--	--	85	
Allens Creek	1997-2012	2009 -	Excellent (98)	100	2.8	94	100	Alkalinity
		2012 -	Good (88)	92	14.3	--	83	
Eaglenest Creek	1996-2012	2009 -	Average (74)	50	25.0	81	92	Conductivity, sediment was an issue
		2012 -	Average (75)	67	27.9	--	83	but improving
Hyatt Creek upstream	1999-2012	2009 -	Poor (51)	25	75.0	69	58	Conductivity, sediment, copper, ortho-
		2012 -	Poor (55)	42	58.1	--	67	P, nitrate-N
Hyatt Creek downstream	1999-2012	2009 -	Poor (56)	25	55.6	75	67	Conductivity, sediment, ortho-P,
		2012 -	Poor (46)	33	51.0	--	58	nitrate-N
Plott Creek	1996-2012	2009 -	Good (83)	63	19.4	94	92	Alkalinity, sediment was an issue but
		2012 -	Good (83)	83	14.3	--	83	improving
Ratcliff Cove Branch	2000-2012	2009 -	Below Average (67)	38	51.8	88	75	Conductivity, sediment, ortho-P
		2012 -	Poor (59)	42	38.6	--	75	
Raccoon creek upstream	2000-2012	2009 -	Average (75)	63	29.6	88	75	Conductivity, sediment was an issue
		2012 -	Below average (67)	67	28.9	--	67	but improving, ortho-P, nitrate-N
Raccoon Creek downstream	2000-2012	2009 -	Average (77)	75	18.5	81	75	Conductivity, sediment was an issue
		2012 -	Average (71)	75	26.7	--	67	but improving, ortho-P, nitrate-N
Richland Creek upstream	1996-2012	2009 -	Excellent (91)	88	16.0	94	92	Alkalinity
		2012 -	Good (84)	75	15.4	--	92	
Richland Creek at Lake Junaluska	1996-2012	2009 -	Good (83)	75	12.9	81	92	Conductivity, sediment was an issue
		2012 -	Average (79)	75	14.0	--	83	but improving
Sites no longer active								
Green Valley Branch (Hyatt Ck)	2006-2009	2009 -	Poor (52)	50	31.4	56	50	Conductivity, sediment, zinc, ortho-P,
		2010 -	Poor (33)	33		--	33	ammonia-N, nitrate-N
Left Branch (Hyatt Ck)	2006-2009	2009 -	Below Average (65)	38	57.1	75	83	Conductivity, sediment
		2010 -	Poor (54)	25		--	83	
Owl Ridge Branch (Hyatt Ck)	2006-2009	2009 -	Poor (56)	25	77.8	69	75	Conductivity, sediment, copper, ortho-
		2010 -	Poor (54)	33		--	75	

[1]Ratings based on scale 0-100

2009 Ratings based on data from 2007 to 2009

2012 Ratings based on data from 2008 to 2012

[2]Parameters considered a significant issue if it received a grade of C or D.

Table 10. Single-Stage Stormwater Sediment Data

	Hyatt Creek	Ratcliff Creek	Raccoon Creek DWS	Raccoon Creek MID	Raccoon Creek UPS	Wolfpen Creek*
Total number of significant rain events	189	40	127	100	8	10
Stage A - Number of rain events	181	40	125	90	9	10
Average TSS concentration (mg/L)	495.9	768.9	1,003.5	690.0	2,286.4	491.2
TSS concentration range (mg/L)	15.6-5,818.8	48.6 – 4,900	7.2 - 32,866.7	60-5,831.6	280.1–13,166.7	273.8 – 876.2
Stage B - Number of rain events	151	22	69	49	1	3
Average TSS concentration (mg/L)	970.5	5013.3	2,724.7	1,736.7	2,635	1,426
TSS concentration range (mg/L)	12.8 – 4,766.7	189 – 31,435.9	5.2 - 40,950	166.7-24,870	--	935.8 – 1,881.2
Stage C - Number of rain events	95	12	28	26		
Average TSS concentration (mg/L)	1,654.4	5,728.2	1,642.8	1,816.9		
TSS concentration range (mg/L)	34.4 – 18,765.2	651 – 18,883.3	11.2 - 12,250	262.9-7,920		
Stage D - Number of rain events	47	8	16	12		
Average TSS concentration (mg/L)	1,479.4	3,851.1	4,823.0	4,527.2		
TSS concentration range (mg/L)	167.3 – 4,072.7	1,100 – 7,447.1	466.7 - 30,050	1,148.2 – 18,520		
Stage E - Number of rain events	4	5	11	4		
Average TSS concentration (mg/L)	3,204.5	4,848.4	3,845.2	7,717.9		
TSS concentration range (mg/L)	396.8 – 10,440	1,234 – 10,914.3	762.6 - 10,700	955.4-27,180		
Stage F - Number of rain events			4	3		
Average TSS concentration (mg/L)			7,324.4	2,816.9		
TSS concentration range (mg/L)			1,162.4 -14,714.3	1,325.1-4,440		

*Tributary in the Raccoon Creek Subwatershed

Table 11. Raccoon Creek ISCO Stormwater Data

Date	NH3 (mg/L)	NO3 (mg/L)	Ortho-P (mg/L)	Turbidity (NTU)	TSS (mg/L)
11/25/11	0.20	0.5	0.56	260.0	340.7
12/1/11	0.08	0.7	0.23	180.0	312.0
12/8/11	0.25	0.6	0.45	230.0	516.4
1/24/12	0.36	0.7	0.87	320.0	335.5
2/6/12	0.10	0.8	0.18	95.0	94.8
3/1/12	0.12	0.8	0.27	170.0	210.4
3/7/12	0.46	0.4	0.37	550.0	774.5
4/18/12	0.21	0.5	0.50	350.0	522.4
Standard =	1.0 in summer 2.0 in winter	10.0	>0.5 is high	10 Trout 50 General	>100 considered high

2.4 Nutrients

The IPSI models estimates 80,200 lbs of nitrogen and 11,676 lbs of phosphorus are flushed into the Richland Creek Watershed each year (Table 12). Most is coming from Middle Richland Creek subwatershed.

The VWIN data indicate orthophosphate and nitrates are also an issue in the Hyatt Creek and Raccoon Creek subwatersheds (Tables 6 and 9). According to Westphal et al. (2009), the most probable sources of nutrients are septic drainage, agricultural operations and residential fertilizers. The ISCO samples provide additional evidence orthophosphate levels are periodically high in Raccoon Creek (Table 11).

2.5 Metals

According to the VWIN data, metals are not a significant issue except in the Hyatt Creek subwatershed (Tables 6 and 9). There is very little industrial influence in the watershed except for two landfills. There have also been many failing septic systems and an outdated package treatment plant for a mobile home park. A conductivity field survey by Haywood Waterways found high readings in Owl Ridge Branch and attributes that to two closed livestock waste treatment lagoons. There were no indications the landfills were leaking. Starting in 2010, metals were no longer included in VWIN sampling due to the lack of evidence of impacts.

2.6 Fecal Coliform Bacteria

At the DWQ ambient site on Richland Creek the average sample was 430 with a range of 280 to 800 (Table 13). While the data indicate multiple sources, DWQ have historically found primary sources originating from the Hyatt Creek and Shelton Branch subwatersheds. Hyatt Creek at the mouth had mean of 2,098 colonies/100 ml. At one site on Oxner Cove Branch, a tributary within the Hyatt Creek subwatershed, a mean of 4,625 was found. There have been many septic repairs made by project partners in the Hyatt Creek watershed since and concentrations are expected to be lower. Raccoon Creek also appears to have issues as three sites all had samples greater than 200. However, additional sampling is needed as those results are based on only one sample from 2006.

