MITIGATION PLAN

FINAL

MIDDLE SOUTH MUDDY CREEK RESTORATION
McDowell County, NC
EEP Project No: 93875

CATAWBA RIVER BASIN CATALOGING UNIT 03050101

Prepared for:

NC Department of Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

March 2012

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Prepared by:

Wolf Creek Engineering, PLLC
7 Florida Ave
Weaverville, North Carolina 28787
828-658-3649

EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) proposes to restore, enhance, and preserve reaches of South Muddy Creek and two of its tributaries at two sites located in southeastern McDowell County. This Mitigation Plan describes the details, methods, and monitoring protocols proposed to generate approximately **3,281 stream mitigation credits**, which includes approximately **1,990 linear feet of stream restoration**, approximately **195 linear feet of stream enhancement** and approximately **5,836 linear feet of preservation**.

General Site Conditions
The Middle South Muddy Creek Site (the Site) occurs near the intersection of Brackett Town Road and Sprouse Road in southeastern McDowell County. The Site encompasses approximately 5.87 acres of predominately agricultural land. Within the Site, approximately 2,201 linear feet of channel exhibit mitigation potential. Agricultural practices including cattle grazing, maintenance and removal of vegetation, and relocating, dredging, and straightening of on-site streams have contributed to the degraded water quality and unstable channel characteristics.

Included as a part of this project is the Haney Preservation Tract, which is located just north of the Middle South Muddy Creek Site along Vein Mountain Road. This tract preserves 5,836 LF of stream and approximately 35 acres of buffer along South Muddy Creek.

The Middle South Muddy Creek Site and the Haney Preservation Tract were both identified as part of a Local Watershed Planning (LWP) initiative conducted by the Muddy Creek Restoration Partnership and covering the entire Muddy Creek Watershed, which culminated in development of a Feasibility Report & Restoration Plan in late 2003. An updated and expanded project atlas for the Muddy Creek LWP area was completed using EEP funding in 2008. This LWP meets criteria for CFR-compliant watershed assessment and planning to support mitigation requirements under the Clean Water Act.

Restoration Concept
Restoration and enhancement practices proposed for this project have been designed with the intent to minimize unnecessary disturbance to adjacent land. Professional judgment has been used to determine which channel reaches could potentially benefit most from preservation or enhancement over full restoration. Where restoration was determined to be warranted, consideration was given to which reaches could best be served by maintaining as much of the existing channel pattern as possible.

Proposed South Muddy Creek is designed as a Type C4 stream. This channel configuration provides a stable and natural form in the Type VIII(b) alluvial valley in which the existing stream is found. Proposed Sprouse Branch and Iva Branch are designed as Type B5 streams. These channel configurations provide the most stable and natural form for these slightly entrenched channels flowing through moderately sloped colluvial valleys. The proposed channel dimensions, patterns, and profiles are based on hydraulic relationships and morphologic dimensionless ratios of the reference reaches.

The installation of brush, rock, and wood structures will be utilized throughout the restored reaches of the Site. Brush toe structures will be installed along the toe of bank to provide roughness and bank stability on outer meander bends. Boulder structures will be used for grade control to prevent headcut formation. Log vanes with rootwads will be installed in meander bends to direct the flow away from the outside of the bend and provide toe and bank protection. On-site material including brush, boulders, logs, and bed material will be used to the maximum extent possible and in-stream structures will be designed to improve aquatic habitat.

This mitigation plan has been written in conformance with the requirements of the following:

- Federal rule for compensatory mitigation project sites as described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.8 paragraphs (c)(2) through (c)(14).

- NCDENR Ecosystem Enhancement Program In-Lieu Fee Instrument signed and dated July 28, 2010

These documents govern NCEEP operations and procedures for the delivery of compensatory mitigation.

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1.0 RESTORATION PROJECT GOALS AND OBJECTIVES

The Middle South Muddy Creek Project (the Site) is located in the Muddy Creek Local Watershed planning area (http://www.nceep.net/services/lwps/muddy_creek/Muddy_Creek_plan_2003.pdf). The Project Site watershed includes Hydrologic Unit Code (HUC) 03050101040020 which was identified as a Targeted Local Watershed (TLW) in EEP's 2009 Upper Catawba River Basin Restoration Priority (RBRP) Plans (http://www.nceep.net/services/restplans/Upper_Catawba_RBRP_2009.pdf).

The Muddy Creek Restoration Partnership (MCRP) developed a local watershed plan (LWP) for the 111 sq mi drainage area that included land use analysis, water quality monitoring and stakeholder input to identify problems with water quality, habitat and hydrology. The Muddy Creek watershed is characterized as primarily agricultural and has a history of entrenchment and increased sediment problems due to barren bank issues. MCRP completed the Feasibility Report and Restoration Plan for the Muddy Creek Watershed in December 2003
(http://www.nceep.net/services/lwps/muddy_creek/Muddy_Creek_plan_2003.pdf).

The Muddy Creek LWP identified nutrients, streambank erosion and livestock access to streams as major stressors within this watershed. The LWP Feasibility Report (2003) included an initial set of project site recommendations, including identification of the Middle South Muddy Creek Project as a stream restoration and enhancement opportunity with the potential to improve water quality and habitat within the Muddy Creek watershed. The Muddy Creek Mitigation Search Final Summary Report (2008), which was prepared to address the plans and objectives of the MCRP, additionally identified the Haney Tract as a mitigation opportunity.

The goals of the Middle South Muddy Creek Project address stressors identified in the LWP and include the following:

The following goals are established to guide the restoration process for the project:

1.) Improve local water quality within the restored channel reaches as well as the downstream watercourses through: (a) the reduction of current channel sediment loads by restoring appropriately sized channels with stable beds and banks, (b) the reduction of nutrient loads from adjacent agricultural fields with a restored riparian buffer, and (c) the reduction of water temperatures provided through shading of the channel by canopy species along with the resultant increase in oxygen content.
2.) Improve local aquatic and terrestrial habitat and diversity within the restored channels and their vicinity through: (a) the restoration of appropriate bed form to provide habitat for fish, amphibian, and benthic species, (b) the restoration of a suitable riparian buffer corridor in order to provide both vertical and horizontal structure and connectivity with adjacent upland areas, and (c) the restoration of understory and canopy species in order to provide forage, cover, and nesting for a variety of mammals, reptiles, and avian species.
3.) Preclude land disturbing activities including the construction of additional infrastructure, future mining activities and agricultural practices including cattle grazing and the application of pesticides and fertilizer within the riparian buffer area by providing a permanent conservation easement.

The following objectives are proposed for accomplishing the above listed goals:

1.) **Provide approximately 3,281 stream mitigation units (SMU's)** through Priority I and II restoration of approximately **1,990** linear feet of stream, enhancement of approximately **195** linear feet of stream, and preservation of approximately **5,836** linear feet of stream threatened by mining activities.
2.) Restore natural stable channel morphology and proper sediment transport capacity.
3.) Create and/or improve bed form diversity and improve aquatic and benthic macroinvertebrate habitat.
4.) Construct a floodplain bench that is accessible at the proposed bankfull discharge.
5.) Improve channel and stream bank stabilization by integrating in-stream structures and native bank vegetation.

6.) Provide approximately 5.87 acres of riparian buffer restoration by establishing a native forested and herbaceous riparian buffer plant community with a minimum width of 30 feet from the edge of the restored channels. This new community will be established in conjunction with the eradication of any existing exotic and/or undesirable plant species.
7.) Construct barricades on existing dirt road network on Haney Tract to prevent future vehicular trespassing.

2.0 SITE SELECTION

2.1 Directions to Site

The Middle South Muddy Creek Restoration Site is located approximately 9.5 miles southeast of Marion, NC in southeast McDowell County (See Figure 1). From Raleigh take I-40 West, or from Asheville take I-40 East toward Marion. Take exit 85 and follow NC-221 South for approximately 5.5 miles. Turn left onto Polly Spouts Rd. and follow for approximately 2 miles. Turn left onto Vein Mountain Rd. and follow for approximately 3 miles. Turn right onto Brackett Town Rd. and follow for approximately 1 mile. The entrance to the Site is on the left at Sprouse Rd. and is located at a Lat/Long of 35.5635° N and 81.9249° W.

2.2 Site Selection

2.2.1 Description

The Site encompasses approximately 5.87 acres of predominately agricultural and forested land and includes approximately 2,513 linear feet of degraded channel proposed for restoration and enhancement. Historic land use at the Site has consisted primarily of agriculture and livestock grazing. Livestock have unrestricted access to the majority of Site streams, resulting in significant local disturbance to stream banks. Additional land use practices, including the maintenance and removal of riparian vegetation, and the relocating, dredging, and straightening of on-site streams have contributed to the degraded water quality and unstable channel characteristics.

2.2.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

The Site is located in the Catawba River Basin, United States Geological Survey (USGS) 14-digit Hydrologic Unit 03050101040020, within the North Carolina Division of Water Quality (DWQ) sub basin 03-08-30. The Site lies within a NC EEP Targeted Local Watershed and is part of a Local Watershed Plan. Site tributaries are not listed on the NCDWQ final 2010 303(d) lists (NCDWQ 2010). South Muddy Creek drains to Muddy Creek approximately 12.5 miles downstream of the Site which in turn drains into the Catawba River another 4.5 miles downstream. South Muddy Creek has been assigned the Stream Index Number 11-32-2 by DWQ.

2.2.3 Watershed Characterization

The Site watershed is characteristic of the Foothills region with moderate rainfall and moderate valley slopes (5% to 20%). Annual precipitation within McDowell County averages 56.1 inches and elevations within the Site range from 1,315 ft. on upper slopes above Sprouse Branch to 1,263 ft. at the site outfall (NGVD). The Site encompasses approximately 2,513 linear feet of streams including **South Muddy Creek** and two tributaries, named for the purposes of this project as **Sprouse Branch** and **Iva Branch**.

The drainage area of South Muddy Creek is 4.52 mi^2 (2,893 ac) at the upstream project limits and 4.69 mi^2 (3,002 ac) at the downstream limits. The headwaters of both Sprouse Branch and Iva Branch are located within the project extents, and the drainage areas at their confluences with South Muddy Creek are 0.042 mi^2 and 0.046 mi^2, respectively.

2.2.4 Surface Water Classification

According to the North Carolina Department of Environment and Natural Resources (NCDENR), Division of Water Quality (DWQ) website, South Muddy Creek has been assigned a Best Usage Classification of **C**. The section of the Catawba River that South Muddy Creek and the project tributaries drain to has been assigned the Best Usage Classification of **WS-IV; Tr**. Class **C** waters are suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. The designation **Tr** (Trout Waters) includes areas protected for natural trout propagation and survival of stocked trout. The designation **WS-IV** (Water Supply IV) indicates waters used as sources of water supply for drinking, culinary or food processing purposes where a WS-I, II or III classification is not feasible. These waters are also protected for Class C uses. WS-IV waters are generally in moderately to highly developed watersheds or Protected Areas.

2.2.5 Physiography, Geology, and Soils

The Site is located in the Eastern Blue Ridge Foothills ecoregion of North Carolina. Regional physiography is characterized by open, low mountains at a lower elevation than most Blue Ridge regions having more Piedmont influences. This region includes the Brushy Mountains to the north and the South Mountains to the south. Covered with mixed oak and oak-hickory-pine forests, these mountains tend to be slightly drier and warmer than most of the Blue Ridge ecoregion. The underlying geology within the ecoregion consists of primarily metamorphic rocks with occasional igneous and sedimentary deposits. The local lithology is mapped as migmatitic granitic gneiss.

The valley associated with the portion of South Muddy Creek within the project extents is a narrow alluvial valley, Type VIII(b) (Rosgen) with cross-slopes ranging from 1% to 3% and a longitudinal slope approximately 0.4%. The valleys of Sprouse Branch and Iva Branch are moderately sloped Type II (Rosgen) colluvial valleys with a down valley gradient of 2% to 5% that transition onto the gentle alluvial valley of South Muddy Creek.

The Site lies in the low mountains of North Carolina in rolling topography underlain by metamorphic and igneous bedrock. The side slopes in the area are well drained, moderately permeable, sandy-loamy sub-soils (Hayesville-Evard Soil Series). The alluvial soils along the stream systems in the area are generally underlain by yellowish-brown, sandy-loamy sub-soils belonging to the Iotla series. These somewhat poorly drained soils are moderately permeable and are non-hydric.

2.2.6 Historical Land Use and Development Trends

The watershed upstream of the Site is characterized mainly by agricultural and forested land with moderate to heavy mineral mining activity occurring in close proximity to tributaries. Mining activities appear to be non-commercial individual prospecting for gold. Most of these activities appear to have occurred in the floodplain, however there is evidence of some incursion into the stream channels. Residential land use accounts for only a marginal percentage of the watershed. Currently rural residential land use makes up approximately 3 percent of the watershed and impervious area covers less than 1 percent of the total watershed. Historical land use was evaluated through conducting interviews of property owners and reviewing aerial photos from 1954 through 2010 (ERTR, June 2011). Historical land use has been consistent with present land use practices that include pastureland for cattle, hay production, and some forest stands. Grazing livestock have historically had access to most on-site stream reaches and the adjacent terraces.

2.2.7 Existing Site Conditions

<u>South Muddy Creek</u>

Based on the present configuration of the channel and on typical historical agricultural practices it is likely that South Muddy Creek was realigned and dredged throughout the project reach. The resulting channel form exhibits low sinuosity and moderate incision. The channel classifies as a Type G4 stream under the Rosgen channel classification system throughout the majority of the on-site reach. The existing entrenchment ratios range from 1.2 – 2.6, bank-height ratios range from 1.8 – 2.5, and the width/depth ratio is 3.3 – 9.6. The high bank-height ratios and low width/depth ratios result in increasing the stress on the stream banks. The profile appears vertically stable due to the low channel gradient, although the riffle-pool form is poorly developed and often misaligned with the pattern, further contributing to near-bank stress. Mobile bed material consists mainly of gravel (38%-65%) with lesser constituents of cobble (19%-24%) and a considerable fraction of sand (16%-37%).

South Muddy Creek was divided into two vegetative community types due to the presence of livestock below the culvert. The upper reach is characterized as agricultural pastureland and is utilized primarily for hay production with the dominant grass being fescue (*Festuca sp.*). The riparian buffer, adjacent to the agricultural field, is only 5 to 10 feet wide and is dominated by tag alder (*Alnus serrulata),* red maple *(Acer rubrum)* and river birch *(Betula nigra).* The existing riparian buffer consists of less than 5% invasive exotics including Japanese honeysuckle (*Lonicera japonica*) and Chinese privet (*Ligustrum sinense*). The lower reach is also characterized as agricultural pastureland, but it is primarily used for livestock production. The riparian buffer is 0 to 5 feet and is dominated by tag alder, red maple, tulip poplar (*Liriodendron tulipifera*), and river birch. There were no significant invasive exotics populations observed in this reach.

Sprouse Branch

Sprouse Branch originates from a spring within a forested reach at the upstream project extents. The toe-of-slope spring, which forms a small channel within a confined valley, is impacted by livestock and erosion. At the termination of the forested reach, Sprouse Branch continues as a dredged and straightened ditch. Entrenchment ratios are generally low; between 1.1 and 1.9. Width/depth ratios are moderate at the upstream end and low at the downstream end; 11 – 13 and 6 – 7, respectively. The channel classifies as a Type G5 stream. Bed material is composed mainly of sand with only a small fraction of gravel (<10%). The gravel present in the channel is in the fine gravel class (4-8 mm).

The upper reach (~200') of Sprouse Branch is dominated by red maple, black cherry (*Prunus serotina*), and tulip poplar. The lower reach is agricultural pastureland dominated by fescue with tag alder present along the ditch banks. Less than 5% of the riparian buffer contained invasive exotics including multiflora rose (*Rosa multiflora*), Japanese honeysuckle and Chinese privet.

Iva Branch

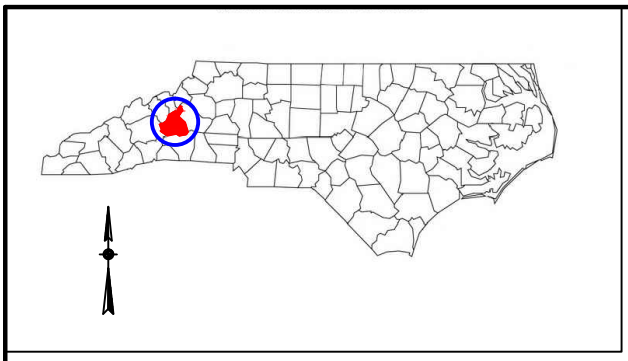
Iva Branch originates within a drawline that drains a small catchment at the northeast project extents. The channel remains vertically unstable as multiple headcuts have formed and migrated upstream to form a deeply entrenched channel with steep, vertical bluffs. Unrestricted livestock access continues to exacerbate instability. Entrenchment ratios range between 1.1 and 1.4. Banks are up to eight (8) feet high at the upstream end of the channel and decrease to four (4) feet near the downstream end. The channel bed slope ranges from 3% to 5% and the typical valley slope is 3.5%. The channel classifies as a Type G5 stream as bed material is composed mainly of sand (79%) with small gravel (19%) accumulating towards the downstream end.

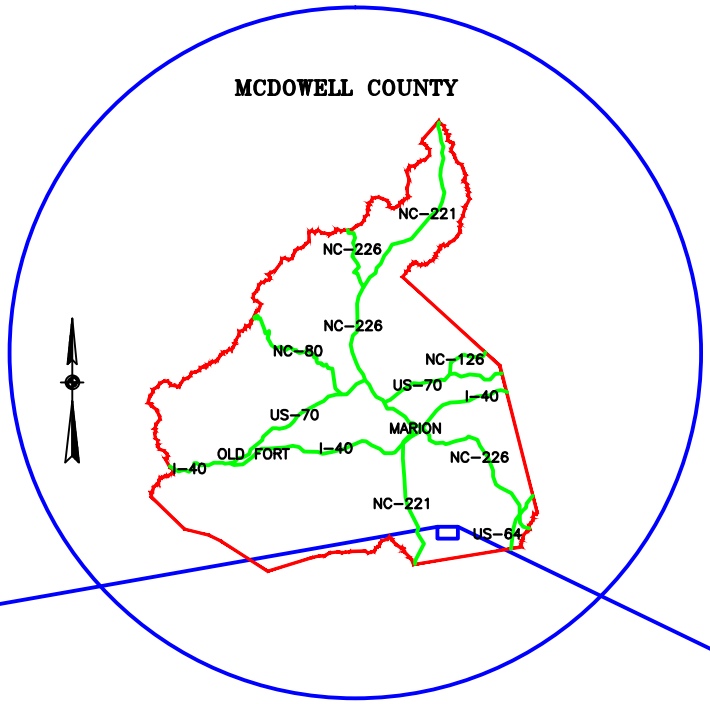
Iva Branch has a 5 to 15 foot riparian buffer comprised of red maple, river birch, American sycamore (*Platanus occidentalis*), and black cherry. The surrounding pastureland is dominated by fescue. Other species observed within the riparian zone include American holly (*Ilex opaca*), shortleaf pine (*Pinus echinata*), black walnut (*Juglans nigra*) and red cedar (*Juniperus virginiana*). Iva Branch contained the largest amount of invasive exotics (15%). Invasives observed included multiflora rose, Chinese privet, and Japanese honeysuckle.

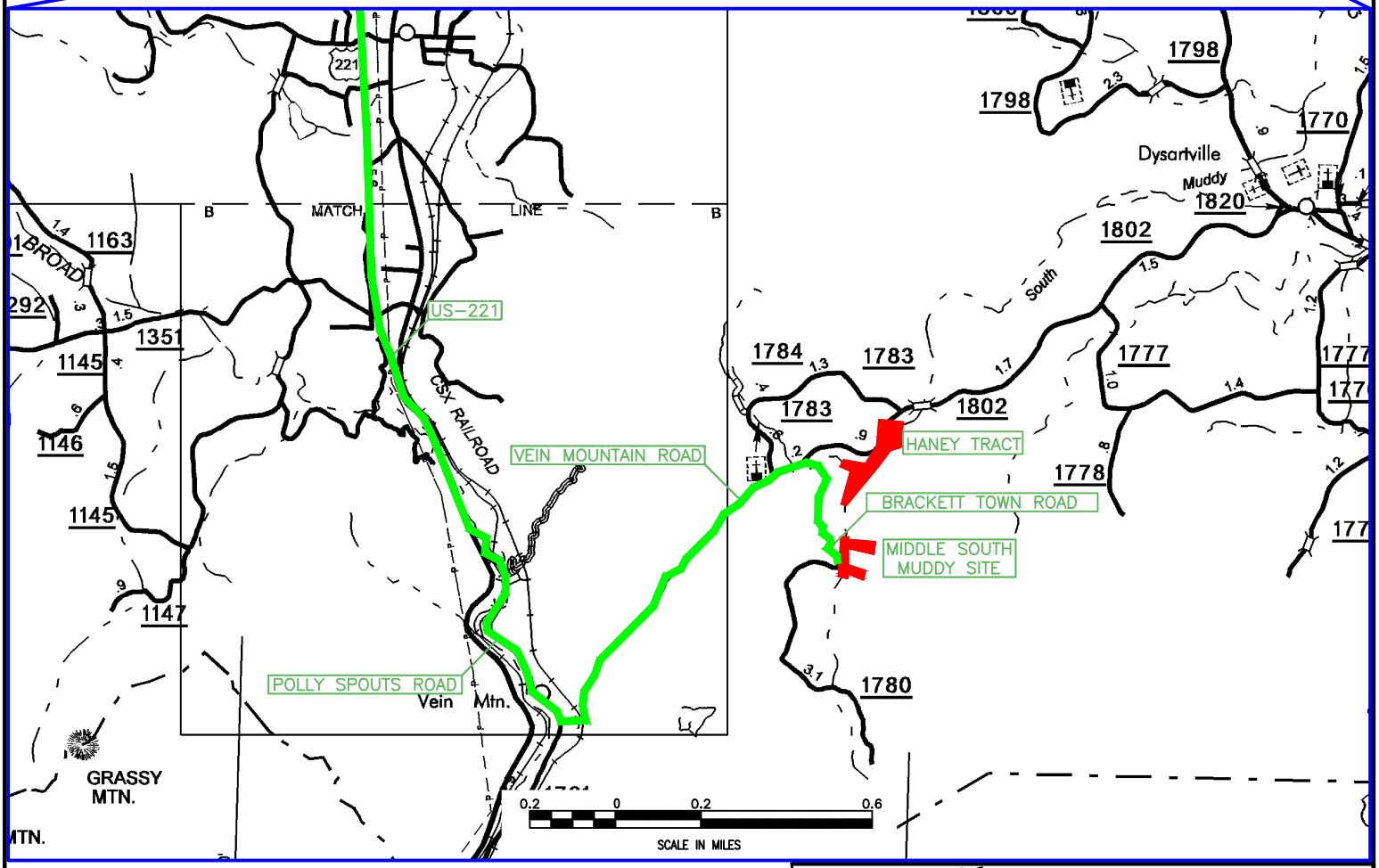
Haney Tract

The Haney Tract is located approximately 1,000 feet downstream of the Middle South Muddy Creek Site. This tract was identified as a target for preservation in the 2008 Muddy Creek Mitigation Search Final Summary Report (September 2008). This tract has since been acquired for preservation and will preserve 5,836 LF of stream channel and approximately 35 acres of riparian buffer.

Historically the property has been the location of continuous mining for at least 50 years. Mining operations may have been commercial at one time, but recently consisted of a club of individual prospectors mining for gold lag deposits in the floodplain. Establishment of the conservation easement will protect the stream and adjacent floodplain from future destructive mining activities.







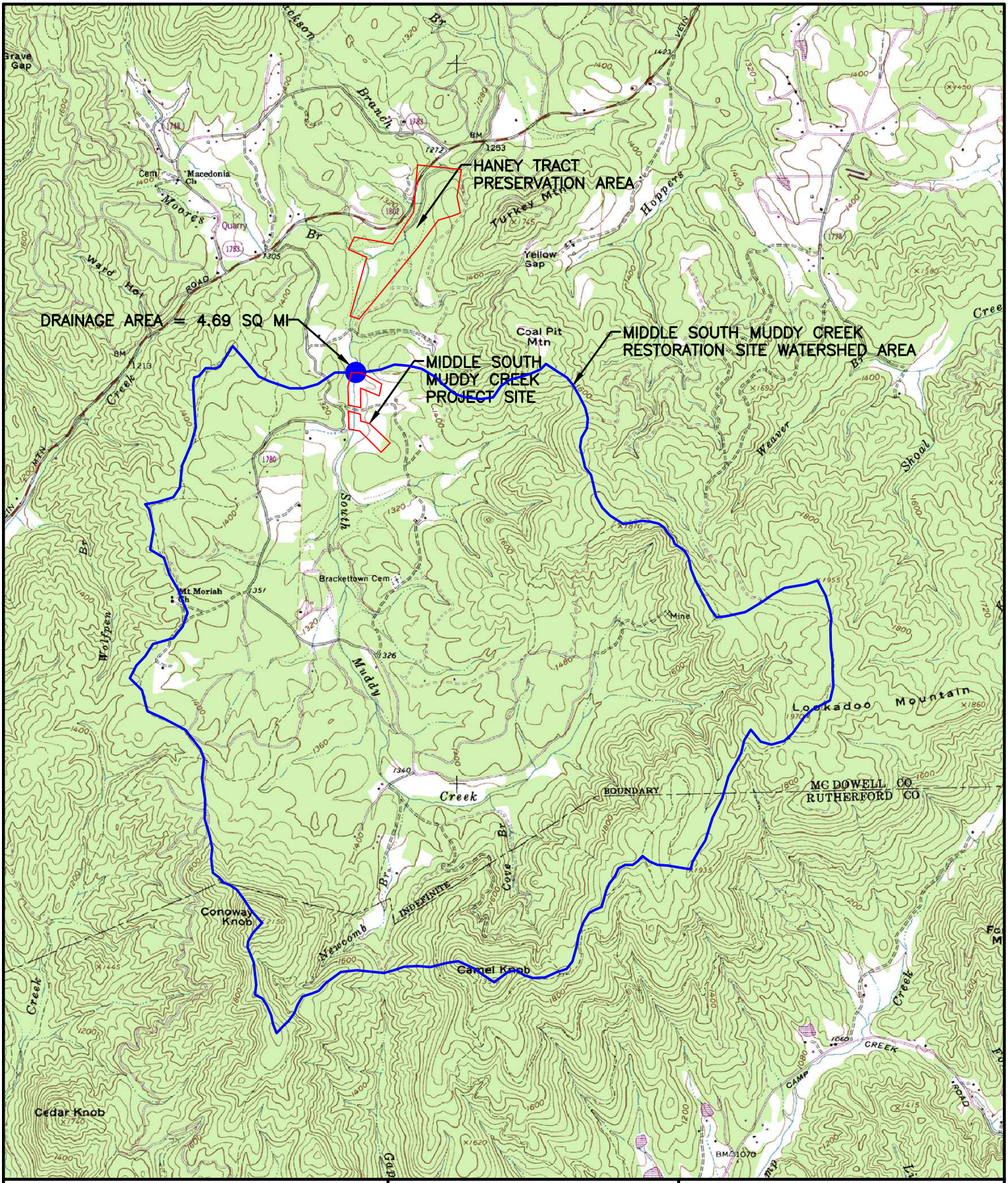
DIRECTIONS TO SITE FROM RALEIGH & ASHEVILLE:
- -FROM RALEIGH TAKE I-40 WEST, OR FROM ASHEVILLE TAKE I-40 EAST TOWARDS MARION AND TAKE EXIT 85.
- -TURN SOUTH ON US-221 AND FOLLOW FOR APPROXIMATELY 5.5 MILES.
- -TURN LEFT ONTO POLLY SPOUTS ROAD AND FOLLOW FOR APPROXIMATELY 1.7 MILES.
- -TURN LEFT ONTO VEIN MOUNTAIN ROAD AND FOLLOW FOR APPROXIMATELY 2.6 MILES.
- -TURN RIGHT ONTO BRACKETT TOWN ROAD AND FOLLOW FOR APPROXIMATELY 0.8 MILES.
- -TURN LEFT ONTO SPROUSE ROAD AT PROJECT ENTRANCE.

LAT/LONG COORDINATES FOR THE ENTRANCE TO THE SITE ARE N 35.5635, W 81.9249.

