Middle Fork New River Restoration Prioritization Plan

Watauga County, North Carolina

Prepared for:

Middle Fork Greenway
A Blue Ridge Conservancy Project

Prepared by:

Jennings Environmental

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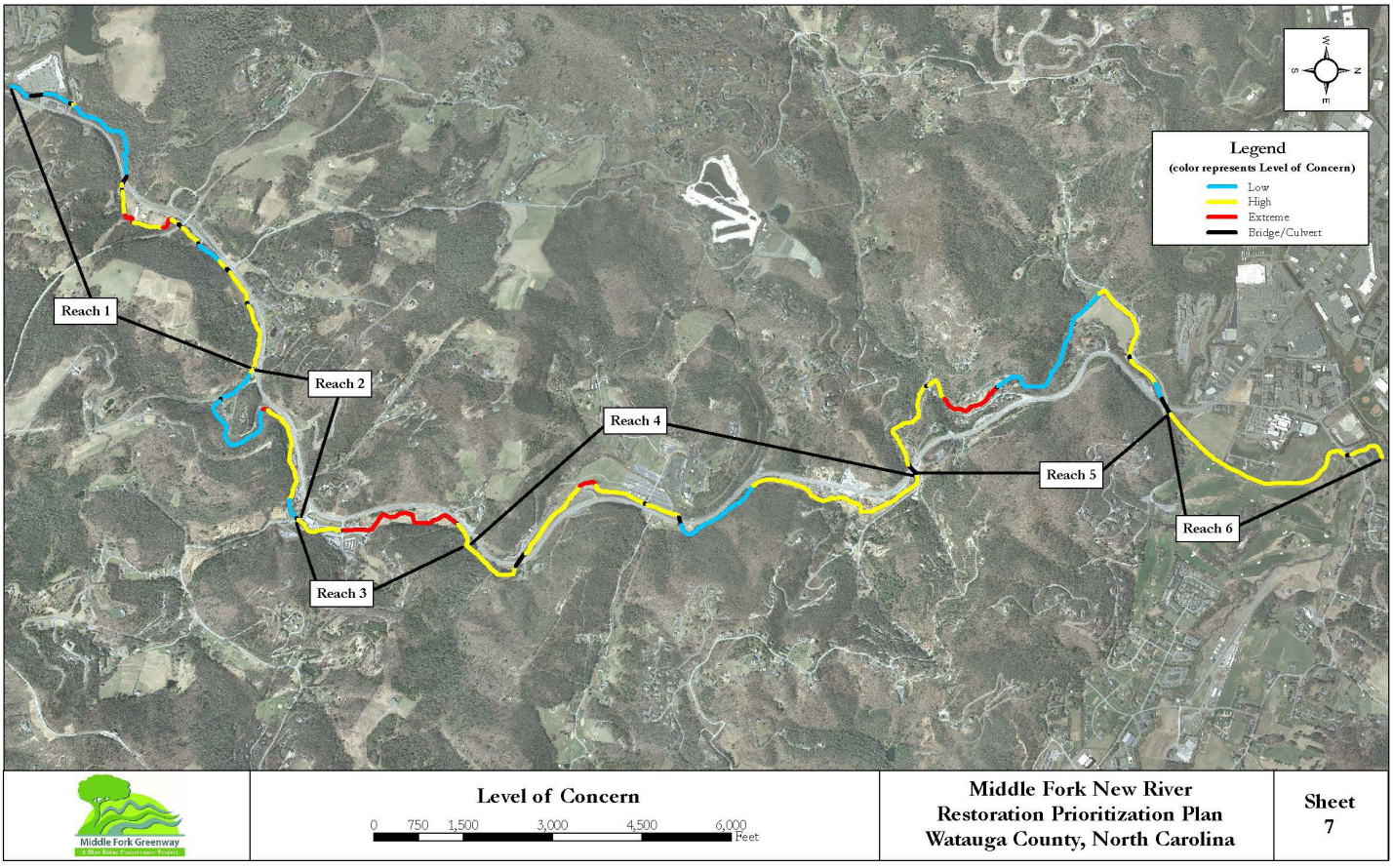
TABLE OF CONTENTS

EXECUTIVE SUMMARY

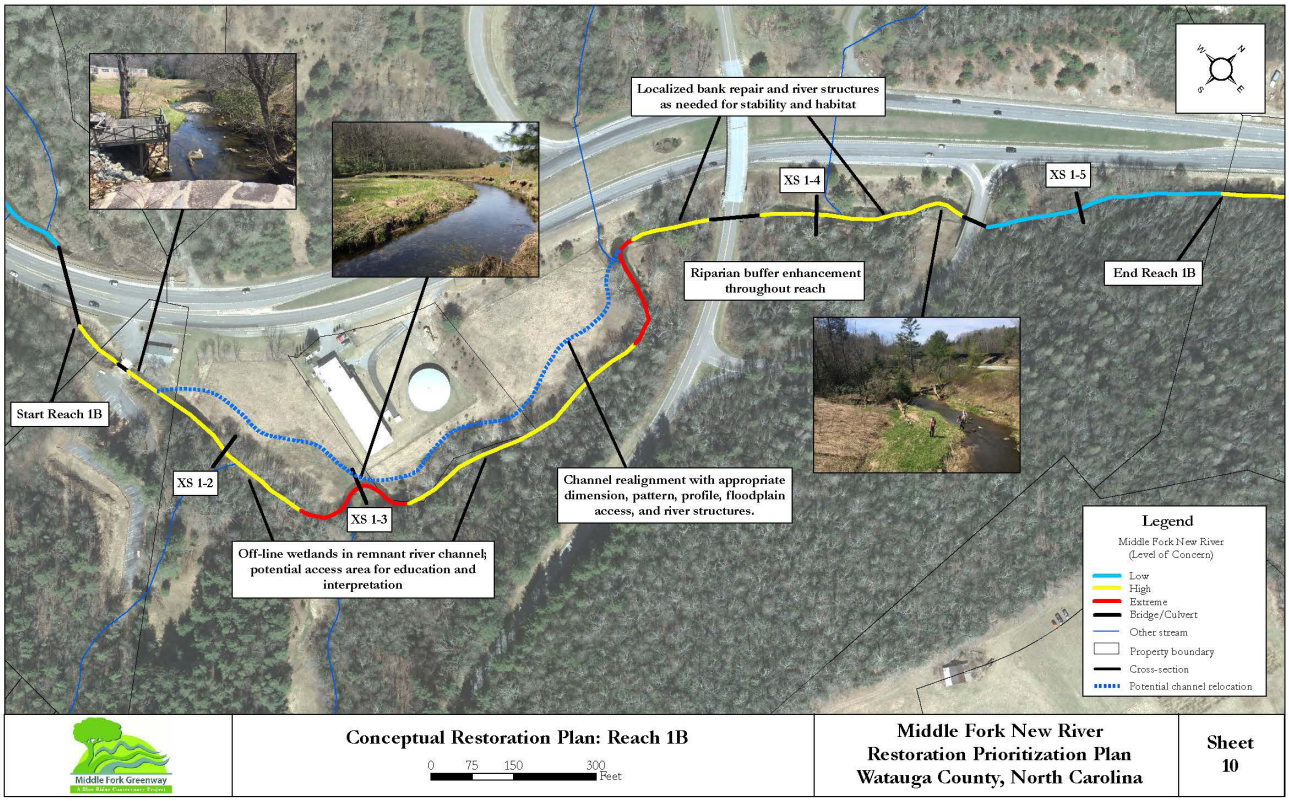
The Middle Fork Greenway is an emerging multi-use greenway connecting the towns of Blowing Rock and Boone along the Middle Fork New River in Watauga County, NC. As the Middle Fork Greenway trail is being established, the MFG Team and partners believe there is great opportunity to restore the river and tributaries, riparian buffer and provide habitat in areas where needed. A comprehensive River Restoration Prioritization Plan was developed by Jennings Environmental and the MFG Team in 2018 to guide these activities and contribute to the overall health of the corridor as the trail is developed.

This restoration plan describes existing conditions for each of the six river reaches extending from Blowing Rock to Boone shown on the map below. Assessments of stream channel morphology, erosion potential, and riparian vegetation were used to classify river segments based on color-coded level of concern as Low, High, or Extreme. For each segment, specific river restoration opportunities were identified to improve water quality, aquatic habitat, floodplain function, streamside vegetation, and environmental educational opportunities for greenway users. Riparian vegetation enhancement using native planting and invasive plant removal is a critical component of the overall restoration plan for the entire seven miles of river corridor. Areas of healthy native plants should be used as references for selecting plant communities to provide optimal riparian conditions.



River segments classified as Low level of concern are colored blue on the map and have mostly stable, well-vegetated streambanks and floodplains. These river segments should be protected and observed for signs of bank erosion and invasive plants. Short segments of eroding streambanks should be addressed using minor bank grading and planting as needed. River segments classified as High level of concern are colored yellow on the map and have many areas with substantial bank erosion, poor in-stream habitat, and poor riparian vegetation. Recommended restoration plans for these river segments include streambank grading, in-stream log and rock structures for protecting banks and enhancing habitat, and native riparian vegetation planting.

River segments classified as Extreme level of concern are colored red on the map. These areas are the highest priority for restoration due to severe problems with bank erosion, in-stream habitat, floodplain functions, and riparian vegetation. Recommended restoration plans for these river segments include channel realignment and floodplain connection, streambank grading, in-stream log and rock structures for protecting banks and enhancing habitat, and native riparian vegetation planting. An example Conceptual Restoration Plan is shown for the middle section of Reach 1 in the map below. These extensive restoration projects require substantial planning, engineering, permitting, and construction work followed by long-term vegetation management in order to achieve ecological objectives.



The two highest priorities for stream restoration are in Reaches 1 and 4 based upon need for water quality and habitat improvements in addition to access availability. In Reach 1, the estimated cost range is $360,000 to $720,000, and in Reach 4, the estimated range is $350,000 to $650,000. Estimated costs for restoring other stream reaches are expected to total more than $1.5 million. Additional costs may be required for land acquisition and infrastructure improvements associated with stream crossings or utilities. Potential funding sources for stream restoration projects include grant programs such as NC Clean Water Management Trust Fund and NC DEQ Water Resources Development Grant Program. Stream restoration projects require permitting at the federal, state, and local levels for environmental and floodplain impacts.

I. INTRODUCTION

The Middle Fork Greenway (MFG) is an emerging multi-use greenway connecting the towns of Blowing Rock and Boone along the Middle Fork New River in Watauga County, NC. The Middle Fork Greenway Team is a partnership between High Country Pathways, Inc., a nonprofit organization which promotes, constructs and maintains transportation/recreational trails, and the Blue Ridge Conservancy, which acquires land rights and conducts other activities related to the conservation of land and natural resources. A written Master Plan for the Middle Fork Greenway is in place, and the MFG Team is pursuing its implementation in partnership with the three local governments: Blowing Rock, Boone, and Watauga County.

Recently-expanded partnerships with New River Conservancy, Blue Ridge RC&D, and the High Country Council of Governments sparked interest in developing a River Restoration Prioritization Plan along the Middle Fork New River and tributaries as the greenway is developed. As the Middle Fork Greenway trail is being established, the MFG Team and partners believe there is great opportunity to restore the river and tributaries, riparian buffer and provide habitat in areas where needed. A comprehensive River Restoration Prioritization Plan will guide these activities and contribute to the overall health of the corridor as the trail is developed.

The Jennings Environmental team initiated project work in April 2018, working closely with the MFG Team members to facilitate access to field sites and existing data. The Jennings Environmental team spent time working in the field along the MFG route: meeting partners, understanding current conditions, collecting data, and developing conceptual restoration plans.

The project begins at the greenway parking area near the Tanger Outlets and ends at the confluence of the Middle Fork and the East Fork of the South Fork New River. Total river length within this project is 7.46 miles. The six planning reaches delineated in the “Middle Fork Greenway Master Plan” have generally been adopted as the stream reaches for the Middle Fork New River Restoration Prioritization Plan. Precise reach boundaries have been adjusted based on property ownership, stream conditions, and potential restoration approaches. These reaches are listed below, and shown in Figure 1 and on Sheets 1 through 7.

Reach 1: Tanger Outlets to Alpine Valley Drive (7,735 feet)
Reach 2: Alpine Valley Drive to Aho Road (4,835 feet)
Reach 3: Aho Road to Sterling Creek Park (3,531 feet)
Reach 4: Sterling Creek Park to US 321 at Niley Cook Road (9,819 feet)
Reach 5: US 321 at Niley Cook Road to US 321 at Jordan V. Cook Road (9,055 feet)
Reach 6: US 321 at Jordan V. Cook Road to confluence with East Fork (4,413 feet)

Further, these reaches have been divided into subreaches based on stream conditions and potential restoration approaches. A conceptual plan for each subreach is detailed as an individual plan sheet. The subreaches are listed in Table 1.

TABLE 1. REACH DESCRIPTIONS.

Reach	Start	End	Length (feet)	Average Reach Slope (ft/ft)
1A	Tanger Outlets	US 321 crossing	3,084	0.0052
1B	US 321 crossing	NPS property line	2,593	0.0069
1C	NPS property line	Alpine Valley Drive	2,058	0.0078
2A	Alpine Valley Drive	End of Firethorn	3,756	0.0101
2B	End of Firethorn	Aho Road	1,079	0.0056
3	Aho Road	Sterling Creek Park	3,531	0.0068
4A	Sterling Creek Park	US 321 crossing	4,872	0.0053
4B	US 321 crossing	Goldmine Branch Park	3,123	0.0051
4C	Goldmine Branch Park	US 321 crossing	1,824	0.0033
5A	US 321 crossing	End of residential area	2,178	0.0083
5B	End of residential area	Bridge below Payne Dam	1,411	0.0198
5C	Bridge below Payne Dam	US 321 crossing	5,466	0.0223
6	US 321 crossing	Confluence with East Fork	4,413	0.0052
Overall			39,388	0.0091

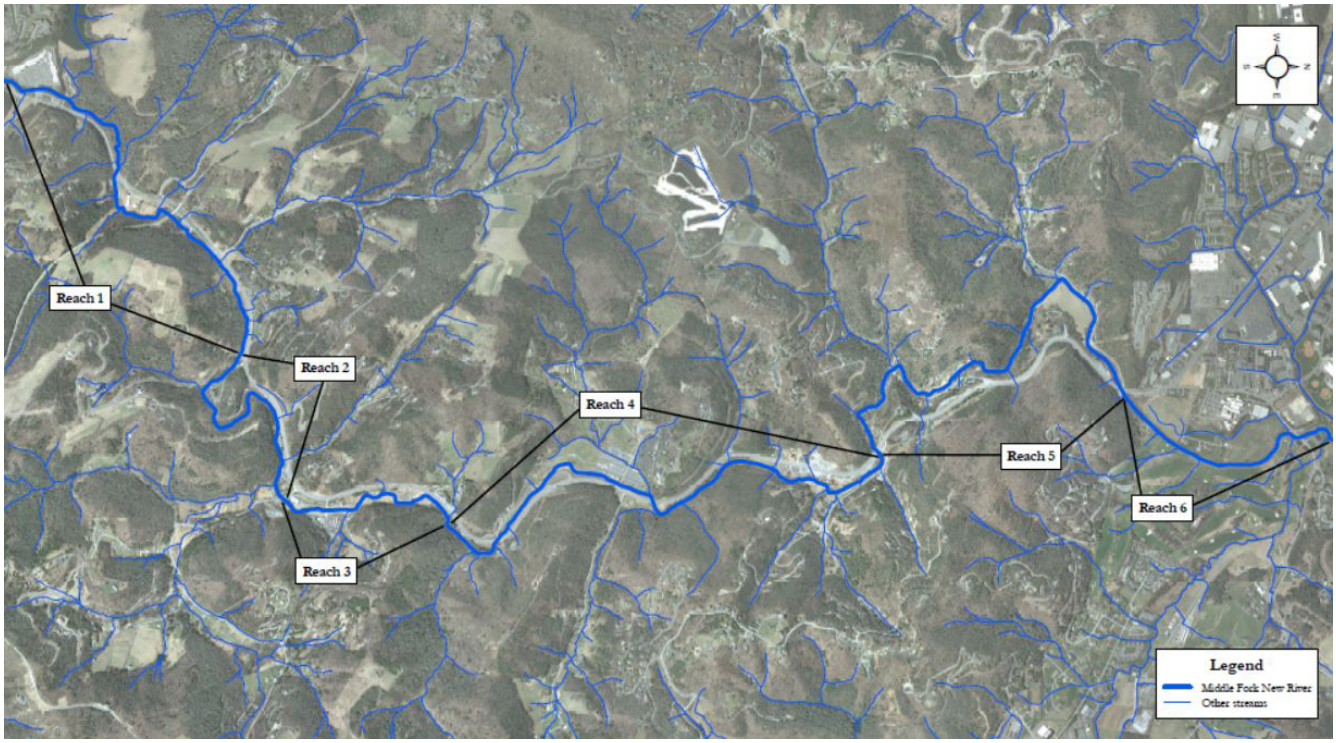


Figure 1. Reach Overview

Jennings Environmental has completed the following scope of services:

Task A

Stream Reach Deliniation

The project will be divided into accessible and practical stream reaches for assessment and project implementation. Individual stream reaches will be selected based on existing conditions such as property boundaries and site constraints, as well as changes in stream type, morphology, and influence of tributaries.

Task B

Existing Conditions Assessment

Desktop data review and field reconnaissance will identify and document: topography, hydrology, stream morphology, soils and geology, site constraints, property boundaries, utilities, potential cultural resources, significant natural heritage areas, vegetation and aquatic biology, existing stream stability issues, sediment loading downstream, and available land for reconnecting floodplains in areas with incised streams.

Task C

Stream Morphology

Measure cross-section channel dimensions to document existing conditions. This will yield dimensions such as cross-section area, width, and depth. Stream morphology assessments will also include calculation of width/depth ratio, entrenchment ratio, channel slope, bed sediment size, and stream type.

Task D

Sediment Modeling

Computer analyses will be used to estimate streambank erosion rates based on field measurements of Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). These analyses evaluate streambanks on a quantitative scale of Very Low/Low/Moderate/High/Very High/Extreme and can be translated into expected erosion rates (e.g., tons of streambank erosion per year). A color-coded map will be produced showing the expected streambank erosion rates.

Task E

Riparian Vegetation Community

For each reach, conduct field reconnaissance and propose a riparian vegetation plan that might include revegetation, preservation, thinning, and/or invasive species management.

Task F

Restoration Opportunities

Identify and describe potential stream restoration and stormwater management projects needed to improve water quality, aquatic habitat, floodplain function, streamside vegetation, and environmental educational opportunities for greenway users.

Task G

River Access

Identify safe and sustainable areas for greenway users that will minimize erosion and sedimentation, and highlight significant river features.

Task H

Project Road Map

Provide cost estimates, potential sources of funding, permitting requirements, and preliminary concept work for prioritized reaches to provide necessary information to implement future restoration projects for each reach.

Task I

Trail-Stream Crossings

Identify potential trail-stream crossings and make recommendations for crossings that support safe and sustainable greenway functions and support aquatic organism passage.

II. EXISTING CONDITIONS

MAPPING

The project team received and evaluated GIS data from Blue Ridge Conservancy, including: aerial photography, topography, hydrography, soils, property boundaries, cultural resources, and natural heritage areas. During field visits, the project team reviewed existing conditions throughout the project. This included photodocumentation and observations of topography, site constraints, stream stability, sediment loading, and vegetation. Sheet 2 shows aerial photography and hydrography, while Sheet 3 shows topography and hydrography. Table 2 and Sheet 4 shows documented cultural and natural resources. Table 3 and Sheet 5 shows soil types within 500 feet of the Middle Fork New River. Future restoration projects should include consideration of specific conditions present within individual project areas.

TABLE 2. NATURAL AND CULTURAL RESOURCES (SEE SHEET 4).

	Name	Type
1	Moses Cones Park/Flat Top Mountain	NHP Natural Area
2	South Fork New River Aquatic Habitat	NHP Natural Area
3	Blue Ridge Parkway	Historic property/district boundary
4	Blair Farm	Historic property/district boundary
5	Dougherty House	Historic property/district point
6	East TN and Western NC Railroad Locomotive #12	Historic property/district point
7	Blair Farm	Historic property/district point
8	Loudermilk House	Historic site (undesignated)
9	Frank and Isadora Edmisten House	Historic site (undesignated)
10	Sholl House	Historic site (undesignated)
11	Coffey-Broyhill House	Historic site (undesignated)
12	Payne Cabin	Historic site (undesignated)
13	Henry Brown House	Historic site (undesignated)
14	George and Lizzie Keller House	Historic site (undesignated)
15	Hicks-Yates House	Historic site (undesignated)

TABLE 3. SOILS WITHIN 500 FEET OF MIDDLE FORK NEW RIVER (SEE SHEET 5).

Label	Soil Map Unit
AcD	Ashe-Chestnut complex, 15-30% slopes, very rocky
AcE	Ashe-Chestnut complex, 30-50% slopes, very rocky
AcF	Ashe-Chestnut complex, 50-95% slopes, very rocky
CkD	Chestnut-Edneyville complex, 15-30% slopes, stony
CkE	Chestnut-Edneyville complex, 30-50% slopes, stony
CsC	Cullasaja very cobbly loam, 8-15% slopes, very stony
CsD	Cullasaja very cobbly loam, 15-30% slopes, very stony
CsE	Cullasaja very cobbly loam, 30-50% slopes, very stony
CtD	Cullasaja very cobbly loam, 15-30% slopes, extremely bouldery
CtE	Cullasaja very cobbly loam, 30-50% slopes, extremely bouldery
CuA	Cullowhee loam, 0-3% slopes, frequently flooded
DeB	Dellwood cobbly sandy loam, 1-5% slopes, occasionally flooded
EdC	Edneytown loam, 8-15% slopes
EdD	Edneytown loam, 15-30% slopes
NkA	Nikwasi loam, 0-3% slopes, frequently flooded
PuC	Porters loam, 8-15% slopes, stony
PuD	Porters loam, 15-30% slopes, stony
PuE	Porters loam, 30-50% slopes, stony
RdA	Reddies loam, 0-3% slopes, frequently flooded
RoA	Rosman fine sandy loam, 0-3% slopes, occasionally flooded
SnB	Saunook loam, 2-8% slopes
SoC	Saunook loam, 8-15% slopes, very stony
SoD	Saunook loam, 15-30% slopes, very stony
SoE	Saunook loam, 30-50% slopes, very stony
SwC	Saunook-Nikwasi complex, 2-15% slopes
TxA	Toxaway loam, 0-2% slopes, frequently flooded
Ud	Udorthents, loamy
UkD	Unaka-Porters complex, 15-30% slopes, very rocky
UkE	Unaka-Porters complex, 30-50% slopes, very rocky
UkF	Unaka-Porters complex, 50-95% slopes, very rocky
Ur	Urban land
Ux	Urban land, flooded
W	Water

GEOMORPHOLOGY

A total of 15 cross-sections were surveyed on the Middle Fork New River. These cross-sections include both reference and impaired sections. Reference stream morphology measurements represent tools that may be used to verify field bankfull stage determinations and to plan and evaluate design ranges for channel morphology in restoration projects. When possible, reference stream cross-sections were selected based upon their natural equilibrium conditions indicated by floodplain connectivity, bedform diversity, and well-vegetated stable streambanks.

Based on field measurements from cross-sections of the Middle Fork New River with drainage areas ranging from 3.19 to 12.2 square miles, bankfull channel cross-section area and mean depth were found to be correlated to watershed drainage area. Bankfull width was not strongly correlated with drainage area; likely a result of lateral constraints to river from surrounding land use. The resulting hydraulic geometry regional curve relationships are shown below with drainage area in square miles, area in square feet, and width and depth in feet.

$A_{bkf} = 24.9\ DA^{0.70}$ $R^2 = 0.89$

$W_{bkf} = 22.9\ DA^{0.25}$ $R^2 = 0.21$

$d_{bkf} = 1.09\ DA^{0.46}$ $R^2 = 0.63$

The measured bankfull riffle cross-sectional areas range from 56.1 to 133.8 square feet (Table 4 and Appendix A), with the relationship between cross-sectional area (A_{bkf}) and drainage area (DA) shown in Figure 2. Similarly, the bankfull channel riffle widths (W_{bkf}) and mean depths (d_{bkf}) related to drainage area are shown in Figures 3 and 4.

This set of regional curves for bankfull channel dimensions provides a tool for verifying bankfull stage in field surveys and for estimating dimensions for stream restoration projects along the Middle Fork New River. Stream assessment and restoration practitioners should carefully consider the natural variability demonstrated in these data. Designers should not use this information as the sole basis for planning restoration projects, but should evaluate evidence from hydrologic and hydraulic monitoring and modeling, nearby reference stream morphology, and existing stream conditions in order to determine appropriate restoration design parameters.

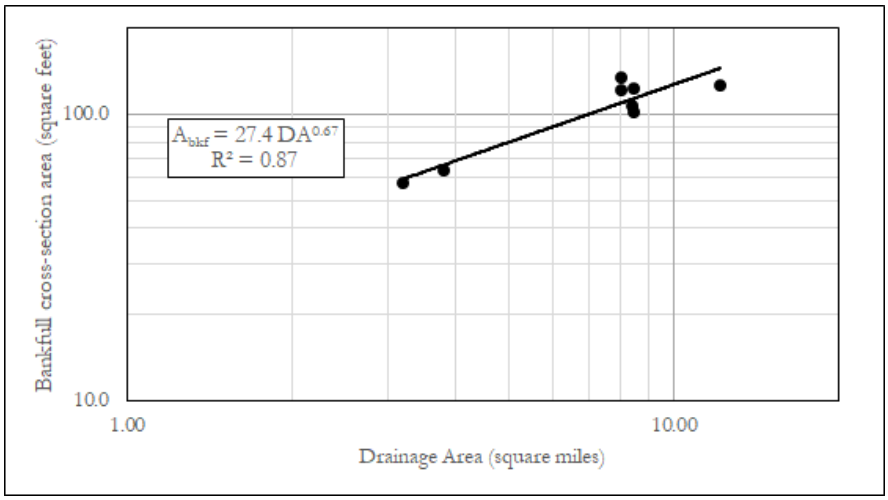


Figure 2. Bankfull riffle cross-section area related to drainage area.

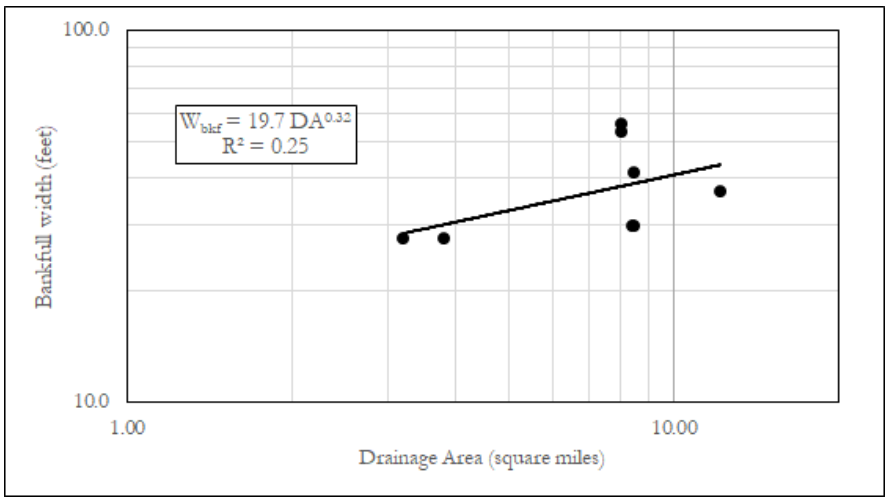


Figure 3. Bankfull riffle width related to drainage area.

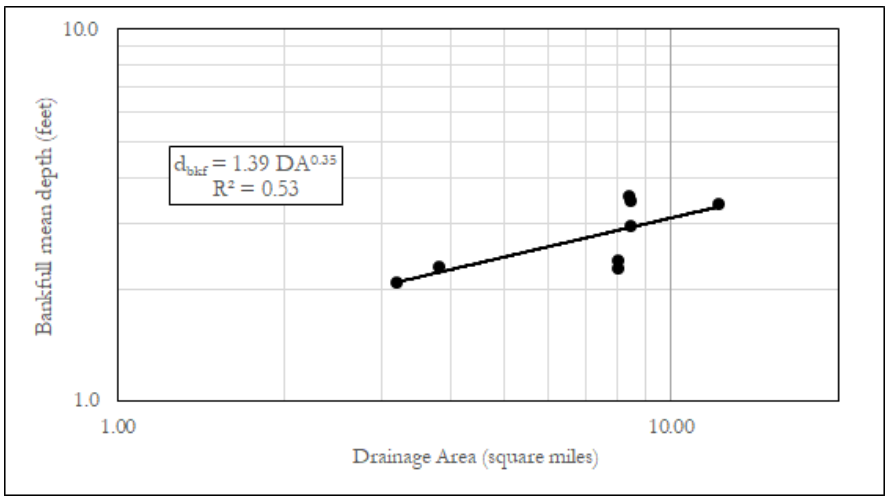


Figure 4. Bankfull riffle mean depth related to drainage area.

TABLE 4. CROSS-SECTION DIMENSIONS.

