High Country Water Quality Initiative

High Country Council of Governments

September 2012

High Country Council of Governments
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HIGH COUNTRY REGIONAL WATER QUALITY INITIATIVE

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HIGH COUNTRY REGIONAL WATER QUALITY INITIATIVE

Narrative

I. Introduction

The High Country Regional Water Quality Initiative project consists of a series of tasks designed to advance water quality protection in the High Country region of North Carolina. The High Country region includes Alleghany, Ashe, Avery, Mitchell, Watauga, Wilkes, and Yancey Counties. The region is rural, mountainous, and heavily-dissected by streams. The New, Watauga, French Broad, Catawba, and Yadkin Rivers all have headwaters in the region. There are 19 Towns in the region, none of which are subject to EPA Phase I or Phase II Stormwater Program regulations.

The High Country Regional Water Quality Initiative project included the following work elements:

- Review of existing local government ordinances related to stormwater management
- Mapping of property owned by local governments, to aid in stormwater BMP site selection
- Consultation with local government staff to identify feasible stormwater BMP sites
- Consultation with local Soil and Water Conservation District staff to identify feasible stormwater BMP sites
- Development of GIS datasets depicting town and county-owned properties, catchment areas, and BMP sites
- Development of site-specific stormwater BMP site plans
- Presentation to local governments of model ordinance addressing stormwater management
- Creation of GIS datasets depicting erodible soils, steep slopes, and impervious surfaces in the region
- Edit of hydrology data to accurately reflect flowline characteristics within the BMP drainage area based on field observations.

II. Stormwater Best Management Practices

A total of 26 stormwater BMP plans were developed. The BMP plans are site specific, and are recommended based on available property, feasibility to construct, potential to reduce pollutants from entering streams, and demonstration value.

The project initially intended to develop plans for agricultural BMPs and streambank restoration projects Following discussions with Soil and Water Conservation District

(SWCD) and Natural Resources Conservation Service (NRCS) staff and Boards throughout the region, it was determined that the agricultural community is already being served with technical and financial assistance through existing, proven SWCD and NRCS programs. SWCD and NRCS staff assists the farming community in developing BMPs funded through the NC Agricultural Cost Share Program and the Community Conservation Assistance Program.

High Country Council of Governments staff assessed approximately 100 potential BMP sites throughout the region. Feasible sites were not identified in all jurisdictions, and multiple sites were identified in some jurisdictions. Stormwater BMP plans were developed for the following sites:

1. Alleghany County – Alleghany County EMS Station
2. Town of Sparta – Town Maintenance Facility
3. Ashe County – Ashe County Courthouse
4. Town of Jefferson – Ashe Memorial Hospital
5. Town of Jefferson – Jefferson Fire Station/Gates Corporation
6. Town of Lansing – Bridge at Old Field Branch
7. Town of West Jefferson – Bowie Seagraves Park
8. Avery County – Banner Cabinets/Avery County Ballfield
9. Town of Banner Elk – Tate Evans Park
10. Town of Crossnore – Town Center/Crossnore School
11. Town of Newland – Old Public Road/North Toe River
12. Village of Sugar Mountain – Craggy Pointe
13. Mitchell County – Mitchell County Senior Center
14. Town of Bakersville – Creekwalk Trailhead
15. Town of Bakersville – Hemlock Drive Parking Lot
16. Town of Spruce Pine – Brad Ragan Park
17. Watauga County – Cooperative Extention/EMS Parking Lot
18. Town of Blowing Rock – Maple Street Parking Lot
19. Town of Boone – Appalachian State University, Duncan Hall
20. Wilkes County – Wilkes County Senior Center
21. Town of Ronda – Memorial Park
22. Town of Wilkesboro – Tyson Plant (Main/Cherry Streets)
23. Town of Wilkesboro – Wilkesboro United Methodist Church
24. Yancey County – Yancey County Health Department
25. Yancey County – Ray Cort Park
26. Town of Burnsville – Yancey County Department of Social Services

III. Model Stormwater Ordinance

High Country COG has developed a model stormwater ordinance that can be used by local governments in the region. The model ordinance is intended to address development projects that involve less than one acre of disturbance. The purpose of the

model ordinance is to provide a mechanism to regulate stormwater in small municipalities that have limited capacity to review, permit, and inspect development.

Generally, the model ordinance presented in this project is based on UNC Environmental Finance Center's *Universal Stormwater Model Ordinance for North Carolina*. It removes much of the administrative functions (i.e., application review, permitting) from the Universal Ordinance, but sets standards for new development and requires new development projects to provide site plans prepared by a professional engineer that address post-construction stormwater management.

The model ordinance was provided to local governments in the region. Additionally, High Country COG staff presented the model ordinance to the Planning Boards of the Towns of Wilkesboro and North Wilkesboro. As of September 30, 2012, no local governments in the region have adopted a version of the model ordinance.

IV. Regional Mapping

The following GIS datasets were created to help guide local decisions on future stormwater BMP projects:

1. Erodible Soils – based on NRCS SSURGO soil tabular data. Data was extracted in Microsoft Access and imported in ArcGIS to map highly erodible soils based on the soil K factor. The K factor indicates erodibility based solely on surface texture. K factors greater than or equal to 0.24 were chosen based on academic articles to reflect erodible soils.
2. Steep Slopes – based on 2007 NC DOT LiDAR digital elevation data. Slopes were generated in percent rise and reclassified to only show slopes greater than 30%.
3. Highly Erodible Lands – retrieved from USDA NRCS Waynesville office. Depicts Highly Erodible Lands in our region based on soil texture and topographic characteristics, i.e. slope, length of slope, etc.
4. Regional Impervious Surfaces – retrieved 2006 National Land Cover Data and extracted to show impervious surfaces across the region.
5. Site Impervious Surfaces – digitized impervious surfaces for each BMP drainage area using 2010 orthophotography.
6. Hydrology – based on NC Stream Mapping Program data generated from LiDAR technology and aerial imagery resources. The data is unavailable for Wilkes County, therefore the NC Floodplain Mapping Program hydrology data was substituted.
7. Catchment Areas – Delineated sub-catchments for all 19 municipalities and surrounding areas based on NED 1/3 arcsecond (10m resolution) digital elevation model and NC Stream Mapping Program hydrology data. In Wilkes County, NC Floodplain Mapping Program hydrology data was used in the absence of NC Stream Mapping Program data. The Stream Definition tool was used to define smaller catchment areas. The sub-catchments were delineated in order to view

catchments at a smaller scale than the National Hydrologic Datasets' available catchment data.

8. BMP Drainage Areas – Created micro-level drainage areas specific to the proposed BMP sites based on field observation, delineated sub-catchments, hydrology and topographic digital data.
9. Public Property – Queried each county's tax parcel digital data to extract all county and town-owned parcels to help locate potential BMP sites.

High Country Council of Governments
Regional Stormwater Project

Alleghany County

Alleghany County EMS Station

Problem

The adjacent fire department and EMS properties are heavily paved to accommodate the emergency vehicles and thus generate a significant amount of runoff which flows offsite, causing erosion on a neighboring property. The site contributes to stormwater from elsewhere in town which discharges into a stream approximately 200 feet away. The runoff from the site introduces oils and grease, hydrocarbons, metals, and road salt to the stream.

Drainage area = 0.81 acre Impervious surface = 0.67 acre; 83%
Affected stream = unnamed tributary to Bledsoe Creek Stream classification = C, Tr

BMP solution

Much of the runoff can be captured at a point behind the EMS building, held, and filtered with a bioretention cell. This BMP was selected based on site characteristics, space limitation, and the desire of the building occupants to maintain a landscaped appearance. There is approximately 600 square feet of space available for the bioretention cell.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will help lessen erosion downstream that often results from higher stream volumes. The site is located in Sparta where the Town government has recently completed a number of significant stormwater retrofit projects, with more planned. This BMP will augment those projects and contribute to the overall reduction of runoff throughout town.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	17	5	13
COD	300	U	U
TSS	771	108	663
LEAD	1	1	0
COPPER	0	U	U
ZINC	1	1	0
TDS	2,068	U	U
TN	4	2	2
TKN	6	U	U
DP	0	U	U
TP	1	0	0
CADMIUM	0	U	U

Cost estimate[2]

Construction	$40,795
Design & engineering	2,039
	$42,834

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Project Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

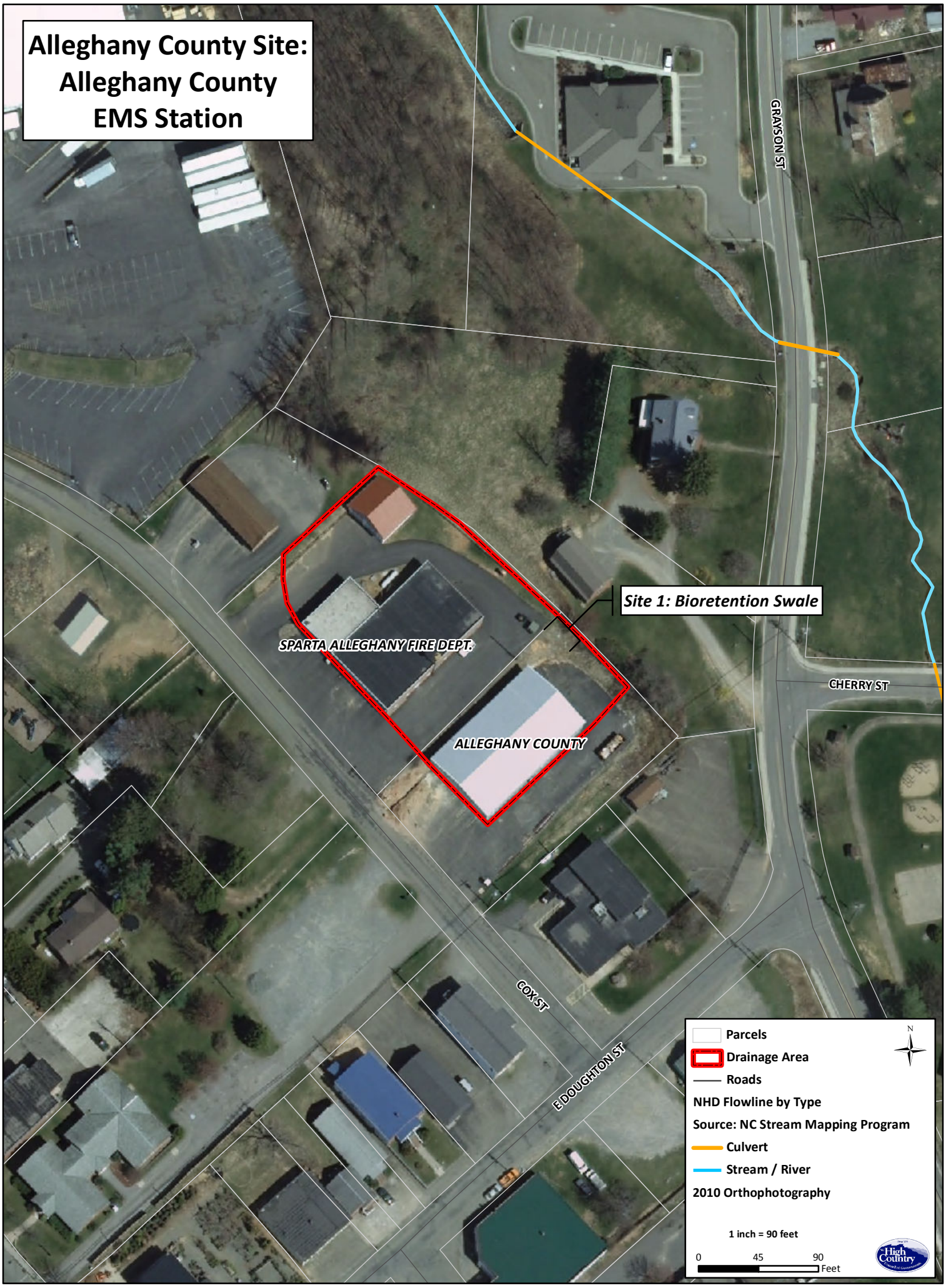
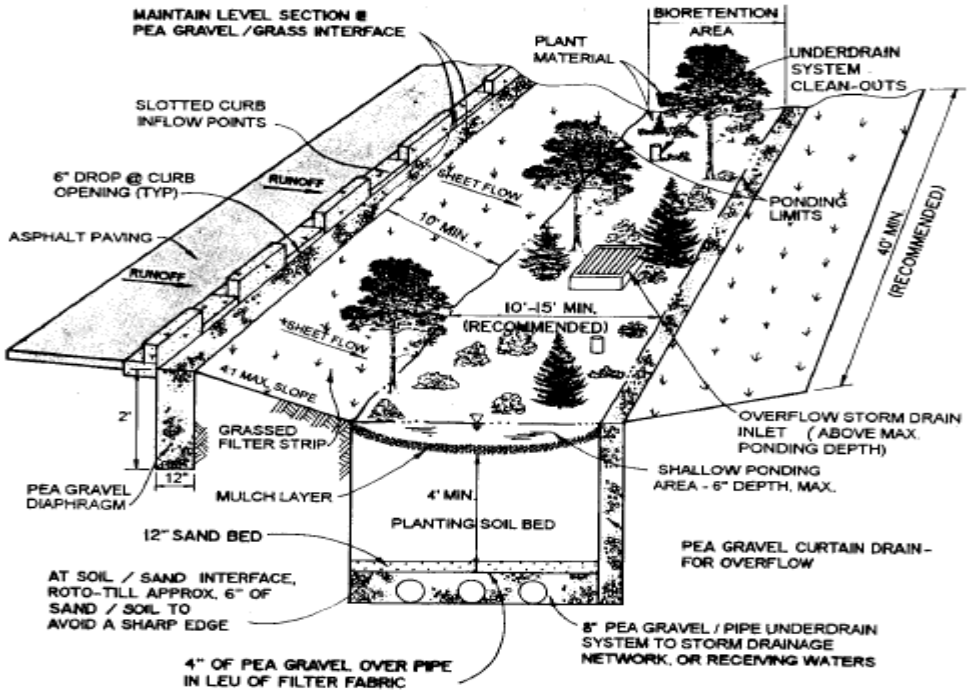

Alleghany County Site:
Alleghany County
EMS Station
GRAYSON ST
Site 1: Bioretention Swale
SPARTA ALLEGHANY FIRE DEPT.
ALLEGHANY COUNTY
CHERRY ST
COX ST
E DOUGHTON ST
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 90 feet
0
45
90
Feet
N

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of Sparta

Town Maintenance Facility

Problem

Impervious surfaces at the Town maintenance facility results in a substantial amount of uncontrolled runoff. The runoff from the site contains oils and grease, hydrocarbons, metals, and road salt that drains to neighboring properties and ultimately to a stream located approximately 600 feet from the site.

Drainage area = 1.86 acre
Impervious surface = 1.38 acre; 74%

Affected stream = unnamed tributary to Bledsoe Creek Stream classification = C, Tr

BMP solution

The only available space for BMP treatment is the two grassy strips flanking the entrance drive. Their shapes and dimensions dictate that vegetated swales will be the BMP used. A grade-level drain will be necessary to direct the runoff to the swales.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the nearby stream. The Town is aware of the need for stormwater management and recently completed a number of significant retrofit projects, with more planned. This BMP will augment those projects and contribute to the overall reduction of runoff throughout town.

Vegetated swale	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	56	28	28
COD	963	578	385
TSS	2,474	668	1,806
LEAD	3	2	1
COPPER	1	U	U
ZINC	4	1	2
TDS	6,631	U	U
TN	14	9	6
TKN	20	U	U
DP	0	U	U
TP	2	1	1
CADMIUM	0	U	U

Cost estimate[2]

Construction	$25,047
Design & engineering	2,500
	$27,547

Funding

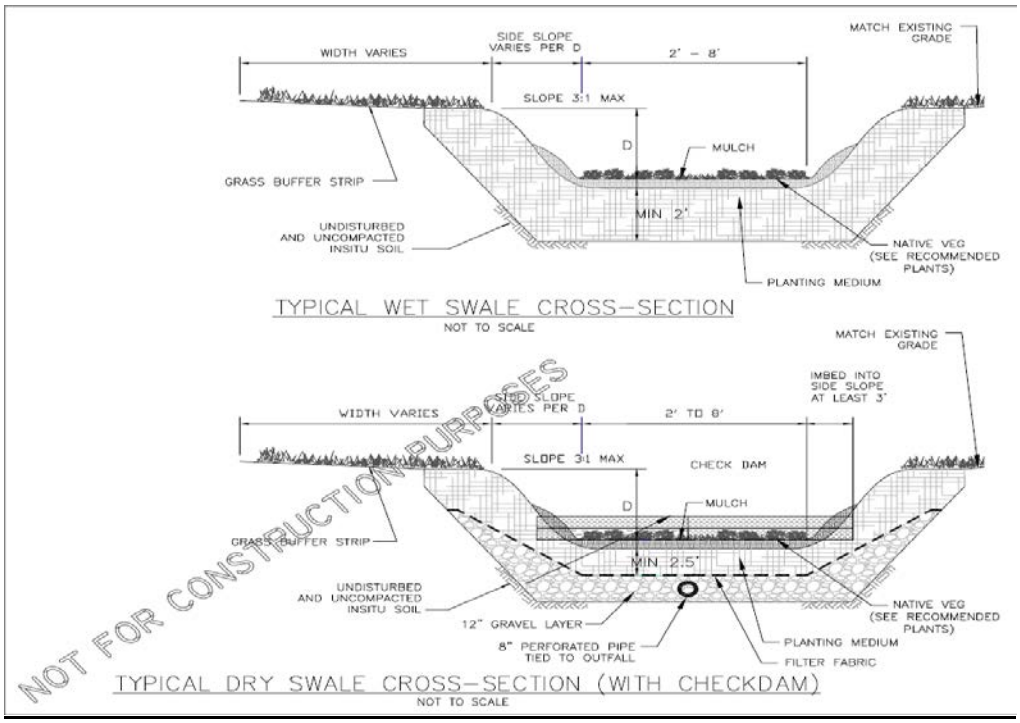
NC Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007


Town of Sparta Site:
Town Maintenance Facility
MEMORIAL PARK DR
S MAIN ST
SPARTA TOWN HALL
Site 1: Vegetated Swale
TOWN OF SPARTA
Site 2: Vegetated Swale
ALLEGHANY COUNTY
JONES ST
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 65 feet
0
30
60
Feet
N

Diagram and photograph of a typical swale:



High Country Council of Governments
Regional Stormwater Project

Ashe County

Ashe County Courthouse

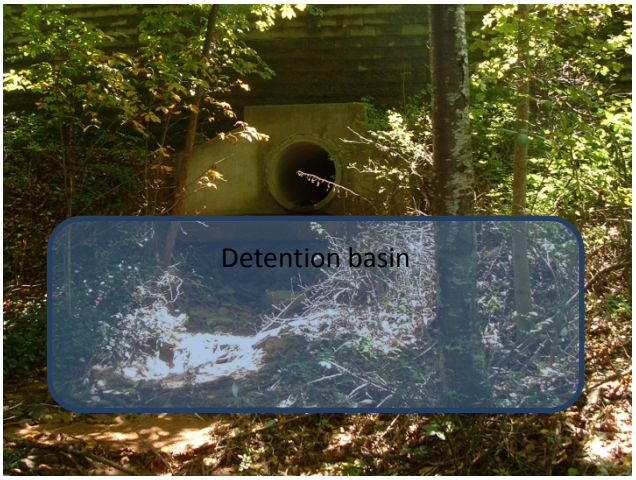
Problem

Runoff from parking lots (one complete; one under construction) is piped below the road and exits below a retaining wall as shown in the photos. Runoff from the site introduces oils and grease, hydrocarbons, metals, and road salt to an intermittent stream channel. During extremely heavy rains, the stormwater contributes to flooding in the highway below and enters Naked Creek. In addition to existing stormwater concerns, future development planned for the area below the discharge will require management of stormwater from this site.

Drainage area = 11.72 acres
Impervious area = 2.29 acres; 20%
Affected stream = unnamed tributary to Naked Creek
Stream classification = C +

BMP solution

A detention basin will be constructed below the discharge point in the retaining wall. The site will not interfere with planned development elsewhere at this location. The BMP was selected based on the volume of stormwater, the availability of space, and the inconspicuous location.



Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will lessen erosion downstream that is often associated with higher stream volumes. Temperature fluctuations caused by this site's runoff will be eliminated.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	69	50	19
COD	1,186	949	237
TSS	3,046	1,294	1,751
LEAD	4	2	2
COPPER	1	U	U
ZINC	4	3	1
TDS	8,164	U	U
TN	18	12	5
TKN	25	U	U
DP	0	U	U
TP	3	2	1
CADMIUM	0	U	U

Cost estimate[2]

Construction	$17,175
Engineering	1,000
	$18,175

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

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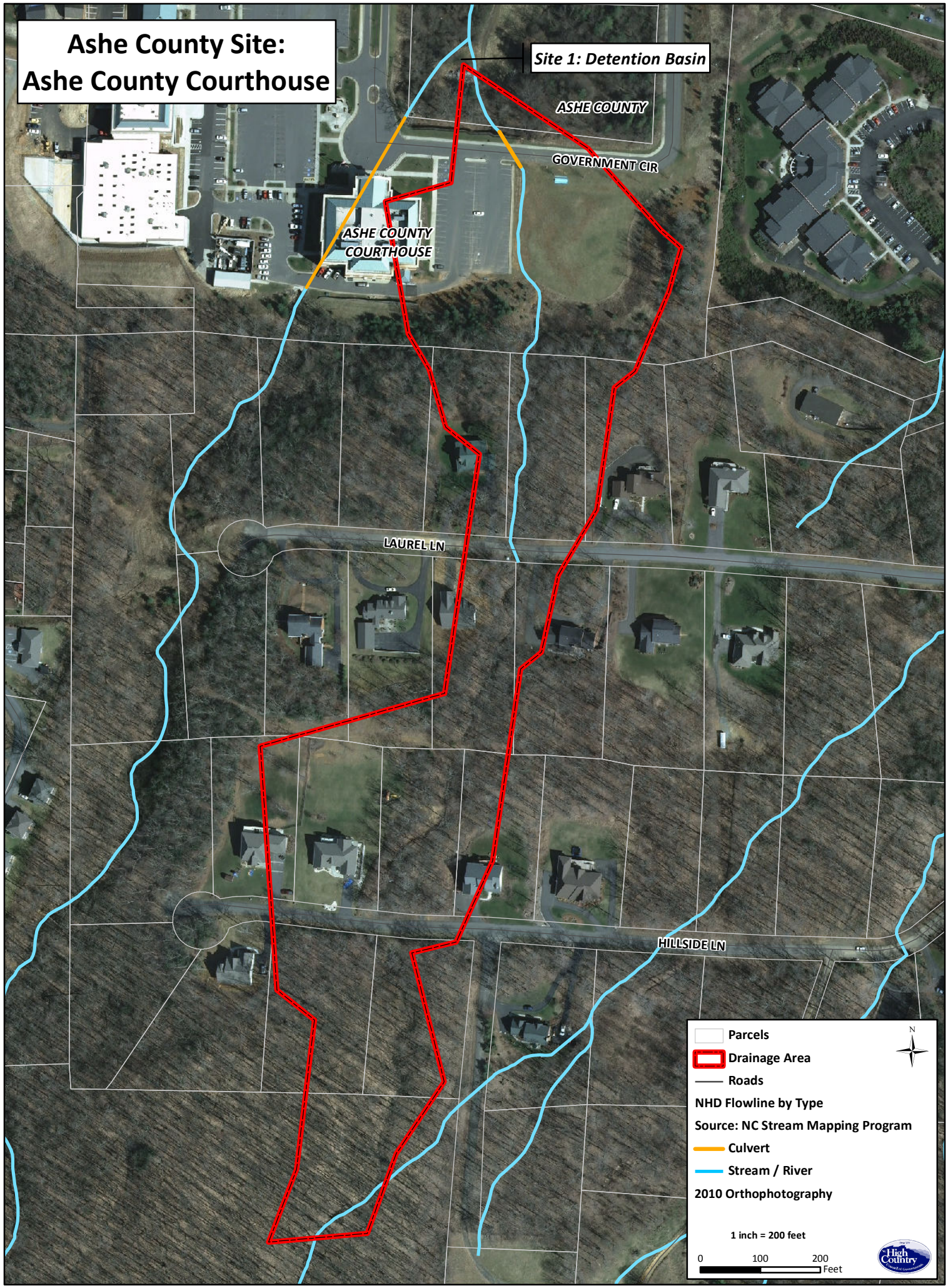
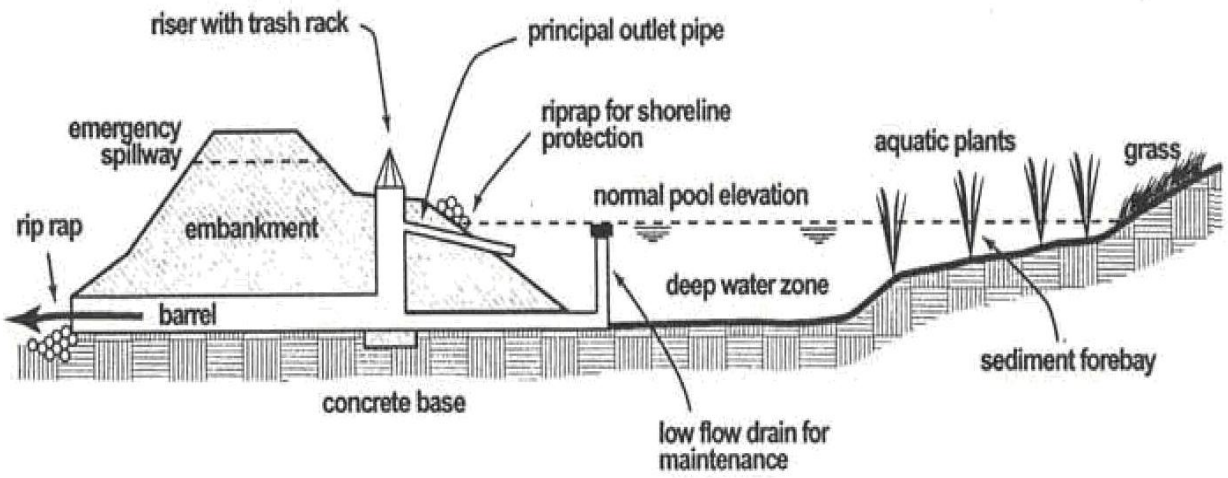

Ashe County Site:
Ashe County Courthouse
Site 1: Detention Basin
ASHE COUNTY
GOVERNMENT CIR
ASHE COUNTY
COURTHOUSE
LAUREL LN
HILLSIDE LN
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 200 feet
0
100
200
Feet
N

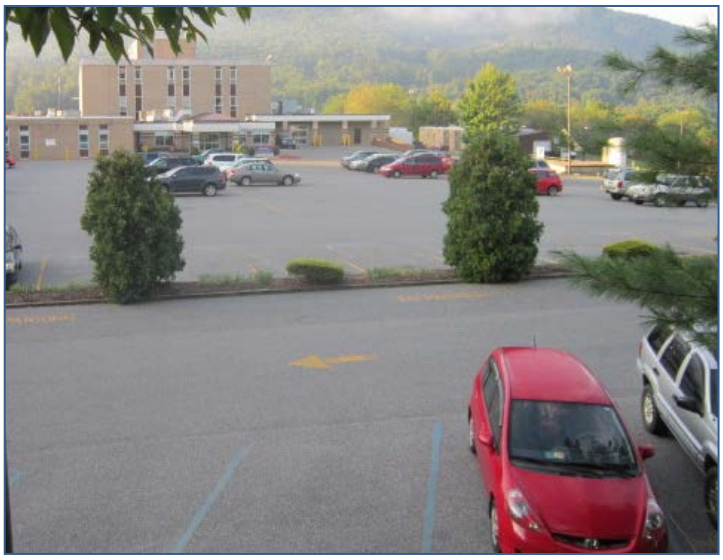
Diagram and photograph of a typical detention basin:



High Country Council of Governments
Regional Stormwater Project

Town of Jefferson

Ashe Memorial Hospital



Problem

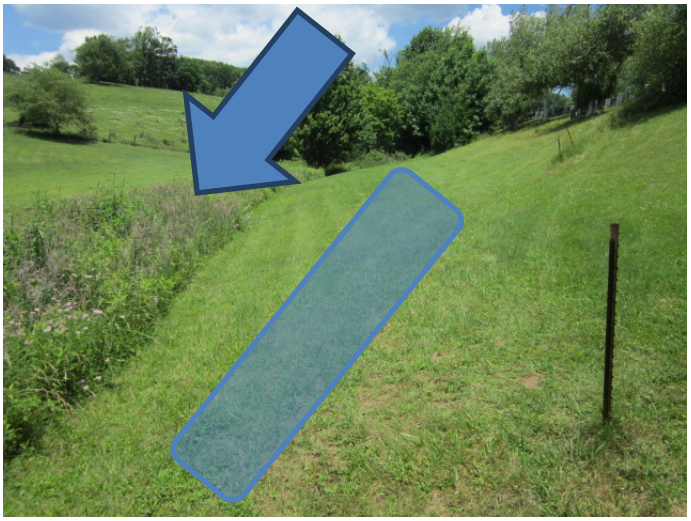
The hospital is located on top of a hill. Much of the runoff from the hospital building, parking, and roads collects at a single culvert which drains directly into a stream (red arrow indicates location of discharge). The runoff from the site introduces oils and grease, hydrocarbons, metals, and road salt to the receiving stream.

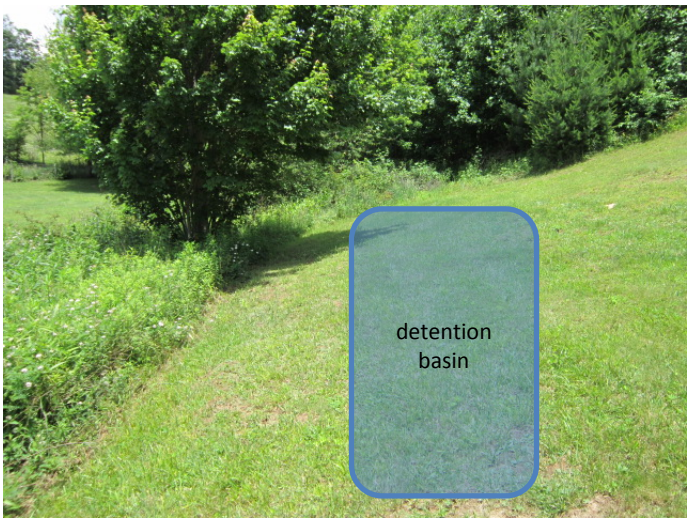
Drainage area = 4.93 acres
Impervious surface = 3.20 acres; 65%

Affected stream = unnamed tributary to Naked Creek
Stream classification= C +

BMP solution

The stormwater enters the stream via a culvert in the wooded area (blue arrow). The stream flows out of the woods into the unmowed area on the left. Because the site is not visible from the hospital campus and abundant space is available, stormwater will be diverted via a flowsplitter into an extended linear detention basin that will be constructed parallel to the stream.





Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will lessen erosion downstream that is often associated with higher stream volumes. Temperature fluctuations caused by this site's runoff will be eliminated.

Detention basin	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	148	41	106
COD	2,554	U	U
TSS	6,557	918	5,639
LEAD	8	5	3
COPPER	2	U	U
ZINC	9	7	2
TDS	17,575	U	U
TN	38	17	21
TKN	54	U	U
DP	0	U	U
TP	5	2	4
CADMIUM	0	U	U

Cost estimate[2]

Construction, including flowsplitter	$35,325
Design & engineering	7,065
	$42,390

Funding

NC Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Program

North Carolina Division of Water Resources Development Project Grant Program

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[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

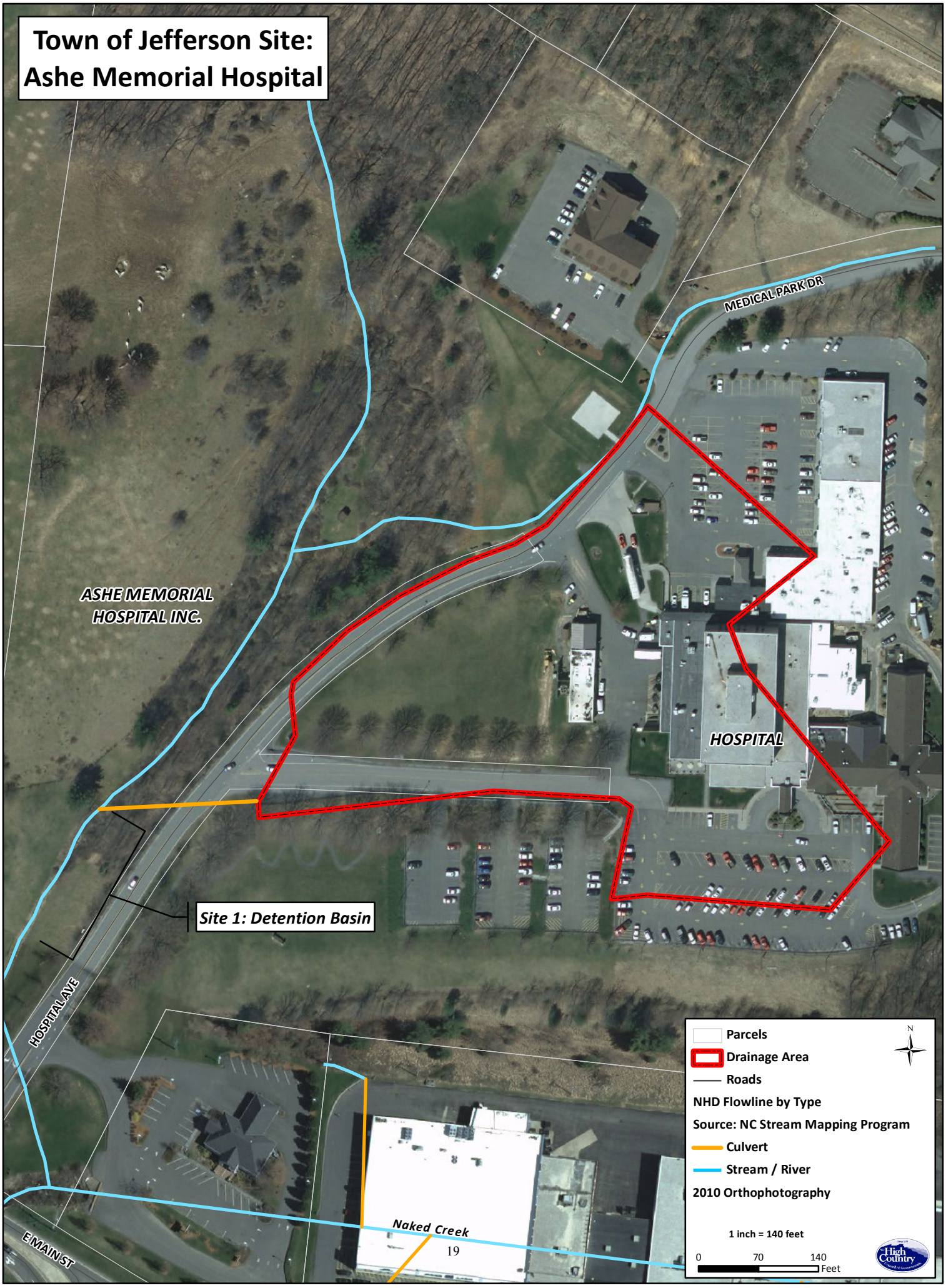
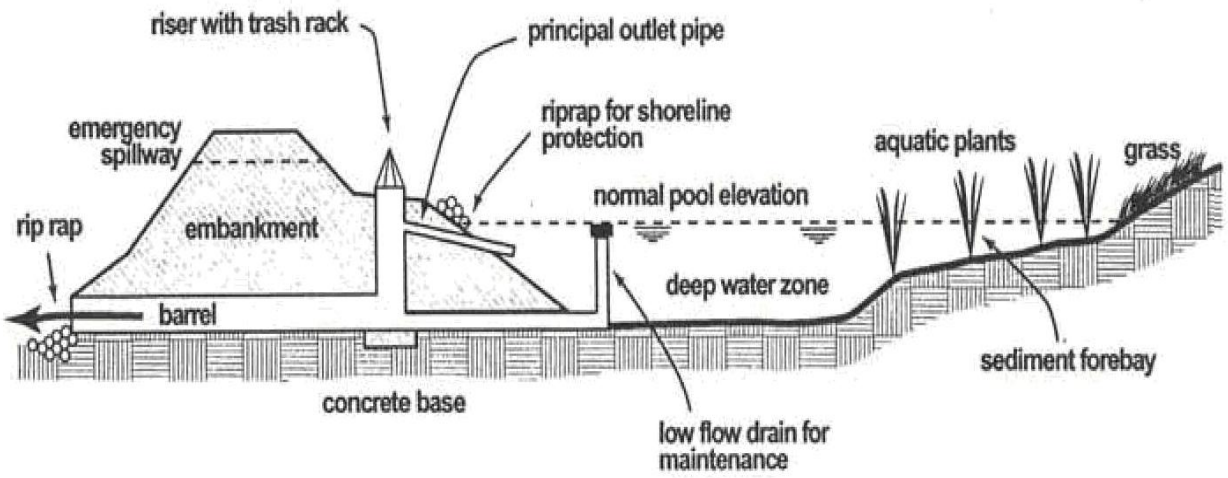

Town of Jefferson Site:
Ashe Memorial Hospital
MEDICAL PARK DR
ASHE MEMORIAL
HOSPITAL INC.
HOSPITAL
Site 1: Detention Basin
HOSPITAL AVE
E MAIN ST
Naked Creek
19
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 140 feet
0
70
140
Feet
N

Diagram and photograph of a typical detention basin:



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Town of Jefferson
Jefferson Fire & Gates Corporation

Location Northwest Drive off Hwy 88 in Jefferson

Landowner Project activities will occur on two tracts, separately owned by the Town of Jefferson and Ashe County Job Development, Inc. The Ashe County tract is leased to Gates Corporation.

Affected stream unnamed tributary; New River basin

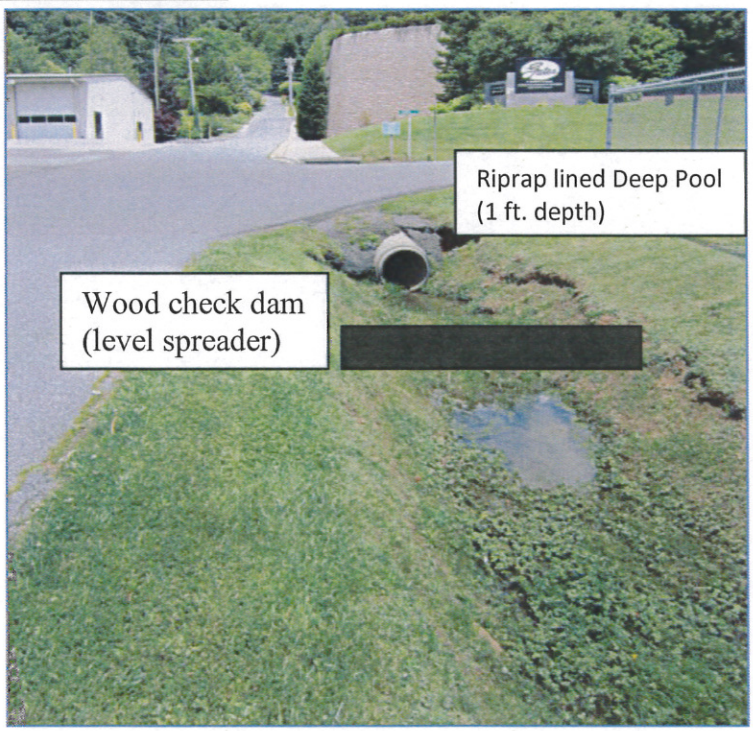
Problem This site contains two problem areas exhibiting erosion and impervious surface runoff. The proposed solution aims to address these concerns by developing each site individually and attempting treat the stormwater in a piecemeal approach rather than with an end-of-the-line, large-scale solution. Site 1 consists of the eroding drainage ditch on the eastern side of Northwest Dr. between the road and the fence (Photo Page; Photo 2). Currently the ditch receives runoff from a culvert running under Gates Ln. and discharges through an outlet culvert which passes underneath Northwest Dr. The ditch is currently experiencing minor erosion along its banks. The ditch can be developed into a stormwater BMP to treat the runoff passing through. At Site 2 a stream passes through a culvert under the fire department parking lot and then flows in an open channel (Photo 1) approximately 25 feet before flowing under Northwest Drive. The open channel on the western side of Northwest Dr. receives stormwater from both Site 1 (Photo 3) and surface flow from Northwest Drive and the fire department parking lot (Photos 1 & 4). As a result, the open channel is experiencing significant erosion along the banks. Likewise, the site also has space to introduce a BMP to treat the incoming stormwater.

	Site 1	Site 2
Proposed structure	vegetated swale w/ check-dams	streambank restoration
Cost	$10,106	$4,211

Water quality objective reduction of pollutants
Anticipated result reduction in nitrogen (20%)
phosphorus (20%)
suspended solids (35%)

Drainage area 10.5 acres
Impervious area 5.9 acres or 56% of drainage area

Solution description



SITE 1
Site 1 will be developed into a vegetated swale with intermediate check dams to both slow velocity and treat incoming stormwater. The lower velocity will prevent bank erosion and allow sediment to fall out of suspension in the stormwater, thus decreasing the TSS (total suspended solids) of the stormwater effluent. This treatment is accomplished by two facets of the vegetated swale design: enhanced vegetation and intermediate check dams. Taller grass in the channel will act as an energy dissipater for the passing water, slowing it as it moves from inlet to outlet. The grass will also allow greater infiltration by promoting soil channels as it roots and naturally filter pollutants in the runoff through phytoremediation. The check dams additionally slow water velocity and increase the retention time of the water in the BMP. Increased retention time allows the soil, plants, and bacteria additional time to biodegrade undesirable pollutants in the runoff such as TP, TN, metals, and other substances.

