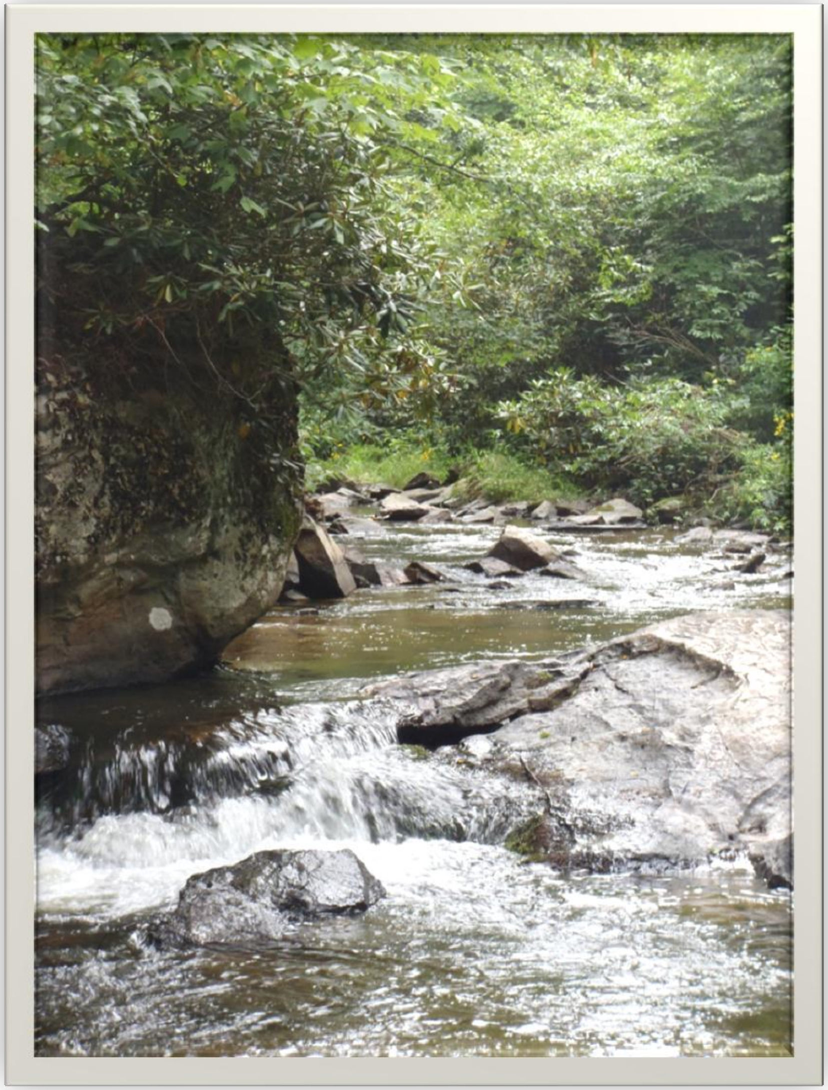

BEAVERDAM CREEK WATERSHED PLAN

Funded by: North Carolina 319 Program
Grant Applicant: Watauga River Partners

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Partners

North Carolina Cooperative Extension
Watauga County

Watauga River Partners

Brushy Fork Environmental Consulting, Inc.

North Carolina Division of Soil and Water Conservation

Context

A tributary to the Watauga River in western North Carolina, Beaverdam Creek flows through farmland and along rural roads in the western part of Watauga County, North Carolina. Although Beaverdam Creek flows through a picturesque landscape, the stream itself has been listed as "impaired" by the North Carolina Division of Water Quality. Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters that do not meet water quality standards. In 2008, the North Carolina Division of Water Quality included Beaverdam Creek on this list of "impaired" streams. Listed waters must be prioritized, and a management strategy must subsequently be developed for all listed waters.

The presence of several pollutants, such as biological pollutants, sediment, or high water temperatures, could be the cause of the "impaired" designation. Biological pollutants generally come from non-point sources, such as residential or agricultural run-off. Specifically, animal waste, the use of fertilizers and septic leakage can cause pollution in rural areas. In addition, streambank erosion will cause sediment to enter streams and water will become turbid, or cloudy. Streambank erosion has many causes but primarily the lack of planted streamside forests, or riparian buffers, will cause banks to erode and sediment to enter the stream. Excess sediment is detrimental to fish populations due to less available oxygen. Furthermore, as development increases in the watershed, a greater amount of impervious surface, such as pavement and rooftops, increases the likelihood of thermal pollution, or waters heated above a seasonal normal. Rainwater running across impervious surfaces will heat up before entering nearby streams. Thermal pollution is also detrimental to fish species, especially native trout which require relatively cool waters to grow, spawn and survive.

Impaired water quality from sediment, runoff and thermal pollution not only affects this creek, but the overall water quality of the Watauga River since Beaverdam Creek is a headwater stream. Therefore, developing a plan to remedy these impacts is important to water quality in the Watauga River basin.

Purpose

Watauga River Partners (WRP), a local non-profit organization, has a mission to protect the water quality and quantity of the Watauga River Basin. In 2011, Watauga River Partners received a grant from the North Carolina Department of Environment and Natural Resources to develop a watershed rehabilitation plan for Beaverdam Creek. Watauga River Partners hired Brushy Fork Environmental Consulting, Inc. a firm of wetland scientists and planners, to complete this plan.

The purpose of this plan is to study the entire watershed of Beaverdam Creek to identify areas of pollution and stream degradation. The recommendations included in this watershed plan provide a general vision for how Beaverdam Creek can become an ecologically, functionally, and economically significant feature of the Bethel community. Site-by-site implementation of the plan will take place on land where landowners are willing to partner and will focus on areas at high-risk for bank erosion and sedimentation. Rehabilitation projects will showcase rural stream management and provide a model for partnerships. The overarching goal of this project is ultimately to remove Beaverdam Creek from the "impaired" listing.

The objectives of this plan are threefold: 1) to locate non-point sources of pollution; 2) to propose measures that would minimize sedimentation and chemical inputs through Best Management Practices; and 3) to encourage landowners to take measures to protect and enhance the water quality of Beaverdam Creek and its tributaries. All recommended measures are completely voluntary and landowners can participate or not. For interested landowners whose land qualifies, Watauga River Partners will assist individual landowners with water quality improvements on their property.

The project team found numerous opportunities in the watershed to improve water quality. Such measures include stabilizing streambanks, introducing native riparian forests, changing livestock management practices, installing rain gardens and other practices to treat stormwater and providing information to private landowners on land practices for improved water quality.

Project Team

During this planning phase, Brushy Fork Environmental Consulting, Inc. provided project oversight, landowner contact and organizational coordination as needed by Watauga River Partners. The following representatives contributed to the project through expert advice and overseeing progress:

- Wendy Patoprsty, Watershed Project Coordinator – Watauga County Cooperative Extension Agent, WRP Board Member
- Kristan Cockerill, Watershed Project Coordinator – Appalachian State University, WRP Board Member
- Carol Babyak, Professor - Appalachian State University Chemistry Department
- Ashley Wilson, Watershed Project Administrator – Watauga River Partners
- Brian Chatham, Conservation Technician – Watauga County Soil & Water Conservation District
- Eddy Labus, Livestock Extension Agent – Watauga County Cooperative Extension

Planning Process

The planning process consisted of the following major steps:

1. Community outreach meetings
2. Baseline Data Collection
3. Visual Stream Assessment
4. Report Writing

Realizing that building trust with private landowners is perhaps the most important element of the project, the project team began the process with a community meeting in January of 2011. At a community dinner, the project team explained the grant and held a "Question and Answer" Session. With positive feedback from this gathering, the project team began fieldwork and landowner contact in April of 2011.

A second community meeting, held in October 2011, provided another opportunity for the project team to reach out to private landowners in the watershed. The team presented data on water quality, explained Best Management Practices for farming near streams and answered questions from interested landowners.

In addition to landowner outreach, the project team then mapped the watershed; conducted stream assessment for its chemical, biological, and physical characteristics; and performed visual reconnaissance of problem areas throughout the watershed. The results are laid out in this report.

Watershed Assessment Measures Included:

1. Locating problem areas within the Beaverdam Creek Watershed
2. Landowner coordination
3. Data collection including:
   - Natural heritage data, parcel polygons, hydrologic data for GIS (Geographic Information Systems) analysis
   - Creating overall site map
   - Assessing existing conditions of multiple stream sections
   - Photo documentation of current conditions.

Watershed Characteristics

The Beaverdam Creek Watershed is comprised of mixed land cover features that are consistent with the Southern Appalachian region. The majority of the Beaverdam Creek Watershed consists of agricultural and rural residential land use. The only town in the watershed is Bethel, NC, with an estimated population of 1,759 (US Census Bureau 2010). The remainder of the Beaverdam Creek Watershed is comprised of forested areas with Upland Coniferous Forest, Upland Deciduous Forest, and Upland Mixed Forest.

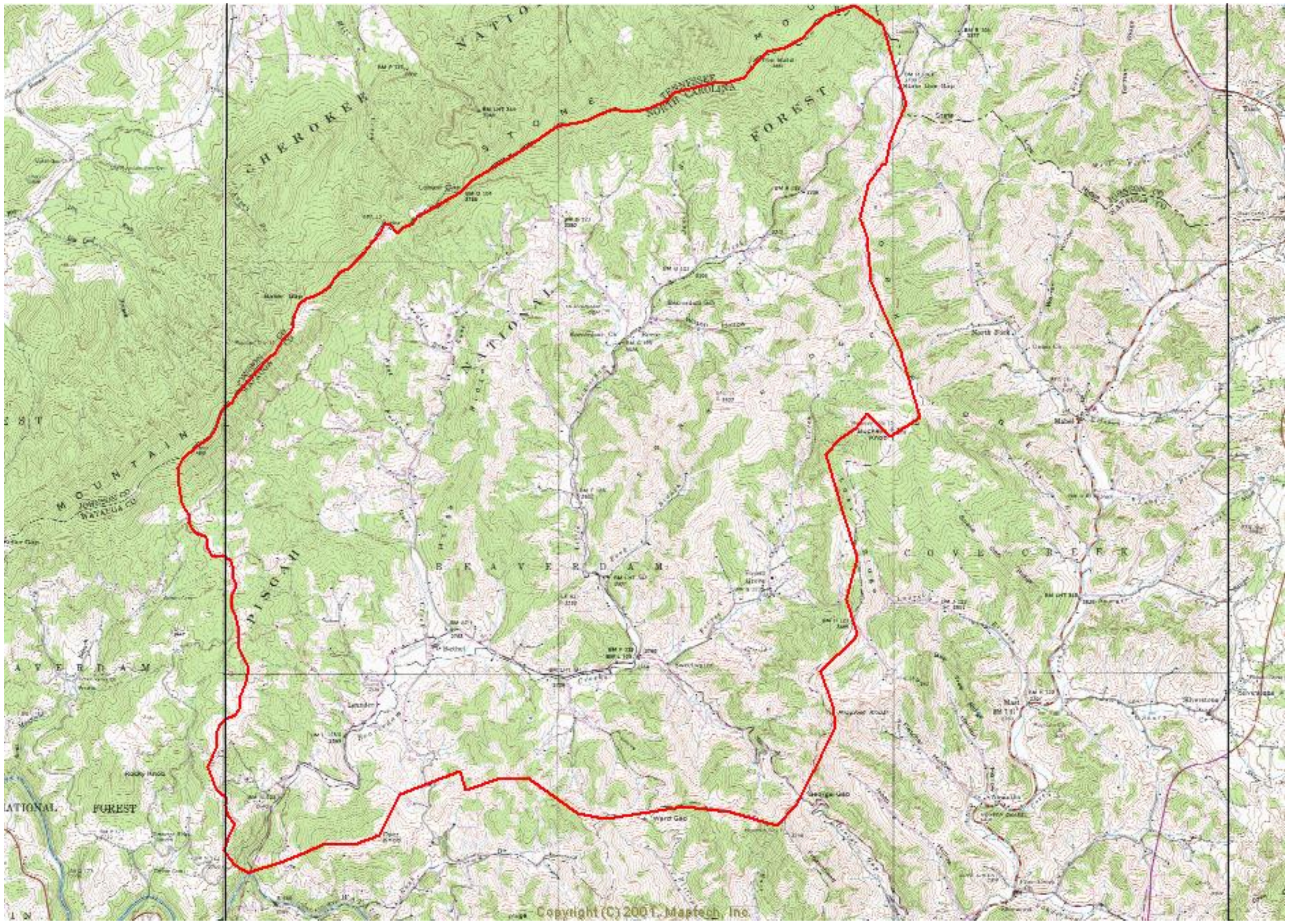


Figure 1: USGS map of Bethel area showing the Beaverdam Creek Watershed outlined in red.

The Beaverdam Creek Watershed is made up of high-gradient, or steep, cold water habitat streams. These have the potential to support a variety of aquatic habitat and wide range of biodiversity.

The Watershed is made up of Beaverdam Creek, Little Beaverdam Creek, Rube Creek, Forest Grove Creek and all the un-named tributaries flowing into these creeks. Elevation in this watershed ranges from approximately 3,880 feet above mean sea level in the far northern upland areas to approximately 2,510 feet above mean sea level in the far western section.

Agricultural lands, lying mostly in the lower elevations along Beaverdam Creek, are largely a mixture of pasture, small row crops and fallow fields. Row crops and animal grazing are the two primary agricultural uses in this community. This is important because animal feeding areas can contribute significant sediment and pollution to nearby streams when cattle trample streamside plants and deposit waste directly into streams.

Natural Heritage

Mountain communities in Western North Carolina typically have unique and diverse species of plants and animals. The Bethel area is no exception. One of the reasons to improve the quality of this watershed is to protect the unique natural heritage of this area. According to data from the North Carolina Natural Heritage Program, several species of concern are found within the Beaverdam Creek Watershed (see Figure 2). Rare plant species within the watershed include the terrestrial vascular plant Tower Mustard (*Turritis glabra*), and the terrestrial natural community Montane Oak-Hickory forest. The terrestrial vertebrate Weller's Salamander (*Plethodon welleri*) can also be found in this watershed. Additionally, the aquatic invertebrate called Green Floater (*Lasmigona subviridis*), and the aquatic vertebrate animal Hellbender (*Cryptobranchus alleganiensis*) are species of concern within this watershed. Plant and animal species included in the North Carolina Natural Heritage list should be given special consideration in environmental planning.

Table 1: Natural Heritage Species and Communities Found in the Watershed

SCIENTIFIC NAME	COMMON NAME	PHOTO IDENTIFICATION	NC STATE STATUS	NC STATE RANK
Cryptobranchus alleganiensis	Hellbender	 Photo: J. Humphries hellbenders.org	**SC**	**S3**
Lasmigona subviridis	Green Floater	 Photo: cbc.amnh.org	**E**	**S1**
Plethodon welleri	Weller's Salamander	 Photo: wdfw.wa.gov	**SC**	**S2**
Turritis glabra	Tower Mustard	 Photo: ele-middleman.at.webry.info	**E**	**S1**
	Montane Oak-Hickory Forest	 Photo: dcr.virginia.gov		**S5**

E - Endangered "Any native or once-native species of wild animal whose continued existence as a viable component of the State's fauna is determined by the Wildlife Resources Commission to be in jeopardy or any species of wild animal determined to be an 'endangered species' pursuant to the Endangered Species Act." (Article 25 of Chapter 113 of the General Statutes; 1987).
SC - Special Concern "Any species of wild animal native or once-native to North Carolina which is determined by the Wildlife Resources Commission to require monitoring but which may be taken under regulations adopted under the provisions of this Article." (Article 25 of Chapter 113 of the General Statutes; 1987).
S1 - Critically imperiled in North Carolina because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from North Carolina.
S2 - Imperiled in North Carolina because of rarity or because of some factor(s) making it very vulnerable to extirpation from North Carolina.
S3 - Rare or uncommon in North Carolina.
S5 - Demonstrably secure in North Carolina and essentially ineradicable under present conditions.

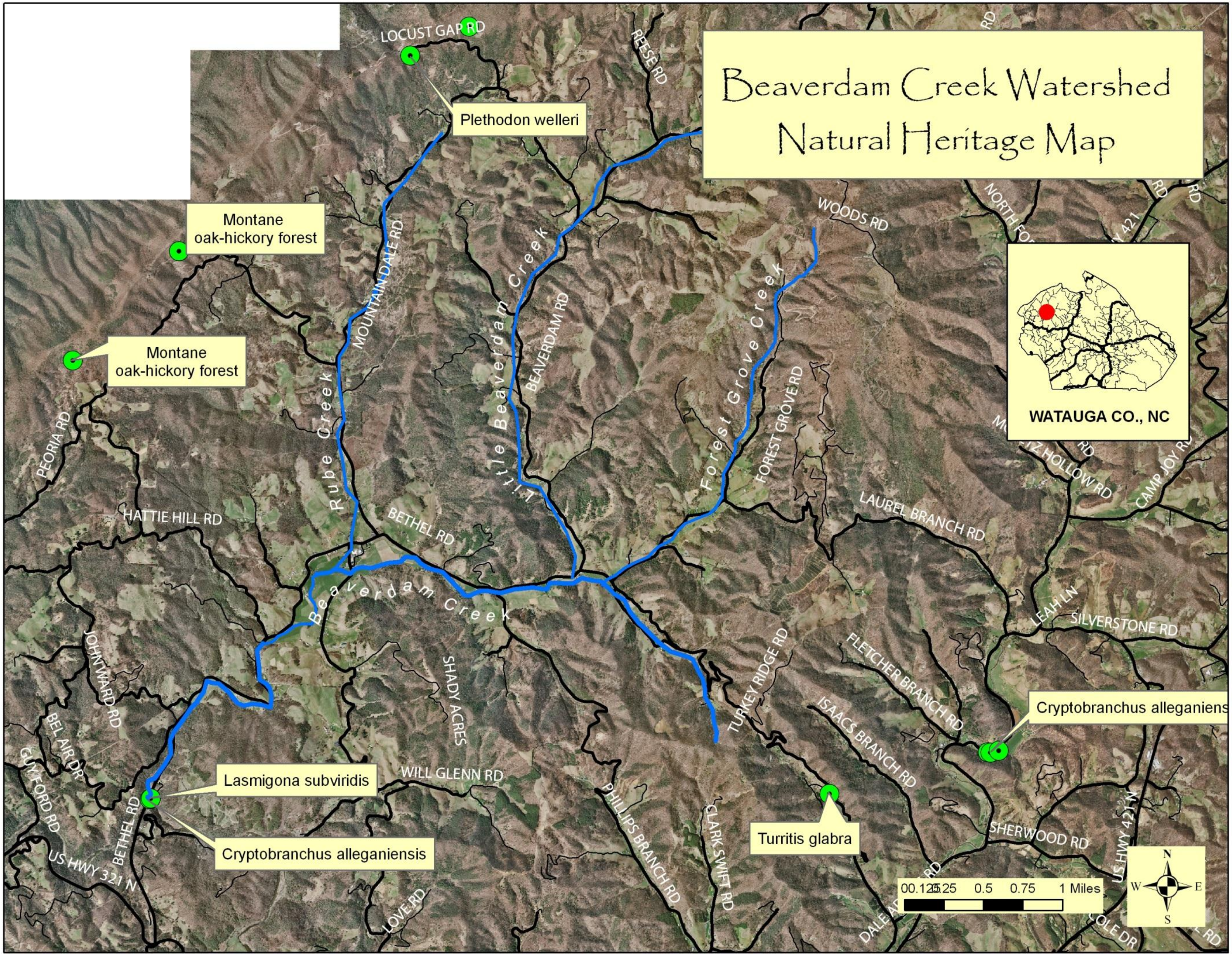


Figure 2: Natural Heritage Sites in the Watershed

Beaverdam Creek at the Confluence with Watauga River.

The Confluence of Beaverdam Creek and the Watauga River

The confluence, or the point where Beaverdam Creek flows into the Watauga River, is located just below the bridge where Bethel Road crosses the Watauga River.

The project team conducted a site visit to the confluence to determine its characteristics: the sediment load in this portion is illustrative of conditions and the overall health of the water in the watershed upstream. Beaverdam Creek at this location is a high-gradient (steep) stream with sandy sediment evident. High amounts of deposition were noted here, indicating sediment travelling from upstream. This section of the creek does not evidence much erosion and has mostly native plants growing along the banks (see photo at left). The team noted the presence of invertebrates that indicate good water quality such as stoneflies and mayflies. However, some algae were also present as well as foam, most likely from the presence of phosphorous.

Landownership

Because the vast majority of land in this watershed is privately owned, landowner engagement is a crucial element to the success of this project. Watauga River Partners respects private landownership and seeks to work with landowners to help improve land practices and water quality.

Many landowners manage their land so as not to disturb nearby creeks. However, whether landowners realize it or not, some activity adversely affects water quality and when multiplied over large areas, has a detrimental effect on the health of a watershed. For example, mowing land up to the bank of the creek will cause the streambank to weaken and possibly fail over time. A few landowners have witnessed significant stream erosion on their property and each year lose productive land to erosion. Some of landowners have requested assistance from Watauga County Extension to address the problem.

Types of Pollutants

Non-Point Source Pollution

Pollutant sources can be divided into two categories: nonpoint source pollutants and point source pollutants. Nonpoint source (NPS) pollution is defined as water pollution affecting a water body from diffuse sources. Rainwater picks up these pollutions as it runs across feedlots, parking lots, rooftops and roads and deposits these pollutants into streams and rivers.

Examples of nonpoint pollutants are sediment, phosphorous, nitrogen, and bacteria.
According to the U.S. Environmental Protection Agency, nonpoint sources are the leading cause of water pollution in the United States today (US Environmental Protection Agency 2007).

Sediment

Past channelization, or straightening of the creek, has also contributed to erosion and sedimentation by creating steep banks with no vegetation. Channelized sections are obvious from their straightened pattern and generally flow along roadways, through pastures, or are squeezed onto residential or commercial lots.

If land is mowed to the stream, the lack of buffer causes erosion.

A mature meadow along the stream acts as a buffer and helps to stabilize the streambanks.

The lack of riparian buffers is a significant factor leading to erosion: native woodland and herbaceous plants help to reduce sedimentation by stabilizing banks with their roots as well as remediate pollutants before entering the stream. As landowners mow or allow cattle to graze up to the edge of the water, the stream will lose native plants that stabilize the bank and eventually begin to lose land to erosion.

Thermal Pollution

In addition to chemical pollutants and sediment, high temperature is also considered a pollutant in the stream. Rainwater falling onto parking lots, roads and rooftops heats up before entering the streams, causing thermal pollution (high temperatures that are unhealthy for aquatic life). Mature native plants along streambanks can shade the creek to keep water relatively cool in the summertime which is critical for healthy native trout populations.

Best Management Practices

Best Management Practices recommended for the Beaverdam Creek Watershed that offer the most benefit to landowners and the health of the creek include: livestock management for water quality, streambank stabilization and riparian buffer planting. Within each of these three areas are listed specific practices to achieve these objectives.

Livestock management

- Providing alternate feeding and watering stations to encourage livestock to eat and drink away from the creek
- Installing a cistern to capture water from out-buildings near the creek to provide a watering source for livestock and prevent runoff from directly entering the creek
- Fencing livestock out of the creek
- Practicing rotational grazing

Streambank stabilization:

- Streambank stabilization is proposed in areas that are not significantly entrenched but need protection to decrease nearbank stress and reduce erosion.

- Boulder toe protection (an example of streambank stabilization) stabilizes the toe of an existing slope with the use of boulders.
- This practice might also include removing excess debris from the streambank. These materials should be removed for the safety of the community and for the stability of the stream.

Riparian buffer rehabilitation and planting:

- This option is widely-used as a recommendation because many landowners in the watershed currently employ land activities that remove or degrade the native riparian plants (by mowing up to the wetted edge of the channel).
- Native riparian buffers can be established by planting native shrubs and trees and sowing native seed to propagate healthy herbs and grasses.
- A healthy riparian buffer will reduce pollution runoff (sediment filtration), prevent streambank erosion, provide shade (thus reducing temperatures), and provide food and habitat for fish and other aquatic organisms.

  To ensure the success of native plantings, invasive species may need to be removed. Two specific invasive plant species were observed throughout the watershed:

  - *Polygonum cuspidatum* – Japanese knotweed
    - This species is very prolific in the Beaverdam Creek Watershed. Every effort will be employed to remove and suppress this species from further dominating riparian areas.
    - Knotweed is so prolific because of its ability to reproduce asexually and sexually. Propagation can occur simply by a stem lodging itself in a streambank.
    - Proposed removal methods include: scarify the ground in these areas, sowing temporary seed to compete; haul off the remains of the invasive plant material to a burn site; use herbicides (sparingly) where applicable.
  - *Rosa multiflora* – Multiflora rose
    - Multiflora rose was once thought of as a “natural fence” and planted by farmers intending to keep cattle enclosed. Today, this thorny, invasive plant has spread through many areas in this watershed.
    - To remove, one must begin by cutting the stems at ground level (haul away to burn) and immediately paint the remaining stem with Rodeo ™, an aquatic-approved herbicide. (Hand-painting this chemical prevents ground contamination.)

Innovative Stormwater Management:

- Rain gardens to capture and filter polluted stormwater runoff before it can enter the creek
- Cisterns to capture polluted stormwater runoff from rooftops so that it does not enter the creek.
- Signs should be incorporated into using the Best Management Practices to explain how the technology helps to improve water quality and the relationship between community development and creek health.

Benefits to Landowners

The benefits of enhancing and protecting water resources are numerous. Perhaps most important to landowners, adjusting land practices to improve water quality can have economic benefits. Specifically, economic benefits can result from better understanding livestock management relevant to creek health, soil nutrient testing, pasture field management, and stormwater runoff management.

Table 2: Recommended Best Management Practices and Associated Benefits

Best Management Practice (BMP):	Benefits to Landowner
Alternate Livestock Watering/feeding	Cattle drink more, increases milk production and/or weight gain
Fencing Livestock from Streams	Reduced risk of disease, including mastitis, Johne's disease and Cryptosporidium; also lower risk of foot rot.
Rotational Grazing	Less forage wasted
Streambank Stabilization	Reduces loss of land due to erosion

The benefits of Best Management Practices in areas of intense agricultural land use include increasing livestock health and improved productivity. Studies have shown that cattle prefer off-stream watering sources, such as troughs, and cattle that have access to off-stream watering sources are healthier (Whitescarver 2006; Zeckoski et al. 2007). Dairy farmers report that cows with off-stream sources drink more, which increases their milk production and beef cattle show weight gain of five to ten percent over nine to ten months. Additionally, cows that drink from streams or ponds face increased risk of disease, including mastitis, Johne's disease, Cryptosporidium, and Leptospirosis. Animals walking along creek banks and in creeks also increase the risk of foot or other injury to the animal. Improving animal health has clear economic benefits to the farmer.

Keeping cattle and horses away from streams has additional economic benefits in terms of pasture productivity and reducing soil loss. Keeping livestock within a pasture, rather than in a creek, increases the productivity of that pasture as the manure and urine increase the organic matter and thereby increase the soil's ability to retain moisture, and remain stable. This helps to reduce erosion from both wind and water. Landowners face increasing risk of land loss from erosion if livestock have free access to streams and/or rely on streams for their drinking water. Studies have shown that grazed streambanks erode three to six times faster than ungrazed streambanks. One study in Tennessee, reported soil loss from a grazed streambank of more than 50 cubic yards per year (40m3) over about a half mile (1km) of stream (Trimble 1994). Again, this soil loss has economic ramifications for landowners.

Baseline Watershed Information

Understanding the current conditions is critical to the watershed management planning process. On three separate data collection trips, the project team collected baseline data that can be used in the future to measure influences from implementing the recommendations in the watershed plan. Data were gathered for the physical, biological, and chemical conditions of the creek. The data collection trips were scheduled at different times of the year to account for seasonal adjustments of certain data. Data collected took place on April 29^{th}, August 15^{th}, and November 4^{th}, 2011.

Three sites, spread throughout the watershed, were identified for baseline data sampling, (see Figure 3). These sites represent different conditions in the watershed: the first, a higher elevation, low-flow section of stream; the second, a middle elevation section with higher flow and near a pasture; and the third, a still lower section of stream that is below the confluence of Rube Creek with Beaverdam Creek adjacent to a farm field. An additional water quality monitoring site was established where Beaverdam Creek flows under Bethel Road. No cross-sectional data or benthic macro-invertebrate data was taken here, but fish species data and water chemistry data was documented. All procedures were based on the approved Quality Assurance Project Plan.