Wolf Creek Engineering
ENGINEERING & ENVIRONMENTAL CONSULTING
LICENSE NO. P-0417
7 FLORIDA AVENUE WEAVERVILLE, NC 28787
PHONE: (828) 658-3649 WWW.WOLFCREEKENG.COM

PROJECT: MIDDLE S. MUDDY CREEK RESTORATION PROJECT
OWNER: NORTH CAROLINA EEP
TITLE: VICINITY MAP

SCALE	DRWN. BY	PROJECT NO.	DRAWING NUMBER
AS NOTED	cme	1049	FIGURE 1
DATE 8/5/11	CHKD. BY SGG		



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Ecosystem Enhancement Program

PREPARED BY:

Wolf Creek Engineering

SCALE

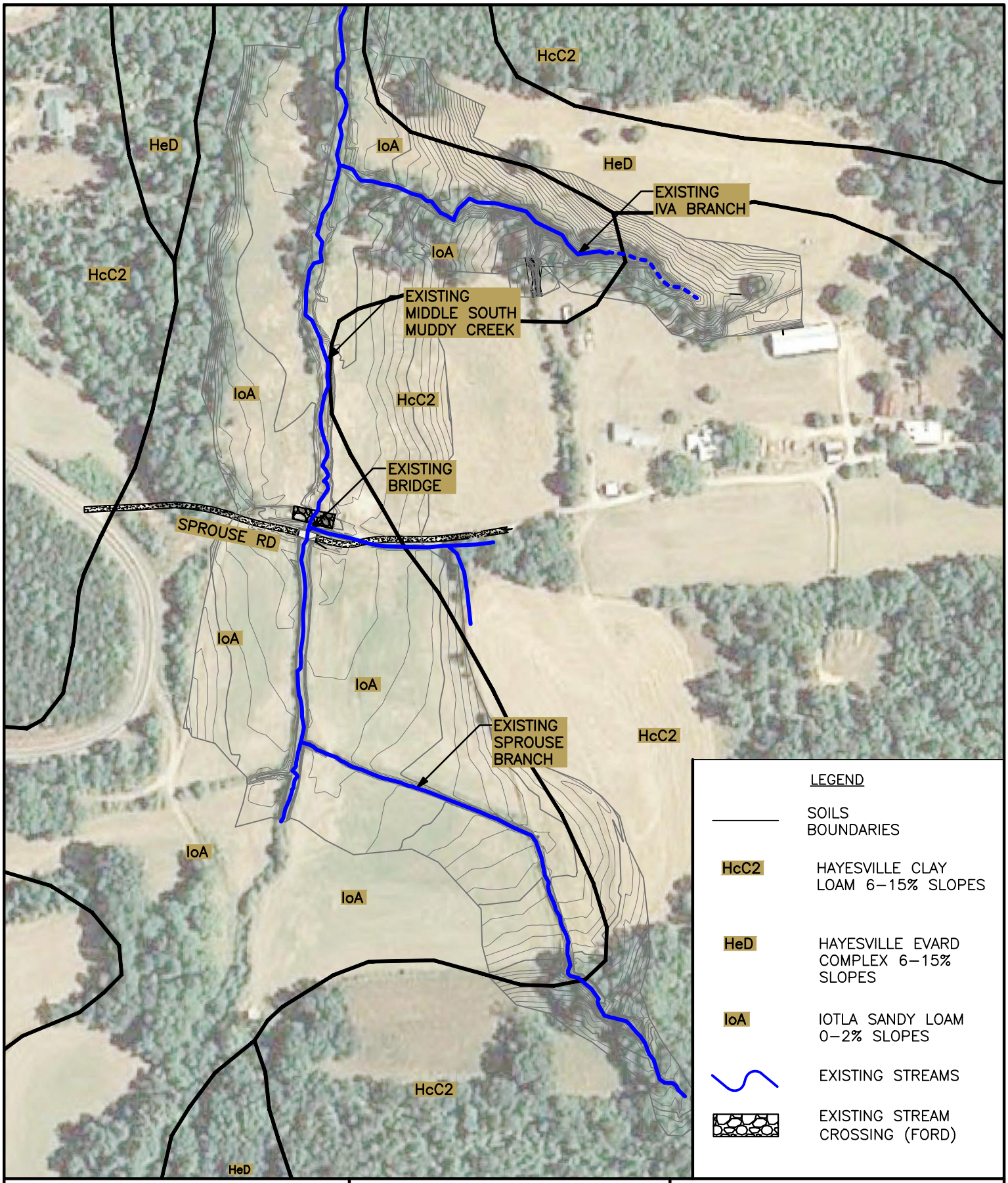
0.5 0 0.5 1.5

MILES

WATERSHED MAP

MIDDLE S. MUDDY CREEK RESTORATION SITE
MCDOWELL COUNTY, NORTH CAROLINA

FIGURE 2



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PREPARED BY: Wolf Creek Engineering

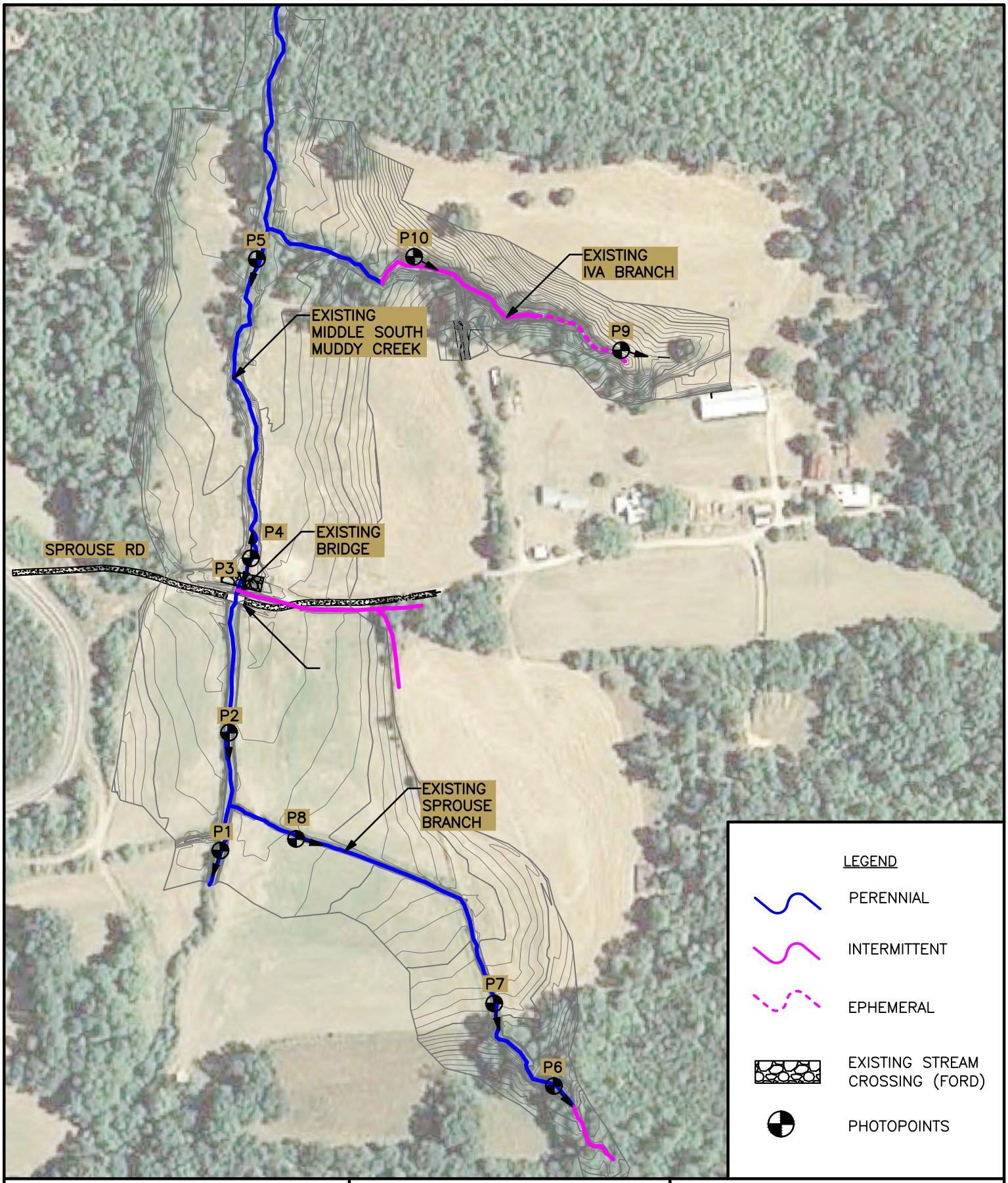
200 0 200 600

SCALE IN FEET

SOILS MAP

MIDDLE S. MUDDY CREEK RESTORATION SITE
MCDOWELL COUNTY, NORTH CAROLINA

FIGURE 3



PREPARED FOR:

PREPARED BY:

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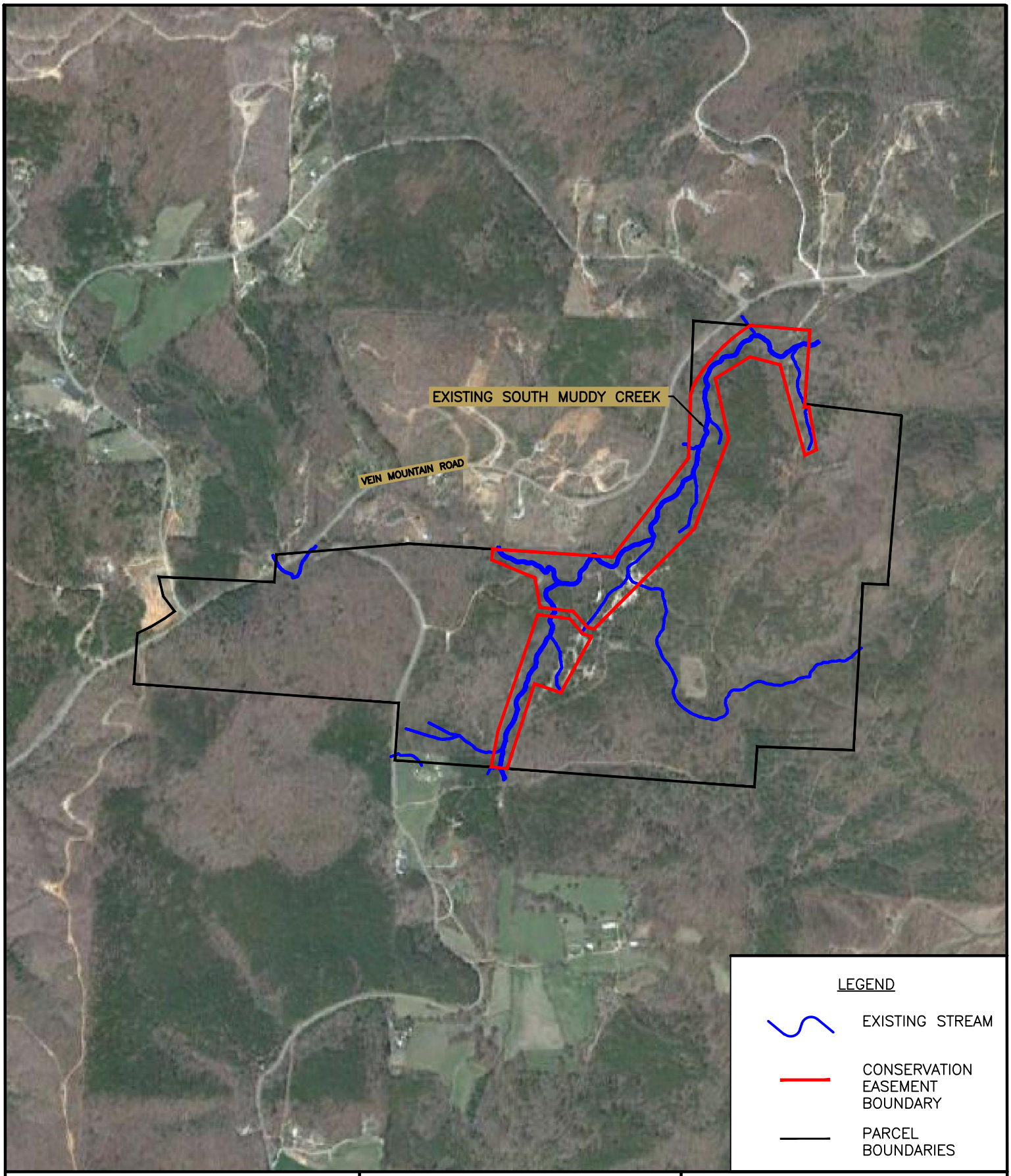
SCALE IN FEET

EXISTING HYDROLOGIC FEATURES MAP

MIDDLE S. MUDDY CREEK RESTORATION SITE
MCDOWELL COUNTY, NORTH CAROLINA

FIGURE 4



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Wolf Creek Engineering

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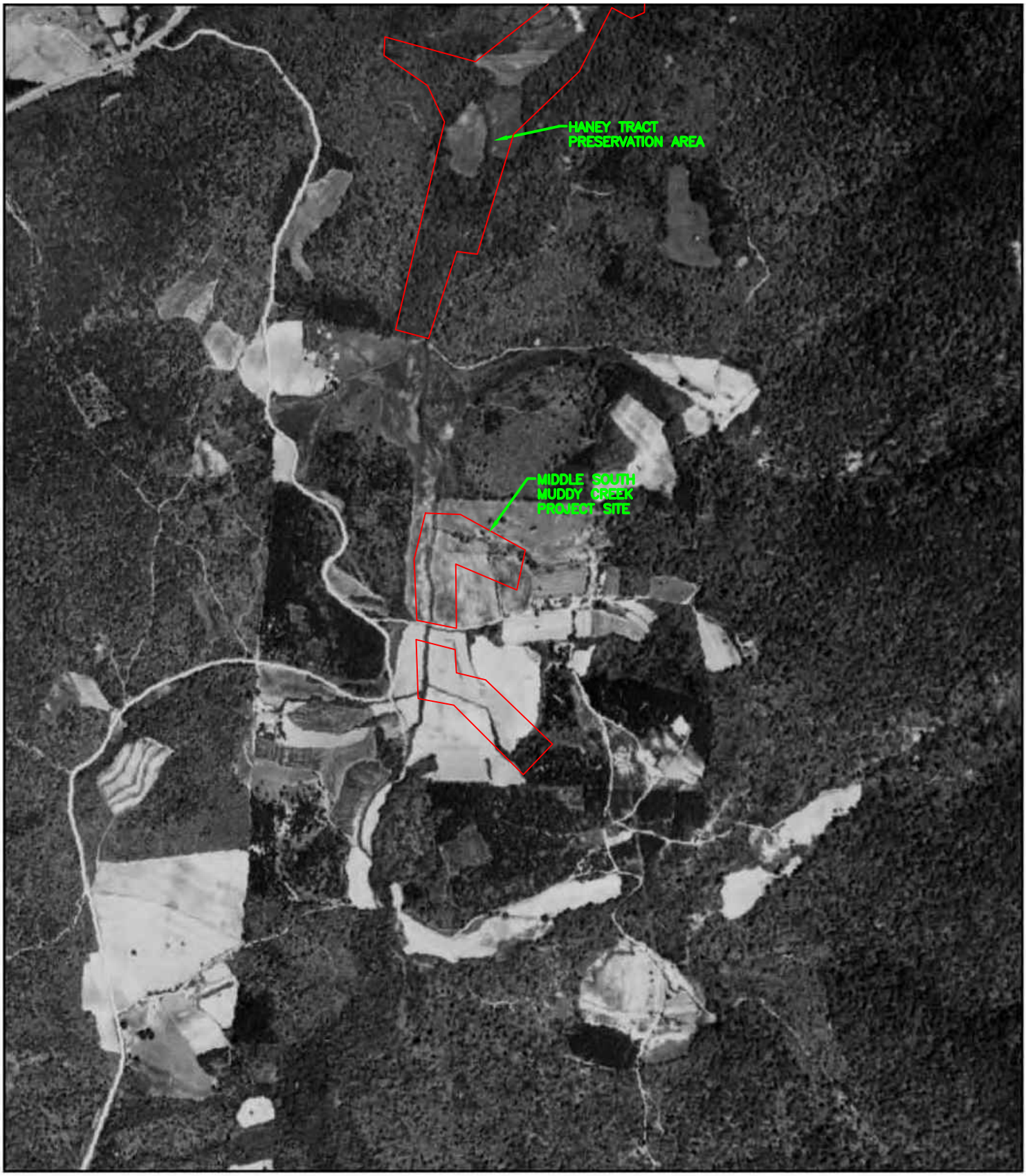
SCALE IN FEET

EXISTING HYDROLOGIC FEATURES MAP

HANEY PRESERVATION SITE
MCDOWELL COUNTY, NORTH CAROLINA

FIGURE 5



Historical Aerial Photo
1954

827 BRACKETT TOWN ROAD
NEBO, NC 28761

Target Site: 35.564 -81.922; Job Number: 827 BRACKETT TOWN RD

N
W E
S

1 inch equals 750 feet

Photo No. 1

South Muddy Creek facing upstream @ Sta 100+50 3/21/11

Photo No. 2

South Muddy Creek facing downstream @ Sta 102+50 3/21/11

Photo No. 3

Downstream of Bridge on South Muddy Creek @ Sta 105+25 facing upstream 2/18/11

Photo No. 4

Livestock Access - Eroding 3.5’ banks on SMC @ Sta 105+25 downstream 2/18/11

Photo No. 5

Mature trees on SMC at Sta 110+50 facing upstream 3/21/11

Photo No. 6

Sprouse Branch spring @ Sta 200-50 facing upstream 2/18/11

Photo No. 7

Sprouse Branch transition from woods to ag ditch @ Sta 201+00 facing upstream 2/18/11

Photo No. 8

Sprouse Branch agricultural ditch @ Sta 206+00 facing upstream 2/18/11

Photo No. 9

Draw forming Iva Branch @ Sta 300+00 facing upstream 2/18/11

Photo No. 10

High banks and erosion on Iva Branch @ Sta 303+75 facing upstream 2/18/11

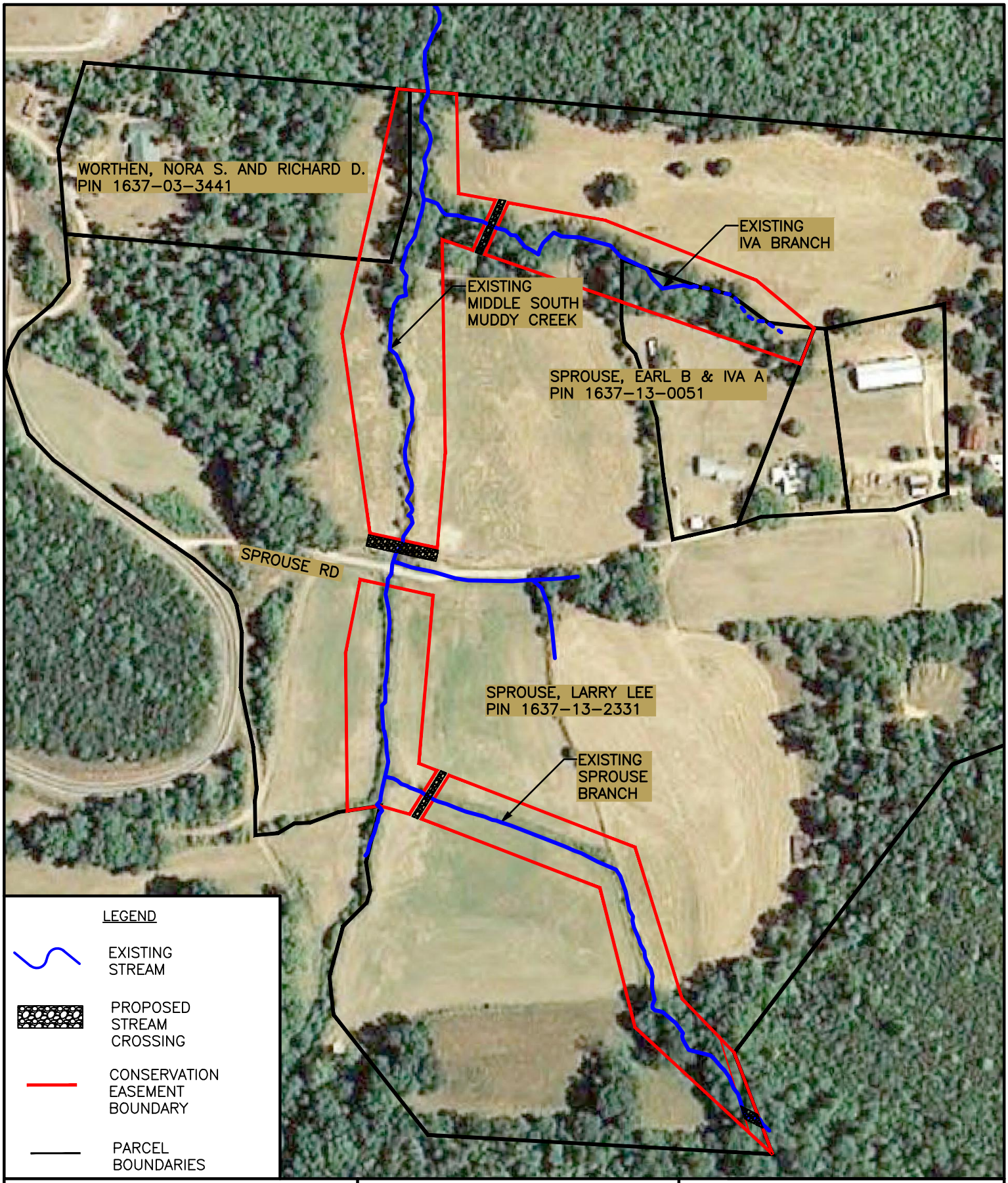
3.0 SITE PROTECTION INSTRUMENT

The land required for the construction, management, and stewardship of this mitigation project includes portions of the following parcels. A copy of the land protection instrument(s) is included in the appendices.

	Landowner	PIN	County	Site Protection Instrument	Deed Book and Page Number	Acreage protected
Parcel A	Larry Lee Sprouse	1637-13-2331	McDowell	Easement (Pending)		
Parcel B	Nora & Richard Worthen	1637-03-3441	McDowell	Easement (Pending)		
Parcel C	Earl & Iva Sprouse	1637-13-3051	McDowell	Easement (Pending)		
Parcel D	Demming Company (James Haney)	1637-25-3891	McDowell	Easement	DB:772 PG: 600	35.19 ac

When available, the recorded document(s) will be provided. If the recorded document(s) are not available, the template documents will be provided.

All site protection instruments require 60-day advance notification to the Corps and the State prior to any action to void, amend, or modify the document. No such action shall take place unless approved by the State.



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PREPARED BY: Wolf Creek Engineering

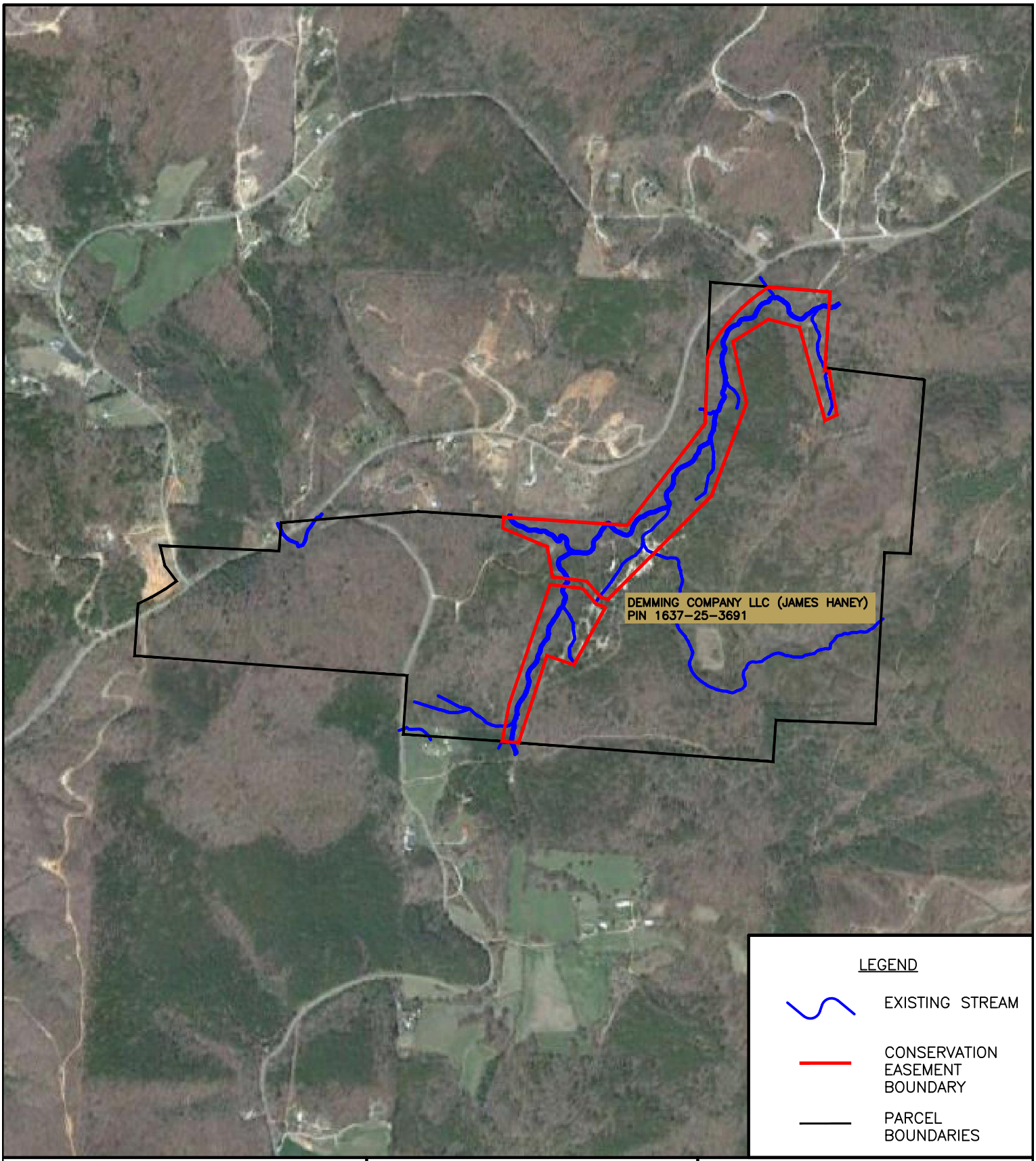
100 0 100 300

SCALE IN FEET

CONSERVATION EASEMENT BOUNDARY

MIDDLE S. MUDDY CREEK RESTORATION SITE
MCDOWELL COUNTY, NORTH CAROLINA

FIGURE 7



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Ecosystem Enhancement Program

PREPARED BY:

Wolf Creek Engineering

200 0 200 600

SCALE IN FEET

CONSERVATION EASEMENT BOUNDARY

HANEY PRESERVATION SITE
MCDOWELL COUNTY, NORTH CAROLINA

FIGURE 8

4.0 BASELINE INFORMATION

Project Information			
Project Name	Middle South Muddy Creek		
County	McDowell		
Project Area (acres)	5.87		
Project Coordinates (latitude and longitude)	35.5635° N , 81.9249° W		
Project Watershed Summary Information			
Physiographic Province	Blue Ridge		
River Basin	Catawba River		
USGS Hydrologic Unit 8-digit	03050101	USGS Hydrologic Unit 14-digit	03050101040020
DWQ Sub-basin	03-08-30		
Project Drainage Area (acres)	2,893		
Project Drainage Area Percentage of Impervious Area	> 1%		
CGIA Land Use Classification	2.03.01.01		

Reach Summary Information			
Parameters	**South Muddy Creek**	**Iva Branch**	**Sprouse Branch**
Length of reach (linear feet)	1108	471	622
Valley classification (Rosgen)	Valley Type VIIIb	Valley Type II	Valley Type II
Drainage area (acres)	3,002	27	29
NCDWQ stream identification score	44	31	34
NCDWQ Water Quality Classification	C	C	C
Morphological Description (stream type) (Rosgen)	G4	G5	G5
Evolutionary trend (Rosgen)	F4	G5	G5
Underlying mapped soils	Iotla, Hayesville Clay	Iotla, Hayesville Clay	Iotla, Hayesville Clay
Drainage class	Poorly drained	Poorly drained	Poorly drained
Soil Hydric status	Non-hydric	Non-hydric	Non-hydric
Slope	0.4%	4.6 %	2.2 %
FEMA classification	Limited Detail	N/A	N/A
Native vegetation community	Agricultural	Agricultural	Agricultural
Percent composition of exotic invasive vegetation	<5%	15%	<5%

Wetland Summary Information			
Parameters	**Wetland 1**	**Wetland 2**	**Wetland 3**
Size of Wetland (acres)	-	-	-
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	-	-	-
Mapped Soil Series	-	-	-
Drainage class	-	-	-
Soil Hydric Status	-	-	-
Source of Hydrology	-	-	-
Hydrologic Impairment	-	-	-
Native vegetation community	-	-	-
Percent composition of exotic invasive vegetation	-	-	-

Regulatory Considerations			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	To Be Permitted	
Waters of the United States – Section 401	Yes	To Be Permitted	
Endangered Species Act	No	N/A	ERTR
Historic Preservation Act	No	N/A	ERTR
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	
FEMA Floodplain Compliance	Yes	Pending CLOMR Submittal	
Essential Fisheries Habitat	No	N/A	

5.0 DETERMINATION OF CREDITS

Mitigation credits presented in these tables are projections based upon site design. Upon completion of site construction the project components and credits data will be revised to be consistent with the as-built condition.