Table 12. Nutrient Load Estimates by Subwatershed

Subwatershed	Total Nitrogen		Total Phosphorus	
	Lbs/yr	*lbs/acre/yr*	*Lbs/yr*	*lbs/acre/yr*
Allens Creek	8,112.1	0.75	1,939.6	0.18
Eaglesnest Creek	10,250.6	2.17	1,244.0	0.30
Browning Branch	1,956.5	1.99	269.4	0.28
Hyatt Creek	3,284.4	2.20	505.0	0.34
Plott Creek	2,850.3	1.18	280.0	0.12
Raccoon Creek	8,186.1	2.48	1,253.9	0.38
Ratcliff Cove Branch	4,902.2	1.96	814.2	0.33
Richland Creek, Lower (downstream of Lake Junaluska)	8,742.7	2.10	1,163.4	0.28
Richland Creek, Middle (Lake Junaluska to Plott Creek)	25,524.9	3.37	3,222.2	0.44
Richland Creek, Upper (Plott Creek to head)	6,396.6	1.42	884.6	0.17
Totals =	**80,206.4**	**1.84**	**11,676.3**	**0.27**

Table 13. Fecal Coliform Bacteria Data (2010 data unless noted)

Stream	Location	Mean	Range
Richland Creek	UPS confluence with Hyatt Creek	452	200-730
Hyatt Creek	Confluence with Richland Creek (2007)	2,098	290-5,200
Oxner Cove Branch	Near confluence with Hyatt Creek (2007)	4,625	2,000-7,900
Richland Creek	DWS confluence with Hyatt Creek	1,080	370-1,900
Richland Creek	At Elsynia Road	354	180-700
Richland Creek	At Water Street	428	120-730
Shelton Branch	Confluence with Richland Creek	638	180-1,000
Richland Creek	UPS Shelton Branch	390	120-700
Richland Creek	DWQ ambient, UPS confluence of Raccoon Ck and Lake Junaluska	430	280-800
Raccoon Creek	3 sites (Only one sample collected at each site in 2006)	1,263	480-2,700

2.7 Benthic Macroinvertebrates

Macroinvertebrates play a critical role in aquatic ecosystems in terms of nutrient processing and as a food source for fish, birds, amphibians, and other insects. Some species are more sensitive to poor water quality and DWQ uses the presence/absence of specific macroinvertebrates to identify potential issues. The following results are from data collected by Watershed Science and are summarized in Table 14.

Upper Raccoon Creek: The bioclassification of all surveys were given Good/Fair ratings; however, most of the metrics increased towards better water quality conditions. EPT taxa richness, the number of intolerant taxa (< or 2.0) and the biotic index values were all significantly improved during this investigation. Many of the intolerant taxa were either abundant or common during all surveys (*Malirekus hastatus*, *Pteronarcys* spp., *Glossosoma* spp., *Dolophilodes* spp., and *Rhyacophila fuscula*); however many intolerant taxa were only collected during the 2011 or 2012 investigations (*Maccaffetitum meririvulanum*, *Paraleptophlebia* spp. *Tallaperla* spp., *Isoperla holochlora*, and *Goera* spp.) suggesting that water quality conditions are improving.

Middle Raccoon Creek: It is apparent that water quality conditions decline at this location compared to upstream. Taxa richness, EPT abundance, and the number of intolerant taxa all are much lower and the Biotic Index values are greater. The site received a Poor bioclassification in 2010 but conditions improved and a Fair rating was given in 2011 and 2012. Many of the intolerant taxa collected upstream were eliminated at this location. An intolerant hydropsyche caddisfly (*Diplectrona modesta*) was abundant upstream and not collected at this location. It is interesting to note that two intolerant caddisflies (*Glossoma* spp., and *Dolophilodes* spp.) were abundant only during 2011 and 2012.

Lower Raccoon Creek: An improvement in the bioclassification rating was noted at this location in 2012; however, this improvement is based only on the marginal increase in the number of EPT (22 EPT taxa is the cutoff for a Good/Fair score in mountain streams) and the Biotic Index value is higher in 2012 than the initial survey in 2010. Also the fauna is dominated by filter-feeding caddisflies in the family Hydropsychidae. A very tolerant hydropsychid (*Hydropsyche betteni*) was abundant at this location. Other tolerant taxa were also common or abundant during the 2011-2012 surveys (*Nais* spp., *Physella* spp. and *Dugesia tigrina*). These data suggest that water quality conditions in this stream continue to be problematic, despite the increase in bioclassification.

Lower Richland Creek: The bioclassification rating was consistently Good/Fair during the three surveys. However there was an increase in the number of intolerant taxa from only 6 in 2010 to 11 taxa in 2012 and the Biotic Index value was lower each year as well. These data suggest that some improvements in water quality conditions. Many intolerant taxa were collected for the first time in 2012 or increased in abundance during this time period. These taxa include mayflies (*Baetis tricaudatus*, *Serratella serratoides*, *Rhithrogena* spp., and *Paraleptophlebia* spp.), stoneflies (*Sweltsa* spp., *Helopicus subvarians* and *Pteronarcys* spp.) and caddisflies (*Glossosoma* spp. and *Rhyacophila fuscula*).

Plott Creek: A Good/Fair bioclassification was given during each of the investigations (based only on the number of EPT taxa collected). Very subtle, insignificant differences were seen in most metrics between years. However there was a fairly significant decline in the Biotic Index between years which was accounted for by an increase in the number of intolerant taxa in 2012. These taxa include the following; *Baetis tricaudatus*, *Epeorus dispar*, *Rhithrogena* spp., *Sweltsa* spp., *Isoperla holochlora*, *Rhyacophila fuscula*, *Atherix* spp., *Dicranota* spp. and *Promoresia tardella*. The abundance of these organisms resulted in a lower Biotic Index during the 2012 survey.

Table 14. Benthic Macroinvertebrate Summary Data (Watershed Science)

	Upper Raccoon Cr			Mid. Raccoon Cr			Lower Raccoon Cr			Lower Richland Cr			Plott Creek			Cataloochee Cr		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
Ephemeroptera	10	10	10	5	10	8	8	8	13	11	7	13	12	15	13	19	19	18
Plecoptera	4	6	8	0	2	1	2	3	1	3	3	5	7	6	7	11	11	11
Trichoptera	7	8	8	5	5	7	6	7	8	8	6	7	7	8	7	15	19	16
Diptera: Misc	3	4	4	2	2	2	2	2	3	3	4	3	4	6	5	5	6	5
Diptera: Chironomidae	5	6	2	6	6	5	6	7	8	12	9	10	8	6	3	7	14	6
Coleoptera	5	3	3	3	0	2	1	2	0	2	2	2	4	2	3	1	2	3
Odonata	1	4	4	4	3	4	3	3	3	4	5	2	2	2	1	0	1	2
Oligochaeta	1	1	0	2	1	1	1	1	2	2	2	2	2	3	2	1	2	1
Megaloptera	1	1	0	2	1	0	0	1	1	1	2	1	0	0	0	1	1	1
Crustacea	1	0	1	1	0	0	2	2	1	1	0	1	1	1	2	2	1	1
Mollusca	2	1	1	2	2	3	1	3	3	3	5	2	2	2	2	1	1	1
Other Misc. Taxa	0	0	0	0	1	0	0	1	1	1	0	0	1	0	0	0	0	0
EPT taxa richness	21	24	26	10	17	16	16	18	22	22	16	25	26	29	27	45	49	45
Seasonal Correction	21	23	24	10	17	15	16	18	22	22	15	23	25	27	24	43	45	41
Total Taxa richness	40	44	41	32	33	33	32	40	44	51	45	48	50	51	45	63	77	65
EPT abundance	96	126	96	43	90	62	71	84	117	109	82	120	113	128	157	237	227	230
No. of taxa $\leq$ 2.0 BI	10	12	14	2	3	2	5	3	4	6	7	11	14	14	15	30	30	27
Biotic Index	4.46	3.77	3.31	6.08	4.97	4.91	5.48	5.56	5.56	4.80	4.50	4.39	4.15	3.46	2.73	2.39	2.45	2.86
Seasonal BI correction	4.86	4.17	3.71	6.48	5.37	5.31	5.88	5.96	5.96	5.20	4.90	4.78	4.55	3.86	3.12	2.79	2.89	3.26
Bioclassification	G/F	G/F	G/F	Poor	Fair	Fair	Fair	Fair	G/F	G/F	G/F	G/F	G/F	G/F	G/F	Ex	Ex	Ex

BI = Biotic Index
EPT = Ephemeroptera, Plecoptera, Trichoptera

Cataloochee Creek. Cataloochee Creek was selected as an ecoregional reference location. Data from this site have consistently resulted in Excellent bioclassifications. The fauna at this site is dominated by very intolerant organisms – 27-30 taxa have biotic index values of < 2.0. Many of the EPT taxa found in the project study are only collected at this location.