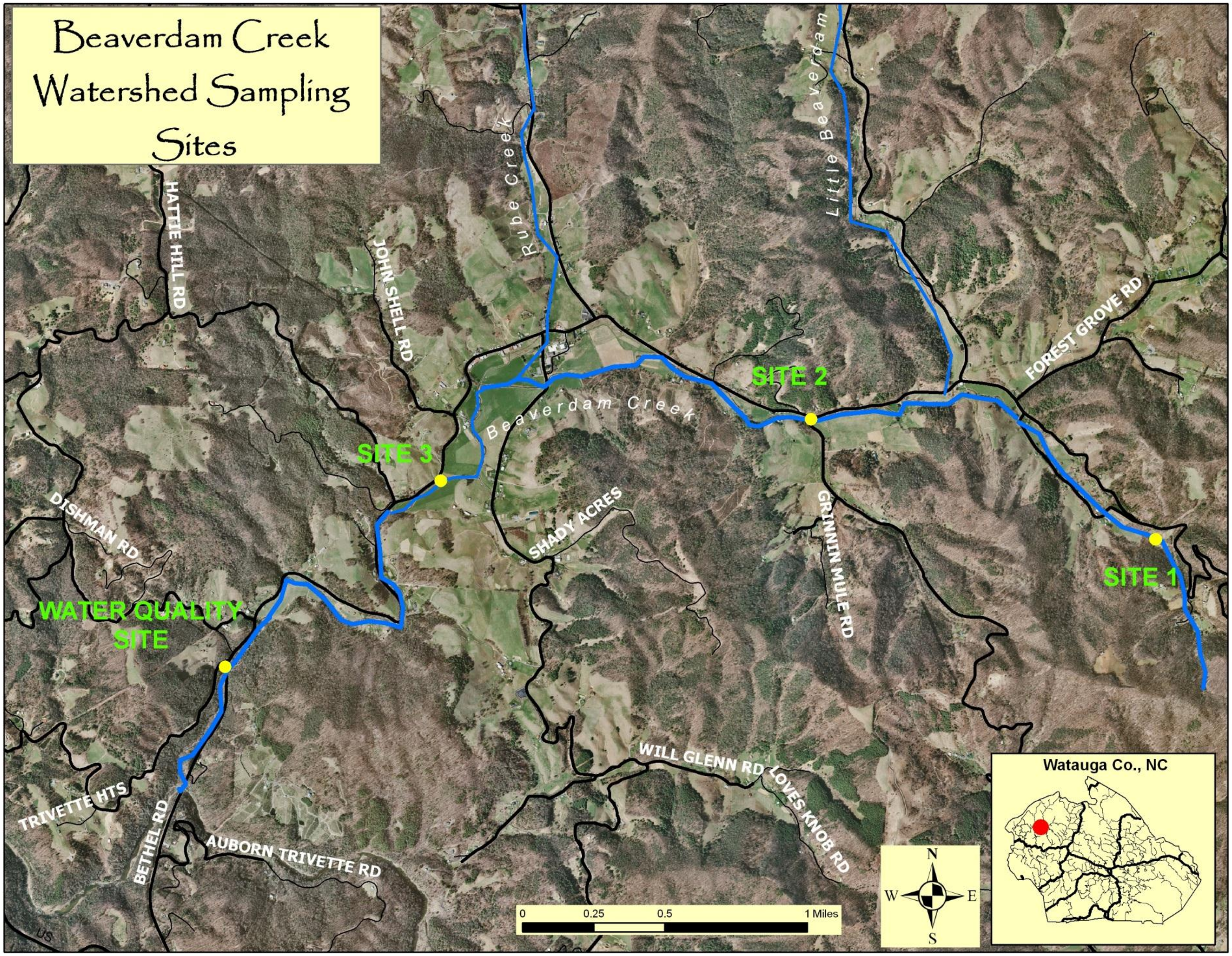


Figure 3: Baseline Data Monitoring Sites

Physical Conditions
The physical condition of the stream is documented by taking elevations along a cross section of the creek as well as a visual assessment of how significantly the banks are eroding. The visual assessment of stream characteristics is charted to determine how susceptible the streambank is to erosion. Data indicated that two of the three sampling sites have a high susceptibility to erosion and therefore, maintaining and improving streambank stability is critical to protecting water quality in the watershed.

Cross-sectional elevation data of Beaverdam Creek along with a Bank Erodibility Hazard Index (BEHI), visual assessment and pebble counts were taken at the three sampling sites in the watershed. Since this data is not likely to change significantly based upon the time of year, it was collected on the first visit and not on subsequent trips. However, this data will be assessed on a yearly basis during the duration of the study to determine if changes in the bank at these locations take place over time.

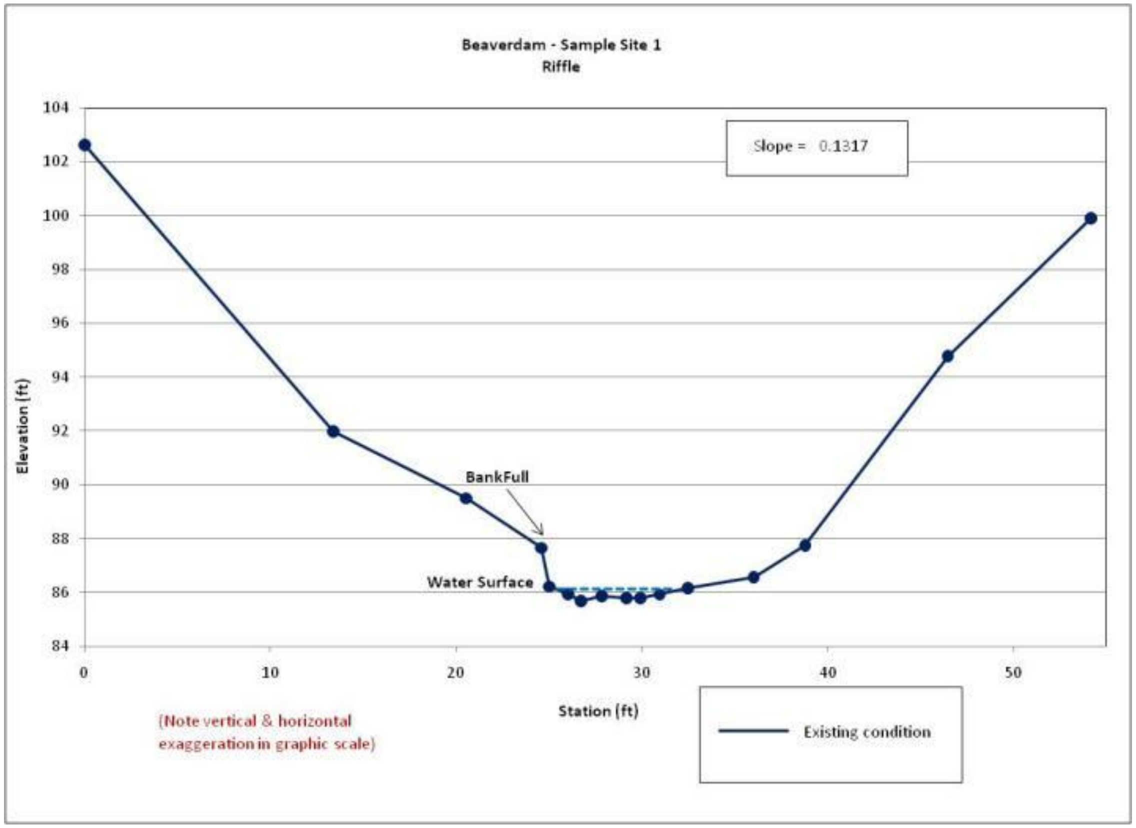
The Bank Erodibility Hazard Index, developed by David Rosgen (1996a, 1996b), was used to assess the potential for stream bank erosion for each site. BEHI scores integrate several field measurements in order to determine the potential for stream bank erosion (these are found in Appendix D).

Table 3: Sample Site BEHI Data.

Site Name	Highest Bank Height - A	Max Bankfull Depth - B	A/B = C	Root Depth - D	Study Bank Height - E	D/E = F	Root Density (%) = G	G X F = H	Bank Angle (Deg) = I	Height of Bank Protection = J	J X E = K	Surface Protection (%)	TOTALS	Very Low - Extreme Rank
Sampling Site One	0.7	0.5	1.4	0.5	0.7	0.714286	80	57.14286	30	2	1.4	100	12.9	Low
Sampling Site Two	15	4	3.75	0.4	4	0.1	50	5	85	0.2	0.8	70	32.5	High
Sampling Site Three	6	4	1.5	0.3	5	0.06	40	2.4	85	2	10	60	30.4	High

__Cross Sectional Elevation Data__

Sample Site 1



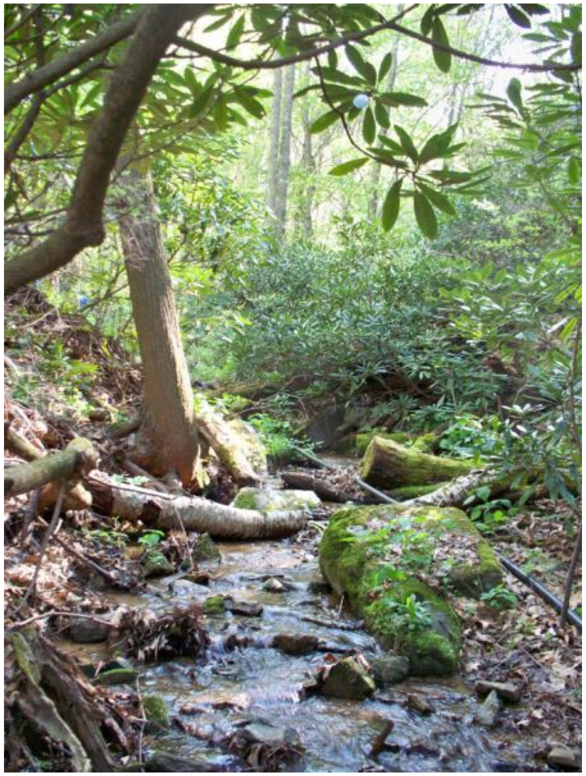


Figure 4: Cross Section Sample Site 1

Sample Site 2

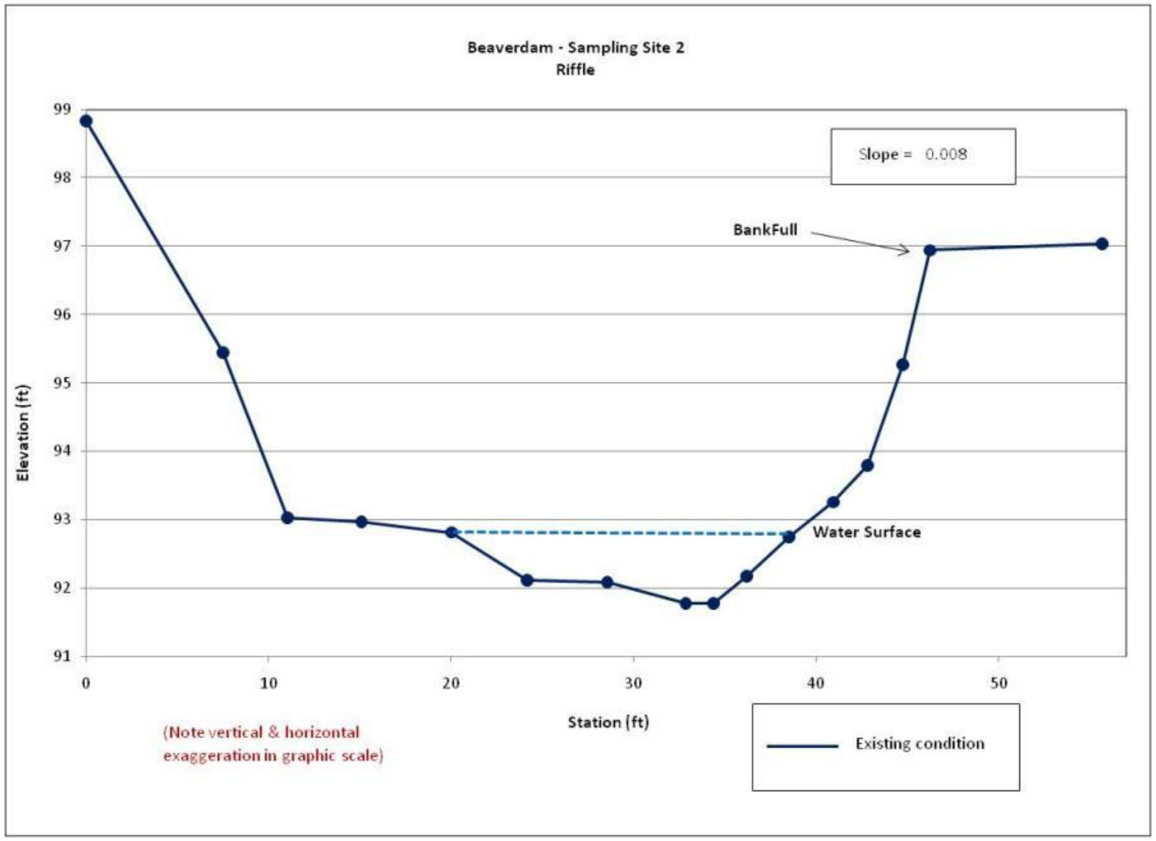


Figure 5: Cross Section Sample Site 2

Sample Site 3

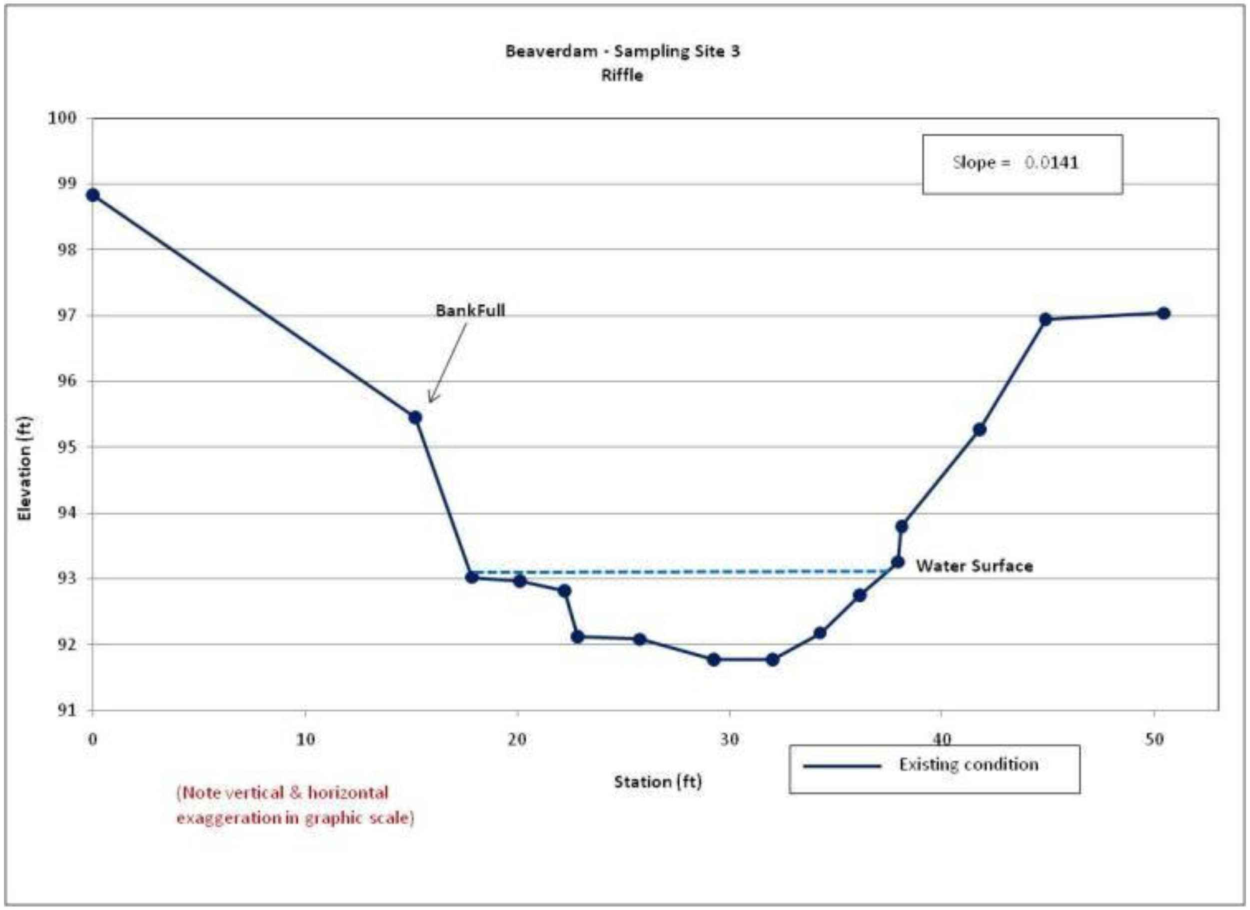


Figure 6: Cross Section Sample Site 3

Benthic Macro Invertebrate and Habitat Data

During each sampling trip, the project team conducted a count of the various types of benthic macro invertebrates. These aquatic insects live directly in streams. Some macro invertebrates, such as mayflies and stoneflies, are indicators of high water quality. The types of insects found include the following:

- Clubtail Dragonfly
- Common Stonefly
- Perlodid Stonefly
- Burrowing Stonefly
- Flatheaded Mayfly
- Brushlegged Mayfly
- Water Penny
- Riffle Bettle
- Helgrammite

Benthic macro invertebrate samples were taken at all three sites during the three data sampling trips. At each site and each trip, the type and number of insects sampled was recorded along with the sensitivity measure and any other observations. Table 4 shows a compilation of the data, (See Appendix B for the complete data) showing the total number of individuals and water quality sensitivity index. Each site indicates excellent levels and, therefore, relatively high water quality at each site. However, fine layers of silt were present in the gills, hairs and tails of some individuals, especially at Site 3, which is the most down-stream location sampled. This could indicate an excess of silt in the stream, most likely caused from erosion upstream.

Table 4: Benthic Macro Invertebrate Sampling Results

Month Sampled in 2011		Total Individuals	Sensitivity Index	Water Quality Indicator	Notes:
April					
	Site 1	117	33	Excellent	
	Site 2	254	43	Excellent	
	Site 3	231	34	Excellent	
August					
	Site 1	8	15	Good	Very dry conditions with minimal water in stream
	Site 2	127	29	Excellent	
	Site 3	151	35	Excellent	Few Mayflies had a fine layer of silt in gills
November					
	Site 1	6	8	Good	More silt and sediment observed in stream
	Site 2	28	24	Excellent	
	Site 3	103	32	Excellent	Many insects had fine, silty sediment on tails, gills and hairs

Note: Benthic macro invertebrate sampling counts represent two 5-meter kick seines (nets) in riffle areas of the stream. Sensitivity index is based on the Georgia Adopt-a-Stream benthic assessment method.

Water Chemistry Data

For chemical analysis, the project team added an additional water quality sampling site, which is just above the confluence of Beaverdam Creek with the Watauga River. At each site temperature, pH, dissolved oxygen, and conductivity were measured using a calibrated field meter. As shown in Table 5, all of the water quality parameters fell within suggested guidelines, but some interesting trends can be observed. First, temperature increased moving downstream, most likely due to time of day as well as decreased shade. Second, conductivity, which is the ability of water to carry a current and is due to the presence of dissolved substances, also increased moving downstream and may indicate the input of dissolved substances due to natural or anthropogenic causes.

Table 5 shows temperature, pH, conductivity, and dissolved oxygen for the first three sample collections. Temperature, pH, and conductivity generally increased moving from Site 1 to Site 4 (upstream to downstream). The results in Table 5 generally fall within suggested guidelines (NC Administrative Code, 2007). The increase in temperature at the downstream sites is probably caused by the lack of shade and riparian buffers at these sites.

Table 5: Temperature, pH, Conductivity, and Dissolved Oxygen at Collection Sites

Date	TEMPERATURE, C				pH				Conductivity, uS/cm				Dissolved Oxygen, mg/L			
	SITE 1	SITE 2	SITE 3	SITE 4	SITE 1	SITE 2	SITE 3	SITE 4	SITE 1	SITE 2	SITE 3	SITE 4	SITE 1	SITE 2	SITE 3	SITE 4
4/29/11	10.7	12.7	15.1	15.7	7.74	7.94	7.89	7.85	41.1	58.4	58.7	60.3	9.95	10.24	10.06	9.47
8/15/11	17.1	18.2	18.4	18.9	6.93	7.44	7.59	7.77	45.5	82.3	76.9	78.2	7.58	8.35	8.61	8.41
11/4/11	8.8	9.1	9.1	9.0	6.87	6.83	7.18	7.4	43.6	77.0	76.5	77.3	No data, DO probe temporarily not working			

Table 6 shows total suspended solids (TSS), nitrate, and phosphate concentrations for the first three sample collections in the Beaverdam Creek watershed. Although no federal or state guideline has been set for TSS in surface water, effluent which discharges into an Outstanding Water Resource must be less than 10 mg/L for trout waters or 20 mg/L for all other water(NC Department of Environment and Natural Resources, 2007). The TSS values shown in Table 6 are relatively low for the first two sample collections; however, the third sample collection, which took place after a rain event yields noticeably higher TSS values at the downstream sites. This is probably due to sedimentation caused by lack of a riparian buffer at these downstream sites. (Water was much more turbid during the final sample collection as compared to others.)

Table 6: TSS, Nitrate, and Phosphate Concentrations at Collection Sites

Date	TSS, mg/L[a]				NITRATE,[b] mg/L				PHOSPHATE,[b] mg/L			
	SITE 1	SITE 2	SITE 3	SITE 4	SITE 1	SITE 2	SITE 3	SITE 4	SITE 1	SITE 2	SITE 3	SITE 4
4/29/11	16.6	8.1	9.66	9.29	3.66	2.92	3.02	3.03	<MDL	<MDL	<MDL	<MDL
8/15/11	30.8	21.9	2.60	2.58	2.16	2.22	2.73	2.62	<MDL	<MDL	<MDL	<MDL
11/4/11	17.7	46.9	62.6	69.5	I.P.[c]				I.P.[c]			

[a]TSS was determined using Standard Method 2540D. [b]Nitrate and phosphate were determined using ion exchange chromatography. < MDL = Less than the method detection limit. [c]I.P. = In progress

Nitrate concentrations are all less than the suggested guideline of 10 mg/L,[2] with the highest concentration observed at Site 1 (the reference site) during the first sample collection. It should be noted that during the second sample collection, nitrate concentrations are greater at the downstream sites compared to Site 1, although statistical analyses still need to be performed in order to determine if there is a significant difference in the upstream and downstream concentrations. All phosphate concentrations are below our detection limit of 0.2 mg/L. Phosphate is a nutrient that can make waters eutrophic when present in excess. Eutrophic waters are unable to support aquatic life, and typically have phosphate concentrations between 35 and 100 mg/L(vanLoon, 2000).

Quality Control and Data Integrity

Nitrate and phosphate samples were analyzed in triplicate. There was little variation in replicate concentrations, with relative standard deviations (RSDs) less than 4%. Instrument detection limits were determined using method 40CFR Part 136B for nitrate and phosphate and found to be 0.06 and 0.2 mg/L, respectively. Laboratory fortified blanks (LFBs) and calibration check standards (CCS) were analyzed with every batch of samples and the percent recoveries were always greater than 95%. Field duplicates were taken each sampling trip and the percent difference in the nitrate concentrations was always less than 2% (phosphate concentrations were always below the detection limit for the field duplicates). In general, these results indicate that the data gathered so far are accurate and reliable. The only concern we have at this point is field blank samples that tested positive for nitrate on two sampling trips.

Fish Species Data

During the August 15, 2011 data collection representatives from North Carolina's Wildlife Resource Commission shocked fish to collect and document types and number of fish species present at each of the three sampling sites, as well as at the additional water quality sampling site. The following data indicate the presence of native trout, however the individuals were small in comparison to others of the species found in different watersheds. In addition, the overabundance of central stone roller species is indicative of high nutrient levels in the waters.

Table 7: Fish Species Sampling Results

SITE 1
No fish sampling: not enough water in creek to hold fish
SITE 2
Central stoneroller (Campostoma anomalum)
Creek chub (Semotilus atromaculatus)
Rock bass (Ambloplites rupestris)
Northern hug sucker (Hypentelium nigricans)
Blacknose dace (Rhinichthys atratulus)
River chub (Nocomis micropogon)
Rainbow trout (Oncorhynchus mykiss) - all rainbow trout observed were wild trout, N = 4
Total length's (mm) - 153, 177, 193, and 125
Note - also collected two stocked brown trout (Salmo trutta)
SITE 3
Central stoneroller (Campostoma anomalum)
Creek chub (Semotilus atromaculatus)
Rock bass (Ambloplites rupestris)
Northern hug sucker (Hypentelium nigricans)
Blacknose dace (Rhinichthys atratulus)
River chub (Nocomis micropogon)
Rainbow trout (Oncorhynchus mykiss) - all rainbow trout observed were wild trout, N = 2
Total length's (mm) - 161 and 178
Note - also collected two stocked brown trout (Salmo trutta)
ADDITIONAL WATER QUALITY SITE
Central stoneroller (Campostoma anomalum)
Creek chub (Semotilus atromaculatus)
Blacknose dace (Rhinichthys atratulus)
River chub (Nocomis micropogon)

Native Trout found during sampling tended to be thin compared to those found in other watershed in the mountains.

General Field Assessment

During the field assessments, the project team noted the following examples of land practices that are detrimental to the watershed:

- Dredging the creek and building berms to prevent flooding on one property
- Mowing or using a weed-eater to edge and removing any native trees and shrubs de-stabilizes the bank
- Straightening the stream
- Pushing the creek "to the side and out of the way"

Each of these practices is detrimental to water quality and degrades habitat for both aquatic and terrestrial wildlife. Additionally, these have the potential to increase erosion, which means lost land to a landowner. In the next section, this plan identifies specific sites that would benefit from Best Management Practices to rehabilitate the stream.

Specific Sites Assessment and Recommendations

While numerous sections of Beaverdam Creek and its tributaries merit rehabilitation, the specific sites identified (named, for reference, Sites 1-28) represent the greatest positive impact to water quality and habitat quality if recommended changes to these sites are implemented. Included in each site description are associated photographs, recommendations and priority level.

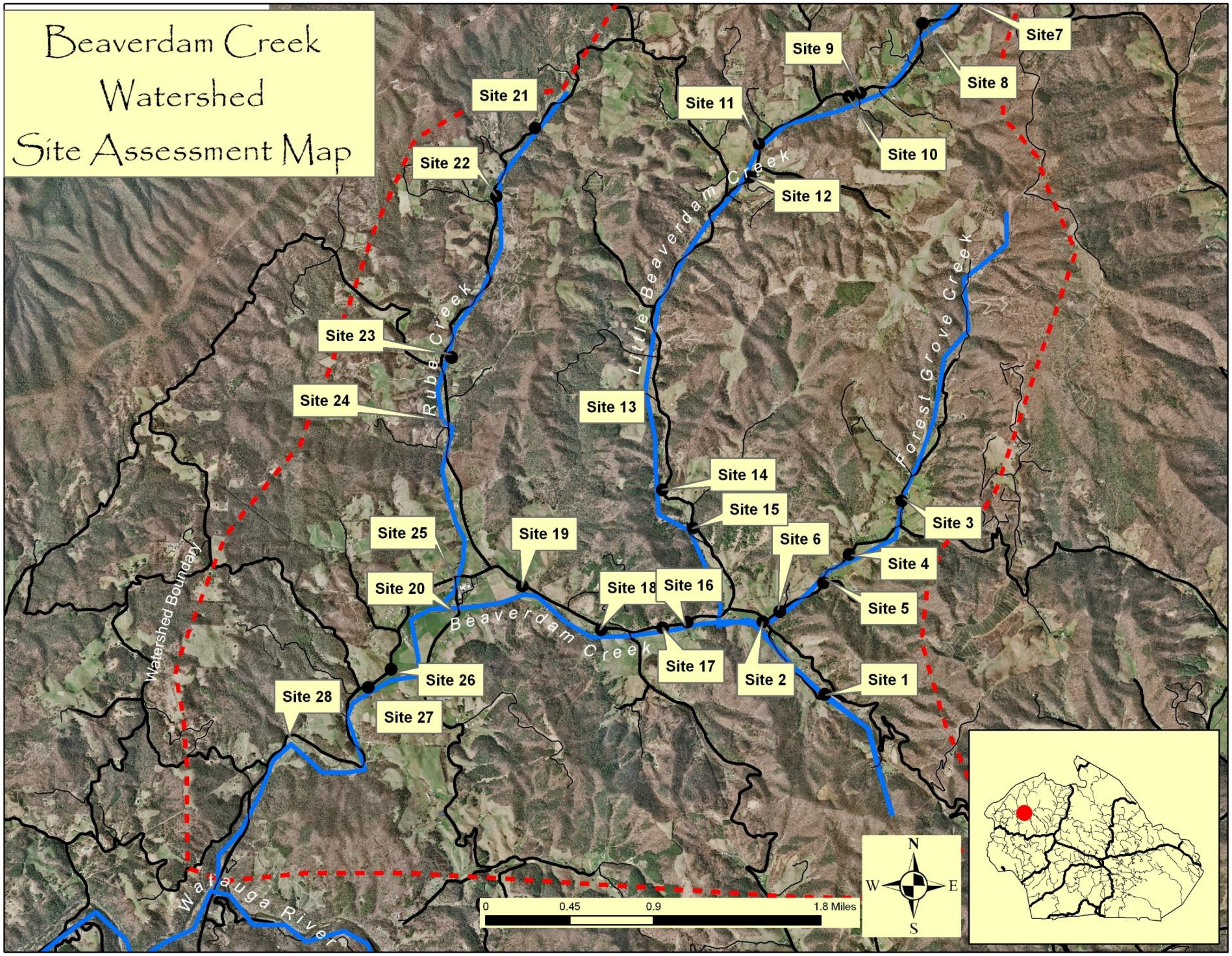


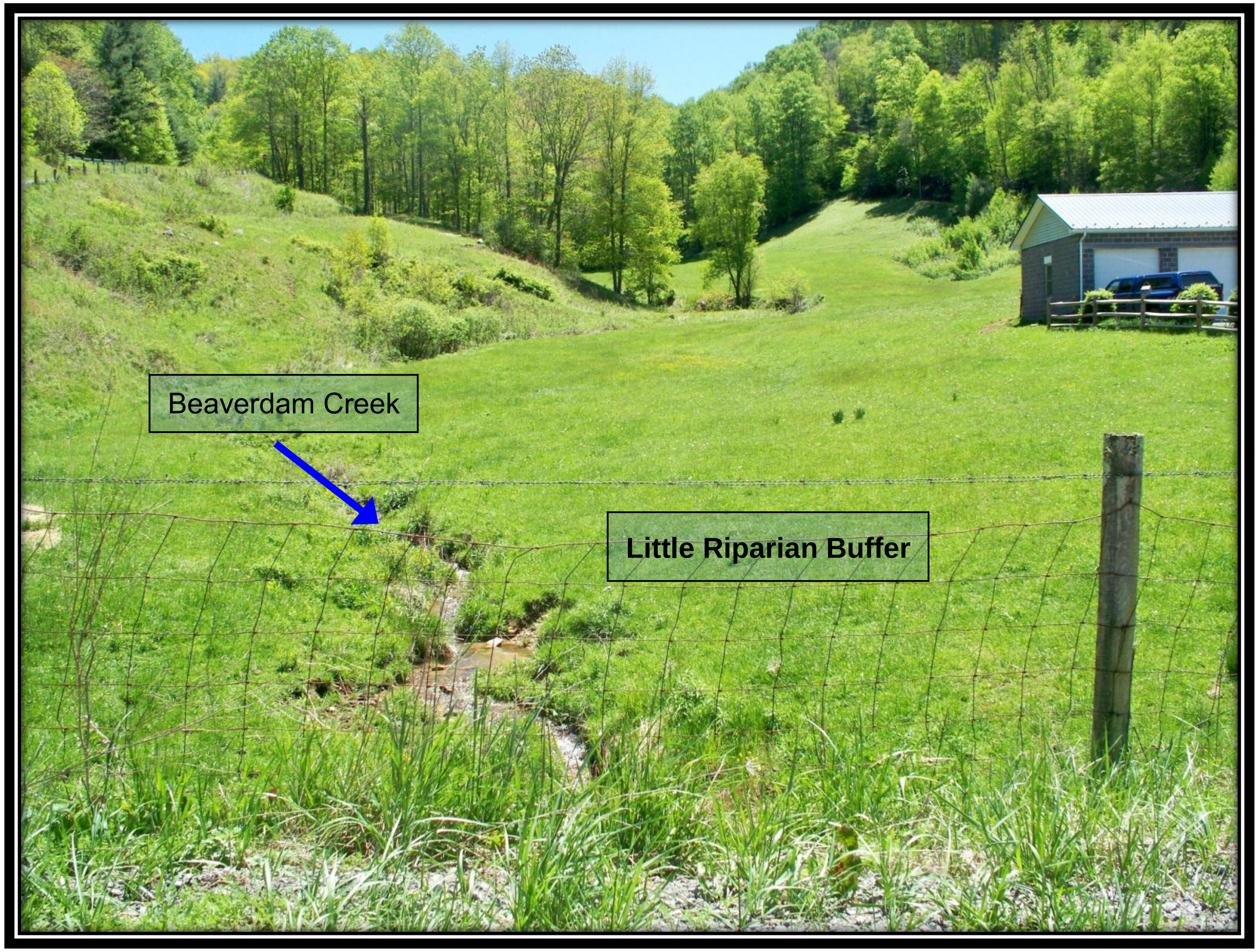
Figure 7: Specific Sites Recommended for Implementing Best Management Practices