Middle South Muddy Creek, McDowell
EEP Project No: 93875

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	**2114**	**1167**							

Project Components

Project Component -or- Reach ID	Stationing/Location	Existing Footage/Acreage	Approach (PI, PII etc.)	Restoration -or- Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
South Muddy Creek	**101+00 – 112+61**	**931**	**PII**	**R**	**916**	**1:1**
Lower South Muddy Creek	**110+91 – 112+61**	**177**	**EI**	**R**	**171**	**1.5:1**
Upper Sprouse Branch	**201+50 – 201+74**	**24**	**EII**	**R**	**24**	**2.5:1**
Middle and Lower Sprouse Branch	**201+74– 208+04**	**598**	**PII**	**R**	**611**	**1:1**
Iva Branch	**302+14 – 306+96**	**471**	**PI**	**R**	**463**	**1:1**
Haney Tract		**5836**	**Preservation**	**RE**	**5836**	**5:1**

Component Summation

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1990					
Enhancement						
Enhancement I	171					
Enhancement II	24					
Creation						
Preservation	5836					
High Quality Preservation						

BMP Elements

Element	Location	Purpose/Function	Notes
FB	Entire Site	Protect Stream Channel	

BMP Elements
BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed Swale; LS = Level Spreader; NI = Natural Infiltration Area; FB = Forested Buffer

6.0 Credit Release Schedule

All credit releases will be based on the total credit generated as reported by the as-built survey of the mitigation site. Under no circumstances shall any mitigation project be debited until the necessary DA authorization has been received for its construction or the District Engineer (DE) has otherwise provided written approval for the project in the case where no DA authorization is required for construction of the mitigation project. The DE, in consultation with the Interagency Review Team (IRT), will determine if performance standards have been satisfied sufficiently to meet the requirements of the release schedules below. In cases where some performance standards have not been met, credits may still be released depending on the specifics of the case. Monitoring may be required to restart or be extended, depending on the extent to which the site fails to meet the specified performance standard. The release of project credits will be subject to the criteria described as follows:

Forested Wetlands Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Released**
0	Initial Allocation – see requirements above	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50%
3	Third year monitoring report demonstrates performance standards are being met	10%	60%
4	Fourth year monitoring report demonstrates performance standards are being met	10%	70%
5	Fifth year monitoring report demonstrates performance standards are being met; Provided that all performance standards are met, the IRT may allow the NCEEP to discontinue hydrologic monitoring after the fifth year, but vegetation monitoring must continue for an additional two years after the fifth year for a total of seven years.	10%	80%
6	Sixth year monitoring report demonstrates performance standards are being met	10%	90%
7	Seventh year monitoring report demonstrates performance standards are being met, and project has received close-out approval	10%	100%

Non-forested Wetlands Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Released**
0	Initial Allocation – see requirements above	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	15%	55%
3	Third year monitoring report demonstrates performance standards are being met	20%	75%
4	Fourth year monitoring report demonstrates performance standards are being met	10%	85%
5	Fifth year monitoring report demonstrates performance standards are being met and project has received closeout approval	15%	100%

Stream Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Released**
0	Initial Allocation – see requirements above	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50% (65%*)
3	Third year monitoring report demonstrates performance standards are being met	10%	60% (75%*)
4	Fourth year monitoring report demonstrates performance standards are being met	10%	70% (85%*)
5	Fifth year monitoring report demonstrates performance standards are being met and project has received closeout approval	15%	100%

6.1 Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the NCEEP without prior written approval of the DE upon satisfactory completion of the following activities:

a. Approval of the final Mitigation Plan
b. Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property
c. Completion of project construction (the initial physical and biological improvements to the mitigation site) pursuant to the mitigation plan; Per the NCEEP Instrument, construction means that a mitigation site has been constructed in its entirety, to include planting, and an as-built report has been produced. As-built reports must be sealed by an engineer prior to project closeout, if appropriate but not prior to the initial allocation of released credits.
d. Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

6.2 Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the IRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 15% of a site's total stream credits shall be released after two bank-full events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than two bank-full events occur during the monitoring period, release of these reserve credits shall be at the discretion of the IRT. As projects approach milestones associated with credit release, the NCEEP will submit a request for credit release to the DE along with documentation substantiating achievement of criteria required for release to occur. This documentation will be included with the annual monitoring report.

7.0 MITIGATION WORK PLAN

7.1 Description of Target Stream and Vegetation Communities

Reference reaches were sought to provide a target for design of the proposed streams. Searches were conducted first upstream and downstream of the Site and then into surrounding watersheds to find suitable references that contained comparable slope, bed material, and valley type. A Type C4 reference was located on Toms Creek, a tributary of the Catawba River in McDowell County and a Type B4 reference was located on Cold Springs Creek, a tributary to the Pigeon River in Haywood County. The reference vegetation community data were collected at the Toms Creek reference site.

7.1.1 Reference Reach

The reference reaches were selected to represent the probable configurations for the proposed stream restoration. Detailed geomorphic survey and Level II Rosgen classification were conducted on each reference reach (See Appendix C).

Toms Creek Reference

The Toms Creek reference reach is located in the Blue Ridge hydrophysiographic region of North Carolina. The watershed for Toms Creek reference is similar to the character of the South Muddy Creek watershed including average annual rainfall, elevation changes, and valley type. The reference watershed is located northwest of the project site within Pisgah National Forest and is predominantly forested. The drainage area for the Toms Creek reference is 3.33 mi^2.

The Toms Creek reach is representative of a C4 channel in a moderately sloped valley. Bed material, channel slope, and valley form of this stream are consistent with the Site and provide reasonable analogues for the potential channel forms that can be expected at the Site. The Toms Creek reference reach has a D_{50} of 31mm, D_{84} of 71mm, channel slope of 0.93 % and width/depth ratio of 15.

Cold Springs Reference

The Cold Springs Creek reference reach is located in the Blue Ridge hydrophysiographic region of North Carolina. The watershed is similar in many ways to the character of the Site watershed including average annual rainfall, elevation changes, and valley type. However, the two tributaries on the project site are sand bed streams with moderate gradient valleys (2%-5%) and a similar stream in reference condition was not identified. The Cold Springs Creek reference represents a stable stream type with a gravel bed in a similar valley type and slope. The reference watershed is rural and consists predominantly of forest stands with some grassy fields although there are no livestock on the adjacent land. The drainage area for the Cold Springs Creek reference is 2.77 mi^2.

The Cold Springs reach is representative of a B4 channel in a moderately sloped valley with a narrow, constrained floodplain. Channel slope, and valley form of this stream are consistent with the project site and provide reasonable analogues for the potential channel forms that can be expected at the Site. The Cold Springs reference reach has a D_{50} of 45mm, D_{84} of 130mm, channel slope of 0.024 ft/ft, and width/depth ratio of 16.

Discharge and Bankfull Verification

Bankfull was readily identified on the reference streams as they exhibited consistent indicators throughout the reach. Verification of bankfull was accomplished by plotting the bankfull cross sectional area against the regional curve data. The graph indicates that the bankfull identified in the surveyed reach is consistent with the regional curve data.

After verification of bankfull cross sectional area, bankfull discharge was calculated for the surveyed reach using a single-section analysis. Manning's 'n' was estimated from relative roughness calculations of the bed material and from observation of the channel flow conditions. Water surface slope was assumed to be consistent with the slope of the bed profile. Discharge was then plotted against a graph of the regional curve data. The graphing of this data indicated that the calculated bankfull discharges were consistent with the regional curve data.

Channel Stability Assessment

A detailed channel stability assessment was not performed for these reaches since the bank and bed stability were obvious from observation. Subsequent review of the surveyed dimensions confirmed that width-depth ratios and bank height ratios were within the appropriate range for stable, self-maintaining streams. Additional observations included significant upstream and downstream reconnaissance to identify any past, present, or future signs or sources of degradation.

Limited Reach Reference

Through the course of conducting the reference reach searches, several streams were identified as possessing qualities of stability and natural form. However, these reaches were determined not to be suitable references for the project due to either incompatible stream type, valley form, or insufficient reach length. In these locations morphological measurements were taken to supplement the data acquired from the reference reach sites. Measurements on eight (8) individual reaches included bankfull width, bed width, depth of bankfull, toe depth, and width of thalweg. A graph of this data is included in Appendix C.

7.1.2 Reference Vegetation Community

The plant community survey was performed at Toms Creek on July 6, 2011. The riparian plant community most closely resembles a *Montane Alluvial Forest* as described by Schafale and Weakley (1990). Canopy species observed included Sycamore (*Platanus occidentalis*), Green Ash (*Fraxinus pennsylvanica*), American Beech (*Fagus grandifolia*), River Birch (*Betula nigra*), White Oak (*Quercus alba*), Black Oak (*Quercus velutina*), Red Maple (*Acer rubrum*), and Tulip Poplar (*Liriodendron tulipifera*). Subcanopy species included Spicebush (*Lindera benzoin*), American holly (*Ilex opaca*), iron wood (*Carpinus caroliniana*), and witch hazel (*Hamamelis virginiana*). Herbaceous species included Christmas Fern (*Polystichum acrostichoides*), Dog Hobble (*Leucothoe fontanesiana*), New York Fern (*Thelyptris novaboracensis*), Virginia Creeper (*Parthenocissus quinquefolia*), and Yellowroot (*Xanthorhiza* simplicissima).

7.2 Narrative of Design Parameters

South Muddy Creek

South Muddy Creek will be designed as a Type C4 stream with moderate sinuosity. Priority II Restoration will be implemented with the intent being to create a stable channel with a floodplain capable of conveying storm flows and routing the moderately high sediment loads supplied by the watershed. The presence of an existing bridge in the middle of project requires that the floodplain bench be transitioned at the approach and exiting of the channel. Generally, the channel appears to be vertically stable; therefore, only minor adjustment will be made to the profile which will include re-establishment of proper riffle-pool sequence and installation of in-stream log and brush structures. Reference data will provide the basis for pattern and dimension adjustments, and a new floodplain bench will be excavated below the existing terrace. Existing topsoil will be salvaged for use on the floodplain bench to facilitate vegetation success.

Sprouse Branch

The upper reach of Sprouse Branch has a mature forested canopy and channel instabilities are minor. Enhancement (EII) is proposed for this reach. It is anticipated that the exclusion of livestock from the area will greatly reduce erosion and instability within this reach. Enhancement efforts will include the installation of a grade control at the spring head to prevent further headcut migration. Supplemental plantings will be used to treat existing bare banks. Enhancement activities will be minimally invasive to provide for the protection of mature riparian buffer.

Middle Sprouse Branch and Lower Sprouse Branch are designed as Type B5 and Type B5c channels, respectively. As Sprouse Branch exits the upper forested reach and flows into the pasture, the moderately high gradient (3%) warrants the installation of rock grade-control structures to stabilize the vertical profile. As Sprouse Branch intersects the valley of South Muddy Creek, the gradient decreases (1.8%), resulting in a transition to a Type B5c stream. In both cases, construction of a stream profile that is consistent with the valley gradient would be unstable for the sand bed material supplied by the watershed. In order to accommodate the steeper valley gradient a terraced profile is proposed with intermediate slopes of less than 0.2%. Dimension adjustments will include an increase in width/depth

ratio to reduce the stress on channel banks, and the excavation of a floodplain bench to provide for the conveyance of flood flows. Existing topsoil will be salvaged for use on the floodplain bench to facilitate vegetation success.

Iva Branch
Upper Iva Branch is a candidate for Priority I Restoration which will involve filling the existing incised valley to raise the channel as much as eight (8) feet. Material from the excavation of South Muddy Creek will be used to fill the valley and the woody material in the gully will be salvaged for use throughout the rest of the project. The fill material will be placed in no greater than 2-ft lifts and compacted to in situ soil densities. The constructed channel will be designed as a Type B5 stream and will be vertically stabilized through the installation of rock structures.

The short reach comprising Lower Iva Branch traverses the South Muddy Creek Valley and is designed as a Type B5c channel. Profile, pattern, and dimension shall be adjusted to provide for proper pool spacing, riffle-pool sequence, and reductions of stress along stream banks. A bankfull bench shall be constructed to provide for proper conveyance of greater-than-bankfull flows. Log and rock structures will be installed to control vertical alignment and provide aquatic habitat. In order to accommodate the steeper gradient of the valley, a terraced profile is proposed with intermediate slopes of less than 0.2%.

Vegetation
In order to address potential poor soil conditions on the graded bench and floodplain, EEP may plant a mixture of leguminous and grassy cover crop species to add organic matter and fix nitrogen in the soil. Cover crops will be disked into the soil after construction to incorporate the biomass and attempt to avoid dominance of the site by these species. In addition, a combination of containerized woody plants and tolerant bare roots will be planted in these sensitive areas.

Haney Tract
The Haney Tract will be established as a preservation site to protect and buffer the existing stream. The network of dirt roads that occur throughout this tract will be barricaded in strategic locations to prevent future vehicular access. The barricades will be constructed of boulders and large diameter tree trunks.

7.3 Narrative of Data Analysis

Hydraulic Analysis

The proposed channel sections were evaluated for their ability to convey the bankfull flows and the flood flows (2Yr, 10Yr, 50Yr, 100Yr) of the watershed by performing a hydraulic analysis. Bankfull discharge was determined from the revised North Carolina mountain and piedmont regional curve (NRCS) and flood flow discharges were taken from the existing FEMA model. The analysis consisted of first modeling the existing conditions with the HEC-RAS water surface profile model. Cross sections were taken through the channel and the adjacent valley at representative locations throughout the project reach. Existing hydraulic conditions were evaluated and the model calibrated based on available site data including the presence of rack lines and testimony of past flooding from local residences. Proposed conditions were analyzed by revising the existing sections based on the proposed channel geometry and by revising the model to reflect proposed pattern conditions and anticipated future roughness coefficients. Comparison of the existing and proposed HEC-RAS models provided assistance in the analysis of the sediment transport, bankfull flow capacity, and confirmation that there will be no hydraulic trespass onto adjacent properties.

FEMA Results
South Muddy Creek is a limited detail study stream. The HEC-RAS model of the 100-yr event indicates no appreciable increase in the water surface elevation within or upstream of the project. However, there is a 0.1’ rise in one section upstream of the site and there is a significant decrease in the water surface elevation upstream of the bridge that may require a CLOMR submittal. This determination will be subject to review of the floodplain manager.

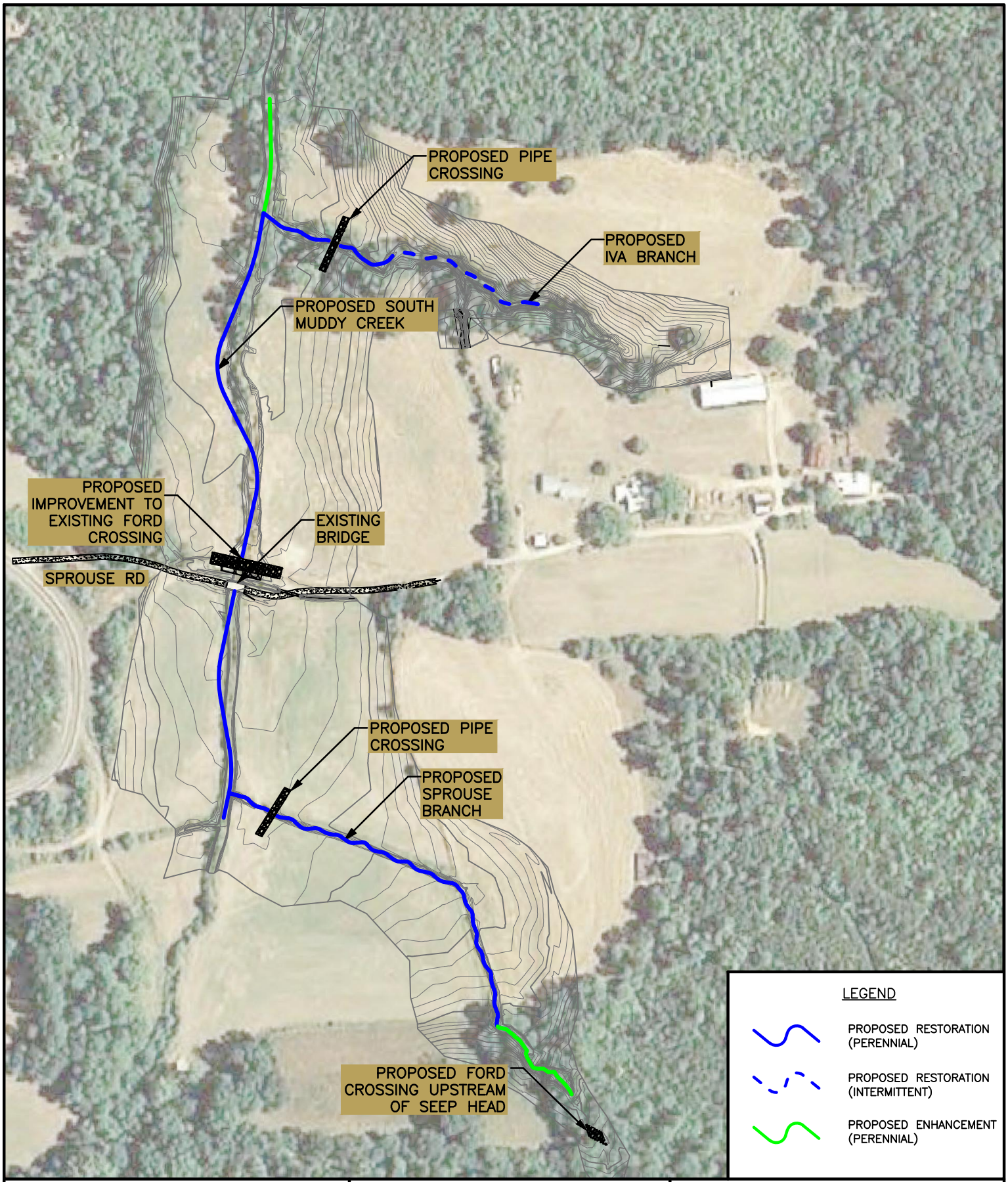
Sediment Competence Analysis
The design sections were evaluated for competence to transport the sediment supplied by the watershed. Critical shear stress was calculated for bankfull discharge for each design section and related to particle

sizes expected to be mobilized. These predicted particle sizes were compared to the caliber of the bed material found in the existing channels. The material composing the bed of existing South Muddy Creek consists of particles with a D_{50} of 19 mm and a D_{max} of 57 mm. The proposed channel was designed by calculating threshold conveyance for the maximum mobile particle and the representative particle size. Bed material in existing Sprouse and Iva Branch is composed of primarily of sand and silt particles and shear stress calculations suggest that profile slopes less than 0.2 % are required for bed stability (See Appendix C for sediment transport calculations).

Sediment Capacity Evaluation

The design configuration was evaluated for sediment transport capacity by assessing continuity and magnitude of stream power. Stream power was determined from the HEC-RAS modeling for a range of events greater than bankfull (2Yr, 10Yr, 50Yr, 100Yr) and comparisons were made with existing and proposed conditions. Results indicate that maintaining stream power values above 1.0 are necessary to provide for capacity continuity and to accommodate the moderately high bed loads of the channel. The model indicates that a spike in stream power will result at the upstream end (section 64854.66) from the construction of the restored channel. The risk of adverse effects will be greatest in the first two years following construction with risk diminishing as vegetation on the banks increase channel roughness. Several channel configurations were evaluated in an attempt to reduce this effect. However, none demonstrated a significant advantage over the design section. Additionally, flood plain pipes were evaluated to improve floodplain performance. The model results indicated that floodplain pipes will have only a marginal effect and may in some instances negatively influence sediment conveyance. Given these results along with the cost of installation and presence of timber retaining walls on the bridge approach; floodplain pipes are not recommended on this site.

Sediment capacity calculations were not performed on Iva Branch or Sprouse Branch since both streams have low sediment supply. Stability issues associated with sediment transport on low sediment supply streams are focused on providing the correct balance with respect to sediment transport competence.



PREPARED FOR: Ecosystem Enhancement Program

PREPARED BY: Wolf Creek Engineering

200 0 200 600

SCALE IN FEET

PROPOSED HYDROLOGIC FEATURES MAP

MIDDLE S. MUDDY CREEK RESTORATION SITE
MCDOWELL COUNTY, NORTH CAROLINA

FIGURE 9

8.0 MAINTENANCE PLAN

NCEEP shall monitor the site on a regular basis and shall conduct a physical inspection of the site a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include the following:

Component/Feature	**Maintenance through project close-out**
Stream	Routine channel maintenance and repair activities may include chinking of in-stream structures to prevent piping, securing of loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel. Areas where stormwater and floodplain flows intercept the channel may also require maintenance to prevent bank failures and head-cutting.
Wetland	Routine wetland maintenance and repair activities may include securing of loose coir matting and supplemental installations of live stakes and other target vegetation within the wetland. Areas where stormwater and floodplain flows intercept the wetland may also require maintenance to prevent scour.
Vegetation	Vegetation shall be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Exotic invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, tree-blazing, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.
Utility Right-of-Way	Utility rights-of-way within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Ford Crossing	Ford crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Road Crossing	Road crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Stormwater Management Device	Storm water management devices will be monitored and maintained per the protocols and procedures defined by the NC Division of Water Quality Storm Water Best Management Practices Manual.

9.0 PERFORMANCE STANDARDS

9.1 Morphologic Parameters and Channel Stability

Restored and enhanced streams should demonstrate morphologic stability to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that is also to be expected. If some trend is evident, it should be very modest or indicate migration to another stable form.

Dimension

Cross-section measurements should indicate little change from the as-built cross-sections. If changes do occur, they will be evaluated to determine whether the adjustments are associated with increased stability or whether they indicate movement towards an unstable condition.

Pattern and Profile

Measurements and calculated values should indicate stability with little deviation from as-built conditions and established morphological ranges for the restored stream type. Annual measurements should indicate stable bed-form features with little change from the as-built survey. The pools should maintain their depth with flatter water surface slopes, while the riffles should remain shallower and steeper.

Substrate

Calculated D_{50} and D_{84} values should indicate coarser size class distribution of bed materials in riffles and finer size class distribution in pools. Generally, it is anticipated that the bed material will coarsen over time.

Sediment Transport

Depositional features should be consistent with a stable stream that is effectively managing its sediment load. Point bar and inner berm features, if present, should develop without excessive encroachment of the channel. Lateral and mid-channel bar features should typically not be present and if so only in isolated instances. Bar features may be more prevalent in sand bed channels but should be transient in nature and should occupy no more than 20% of the cross sectional area.

9.2 Vegetation

Riparian vegetation monitoring shall be conducted for a minimum of five years to ensure that success criteria are met per USACE guidelines. Accordingly, success criteria will consist of a minimum survival of 320 stems per acre by the end of the Year 3 monitoring period and a minimum of 260 stems per acre at the end of Year 5. If monitoring indicates either that the specified survival rate is not being met or the development of detrimental conditions (i.e., invasive species, diseased vegetation), appropriate corrective actions will be developed and implemented.

10.0 MONITORING REQUIREMENTS

Annual monitoring data will be reported using the EEP monitoring template. The monitoring report shall provide a project data chronology that will facilitate an understanding of project status and trends, population of EEP databases for analysis, research purposes, and assist in decision making regarding project close-out.

Required	Parameter	Quantity	Frequency	Notes
NO	Pattern			
YES	Dimension	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	
YES	Profile	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	
YES	Substrate	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	
YES	Surface Water Hydrology	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	A Crest Gauge will be installed on site; the device will be inspected on a semi-annual basis to document the occurrence of bankfull events on the project
NO	Groundwater Hydrology	Quantity and location of gauges will be determined in consultation with EEP	annual	Groundwater monitoring gauges with data recording devices will be installed on site; the data will be downloaded on a monthly basis during the growing season
YES	Vegetation	Quantity and location of vegetation plots will be determined in consultation with EEP	annual	Vegetation will be monitored using the Carolina Vegetation Survey (CVS) protocols
YES	Exotic and nuisance vegetation		annual	Locations of exotic and nuisance vegetation will be mapped
YES	Project boundary		Semi-annual	Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped

11.0 LONG-TERM MANAGEMENT PLAN

Upon approval for close-out by the Interagency Review Team (IRT) the site will be transferred to NCDENR or other IRT-approved stewardship entity. This party shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

The NCDENR Division of Natural Resource Planning and Conservation's Stewardship Program currently houses EEP stewardship endowments within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by North Carolina General Statute GS 113A-232(d)(3). Interest gained by the endowment fund may be used only for the purpose of stewardship, monitoring, stewardship administration, and land transaction costs, if applicable. The NCDENR Stewardship Program intends to manage the account as a non-wasting endowment. Only interest generated from the endowment funds will be used to steward the compensatory mitigation sites. Interest funds not used for those purposes will be re-invested in the Endowment Account to offset losses due to inflation.

12.0 ADAPTIVE MANAGEMENT PLAN

Upon completion of site construction EEP will implement the post-construction monitoring protocols previously defined in this document. Project maintenance will be performed as described previously in this document. If, during the course of annual monitoring it is determined the site's ability to achieve site performance standards are jeopardized, EEP will notify the USACE of the need to develop a Plan of Corrective Action. The Plan of Corrective Action may be prepared using in-house technical staff or may require engineering and consulting services. Once the Corrective Action Plan is prepared and finalized EEP will:

1. Notify the USACE as required by the Nationwide 27 permit general conditions.
2. Revise performance standards, maintenance requirements, and monitoring requirements as necessary and/or required by the USACE.
3. Obtain other permits as necessary.
4. Implement the Corrective Action Plan.
5. Provide the USACE a Record Drawing of Corrective Actions. This document shall depict the extent and nature of the work performed.

13.0 FINANCIAL ASSURANCES

Pursuant to Section IV H and Appendix III of the Ecosystem Enhancement Program's In-Lieu Fee Instrument dated July 28, 2010, the North Carolina Department of Environment and Natural Resources has provided the U.S. Army Corps of Engineers Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by EEP. This commitment provides financial assurance for all mitigation projects implemented by the program.

14.0 OTHER INFORMATION

14.1 DEFINITIONS

Morphological description – the stream type; stream type is determined by quantifying channel entrenchment, dimension, pattern, profile, and boundary materials; as described in Rosgen, D. (1996), *Applied River Morphology, 2nd edition*

Native vegetation community – a distinct and reoccurring assemblage of populations of plants, animals, bacteria and fungi naturally associated with each other and their population; as described in Schafale, M.P. and Weakley, A. S. (1990), *Classification of the Natural Communities of North Carolina, Third Approximation*

Project Area - includes all protected lands associated with the mitigation project

14.2 REFERENCES

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Peet, R.K., Wentworth, T.S., and White, P.S. (1998), *A flexible, multipurpose method for recording vegetation composition and structure*. Castanea 63:262-274

Pope, B.F., Tasker, G.D. 1999, Estimating the magnitude and frequency of floods in rural basins of North Carolina. U.S. Geological Survey Water Resources Investigations Report 99-4114. U.S. Geological Survey, Raleigh, NC.

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APPENDIX A
SITE PROTECTION INSTRUMENT(S)

METAL STAKE
6TH CNR
DB: 92 PG: 638

NCGS MONUMENT "GADDY"
NAD 83(NSRS) 2007
N: 706375.16 FEET
E: 1136588.51 FEET
CF: .99983158

N 11°43'08" E
3131.44' (GROUND)
3126.86' (GRID)

KEE GPS CONTROL MONUMENT
N:673939.76'
E:1129860.32'

N 03°50'21" E
926.05'

4" PVC IN CONCRETE

PLANTED STONE
POB DB: 92 PG: 638

(TIE)
(156.42')

N 40°17'56" W
432.38'

(TIE)
(289.41')

I" IR (CC)
N:673610.01'
E:1130139.96'

NORA S WORTHEN & RICHARD D. WORTHEN
PIN: 1637-93-8300
DB: 557 PG: 479

CORNER #	NORTHING	EASTING
1	673568.36	1130635.91
2	673564.36	1130683.52
3	673488.92	1130683.25
4	673411.82	1130672.43
5	673323.85	1130655.41
6	673266.99	1130644.48
7	673277.38	1130570.00
8	673560.39	1130729.94
9	673402.41	1130732.62
10	673391.54	1130791.65
11	673312.47	1130755.39
12	673329.24	1130707.10
13	672989.14	1130711.88
14	672840.05	1130699.10
15	672863.59	1130592.21
16	673180.62	1130548.09
17	673387.80	1130811.94
18	673359.71	1130966.65
19	673264.35	1131206.14
20	673188.19	1131297.14
21	673196.61	1131223.80
22	673242.59	1131165.16
23	673254.17	1131111.68
24	673282.94	1131030.28
25	673298.61	1130992.34
26	673230.49	1130991.49
27	673305.88	1130774.37
28	673131.94	1131275.31
29	672764.67	1130692.65
30	672498.33	1130669.80
31	672487.05	1130698.77
32	672417.65	1130655.03
33	672430.98	1130608.37
34	672423.16	1130556.50
35	672443.16	1130556.29
36	672674.16	1130553.79
37	672790.17	1130576.89
38	672479.69	1130717.77
39	672365.27	1131013.16
40	672125.09	1131087.42
41	672039.04	1131170.43
42	671878.01	1131231.10
43	672080.06	1131012.48
44	672300.73	1130957.25
45	672410.30	1130674.04
46	672062.76	1131147.55
47	671912.23	1131194.06

CONSERVATION EASEMENT ACCESS:

CONSERVATION EASEMENT AREAS TO BE ACCESSED FROM EXISTING ROADS AS SHOWN ON PLAT.

TOTAL CONSERVATION EASEMENT AREA = 5.87 ACRES

THIS PLAT DOES NOT CREATE A SUBDIVISION OF PROPERTY IN MCDOWELL COUNTY. THE PURPOSE OF THIS SURVEY IS TO IDENTIFY THE CONSERVATION EASEMENT AREAS ONLY. NO TRANSFER OF PROPERTY IS TAKING PLACE.

CERTIFICATE OF OWNERSHIP AND DEDICATION:

I HEREBY CERTIFY THAT I AM THE OWNER OF THE PROPERTY AS SHOWN AND DESCRIBED HEREON. I ALSO HEREBY ACCEPT AND ADOPT THIS RECORD PLAT AND CONSERVATION EASEMENT WITH MY FREE CONSENT AND DEDICATED ALL EASEMENTS, RIGHT OF WAYS AND ACCESS ROADS TO PUBLIC AND/OR PRIVATE USE AS NOTED ON SAID PLAT.