Site	Drainage area (mile²)	Cross-section area (ft²)	Bankfull width (ft)	Bankfull mean depth (ft)	Width/ depth ratio	Entrenchment ratio	Median particle size	Stream
1-1	3.19	57.6	27.6	2.1	13.3	3.3	gravel	C4
1-2	3.80	63.4	27.6	2.3	12.0	3.4	cobble	E3
1-3*	3.86	56.1	32.3	1.7	-	-	gravel	-
1-4	4.04	62.6	37.2	1.7	22.1	3.0	gravel	C4
1-5	4.07	73.3	36.4	2.0	18.1	2.0	gravel	B4c
1-6	4.89	69.1	37.2	1.9	20.0	2.4	gravel	C4
2-1	5.56	83.7	32.1	2.6	12.3	2.2	cobble	C3
2-2	5.57	73.7	30.1	2.4	12.3	2.5	cobble	C3
3-1	8.01	120.9	53.4	2.3	23.5	2.9	gravel	C4
4-1	8.01	133.8	56.0	2.4	23.5	1.3	gravel	B4c
4-2	8.40	106.8	29.9	3.6	8.4	2.6	cobble	E3
4-3	8.47	102.4	29.8	3.4	8.6	4.5	cobble	E3
4-4	8.47	123.2	41.6	3.0	14.0	3.1	cobble	C3
4-5	10.20	130.5	42.6	3.1	13.9	2.6	cobble	C3
6-1	12.20	126.1	37.1	3.4	10.9	4.6	gravel	E4

* indicates cross-section was at a pool and not included in regional curves

SEDIMENT MODELING

The project team made field observations of BEHI and NBS throughout the project. Table 5 summarizes BEHI observations along both streambanks for the 7.46 miles of the project. Sheet 6 shows color-coded BEHI observations throughout the project.

TABLE 5. BEHI OBSERVATIONS.

BEHI Category	Length of Streambank (feet)	Percent of Total Length
Very Low	614	0.8%
Low	33,815	42.9%
Moderate	37,522	47.6%
High	2,567	3.3%
Very High	138	0.2%
Extreme	0	0.0%
Bridge/Culvert	4,120	5.2%

BEHI and NBS observations were combined to predict streambank erosion rates. Table 6 summarizes predicted streambank erosion for each reach, while Appendix B documents all individual BEHI and NBS observations. These observations and predictions will inform project prioritization and restoration approaches.

TABLE 6. PREDICTED STREAMBANK EROSION RATES.

Reach	Streambank Erosion Rates (tons/year)	Average Erosion per Linear Foot (tons/year/ foot)
1	67	0.008
2	69	0.014
3	47	0.013
4	124	0.013
5	95	0.010
6	104	0.024
Total	505	0.013

Vegetation inventories of each reach of the project area were conducted. Three reference-condition reaches consisting of stable and healthy native plant communities were observed in Reaches 1, 4, and 5. The flora in these areas, along with other native flora noted throughout the project area, plus flora lists/successes from projects elsewhere in the High Country are the basis for recommended vegetation lists for areas in need of restoration and enhancement. A master list of all flora observed during the vegetation inventories of the project area is included as Table 7. A description of the plant communities for each reach is discussed below. The publication *Classification of the Natural Communities of North Carolina, Third Approximation* (Schafale and Weakley, 1990) was utilized to characterize the structured plant communities encountered. See Appendix C for a list of flora documented and representative photographs for each reach. Note that the plant community referenced as "field/ turf grass and roadside community" is not included in the publication utilized. This nomenclature is utilized to indicate a scrub/shrub and herbaceous type of plant community commonly found along roadsides or in fields.

TABLE 7. FLORA INVENTORY MASTER LIST.

Scientific Name	Common Name
Trees/Saplings	
Acer pensylvanicum	Striped maple
Acer rubrum	Red maple
Acer saccharum	Sugar maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Carya glabra	Pignut hickory
Carya ovata	Shagbark hickory
Carya tomentosa	Mockernut hickory
Cornus alternifolia	Alternate-leaf dogwood
Cornus amomum	Silky dogwood
Cornus florida	Flowering dogwood
Fraxinus pennsylvanica	Green ash
Lirodendron tulipifera	Tuliptree
Magnolia fraseri	Fraser magnolia

Pinus strobus	Eastern white pine
Prunus caroliniana	Laurel cherry
Prunus pensylvanica	Pin cherry
Prunus serotina	Black cherry
Quercus rubra	Northern red oak
Robinia pseudoacacia	Black locust
Salix nigra	Black willow
Salix sericea	Silky willow
Tilia americana	American basswood
Tsuga canadensis	Eastern hemlock
Shrubs	
Alnus serrulata	Hazel alder
Clethra acuminata	Mountain sweet pepperbush
Crataegus sp.	Hawthorn
Hamamelis virginiana	American witchhazel
Hydrangea arborescens	Wild hydrangea
Ilex montana	Large-leaf winterberry
Ilex verticillata	Common winterberry
Kalmia latifolia	Mountain laurel
Physocarpus opulifolius	Ninebark
Rhododendron arborescens	Smooth azalea
Rhododendron calendulaceum	Flame azalea
Rhododendron maximum	Rosebay
**Rosa multiflora*	*Multiflora rose
Sambucus canadensis	Elderberry
Sassafras albidum	Sassafras
Spiraea alba	White meadowsweet
Viburnum prunifolium	Smooth blackhaw
Herbaceous	
**Alliaria petiolata*	*Garlic mustard
**Hesperis matronalis*	*Dame's rocket
**Phalaris arundinacea*	*Reed canary grass
Achillea millefolium	Common yarrow
Alopecurus sp.	Foxtail
Angelica atropurpurea	Great angelica
Aralia nudicaulis	Wild sarsaparilla
Arisaema triphyllum	Jack in the pulpit
Asclepias syriaca	Common milkweed

Athyrium filix-femina	Lady fern
Carex pensylvanica	Pennsylvania sedge
Chimaphila maculata	Striped wintergreen
Dennstaedtia punctilobula	Hayscented fern
Dichanthelium clandestinum	Deertongue
Dryopteris sp.	Wood fern
Erigeron annuus	Eastern daisy fleabane
Eurybia divaricata	White wood aster
Fragaria vesca	Wild strawberry
Galax urceolata	Galax/beetleweed
Galium aparine	Cleavers
Glechoma hederacea	Ground ivy
Goodyera pubescens	Downy rattlesnake plantain
Hexastylis shuttleworthii	Largeflower heartleaf
Houstonia purpurea	Woodland bluet
Hydrophyllum canadense	Blunt-leaved waterleaf
Impatiens capensis	Jewelweed
Iris cristata	Dwarf crested iris
Juncus effusus	Soft rush
Lysimachia quadrifolia	Whorled yellow-loosestrife
Maianthemum canadense	Canada mayflower
Maianthemum racemosum	Solomon's plume
Medeola virginiana	Indian cucumber
Mitchella repens	Patridgeberry
Monarda didyma	Scarlet beebalm
Onoclea sensibilis	Sensitive fern
Packera aurea	Golden ragwort
Polygonatum biflorum	Solomon's seal
Polystichum acrostichoides	Christmas fern
Potentilla spp.	Cinquefoil
Ranunculus acris	Tall buttercup
Rudbeckia laciniata	Cut-leaf coneflower
Schizachyrium scoparium	Little bluestem
Sisyrinchium angustifolium	Blue-eyed grass
Solidago spp.	Goldenrods
**Various turf grasses*	*Various turf grasses
**Veronica chamaedrys*	*Germander speedwell
Stellaria pubera	Star chickweed
Tradescantia ohiensis	Spiderwort
Trillium spp.	Wake robin

Viola spp.	Violet
Zizea aurea	Golden alexander
Vines	
**Celastrus orbiculatus*	*Oriental bittersweet
Clematis sp.	Virgin's bower
Dioscorea villosa	Wild yam
Parthenocissus quinquefolia	Virginia creeper
**Pueraria montana*	*Kudzu
Rubus spp.	Blackberry and raspberry
Smilax spp.	Greenbrier
Toxicodendron radicans	Poison ivy

*Non-native/invasive species

REACH 1

The southern portion of Reach 1 consists of a reach owned by the Blue Ridge Parkway (BRP) beginning at the Tanger Outlets and ending just south of Old Camp Catawba Road where the river crosses under Highway 321. An acidic cove forest community is present in this reach. This area served as a Reference Reach 1 for desirable vegetation for use in areas in need of enhancement and restoration. Per Blue Ridge Conservancy personnel, this reach will not be included in the vegetation recommendations in this Plan since this area is owned and maintained by the BRP (also, the Greenway begins to the north of this area). The remaining reaches consist of a mesic field-type vegetation community in the floodplain area behind the Wastewater Treatment Plant on the west side of the river; an acidic cove plant community along most of the east side of the river; a partial acidic cove plant community and partial field/turf grass and roadside community along the west side of the river in the southern portion; and a field/turf grass and roadside plant community in areas adjacent to Highway 321 in the northern portion.

REACH 2

An acidic cove forest plant community is present throughout the southern portion within the Firethorn development. This plant community is also present on the east side of the river in the northern half, except in the northernmost portion, which is partial acidic cove forest community and partial field/turf grass and roadside community. A field/turf grass and roadside community is present in areas adjacent to Highway 321.

REACH 3

The reach is in a commercial area and consists a field/turf grass and roadside community. Both native riparian/facultative and non-native invasive vegetation were noted. The northernmost east bank consists of an acidic cove plant community.

REACH 4

REACH 4A

The Sterling Creek Park area consists of an acidic cove forest community on the east bank and a partial acidic cove plant community and a partial field/turf grass and roadside community along the west side of the river and northern end of the park. The remaining area from Mystery Hill to the Tweetsie Railroad entrance consists of a field/turf grass and roadside community. Non-native invasive species are present throughout this commercial area. The southernmost portion between the Tweetsie Railroad entrance and the culvert under Highway 321 consists of field/turf grass and roadside community. Non-native invasive species are prevalent.

REACH 4B

The east side of the river throughout the reach (except for the northern portion) consists of an acidic cove forest plant community. This area was noted as Reference Reach 2 for desirable vegetation to be used in areas in need of enhancement and restoration. The central portion of the west bank consists a field/turf grass and roadside community. One small area of acidic cove forest is present adjacent to Highway 321 on the south-central portion of the west bank, and to the south of this area is a small area of partial acidic cove plant community and partial field/turf grass and roadside community. The northernmost portion consists of a partial acidic cove plant community and a partial field/turf grass and roadside community on the west bank and a field/turf grass and roadside community located on the east bank due to residential development.

REACH 4C

Most of this reach consists of a partial acidic cove forest community and a partial field/turf grass and roadside community, with a small area of field/turf grass and roadside community on the northernmost east bank. The west side of the river is commercial, and to the east is a small field which is the planned location for Goldmine Branch Park.

REACH 5

The southern portion (along the roads Rippling Water/Hemlock Hollow/River View) consists of partial acidic cove forest community and a partial field/turf grass and roadside community. This area is low-density residential. The south-central portion between Hemlock Hollow Road and the dam just off Payne Branch Road from Highway 321 contains a reach that, according to Blue Ridge Conservancy personnel, will be restored. An acidic cove forest is present between the dam and around the end of Old Blowing Rock Road. This area was noted as Reference Reach 3 for desirable vegetation to be used in areas in need of enhancement and restoration. From the end of Blowing Rock Road to the approximately the beginning of Old Blowing Rock Road, there are areas of acidic cove forest communities; areas of partial acidic cove forest communities and partial field/turf grass and roadside communities. Along portions of Jordan V. Cook Road, there are areas of a field/turf grass and roadside communities. The northernmost portion is in a steep-sided acidic cove forest community between Jordan V. Cook Road and Highway 321.

The southern portion contains a moderate to narrow acidic cove forest community, with residential areas to the east of the river and a large field to the west. The central portion is bordered by a golf course to the east and a residential area to the west and contains partial acidic cove forest communities and partial field/turf grass and roadside communities. The northern portion is bordered to the east by the golf course and to the west by an agricultural field (cattle were noted) and contains the same plant communities as the central portion, except for the northernmost area. This area contains a field/turf grass and roadside community.

III. RESTORATION OPPORTUNITIES

The project team applied results of the sediment analysis, observations of the reaches, and professional judgment to classify segments of the river by Level of Concern (Low/ /High/Extreme). This classification is shown on Sheets 7 and 8. Sheets 9-21 show conceptual restoration plans for all reaches. These sheets include the greenway alignments presented in the 2013 Master Plan, as well as river segments color-coded by Level of Concern. Sheets 22-27 show typical details for restoration and stabilization approaches that would be applicable to the Middle Fork New River. Below are descriptions of restoration opportunities within each reach.

REACH 1

REACH 1A

Reach 1A is generally very stable with a Low BEHI. Streambanks are well vegetated, and the streambed is diverse with riffles, pools, and large woody debris. Localized areas of minor bank erosion and channel over-widening do exist, though restoration in these areas is not recommended due to difficult access and the minor nature of the impairment. One notable area of instability does exist at the outfall to a Publicly Owned Treatment Works (POTW). In this vicinity, the stream makes sharp turns to the right, then left, downstream of a culvert. The left bank is poorly vegetated and eroding for approximately 50 feet. The restoration approach for Reach 1A could include the following:

- With the exception of the area near the POTW, preserve the existing stream channel and riparian areas.
- At the POTW, stabilize the left streambank downstream of the culvert and install river structure(s) to protect the streambank and direct flow through meander bends.
- Throughout the Tanger Outlets property, install Stormwater Control Measures (SCMs) to treat and reduce stormwater runoff to the river. Appropriate SCMs for this area could include vegetated swales, bioretention, permeable pavement, and impervious surface reduction.
- Near the parking area at the top of Reach 1, create an education/interpretation area and river access via steps or an overlook.

REACH 1B

Reach 1B, between Highway 321 and the Blue Ridge Parkway, is highly unstable, with eroding streambanks and poor riparian vegetation. BEHI is Moderate or High throughout this area. The channel is located along the right side of the valley, against a steep valley wall. To the left of the stream are open, low-lying fields and a water treatment facility. Downstream of the Blue Ridge Parkway, Reach 1B becomes more stable, with a BEHI of Low or Moderate. The restoration approach for Reach 1B could include the following:

- Enhance the riparian buffer throughout the reach.
- Realign approximately 1,200 feet of channel, generally between Highway 321 and the Blue Ridge Parkway. The realigned channel should maximize floodplain width between topographic and infrastructure constraints. The realigned channel should have an appropriate dimension, pattern, and profile, as well as river structures to control grade, protect streambanks, and promote bedform diversity.
- Create off-line wetlands for habitat and water storage in the remnant channel along the valley wall.
- Create an education/interpretation area in the vicinity of the new river channel and wetlands. This could be access via a spur trail from the MFG, possibly including a boardwalk.
- In the vicinity of and downstream of the Blue Ridge Parkway, perform localized bank repair and install river structures as needed for bank protection and habitat enhancement.

REACH 1C

Reach 1C flows along the side of Highway 321, often very close to the road. BEHI is generally Moderate throughout the reach, with short segments of Low and High. Some bank erosion exists, particularly on the left bank in areas where the river is near the highway. The channel is relatively straight with a lack of bedform diversity. The restoration approach for Reach 1C could include the following:

- Enhance the riparian buffer throughout the reach.
- Realign approximately 500 feet of channel between the two bridges located on the Foley Center property. This channel should be realigned away from the road, and have appropriate dimension and profile. River structures should be installed to control grade, protect streambanks, and promote bedform diversity.
- Elsewhere within Reach 1C, perform localized bank repair and install river structures as needed for bank protection and habitat enhancement.

REACH 2

REACH 2A

Reach 2A generally coincides with a residential area. BEHI ranges from Low to Very High, with most of the reach having a stable streambed and banks. A short section at the upstream end of the reach appears to have been recently altered, with the bank lacking vegetation and consisting of placed river sediment. Additionally, near the downstream end, a short portion of the left bank abutting Highway 321 has recently been stabilized with a boulder wall. The end of Reach 2A is adjacent to the Aho Waste Convenience Center. The restoration approach for Reach 2A could include the following:

- Enhance the riparian buffer throughout the reach.
- Preserve existing stream and riparian areas throughout residential areas.
- Vegetate bare streambanks at the upstream end of the reach, just downstream of Alpine Village Drive.
- Vegetate and monitor the recent bank repair consisting of a boulder wall near Highway 321.
- Downstream of the boulder wall, perform localized bank repair and install river structures as needed for bank protection and habitat enhancement.

REACH 2B

Reach 2B flows between the Aho Waste Convenience Center and Aho Road. The reach includes both stable and unstable areas. The first third of the reach has a Moderate BEHI, with poor streamside vegetation and some bank erosion. The middle third is unstable with High BEHI as the stream flows against a tall bank adjacent to the Mustard Seed Market. The lower third of the reach is stable with a Low BEHI. The restoration approach for Reach 2B could include the following:

- Enhance the riparian buffer throughout the reach.
- Within the first third of the reach, perform localized bank repair and install river structures as needed for bank protection and habitat enhancement.
- Within the middle third of the reach, realign a short portion of the stream away from the left bank. The realigned channel should have appropriate dimensions, and use river structures to control grade and protect streambanks.
- Where the channel flows adjacent to the Mustard Seed Market, use river structures to protect the left streambank.
- Preserve existing stream and riparian areas within the lowest third of the reach.
- In the vicinity of Aho Road and the FaithBridge church parking area, create an education/interpretation area.

REACH 3

Reach 3, between Aho Road and Sterling Creek Park, is unstable, with eroding streambanks and poor riparian vegetation. BEHI is Moderate throughout the reach. Some infrastructure and topographic constraints exist near each end of the reach, though most of the reach is within a relatively wide, open valley. The restoration approach for Reach 3 could include the following:

- Enhance the riparian buffer throughout the reach.
- Between Aho Road and Pine Gap Road, perform localized bank repair and install river structures as needed for bank protection and habitat enhancement.
- Realign approximately 2,000 feet of channel, generally between Pine Gap Road and Dexter Road. The realigned channel should maximize floodplain width between topographic and infrastructure constraints. The realigned channel should have an appropriate dimension, pattern, and profile, as well as river structures to control grade, protect streambanks, and promote bedform diversity.

REACH 4

REACH 4A

Reach 4A flows through Sterling Creek Park, Mystery Hill, and Tweetsie Railroad properties. The Middle Fork Greenway has been mostly completed throughout this reach. Despite poor streamside vegetation, streambanks are generally stable throughout this reach, with localized areas of bank erosion. BEHI is mostly Moderate, with a short portion of Low and two instances of High. The restoration approach for Reach 4A could include the following:

- Enhance the riparian buffer throughout the reach, particular on the Mystery Hill and Tweetsie Railroad properties.
- Within Sterling Creek Park, remove the existing mid-channel bar and stabilize / revegetate eroding banks.
- Realign approximately 300 feet of channel at a sharp meander bend between Mystery Hill and Tweetsie Railroad. The realigned channel should have an appropriate dimension, bank stabilization, and river structures to direct flow and protect streambanks.
- Create an education/interpretation area in the vicinity of the channel relocation, potentially including a fishing pier off of the existing greenway.

REACH 4B

Reach 4B flows along Highway 321, though it is generally a stable reach. In the upper half of the reach, BEHI is Low with well-vegetated streambanks. Within the lower half of the reach, BEHI is Moderate on the left bank due to poor vegetation and proximity to Highway 321. The restoration approach for Reach 4B could include the following:

- Enhance the riparian buffer throughout the reach.
- Within the upper half of the reach, preserve existing stream and riparian areas.
- Within the lower half of the reach, perform localized bank repair and install river structures as needed for bank protection and habitat enhancement.

REACH 4C

Most of Reach 4C is located with Goldmine Branch Park on the right streambank. The reach is moderately incised with localized bank erosion. The right bank generally has a narrow riparian buffer adjacent to grassed fields. The left bank is lined with commercial land uses that are adjacent to the river. BEHI is Moderate throughout the reach. The restoration approach for Reach 4C could include the following:

- Enhance the riparian buffer throughout the reach, particularly on the left streambank.
- Throughout the reach, perform localized bank repair, revegetate, and install river structures as needed for bank protection and habitat enhancement.
- Within Goldmine Branch Park, create an education/interpretation area, potentially including a fishing pier accessible from a spur off the greenway.

REACH 5A

Reach 5A coincides with a residential area. BEHI is generally Low, with some portions of Moderate. A variety of streambank vegetation and stabilization approaches are evident among the many properties. The restoration approach for Reach 5A could include the following:

- Enhance the riparian buffer throughout the reach.
- Throughout the reach, work with landowners to promote SCMs, bank stabilization, and a vegetated riparian buffer. Appropriate SCMs for this area include rainwater harvesting, bioretention areas, and vegetated areas.

REACH 5B

Reach 5B generally includes areas affected by the historic Payne Dam, including the backwater of the dam, the dam itself, and a cascade below the dam. While BEHI throughout this reach is Low and Moderate, this reach is strongly affected by historic sedimentation and flow manipulation. A stream restoration and dam removal project is currently in progress, so no further restoration approach is detailed herein.

REACH 5C

The upper third of Reach 5C includes a very stable, high-gradient stream through a well-vegetated valley. Below this portion, the river flows along the perimeter of an open field and alongside Jordan V. Cook Road. The high-gradient portion of the river has a Low BEHI, while the portion adjacent to the field and road generally has a Moderate BEHI. At the lower end of the reach, between Old Blowing Rock Road and Highway 321, the river enters another well-vegetated area and has a Low BEHI. The restoration approach for Reach 5C could include the following:

- Enhance the riparian buffer throughout the reach.
- Within the upper and lower thirds of the reach, preserve existing stream and riparian areas.
- For the portion of river that flows near the field and/or Jordan V. Cook Road, perform localized bank repair and install river structures as needed for bank protection and habitat enhancement.

Reach 6 flows from the crossing under Highway 321 to the confluence with the East Fork New River near the Boone Greenway. This reach is characterized by a moderately incised channel with a narrow riparian buffer and localized streambank erosion. BEHI is Moderate throughout, with the exception of portions of High BEHI upstream of and along the Boone Greenway. Most of the right bank is adjacent to the Boone Golf Club, with the left bank adjacent to open fields, residences, and a cattle farm. The restoration approach for Reach 6 could include the following:

- Enhance the riparian buffer throughout the reach.
- Within the large property at the upstream end and the cattle farm, construct stormwater treatment wetlands and other SCMs to mitigate runoff from future development.
- Within the large property at the upstream end of Reach 6, create an education / interpretation area, which could be accessed via side trails from the greenway.
- Create a vegetated riparian buffer, minimum 50 feet width on each side of the streambank, along the entire reach.
- Throughout the reach, perform localized bank repair and install river structures as needed for bank protection and habitat enhancement.
- Along the Boone Greenway, grade all streambanks to a stable slope, plant riparian vegetation, and install river structures to protect streambanks.

VEGETATION

Lists of recommended native flora have been developed for project areas in need of vegetation enhancement or restoration. These lists also include native vegetation recommended by the North Carolina State University Cooperative Extension for mountainous regions in the state and the team's recommended inclusions. All recommended vegetation is native to Watauga County per the USDA Natural Resource Conservation Service Plants Database and/or the Biota of North America Program Database. Appendix D contains recommended vegetation for each planting zone within suggested enhancement and restoration areas. These planting zones are described below, and shown conceptually on Sheet 28:

- Planting Zone 1: Located where soil saturation occurs from the water's edge up to approximately 6 feet away from the water's edge. Consists of small trees/shrubs and herbaceous flora that are adapted to saturated soil conditions and will bend with the river during elevated flow. The distance from the water's edge for this zone depends upon the bank slope (the steeper the slope, the narrower this zone will be).

- Planting Zone 2: Located above Zone 2 into the upper portion of the stream bank. Consists of trees, shrubs, and herbaceous flora that prefer more mesic soil conditions, but are adapted to occasional or seasonal flooding.

- Planting Zone 3: Located above Zone 2 in the floodplain. Consists of trees, shrubs, and herbaceous flora that prefer upland mesic to drier soil conditions.

- Planting Zone 4: Located in upland areas adjacent to the existing and future Greenway. Consists of herbaceous flora suited to drier conditions.

IV. PROJECT ROADMAP

Following the assessment of restoration opportunities outlined in Section III of this report and described in concept in the Appendix, the project team determined the relative priority and estimated cost range for restoration implementation for each reach (Table 8).

TABLE 8. RESTORATION PRIORITIES AND ESTIMATED COSTS.

Reach	Appendix Sheet Number	Relative Priority	Estimated Cost Range ($)
1a	9	Low	$ 10,000 to 20,000
1b	10	High	$ 250,000 to 500,000
1c	11	Moderate	$ 100,000 to 200,000
2a	12	Moderate	$ 80,000 to 150,000
2b	13	Moderate	$ 80,000 to 150,000
3	14	Moderate	$ 250,000 to 500,000
4a	15	High	$ 150,000 to 300,000
4b	16	High	$ 80,000 to 150,000
4c	17	High	$ 120,000 to 200,000
5a	18	Moderate	$ 150,000 to 300,000
5b	19	Moderate	$ 300,000 to 600,000
5c	20	Low	$ 80,000 to 150,000
6	21	Moderate	$ 200,000 to 400,000

The relative priorities for each reach are based upon need for water quality and habitat improvements in addition to access availability. The two highest priorities for stream restoration are in Reaches 1 and 4. Both of these projects are currently in development with engineering and planning teams.

Cost estimates are based on typical fees for design, permitting, and implementation of similar river restoration projects in Western North Carolina. Additional costs may be required for land acquisition and infrastructure improvements associated with stream crossings or utilities. These are broad ranges of costs to be used only for general planning purposes.

Potential funding sources for stream restoration in North Carolina include the following grant programs, all of which require local matching funds:

- NC Clean Water Management Trust Fund:
    - https://cwmtf.nc.gov/
    - Applications are due annually in February.

- NC DEQ Water Resources Development Grant Program:
    - https://deq.nc.gov/about/divisions/water-resources/water-resources-grants/financial-assistance
    - Applications are due semi-annually in June and December.

- NC DEQ 319 Grant Program:
    - https://deq.nc.gov/about/divisions/water-resources/planning/nonpoint-source-management/319-grant-program
    - Applications are due annually in May.

Other private foundation grants available for watershed restoration are described on the NC DEQ web site:

https://deq.nc.gov/about/divisions/water-resources/planning/basin-planning/use-restoration-watershed-programs/funding

Stream restoration projects require permitting at the federal, state, and local levels for environmental and floodplain impacts. Environmental permitting is coordinated by the NC Division of Water Resources and US Army Corps of Engineers using the web-based Pre-Construction Notification (PCN) Form for Nationwide Permits along with corresponding Water Quality Certifications:

https://edocs.deq.nc.gov/Forms/Pre-Construction_Notification_Form

Once the application is complete, the Corps will process it within 45 days for a Nationwide or General Permit, and the NC DWR will process the 401 Certification within 60 days. Other permit approvals may be required by NC Wildlife Resources Commission, US Fish & Wildlife Service, and the State Historic Preservation Office.

If a Floodplain Development Permit is required, the stream restoration project may require coordination with NC Department of Public Safety Floodplain Management Branch to obtain a "No-Rise" Certification or a Letter of Map Revision (LOMR). Project managers should work closely with permitting agencies to determine specific requirements for implementation.