The most recent TVA data from 2011 and 2012 indicate Richland Creek has Poor to Fair/Good water quality (Table 15). The 2011 data showed a downward trend from 2010 but the 2012 data provide evidence of an improving community. Between 2008 and 2009, Hyatt Creek improved from Poor to Fair and has remained constant since. Raccoon Creek is considered Fair. Data from the Stream Monitoring Information Exchange Program (SMIE) indicate water quality is Fair to Good but it has varied over the years (Table 16; SMIE 2012).

Table 15. Benthic Macroinvertebrate Community Ratings (TVA)

		Year							
Stream	**Location**	**1997**	**2003**	**2006**	**2008**	**2009**	**2010**	**2011**	**2012**
Richland Creek	Vance Street Park	Poor/ Fair			Fair		Fair	Fair	
Richland Creek	Eaglesnest Road bridge		Good		Good		Good	Fair/ Good	
Richland Creek	Richland Ck Road bridge		Poor/ Fair		Fair		Fair	Poor	Poor/ Fair
Hyatt Creek	Little Acres Road			Poor	Poor	Fair	Fair	Fair	
Raccoon Creek	Junaluska Elementary						Fair	Fair	

Table 16. Benthic Macroinvertebrate Community Data (SMIE)

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Raccoon Creek	--	--	--	Good	Good	Fair	Good
Richland Creek	Fair	Fair	Good	Good	Poor	Fair	Fair/Good

Izaak Walton Score: Excellent > 22, Good 17-22, Fair 11-16, Poor < 11

2.8 Fish

DWQ's survey in 2012 found the fish community to have a Fair rating (IBI Score = 36) at the ambient monitoring site. This is lower than previous years due to the absence of eight species typically collected at the site - river chub, longnose dace, blacknose dace, Tennessee shiner, silver shiner, white sucker, greenfin darter, and olive darter. The upstream site at SR 1184 was "Not Rated" because multiple species being introduced have not established themselves yet and others are lake migrants. If it was eligible to be scored it would have received a "Good-Fair" rating.

The most recent TVA data indicate Richland Creek has Very Poor to Fair water quality (Table 17). The Fair rating in 2012 is an improvement over previous years. Hyatt Creek has shown subtle improvements since 2006 but conditions are only Poor/Fair. Raccoon Creek is considered Poor.

In Hyatt Creek, WRC's assessment revealed the presence of only six species (NCWRC 2006). The total number of individuals encountered was low, with two species represented by a single individual. The overall in-stream habitat was considered poor; silt and sand, along with the general lack of habitat diversity for various life stages is likely suppressing the density of all species. Fish communities are limited by multiple barriers in the form of metal pipes or concrete box culvert stream crossings.

Table 17. Fish Community Ratings (TVA)

Stream	Location	1997	2003	2006	2008	2009	2010	2011	2012
Richland Creek	Vance Street Park	Poor			Poor		Poor	Fair	
Richland Creek	Eaglesnest Road bridge		Poor/ Fair		Fair		Poor	Very Poor	
Richland Creek	Richland Ck Road bridge		Poor		Poor/ Fair		Poor	Poor	Fair
Hyatt Creek	Little Acres Road			Very Poor/ Poor	Poor	Poor/ Fair	Poor/ Fair	Poor/ Fair	
Raccoon Creek	Junaluska Elementary						Very Poor/ Poor	Poor	

2.9 Other Issues

Exotic species

Stream corridors are ideal for many exotic and invasive species. The open canopy allows abundant sunlight to penetrate and support a variety of plants that out-compete native vegetation. There are multiple species prolific along Richland Creek Watershed streams, including multiflora rose (*Rosa multiflora*), kudzu (*Pueraria lobata*), Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and bamboo (*Bambusa* spp., *Phyllostachys* spp).

These species can cover and strangle native species and form an extremely dense understory that prevents any other species from growing. Vines like kudzu can cause trees to fall and when the canopy is open, it opens up new habitat for the invasives. Because wildlife is not adapted to exotic species, there is less food available for terrestrial and aquatic animals. Also, exotic species typically lack the deep, stabilizing root systems that help hold stream banks together during high water events.

Litter

Haywood Waterways Association started an Adopt-A-Stream program to help clean up Haywood County rivers and streams. Trash finds its way into waterways by way of stormwater runoff, wind action, and careless individuals. Trash can obstruct storm drains and cause flooding, clog intake pipes for water supplies and industry, and affect recreational uses, such as fishing, swimming, and paddling.

Since the Adopt-A-Stream program began in 2009, eleven organizations have adopted stream sections within the Richland Creek Watershed. Most of the focus has been on the main stem of Richland Creek but sites have been adopted in Allens Creek and Raccoon Creek. In that time, 290 volunteers participated in 22 clean-ups that removed over 8.8 tons of trash; most of that from the main stem of Richland Creek. However, new trash loads are continuously added to local streams, primarily due to the urban setting surrounding the Town of Waynesville. Most of the focus continues to be on Richland Creek but sites have been adopted in Allens Creek and Raccoon Creek.

SECTION 3. MANAGEMENT MEASURES & EVALUATION CRITERIA

This section provides a series of strategies and action items to address those stressors. Tables 18 and 19 summarize the stressors, sources, management measures, restoration indicators and target goals. Table 20 summarizes the primary stressors in each subwatershed.

If these measures are implemented, it is anticipated that Richland Creek and Raccoon Creek can be candidates for removal from the state list of impaired waterways within five years. They will also provide long-term protection of water quality throughout the watershed.

The common cause of pollution in all subwatersheds is stormwater. Richland Creek and multiple tributaries flow through the Town of Waynesville with heavily urbanized land uses. There are also abundant residential communities and scattered commercial and industrial properties throughout the watershed. The impervious surfaces and poorly vegetated areas associated with these land uses contribute to stormwater impacts. Impervious surfaces and unvegetated areas with highly compacted soil lead to greater runoff rather than absorption into groundwater. As the water flows over these surfaces, it picks up dirt, fertilizers, animal waste, bacteria, pesticides, oil, and other pollutants, all of which ultimately end up in streams. Also, the more impervious surfaces there are in an area the faster the rate of runoff will be, which can overwhelm a stream and cause significant bank erosion and flooding of downstream neighbors. Most of the sediment that washes into the Richland Creek Watershed occurs during periods of high precipitation when stormwater runoff is at its greatest. The strategies addressed in this section all provide some level of stormwater control and treatment.

Erosion and sedimentation is a result of issues related to stormwater, development, and agricultural. Soil is getting into streams due to eroding stream banks, poorly designed and maintained road systems, inadequate riparian buffers, channelization, poor pasture conditions, impervious surfaces, and animal access to streams. There are many programs and best management practices available to address these issues; first and foremost they should focus on erosion prevention followed by sedimentation control.

Richland Creek is on the NC impaired waterways list primarily due to fecal coliform bacteria. The sources have been identified as failing sewer infrastructure and septic systems, and runoff containing pet and livestock waste. A failing system near a waterway can dump up to 360 gallons of untreated wastewater in to the stream every day. Some of the harmful materials possibly found in septic waste as well as animal waste in runoff include raw human feces, nutrients, pharmaceuticals, and household cleaners. Feces itself can contain bacteria and viruses that are a serious threat to human health. Hazards include ear infections, typhoid fever, hepatitis A, viral and bacterial gastroenteritis, and dysentery.

Nutrients occur naturally in the environment. However, some human activities increase the nutrient concentrations to levels unsafe for humans and livestock. Nutrients are most commonly found in animal waste, septic waste, and fertilizers. When fertilizers are used too close to a water source and shortly before a rain event, heavy rains can wash the fertilizer into a waterway. Nutrification can lead to "blue baby syndrome, as well nuisance algal blooms, which, when the algae die, can lead to fish kills due to the decomposing bacteria robbing the water of oxygen.

High temperatures are another negative result of impervious surfaces and insufficient riparian cover. In the heat of summer an asphalt parking lot can 120 - 150°F. When it rains, that heat is transferred to the runoff, which travels downstream to the nearest waterways. The Richland Creek Watershed is a coldwater stream supporting a high diversity of aquatic organisms, such as trout, darters, and stoneflies. Sudden temperature swings can cause severe stress on wildlife, which can result in death, reduced eating behavior, or impaired reproductive capabilities.