Directly below the inlet culvert a deep pool will be established, roughly one foot deep and two feet long. This deep pool will be lined with riprap to dissipate the energy of water exiting the culvert and prevent erosion. At the

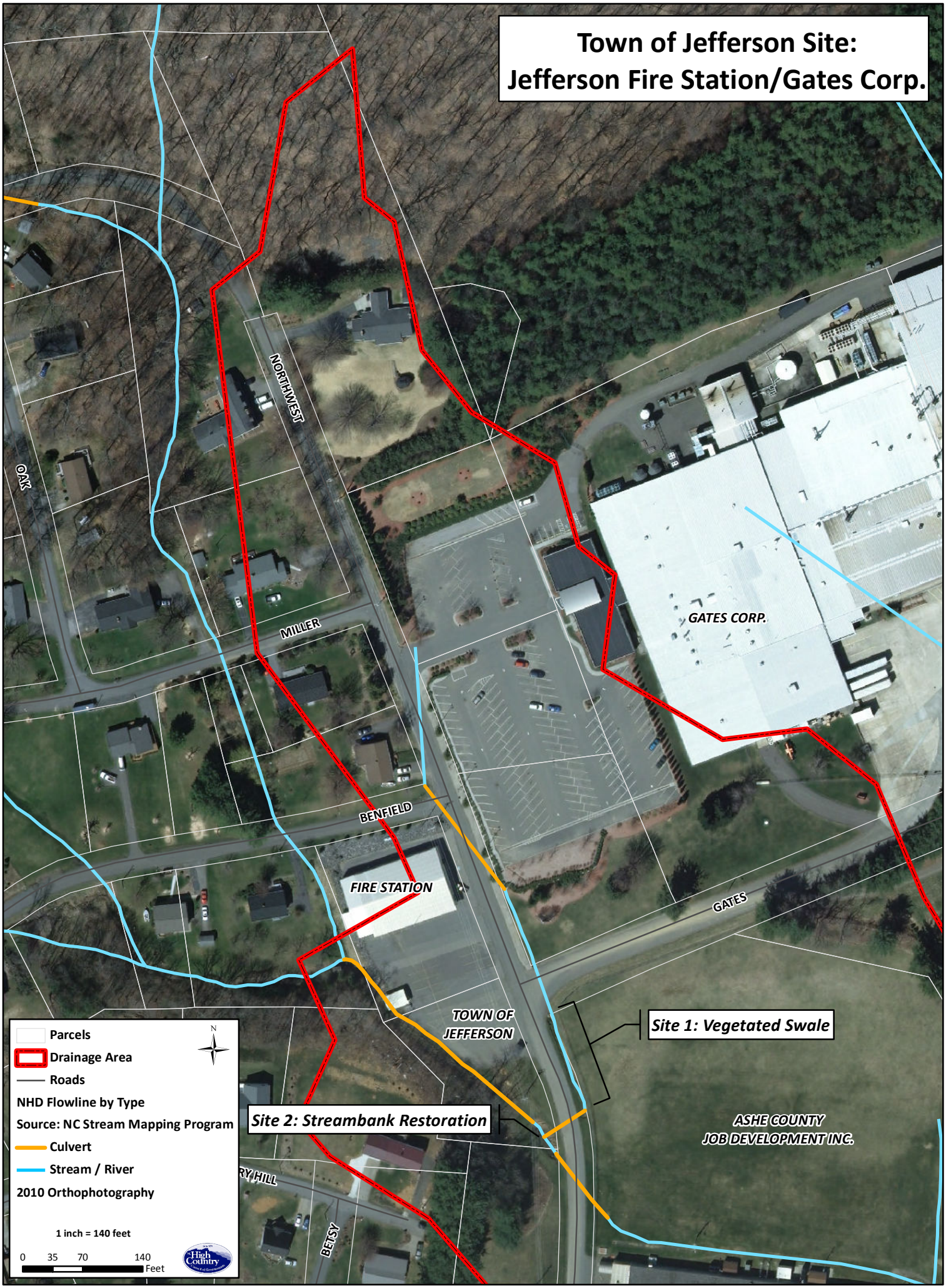

Town of Jefferson Site:
Jefferson Fire Station/Gates Corp.
NORTHWEST
OAK
MILLER
BENFIELD
FIRE STATION
GATES CORP.
GATES
TOWN OF JEFFERSON
Site 1: Vegetated Swale
Site 2: Streambank Restoration
ASHE COUNTY JOB DEVELOPMENT INC.
BETSY
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 140 feet
0 35 70 140
Feet
N

Photo Page

Photo 1

Culvert carrying flow from ditch

Photo 2

Photo 3

Photo 4

Photo 5

downstream edge of this deep pool area a wood check dam will be constructed out of treated 2x8. The top of this initial check dam will not rise above the inlet culvert and serves as a level spreader for water entering the channel. Following this wood check dam will be a series of 4 check dams (one dam approximately every 30 ft. of channel) constructed of rip rap. Rip rap was selected as a check dam material because of its resistance to erosion. Other suitable materials may also be used, such as river rock or other aesthetic alternatives. Earthen check dams typically erode over time with heavy storm events and would increase site maintenance costs. The final check dam will be located roughly 4-5 feet from the outlet culvert. The entrance to the outlet culvert will also be excavated to a depth of one foot and a deep pool constructed to allow greater retention time and slow velocity sharply. This particular area is experiencing the greatest amount of erosion. The top elevation of any of the rip rap check dams should not come within 3-4" of the top of the channel to prevent stormwater from leaving the channel and entering the road.

Between the wood check dam and the final rip rap dam the entire channel will be planted with a close-growth, water-tolerant grass. This grass will need to be allowed to grow to an adequate height, preferably between 12-18". Successful swale grasses include red fescue, Kentucky bluegrass, and reed canary; however a local landscape professional should be consulted to ensure successful growth. If a grass is seeded that is not particularly suited to long periods of soil saturation the vegetative growth may die and the channel will lose its treatment efficiency. A landscape professional may be able to help develop a more aesthetic planting design if vegetation other than grass is desired. Trees and shrubs, however, are not recommended. The banks of the channel should be seeded or allowed to grow grass naturally. Spraying of the banks to kill growth should be avoided as it decreases the stability of the channel banks.

Vegetated swale similar to the recommended solution for Site 1. The grassed section in the background & the ornamental plantings in the foreground illustrate the available options.

Pollutant Loading

An analysis of the incoming runoff from the surrounding area was done using the SCS Curve Number Method in conjunction with Schuler's Simple Method. Estimates of pollutant loading in this runoff show 150 lb. TSS, 1 lb. TP, and 6 lb. TN annually. Sediment, in addition to the suspended solids in the runoff, is lost from bank erosion due to high velocity runoff. The grass swale with check dams and forebays addresses this problem by slowing runoff velocity and allowing sediment to settle out. NCDENR projects grassed swales to have removal efficiencies of 35% TSS, 20% TN, and 20% TP. This is an accurate estimate for this design, particularly considering the effect the check dams and forebays will have on runoff velocity. Several studies have also shown that grassed swales and vegetative waterways have moderate efficiency in removing heavy metals from stormwater. Runoff from the parking area, nearby roofs, and roads carries copper, lead, and zinc into the drainage ditch.

Results

	total nitrogen	total phosphorus	total suspended solids
annual pollutant load (lbs)	6	1	150
wetland removal %	20%	20%	35%
net pollutant reduction (lbs)	1.2	0.2	52.5

Site 1 Cost

$84.22 per linear foot (EPA-estimated cost for vegetated swales) x 120' = $10,106

SITE 2

Site 2 at this location is the open stream channel to the west of Northwest Dr. It receives overland flow from the Jefferson Firehouse parking lot and Northwest Dr., and an inlet culvert draining water from the upper drainage ditch to the east of Northwest Dr. (Site 1).

The streambank is experiencing significant erosion from high velocity runoff along the upper and right banks. High velocity of the stormwater is due to the unimpeded flow of water across the parking lot and the steeply sloping Northwest Dr. which directs water towards the ditch. A Bank Erosion Hazard Index (BEHI) evaluation results in a "High" erodibility rating. Bank erosion is of concern not simply for the amount of suspended solids it introduces to the stormwater runoff; current erosion patterns indicate the bank will

continue to lose sediment in the direction of Northwest Dr. This will lead to cracking, depression formation, and potentially failure of the asphalt if left unchecked. Additionally, runoff is entering the stream with little filtration.

The steep grades of the firehouse parking lot and Northwest Dr. move runoff rapidly across the impervious asphalt, generating high velocity. Current maintenance of the site involves mowing the grass uphill and to the right of the drainage ditch. During large rain events this allows water to move relatively unobstructed when soil conditions are saturated. Water can be slowed down before moving down the ditch slope by simply allowing established grasses to reach a taller height. Current maintenance of the site should be altered to allow the grass surrounding the channel to reach a height of 18-24". This will create a vegetative buffer between the asphalt and the channel, reducing the velocity of the stormwater. Interspersed shrubs contained within the grassy area can give a more aesthetic alternative to simple grassed waterway. An ornamental border grass such as monkey grass is another alternative that would give the site a landscaped look while filtering the runoff. It appears that herbicide has been applied to the banks to control grass growth. Not only is this practice harmful for the chemicals it introduces to the immediate stream but it prohibits necessary vegetation that helps stabilize the channel banks.

The streambank can be stabilized on the existing grade of the bank and erosion eliminated by establishing vegetation. The bank will be seeded with reed canary grass, or available alternative with dense growth. After seeding and planting is completed the vegetated area should be covered with mulch and an erosion blanket until vegetation is established. An initial fertilization of the bank along with a brief period of watering may be necessary to ensure plant growth. A landscape professional should be consulted regarding appropriate vegetation, planting schedule, soil mix, fertilization if necessary, and other possible concerns such as aesthetics.

Pollutant Loading

Pollutant loading calculations were done to determine if the site uphill of the drainage ditch would be a viable location for a bioretention cell. This site would treat only the runoff from the firehouse parking lot. Although the location would be ideal for a bioretention cell, pollutant estimates show that because the area is so small the construction costs outweight the potential benefits. Less than a 1 lb. of TN and TP would be carried in runoff annually from the site. TSS loading is 11.1 lb/year from the parking lot runoff. A major amount of sediment is exported from the site annually by the continuous erosion of the streambanks. This maintenance and landscape plan will help to stop the excessive sediment removal from the site by stabilizing the soil and slowing nearby runoff velocity. Several studies have also shown that grassed swales and vegetative waterways have moderate efficiency in removing heavy metals from stormwater. Runoff from the parking area carries copper, lead, and zinc into the stream. The vegetative filter strip above the open channel will be effective but will have a lower efficiency for heavy metal treatment than the upper grassed swale due to a decreased retention time.

Site 2 Cost

$84.22 per linear foot (EPA-estimated cost for vegetated swales) x 50' = $4,211

Total Costs

$84.22 per linear foot (EPA-estimated cost for vegetated swales) x 120' =	$10,106	Site 1
$84.22 per linear foot (EPA-estimated cost for vegetated swales) x 50' =	$ 4,211	Site 2
	$14,317	**Total cost for location**

Permitting

Due to the low development of this design, minimal grading, and no clearing; no permitting will be required. Proper erosion control methods should be observed when grading to prevent sediment pollution and soil loss.

Maintenance

After the site is landscaped and constructed as described, several current maintenance patterns would need to be changed. Spraying of the banks to kill vegetation in either drainage ditch is strongly discouraged. Vegetation will help to stabilize the slopes from high velocity runoff and removing this vegetation will continue the current soil loss trend.

Grass above the stream channel should be maintained at a height of 18-24" or higher in order to slow runoff coming from the firehouse parking lot and provide some filtration for the water. Grass alongside the channel next to Northwest Dr. should also be kept at this height as runoff coming down the road and spilling over the sides of the channel is causing erosion. The streambank should be monitored biweekly for several months after initial construction to verify that vegetation has established. The site should be inspected over the course of a year to detect other possible concerns and determine if erosion has been brought under control.

Height of the grass within the upper drainage ditch should be kept at a height of 12-18". This includes the ditch bottom as well as the side slopes. Grass height alongside the ditch does not impact the effectiveness of the swale or seems to be affecting erosion so the

landscaper may choose a maintenance height. Rip rap check dams should be checked periodically for debris and for any signs of failure. The area should also be observed, if possible, during a significant rain event; if the surface of the check dams are too close to the top of the ditch and are causing flooding due to constricted flow, dam height will need to be adjusted. Since the forebays are responsible for causing sedimentation, these areas need to be checked regularly and cleared of sediment. Failure of forebays to remove sediment from runoff is typically due to poor maintenance and loss of the pooling area due to sediment collection. The site should be checked periodically for erosion, debris, and vegetative establishment.

Possible funding sources

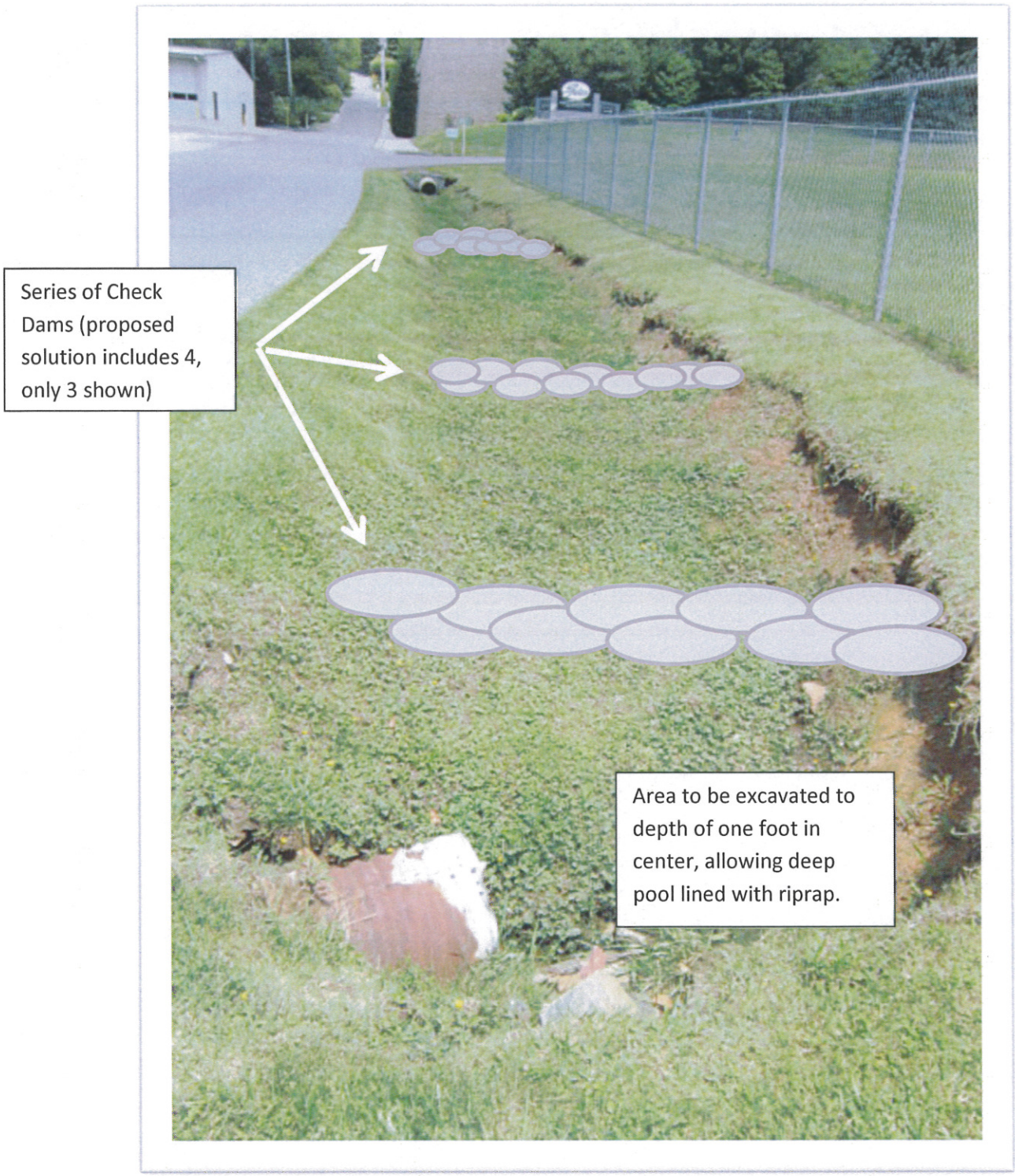
North Carolina Clean Water Management Trust Fund

Application due date:	February 1
Eligible expenses:	planning, designing and constructing a project, including excess or reserve capacity costs; legal, fiscal administrative and contingency costs; fees to obtain a loan or grant; permit fees; and property acquisition costs.
Maximum:	$3.0 million per grant recipient
Match:	20% required but can be waived; level of match affects the project's score
Other requirements:	permanent conservation agreement with the landowner; 10-year maintenance

Community Conservation Assistance Program- Soil & Water Conservation Districts

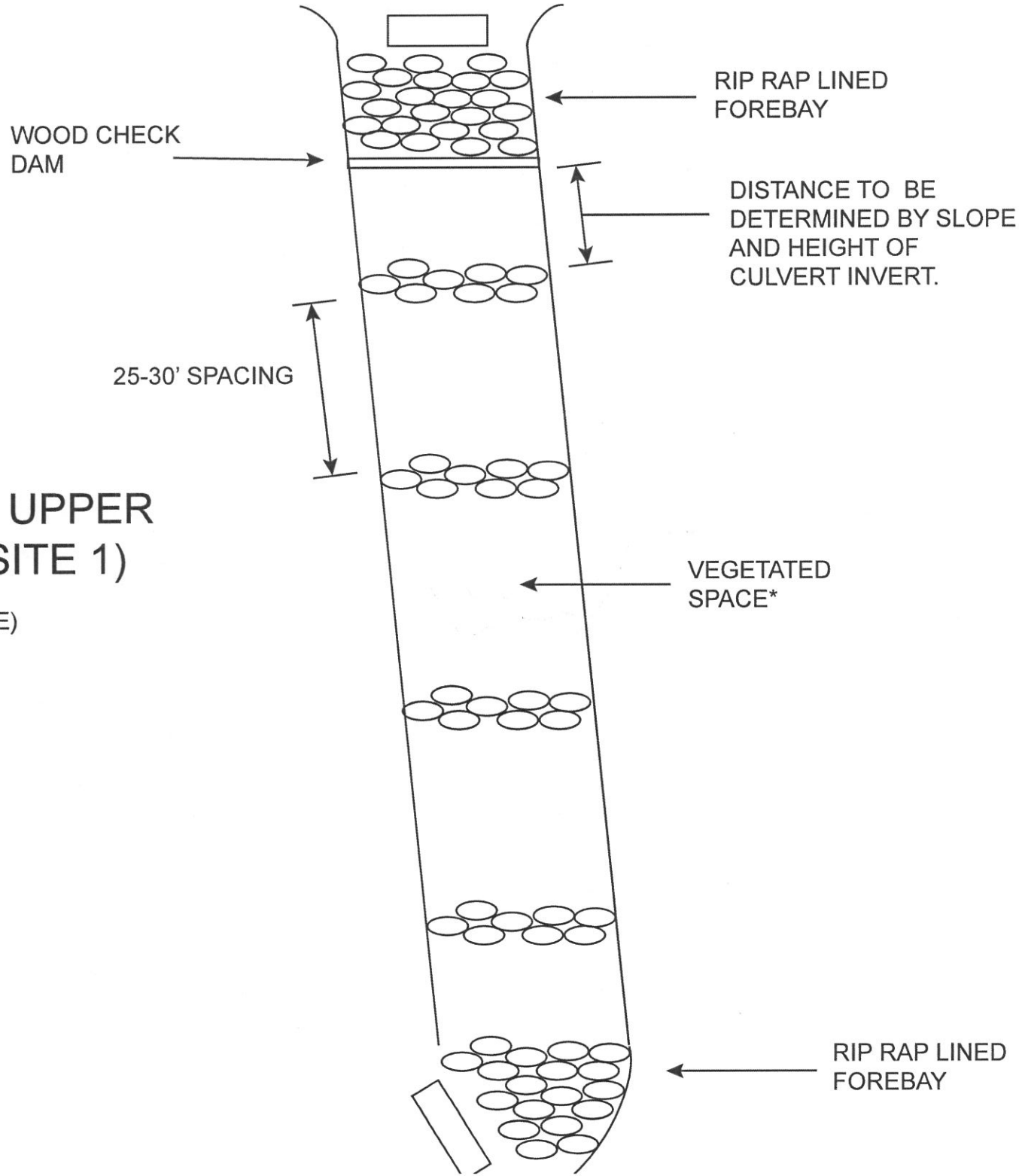
- Individual counties usually receive less than $5,000 annually based on a variety of funding factors.
- Funds up to 75% of the cost of the BMP
- No strict deadline, but funds usually are encumbered by March

Gates Corporation


Series of Check Dams (proposed solution includes 4, only 3 shown)
Area to be excavated to depth of one foot in center, allowing deep pool lined with riprap.

OVERHEAD VIEW OF UPPER DRAINAGE DITCH (SITE 1)

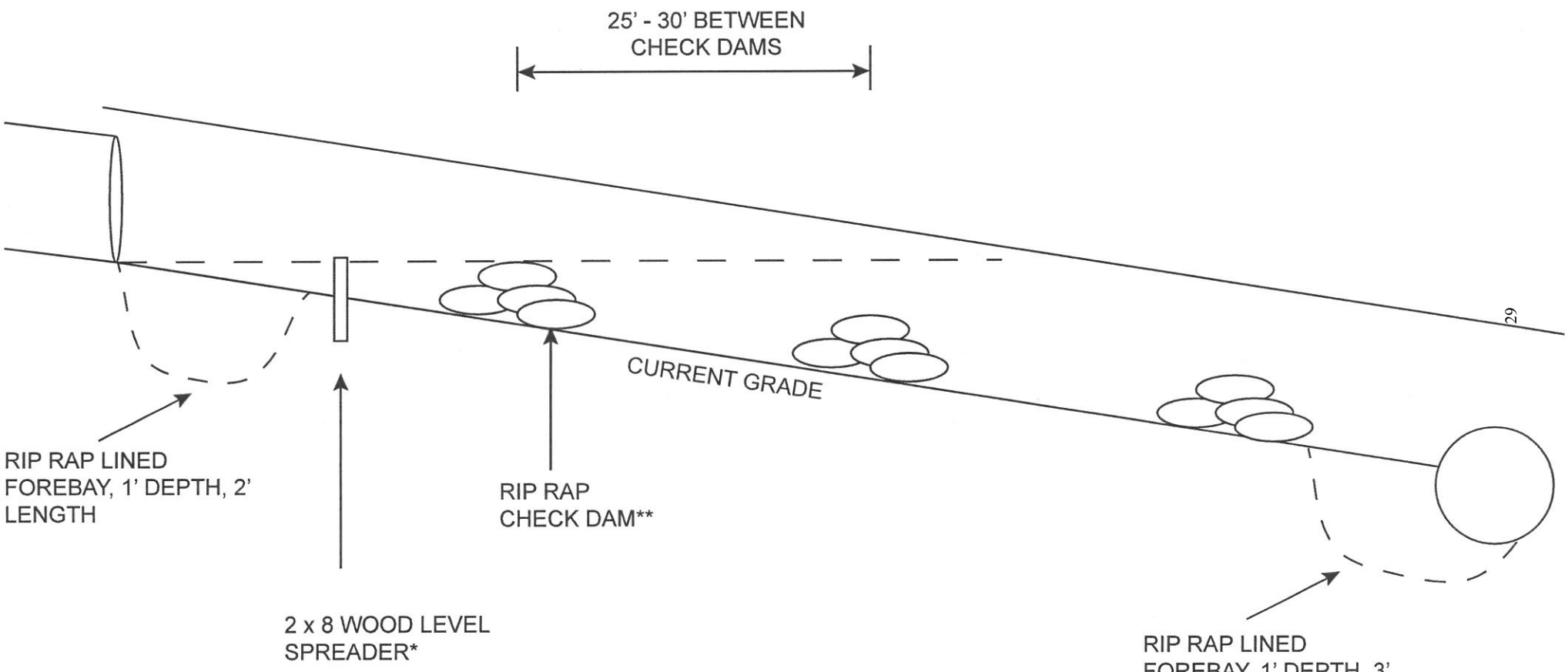
(DRAWING NOT TO SCALE)



*Spaces between check dams shall be seeded with an appropriate grass mixture and allowed to grow to 12-18" in height. Vegetated space includes ditch and banks.

PROFILE VIEW OF UPPER DRAINAGE DITCH (SITE 1)

(DRAWING NOT TO SCALE)

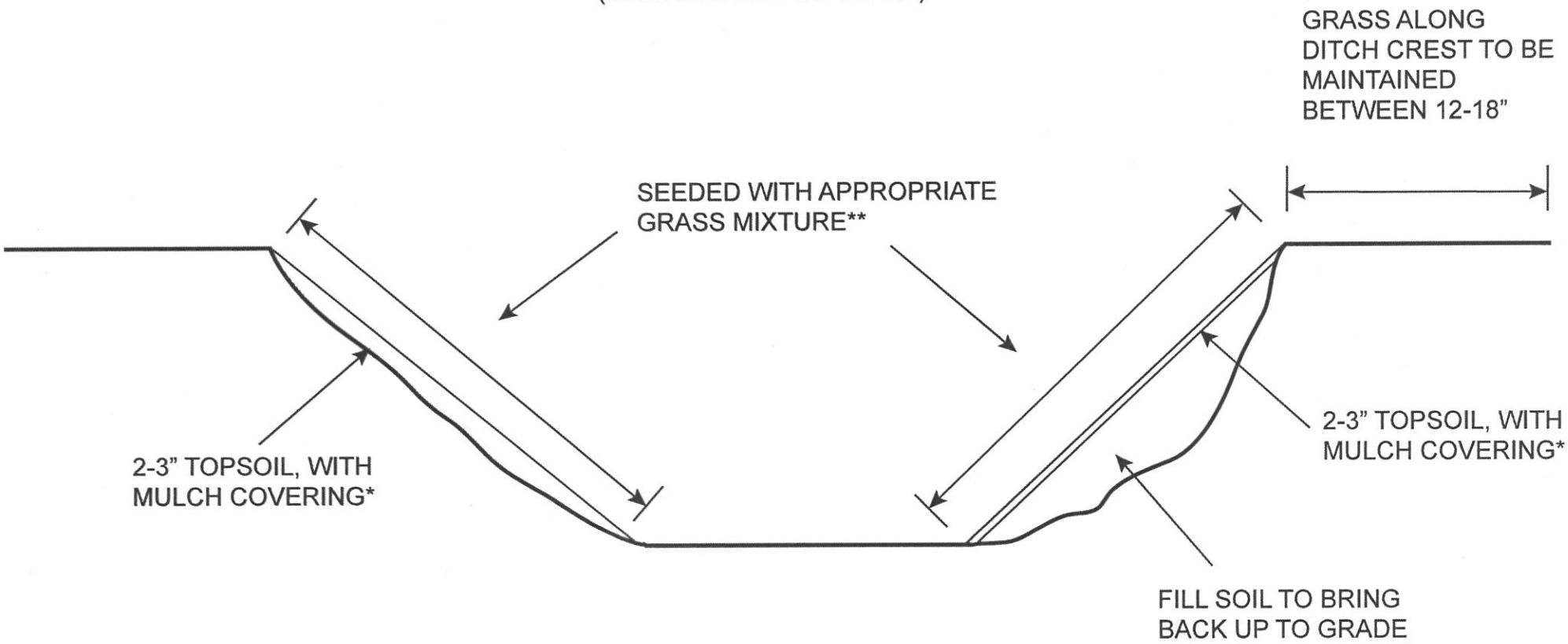


* Top of wood level spreader shall not be more than 1" above inlet invert. Shall be constructed of treated 2 x 8, if necessary held in place by supporting 4 x 4 or 2 x 4 or rip rap brace.

** Top of first check dam shall not be above the invert inlet. Check dams should be constructed of graded rip rap, river rock, or equivalent.

PROFILE VIEW OF LOWER DRAINAGE DITCH (SITE 2)

(DRAWING NOT TO SCALE)



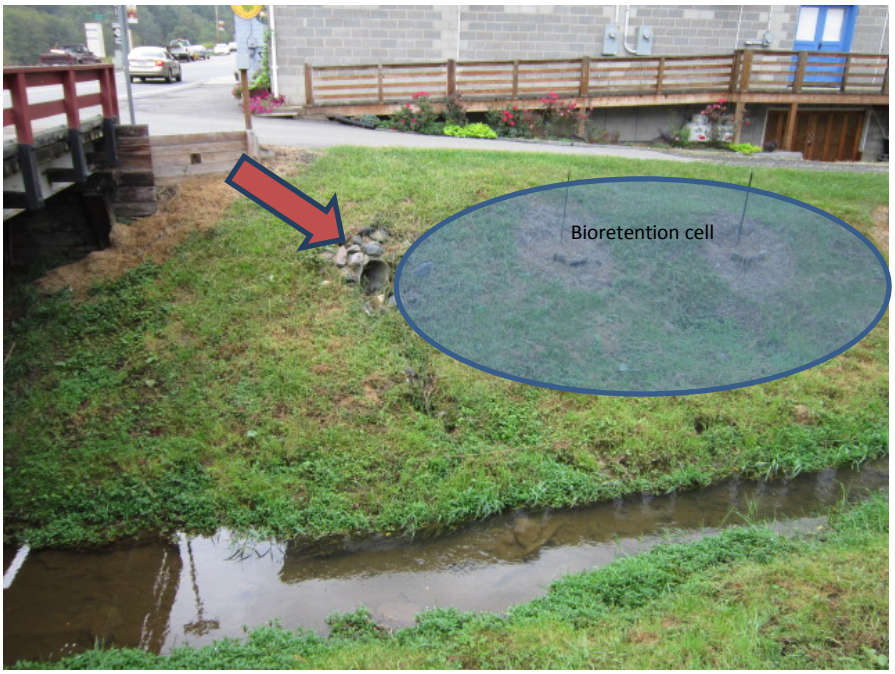
*If an erosion blanket is recommended by the landscaper, one should be used and placed over top of mulch to prevent erosion during vegetative establishment.
**Reed canary grass or kentucky bluegrass are good seeding mixtures. Landscaper may be helpful in recommending other aesthetic and appropriate alternatives.

High Country Council of Governments
Regional Stormwater Project

Town of Lansing

Bridge at Old Field Branch

Problem



Runoff from the street is piped directly into the receiving stream. The runoff from the pavement introduces oils and grease, hydrocarbons, metals, and road salt to the stream.

Drainage area = 0.12 acre
Impervious surface = 0.11; 94%

Affected stream = Old Field Branch
Stream classification = C, Tr, HQW

BMP solution

A bioretention cell will be installed at the discharge point to capture and filter the runoff. The inclusion of appropriate plants will enhance its filtering capacity while maintaining the manicured appearance of the site. The slope and width of the area available will limit the size of the bioretention cell.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will lessen erosion downstream that often results from higher stream volumes.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	4	1	3
COD	62	U	U
TSS	160	10	150
LEAD	0	U	U
COPPER	0	U	U
ZINC	0	U	U
TDS	428	U	U
TN	1	U	U
TKN	1	U	U
DP	0	U	U
TP	0	0	0
CADMIUM	0	U	U

Cost estimate[2]

Construction	$2,794
Design & engineering	500
	$3,294

Funding

North Carolina Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Project Program

North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

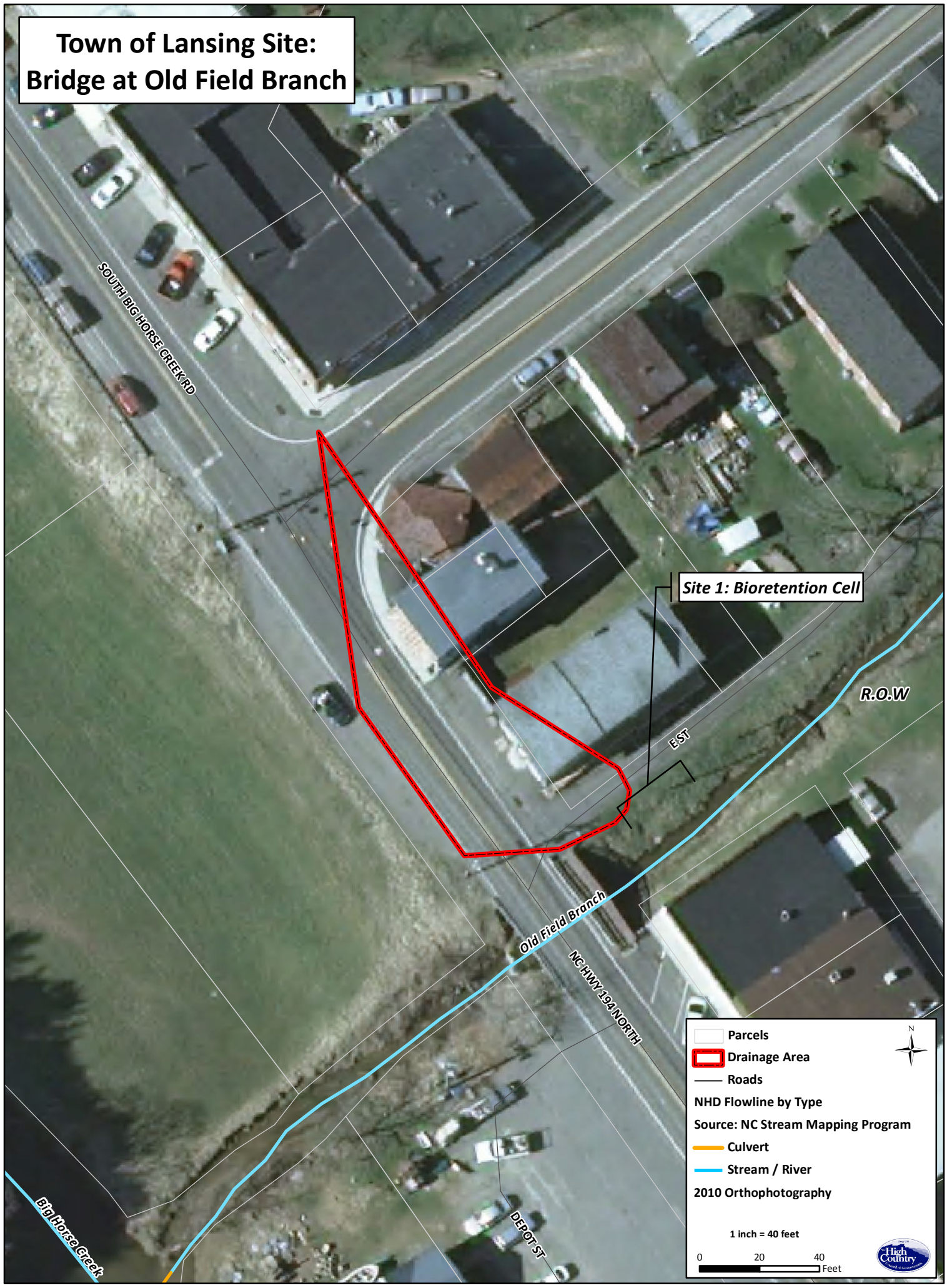
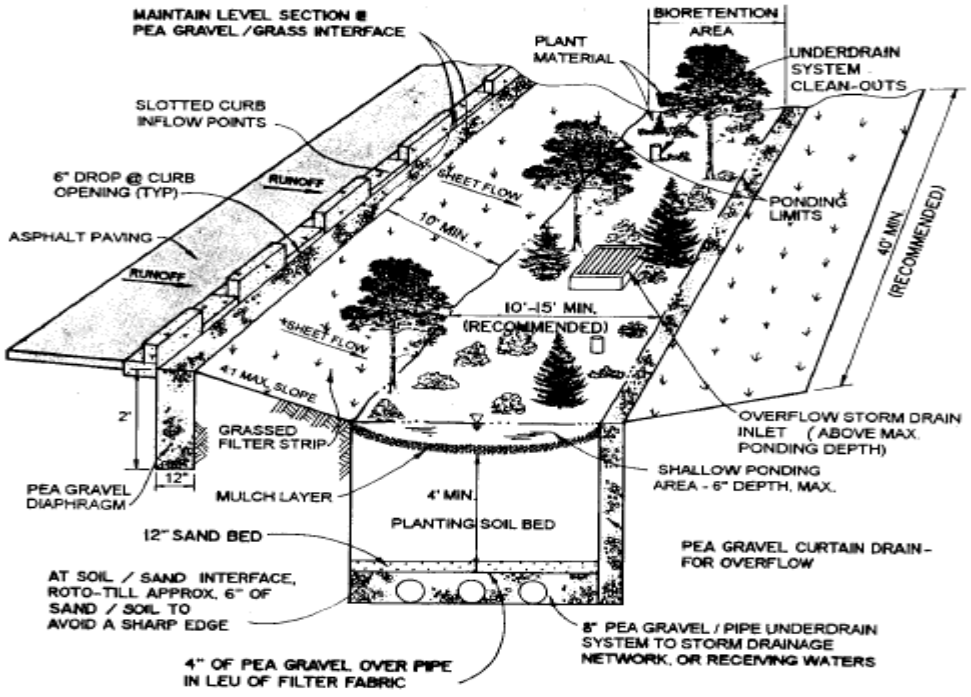

Town of Lansing Site:
Bridge at Old Field Branch
SOUTH BIG HORSE CREEK RD
Site 1: Bioretention Cell
R.O.W
E ST
Old Field Branch
NC HWY 194 NORTH
Big Horse Creek
DEPOT ST
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 40 feet
0
20
40
Feet
N

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of West Jefferson

Bowie-Seagraves Park

Problem

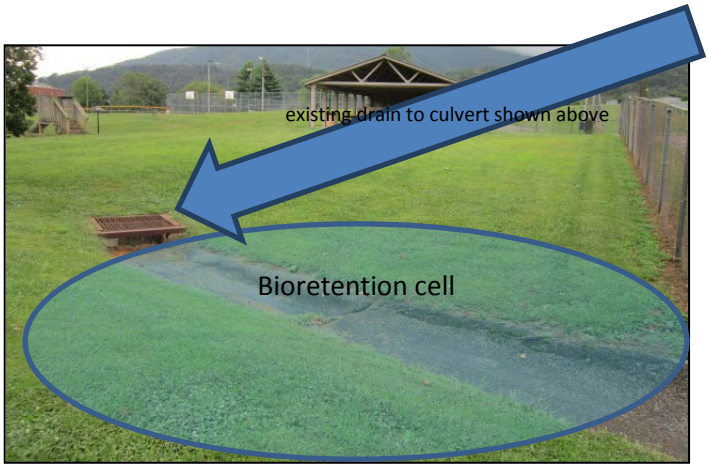
A stream flows under the parking lot via a culvert and discharges into the park. Runoff from the parking lot and street is channeled and drained to the stream prior to its flow out of the culvert. Because the runoff adds considerable volume to the stream, it is contributing to streambank erosion in the park.

Drainage area = 6.47 acres
Impervious surfaces = 2.05 acres; 32%

Affected stream = unnamed tributary to Little Buffalo Creek
Stream classification = C, Tr +

BMP solution

A bioretention cell will be installed where the paved channel is located, with the existing drain used to capture overflow from extreme rain events. Bioretention with appropriate plants and landscaping is the best solution due to the need to maintain the park environment. With interpretive signage the BMP will also serve an educational purpose.



Water quality benefits

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. A lower stream volume during heavy rains will help reduce the amount of streambank erosion and sedimentation now occurring.

bioretention[1]	Load before BMP (lbs/yr)		Load after BMP (lbs/yr)		Load Reduction (lbs/yr)
BOD	194		96		98
COD	3,351		2,011		1,341
TSS	8,605		2,323		6,282
LEAD	10		6		5
COPPER	2		U		U
ZINC	12		5		7
TDS	23,066		U		U
TN	50		30		20
TKN	71		U		U
DP	1		U		U
TP	7		4		3
CADMIUM	0		U		U

Cost estimate[2]

Construction	$40,795
Design & engineering	2,039
	$42,834

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Project Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

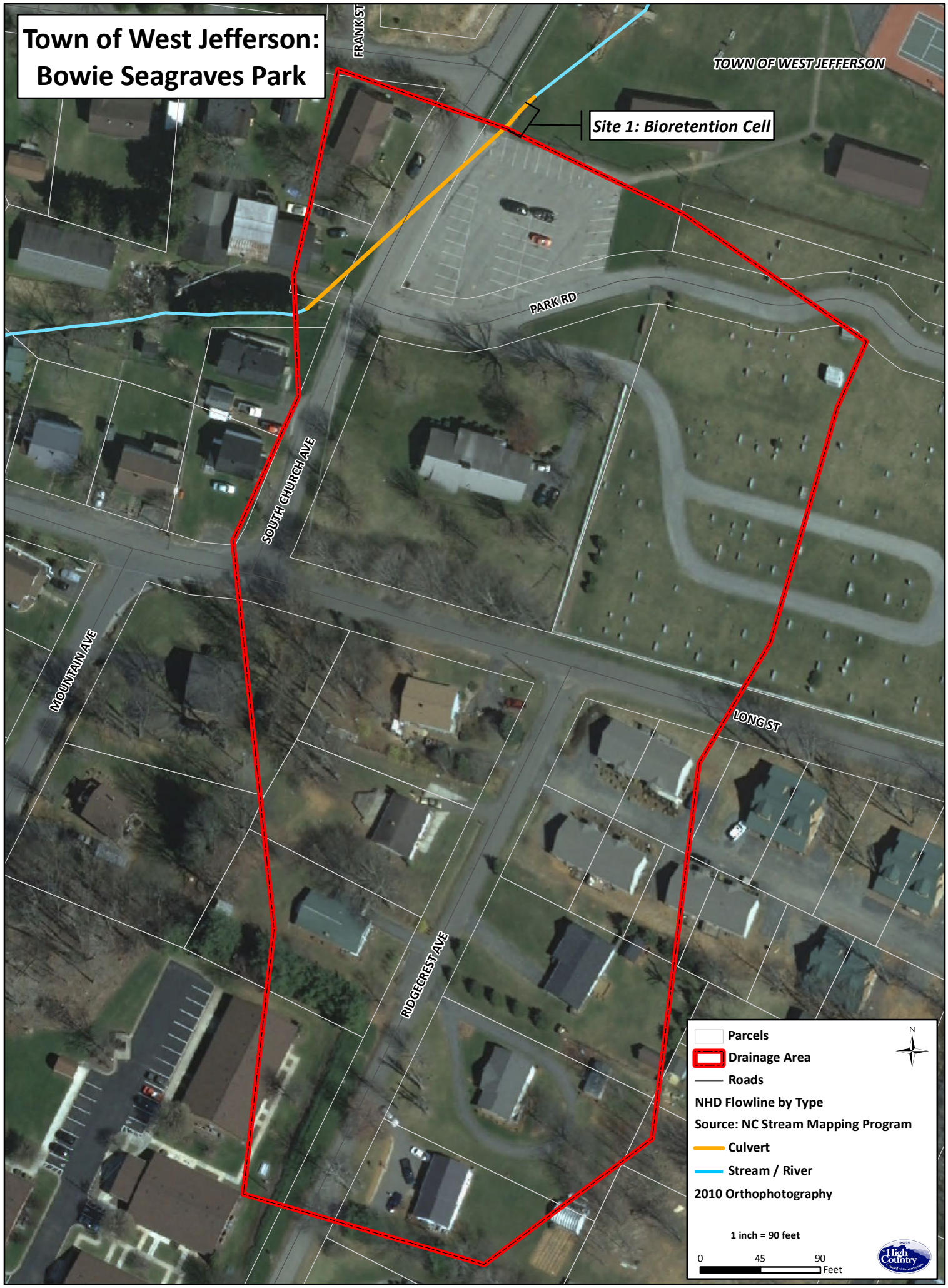
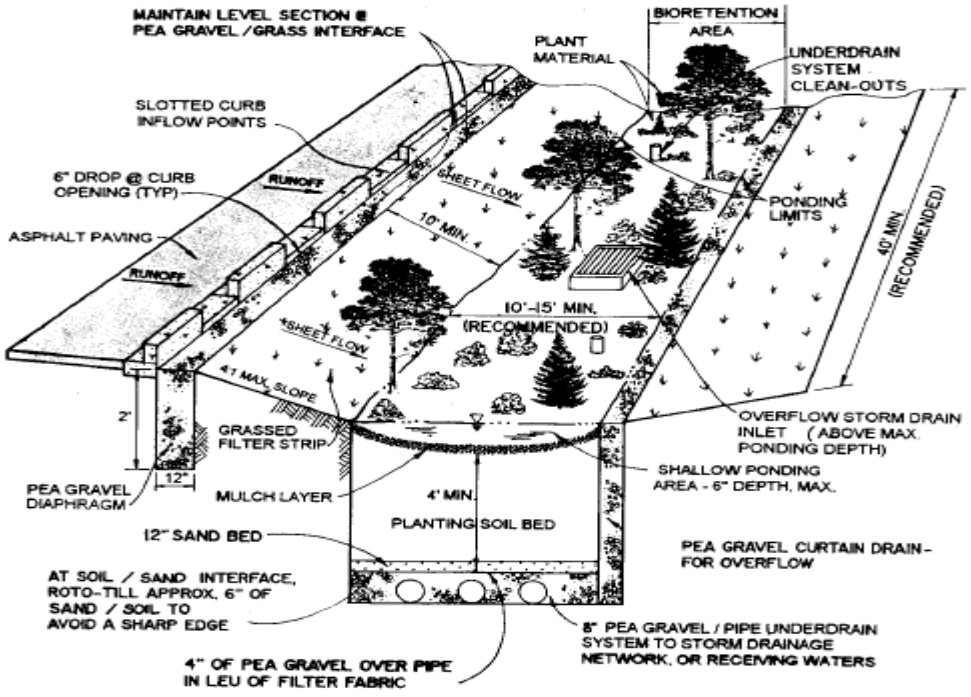

Town of West Jefferson:
Bowie Seagraves Park
FRANK ST
TOWN OF WEST JEFFERSON
Site 1: Bioretention Cell
PARK RD
SOUTH CHURCH AVE
MOUNTAIN AVE
LONG ST
RIDGECREST AVE
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
N
1 inch = 90 feet
0
45
90
Feet

Diagram and photograph of a typical bioretention cell:

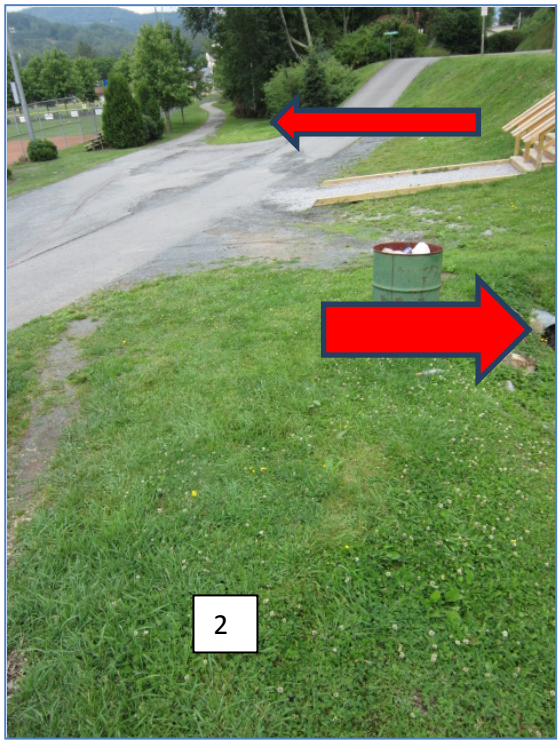


High Country Council of Governments
Regional Stormwater Project

Avery County

Banner Cabinets/Avery County Ballfield

Problem

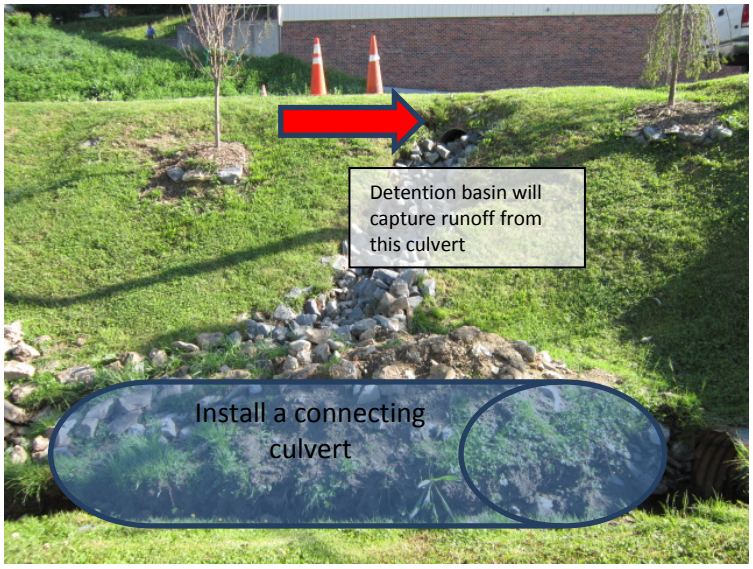


The culvert on the right in Photo 1 carries a small stream and also captures runoff from the road. The culvert on the left drains the area around a cabinet manufacturer. Both culverts flow into a single culvert shown on the right in Photo 2, which then transports the stream and storm runoff to the edge of the wooded area in the background (other end shown in Photo 3). Surface runoff from pavement and surrounding structures contributes to stormflow in the same area. (3) The stream/runoff flows on the surface parallel to the walking trail and enters a drain pipe (Photo 4). The pipe cannot handle the storm flow, and is clogged with sediment.