SITE 1 Coordinates: 36°17.228"N 81°48.829"W

Stream Name: Beaverdam Creek
Length of Degraded Portion of Stream: approximately 650 linear feet
Recommendations:

- Riparian buffer planting

Priority Ranking: Low

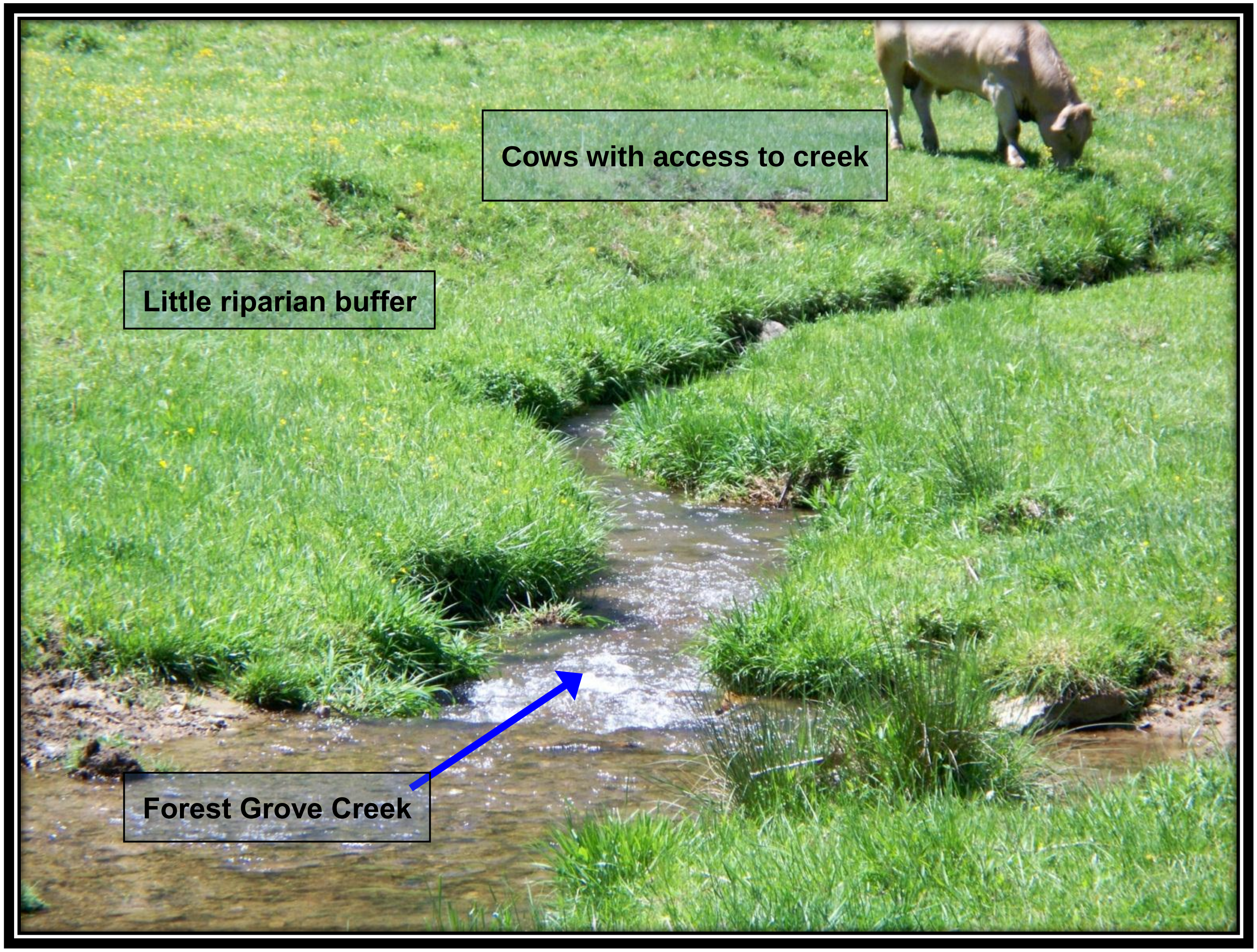


SITE 2 Coordinates: 36°17.557"N 81°49.199"W

Stream Name: Beaverdam & Forest Grove Creek
Length of Degraded Portion of Stream:
Approximately 220 linear feet of Beaverdam Creek and approximately 200 linear feet of Forest Grove Creek
Recommendations:

- Alternate watering source
- Riparian buffer planting

Priority Ranking: Moderate to High



SITE 3 Coordinates: 36°18.140”N 81°48.418”W

Stream Name: Forest Grove Creek
Length of Degraded Portion of Stream:
Approximately 325 linear feet
Recommendations:

- Riparian buffer planting

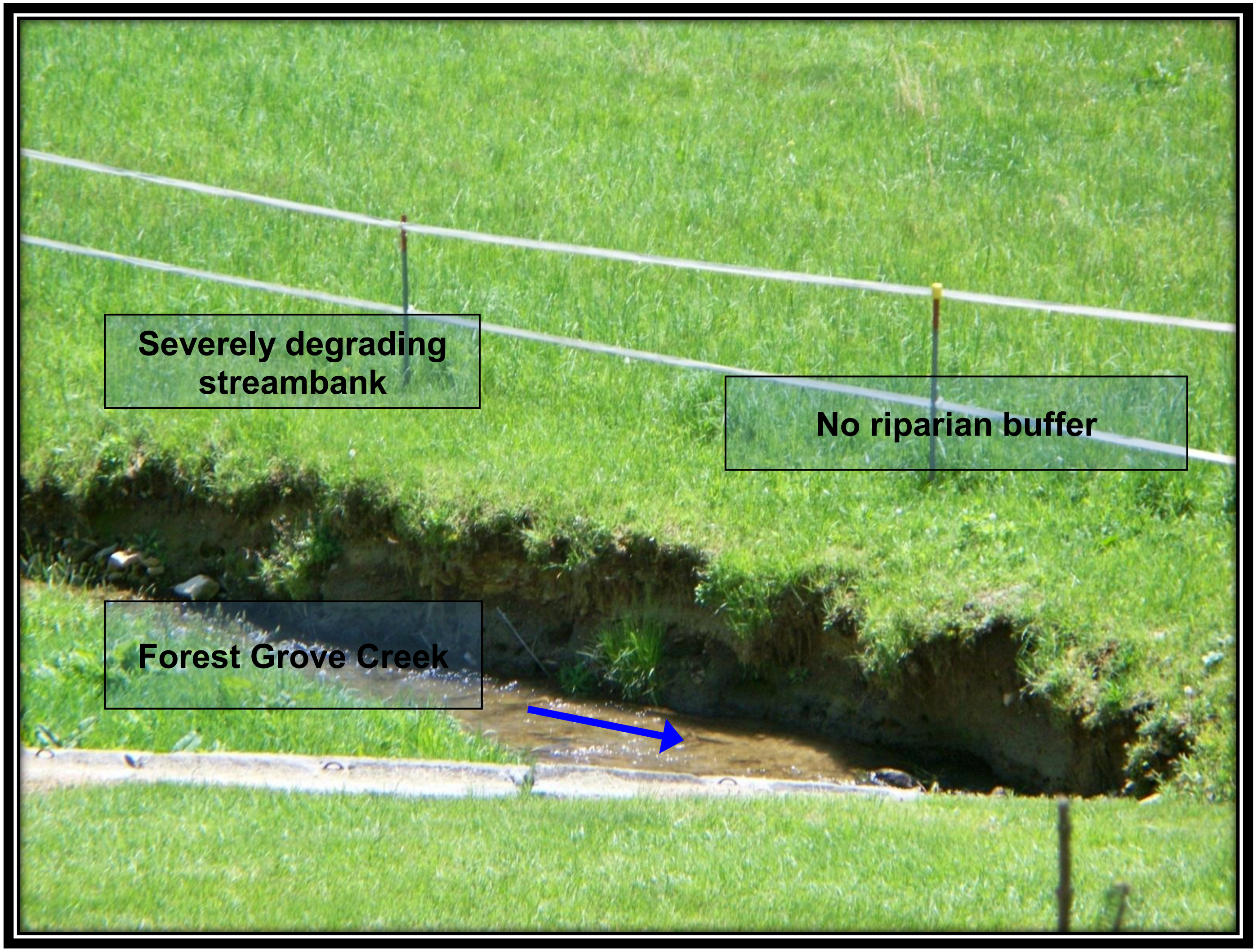
Priority Ranking: Low

SITE 4 Coordinates: 36°17.885"N 81°48.712"W

Stream Name: Forest Grove Creek
Length of Degraded Portion of Stream:
Approximately 500 linear feet
Recommendations:

- Streambank stabilization
- Riparian buffer planting

Priority Ranking: Moderate

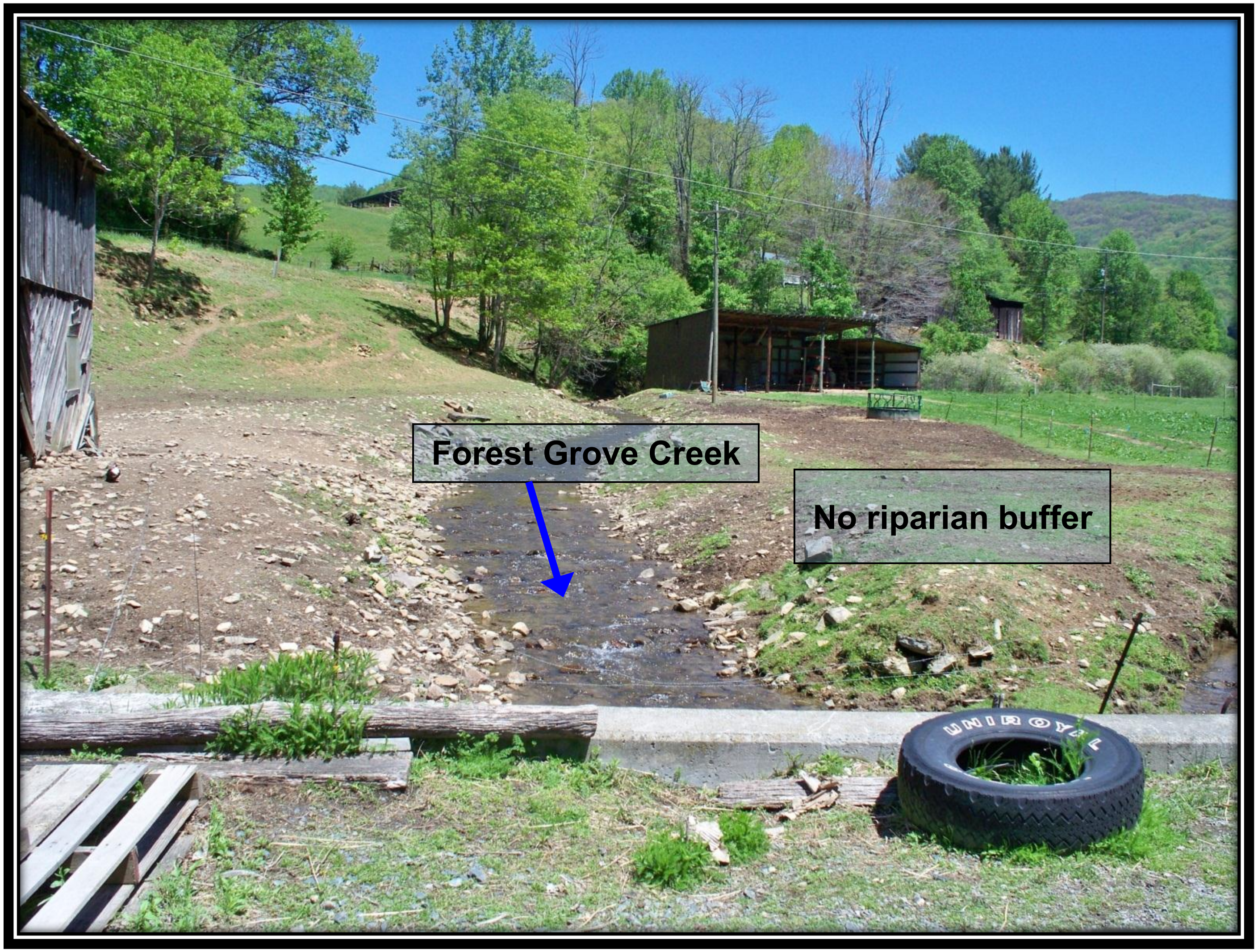


SITE 5 Coordinates: 36°17.747”N 81°48.857”W

Stream Name: Forest Grove Creek
Length of Degraded Portion of Stream:
Approximately 390 linear feet
Recommendations:

- Streambank stabilization
- Alternate watering source
- Riparian buffer planting

Priority Ranking: High

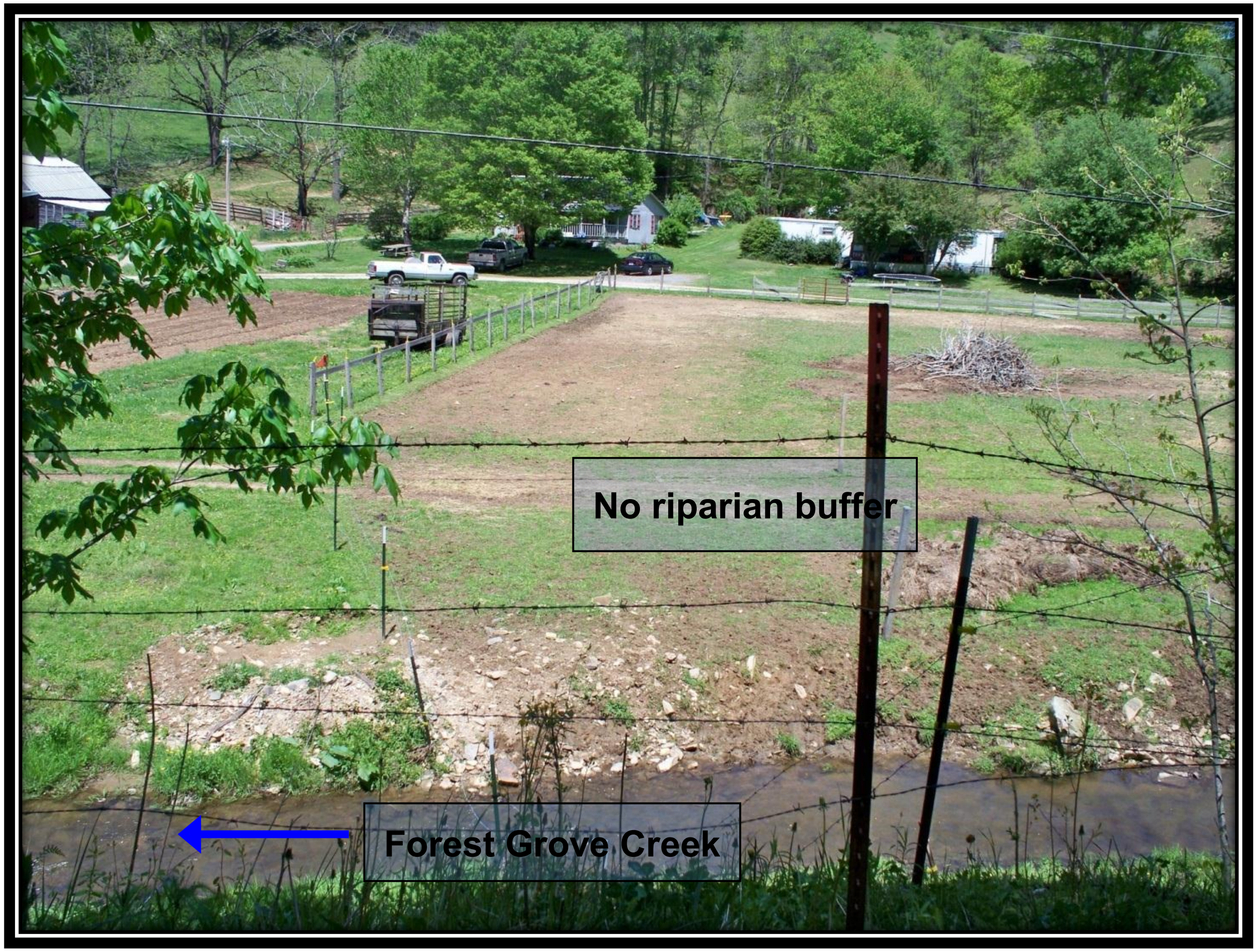


SITE 6 Coordinates: 36°17.609"N 81°49.103"W

Stream Name: Forest Grove Creek
Length of Degraded Portion of Stream:
Approximately 570 linear feet
Recommendations:

- Streambank stabilization
- Livestock exclusion
- Riparian buffer planting

Priority Ranking: High

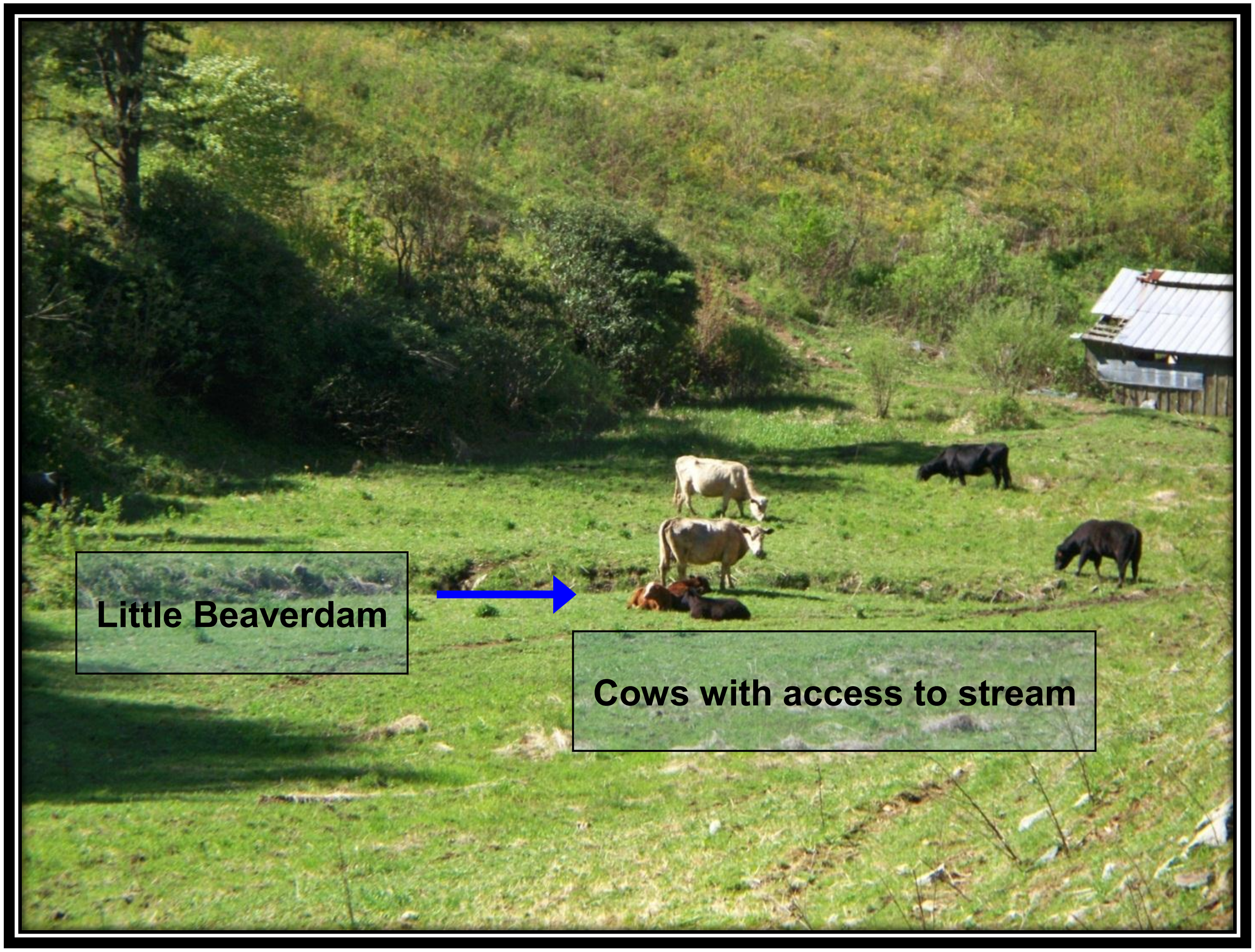


SITE 7 Coordinates: 36°20.528"N 81°48.148"W

Stream Name: Upper Little Beaverdam
Length of Degraded Portion of Stream: ~450 linear feet
Recommendations:

- Streambank stabilization
- Alternate watering source
- Native plants along banks

Priority Ranking: High

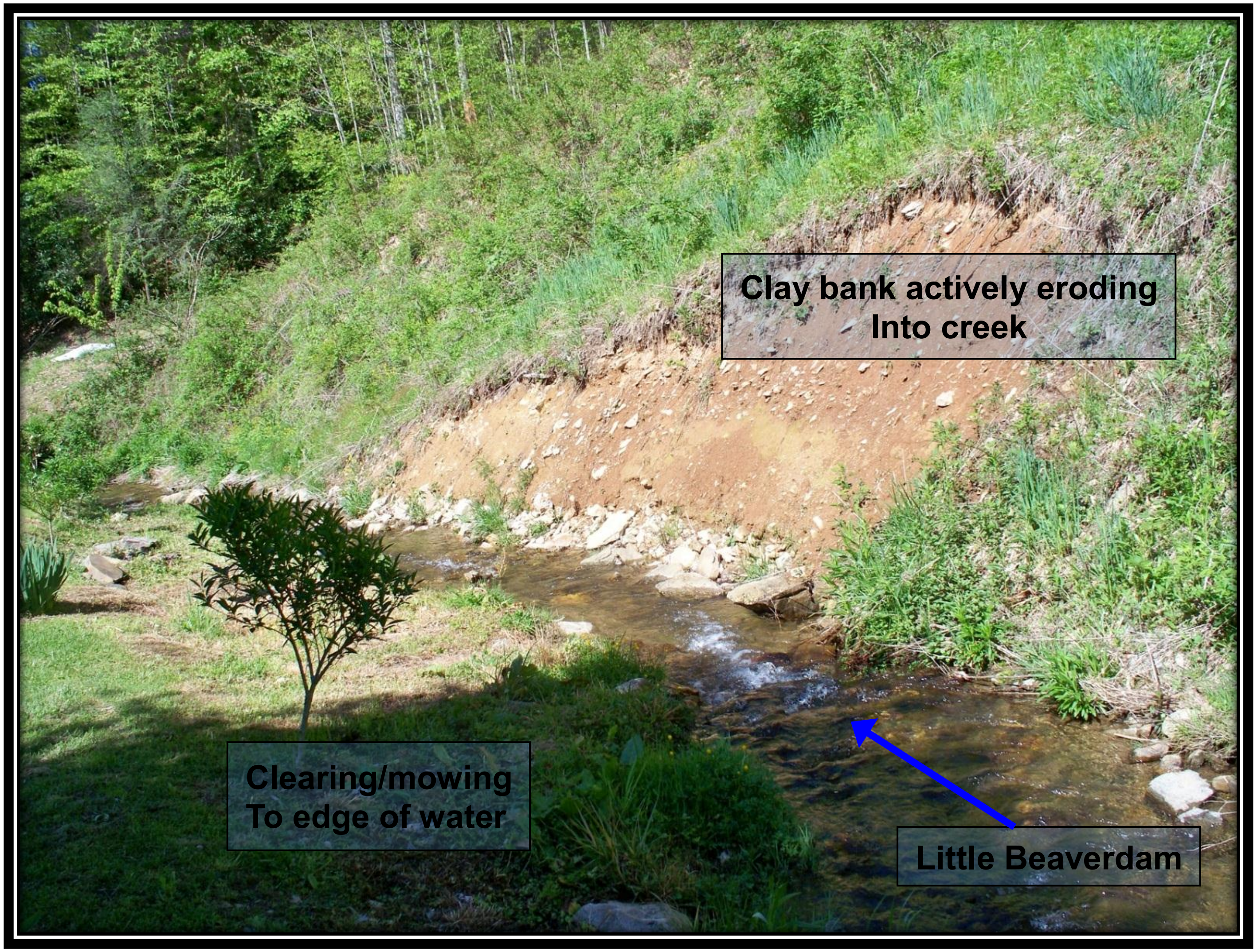


SITE 8 Coordinates: 36°20.371"N 81°48.374"W

Stream Name: Upper Little Beaverdam
Length of Degraded Portion of Stream: Approximately 400 linear feet
Recommendations:

- Riparian planting
- Natural Channel Design

Priority Ranking: Moderate

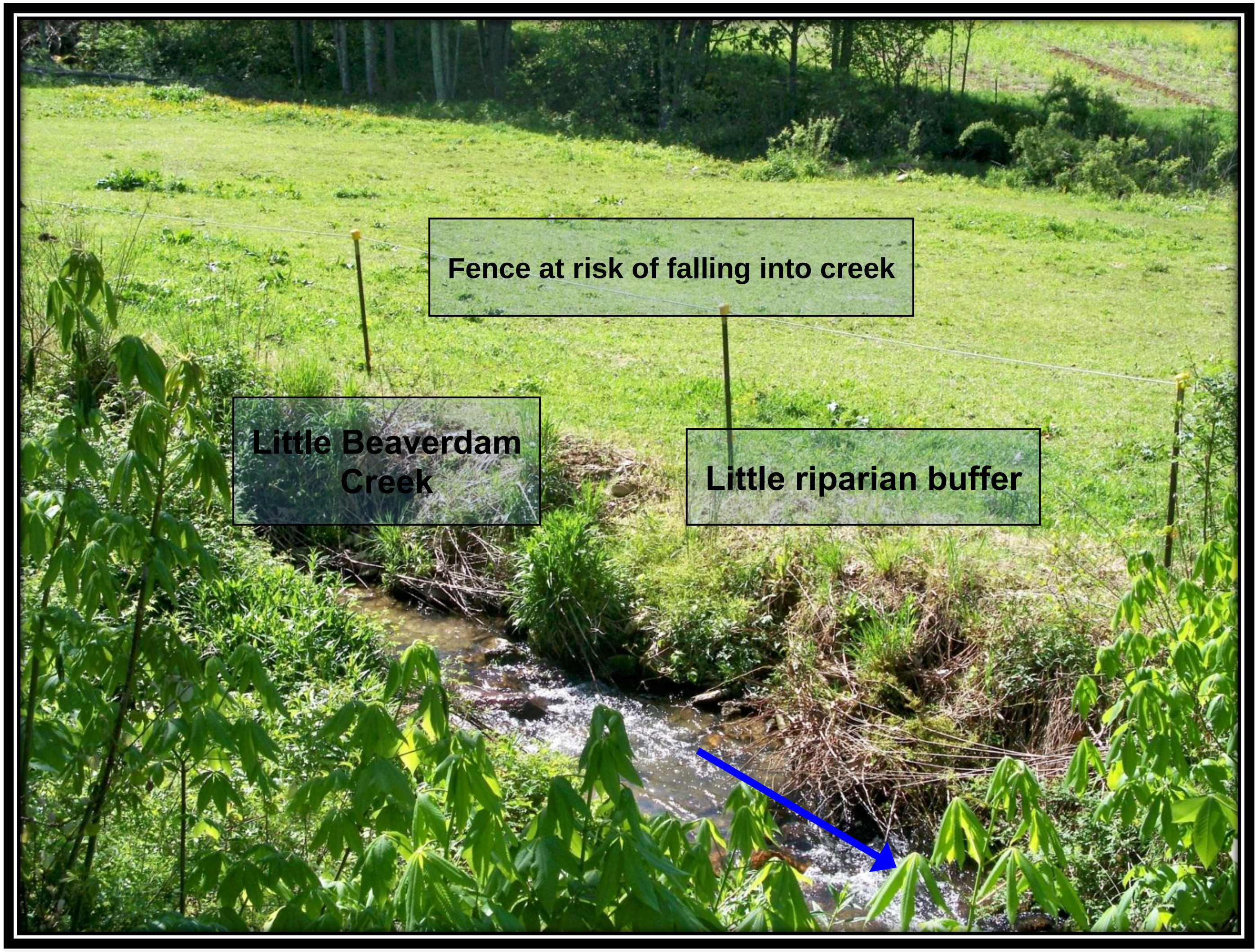


SITE 9 Coordinates: 36°20.039"N 81°48.721"W

Stream Name: Upper Little Beaverdam
Length of Degraded Portion of Stream:
Approximately 560 linear feet
Recommendations:

- Alternate watering source
- Streambank stabilization

Priority Ranking: Moderate

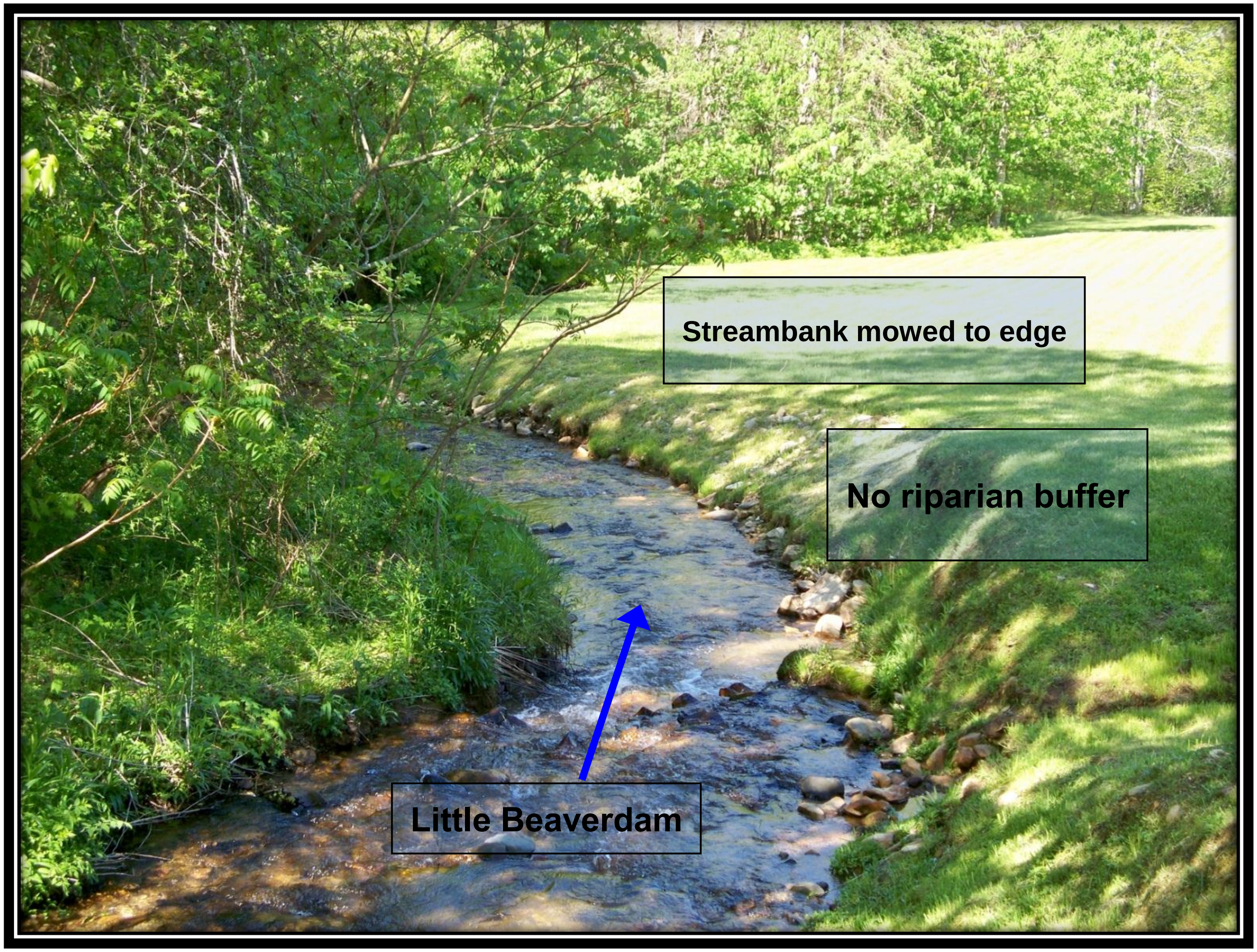


SITE 10 Coordinates: 36°20.020”N 81°48.789”W

Stream Name: Upper Little Beaverdam Creek
Length of Degraded Portion of Stream:
Approximately 300 linear feet
Recommendations:

- Riparian planting

Priority Ranking: Low

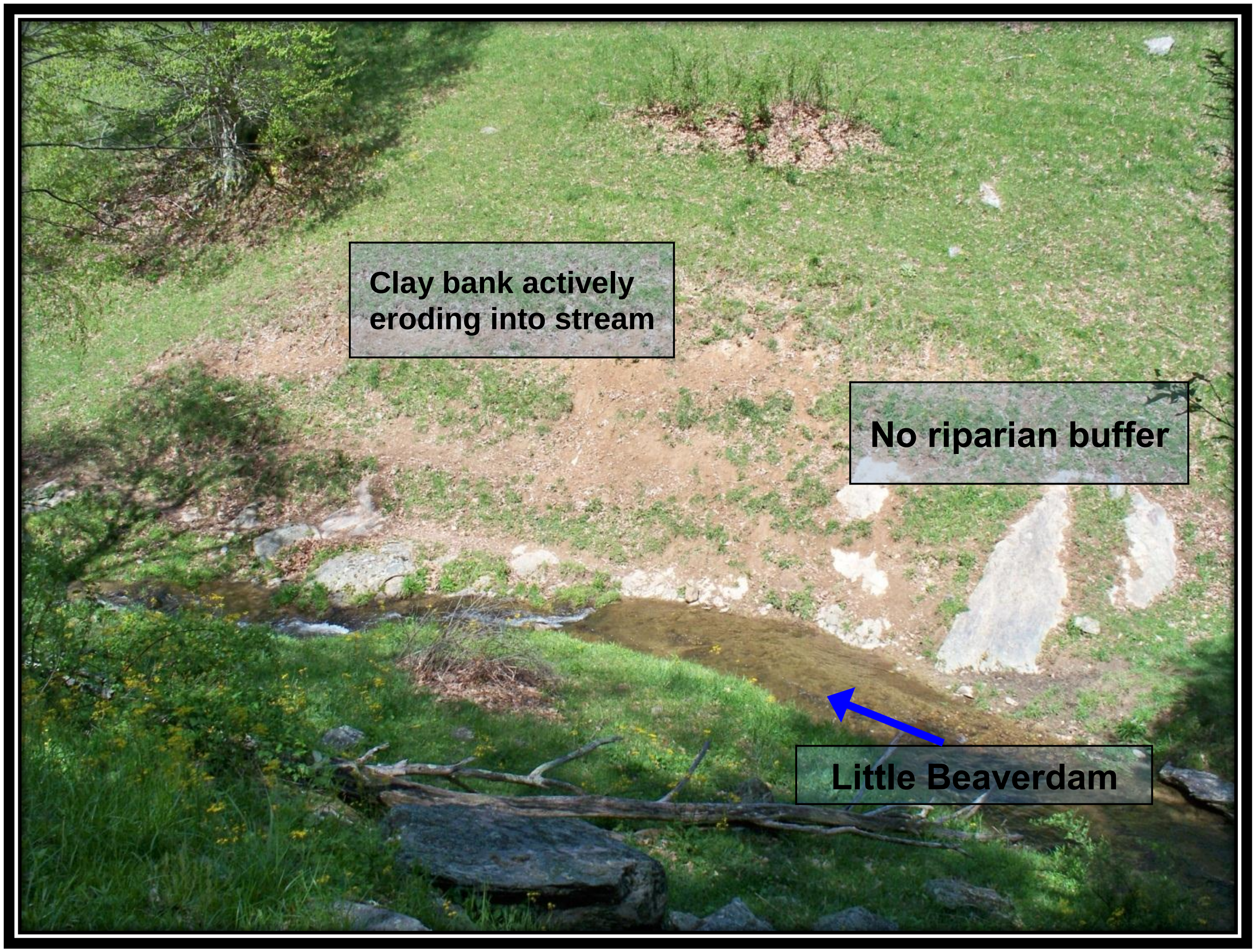


SITE 11 Coordinates: 36°19.788"N 81°49.298"W

Stream Name: Upper Little Beaverdam
Length of Degraded Portion of Stream:
Approximately 930 linear feet
Recommendations:

- Streambank stabilization
- Livestock exclusion
- Riparian buffer planting

Priority Ranking: High

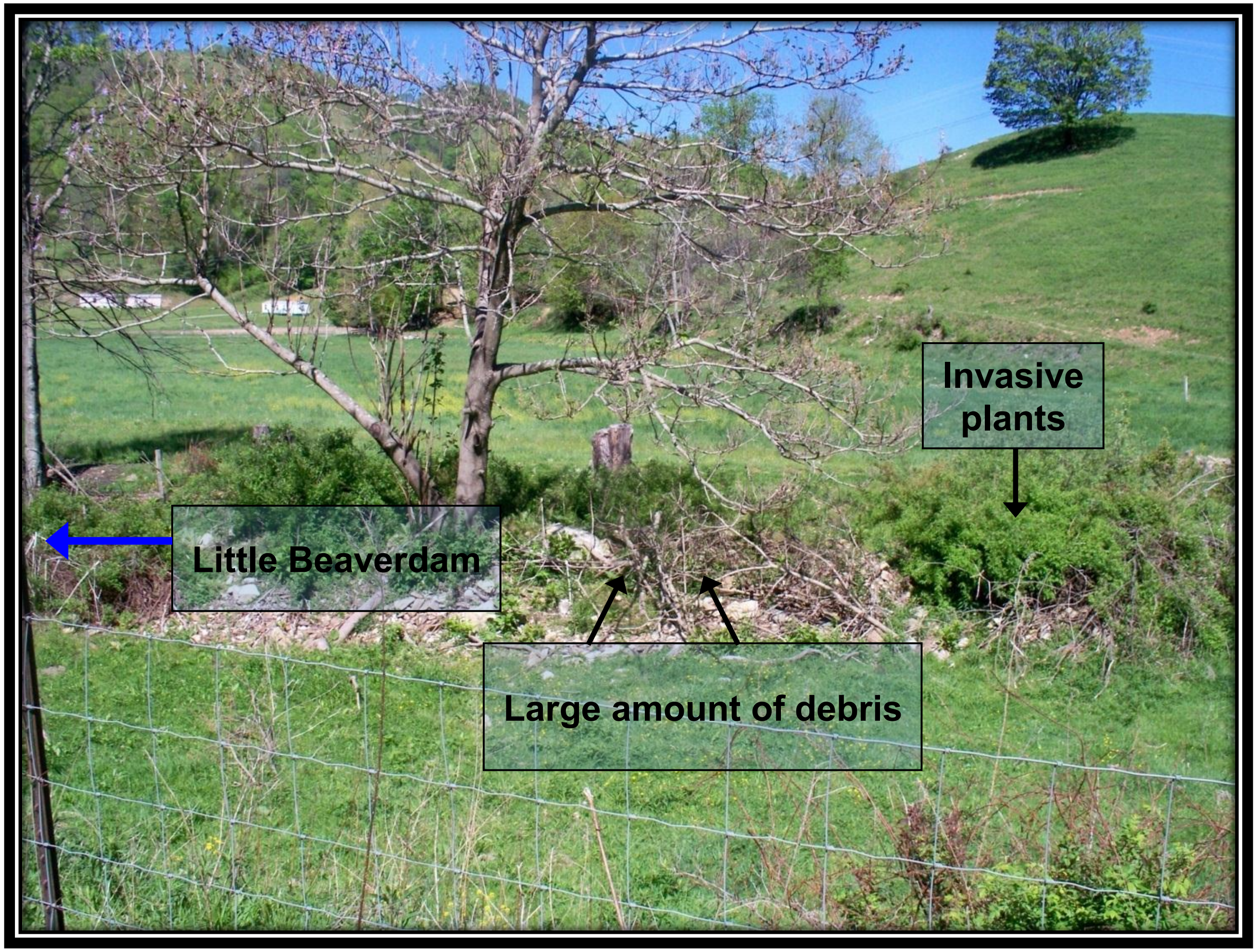


SITE 12 Coordinates: 36°19.632”N 81°49.343”W

Stream Name: Upper Little Beaverdam
Length of Degraded Portion of Stream: Approximately 1,380 linear feet
Recommendations:

- Alternate watering source
- Riparian buffer planting

Priority Ranking: Moderate



SITE 13 Coordinates: 36°18.494”N 81°49.791”W

Stream Name: Little Beaverdam
Length of Degraded Portion of Stream:
Approximately 1,200 linear feet
Recommendations:

- Streambank stabilization
- Alternate watering source
- Riparian buffer planting

Priority Ranking: High

SITE 14 Coordinates: 36°18.161"N 81°49.799"W

Stream Name: Little Beaverdam
Length of Degraded Portion of Stream:
Approximately 520 linear feet
Recommendations:

- Riparian buffer planting

Priority Ranking: Low

SITE 15 Coordinates: 36°17.986"N 81°49.617"W

Stream Name: Little Beaverdam
Length of Degraded Portion of Stream: Approximately 2,130 linear feet
Recommendations:

- Streambank stabilization
- Riparian buffer planting

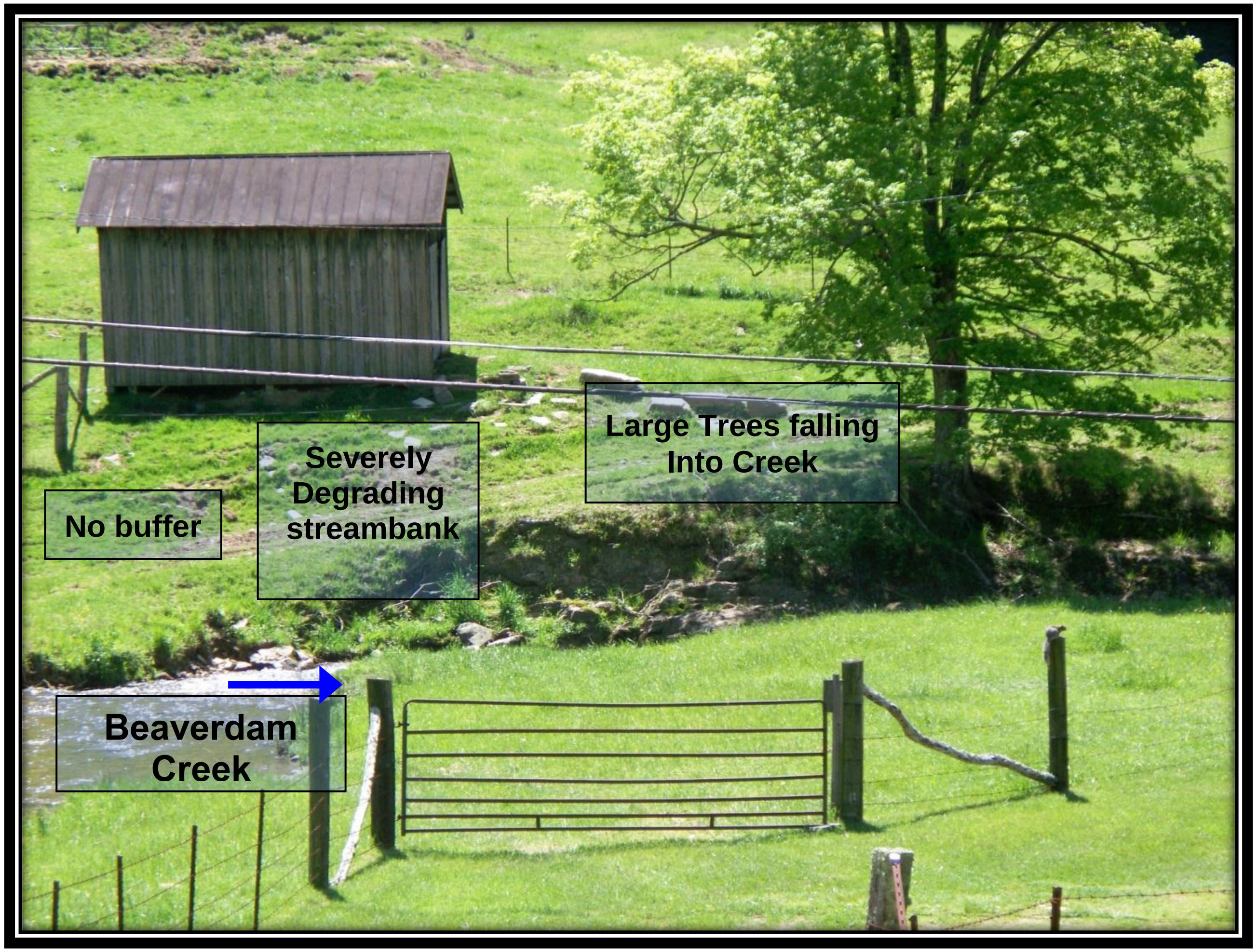
Priority Ranking: Moderate

SITE 16 Coordinates: 36°17.545”N 81°49.632”W

Stream Name: Beaverdam Creek
Length of Degraded Portion of Stream:
Approximately 790 linear feet
Recommendations:

- Streambank stabilization
- Alternate watering source
- Riparian buffer planting

Priority Ranking: High



SITE 17 Coordinates: 36°17.517"N 81°49.774"W

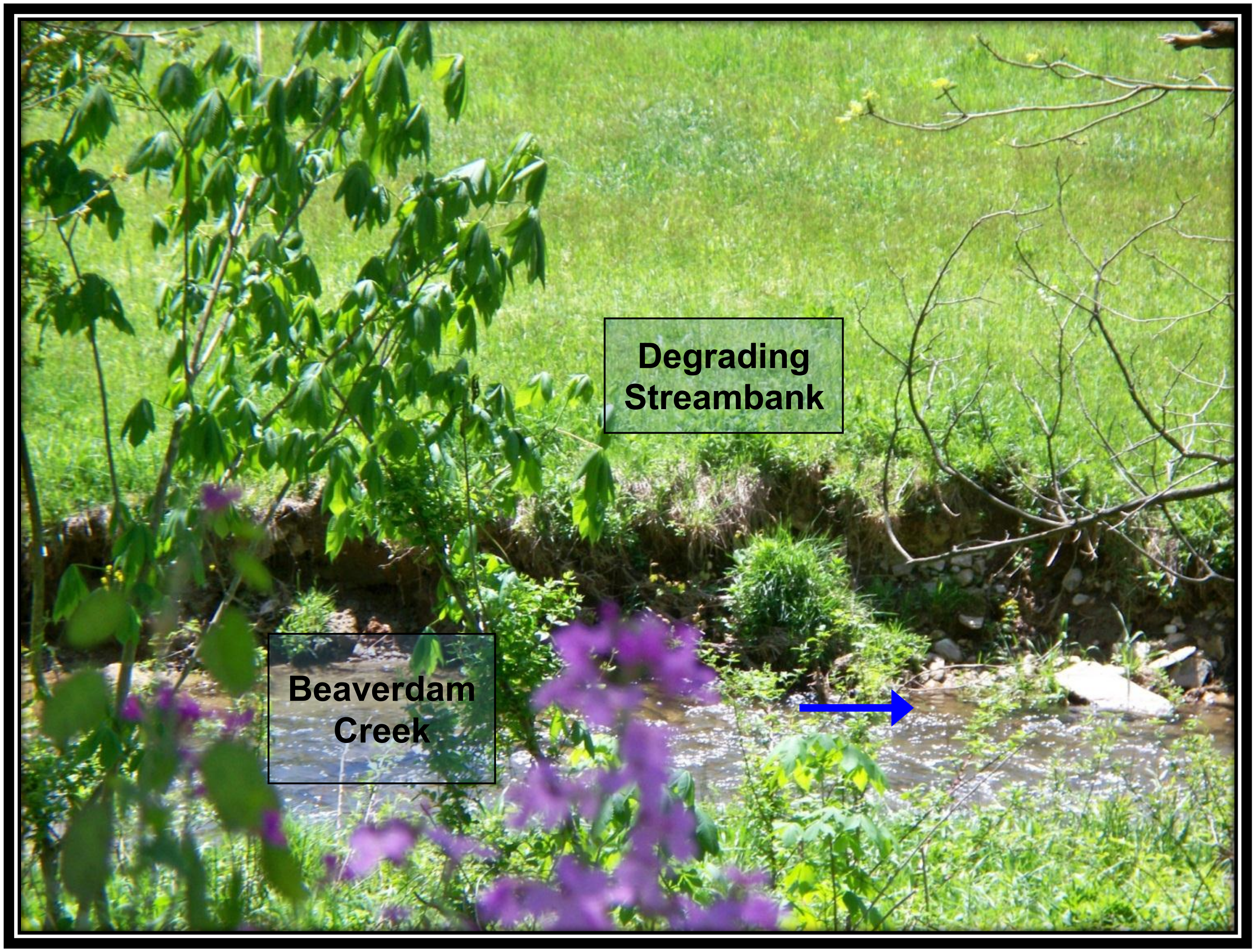
Stream Name: Beaverdam

Length of Degraded Portion of Stream: Approximately 1,030 linear feet

Recommendations:

- Streambank stabilization
- Alternate watering source
- Riparian buffer planting

Priority Ranking: High

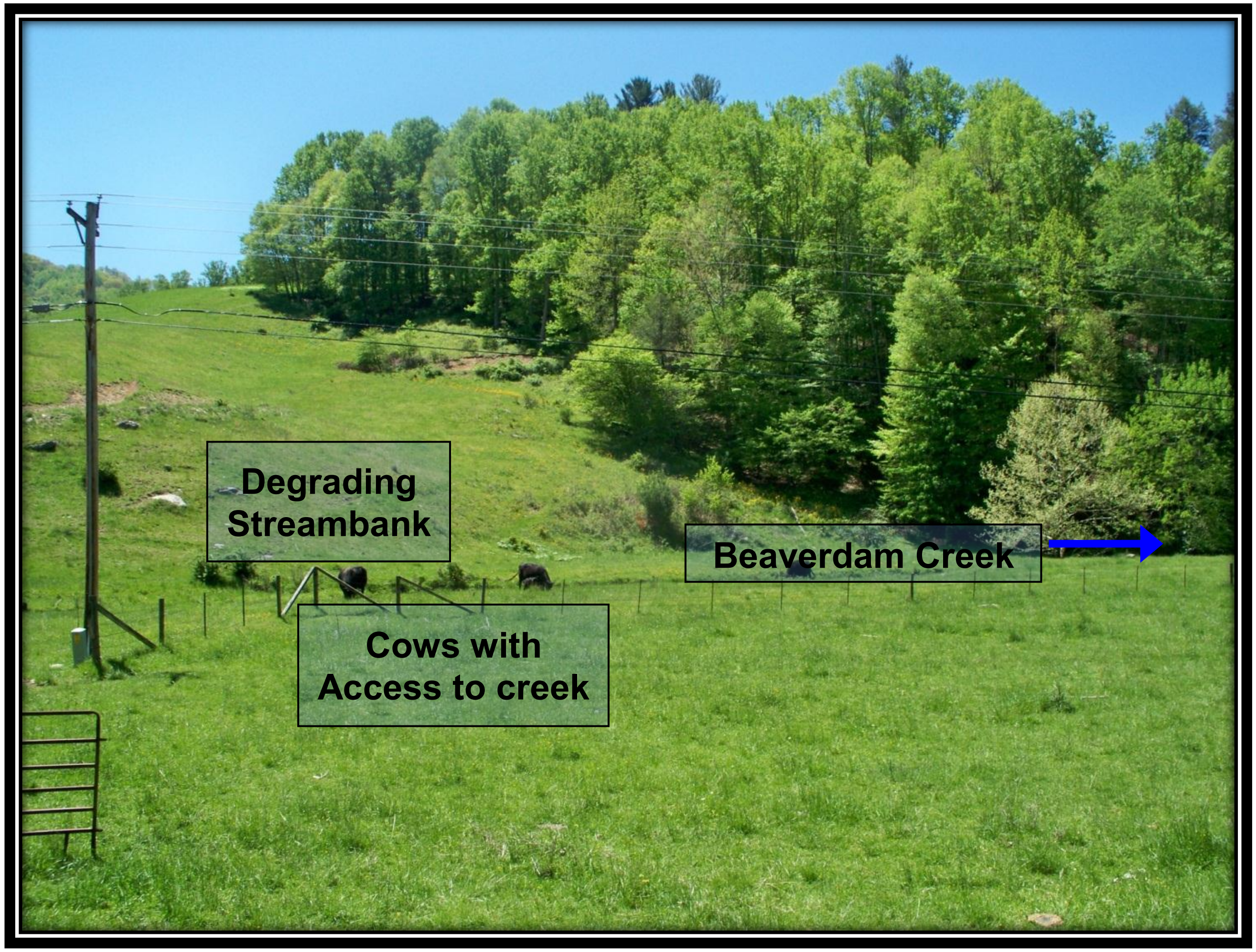


SITE 18 Coordinates: 36°17.501"N 81°50.129"W

Stream Name: Beaverdam Creek
Length of Degraded Portion of Stream:
Approximately 1,000 linear feet
Recommendations:

- Streambank stabilization
- Alternate watering source
- Riparian buffer planting

Priority Ranking: High

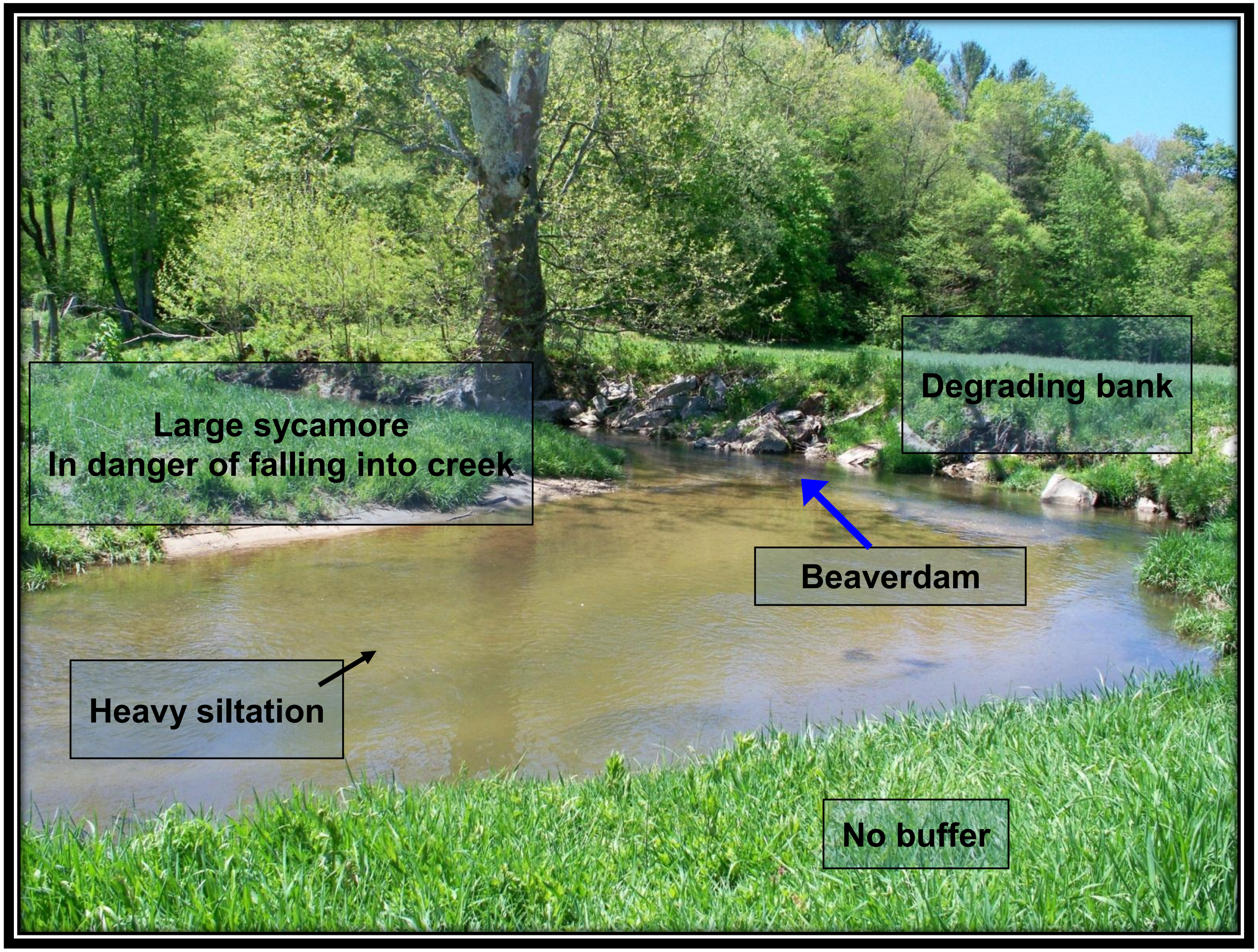


SITE 19 Coordinates: 36°17.692"N 81°50.591"W

Stream Name: Beaverdam Creek
Length of Degraded Portion of Stream: Approximately 1,900 linear feet
Recommendations:

- Streambank stabilization
- Riparian buffer planting

Priority Ranking: Moderate

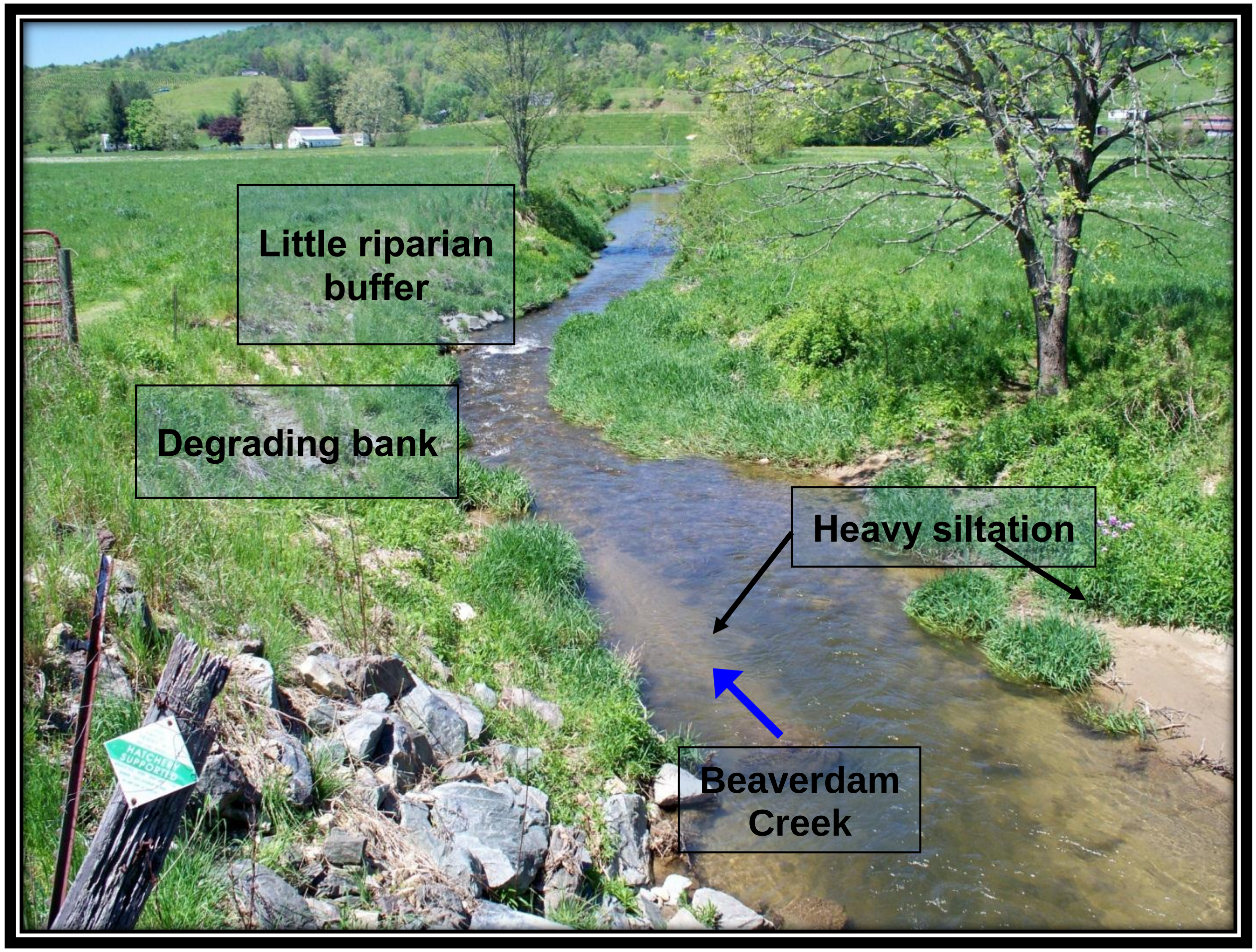


SITE 20 Coordinates: 36°17.555"N 81°50.966"W

Stream Name: Beaverdam Creek
Length of Degraded Portion of Stream:
Approximately 1,250 linear feet of Beaverdam Creek and approximately 800 linear feet of Rube Creek
Recommendations:

- Streambank stabilization
- Alternate watering source
- Riparian buffer planting

Priority Ranking: High

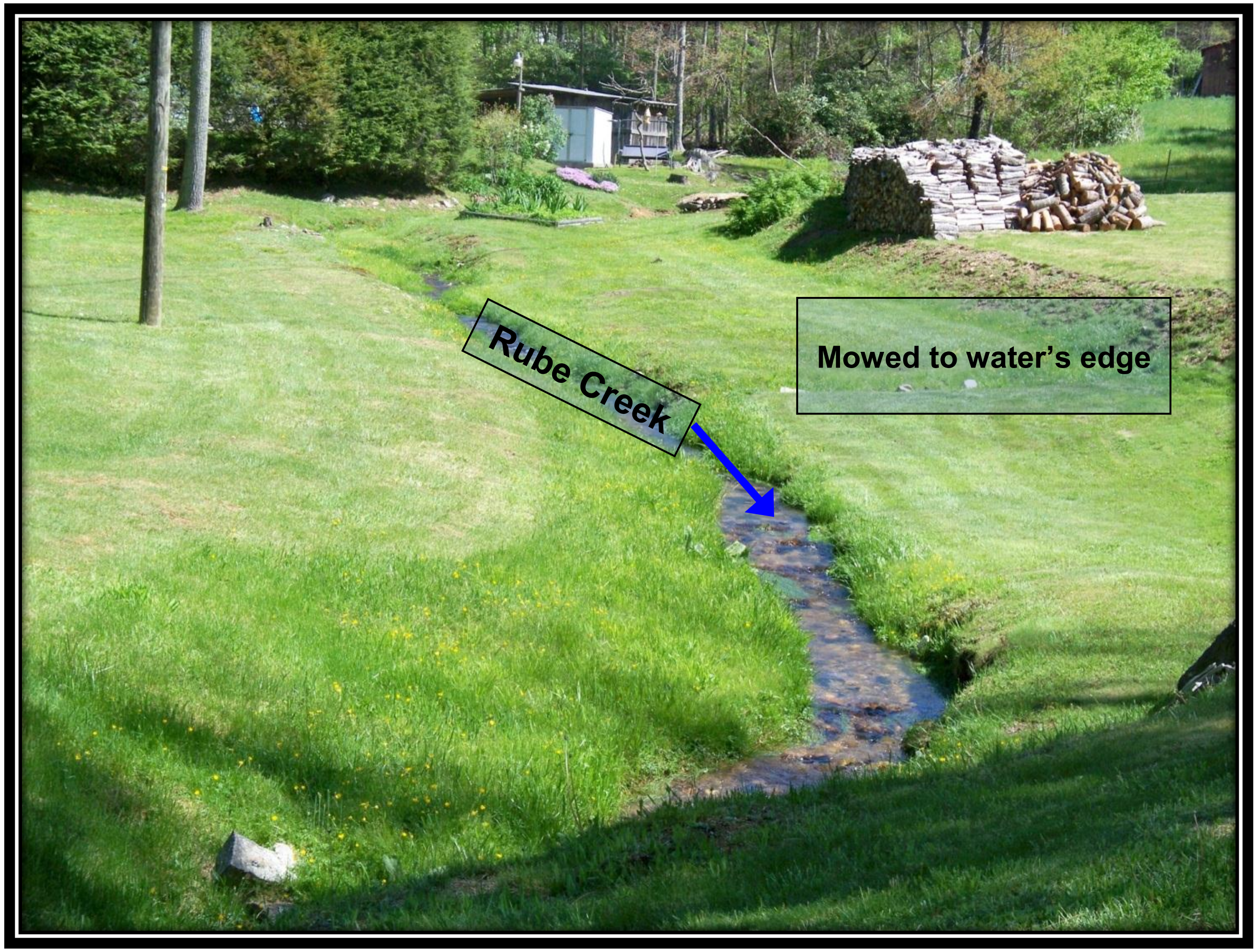


SITE 21 Coordinates: 36°19.832"N 81°50.593"W

Stream Name: Rube Creek
Length of Degraded Portion of Stream:
Approximately 220 linear feet
Recommendations:

- Riparian buffer planting

Priority Ranking: Low

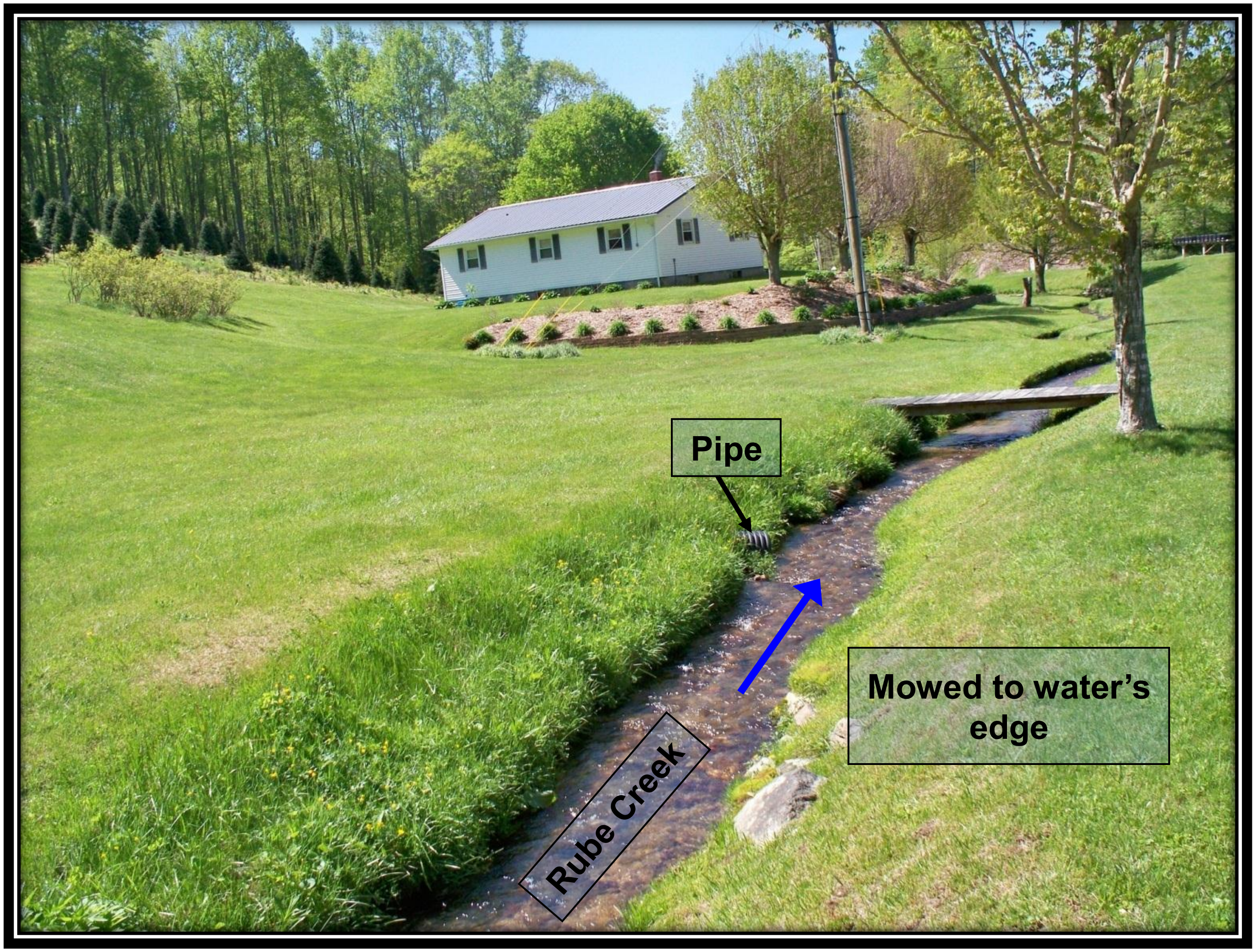


SITE 22 Coordinates: 36°19.510"N 81°50.805"W

Stream Name: Rube Creek
Length of Degraded Portion of Stream:
Approximately 200 linear feet
Recommendations:

- Riparian buffer planting

Priority Ranking: Low



SITE 23 Coordinates: 36°19.510"N 81°50.805"W

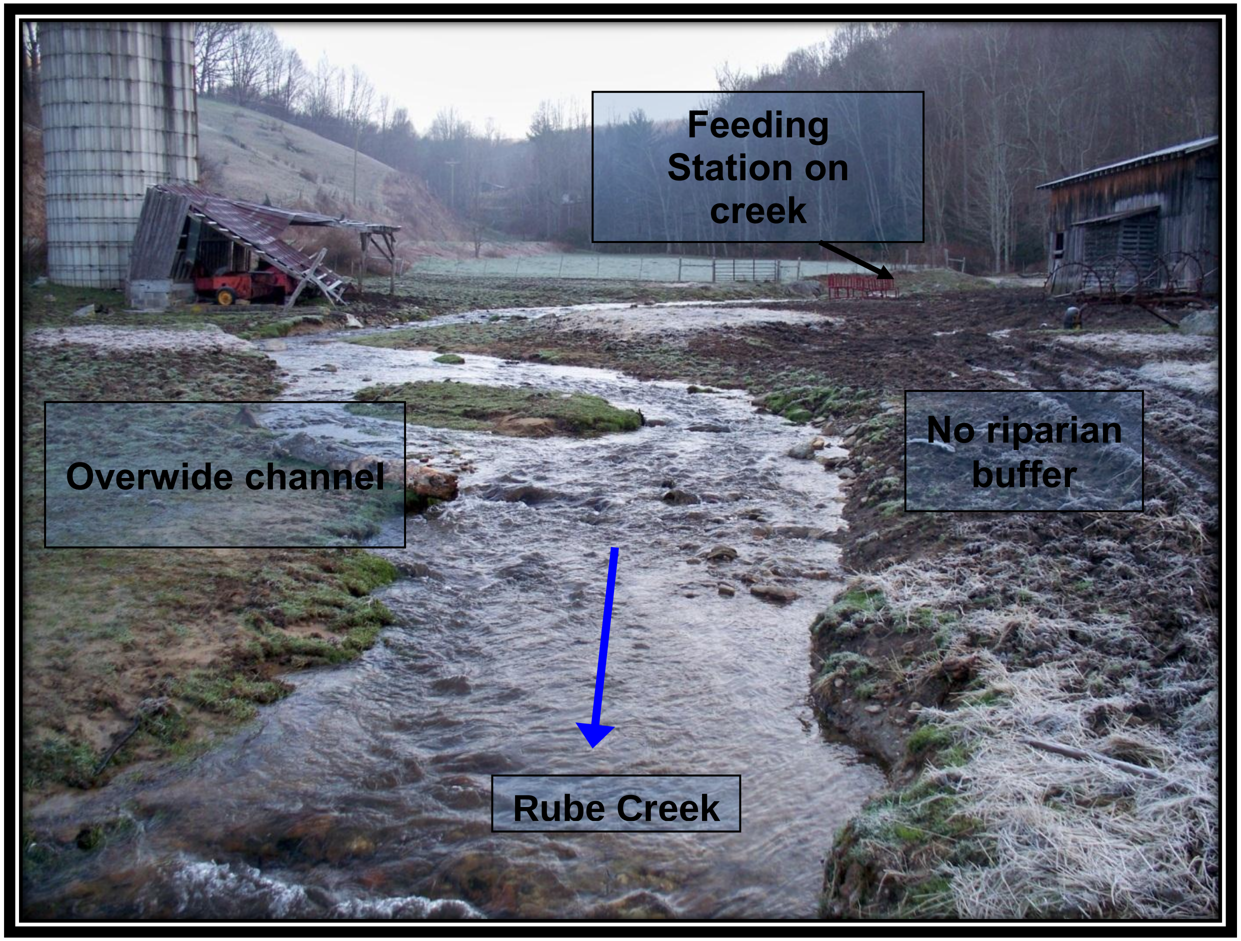
Stream Name: Rube Creek

Length of Degraded Portion of Stream:
Approximately 375 linear feet

Recommendations:

- Streambank stabilization
- Alternate watering source
- Riparian buffer planting

Priority Ranking: High



SITE 24 Coordinates: 36°18.454"N 81°51.059"W

Stream Name: Rube Creek

Length of Degraded Portion of Stream: Approximately 775 linear feet

Recommendations:

- Streambank stabilization
- Livestock exclusion
- Riparian buffer planting

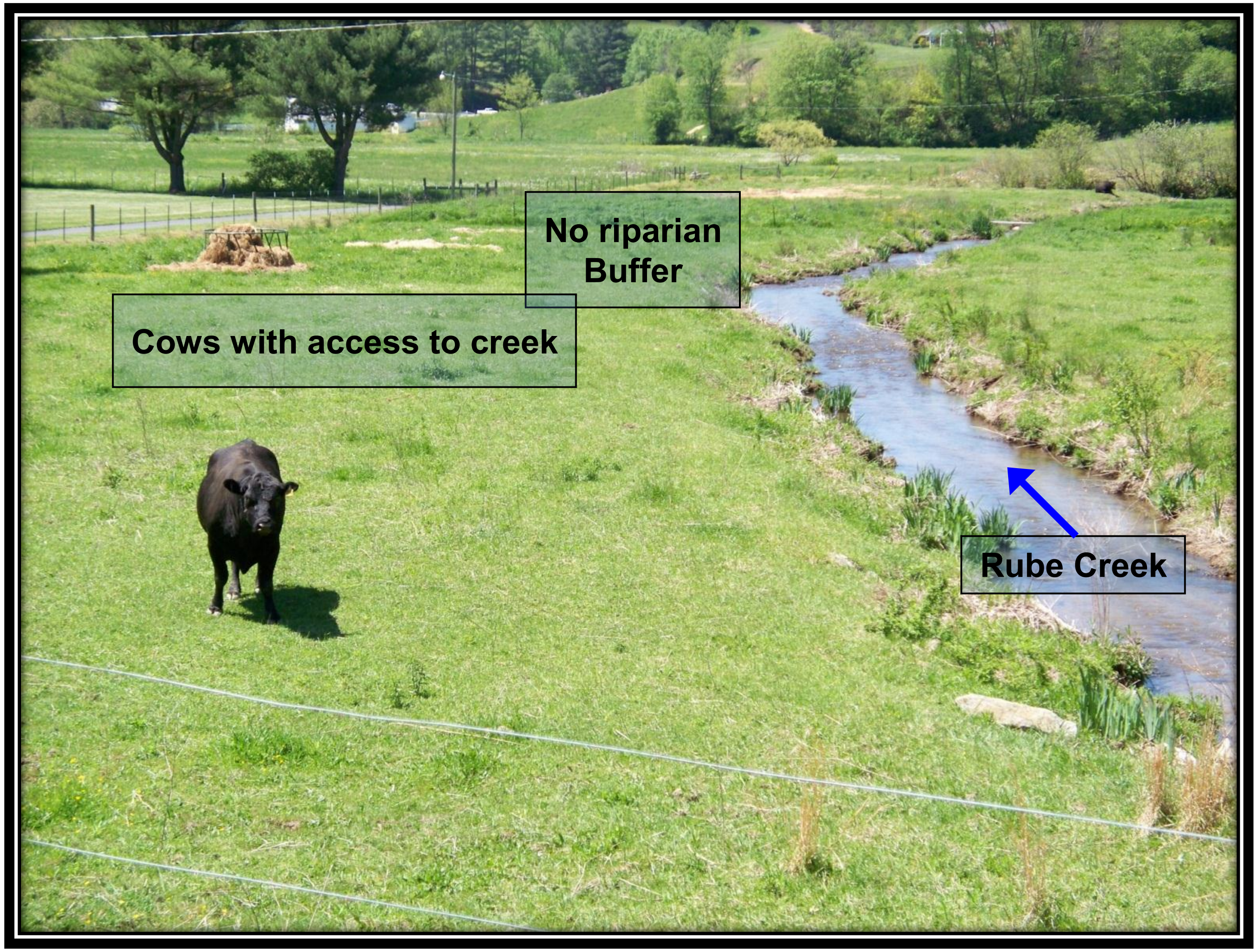
Priority Ranking: High

SITE 25 Coordinates: 36°17.707"N 81°50.984"W

Stream Name: Rube Creek
Length of Degraded Portion of Stream: Approximately 800 linear feet
Recommendations:

- Streambank stabilization
- Alternate watering source
- Riparian buffer planting

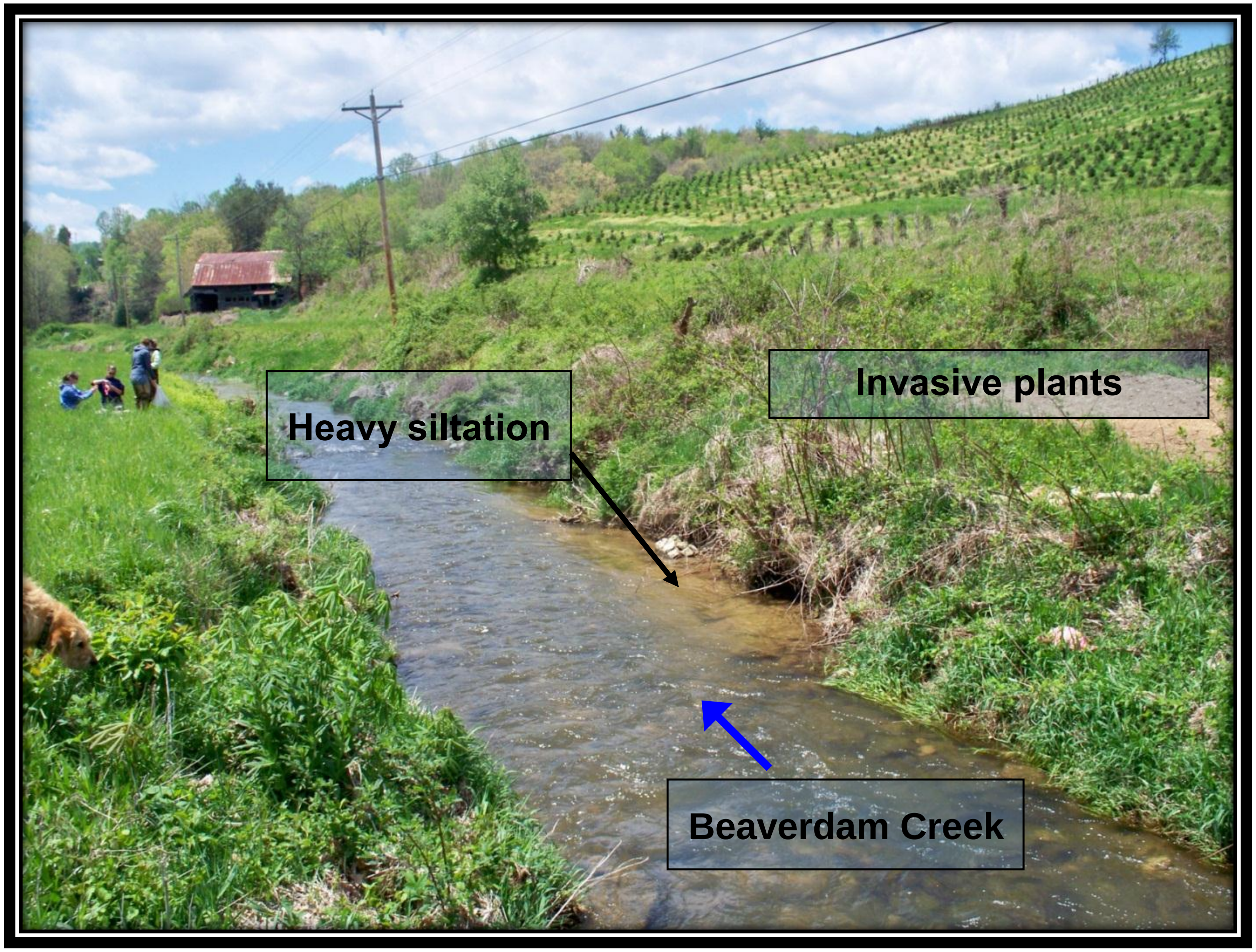
Priority Ranking: High



SITE 26 Coordinates: 36°17.199"N 81°51.463"W

Stream Name: Beaverdam Creek
Length of Degraded Portion of Stream:
Approximately 1,000 linear feet
Recommendations:

- Streambank stabilization
- Riparian buffer planting



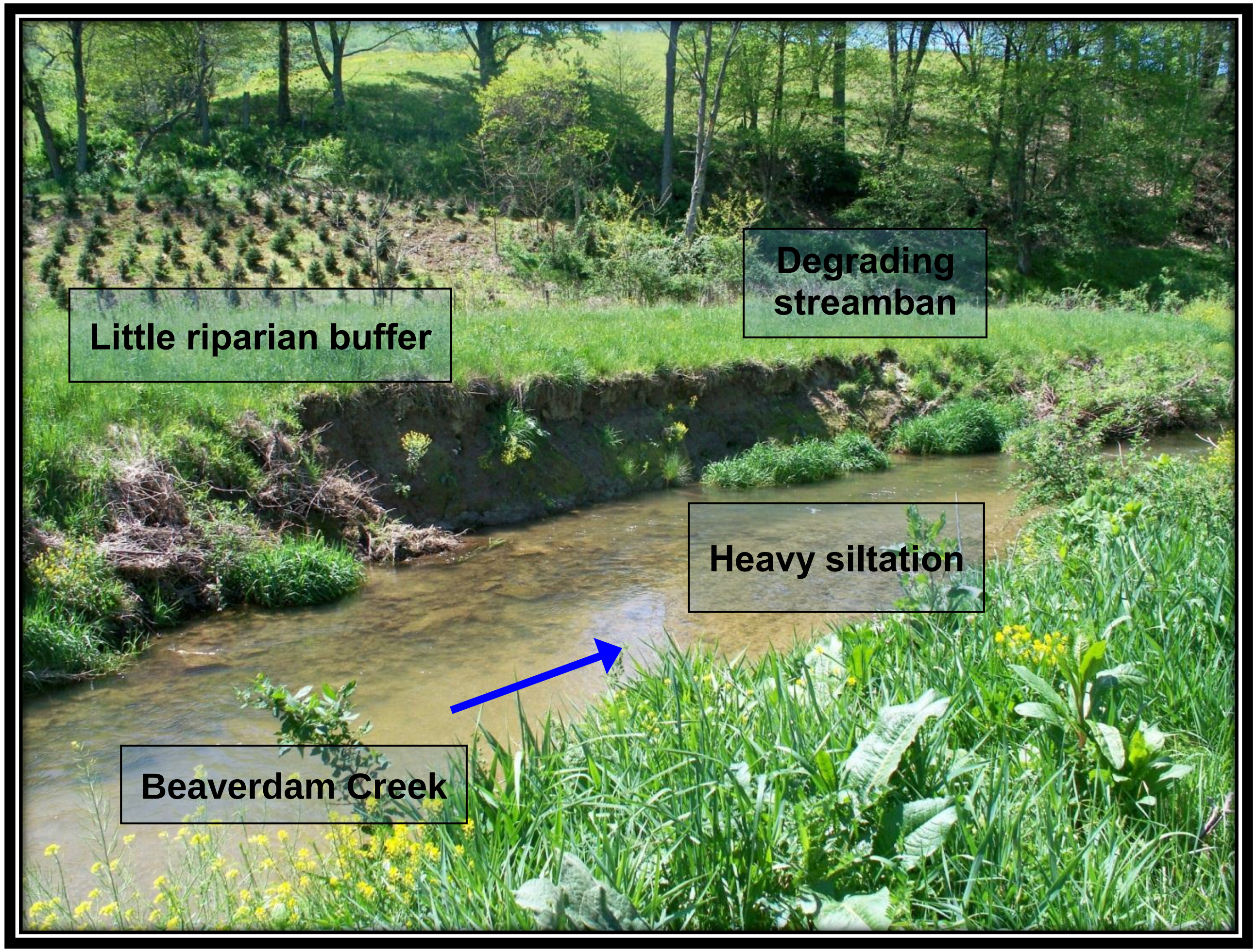
Priority Ranking: Moderate

SITE 27 Coordinates: 36°17.199"N 81°51.463"W

Stream Name: Beaverdam Creek
Length of Degraded Portion of Stream:
Approximately 1,600 linear feet
Recommendations:

- Streambank stabilization
- Riparian buffer planting

Priority Ranking: Moderate

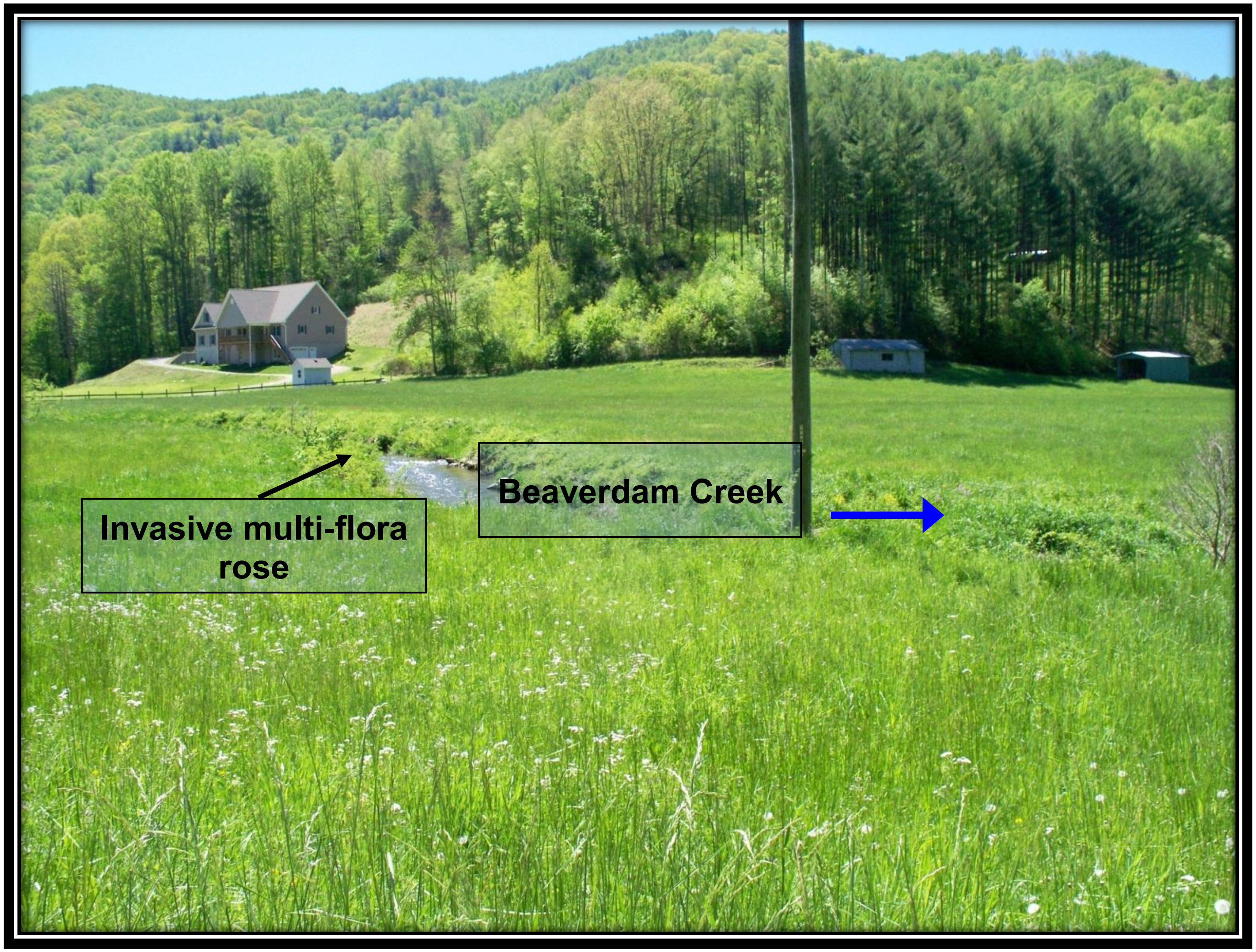


SITE 28 Coordinates: 36°16.960"N 81°51.909"W

Stream Name: Beaverdam
Length of Degraded Portion of Stream:
Approximately 550 linear feet
Recommendations:

- Riparian buffer planting

Priority Ranking: Low



Stormwater Management

Local institutions, such as schools and churches, can take measures to improve water quality in the watershed. Water running off of impervious surfaces (rooftops, parking lots, roads) can increase stream temperature and sediment load, negatively impacting native fish, such as trout and other aquatic life. Treating polluted stormwater runoff from impervious surfaces by using water capture and native plants can improve water quality.