Table 18. Stressors, Sources, and Target Indicators to Achieve Management Measure Goals

Primary Stressors	Sources	Restoration Indicator and Target[1]	Five-Year Target
Sediment	• Stormwater • Riparian vegetation • Eroding streambank • Unpaved roads • Livestock access • Land disturbing activities	Substrate = course materials TSS = <30 mg/L, <100 mg/L Turbidity <10 NTU Benthos community = Good/Fair Fish community = Good/Fair	Substrate = course materials TSS = 50% reduction in VWIN concentrations >100 mg/L TSS = 50% reduction in stormwater concentrations Turbidity: 50% reduction in samples exceeding 10 NTU standard Benthos community = Good/Fair Fish community = Good/Fair
Bacteria	• Septic systems • Town sewage system • Livestock waste • Pet waste	Fecal coliform < 200 colonies/100 ml	Fecal coliform: 50% reduction in samples exceeding 200 colonies
Nutrients	• Riparian vegetation • Livestock waste • Fertilizers • Wastewater treatment systems	Nitrate/Nitrogen <10 mg/L Orthophosphorus <0.05 mg/L Benthos community = Good/Fair Fish community = Good/Fair	Nitrate/Nitrogen: 25% reduction in samples exceeding VWIN target of 1.0 mg/L Orthophosphorus: 25% reduction in samples exceeding VWIN target of 0.10 mg/L Benthos community = Good/Fair Fish community = Good/Fair
Temperature	• Riparian vegetation • Impervious surfaces • Illicit dischargers	Temperature <68° F Benthos community = Good/Fair Fish community = Good/Fair	Temperature: 25% reduction in samples exceeding 68° F Benthos community = Good/Fair Fish community = Good/Fair

[1]Basis for targets

- Substrate composition: no standard, predominantly course materials ideal for biological communities
- TSS: no legal standard,
  - Non-stormwater <30.0 mg/l (Westphal et al. 2009)
  - Stormwater <100 mg/L (Westphal et al. 2009)
- Turbidity: DWQ standards (trout waters)
- Temperature: DWQ standard (trout waters)
- Nitrogen: DWQ standard (water supply waters)
- Phosphorus: no legal standard, <0.05 mg/L to prevent eutrophication (Westphal et al. 2009)
- Fecal coliform bacteria: DWQ standards (geometric mean)
- Benthos community: DWQ standards
- Fish community: DWQ standards

Table 19. Management Measures, Load Reduction Parameters and Evaluation Measures

Management Measure	Target Stressor(s)	Parameter Targeted for Load Reduction	Evaluation Measures
Stormwater collection devices[1]	High flow Eroding streambanks	Discharge: ft^3/s Sediment: tons/yr	Discharge Streambed composition, TSS
Stormwater collection devices[1]	Excess nutrients, bacteria	Nutrients: lbs/yr Fecal coliform: colonies/100ml	Nitrogen, Phosphorus Fecal coliform
Stormwater collection devices[1]	High temperature	Temperature: degrees F	Temperature
Stormwater drainage controls[2]	High flow	Discharge: ft^3/s	Discharge
Revegetating exposed ground	Excess sediment	Sediment: tons/yr	Streambed composition, TSS
Instream modifications[3]	Eroding streambanks	Sediment: tons/yr	Streambed composition, TSS
Streambank modifications[4]	Eroding streambanks	Sediment: tons/yr	Streambed composition, TSS
Streambank modifications[4]	Excess nutrients, bacteria	Nutrients: lbs/yr Fecal coliform: colonies/100ml	Nitrogen, Phosphorus Fecal coliform
Streambank modifications[4]	High temperature	Temperature: °F	Temperature
Agricultural improvements[5]	Eroding streambanks	Sediment: tons/yr	Streambed composition, TSS
Agricultural improvements[5]	Excess nutrients, bacteria	Nutrients: lbs/yr Fecal coliform: colonies/100ml	Nitrogen, Phosphorus Fecal coliform
Wastewater treatment[6]	Excess nutrients, bacteria	Nutrients: lbs/yr Fecal coliform: colonies/100ml	Nitrogen, Phosphorus Fecal coliform

[1]Stormwater collection devices: constructed wetland, bioretention, retention/infiltration ponds, storage tanks
[2]Stormwater drainage controls: permeable surfaces, bioswales, level spreader, berms, drop box, diversion ditch, check dams, proper culvert spacing, undersized culvert replacement, paving very steep roads
[3]Instream modifications: cross vanes, j-hook vanes, w-vanes, boulders, tree revetments
[4]Streambank modifications: riparian buffers, silt fences, slope enhancements, sinuosity, root wads, bank hardening
[5]Agricultural improvements: livestock fencing, designated stream crossings, pasture improvements, treatment lagoons, concentrated feeding and waste stations
[6]Wastewater treatment: septic system repair, municipal sewage treatment system upgrades

Table 20. Primary Issues within Richland Creek Subwatersheds

Subwatershed	Stressors	Primary Issues
Allens Creek	Sediment, temperature, bacteria, litter	Unpaved roads and eroding road banks in Waynesville Watershed; aging septic systems; heavily urbanized land uses at confluence with Richland Creek; rock quarry
Eaglesnest Creek	Sediment	Development, stormwater
Browning Branch	Sediment, temperature	Heavily urbanized land uses at confluence with Richland Creek (8.4% impervious); unpaved roads; >50% insufficient riparian buffer; golf course
Hyatt Creek	Sediment, temperature, bacteria, metals, nutrients	>85% insufficient riparian buffer; eroding pasture conditions; livestock access points; failing septic systems
Plott Creek	Sediment	Unpaved roads; eroding road banks; eroding stream banks; >40% insufficient riparian buffer; development
Raccoon Creek	Sediment, temperature, nutrients, bacteria	Unpaved roads; eroding stream banks; >80% insufficient riparian buffer; eroding pasture conditions; livestock access points
Ratcliff Cove	Sediment, temperature, nutrients	Eroding stream banks; >80% insufficient riparian buffer; eroding pasture conditions; livestock access points
Richland Creek, Lower (downstream Lake Junaluska)	Sediment, temperature	Unpaved roads; eroding road banks; >70% insufficient riparian buffer; eroding pasture conditions
Richland Creek, Middle (Lake Junaluska to Plott Creek)	Sediment, Temperature, nutrients, litter	Stormwater (over 14% impervious land uses); unpaved roads; eroding stream banks; >85% insufficient riparian buffer; eroding pasture conditions
Richland Creek, Upper (Plott Creek to head)	Sediment	Unpaved roads; >35% insufficient riparian buffer

The data review gave an indication of the issues that should be focused on in each subwatershed (Table 20). Much of the initial restoration efforts should be on Raccoon Creek, Ratcliff Cove Branch, Hyatt Creek and Middle Richland Creek subwatersheds. The strategies, or best management practices, outlined in this section will have significant benefits for the environment, community, and economy of Haywood County and help the partnership attain the long-term goals. Oftentimes, multiple action steps should be integrated approach to maximize effectiveness and address the many challenges of working in this mountainous region.

As the Richland Creek Watershed is developed, many landscape changes can cause expensive problems in the future. The management measures will also provide preventative steps to address future water quality issues. It is far more economical to prevent pollution and degradation of our waterways than it is to clean up after the damage has been done.

3.1 Continue and Improve Water Quality Monitoring

Monitoring is one of the primary strategies in this WAP. It is critical to maintain a comprehensive monitoring program to characterize current conditions, changing watershed conditions, identify restoration needs, justify grant applications and demonstrate measurable results from watershed improvement projects.

Action Steps:

1. Continue current monitoring programs for temperature, stormwater TSS, substrate composition, VWIN, nutrients, and biological communities.
2. Use a comprehensive monitoring plan to document water quality improvements as management measures are implemented.
3. Expand temperature monitoring in Lower Richland Creek, Middle Richland Creek (including Shelton Branch), middle Raccoon Creek, Ratcliff Cove Branch, Browning Branch, and Hyatt Creek.
4. Expand stormwater TSS monitoring in Plott Creek, Lower Richland Creek, Middle Richland Creek, and Upper Richland Creek.
5. Expand VWIN monitoring in Lower Richland Creek and Browning Branch.
6. Start bacteria monitoring program through Haywood Waterways, the county, or the Town of Waynesville.
7. Make the data available to public officials and agencies and organizations working on water quality improvement projects.
8. Periodically review monitoring parameters, locations and frequency; modify as needed to ensure they represent the highest priority needs.
9. Acquire revised IPSI data sets every 5 years.
10. Share information about changing conditions and threats with stakeholders.
11. Include monitoring funds in grant requests.
12. Work with Haywood Waterway and other organizations to continue offering volunteer monitoring opportunities.