LARRY L. SPROUSE DATE

NORA S. WORTHEN DATE

RICHARD D. WORTHEN, JR. DATE

EARL B. SPROUSE DATE

IVA A. SPROUSE DATE

LEGEND:

- CALCULATED POINT (NOT SET)
- EXISTING IRON PIN (3/4" IR UNLESS OTHERWISE STATED)
- CONSERVATION EASEMENT CORNER (#5 REBAR WITH EEP CAP SET)
- NCGS MONUMENT
- UTILITY POLE
- NOT TO SCALE (NTS)
- IP IRON PIPE
- IR IRON ROD
- RRS RAILROAD SPIKE
- CC CONTROL CORNER
- CNR CORNER
- DB: DEED BOOK
- PG: PAGE
- PB: PLAT BOOK
- CMP CORRUGATED METAL PIPE
- SR STATE ROAD
- CNF CORNER NOT FOUND
- PL PROPERTY LINE
- BOUNDARY LINE
- BOUNDARY LINE NOT SURVEYED
- TIE LINE ONLY
- ADJOINING DEED LINES
- RIGHT OF WAY (R/W)
- FENCE LINE
- OW OVERHEAD WIRE
- UNDERGROUND TELEPHONE (APPROX.)
- STREAM
- CONSERVATION EASEMENT AREA
- TEMPORARY CONSTRUCTION EASEMENT
- GRAVEL
- SOIL ROADBED
- NCGS NORTH CAROLINA GEODETIC SURVEY
- N.A.D. NORTH AMERICAN DATUM 1983
- SPC STATE PLANE COORDINATES
- POB POINT OF BEGINNING
- O/S OFFSET

INSET

3/4" IP

S 85°11'58" E (NT5)
(27.78') (20) (72) (46.59') S 85°06'45" E (8)

DONNA KAY ARROWOOD HUDSPETH
PIN: 1637-03-2177
DB: 603 PG: 168

MICHAEL D. ALLISON AND WIFE, BRENDA C. ALLISON
PIN: 1637-03-9959
DB: 199 PG: 617

JONATHON ANDREW FLOWERS & CAROLYN CAVENY BOWMAN
PIN: 1637-13-9927
DB: 965 PG: 21

S 85°11'58" E 991.30'
(497.69')

S 85°06'45" E 1857.68'
(1627.11')

I" IR W/CAP "KEE"
SEE PB: 20 PG: 90

1/2" IR
(183.98')
1/2" IR

NORA S WORTHEN & RICHARD D. WORTHEN JR.
PIN: 1637-03-3441
DB: 618 PG: 732

WELL
DWELLING
SHED

3/4" IR

I" IP

N 82°03'43" W 465.80'

AREA A .46 ACRES

N 12°45'43" E 298.35'

AREA C .79 ACRES

N 70°51'05" W 229.83'

I" IR

AREA D .42 ACRES

EARL B. SPROUSE AND WIFE, IVA, A. SPROUSE
PIN: 1637-13-0051
DB: 385 PG: 406
SECOND PARCEL

EARL B. SPROUSE & IVA, A. SPROUSE
PIN: 1637-13-3051
DB: 385 PG: 406
THIRD PARCEL

S 21°12'46" W 274.46'

ANN SPROUSE REEL
PIN: 1637-12-2944
DB: 695 PG: 482

LARRY L. SPROUSE
PIN: 1637-13-2331
DB: 185 PG: 517

SEE NOTE #10

3/4" IP
0.25' O/S

S 00°41'55" E 340.14'

20' WIDE CROSSING

CONSERVATION ACCESS ROAD (APPROX. LOCATION)

SOUTH MUDDY CREEK

AREA B 1.82 ACRES

N 10°55'26" W 320.08'

WITH CENTER OF DITCH

SHED

DWELLING

CONSERVATION ACCESS ROAD

3/4" IR
0.25' O/S

20 FOOT R/W PER DB: 385 PG: 406

CNF

RRS

BRACKETT TOWN ROAD
(60 FOOT R/W PER DB: 316 PG: 683)
SR 1780

75' CROSSING

AREA E 1.00 ACRES

CONSERVATION ACCESS ROAD (APPROX. LOCATION)

MAVIS F. SPROUSE
PIN: 1627-92-7985
DB: 231 PG: 386

LARRY L. SPROUSE
PIN: 1637-13-2331
DB: 185 PG: 517

N 00°37'09" W 291.01'

5' IP @ 25' O/S

HOYT L. REEL AND WIFE, ANN SPROUSE REEL
PIN: 1637-11-7396
DB: 668 PG: 671

FLOW

S 68°49'37" E 316.77'

AREA F 1.38 ACRES

20' WIDE CROSSING

N 68°51'00" W 303.67'

CEMETERY

S 17°10'57" E 251.60'

N 14°03'04" W 227.48'

LARRY L. SPROUSE AND WIFE, BARBARA G. SPROUSE
PIN: 1637-12-5567
DB: 1009 PG: 345

LEO DONALD BREVARD REVOCABLE TRUST
PIN: 1637-33-1940
DB: 795 PG: 498

CNF

HOYT L. REEL AND WIFE, ANN SPROUSE REEL
PIN: 1637-11-7396
DB: 385 PG: 422

LARRY L. SPROUSE
PIN: 1637-12-3056
DB: 385 PG: 394

0' 100' 200' 300'
ONE INCH=ONE HUNDRED FEET

NC GRID NORTH NAD 83

(32.96')
48" OAK
STREAM CROSSING (WIDTH VARIES)

N 47°15'19" W 291.69'

N 38°08'48" W 242.97'

I" IR
37.52'
O/S

N 86°45'57" W 547.57'

I" IR

AXLE

HOYT L. REEL AND WIFE, ANN SPROUSE REEL
PIN: 1637-11-7396
DB: 385 PG: 422

LINE	BEARING	DISTANCE
L1	S 00°12'30" W	75.44'
L2	S 07°59'11" W	77.85'
L3	S 10°56'55" W	89.61'
L4	S 10°53'17" W	57.89'
L5	N 82°03'43" W	75.19'
L6	S 00°58'15" E	158.00'
L7	S 79°33'38" E	60.02'
L8	S 24°38'10" W	86.98'
L9	N 70°51'04" W	51.12'
L10	S 04°53'52" W	149.63'
L11	N 77°34'40" W	109.45'
L12	N 12°45'41" E	99.21'
L13	S 79°42'36" E	157.25'
L14	S 68°17'15" E	257.77'
L15	S 50°04'39" E	118.66'
L16	N 83°27'10" W	73.82'
L17	N 51°54'08" W	74.52'
L18	N 77°47'05" W	54.72'
L19	N 70°32'04" W	86.33'
L20	N 67°33'36" W	41.05'
L21	S 00°43'03" W	68.12'
L22	N 24°38'10" E	90.12'
L23	S 21°12'55" W	60.34'
L24	N 70°51'05" W	300.44'
L25	S 04°54'11" W	267.32'
L26	S 68°43'33" E	31.09'
L27	S 32°13'24" W	82.03'
L28	N 74°03'17" W	48.52'
L29	S 81°25'33" W	52.45'
L30	N 11°15'34" E	118.29'
L31	S 77°34'40" E	118.53'
L32	S 43°58'15" E	119.56'
L33	S 20°38'30" E	172.08'
L34	N 32°13'24" E	82.02'
L35	N 05°47'25" W	60.71'
L36	N 14°59'01" E	82.27'
L37	N 44°52'56" E	53.06'
L38	N 16°48'33" E	19.57'
L39	N 08°29'18" W	46.05'
L40	N 13°38'56" E	46.28'
L41	N 14°47'04" E	45.79'
L42	S 04°29'46" E	80.94'
L43	N 04°28'36" W	132.71'
L44	N 17°01'27" E	142.23'
L45	S 88°29'32" E	17.88'
L46	N 04°06'40" E	955.35'
L47	S 79°33'42" E	20.63'
L48	S 04°53'39" W	75.65'
L49	S 68°49'29" E	20.38'
L50	S 77°27'37" W	78.06'
L51	S 76°50'49" W	27.81'
L52	N 09°01'30" W	96.77'
L53	N 06°04'50" W	96.95'
L54	N 17°39'38" W	75.88'
L55	N 20°02'46" W	31.56'
L56	N 42°18'36" W	26.51'
L57	N 07°29'54" W	34.30'
L58	N 00°43'03" E	30.16'
L59	N 17°10'18" W	157.55'

MCDOWELL COUNTY, NORTH CAROLINA

I, _____, REVIEW OFFICER FOR MCDOWELL COUNTY, CERTIFY THAT THE MAP OR PLAT TO WHICH THIS CERTIFICATION IS AFFIXED, MEETS ALL STATUTORY REQUIREMENTS FOR RECORDING.

REVIEW OFFICER DATE

CERTIFICATE OF SURVEY AND ACCURACY:

I, PHILLIP B. KEE, CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION (DEED DESCRIPTION RECORDED IN DB: 185, PG: 517, DB: 618, PG: 732, DB: 385, PG: 406,); THAT DASHED LINES INDICATE LINES NOT SURVEYED; THAT THE RATIO OF PRECISION AS CALCULATED DOES NOT EXCEED 1:10,000; AND THAT THIS PLAT WAS PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED.

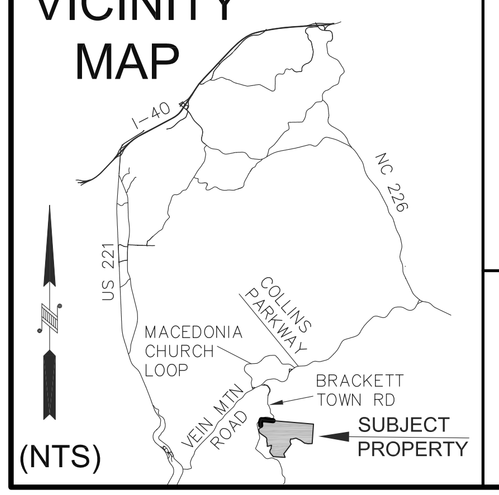
I ALSO HEREBY CERTIFY THAT THIS PLAT IS OF ONE OF THE FOLLOWING: GS 47-30 F(11) D; THAT THE SURVEY IS OF ANOTHER CATEGORY, SUCH AS THE RECOMBINATION OF EXISTING PARCELS, A COURT-ORDERED SURVEY, OR OTHER EXCEPTION TO THE DEFINITION OF SUBDIVISION.

WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 2ND DAY OF FEBRUARY, A.D., 2012.

THIS DOCUMENT IS NOT VALID UNLESS SIGNED AND SEALED

PHILLIP B. KEE, PLS NC-4647

VICINITY MAP



CONSERVATION EASEMENT CORNER (TYPICAL)

REGISTER OF DEEDS STAMP

SURVEYOR'S NOTES:

1. ALL DISTANCES ARE GROUND MEASUREMENTS IN US SURVEY FEET UNLESS OTHERWISE NOTED.
2. AREAS CALCULATED BY THE COORDINATE METHOD.
3. PROPERTY SUBJECT TO ALL EASEMENTS, RIGHT OF WAYS AND RESTRICTIONS THAT ARE RECORDED, UNRECORDED, WRITTEN AND UNWRITTEN.
4. MCDOWELL COUNTY GIS WEBSITE USED TO IDENTIFY ADJOINING PROPERTY OWNERS.
5. THE PROFESSIONAL SURVEYOR HAS MADE NO INVESTIGATION OR INDEPENDENT SEARCH FOR EASEMENTS, RIGHT OF WAYS, ENCUMBRANCES, RESTRICTIVE COVENANTS, CORRECT OWNERSHIP OR ANY OTHER FACTS THAT AN ACCURATE AND CURRENT TITLE SEARCH MAY DISCLOSE. A NC LICENSED ATTORNEY SHOULD BE CONSULTED.
6. GRID COORDINATES AND BEARINGS WERE DERIVED FROM GLOBAL POSITIONING SYSTEM OBSERVATIONS THAT WERE PERFORMED TO THE GEOSPATIAL POSITIONING ACCURACY STANDARDS, PART 2: STANDARDS FOR GEODETIC NETWORKS AT THE 95% CONFIDENCE LEVEL USING GPS L1 STATIC OBSERVATION WITH MAGELLAN PROMARK3 RECEIVERS.
7. INTERIOR ROADBEDS AND TRAILS WERE LOCATED USING HAND HELD GPS UNITS AND THEY DO NOT MEET THE REQUIREMENTS AS SET FORTH IN THE CERTIFICATE OF SURVEY AND ACCURACY.
8. BY GRAPHIC DETERMINATION, A PORTION OF THE SUBJECT PROPERTY APPEARS TO LIE IN A SPECIAL FLOOD HAZARD AREA (ZONE AE) AS DETERMINED BY THE F.E.M.A. MAP # 3710162600J DATED OCTOBER 2, 2008.
9. UTILITIES WERE LOCATED BASED ON VISIBLE ABOVE GROUND STRUCTURES, THEREFORE THE LOCATION OF UNDERGROUND UTILITIES ARE APPROXIMATE OR MAY BE PRESENT AND NOT SHOWN HEREON. CALL 1-800-632-4949 BEFORE DIGGING.
10. BOUNDARY LINES NOT SURVEYED ARE INDICATED AS DASHED LINES AND WERE TAKEN FROM AN UNRECORDED SURVEY FOR THE "J.J. SPROUSE PROPERTY"; PREPARED BY: KENNETH D. SUTTLES; DATED: MARCH 8, 1988; FILE #: 10074.
11. ALL EXISTING FENCES WITHIN THE CONSERVATION EASEMENT AREAS ARE TO BE REMOVED.

FINAL PLAT OF A CONSERVATION EASEMENT SURVEY FOR:

THE STATE OF NORTH CAROLINA, NC DEPARTMENT OF ADMINISTRATION, ECOSYSTEM ENHANCEMENT PROGRAM,

MIDDLE SOUTH MUDDY CREEK

SPO FILE NUMBER: 059-AO, 059-AN, & 059-AT

EEP PROJECT ID: 93875

CURRENT OWNERS LISTED AS:
LARRY L. SPROUSE
NORA S WORTHEN AND HUSBAND RICHARD D. WORTHEN
EARL B. SPROUSE AND WIFE, IVA, A. SPROUSE

PARCEL IDENTIFICATION NUMBER'S:
1637-00-13-2331, 1637-00-03-3441, & 1637-00-13-0051
DEED REFERENCES:
DB: 185 PG: 517, DB: 618 PG: 732, & DB: 385 PG: 406
BRACKETTS TOWNSHIP, MCDOWELL COUNTY, NORTH CAROLINA

SURVEY BY: RIP,RMT,NH,KJ, DRAWN BY: PBK SCALE: 1"=100'
SURVEY DATES: 05/15/11-09/26/11 JOB #110652-SPROUSE

Kee MAPPING & SURVEYING
P.O. Box 2566
Asheville, NC 28802
(828) 645-8275
www.keemap.com
License # C-3039

SURVEYOR'S NOTES:

1. ALL DISTANCES ARE GROUND MEASUREMENTS IN US SURVEY FEET UNLESS OTHERWISE NOTED.
2. AREAS CALCULATED BY THE COORDINATE METHOD.
3. PROPERTY SUBJECT TO ALL EASEMENTS, RIGHT OF WAYS AND RESTRICTIONS THAT ARE RECORDED, UNRECORDED, WRITTEN AND UNWRITTEN.
4. MCDOWELL COUNTY GIS WEBSITE USED TO IDENTIFY ADJOINING PROPERTY OWNERS.
5. THE PROFESSIONAL SURVEYOR HAS MADE NO INVESTIGATION OR INDEPENDENT SEARCH FOR EASEMENTS, RIGHT OF WAYS, ENCUMBRANCES, RESTRICTIVE COVENANTS, CORRECT OWNERSHIP OR ANY OTHER FACTS THAT AN ACCURATE AND CURRENT TITLE SEARCH MAY DISCLOSE. A NC LICENSED ATTORNEY SHOULD BE CONSULTED.
6. BY GRAPHIC DETERMINATION, THE SUBJECT PROPERTY APPEARS TO LIE IN AN AREA THAT IS DETERMINED TO BE INSIDE OF THE 500 YEAR FLOOD PLAIN (ZONE AE) AS DETERMINED BY THE F.E.M.A. MAP#37101162600J DATED OCT 2, 2008.
7. INTERIOR ROADBEDS AND TRAILS WERE LOCATED USING HAND HELD GPS UNITS AND THEY DO NOT MEET THE REQUIREMENTS AS SET FORTH IN THE CERTIFICATE OF SURVEY AND ACCURACY.
8. GRID COORDINATES AND BEARINGS WERE DERIVED FROM GLOBAL POSITIONING SYSTEM OBSERVATIONS THAT WERE PERFORMED TO THE GEOSPATIAL POSITIONING ACCURACY STANDARDS, PART 2: STANDARDS FOR GEODETIC NETWORKS AT THE 95% CONFIDENCE LEVEL USING GPS LT STATIC OBSERVATION WITH MAGELLAN PROMARK3 RECEIVERS.
9. UTILITIES WERE LOCATED BASED ON VISIBLE ABOVE GROUND STRUCTURES, THEREFORE THE LOCATION OF UNDERGROUND UTILITIES ARE APPROXIMATE OR MAY BE PRESENT AND NOT SHOWN HEREON. CALL 1-800-632-4949 BEFORE DIGGING.
10. THE LOCATION OF STREAMS WERE DERIVED FROM GIS SHAPEFILES PROVIDED BY THE ECOSYSTEM ENHANCEMENT PROGRAM FOR INCLUSION ON THIS MAP. KEE MAPPING & SURVEYING, P.A. SHOULD NOT BE HELD RELIABLE FOR THE ACCURACY OR COMPLETENESS OF THIS DATA.
11. ONE INCH IRON PIPE WITH KEE CAP WAS SET IN PLACE OF 6" BLACK GUM, WHICH WAS LOCATED IN A PRIVATE SURVEY BY K.D. SUTTLES DATED MARCH 8TH, 1988. SAID CORNER BEING THE 23RD CORNER DESCRIBED IN TRACT 2 OF DB: 795 PG: 498.

LEGEND:

- CALCULATED POINT (NOT SET)
- EXISTING IRON PIN (3/4" IR UNLESS OTHERWISE STATED)
- SET 1" IRON PIPE W/CAP (SIP)
- #5 REBAR WITH EEP CAP SET
- NCGS MONUMENT
- MARKED PAINTED TREE FOUND
- UTILITY POLE
- NOT TO SCALE (NTS)
- IP IRON PIPE
- IR IRON ROD
- CC CONTROL CORNER
- CNR CORNER
- DB: DEED BOOK
- PG: PAGE
- PB: PLAT BOOK
- CMP CORRUGATED METAL PIPE
- CON CONCRETE
- BOUNDARY LINE
- TIE LINE ONLY
- ADJOINING DEED LINES
- RIGHT OF WAY (R/W)
- WOVEN WIRE FENCE LINE
- OVERHEAD WIRE
- STREAM
- CONSERVATION EASEMENT AREA
- SOIL ROADBED
- NCGS NORTH CAROLINA GEODETIC SURVEY
- N.A.D. NORTH AMERICAN DATUM 1983
- SPC STATE PLANE COORDINATES
- RRS RAILROAD SPIKE
- POB POINT OF BEGINNING
- PL PROPERTY LINE
- SR STATE ROAD
- CNF CORNER NOT FOUND

CURVE	RADIUS	ARC LENGTH	CHORD LENGTH	CHORD BEARING	DELTA ANGLE
C1	800.00'	125.34'	125.22'	N 59°21'54" E	08°58'38"
C2	300.00'	123.36'	122.49'	N 24°41'19" W	23°33'37"
C3	750.00'	324.00'	321.49'	N 38°18'55" E	24°45'07"

LINE	BEARING	DISTANCE	LINE	BEARING	DISTANCE
L1	N 63°51'14" E	114.82'	L20	N 82°43'17" W	266.65'
L2	N 54°52'35" E	102.20'	L21	N 09°34'39" W	234.99'
L3	N 36°28'08" W	90.19'	L22	N 67°18'27" W	371.41'
L4	N 12°54'30" W	92.44'	L23	N 05°12'05" E	85.08'
L5	S 89°35'39" E	55.73'	L24	N 20°08'18" E	83.45'
L6	N 04°32'38" E	220.29'	L25	N 25°56'21" E	42.83'
L7	N 00°33'48" E	115.29'	L26	N 50°41'28" E	91.67'
L8	N 02°16'53" E	386.47'	L27	N 51°39'20" E	195.92'
L9	N 87°25'11" W	196.28'	L28	S 82°43'17" E	253.45'
L10	S 04°06'40" W	321.00'	L29	S 41°13'10" E	161.52'
L11	N 28°35'23" W	4.59'	L30	S 74°44'46" E	72.38'
L12	S 81°19'10" W	42.55'	L31	N 71°02'57" W	218.64'
L13	N 63°12'07" W	19.98'	L32	N 11°01'01" E	295.07'
L14	S 09°53'48" E	342.02'	L33	N 04°36'04" E	89.85'
L15	S 63°52'25" W	101.69'	L34	N 04°05'32" E	359.45'
L16	N 75°25'03" W	245.56'	L35	N 04°23'36" E	114.31'
L17	S 58°15'11" W	322.88'	L36	N 75°23'48" E	180.20'
L18	N 74°44'46" W	54.31'	L37	N 85°47'08" W	293.55'
L19	N 41°13'10" W	166.18'	L38	N 03°27'38" E	240.19'

CONSERVATION EASEMENT ACCESS:

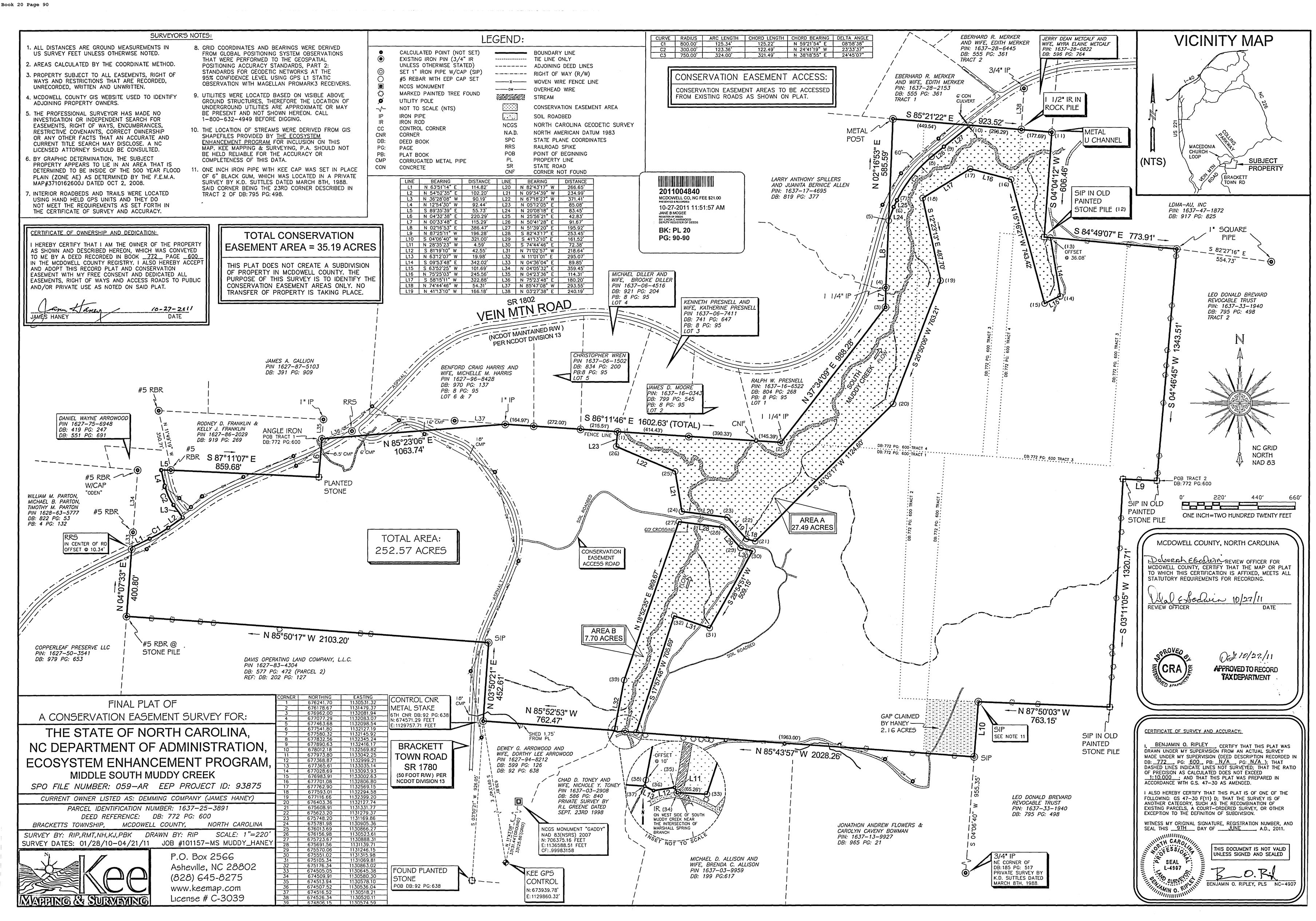
CONSERVATION EASEMENT AREAS TO BE ACCESSED FROM EXISTING ROADS AS SHOWN ON PLAT.

2011004840
MCDOWELL CO, NC FEE $21.00
PRESENTED & RECORDED
10-27-2011 11:51:57 AM
JANE B MCGEE
REGISTER OF DEEDS
BY: LINDA C HARWOOD
DEPUTY REGISTER OF DEEDS
BK: PL 20
PG: 90-90

VICINITY MAP

(NTS)

I-40, NC 226, US 221, COLLINS FARWAY, MACEDONIA CHURCH LOOP, KEN MTN ROAD, BRACKETT TOWN RD, SUBJECT PROPERTY



CERTIFICATE OF OWNERSHIP AND DEDICATION:

I HEREBY CERTIFY THAT I AM THE OWNER OF THE PROPERTY AS SHOWN AND DESCRIBED HEREON, WHICH WAS CONVEYED TO ME BY A DEED RECORDED IN BOOK 772 PAGE 600 IN THE MCDOWELL COUNTY REGISTRY. I ALSO HEREBY ACCEPT AND ADOPT THIS RECORD PLAT AND CONSERVATION EASEMENT WITH MY FREE CONSENT AND DEDICATED ALL EASEMENTS, RIGHT OF WAYS AND ACCESS ROADS TO PUBLIC AND/OR PRIVATE USE AS NOTED ON SAID PLAT.

JAMES HANEY — 10-27-2011 DATE

TOTAL CONSERVATION EASEMENT AREA = 35.19 ACRES

THIS PLAT DOES NOT CREATE A SUBDIVISION OF PROPERTY IN MCDOWELL COUNTY. THE PURPOSE OF THIS SURVEY IS TO IDENTIFY THE CONSERVATION EASEMENT AREAS ONLY. NO TRANSFER OF PROPERTY IS TAKING PLACE.

FINAL PLAT OF A CONSERVATION EASEMENT SURVEY FOR:

THE STATE OF NORTH CAROLINA, NC DEPARTMENT OF ADMINISTRATION, ECOSYSTEM ENHANCEMENT PROGRAM,

MIDDLE SOUTH MUDDY CREEK

SPO FILE NUMBER: 059-AR EEP PROJECT ID: 93875

CURRENT OWNER LISTED AS: DEMMING COMPANY (JAMES HANEY)

PARCEL IDENTIFICATION NUMBER: 1637-25-3891

DEED REFERENCE: DB: 772 PG: 600

BRACKETTS TOWNSHIP, MCDOWELL COUNTY, NORTH CAROLINA

SURVEY BY: RIP,RMT,NH,KJ,PBK DRAWN BY: RIP SCALE: 1"=220'

SURVEY DATES: 01/28/10-04/21/11 JOB #101157-MS MUDDY_HANEY

Kee MAPPING & SURVEYING
P.O. Box 2566
Asheville, NC 28802
(828) 645-8275
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License # C-3039

CORNER	NORTHING	EASTING
1	676241.70	1130531.32
2	676178.67	1131479.37
3	676962.00	1132081.94
4	677077.29	1132083.07
5	677463.68	1132098.54
6	677541.80	1132127.19
7	677580.32	1132145.92
8	677832.56	1132345.24
9	677890.63	1132416.17
10	678012.18	1132569.82
11	677973.80	1133042.25
12	677368.87	1132999.21
13	677365.61	1133035.14
14	677028.69	1133093.93
15	676983.91	1133002.63
16	677701.08	1132806.80
17	677767.90	1132569.15
18	677593.01	1132294.58
19	677116.66	1132399.20
20	676403.36	1132127.74
21	675608.91	1131331.77
22	675623.20	1131279.37
23	675748.20	1131169.86
24	675781.98	1130905.36
25	676013.69	1130866.27
26	676156.98	1130523.61
27	675723.67	1130888.31
28	675691.56	1131139.71
29	675570.06	1131246.15
30	675551.02	1131315.98
31	675105.34	1131089.81
32	675176.34	1130863.02
33	674505.05	1130645.38
34	674509.91	1130580.30
35	674513.94	1130578.10
36	674507.52	1130536.04
37	674516.52	1130518.21
38	674526.34	1130520.11
39	674806.15	1130574.59

MCDOWELL COUNTY, NORTH CAROLINA

Deborah E Goodwin REVIEW OFFICER FOR MCDOWELL COUNTY, CERTIFY THAT THE MAP OR PLAT TO WHICH THIS CERTIFICATION IS AFFIXED, MEETS ALL STATUTORY REQUIREMENTS FOR RECORDING.

Deborah E Goodwin 10/27/11
REVIEW OFFICER DATE

APPROVED BY WATERSHED ADMINISTRATOR CRA
10/27/11
APPROVED TO RECORD TAX DEPARTMENT

CERTIFICATE OF SURVEY AND ACCURACY:

I, BENJAMIN O. RIPLEY CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION (DEED DESCRIPTION RECORDED IN DB: 772 PG: 600 PB: N/A PG: N/A); THAT DASHED LINES INDICATE LINES NOT SURVEYED; THAT THE RATIO OF PRECISION AS CALCULATED DOES NOT EXCEED 1:10,000 ; AND THAT THIS PLAT WAS PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED.

I ALSO HEREBY CERTIFY THAT THIS PLAT IS OF ONE OF THE FOLLOWING: GS 47-30 F(11) D; THAT THE SURVEY IS OF ANOTHER CATEGORY, SUCH AS THE RECOMBINATION OF EXISTING PARCELS, A COURT-ORDERED SURVEY, OR OTHER EXCEPTION TO THE DEFINITION OF SUBDIVISION.

WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 9TH DAY OF JUNE A.D., 2011.