Bethel Elementary School

The local elementary school has the largest concentration of impervious surface in the watershed including the rooftop and parking lot. Built upon a steep slope, the school is challenged with significant stormwater issues from eroding slopes to sediment deposition. Kids using the playground must walk through the storm drain creating a potential safety issue. The project team is recommending measures to help slowly filter stormwater before it drains through culverts and into Beaverdam Creek. One proposed measure is a large rain garden, or bioretention swale to capture and treat stormwater coming from the building's rooftop. Students at the school have already begun working with County Extension Agent, Wendy Patoprsty, to determine the amount of rain water coming from the rooftop.

Figure 8: Aerial photo of Bethel Elementary School showing extent of rooftops and parking with contours shown in blue.

Upper Left: large storm drain connects school property to playground across Rush Branch Rd. During rainstorms this could present a hazard with rushing water.
Lower Left: Significant deposition is covering sidewalk used to access playground.
Above: Significant erosion at the outlet pipes from the rooftop.

Rain Garden

A rain garden is proposed to capture stormwater coming from rooftop outlet pipes at Bethel Elementary School. As is evident from the photos, stormwater has severely cut into the hillside just below the outlet pipe, leaving a scar on the landscape and further causing sediment to flow into nearby Beaverdam Creek. This slope will need to be stabilized and the rain garden can be located in the flatter ditch line along Rush Branch Road. If funds allow, a second rain garden will be developed in the flat area in front of the school to capture and treat stormwater from rooftop drains that outlet there.

An additional benefit to constructing a rain garden on the grounds of the school is that it will provide a demonstration and educational opportunities for students and the general public.

Other Institutions

Local churches and the volunteer fire station offer other opportunities to implement stormwater Best Management Practices. These institutions have been invited to participate in public sessions about the project. The project team will communicate directly with each institution. Rain gardens to capture and filter stormwater before entering nearby creeks; re-establishing riparian buffers; and the use of rain harvesting cisterns are recommended practices that these institutions could implement.

Table 8: Institutions and Recommendations for Stormwater Management

Institution	Creek Name	Recommendation
Beaverdam Baptist Church	Little Beaverdam Creek	Change practice of mowing to the creek edge and re-establish native shrubs and trees along creek
Bethel Baptist Church	Upstream from Rube Creek	Rain garden on lower portion of property to treat parking lot
Bethel Elementary School	Beaverdam & Rube Creek	Rain garden to capture rooftop runoff; stabilize slopes
Forest Grove Baptist	Forest Grove Creek	Rain Garden between parking lot and creek to treat parking lot
Mountain Dale Baptist Church	Rube Creek	Change practice of mowing to the creek edge and re-establish native shrubs and trees along creek
Volunteer Fire Station	Rube Creek	Cistern to capture and store rainwater from rooftop

Upper Left: Opportunity to re-establish a streamside forest at Beaverdam Baptist Church. Photo shows a comparison of one side of the streambank with native plants and the other mowed to edge.

Right: Another opportunity (at Mountain Dale Baptist Church) to re-establish native plants along the river bank to create habitat and prevent erosion.

Plan Implementation

There are several steps required to implement the plan as outlined in this document. Implementation requires coordination among multiple parties, including landowners, community institutions, Watauga River Partners, Brushy Fork Environmental Consulting, Inc. and others. Here are the general steps envisioned for implementing this plan:

- Community acceptance of plan
- NC Department of Environment and Natural Resources approval of plan
- Work with landowners and community institutions to implement Best Management Practices
- Focus on the prioritized specific sites to implement Best Management Practices at each willing landowner's site
- Assess, design, and permit proposed work with the applicable regulatory agencies such as US Army Corps of Engineers, NC Division of Water Quality, and the NC Division of Wildlife Resources
- Continue to monitor physical, chemical, and biological conditions
- Utilize the implemented projects as "demonstrations" of the possibilities for communities to improve water quality

Prioritized Sites for Implementing Best Management Practices

Prioritization of specific sites in this watershed was based on a combination of the following factors:

- Extent of erosion and sediment contribution to the watershed (high levels of sediment contribution equals higher priority);
- Site visibility (highly visible tracts received a higher ranking);
- Each site's specific contribution to the Beaverdam Creek 303(d) listed watershed status (i.e. channelization and lack of stream-side vegetative cover).

Based on these factors, the proposed project sites are rated on a spectrum from high to low priority. Those rated "high priority" are likely to deliver the most benefit to the stream and potentially to the landowner from implementing Best Management Practices. To the extent possible, the project team will focus on addressing high priority sites, but will work with landowners for any of these sites until all of the available funding is committed.

Project Phasing:
Proposed project phasing is directly associated with the prioritization of each site ranking from low to high priority. Below find prioritization as it is linked to proposed implementation phasing:

Table 9: Phasing of Implementation

Priority	Proposed Implementation Phasing	Proposed Project Timeline
High	Phase 1	6 months- 1 year
Moderate	Phase 2	18 months – 2 years
Low	Phase 3	As funding is available

Site Specific Phasing:
Note: Many of the sites listed below have been divided into sub-sections ranging in priority. To be efficient, if a low priority section exists directly adjacent to a high priority section, the phasing may reflect the higher priority phasing. Planning and construction will be most cost-effective if we combine these sites.

Table 10: Site Prioritization for Implementing Best Management Practices

Site #	Priority	Recommendations
5, 6, 7, 11, 13, 16, 17, 18, 20, 23, 24, 25	HIGH	Streambank Stabilization Livestock Management Riparian Planting
2, 12	MODERATE TO HIGH	Livestock Management Riparian Planting
4, 9, 15, 19,26, 27	MODERATE	Streambank Stabilization Riparian Planting
3, 8, 10, 14, 21, 22, 28	LOW	Riparian Planting

Planning and Permitting

The Watauga River Partners consultant, Brushy Fork Environmental Consulting, Inc., will work with landowners to plan the actual activities to be implemented and will be responsible for coordinating with relevant regulatory agencies regarding implementing the recommended Best Management Practices. Brushy Fork Environmental Consulting, Inc. has significant experience in working with landowners and regulatory agencies.

Monitoring

The monitoring activities described in this plan will continue during and after Best Management Practices are implemented to ascertain positive gains from the implemented projects. Specifically, the project team will use past and present macrobenthic data, noting increases or decreases in tolerant or in-tolerant taxa and will use past and present chemical composition data to gauge the presence/absence and concentration of toxins.

Utilize the implemented projects

As projects are implemented they have an added benefit in the community to serve as demonstrations of how these Best Management Practices work and their success in improving creek conditions as well as providing economic benefits to landowners. As the plan is implemented, the projects can be used as guides for others who want to explore stream rehabilitation. They can also serve as educational sites for school children and others to learn about stream health.

Conclusion

While the water quality and macro invertebrate sampling data show that the creek is within healthy parameters, the site assessment as documented in the photos in this report and the overabundance of central stone roller fish species in the stream suggest that conditions are degrading. Implementing Best Management Practices at this time will allow landowners and community institutions to help ensure that the watershed continues to be healthy and to be able to support fish and other aquatic life. Not implementing Best Management Practices will let the stream continue to degrade. Rehabilitating a badly degraded stream is significantly more difficult and expensive than maintaining a relatively healthy creek. Additionally, practices designed to maintain a healthy creek have direct economic benefits to the landowners as they prevent soil loss and can improve agricultural productivity.

This proposed watershed project cannot be successful without community acceptance and involvement. Landowners must be directly engaged in implementing the Best Management Practices that are most suited to the conditions on the creek and to their preferences. The project team has already begun this process with some individual landowners. For example, landowners Alan Zimmerman & Katherine Graham have agreed to participate in the project on their property along approximately 376 linear feet of Rube Creek (see Site 23).

Community institutions need to be engaged to address stormwater runoff issues that directly impact creek conditions. An example of this is the coordination between the project team and the faculty and staff at Bethel Elementary School. The proposed rain garden will contribute to improved water quality as well as offer an excellent opportunity for young people (and others in the community) to learn about the importance of water quality and how our practices affect local streams.

References:

NC Department of Environmental and Natural Resources, Division of Water Quality, 2007. *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of N.C. 15A NCAC 2B .0300*. Environmental Management Commission, Raleigh, NC. Available at http://portal.ncdenr.org/web/wq/ps/csu/rules.

NC State University. Stormwater BMPs and LID Overview. http://legacy.ncsu.edu/classes-a/bae/cont_ed/bmp/index.htm

Rosgen, David. 1996a. Applied River Morphology. Wildland Hydrology. Pagosa Springs, Colorado. p. 54-56.

Rosgen, David. 1996b. River Assessment and Monitoring. Coursework at Wildland Hydrology.

US EPA, Water: Monitoring and Assessment, Section 5.9 Conductivity, http://water.epa.gov/type/rsl/monitoring/vms59.cfm, accessed July 22, 2011.

Van Loon, G.W.; Duffy, S.J., 2000. *Environmental Chemistry, a Global Perspective*; Oxford University Press: New York; p. 300.

Trimble, Stanley W. 1994. Erosional Effects of Cattle on Streambanks in Tennessee, USA. Earth Surface Process and Landforms, 19: 451-464.

Whitescarver, Bobby. 2006. Clean Water Means Healthier Livestock. The Watershed, Lord Fairfax Soil and Water Conservation District.

Zeckoski, R., Benham, B. and Lunsford, C. 2007. Streamside Livestock Exclusion: A Tool for Increasing Farm Income and Improving Water Quality. Virginia Cooperative Extension, VCE Number 442-766.

Appendix A: Definitions

Several technical terms are used throughout this document. These terms are defined here.

“Bankfull” refers to the active stream channel formed by dominant discharge. The bankfull stage corresponds to the discharge at which channel maintenance is the most effective; that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels.

“BEHI” or “Bank Erosion Hazard Index” is a method for assessing streambank erosion potential. Values are assigned based upon several aspects of bank condition (such as bank height, root depth, root density, bank angle, and surface protection) and provides an overall score that can be used to inventory streambank condition over large areas and prioritize restoration efforts. The BEHI scoring index numbers range from 5, (very low susceptibility to bank erosion) to 50, (extreme susceptibility to bank erosion).

“Channelization” includes methods of stream modification (straightening, levee construction, diversions, etc.) that modify existing river channels or create new channels, often changing the relationship between rivers/streams and their floodplains.

“Entrenchment” refers to the relationship a stream has with its surrounding floodplain. An entrenched stream is one that is deeply cut into its valley and cut off from its floodplain; reconnecting a stream to its floodplain helps dissipate stormwater energy/velocity.

“Entrenchment ratio” refers to the width of the flood prone area (width at twice max depth of bankfull) relative to the width of the bankfull channel (Wfpa/Wbkf). Lower numeric values indicate a less accessible floodplain; higher values indicate a more accessible floodplain.

“Perennial streams” refer to streams which flow throughout the year.

“Priority 1” restoration means to replace the incised channel with a new, stable stream at a higher elevation. This is accomplished by excavating a new channel with the appropriate dimension, pattern, and profile (based on reference-reach data) to fit the watershed and valley type.

“Priority 2” restoration means to create a new, stable stream and floodplain at the existing channel-bed elevation. This is accomplished by excavating a new floodplain and/or stream channel at the elevation of the existing incised stream.
“Priority 3” restoration (or floodplain connectivity) is similar to Priority 2 in its objective to widen the floodplain at the existing channel elevation to reduce shear stress. This is accomplished by excavating a floodplain bench on one or both sides of the existing stream channel at the elevation of the existing bankfull stage.

“Priority 4” or “bank stabilization” projects use various stabilization techniques to armor the bank in place. These projects do not attempt to correct problems with dimension, pattern or profile. Priority 4 projects often use typical engineering practices to harden (armor) one or more streambanks.

“Stream order” refers to the stream size, based on the confluence of one stream with another. First order streams are the origin or headwaters. The confluence or joining of two 1st order streams forms a 2nd order stream, the confluence of two 2nd order streams forms a 3rd order stream, and so on.

“Riffle-Pool Sequence” refers to the predictable sequence of riffles and pools at intervals that relate to the width of the stream. (Riffles are where shallow water is rippling over rocks; pools are deeper and calmer areas.) Determining the riffle-pool sequence and stream width can give an indication of the extent to which the stream is out of equilibrium with the forces that create it. In most streams the riffles are found a distance apart that is equal to 5 to 7 times the width of the stream.

“Riparian Buffer” refers to a native vegetated area that extends laterally from the wetted edge of the stream or water body. Riparian buffers protect water bodies from nonpoint source pollution and provide bank stabilization and aquatic and wildlife habitat.

“Sinuosity” is a stream’s tendency to move back and forth across the floodplain. High sinuosity indicates a stream with frequent curvature, as opposed to a stream that is channelized. A sinuosity of 1 = a straight stream, higher numeric values reflect a more sinuous stream.

“Width to Depth” (W/D) refers to a channels bankfull width’s relation to its bankfull mean depth.

Appendix B: Benthic Macro Invertebrate Sampling Data (Sites #1-3)

April 2011 Data Collection Visit (Data from Sites #1-3 follows):

Site 1

Notes: Headwater/reference Reach/ hairpin curve where water is close to the road on Georges Gap Rd/ in forested area

Phylum	Order	Family	Common Name	Number of Individuals	Adopt-a Stream method Sensitivity
Arthropoda	Ephemeroptera	Heptageniidae	Flatheaded Mayfly	26	3
		Ephemeridae	Common Burrower	3	3
		Ephemerellidae	Spiny Crawler	4	3
	Plecoptera	Peltoperlidae	Roach like stonefly	22	3
		Perlodidae	Perlodid stonefly	24	3
		Chloroperlidae	Green stonefly	5	3
	Tricoptera	Hydropsychidae	Netspinner	15	3
	Diptera	Tipulidae	Cranefly	4	2
		Athericidae	Snipefly	1	2
	Odonata	Anisoptera	Clubtail	4	2
	Coleoptera	Psephenidae	water penny	1	3
Mollusca	Gastropoda	Pleroceridae	Elimia sp. Snails	8	3
			Total:	**117**	**33** Excellent (>22)

Site 2

Bridge at Phillips Branch Rd.

Phylum	Order	Family	Common Name	Number of Individuals	Adopt-a Stream method Sensitivity
Arthropoda	Odonata	Anisoptera	Clubtail Dragonfly	25	2
	Plecoptera	Perlidae	Common Stonefly	5	3
		Perlodidae	Perlodid Stonefly	3	3
	Ephemeroptera	Ephemeridae	Burrowing Stonefly	1	3
		Heptageniidae	Flatheaded Mayfly	16	3
		Isonichiidae	Brushlegged Mayfly	1	3
		Baetidae	Small Minnow Mayfly	8	3
		Ephemerillidae	Spiny Crawler Mayfly	80	3
	Tricoptera	Hydropsychidae	Netspinner	30	3
		Ryacophilidae	Free Living Caddisfly	1	3
	Diptera	Tipulidae	Cranefly	4	2
		Blephariceridae	netwing Midge	1	1
	Coleoptera	Psephenidae	Water Penny	11	3
		Elmidae	Riffle Beetle	1	3
	Megaloptera	Corydalidae	Helgrammite	5	3
	Odonata	Gomphidae	Clubtail Dragonfly	62	2
			Total:	**254**	**43** Excellent (>22)

Site 3 -
Reese Property

Phylum	Order	Family	Common Name	Number of Individuals	Adopt-a Stream method Sensitivity
Arthropoda	Ephemeroptera	Heptageniidae	Flathead Mayfly	12	3
		Ephemerillidae	Spiny Crawler Mayfly	123	3
	Coleoptera	Elmidae	Riffle Beetle	4	3
		Psephenidae	Water Penny	7	3
	Plecoptera	Perlidae	Common Stonefly	7	3
		Perlodidae	Perlodid Stonefly	13	3
	Tricoptera	Rhyacophilidae	Freeliving	4	3
		Hydropsychidae	Netspinner	31	3
			Cases	12	3
	Odonata	Gomphidae	Clubtail Dragonfly	10	2
	Diptera	Tipulidae	Cranefly	4	2
		Athericidae	Snipe	1	2
		Dixidae	Midge	3	1
			Total:	**231**	**34** Excellent (>22)

August 2011 Data Collection Visit (Data from Sites #1-3 follows):

Site 1
Headwater/reference Reach/ hairpin curve where water is close to the road on Georges Gap Rd/ in forested area

Very Dry, hardly any water in the stream

Phylum	Order	Family	Common Name	Number of Individuals	Adopt-a Stream method Sensitivity
Arthropoda	Ephemeroptera	Isonichiidae	Brushlegged Mayfly	2	3
	Odonata	Gomphidae	Clubtail Dragonfly	2	3
		Aeshnidae	Darner Dragonfly	1	3
	Tricoptera	Limnephilidae	Northern Casemaker	2	3
Mollusca	Gastropoda	Pleroceridae	*Elimia* sp. Snails	1	3
			Total:	**8**	**15** Excellent (>22)

Site 2 - Bridge at Phillips Branch Rd.

15-Aug-11

Phylum	Order	Family	Common Name	Number of Individuals	Adopt-a Stream method Sensitivity
Arthropoda	Odonata	Gomphidae	Clubtail Dragonfly	4	2
	Plecoptera	Perlidae	Common Stonefly	35	3
	Ephemeroptera	Heptageniidae	Flatheaded Mayfly	13	3
		Isonychiidae	Brushlegged Mayfly	4	3
		Baetidae	Small Minnow Mayfly	2	3
	Tricoptera	Hydropsychidae	Netspinner	60	3
		Limnephilidae	Northern casemaker caddisfly	1	3
	Diptera	Tipulidae	Cranefly	2	2
		Psephenidae	Water Penny	1	3
		Elmidae	Riffle Beetle	3	3
		Athericidae	Aquatic Snipe Fly	2	1
			Total:	**127**	**29**
					Excellent (>22)

Site 3 - Reese Property

15-Aug-11

Phylum	Order	Family	Common Name	Number of Individuals	Sensitivity
Arthropoda	Ephemeroptera	Heptageniidae	Flathead Mayfly	20	3
		Isonychiidae	Brushlegged Mayfly	5	3
		Baetidae	Small Minnow Mayfly	8	3
		Potamanthidae		2	3
	Coleoptera	Elmidae	Riffle Beetle	9	3
		Psephenidae	Water Penny	2	3
	Plecoptera	Perlidae	Common Stonefly	11	3
		Leuctridae	Rolledwing Stonefly	2	3
		Perlodidae	Perlodid Stonefly	1	3
	Tricoptera	Hydropsychidae	Netspinner	64	3
	Odonata	Gomphidae	Clubtail Dragonfly	9	2
	Diptera	Athericidae	Snipe	16	2
		Dixidae	Midge	2	1
			Total:	**151**	**35**
					Excellent (>22)

Comments: a few mayflies had a fine layer of silt on their gills and hairs

November 2011 Data Collection Visit (Data from Sites #1-3 follows):

Site 1
Headwater/reference Reach/ hairpin curve where water is close to the road on Georges Gap Rd/ in forested area

Phylum	Order	Family	Common Name	Number of Individuals	Adopt-a Stream method Sensitivity
Arthropoda	Plecoptera	Peltoperlidae	Roachlike stonefly	3	3
	Tricoptera	Hydropsychidae	Common Netspinner	2	3
	Diptera	Tipulidae	Cranefly	1	2
			Total:	**6**	**8**
					Excellent (>22)

Comments: Very silty bottom, more silt and sediment than observed last time.

Site 2 - Bridge at Phillips Branch Rd. method

4-Nov-11

Phylum	Order	Family	Common Name	Number of Individuals	Sensitivity
Arthropoda	Odonata	Gomphidae	Clubtail Dragonfly	2	2
	Plecoptera	Perlidae	Common Stonefly	3	3
	Ephemeroptera	Heptageniidae	Flatheaded Mayfly	10	3
		Isonychiidae	Brushlegged Mayfly	4	3
		Ephemeridae	Common Burrower Mayfly	2	3
	Tricoptera	Hydropsychidae	Netspinner	3	3
		Limnephilidae	Northern casemaker caddisfly	1	3
	Diptera	Athericidae	Aquatic Snipe Fly	2	1
	Megaloptera	Corydalidae	Hellgramite	1	3
			Total:	**28**	**24**
					Excellent (>22)

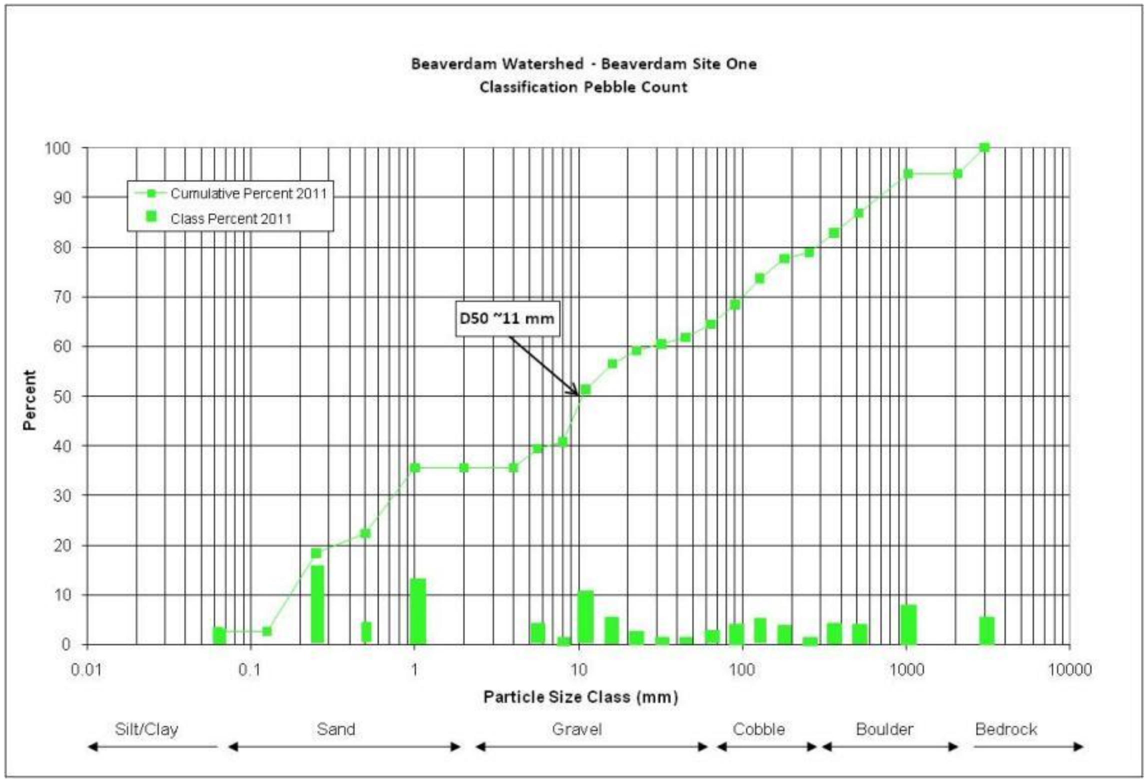
Site 3

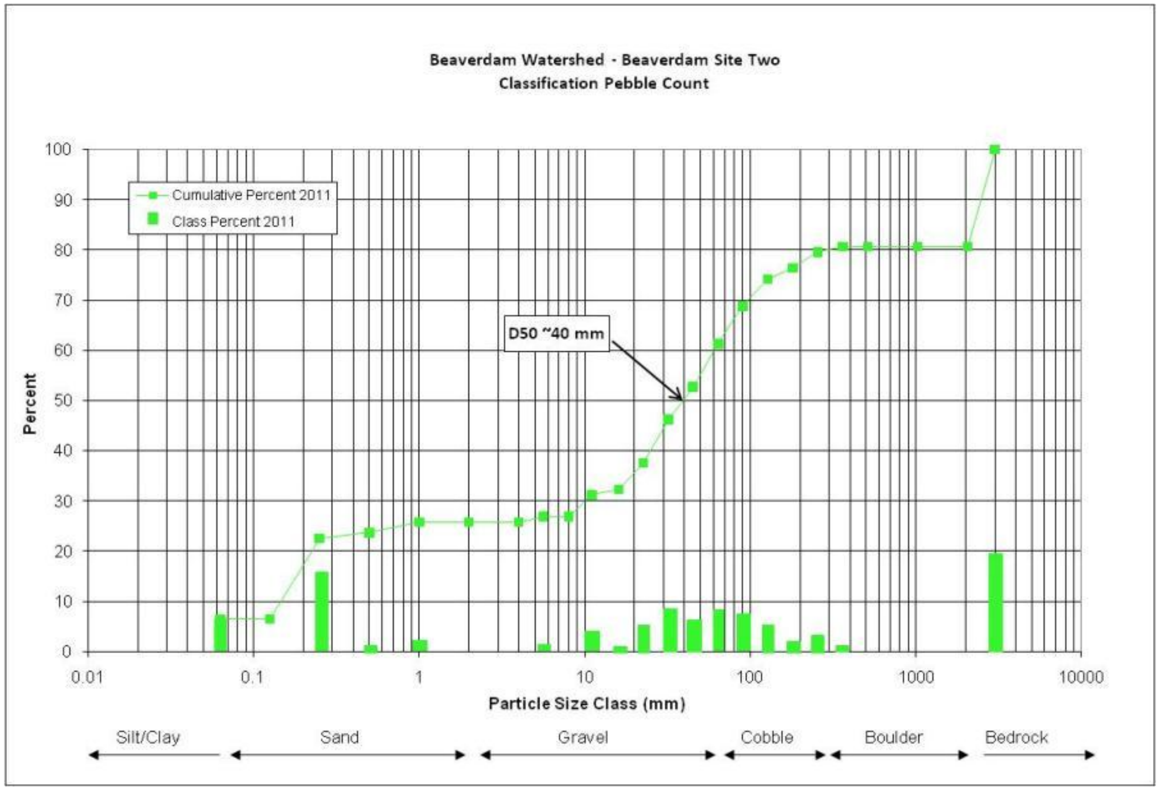
NOTE: sampled on November 22 due to high water on the 4th

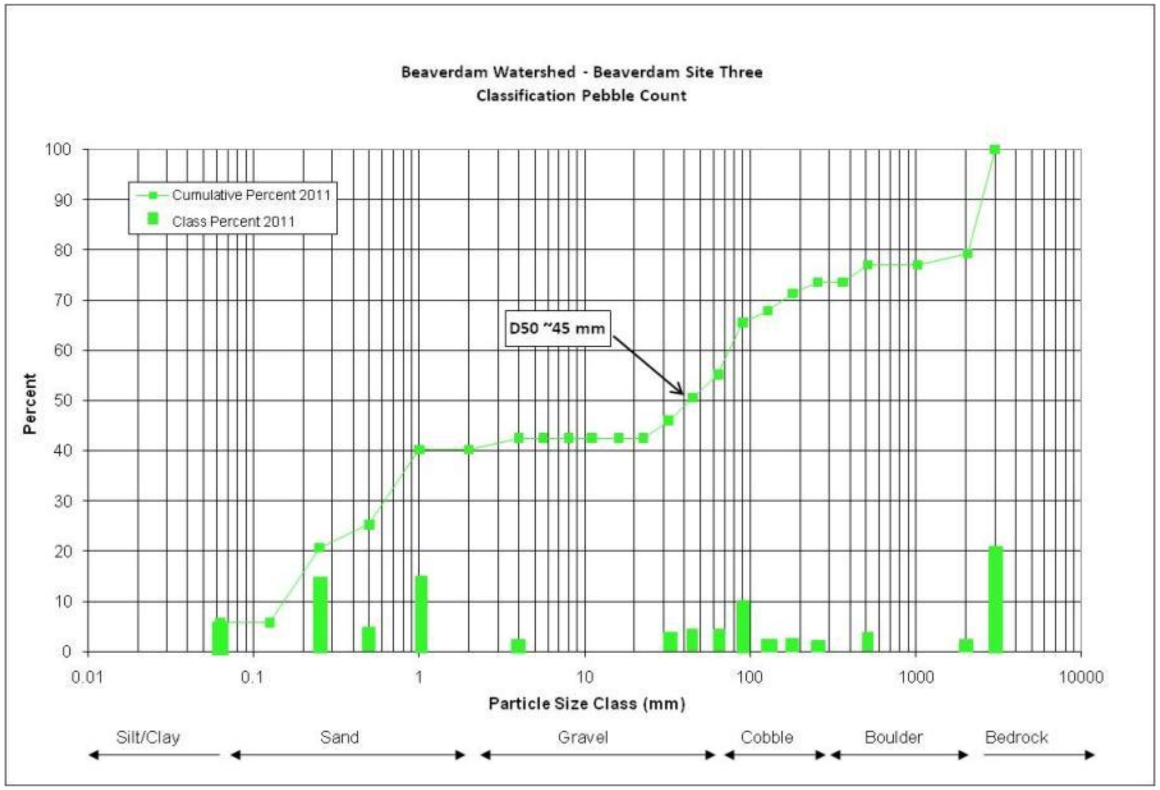
Phylum	Order	Family	Common Name	Number of Individuals	Sensitivity
Arthropoda	Odonata	Gomphidae	Clubtail Dragonfly	8	2
		Anisoptera	Aeshnidae	1	2
	Plecoptera	Perlidae	Common Stonefly	11	3
	Ephemeroptera	Heptageniidae	Flatheaded Mayfly	3	3
		Isonychiidae	Brushlegged Mayfly	1	3
		Ephemerellidae	Spiny Crawler Mayfly	5	3
	Tricoptera	Hydropsychidae	Netspinner	57	3
		Limnephilidae	Northern casemaker caddisfly	3	3
	Diptera	Athericidae	Aquatic Snipe Fly	3	1
		Tipulidae	CraneFly	6	2
		Chironomidae	Midge	1	1
	Coleoptera	Psephenidae	Water Penny	2	3
	Megaloptera	Corydalidae	Hellgramite	2	3
			Total:	**103**	**32**
					Excellent (>22)

NOTE: Many of the insects had a fine slimey, silty sediment on tails and hairs.