3.2 Continue and Expand Education Campaigns

There are many excellent educational and awareness efforts ongoing in Haywood County. Educating the public is one of the best strategies for the long-term benefit of water quality. It helps build community participation, giving citizens a vested interest in the health of their waterways. Much of the focus should be on youth to instill environmentally responsible behaviors at an early age. Public presentations should focus on the management measures and recommendations found in this section of the Watershed Action Plan, in part to recruit landowners to implement management measures. The key project partners working on education include HWA, HSWCD, Cooperative Extension Service, WRC, USFWS, and GSMNP, but there are many others that assist these organizations.

One of the most important education programs should be erosion control training, not only for developers and general contractors but for the equipment operators and staff working the shovels. The staff involved with actual construction are ultimately the ones responsible for implementing the plans as well as troubleshooting. They are the ones that need to identify issues in the field and relay that information to the developers, engineers, and other responsible for site planning. The training options typically available are Clean Water Contractor Program offered by The Mayberry Group and the Green Dozer Program offered by NCSU. However, they are offered infrequently and may not be cost-effective. There is also the Regional Erosion and Sediment Control Initiative, an effort by the watershed organizations in the seven western-most counties to develop a training system that is affordable, on-going, and mountain specific. The organizations are working on a delivery system with local community colleges and have a goal to start the trainings within two years.

Action Steps: See Table 21.

Table 21. Recommended Education Action Steps

Program/Activity	Organization
Adopt A Stream (litter control)	HWA
Conservation Field Days	HSWCD
EnviroThon	HSWCD
Kids in the Creek	HWA, Haywood County School System
Informational brochures	All
Newsletters	All
Newspaper columns and articles	All
Presentations to public	All
Presentations in schools	All
Public displays	All
Public meetings	All
Signs – stream and watershed	All
Social media – facebook, Twitter	All
Surveys	HWA
Tours of projects	All
Training sessions in erosion control, conservation-based development	All
Websites	All
Y.E.S. Camp	HSWCD

3.3 Implement Stormwater Treatment and Control Systems

Stormwater is the number one cause of nonpoint source pollution to waterways. The primary concerns with stormwater are high stream flows and the transport of pollutants off the landscape into steams. To reduce risks associated with high flows, stormwater should be collected and retained on or near the point of origin. By keeping stormwater on-site, stream discharge is reduced which results in less stream bank erosion. It also allows water to seep into the groundwater supply. Any collection methods should also provide some measure of treatment to filter pollutants, including sediment, nutrients, and thermal pollution. Retaining runoff onsite allows water to cool.

If stormwater cannot be retained on site, then steps must be taken to avoid concentrating water flows. Concentrating flows greatly increases the erosive capacity of the water. Culvert spacing on roads illustrates this concept. If there are not enough culverts along road sections, the volume and velocity of the water will greatly accelerate erosion in the ditch line of the road and eventually the adjacent cut banks and roadbed. Intercepting the water with properly spaced and installed culverts, then dispersing the water from the culvert outlet so it can be readily absorbed into the ground, will reduce this problem.

One issue highlighted by the temperature data is the presence of illicit dischargers. These are any discharges into a storm drain system this is not entirely stormwater, such as water from a commercial car wash or a hotel emptying a pool into a storm drain. This is a Phase II requirement in the Town of Waynesville's permit and they have mapped all drainage pipes into Richland Creek and its tributaries, which will help when it is necessary to investigate sources of pollution. Haywood County should complete this mapping for rest of the watershed.

Installing these planned stormwater practices before building construction begins may be one of the most effective ways to minimize impacts. This avoids having to play catch-up later during the project, which can lead to delays or additional expenditures.

It is also possible to retrofit existing sites, though it may take additional planning to accommodate utilities and other challenges. Working with Homeowners Associations should be one targeted group. These properties tend to have major issues due to lack of maintenance and changes in the landscape as new houses are constructed.

The Lake Junaluska Assembly and Town of Waynesville both have stormwater management plans. The Lake Junaluska plan includes an analysis of the property, identification of issues, recommended BMPs, and prioritization of those recommendations. The Town of Waynesville's Stormwater Master Plan outlines a comprehensive, innovative and aggressive stormwater program. The Plan covers current stormwater regulations and policies; implements the requirements of the NPDES Phase II Permit including NPDES Outfall Inventory and Illicit Discharge Detection; assesses existing land uses and stormwater infrastructure conditions and capacity; identifies additional infrastructure needs; identifies solutions for stormwater quantity and quality issues; and contains a Capital Improvements Plan to manage current and future stormwater needs.

The following techniques should be considered for controlling and treating stormwater runoff:

- Stormwater collection devices: constructed wetlands, bioretention (rain gardens), retention ponds, and storage tanks (underground, above ground);
- Stormwater drainage controls: permeable surfaces, bioswale, level spreader, berms, drop box, diversion ditch, check dams, culvert spacing, culvert size, and paving very steep road sections;
- Streambank modifications: riparian buffers and silt fences;
- Revegetating exposed ground.

Action Steps:

1. Identify and prioritize properties in need of assistance.
2. Encourage developers, public officials, and others to install stormwater treatment and control techniques in all new construction.
3. Encourage property owners and public officials to retrofit existing sites.
4. Work with technical resource agencies to identify appropriate stormwater treatment and control devices for new construction or to retrofit existing sites.
5. Apply for financial resources to assist property owners.
6. Implement stormwater management measures.
7. Follow recommendations in Lake Junaluska Assembly Stormwater Management Plan and Town of Waynesville Stormwater Master Plan.
8. Map storm drains throughout watershed to help identify illicit dischargers.

3.4 Stabilize Streambanks

Streambanks are one of the primary sources of sediment in streams. There are many techniques that can be used to stabilize banks and prevent erosion. These include:

- Instream modifications: cross vanes, j-hook vanes, w-vanes, boulders, and tree revetments;
- Streambank modifications: riparian buffers, slope enhancements, sinuosity, root wads, and bank hardening; and
- Agricultural operations: livestock fencing, alternative water sources, designated stream crossings, and pasture rotation.

Planting riparian vegetation is one of the most basic techniques and perhaps gives the best return on the investment. The buffer should consist of mixed, native vegetation, including trees, shrubs, and ground cover. DWQ recommends this strategy in their French Broad Basinwide Plan (2011). Having the mixed vegetation will reduce the erosive forces of rainfall and the deep roots will hold streambanks together during periods of high discharge. Additional benefits of buffer vegetation are filtration of sediment, nutrients, and bacteria; shading to reduce thermal stress; habitat for aquatic and terrestrial wildlife; food for wildlife; retaining water during heavy rainfall to reduce floodwater levels; and even income from commercial and recreational uses (ex. greenways). A recent initiative in western NC is the Shade Your Stream campaign developed by the Land Trust for the Little Tennessee and being implemented throughout the region through the Western North Carolina Water Quality Collaborative (https://sites.google.com/site/wncwater/home). The Campaign is working to encourage landowners to restore a healthy riparian buffer on their land.

Action Steps:

1. Identify and prioritize properties in need of assistance.
2. Encourage property owners, developers, and agricultural operators to install streambank protection measures.
3. Work with technical resource agencies to identify the appropriate streambank stabilization management measures.
4. Remove exotic and invasive species and replace with native vegetation.
5. Apply for financial resources to assist property owners.
6. Implement streambank stabilization management measures.
7. Promote the Shade Your Stream Campaign of the Western NC Water Quality Collaborative.
8. Promote greenways that include riparian buffer and other streambank protective measures.
9. Work with Haywood Waterway and other organizations to offer volunteer opportunities for riparian plantings.

3.5 Eliminate Sources of Bacteria

Richland Creek is on the state list of impaired waterways, in part, due to bacteria. DWQ conducted a multi-year survey of fecal sources in the Richland Creek watershed through sampling and characterization of the watershed, stream walking to identify sources, and repair of those sources. Sources of bacteria include failing septic systems, straight pipes, agricultural operations, and possibly the Town of Waynesville's wastewater treatment system.