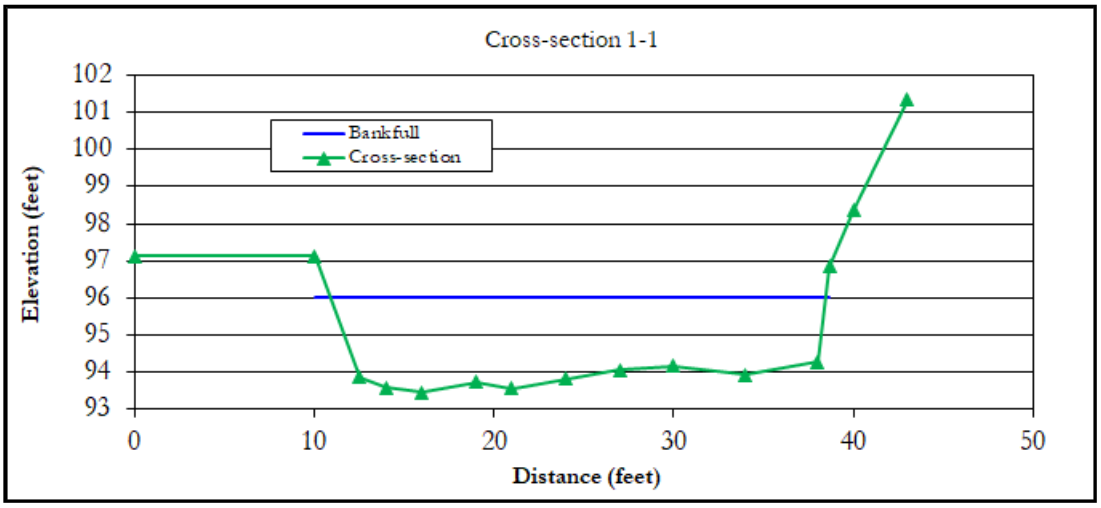
APPENDIX A

CROSS-SECTION DATA

Cross-section 1-1
Middle Fork New River

Latitude: 36.142890
Longitude: -81.668688
Drainage area: 3.19 square miles
Median particle size: gravel
Stream classification: C4

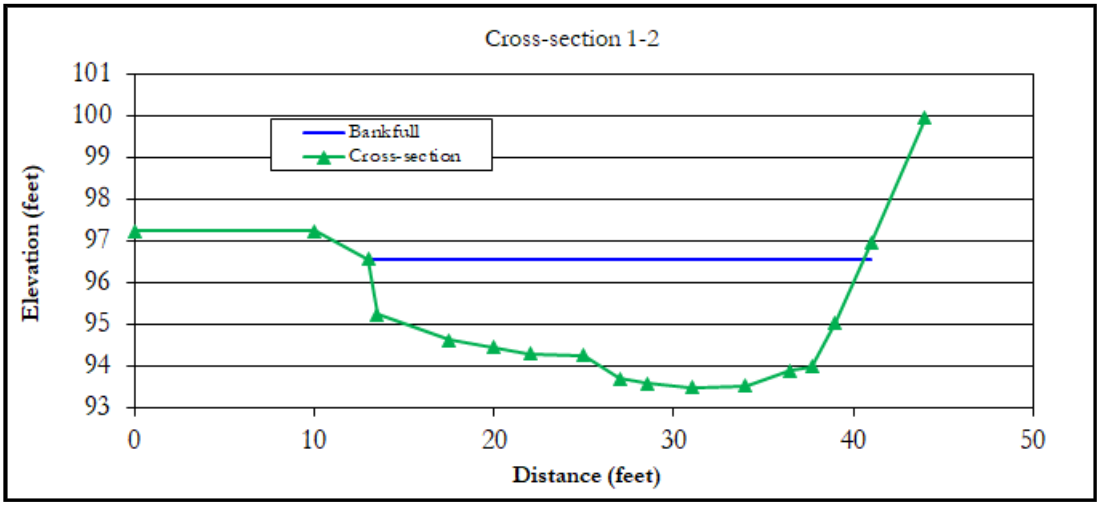
	1-1
Area (square feet) =	57.6
Width (feet) =	27.6
Mean depth =	2.1
Max depth =	2.6
Width/depth ratio =	13.3
Entrenchment ratio =	3.3



Cross-section 1-2
Middle Fork New River

Latitude: 36.144957
Longitude: -81.663464
Drainage area: 3.80 square miles
Median particle size: cobble
Stream classification: E3

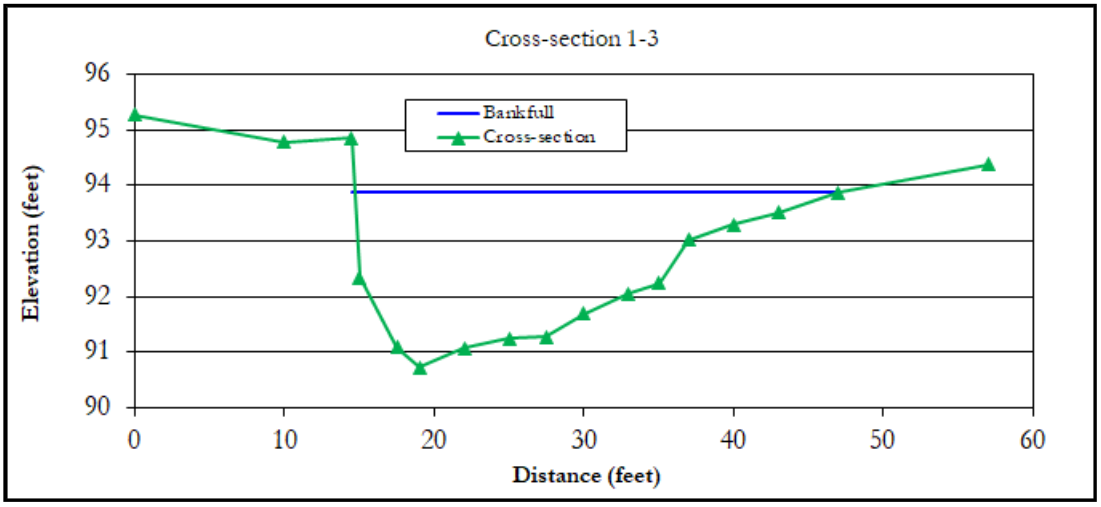
	1-2
Area (square feet) =	63.4
Width (feet) =	27.6
Mean depth =	2.3
Max depth =	3.1
Width/depth ratio =	12.0
Entrenchment ratio =	3.4



Cross-section 1-3
Middle Fork New River

Latitude: 36.145324
Longitude: -81.662814
Drainage area: 3.86 square miles
Median particle size: gravel

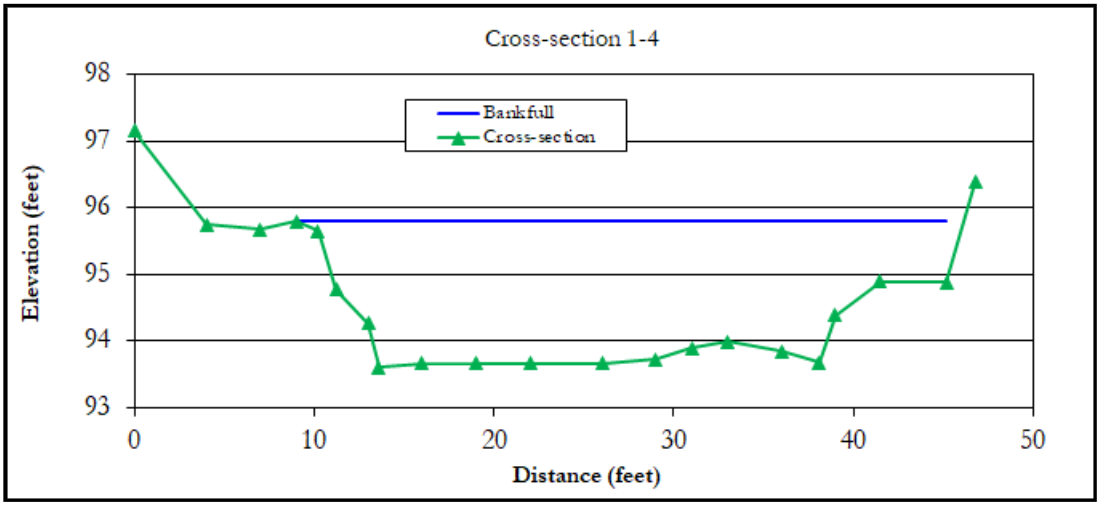
	1-3
Area (square feet) =	56.1
Width (feet) =	32.3
Mean depth =	1.7
Max depth =	3.2



Cross-section 1-4
Middle Fork New River

Latitude: 36.148012
Longitude: -81.661858
Drainage area: 4.04 square miles
Median particle size: gravel
Stream classification: C4

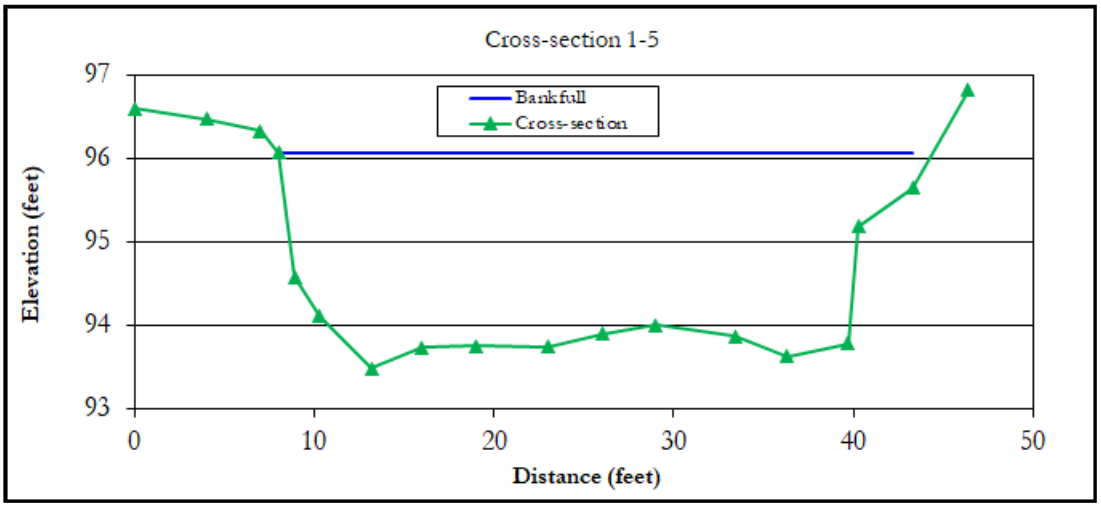
	1-4
Area (square feet) =	62.6
Width (feet) =	37.2
Mean depth =	1.7
Max depth =	2.2
Width/depth ratio =	22.1
Entrenchment ratio =	3.0



Cross-section 1-5
Middle Fork New River

Latitude: 36.150123
Longitude: -81.659937
Drainage area: 4.07 square miles
Median particle size: gravel
Stream classification: B4c

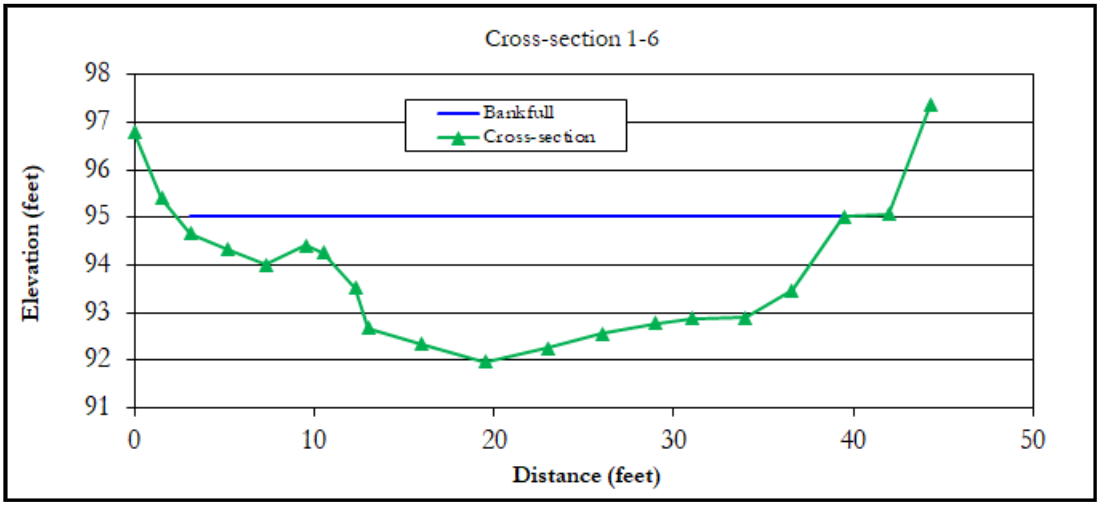
	1-5
Area (square feet) =	73.3
Width (feet) =	36.4
Mean depth =	2.0
Max depth =	2.6
Width/depth ratio =	18.1
Entrenchment ratio =	2.0



Cross-section 1-6
Middle Fork New River

Latitude: 36.150056
Longitude: -81.659949
Drainage area: 4.89 square miles
Median particle size: gravel
Stream classification: C4

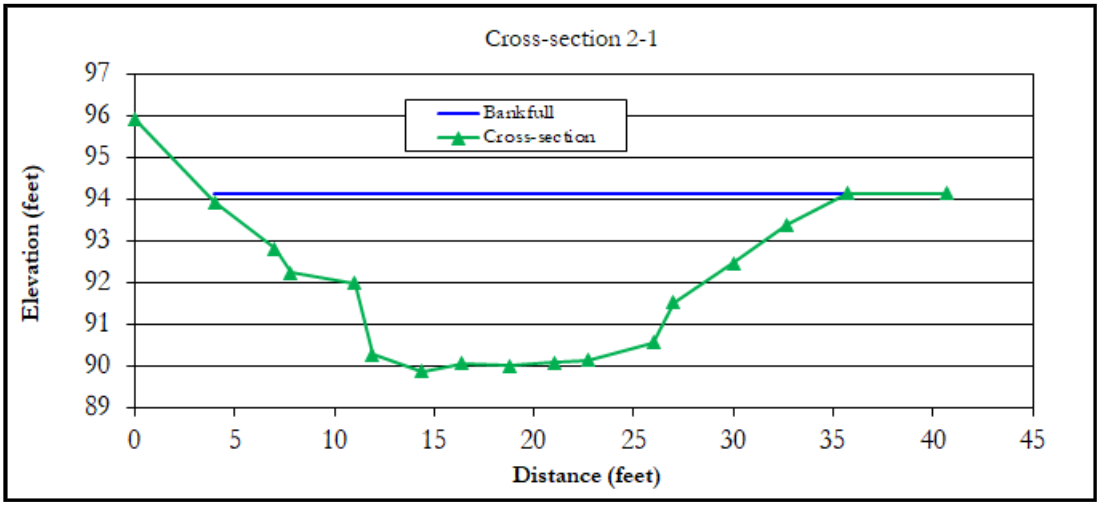
	1-6
Area (square feet) =	69.1
Width (feet) =	37.2
Mean depth =	1.9
Max depth =	3.0
Width/depth ratio =	20.0
Entrenchment ratio =	2.4



Cross-section 2-1
Middle Fork New River

Latitude: 36.152769
Longitude: -81.649552
Drainage area: 5.56 square miles
Median particle size: cobble
Stream classification: C3

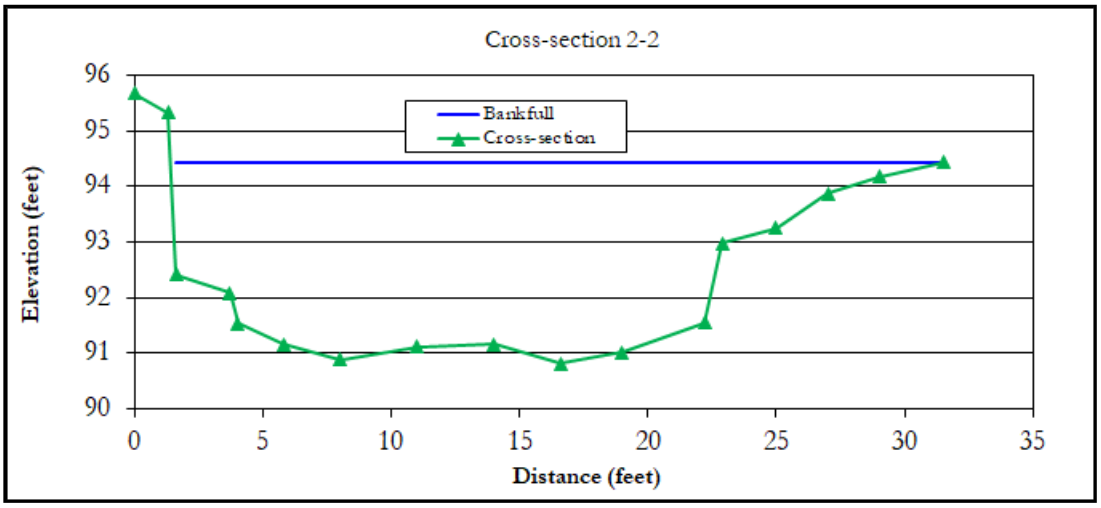
	2-1
Area (square feet) =	83.7
Width (feet) =	32.1
Mean depth =	2.6
Max depth =	4.3
Width/depth ratio =	12.3
Entrenchment ratio =	2.2



Cross-section 2-2
Middle Fork New River

Latitude: 36.154511
Longitude: -81.647796
Drainage area: 5.57 square miles
Median particle size: cobble
Stream classification: C3

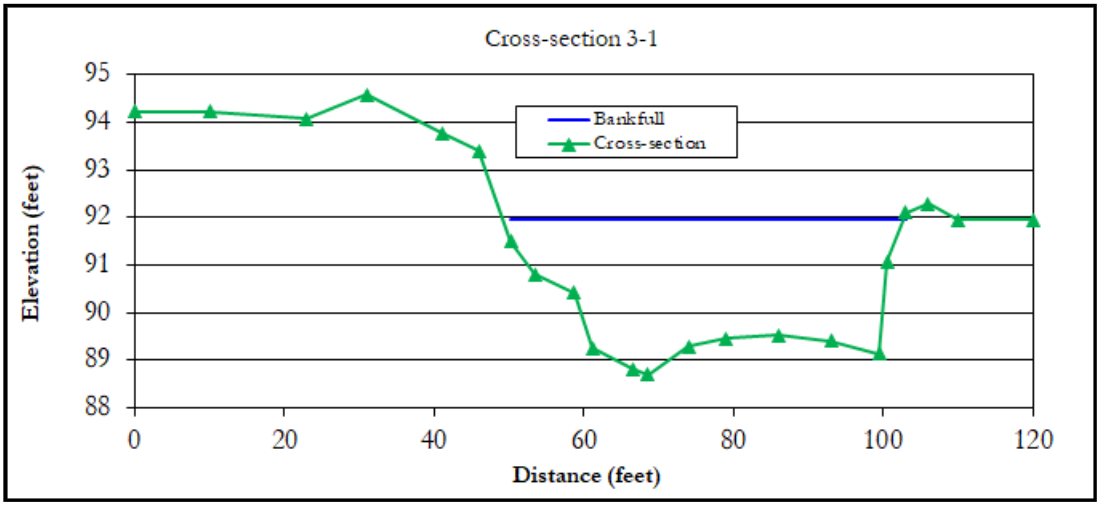
	2-2
Area (square feet) =	73.7
Width (feet) =	30.1
Mean depth =	2.4
Max depth =	3.6
Width/depth ratio =	12.3
Entrenchment ratio =	2.5



Cross-section 3-1
Middle Fork New River

Latitude: 36.161053
Longitude: -81.644227
Drainage area: 8.01 square miles
Median particle size: gravel
Stream classification: C4

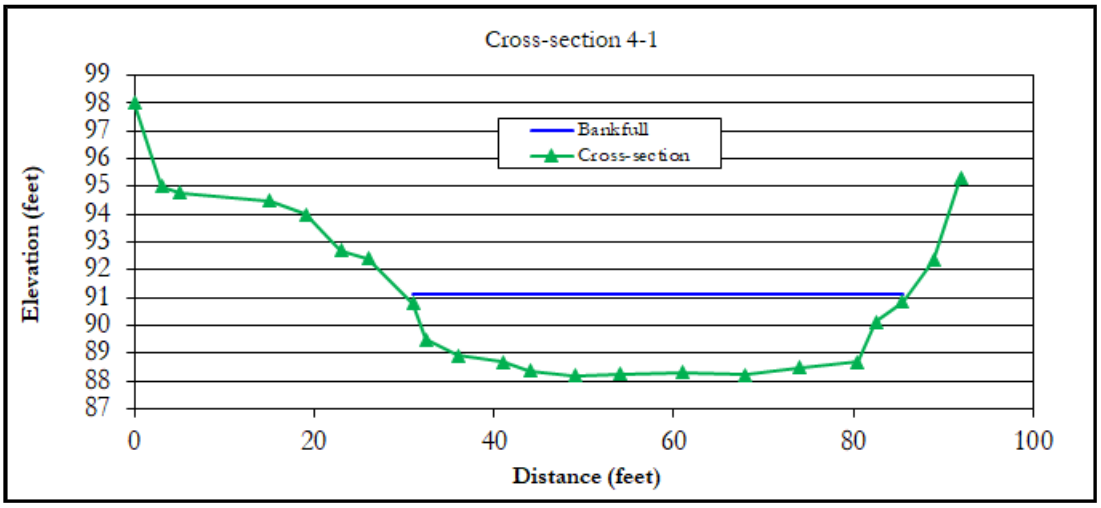
	3-1
Area (square feet) =	120.9
Width (feet) =	53.4
Mean depth =	2.3
Max depth =	3.3
Width/depth ratio =	23.5
Entrenchment ratio =	2.9



Cross-section 4-1
Middle Fork New River

Latitude: 36.161398
Longitude: -81.643681
Drainage area: 8.01 square miles
Median particle size: gravel
Stream classification: B4c

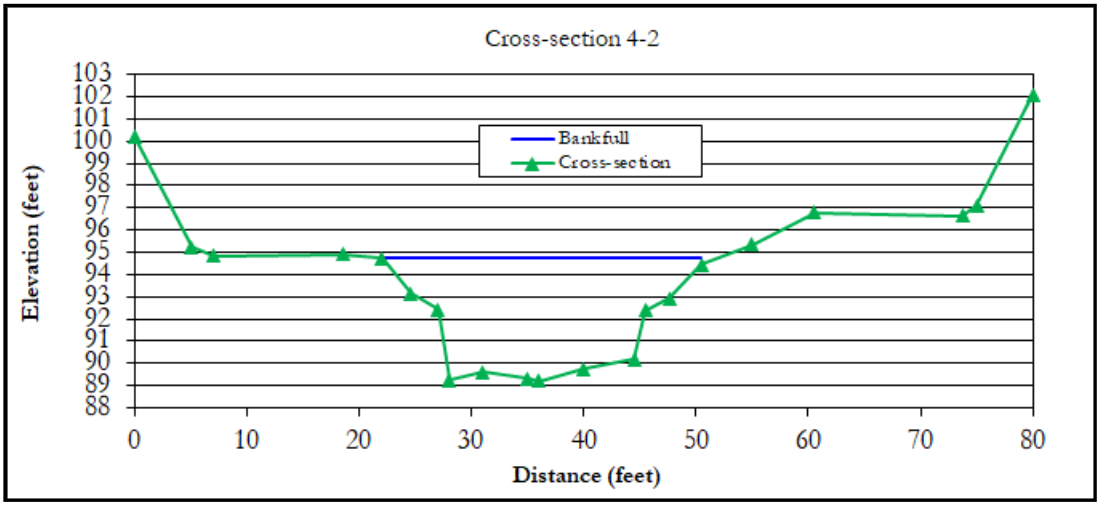
	4-1
Area (square feet) =	133.8
Width (feet) =	56.0
Mean depth =	2.4
Max depth =	2.9
Width/depth ratio =	23.5
Entrenchment ratio =	1.3



Cross-section 4-2
Middle Fork New River

Latitude: 36.164174
Longitude: -81.644629
Drainage area: 8.40 square miles
Median particle size: cobble
Stream classification: E3

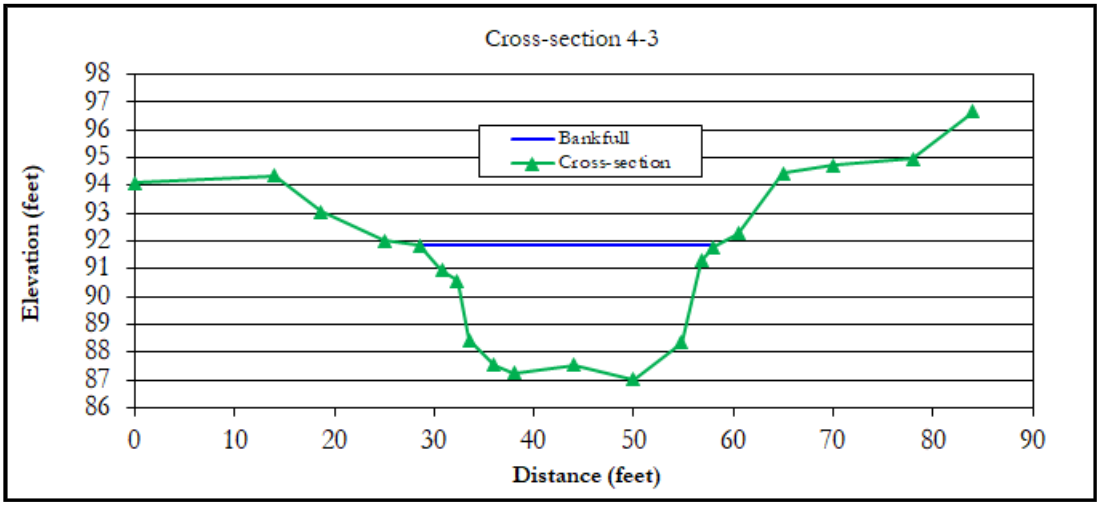
	4-2
Area (square feet) =	106.8
Width (feet) =	29.9
Mean depth =	3.6
Max depth =	5.5
Width/depth ratio =	8.4
Entrenchment ratio =	2.6



Cross-section 4-3
Middle Fork New River

Latitude: 36.167426
Longitude: -81.647332
Drainage area: 8.47 square miles
Median particle size: cobble
Stream classification: E3

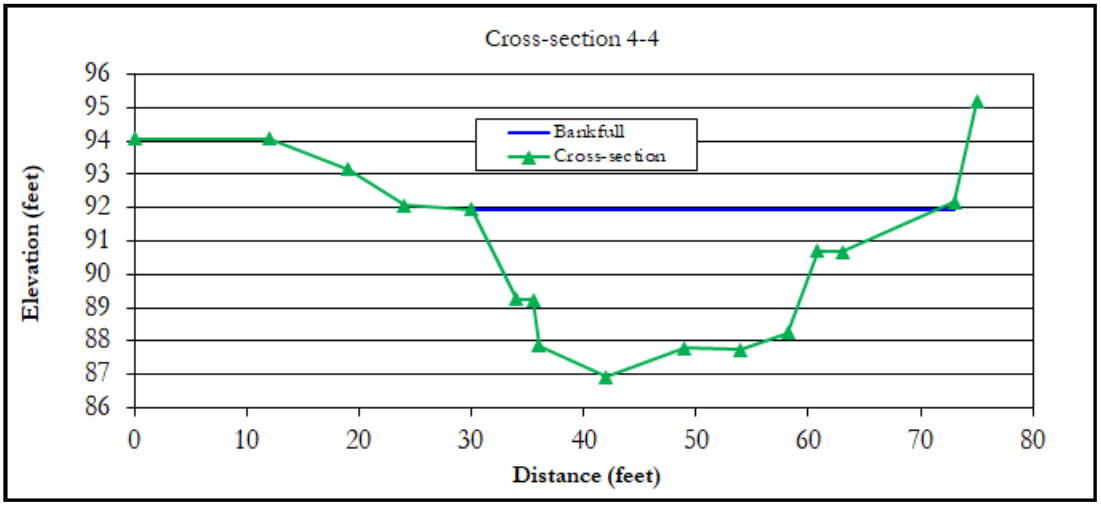
	4-3
Area (square feet) =	102.4
Width (feet) =	29.8
Mean depth =	3.4
Max depth =	4.8
Width/depth ratio =	8.6
Entrenchment ratio =	4.5



Cross-section 4-4
Middle Fork New River

Latitude: 36.168001
Longitude: -81.647273
Drainage area: 8.47 square miles
Median particle size: cobble
Stream classification: C3

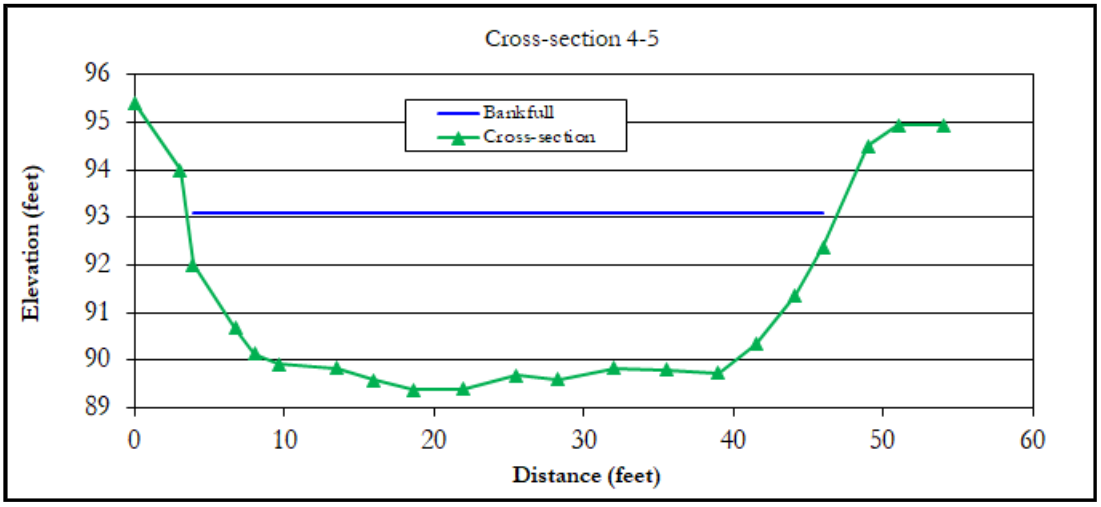
	4-4
Area (square feet) =	123.2
Width (feet) =	41.6
Mean depth =	3.0
Max depth =	5.0
Width/depth ratio =	14.0
Entrenchment ratio =	3.1



Cross-section 4-5
Middle Fork New River

Latitude: 36.180093
Longitude: -81.646711
Drainage area: 10.20 square miles
Median particle size: cobble
Stream classification: C3