NORTH CAROLINA PROFESSIONAL SEAL L-4907 LAND SURVEYOR BENJAMIN O. RIPLEY

THIS DOCUMENT IS NOT VALID UNLESS SIGNED AND SEALED

BENJAMIN O. RIPLEY, PLS NC-4907

APPENDIX B
BASELINE INFORMATION DATA

NC DWQ Stream Identification Form Version 4.11

Date: 3/22/2011 WP4	**Project/Site:** MS Muddy Sprouse Br.	**Latitude:** 35.56138
Evaluator: S. Melton / K. Mitchell	**County:** McDowell	**Longitude:** -81.92179
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 34	**Stream Determination (circle one)** Ephemeral Intermittent (Perennial)	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 16)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	1	2	(3)
5. Active/relict floodplain	0	1	(2)	3
6. Depositional bars or benches	0	(1)	2	3
7. Recent alluvial deposits	0	(1)	2	3
8. Headcuts	0	1	2	(3)
9. Grade control	0	(0.5)	1	1.5
10. Natural valley	0	(0.5)	1	1.5
11. Second or greater order channel	(No = 0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 12)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	1	2	(3)
14. Leaf litter	1.5	(1)	0.5	0
15. Sediment on plants or debris	0	0.5	(1)	1.5
16. Organic debris lines or piles	0	0.5	(1)	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 6)				
18. Fibrous roots in streambed	3	(2)	1	0
19. Rooted upland plants in streambed	3	(2)	1	0
20. Macrobenthos (note diversity and abundance)	(0)	(1)	2	3
21. Aquatic Mollusks	(0)	(1)	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	(0)	0.5	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch: Photo # 9, 10 - Caddisflies are present

NC DWQ Stream Identification Form Version 4.11

Date: 3/22/2011 WP5	**Project/Site:** NS Muddy Spruce Br	**Latitude:** 35.56107
Evaluator: S. Melton / K. Mitchell	**County:** McDowell	**Longitude:** -81.92156
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 28	**Stream Determination (circle one)** Ephemeral (Intermittent) Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 10.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	(0)	1	2	3
5. Active/relict floodplain	0	(1)	2	3
6. Depositional bars or benches	(0)	1	2	3
7. Recent alluvial deposits	(0)	1	2	3
8. Headcuts	0	1	2	(3)
9. Grade control	0	(0.5)	1	1.5
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	No = (0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	1.5	1	(0.5)	0
15. Sediment on plants or debris	(0)	0.5	1	1.5
16. Organic debris lines or piles	0	(0.5)	1	1.5
17. Soil-based evidence of high water table?	No = (0)		Yes = 3	

C. Biology (Subtotal = 4.5)				
18. Fibrous roots in streambed	3	(2)	1	0
19. Rooted upland plants in streambed	3	(2)	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch: Photo # 8

NC DWQ Stream Identification Form Version 4.11

Date: 3/22/2011 S. Muddy GPS #6	**Project/Site:** MS Muddy S. Muddy	**Latitude:** 35.56250
Evaluator: S Melton / K. Mitchell	**County:** McDowell	**Longitude:** 81.9236
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 44	**Stream Determination (circle one)** Ephemeral Intermittent (Perennial)	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 23)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	(2)	3
4. Particle size of stream substrate	0	1	2	(3)
5. Active/relict floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	(2)	3
7. Recent alluvial deposits	0	1	2	(3)
8. Headcuts	0	(1)	2	3
9. Grade control	0	(0.5)	1	1.5
10. Natural valley	0	0.5	1	(1.5)
11. Second or greater order channel	No = 0		Yes = (3)	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	(1.5)	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	(1.5)
16. Organic debris lines or piles	0	0.5	1	(1.5)
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 10.5)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	(3)
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	0	0.5	1	(1.5)
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	(0)	0.5	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch: Photo # 12

NC DWQ Stream Identification Form Version 4.11

Date: 3/22/2011 GPS # 7	**Project/Site:** MS Muddy Ditch 1	**Latitude:** 35.56347
Evaluator: S Melton / K. Mitchell	**County:** McDowell	**Longitude:** 81.92268
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 26	**Stream Determination (circle one)** Ephemeral (Intermittent) Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 13)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	(1)	2	3
5. Active/relict floodplain	0	1	(2)	3
6. Depositional bars or benches	0	1	(2)	3
7. Recent alluvial deposits	0	1	(2)	3
8. Headcuts	(0)	1	2	3
9. Grade control	0	(0.5)	1	1.5
10. Natural valley	0	(0.5)	1	1.5
11. Second or greater order channel	No = (0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	1.5	1	(0.5)	0
15. Sediment on plants or debris	0	(0.5)	1	1.5
16. Organic debris lines or piles	0	(0.5)	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 4.5)				
18. Fibrous roots in streambed	3	(2)	1	0
19. Rooted upland plants in streambed	3	(2)	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch: Photo # 14, 15

NC DWQ Stream Identification Form Version 4.11

Date: 3/22/2011 GPS #8	**Project/Site:** MS Muddy Ditch 2	**Latitude:** 35.56311
Evaluator: S. Melton / K. Mitchell	**County:** McDowell	**Longitude:** -81.92278
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 20	**Stream Determination (circle one)** Ephemeral (Intermittent) Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 9)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	(2)	3
2. Sinuosity of channel along thalweg	(0)	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	1	(2)	3
5. Active/relict floodplain	0	(1)	2	3
6. Depositional bars or benches	0	(1)	2	3
7. Recent alluvial deposits	0	(1)	2	3
8. Headcuts	0	(1)	2	3
9. Grade control	(0)	0.5	1	1.5
10. Natural valley	(0)	0.5	1	1.5
11. Second or greater order channel	No = (0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7)				
12. Presence of Baseflow	0	(1)	2	3
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	1.5	(1)	0.5	0
15. Sediment on plants or debris	0	(0.5)	1	1.5
16. Organic debris lines or piles	0	(0.5)	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 4)				
18. Fibrous roots in streambed	3	(2)	1	0
19. Rooted upland plants in streambed	3	(2)	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	(0)	0.5	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch: Photo 16, 17

NC Division of Water Quality –Methodology for Identification of Intermittent and Perennial Streams and Their Origins v. 4.1

NC DWQ Stream Identification Form Version 4.1 C Iva Branch

Date: 8/23/11	**Project/Site:** Sprouse Farm	**Latitude:**
Evaluator: CC	**County:** McDowell	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 30	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 10.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	(1)	2	3
5. Active/relict floodplain	(0)	1	2	3
6. Depositional bars or benches	0	(1)	2	3
7. Recent alluvial deposits	0	(1)	2	3
8. Headcuts	0	(1)	2	3
9. Grade control	0	0.5	(1)	1.5
10. Natural valley	0	(0.5)	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 11.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	(0)	1	(2)	3
14. Leaf litter	1.5	(1)	0.5	0
15. Sediment on plants or debris	0	0.5	(1)	1.5
16. Organic debris lines or piles	0	0.5	1	(1.5)
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 8)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	0	(0.5)	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	0	0.5	(1)	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC Division of Water Quality –Methodology for Identification of Intermittent and Perennial Streams and Their Origins v. 4.1

NC DWQ Stream Identification Form Version 4.1 — B Iva Branch

Date: 8/23/11	**Project/Site:** Sprouse Farm	**Latitude:**
Evaluator: CC	**County:** McDowell	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 24	**Stream Determination (circle one)** Ephemeral (Intermittent) Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 13.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	1	(2)	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	1	(2)	3
5. Active/relict floodplain	(0)	1	2	3
6. Depositional bars or benches	0	(1)	2	3
7. Recent alluvial deposits	0	1	(2)	3
8. Headcuts	0	1	(2)	(3)
9. Grade control	0	0.5	(1)	1.5
10. Natural valley	0	(0.5)	1	1.5
11. Second or greater order channel	No = (0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 5.5)				
12. Presence of Baseflow	(0)	1	2	3
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	1.5	(1)	0.5	0
15. Sediment on plants or debris	0	(0.5)	1	1.5
16. Organic debris lines or piles	0	0.5	(1)	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 3)				
18. Fibrous roots in streambed	3	2	(1) →	0
19. Rooted upland plants in streambed	3	(2)	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	(0)	0.5	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = (0)			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Middle South Muddy Creek
County Name:	McDowell County
EEP Number:	93875
Project Sponsor:	NCEEP
Project Contact Name:	Julie Cahill
Project Contact Address:	5 Ravenscroft Drive, Suite 102, Asheville, NC 28801
Project Contact E-mail:	Julie.Cahill@ncdener.gov
EEP Project Manager:	Julie Cahill

Project Description

Stream restoration activities will restore approximately 2,414 feet of stream and enhance 207 feet of stream along Middle South Muddy Creek and two of its tributaries, Sprouse and Iva Branches by restoring natural channel morphology and proper sediment transport capacity, improving bed form diversity, constructing a floodplain bench, improving channel and stream bank stabilization, establishing a forested and herbaceous riparian buffer plant community.

For Official Use Only

Reviewed By:

Date | **EEP Project Manager**

Conditional Approved By:

Date | **For Division Administrator FHWA**

☐ **Check this box if there are outstanding issues**

Final Approval By:

Date | **For Division Administrator FHWA**

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☑ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☑ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☑ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☑ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☐ Yes ☑ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☐ No ☑ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☑ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☑ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☑ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☑ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☑ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☐ Yes ☑ No
2. Does the project require the acquisition of real estate?	☐ Yes ☐ No ☑ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☐ No ☑ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☐ Yes ☐ No ☑ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☑ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☑ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☑ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☑ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☑ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☑ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☑ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☐ Yes ☑ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☑ No ☐ N/A
4. Is the project "likely to adversely affect" the species and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☑ No ☐ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☑ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☑ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☑ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☑ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☑ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☑ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☑ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☑ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☑ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☑ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☑ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☑ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☑ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☑ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☑ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☑ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☑ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☑ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☑ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☑ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☑ N/A

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Middle South Muddy Creek Stream Restoration
Name if stream or feature:	South Muddy Creek
County:	McDowell
Name of river basin:	Catawba
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	McDowell County
DFIRM panel number for entire site:	3710162600J
Consultant name:	Wolf Creek Engineering, PLLC (PRIME) WAZ Engineering, PC (SUB – hydraulic modeling)
Phone number:	(828) 658-3649 (Wolf Creek) (919) 567-0495 (WAZ)
Address:	7 Florida Ave Weaverville, NC 28787 (Wolf Creek) 112 N. Main Street Holly Spring, NC 27540 (WAZ)

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500".

Summarize stream reaches or wetland areas according to their restoration priority.

Reach	Length	Priority
South Muddy Creek	*900*	*II (Restoration)*

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

☑ Yes ☐ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☑ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation: Zone AE

Check if applies:

☑ AE Zone

- ☐ Floodway
- ☑ Non-Encroachment
- ☐ None

☐ A Zone

- ☐ Local Setbacks Required
- ☐ No Local Setbacks Required

If local setbacks are required, list how many feet:

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

☑ Yes ☐ No

Land Acquisition (Check)

☐ State owned (fee simple)

☑ Conservation easment (Design Bid Build)

☐ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

◉ Yes ○ No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: Edward Curtis, (919) 715-8000 x369)

Name of Local Floodplain Administrator: Jerry Silvers
Phone Number: 828-652-7121

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☐ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision

☐ Other Requirements

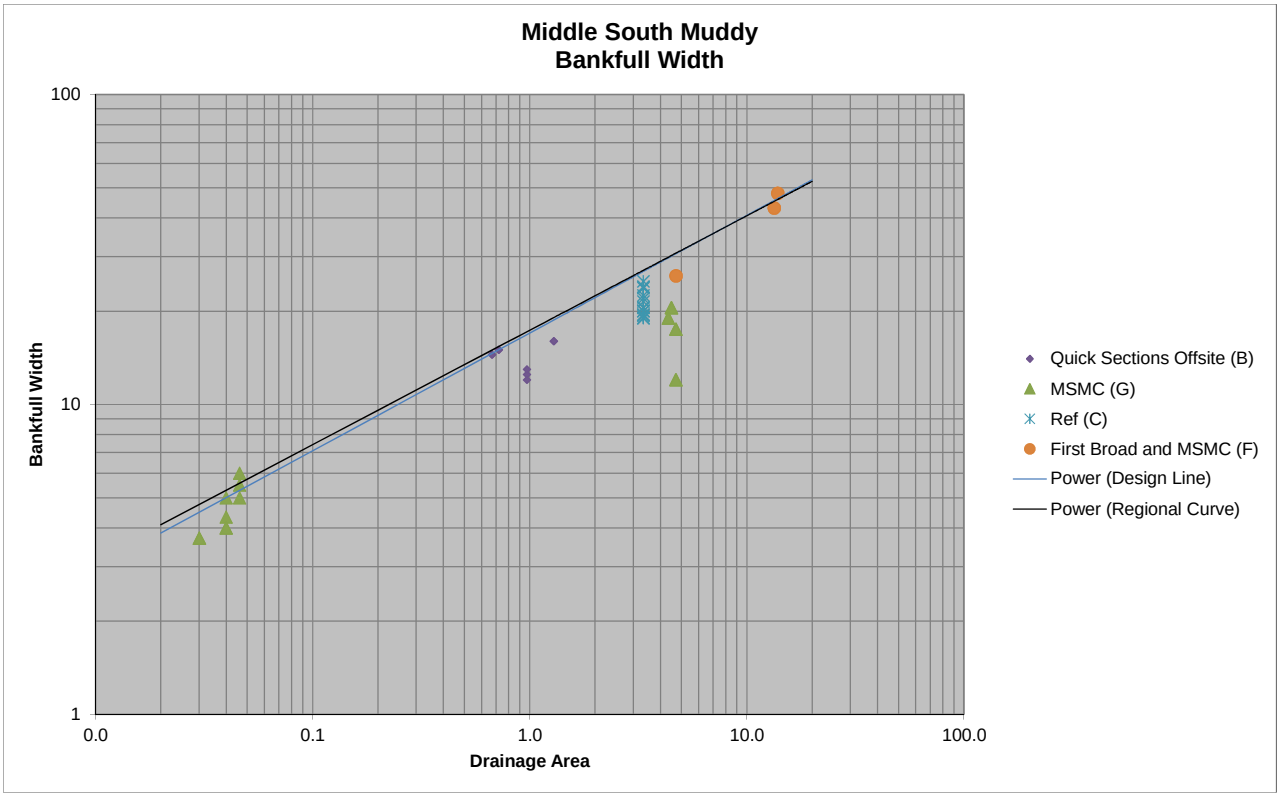
List other requirements:
To be determined once DRAFT design is approved. Will likely require a CLOMR. McDowell Co. may allow a No-Rise on the condition that a LOMR will be completed after construction.

Comments:

Name: Amy J. Wazenegger, PE Signature: _____

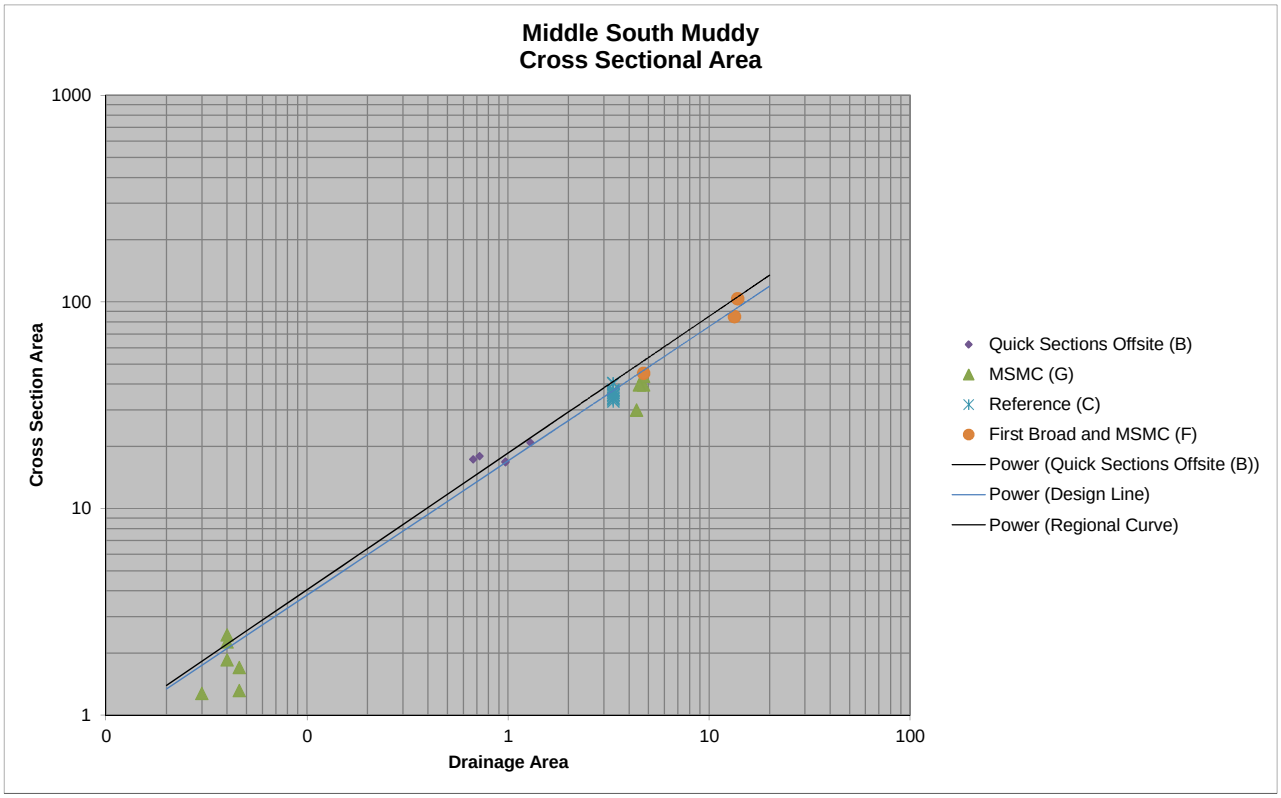
Title: President/Sr. Engineer (WAZ) Date: _____

APPENDIX C
MITIGATION WORK PLAN DATA and ANALYSES



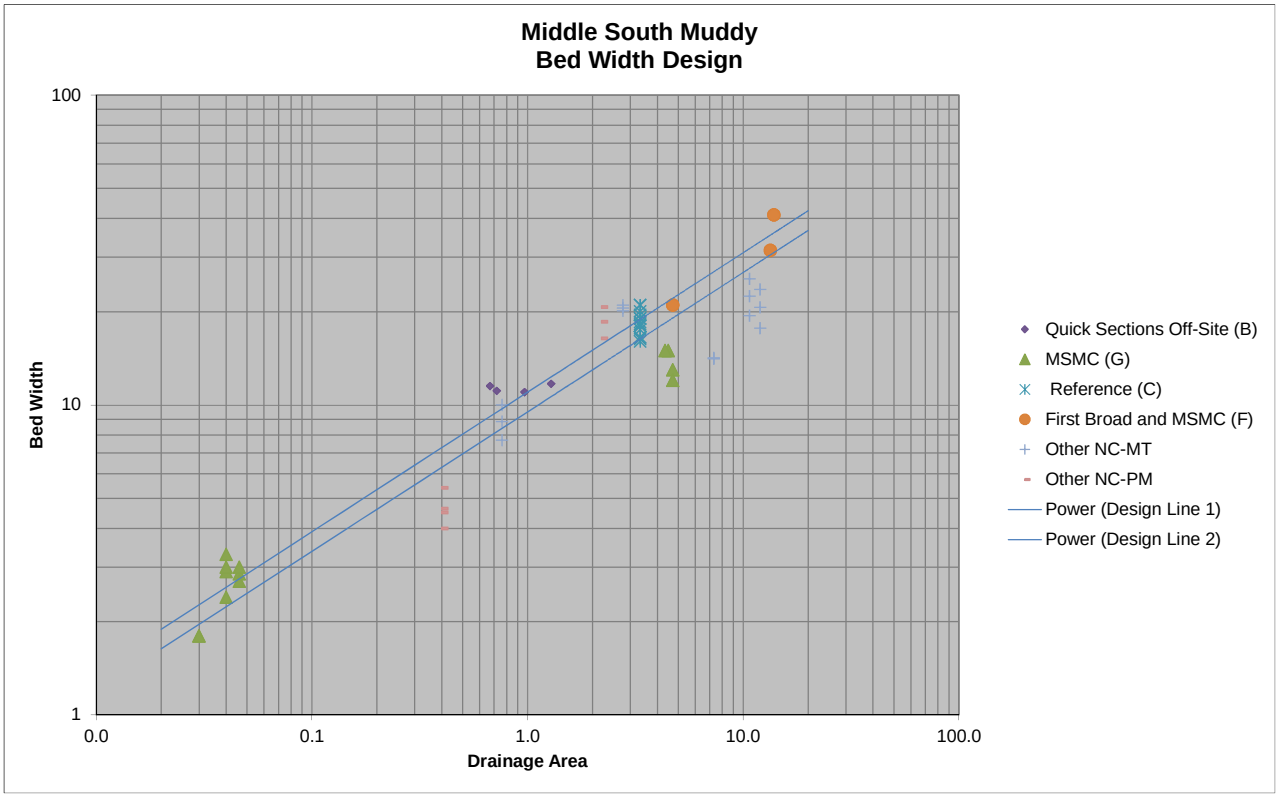
	Coefficient	Exponent
Trendline Reference Streams		
Design Range (+/-)		
Design Line	17.0	0.38
Regional Curve	17.4	0.37

Design Line		Regional Curve	
X	Y	X	Y
0.02	3.845	0.02	4.094
20	53.069	20	52.483



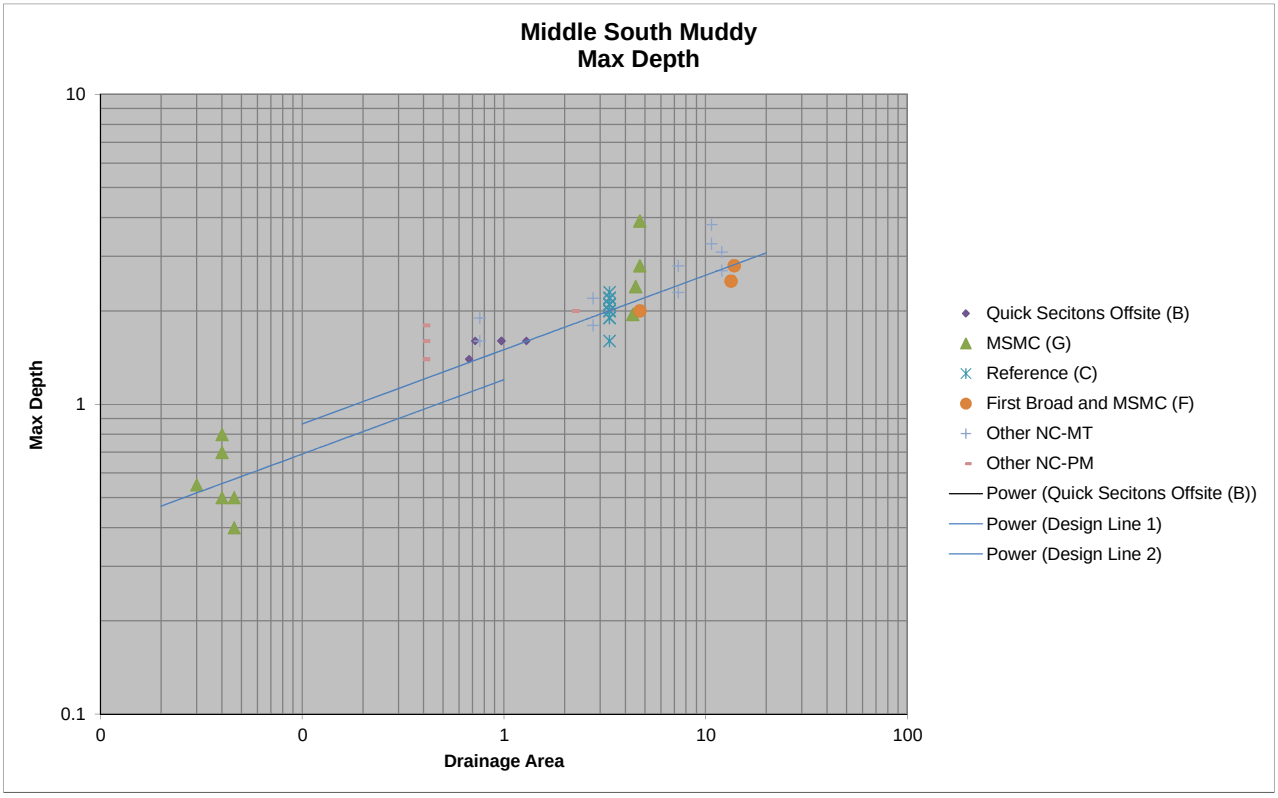
	Coefficient	Exponent
Trendline Reference Streams		
Design Range (+/-)		
Design Line	17.0	0.65
Regional Curve	18.6	0.66

Design Line		Regional Curve	
X	Y	X	Y
0.02	1.337	0.02	1.395
20	119.157	20	134.684



	Coefficient	Exponent
Trendline All Streams		
Design Range (+/-)		
Design Line (1)	11.0	0.45
Design Line (2)	9.5	0.45

Design Line		Design Line (2)	
X	Y	X	Y
0.02	1.892	0.02	1.634
20	42.350	20	36.575



	Coefficient	Exponent
Trendline Reference Streams		
Design Range (+/-)		
Design Line (1)	1.50	0.24
Design Line (2)	1.2	0.24

Design Line (1)		Design Line (2)	
X	Y	X	Y
0.1	0.863	0.02	0.469
20	3.078	1	1.200

Conceptual Design

Estimated Channel Values from Regional Curves

Project:	Middle South Muddy
Project No.:	1049-MSMC
Client:	NCEEP
Contract No.:	93875
County/State:	McDowell County, NC
Hyd-Physio Provence:	NC Mountains

Regional Curve

Province Code: NCMT

Dimension	Coefficient	Exponent
W_{BKF}	17.36	0.3693
A_{BKF}	18.559	0.6616
d_{MEAN}	1.1771	0.2697
Q_{BKF}	55.425	0.7874
W_{BED}	0	0
d_{MAX}	0	0
Approximate W_{BED} :	14.53	0.388
Approximate d_{MAX} :	1.65	0.270

Feature Dimensions

Pool-Pool/W_{BKF} Ratio:	5
Rc / W_{BKF} Ratio:	2
Tan Len/W_{BKF} Ratio:	2
Use Approximate W_{BED} (Yes/No):	Yes
Use Approximate d_{MAX} (Yes/No):	Yes

Estimated Dimensions from Regional Curve Data

Reach	Drainage Area (mi^2)	W_{BKF} (ft)	A_{BKF} (ft^2)	d_{MEAN} (ft)	W_{BED} (ft)	d_{MAX} (ft)	Pool Spacing (ft)	Rc (ft)	Tangent Length (ft)
South Muddy Creek	4.7	30.7	51.7	1.8	26.5	2.5	154	61	61
Sprouse Branch	0.03	4.8	1.8	0.5	3.7	0.6	24	10	10
Sprouse Branch	0.04	5.3	2.2	0.5	4.2	0.7	26	11	11
Iva Branch	0.03	4.8	1.8	0.5	3.7	0.6	24	10	10
Iva Branch	0.046	5.6	2.4	0.5	4.4	0.7	28	11	11

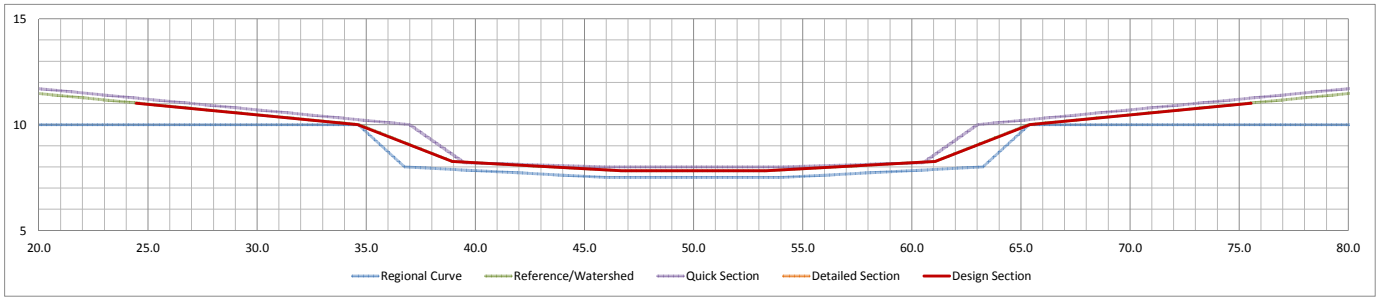
Sediment Regime

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC

Reach	South Muddy Creek	Sprouse Branch	Iva Branch		Upstream Adjacent Forecast Reach	Upstream Extended Forecast Reach	Reference Reach Tom's Creek	Reference Reach Cold Springs
Bed Material Nature								
Depth of Bed Probe	0.8 - 1.0	0.2	0.3		0.6	0.6	0.5	0.2
Matrix Bonding	Loose	Loose	Loose		Loose	Loose	Moderate	Moderate
Parent Material Exposure	None	Occasional	Frequent		Occasional	None	None	None
Well Graded	Yes	No	No		Yes	Yes	Yes	Yes
Depositional Patterns *(None-Minimal-Moderate-Extensive)*								
Point Bars	Minimal	None	Minimal		Moderate	Extensive	Extensive	Minimal
Mid-channel Bars	Moderate	None	None		Moderate	Extensive	Moderate	Minimal
Side-channel Bars	None	None	None		Minimal	Moderate	Moderate	None
Diagonal Bars	Moderate	None	None		Minimal	Moderate	Moderate	Minimal
Bar Length/W_{BED}	1	None	None		1	1.5	2	1
Dune Presentation of Bars	Minimal	None	None		Minimal	Moderate	None	None
Channel Branching	None	None	None		None	Mininal	None	None
Tributary Deltas	None	None	None		N/a	Moderate	None	None
Dune Length/Height (FT)	10/0.5	None	None		10/0.5	10/0.5	N/a	N/a
Ripple Length/Height (FT)	0.5/0.1	0.2/0.05	0.2/0.05		N/a	N/a	N/a	N/a
Sediment Measurements								
Riffle - Pebble Count								
% Sand	16%	80%	80%			35%	9%	11%
D_{50}	19	0.3	0.3			12	29	45
D_{84}	71	4	4			42	69	130
D_{95}	110	16	16			80	120	190
Reach - Pebble Count								
% Sand	37%						4%	11%
D_{50}	18						31	31
D_{84}	83						71	120
D_{95}	140						94	170
Bar (Pavement)								
% Sand						3%	2%	5%
D_{50}						25	46	79
D_{84}						47	88	99
D_{95}						58	110	110
D_{MAX}						57	110	110
Bar (Sub-Pavement)								
% Sand						10%	23%	35%
D_{50}						11	10	33
D_{84}						16	35	66
D_{95}						27	52	82
Sediment Regime *(Low - Mod. Low - Moderate - Mod. High - High)*								
Sediment Load	Mod. High	Low	Low		Mod. High	High	Mod. High	Mod. Low
Sediment Mobility	Mod. High	High	High		Mod. High	High	Moderate	Mod. Low

Design Section 1

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC



Regional Curve

	Coef	Exp
A_{BKF}	18.56	0.66
W_{BKF}	17.36	0.37
W_{BED}	14.53	0.388
d_{MAX}	1.65	0.270
d_{MEAN}	1.18	0.27
F/p-Bench Width	50	
F/p-Bench Slope	0	(H:1)
Thalweg Ratio	0.30	
Toe Depth Ratio	0.80	

W_{BKF}	30.7
W_{BED}	26.5
W_{THL}	7.9
d_{MAX}	2.5
d_{TOE}	2.0

Plot Section: yes (Yes/No)

Point No.	X	Y
Center	50	10
1	-15.4	10
2	34.6	10.0
3	36.8	8.0
4	46.0	7.5
5	54.0	7.5
6	63.2	8.0
7	65.4	10.0
8	115.4	10

Reference/Watershed Curve

	Coef	Exp
A_{BKF}	17.00	0.65
W_{BKF}	17.00	0.38
W_{BED}	11.00	0.450
d_{MAX}	1.50	0.240
d_{MEAN}		
F/p-Bench Width	50	
F/p-Bench Slope	10	(H:1)
Thalweg Ratio	0.30	
Toe Depth Ratio	0.80	

W_{BKF}	30.6
W_{BED}	22.1
W_{THL}	6.6
d_{MAX}	2.2
d_{TOE}	1.7

Plot Section: yes (Yes/No)

Point No.	X	Y
Center	50	10
1	-15.3	15
2	34.7	10.0
3	39.0	8.3
4	46.7	7.8
5	53.3	7.8
6	61.0	8.3
7	65.3	10.0
8	115.3	15

Existing Quick Section

F/p-Bench Width	50
F/p-Bench Slope	10 (H:1)

W_{BKF}	26.0
W_{BED}	21.0
W_{THL}	8.0
d_{MAX}	2.0
d_{TOE}	1.8

Plot Section: yes (Yes/No)

Point No.	X	Y
Center	50	10
1	-13.0	15
2	37.0	10.0
3	39.5	8.2
4	46.0	8.0
5	54.0	8.0
6	60.5	8.2
7	63.0	10.0
8	113.0	15

Existing Detailed Section

Point No.	Offset	Elevation
1	10	100
2	20	99
3	30	98
4	40	98
5	50	99
6	60	99
7	70	99
8	80	99
9	90	99
10	92	97
11	93	96.5
12	94	96
13	106	96
14	107	97
15	108	98
16	109	98.5
17	115	99
18	180	100
19	190	100
20	200	100

Center of Channel: 100 (Offset)
Bankfull Elevation: 99
Plot Section: no (Yes/No)

Point No.	X	Y
Center	50	10
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Design Section

Drainage Area: 4.7 (sq. mi.)