DWQ recommends in the French Broad Basinwide Plan (2011) for local efforts to continue finding and repairing straight pipes and failing septic systems. Each septic repair can eliminate up to 360 gallons of untreated wastewater from discharging into local waterways per day. It will eliminate fecal coliform bacteria, excess nutrients, gray water waste (soaps, grease), pharmaceuticals, household chemicals, and heated water from entering our cold-water streams. It will also ensure continued treatment of human waste.

There is great demand for financial assistance to repair failing septic systems. Many homeowners are low income. Between 2007 and 2011, the Wastewater Discharge Elimination Program was a state-run program within the Division of Environmental Health. They worked with Mountain Projects, Inc to identify and repair failing septic systems for low and very low income households. They provided 100% of repairs costs for qualifying households through a grant from the NC Clean Water Management Trust Fund. In that time they repaired over 45 failing systems. Many were found to be "blackwater to surface", or leaking raw sewage. In 2011, the state cut the program for financial reasons. If the program is ever considered for reinstatement, project partners should support the effort.

The Town of Waynesville has made significant repairs and improvements to the sewer infrastructure in recent years and measurable improvement has been documented in Shelton Branch (Figure 7), a tributary to Richland Creek. Shelton Branch is within the Town of Waynesville and served by the Town's sanitary sewer collection system. Leaks in the collection system were identified and repaired, which resulted in the measured reduction in fecal coliform levels. DWQ (2011) also recommends the Town of Waynesville complete an inflow/infiltration study of the wastewater collection system and repairs made for any damaged lines and equipment discovered.

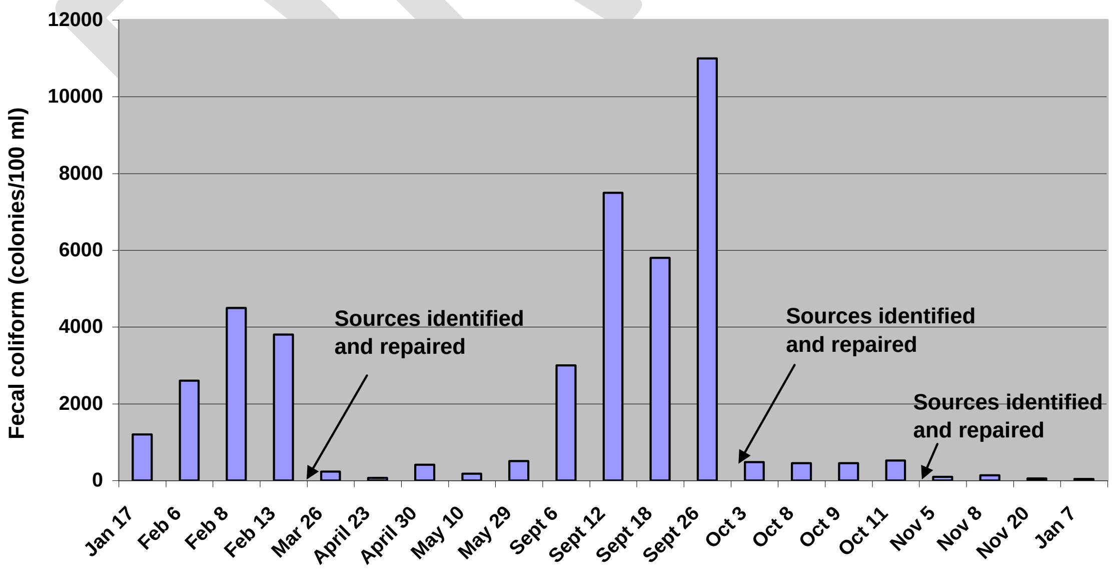

Figure 7. Fecal Bacteria Contamination in Shelton Branch

There are multiple steps that can be taken to reduce bacteria from livestock operations. Methods include livestock fencing, riparian buffers, treatment lagoons, concentrated feeding and waste stations, timing of manure applications, pasture improvements, and buyouts. Though not a major issue, stakeholders should encourage pet owners to pick up waste after their pets.

Action Steps:
1. Identify and prioritize properties in need of assistance.
2. Encourage livestock operators to install wastewater treatment management measures.
3. Work with technical resource agencies to identify the appropriate wastewater treatment management measures.
4. Apply for financial resources to assist property owners.
5. Implement wastewater treatment management measures.
6. The Town of Waynesville should continue monitoring their wastewater infrastructure and upgrade or repair any issues.
7. Encourage the public to pick up pet waste.
8. Encourage public officials to fund the WaDE Program and support the program if it returns.

3.6 Promote Conservation-Based Development Practices

Low impact development practices (LID) are construction techniques used to minimize stormwater runoff from sites transitioning from natural state to impervious surfaces. The first step in LID and the most effective tool to minimize pollutant loads is a good plan. A good plan will identify where the desired practices will best fit on the landscape and incorporate proven measures to minimize erosion. Avoiding problem areas and sites during the planning and design phase is one of the most cost-effective strategies for good project design and good conservation.

Haywood Soil & Water Conservation District, Natural Resource Conservation Service, Haywood Waterways, and Haywood Community College offer Resource Assessment for Mountainside Development projects as one planning tool. This approach provides up front assessments by resource professionals, such as soil scientists and geologists, to identify the most suitable areas for development as well as the most limited or hazardous areas.

Another planning tool will be Geologic Stability Maps currently being created for the Richland Creek Watershed. The maps will provide information on unstable soils that may require special engineering techniques or avoidance before construction starts.

The Town of Waynesville and Haywood County have established ordinances to guide development. The planning and construction processes must take into account these ordinances. They are critical standards for protecting water quality as well as human safety. They set standards for building density, water supply protection, subdivision development, steep slopes, floodplains and floodways, stormwater and other protective measures. However, it's common for LID principles to go beyond the standard requirements. One of the core principles of LID is building according to the site, which may differ from established ordinances.

Incentives can be effective tools for conservation-minded development. Incentives provide a means of making changes easier by focusing on a goal rather than a regulation. They may also help homeowners, developers, and farmers increase profits. They can provide recognition to conservation leaders, help defray costs, and reward new initiatives. Examples include certification programs, performance bonds, County and State recognition, fee offsets for important training, and providing materials to implement practices (such as grass seed and trees). Designing incentives in support of the most needed changes will provide additional publicity and provide affirmation to the individuals and corporations willing to be first.

Action Steps:
1. Encourage developers and public officials use LID principles in all new construction.
2. Encourage developers and landowners to participate in the Resource Assessment for Mountainside Development program.
3. Encourage developers and landowners to use information from the Geologic Stability Maps.
4. Work with technical resource agencies to identify the appropriate LID management measures.
5. Apply for financial resources to assist property owners.
6. Implement LID management measures.
7. Examples, principles, and practices associated with conservation-based development should be collected and distributed.
8. Develop and/or promote watershed protection incentives, such as "River Friendly Homeowner", "River Friendly Subdivision", "Clean Water Contractor", Professional Development Credits, and others.
9. Contact stakeholders to determine the most effective form of incentives.

3.7 Support Improvements to Watershed Protection Ordinances

Several good ordinances exist for protecting water quality (e.g., the erosion control ordinance). However, as the population grows and the landscape changes, there will be a need periodically revisit current ordinances and revise as necessary. Another challenge is enforcement. One of the key positions in the effort to control nonpoint pollution is the County Erosion and Sedimentation Control Officer. However, there is often more work than one person can accomplish. This strategy includes sharing information, participating in the development of ordinances, publicly supporting key issues, lobbying for new ordinances, and lobbying for increased funding and staff.

Action Steps:
1. Understand and stay up to date with watershed protection ordinances
2. Encourage a consistent set of watershed protection ordinances for the county and municipality; this will make enforcement easier and may enable the hiring of additional staff.
3. Evaluate what state-wide ordinances don't work in the mountains and what holes exist in the current local ordinances.
4. Participate in the development of ordinances to protect water quality.
5. Determine if there are barriers to enforcement and implement strategies to remove those barriers.
6. Track local and state legislation, rule-making, and planning processes that have implications for water quality; submit comments and recommendations as needed.
7. Develop relationships with local, state, and federal officials whose decisions affect water quality.
8. Assist local governments with obtaining funds and skills to address nonpoint source pollution abatement opportunities.
9. Recognize and support initiatives by all levels of government that help keep our waters clean.
10. Support a new ordinance requiring developers and contractors to attend training workshops in erosion and sediment control.