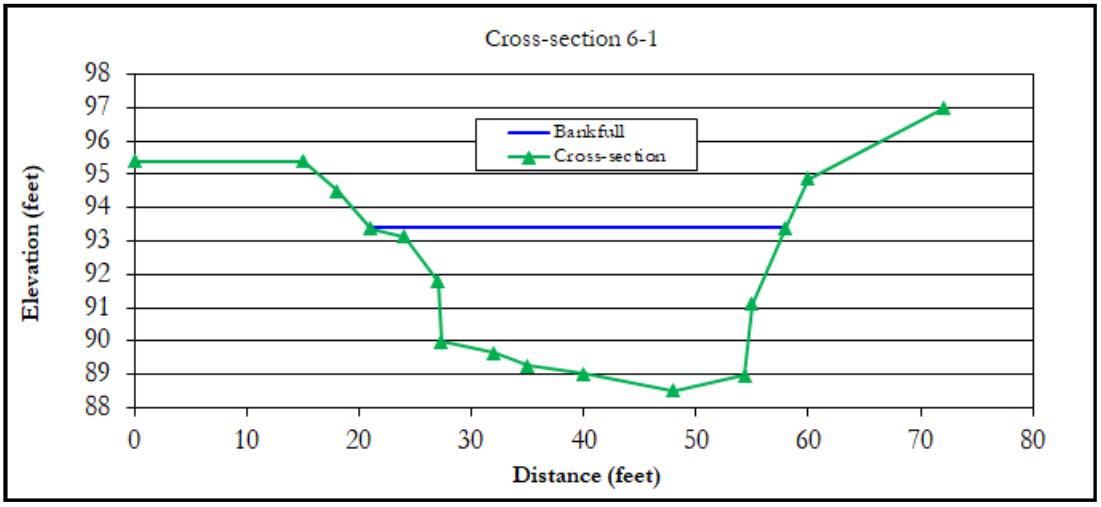
	4-5
Area (square feet) =	130.5
Width (feet) =	42.6
Mean depth =	3.1
Max depth =	3.7
Width/depth ratio =	13.9
Entrenchment ratio =	2.6



Cross-section 6-1
Middle Fork New River

Latitude: 36.202404
Longitude: -81.650136
Drainage area: 12.20 square miles
Median particle size: gravel
Stream classification: E4

	6-1
Area (square feet) =	126.1
Width (feet) =	37.1
Mean depth =	3.4
Max depth =	4.9
Width/depth ratio =	10.9
Entrenchment ratio =	4.6



APPENDIX B

BEHI AND NBS OBSERVATIONS

BEHI and NBS Observations

Reach	Bank Length	Left BEHI	Left NBS	Right BEHI	Right NBS	Left Bank Erosion Rate	Right Bank Erosion Rate	Erosion Rate
	(feet)					(feet/year)	(feet/year)	(cu feet/year)
1A	386	Low	Low	Low	Low	0.02	0.02	39
1A	246	None	None	None	None	0	0	0
1A	456	Low	Low	Low	Low	0.02	0.02	46
1A	55	None	None	None	None	0	0	0
1A	54	Very High	Moderate	Low	Low	0.75	0.02	205
1A	712	Low	Low	Low	Low	0.02	0.02	85
1A	639	Low	Moderate	Low	Low	0.05	0.02	89
1A	387	Low	Low	Low	Low	0.02	0.02	31
1A	148	None	None	None	None	0	0	0
1B	99	Low	Low	Moderate	Moderate	0.02	0.05	14
1B	22	None	None	None	None	0	0	0
1B	129	Moderate	Low	Moderate	Low	0.02	0.02	13
1B	277	Moderate	Low	Low	Low	0.02	0.02	28
1B	98	Moderate	Low	High	High	0.02	0.2	82
1B	135	High	High	Low	Very Low	0.2	0.008	110
1B	510	Moderate	Low	Low	Low	0.02	0.02	61
1B	153	Moderate	Moderate	Moderate	Moderate	0.05	0.05	46
1B	68	Moderate	Very High	Moderate	Moderate	0.28	0.05	84
1B	146	Moderate	Low	Moderate	Low	0.02	0.02	18
1B	92	None	None	None	None	0	0	0
1B	162	Low	Low	Low	Low	0.02	0.02	13
1B	219	Moderate	Moderate	Low	Low	0.05	0.02	31
1B	46	None	None	None	None	0	0	0
1B	436	Low	Low	Very Low	Low	0.02	0.02	35
1C	177	Moderate	Low	Very Low	Low	0.02	0.02	14
1C	81	None	None	None	None	0	0	0
1C	182	Moderate	Low	Low	Low	0.02	0.02	15
1C	427	Moderate	Moderate	Low	Low	0.05	0.02	81
1C	46	None	None	None	None	0	0	0
1C	53	Low	Low	Low	Low	0.02	0.02	4
1C	112	High	High	Moderate	Low	0.2	0.02	71
1C	614	Moderate	Moderate	Low	Low	0.05	0.02	107
1C	364	Moderate	Moderate	Low	Low	0.05	0.02	64
2A	18	None	None	None	None	0	0	0
2A	95	High	Low	High	Low	0.1	0.1	57
2A	474	Low	Low	Low	Low	0.02	0.02	47
2A	178	Moderate	Low	Low	Low	0.02	0.02	18
2A	45	None	None	None	None	0	0	0

BEHI and NBS Observations

Reach	Bank Length	Left BEHI	Left NBS	Right BEHI	Right NBS	Left Bank Erosion Rate	Right Bank Erosion Rate	Erosion Rate
	(feet)					(feet/year)	(feet/year)	(cu feet/year)
2A	90	Moderate	Low	Low	Low	0.02	0.02	7
2A	132	Moderate	Low	Low	Moderate	0.02	0.05	19
2A	275	Moderate	Low	Low	Low	0.02	0.02	22
2A	151	Moderate	Moderate	Low	Low	0.05	0.02	21
2A	200	Low	Low	Low	Low	0.02	0.02	16
2A	86	Low	Low	Low	Moderate	0.02	0.05	12
2A	484	Low	Low	Low	Low	0.02	0.02	39
2A	165	Low	Low	Low	Moderate	0.02	0.05	23
2A	243	Low	Moderate	Moderate	Low	0.05	0.02	34
2A	84	Very High	High	Low	Low	0.9	0.02	607
2A	267	Moderate	Low	Low	Low	0.02	0.02	40
2A	443	Moderate	Moderate	Low	Low	0.05	0.02	106
2A	327	Moderate	Low	Low	Low	0.02	0.02	39
2B	344	Moderate	Moderate	Low	Low	0.05	0.02	83
2B	109	Moderate	High	Low	Very Low	0.12	0.008	54
2B	250	High	Moderate	Low	Low	0.15	0.02	160
2B	327	Low	Low	Low	Low	0.02	0.02	26
2B	49	None	None	None	None	0	0	0
3	226	Moderate	Low	Low	Low	0.02	0.02	32
3	176	Moderate	Low	Low	Moderate	0.02	0.05	28
3	450	Moderate	Low	Low	Low	0.02	0.02	63
3	20	None	None	None	None	0	0	0
3	377	Moderate	Low	Moderate	Low	0.02	0.02	60
3	136	Moderate	Low	Moderate	High	0.02	0.12	57
3	215	Moderate	Low	Moderate	Low	0.02	0.02	26
3	113	Moderate	High	Moderate	Low	0.12	0.02	47
3	192	Moderate	Low	Moderate	High	0.02	0.12	81
3	341	Moderate	High	Moderate	Low	0.12	0.02	143
3	115	Moderate	Low	Moderate	High	0.02	0.12	48
3	163	Moderate	Low	Moderate	Low	0.02	0.02	20
3	178	Moderate	High	Moderate	High	0.12	0.12	128
3	217	Moderate	High	Moderate	Low	0.12	0.02	91
3	192	Moderate	Moderate	Moderate	Low	0.05	0.02	40
3	19	None	None	None	None	0	0	0
3	401	Moderate	Moderate	Low	Low	0.05	0.02	104
4A	459	Moderate	Low	Low	Low	0.02	0.02	55
4A	202	Low	Low	High	Moderate	0.02	0.15	133
4A	352	Moderate	Low	High	High	0.02	0.2	303

BEHI and NBS Observations

Reach	Bank Length	Left BEHI	Left NBS	Right BEHI	Right NBS	Left Bank Erosion Rate	Right Bank Erosion Rate	Erosion Rate
	(feet)					(feet/year)	(feet/year)	(cu feet/year)
4A	120	Low	Low	Low	Low	0.02	0.02	14
4A	272	None	None	None	None	0	0	0
4A	756	Moderate	Low	Moderate	Low	0.02	0.02	121
4A	358	Moderate	Low	Moderate	Moderate	0.02	0.05	100
4A	376	Moderate	Moderate	Moderate	Low	0.05	0.02	105
4A	303	High	High	Moderate	Low	0.2	0.02	267
4A	143	Moderate	Low	Moderate	Moderate	0.02	0.05	40
4A	770	Moderate	Low	Moderate	Low	0.02	0.02	123
4A	47	None	None	None	None	0	0	0
4A	582	Moderate	Low	Moderate	Low	0.02	0.02	81
4A	132	None	None	None	None	0	0	0
4B	142	Low	Low	Low	Low	0.02	0.02	17
4B	153	Low	Very Low	Low	High	0.008	0.12	58
4B	1313	Low	Low	Low	Low	0.02	0.02	131
4B	239	Moderate	Moderate	Low	Low	0.05	0.02	50
4B	714	Moderate	Moderate	Moderate	Low	0.05	0.02	150
4B	561	Moderate	Low	Low	Moderate	0.02	0.05	118
4C	407	Moderate	Moderate	Moderate	Moderate	0.05	0.05	163
4C	105	Moderate	Moderate	Moderate	Low	0.05	0.02	29
4C	116	Moderate	Low	Moderate	High	0.02	0.12	65
4C	999	Moderate	Moderate	Moderate	Moderate	0.05	0.05	400
4C	198	Moderate	Low	Moderate	Moderate	0.02	0.05	55
5A	187	None	None	None	None	0	0	0
5A	560	Low	Low	Low	Low	0.02	0.02	67
5A	147	Moderate	High	Moderate	Low	0.12	0.02	62
5A	235	Low	Low	Low	Low	0.02	0.02	28
5A	329	Low	Low	Low	Moderate	0.02	0.05	69
5A	439	Low	Moderate	Low	Low	0.05	0.02	92
5A	56	None	None	None	None	0	0	0
5A	108	Moderate	Moderate	Moderate	Low	0.05	0.02	23
5A	117	Moderate	High	Moderate	Low	0.12	0.02	49
5B	251	Low	Low	Low	Moderate	0.02	0.05	53
5B	188	Moderate	Low	Moderate	Low	0.02	0.02	23
5B	122	Moderate	Low	Moderate	High	0.02	0.12	51
5B	126	Moderate	High	Moderate	Low	0.12	0.02	53
5B	113	Moderate	Low	Moderate	High	0.02	0.12	48
5B	127	Moderate	High	Moderate	Low	0.12	0.02	53
5B	206	Moderate	Moderate	Moderate	Moderate	0.05	0.05	52

BEHI and NBS Observations

Reach	Bank Length	Left BEHI	Left NBS	Right BEHI	Right NBS	Left Bank Erosion Rate	Right Bank Erosion Rate	Erosion Rate
	(feet)					(feet/year)	(feet/year)	(cu feet/year)
5B	80	Low	Low	Low	High	0.02	0.12	28
5B	177	Low	High	Low	High	0.12	0.12	106
5B	20	None	None	None	None	0	0	0
5C	268	Low	Low	Low	Low	0.02	0.02	27
5C	274	Low	High	Low	Low	0.12	0.02	96
5C	94	Low	High	Low	High	0.12	0.12	57
5C	263	Low	Moderate	Low	Moderate	0.05	0.05	66
5C	114	Low	Low	Low	High	0.02	0.12	40
5C	422	Low	Moderate	Low	Moderate	0.05	0.05	106
5C	1356	Low	Low	Low	Low	0.02	0.02	163
5C	176	Moderate	High	Moderate	Low	0.12	0.02	98
5C	549	Moderate	Low	Moderate	Low	0.02	0.02	110
5C	343	Moderate	Moderate	Moderate	Low	0.05	0.02	120
5C	375	Low	Low	Low	Low	0.02	0.02	75
5C	81	None	None	None	None	0	0	0
5C	180	Low	Low	Low	Moderate	0.02	0.05	38
5C	392	Low	Moderate	Low	Low	0.05	0.02	82
5C	272	Low	Low	Low	Low	0.02	0.02	33
5C	306	None	None	None	None	0	0	0
6	1199	Moderate	Low	Moderate	Low	0.02	0.02	216
6	953	Moderate	Low	Moderate	Moderate	0.02	0.05	300
6	779	Moderate	Low	Moderate	Moderate	0.02	0.05	273
6	263	Moderate	Moderate	High	Moderate	0.05	0.15	302
6	487	Moderate	High	Moderate	Low	0.12	0.02	341
6	71	None	None	None	None	0	0	0
6	298	Moderate	Moderate	High	Moderate	0.05	0.15	283
6	204	High	High	Low	Low	0.2	0.02	261
6	160	High	High	Moderate	Moderate	0.2	0.05	192

APPENDIX C

EXISTING VEGETATION

Flora Documented along the Middle Fork New River

Reach 1

Scientific Name	Common Name
Trees/Saplings	
Acer rubrum	Red maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Cornus alternifolia	Alternate-leaf dogwood
Cornus amomum	Silky dogwood
Fraxinus pennsylvanica	Green ash
Lirodendron tulipifera	Tuliptree
Magnolia fraseri	Fraser magnolia
Pinus strobus	Eastern white pine
Prunus caroliniana	Laurel cherry
Prunus serotina	Black cherry
Quercus rubra	Northern red oak
Robinia pseudoacacia	Black locust
Tsuga canadensis	Eastern hemlock
Shrubs	
Alnus serrulata	Hazel alder
Clethra acuminata	Mountain sweet pepperbush
Crataegus sp.	Hawthorn
Hamamelis virginiana	American witchhazel
Hydrangea arborescens	Wild hydrangea
Kalmia latifolia	Mountain laurel
Physocarpus opulifolius	Ninebark
Rhododendron arborescens	Smooth azalea
Rhododendron calendulaceum	Flame azalea
Rhododendron maximum	Rosebay
**Rosa multiflora*	*Multiflora rose
Sambucus canadensis	Elderberry
Sassafras albidum	Sassafras
Viburnum prunifolium	Smooth blackhaw
Herbaceous	
**Phalaris arundinacea*	*Reed canary grass
Achillea millefolium	Common yarrow
Angelica atropurpurea	Great angelica
Arisaema triphyllum	Jack in the pulpit
Athyrium filix-femina	Lady fern
Chimaphila maculata	Striped wintergreen
Dennstaedtia punctilobula	Hayscented fern

Flora Documented along the Middle Fork New River

Dichanthelium clandestinum	Deertongue
Eurybia divaricata	White wood aster
Galax urceolata	Galax/beetleweed
Galium aparine	Cleavers
Glechoma hederacea	Ground ivy
Goodyera pubescens	Downy rattlesnake plantain
Hexastylis shuttleworthii	Largeflower heartleaf
Houstonia purpurea	Large bluet
Impatiens capensis	Jewelweed
Juncus effusus	Soft rush
Onoclea sensibilis	Sensitive fern
Packera aurea	Golden ragwort
Polygonatum biflorum	Solomon's seal
Polystichum acrostichoides	Christmas fern
Potentilla spp.	Cinquefoil
Ranunculus acris	Tall buttercup
Schizachyrium scoparium	Little bluestem
Solidago spp.	Goldenrod
Stellaria pubera	Star chickweed
**Veronica chamaedrys*	*Germander speedwell
*Various turf grasses	*Various turf grasses
Viola spp.	Violet
Zizea aurea	Golden alexander
Vines	
Celastrus orbiculatus	Oriental bittersweet
Clematis sp.	Virgin's bower
Parthenocissus quinquefolia	Virginia creeper
Rubus spp.	Blackberry and raspberry
Smilax spp.	Greenbrier
Toxicodendron radicans	Poison ivy
*Non-native/invasive species	

Flora Documented along the Middle Fork New River

Southern portion behind WWTP, facing north

North-central portion at Chestnut Ridge Bridge, facing north

Flora Documented along the Middle Fork New River

Stormwater feature on the northern portion for future enhancement, facing northeast

Flora Documented along the Middle Fork New River

Reach 2

Scientific Name	Common Name
Trees/Saplings	
Acer rubrum	Red maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Fraxinus pennsylvanica	Green ash
Lirodendron tulipifera	Tuliptree
Magnolia fraseri	Fraser magnolia
Prunus serotina	Black cherry
Quercus rubra	Northern red oak
Robinia pseudoacacia	Black locust
Tsuga canadensis	Eastern hemlock
Shrubs	
Hamamelis virginiana	American witchhazel
Kalmia latifolia	Mountain laurel
Rhododendron arborescens	Smooth azalea
Rhododendron maximum	Rosebay
**Rosa multiflora*	*Multiflora rose
Sambucus canadensis	Elderberry
Herbaceous	
**Phalaris arundinacea*	*Reed canary grass
Achillea millefolium	Common yarrow
Athyrium filix-femina	Lady fern
Dennstaedtia punctilobula	Hayscented fern
Dichanthelium clandestinum	Deertongue
Galium aparine	Cleavers
Hexastylis shuttleworthii	Largeflower heartleaf
Impatiens capensis	Jewelweed
Juncus effusus	Soft rush
Polystichum acrostichoides	Christmas fern
Solidago spp.	Goldenrod
*Various turf grasses	*Various turf grasses
Viola spp.	Violet
Vines	
Parthenocissus quinquefolia	Virginia creeper
Rubus sp.	Blackberry
Toxicodendron radicans	Poison ivy
*Non-native/invasive species	

Flora Documented along the Middle Fork New River

Southern portion within Firethorn residential area

North-central portion by recycling center, facing south

Flora Documented along the Middle Fork New River

Northernmost portion facing east to tributary

Flora Documented along the Middle Fork New River

Reach 3

Scientific Name	Common Name
Trees/Saplings	
Acer rubrum	Red maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Cornus amomum	Silky dogwood
Pinus strobus	Eastern white pine
Quercus rubra	Northern red oak
Robinia pseudoacacia	Black locust
Salix nigra	Black willow
Shrubs	
Hamamelis virginiana	American witchhazel
Kalmia latifolia	Mountain laurel
Rhododendron maximum	Rosebay
**Rosa multiflora*	*Multiflora rose
Sambucus canadensis	Elderberry
Viburnum prunifolium	Smooth blackhaw
Herbaceous	
**Phalaris arundinacea*	*Reed canary grass
Achillea millefolium	Common yarrow
Athyrium filix-femina	Lady fern
Galium aparine	Cleavers
Impatiens capensis	Jewelweed
Juncus effusus	Soft rush
Polystichum acrostichoides	Christmas fern
Solidago spp.	Goldenrod
*Various turf grasses	*Various turf grasses
Viola spp.	Violet
Vines	
Rubus sp.	Blackberry
Toxicodendron radicans	Poison ivy
*Non-native/invasive species	

Flora Documented along the Middle Fork New River

Southern portion at Mack Hampton Road, facing south

Central portion, facing south

Flora Documented along the Middle Fork New River

Northern portion from Dexter Road bridge, facing south

Flora Documented along the Middle Fork New River

Reach 4

Scientific Name	Common Name
Trees/Saplings	
Acer pensylvanicum	Striped maple
Acer rubrum	Red maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Cornus alternifolia	Alternate-leaf dogwood
Cornus amomum	Silky dogwood
Cornus florida	Flowering dogwood
Fraxinus pennsylvanica	Green ash
Liriodendron tulipifera	Tuliptree
Magnolia fraseri	Fraser magnolia
Pinus strobus	Eastern white pine
Prunus caroliniana	Laurel cherry
Prunus serotina	Black cherry
Quercus rubra	Northern red oak
Robinia pseudoacacia	Black locust
Salix sericea	Silky willow
Tsuga canadensis	Eastern hemlock
Shrubs	
Alnus serrulata	Hazel alder
Hamamelis virginiana	American witchhazel
Hydrangea arborescens	Wild hydrangea
Kalmia latifolia	Mountain laurel
Physocarpus opulifolius	Ninebark
Rhododendron arborescens	Smooth azalea
Rhododendron calendulaceum	Flame azalea
Rhododendron maximum	Rosebay
**Rosa multiflora*	*Multiflora rose
Sambucus canadensis	Elderberry
Sassafras albidum	Sassafras
Viburnum prunifolium	Smooth blackhaw
Herbaceous	
**Alliaria petiolata*	*Garlic mustard
**Hesperis matronalis*	*Dame's rocket
**Phalaris arundinacea*	*Reed canary grass
Achillea millefolium	Common yarrow
Arisaema triphyllum	Jack in the pulpit
Asclepias syriaca	Common milkweed
Athyrium filix-femina	Lady fern
Herbaceous (continued)	
Carex pensylvanica	Pennsylvania sedge
Chimaphila maculata	Striped wintergreen
Dennstaedtia punctilobula	Hayscented fern
Dichanthelium clandestinum	Deertongue
Dryopteris sp.	Wood fern
Erigeron annuus	Eastern daisy fleabane
Eurybia divaricata	White wood aster

Flora Documented along the Middle Fork New River

Galax urceolata	Galax/beetleweed
Galium aparine	Cleavers
Hexastylis shuttleworthii	Largeflower heartleaf
Houstonia purpurea	Woodland bluet
Impatiens capensis	Jewelweed
Juncus effusus	Soft rush
Maianthemum canadense	Canada mayflower
Mitchella repens	Patridgeberry
Monarda didyma	Scarlet beebalm
Packera aurea	Golden ragwort
Polystichum acrostichoides	Christmas fern
Potentilla spp.	Cinquefoil
Ranunculus acris	Tall buttercup
Schizachyrium scoparium	Little bluestem
Sisyrinchium angustifolium	Blue-eyed grass
Solidago spp.	Goldenrod
Stellaria pubera	Star chickweed
**Veronica chamaedrys*	*Germander speedwell
Trillium spp.	Wake robin
*Various turf grasses	*Various turf grasses
Viola spp.	Violet
Zizea aurea	Golden alexander
Vines	
**Celastrus orbiculatus*	Oriental bittersweet
Clematis sp.	Virgin's bower
Parthenocissus quinquefolia	Virginia creeper
Rubus spp.	Blackberry and raspberry
Smilax spp.	Greenbrier
Toxicodendron radicans	Poison ivy
*Non-native/invasive species	

Flora Documented along the Middle Fork New River

4a: Northern portion from Tweetsie Railroad entrance, facing south

4b: Southern portion from Tweetsie Railroad entrance, facing north

Flora Documented along the Middle Fork New River

4b: South-central portion behind "red bus," facing east towards Reference Reach 2

4b: North-central portion across Highway 321 from Chandler Concrete, facing south

Flora Documented along the Middle Fork New River

4c: South-facing view of reach from the intersection of Highway 321 and Mine Branch Road

Flora Documented along the Middle Fork New River

Reach 5

Scientific Name	Common Name
Trees/Saplings	
Acer rubrum	Red maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Cornus alternifolia	Alternate-leaf dogwood
Cornus amomum	Silky dogwood
Fraxinus pennsylvanica	Green ash
Ilex montana	Large-leaf winterberry
Ilex verticillata	Common winterberry
Liriodendron tulipifera	Tuliptree
Pinus strobus	Eastern white pine
Prunus pensylvanica	Pin cherry
Prunus serotina	Black cherry
Quercus rubra	Northern red oak
Robinia pseudoacacia	Black locust
Salix nigra	Black willow
Tsuga canadensis	Eastern hemlock
Shrubs	
Alnus serrulata	Hazel alder
Crataegus sp.	Hawthorn
Hamamelis virginiana	American witchhazel
Kalmia latifolia	Mountain laurel
Physocarpus opulifolius	Ninebark
Rhododendron maximum	Rosebay
**Rosa multiflora*	*Multiflora rose
Sambucus canadensis	Elderberry
Sassafras albidum	Sassafras
Herbaceous	
**Hesperis matronalis*	*Dame's rocket
**Phalaris arundinacea*	*Reed canary grass
Achillea millefolium	Common yarrow
Alopecurus sp.	Foxtail
Athyrium filix-femina	Lady fern
Carex pensylvanica	Pennsylvania sedge
Dichanthelium clandestinum	Deertongue
Erigeron annuus	Eastern daisy fleabane
Eurybia divaricata	White wood aster
Impatiens capensis	Jewelweed
Maianthemum racemosum	Solomon's plume
Herbaceous (continued)	
Packera aurea	Golden ragwort
Polygonatum biflorum	Solomon's seal
Polystichum acrostichoides	Christmas fern
Potentilla spp.	Cinquefoil
Schizachyrium scoparium	Little bluestem
Sisyrinchium angustifolium	Blue-eyed grass
*Various turf and pasture grasses	*Various turf and pasture grasses

Flora Documented along the Middle Fork New River

Tradescantia ohiensis	Spiderwort
Viola spp.	Violet
Vines	
**Celastrus orbiculatus*	Oriental bittersweet
Clematis sp.	Virgin's bower
Parthenocissus quinquefolia	Virginia creeper
Rubus spp.	Blackberry
Smilax spp.	Greenbrier
Toxicodendron radicans	Poison ivy
*Non-native/invasive species	

South portion from Rippling Water Road, facing south

Flora Documented along the Middle Fork New River

North portion from Old Blowing Rock Road, facing north

South-central portion downstream of the dam off Paynes Way, facing north
(within Reference Reach 3)

Flora Documented along the Middle Fork New River

North-central portion from near the intersection of Jordan V. Cook Road and Edna Road, facing southwest

North portion near the intersection of Jordan V. Cook Road and Old Blowing Rock Road, facing northeast (standing on east side of river)

Flora Documented along the Middle Fork New River

Reach 6

Scientific Name	Common Name
Trees/Saplings	
Acer pensylvanicum	Striped maple
Acer rubrum	Red maple
Acer saccharum	Sugar maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Carya glabra	Pignut hickory
Carya ovata	Shagbark hickory
Carya tomentosa	Mockernut hickory
Cornus alternifolia	Alternate-leaf dogwood
Cornus amomum	Silky dogwood
Cornus florida	Flowering dogwood
Fraxinus pennsylvanica	Green ash
Ilex montana	Large-leaf winterberry
Ilex verticillata	Common winterberry
Lirodendron tulipifera	Tuliptree
Magnolia fraseri	Fraser magnolia
Pinus strobus	Eastern white pine
Prunus caroliniana	Laurel cherry
Prunus pensylvanica	Pin cherry
Prunus serotina	Black cherry
Quercus rubra	Northern red oak
Robinia pseudoacacia	Black locust
Salix nigra	Black willow
Salix sericea	Silky willow
Tilia americana	American basswood
Tsuga canadensis	Eastern hemlock
Shrubs	
Alnus serrulata	Hazel alder
Clethra acuminata	Mountain sweet pepperbush
Crataegus sp.	Hawthorn
Hamamelis virginiana	American witchhazel
Hydrangea arborescens	Wild hydrangea
Kalmia latifolia	Mountain laurel
Physocarpus opulifolius	Ninebark
Rhododendron arborescens	Smooth azalea
Rhododendron calendulaceum	Flame azalea
Rhododendron maximum	Rosebay
**Rosa multiflora*	*Multiflora rose
Sambucus canadensis	Elderberry
Sassafras albidum	Sassafras
Spiraea alba	White meadowsweet
Viburnum prunifolium	Smooth blackhaw
Herbaceous	
**Alliaria petiolata*	*Garlic mustard
**Hesperis matronalis*	*Dame's rocket
**Phalaris arundinacea*	*Reed canary grass
Achillea millefolium	Common yarrow

Flora Documented along the Middle Fork New River

Alopecurus sp.	Foxtail
Angelica atropurpurea	Great angelica
Aralia nudicaulis	Wild sarsaparilla
Arisaema triphyllum	Jack in the pulpit
Asclepias syriaca	Common milkweed
Athyrium filix-femina	Lady fern
Carex pensylvanica	Pennsylvania sedge
Chimaphila maculata	Striped wintergreen
Coreopsis verticillata	Whorled coreopsis
Dennstaedtia punctilobula	Hayscented fern
Dichanthelium clandestinum	Deertongue
Dryopteris sp.	Wood fern
Erigeron annuus	Eastern daisy fleabane
Eurybia divaricata	White wood aster
Fragaria vesca	Wild strawberry
Galax urceolata	Galax/beetleweed
Galium aparine	Cleavers
Glechoma hederacea	Ground ivy
Goodyera pubescens	Downy rattlesnake plantain
Hexastylis shuttleworthii	Largeflower heartleaf
Houstonia purpurea	Woodland bluet
Hydrophyllum canadense	Blunt-leaved waterleaf
Impatiens capensis	Jewelweed
Iris cristata	Dwarf crested iris
Juncus effusus	Soft rush
Maianthemum canadense	Canada mayflower
Maianthemum racemosum	Solomon's plume
Medeola virginiana	Indian cucumber
Mitchella repens	Patridgeberry
Monarda didyma	Scarlet beebalm
Onoclea sensibilis	Sensitive fern
Packera aurea	Golden ragwort
Polygonatum biflorum	Solomon's seal
Polystichum acrostichoides	Christmas fern
Potentilla spp.	Cinquefoil
Ranunculus acris	Tall buttercup
Rudbeckia laciniata	Cut-leaf coneflower
Schizachyrium scoparium	Little bluestem
Sisyrinchium angustifolium	Blue-eyed grass
Solidago spp.	Goldenrods
Herbaceous (continued)	
*Various turf grasses	*Various turf grasses
**Veronica chamaedrys*	*Germander speedwell
Stellaria pubera	Star chickweed
Tradescantia ohiensis	Spiderwort
Trillium spp.	Wake robin
Viola spp.	Violet
Zizea aurea	Golden alexander
Vines	
**Celastrus orbiculatus*	Oriental bittersweet
Clematis sp.	Virgin's bower
Dioscorea villosa	Wild yam
Parthenocissus quinquefolia	Virginia creeper