Appendix C: Pebble Count for Sampling Sites (#1-3)




Beaverdam Watershed - Beaverdam Site Two
Classification Pebble Count
Cumulative Percent 2011
Class Percent 2011
D50 ~40 mm
Percent
0
10
20
30
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1000
10000
Particle Size Class (mm)
Silt/Clay
Sand
Gravel
Cobble
Boulder
Bedrock


Beaverdam Watershed - Beaverdam Site Three
Classification Pebble Count
Cumulative Percent 2011
Class Percent 2011
D50 ~45 mm
Percent
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size Class (mm)
Silt/Clay
Sand
Gravel
Cobble
Boulder
Bedrock

Appendix D: Criteria for Assessing Streambank Erosion

Bank Height (ft)	The length from top of bank to toe of bank.
Root Depth (ft)	Root length from top of bank or typical values for present species.
Root Density (%)	Total amount of study streambank comprised of roots.
Bank Angle (^{0})	Measure of streambank angle.
Surface Protection (%)	Calculation of surface cover that prevents soil erosion (i.e. vegetation).
BEHI Score	Sum of Bank Erodibility Hazard Rating Indices ranging from 1-50.
Sediment Load (Total Tons/Ft/Yr)	Estimate of sediment load based on BEHI score, shear stress, and site stream length.

Appendix E: Bank Erosion Hazard Index Rankings for Each Residential Site

Site Name	Highest Bank Height - A	Max Bankfull Depth - B	A/B = C =	Root Depth - D	Study Bank Height - E	D/E = F	Root Density (%) = G	G X F = H	Bank Angle (Deg) = I	Height of Bank Protection = J	J X E = K	Surface Protection (%)	TOTALS	Very Low - Extreme Rank
Site 1	2	1.5	1.333333	0.3	1	0.3	40	12	70	0.2	0.2	50	23	Moderate
Site 2	2	1.5	1.333333	0.3	1	0.3	40	12	70	0.2	0.2	45	24	Moderate
Site 3	2.5	2.5	1	0.2	2	0.1	30	3	80	0.2	0.4	50	25.8	Moderate
Site 4	2.5	2.5	1	0.2	2	0.1	30	3	100	0.2	0.4	20	30.4	High
Site 5	3	1.5	2	0.05	1.5	0.033333	1	0.033333	81	0	0	0	46	Extreme
Site 6	6	3.5	1.714286	0.1	3	0.033333	12	0.4	85	0.2	0.6	10	41.4	Very High
Site 7	3	3	1	0.2	3	0.066667	10	0.666667	90	0.2	0.6	25	31.9	High
Site 8	50	2	25	0.3	50	0.006	25	0.15	75	0.1	5	20	36.5	High
Site 9	2.5	2	1.25	0.5	2.5	0.2	50	10	60	1	2.5	55	21.3	Moderate
Site 10	3	2	1.5	0.3	3	0.1	25	2.5	70	0.2	0.6	60	27.9	Moderate
Site 11	50	3	16.66667	0.2	50	0.004	15	0.06	85	0.2	10	40	38.4	High
Site 12	4.5	3	1.5	1	4.5	0.222222	50	11.11111	85	4	18	60	27.9	Moderate
Site 13	3	1	3	0.1	2	0.05	5	0.25	30	0.1	0.2	5	43	Very High
Site 14	2.5	2	1.25	0.3	2	0.15	40	6	45	0.4	0.8	50	22.3	Moderate
Site 15	3	2	1.5	0.2	3	0.066667	30	2	65	0.2	0.6	40	29.7	Moderate
Site 16	5.5	3	1.833333	0.3	5.5	0.054545	30	1.636364	85	0.3	1.65	50	32.9	High
Site 17	2.5	2	1.25	0.4	2.5	0.16	45	7.2	90	0.3	0.75	30	30.2	High
Site 18	3	3	1	0.2	3	0.066667	40	2.666667	90	0.3	0.9	20	30.4	High
Site 19	4	2	2	0.4	4	0.1	40	4	70	0.3	1.2	40	30.9	High
Site 20	6	2	3	0.2	6	0.033333	30	1	75	0.3	1.8	40	34.9	High
Site 21	1	0.75	1.333333	0.1	1	0.1	30	3	45	0.1	0.1	70	24.4	Moderate
Site 22	1.5	0.75	2	0.1	1.5	0.066667	30	2	60	0.2	0.3	70	28.7	Moderate
Site 23	1	0.3	3.333333	0.1	1	0.1	5	0.5	100	0.1	0.1	10	46	Extreme
Site 24	3	1	3	0	3	0	2	0	70	0	0	0	45.5	Extreme
Site 25	3	2	1.5	0.3	3	0.1	30	3	60	0.3	0.9	60	27.2	Moderate
Site 26	6	4	1.5	0.3	5	0.06	40	2.4	85	2	10	60	30.4	High
Site 27	7	6	1.166667	0.2	7	0.028571	15	0.428571	110	0.2	1.4	5	39.8	Very High
Site 28	4	3.5	1.142857	0.2	4	0.05	25	1.25	85	0.3	1.2	45	27.8	Moderate

Appendix F: Landowner Names for Each Residential Site

Site #	Name	Approx. Length in linear feet
1	Joe and Bobbie Edmisten	650
2	Walter Henson Estate	200
3	Robert Warren	325
4	Robert Warren	500
5	Scottie & Rebecca Corum	390
6	Walter Henson Estate	570
7	Donald and Kathy Thompson	450
8	Edwin Greene	400
9	Andy Reese	560
10	Malcolm Wooley	300
11	Bradley	930
12	Ronnie&Margaret Sherwood McGlamery	1380
13	Dean and Raleigh Wilson	1200
14	Jamie Johnston	560
15	Joe Hipp	2130
16	Robert Norris	790
17	Dudley Norris	1030
18	Kurtis Moody	1000
19	Anne Herlong & John Farthing	1900
20	Bill Sherwood	1250 (Beaverdam) +800 (Rube)
21	Bernice Braswell	220
22	Martin Lee Cornett; Charlie Cornett	200
23	Al Zimmerman & Katherine Graham	375
24	Dean Kirby & Selma Farthing	775
25	Bill Sherwood	800
26	Hite and Joyce Reese	1000
27	Hite and Joyce Reese	1600
28	Frank Guy	550

Appendix G: Geology in The Watershed

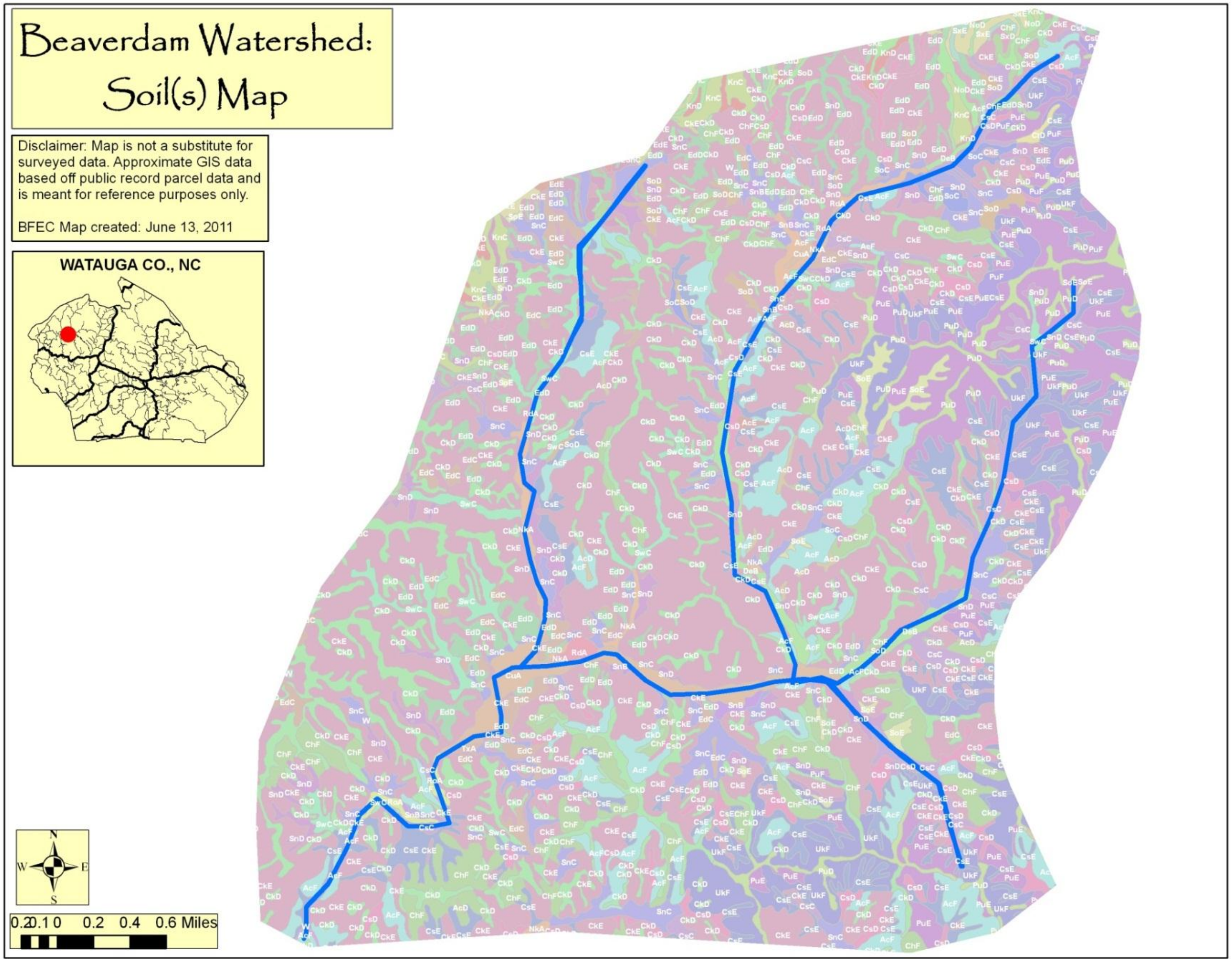
United States Geological Service descriptions for each geological group are below:

Chilhowee Group (Ccl) : largely sedimentary rock outcrops; interbedded quartzites and shales. Primary rock – quartzite. A granoblastic metamorphic rock consisting mainly of quartz and formed by recrystallization of sandstone or chert by either regional or thermal metamorphism. Secondary rock – Slate. A compact, fine-grained metamorphic rock that possesses slaty cleavage and hence can be split into slabs and thin plates. Other rock type - metasedimentary rock. Age - Cambrian.

Blowing Rock Gneiss: (Ybgg and Ygg) : Primary rock - Gneiss. A foliated rock formed by regional metamorphism, in which bands or lenticles of granular minerals alternate with bands or lenticles in which minerals having flaky or elongate prismatic habits predominate. Generally less than 50% of the minerals show preferred orientation. Secondary rock – Schist. A strongly foliated crystalline rock, formed by dynamic metamorphism, that can be readily split into thin flakes or slabs due to the well developed parallelism of more than 50% of the minerals present, particularly those of the lamellar or elongate prismatic habit, e.g. mica and hornblende. Other rock types - phyllite; slate; quartzite; greenstone; tuff. Age- Middle Proterozoic.

Crossnore Plutonic Suite (Zg) : Metamorphosed granitic rock - Massive to foliated, locally mylonitic. Beech, Crossnore, Brown Mountain, Lansing, and other granitic rocks. Age - Precambrian.

Appendix H: Soils in Watershed

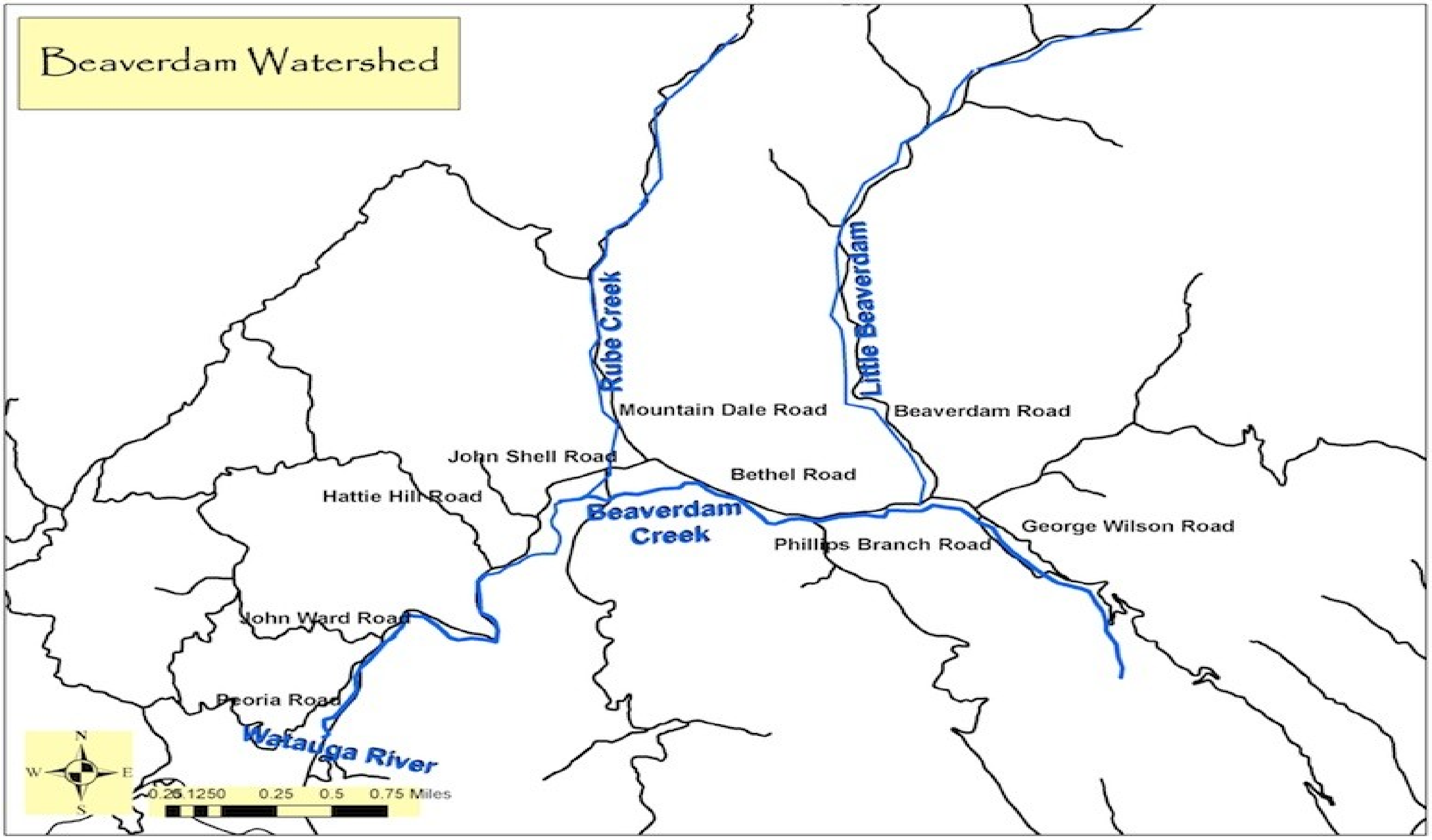


Appendix I: Fact Sheets

Fact sheets found on the following pages were distributed to landowners in the watershed during the October 17th 2011 outreach meeting by the project team.

Be a Part of the Beaverdam Creek Planning Project

The health of this water source depends on you!



If you own land along Beaverdam Creek or its tributaries, money is available for your use!

The Beaverdam Creek Planning Project can help you:

•Implement best management practices for your farm
•Prevent land loss
•Improve fish habitat
•Improve drinking water

The Beaverdam Creek Planning Project is funded by Section 319 funds from the NC Department of Environment and Natural Resources.

What can the money be used for?

•Plants along creek banks
•Alternate watering and feeding approaches
•Cattle crossings and fencing
•Rain gardens
•Other alternatives as approved

Who is involved?

YOU!

Bethel landowners and community members

Watauga River Partners

North Carolina Division of Soil & Water Conservation

NC State University A&T State University Cooperative Extension — Empowering People · Providing Solutions

For more information or to participate in the Beaverdam Creek Planning Project, call Wendy at 828-264-3601.

Bethel Agriculture:

Protect Your Investment While Improving Beaverdam Creek

The Problem

Cattle crossing the creek without "stream crossings" can contribute to increased erosion and polluted water. When livestock drink this water they are at increased risk for disease. Streambank erosion also means that the landowner is losing valuable land. Poor water quality harms fish populations and negatively impacts the overall health of the stream

Why should I care?

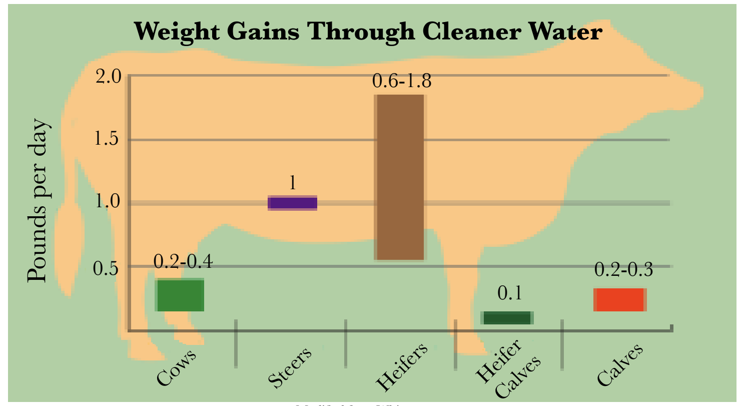
•You may be losing land
•You may be able to increase efficiency (have the same number of cows with more weight) by using best management practices on your farm.
•Polluted water negatively affects:
- Drinking water
- Fish and other aquatic life
- Swimming holes

Sources:
Whitescarver, Bobby. 2006. Clean Water Means Healthier Livestock. The Watershed, Lord Fairfax Soil and Water Conservation District.

Zeckoski, R., Benham, B. and Lunsford, C. 2007. Streamside Livestock Exclusion: A Tool for Increasing Farm Income and Improving Water Quality. Virginia Cooperative Extension, VCE Number 442-766.

Best Management Practices

The benefits of Best Management Practices (BMPs) in areas of intense agricultural land use include increasing livestock health and improved productivity.



Modified from Whitescarver

Studies have shown that cattle prefer off-stream water sources, such as troughs, and cattle that have access to off-stream water sources are healthier (Whitescarver, 2006; Zeckoski et al. 2007). Cows with off-stream sources drink more, which increases milk production and/or weight gain of five to ten percent over nine to ten months.

Increase weight-gain translates into more money per head

Typical calf sale weight	Additional weight gain due to off-stream waterer	Price	Increased revenue due to off-stream waterer
500 lb/calf	5% or 25 lb	$1.20 per lb per calf in 2011	$30 per calf

The weight gains illustrated in the above example are conservative.
Modified from Zeckoski et. al.

Cows that drink from streams face increased risk of disease, including mastitis, Johne's disease, and Cryptosporidium. Calves that nurse udders that have dirt or mud on them have increased incidence of scours and other health problems. Cattle are prone to foot rot while feeding in wet areas. Managing these areas not only improves cattle health, but also water quality.

Recommended BMPs

The BMPs recommended for the Beaverdam Creek Watershed that offer the best economic benefit to landowners include:
•Alternate livestock watering and/or feeding practices
•Rotate / limit grazing
•Streambank stabilization and native plants to reduce erosion
•Restricting livestock access to streams

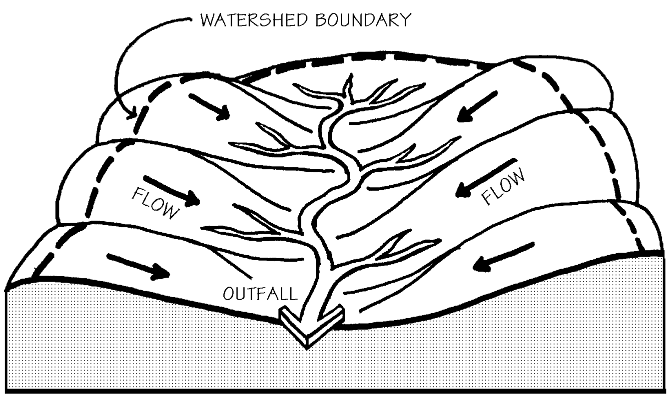
Protect the Creek You Love:

Enhance the Bethel Community by Improving Beaverdam Creek

The state is concerned with water quality on Beaverdam Creek because of:

•Development: houses, buildings, and roads
•Lack of vegetation along creek banks = soil loss
•Confined animal feeding operations
•Mowing or grazing to the edge of creek banks

All of these lead to polluted stormwater runoff.



Why should I care?

•You may be losing land
•Polluted water negatively affects:
- Drinking water
- Fish and other aquatic life
- Swimming holes

What can I do to help?

•Plant vegetation along creek banks
•Implement alternate water and feeding sources for livestock
•Stabilize eroding creek banks
•Install rain gardens
•Participate in the Beaverdam Creek Planning Project

What is stormwater runoff?

When rainwater, snowmelt or irrigation water doesn't soak into the ground the water runs off the land.

As runoff flows over surfaces, including our streets, parking lots, yards, construction sites, farms, and forests, it picks up the things in its path including fertilizers, loose soil, animal waste, motor oil, pesticides and herbicides, grease, metals, and trash.

This runoff then drains directly into waterways like Beaverdam Creek.

Alternate watering for livestock

Rain garden

Appendix J: Landowner Presentation

The following presentation was given during the October 17, 2011 community meeting.

Beaverdam Creek Watershed Plan

Welcome!

- Who we are:
- local non-profit board members, consultants and extension agents
- We are not from DENR and aren't documenting "violations" or imposing regulations

- Questions?

Why We Are Here

- To share information,
- Explain grant funding available, and
- Promote water quality

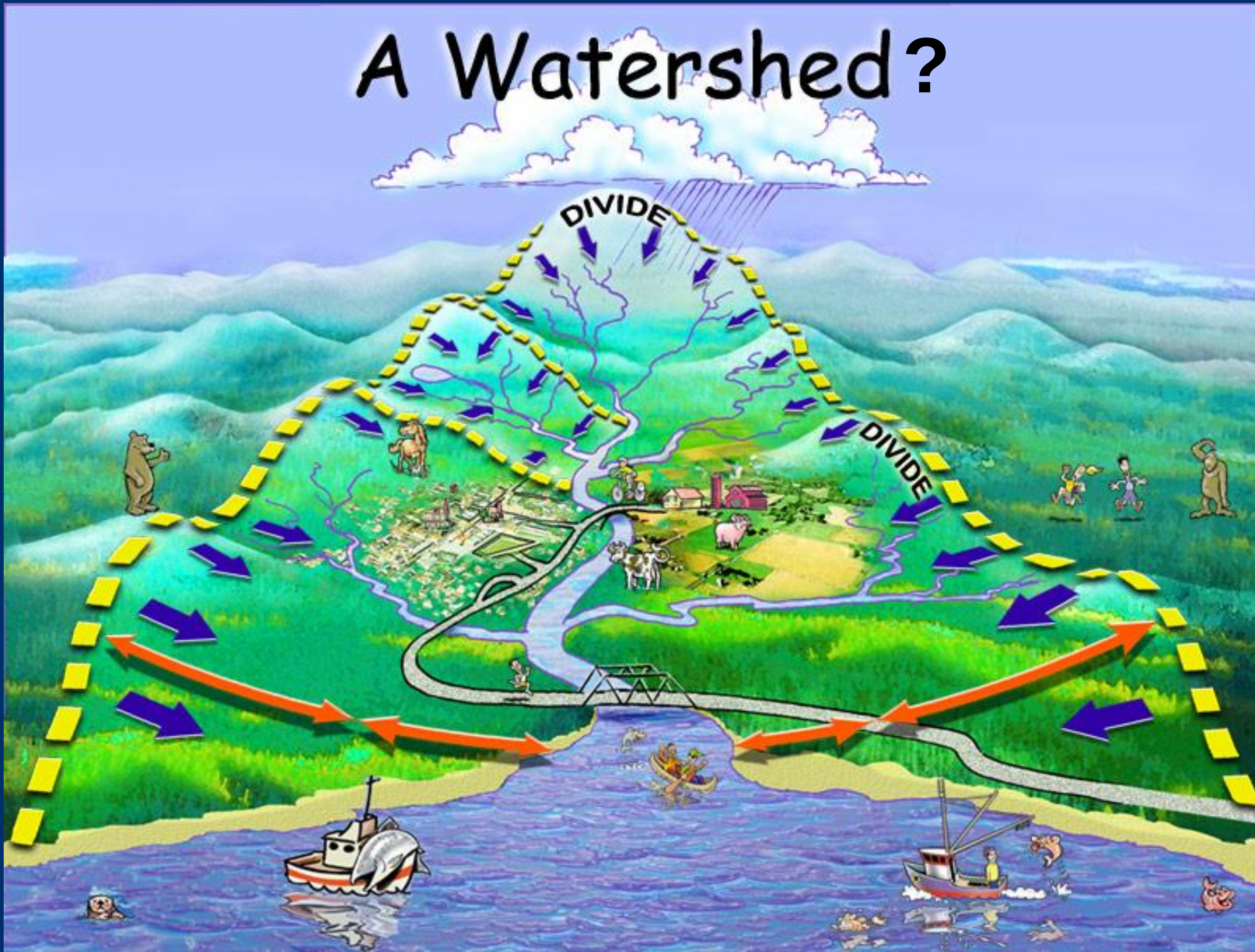
Your participation is up to you

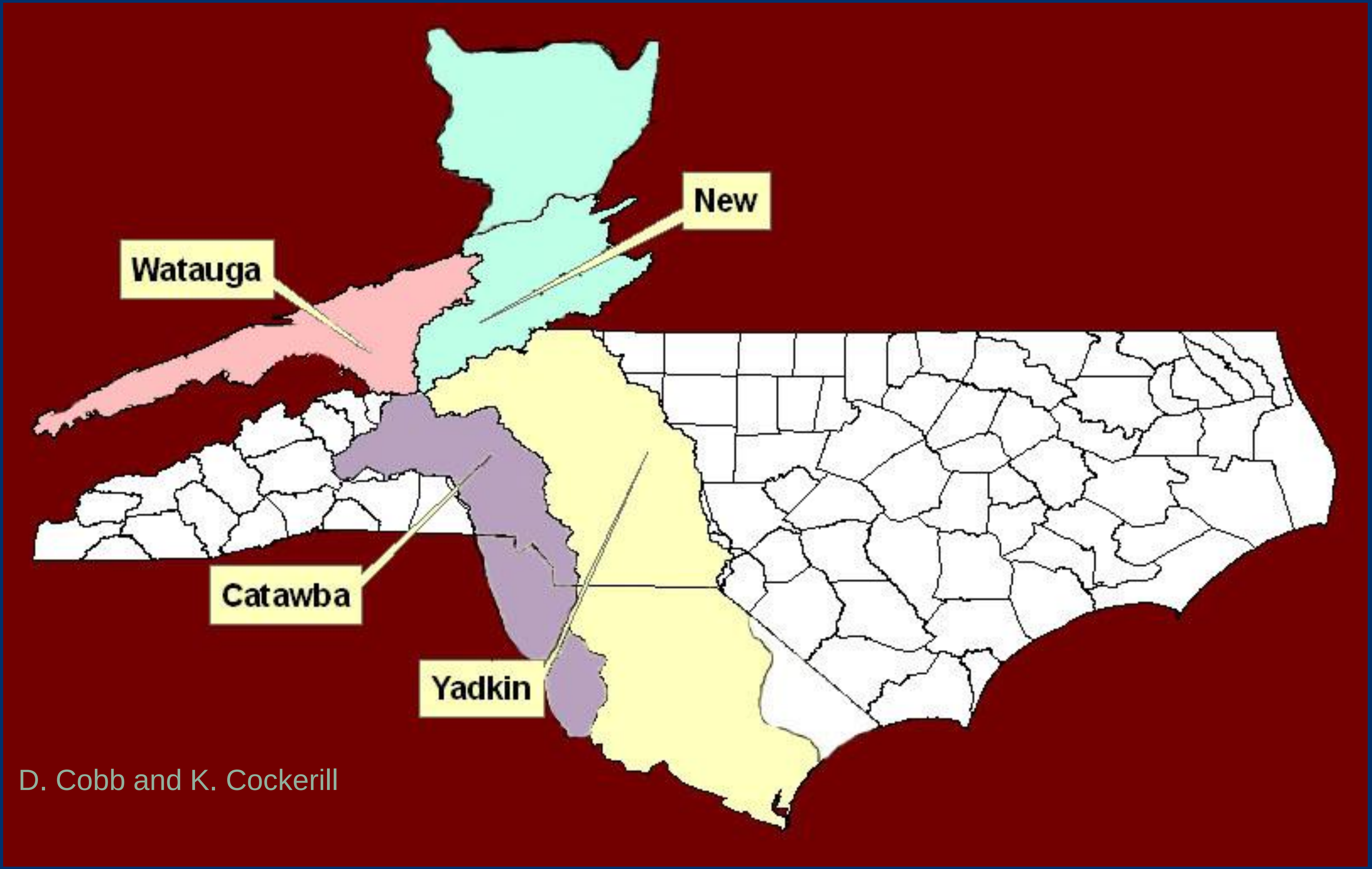
- If you want to participate to help protect water quality in Beaverdam Creek, then this grant may be helpful to you.