3.8 Encourage Development of Greenways

Riparian corridors are critical elements for water quality. Greenways can serve as multi-use corridors along streams that protect riparian buffers and water quality while providing recreation and wildlife corridors. As a buffer, they help stabilize stream channels, maintain cooler water temperatures, and serve as effective filters that prevent harmful pollutants from entering the stream. There are several ongoing efforts in the Richland Creek Watershed. These efforts often need support to succeed, including grant writing, trail planning and design, easement-drafting services, negotiating skills, and other assistance.

Action Steps:
1. Provide publicity and public support for greenways.
2. Provide technical support for the Haywood Greenways Advisory Council.
3. Assist in grant writing for new greenways.
4. Host public forums as needed to focus attention and support for greenway initiatives.

3.9 Promote Conservation Easements

The value of conservation easements includes protecting special places; maintaining open spaces; protecting water quality, wildlife habitat, and viewsheds; providing recreation and educational opportunities; and maintaining prime farmland in agriculture. One of the key values is reducing development density on steep mountain slopes. Reducing development density means fewer roads, house sites, driveways, and associated runoff impacts from stormwater.

Conservation easements can be gifts that keep on giving. They provide a mechanism whereby a landowner can donate property rights to a public agency or qualifying nonprofit corporation. The rights they donate can insure that the property is maintained in its present use, whether that is agriculture, forestry, or limited residential. Easements can maintain certain desirable land uses and open space, reduce development pressure on sensitive watersheds, protect riparian areas, and perform many other functions. Since such gifts are considered to be in the public interest, the federal government and the State of North Carolina have enacted favorable tax laws for such gifts. Conservation easements can also provide substantial estate and inheritance tax advantages. An easement reduces the value of the taxable assets, therefore lowering the potential estate tax liability.

If developers or other landowners were encouraged to make such donations, either to the County/Towns or a qualifying nonprofit land trust, it would help protect riparian buffers, stormwater controls, and other mitigative techniques that protect and improve water quality. There are a number of ways to encourage such donations, ranging from public support to providing specialized skills to complete such transactions.

Action Steps:
1. Identify and prioritize properties for easements.
2. Link interested landowners with the appropriate agencies and organizations to facilitate the donation of appropriate easements.
3. Maintain a library of resources providing introductory information on the nature of easements; their structure, form, and function; and the federal and state tax implications.
4. Support efforts to obtain state, federal, and grant funding to acquire easements.
5. Establish conservation easements.

3.10 Promote Land Use Planning Efforts

As the population of Haywood County grows so does the degree of stress on water quality and other natural resources. Issues like eroding mountainside roads, construction on unstable soils and steep slopes, destruction of riparian buffers, replacement of pervious surfaces with impervious ones, and loss of prime agricultural lands will become more frequent unless proper protection measures are put in place. It will be critical for public leaders to address these growth issues through planning.

In 2007 and 2008, NC State University, Haywood Waterways, TVA, and Southeast Watershed Forum hosted a series of Growth Readiness Roundtables. The effort brought together a diverse group of community members including local government and realty, homebuilding, environmental, and citizen interests to work collaboratively and proactively addressing issues associated with growth and development. Recommendations included how to encourage growth and development that is sensitive to both natural resources and quality of life. Implementing the many recommendations for ordinances, stormwater, and other key issues would provide many benefits for water quality.

A current initiative is GROWNC, the Sustainable Communities Initiative funded by the U.S. Department of Housing and Urban Development. GROWNC is focused on economic competitiveness and job creation for western NC. Several public meetings are being held to collect community input, review existing plans, and present models of what future economic growth looks like for the region. Communities are being asked about their goals for the future and to identify strategies, actions and early implementation projects that will lead to creation of better use of natural and cultural resources among other goals like better quality jobs, efficient transportation systems, energy and financial savings, and healthier people and communities.

Critical for any planning process is information about growth projections, status of natural resources, and expected issues that will affect the county. These tools will help community leaders make informed decisions, which will also help build community understanding and support. One recent tool is the Linking Lands and Communities Project developed by the Land of Sky Regional Council, which collected information about the county's natural resources and is identifying opportunities that link natural systems through a Regional Green Infrastructure Network. Over 45 data sets were used to identify landscape hubs and connecting corridors. Resource assessments were also conducted to identify lands that significantly contribute to water quality, wildlife habitat, biodiversity, and sustainable agriculture. The results were a series of maps and Geographic Information System (GIS) models for supporting land conservation, land use planning and land management efforts. Other readily available tools include Geologic Stability Maps, water quality monitoring information, and public surveys.

Action Steps:
2. Encourage public leaders and other stakeholders to participate in ongoing planning efforts.
1. Support public leaders in their efforts towards better planning and zoning.
3. Encourage public leaders and stakeholders to implement recommendations of planning efforts.
4. Encourage community leaders to contact technical resource agencies and organizations to determine what tools are available and to use them in planning efforts
5. Develop tools to help with planning efforts (ex. GIS maps).

3.11 Promote Local Water Quality Initiatives

Several organizations have already been working to improve the watershed. These projects work to control stormwater runoff, erosion, sedimentation, and non-point source pollutant loadings. They also protect riparian corridors and reduce landslide risks and septic system failures.

DWQ Fish Reintroductions: Water quality has greatly improved over the years in Richland Creek. Although the fish community has also greatly improved, some species are absent and will not recover due to Lake Junaluska acting as a barrier. DWQ is reintroducing native fish upstream of the reservoir in order to bring back the community that was once present. Species include rock bass, warpaint shiners, river chubs, Tuckasegee and greenfin darters and mottled sculpins, and were first released in April 2011. Spring and fall each year, DWQ biologists are collecting native fish from downstream and reintroducing them upstream. They are also periodically assessing the repopulation efforts. Once the population establishes itself, DWQ will continue to monitor the fish populations every five years at a minimum.

Haywood Community College Low Impact Development Program: Haywood Community College's Low Impact Development Program is preparing students interested in sustainable development and natural resource management with the technical skills to serve as specialists in the analysis of land and preparation of LID recommendations. Graduates are being prepared for careers in the public and private sector that require an understanding of geospatial technology, drafting, and the principles and practices of LID. The program requires a coursework in land planning software programs, soils, site analysis, hydrology, geospatial technology, and environmental regulations. Graduating students have the skills to develop and use plans for site development, storm and gray water treatment, and landscape restoration projects, as well as local and regional permitting issues and environmental concerns.

Haywood Environmental Initiative: The Haywood Environment Initiative is a curriculum-based program that provides classroom and field activities for students in 5^{th}, 8^{th} and 9^{th} grades to learn about water quality issues and their roles in protecting water quality. The initiative is comprised of several local agencies and organizations interested in water quality, include the Haywood County Schools, Haywood Waterways, National Park Service, and Lake Logan Episcopal Center. Programs in the Initiative include teacher training days, support of classroom lessons, native fish release from classroom aquariums, and coordination of resources across all schools in Haywood County.

Haywood Greenways Advisory Council: The Haywood Greenways Advisory Council guides, plans, and promotes greenway opportunities for Haywood County. The Council consists of 13 members and includes the Haywood County Recreation and Parks Director and representatives from the Haywood County Health Department, the four incorporated towns in Haywood County, Lake Junaluska Assembly, Haywood Waterways Association, Blue Ridge Bicycle Club, Southwestern NC RC&D Council, and two appointed by the Board of Commissioners. Several greenways have been constructed or planned since the Council began. The Town of Waynesville has also adopted a comprehensive Pedestrian Plan which includes a Greenway Master Plan.

Haywood Waterways Association: The mission of Haywood Waterways is to protect and conserve water resources by reducing non-point sources of pollution. They are known by local government and community leaders as a valuable resource and credible advisor on resolving water resource issues. They partner with like-minded organizations to help willing landowners protect their land, reduce soil erosion, and improve water quality.

Southern Appalachian Highlands Conservancy: Land trusts work with landowners to protect critical lands for drinking water, recreation, tourism, healthy forests, and working farms. The mission of the Southern Appalachian Highlands Conservancy is to conserve the unique plant and animal habitat, clean water, farmland, and scenic beauty of the mountains of North Carolina and Tennessee for the benefit of present and future generations. Since 1974, they have protected over 60,000 acres from the Highlands of Roan to the Great Smoky Mountains National Park.

Action Steps:
1. Support local water quality initiatives.
2. Promote new initiatives as needed.