Flora Documented along the Middle Fork New River

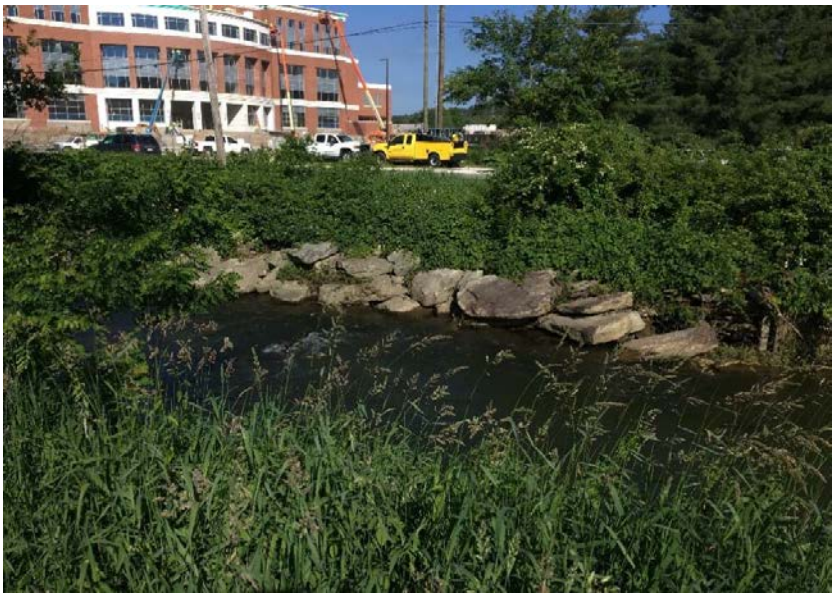
Pueraria montana	Kudzu
Rubus spp.	Blackberry and raspberry
Smilax spp.	Greenbrier
Toxicodendron radicans	Poison ivy
*Non-native/invasive species	

View along the west side of the river from the south portion of large field (south of the hospital), facing north

North-central portion from the golf course, facing southwest

Flora Documented along the Middle Fork New River

North-central portion from the golf course, facing south (standing on the east side of the river)



Northernmost portion just upstream of the Deerfield Road bridge, facing west

APPENDIX D

RECOMMENDED VEGETATION BY PLANTING ZONE

Recommended Vegetation by Planting Zone

Planting Zone 1 Recommended Vegetation

Scientific Name	Common Name
Small Trees/Shrubs	
Alnus serrulata	Hazel alder
**Cornus amomum*	Silky dogwood
Ilex verticillata	Winterberry
**Physocarpus opulifolius*	Ninebark
Rhododendron viscosum	Swamp azalea
Rosa palustris	Swamp rose (shrub)
**Salix sericea*	Silky willow
**Sambucus canadensis*	Elderberry
Vaccinium corymbosum	Highbush blueberry
Viburnum nudum	Possumhaw
Xanthorhiza simplicissima	Yellowroot
Herbaceous Flora	
Arisaema triphyllum	Jack in the pulpit
Asclepias incarnata	Swamp milkweed
Carex intumescens	Greater bladder sedge
Carex lurida	Shallow sedge
Carex scoparia	Broom sedge
Carex vulpinoidea	Fox sedge
Cyperus strigosus	Straw-colored flatsedge
Dichanthelium clandestinum	Deer tongue
Elymus riparius	Riverbank wildrye
Elymus virginicus	Virginia wild rye
Eupatorium fistulosum	Joe-pye weed
Eupatorium perfoliatum	Common boneset
Iris virginica	Blue flag iris
Juncus effusus	Soft rush
Lobelia cardinalis	Cardinal flower
Lobelia siphilitica	Great blue lobelia
Monarda didyma	Scarlet beebalm
Polygonum pensylvanicum	Pennsylvania smartweed
Pycnanthemum tenuifolium	Narrowleaf mountain mint
Rudbeckia laciniata	Cut-leaf coneflower
Sagittaria latifolia	Broadleaf arrowhead
Scirpus cyperinus	Woolgrass
Sparganium americanum	Eastern bur-reed
Verbena hastata	Swamp verbena
Vernonia noveboracensis	New York ironweed
*Use livestakes for these species	

Recommended Vegetation by Planting Zone

Planting Zone 2 Recommended Vegetation

Scientific Name	Common Name
Trees	
Acer rubrum	Red maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Carpinus caroliniana	American hornbeam/ironwood
Cornus alternifolia	Alternate-leaf dogwood
Fraxinus pennsylvanica	Green ash
Ilex verticillata	Common winterberry
Nyssa sylvatica	Blackgum
Shrubs	
Euonymus americanus	Strawberry bush
Lindera benzoin	Spicebush
Rhododendron arborescens	Smooth azalea
Rhododendron calendulaceum	Flame azalea
Rhododendron maximum	Rosebay
Herbaceous Flora	
Adiantum pedatum	Northern maidenhair fern
Athyrium filix-femina	Southern lady fern
Dichanthelium clandestinum	Deer tongue
Panicum philadelphicum	Philadelphia panicgrass
Parathelypteris noveboracensis	New York fern

Recommended Vegetation by Planting Zone

Planting Zone 3 Recommended Vegetation

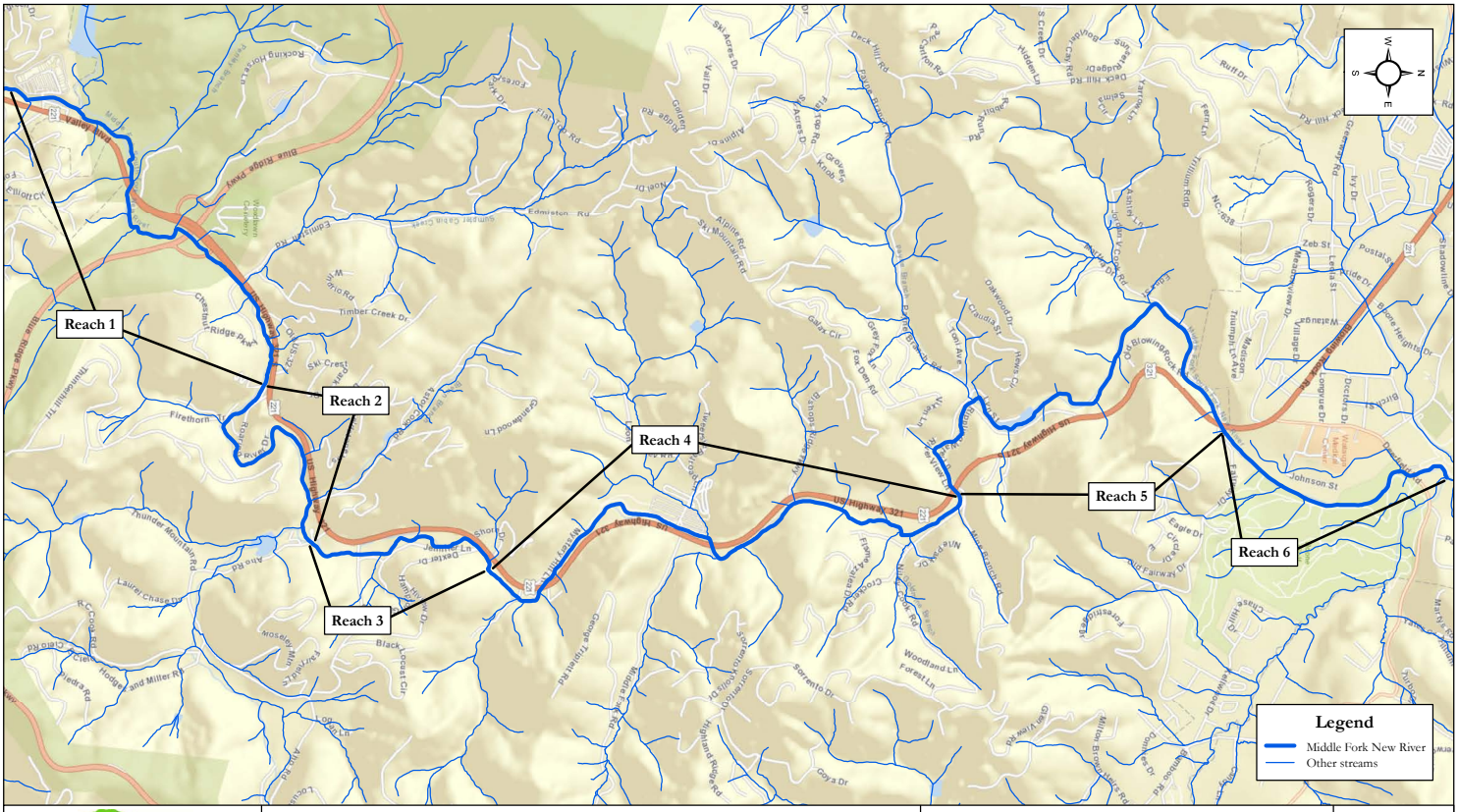
Scientific Name	Common Name
Trees	
Acer pensylvanicum	Striped maple
Acer rubrum	Red maple
Amelanchier arborea	Common serviceberry
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Carya glabra	Pignut hickory
Carya ovata	Shagbark hickory
Carya tomentosa	Mockernut hickory
Cornus alternifolia	Alternate-leaf dogwood
Cornus florida	Flowering dogwood
Ilex montana	Mountain winterberry
Magnolia fraseri	Fraser magnolia
Nyssa sylvatica	Blackgum
Pinus strobus	Eastern white pine
Quercus rubra	Northern red oak
Quercus velutina	Black oak
Robinia pseudoacacia	Black locust
Tilia americana	American basswood
Tsuga canadensis	Eastern hemlock
Shrubs	
Calycanthus floridus	Eastern sweetshrub
Clethra acuminata	Mountain sweet pepperbush
Cornus alternifolia	Alternate-leaf dogwood
Hamamelis virginiana	American witchhazel
Hydrangea arborescens	Wild hydrangea
Ilex montana	Mountain winterberry
Kalmia latifolia	Mountain laurel
Lindera benzoin	Spicebush
Rhododendron arborescens	Smooth azalea
Rhododendron calendulaceum	Flame azalea
Rhododendron maximum	Rosebay
Sassafras albidum	Sassafras
Viburnum prunifolium	Smooth blackhaw
Herbaceous Flora	
Adiantum pedatum	Northern maidenhair fern
Carex pensylvanica	Pennsylvania sedge
Dennstaedtia punctilobula	Hayscented fern
Eurybia divaricata	White wood aster
Helianthus divaricatus	Woodland sunflower
Houstonia purpurea	Woodland bluet
Lysimachia quadrifolia	Whorled yellow-loosestrife
Parathelypteris noveboracensis	New York fern
Rudbeckia hirta	Black-eyed susan
Schizachyrium scoparium	Little bluestem
Zizea aurea	Golden alexander

Recommended Vegetation by Planting Zone

Planting Zone 4 Recommended Vegetation

Scientific Name	Common Name
Herbaceous Flora	
Allium cernuum	Nodding onion
Asclepias tuberosa	Butterfly milkweed
Asclepias syriaca	Common milkweed
Coreopsis lanceolata	Lanceleaf tickseed
Coreopsis major	Greater tickseed
Elymus hystrix	Eastern bottlebrush grass
Fragaria vesca	Wild strawberry
Houstonia purpurea	Woodland bluet
Lysimachia quadrifolia	Whorled yellow-loosestrife
Monarda clinopodia	Basil beebalm
Monarda fistulosa	Wild bergamont
Pycnanthemum incanum	Hoary mountain mint
Rudbeckia hirta	Black-eyed susan
Schizachyrium scoparium	Little bluestem
Sisyrinchium angustifolium	Blue-eyed grass
Zizia trifoliata	Meadow alexander

PLAN SHEETS



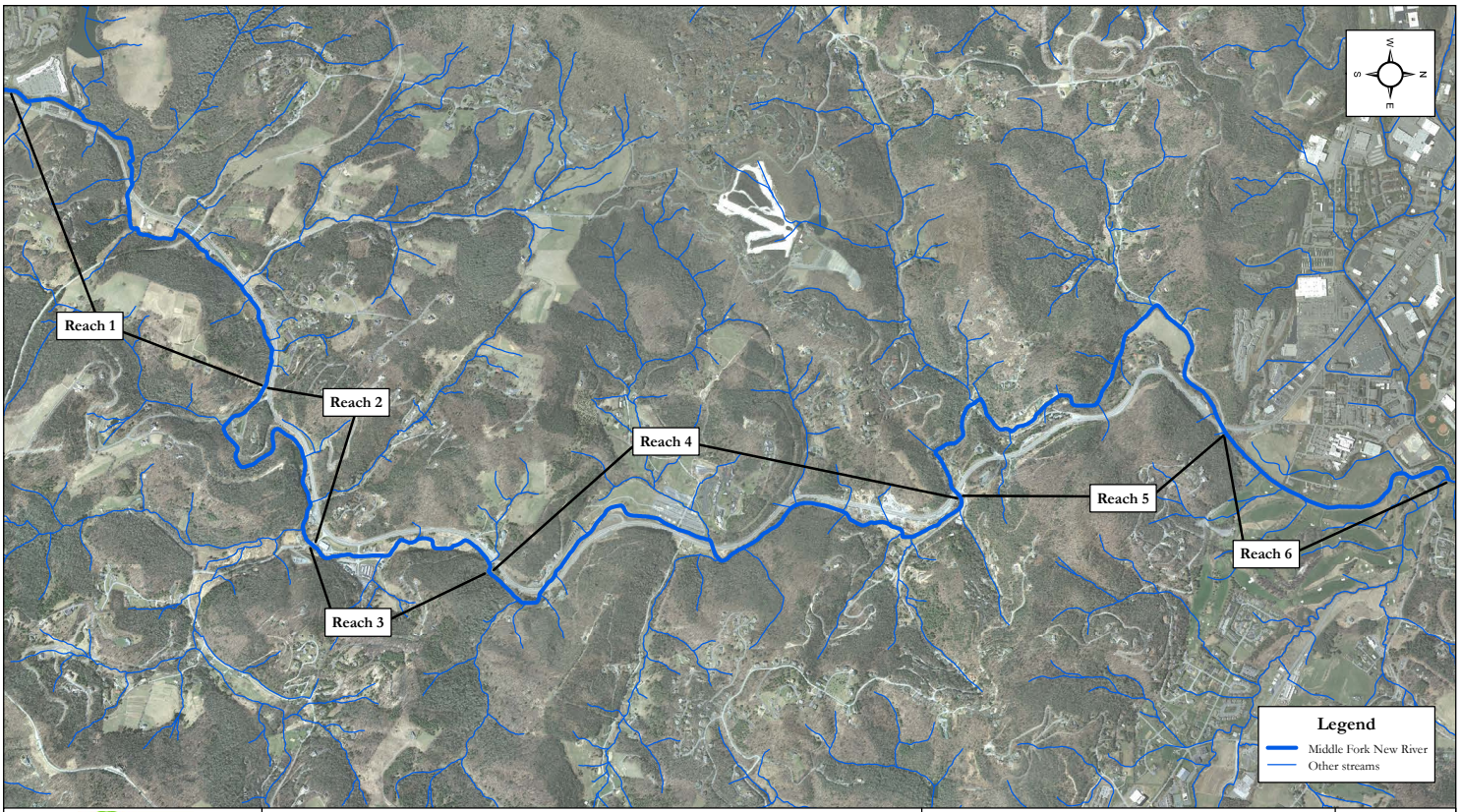
Middle Fork Greenway

Project Overview

0 750 1,500 3,000 4,500 6,000 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 1



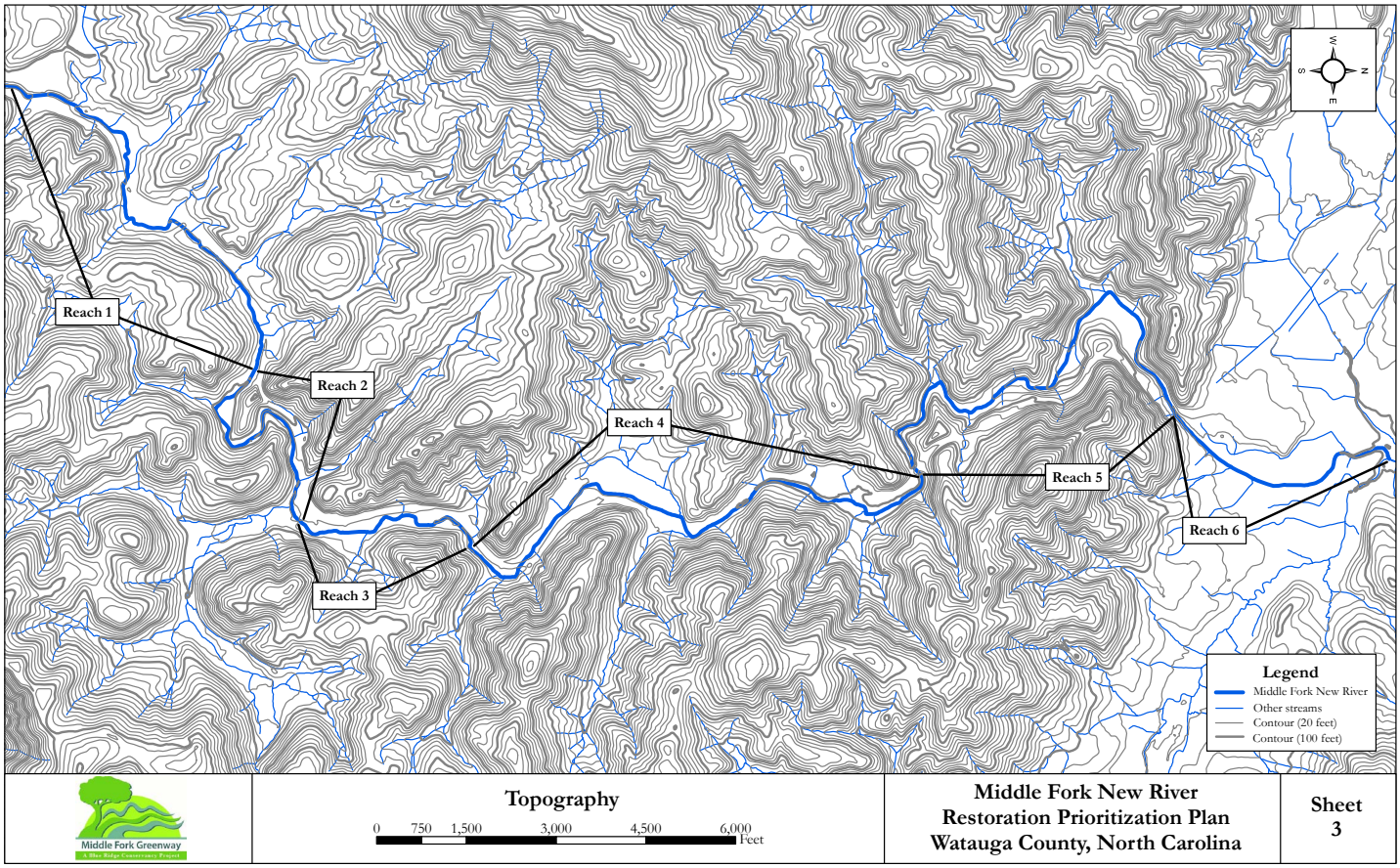
Middle Fork Greenway

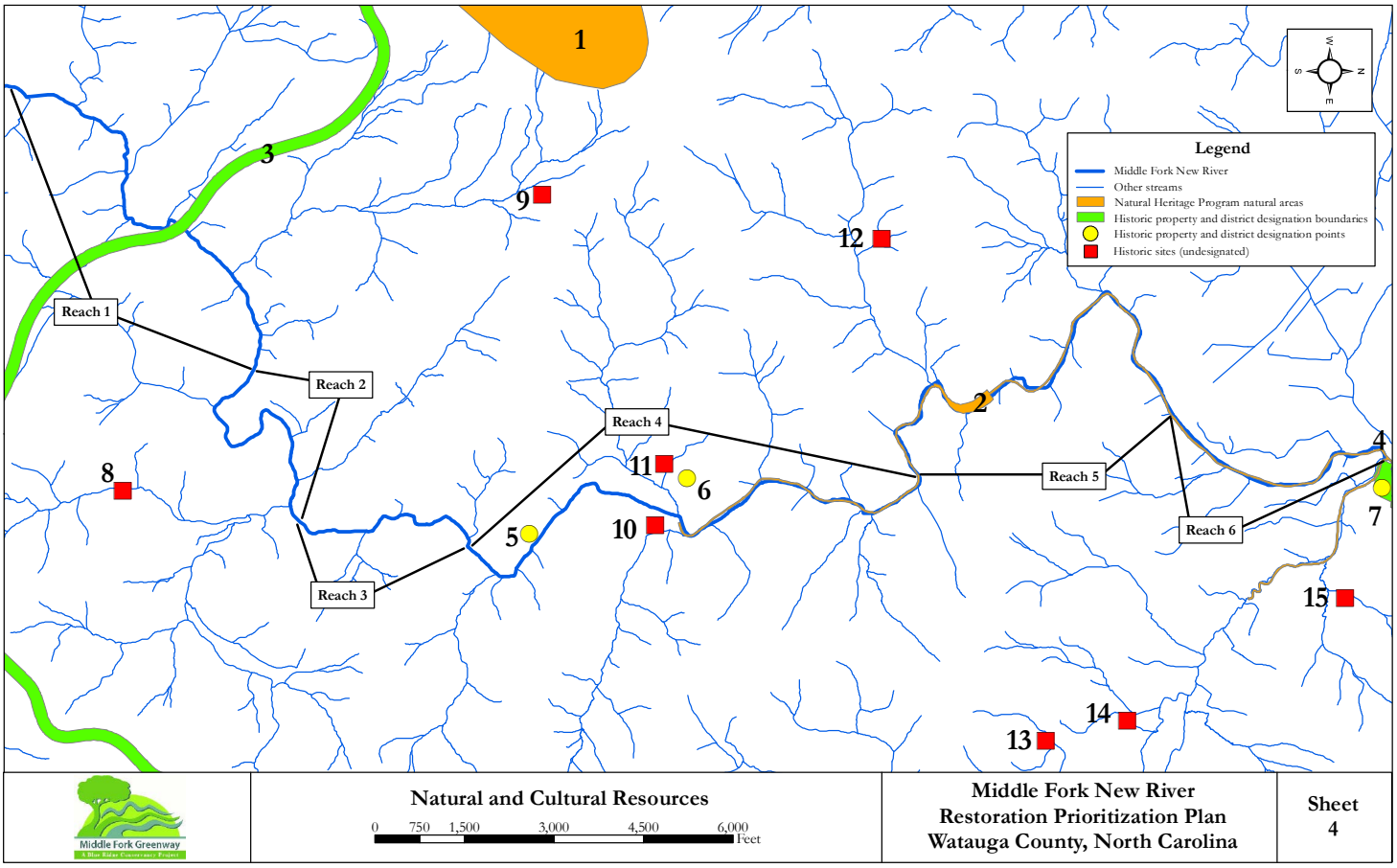
Aerial Photography

0 750 1,500 3,000 4,500 6,000 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 2


Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Legend
Middle Fork New River
Other streams
Contour (20 feet)
Contour (100 feet)
Middle Fork Greenway
Topography
0 750 1,500 3,000 4,500 6,000 Feet
Middle Fork New River
Restoration Prioritization Plan
Watauga County, North Carolina
Sheet
3


1
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13
14
15
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Legend
Middle Fork New River
Other streams
Natural Heritage Program natural areas
Historic property and district designation boundaries
Historic property and district designation points
Historic sites (undesignated)
Middle Fork Greenway
Natural and Cultural Resources
0 750 1,500 3,000 4,500 6,000 Feet
Middle Fork New River
Restoration Prioritization Plan
Watauga County, North Carolina
Sheet
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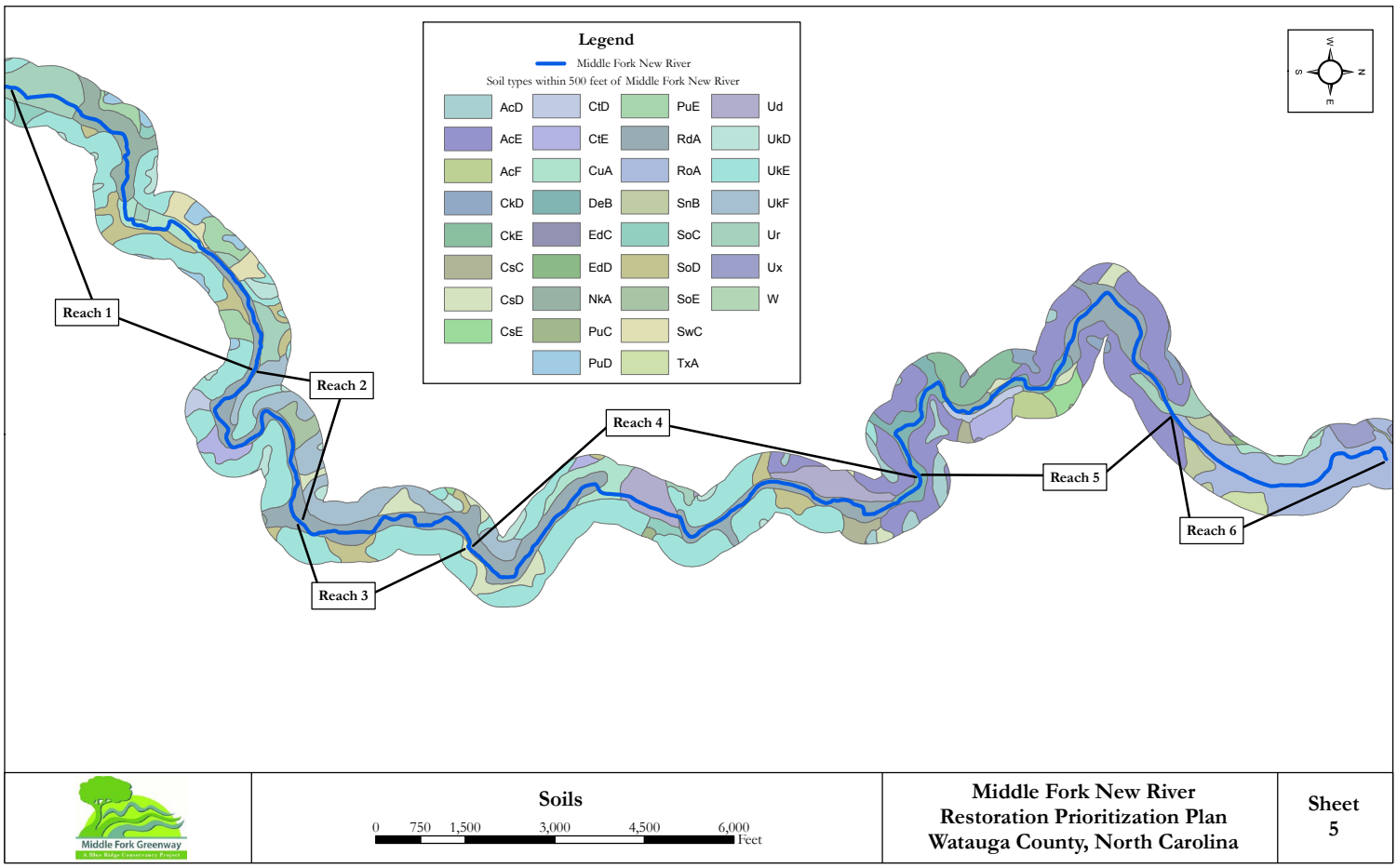