The water that is able to enter the pipe empties into the creek, contributing to flooding in this area. (Photo 5)

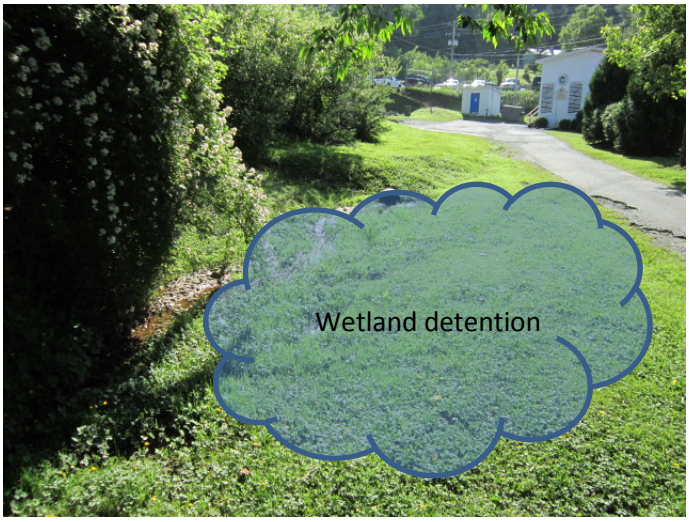
Drainage area = 26.27 acres
Impervious surface = 4.92 acres

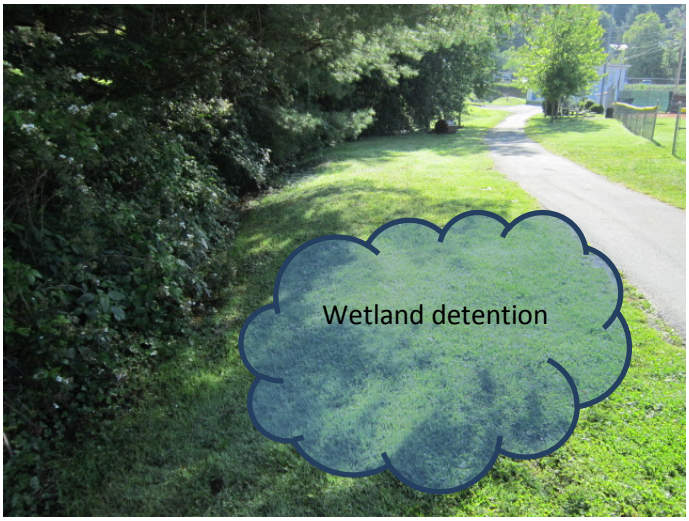
Affected stream = unnamed tributary to North Toe River
Stream classification = WS-V, Tr



BMP solution

The area in Photo 1 has already been modified into a basin-like structure to capture and direct the stormwater. The site will be further modified into a functioning stormwater detention basin to store and treat the runoff from the higher culvert. This will reduce the runoff into the stream, gradually release it, or eliminate it totally. The two lower culverts will be connected in order to carry the streamflow and runoff to the area in Photo 3 without interfering with the proposed detention basin.





The current route of the stream/runoff parallels an open grassy area where the topography is conducive to the construction of connecting wetland detention cells appropriate to the character of the park. The stormwater will spread over a larger area with the capacity to store a significant amount of water, and pollutants will be filtered as the water slowly discharges from the cell.

Dry detention basin	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	120	88	32
COD	690	552	138
TSS	3,240	1,377	1,863
LEAD	4	2	2
COPPER	1	U	U
ZINC	4	3	1
TDS	3,390	U	U
TN	36	25	11
TKN	12	U	U
DP	2	U	U
TP	4	3	1
CADMIUM	0	U	U

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the larger creek. Sediment will be captured as well. Reduction or elimination of the stormwater volume entering the creek will mitigate flooding at the confluence and downstream; thus lessening erosion that often results from higher stream volumes.

Wetland detention	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	289	211	78
COD	1,865	1,492	373
TSS	4,046	1,719	2,326
LEAD	3	2	2
COPPER	1	U	U
ZINC	12	9	2
TDS	5,727	U	U
TN	81	57	24
TKN	42	U	U
DP	3	U	U
TP	11	8	3
CADMIUM	0	U	U

Cost estimate[2]

Dry detention basin	$11,400	construction
	570	engineering
	$11,970	
Wetland detention	$14,268	construction
	1,000	engineering
	$15,268	
TOTAL PROJECT COST	**$27,238**	

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

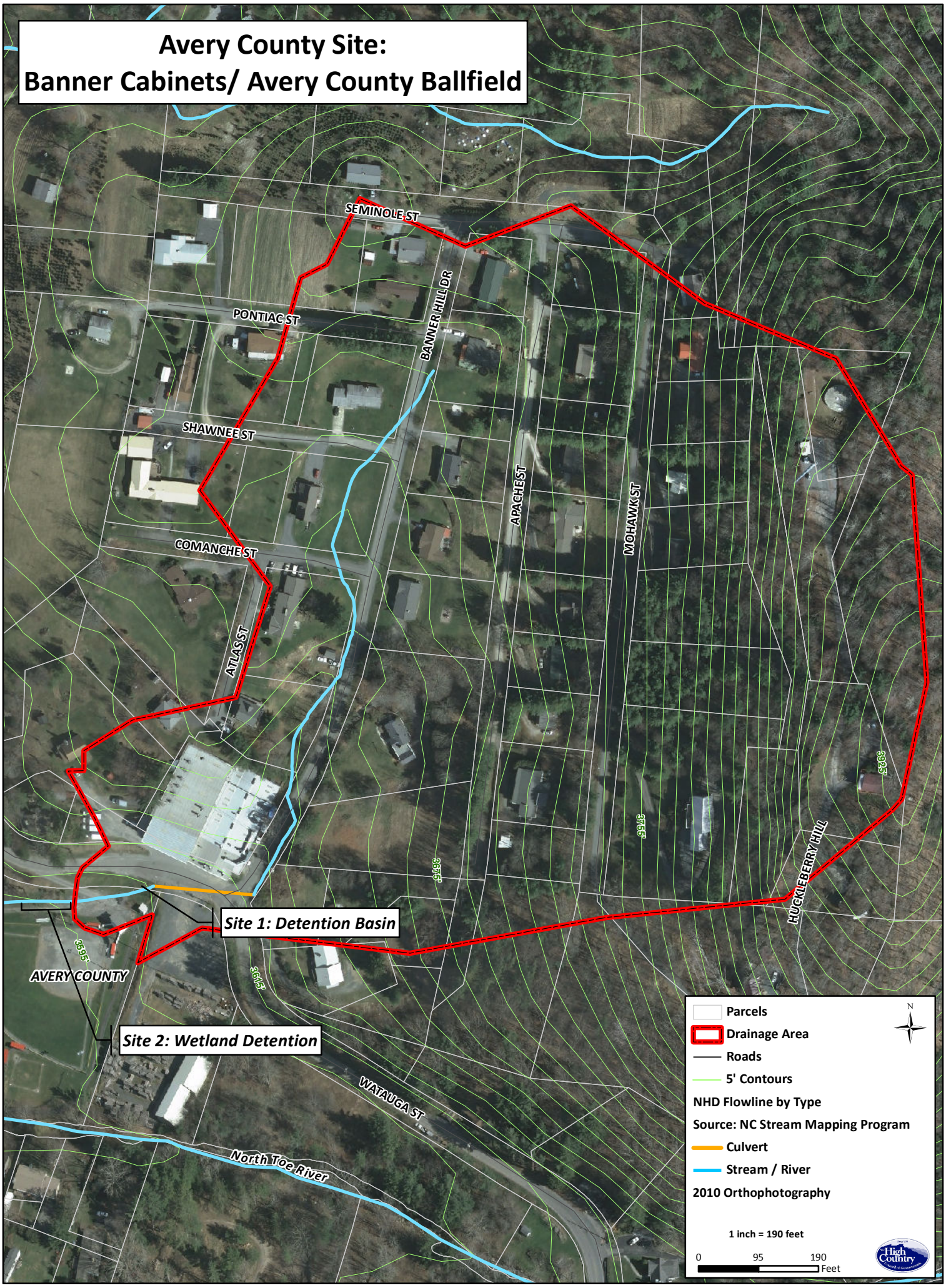

Avery County Site:
Banner Cabinets/ Avery County Ballfield
SEMINOLE ST
PONTIAC ST
BANNER HILL DR
SHAWNEE ST
APACHE ST
MOHAWK ST
COMANCHE ST
ATLAS ST
HUCKLEBERRY HILL
Site 1: Detention Basin
AVERY COUNTY
Site 2: Wetland Detention
WATAUGA ST
North Toe River
Parcels
Drainage Area
Roads
5' Contours
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 190 feet
0
95
190
Feet
N

Diagram and photograph of a typical detention basin:

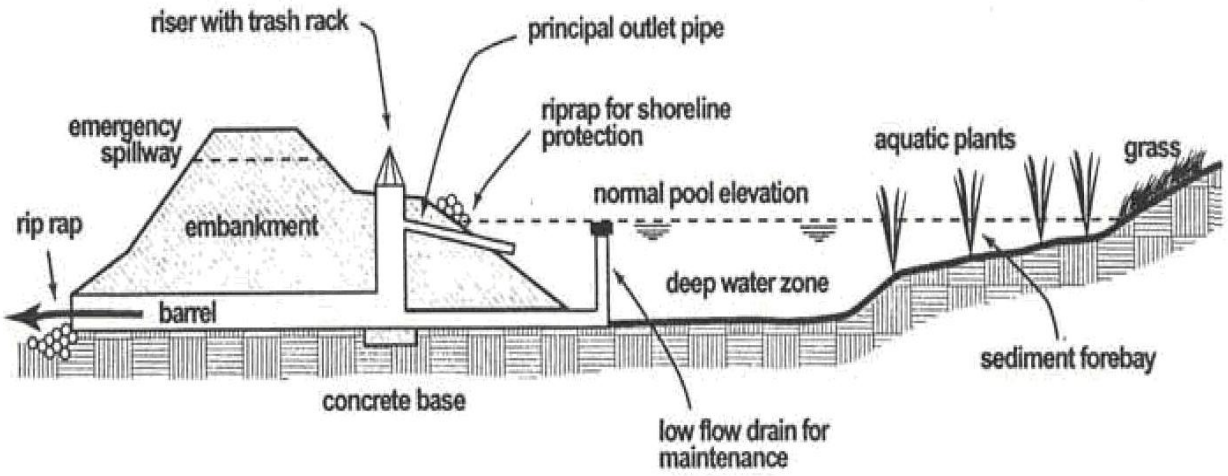
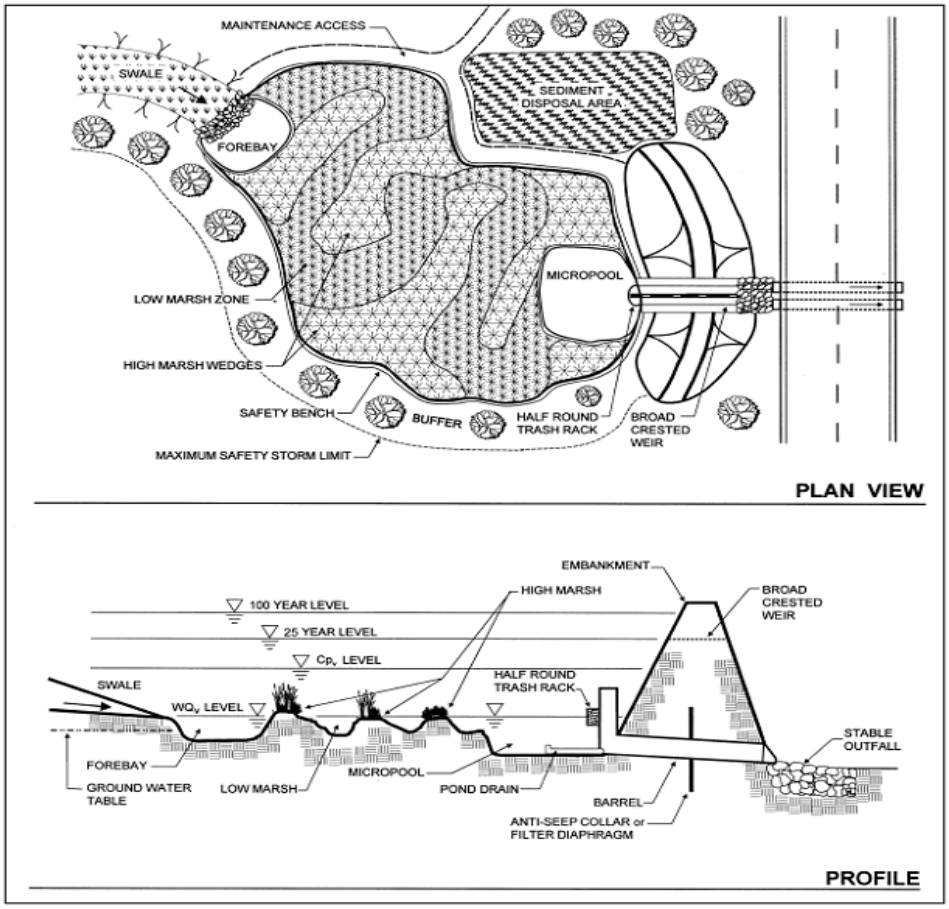


Diagram and photograph of a typical stormwater wetland:



High Country Council of Governments
Regional Stormwater Project

Town of Banner Elk

Tate Evans Park

Problem

Runoff from parking lots & drives is piped directly into Shawneehaw Creek. The creek was the focus of a major stream restoration effort and is a central feature of the Town park. The park is heavily used for active recreation, including the creek. The runoff from the paved surfaces introduces oils and grease, hydrocarbons, metals, and road salt to the stream, and can increase water temperature.

Drainage area = 0.92 acre
Impervious surface = 0.83 acre

Affected stream = Shawneehaw Creek
Stream classification = C, Tr

BMP solution

Because the park is heavily used, an expansive BMP is not feasible. The lack of space can be mitigated by developing a linear BMP bordering the creek; in effect, a relatively shallow and narrow bioretention cell that will dissipate and absorb the flow over several linear feet as opposed to one that is conventionally deep and wide. The existing culvert (red arrow) will be sheared back a few feet to obtain an angle where runoff can flow into the proposed BMP (blue arrows). A flowsplitter will be installed to direct stormwater into the BMP while allowing extremely excessive flows to spill over into the former channel.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Reduction or elimination of the stormwater volume entering the creek will lessen erosion downstream associated with higher stream volumes.

Bioretention cell	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	33	12	21
COD	570	285	285
TSS	1,463	329	1,134
LEAD	2	1	1
COPPER	0	U	U
ZINC	2	1	1
TDS	3,922	U	U
TN	8	7	2
TKN	12	U	U
DP	0	U	U
TP	1	1	1
CADMIUM	0	U	U

Cost estimate[2]

Bioretention cell & flowsplitter	$19,304
Design & engineering	7,721
	$27,025

Funding

NC Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Program

North Carolina Division of Water Resources Development Project Grant Program

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[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

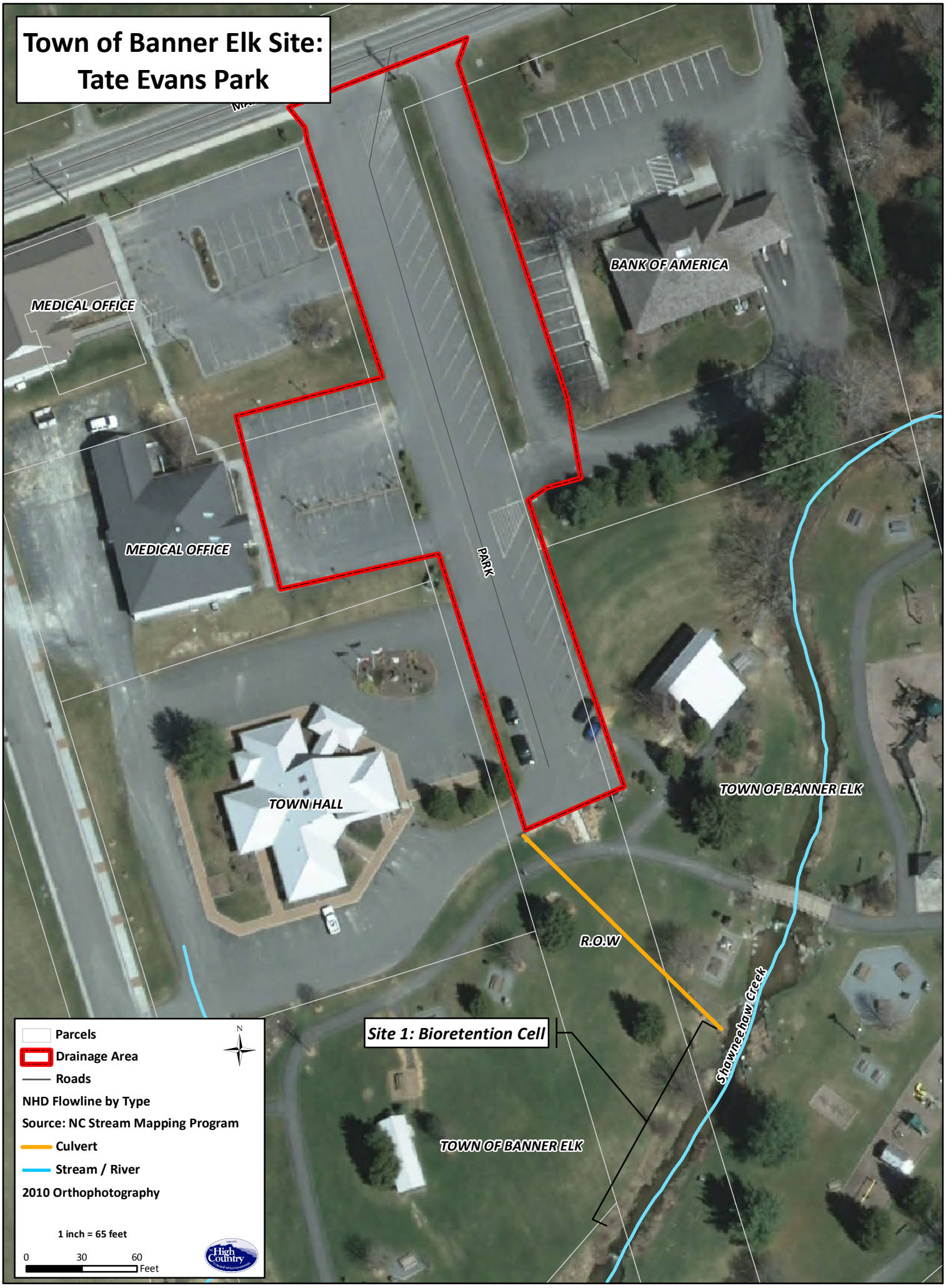
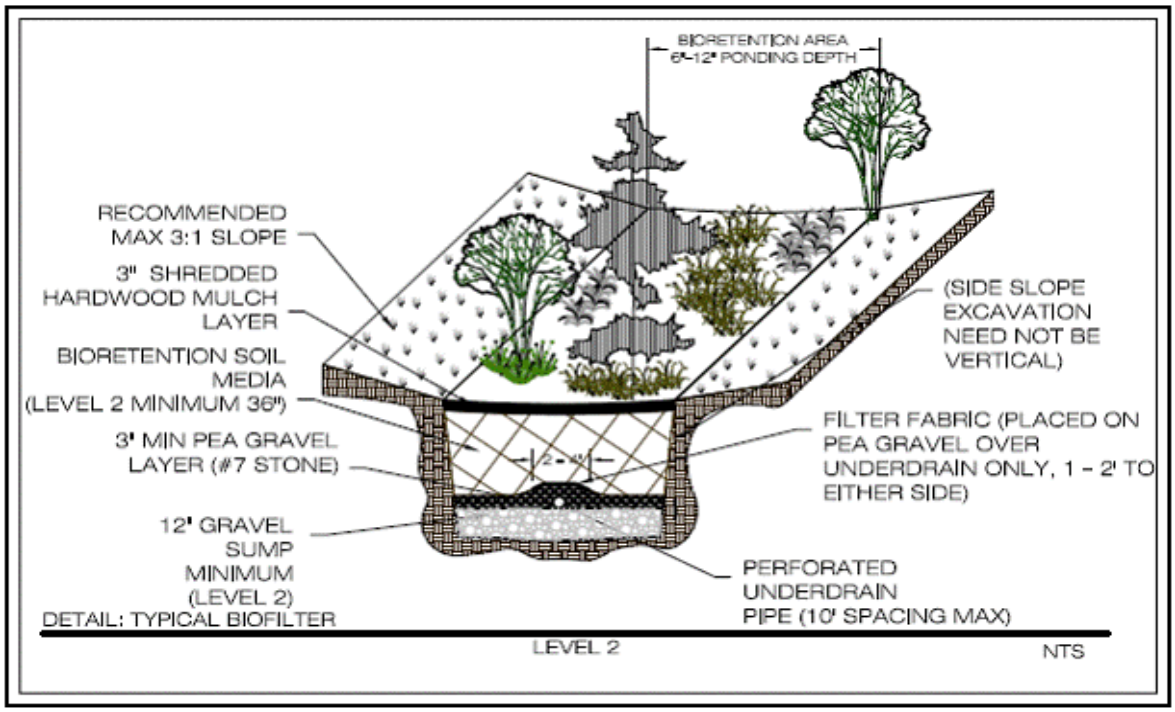

Town of Banner Elk Site:
Tate Evans Park
MEDICAL OFFICE
BANK OF AMERICA
MEDICAL OFFICE
PARK
TOWN HALL
TOWN OF BANNER ELK
R.O.W
Site 1: Bioretention Cell
Shawneehaw Creek
TOWN OF BANNER ELK
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
N
1 inch = 65 feet
0
30
60
Feet

Diagram and photograph of a typical linear bioretention cell:



Town Center/Crossnore School

Problem

Runoff from one of the Crossnore School parking lot flows to a drain near Town Hall where it is directed into a stream.

Drainage area = 0.36 acre
Impervious surface = 0.15 acre; 41%
Affected stream = unnamed tributary to Crossnore Creek
Stream classification = C

BMP solution

The landscaped area will be expanded slightly (with no loss of parking space) and converted into a bioretention area. The site will be landscaped in a similar fashion, but the soil will be replaced with materials and a soil mix that will retain greater quantities of runoff. The addition of appropriate plants will enhance its filtering and retention capacity. A grade-level road drain will direct flow into the biorention area.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots will be prevented from entering the stream. Elimination of the stormwater volume from the creek will help lessen erosion downstream that often results from higher stream volumes. The bioretention cell will also help filter road salts and reduce water temperature spikes.

Bioretention cell	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	11	2	9
COD	186	U	U
TSS	479	29	450
LEAD	1	U	U
COPPER	0	U	U
ZINC	1	U	U
TDS	1,283	U	U
TN	3	U	U
TKN	4	U	U
DP	0	U	U
TP	0	0	0
CADMIUM	0	U	U

Cost estimate[2]

Construction	$3,810
Design & engineering	500
	$4,310

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Project Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

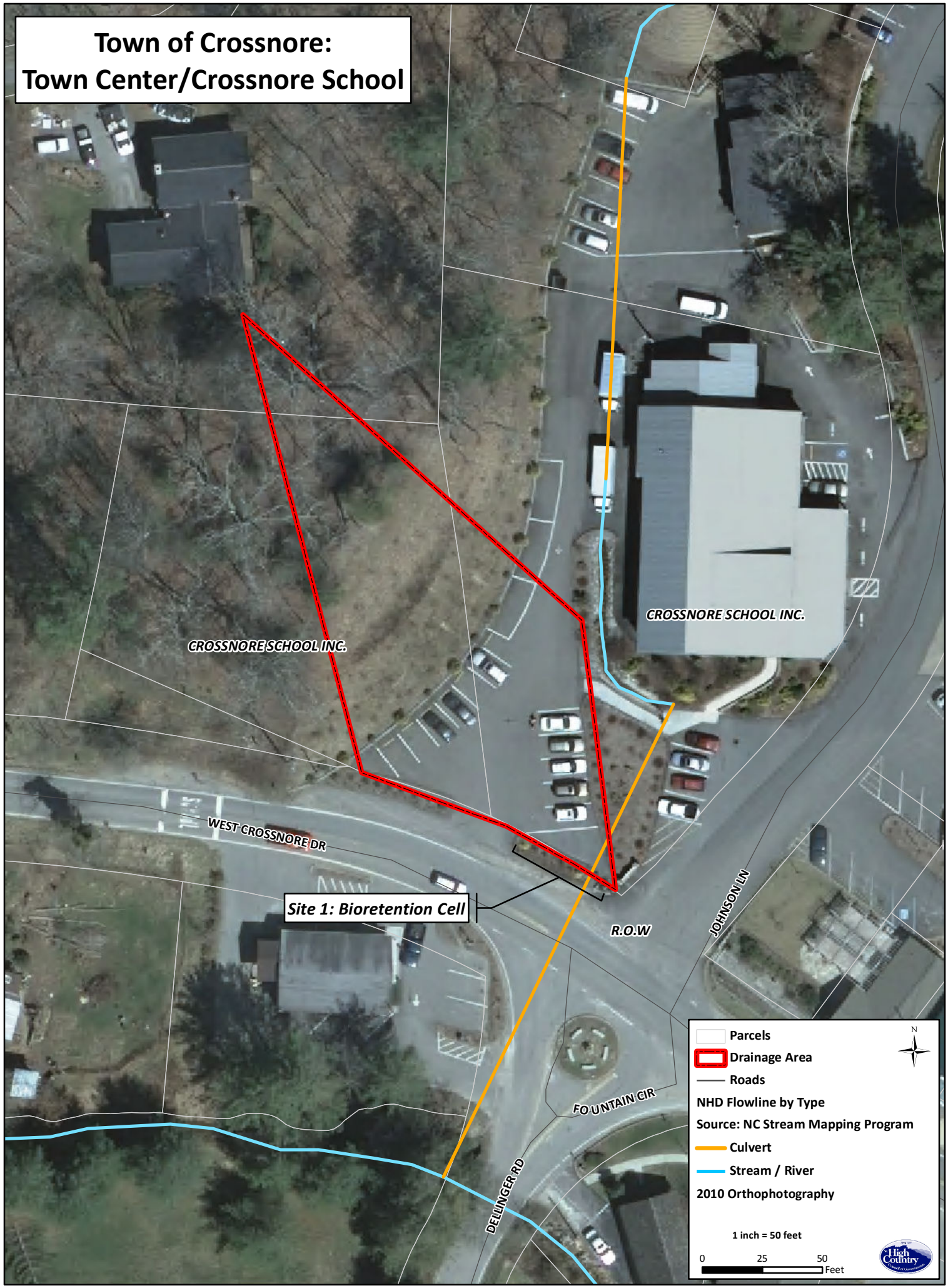
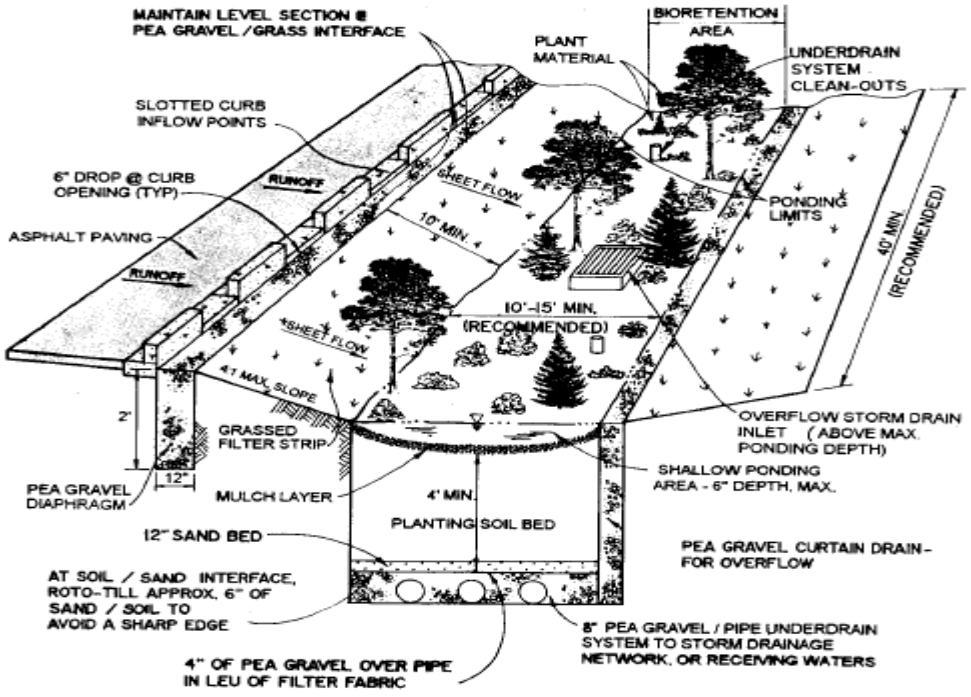

Town of Crossnore:
Town Center/Crossnore School
CROSSNORE SCHOOL INC.
CROSSNORE SCHOOL INC.
WEST CROSSNORE DR
Site 1: Bioretention Cell
R.O.W
JOHNSON LN
FO UNTAIN CIR
DELLINGER RD
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 50 feet
0
25
50
Feet
N

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of Newland

Old Public Road/North Toe River

Problem

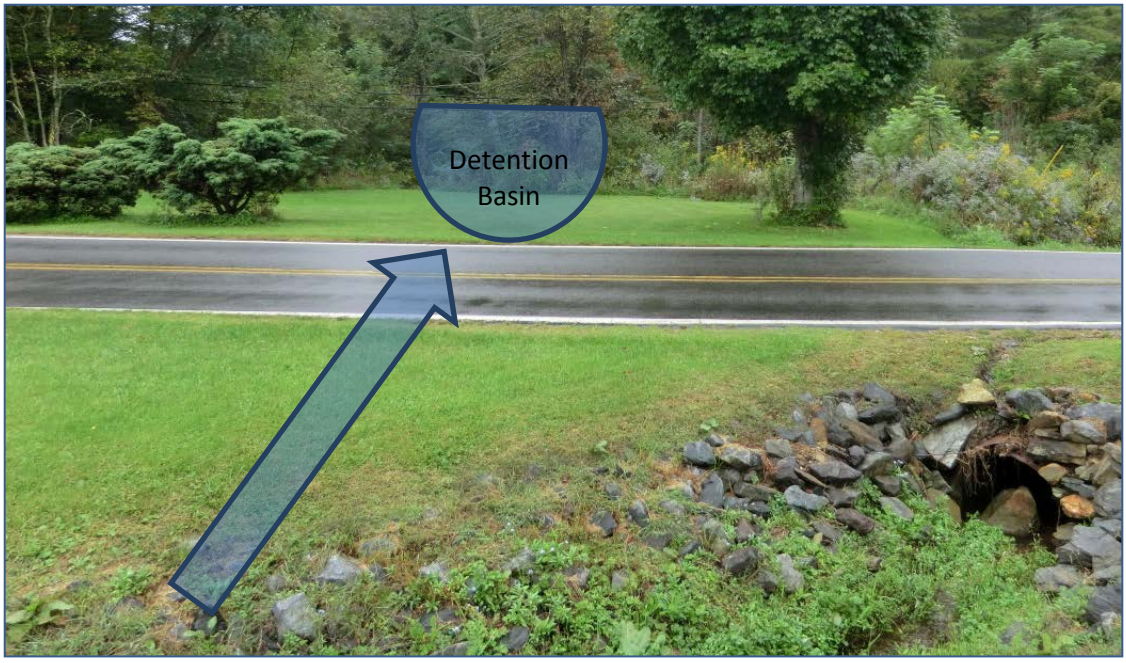
Runoff from an area near the center of town concentrates in this headwater tributary stream to the Toe River, causing flooding problems and contributing pollutants to the streamflow. The drainage area consists of various urban land uses- residential, commercial, streets, and parking.

Drainage area = 76.14 acres
Impervious surface = 18.94 acres; 25%

Affected stream = unnamed tributary to North Toe River
Stream classification = WS-V, Tr

BMP solution

The area in the stream vicinity is heavily developed with little space for a BMP. A parcel of land across the road from the stream is owned by the Town and available for a BMP. A detention basin will be necessary to treat the high volume of stormwater in this drainage area. As indicated by the photo, the base flow of the stream is very low. A weir structure will be installed (blue arrow) on the stream to capture only the stormflow and divert it via a culvert across the road to the proposed detention basin. The detention basin will hold and filter the runoff to remove pollutants.



Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Reduction or elimination of the stormwater volume entering the creek will mitigate erosion associated with higher stream volumes.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	5,711	1,599	4,112
COD	39,593	U	U
TSS	79,186	11,086	68,100
LEAD	69	41	27
COPPER	14	U	U

Cost estimate[2]

Construction	$41,668
Design & engineering	$ 2,083
	$43,751

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Project Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

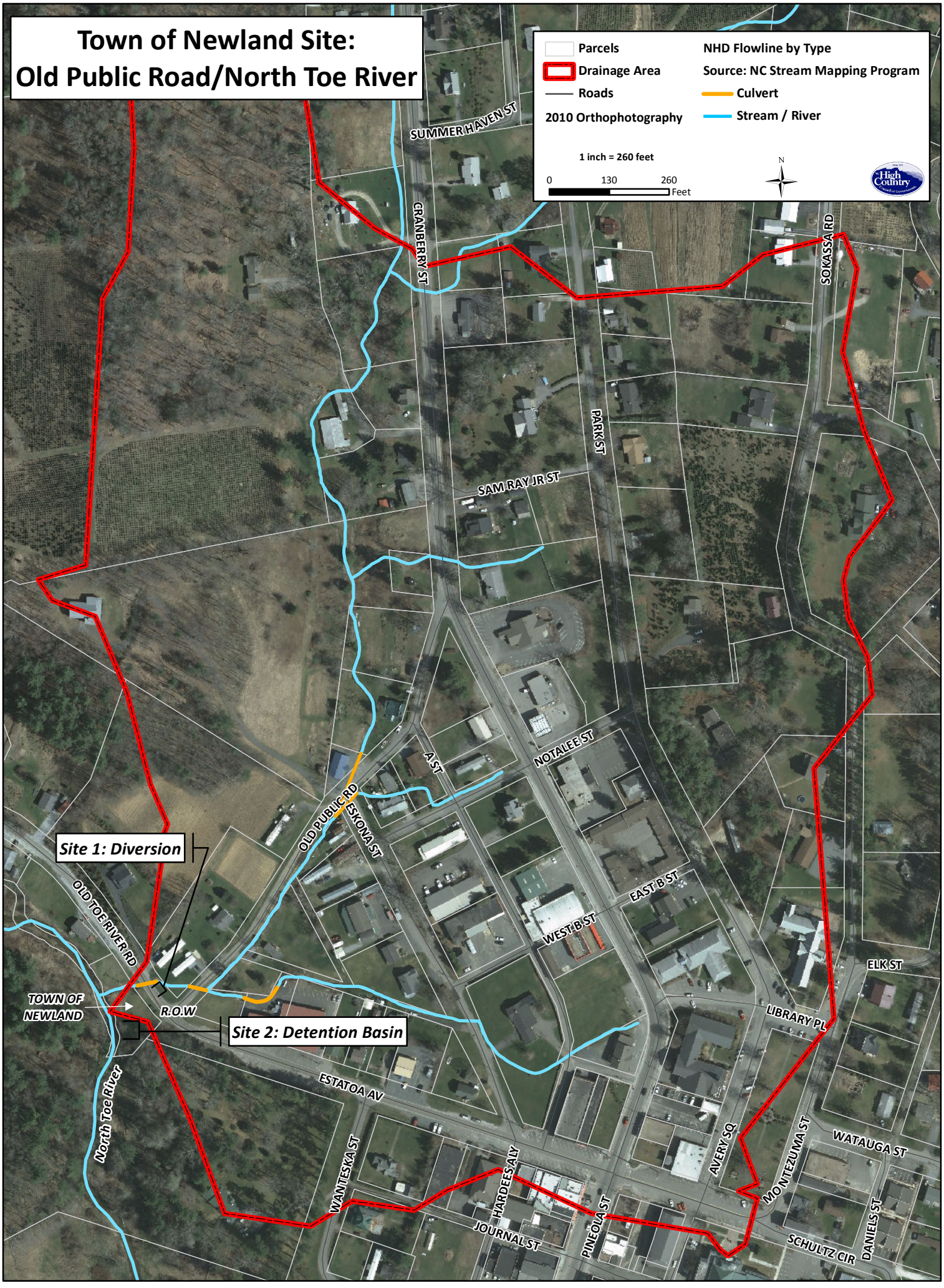
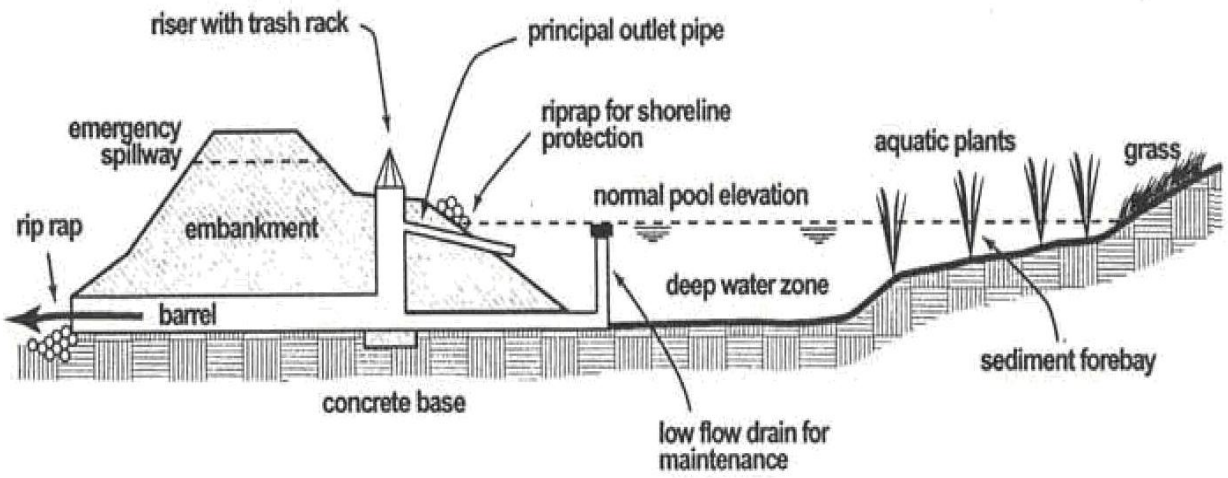

Town of Newland Site:
Old Public Road/North Toe River
Parcels
Drainage Area
Roads
2010 Orthophotography
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
1 inch = 260 feet
0
130
260
Feet
N
SUMMER HAVEN ST
CRANBERRY ST
SOKASSA RD
PARK ST
SAM RAY JR ST
NOTALEE ST
A ST
OLD PUBLIC RD
ESKOWA ST
Site 1: Diversion
OLD TOE RIVER RD
TOWN OF NEWLAND
R.O.W
Site 2: Detention Basin
North Toe River
EAST B ST
WEST B ST
ELK ST
LIBRARY PL
ESTATOA AV
WANTEESKA ST
HARDEES AV
JOURNAL ST
PINEOLA ST
AVERY SQ
MONTEZUMA ST
WATAUGA ST
SCHULTZ CIR
DANIELS ST

Diagram and photograph of a typical detention basin:



High Country Council of Governments
Regional Stormwater Project

Village of Sugar Mountain

Craggy Pointe

Problem

Runoff from a street and parking area (photo above left) is causing severe erosion at several points downhill of the site (photos below and right).