3.12 Provide Financial and Technical Incentives

Most landowners are conservation-minded and do not want to degrade water quality. In some cases, an individual or corporation may inherit problems when purchasing property. In both cases, the landowner may not fully recognize the nature of the problem, and may not have the experience, training, or resources to design and implement the most effective ways to maintain or improve water quality. Many forms of technical and financial assistance are available to help landowners in these situations. Table 22 provides estimates of cost for typical management measures along with technical resource contacts. Each measure will be considered ongoing as willing landowners are identified and financial and technical resources are available. Once the impaired waterways in the Richland Creek Watershed are delisted; these actions will continue for the continued protection of water quality and ensure local streams remain off the list.

Table 22. Typical Management Measure Cost Estimates and Technical Resources

Management Measure	Cost	Technical Assistance
Monitoring	Depends on parameter	HSWCD, HCES, WRC, DWQ, HWA,
Education	Depends on type	HWSCD, HCES, WRC, HWA,
Conservation easement	State appraisal	HSWCD, RC&D Council
Storage tank	\$50 - \$100 rain barrel \$1.00 per gallon cistern	HSWCD, NRCS
Permeable surface	\$12 ft^2	HSWCD, HCES
Boulders	\$77 ton	HSWCD
Tree revetments	\$30 linear ft	HSWCD
Silt fence	\$1.50 linear ft	HSWCD
Root wads	\$80	HSWCD
Pasture renovation	\$300 acre	HSWCD, NRCS
Revegetating exposed ground	\$700 acre	HSWCD, NRCS
Livestock fencing	\$3.24 linear ft	HSWCD, NRCS
Well	\$13 linear ft	HSWCD, NRCS
Watering tank	\$1,000	HSWCD, NRCS
Stream crossing	\$1,100	HSWCD, NRCS
Septic system repair	\$4,600 Average	Haywood County Environmental Health Dept
Resource Assessment for Mountainside Development	\$7,000	HSWCD, HWA, HCC

DWQ: NC Division of Water Quality
HCC: Haywood Community College
HCES: Haywood Cooperative Extension Service
HSWCD: Haywood Soil & Water Conservation District
HWA: Haywood Waterways Association
RC&D Council: Southwestern NC Resource Conservation & Development Council
WRC: NC Wildlife Resources Commission

Sources of financial assistance include the Pigeon River Fund, the NC Clean Water Management Trust Fund, DWQ Section 319 Program, TVA, and other grant-making organizations with conservation goals (Table 23). Some cover 100% of costs, while others offer cost-share assistance. Cost share payments are usually the case and can substantially reduce the cost to the landowner of implementing specific practices. One example is the Environmental Quality Incentives Program (EQIP). The program provides assistance with BMPs to landowners that have approved conservation plans. However, this program depends on federal appropriations. Increased awareness and support of such programs could result in increased appropriations for Haywood County. Other sources of funding and assistance, including state and federal appropriations, should be investigated.

Landowners interested in permanently protecting important riparian areas on their properties could benefit from conservation easement programs. Some programs provide cash payments for conservation easements or fee purchase of riparian areas. The State of North Carolina provides significant income tax credits for the donation of conservation easement to an appropriate entity. The federal government may provide income tax deductions for such donations. If so desired, easements can be written to maintain less intensive land uses—such as agriculture in lieu of subdivision development. Such easements may serve to reduce property and inheritance taxes, permitting a property to remain in the family.

Technical assistance, including engineering in some cases, is available through the Haywood Soil and Water Conservation District, the local offices of the Natural Resources Conservation Service, Haywood Cooperative Extension Service, and others (Table 24). These organizations work with landowners on a variety of programs and administer cost share programs for agricultural improvements. They provide help in analyzing land and water quality problems, help landowners select management measures best suited to their land, and provide current information on the availability of program funds they administer.

Action Steps:

1. Maintain a current database of existing technical and financial programs, responsible agencies and local contacts, federal or state oversight and appropriation committees, funding history, and an estimate of qualifying projects.
2. Annually identify and focus efforts on those programs that have the greatest potential to substantially contribute to nonpoint pollution source reduction.
3. Annually contact our elected officials to inform them of the opportunities to assist Haywood County in addressing nonpoint pollution issues.

Table 23. Sources of Financial Assistance

Source	Grant Due Date	Website
DWQ 319 Program	May	portal.ncdenr.org/web/wq/ps/nps/319program
Ecosystem Enhancement Program	Ongoing	portal.ncdenr.org/web/eep
Haywood County Community Foundation	September	www.nccommunityfoundation.org/section/haywood
National Fish & Wildlife Foundation, Five Star and Urban Waters Restoration Grant Program	February	www.nfwf.org/Pages/default.aspx
NC Clean Water Management Trust Fund	February	www.cwmtf.net/
NC Dept. of Justice Environmental Grants	August	ncdoj.gov/EEG.aspx
NRCS Environmental Quality Incentives Program (EQIP)	January/ February	www.nc.nrcs.usda.gov/programs/EQIP/index.html
Pigeon River Fund	March, September	www.cfwnc.org/Nonprofits/GrantPrograms/PigeonRiverFund.aspx
RBC Bank Blue Water Project	February	www.rbc.com/community-sustainability/environment/rbc-blue-water/index.html
TVA Ag & Forestry Fund	January	www.wnccommunities.org/
TVA Community Relations Grant	Ongoing	www.tva.gov/community/contribution.htm
Wildlife Habitat Incentives Program (WHIP)	Ongoing	www.nc.nrcs.usda.gov/programs/WHIP/index.html
Z Smith Reynolds Foundation	February, August	www.zsr.org/

Table 24. Sources of Technical Assistance

Source	Contact Information	Website
Haywood County Environmental Health Office	157 Paragon Parkway, Suite 200, Clyde, NC 28721, 828-452-6682	www.haywoodnc.net
Haywood County Planning Office	157 Paragon Parkway, Suite 200, Clyde, NC 28721, 828-452-6632	www.haywoodnc.net
Haywood County Erosion Control Program	157 Paragon Parkway, Suite 200, Clyde, NC 28721, 828-452-6706	www.haywoodnc.net
Haywood Soil & Water Conservation District	589 Raccoon Road Suite 203, Waynesville, NC 28786, 828 452-2741 x 3	www.haywoodnc.net
Haywood Waterways Association	PO Box 389, Waynesville, NC 28786, 828-476-4667, info@haywoodwaterways.org	www.haywoodwaterways.org
NC Cooperative Extension Service	589 Raccoon Rd, Suite 118, Waynesville, NC 28786, 828-456-3575	http://haywood.ces.ncsu.edu/
NC DENR, Division of Forest Resources	Haywood County, 88 Ed Greene Road, Clyde, NC 28721, 828-627-6551,	http://ncforestservice.gov/index.htm
NC DENR, Division of Water Quality	2090 US Highway 70, Swannanoa, NC 28778, 828-296-4500	http://portal.ncdenr.org/web/wq/
NC DENR, Wetlands/401 Water Quality Certification Unit	1601 Mail Service Center, Raleigh, NC 27699-1601, 877-623-6748	http://portal.ncdenr.org/web/wq/swp/ws/webscape
NC DENR, Aquifer Protection Section	2090 US Highway 70, Swannanoa, NC 28778, 828-296-4500	http://portal.ncdenr.org/web/wq/aps
NC DENR, Land Quality Section	2090 US Highway 70, Swannanoa, NC 28778, 828-296-4500	http://portal.ncdenr.org/web/lr/land-quality
NC Wildlife Resources Commission, Mountain Region	20830 Great Smoky Mountain Expressway, Waynesville, NC 28786, 828-452-6191	http://www.ncwildlife.org/
Southwestern NC Resource Conservation & Development Council	PO Box 1230, Waynesville, NC 28786, 828-452-2519	http://southwesternrcd.org/
US Army Corps of Engineers, Asheville Regulatory Field Office	151 Patton Avenue, Room 208, Asheville, NC, 28801-5006, 828-271-7980	www.saw.usace.army.mil/Missions/RegulatoryPermitProgram/Contact.aspx
USDA, Natural Resources Conservation Service	589 Raccoon Rd., Suite 246, Waynesville, NC 28786, 828-456-6341 x5	www.nc.nrcs.usda.gov
US Fish & Wildlife Service, Asheville Field Office	160 Zillicoa Street, Asheville, North Carolina 28801, 828-258-3939	http://www.fws.gov/asheville/

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