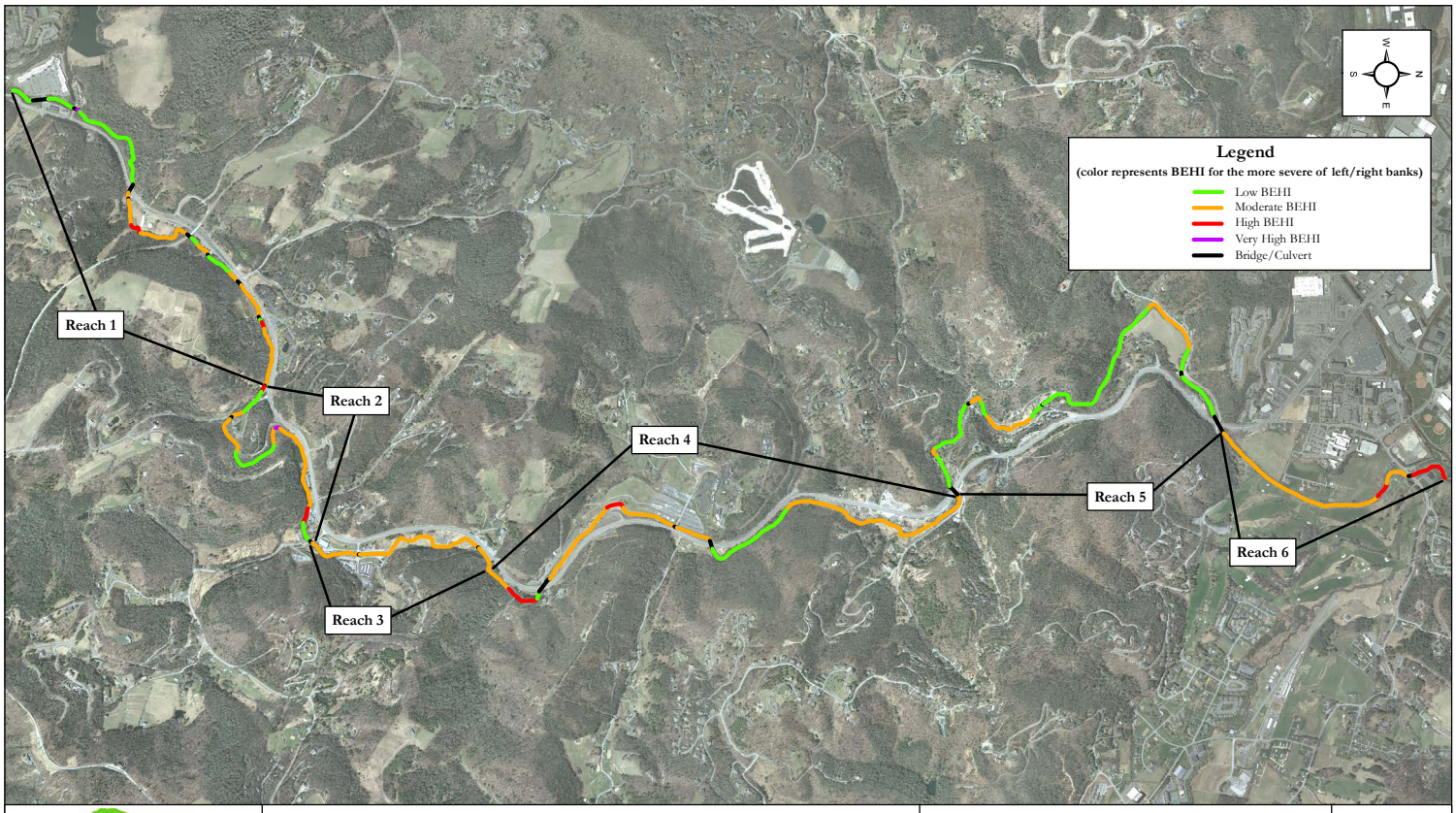
Middle Fork Greenway

Soils

0 750 1,500 3,000 4,500 6,000 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 5



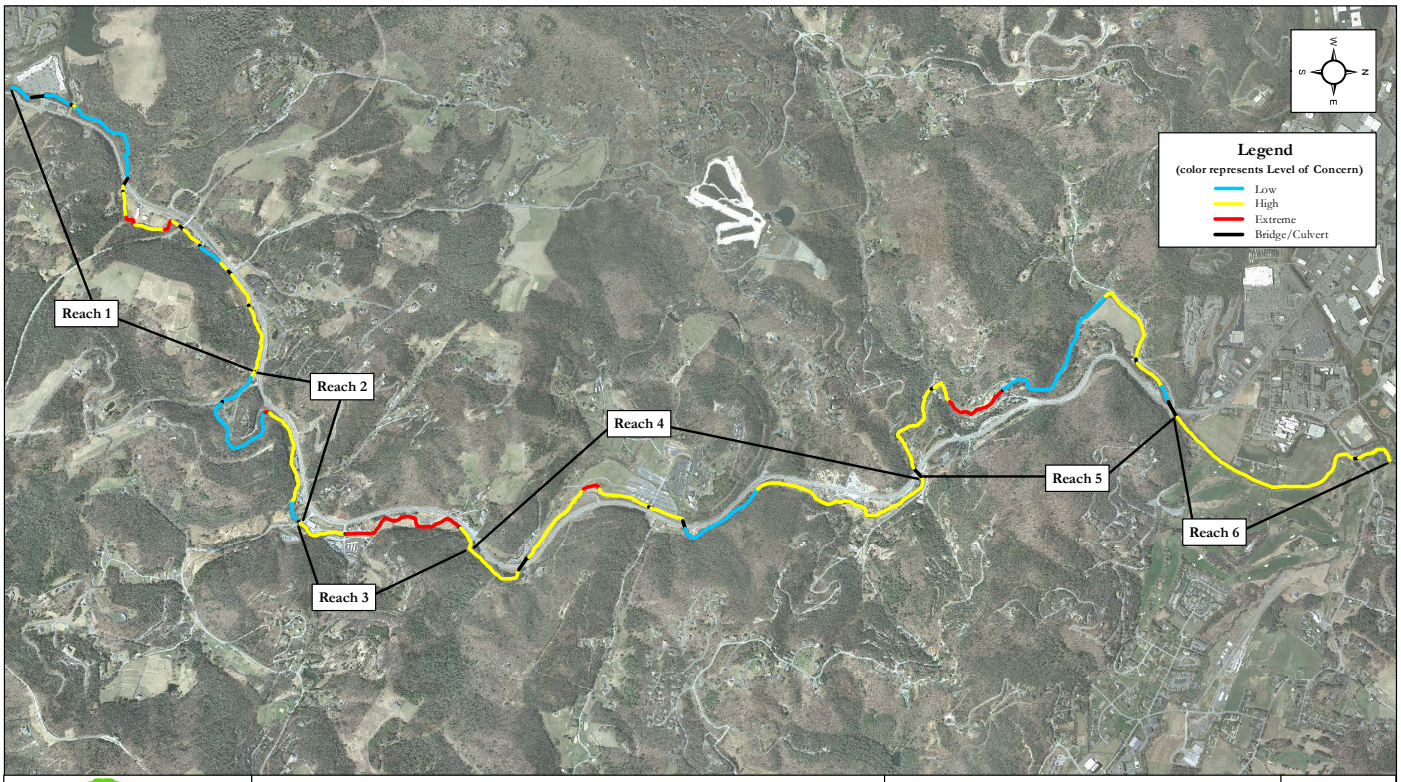
Middle Fork Greenway

Bank Erosion Hazard Index (BEHI)

0 750 1,500 3,000 4,500 6,000 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 6



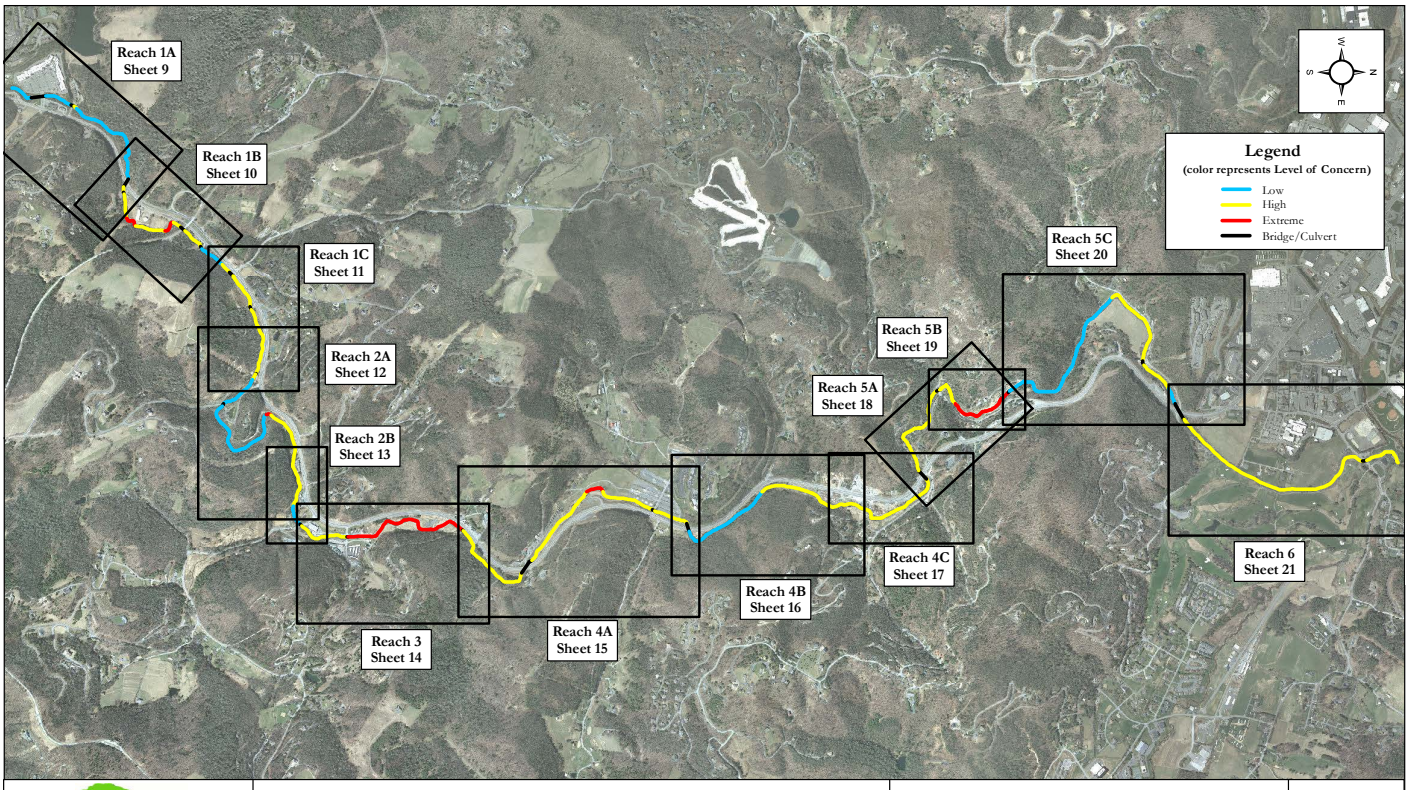
Middle Fork Greenway

Level of Concern

0 750 1,500 3,000 4,500 6,000 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 7



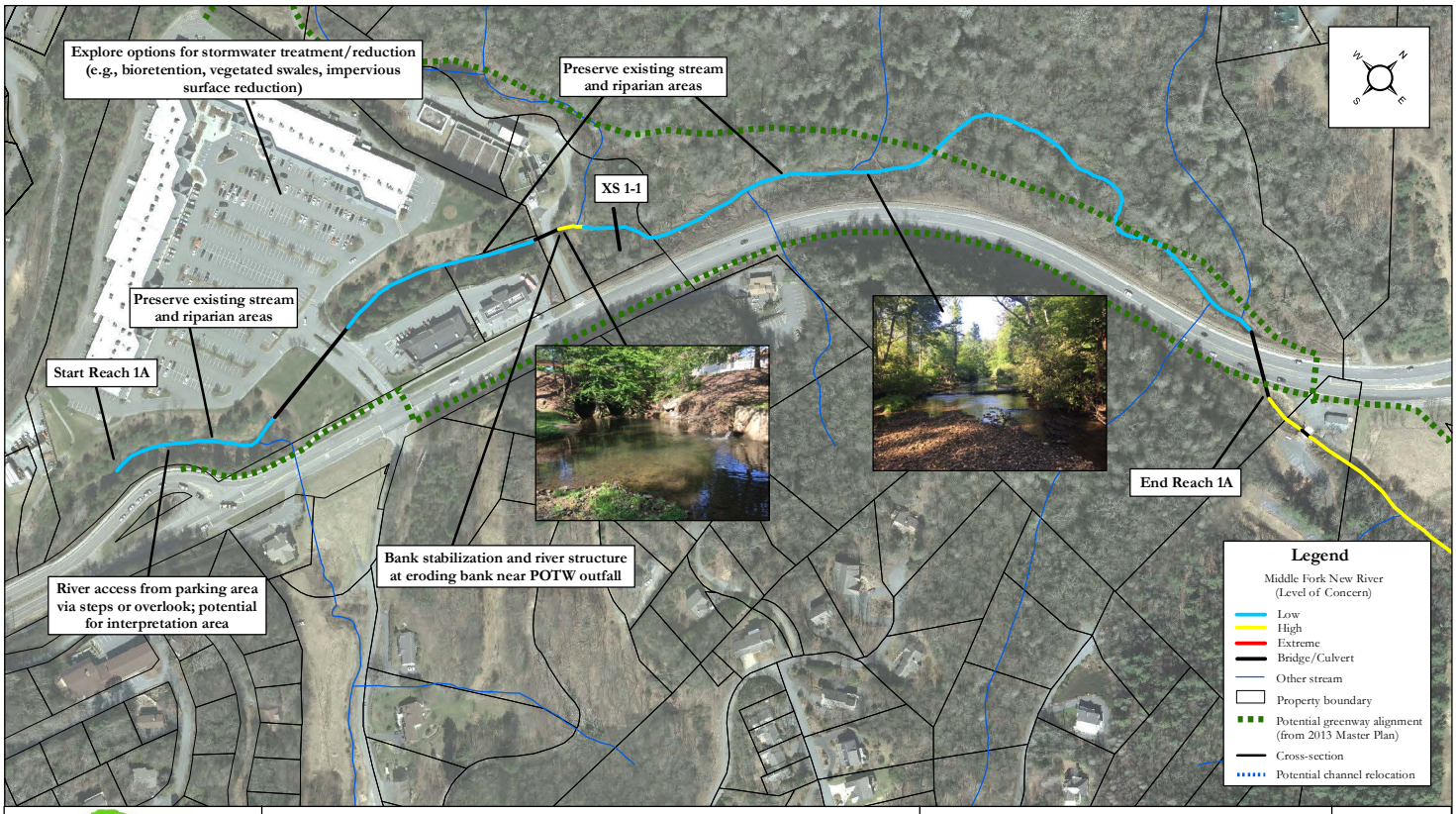
Middle Fork Greenway

Index Sheet

0 750 1,500 3,000 4,500 6,000 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 8