Drainage area = 8.15 acres
Impervious surface = 1.41 acre; 17%

Affected stream = unnamed tributary to West Fork of Linville River
Stream classification = C Tr

BMP solution

A detention basin will be installed near the impervious area to capture, retain, and treat the runoff.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the receiving stream, located approximately 200 feet from the BMP site. Reducing the velocity of the runoff will also reduce erosion and sedimentation.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	42	7	35
COD	730	U	U
TSS	1,875	113	1,763
LEAD	2	U	U
COPPER	0	U	U
ZINC	3	U	U
TDS	5,027	U	U
TN	11	U	U
TKN	16	U	U
DP	0	U	U
TP	2	0	1
CADMIUM	0	U	U

Cost estimate[2]

Construction	$28,000
Design & engineering	$ 1,400
	$29,400

Funding

North Carolina Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Project Program

North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

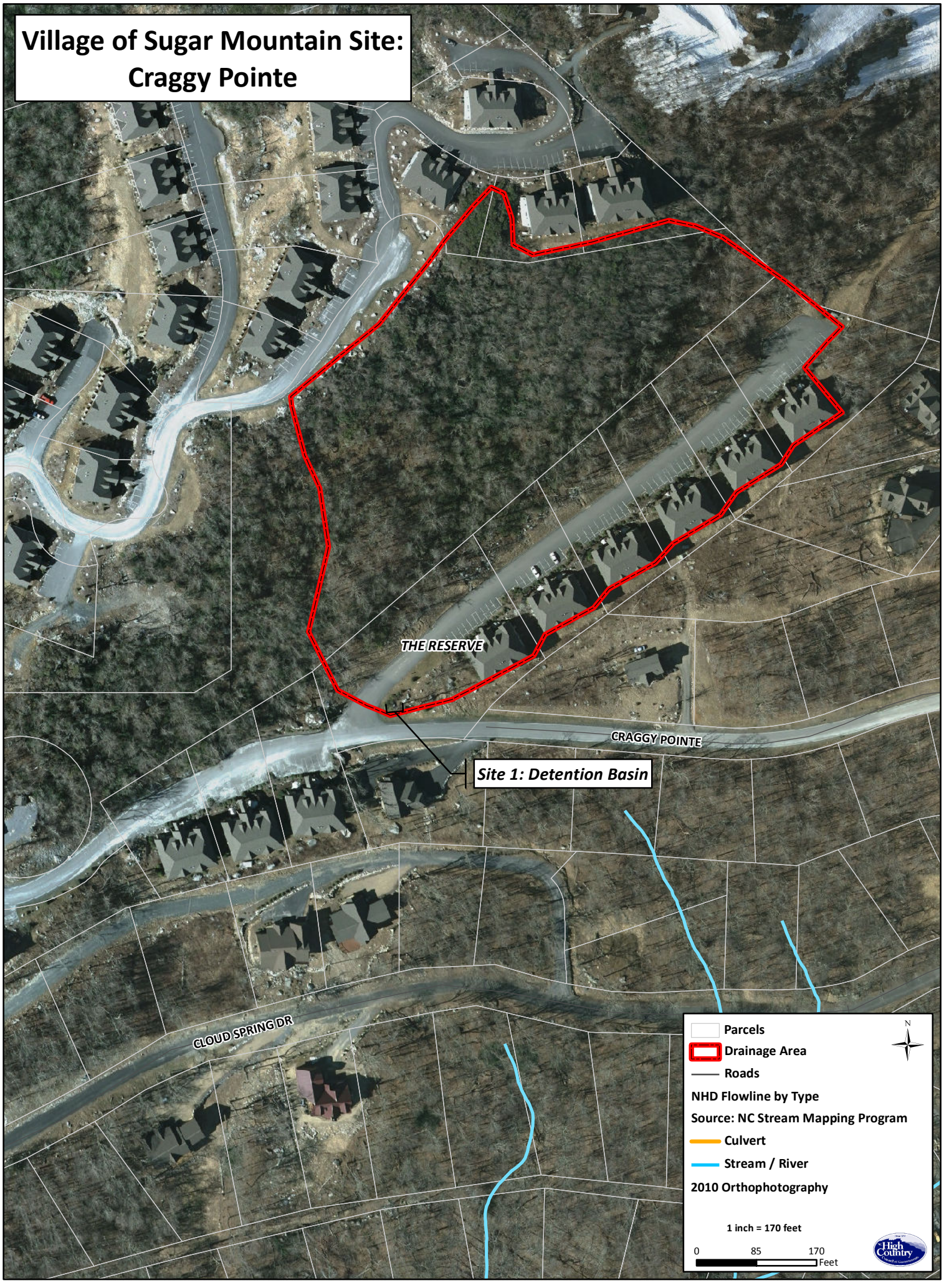
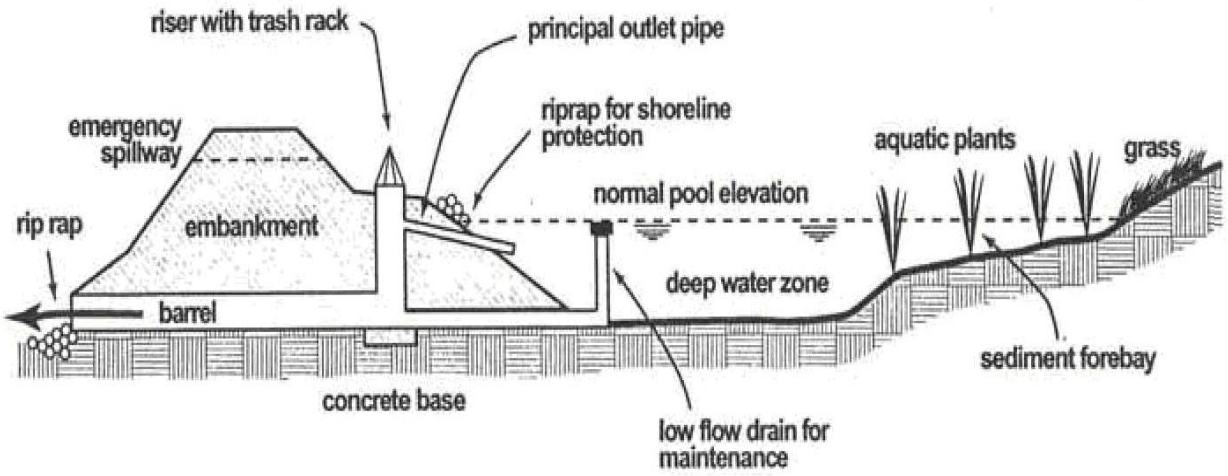

Village of Sugar Mountain Site:
Craggy Pointe
THE RESERVE
CRAGGY POINTE
Site 1: Detention Basin
CLOUD SPRING DR
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 170 feet
0
85
170
Feet
N

Diagram and photograph of a typical detention basin:



High Country Council of Governments
Regional Stormwater Project

Mitchell County

Mitchell County Senior Center

Problem

Several Mitchell County agency buildings occupy a site in the Ledger Community. Runoff from the site and the access road collects in a ditch in front of the Senior Center (brick building in photo) and the Board of Education building, and eventually reaches a creek. Erosion from the runoff is evident in several locations. Some stormflow from the road also reaches the ditch. The runoff from the site introduces oils and grease, hydrocarbons, metals, and road salt to the stream.

Drainage area = 15.64 acres Impervious surface = 5.02 acres; 32%

Affected stream = unnamed tributary to Cranberry Branch

Stream classification = C, Tr

BMP solution

The drainage ditch's existing form will be used to convert it to a bioretention swale, replacing at least some of the soil with materials and a soil mix that will retain greater quantities of runoff. Space is available to widen it to increase its volume. The addition of appropriate plants will also enhance its filtering and retention capacity, and give this BMP a landscaped appearance that is needed at this highly visible location. A series of checkdams will slow the velocity to allow more infiltration.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will lessen erosion downstream that is often associated with higher stream volumes. With erosion no longer an issue, sedimentation from the site will no longer enter the stream.

Vegetated swale	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	469	232	237
COD	8,102	4,861	3,241
TSS	20,801	5,616	15,185
LEAD	25	14	11
COPPER	5	U	U
ZINC	30	12	18
TDS	55,757	U	U
TN	120	72	48
TKN	172	U	U
DP	2	U	U
TP	17	9	8
CADMIUM	0	U	U

Cost estimate[2]

Construction	$91,113
Design & engineering	4,555
	$95,668

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

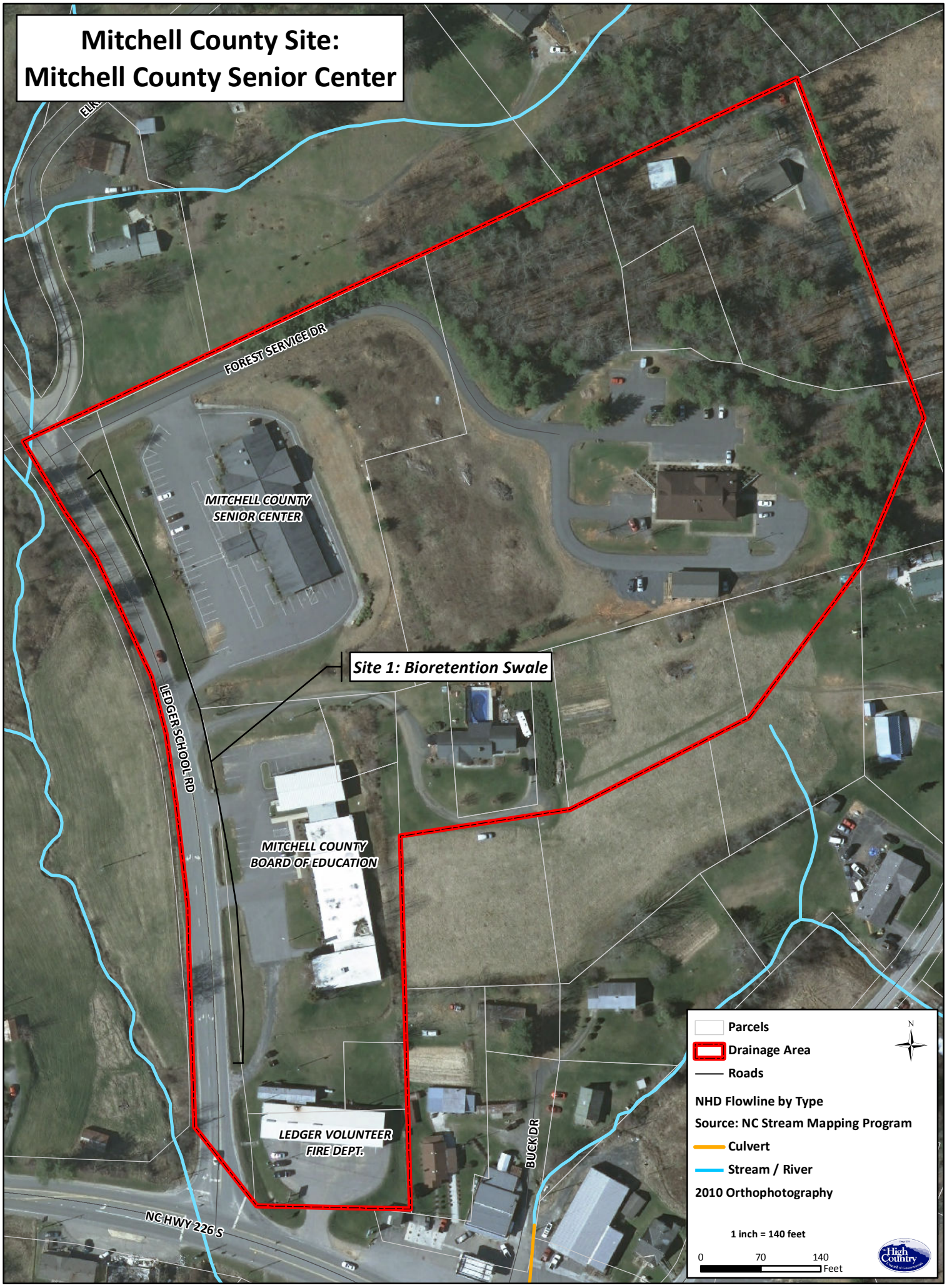
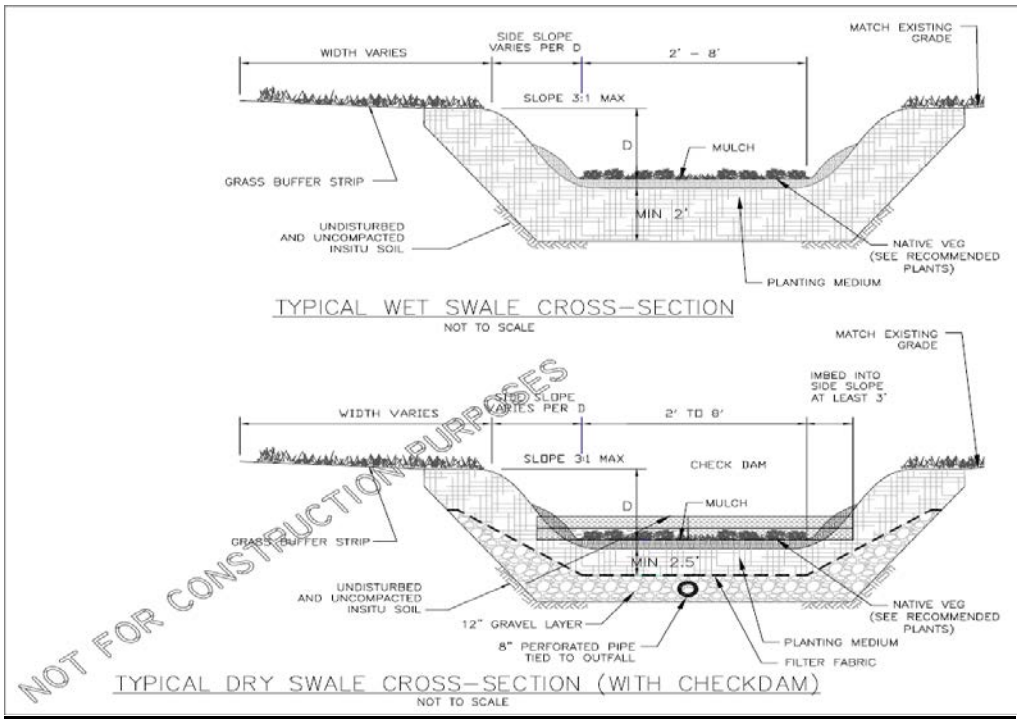

Mitchell County Site:
Mitchell County Senior Center
ELK
FOREST SERVICE DR
MITCHELL COUNTY
SENIOR CENTER
Site 1: Bioretention Swale
LEDGER SCHOOL RD
MITCHELL COUNTY
BOARD OF EDUCATION
LEDGER VOLUNTEER
FIRE DEPT.
BUCK DR
NC HWY 226 S
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
N
1 inch = 140 feet
0
70
140
Feet

Diagram and photograph of a typical swale:



High Country Council of Governments
Regional Stormwater Project

Town of Bakersville

Creekwalk Trailhead

Problem

Runoff from the school campus and adjacent street is piped off-site and drains into the creek. The flattened vegetation indicates that the existing grassy area is insufficient to filter the high volume of stormwater. The runoff from the street, parking lots, and rooftops introduces oils and grease, hydrocarbons, metals, and road salt to the stream.

BMP solution

The site is adjacent to a town park that serves as a trailhead for a walking path. A linear bioretention cell with ornamental plantings will enhance the park environment while achieving the desired water quality objectives.

Drainage area = 6.53 acres
Impervious surface = 2.45 acres; 37%
Affected stream = White Oak Creek
Stream classification = C, Tr

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will lessen erosion downstream that is often associated with higher stream volumes. Temperature fluctuations caused by this site's runoff will be eliminated.

bioretention	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	196	72	123
COD	3,383	1,691	1,691
TSS	8,685	1,954	6,731
LEAD	10	4	7
COPPER	2	U	U
ZINC	12	8	4
TDS	23,279	U	U
TN	50	40	10
TKN	72	U	U
DP	1	U	U
TP	7	4	3
CADMIUM	0	U	U

Cost estimates[2]

Construction	$11,938
Design & engineering	1,193
	$13,131

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

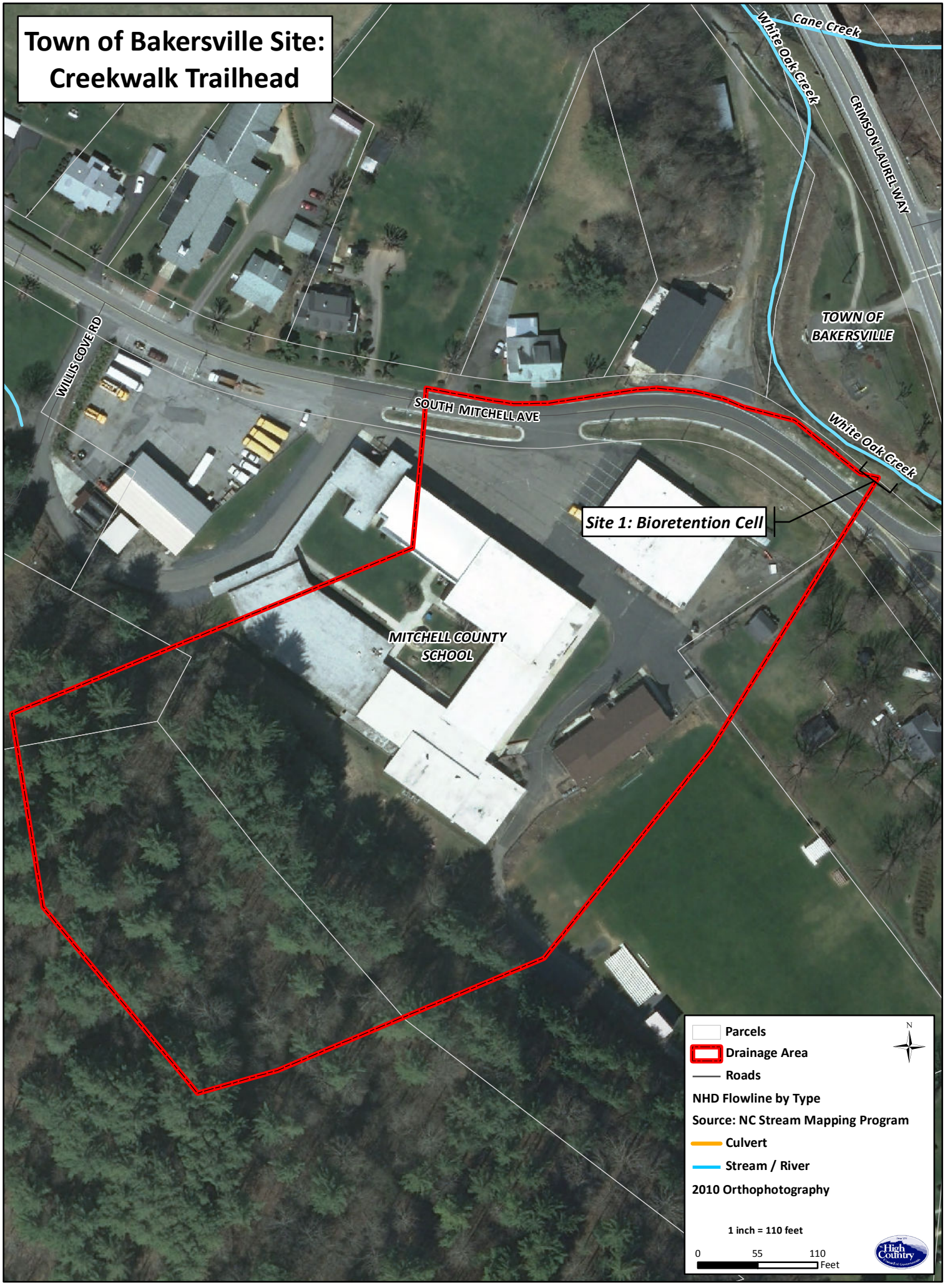
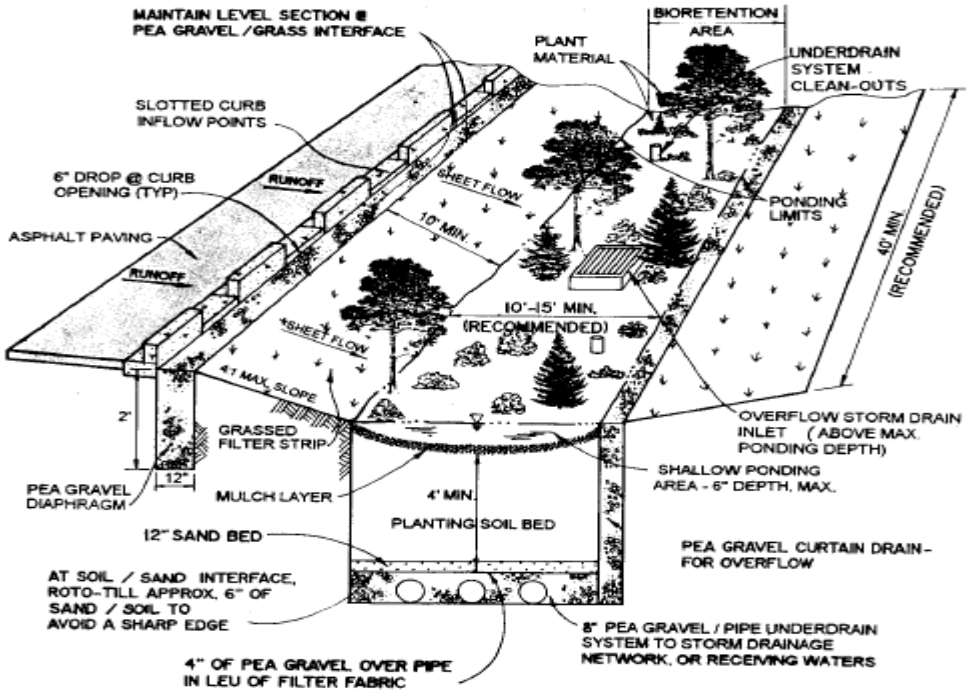

Town of Bakersville Site:
Creekwalk Trailhead
Cane Creek
White Oak Creek
CRIMSON LAUREL WAY
TOWN OF BAKERSVILLE
WILLIS COVE RD
SOUTH MITCHELL AVE
White Oak Creek
Site 1: Bioretention Cell
MITCHELL COUNTY SCHOOL
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 110 feet
0
55
110
Feet
N

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of Bakersville

Hemlock Drive Parking Lot

Problem

Runoff from the parking lot flows off the lot through a 15' grass area and into the creek. While the grass may capture much of the sheetflow, flattened vegetation shows that some stormwater concentrates at specific locations and flows unimpeded into the stream. The runoff from the site introduces oils and grease, hydrocarbons, metals, and road salt to the stream.

Drainage area = 0.5 acre
Impervious surface = 0.46 acre; 92%

Affected stream = Honeycutt Branch
Stream classification = C, Tr

BMP solution

Because the Town desires to maintain a trimmed border, the grassy area will be enhanced with bioretention features that will avoid an overgrown, messy appearance. A portion of the soil will be replaced with appropriate bioretention media. Landscape features, such as ornamental bunch grass, will be planted to capture and filter runoff, with thicker plantings at spots where the runoff tends to concentrate.

Water quality benefits

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will lessen erosion downstream that is often associated with higher stream volumes. Temperature fluctuations caused by this site's runoff will be eliminated.

Vegetated filter strip[1]	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	74	36	37
COD	1,269	761	508
TSS	3,259	880	2,379
LEAD	4	2	2
COPPER	1	U	U
ZINC	5	2	3
TDS	8,734	U	U
TN	19	11	8
TKN	27	U	U
DP	0	U	U
TP	3	1	1
CADMIUM	0	U	U

Cost estimate[2]

Construction	$4,900
Design & engineering	500
	$5,400

Funding

North Carolina Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Program

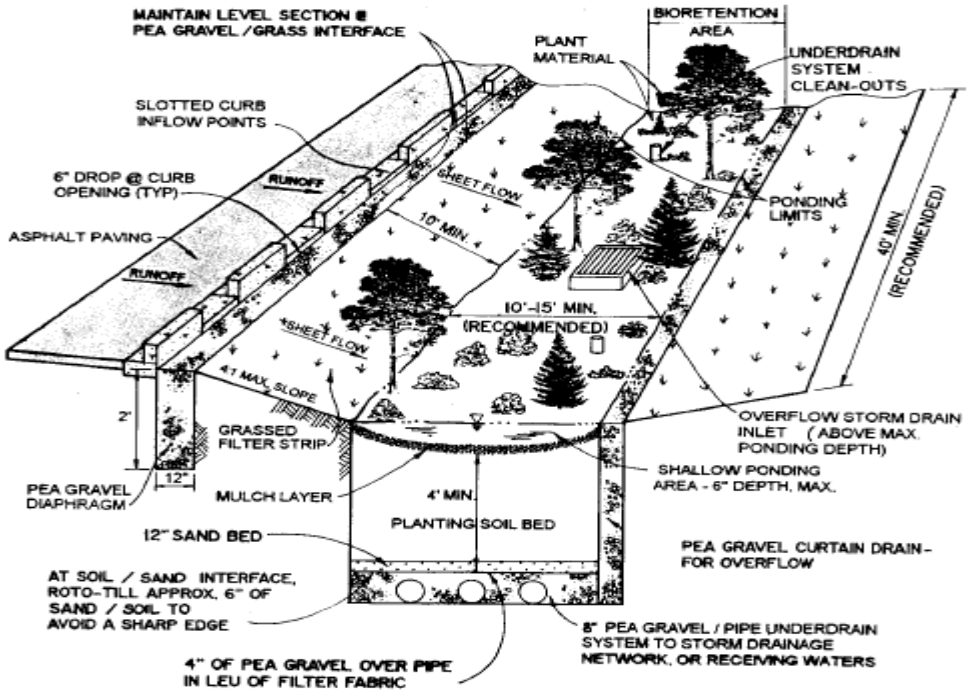
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007


Town of Bakersville Site:
Hemlock Drive Parking Lot
THOMPSON LN
TOWN OF BAKERSVILLE
HEMLOCK DR
TOWN OF BAKERSVILLE
Site 1: Bioretention Features
Honeycut Branch
Honeycut Branch
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 30 feet
0
15
30
Feet
N

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of Spruce Pine

Brad Ragan Park

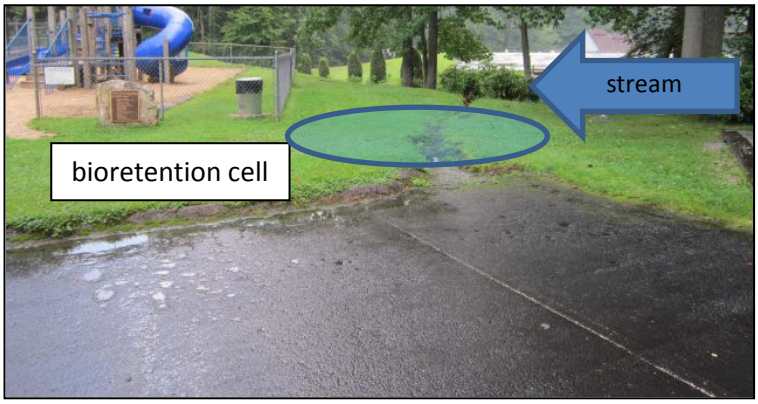
Problem

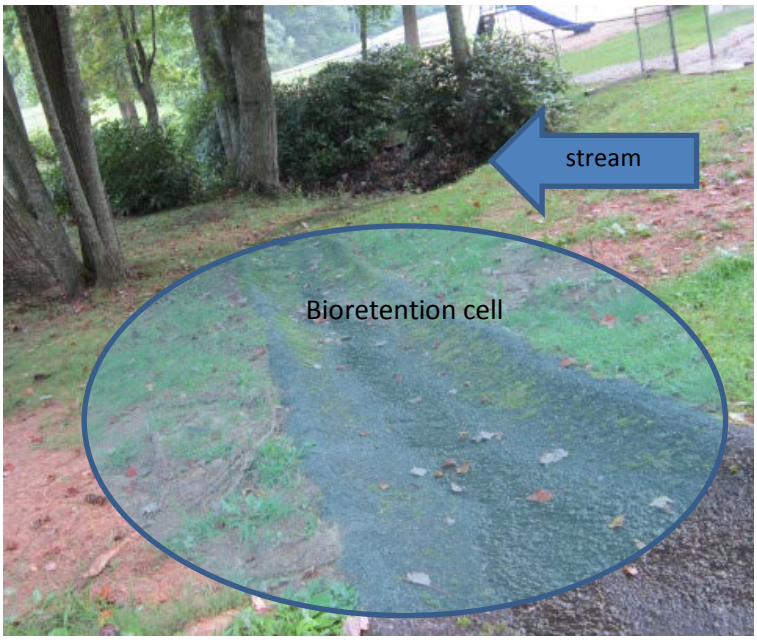
The park contains several areas where runoff from parking lots & roads is diverted directly into a stream. The runoff introduces oils and grease, hydrocarbons, metals, and road salt to the receiving stream.

Drainage area = 1.69 acres
Impervious surfaces = 1.06 acres; 63%
Affected stream = unnamed tributary to English Creek
Stream classification = C, Tr

BMP solution

Four bioretention cells will be installed at separate locations to retain runoff & prevent stormwater from entering streams. Bioretention is the preferred BMP because the park environment will require a treatment that will blend well with the landscape and be unobtrusive to recreation activities. The park is heavily used by school groups and therefore the stormwater treatments will also serve an educational purpose with interpretive signage.





Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will lessen erosion downstream that is often associated with higher stream volumes. Temperature fluctuations caused by this site's runoff will be eliminated.

Bioretention cells	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	51	25	26
COD	875	525	350
TSS	2,248	607	1,641
LEAD	3	1	1
COPPER	1	U	U
ZINC	3	1	2
TDS	6,025	U	U
TN	13	8	5
TKN	19	U	U
DP	0	U	U
TP	2	1	1
CADMIUM	0	U	U

Cost estimate[2]

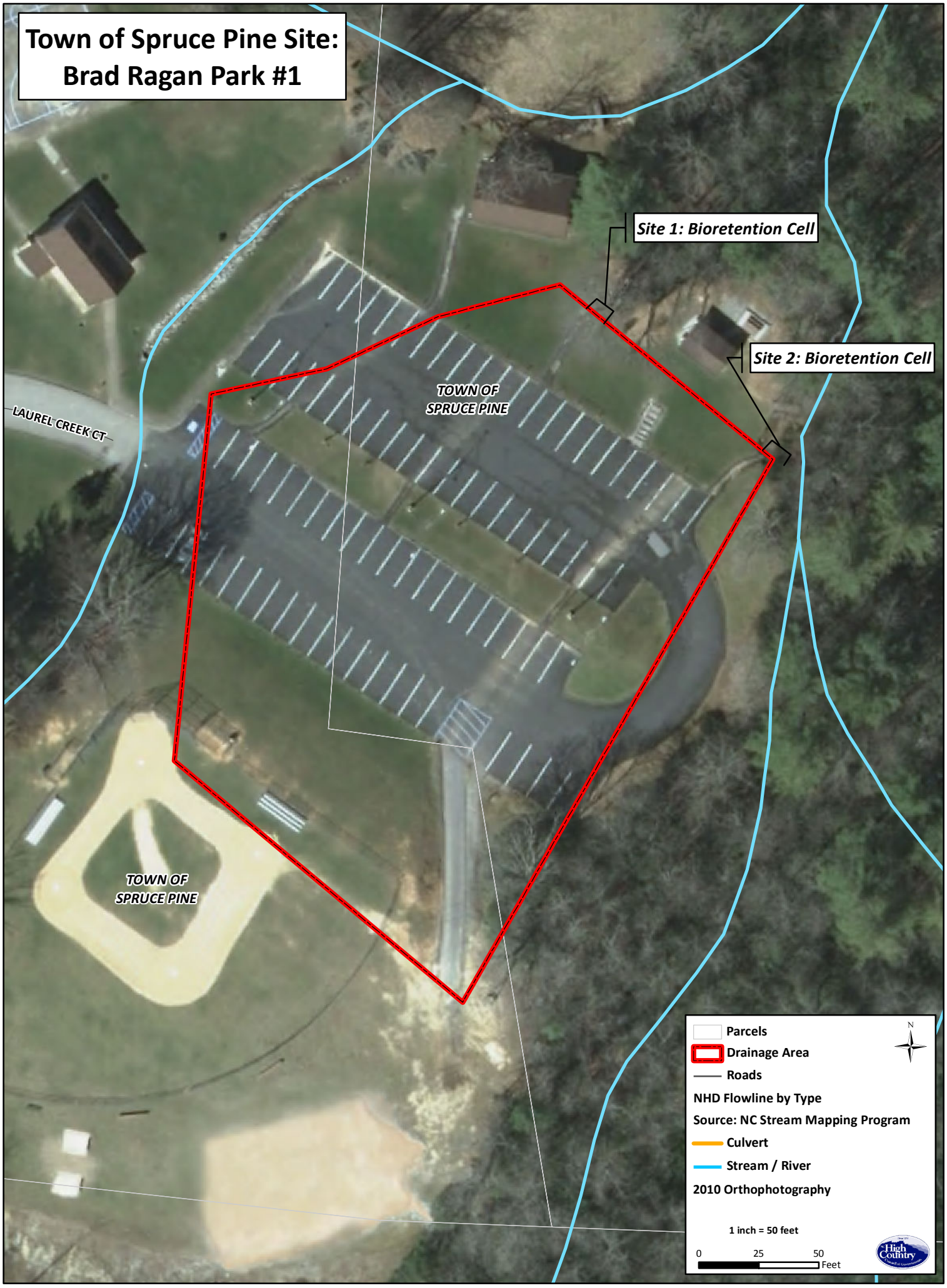
Construction	$26,924
Design & engineering	2,600
	$29,524

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

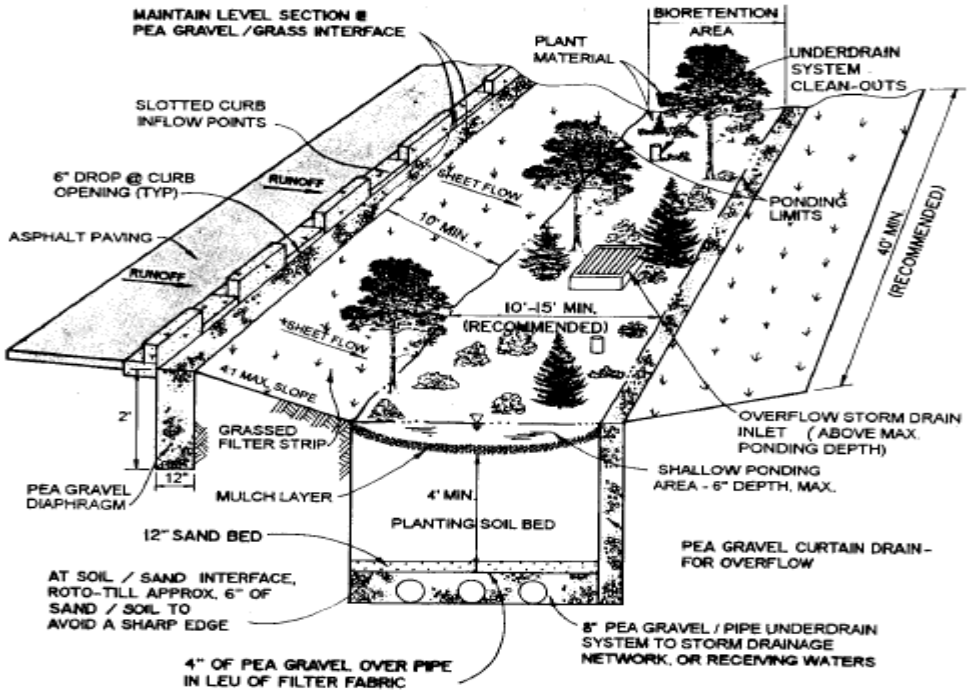
[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007


Town of Spruce Pine Site:
Brad Ragan Park #1
Site 1: Bioretention Cell
Site 2: Bioretention Cell
TOWN OF
SPRUCE PINE
LAUREL CREEK CT
TOWN OF
SPRUCE PINE
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 50 feet
0
25
50
Feet
N


Town of Spruce Pine Site:
Brad Ragan Park #2
TOWN OF
SPRUCE PINE
LAUREL CREEK CT
Site 1: Bioretention Cell
Site 2: Bioretention Cell
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 42 feet
0
20
40
Feet
N

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Watauga County

Cooperative Extension Parking Lot

Problem

Runoff from two connected parking lots serving County agencies in downtown Boone drains directly into Boone Creek. Boone Creek flows through downtown Boone and Appalachian State University (ASU) campus. It is culverted for most of its length in downtown, and is impacted by point and non-point source pollution sources. Boone Creek is the focus of many restoration projects.

On the Cooperative Extension parking lot, runoff is directed to a single catch basin over the culerted creek.

Drainage area = 0.35 acre
Impervious surface = 0.35 acre; 100%

Affected stream = Boone Creek
Stream classification = C, Tr +

BMP solution

Stormwater will be directed away from the catch basin via a grade-level drain (blue lines in photo above) to a point where it will flow to a bioretention cell at the back of the lot (red arrow in photo above).

EMS Parking Lot

Problem

On the EMS parking lot, runoff is channeled directly into Boone Creek through a concrete spillway (photo above right).

Drainage area = 0.34 acre
Impervious surface = 0.34 acre; 100%

Affected stream = Boone Creek
Stream classification = C, Tr +

BMP solution

A bioretention cell will be constructed at the point where the runoff collects at the spillway.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will help lessen erosion downstream that often results from higher stream volumes. Temperature fluctuations associated with runoff from this site will be reduced. Efforts are being made to restore Boone Creek to a more natural condition with diverse objectives related to water quality, flood mitigation, and aesthetics. This BMP will help achieve the goals of that overall project.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	21	4	17
COD	357	U	U
TSS	918	55	863
LEAD	1	U	U
COPPER	0	U	U
ZINC	1	U	U
TDS	2,460	U	U
TN	5	U	U
TKN	8	U	U
DP	0	U	U
TP	1	0	1
CADMIUM	0	U	U

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

Cost estimate[2]

Construction	$17,526
Design & engineering	$ 876
	$18,402

Funding

North Carolina Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Project Program

North Carolina Division of Water Resources Development Project Grant Program

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007


Watauga County Site:
Cooperative Extension Parking Lot
GREEN ST
W KING ST
WATAUGA COUNTY
Boone Creek
Site 1: Bioretention Cell
POPLAR GROVE RD
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 45 feet
0
20
40
Feet
N

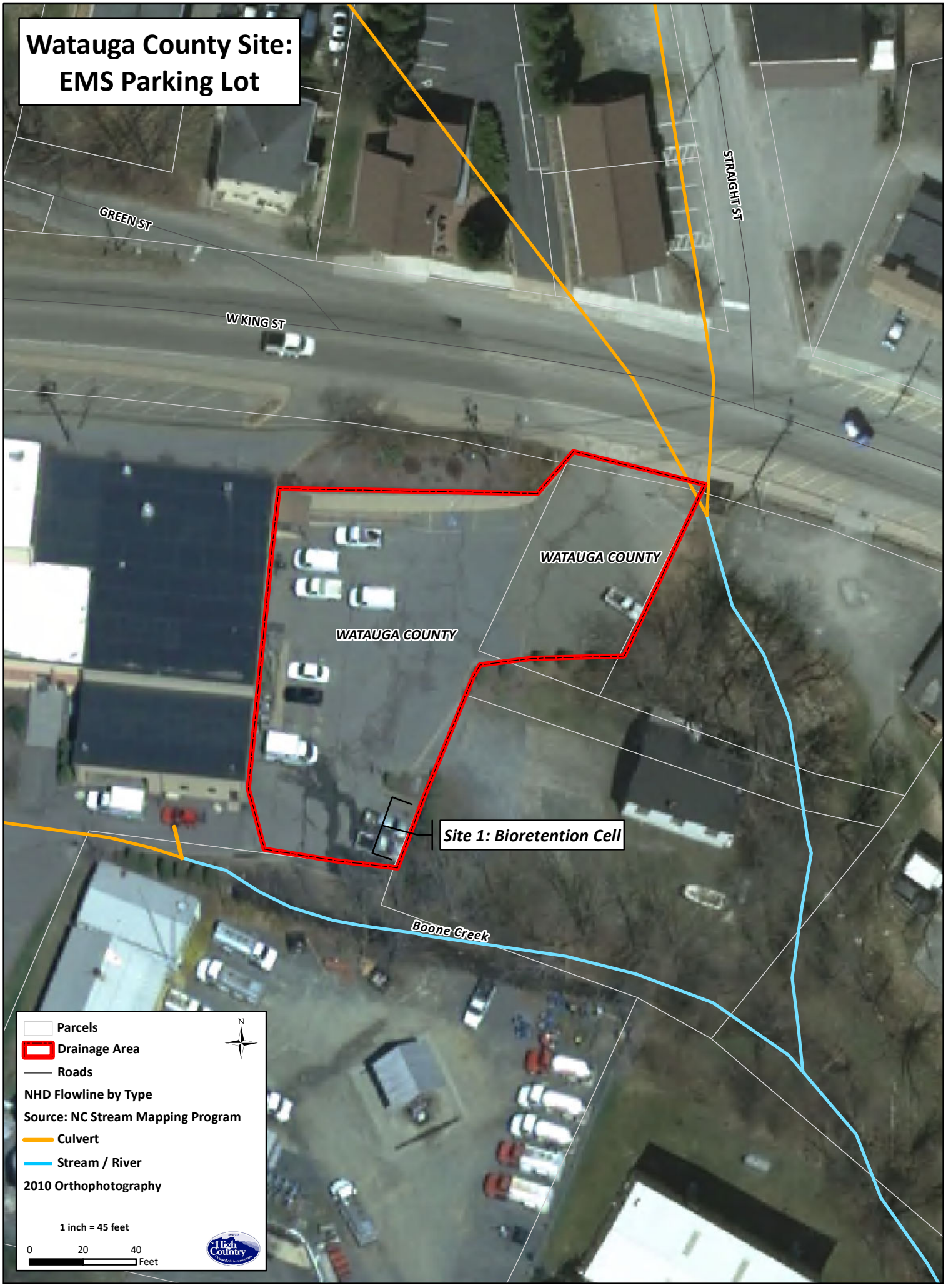
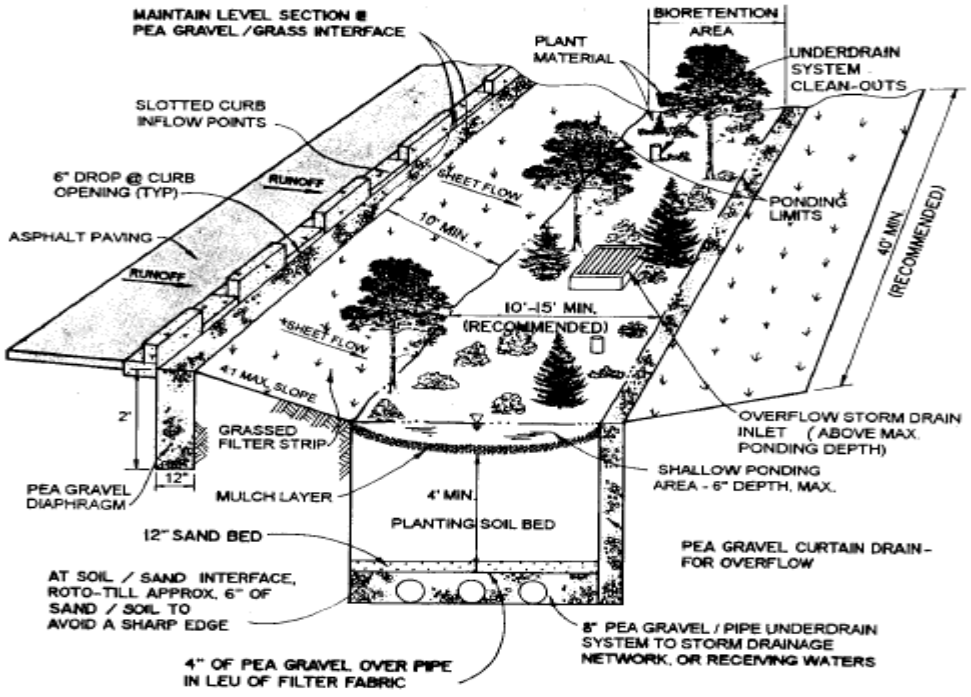

Watauga County Site:
EMS Parking Lot
GREEN ST
W KING ST
STRAIGHT ST
WATAUGA COUNTY
WATAUGA COUNTY
Site 1: Bioretention Cell
Boone Creek
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 45 feet
0
20
40
Feet
N

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of Blowing Rock

Maple Street Parking Lot

Problem

Runoff from the parking lot flows offsite to neighboring properties. The runoff contributes to stormwater flow from other locations in town, channeling approximately 400 feet east of the site and draining into a perennial stream approximately 1,200 feet from the site. The entire area is urbanized, consisting of commercial development and residential development on small lots. The runoff from the paved areas introduces oils and grease, hydrocarbons, metals, and road salt to the stream.

Drainage area = 0.84 acre
Impervious area = 0.77 92%

Affected stream = unnamed tributary to Middle Fork, South Fork New River
Stream classification = WS-IV +

BMP solution

The existing vegetated border area, located downslope of the parking lot, is ideal for conversion to a linear bioretention cell to capture and filter the runoff. Bioretention will enhance the appearance of the lot, which is centrally located, highly visible, and heavily used by visitors. A grade-level drain may be necessary to direct flow to the border area in the background.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots will be prevented from entering the stream. Elimination of the stormwater volume from the creek will help lessen erosion downstream that often results from higher stream volumes.