Tonight's Presentation

- Wendy Patoprsty: Introduction to Water Quality Principles
- Adam Williams: Best Management Practices to protect water quality
- Benefits of BMP's
- Explanation of Grant
- Next Steps

What is

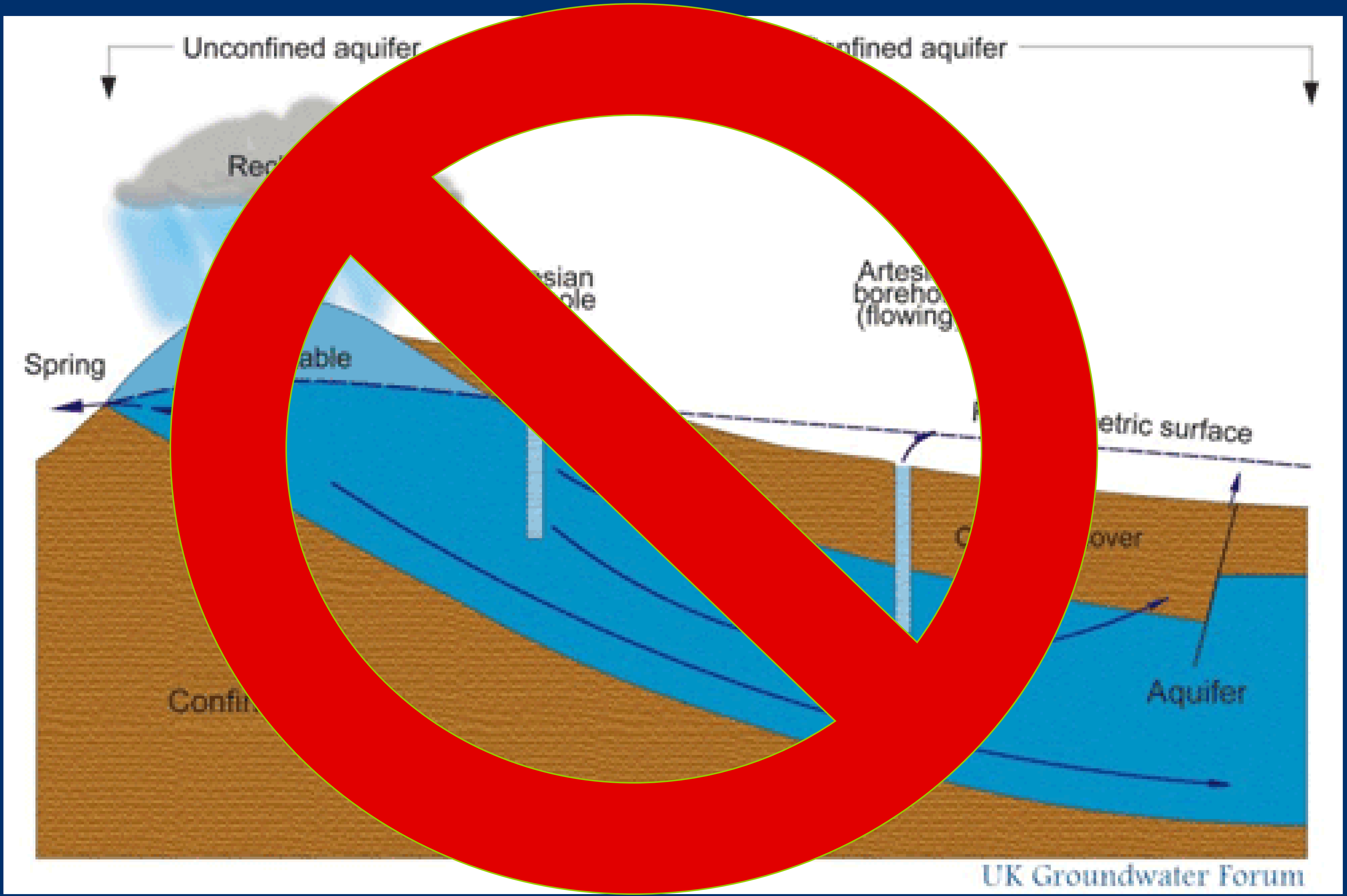




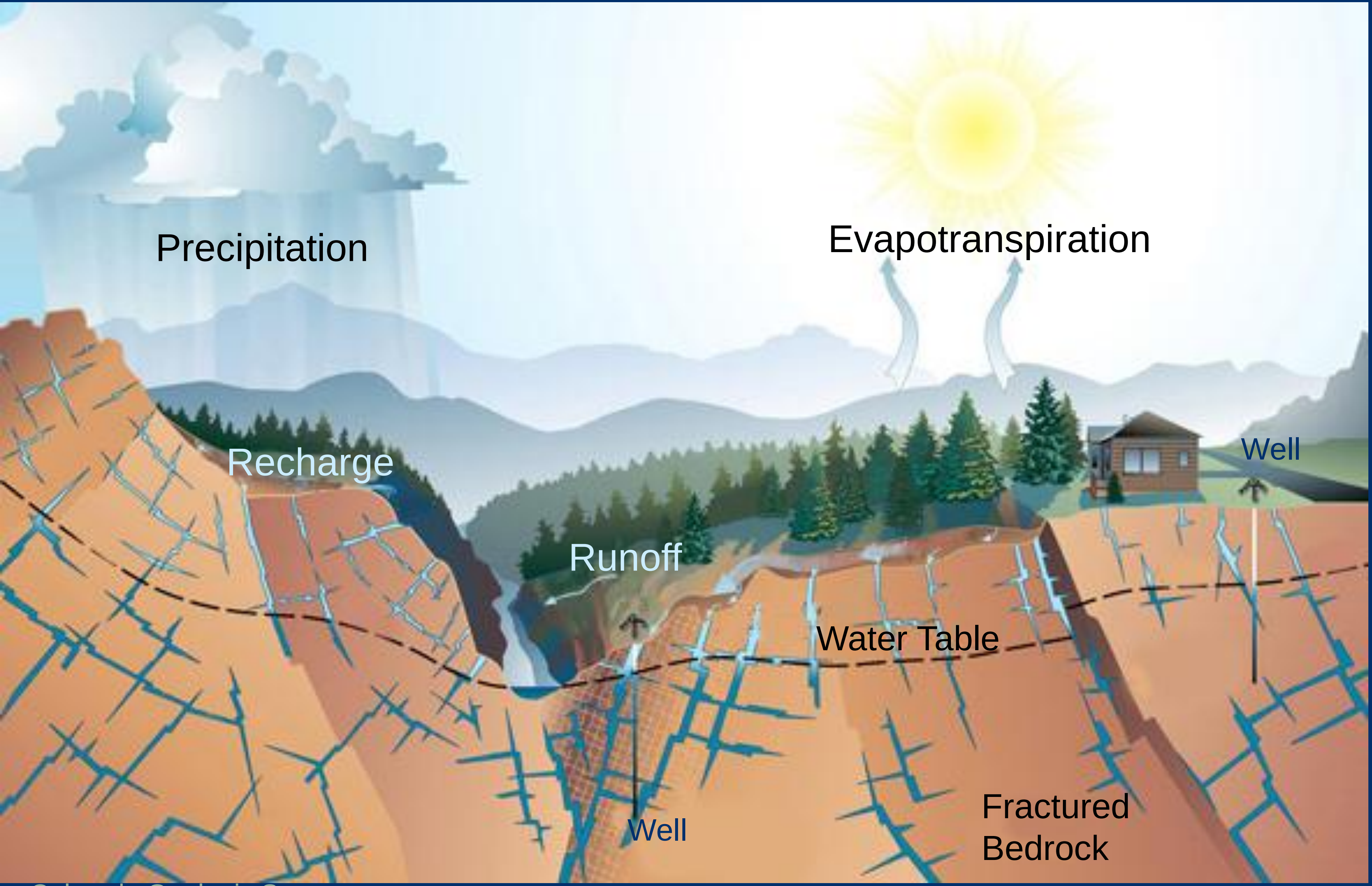
Decisions about water in the High Country affect people in five states

Mississippi River Basin

NOT how water works in the High Country

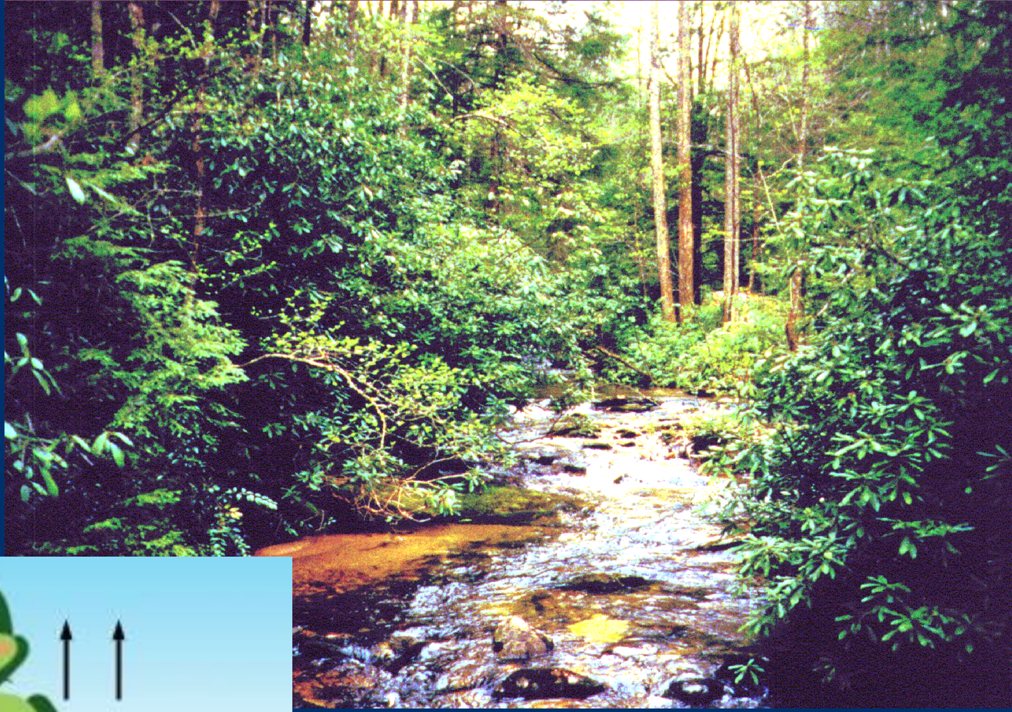


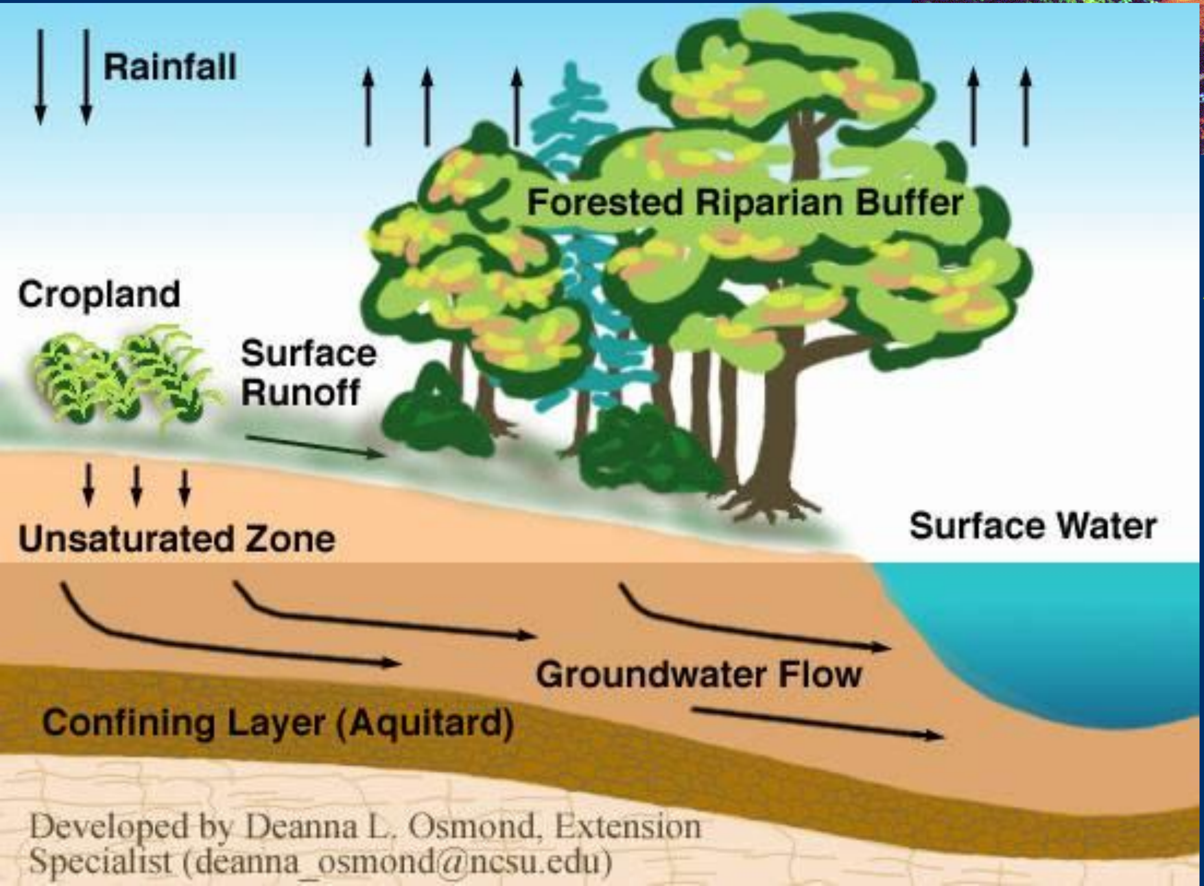
Water *(hydrologic)* cycle



Colorado Geologic Survey

Forested land allows water to infiltrate into the ground to recharge the groundwater resources.





Permeable Surfaces Allow Water to:

- -Infiltrate
- -Percolate
- -Saturate
- -Permeate

RECHARGING Groundwater Resources

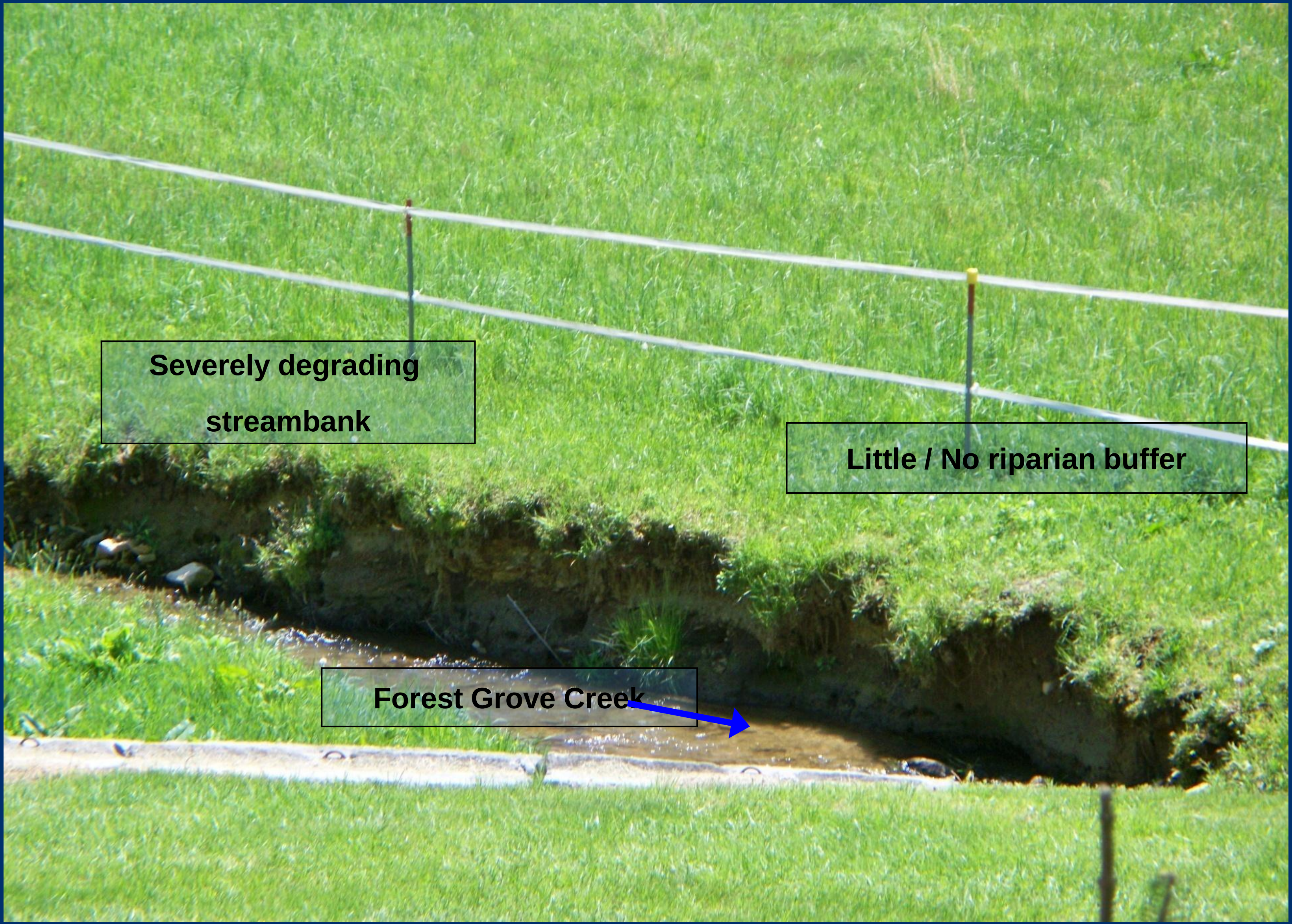
What pollutes our mountain headwater streams and rivers?

Stormwater – many times flows directly to rivers and streams

Stormwater pollutants include any materials that can build up roads and parking lots: oil, grease, gas, auto fluids, trash, dirt, etc.

- Example of what NOT to do!
- Straight piping your gutters to the creek!
- "Flashy Streams"
- Thermal Pollution

No plants on the stream bank minimizes shade, increasing temperature and increases sediment in the creek.

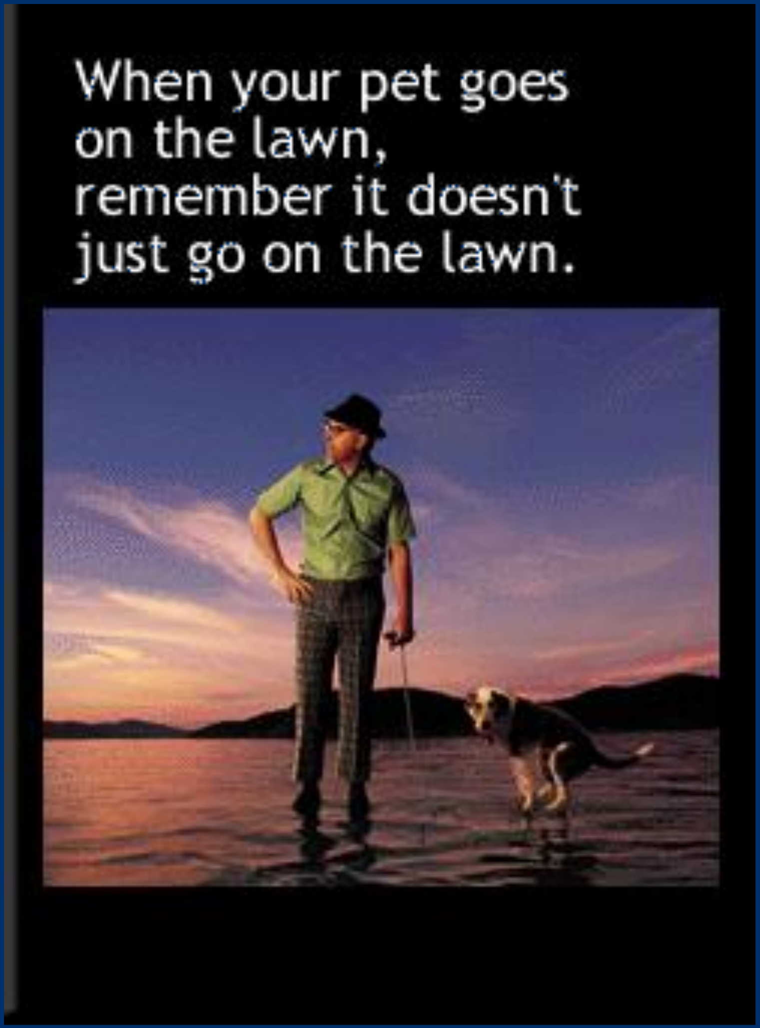


Sediment…

…Affects habitat, wildlife, water temperature, and drinking water

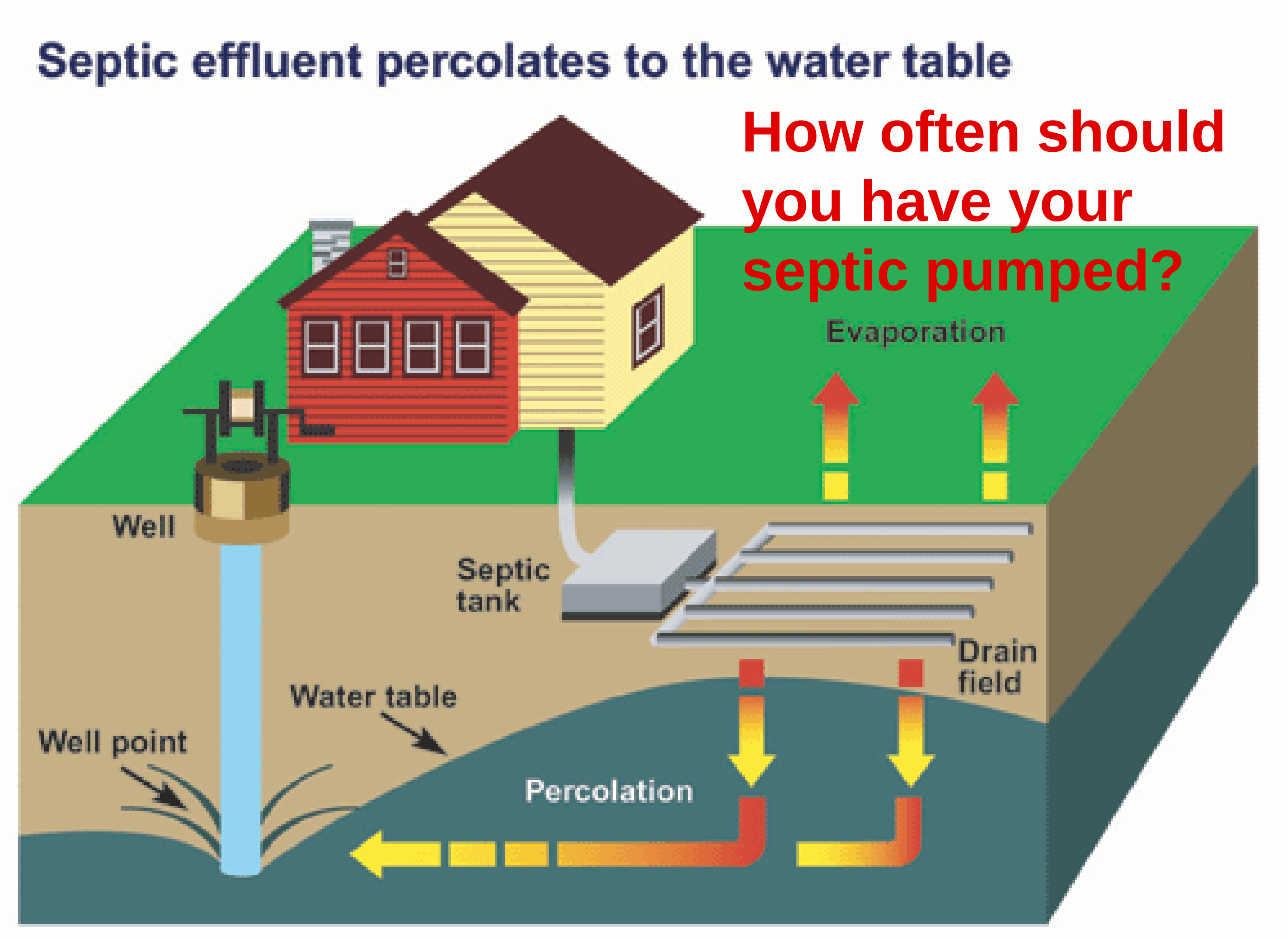
Bacteria…(fecal coliform)

pets, wildlife, livestock, septic systems



How is your home connected to Ground Water?

- Largest source by volume of waste discharged to the land
- Bacteria
- Viruses
- Nitrates
- Chemical Cleaning Compounds
- Paint Products



Have you had your drinking water tested lately?

There is NO STATE LAW that says cows cannot be in the creek.

- The state will come out and inspect and test a farm when a complaint has been filed. (99%)

- A Notice of Violation (NOV) will be received if if the property has exceeded the water quality standards, dissolved oxygen, pH, turbidity, fecal coliform.

- You will not be fined if you demonstrate that you are taking steps to improve the situation

Best Management Practices

Residential:

- Rain gardens
- Stabilize streambanks
- Use native plants
- Use less fertilizer
- Have your groundwater checked

Agricultural:

- Alternate Livestock watering
- Feeding as far away from streamside as possible
- Rotate grazing
- Limiting livestock access to streams

Losing Your Land?

Streamside Forests

Riparian Buffers

- Critical area for health of stream and habitat
- If this area is protected, it can protect your land and water
- Roots provide stability - hold the soil in place
- Provide temperature moderation Shade
- Intercepts pollution - “acts like a sponge” to absorb extra fertilizer, pesticides, sediments, etc.
- Provides habitat

Native Plants

- Accustomed to the climate
- Low maintenance!
- Beautiful selections

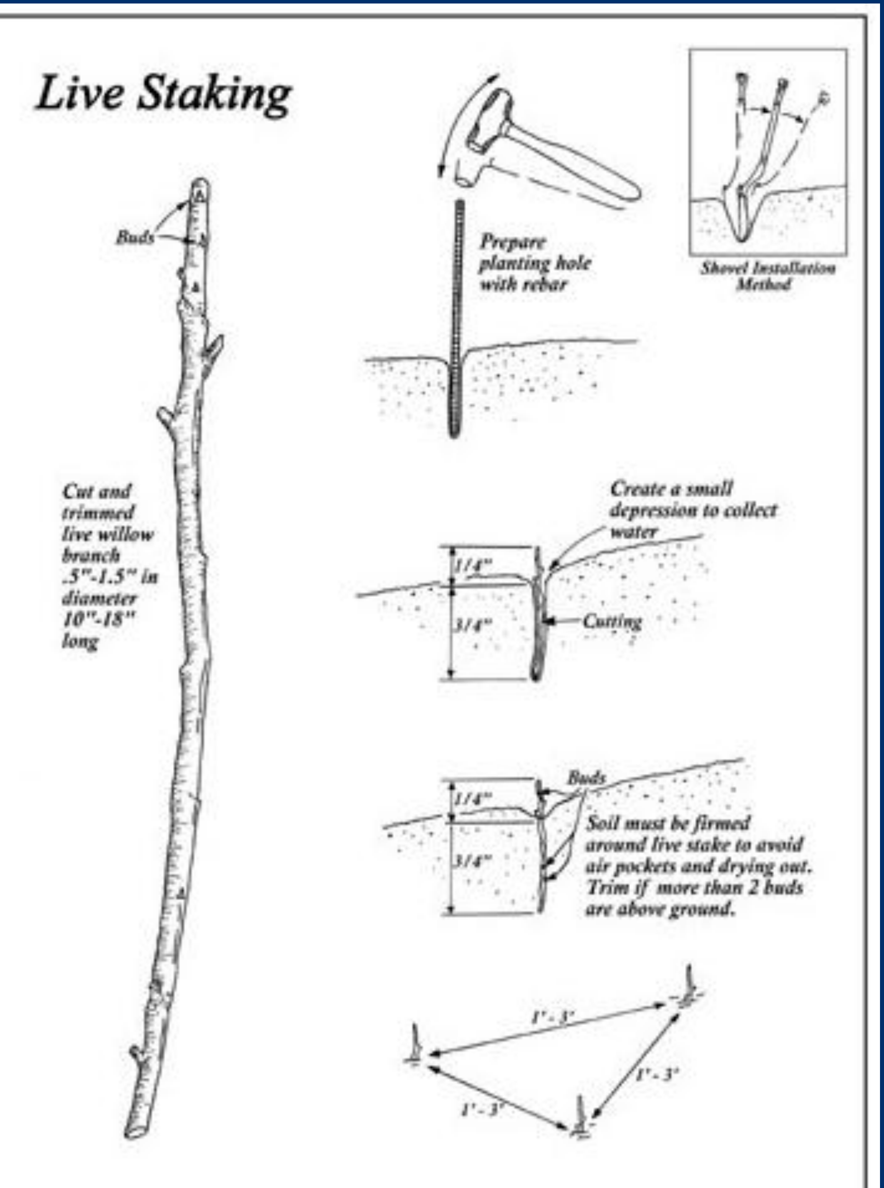






Live staking

Homeowners can easily install live stakes.



silky dogwood

Benefits of BMP's

- Clean Water
- Better Fishing
- Cows with off-stream sources drink more
- Increased production and/or weight gain for cattle of 5-10% over nine to ten months
- Lower risk of disease

What are some rain garden benefits?

- Adds beauty (and value) to your property
- Provides wildlife habitat
- Protecting our valuable water resources by minimizing rainwater runoff to streams while allowing excess rainwater to filter slowly into the soil

Rain garden after two years.

Next Steps

- Sign Up If you want more information
- Call Brushy Fork Environmental at 423-727-4476 if you want to participate
- Grant funds available on first-come, first-served basis.
- March workshop on well-water testing and planting live stakes

Thank You!

Questions?