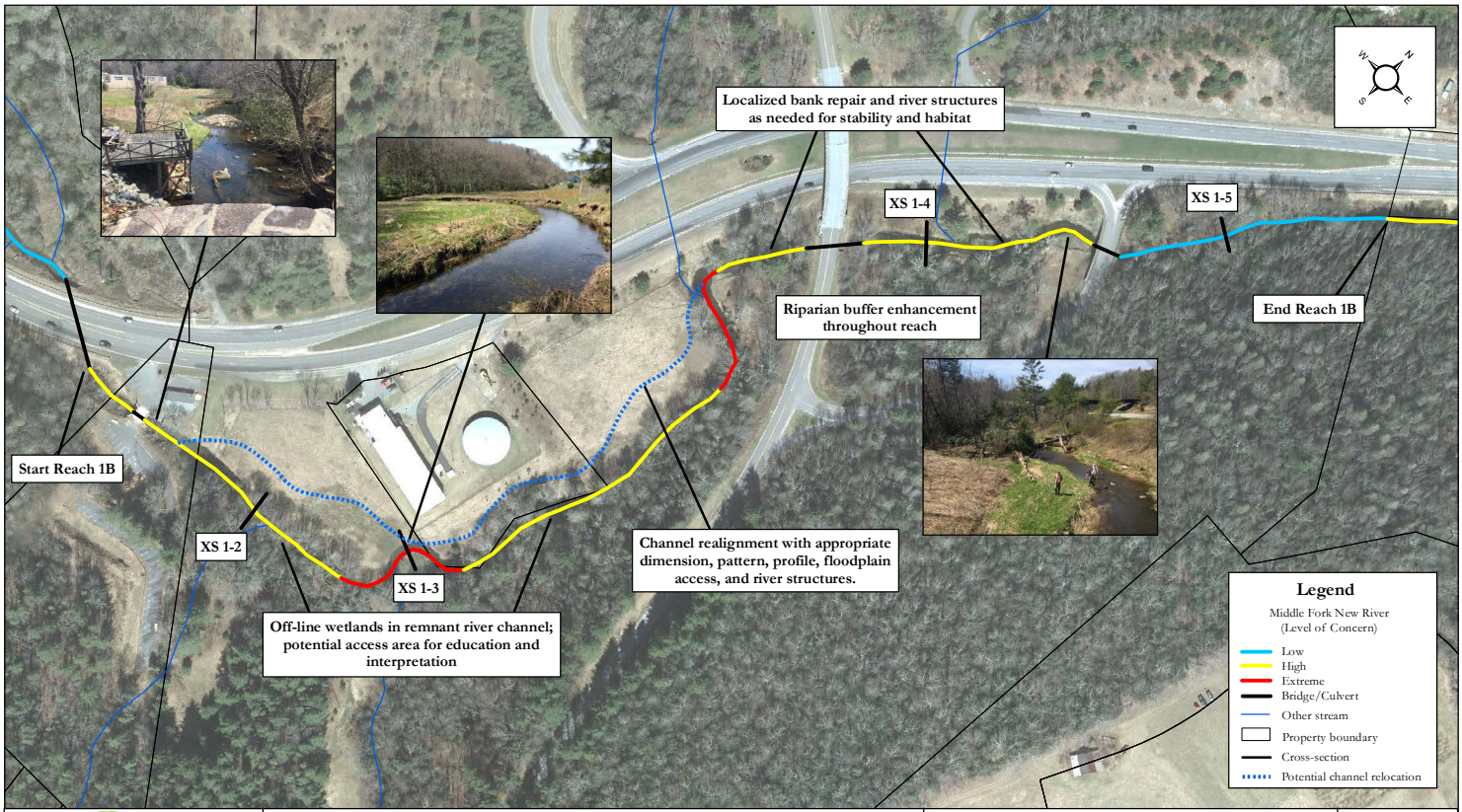


Conceptual Restoration Plan: Reach 1A

0 125 250 500 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 9

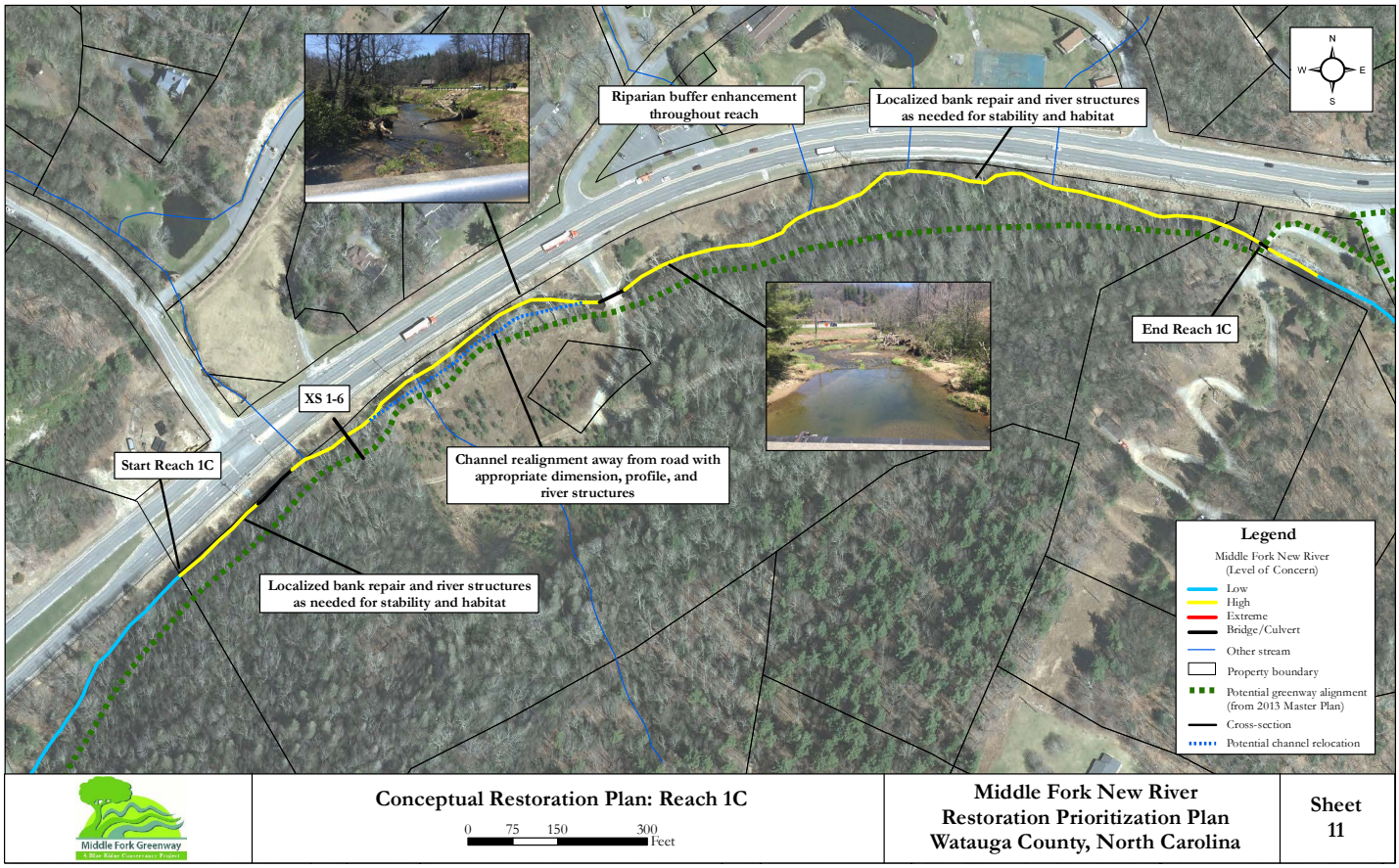


Conceptual Restoration Plan: Reach 1B

0 75 150 300 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 10



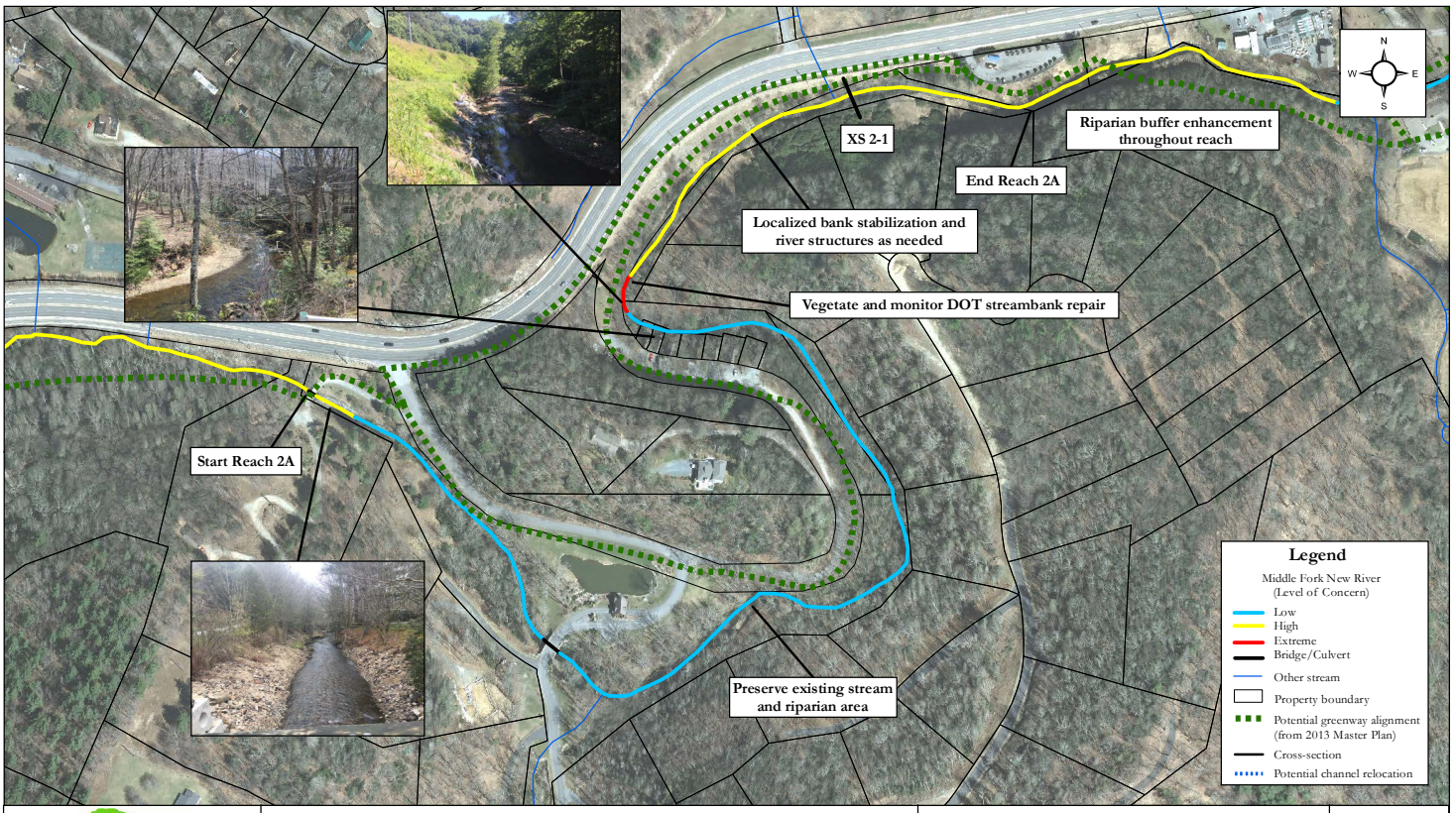
Middle Fork Greenway

Conceptual Restoration Plan: Reach 1C

0 75 150 300 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 11



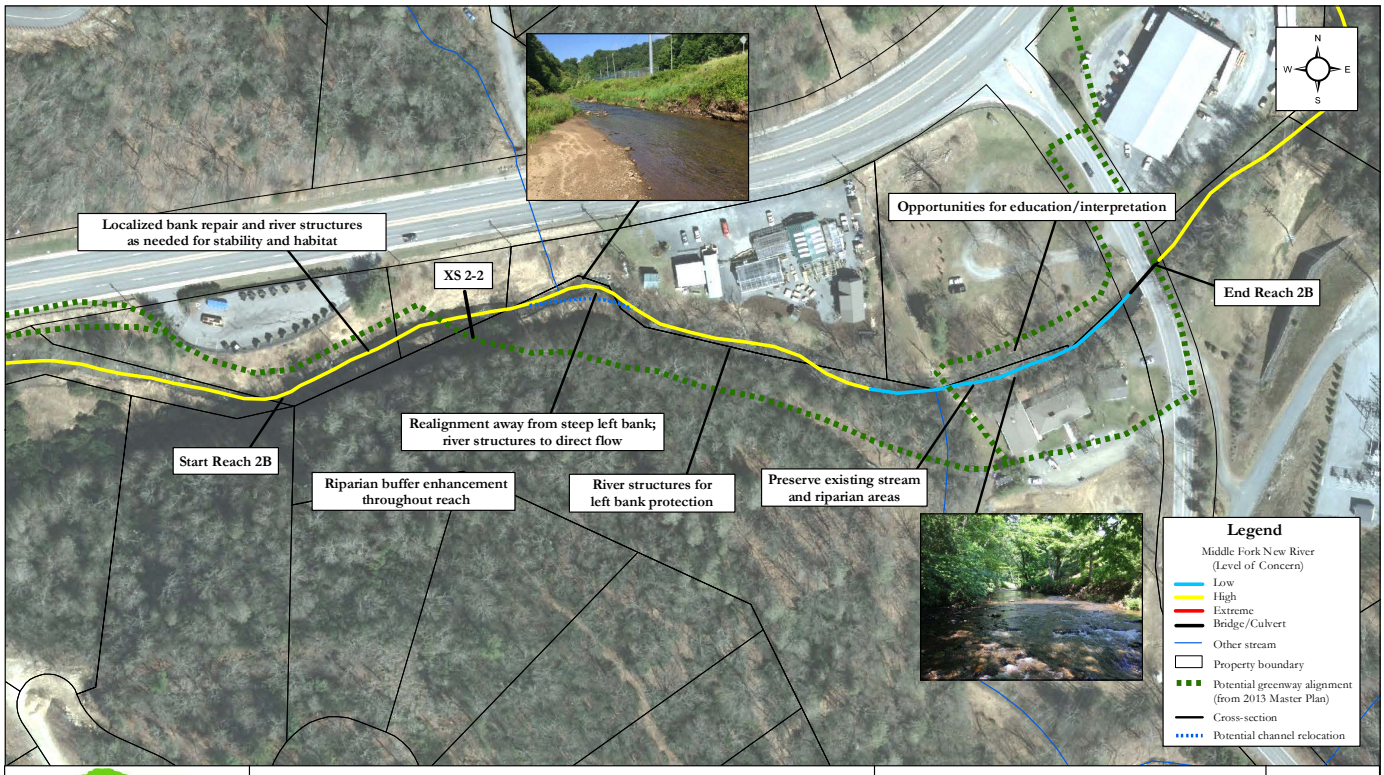
Middle Fork Greenway

Conceptual Restoration Plan: Reach 2A

0 100 200 400 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 12



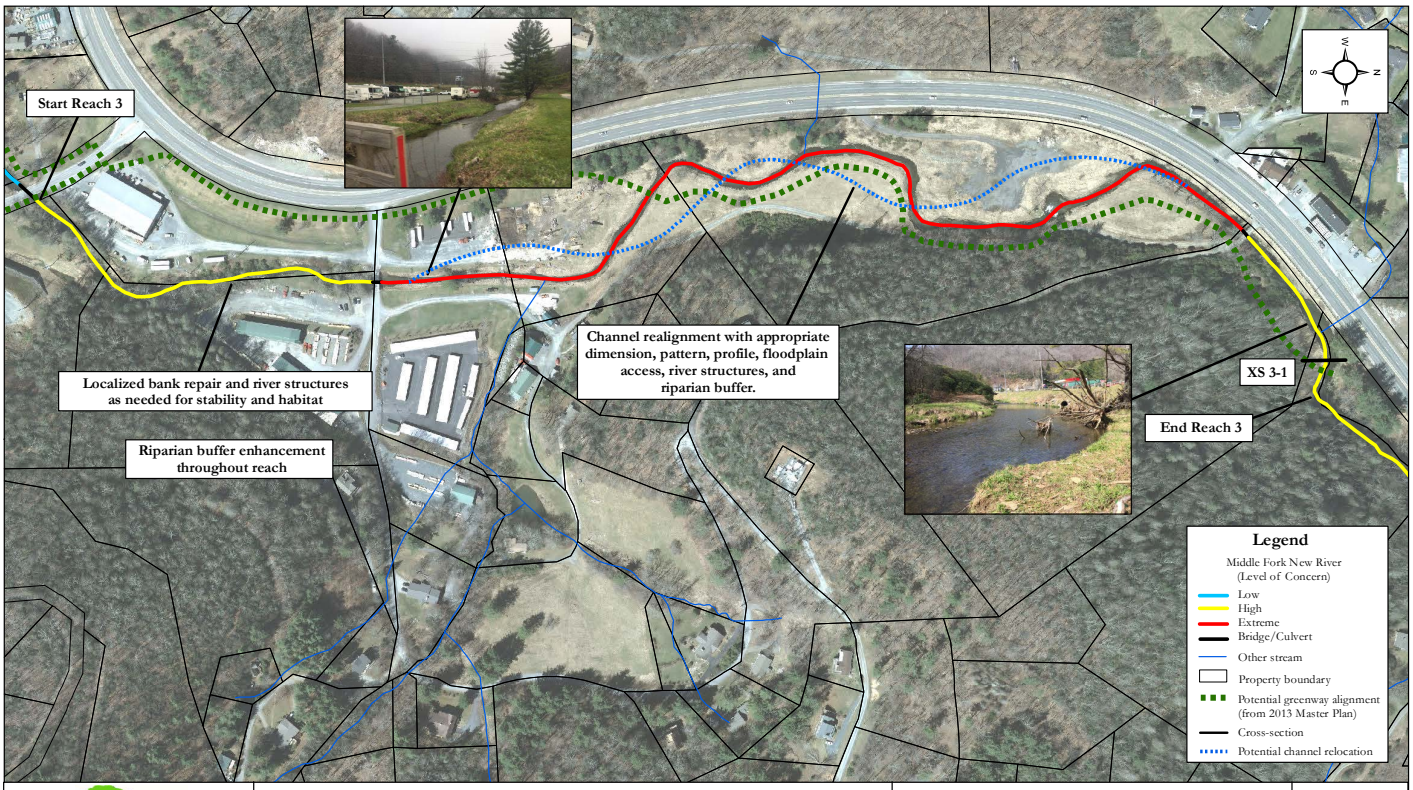
Middle Fork Greenway

Conceptual Restoration Plan: Reach 2B

0 50 100 200 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 13



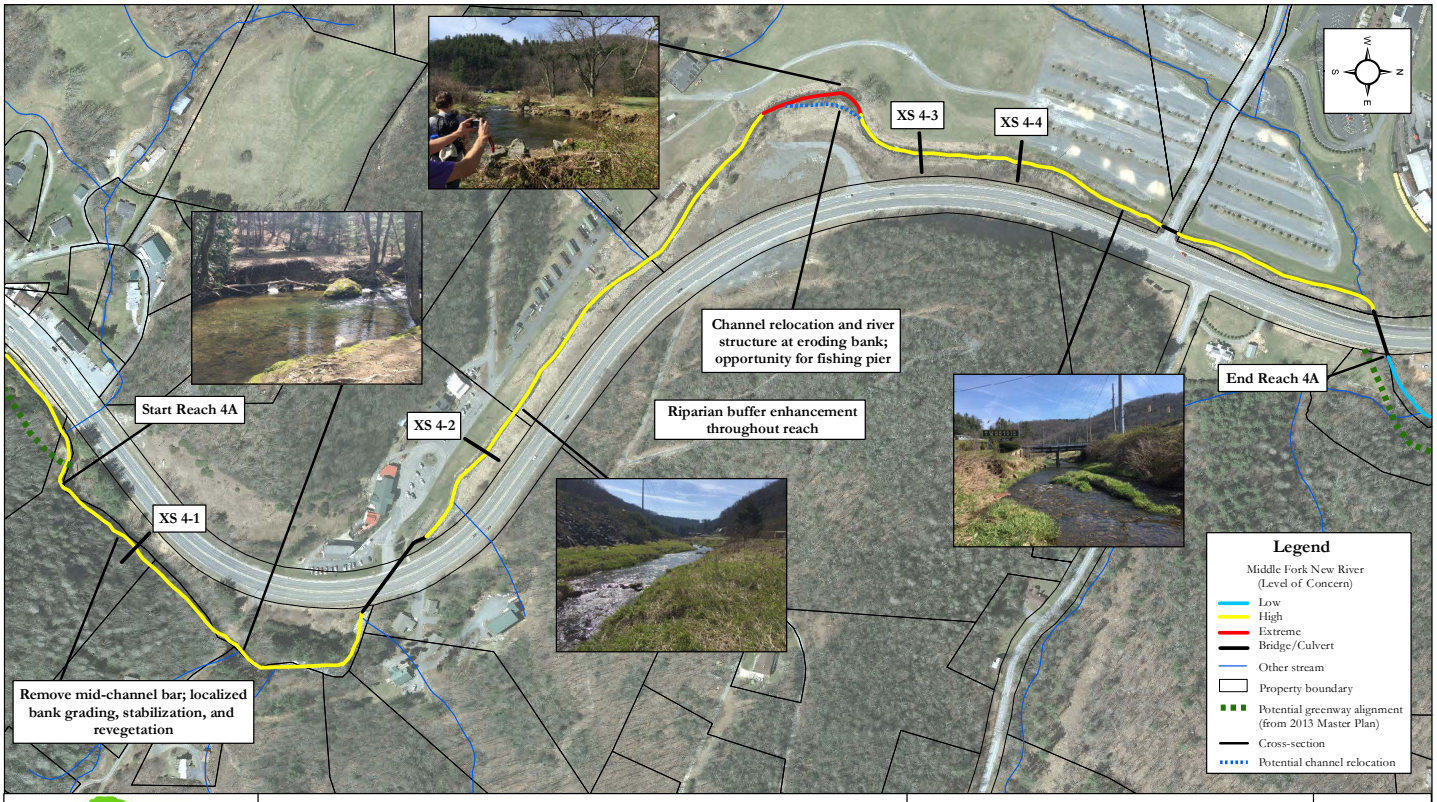
Middle Fork Greenway

Conceptual Restoration Plan: Reach 3

0 100 200 400 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 14



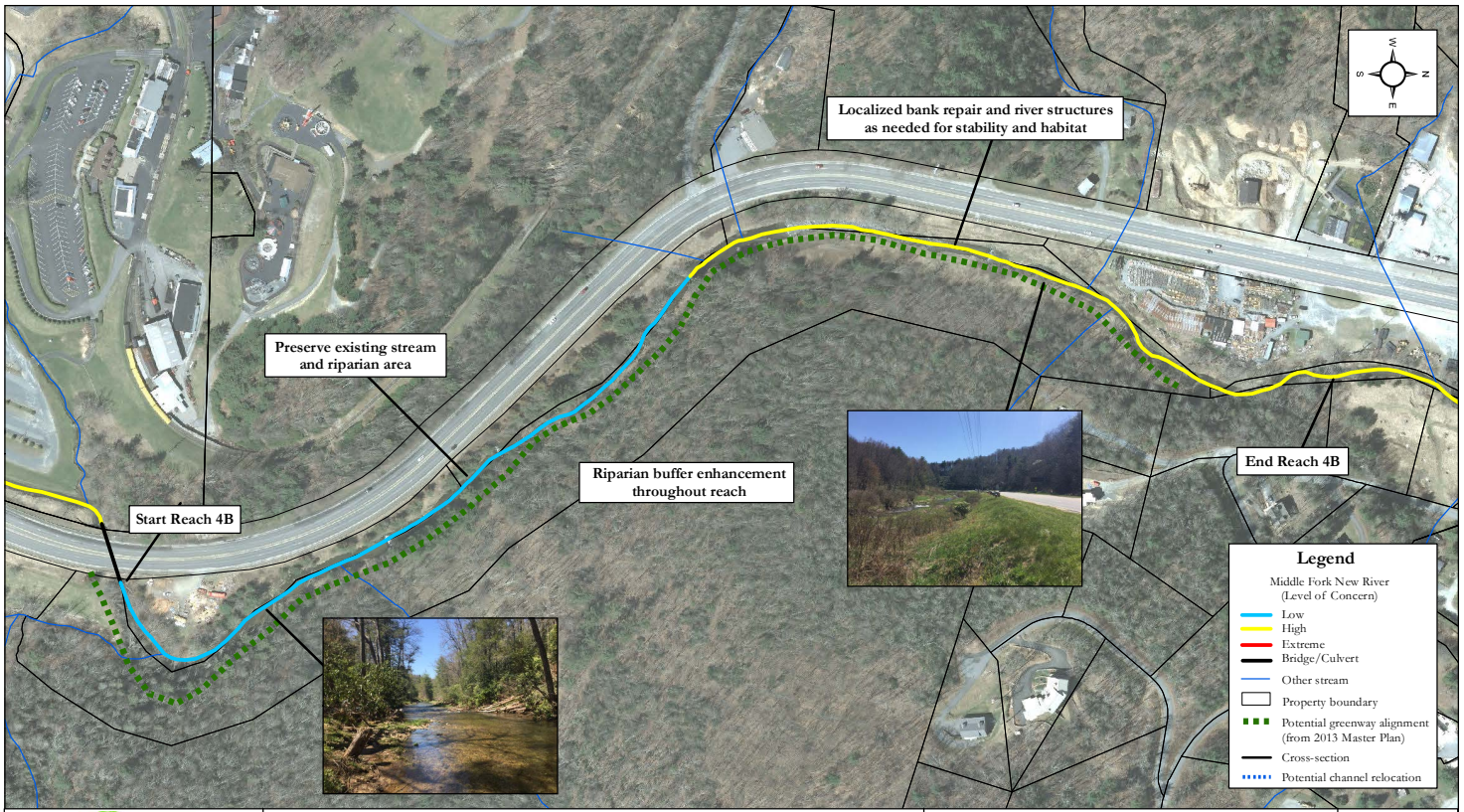
Middle Fork Greenway

Conceptual Restoration Plan: Reach 4A

0 125 250 500 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 15



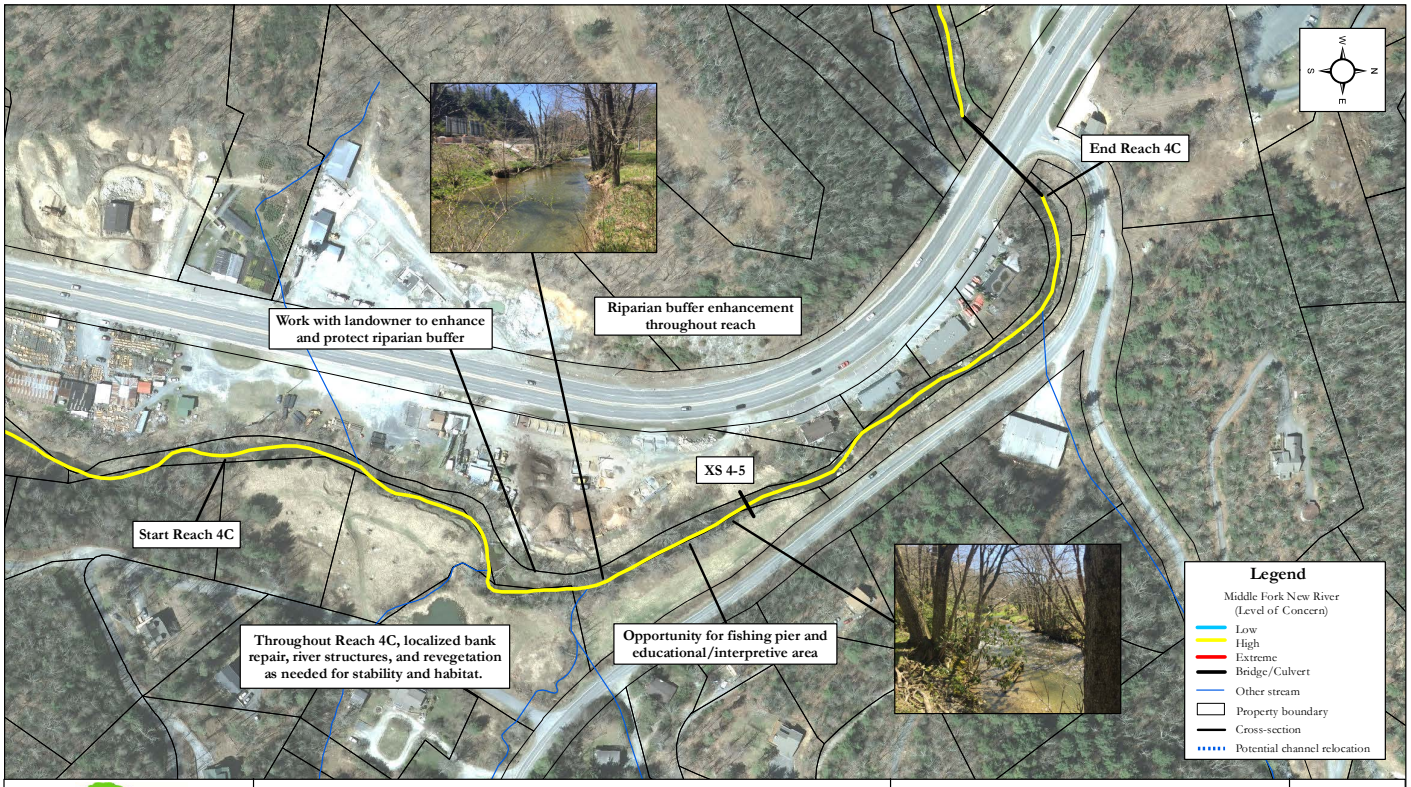
Middle Fork Greenway

Conceptual Restoration Plan: Reach 4B

0 100 200 400 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 16



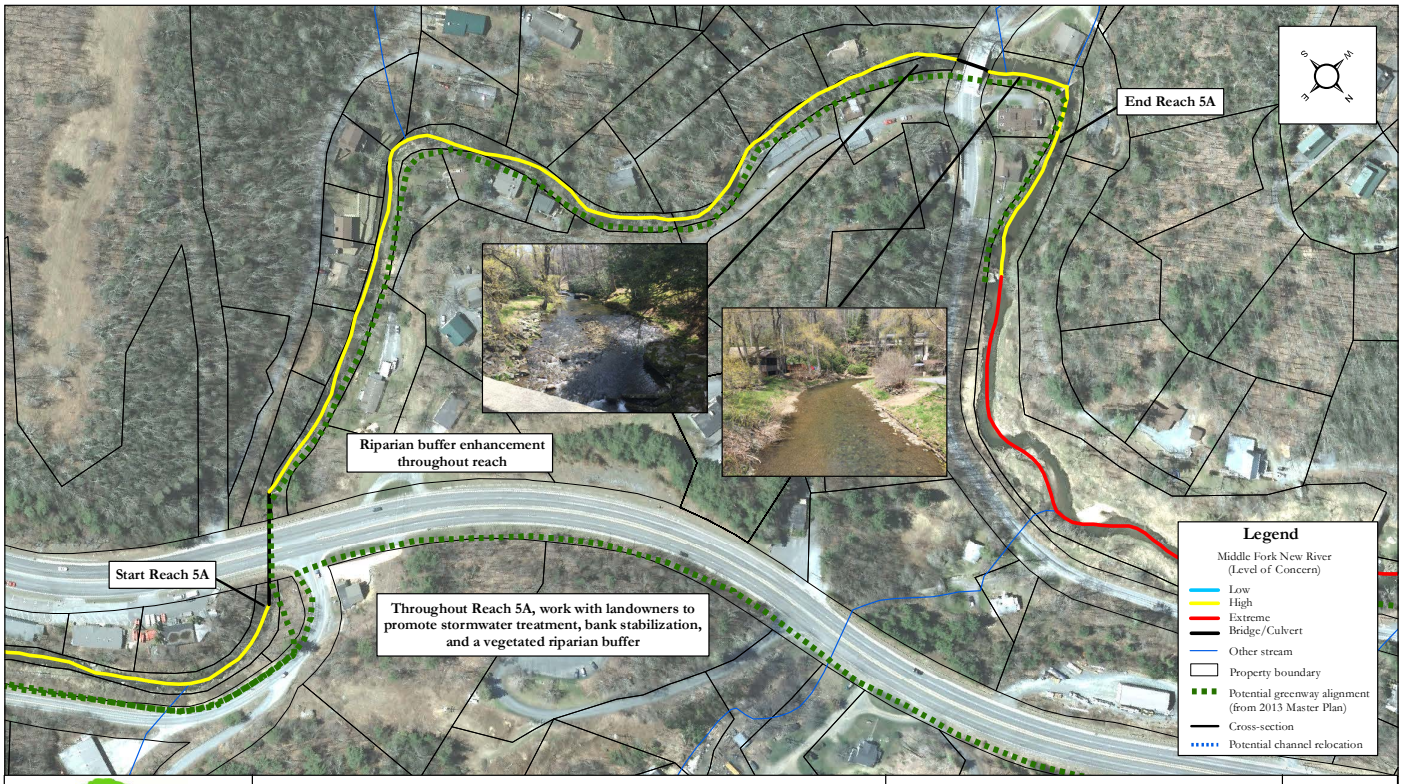
Middle Fork Greenway

Conceptual Restoration Plan: Reach 4C

0 75 150 300 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 17



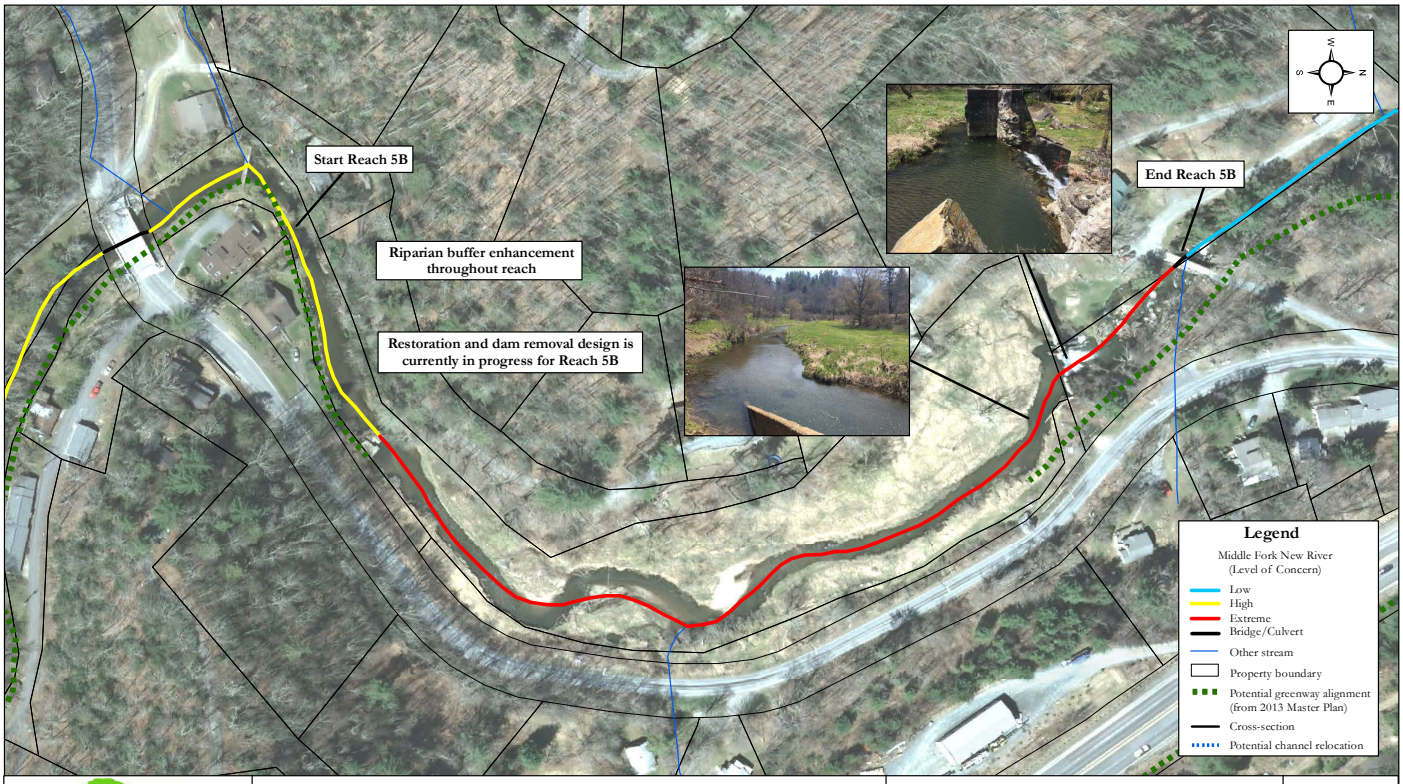
Middle Fork Greenway

Conceptual Restoration Plan: Reach 5A

0 75 150 300 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 18



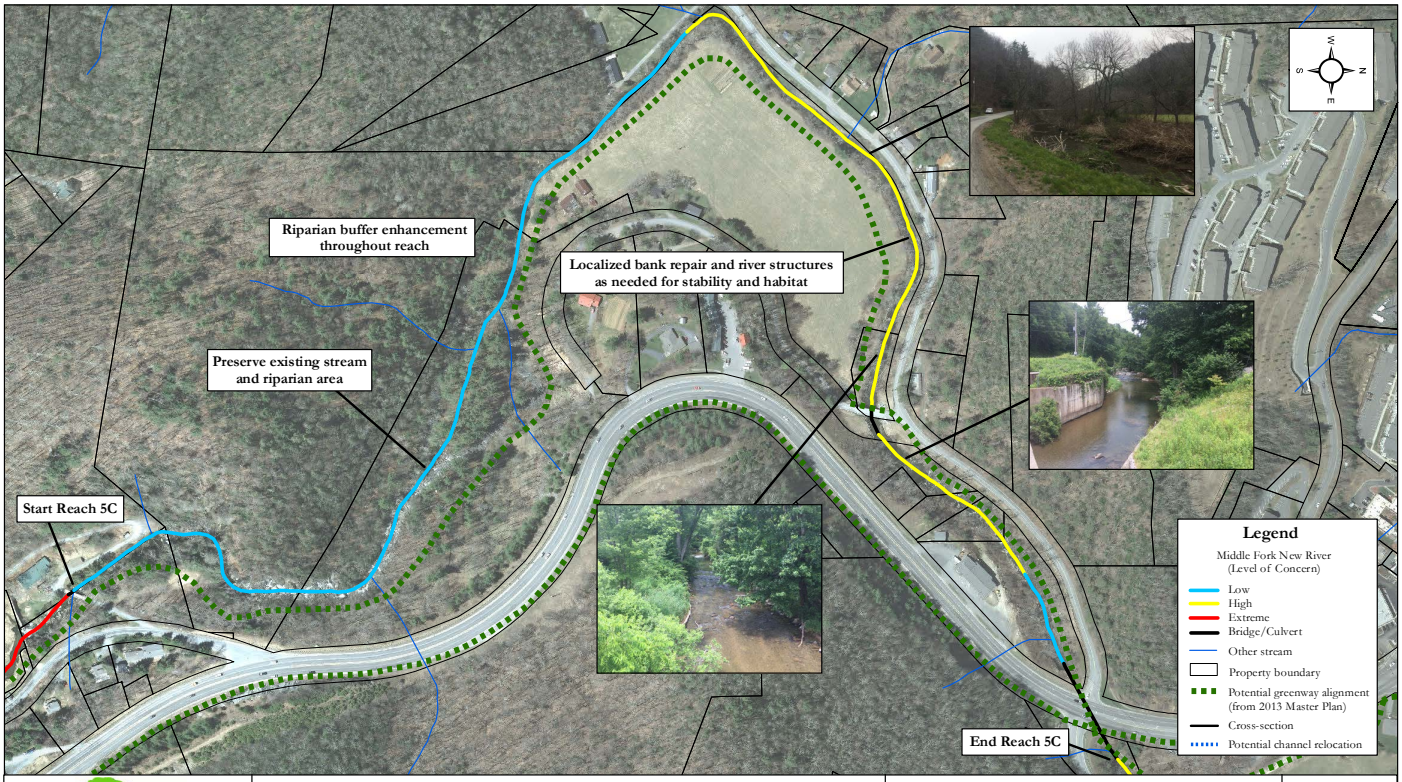
Middle Fork Greenway

Conceptual Restoration Plan: Reach 5B

0 50 100 200 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 19



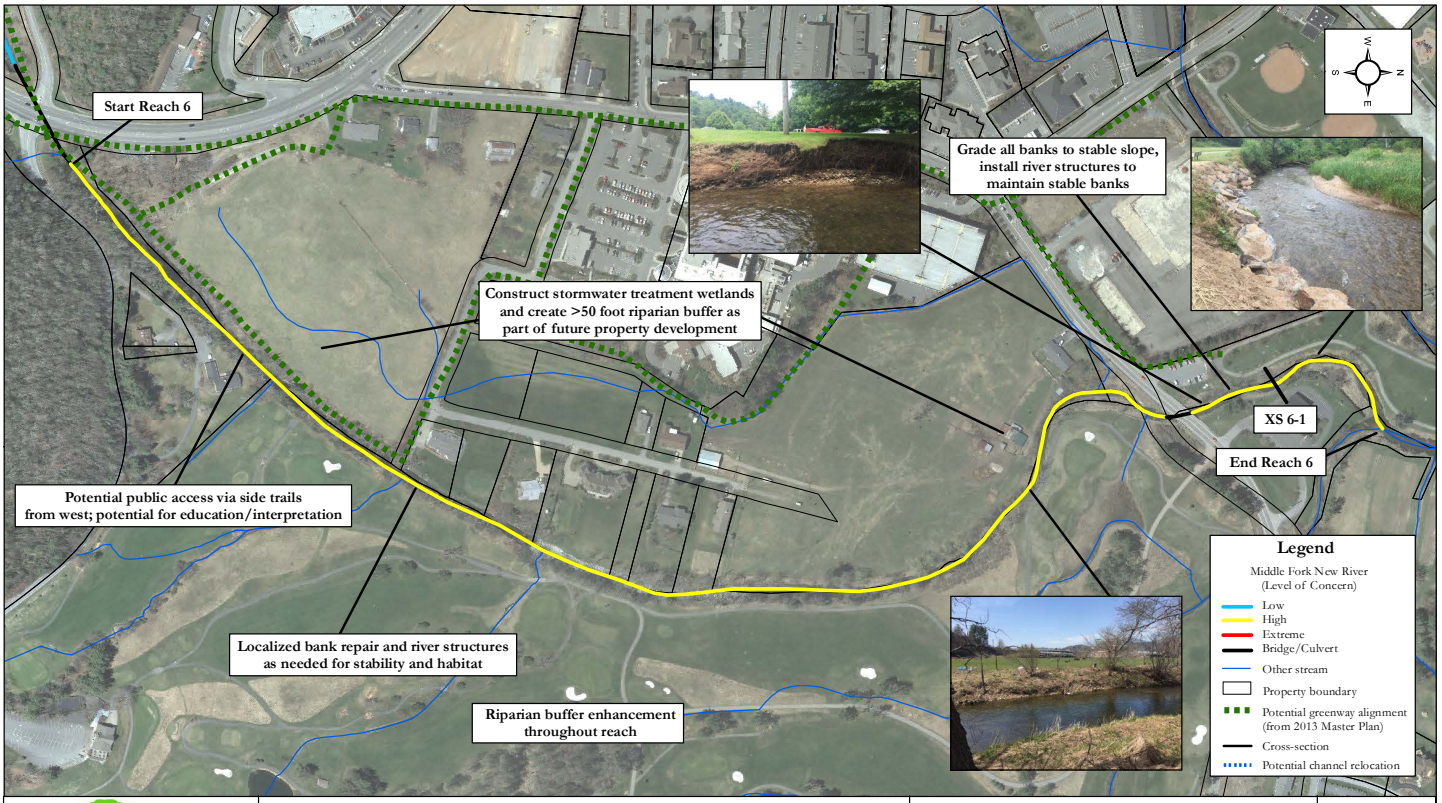
Middle Fork Greenway

Conceptual Restoration Plan: Reach 5C

0 125 250 500 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

Sheet 20



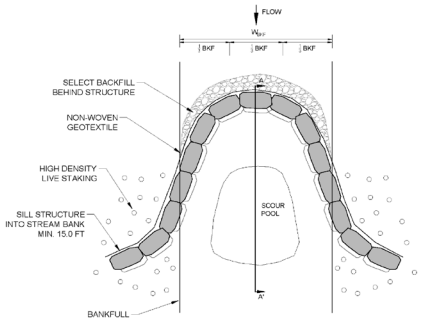
Middle Fork Greenway

Conceptual Restoration Plan: Reach 6

0 125 250 500 Feet

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

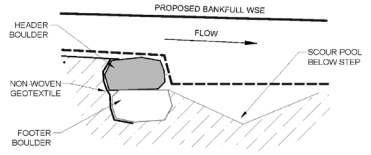
Sheet 21



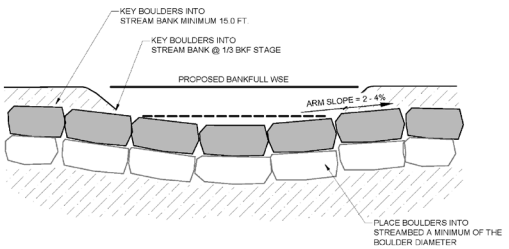
BOULDER CROSS-VANE
DETAILED PLAN
NOT TO SCALE

BOULDER CROSS-VANE
NOTES

1. THE BOULDER CROSS-VANE IS A DESIGN FEATURE USED TO CONTROL GRADE IN HIGH IN GRADIENT REACHES OR AT CRITICAL JUNCTURES OF THE PROPOSED CHANNEL. THE CROSS-VANE IS ALSO USED TO PROVIDE ENERGY DISSIPATION, REDUCE NEAR BANK STRESS (NBS), AND CREATE A DIVERSITY OF AQUATIC HABITAT THROUGH SCOUR OF THE STREAM BED. THE CROSS-VANE IS COMPOSED OF A BOULDER SILL, WHICH IS A ROW OF BOULDERS SET AT AN ELEVATION PROVIDED IN THE PROPOSED PROFILE THAT SPANS PERPENDICULAR TO AND SLIGHTLY ARCED ACROSS THE CHANNEL. THE BOULDER SILL EXTENDS APPROXIMATELY 1/3 OF THE CHANNEL WIDTH IN THE CENTER OF THE CHANNEL FROM THE EXTENTS OF THE SILL BOULDERS, TWO VANE ARMS EXTEND UP AND TOWARDS THE STREAM BANK. EVENTUALLY KEYING INTO THE BANK AT AN ELEVATION HIGHER THAN THE SILL BOULDERS.
2. ALL BOULDERS USED FOR THE OFFSET BOULDER STEP SHALL BE STRUCTURAL STONE, CUBICAL OR RECTANGULAR IN SHAPE. THE ENGINEER MUST APPROVE THE USE OF BOULDERS THAT MAY BE AVAILABLE ONSITE.
3. DIMENSIONS AND SLOPES OF STRUCTURES DESCRIBED IN THE DETAIL MAY BE ADJUSTED BY DESIGN ENGINEER TO FIT CONDITIONS ONSITE.
4. CONTRACTOR WILL BE REQUIRED TO FIT BOULDERS TOGETHER TIGHTLY.
5. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER AND PLUGGING WITH NC DOT CLASS A AND SELECT MATERIAL OR CHINKING STONE APPROVED BY DESIGN ENGINEER, AND LINING WITH FILTER FABRIC.
6. THERE SHALL BE NO DROP GREATER THAN 0.5 FT OVER A SINGLE STEP. BOULDERS SHALL BE 3 FT X 4 FT X 2 FT +/- 0.5 FT.
7. NON-WOVEN GEOTEXTILE SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF THE STRUCTURE.