Bioretention cells	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	25	U	U
COD	435	152	283
TSS	1,117	279	838
LEAD	1	0	1
COPPER	0	U	U
ZINC	2	1	1
TDS	2,995	U	U
TN	6	3	4
TKN	9	U	U
DP	0	U	U
TP	1	0	1
CADMIUM	0	U	U

Cost estimate[2]

Construction	$19,558
Design & engineering	1,000
	$20,558

Funding

North Carolina Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Project Program

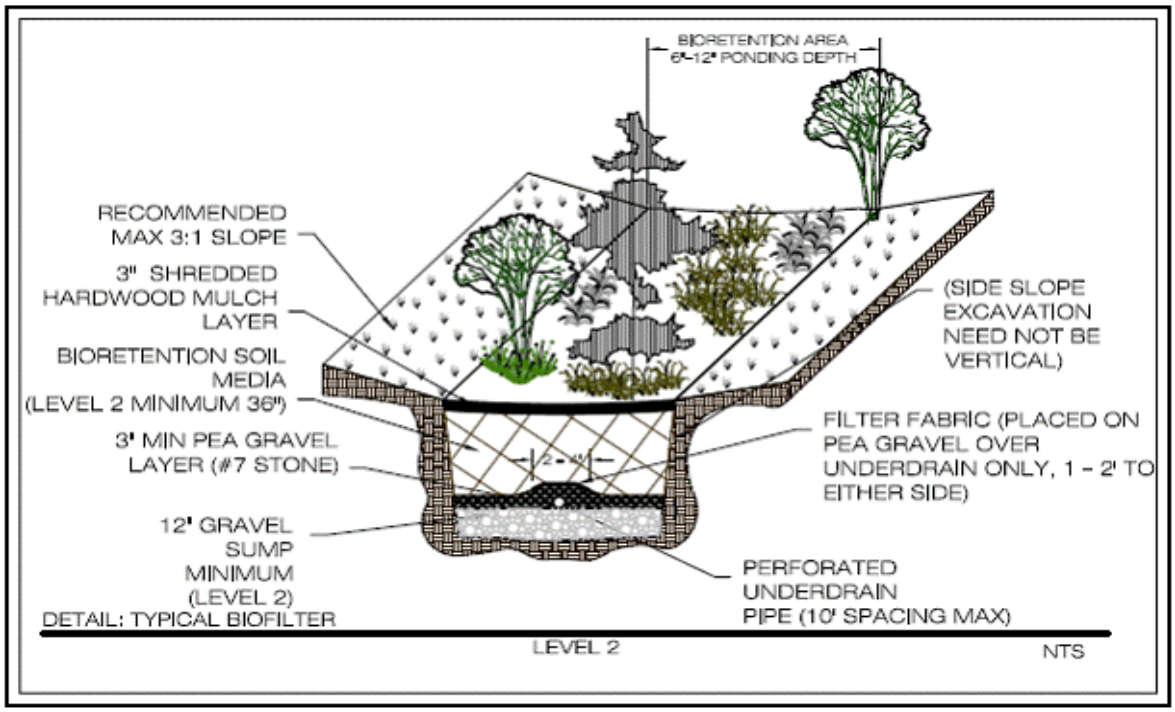
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007


Town of Blowing Rock Site:
Maple Street Parking Lot
Site 1: Bioretention Cell
MAPLE ST
Site 2: Bioretention Cell
FIRST CITIZENS BANK & TRUST
TOWN OF BLOWING ROCK
MAPLE ST
SUNSET DR
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 50 feet
0
25
50
Feet
N

Diagram and photograph of a typical linear bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of Boone

Appalachian State University, Duncan Hall

Problem

A stormdrain (below) flows to this concrete channel (upper left photo) which runs directly into the stream. The channel also captures overland flow from the surrounding area (right photos; arrow shows location of channel). While the existing grassy areas provide some filtration for this sheetflow, observation during a rain event revealed that it is not sufficient for the high volume and rapid velocity of the runoff. As flow in the receiving stream increases during storm events, stormwater backs up into the concrete channel and surrounding area.

Drainage area = 0.31 acre
Impervious surface = 0.17 acre

Affected stream = Boone Creek
Stream Classification = C, Tr +

BMP solution

The site has an obvious swale form and drainage pattern that can easily be converted into a linear bioretention area with minimal disturbance. After removing the concrete channel, the area will be excavated to have sufficient depth to hold and filter stormwater before it reaches the stream. Vegetation in addition to grass will further enhance these BMP outcomes.

Water quality benefits[1]

In the winter, the area's sidewalks, drives, and parking lots are heavily coated with salt and/or ice-melt chemicals. By capturing and treating the runoff, salt, heavy metals, and other pollutants associated with roadways will be prevented from entering the stream. Elimination of the stormwater volume from the creek will help lessen erosion downstream that often results from higher stream volumes. Efforts are being made to restore Boone Creek to a more natural condition with diverse objectives related to water quality, water temperature fluctuations, flood mitigation, and aesthetics. This BMP will help achieve the goals of that overall project.

Vegetated swale	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	9	5	5
COD	161	96	64
TSS	412	111	301
LEAD	0	0	0
COPPER	0	U	U
ZINC	1	0	0
TDS	1,105	U	U
TN	2	1	1
TKN	3	U	U
DP	0	U	U
TP	0	0	0
CADMIUM	0	U	U

Cost estimate[2]

Construction	$3,085
Design & engineering	$ 500
	$3,585

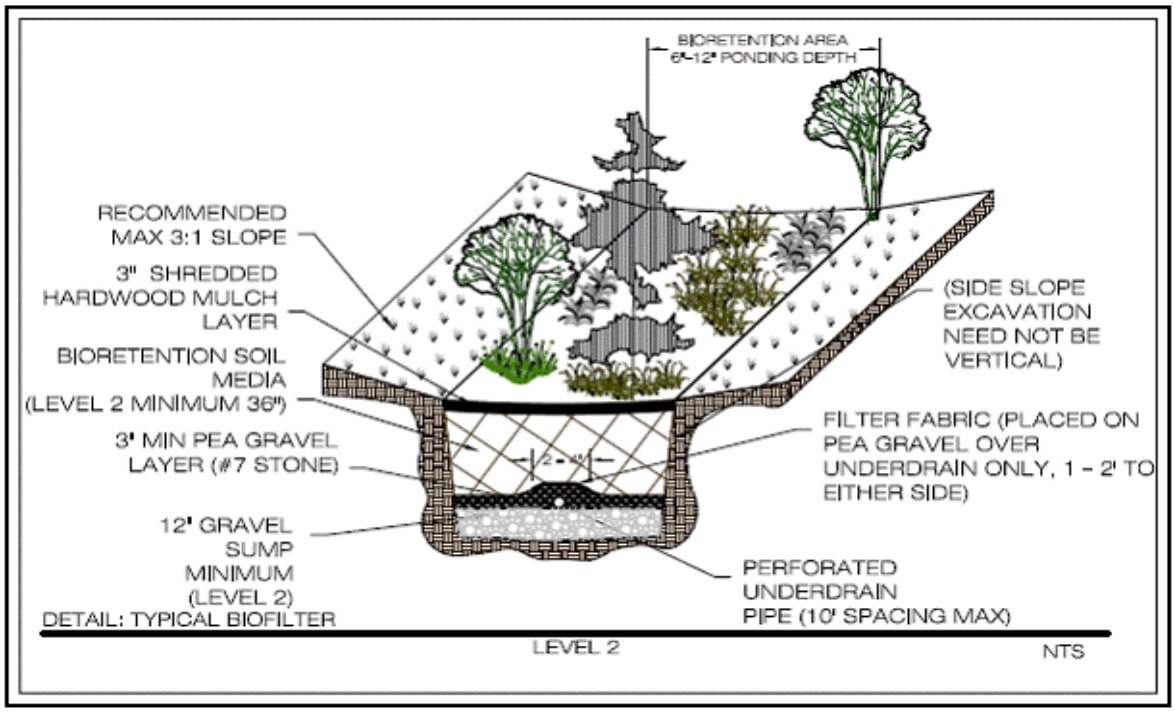
Funding

NC Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable
[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007


Town of Boone Site:
Appalachian State University,
Duncan Hall
JOYCE LAWRENCE LN
APPALACHIAN STATE UNIVERSITY
Site 1: Linear Bioretention
Boone Creek
RIVERS ST
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 60 feet
0
30
60
Feet
N

Diagram and photograph of a typical linear bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Wilkes County

Wilkes County Senior Center

Problem

Runoff from the building and parking lots is directed into a ditch, causing erosion and thereby introducing sediment into Long Creek in addition to pollutants from the stormwater.

Drainage area = 2.33 acres
Impervious surface = 1.76 acres; 76%

Affected stream = Long Creek
Stream classification = C

BMP solution

The ditch will be converted to a bioretention swale, replacing at least some of the soil with materials and a soil mix that will retain greater quantities of runoff. The addition of appropriate plants will increase its filtering and retention capacity while also enhancing the appearance of this public site. A series of checkdams will slow the velocity to allow more infiltration.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. The bioretention swale will also reduce erosion and sedimentation within the ditch. Reduction of stormwater velocity will help lessen erosion downstream that often results from higher stream volumes.

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

	Load before BMP (lbs/yr)		Load after BMP (lbs/yr)		Load Reduction (lbs/yr)
BOD	70		35		35
COD	1,207		724		483
TSS	3,099		837		2,262
LEAD	4		2		2
COPPER	1		U		U
ZINC	4		2		3
TDS	8,306		U		U
TN	18		11		7
TKN	26		U		U
DP	0		U		U
TP	3		1		1
CADMIUM	0		U		U

Cost estimate[2]

Construction	$19,184
Design & engineering	$ 1,083
	$20,267

Funding

North Carolina Clean Water Management Trust Fund

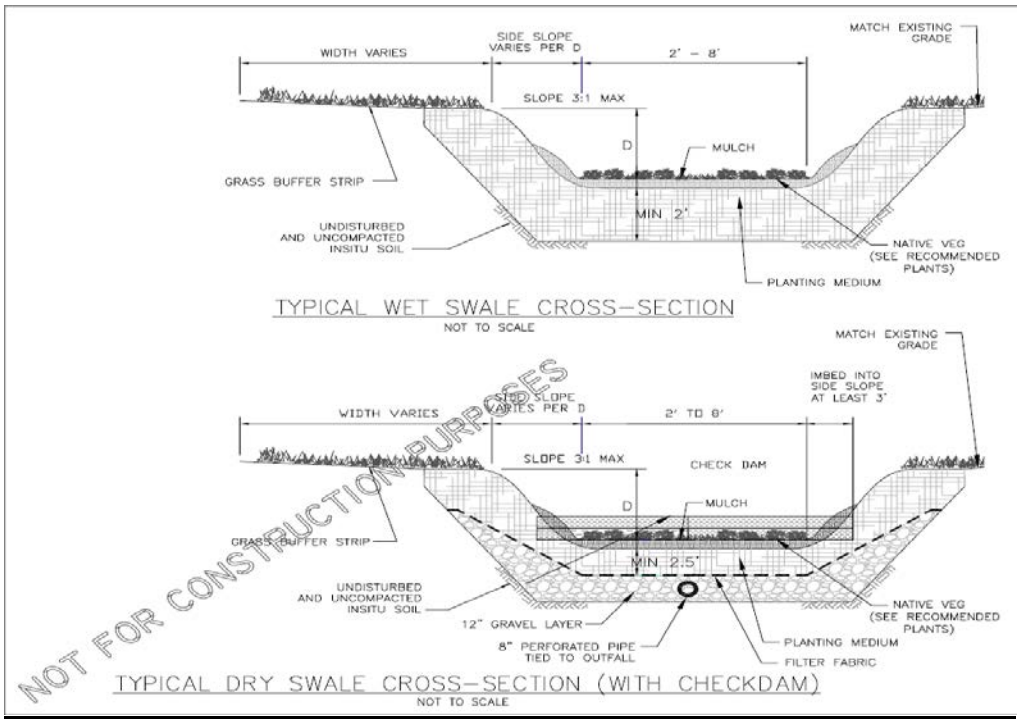
Soil & Water District Community Conservation Assistance Project Program

North Carolina Division of Water Resources Development Project Grant Program

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007


Wilkes County Site:
Wilkes County Senior Center
Site 1: Bioretention Swale
Site 2: Bioretention Swale
Site 3: Bioretention Swale
FAIRPLAINS SCH RD
WILKES COUNTY
SENIOR CENTER
Parcels
Drainage Area
Roads
Hydrology
Source: NC Floodplain Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 75 feet
0
37.5
75
Feet
N

Diagram and photograph of a typical swale:



High Country Council of Governments
Regional Stormwater Project

Ronda

Memorial Park

Problem

The Ronda Memorial Park contains a paved parking lot and a concrete canoe launch. Runoff from the majority of the parking lot flows down a steep bank approximately 20 feet to the Yadkin River. Runoff from the parking lot, driveway, and roadway above flows down the canoe ramp directly into the Yadkin River. The runoff from the site introduces oils and grease, hydrocarbons, metals, and road salt to the stream.

Drainage area = 1.33 acre
Impervious surface = 0.50 acre; 38%

Affected stream = Yadkin River
Stream classification = WS-IV

BMP solution

A grade-level drain will be installed to capture the runoff and drain it to a channel that will connect to a bioretention cell in the grassy area. Bioretention is the preferred BMP, considering the park environment.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. The bioretention cell will also reduce erosion and sedimentation resulting from stormwater draining unchecked down the bank to the river.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	15	3	12
COD	259	U	U
TSS	665	40	625
LEAD	1	U	U
COPPER	0	U	U
ZINC	1	U	U
TDS	1,783	U	U
TN	4	U	U
TKN	6	U	U
DP	0	U	U
TP	1	0	0
CADMIUM	0	U	U

Cost estimate[2]

Construction	$9,950
Design & engineering	$ 500
	$10,450

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Project Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

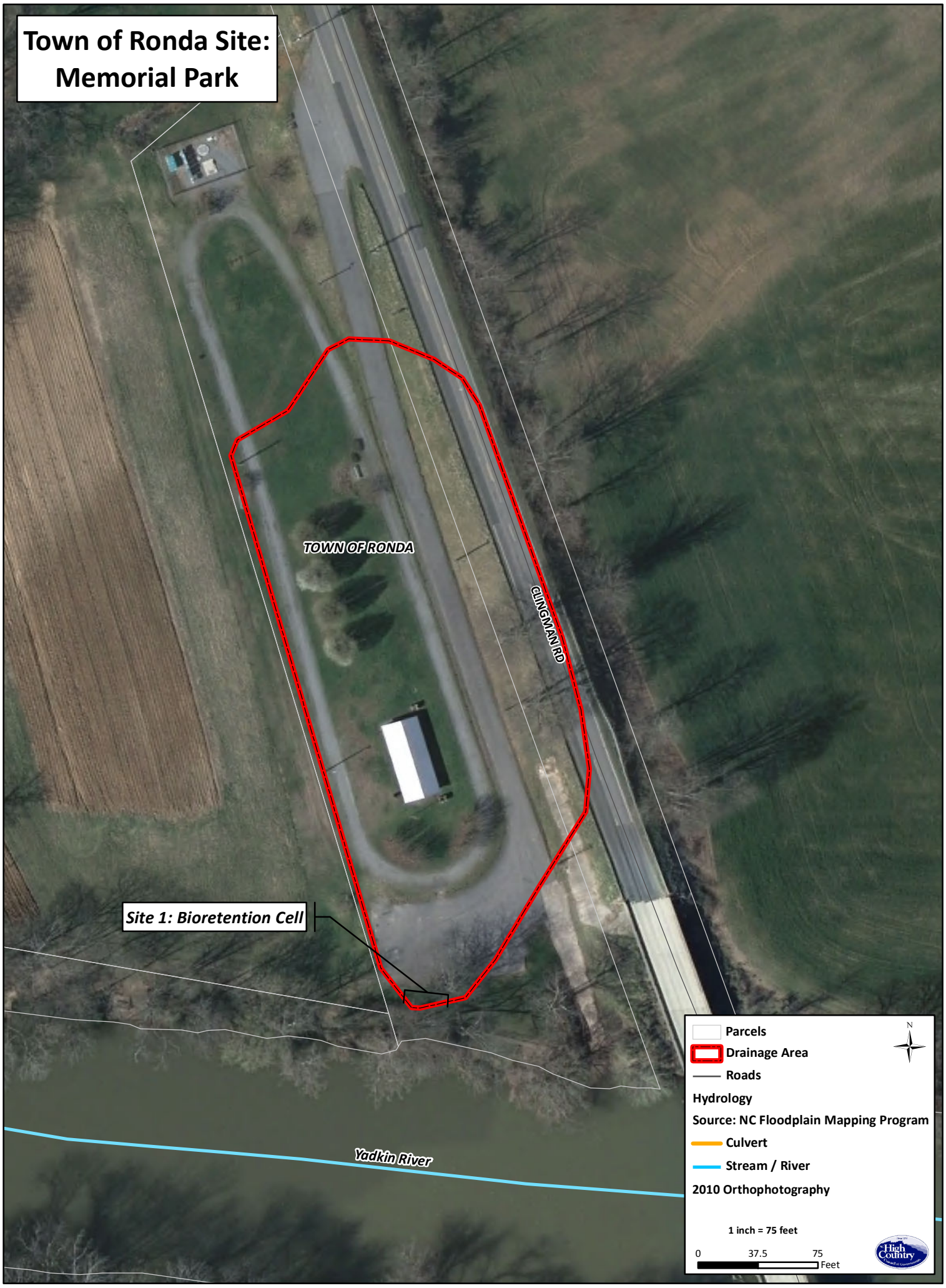
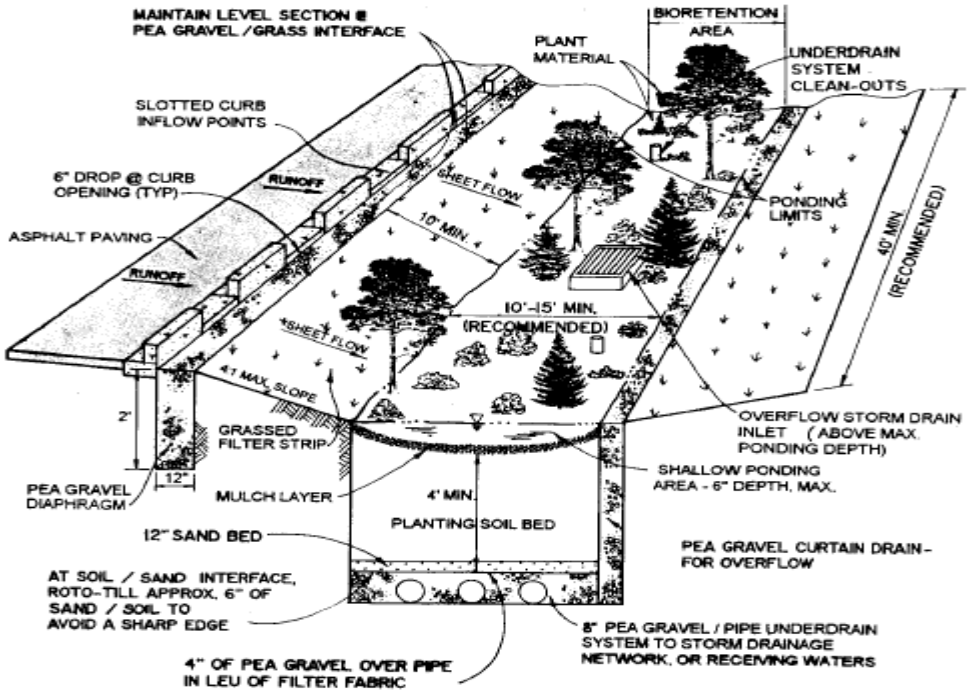

Town of Ronda Site:
Memorial Park
TOWN OF RONDA
CLINGMAN RD
Site 1: Bioretention Cell
Yadkin River
Parcels
Drainage Area
Roads
Hydrology
Source: NC Floodplain Mapping Program
Culvert
Stream / River
2010 Orthophotography
N
1 inch = 75 feet
0
37.5
75
Feet

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of Wilkesboro

Tyson Plant (Main/Cherry Streets)

Problem

An unnamed tributary of Cub Creek and the stormwater from the Tyson plant and surrounding area flow down the channel shown in the right photo (flow and channel location shown by red arrow). In addition to the typical pollutants associated with parking lots, drives, and rooftops, water quality testing by the Town a few feet downstream revealed high levels of BOD, low dissolved oxygen, and high levels of fecal coliform bacteria.

Drainage area = 116.57 acres Impervious surface = 62.8 acres; 54%

Affected stream= unnamed tributary to Cub Creek
Stream classification = C

BMP solution

A weir will be installed on the existing concrete channel to divert stormflow to an adjacent parcel where a series of wetland cells will be constructed. The topography is conducive to this BMP and will provide substantial filtration of the targeted pollutants. The Town is currently engaged in a major streambank restoration effort on Cub Creek only a short distance downstream, which this BMP will complement and help protect from excessive stormwater flows.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be filtered. The BMP will remedy high levels of BOD, low dissolved oxygen, and high levels of fecal coliform bacteria currently in the stream. Elimination of the stormwater volume from the creek will lessen erosion downstream that often results from higher stream volumes.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	4,663	1,725	2,938
COD	26,811	13,406	13,406
TSS	125,896	28,327	97,569
LEAD	162	57	105
COPPER	21	U	U
ZINC	140	91	49
TDS	131,724	U	U
TN	1,399	1,119	280
TKN	466	U	U
DP	87	U	U
TP	152	85	67
CADMIUM	3	U	U

Cost estimate[2]

Construction	$182,236
Design & engineering	$ 9,111
	$191,347

Funding

North Carolina Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Project Program

North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

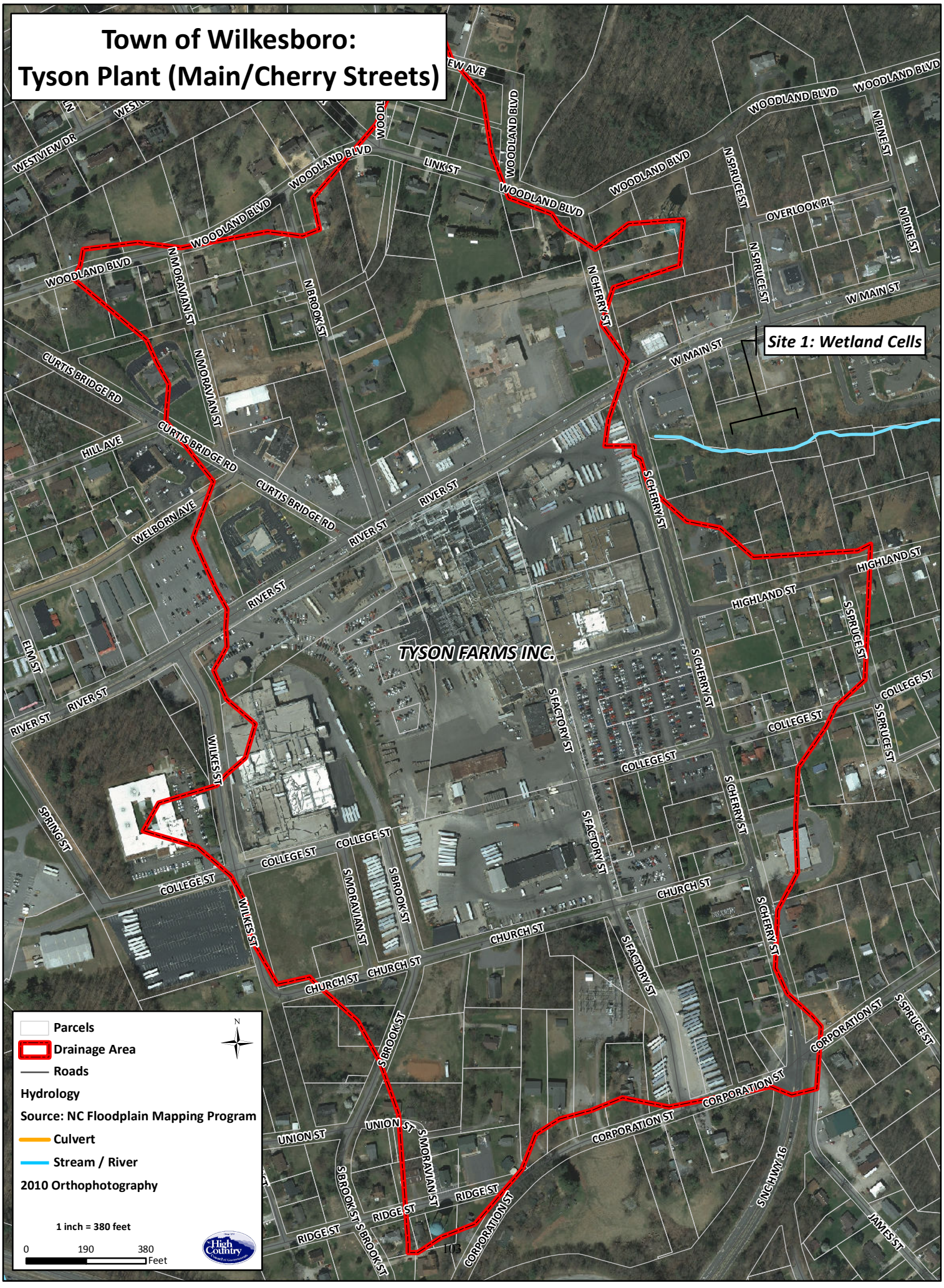
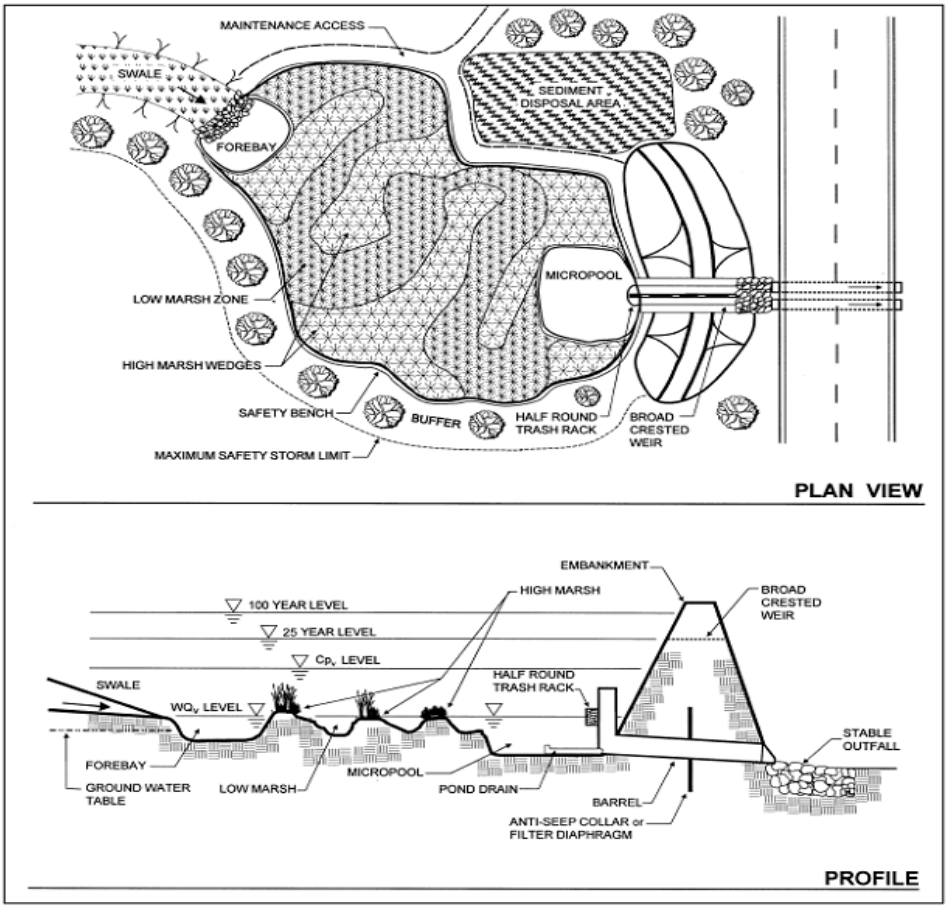

Town of Wilkesboro:
Tyson Plant (Main/Cherry Streets)
Site 1: Wetland Cells
TYSON FARMS INC.
WOODLAND BLVD
LINK ST
WESTVIEW DR
N MORAVIAN ST
N BROOK ST
N CHERRY ST
N SPRUCE ST
N PINE ST
OVERLOOK PL
W MAIN ST
CURTIS BRIDGE RD
HILL AVE
WELBORN AVE
RIVER ST
ELM ST
WILKES ST
SPRING ST
COLLEGE ST
S MORAVIAN ST
S BROOK ST
S FACTORY ST
S CHERRY ST
S SPRUCE ST
HIGHLAND ST
CHURCH ST
CORPORATION ST
UNION ST
RIDGE ST
JAMES ST
SNC HWY 16
Parcels
Drainage Area
Roads
Hydrology
Source: NC Floodplain Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 380 feet
0
190
380
Feet
N
High Country

Diagram and photograph of a typical stormwater wetland:



High Country Council of Governments
Regional Stormwater Project

Town of Wilkesboro

Wilkesboro United Methodist Church

Problem

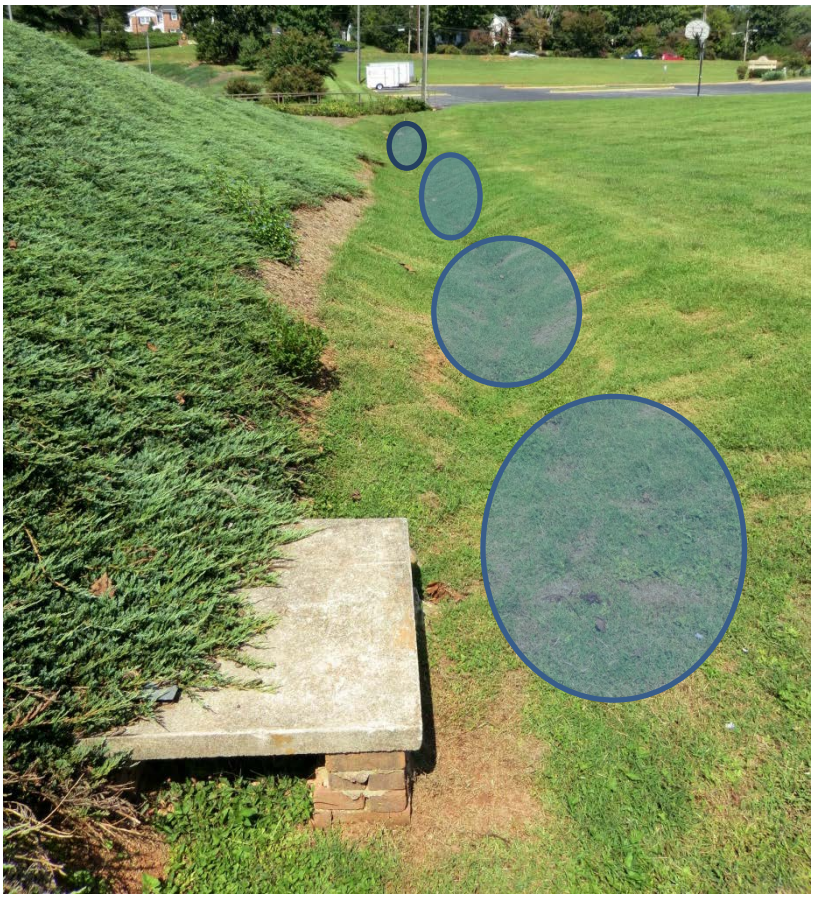
Runoff from the church parking lot flows down a drainage ditch to a pipe where it is discharged directly into a tributary of Cub Creek.

Drainage area = 0.51 acre
Impervious surface = 0.47 acre; 92%

Affected stream = unnamed tributary to Cub Creek
Stream classification = C

BMP solution

A bio-grade step or series of bioretention cells will be installed along the drainage ditch. This BMP will fit well into the existing topography and landscaping of the church grounds without excessive modification. The Town is currently engaged in a substantial streambank restoration effort on Cub Creek only a short distance downstream, which this BMP will complement and help protect from excessive flows.



Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. The BMP will also reduce velocity of stormwater discharging to the creek, reducing streambank erosion.

	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	15	3	13
COD	264	U	U
TSS	678	41	638
LEAD	1	U	U
COPPER	0	U	U
ZINC	1	U	U
TDS	1,818	U	U
TN	4	U	U
TKN	6	U	U
DP	0	U	U
TP	1	0	0
CADMIUM	0	U	U

Cost estimate[2]

Construction	$11,938
Design & engineering	$ 1,000
	$12,938

Funding

North Carolina Clean Water Management Trust Fund

Soil & Water District Community Conservation Assistance Project Program

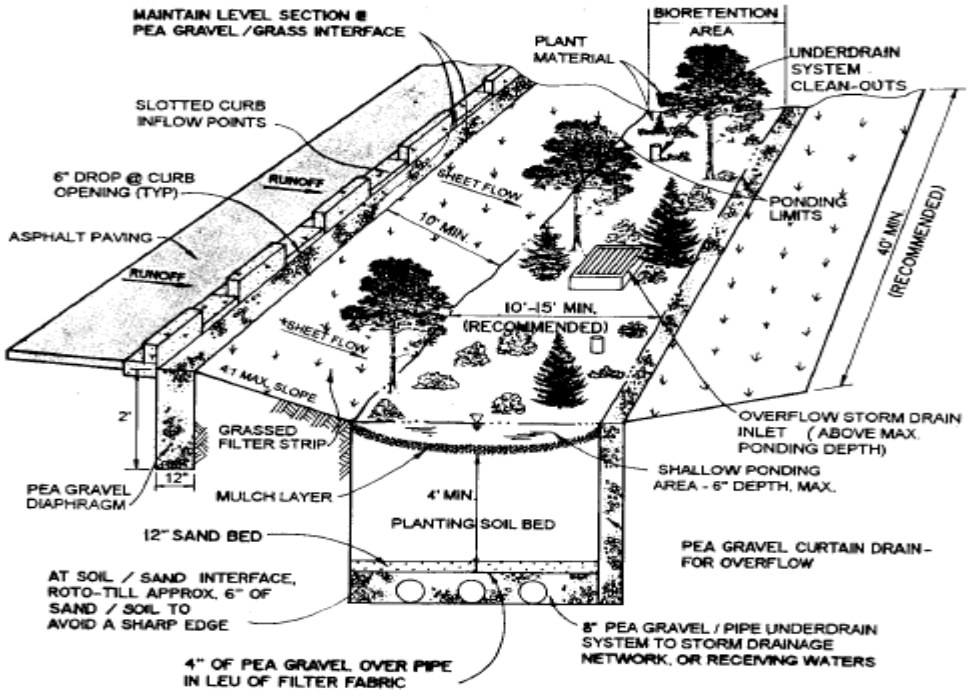
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007


Town of Wilkesboro Site:
United Methodist Church
W MAIN ST
WILKESBORO METHODIST CHURCH INC.
Site 1: Bioretention Cells
Parcels
Drainage Area
Roads
Hydrology
Source: NC Floodplain Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 50 feet
0
25
50
Feet
N

Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Yancey County

Yancey County Health Department

Problem

Runoff from the Health Department parking lot and Wheeler Hills Road is directed via drains to the roadside ditch where it eventually flows into a nearby stream. The runoff is introducing pollutants, and increasing runoff velocity, to the receiving sream.

Drainage area = 0.56 acre Impervious surface = 0.37 acre; 65%

Affected stream = unnamed tributary to Cane River Stream classification = C, Tr

BMP solution

The drainage ditch will be converted to a bioretention swale, replacing at least some of the soil with materials and a soil mix that will retain greater quantities of runoff. The addition of appropriate plants will enhance its filtering and retention capacity. A series of checkdams will slow the velocity to allow more infiltration. Bioretention will achieve water quality objectives while maintaining a landscaped appearance at the entrance to the agency.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Slowing velocity of the runoff to neighboring properties will reduce sedimentation. This BMP's impact in the Cane River watershed will augment improvements currently underway on the Town of Burnsville's wastewater treatment system.

bioretention[1]	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	49	24	25
COD	844	507	338
TSS	2,168	585	1,583
LEAD	3	1	1
COPPER	1	U	U
ZINC	3	1	2
TDS	5,811	U	U
TN	13	8	5
TKN	18	U	U
DP	0	U	U
TP	2	1	1
CADMIUM	0	U	U

Cost estimate[2]

Construction	$13,975
Design & engineering	$ 1,300
	$15,275

Funding

NC Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

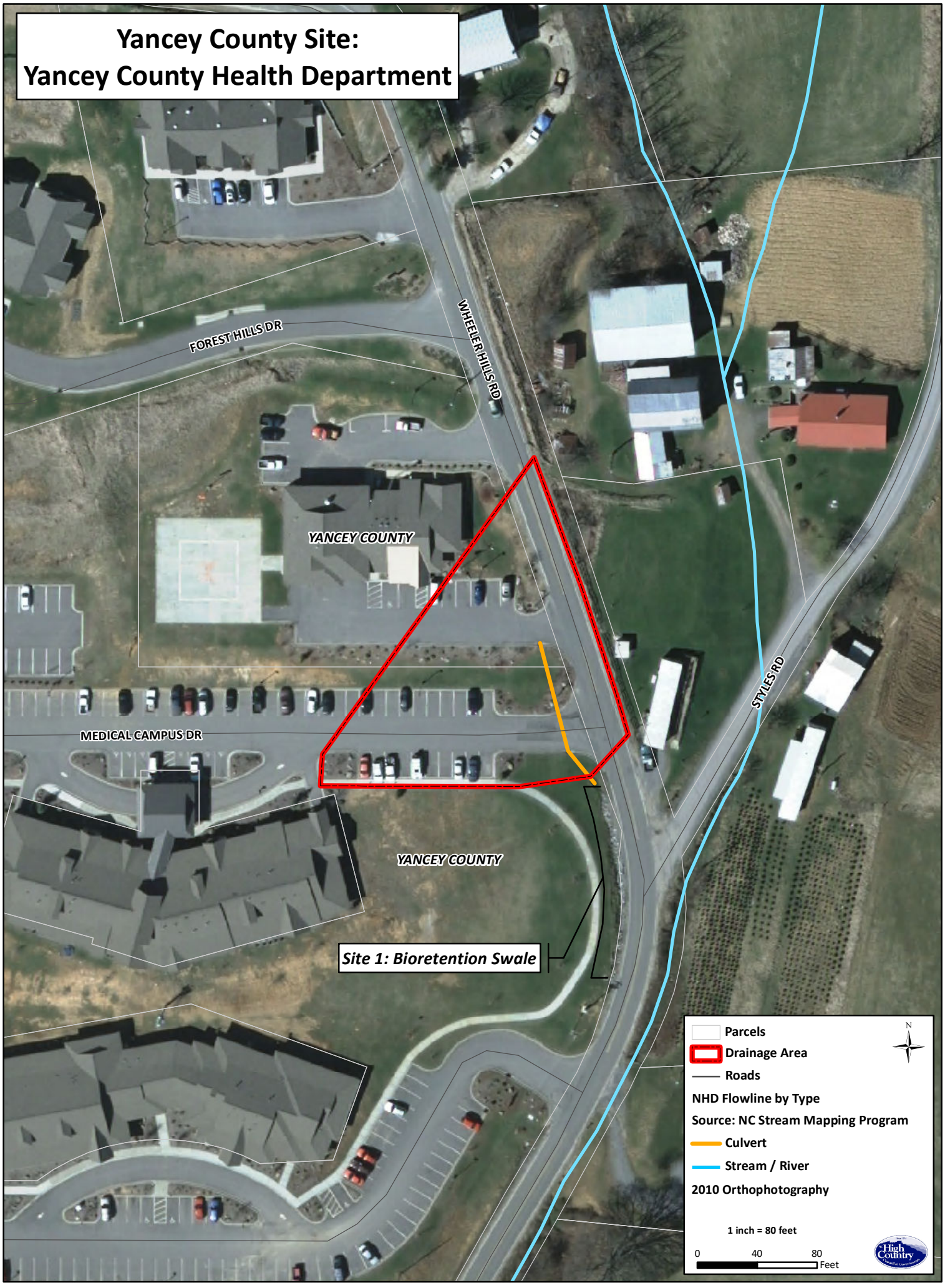
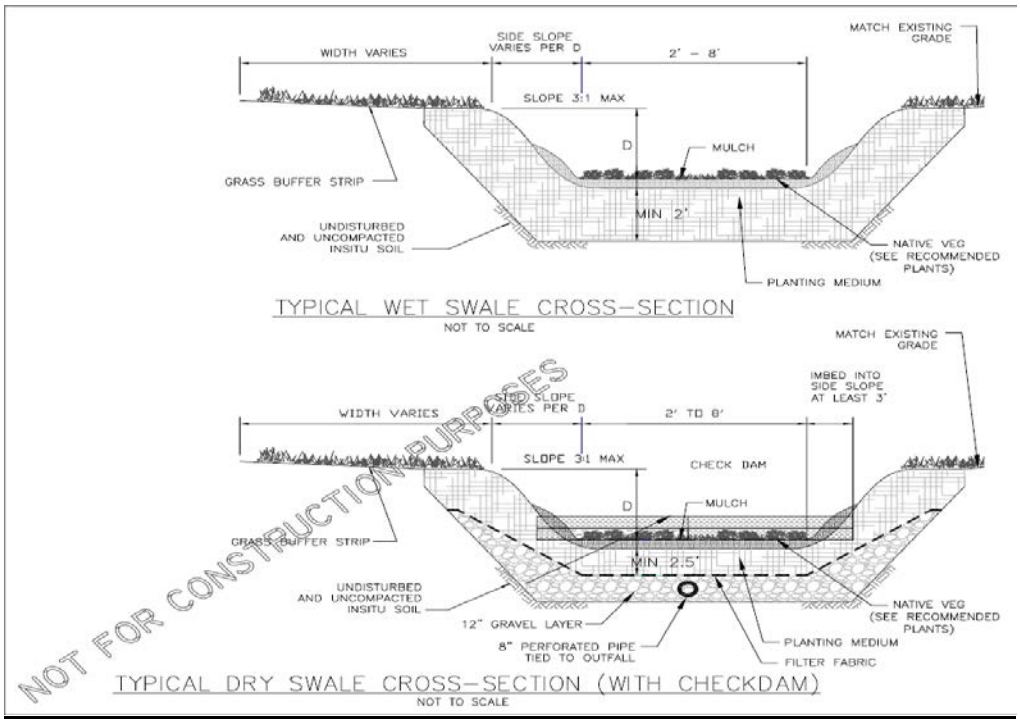

Yancey County Site:
Yancey County Health Department
FOREST HILLS DR
WHEELER HILLS RD
YANCEY COUNTY
MEDICAL CAMPUS DR
STYLES RD
YANCEY COUNTY
Site 1: Bioretention Swale
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 80 feet
0
40
80
Feet
N

Diagram and photograph of a typical swale:



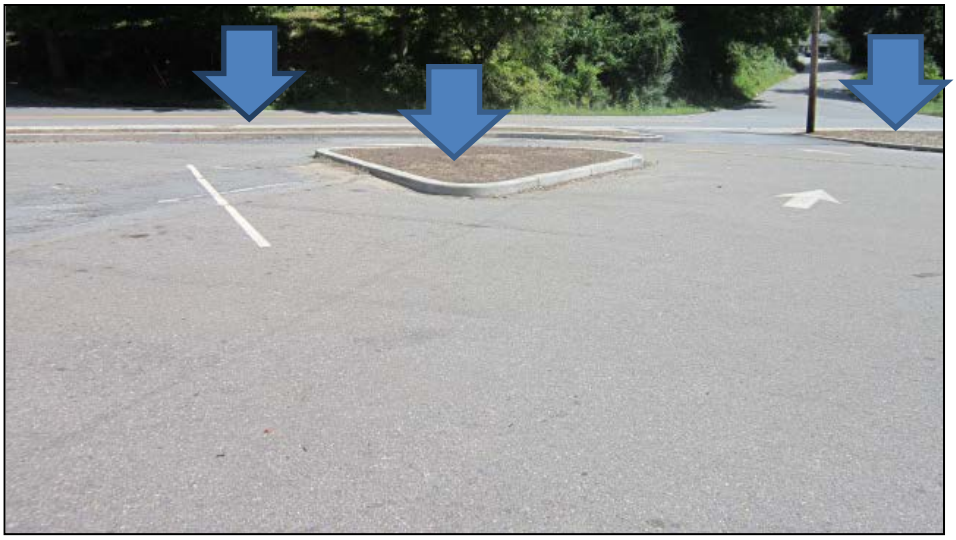
High Country Council of Governments
Regional Stormwater Project

Yancey County

Ray Cort Park

Problem

Runoff from the Ray Cort Park parking lot drains directly to the stream that flows parallel to the lot.