BOULDER CROSS-VANE
SECTION A - A'
NOT TO SCALE



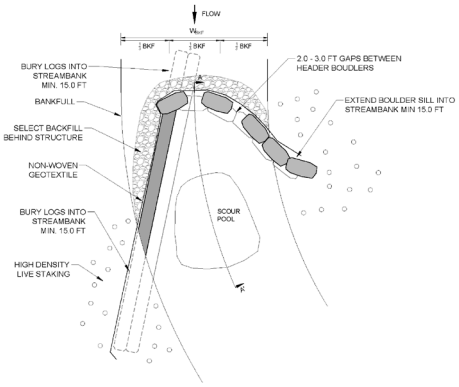
BOULDER CROSS-VANE
CROSS-SECTION
NOT TO SCALE

Middle Fork Greenway

Typical Restoration Detail: Boulder Cross Vane

Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina

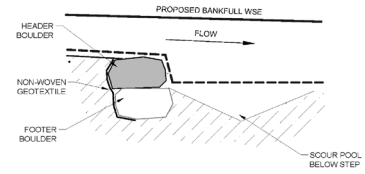
Sheet 22



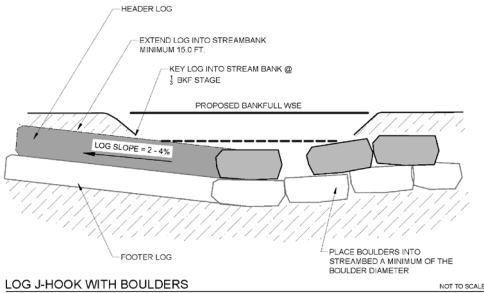
LOG J-HOOK WITH BOULDERS
DETAILED PLAN
NOT TO SCALE

LOG J-HOOK WITH BOULDERS
NOTES

1. THE LOG J-HOOK WITH BOULDERS IS A DESIGN FEATURE USED TO PROVIDE ENERGY DISSIPATION, FLOW DIRECTION CONTROL AND TO REDUCE NEAR BANK STRESS. THIS STRUCTURE WILL ALSO ENCOURAGE POOL MAINTENANCE AND CREATE A DIVERSITY OF AQUATIC HABITAT THROUGH SCOUR OF THE RIVER BED. THE LOG J-HOOK WITH BOULDERS IS COMPOSED OF A BOULDER SILL, WHICH IS A ROW OF BOULDERS SET AT AN ELEVATION PROVIDED IN THE PROPOSED PROFILE THAT SPANS PERPENDICULAR TO AND SLIGHTLY ARCED ACROSS THE CHANNEL. THE BOULDER SILL EXTENDS EXTENDS FROM A LOG VANE ARM INTO THE OPPOSITE STREAMBANK. THE LOG VANE ARM EXTENDS UP AND TOWARDS THE OUTSIDE STREAM BANK, EVENTUALLY KEYING INTO THE BANK AT AN ELEVATION HIGHER THAN THE SILL BOULDERS.
2. ALL BOULDERS USED FOR THE BOULDER SILL SHALL BE STRUCTURAL STONE, CUBICAL OR RECTANGULAR IN SHAPE. BOULDERS AVAILABLE ONSITE MAY BE USED IF APPROVED BY THE ENGINEER.
3. DIMENSIONS AND SLOPES OF STRUCTURES DESCRIBED IN THE DETAIL MAY BE ADJUSTED BY DESIGN ENGINEER TO FIT CONDITIONS ONSITE.
4. CONTRACTOR WILL BE REQUIRED TO FIT LOGS AND BOULDERS TOGETHER TIGHTLY. ALL LOGS AND BOULDERS SHALL BE INSTALLED WITH FOOTERS.
5. HEADER BOULDERS SHALL HAVE 2.0 FT - 3.0 FT GAPS BETWEEN EACH BOULDER TO MAINTAIN SEDIMENT TRANSPORT FUNCTIONS AND FISH PASSAGE.
6. GAPS BETWEEN LOGS AND FOOTER BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER AND PLUGGING WITH NC DOT CLASS A, WOODY DEBRIS AND SELECT MATERIAL OR CHINKING STONE APPROVED BY DESIGN ENGINEER, AND LINING WITH FILTER FABRIC.
7. THE LOG VANE SHALL EXTEND INTO THE OUTSIDE STREAMBANK AND STREAMBED A MINIMUM OF 15.0 FT ON EACH END.
8. THE BOULDER SILL SHALL EXTEND A MINIMUM OF 15.0 FT INTO THE INSIDE STREAM BANK.
9. BOULDERS SHALL BE 3.0 FT X 4.0 FT X 2.0 FT +/- 0.5 FT. MINIMUM LOG DIAMETER IS 2.0 FT.
10. NON-WOVEN GEOTEXTILE SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH FOOTER BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF THE STRUCTURE.

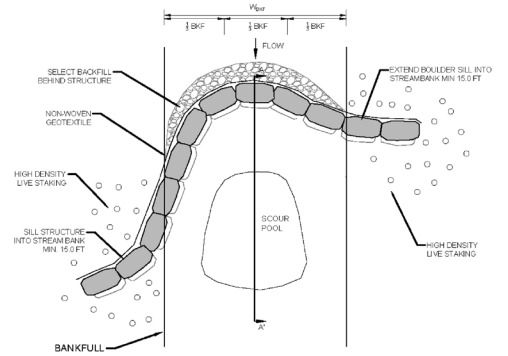


LOG J-HOOK WITH BOULDERS
SECTION A - A'
NOT TO SCALE



LOG J-HOOK WITH BOULDERS
CROSS-SECTION
NOT TO SCALE

Middle Fork Greenway	**Typical Restoration Detail: Log J-hook with Boulders**	**Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina**	**Sheet 23**

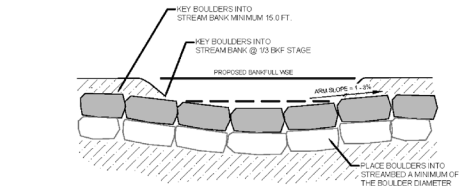


BOULDER J-HOOK
DETAILED PLAN
NOT TO SCALE

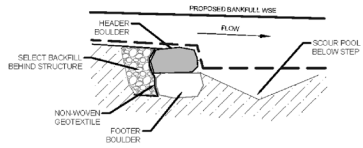
BOULDER J-HOOK
NOTES

THE BOULDER J-HOOK IS A DESIGN FEATURE USED TO CONTROL GRADE IN HIGH IN GRADIENT REACHES OR AT CRITICAL JUNCTURES OF THE PROPOSED CHANNEL. THIS STRUCTURE WILL ALSO ENCOURAGE POOL MAINTENANCE AND CREATE A DIVERSITY OF AQUATIC HABITAT THROUGH SCOUR OF THE RIVER BED. THE BOULDER J-HOOK IS COMPOSED OF A BOULDER SILL, WHICH IS A ROW OF BOULDERS SET AT AN ELEVATION PROVIDED IN THE PROPOSED PROFILE THAT SPANS PERPENDICULAR TO AND SLIGHTLY ARCED ACROSS THE CHANNEL. THE BOULDER SILL EXTENDS FROM A BOULDER VANE ARM INTO THE OPPOSITE STREAMBANK. THE BOULDER VANE ARM EXTENDS UP AND TOWARDS THE OUTSIDE STREAM BANK, EVENTUALLY KEYING INTO THE BANK AT AN ELEVATION HIGHER THAN THE SILL BOULDERS.

1. ALL BOULDERS USED FOR THE OFFSET BOULDER STEP SHALL BE STRUCTURAL STONE, CUBICAL OR RECTANGULAR IN SHAPE. THE ENGINEER MUST APPROVE THE USE OF BOULDERS THAT MAY BE AVAILABLE ONSITE.
2. DIMENSIONS AND SLOPES OF STRUCTURES DESCRIBED IN THE DETAIL MAY BE ADJUSTED BY THE ENGINEER TO FIT CONDITIONS ONSITE.
3. CONTRACTOR WILL BE REQUIRED TO FIT BOULDERS TOGETHER TIGHTLY.
4. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER AND PLUGGING WITH NC DOT CLASS A AND SELECT MATERIAL OR CHINKING STONE APPROVED BY DESIGN ENGINEER, AND LINING WITH FILTER FABRIC.
5. THERE SHALL BE NO DROP GREATER THAN 0.5 FT OVER A SINGLE STEP. BOULDERS SHALL BE 3 FT X 4 FT X 2 FT +/- 0.5 FT.
6. NON-WOVEN GEOTEXTILE SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF THE STRUCTURE. COARSE SELECT BACKFILL MATERIAL SHALL BE PLACED ON THE UPSTREAM SIDE OF THE NON-WOVEN GEOTEXTILE FABRIC.

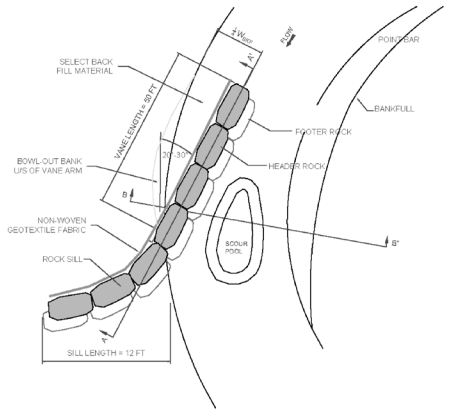


BOULDER J-HOOK
CROSS-SECTION
NOT TO SCALE



BOULDER J-HOOK
SECTION A - A'
NOT TO SCALE

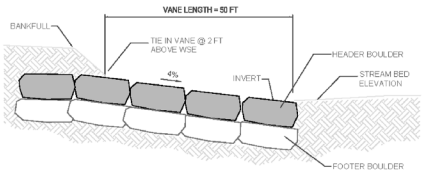
Middle Fork Greenway	**Typical Restoration Detail: Boulder J-hook**	**Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina**	**Sheet 24**



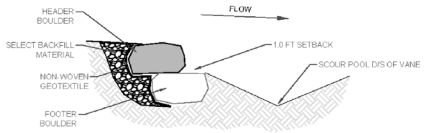
SINGLE ARM BOULDER VANE
DETAILED PLAN
NOT TO SCALE

SINGLE ARM BOULDER VANE
NOTES

1. FOOTER BOULDERS ARE BOULDERS PLACED TO PROVIDE A FOUNDATION AND SCOUR PROTECTION FOR THE HEADER BOULDERS.
2. HEADER BOULDERS SHALL BE UNDERLAIN BY FOOTER BOULDERS WITH A 1 FT SETBACK UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
3. HEADER BOULDERS ARE THE TOP MOST LOGS USED IN EACH LOG STRUCTURE. ALL HEADER BOULDERS CAN BE SEEN PARTIALLY PROTRUDING FROM THE WATER SURFACE DURING EXTREMELY LOW FLOWS.
4. HEADER LOGS SHALL BE OFFSET SLIGHTLY DOWNSTREAM OF THE FOOTING LOGS WHERE SCOUR POOLS ARE ANTICIPATED TO FORM AS SHOWN IN THE DETAIL.
5. SILL BOULDERS SHALL BE PLACED PERPENDICULAR TO THE BANKFULL FLOW DIRECTION.
6. INVERT AND TIE IN ELEVATIONS SHALL BE DETERMINED BY THE ENGINEER ONSITE.
7. ALL GAPS/VOIDS LARGER THAN 1 INCH BETWEEN THE HEADER AND FOOTING BOULDERS SHALL BE CHINKED WITH GRAVEL AND COBBLES.
8. ON THE UPSTREAM SIDE OF THE BOULDERS NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE GEOTEXTILE PLACEMENT AND SELECT BACKFILL DETAIL FOR THE ENTIRE LENGTH OF THE VANE ARM.
9. BACKFILL STRUCTURE WITH SELECT BACKFILL MATERIAL AS SHOWN AND DEFINED IN THE GEOTEXTILE PLACEMENT AND SELECT BACKFILL DETAIL.
10. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
11. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
12. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
13. NO LIVE STAKES SHALL BE INSTALLED ON THE UPSTREAM SIDE OF THE LOG VANE AT OR BELOW THE TIE-IN ELEVATION OF THE HEADER LOG WITH THE STREAM BANK UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
14. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM.

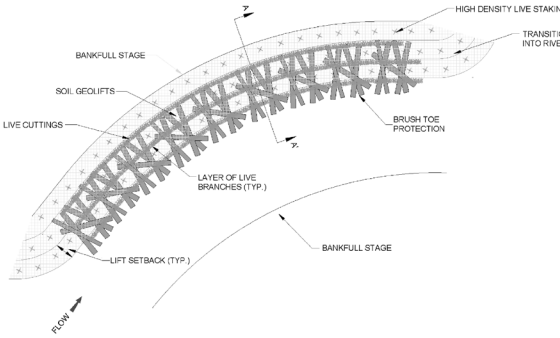


SINGLE ARM BOULDER VANE
DETAILED SECTION A - A'
NOT TO SCALE

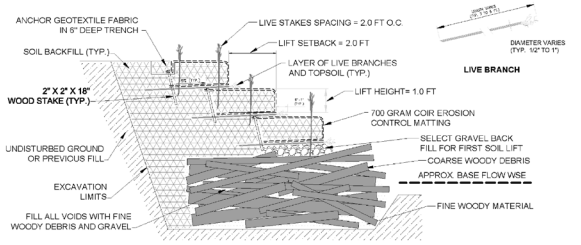


SINGLE ARM BOULDER VANE
DETAILED SECTION B - B'
NOT TO SCALE

Middle Fork Greenway	**Typical Restoration Detail: Single Arm Boulder Vane**	**Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina**	**Sheet 25**



TOE WOOD REVETMENT WITH SOIL GEOLIFT
DETAILED PLAN
NOT TO SCALE

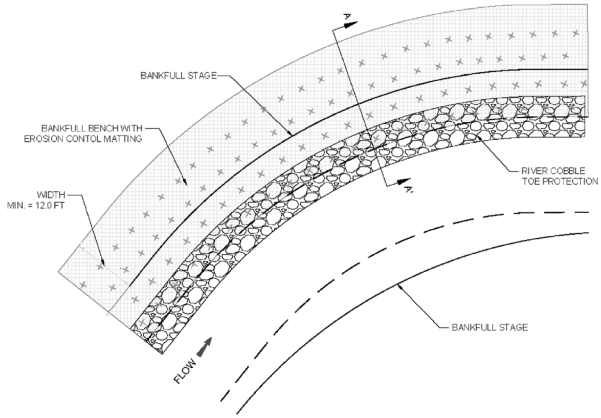


TOE WOOD REVETMENT WITH SOIL GEOLIFT
DETAILED PROFILE - SECTION A - A'
NOT TO SCALE

TOE WOOD REVETMENT WITH SOIL GEOLIFT
NOTES

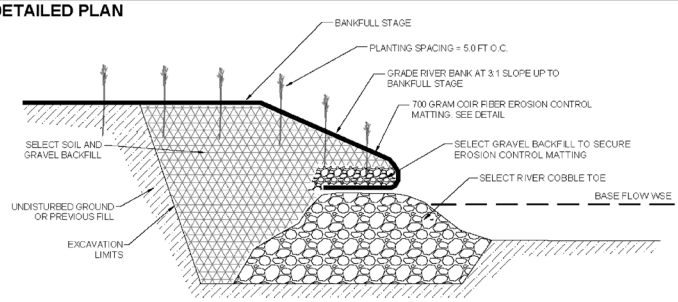
1. **COARSE WOODY DEBRIS SHALL CONSIST OF LOGS, ROOTWADS, AND LARGE BRANCHES NOT SUITABLE FOR CONSTRUCTION OF LOG STRUCTURES. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.**
2. **COARSE WOODY DEBRIS SHALL BE CONSTRUCTED WITH THE LARGEST MATERIAL PLACED FIRST. NO LOGS SHALL BE PLACED PARALLEL TO THE FLOW OF WATER, UNLESS DIRECTED BY THE ENGINEER. LOGS SHALL BE PLACED IN A CROSSING PATTERN OR WEAVE SUCH THAT EACH LOG IS ANCHORED BY ANOTHER LOG.**
3. **SMALL/FINE WOODY DEBRIS SHALL CONSIST OF MEDIUM TO SMALL LIMBS, BRANCHES, BUSHES, AND/OR LOGS. INVASIVE SPECIES SHALL NOT BE USED.**
4. **SMALL/FINE WOODY DEBRIS SHALL BE PLACED ABOVE THE COARSE WOODY DEBRIS WITH THE LARGEST MATERIAL BEING PLACED FIRST AND THE SMALLEST MATERIAL PLACED LAST.**
5. **ALL WOODY DEBRIS SHALL BE COMPACTED WITH THE EXCAVATOR BUCKET IN ORDER TO REDUCE THE PRESENCE OF VOIDS IN THE SMALL/FINE WOODY DEBRIS LAYER.**
6. **THE HORIZONTAL LOCATIONS OF ALL WOODY DEBRIS ARE LOCATED ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE AND LN3 FILE. NO LOCATIONS OF WOODY DEBRIS SHALL VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTION FROM THE ENGINEER.**
7. **GRAVEL LEVELING BASE SHALL BE INSTALLED ABOVE THE HIGHEST ELEVATION OF THE WOODY DEBRIS BEFORE THE SOIL LIFTS ARE INSTALLED.**
8. THE SOIL BACKFILL USED FOR LIFTS AND TOPSOIL USED FOR LAYERING WITH THE LIVE BRANCHES SHALL BE FREE OF ANY LARGE ROOTS OR WOODY DEBRIS AND SHALL GENERALLY BE FREE FROM ANY GRAVEL OR COBBLE MATERIAL.
9. SOIL BACKFILL SHALL BE COMPACTED SUCH THAT FUTURE SETTLING WILL BE KEPT TO A MINIMUM, YET, NOT SUCH THAT THE UNDERLYING BRUSH IS DISPLACED OR DAMAGED.
10. THE TOP OF THE BACKFILL FOR THE FIRST LIFT SHALL BE SLOPED AT APPROXIMATELY 5% AWAY FROM THE STREAM.
11. PLACE A LAYER OF TOPSOIL AND LIVE BRANCHES ON TOP OF EACH SOIL LIFT SUCH THAT APPROXIMATELY 6 INCHES TO 1 FOOT OF EACH LIVE BRANCH WILL BE EXPOSED AND THE REMAINDER (2 TO 4) OF EACH LIVE BRANCH WILL BE COVERED BY THE NEXT SOIL LIFT.
12. LIVE BRANCHES SHALL BE OF THE SPECIES SPECIFIED FOR LIVE STAKES OR APPROVED BY THE ENGINEER.
13. PLACE A LAYER OF 6.5 FEET WIDE GEOCOIR DEKOWE 700 EROSION CONTROL BLANKET, OR EQUIVALENT, ON TOP OF THE TOPSOIL AND LIVE BRANCHES SUCH THAT 2.5 FEET OF THE BLANKET WILL BE BURIED BELOW THE NEXT SOIL LIFT. ALLOW THE REMAINING 4.5 FEET OF BLANKET TO HANG OVER THE PRECEDING SOIL LIFT OR COIR FIBER LOGS.
14. PLACE A LAYER OF 6.5 FEET WIDE NON-WOVEN COIR MATTING OVER THE EROSION CONTROL BLANKET TO THE SAME LIMITS.
15. SOIL CAN BE COMPACTED BY STACKING A PIECE OF 2 X 6 SAWN LUMBER EDGEWAYS UP TO THE LIFT HEIGHT SPECIFIED IN THE STRUCTURE TABLE AND SECURING WITH WOODEN STAKES TO PROVIDE A RIGID BACKSTOP FOR COMPACTING SOIL LIFT.
16. PLACE SOIL BACKFILL UP TO THE LIFT HEIGHT SPECIFIED OF NO GREATER THAN 1.0 FT BEING CAREFUL NOT TO PUSH/PULL OR TEAR THE FABRIC PREVIOUSLY PLACED.
17. THE TOP OF THE SOIL BACKFILL SHALL BE FLAT WITHIN THE LIFT SETBACK DISTANCE SPECIFIED IN THE STRUCTURE TABLE. BEYOND THE LIFT SETBACK DISTANCE, THE SOIL BACKFILL SHALL BE SLOPED AT AN APPROXIMATE 5% SLOPE AWAY FROM THE STREAM.
18. TOP DRESS THE SOIL LIFT WITH TOPSOIL FROM THE FACE OF THE SOIL LIFT BACK INTO THE FLOODPLAIN AT LEAST 4FT.
19. REMOVE THE SAWN LUMBER AND WOODEN STAKES FROM THE FACE OF THE SOIL LIFT AND WRAP THE FACE AND TOP OF THE SOIL LIFT USING THE WOVEN AND NON-WOVEN COIR MATTING HANGING OVER THE PREVIOUS LIFT/COIR FIBER LOGS.
20. THE EROSION CONTROL FABRIC SHALL BE PULLED AS TIGHT AS POSSIBLE WITHOUT TEARING OR EXCESSIVELY DISTORTING THE FABRIC.
21. SECURE THE EROSION CONTROL AND NON-WOVEN MATTING IN PLACE BY STAKING THE END OF THE EROSION CONTROL FABRIC WITH WOODEN STAKES ON 1.5-FOOT CENTERS.
22. BEGIN CONSTRUCTION OF THE NEXT SOIL LIFT BY REPEATING THE PREVIOUS NOTES STARTING WITH NOTE 11.
23. THE OVERALL SLOPE CREATED BY THE LIVE BRUSH LAYERING SHALL MATCH THE PROPOSED CROSS SECTION SHAPE FOR THE OUTER BANK OF THE THE TYPICAL POOL CROSS-SECTION FOR EACH REACH.
24. THE COIR BLANKETS AND GEOTEXTILE FABRIC USED FOR THE UPPER MOST SOIL LIFT WILL BE SECURED WITHIN A 6 INCH DEEP TRENCH AS SHOWN IN DETAIL. TRENCH AS SHOWN IN THE DETAIL.
25. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED OR APPROVED BY THE ENGINEER.
26. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES **AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.**

Middle Fork Greenway	**Typical Restoration Detail: Toe Wood Revetment**	**Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina**	**Sheet 26**



RIVER COBBLE TOE PROTECTION
DETAILED PLAN

NOT TO SCALE



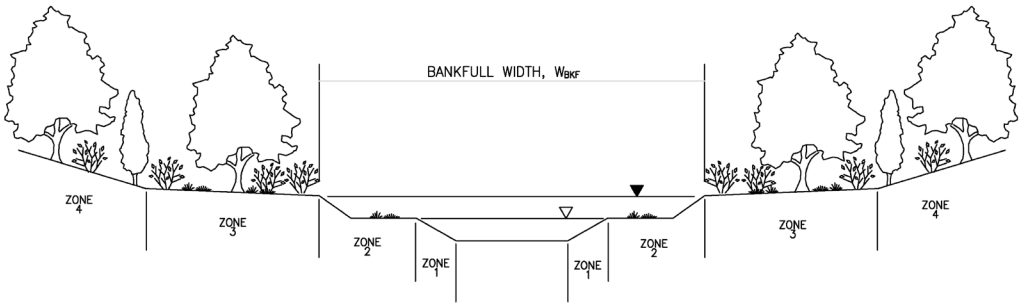
RIVER COBBLE TOE PROTECTION
DETAILED PROFILE - SECTION A - A'

NOT TO SCALE

RIVER COBBLE TOE PROTECTION
NOTES

1. A 1.5 - 2.5 FT THICK BEDDING COURSE CONSISTING OF WELL GRADED COBBLE AND GRAVEL AVAILABLE ONSITE SHALL BE INSTALLED AT THE BASE OF THE RIVER BANK FOR TOE PROTECTION. THE ENGINEER MUST APPROVE ALL ONSITE MATERIAL.
2. GRAVEL LEVELING BASE SHALL BE INSTALLED ABOVE THE HIGHEST ELEVATION OF THE COBBLE TOE PROTECTION BEFORE REBUILDING THE RIVER BANK.
4. PLACE A LAYER OF 6.5 FEET WIDE GEOCOIR DEKOWE 700 EROSION CONTROL BLANKET, OR EQUIVALENT, ON TOP OF THE GRAVEL LEVELING COURSE SUCH THAT 3.0 FEET OF THE BLANKET WILL BE BURIED BELOW THE SOIL BACKFILL.
5. SOIL BACKFILL SHALL BE GRADED TO A 3:1 SLOPE AND COMPACTED SUCH THAT FUTURE SETTLING WILL BE KEPT TO A MINIMUM.
6. THE EROSION CONTROL FABRIC SHALL BE PULLED OVER THE NEWLY GRADED RIVER BANK AS TIGHT AS POSSIBLE WITHOUT TEARING OR EXCESSIVELY DISTORTING THE FABRIC.
7. SECURE THE EROSION CONTROL AND NON-WOVEN MATTING IN PLACE BY STAKING THE END OF THE EROSION CONTROL FABRIC WITH WOODEN STAKES ON 1.5-FOOT CENTERS.
8. SEE DETAIL 5.3 FOR EROSION CONTROL MATTING INSTALLATION.
9. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED OR APPROVED BY THE ENGINEER.
10. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

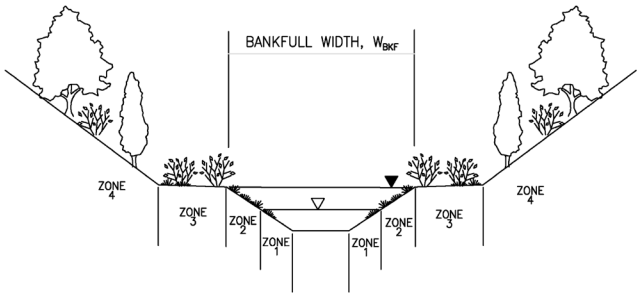
Middle Fork Greenway	**Typical Restoration Detail: River Cobble Toe Protection**	**Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina**	**Sheet 27**



UNCONFINED VALLEY

▼ BANKFULL WATER SURFACE
▽ LOW FLOW WATER SURFACE

SEE APPENDIX D FOR RECOMMENDED PLANTINGS FOR EACH ZONE



CONFINED VALLEY

Middle Fork Greenway	**Conceptual Vegetation Planting Zones**	**Middle Fork New River Restoration Prioritization Plan Watauga County, North Carolina**	**Sheet 28**