Drainage area = 0.40 acre
Impervious surface = 0.35 acre; 88%

Affected stream = Mitchell Branch
Stream classification = C, Tr

BMP solution

Converting the existing planter islands (indicated by arrows) into bioretention cells will achieve water quality objectives while maintaining aesthetic qualities, minimizing costs, and effectively dealing with the lack of space for a BMP. The BMP will also serve an educational purpose at this public park with appropriate interpretive signage installed.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots will be prevented from entering the stream. Reduction of the stormwater velocity discharging to the creek will help lessen erosion and sedimentation downstream that often results from higher stream volumes. Temperature fluctuations caused by this site's runoff will be eliminated.

bioretention	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	11	5	6
COD	192	115	77
TSS	492	133	359
LEAD	1	0	0
COPPER	0	U	U
ZINC	1	0	0
TDS	1,319	U	U
TN	3	2	1
TKN	4	U	U
DP	0	U	U
TP	0	0	0
CADMIUM	0	U	U

Cost estimate[2]

Construction	$7,000
Design & engineering	$ 700
	$7,700

Funding

North Carolina Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

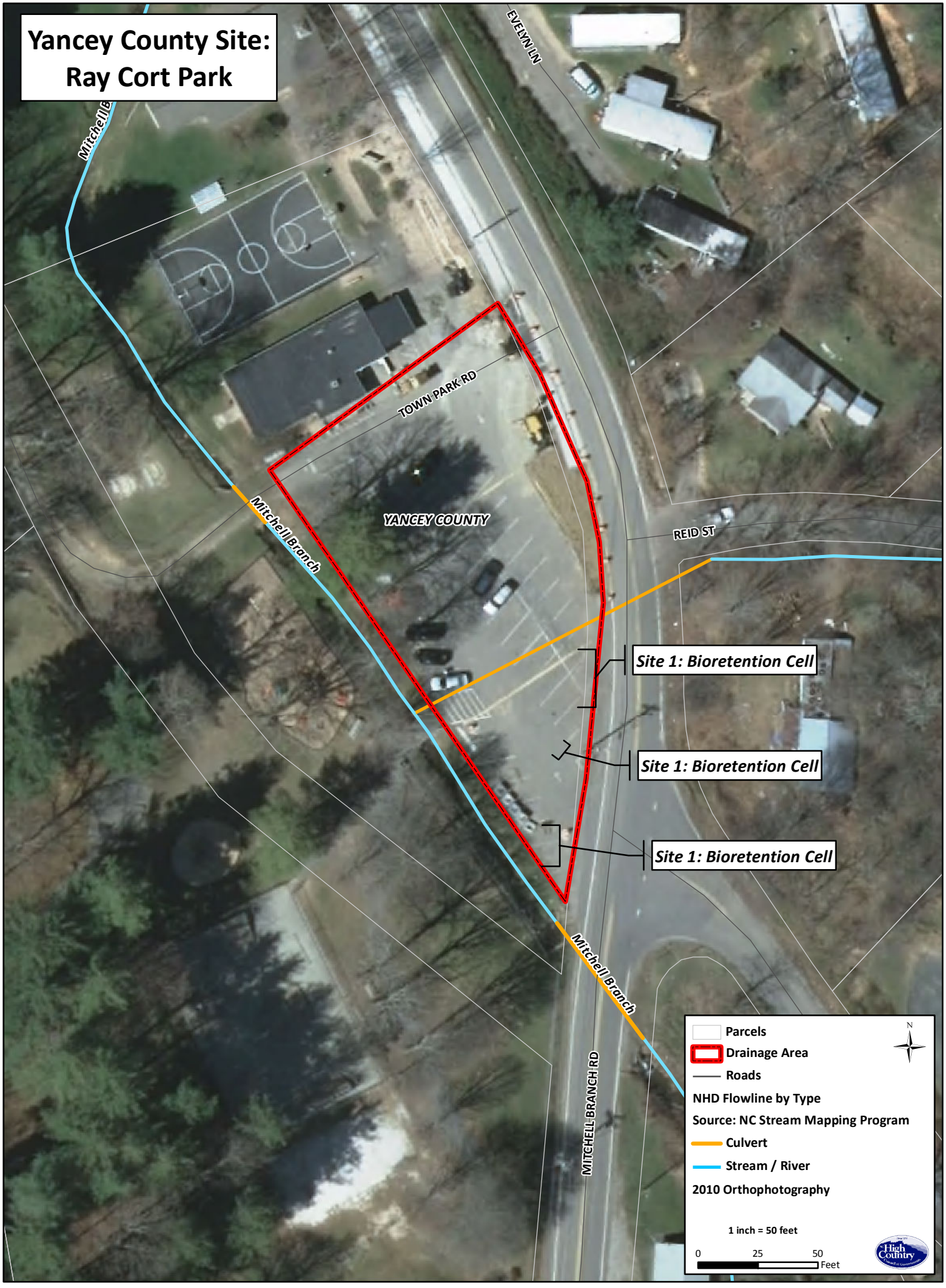
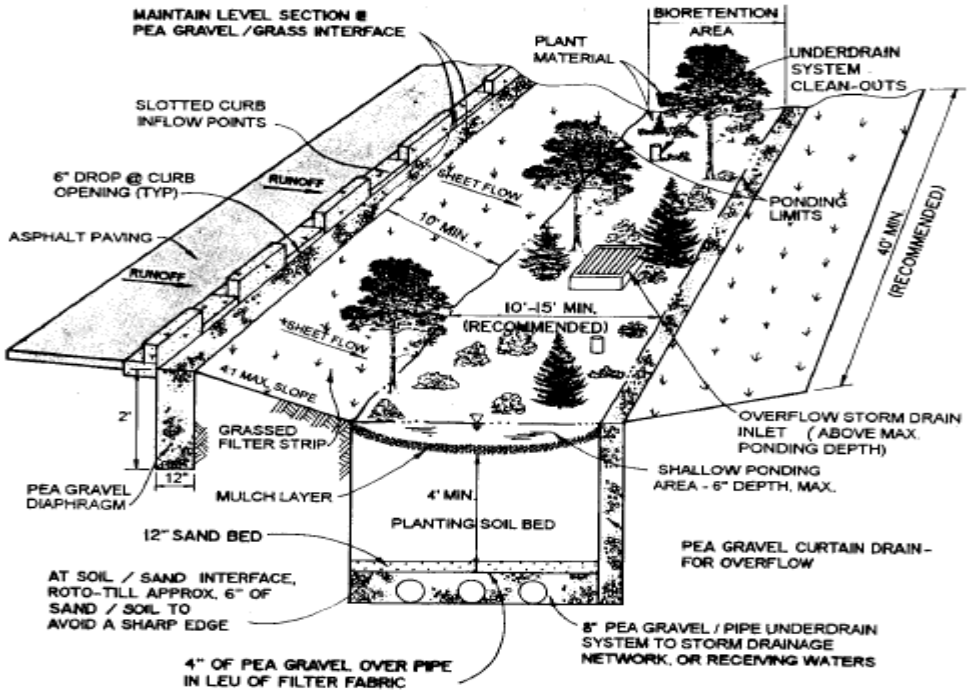

Yancey County Site:
Ray Cort Park
EVELYN LN
TOWN PARK RD
YANCEY COUNTY
Mitchell Branch
REID ST
Site 1: Bioretention Cell
Site 1: Bioretention Cell
Site 1: Bioretention Cell
Mitchell Branch
MITCHELL BRANCH RD
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 50 feet
0
25
50
Feet
N

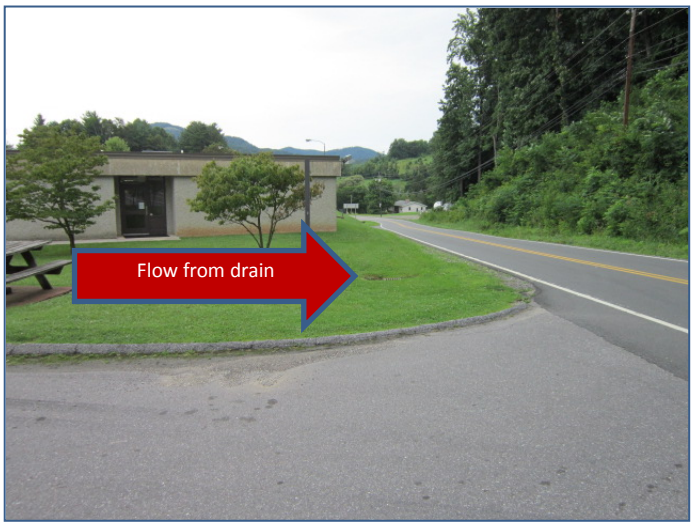
Diagram and photograph of a typical bioretention cell:



High Country Council of Governments
Regional Stormwater Project

Town of Burnsville

Yancey County Department of Social Services



Problem

A significant amount of the site's runoff, primarily from the parking lot, is directed to a ditch in front of the building, where it flows into a stream. The ditch also captures runoff from the road, which includes salt in the winter. The runoff from the pavement introduces oils and grease, hydrocarbons, metals, and road salt to the receiving stream.

Drainage area = 1.63 acre
Impervious surface = 0.77 acre; 47%

Affected stream = unnamed tributary to Little Crabtree Creek
Stream classification = C, Tr

BMP solution

The drainage ditch's existing form will be used to convert it to a bioretention swale, replacing at least some of the soil with materials and a soil mix that will retain greater quantities of runoff. Space is available to widen it to increase its volume. The addition of appropriate plants will also enhance its filtering and retention capacity, and give this BMP a landscaped appearance that is needed at this highly visible location. A series of checkdams will slow the velocity to allow more infiltration.

Water quality benefits[1]

By capturing and treating the runoff, heavy metals and other pollutants associated with parking lots and roadways will be prevented from entering the stream. Reduction or elimination of the stormwater volume entering the creek will mitigate erosion associated with higher stream volumes.

Vegetated swale[1]	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	17	8	8
COD	290	174	116
TSS	745	201	544
LEAD	1	0	0
COPPER	0	U	U
ZINC	1	0	1
TDS	1,996	U	U
TN	4	3	2
TKN	6	U	U
DP	0	U	U
TP	1	0	0
CADMIUM	0	U	U

Cost estimate[2]

Construction	$6,715
Design & engineering	$ 600
	$7,315

Funding

NC Clean Water Management Trust Fund
Soil & Water District Community Conservation Assistance Program
North Carolina Division of Water Resources Development Project Grant Program

[1] The methodology used to obtain values was developed by the Illinois Environmental Protection Agency. U = unavailable

[2] Methodology used to calculate cost estimates is obtained from *Urban Subwatershed Restoration Manual No. 3* URBAN STORMWATER RETROFIT PRACTICES *Version 1.0* Tom Schueler, David Hirschman, Michael Novotney, and Jennifer Zielinski, Center for Watershed Protection, 2007

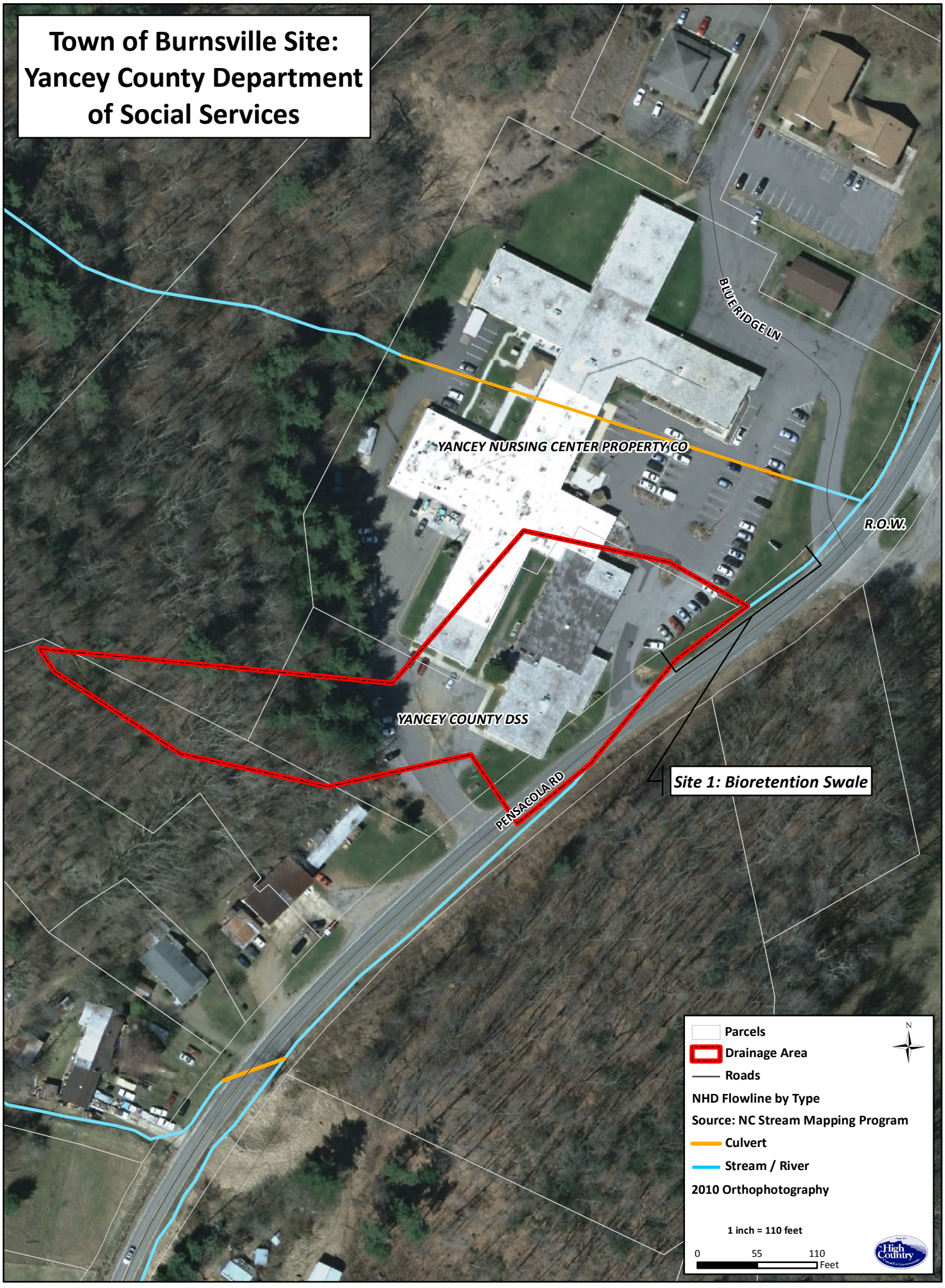
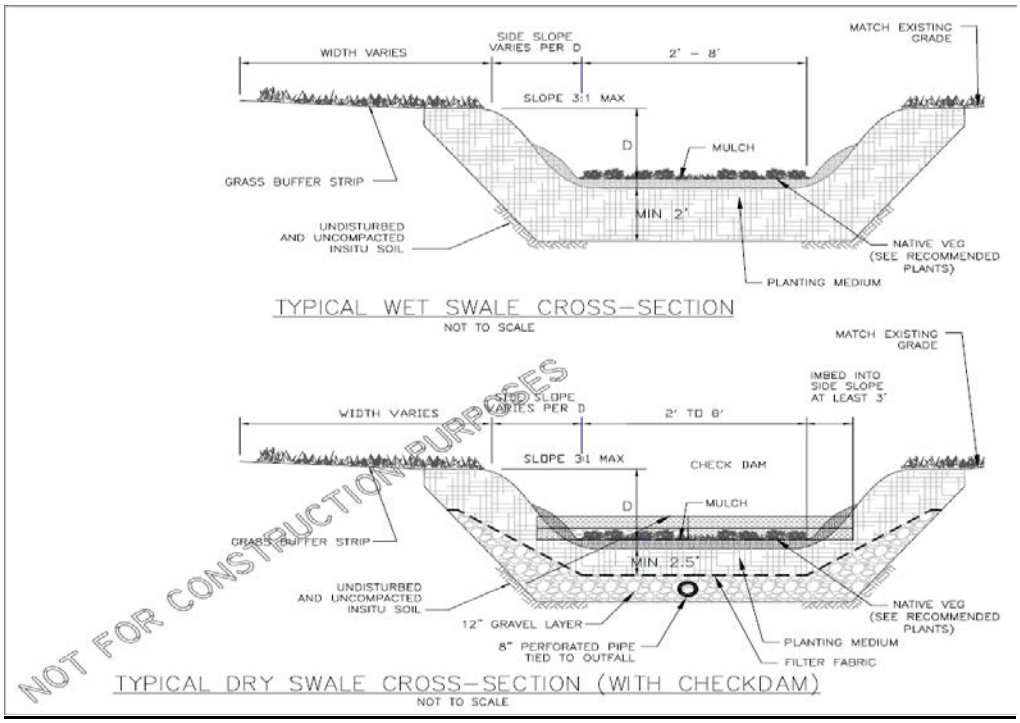

Town of Burnsville Site:
Yancey County Department of Social Services
BLUE RIDGE LN
YANCEY NURSING CENTER PROPERTY CO
R.O.W.
YANCEY COUNTY DSS
PENSACOLA RD
Site 1: Bioretention Swale
Parcels
Drainage Area
Roads
NHD Flowline by Type
Source: NC Stream Mapping Program
Culvert
Stream / River
2010 Orthophotography
1 inch = 110 feet
0
55
110
Feet
N

Diagram and photograph of a typical swale:



MODEL
LOCAL GOVERNMENT STORMWATER MANAGEMENT ORDINANCE

PURPOSE

The purpose of this ordinance is to protect, maintain and enhance the public health, safety, environment and general welfare by establishing minimum requirements and procedures to control the adverse effects of increased post-development stormwater runoff and nonpoint and point source pollution associated with new development and redevelopment as well as illicit discharges into municipal stormwater systems. It has been determined that proper management of construction-related and post-development stormwater runoff will minimize damage to public and private property and infrastructure; safeguard the public health, safety, and general welfare; and protect water and aquatic resources.

APPLICABILITY AND JURISDICTION

(A) The provisions of this ordinance shall apply within the Town Limits and any Extraterritorial Jurisdiction (ETJ).

(B) The following development activities are exempt from the provisions of this ordinance:

(1) Construction of a single-family or two-family residence
(2) Redevelopment, or change in use of a structure, that does not involve more than 5,000 square feet of land disturbance
(3) Redevelopment, or change in use of a structure, that does not involve construction of more than 5,000 square feet of additional impervious surface
(4) Agriculture and forestry practices

RELATIONSHIP TO OTHER LAWS, REGULATIONS AND PRIVATE AGREEMENTS

This ordinance is not intended to modify or repeal any other ordinance, rule, regulation or other provision of law. The requirements of this ordinance are in addition to the requirements of any other ordinance, rule, regulation or other provision of law. Where any provision of this ordinance imposes restrictions different from those imposed by any other ordinance, rule, regulation or other provision of law, whichever provision is more restrictive or imposes higher protective standards for human or environmental health, safety, and welfare shall control.

EFFECTIVE DATE AND TRANSITIONAL PROVISIONS

(A) This Ordinance shall take effect on _____, 201___.

(B) All development and redevelopment projects for which all necessary permits were issued prior to the effective date of this ordinance and which remain valid, unexpired, unrevoked and not otherwise terminated at the time of development or redevelopment shall be exempt from complying with all provisions of this ordinance dealing with the control and/or management of post-construction runoff, but shall be required to comply with all other applicable provisions (including but not limited to illicit discharge provisions).

DRAINAGE PLAN REQUIRED

Any development or redevelopment subject to the provisions of this ordinance shall submit a Drainage Plan for review by the Town in conjunction with application for a Zoning Permit. The Town shall review the Drainage Plan for compliance with the provisions of this ordinance. The Drainage Plan shall be prepared and bear the seal of a licensed professional engineer, and include the following:

(A) Topographic Map of the total drainage area that includes the project site. The Topographic Map shall have a scale not smaller than 1 inch = 50 feet, and include the following:
  (1) Contours at two-foot intervals
  (2) Property lines
  (3) Project construction elements (structures, parking lots, driveways, and other impervious surfaces)
  (4) Existing perennial and intermittent streams; wetlands; and springs
  (5) Existing man-made stormwater facilities

(B) Engineering drawings depicting design and details of proposed piping, drainage structures, retention/detention structures, and channels connecting to a network of man-made or natural drainage features

(C) Specifications of piping, drainage structures, permanent erosion control measures, and retention/detention structures

(D) Computations to support the design and specifications

GENERAL PROVISIONS

(A) To the extent practical, lot lines in subdivisions shall follow natural and existing man-made drainage features

(B) Stormwater shall not be channeled into a sanitary sewer system

DEVELOPMENT STANDARDS

(A) Stormwater runoff from the development shall be transported from the development by vegetated conveyances to the maximum extent practicable.

(B) All built-upon area shall be at a minimum of 30 feet landward of all perennial and intermittent surface waters.

(C) Post-development runoff rate shall not exceed pre-development runoff rate. Runoff rates must be based on the same calculation method.

(D) Stormwater management facilities shall have a minimum design capacity of the 10-year discharge. The design capacity for cross drainage facilities in public streets shall be the 25-year discharge.

(E) Stormwater management facilities shall be designed in accordance with 15A NCAC 2H .1008

(F) Stormwater management facilities shall be permanent, shall be protected with easements or covenants that run with the land, and shall be provided with public access

(G) Projects that drain to Class Tr waters shall include stormwater management measures that do not result in a sustained increase in water temperature of the receiving stream

(H) Minimum pipe diameter shall be 18 inches for open-ended culverts and 15 inches for closed systems and driveway culverts. Minimum pipe diameter for portions of closed systems outside the public right-of-way shall be 12 inches.

MAINTENANCE

The owner (or other responsible party) of each stormwater management facility installed pursuant to this ordinance shall maintain and operate it so as to preserve and continue its function in controlling stormwater quality and quantity at the degree or amount of function for which the facility was designed.

PERFORMANCE SECURITY FOR INSTALLATION AND MAINTENANCE

The Town may, at its discretion, require the submittal of a performance security or bond with surety, cash escrow, letter of credit or other acceptable legal arrangement prior to issuance of a permit in order to ensure that the stormwater management facilities are:

(A) Installed as indicated in the Drainage Plan

(B) Maintained by the owner as required by this ordinance

REMEDIES AND PENALTIES

(A) The remedies and penalties provided for violations of this ordinance, whether civil or criminal, shall be cumulative and in addition to any other remedy provided by law, and may be exercised in any order.

(B) The Town may refuse to issue a certificate of occupancy for the building or other improvements constructed or being constructed on the site and served by the stormwater practices in question until the applicant or other responsible person has taken the remedial measures set forth in the notice of violation or has otherwise cured the violations described therein.

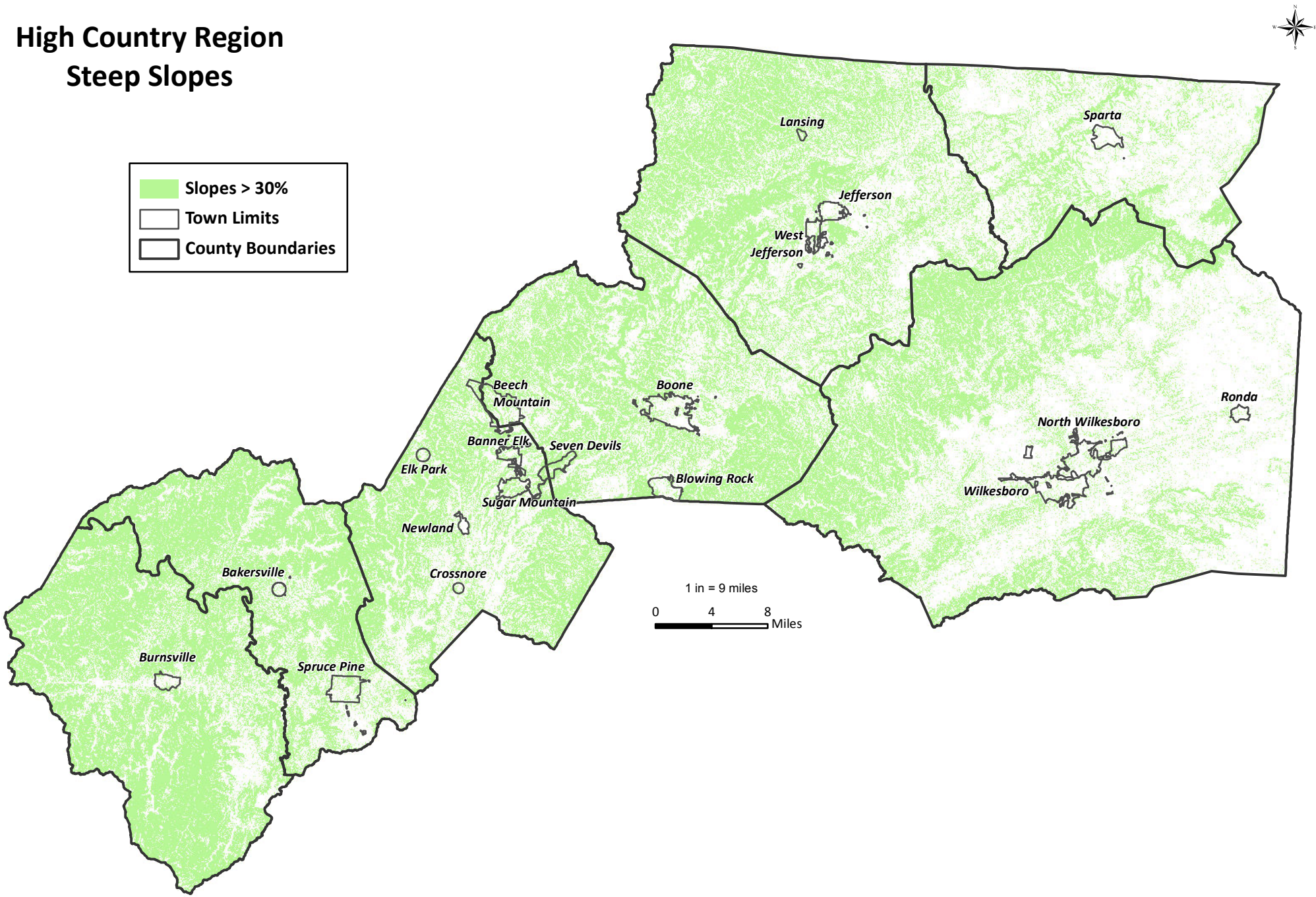
(C) As long as a violation of this ordinance continues and remains uncorrected, the Town may disapprove any request for permit or development approval or authorization on the land on which the violation occurs.

(D) If the violation is deemed dangerous or prejudicial to the public health or public safety and is within the geographic limits prescribed by North Carolina G.S. § 160A-193, the Town may cause the violation to be corrected and the costs to be assessed as a lien against the property.

(E) The Town may issue a stop work order to the person(s) violating this ordinance. The stop work order shall remain in effect until the person has taken the remedial measures set forth in the notice of violation or has otherwise cured the violation or violations described therein. The stop work order may be withdrawn or modified to enable the person to take the necessary remedial measures to cure such violation or violations.

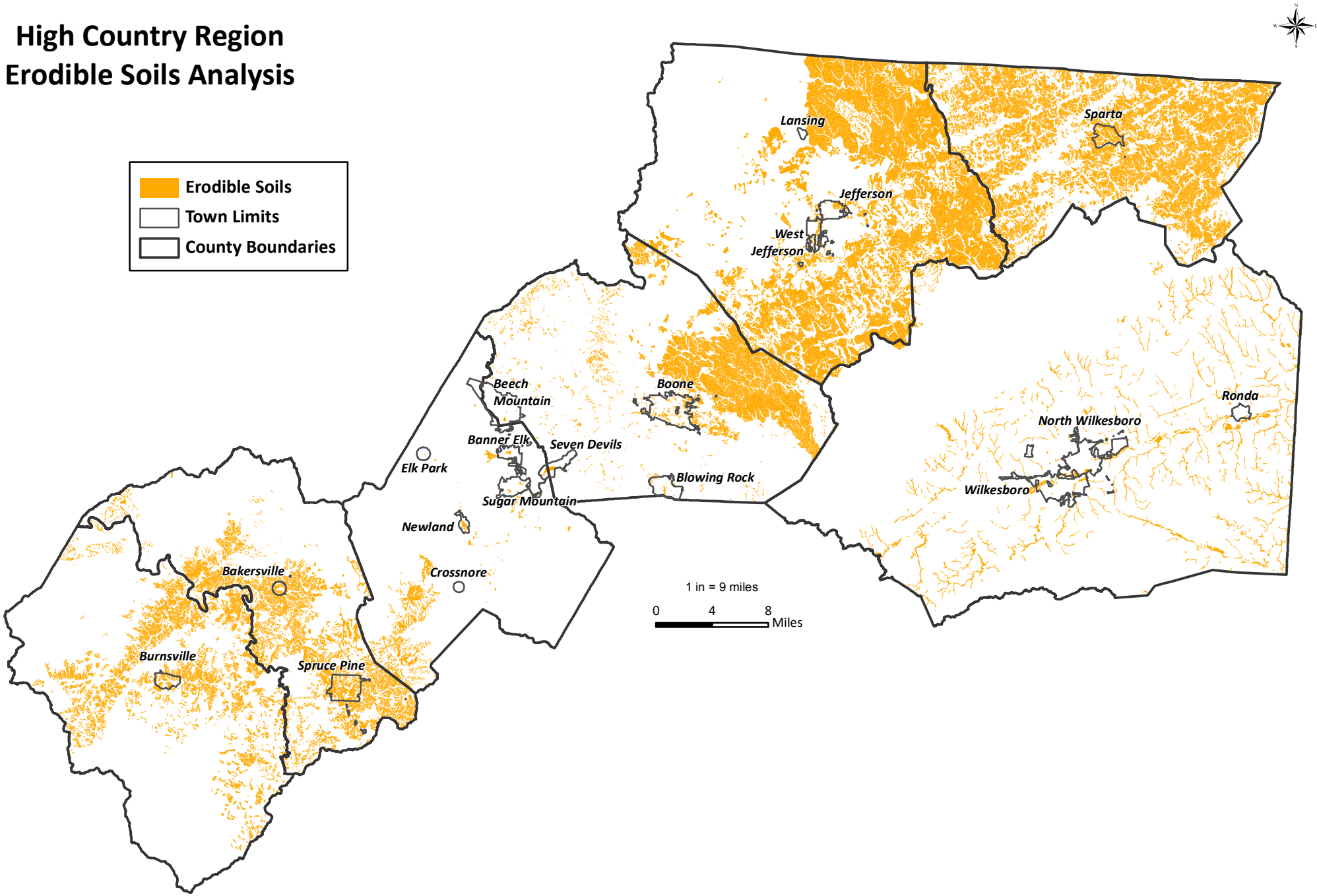
(F) Violation of this ordinance may be enforced as a misdemeanor subject to the maximum fine permissible under North Carolina law.

High Country Region
Steep Slopes



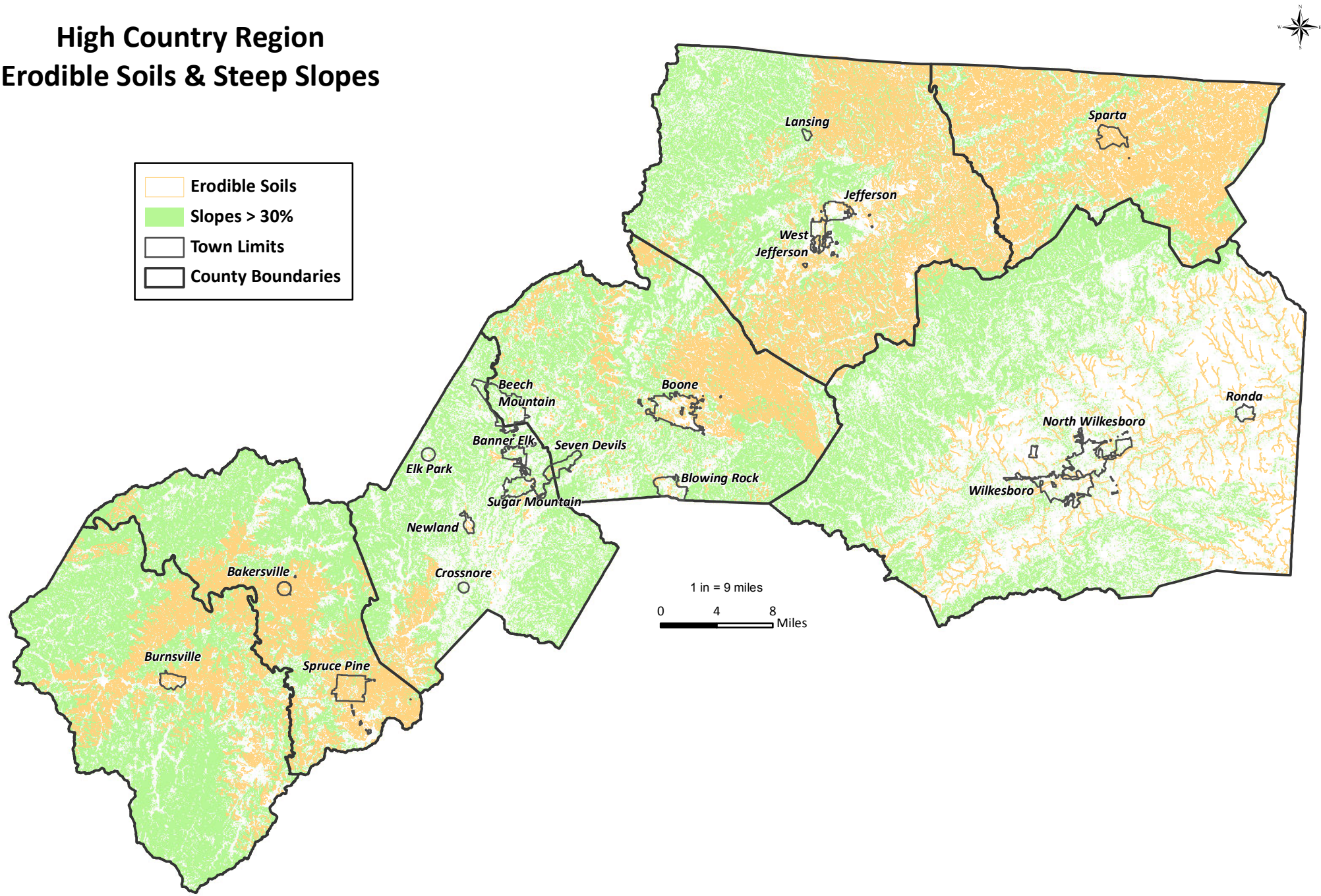
Source: Slopes generated from 2007 NC DOT LiDAR digital elevation data.

High Country Region
Erodible Soils Analysis



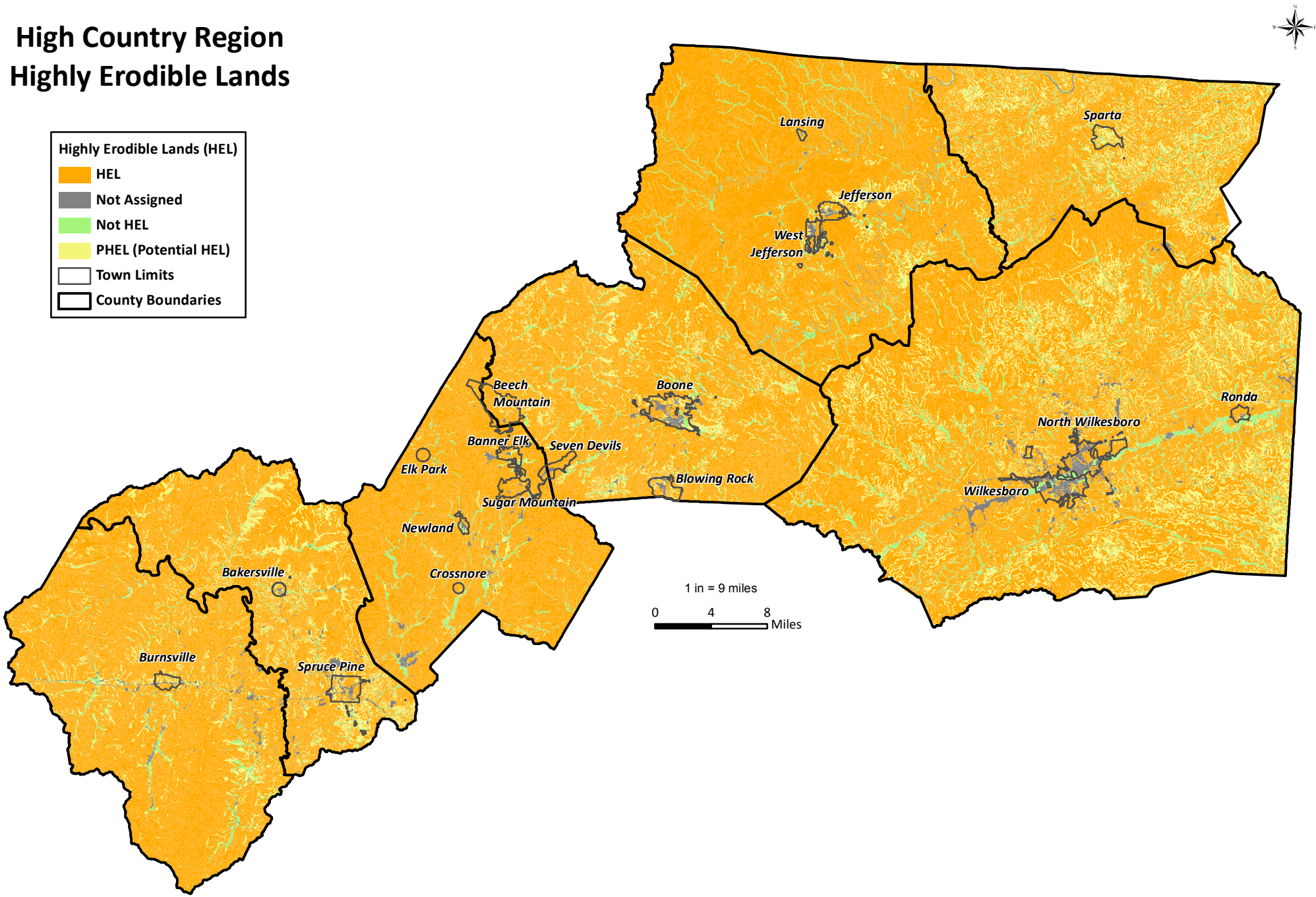
Source: NCRS SSURGO Soil Data.
Soils with a high K factor were extracted to display erodible soils based solely on surface soil texture.

High Country Region
Erodible Soils & Steep Slopes

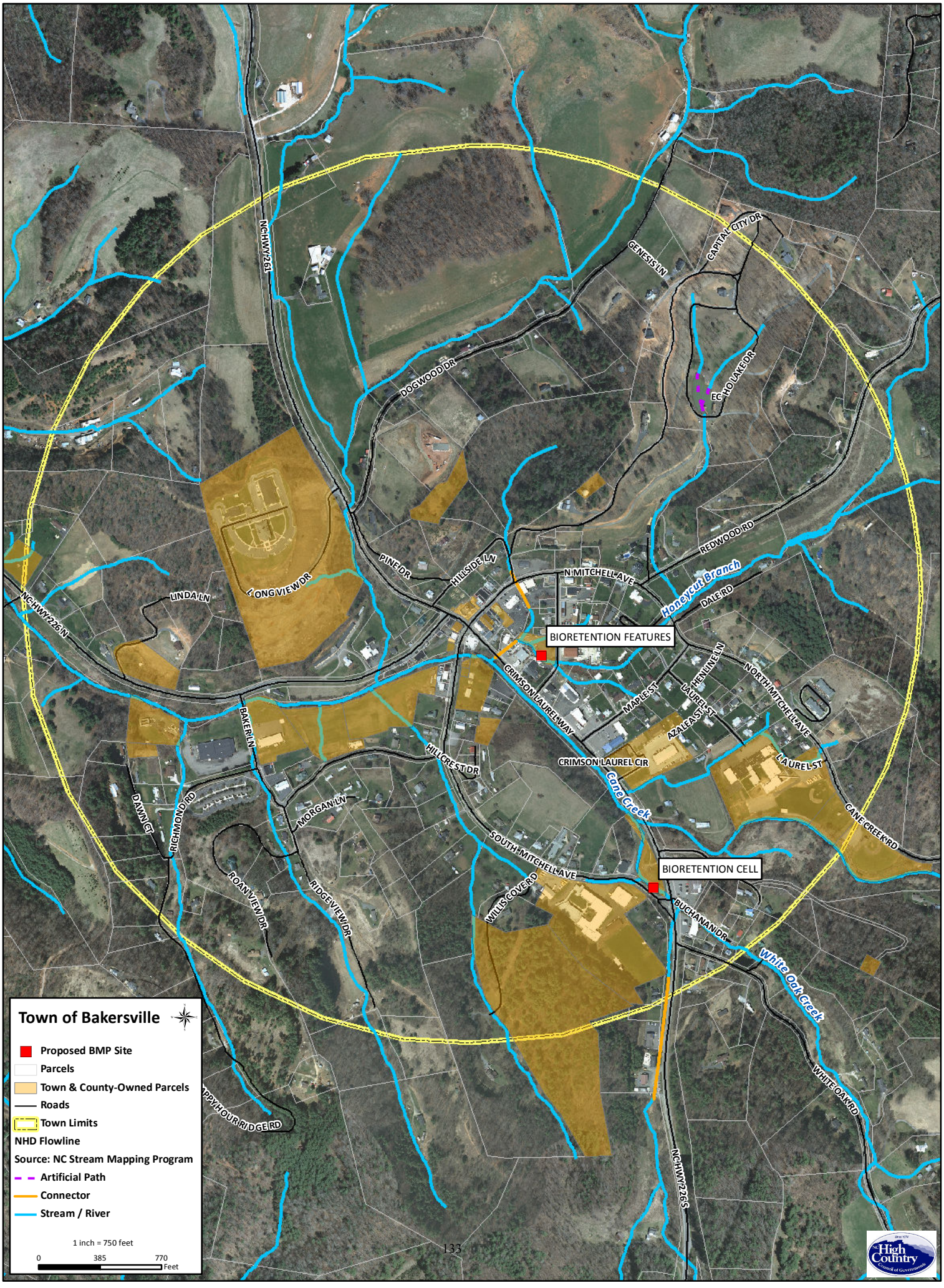


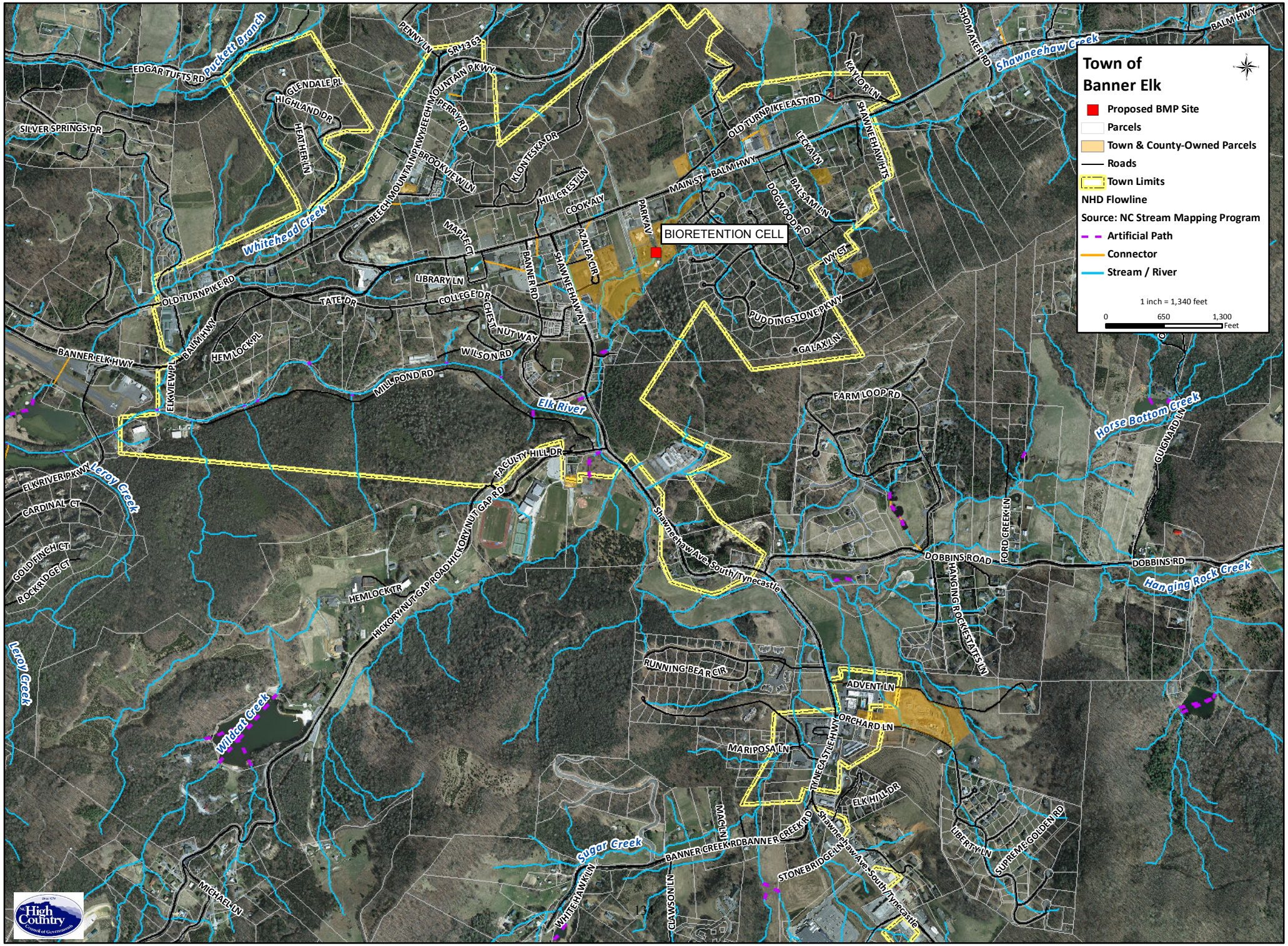
Source: NCRS SSURGO Soil Data &
2007 LiDAR digital elevation data

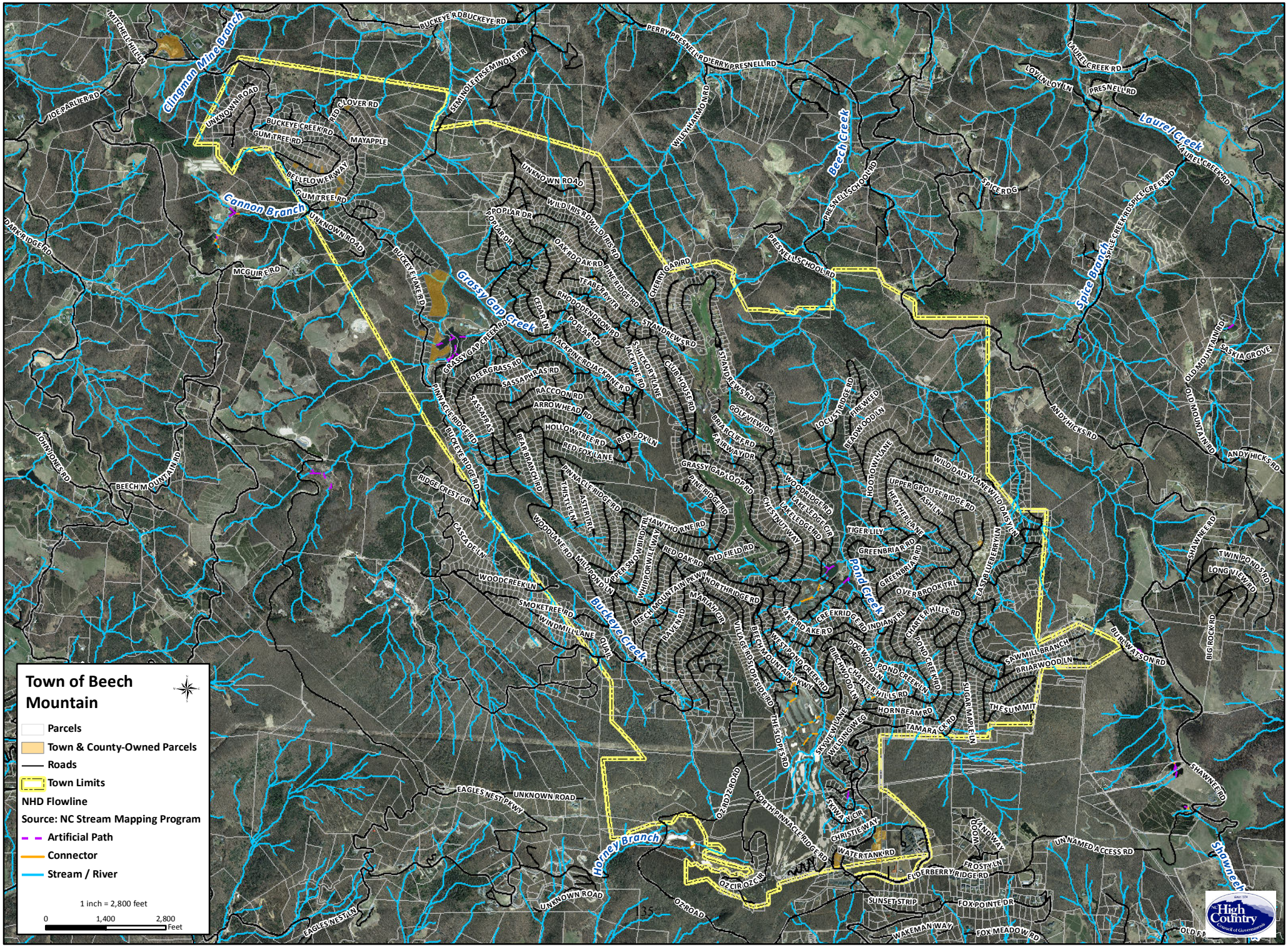
High Country Region
Highly Erodible Lands

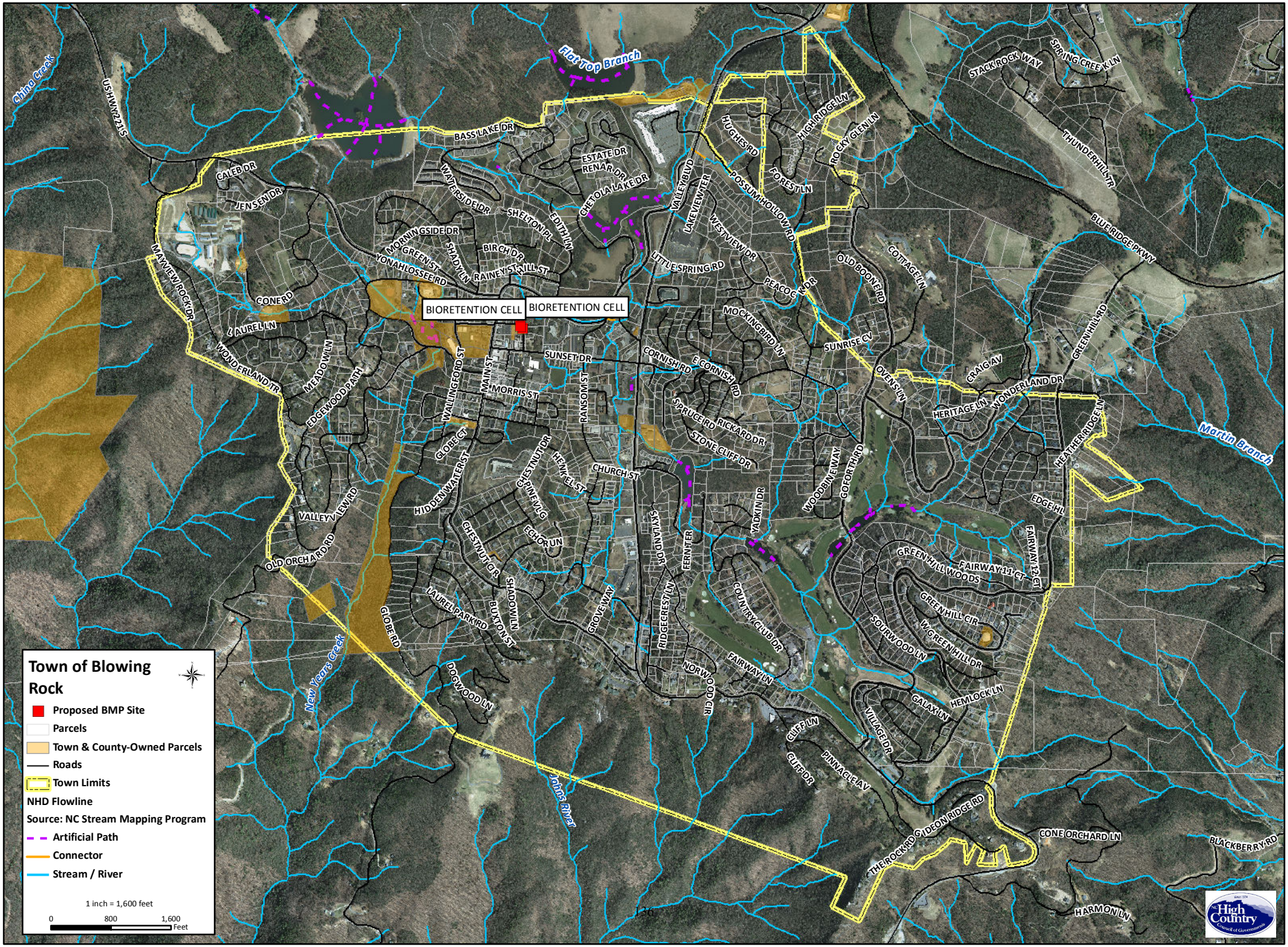


Source: USDA NCRS, 2012.
The Highly Erodible Lands data is based on soil texture and topographic characteristics.


Town of Bakersville
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 750 feet
0
385
770
Feet
BIORETENTION FEATURES
BIORETENTION CELL
NC HWY 261
NC HWY 226 N
NC HWY 226 S
GENESIS LN
CAPITAL CITY DR
DOGWOOD DR
ECHO LAKE DR
REDWOOD RD
PINE DR
HILLSIDE LN
N MITCHELL AVE
LINDA LN
LONG VIEW DR
DALE RD
Honeycut Branch
CRIMSON LAUREL WAY
HENLINE LN
NORTH MITCHELL AVE
MAPLE ST
LAUREL ST
AZALEA ST
CRIMSON LAUREL CIR
LAUREL ST
BAKER LN
HILLCREST DR
DAWN CT
RICHMOND RD
MORGAN LN
Cane Creek
CANE CREEK RD
SOUTH MITCHELL AVE
ROAN VIEW DR
RIDGE VIEW DR
WILLIS COVE RD
BUCHANAN DR
White Oak Creek
WHITE OAK RD
APPY HOUR RIDGE RD


Town of
Banner Elk
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 1,340 feet
0
650
1,300
Feet
BIORETENTION CELL
Whiteoak Creek
Puckett Branch
Shawneehaw Creek
Elk River
Leroy Creek
Wildcat Creek
Sugar Creek
Horse Bottom Creek
Hanging Rock Creek
EDGAR TUFTS RD
PENNY LN
SR 1363
BEECH MOUNTAIN PKWY
SILVER SPRINGS DR
GLENDALE PL
HIGHLAND DR
HEATHER LN
PERRY RD
BROOKVIEW LN
KLONTESKA DR
HILLCREST LN
COOK ALY
MAIN ST
BALM HWY
OLD TURNPIKE EAST RD
SHAWNEEHAW HTS
LEOKA LN
BALSAM LN
DOGWOOD DR
IVY CT
PUDDINGSTONE PKWY
GALAX LN
PARK AV
AZALEA CIR
SHAWNEEHAW AV
BANNER RD
MAPLE CT
LIBRARY LN
COLLEGE DR
CHESTNUT WAY
TATE DR
OLD TURNPIKE RD
BALM HWY
HEMLOCK PL
ELKVIEW PL
BANNER ELK HWY
WILSON RD
MILL POND RD
FACULTY HILL DR
FARM LOOP RD
GUIGNARD LN
ELK RIVER PKWY
CARDINAL CT
GOLDFINCH CT
ROCKRIDGE CT
HEMLOCK TR
HICKORY NUT GAP RD
NUT GAP RD
Shawneehaw Ave. South/Tynecastle
DOBBINS ROAD
DOBBINS RD
FORD GREEK LN
HANGING ROCK ESTATES LN
RUNNING BEAR CIR
ADVENT LN
ORCHARD LN
MARIPOSA LN
TYNECASTLE HWY
ELK HILL DR
MAC LN
BANNER CREEK RD
Shawneehaw Ave. South/Tynecastle
STONEBRIDGE LN
LIBERTY LN
SUPREME GOLDEN RD
WHITEHAWK LN
CLAWSON LN
MICHAEL LN
SHOMAKER RD
KAYLOR LN
BALM HWY


Town of Beech Mountain
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 2,800 feet
0
1,400
2,800
Feet
Clingman Mine Branch
Cannon Branch
Grassy Gap Creek
Buckeye Creek
Horney Branch
Beech Creek
Pond Creek
Laurel Creek
Spice Branch
Shawnee
MITCHELL HILL LN
BUCKEYE RD
PERRY PRESNELL RD
LAUREL CREEK RD
JOE PARLIER RD
UNKNOWN ROAD
CLOVER RD
BUCKEYE CREEK RD
GUM TREE RD
MAYAPPLE
BELLFLOWER WAY
SEMINOLE TR
WILEY HARMON RD
LOY M LOY LN
PRESNELL RD
DARK RIDGE RD
MCGUIRE RD
BUCKEYE LAKE RD
POPLAR DR
WILD IRIS RD
OAK RD
PINE RIDGE RD
TEABERRY TR
RHODODENDRON RD
CHERRY CAP RD
PRESNELL SCHOOL RD
SPICE RDG
SPICE CREEK RD
GRASSY GAP CREEK RD
CEDAR LN
JACKPINE RD
SHICKORY LANE
CLUBHOUSE RD
ST ANDREWS RD
GOLFVIEW DR
OLD MOUNTAIN RD
SASKIA GROVE
ANDY HICKS RD
DEERGRASS RD
SASSAFRAS RD
RACCOON RD
ARROWHEAD RD
HOLLOW TREE RD
RED FOX LN
RED FOX LANE
PINNACLE RIDGE RD
BUCKEYE RIDGE RD
BRIARCLIFF RD
FAIRWAY DR
LOCUST WIDGE RD
FIREWEED
BEADWOOD LN
HOOTOWL LANE
WILD DAISY LN
JOHN JONES RD
BEECH MOUNTAIN RD
RIDGE CREST CIR
CASCADE LN
THISTLE LN
ASTER TRL
WOODLAND RD
MILL POND LN
GRASSY GAP LOOP RD
PINE RIDGE RD
WOODRIDGE RD
LAKE LEDGE RD
LAKE LEDGE CIR
CHESTNUT WAY
UPPER GROUSE RIDGE RD
HEATHER LN
ASH LN
TIGER LILY
GREENBRIAR RD
GREENBRIAR CIR
OVERBROOK TRL
EASTBLUEBERRY LN
SHAWNEE RD
TWIN PONDS RD
LONG VIEW RD
HAWTHORNE RD
RED OAK RD
OLD FIELD RD
UPPER SNOWBIRD RD
WHIPPORWILL WAY
NORTHRIDGE RD
BEECH MOUNTAIN PKWY
MARIA CIR
RAVEN RD
WOODCREEK LN
SMOKETREE RD
WINDMILL LANE
QUAIL
LAKE RD
CREEKRIDGE INDIAN TRL
CHARTER HILLS RD
POND CREEK RD
POND CREEK LN
DOGWOOD LN
BIRCHWOOD LN
WESTMOND CREEK RD
BEECH MOUNTAIN PKWY
VILLA GRD
STONESIDE RD
THE STONE RD
SAWMILL BRANCH
BRIARWOOD LN
BURL WATSON RD
BIG ROCK RD
THE SUMMIT
HORNBEAM RD
TAMARACK RD
SUGAR MAPLE LN
SKYVIEW LANE
WELDING WIG LEG
SKIWAY CIR
CHRISTIE WAY
OZ RD
OZ ROAD
NORTH PINNACLE RIDGE RD
WATER TANK RD
OZ CIR
OZ CIR
MOONWAY
FROSTY LN
ELDERBERRY RIDGE RD
UNNAMED ACCESS RD
SUNSET STRIP
FOX POINTE DR
WAKEMAN WAY
FOX MEADOW RD
EAGLES NEST PKWY
EAGLES NEST LN
UNKNOWN ROAD
135
NC High Country Council of Government



Town of Blowing Rock

- Proposed BMP Site
- Parcels
- Town & County-Owned Parcels
- Roads
- Town Limits

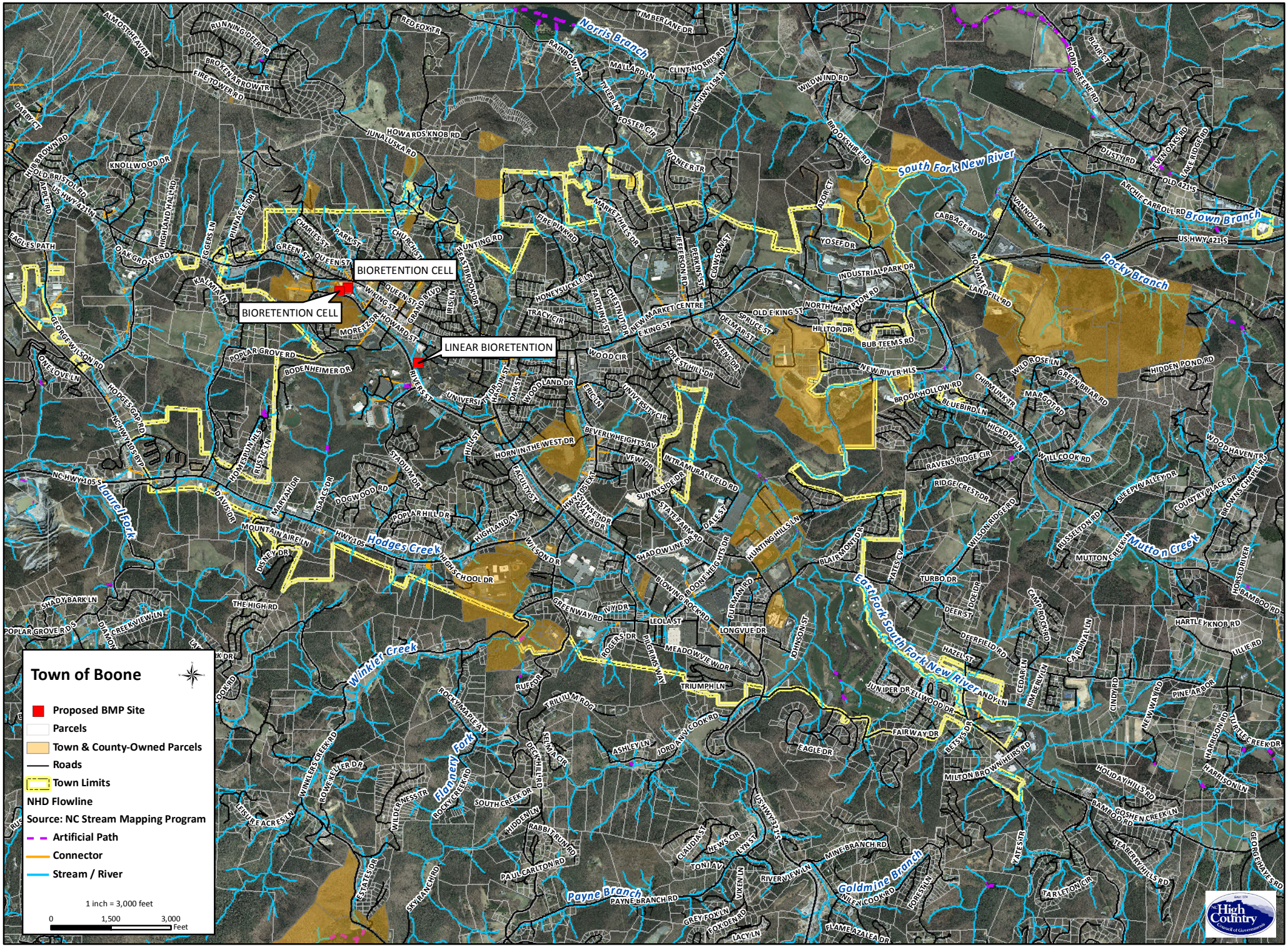
NHD Flowline

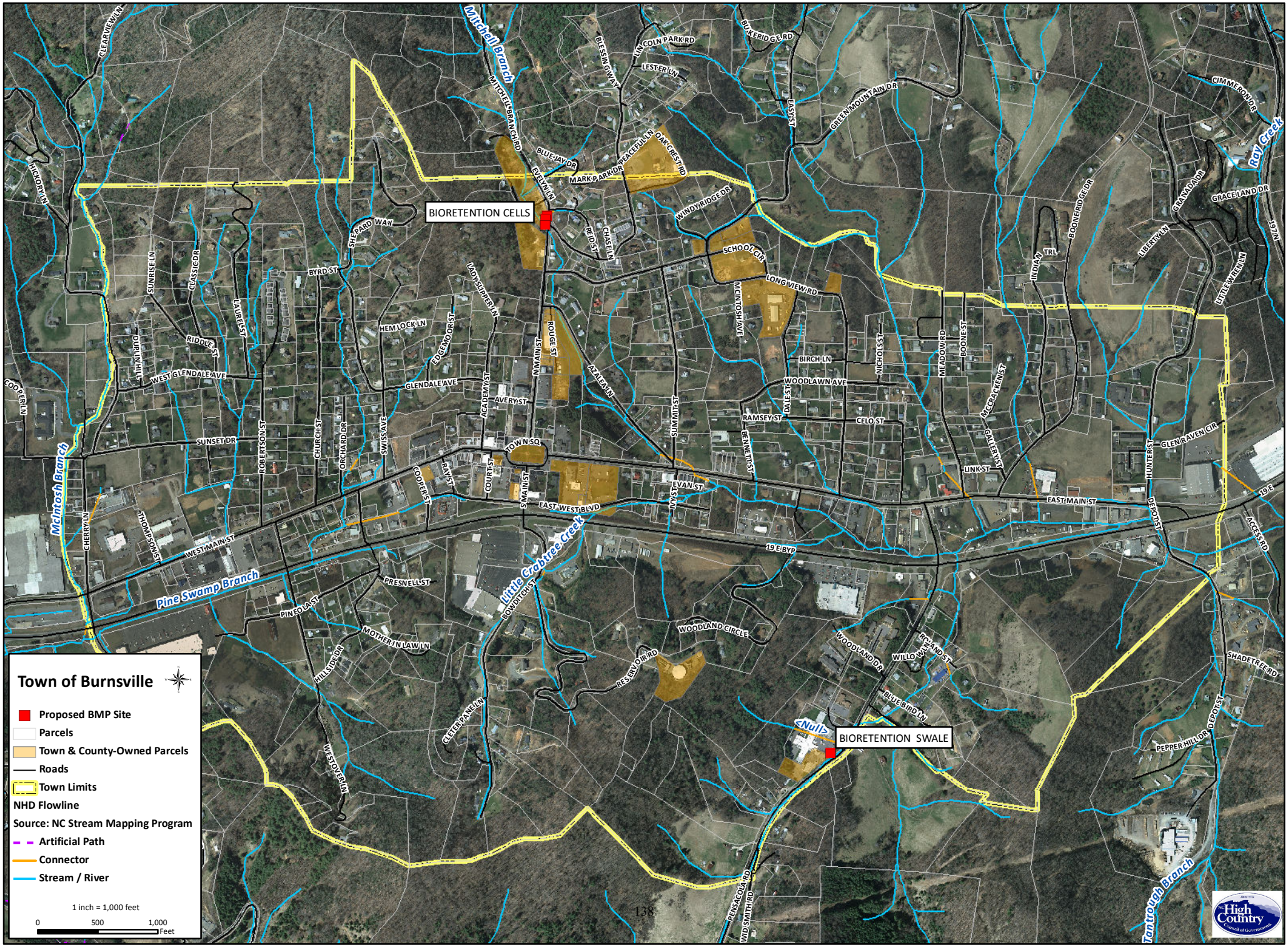
Source: NC Stream Mapping Program

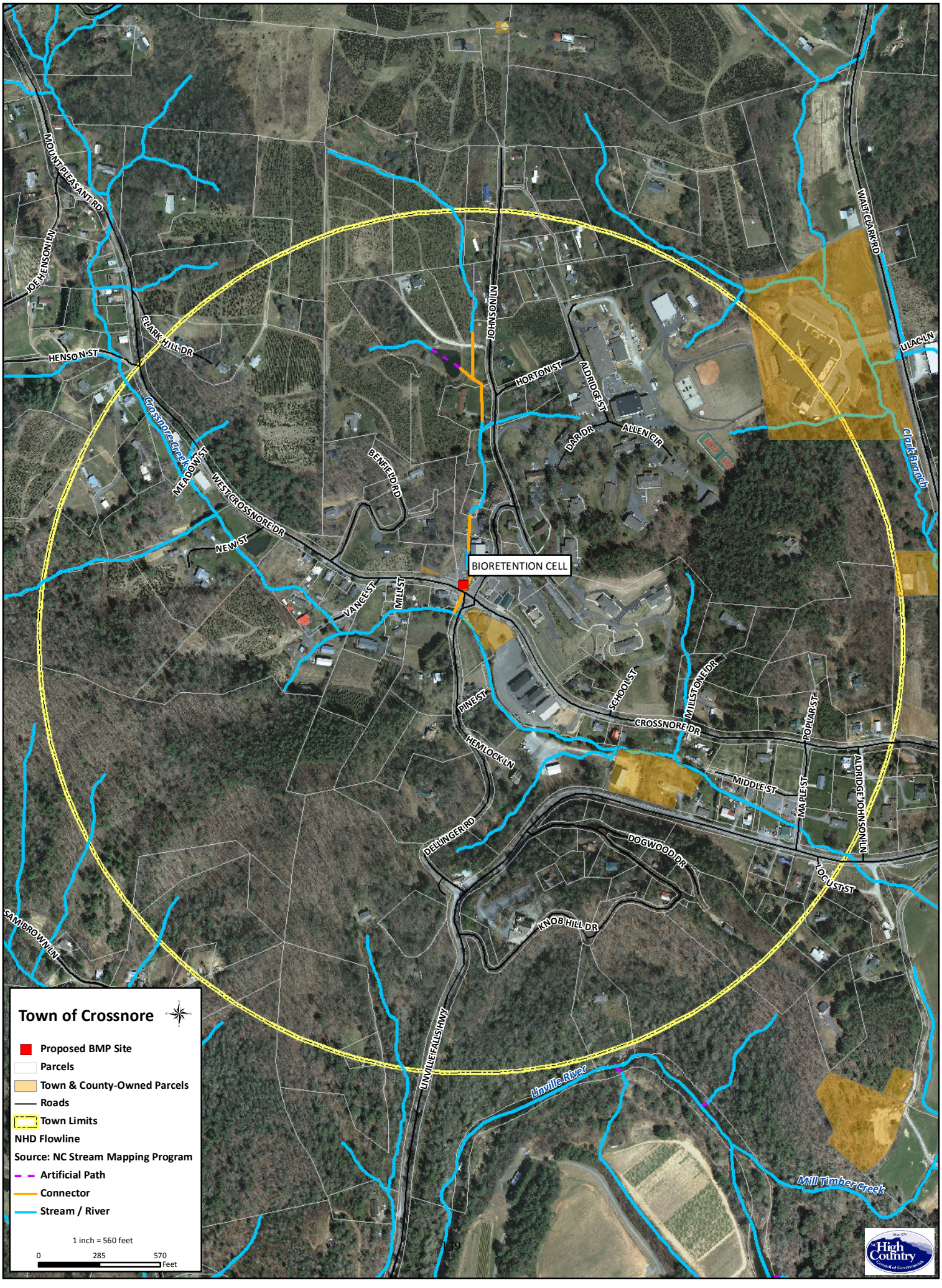
- Artificial Path
- Connector
- Stream / River

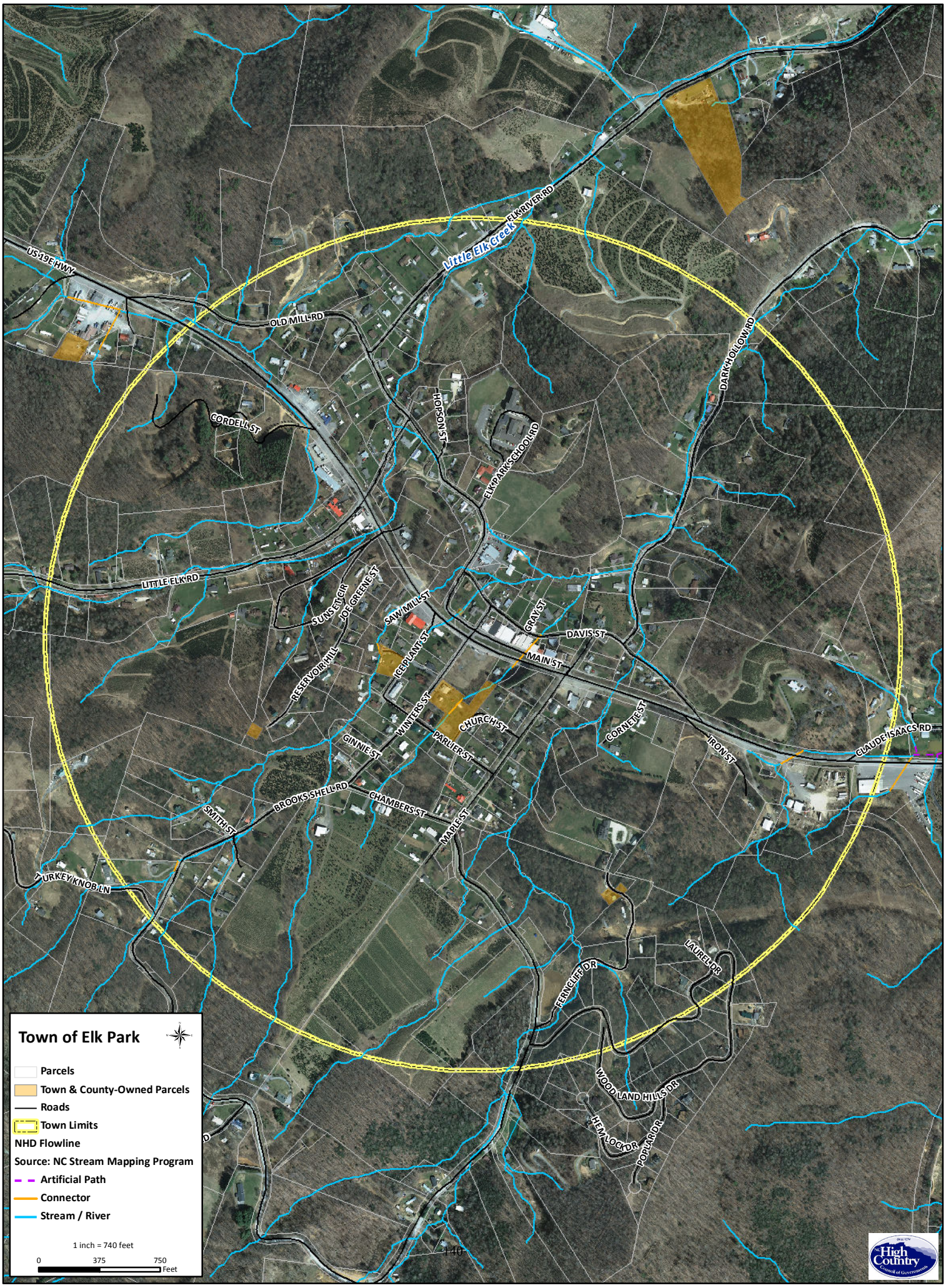
1 inch = 1,600 feet

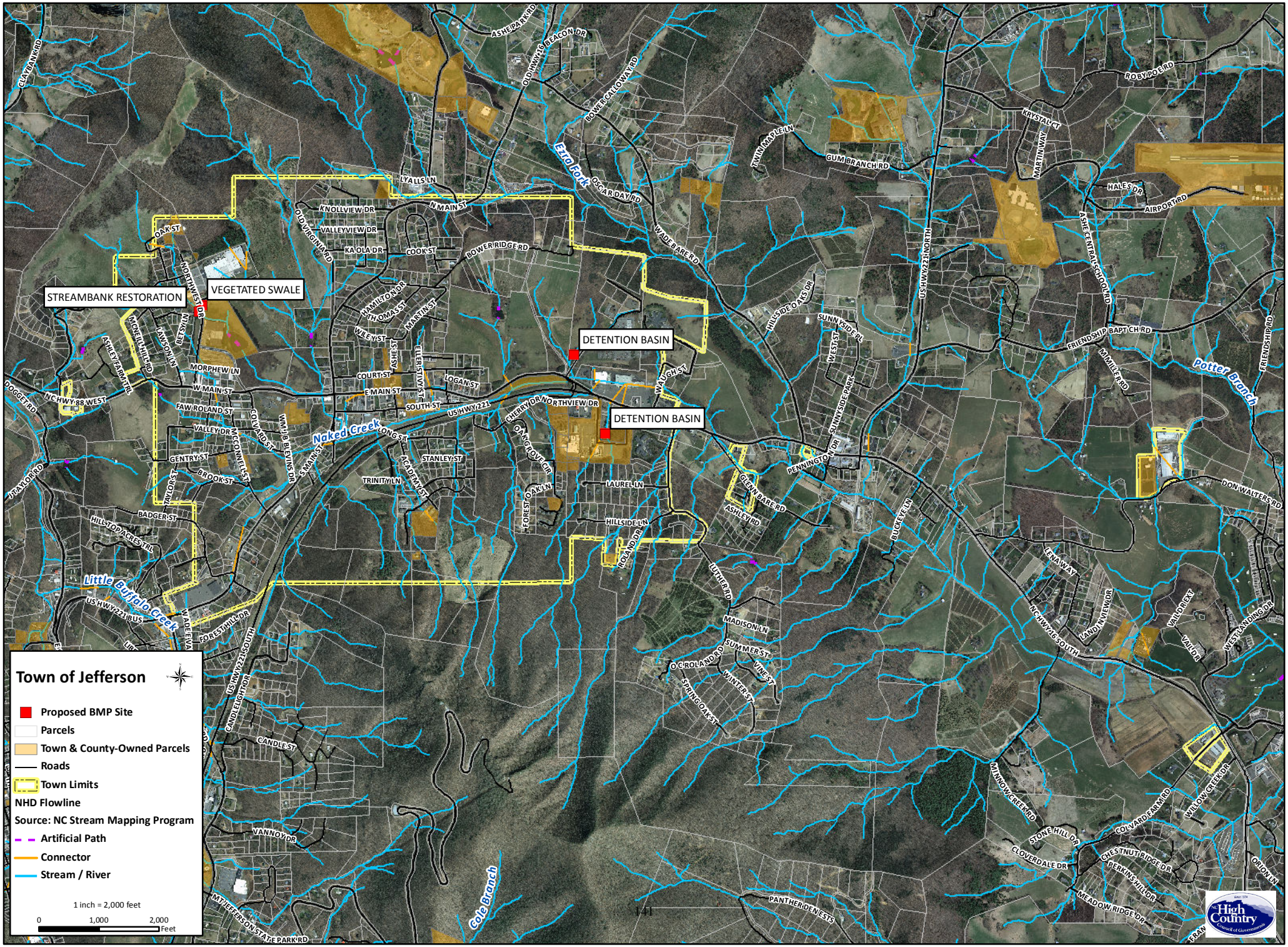
0 800 1,600 Feet

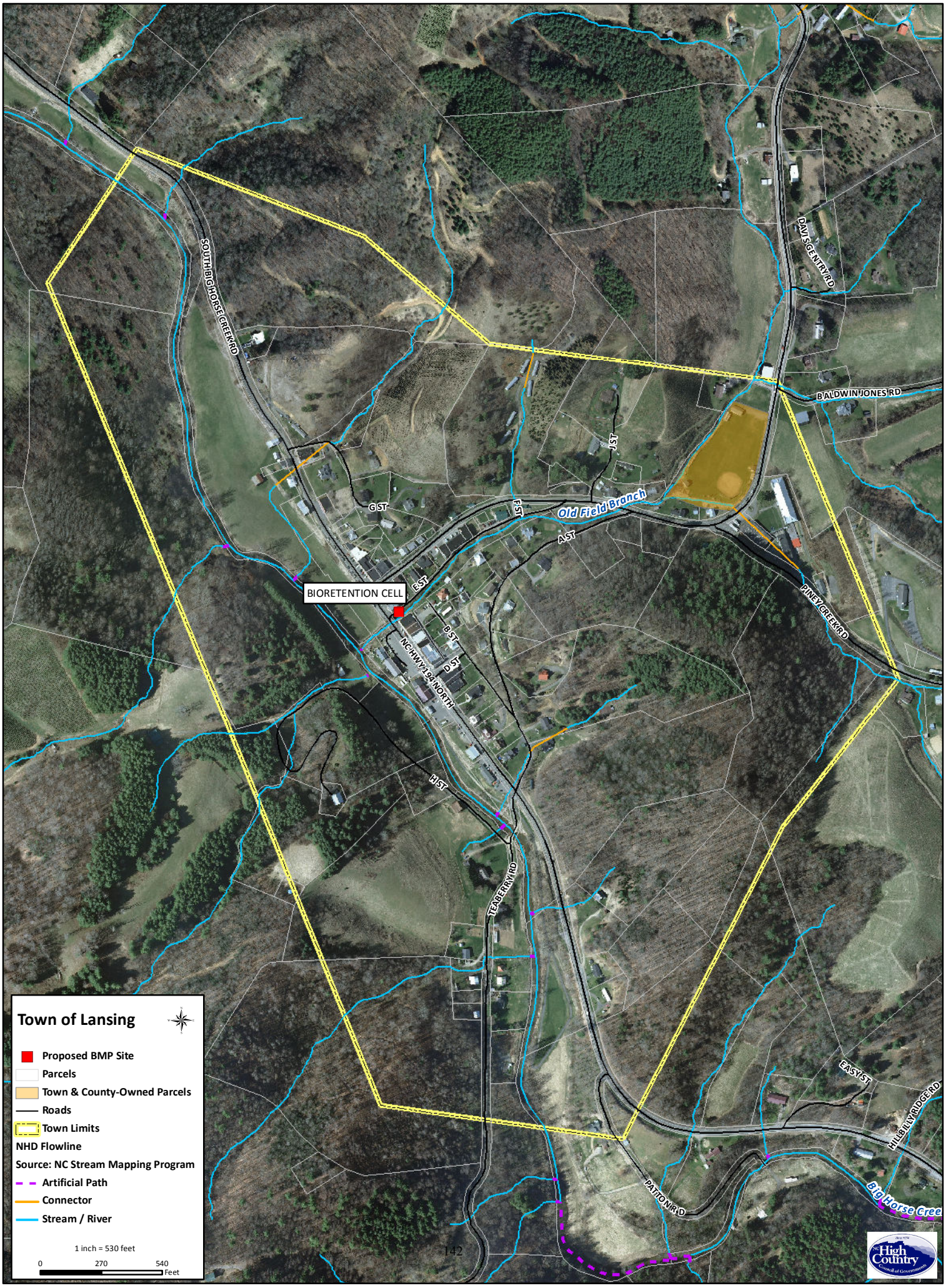

BIORETENTION CELL
BIORETENTION CELL
LINEAR BIORETENTION
Norris Branch
South Fork New River
Brown Branch
Rocky Branch
Laurel Fork
Hodges Creek
Winkler Creek
Flannery Fork
Payne Branch
Goldmine Branch
Mutton Creek
East Fork South Fork New River
Town of Boone
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 3,000 feet
0
1,500
3,000
Feet

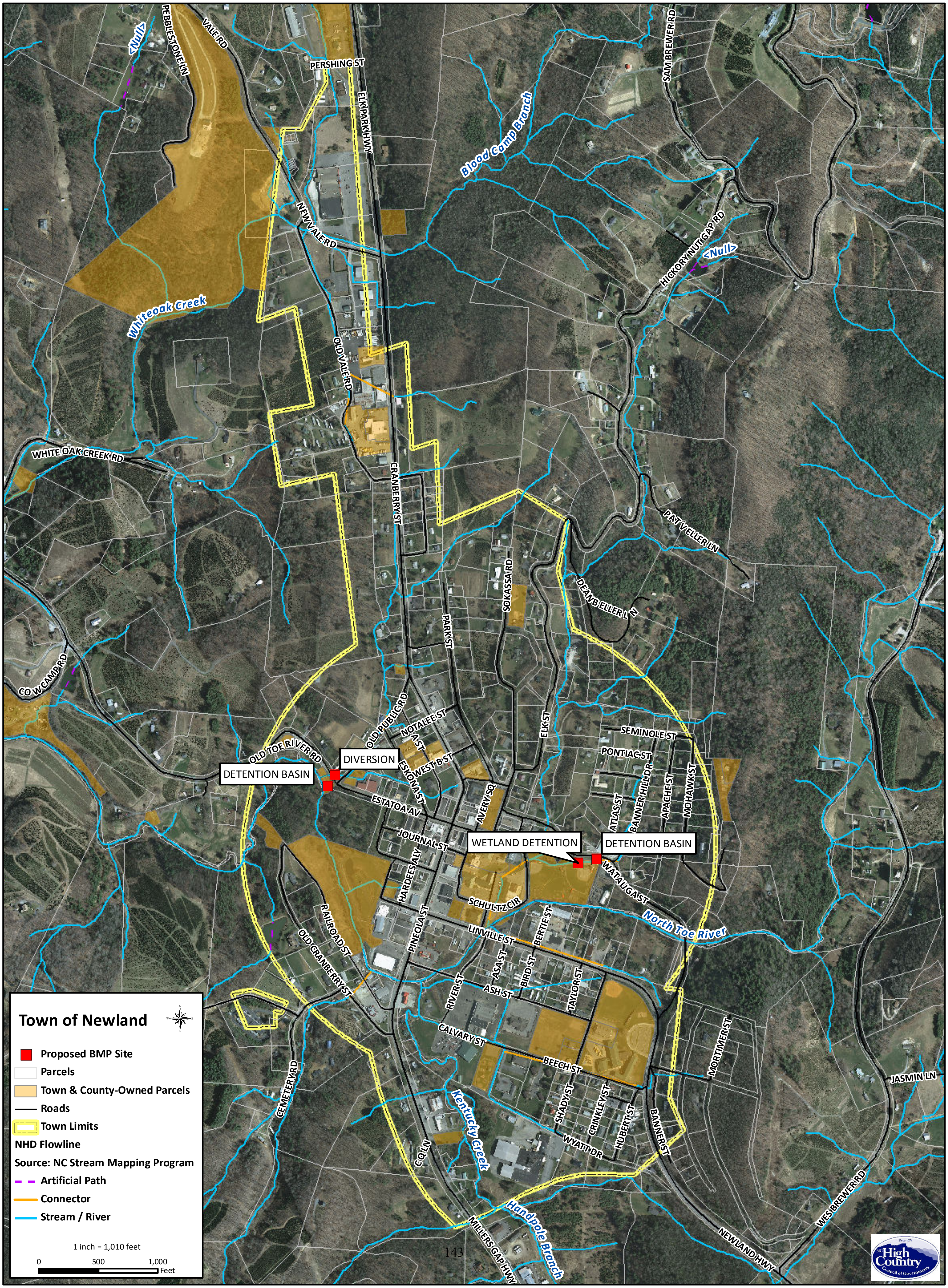

BIORETENTION CELLS
BIORETENTION SWALE
Mitchell Branch
McIntosh Branch
Pine Swamp Branch
Little Crabtree Creek
Ray Creek
Tantrough Branch
Town of Burnsville
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 1,000 feet
0
500
1,000
Feet

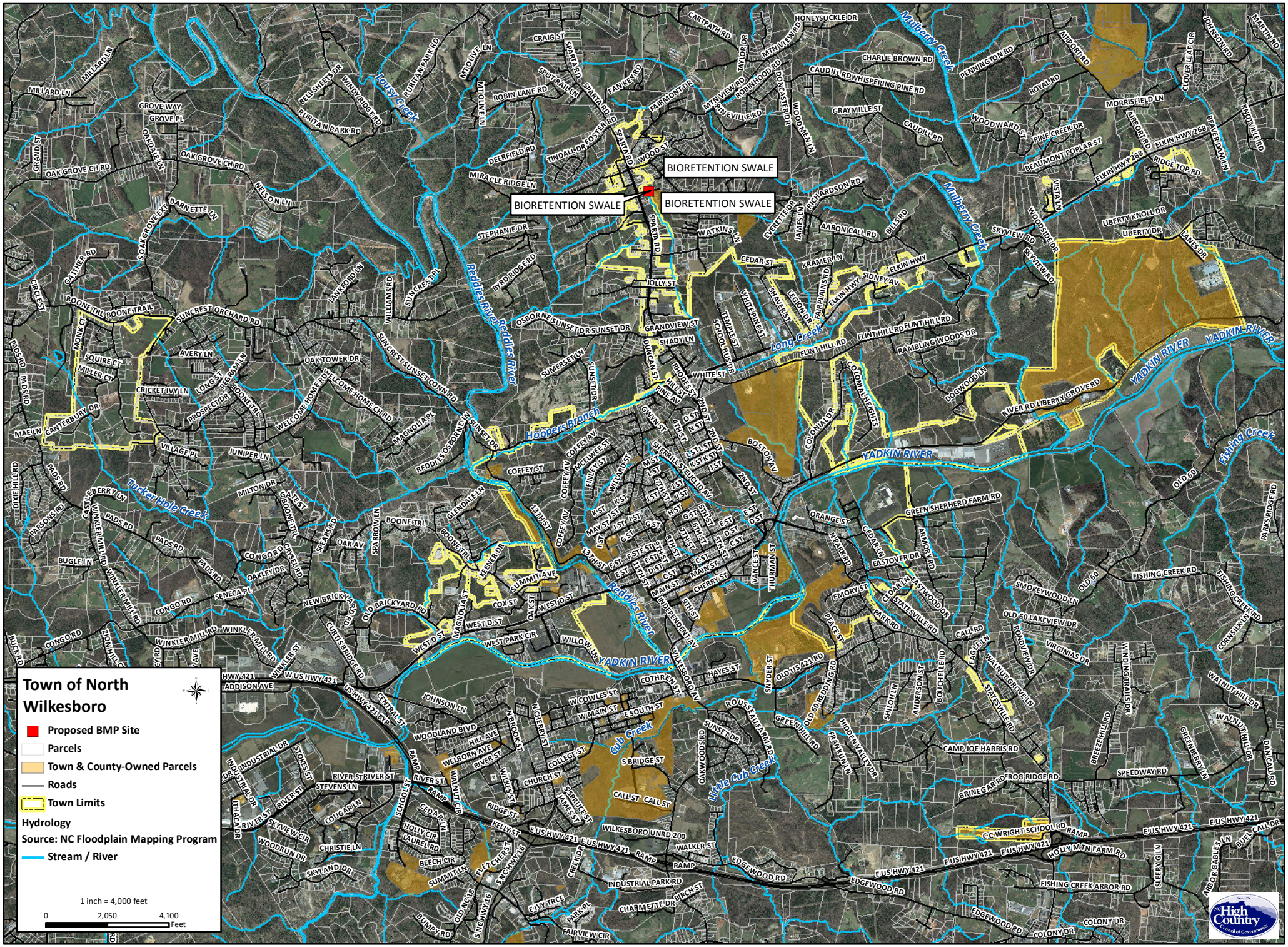

BIORETENTION CELL
MOUNT PLEASANT RD
HENSON ST
CLARK HILL DR
JOHNSON LN
HORTON ST
ALDRIDGE ST
DAR DR
ALLEN CIR
WAR CLARK RD
LILAC LN
Clark Branch
Crossnore Creek
MEADOW ST
WEST CROSSNORE DR
BENFIELD RD
NEW ST
VANCE ST
MILL ST
PINE ST
SCHOOL ST
MILLSTONE DR
CROSSNORE DR
POPLAR ST
HEMLOCK LN
MIDDLE ST
MAPLE ST
ALDRIDGE JOHNSON LN
DELLINGER RD
DOGWOOD DR
LOCUST ST
KNOB HILL DR
SAM BROWN LN
LINVILLE FALLS HWY
Linville River
Mill Timber Creek
Town of Crossnore
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 560 feet
0
285
570
Feet

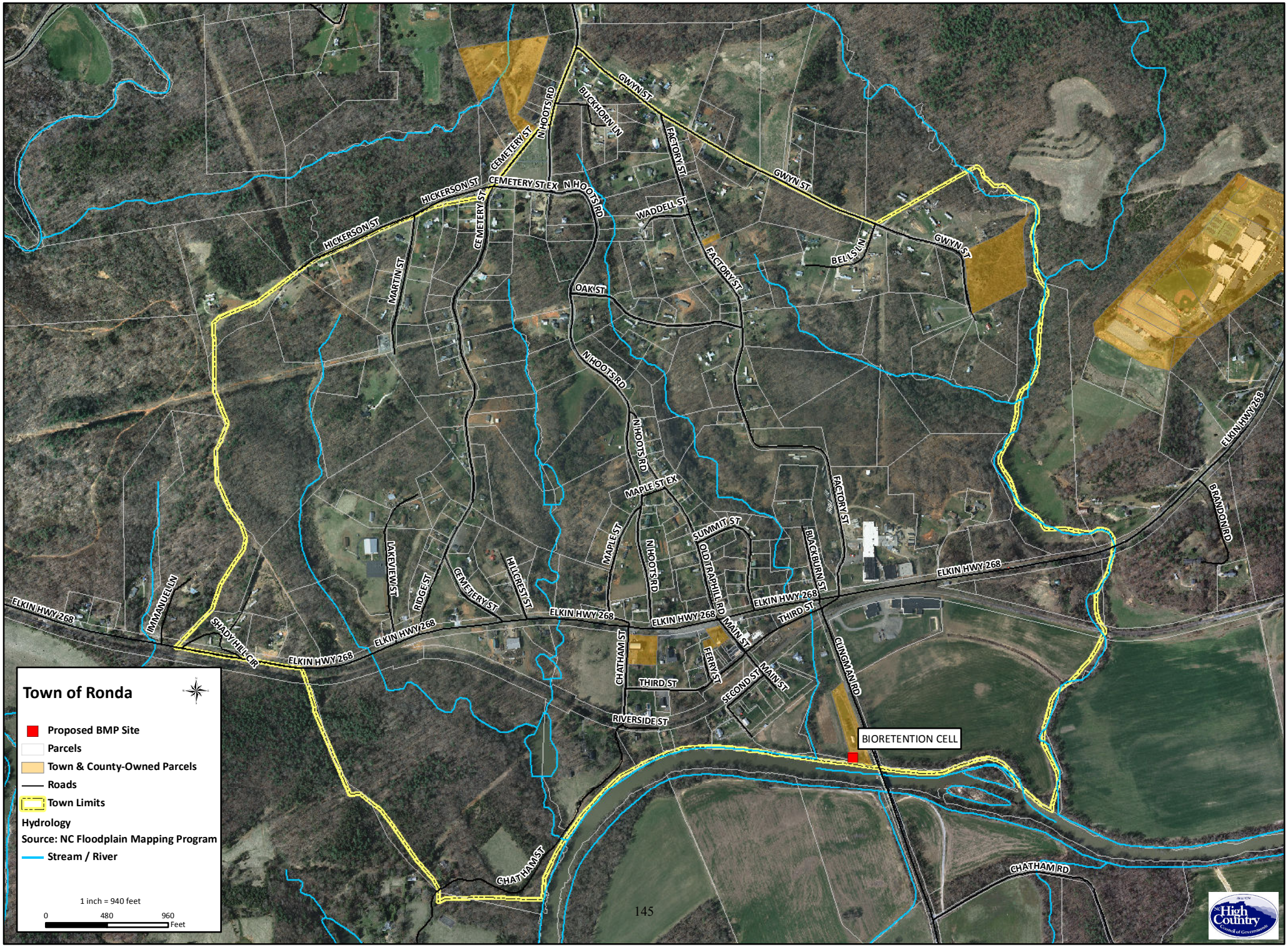

Town of Elk Park
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 740 feet
0
375
750
Feet
US 19E HWY
ELK RIVER RD
Little Elk Creek
OLD MILL RD
DARK HOLLOW RD
CORDELL ST
HOPSON ST
ELK PARK SCHOOL RD
LITTLE ELK RD
SUNSET CIR
JOE GREENE ST
SAW MILL ST
GRAY ST
DAVIS ST
MAIN ST
ICEPLANT ST
RESERVOIR HILL
WINTERS ST
CHURCH ST
CORNETT ST
IRON ST
CLAUDE ISAACS RD
GINNIE ST
PARLIER ST
BROOKS SHELL RD
CHAMBERS ST
SMITH ST
MAPLE ST
TURKEY KNOB LN
LAUREL DR
FERNCLIFF DR
WOODLAND HILLS DR
HEMLOCK DR
POPLAR DR

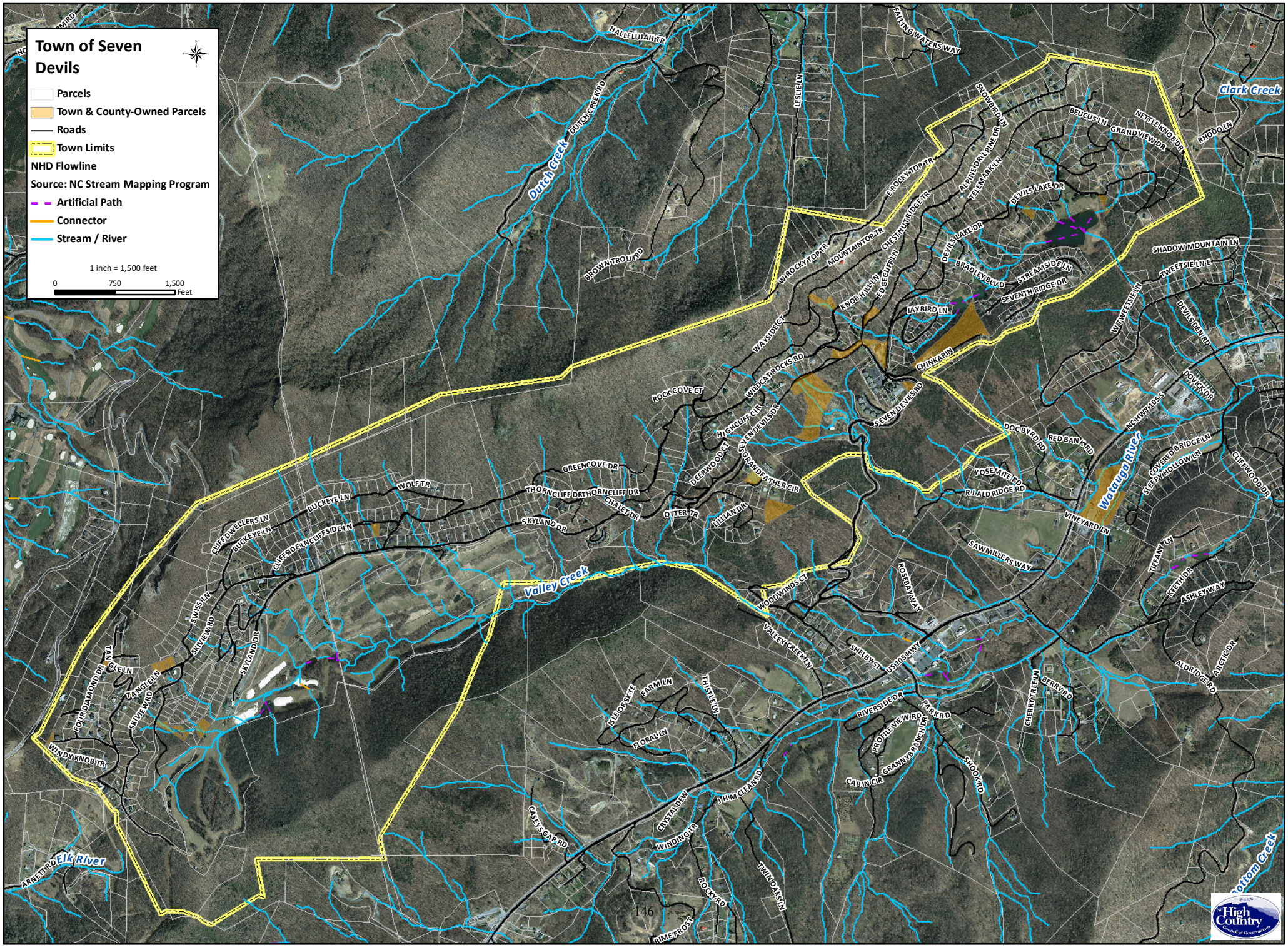

STREAMBANK RESTORATION
VEGETATED SWALE
DETENTION BASIN
DETENTION BASIN
Town of Jefferson
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 2,000 feet
0
1,000
2,000
Feet
Naked Creek
Little Buffalo Creek
Cole Branch
Potter Branch
Ezra Fork
NC HWY 88 WEST
US HWY 221
US HWY 221 BUS
NC HWY 16 SOUTH
N MAIN ST
W MAIN ST
E MAIN ST
SOUTH ST
COURT ST
LOGAN ST
VALLEY DR
FAW ROLAND ST
GENTRY ST
BROOK ST
BADGER ST
HILL TOP ACRES TRL
TRINITY LN
STANLEY ST
LAUREL LN
HILLSIDE LN
FOREST OAK LN
OAK GROVE CIR
CHERRY DR
NORTHVIEW DR
VAUGH ST
PENNINGTON DR
GLENN BARE RD
ASHLEY RD
BUCKEYE LN
LUTHER RD
MADISON LN
SUMMER ST
VINE ST
WINTER ST
SPRING OAK ST
O C ROLAND RD
ROLAND DR
LENA WAY
LANDVIEW DR
VAIL DR
WEST LANDING DR
DON WALTERS RD
FRIENDSHIP BAPT CH RD
FRIENDSHIP RD
M MILLER RD
SUNNYSIDE PARK
SUNNYSIDE PL
WEST ST
HILLSIDE OAKS DR
US HWY 221 NORTH
ASHE CENTRAL SCHOOL RD
KRYSTAL CT
MARTIN WAY
TWIN MAPLE LN
GUM BRANCH RD
ROBY DOZIER RD
HALES DR
AIRPORT RD
BOWER CALLOWAY RD
OSCAR DAY RD
WADE BARE RD
BOWER RIDGE RD
COOK ST
KA OLA DR
VALLEYVIEW DR
KNOLLVIEW DR
OLD VIRGINIA RD
OLD HWY 16
BEACON DR
ASHE PARK RD
LYALLS LN
OAK ST
NORTHWEST DR
HAMILTON DR
THOMAS ST
MARTIN ST
WILSY ST
ASHE ST
ELLERSTIVA ST
LONG ST
SMAIN ST
WM B BLEVINS DR
COLVARD ST
MCCONNELL ST
TAYLOR ST
ACADEMY ST
MORPHEW LN
BETSY LN
LAWSON LN
ASHLEY FARM TRL
MCNEIL HILL RD
CLAYBANK RD
TAYLOR RD
DOGGER RD
FOREST HILL DR
WADE EVA
CANDLE LIGHT DR
CANDLE ST
VANNOY DR
MT JEFFERSON STATE PARK RD
PANTHER DEN ESTS
MINNOW CREEK RD
STONE HILL DR
CLOVERDALE DR
CHESTNUT RIDGE DR
PERKINS HILL DR
MEADOW RIDGE DR
COLVARD FARM RD
WILLOW CREEK DR
ORONN LN
141

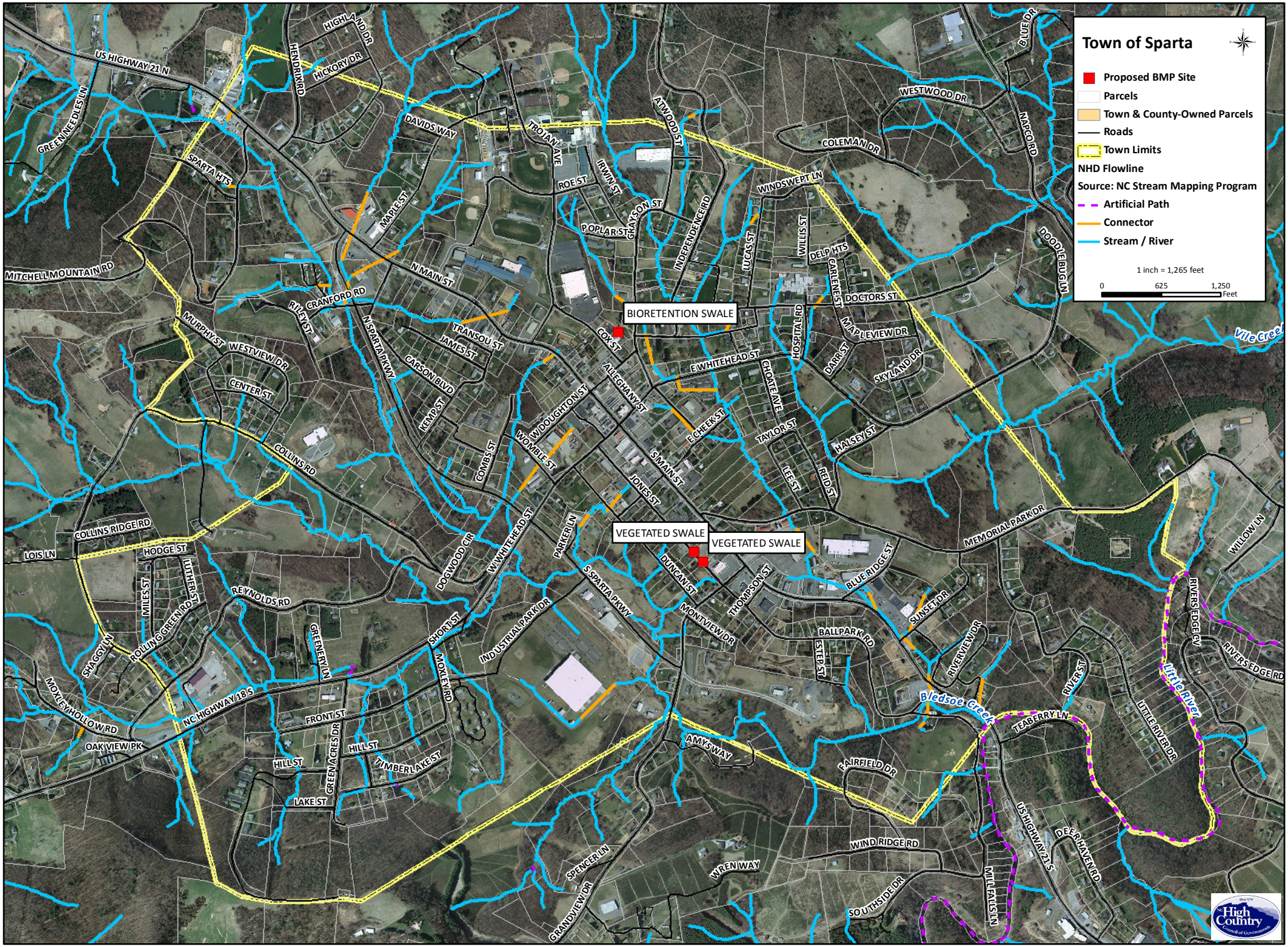

BIORETENTION CELL
SOUTH BIG HORSE CREEK RD
DAVIS GENTRY RD
BALDWIN JONES RD
J ST
G ST
F ST
Old Field Branch
A ST
E ST
B ST
D ST
NC HWY 194 NORTH
H ST
PINEY CREEK RD
TEABERRY RD
EASY ST
HILLBILLY RIDGE RD
PATTON RD
Big Horse Cree
Town of Lansing
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 530 feet
0
270
540
Feet
High Country Council of Governments

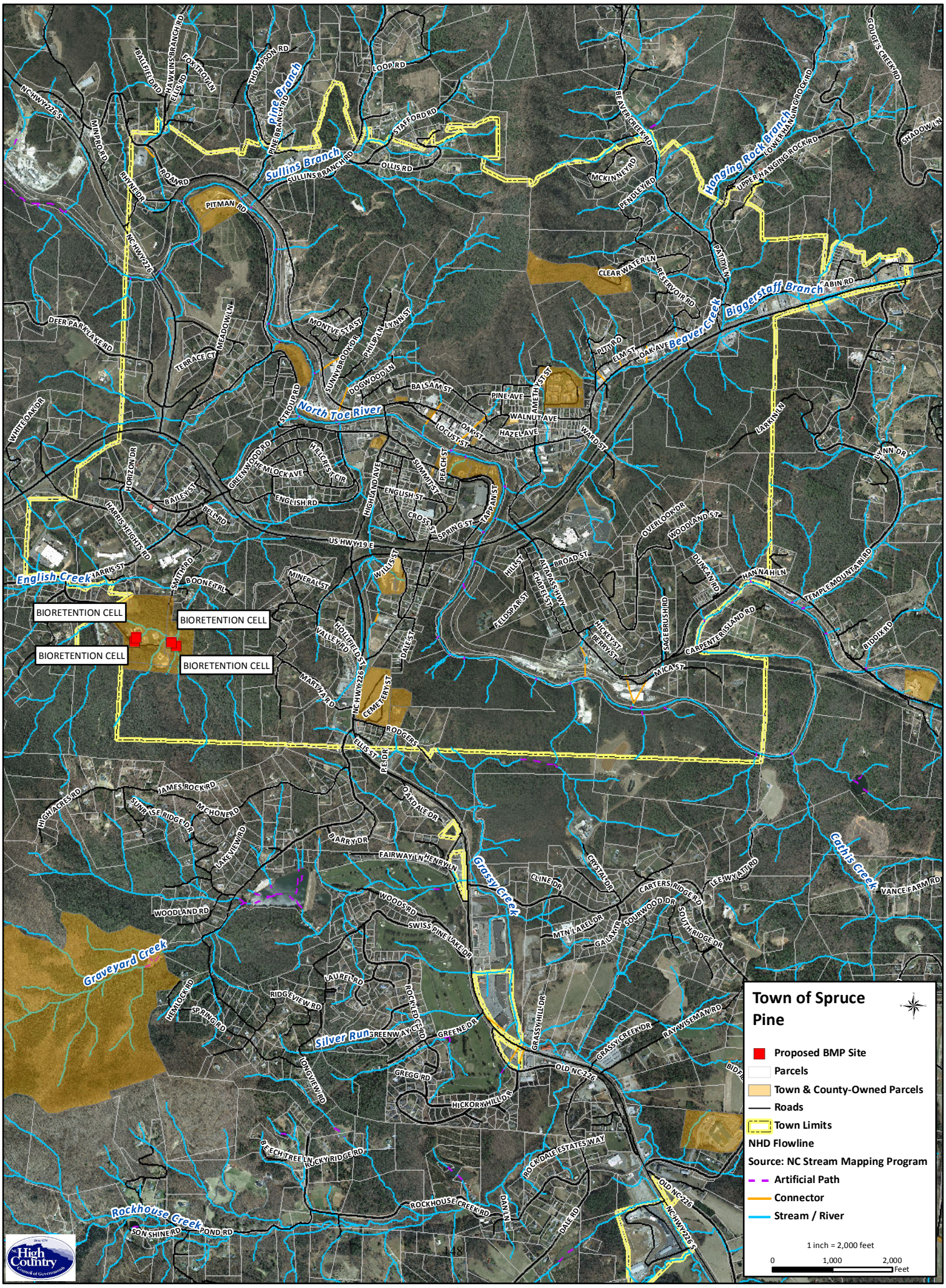

Town of Newland
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 1,010 feet
0
500
1,000
Feet
DETENTION BASIN
DIVERSION
WETLAND DETENTION
DETENTION BASIN
Whiteoak Creek
Blood Camp Branch
North Toe River
Kentucky Creek
Handpole Branch
<Null>
<Null>
PERSHING ST
ELK PARK HWY
VALE RD
PEBBLESTONE LN
NEW VALE RD
OLD VALE RD
SAMBREWER RD
HICKORY NUT GAP RD
WHITE OAK CREEK RD
CRANBERRY ST
PAT VELLER LN
SOKASSA RD
DEAN EELLER LN
PARK ST
CO W CAMP RD
OLD PUBLIC RD
NOTALEE ST
OLD TOE RIVER RD
ELK ST
SEMINOLE ST
PONTIAC ST
ESTATOA AV
WEST B ST
AVERY SQ
BANNER HILL DR
APACHE ST
MOHAWK ST
ATLAS ST
JOURNAL ST
HARDEES ALY
WATAUGA ST
SCHULTZ CIR
RAILROAD ST
PINEOLA ST
LINVILLE ST
BERTIE ST
OLD CRANBERRY ST
ASA ST
BIRD ST
ASH ST
RIVER ST
TAYLOR ST
CALVARY ST
MORTIMER ST
CEMETERY RD
BEECH ST
JASMIN LN
SHADY ST
CRINKLEY ST
HUBERT ST
BANNER ST
WYATT DR
C O LN
WESIBREWER RD
MILLERS GAP HWY
NEWLAND HWY
High Country Council of Governments

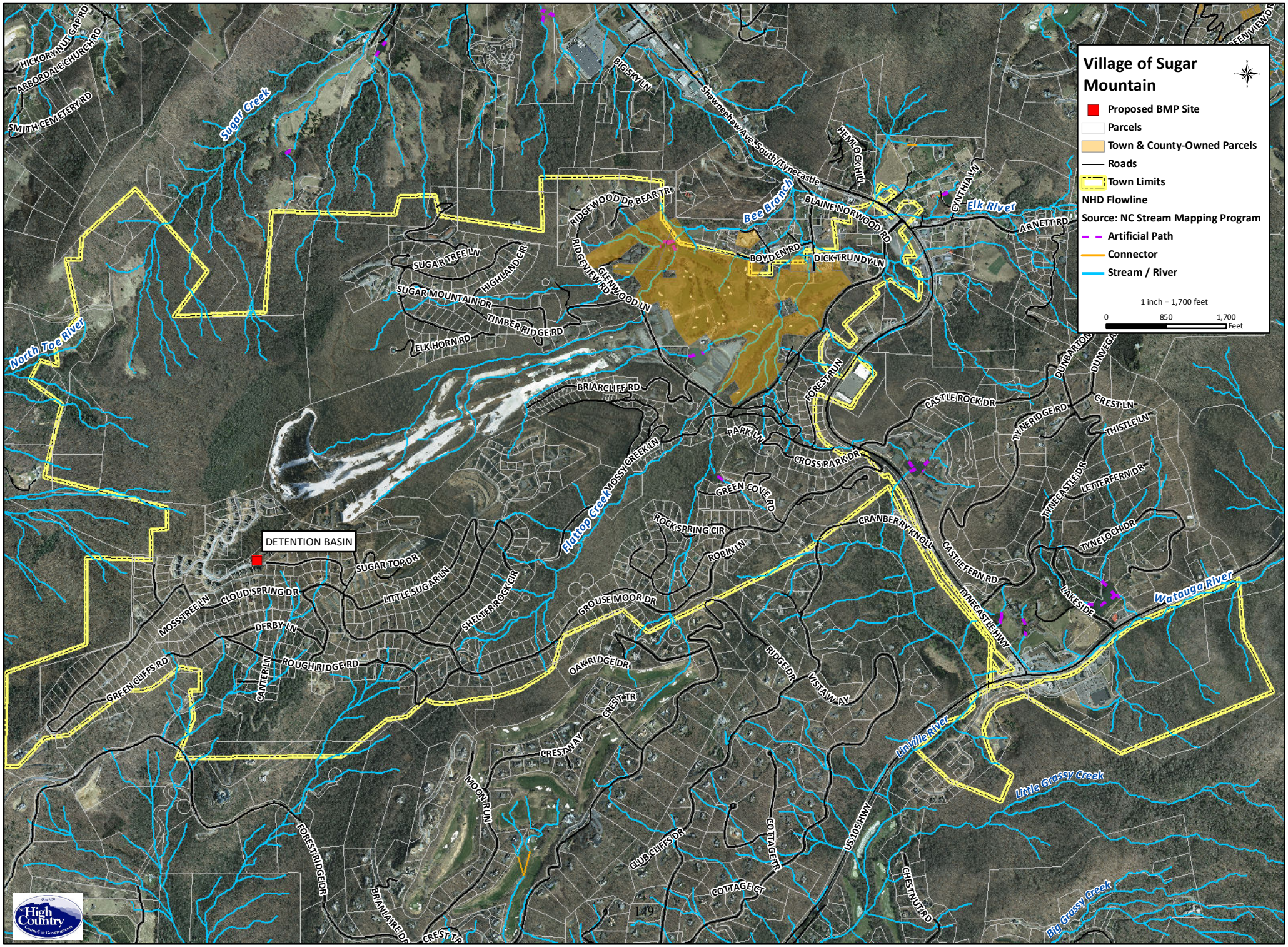

BIORETENTION SWALE
BIORETENTION SWALE
BIORETENTION SWALE
Town of North Wilkesboro
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
Hydrology
Source: NC Floodplain Mapping Program
Stream / River
1 inch = 4,000 feet
0
2,050
4,100
Feet
Mulberry Creek
Lousy Creek
Reddies River
Long Creek
Hoppers Branch
Tucker Hole Creek
YADKIN RIVER
Fishing Creek
Cub Creek
Little Cub Creek
SPARTA RD
WILKESBORO
NORTH WILKESBORO
HIGH COUNTRY COUNCIL OF GOVERNMENTS

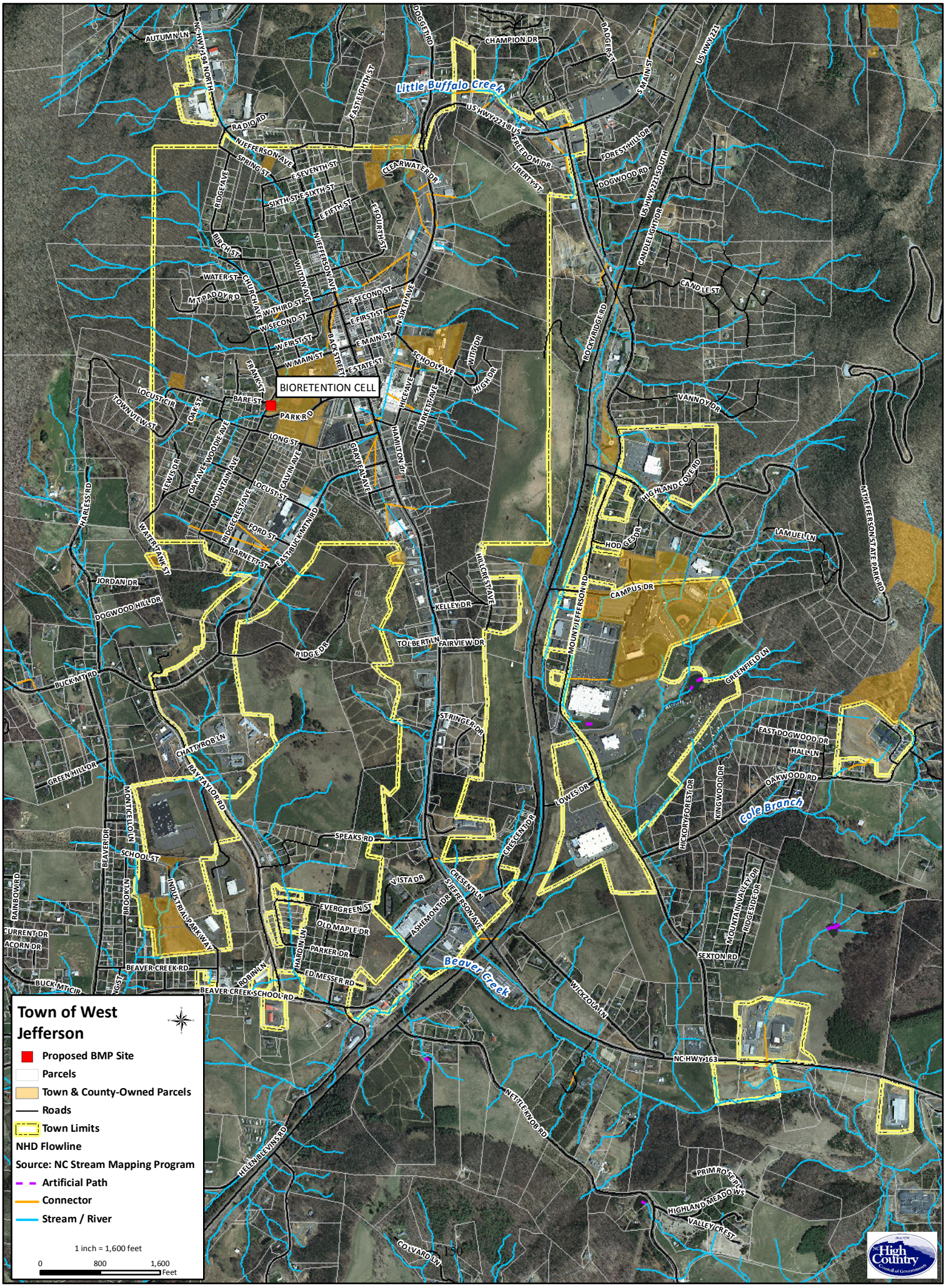

Town of Ronda
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
Hydrology
Source: NC Floodplain Mapping Program
Stream / River
1 inch = 940 feet
0
480
960
Feet
BIORETENTION CELL
HICKERSON ST
CEMETERY ST
CEMETERY ST EX
N HOOTS RD
BUCKHORN LN
GWYN ST
FACTORY ST
WADDELL ST
BELLS LN
OAK ST
MARTIN ST
MAPLE ST EX
MAPLE ST
SUMMIT ST
OLD TRAP HILL RD
BLACKBURN ST
BRANDON RD
ELKIN HWY 268
LAKEVIEW ST
RIDGE ST
HILLCREST ST
EMMANUEL LN
SHADY HILL CIR
THIRD ST
MAIN ST
SECOND ST
FERRY ST
CHATHAM ST
RIVERSIDE ST
CLINGMAN RD
CHATHAM RD

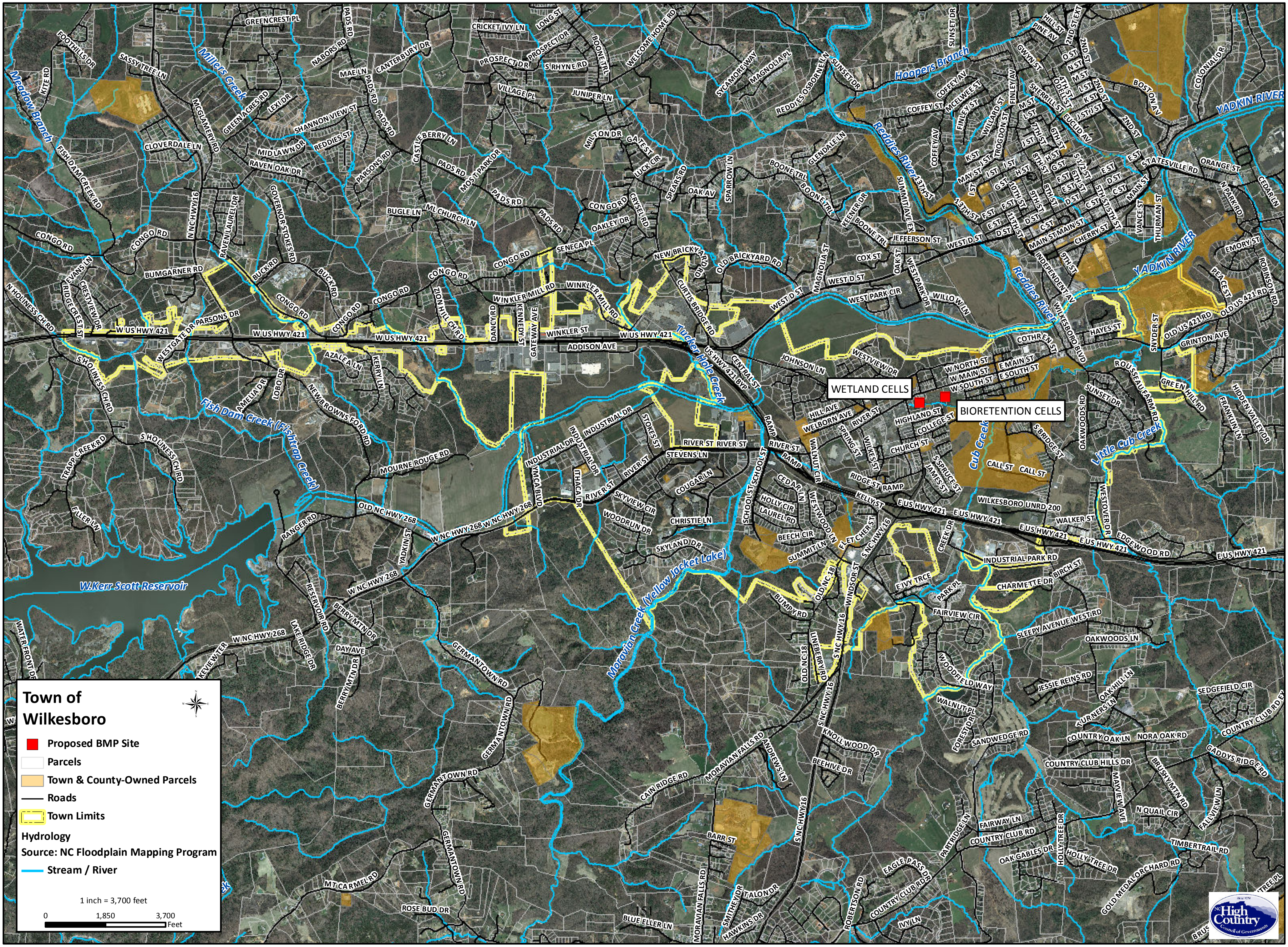

Town of Seven Devils
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 1,500 feet
0
750
1,500
Feet
Dutch Creek
Clark Creek
Valley Creek
Watauga River
Elk River
Bottom Creek
HALLELUJAH TR
DUTCH CREEK RD
BROWN TROUT RD
FALLING WATERS WAY
LESLIE LN
SNOWBIRD LN
BEUGUS LN
NETTLE KNOB DR
GRANDVIEW DR
RHODO LN
E ROCKY TOP TR
W ROCKY TOP TR
MOUNTAINTOP TR
CHESTNUT RIDGE TR
ALPINE DR
PINE DR
TELEMARK LN
DEVILS LAKE DR
BRADLEY BLVD
STREAMSIDE LN
SEVENTH RIDGE DR
EDGECLIFF LN
KNOB HILL LN
JAYBIRD LN
SHADOW MOUNTAIN LN
TWEETSIE LN E
W TWEETSIE LN
DEVILS DEN RD
WAYSIDE CT
WILDCAT ROCKS RD
CHINKAPIN
SEVEN DEVILS RD
ROCK COVE CT
HIGHCLIFF CIR
SEVEN DEVILS DR
DEERWOOD CT
GRANDFATHER CIR
GREEN COVE DR
THORNCLIFF DR
HORNCLIFF DR
CHALET DR
OTTER TR
LILLIAN DR
WOLF TR
BUCKEYE LN
CLIFF DWELLERS LN
CLIFFSIDE LN
SKYLAND DR
SWISS LN
SKYVIEW RD
FOUR DIAMOND DR
TANGLE LN
WINDY KNOB TR
ARNETT RD
DOC BYRD RD
RED BANK RD
YOSEMITE RD
R J ALDRIDGE RD
VINEYARD LN
SAWMILLERS WAY
WOODWINDS CT
ROSEBAY WAY
VALLEY CREEK LN
SHELBY ST
US 105 HWY
NCHWY 105 S
DOWNHOME DR
COVERED BRIDGE LN
SLEEPY HOLLOW LN
CLIFFWOOD DR
TIFFANY LN
KEETHOR
ASHLEY WAY
ARCTIC DR
ALDRIDGE RD
BERRY RD
CHERRYTREE LN
RIVERSIDE DR
PARK RD
PROFILE VIEW RD
GRANNY RANCH DR
CABIN CIR
SHOOK RD
J H M CLEAR RD
CRYSTAL DEW
WINDING DR
CASEY'S GAP RD
ROCKY RD
RIME FROST
TWIN OAKS LN
SLEEPY SIKE FARM LN
THISTLE LN
FLORAL LN


Town of Sparta
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 1,265 feet
0
625
1,250
Feet
BIORETENTION SWALE
VEGETATED SWALE
VEGETATED SWALE
US HIGHWAY 21 N
GREENNEEDLES LN
HIGHLAND DR
HICKORY DR
HENDRIX RD
SPARTA HTS
DAVIDS WAY
TROJAN AVE
ROE ST
IRWIN ST
ATWOOD ST
MAPLE ST
POPLAR ST
GRAYSON ST
INDEPENDENCE RD
WINDSWEPT LN
COLEMAN DR
WESTWOOD DR
NACCO RD
BLUE DR
DOODLE BUG LN
MITCHELL MOUNTAIN RD
N MAIN ST
CRANFORD RD
RILEY ST
MURPHY ST
WESTVIEW DR
CENTER ST
N SPARTA PKWY
TRANSOU ST
JAMES ST
CARSON BLVD
KEMP ST
COMBS ST
COLLINS RD
COLLINS RIDGE RD
LOIS LN
HODGE ST
LUTHER ST
MILES ST
REYNOLDS RD
ROLLING GREEN RD
SHAGGY LN
MOXLEY HOLLOW RD
OAK VIEW PK
NC HIGHWAY 18 S
GREENERY LN
SHORT ST
MOXLEY RD
INDUSTRIAL PARK DR
DOGWOOD CIR
W WHITEHEAD ST
WIDOUGHTON ST
WOMBLE ST
COX ST
ALLEGHANY ST
E WHITEHEAD ST
CHONTE AVE
HOSPITAL RD
DARR ST
MAPLEVIEW DR
SKYLAND DR
DELP HTS
CARLENE ST
DOCTORS ST
WILLIS ST
LUCAS ST
E CHEEK ST
TAYLOR ST
LEE ST
REID ST
HALSEY ST
S MAIN ST
JONES ST
PARKER LN
S SPARTA PKWY
DUNCAN ST
MONTVIEW DR
THOMPSON ST
BLUE RIDGE ST
SUNSET DR
MEMORIAL PARK DR
WILLOW LN
RIVERSEDGE CV
RIVERSEDGE RD
RIVER ST
LITTLE RIVER DR
Little River
Bledsoe Creek
RIVERVIEW DR
BALLPARK RD
ESTEP ST
TEABERRY LN
AMY'S WAY
FAIRFIELD DR
US HIGHWAY 21 S
DEER HAVEN RD
WIND RIDGE RD
WREN WAY
SOUTHSIDE DR
MILL FALLS LN
SPENCER LN
GRANDVIEW DR
FRONT ST
HILL ST
HILL ST
TIMBER LAKE ST
LAKE ST
GREEN ACRES DR
47


BIORETENTION CELL
BIORETENTION CELL
BIORETENTION CELL
BIORETENTION CELL
Pine Branch
Sullins Branch
North Toe River
Beaver Creek
Biggerstaff Branch
Hanging Rock Branch
English Creek
Grassy Creek
Graveyard Creek
Silver Run
Rockhouse Creek
Gathis Creek
US HWY 19 E
NC HWY 226
NC HWY 226 S
OLD NC 226
Town of Spruce Pine
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 2,000 feet
0
1,000
2,000
Feet


Village of Sugar Mountain
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 1,700 feet
0
850
1,700
Feet
DETENTION BASIN
Sugar Creek
North Toe River
Bee Branch
Elk River
Flattop Creek
Watauga River
Linville River
Little Grassy Creek
Big Grassy Creek
HICKORY NUT GAP RD
ARBORDALE CHURCH RD
SMITH CEMETERY RD
BIG SKY LN
Shawneehaw Ave South / Tynecastle
HEMLOCK HILL
CYNTHIA LN
RIDGEWOOD DR
BEAR TR
BLAINE NORWOOD RD
ARNETT RD
BOYDEN RD
DICK TRUNDY LN
SUGAR TREE LN
HIGHLAND CIR
SUGAR MOUNTAIN DR
TIMBER RIDGE RD
ELK HORN RD
RIDGEVIEW RD
GLENWOOD LN
BRIARCLIFF RD
FOREST RUN
CASTLE ROCK DR
DUNBARTON
DUNVEGA
CREST LN
THISTLE LN
TYNERIDGE RD
PARK LN
CROSS PARK DR
MOSSY CREEK LN
GREEN COVE RD
TYNECASTLE DR
LETTERFERN DR
ROCK SPRING CIR
ROBIN LN
CRANBERRY KNOLL
CASTLEFERN RD
TYNELOCH DR
LAKESIDE
TYNECASTLE HWY
SUGAR TOP DR
LITTLE SUGAR LN
CLOUD SPRING DR
MOSSTREE LN
SHELTER ROCK CIR
GROUSE MOOR DR
DERBY LN
GREEN CLIFFS RD
CANTER LN
ROUGH RIDGE RD
OAK RIDGE DR
RIDGE DR
VISTA WAY
CREST TR
CREST WAY
MOON RUN
FOREST RIDGE DR
BRIAR LAKE DR
CREST TR
CLUB CLIFFS DR
COTTAGE TR
COTTAGE CT
US 19E/19W/421
CHESTNUT RD


BIORETENTION CELL
Little Buffalo Creek
Cole Branch
Beaver Creek
Town of West Jefferson
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
NHD Flowline
Source: NC Stream Mapping Program
Artificial Path
Connector
Stream / River
1 inch = 1,600 feet
0
800
1,600
Feet
150
NC High Country Council of Governments


Town of Wilkesboro
Proposed BMP Site
Parcels
Town & County-Owned Parcels
Roads
Town Limits
Hydrology
Source: NC Floodplain Mapping Program
Stream / River
1 inch = 3,700 feet
0
1,850
3,700
Feet
WETLAND CELLS
BIORETENTION CELLS
W.Kerr Scott Reservoir
YADKIN RIVER
Reddies River
Hoopers Branch
Cub Creek
Little Cub Creek
Moravian Creek (Yellow Jacket Lake)
Fish Dam Creek (Fishtrap Creek)
Millers Creek
Meadow Branch
Tucker Hole Creek
W US HWY 421
E US HWY 421
W NC HWY 268