	Coef	Exp
W_{BED}	11.00	0.450
d_{MAX}	1.50	0.240
Bank Slope	2.5	(H:1)
Thalweg Ratio	0.30	(Thalweg/Bed Width)
Toe Depth Ratio	0.80	(Toe/Max Depth)
Bench Width Ratio	0.33	(Bench/Bankfull)
Bench Slope	10	(H:1)

W_{BKF}	30.8		
W_{BED}	22.1		
W_{THL}	6.6		
d_{MAX}	2.2		
d_{TOE}	1.7	S_{TOE}	17.8
d_{MEAN}	1.70		
W_{BENCH}	10.2		

Plot Section: yes (Yes/No)

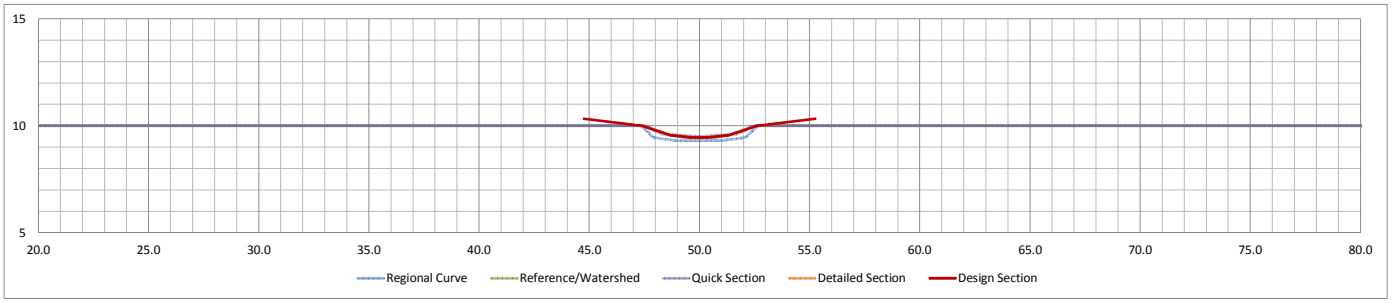
Point No.	X	Y
Center	50	10
1	24.5	11.0
2	34.6	10.0
3	39.0	8.3
4	46.7	7.8
5	53.3	7.8
6	61.0	8.3
7	65.4	10.0
8	75.5	11.0

Section Comparisons

	Regional Curve	Ref/ Wtrshed	Quick Section	Detailed Section	Design Section
A_{BKF}	51.7	46.5	45.2		52.2
Difference	101%	112%	115%		
d_{MEAN}	1.68	1.52	1.74		1.70
Difference	101%	112%	98%		
P	32.36	31.32	27.17		31.47
Hydr. R	1.60	1.48	1.66		1.66
Difference	104%	112%	100%		
W/d Ratio	18.3	20.2	15.0		18.1

Design Section 2

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC



Regional Curve

	Coef	Exp
A_{BKF}	18.56	0.66
W_{BKF}	17.36	0.37
W_{BED}	14.53	0.388
d_{MAX}	1.65	0.270
d_{MEAN}	1.18	0.27
F/p-Bench Width	150	
F/p-Bench Slope	0	(H:1)
Thalweg Ratio	0.50	
Toe Depth Ratio	0.80	

W_{BKF}	5.3
W_{BED}	4.2
W_{THL}	2.1
d_{MAX}	0.7
d_{TOE}	0.6

Plot Section: yes (Yes/No)

Point No.	X	Y
Center	50	10
1	-102.6	10
2	47.4	10.0
3	47.9	9.4
4	49.0	9.3
5	51.0	9.3
6	52.1	9.4
7	52.6	10.0
8	202.6	10

Reference/Watershed Curve

	Coef	Exp
A_{BKF}	17.00	0.65
W_{BKF}	17.00	0.38
W_{BED}	11.00	0.450
d_{MAX}	1.20	0.240
d_{MEAN}		
F/p-Bench Width	150	
F/p-Bench Slope	0	(H:1)
Thalweg Ratio	0.50	
Toe Depth Ratio	0.80	

W_{BKF}	5.0
W_{BED}	2.6
W_{THL}	1.3
d_{MAX}	0.6
d_{TOE}	0.4

Plot Section: yes (Yes/No)

Point No.	X	Y
Center	50	10
1	-102.5	10
2	47.5	10.0
3	48.7	9.6
4	49.4	9.4
5	50.6	9.4
6	51.3	9.6
7	52.5	10.0
8	202.5	10

Existing Quick Section

F/p-Bench Width	50
F/p-Bench Slope	0 (H:1)

W_{BKF}	5.0
W_{BED}	3.3
W_{THL}	0.1
d_{MAX}	0.5
d_{TOE}	0.4

Plot Section: yes (Yes/No)

Point No.	X	Y
Center	50	10
1	-2.5	10
2	47.5	10.0
3	48.4	9.6
4	50.0	9.5
5	50.0	9.5
6	51.7	9.6
7	52.5	10.0
8	102.5	10

Existing Detailed Section

Point No.	Offset	Elevation
1	10	100
2	20	99
3	30	98
4	40	98
5	50	99
6	60	99
7	70	99
8	80	99
9	90	99
10	92	97
11	93	96.5
12	94	96
13	106	96
14	107	97
15	108	98
16	109	98.5
17	115	99
18	180	100
19	190	100
20	200	100

Center of Channel: 100 (Offset)
Bankfull Elevation: 99
Plot Section: no (Yes/No)

Point No.	X	Y
Center	50	10
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Design Section

Drainage Area: 0.04 (sq. mi.)

	Coef	Exp
W_{BED}	11.00	0.450
d_{MAX}	1.20	0.240
Bank Slope	3	(H:1)
Thalweg Ratio	0.30	(Thalweg/Bed Width)
Toe Depth Ratio	0.80	(Toe/Max Depth)
Bench Width Ratio	0.5	(Bench/Bankfull)
Bench Slope	8	(H:1)

W_{BKF}	5.2
W_{BED}	2.6
W_{THL}	0.8
d_{MAX}	0.55
d_{TOE}	0.44
d_{MEAN}	0.37
W_{BENCH}	2.6

S_{TOE}: 8.2

Plot Section: yes (Yes/No)

Point No.	X	Y
Center	50	10
1	44.8	10.3
2	47.4	10.0
3	48.7	9.6
4	49.6	9.4
5	50.4	9.4
6	51.3	9.6
7	52.6	10.0
8	55.2	10.3

Section Comparisons

	Regional Curve	Ref/ Wtrshed	Quick Section	Detailed Section	Design Section
A_{BKF}	2.2	2.1	1.8		1.9
Difference	87%	92%	105%		
d_{MEAN}	0.42	0.42	0.37		0.37
Difference	88%	87%	100%		
P	5.76	5.18	5.18		5.40
Hydr. R	0.38	0.41	0.35		0.36
Difference	93%	88%	101%		
W/d Ratio	12.7	11.9	13.7		14.3

Typical Section Dimensions

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC

Reach	Drainage Area (mi^2)	Design Section	W_{BKF}	W_{BED}	W_{THAL}	W_{BENCH}	d_{MAX}	d_{TOE}	Bank Slope (H:1)
South Muddy Creek	4.7	1	30.8	22.1	6.6	10	2.17	1.74	2.5
Sprouse Branch	0.03	2	4.8	2.3	0.7	2	0.52	0.41	3.0
Sprouse Branch	0.04	2	5.2	2.6	0.8	3	0.55	0.44	3.0
Iva Branch	0.03	2	4.8	2.3	0.7	2	0.52	0.41	3.0
Iva Branch	0.046	2	5.5	2.8	0.8	3	0.57	0.46	3.0

	P_{WIDTH} Ratio	d_{POOL}/d_{MAX} Ratio	Pool Spacing/Bed min	Pool Spacing/Bed max
Design Section 1	1.1	1.5	7	10
Design Section 2	1.1	1.5	7	10
Design Section 3	1.1	1.5	7	10
Design Section 4	1.1	1.5	7	10

Reach	A_{BKF}	P_{WET}	R_{HYD}	d_{MEAN}	W/D	Pool Dimensions W_{IN}	Pool Dimensions W_{OUT}	Pool Dimensions d_{POOL}
South Muddy Creek	52.2	31.5	1.66	1.70	18.1	18.5	15.4	3.26
Sprouse Branch	1.6	4.9	0.33	0.34	14.1	2.9	2.4	0.78
Sprouse Branch	1.9	5.4	0.36	0.37	14.3	3.1	2.6	0.83
Iva Branch	1.6	4.9	0.33	0.34	14.1	2.9	2.4	0.78
Iva Branch	2.1	5.7	0.37	0.38	14.4	3.3	2.8	0.86

Plan/Profile Measurements

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC

Reach	S_{AVG}	S_{VALLEY} Length	S_{VALLEY} Elev Change	Entrench F/p Width	Sinuosity Val Length	Sinuosity Chan length	Meander Width
South Muddy Creek	0.003	897	5	65	1136	1169	100
Sprouse Branch	0.031	257	11	15	187	200	11
Sprouse Branch	0.014	364	8	15	422	450	16
Iva Branch	0.058	329	14	15	424	461	12
Iva Branch	0.026	265	16	15	151	154	12

Morphologic Design Table

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC

Reach	Stream Type	Drainage Area (mi^2)	W_{BKF} (ft)	A_{BKF} (ft^2)	d_{MEAN} (ft)	d_{MAX} (ft)	S_{AVG} (ft/tf)	S_{VALLEY} (ft/tf)
South Muddy Creek	C4	4.700	30.8	52.2	1.7	2.2	0.003	0.006
Sprouse Branch	B5	0.030	4.8	1.6	0.3	0.5	0.031	0.043
Sprouse Branch	B5	0.040	5.2	1.9	0.4	0.6	0.014	0.022
Iva Branch	B5	0.030	4.8	1.6	0.3	0.5	0.058	0.043
Iva Branch	B5	0.046	5.5	2.1	0.4	0.6	0.026	0.060

Reach	W/D Ratio	Entrench Ratio	Sinuosity	Meander Width Ratio	Pool Spacing (ft) (min)	Pool Spacing (ft) (max)	P_{SPACE}/W_{BKF} (min)	P_{SPACE}/W_{BKF} (max)
South Muddy Creek	18.1	2.1	1.03	3.2	154.5	220.7	5.0	7.2
Sprouse Branch	14.1	3.2	1.07	2.3	15.9	22.7	3.3	4.8
Sprouse Branch	14.3	2.9	1.07	3.1	18.1	25.8	3.4	4.9
Iva Branch	14.1	3.2	1.09	2.5	15.9	22.7	3.3	4.8
Iva Branch	14.4	2.7	1.02	2.2	19.3	27.5	3.5	5.0

Structure Dimensions

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC

Arm Length Ratio	1.6	X W_{BED}
Throat Width	1/3	X W_{BKF}
Buried Length	1/3	X L_{ARM}
Minimum Buried Length	3	(ft)
Maximum Buried Length	8	(ft)

Reach	W_{BKF}	W_{BED}	Arm Length (L)	Throat Width (W)	Buried Length (X)	Total Log Length (ft)
South Muddy Creek	30.8	22.1	35	10	8	51
Sprouse Branch	4.8	2.3	4	2	3	10
Sprouse Branch	5.2	2.6	4	2	3	10
Iva Branch	4.8	2.3	4	2	3	10
Iva Branch	5.5	2.8	4	2	3	10

				Boulder Size Based on:			Recommended Boulder Size		
Reach	τ	Structure Drop	Structure Length	Bed Shear	Structure Shear	Bed Width	Length	Width	Depth
South Muddy Creek	0.32	0.4	35	2.5	3.0	3.0	3	2	1.5
Sprouse Branch	0.65	0.5	5	3.0	3.5	2.5	2.5	1.5	1
Sprouse Branch	0.32	0.5	5	2.5	3.5	2.5	2.5	1.5	1
Iva Branch	1.22	1	5	3.5	4.0	2.5	2.5	1.5	1
Iva Branch	0.62	1	5	3.0	4.0	2.5	2.5	1.5	1

Competence Calculations

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC

Bed Material Regime 1

Maximum Particle Critical Dimensionless Shear

D_{50}	19	Riffle Bed Material D_{50} (mm)
$D^{\wedge}_{50}$	11	Bar Sample D_{50} (mm)
D_{MAX}	57	Largest Particle from Bar Sample (mm)
D_{MAX}	0.19	Largest Particle from Bar Sample (ft)
Υ_S	1.65	Submerged Specific Wt. of Sediment

$D_{50}/D^{\wedge}_{50}$	1.7	No	(In range: 3-7)
τ^*	0.052		
D_{MAX}/D_{50}	3.0	Yes	(In range: 1.3-3.0)
τ^*	0.014		
τ^*	0.014		Dimensionless Shear for Max Particle

Representative Particl Bed Material D_{50} (mm)

D_{50}	19	Bed Material D_{50} (ft)
D_{50}	0.06	Submerged Specific Wt. of Sediment
Υ_S	1.65	Estimated Channel Slope
S	0.003	

		Typical Shield's Curve Value
τ^*	0.04	Slope based Lamb Equation
τ^*	0.035	
		Range: 0.03 - 0.06
τ^*	0.05	

Bed Material Regime 2

Maximum Particle Critical Dimensionless Shear

D_{50}	1	Riffle Bed Material D_{50} (mm)
$D^{\wedge}_{50}$	0.5	Bar Sample D_{50} (mm)
D_{MAX}	4	Largest Particle from Bar Sample (mm)
D_{MAX}	0.01	Largest Particle from Bar Sample (ft)
Υ_S	1.65	Submerged Specific Wt. of Sediment

$D_{50}/D^{\wedge}_{50}$	2.0	No	(In range: 3-7)
τ^*	0.046		
D_{MAX}/D_{50}	4.0	No	(In range: 1.3-3.0)
τ^*	0.011		
τ^*	0.03		Dimensionless Shear for Max Particle

Representative Particl Bed Material D_{50} (mm)

D_{50}	1	Bed Material D_{50} (ft)
D_{51}	0.00	Submerged Specific Wt. of Sediment
Υ_S	1.65	Estimated Channel Slope
S	0.002	

		Typical Shield's Curve Value
τ^*	0.04	Slope based Lamb Equation
τ^*	0.032	
		Range: 0.03 - 0.06
τ^*	0.04	

Reach	R_{HYD}	Bed Regime	Largest Particle Calculations τ^*	Υ_S	D_{MAX}	S	Representative Particle Calculations τ^*	Υ_S	D_{50}	S
South Muddy Creek	1.66	1	0.014	1.65	0.19	0.0026	0.05	1.65	0.062	0.0031
Sprouse Branch	0.33	2	0.03	1.65	0.01	0.0020	0.04	1.65	0.003	0.0007
Sprouse Branch	0.36	2	0.03	1.65	0.01	0.0018	0.04	1.65	0.003	0.0006
Iva Branch	0.33	2	0.03	1.65	0.01	0.0020	0.04	1.65	0.003	0.0007
Iva Branch	0.37	2	0.03	1.65	0.01	0.0018	0.04	1.65	0.003	0.0006

Supplemental Bed Material Design

Project: Middle South Muddy
Project No.: 1049-MSMC
Client: NCEEP
Contract No.: 93875
County/State: McDowell County, NC

Material Gradation Percentage of Total by Weight								
Material Size	Sand/Clay	ABC(M)	1/2" Stone (No. 57)	3/4" Stone (No. 5)	2" Stone (Surge)	6" Stone NCDOT (Class A)	12" Stone NCDOT (Class B)	18" Stone NCDOT (Class I)
Sand	100							
#16		12						
#10		9	2					
#8		9	3					
#4		16	12	2				
3/8"		16	25	3				
1/2"		13	48	32				
3/4"		12	7	58				
1"		13	3	5				
1.5"						19		
2"					50	19		
3"					50	19		
4"						19	19	13
5"						19	19	13
6"						5	19	14
8"							19	14
9"							19	14
10"							5	13
12"								14
14"								5
16"								
18"								
24"								
Total %	100	100	100	100	100	100	100	100

Material Composition								
Reach	Sand/Clay	ABC(M)	1/2" Stone (No. 57)	3/4" Stone (No. 5)	2" Stone (Surge)	6" Stone NCDOT (Class A)	12" Stone NCDOT (Class B)	18" Stone NCDOT (Class I)
South Muddy Creek	10%		30%		30%	30%		
Sprouse Branch	100%							
Sprouse Branch	100%							
Iva Branch	100%							
Iva Branch	100%							

Design Size Distribution (mm)						
Reach	D_{16}	D_{35}	D_{50}	D_{65}	D_{84}	D_{95}
South Muddy Creek	5	13	41	50	72	112
Sprouse Branch	<1	<1	<1	<1	<1	<1
Sprouse Branch	<1	<1	<1	<1	<1	<1
Iva Branch	<1	<1	<1	<1	<1	<1
Iva Branch	<1	<1	<1	<1	<1	<1

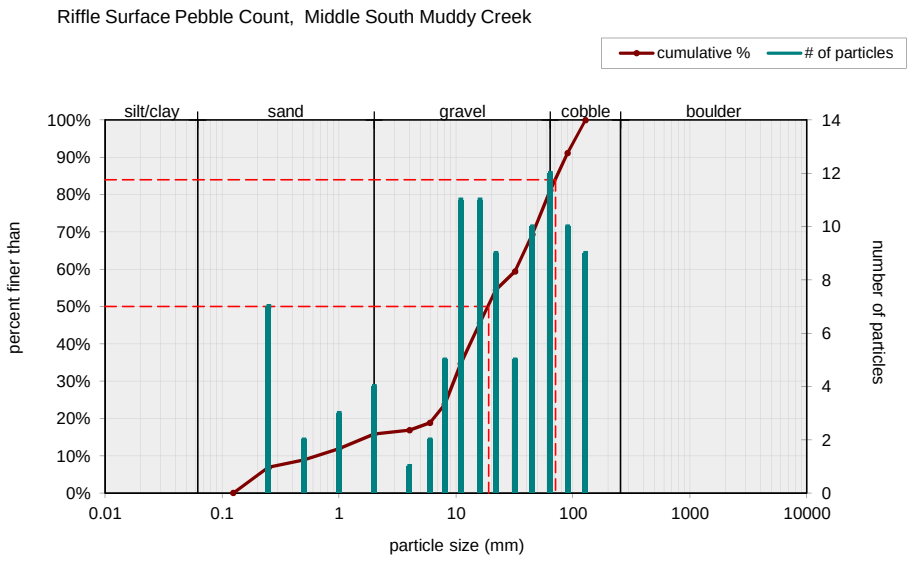
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	7
medium sand	0.25 - 0.5	2
coarse sand	0.5 - 1	3
very coarse sand	1 - 2	4
very fine gravel	2 - 4	1
fine gravel	4 - 6	2
fine gravel	6 - 8	5
medium gravel	8 - 11	11
medium gravel	11 - 16	11
coarse gravel	16 - 22	9
coarse gravel	22 - 32	5
very coarse gravel	32 - 45	10
very coarse gravel	45 - 64	12
small cobble	64 - 90	10
medium cobble	90 - 128	9
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		101
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		101

Note: On-Site Between Fords



Size (mm)	
D16	2.2
D35	11
D50	19
D65	39
D84	71
D95	110

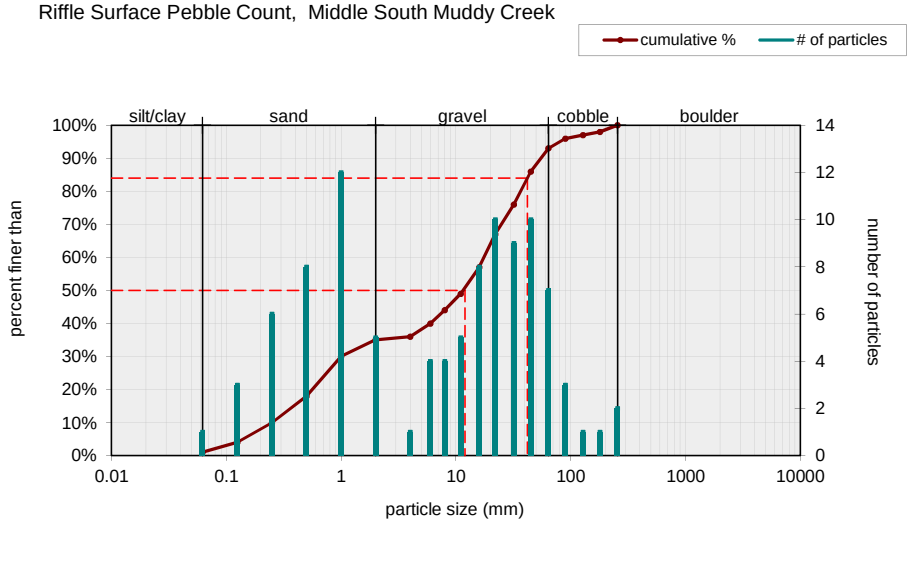
Size Distribution	
mean	12.5
dispersion	6.2
skewness	-0.15

Type	
silt/clay	0%
sand	16%
gravel	65%
cobble	19%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	3
fine sand	0.125 - 0.25	6
medium sand	0.25 - 0.5	8
coarse sand	0.5 - 1	12
very coarse sand	1 - 2	5
very fine gravel	2 - 4	1
fine gravel	4 - 6	4
fine gravel	6 - 8	4
medium gravel	8 - 11	5
medium gravel	11 - 16	8
coarse gravel	16 - 22	10
coarse gravel	22 - 32	9
very coarse gravel	32 - 45	10
very coarse gravel	45 - 64	7
small cobble	64 - 90	3
medium cobble	90 - 128	1
large cobble	128 - 180	1
very large cobble	180 - 256	2
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: Extended Forecast Reach



Size (mm)		
D16	0.42	3.4
D35	2	12
D50	12	17
D65	21	20
D84	42	29
D95	80	39

Size Distribution	
mean	4.2
dispersion	16.0
skewness	-0.32

Type	
silt/clay	1%
sand	34%
gravel	58%
cobble	7%
boulder	0%

2) Weighted Pebble Count

Feature Percent of Reach

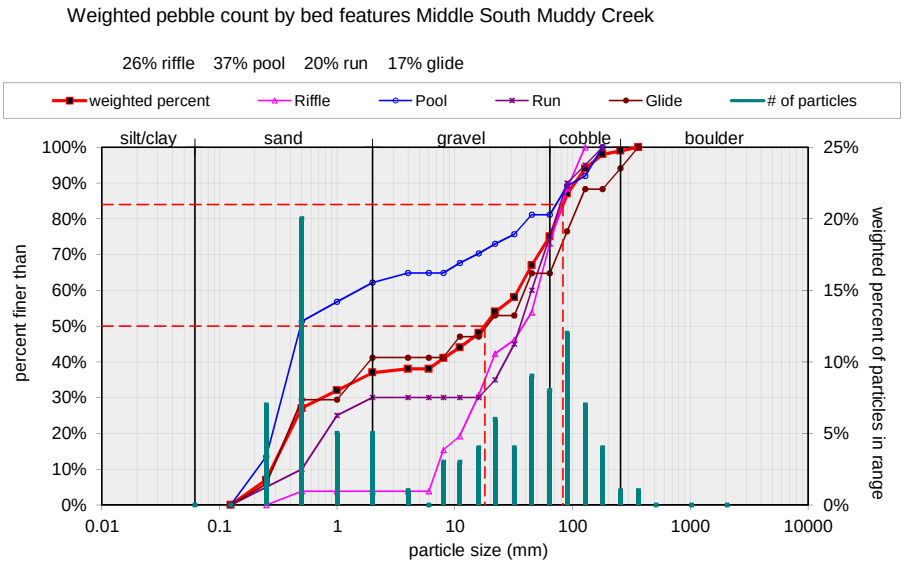
Riffle, Pool, Run, Glide

Riffle	26	%	Run	20	%
Pool	37	%	Glide	17	%

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	0.0
very fine sand	0.062 - 0.125	0.0
fine sand	0.125 - 0.25	7.0
medium sand	0.25 - 0.5	20.0
coarse sand	0.5 - 1	5.0
very coarse sand	1 - 2	5.0
very fine gravel	2 - 4	1.0
fine gravel	4 - 6	0.0
fine gravel	6 - 8	3.0
medium gravel	8 - 11	3.0
medium gravel	11 - 16	4.0
coarse gravel	16 - 22	6.0
coarse gravel	22 - 32	4.0
very coarse gravel	32 - 45	9.0
very coarse gravel	45 - 64	8.0
small cobble	64 - 90	12.0
medium cobble	90 - 128	7.0
large cobble	128 - 180	4.0
very large cobble	180 - 256	1.0
small boulder	256 - 362	1.0
small boulder	362 - 512	0.0
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock		0.0
clay hardpan		0.0
detritus/wood		0.0
artificial		0.0
total weighted count:		100.0

Note: On-Site Between Fords



Size (mm)	
D16	0.34
D35	1.5
D50	18
D65	42
D84	83
D95	140

Size Distribution	
mean	5.3
dispersion	28.8
skewness	-0.34

Type	
silt/clay	0%
sand	37%
gravel	38%
cobble	24%
boulder	1%

Riffle

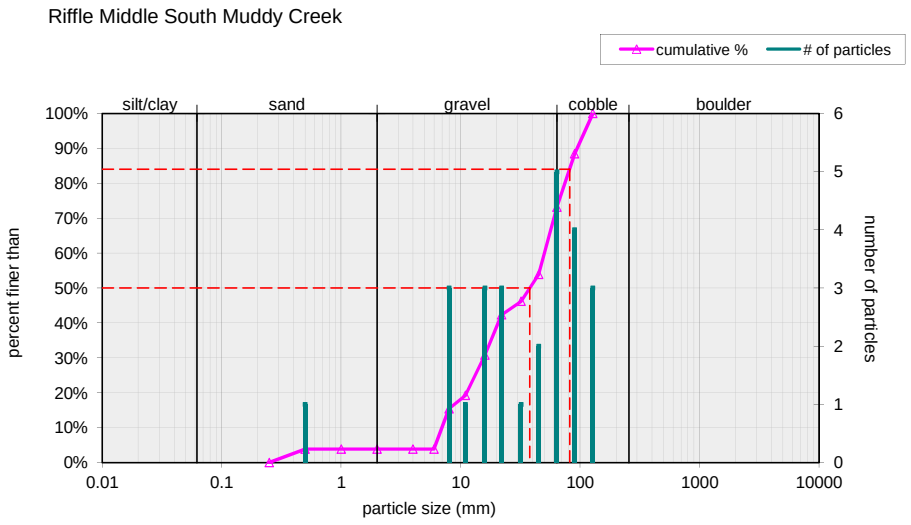
Material	Size Range (mm)		Count
silt/clay	0	- 0.062	
very fine sand	0.062	- 0.125	
fine sand	0.125	- 0.25	
medium sand	0.25	- 0.5	1
coarse sand	0.5	- 1	
very coarse sand	1	- 2	
very fine gravel	2	- 4	
fine gravel	4	- 6	
fine gravel	6	- 8	3
medium gravel	8	- 11	1
medium gravel	11	- 16	3
coarse gravel	16	- 22	3
coarse gravel	22	- 32	1
very coarse gravel	32	- 45	2
very coarse gravel	45	- 64	5
small cobble	64	- 90	4
medium cobble	90	- 128	3
large cobble	128	- 180	
very large cobble	180	- 256	
small boulder	256	- 362	
small boulder	362	- 512	
medium boulder	512	- 1024	
large boulder	1024	- 2048	
very large boulder	2048	- 4096	

total particle count: 26

bedrock	
clay hardpan	
detritus/wood	
artificial	

total count: 26

Note:



Size (mm)	
D16	8.4
D35	18
D50	38
D65	55
D84	82
D95	110

Size Distribution	
mean	26.2
dispersion	3.3
skewness	-0.16

Type	
silt/clay	0%
sand	4%
gravel	69%
cobble	27%
boulder	0%

Pool

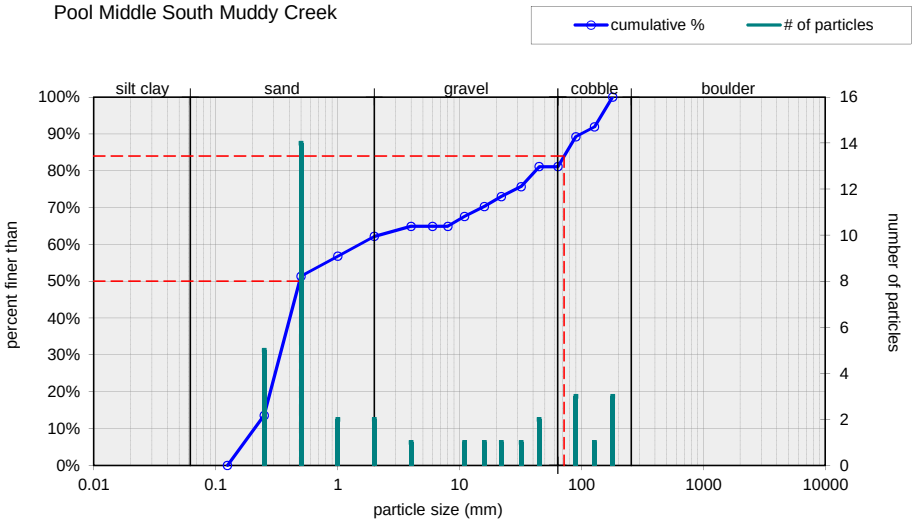
Material	Size Range (mm)		Count
silt/clay	0	- 0.062	
very fine sand	0.062	- 0.125	
fine sand	0.125	- 0.25	5
medium sand	0.25	- 0.5	14
coarse sand	0.5	- 1	2
very coarse sand	1	- 2	2
very fine gravel	2	- 4	1
fine gravel	4	- 6	
fine gravel	6	- 8	
medium gravel	8	- 11	1
medium gravel	11	- 16	1
coarse gravel	16	- 22	1
coarse gravel	22	- 32	1
very coarse gravel	32	- 45	2
very coarse gravel	45	- 64	
small cobble	64	- 90	3
medium cobble	90	- 128	1
large cobble	128	- 180	3
very large cobble	180	- 256	
small boulder	256	- 362	
small boulder	362	- 512	
medium boulder	512	- 1024	
large boulder	1024	- 2048	
very large boulder	2048	- 4096	

total particle count: 37

bedrock	
clay hardpan	
detritus/wood	
artificial	

total count: 37

Note:



Size (mm)	
D16	0.26
D35	0.37
D50	0.49
D65	8.1
D84	72
D95	150

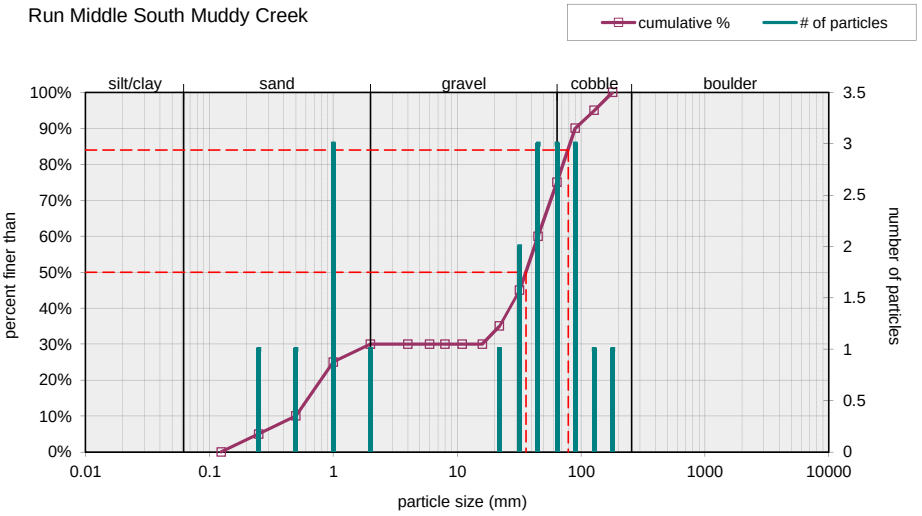
Size Distribution	
mean	4.3
dispersion	74.4
skewness	0.61

Type	
silt/clay	0%
sand	62%
gravel	19%
cobble	19%
boulder	0%

Run

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	1
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	3
very coarse sand	1 - 2	1
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	
coarse gravel	16 - 22	1
coarse gravel	22 - 32	2
very coarse gravel	32 - 45	3
very coarse gravel	45 - 64	3
small cobble	64 - 90	3
medium cobble	90 - 128	1
large cobble	128 - 180	1
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
	total particle count:	20
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
	total count:	20

Note:



Size (mm)	
D16	0.66
D35	22
D50	36
D65	51
D84	79
D95	130

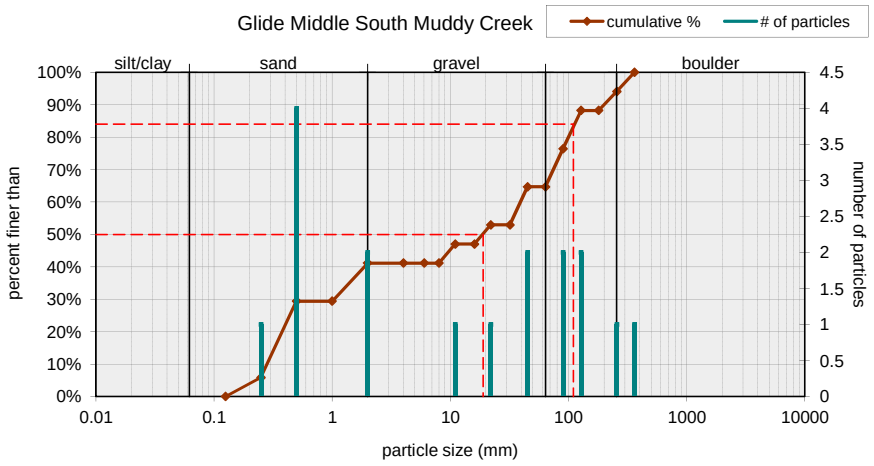
Size Distribution	
mean	7.2
dispersion	28.4
skewness	-0.48

Type	
silt/clay	0%
sand	30%
gravel	45%
cobble	25%
boulder	0%

Glide

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	1
medium sand	0.25 - 0.5	4
coarse sand	0.5 - 1	
very coarse sand	1 - 2	2
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	1
medium gravel	11 - 16	
coarse gravel	16 - 22	1
coarse gravel	22 - 32	
very coarse gravel	32 - 45	2
very coarse gravel	45 - 64	
small cobble	64 - 90	2
medium cobble	90 - 128	2
large cobble	128 - 180	
very large cobble	180 - 256	1
small boulder	256 - 362	1
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
	total particle count:	17
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
	total count:	17

Note:



Size (mm)	
D16	0.34
D35	1.4
D50	19
D65	65
D84	110
D95	270

Size Distribution	
mean	6.1
dispersion	30.8
skewness	-0.31

Type	
silt/clay	0%
sand	41%
gravel	24%
cobble	29%
boulder	6%

3) Bulk Sample Sieve Analysis

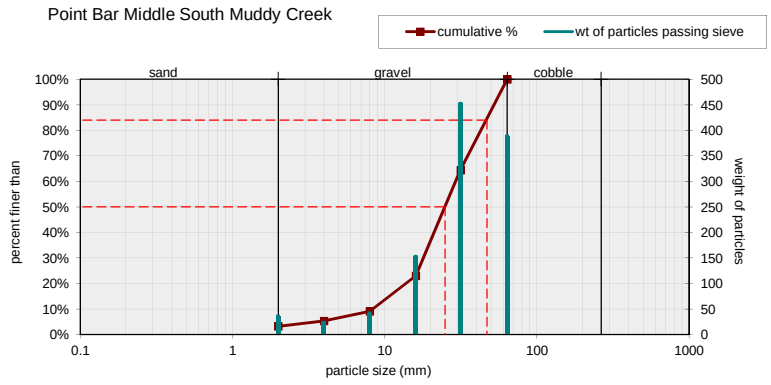
Two samples may be entered below. Select sample type for each.

Point Bar

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
0.5		35	35	3%	---	---
2		23	23	2%	3%	3%
4		41	41	4%	2%	5%
8		152	152	14%	4%	9%
16		452	452	41%	14%	23%
31.5		388	388	36%	41%	64%
64			0	0%	36%	100%

total wt retained in sieves: 1091

Note: Pavement



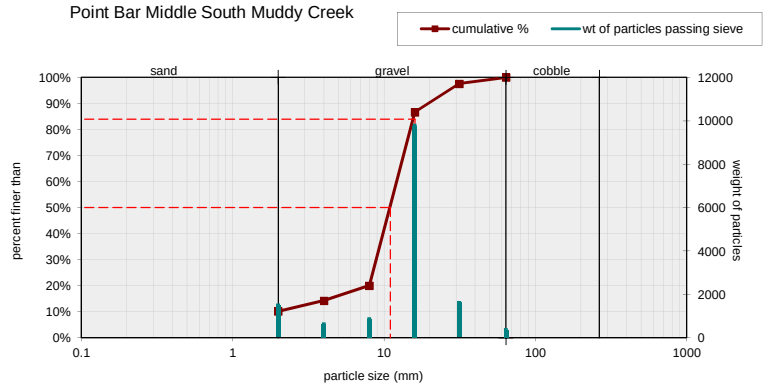
Size (mm)				
D16	11	D65	32	sand 100%
D35	19	D84	47	
D50	25	D95	58	

Point Bar

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
0.5		1483	1483	10%	---	---
2		607	607	4%	10%	10%
4		848	848	6%	4%	14%
8		9778	9778	67%	6%	20%
16		1605	1605	11%	67%	87%
31.5		352	352	2%	11%	98%
64			0	0%	2%	100%

total: 14673

Note: Sub-Pavement



Size (mm)			
D16	4.9	D65	13
D35	9.3	D84	16
D50	11	D95	27

Largest Particle

1	57
2	45
3	
4	
5	
	51.00

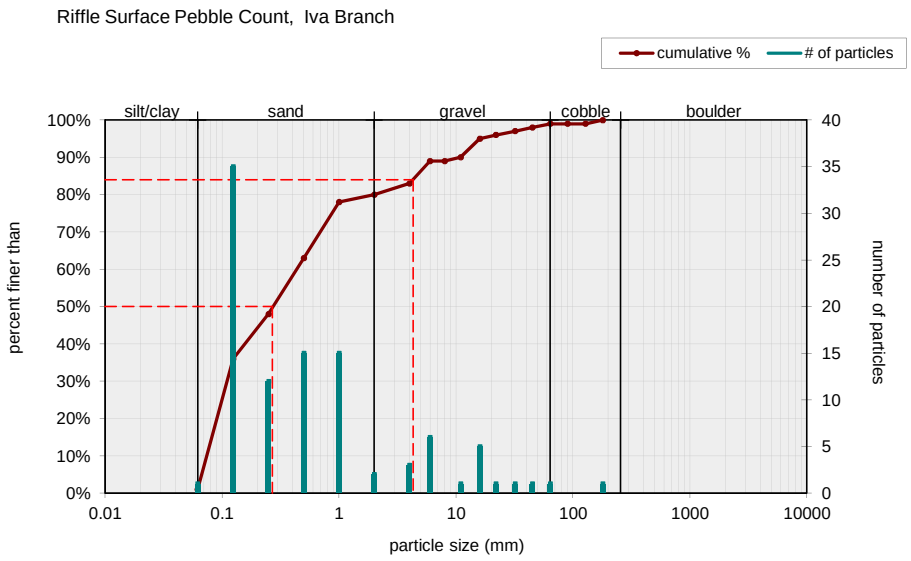
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm			Count
silt/clay	0	-	0.062	1
very fine sand	0.062	-	0.125	35
fine sand	0.125	-	0.25	12
medium sand	0.25	-	0.5	15
coarse sand	0.5	-	1	15
very coarse sand	1	-	2	2
very fine gravel	2	-	4	3
fine gravel	4	-	6	6
fine gravel	6	-	8	
medium gravel	8	-	11	1
medium gravel	11	-	16	5
coarse gravel	16	-	22	1
coarse gravel	22	-	32	1
very coarse gravel	32	-	45	1
very coarse gravel	45	-	64	1
small cobble	64	-	90	
medium cobble	90	-	128	
large cobble	128	-	180	1
very large cobble	180	-	256	
small boulder	256	-	362	
small boulder	362	-	512	
medium boulder	512	-	1024	
large boulder	1024	-	2048	
very large boulder	2048	-	4096	
total particle count:				100
bedrock ----------				
clay hardpan ----------				
detritus/wood ----------				
artificial ----------				
total count:				100

Note:



Size (mm)	
D16	0.084
D35	0.12
D50	0.27
D65	0.55
D84	4.3
D95	16

Size Distribution	
mean	0.6
dispersion	9.6
skewness	0.27

Type	
silt/clay	1%
sand	79%
gravel	19%
cobble	1%
boulder	0%

Erosion Rate Calculations

Project:	1049-MSMC	Date:	3/21/2011
Stream:	MSMC	Crew:	
Reach/Description:		Page:1	Of: 7

Feature	Units	moving u/s from d/s end of project						
Reach Name		msmc	msmc	msmc	msmc	msmc	msmc	
Station/Location		13+00	13+00	12+50	11+50	11+50	08+50	
Photo No.								
Reach Length	ft	150	50	100	150	300	150	
Bank	RT-LT-Both	R	L	L	R	L	L	
Bank Height	ft	5	5	5	4	4	5	
Bankfull Height	ft	1.8	1.8	1.6	1.6	1.6	2	
Root Depth	ft	0.2	0.2	0.2	0.2	0.2	0.2	
Root Density	%	5%	5%	5%	5%	5%	2%	
Bank Angle	Degrees	80	80	60	40	85	35	
Surface Protection	%	30%	40%	75%	80%	60%	10%	
Bank Material	C-G-S-SC	S	S	S	S/G	S/G	S/G	
Stratification	Yes-No	N	N	N	Y	Y	Y	
Thalweg Position	C-OC-Toe	OC	OC	OC	C	C	OC	
D_{TOE}/D_{MEAN}	<1 or >1	<1	<1	1	<1	<1	<1	
Local Slope > Avg	Yes-No	N	N	N	N	N	N	
BEHI Calculation								
Bnk Ht / Bkf Ht		2.8	2.8	3.1	2.5	2.5	2.5	
BEHI Score		9	9	9.8	8.7	8.7	8.7	
Root Depth / Bnk Ht		0.04	0.04	0.04	0.05	0.05	0.04	
BEHI Score		9	9	9	9	9	9	
Weighted Root Density		0.2%	0.2%	0.2%	0.3%	0.3%	0.1%	
BEHI Score		10	10	10	10	10	10	
Bank Angle		80	80	60	40	85	35	
BEHI Score		6	6	4	3	7	2.5	
Surface Protection		30%	40%	75%	80%	60%	10%	
BEHI Score		6	5	2.8	2	3.5	9	
Bank Material Adjustment		10	10	10	5	5	5	
Stratification Adjustment		0	0	0	5	5	5	
Total BEHI Score		50	49	45.6	42.7	48.2	49.2	
Rating		EXTREME	EXTREME	VERY HIGH	VERY HIGH	EXTREME	EXTREME	
NBS Calculation								
Thalweg Position Score		1.5	1.5	1.5	1	1	1.5	
Toe Depth Ratio Score		0	0	0	0	0	0	
Local Slope Score		0	0	0	0	0	0	
Total NBS Rating		1.5	1.5	1.5	1	1	1.5	
Rating		LOW	LOW	LOW	VERY LOW	VERY LOW	LOW	
Erosion Rate Predition								
Erosion Rate (ft/yr)		0.4	0.4	0.23	0.17	0.2	0.4	**Sheet Total**
Erosion Total (ft^3/yr)		300	100	115	102	240	300	1157

Erosion Rate Calculations

Project: 1049-MSMC Date: 3/21/2011

Stream: MSMC Crew:

Reach/Description: Page: 2 Of: 7

Feature	Units							
Reach Name		msmc	msmc	msmc	msmc	msmc	msmc	
Station/Location		10+00	08+50	05+00	05+00	07+00	02+00	
Photo No.								
Reach Length	ft	150	350	300	300	200	200	
Bank	RT-LT-Both	R	R	L	R	L	L	
Bank Height	ft	4	4.5	4.5	4.5	4	6	
Bankfull Height	ft	1.6	2	1.9	1.9	2	2	
Root Depth	ft	0.2	0.2	0.5	0.5	0.2	0.5	
Root Density	%	5%	2%	5%	5%	5%	10%	
Bank Angle	Degrees	75	85	80	80	55	85	
Surface Protection	%	25%	10%	75%	75%	85%	75%	
Bank Material	C-G-S-SC	S/G	S/G	S/G	S/G	S	S	
Stratification	Yes-No	Y	Y	N	N	N	N	
Thalweg Position	C-OC-Toe	OC	OC	C	C	OC	OC	
D_{TOE}/D_{MEAN}	<1 or >1	<1	<1	<1	<1	<1	<1	
Local Slope > Avg	Yes-No	N	N	N	N	N	N	
BEHI Calculation								
Bnk Ht / Bkf Ht		2.50	2.25	2.37	2.37	2.00	3.00	
BEHI Score		8.7	8.4	8.5	8.5	8	9.2	
Root Depth / Bnk Ht		0.05	0.04	0.11	0.11	0.05	0.08	
BEHI Score		9	9	8.5	8.5	9	8.7	
Weighted Root Density		0.3%	0.1%	0.6%	0.6%	0.3%	0.8%	
BEHI Score		10	10	10	10	10	10	
Bank Angle		75	85	80	80	55	85	
BEHI Score		4.2	6.3	6	6	3	6.3	
Surface Protection		25%	10%	75%	75%	85%	75%	
BEHI Score		6	9	2.5	2.5	1.9	2.5	
Bank Material Adjustment		7	7	7	7	10	10	
Stratification Adjustment		0	0	0	0	0	0	
Total BEHI Score		44.9	49.7	42.5	42.5	41.9	46.7	
Rating		VERY HIGH	EXTREME	VERY HIGH	EXTREME	VERY HIGH	EXTREME	
NBS Calculation								
Thalweg Position Score		1.5	1.5	1	1	1.5	1.5	
Toe Depth Ratio Score		0	0	0	0	0	0	
Local Slope Score		0	0	0	0	0	0	
Total NBS Rating		1.5	1.5	1	1	1.5	1.5	
Rating		LOW	LOW	VERY LOW	VERY LOW	LOW	LOW	
Erosion Rate Predition								
Erosion Rate (ft/yr)		0.24	0.41	0.17	0.2	0.23	0.4	**Sheet Total**
Erosion Total (ft^3/yr)		144	645.75	229.5	270	184	480	1953.25

Erosion Rate Calculations

Project: 1049-MSMC Date: 3/21/2011

Stream: MSMC Crew:

Reach/Description: Page: 3 Of: 7

Feature	Units							
Reach Name		MSMC						
Station/Location		02+00						
Photo No.								
Reach Length	ft	200						
Bank	RT-LT-Both	R						
Bank Height	ft	6						
Bankfull Height	ft	2						
Root Depth	ft	0.5						
Root Density	%	10%						
Bank Angle	Degrees	85						
Surface Protection	%	75%						
Bank Material	C-G-S-SC	S						
Stratification	Yes-No	N						
Thalweg Position	C-OC-Toe	OC						
D_{TOE}/D_{MEAN}	<1 or >1	<1						
Local Slope > Avg	Yes-No	N						
BEHI Calculation								
Bnk Ht / Bkf Ht		3						
BEHI Score		9.2						
Root Depth / Bnk Ht		0.08						
BEHI Score		8.7						
Weighted Root Density		0.8%						
BEHI Score		10						
Bank Angle		85						
BEHI Score		6.3						
Surface Protection		75%						
BEHI Score		2.5						
Bank Material Adjustment		10						
Stratification Adjustment		0						
Total BEHI Score		46.7						
Rating		EXTREME						
NBS Calculation								
Thalweg Position Score		1.5						
Toe Depth Ratio Score		0						
Local Slope Score		0						
Total NBS Rating		1.5						
Rating		LOW						
Erosion Rate Predition								
Erosion Rate (ft/yr)		0.4						**Sheet Total**
Erosion Total (ft^3/yr)		480						480

Erosion Rate Calculations

Project:	1049-MSMC	Date:	3/21/2011
Stream:	SPROUSE BRANCH	Crew:	
Reach/Description:		Page: 4	Of: 7

Feature	Units							
Reach Name		SPROUSE	SPROUSE	SPROUSE	SPROUSE			
Station/Location		7+25	7+25	3+50	3+50			
Photo No.								
Reach Length	ft	375	375	350	350			
Bank	RT-LT-Both	L	R	L	R			
Bank Height	ft	3.5	3.5	3.5	3.5			
Bankfull Height	ft	0.4	0.4	0.4	0.4			
Root Depth	ft	1	1	0.7	0.7			
Root Density	%	25%	25%	15%	15%			
Bank Angle	Degrees	40	40	75	75			
Surface Protection	%	100%	100%	70%	70%			
Bank Material	C-G-S-SC	S	S	S, SC	S,SC			
Stratification	Yes-No	N	N	N	N			
Thalweg Position	C-OC-Toe	C	C	C	C			
D_{TOE}/D_{MEAN}	<1 or >1	1	1	1	1			
Local Slope > Avg	Yes-No	N	N	N	N			
BEHI Calculation								
Bnk Ht / Bkf Ht		8.75	8.75	8.75	8.75			
BEHI Score		10	10	10	10			
Root Depth / Bnk Ht		0.29	0.29	0.20	0.20			
BEHI Score		5.8	5.8	6	6			
Weighted Root Density		7.1%	7.1%	3.0%	3.0%			
BEHI Score		8.8	8.8	9.5	9.5			
Bank Angle		40	40	75	75			
BEHI Score		3	3	5	5			
Surface Protection		100%	100%	70%	70%			
BEHI Score		0	0	2.7	2.7			
Bank Material Adjustment		10	10	8	8			
Stratification Adjustment		0	0	0	0			
Total BEHI Score		37.6	37.6	41.2	41.2			
Rating		HIGH	HIGH	VERY HIGH	VERY HIGH			
NBS Calculation								
Thalweg Position Score		1	1	1	1			
Toe Depth Ratio Score		0	0	0	0			
Local Slope Score		0	0	0	0			
Total NBS Rating		1	1	1	1			
Rating		VERY LOW	VERY LOW	VERY LOW	VERY LOW			
Erosion Rate Predition								
Erosion Rate (ft/yr)		0.17	0.17	0.17	0.17			**Sheet Total**
Erosion Total (ft^3/yr)		223.125	223.125	208.25	208.25			862.75

Erosion Rate Calculations

Project: 1049-MSMC Date: 3/21/2011

Stream: IVA BRANCH Crew:

Reach/Description: Page: 5 Of: 7

Feature	Units							
Reach Name		IVA	IVA	IVA	IVA	IVA	IVA	
Station/Location				306+00	306+00	304+50	304+50	
Photo No.								
Reach Length	ft	75	75	150	150	100	100	
Bank	RT-LT-Both	L	R	L	R	L	R	
Bank Height	ft	2.5	2.5	4.5	4.5	6	6	
Bankfull Height	ft	0.6	0.6	0.6	0.6	0.6	0.6	
Root Depth	ft	0.4	0.4	0.2	0.2	0.3	0.3	
Root Density	%	5%	5%	5%	5%	2%	2%	
Bank Angle	Degrees	30	30	80	80	80	80	
Surface Protection	%	75%	75%	60%	60%	15%	15%	
Bank Material	C-G-S-SC	S/G	S/G	S/G	S/G	S/G	S/G	
Stratification	Yes-No	N	N	N	N	N	N	
Thalweg Position	C-OC-Toe	OC	OC	OC	OC	C	C	
D_{TOE}/D_{MEAN}	<1 or >1	1	1	1	1	1	1	
Local Slope > Avg	Yes-No	N	N	N	N	N	N	
BEHI Calculation								
Bnk Ht / Bkf Ht		4.17	4.17	7.50	7.50	10.00	10.00	
BEHI Score		10	10	10	10	10	10	
Root Depth / Bnk Ht		0.16	0.16	0.04	0.04	0.05	0.05	
BEHI Score		8	8	10	10	10	10	
Weighted Root Density		0.8%	0.8%	0.2%	0.2%	0.1%	0.1%	
BEHI Score		10	10	10	10	10	10	
Bank Angle		30	30	80	80	80	80	
BEHI Score		2.5	2.5	6	6	6	6	
Surface Protection		75%	75%	60%	60%	15%	15%	
BEHI Score		2.2	2.2	3.5	3.5	8	8	
Bank Material Adjustment		7	7	7	7	7	7	
Stratification Adjustment		0	0	0	0	0	0	
Total BEHI Score		39.7	39.7	46.5	46.5	51	51	
Rating		VERY HIGH	VERY HIGH	EXTREME	EXTREME	EXTREME	EXTREME	
NBS Calculation								
Thalweg Position Score		1.5	1.5	1.5	1.5	1	1	
Toe Depth Ratio Score		0	0	0	0	0	0	
Local Slope Score		0	0	0	0	0	0	
Total NBS Rating		1.5	1.5	1.5	1.5	1	1	
Rating		LOW	LOW	LOW	LOW	VERY LOW	VERY LOW	
Erosion Rate Predition								
Erosion Rate (ft/yr)		0.23	0.23	0.4	0.4	0.2	0.2	**Sheet Total**
Erosion Total (ft^3/yr)		43.125	43.125	270	270	120	120	866.25

Erosion Rate Calculations

Project: 1049-MSMC Date: 3/21/2011

Stream: IVA BRANCH Crew:

Reach/Description: Page: 6 Of: 7

Feature	Units							
Reach Name		IVA	IVA	IVA	IVA		IVA	
Station/Location		3+50	3+50	3+00	3+00			
Photo No.								
Reach Length	ft	50	50	150	150			
Bank	RT-LT-Both	L	R	L	R			
Bank Height	ft	10	4.5	12	12			
Bankfull Height	ft	0.4	0.4	0.4	0.4			
Root Depth	ft	0.3	0.3	0.3	0.3			
Root Density	%	2%	2%	1%	1%			
Bank Angle	Degrees	90	80	85	85			
Surface Protection	%	10%	25%	10%	10%			
Bank Material	C-G-S-SC	S/G	S/G	S/G	S/G			
Stratification	Yes-No	N	N	N	N			
Thalweg Position	C-OC-Toe	C	C	C	C			
D_{TOE}/D_{MEAN}	<1 or >1	1	1	1	1			
Local Slope > Avg	Yes-No	N	N	N	N			
BEHI Calculation								
Bnk Ht / Bkf Ht		25	11.25	30	30			
BEHI Score		10	10	10	10			
Root Depth / Bnk Ht		0.03	0.07	0.03	0.03			
BEHI Score		10	10	10	10			
Weighted Root Density		0.1%	0.1%	0.0%	0.0%			
BEHI Score		10	10	10	10			
Bank Angle		90	80	85	85			
BEHI Score		8	6	7	7			
Surface Protection		10%	25%	10%	10%			
BEHI Score		9	6.5	9	9			
Bank Material Adjustment		7	7	7	7			
Stratification Adjustment		0	0	0	0			
Total BEHI Score		54	49.5	53	53			
Rating		EXTREME	EXTREME	EXTREME	EXTREME			
NBS Calculation								
Thalweg Position Score		1	1	1	1			
Toe Depth Ratio Score		0	0	0	0			
Local Slope Score		0	0	0	0			
Total NBS Rating		1	1	1	1			
Rating		VERY LOW	VERY LOW	VERY LOW	VERY LOW			
Erosion Rate Predition								
Erosion Rate (ft/yr)		0.2	0.2	0.2	0.2			**Sheet Total**
Erosion Total (ft^3/yr)		100	45	360	360			865

Erosion Rate Calculations

Project: 1049-MSMC Date: 3/21/2011

Stream: IVA BRANCH Crew:

Reach/Description: Page: 7 Of: 7

Feature	Units							
Reach Name		IVA	IVA	IVA	IVA		IVA	
Station/Location		DITCH	DITCH	1+50	1+50			
Photo No.								
Reach Length	ft	75	75	150	150			
Bank	RT-LT-Both	L	R	L	R			
Bank Height	ft	9	9	3	3			
Bankfull Height	ft	0.3	0.3	0.3	0.3			
Root Depth	ft	0.2	0.2	0.5	0.5			
Root Density	%	1%	1%	30%	30%			
Bank Angle	Degrees	80	80	90	90			
Surface Protection	%	15%	15%	10%	10%			
Bank Material	C-G-S-SC	SC	SC	SC	SC			
Stratification	Yes-No	N	N	N	N			
Thalweg Position	C-OC-Toe	OC	OC	OC	OC			
D_{TOE}/D_{MEAN}	<1 or >1	1	1	1	1			
Local Slope > Avg	Yes-No	N	N	N	N			
BEHI Calculation								
Bnk Ht / Bkf Ht		30	30	10	10			
BEHI Score		10	10	10	10			
Root Depth / Bnk Ht		0.02	0.02	0.17	0.17			
BEHI Score		10	10	7.8	7.8			
Weighted Root Density		0.0%	0.0%	5.0%	5.0%			
BEHI Score		10	10	9	9			
Bank Angle		80	80	90	90			
BEHI Score		6	6	8	8			
Surface Protection		15%	15%	10%	10%			
BEHI Score		8	8	9	9			
Bank Material Adjustment		0	0	0	0			
Stratification Adjustment		0	0	0	0			
Total BEHI Score		44	44	43.8	43.8			
Rating		VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH			
NBS Calculation								
Thalweg Position Score		1.5	1.5	1.5	1.5			
Toe Depth Ratio Score		0	0	0	0			
Local Slope Score		0	0	0	0			
Total NBS Rating		1.5	1.5	1.5	1.5			
Rating		LOW	LOW	LOW	LOW			
Erosion Rate Predition								
Erosion Rate (ft/yr)		0.23	0.23	0.23	0.23			**Sheet Total**
Erosion Total (ft^3/yr)		155.25	155.25	103.5	103.5			517.5

EXISTING - CORRECTED

HEC-RAS Plan: Proposed 10' River: SouthMuddyCr Reach: Main

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft/ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
Main	69124.15	BKF	190.00	1272.07	1274.96	0.009308	0.59	4.60	1.01	4.63	4.63
Main	69124.15	2 yr	400.00	1272.07	1276.24	0.008211	0.58	5.65	1.33	7.52	7.52
Main	69124.15	10 yr	930.00	1272.07	1278.09	0.007806	0.60	7.12	1.86	13.25	4.57
Main	69124.15	50 yr	1610.00	1272.07	1279.68	0.005531	0.53	7.35	1.79	13.16	2.81
Main	69124.15	100 yr	2480.00	1272.07	1281.27	0.003802	0.46	7.13	1.55	11.08	2.48
Main	68919.69	BKF	190.00	1270.91	1273.60	0.004818	0.44	3.59	0.59	2.12	2.12
Main	68919.69	2 yr	400.00	1270.91	1275.17	0.003727	0.41	4.21	0.70	2.96	2.96
Main	68919.69	10 yr	930.00	1270.91	1276.79	0.005518	0.52	6.39	1.45	9.25	4.67
Main	68919.69	50 yr	1610.00	1270.91	1277.83	0.007831	0.64	8.68	2.50	21.74	10.48
Main	68919.69	100 yr	2480.00	1270.91	1278.76	0.010449	0.75	11.07	3.88	42.90	19.99
Main	68434.66	BKF	190.00	1267.08	1271.15	0.004957	0.44	4.16	0.74	3.08	3.08
Main	68434.66	2 yr	400.00	1267.08	1272.97	0.005108	0.46	4.95	0.97	4.79	4.79
Main	68434.66	10 yr	930.00	1267.08	1274.43	0.005030	0.47	5.62	1.17	6.57	1.38
Main	68434.66	50 yr	1610.00	1267.08	1275.34	0.004674	0.47	6.15	1.31	8.07	1.28
Main	68434.66	100 yr	2480.00	1267.08	1276.10	0.004565	0.48	6.65	1.47	9.75	1.65
Main	68285.54	BKF	190.00	1265.49	1270.44	0.004786	0.39	3.96	0.68	2.70	2.70
Main	68285.54	2 yr	400.00	1265.49	1272.05	0.006337	0.47	5.38	1.16	~~6.22~~	~~6.22~~
Main	68285.54	10 yr	930.00	1265.49	1273.80	0.003563	0.37	5.00	0.90	4.49	0.72
Main	68285.54	50 yr	1610.00	1265.49	1274.75	0.003337	0.36	5.36	0.98	5.25	1.01
Main	68285.54	100 yr	2480.00	1265.49	1275.43	0.003912	0.40	6.18	1.27	7.83	1.70
Main	68095.50	BKF	190.00	1265.25	1269.70	0.003366	0.36	3.50	0.52	1.81	1.81
Main	68095.50	2 yr	400.00	1265.25	1271.02	0.005067	0.46	4.89	0.95	~~4.65~~	~~3.73~~
Main	68095.50	10 yr	930.00	1265.25	1273.46	0.001216	0.24	3.34	0.37	1.25	0.22
Main	68095.50	50 yr	1610.00	1265.25	1274.38	0.001408	0.27	3.96	0.50	1.99	0.41
Main	68095.50	100 yr	2480.00	1265.25	1274.94	0.002045	0.33	5.03	0.79	3.98	0.88
Main	68051.88		Bridge								
Main	68000.80	BKF	190.00	1266.89	1269.23	0.005311	0.45	3.34	0.54	1.81	1.81
Main	68000.80	2 yr	400.00	1266.89	1270.55	0.003702	0.41	3.82	0.61	2.32	1.36
Main	68000.80	10 yr	930.00	1266.89	1272.00	0.003281	0.41	4.73	0.81	3.83	0.86
Main	68000.80	50 yr	1610.00	1266.89	1273.04	0.003066	0.41	5.30	0.95	5.01	1.10
Main	68000.80	100 yr	2480.00	1266.89	1274.03	0.002879	0.41	5.77	1.06	6.09	1.45
Main	67799.13	BKF	190.00	1264.99	1268.35	0.003460	0.38	3.31	0.48	1.59	1.59
Main	67799.13	2 yr	400.00	1264.99	1269.73	0.003762	0.41	4.25	0.71	3.03	2.01
Main	67799.13	10 yr	930.00	1264.99	1271.32	0.003260	0.41	5.09	0.90	4.59	0.87
Main	67799.13	50 yr	1610.00	1264.99	1272.43	0.002966	0.40	5.58	1.01	5.64	1.11
Main	67799.13	100 yr	2480.00	1264.99	1273.47	0.002799	0.40	6.03	1.12	6.75	1.49
Main	67586.76	BKF	190.00	1264.67	1267.55	0.004013	0.40	3.42	0.52	1.80	1.80
Main	67586.76	2 yr	400.00	1264.67	1268.84	0.004545	0.45	4.37	0.78	3.41	2.64
Main	67586.76	10 yr	930.00	1264.67	1270.20	0.005489	0.53	6.19	1.38	8.53	1.76
Main	67586.76	50 yr	1610.00	1264.67	1271.26	0.005621	0.55	7.25	1.76	12.74	2.50
Main	67586.76	100 yr	2480.00	1264.67	1272.28	0.005519	0.56	8.06	2.05	16.56	3.35
Main	67117.21	BKF	190.00	1262.37	1265.55	0.004512	0.42	3.40	0.53	1.81	1.81
Main	67117.21	2 yr	400.00	1262.37	1266.70	0.004511	0.45	4.46	0.80	3.58	2.08
Main	67117.21	10 yr	930.00	1262.37	1267.98	0.004512	0.47	5.51	1.10	6.07	1.17
Main	67117.21	50 yr	1610.00	1262.37	1269.04	0.004510	0.48	6.37	1.37	8.73	1.85
Main	67117.21	100 yr	2480.00	1262.37	1270.07	0.004511	0.50	7.16	1.63	11.70	2.69

PROPOSED 15' BENCH W/OUT PIPES

HEC-RAS Plan: Proposed 10' River: SouthMuddyCr Reach: Main

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft/ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
Main	69124.15	BKF	190.00	1272.07	1274.96	0.009317	0.59	4.60	1.01	4.64	4.64
Main	69124.15	2 yr	400.00	1272.07	1276.17	0.008769	0.60	5.78	1.40	8.08	8.08
Main	69124.15	10 yr	930.00	1272.07	1278.07	0.007992	0.60	7.18	1.89	13.60	4.77
Main	69124.15	50 yr	1610.00	1272.07	1279.68	0.005531	0.53	7.35	1.79	13.16	2.81
Main	69124.15	100 yr	2480.00	1272.07	1281.27	0.003795	0.46	7.12	1.55	11.05	2.48
Main	68919.69	BKF	190.00	1270.91	1273.67	0.004364	0.42	3.48	0.55	1.91	1.91
Main	68919.69	2 yr	400.00	1270.91	1274.96	0.004519	0.44	4.50	0.81	3.66	3.66
Main	68919.69	10 yr	930.00	1270.91	1276.68	0.006055	0.54	6.58	1.55	10.20	5.18
Main	68919.69	50 yr	1610.00	1270.91	1277.83	0.007838	0.64	8.69	2.51	21.76	10.49
Main	68919.69	100 yr	2480.00	1270.91	1278.82	0.010060	0.74	10.93	3.77	41.19	19.15
Main	68434.66	BKF	190.00	1267.61	1270.56	0.009005	0.60	5.36	1.26	6.74	3.54
Main	68434.66	2 yr	400.00	1267.61	1271.73	0.008678	0.63	6.83	1.79	12.25	6.12
Main	68434.66	10 yr	930.00	1267.61	1273.84	0.005841	0.56	7.61	1.91	14.52	2.01
Main	68434.66	50 yr	1610.00	1267.61	1274.85	0.005977	0.58	8.57	2.30	19.69	1.97
Main	68434.66	100 yr	2480.00	1267.61	1275.58	0.006445	0.61	9.54	2.74	26.17	2.54
Main	68285.54	BKF	190.00	1267.17	1269.94	0.002243	0.31	2.67	0.31	0.84	0.54
Main	68285.54	2 yr	400.00	1267.17	1271.28	0.001784	0.30	3.24	0.39	1.28	0.68
Main	68285.54	10 yr	930.00	1267.17	1273.63	0.001029	0.25	3.44	0.38	1.29	0.22
Main	68285.54	50 yr	1610.00	1267.17	1274.54	0.001387	0.29	4.38	0.58	2.55	0.44
Main	68285.54	100 yr	2480.00	1267.17	1275.10	0.002084	0.37	5.66	0.95	5.37	0.95
Main	68095.50	BKF	190.00	1266.61	1269.59	0.001669	0.27	2.44	0.25	0.62	0.43
Main	68095.50	2 yr	400.00	1266.61	1270.97	0.001511	0.28	3.12	0.36	1.11	0.42
Main	68095.50	10 yr	930.00	1266.61	1273.52	0.000606	0.19	2.77	0.24	0.66	0.11
Main	68095.50	50 yr	1610.00	1266.61	1274.38	0.000861	0.23	3.59	0.38	1.37	0.25
Main	68095.50	100 yr	2480.00	1266.61	1274.84	0.001430	0.31	4.82	0.68	3.26	0.63
Main	68051.88		Bridge								
Main	68000.80	BKF	190.00	1266.34	1268.91	0.003073	0.36	2.95	0.39	1.15	0.83
Main	68000.80	2 yr	400.00	1266.34	1269.97	0.003067	0.38	3.87	0.59	2.28	1.20
Main	68000.80	10 yr	930.00	1266.34	1271.53	0.003184	0.42	5.15	0.91	4.71	0.97
Main	68000.80	50 yr	1610.00	1266.34	1272.67	0.003061	0.43	5.84	1.09	6.39	1.21
Main	68000.80	100 yr	2480.00	1266.34	1273.73	0.002873	0.42	6.33	1.21	7.66	1.49
Main	67799.13	BKF	190.00	1265.72	1268.29	0.003157	0.36	2.97	0.40	1.19	0.87
Main	67799.13	2 yr	400.00	1265.72	1269.35	0.003091	0.39	3.88	0.59	2.29	1.16
Main	67799.13	10 yr	930.00	1265.72	1270.93	0.002965	0.40	4.98	0.85	4.25	0.89
Main	67799.13	50 yr	1610.00	1265.72	1272.12	0.002734	0.40	5.56	0.99	5.48	1.09
Main	67799.13	100 yr	2480.00	1265.72	1273.20	0.002591	0.40	6.05	1.11	6.70	1.41
Main	67586.76	BKF	190.00	1265.08	1267.53	0.003818	0.40	3.15	0.46	1.44	1.14
Main	67586.76	2 yr	400.00	1265.08	1268.62	0.003528	0.41	4.07	0.66	2.68	1.39
Main	67586.76	10 yr	930.00	1265.08	1270.01	0.004431	0.49	5.85	1.20	7.03	1.50
Main	67586.76	50 yr	1610.00	1265.08	1271.09	0.004767	0.53	7.02	1.61	11.30	2.18
Main	67586.76	100 yr	2480.00	1265.08	1272.13	0.004857	0.55	7.95	1.95	15.48	3.02
Main	67117.21	BKF	190.00	1262.37	1265.55	0.004512	0.42	3.40	0.53	1.81	1.81
Main	67117.21	2 yr	400.00	1262.37	1266.70	0.004511	0.45	4.46	0.80	3.58	2.08
Main	67117.21	10 yr	930.00	1262.37	1267.98	0.004512	0.47	5.51	1.10	6.07	1.17
Main	67117.21	50 yr	1610.00	1262.37	1269.04	0.004510	0.48	6.37	1.37	8.73	1.85
Main	67117.21	100 yr	2480.00	1262.37	1270.07	0.004511	0.50	7.16	1.63	11.70	2.69

PROPOSED 10' BENCH W/ PIPES

HEC-RAS Plan: Proposed 10' River: SouthMuddyCr Reach: Main

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft/ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
Main	69124.15	BKF	190.00	1272.07	1274.96	0.009330	0.59	4.60	1.01	4.65	4.65
Main	69124.15	2 yr	400.00	1272.07	1276.17	0.008800	0.60	5.79	1.40	8.12	8.12
Main	69124.15	10 yr	930.00	1272.07	1278.24	0.006796	0.56	6.79	1.67	11.36	3.57
Main	69124.15	50 yr	1610.00	1272.07	1279.71	0.005391	0.52	7.29	1.75	12.77	2.71
Main	69124.15	100 yr	2480.00	1272.07	1281.27	0.003784	0.45	7.11	1.55	11.01	2.47
Main	68919.69	BKF	190.00	1270.91	1273.57	0.004968	0.44	3.63	0.60	2.19	2.19
Main	68919.69	2 yr	400.00	1270.91	1274.95	0.004567	0.45	4.52	0.82	3.71	3.71
Main	68919.69	10 yr	930.00	1270.91	1277.25	0.003910	0.44	5.72	1.13	6.44	3.18
Main	68919.69	50 yr	1610.00	1270.91	1278.12	0.006472	0.58	8.16	2.17	17.73	8.45
Main	68919.69	100 yr	2480.00	1270.91	1278.90	0.009631	0.73	10.78	3.65	39.31	18.22
Main	68434.66	BKF	190.00	1267.61	1270.93	0.005508	0.48	4.60	0.89	4.08	2.39
Main	68434.66	2 yr	400.00	1267.61	1272.16	0.006222	0.55	6.23	1.44	8.94	4.73
Main	68434.66	10 yr	930.00	1267.61	1273.40	0.012002	0.79	10.35	3.62	~~37.49~~	~~18.14~~
Main	68434.66	50 yr	1610.00	1267.61	1274.63	0.008389	0.69	9.94	3.12	~~31.02~~	3.65
Main	68434.66	100 yr	2480.00	1267.61	1275.60	0.006824	0.63	9.83	2.91	28.62	2.68
Main	68285.54	BKF	190.00	1267.17	1270.62	0.000896	0.21	2.01	0.16	0.33	0.20
Main	68285.54	2 yr	400.00	1267.17	1271.91	0.001054	0.24	2.77	0.27	0.76	0.45
Main	68285.54	10 yr	930.00	1267.17	1273.17	0.001748	0.32	4.24	0.59	2.50	0.44
Main	68285.54	50 yr	1610.00	1267.17	1274.19	0.002024	0.35	5.12	0.81	4.13	0.67
Main	68285.54	100 yr	2480.00	1267.17	1275.09	0.002251	0.38	5.88	1.02	6.01	1.03
Main	68095.50	BKF	190.00	1266.61	1270.50	0.000544	0.16	1.72	0.11	0.19	0.10
Main	68095.50	2 yr	400.00	1266.61	1271.77	0.000638	0.19	2.30	0.18	0.42	0.07
Main	68095.50	10 yr	930.00	1266.61	1272.99	0.000955	0.24	3.28	0.34	1.13	0.19
Main	68095.50	50 yr	1610.00	1266.61	1273.99	0.001143	0.27	3.98	0.48	1.92	0.34
Main	68095.50	100 yr	2480.00	1266.61	1274.85	0.001377	0.30	4.73	0.65	3.08	0.60
Main	68051.88		Mult Open								
Main	68000.80	BKF	190.00	1266.34	1268.92	0.003076	0.36	2.95	0.39	1.16	0.92
Main	68000.80	2 yr	400.00	1266.34	1270.00	0.003085	0.39	3.91	0.60	2.34	1.43
Main	68000.80	10 yr	930.00	1266.34	1271.59	0.003241	0.42	5.24	0.94	4.94	0.97
Main	68000.80	50 yr	1610.00	1266.34	1272.73	0.003102	0.43	5.92	1.12	6.62	1.21
Main	68000.80	100 yr	2480.00	1266.34	1273.78	0.002901	0.43	6.39	1.23	7.87	1.50
Main	67799.13	BKF	190.00	1265.72	1268.29	0.003163	0.36	2.97	0.40	1.19	0.95
Main	67799.13	2 yr	400.00	1265.72	1269.37	0.003145	0.39	3.93	0.61	2.38	1.35
Main	67799.13	10 yr	930.00	1265.72	1270.98	0.002989	0.41	5.04	0.87	4.39	0.88
Main	67799.13	50 yr	1610.00	1265.72	1272.17	0.002741	0.40	5.60	1.00	5.58	1.08
Main	67799.13	100 yr	2480.00	1265.72	1273.25	0.002594	0.40	6.09	1.11	6.79	1.41
Main	67586.76	BKF	190.00	1265.08	1267.53	0.003820	0.40	3.15	0.46	1.44	1.22
Main	67586.76	2 yr	400.00	1265.08	1268.63	0.003595	0.41	4.11	0.67	2.77	1.68
Main	67586.76	10 yr	930.00	1265.08	1270.02	0.004605	0.50	5.98	1.25	7.49	1.55
Main	67586.76	50 yr	1610.00	1265.08	1271.11	0.004948	0.54	7.17	1.67	12.00	2.26
Main	67586.76	100 yr	2480.00	1265.08	1272.14	0.005007	0.56	8.08	2.01	16.25	3.11
Main	67117.21	BKF	190.00	1262.37	1265.55	0.004512	0.42	3.40	0.53	1.81	1.81
Main	67117.21	2 yr	400.00	1262.37	1266.70	0.004511	0.45	4.46	0.80	3.58	2.08
Main	67117.21	10 yr	930.00	1262.37	1267.98	0.004512	0.47	5.51	1.10	6.07	1.17
Main	67117.21	50 yr	1610.00	1262.37	1269.04	0.004510	0.48	6.37	1.37	8.73	1.85
Main	67117.21	100 yr	2480.00	1262.37	1270.07	0.004511	0.50	7.16	1.63	11.70	2.69

PROPOSED 10' BENCH W/OUT PIPES

HEC-RAS Plan: Proposed 10' River: SouthMuddyCr Reach: Main

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft/ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
Main	69124.15	BKF	190.00	1272.07	1274.96	0.009301	0.59	4.60	1.01	4.63	4.63
Main	69124.15	2 yr	400.00	1272.07	1276.19	0.008588	0.59	5.74	1.38	7.90	7.90
Main	69124.15	10 yr	930.00	1272.07	1278.10	0.007751	0.59	7.11	1.85	13.15	4.51
Main	69124.15	50 yr	1610.00	1272.07	1279.69	0.005501	0.53	7.34	1.78	13.08	2.79
Main	69124.15	100 yr	2480.00	1272.07	1281.27	0.003785	0.45	7.11	1.55	11.02	2.47
Main	68919.69	BKF	190.00	1270.91	1273.68	0.004296	0.41	3.46	0.54	1.88	1.88
Main	68919.69	2 yr	400.00	1270.91	1275.02	0.004252	0.43	4.41	0.78	3.43	3.43
Main	68919.69	10 yr	930.00	1270.91	1276.83	0.005371	0.51	6.33	1.42	9.00	4.53
Main	68919.69	50 yr	1610.00	1270.91	1277.94	0.007308	0.62	8.49	2.38	20.19	9.69
Main	68919.69	100 yr	2480.00	1270.91	1278.89	0.009646	0.73	10.78	3.65	39.37	18.25
Main	68434.66	BKF	190.00	1267.61	1270.56	0.009180	0.61	5.42	1.29	6.97	4.24
Main	68434.66	2 yr	400.00	1267.61	1271.75	0.009302	0.66	7.10	1.93	13.71	7.49
Main	68434.66	10 yr	930.00	1267.61	1273.83	0.006652	0.60	8.11	2.17	17.59	2.33
Main	68434.66	50 yr	1610.00	1267.61	1274.86	0.006498	0.61	8.95	2.50	22.37	2.13
Main	68434.66	100 yr	2480.00	1267.61	1275.61	0.006747	0.63	9.78	2.88	28.20	2.65
Main	68285.54	BKF	190.00	1267.17	1269.95	0.002250	0.31	2.68	0.31	0.84	0.61
Main	68285.54	2 yr	400.00	1267.17	1271.29	0.001879	0.31	3.33	0.42	1.39	0.84
Main	68285.54	10 yr	930.00	1267.17	1273.62	0.001142	0.26	3.61	0.42	1.50	0.25
Main	68285.54	50 yr	1610.00	1267.17	1274.53	0.001500	0.31	4.56	0.63	2.87	0.47
Main	68285.54	100 yr	2480.00	1267.17	1275.10	0.002222	0.38	5.85	1.01	5.91	1.02
Main	68095.50	BKF	190.00	1266.61	1269.59	0.001689	0.27	2.45	0.26	0.63	0.45
Main	68095.50	2 yr	400.00	1266.61	1270.98	0.001530	0.28	3.14	0.36	1.14	0.43
Main	68095.50	10 yr	930.00	1266.61	1273.50	0.000623	0.20	2.80	0.24	0.68	0.11
Main	68095.50	50 yr	1610.00	1266.61	1274.38	0.000873	0.24	3.61	0.39	1.40	0.26
Main	68095.50	100 yr	2480.00	1266.61	1274.85	0.001438	0.31	4.83	0.68	3.29	0.63
Main	68051.88		Bridge								
Main	68000.80	BKF	190.00	1266.34	1268.92	0.003076	0.36	2.95	0.39	1.16	0.92
Main	68000.80	2 yr	400.00	1266.34	1270.00	0.003085	0.39	3.91	0.60	2.34	1.43
Main	68000.80	10 yr	930.00	1266.34	1271.59	0.003240	0.42	5.24	0.94	4.94	0.97
Main	68000.80	50 yr	1610.00	1266.34	1272.73	0.003100	0.43	5.92	1.12	6.62	1.21
Main	68000.80	100 yr	2480.00	1266.34	1273.78	0.002901	0.43	6.39	1.23	7.87	1.50
Main	67799.13	BKF	190.00	1265.72	1268.29	0.003163	0.36	2.97	0.40	1.19	0.95
Main	67799.13	2 yr	400.00	1265.72	1269.37	0.003145	0.39	3.93	0.61	2.38	1.35
Main	67799.13	10 yr	930.00	1265.72	1270.98	0.002989	0.41	5.04	0.87	4.38	0.88
Main	67799.13	50 yr	1610.00	1265.72	1272.17	0.002738	0.40	5.60	1.00	5.57	1.08
Main	67799.13	100 yr	2480.00	1265.72	1273.25	0.002594	0.40	6.09	1.11	6.79	1.41
Main	67586.76	BKF	190.00	1265.08	1267.53	0.003820	0.40	3.15	0.46	1.44	1.22
Main	67586.76	2 yr	400.00	1265.08	1268.63	0.003595	0.41	4.11	0.67	2.77	1.68
Main	67586.76	10 yr	930.00	1265.08	1270.02	0.004604	0.50	5.98	1.25	7.49	1.55
Main	67586.76	50 yr	1610.00	1265.08	1271.11	0.004921	0.54	7.15	1.67	11.92	2.24
Main	67586.76	100 yr	2480.00	1265.08	1272.14	0.005006	0.56	8.08	2.01	16.24	3.10
Main	67117.21	BKF	190.00	1262.37	1265.55	0.004512	0.42	3.40	0.53	1.81	1.81
Main	67117.21	2 yr	400.00	1262.37	1266.70	0.004511	0.45	4.46	0.80	3.58	2.08
Main	67117.21	10 yr	930.00	1262.37	1267.98	0.004512	0.47	5.51	1.10	6.07	1.17
Main	67117.21	50 yr	1610.00	1262.37	1269.04	0.004510	0.48	6.37	1.37	8.73	1.85
Main	67117.21	100 yr	2480.00	1262.37	1270.07	0.004511	0.50	7.16	1.63	11.70	2.69

PROPOSED 5' BENCH & NARROW SECTION

HEC-RAS Plan: Plan 05 River: SouthMuddyCr Reach: Main

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft/ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
Main	69124.15	BKF	190.00	1272.07	1274.96	0.009213	0.59	4.58	1.00	4.58	4.58
Main	69124.15	2 yr	400.00	1272.07	1276.22	0.008333	0.59	5.68	1.35	7.64	7.64
Main	69124.15	10 yr	930.00	1272.07	1278.16	0.007353	0.58	6.98	1.78	12.40	4.10
Main	69124.15	50 yr	1610.00	1272.07	1279.70	0.005435	0.52	7.31	1.76	12.89	2.74
Main	69124.15	100 yr	2480.00	1272.07	1281.28	0.003772	0.45	7.11	1.54	10.97	2.46
Main	68919.69	BKF	190.00	1270.91	1273.69	0.004237	0.41	3.44	0.54	1.85	1.85
Main	68919.69	2 yr	400.00	1270.91	1275.13	0.003873	0.41	4.27	0.72	3.09	3.09
Main	68919.69	10 yr	930.00	1270.91	1277.03	0.004617	0.48	6.03	1.27	7.67	3.83
Main	68919.69	50 yr	1610.00	1270.91	1278.06	0.006744	0.59	8.27	2.24	18.53	8.85
Main	68919.69	100 yr	2480.00	1270.91	1278.96	0.009300	0.71	10.65	3.55	37.86	17.51
Main	68434.66	BKF	190.00	1267.61	1270.63	0.008806	0.60	5.40	1.26	6.83	5.30
Main	68434.66	2 yr	400.00	1267.61	1271.82	0.010041	0.68	7.46	2.12	15.84	9.60
Main	68434.66	10 yr	930.00	1267.61	1273.84	0.007740	0.64	8.76	2.53	22.14	2.72
Main	68434.66	50 yr	1610.00	1267.61	1274.89	0.007000	0.63	9.32	2.71	25.23	2.27
Main	68434.66	100 yr	2480.00	1267.61	1275.66	0.006915	0.64	9.95	2.98	29.63	2.68
Main	68285.54	BKF	190.00	1267.17	1270.01	0.002546	0.33	2.87	0.36	1.03	0.78
Main	68285.54	2 yr	400.00	1267.17	1271.33	0.002278	0.34	3.67	0.51	1.86	1.24
Main	68285.54	10 yr	930.00	1267.17	1273.62	0.001383	0.29	3.96	0.50	1.98	0.30
Main	68285.54	50 yr	1610.00	1267.17	1274.54	0.001742	0.33	4.90	0.73	3.57	0.55
Main	68285.54	100 yr	2480.00	1267.17	1275.12	0.002516	0.40	6.21	1.14	7.08	1.15
Main	68095.50	BKF	190.00	1266.61	1269.57	0.002158	0.31	2.74	0.32	0.88	0.65
Main	68095.50	2 yr	400.00	1266.61	1270.95	0.001954	0.32	3.51	0.45	1.60	0.59
Main	68095.50	10 yr	930.00	1266.61	1273.50	0.000702	0.21	2.96	0.27	0.81	0.13
Main	68095.50	50 yr	1610.00	1266.61	1274.37	0.000960	0.25	3.77	0.42	1.60	0.28
Main	68095.50	100 yr	2480.00	1266.61	1274.85	0.001567	0.32	5.02	0.74	3.70	0.69
Main	68051.88		Bridge								
Main	68000.80	BKF	190.00	1266.34	1268.92	0.003076	0.36	2.95	0.39	1.16	0.92
Main	68000.80	2 yr	400.00	1266.34	1270.00	0.003085	0.39	3.91	0.60	2.34	1.43
Main	68000.80	10 yr	930.00	1266.34	1271.59	0.003240	0.42	5.24	0.94	4.94	0.97
Main	68000.80	50 yr	1610.00	1266.34	1272.73	0.003101	0.43	5.92	1.12	6.62	1.21
Main	68000.80	100 yr	2480.00	1266.34	1273.78	0.002901	0.43	6.39	1.23	7.87	1.50
Main	67799.13	BKF	190.00	1265.72	1268.29	0.003163	0.36	2.97	0.40	1.19	0.95
Main	67799.13	2 yr	400.00	1265.72	1269.37	0.003144	0.39	3.93	0.61	2.38	1.35
Main	67799.13	10 yr	930.00	1265.72	1270.98	0.002988	0.41	5.04	0.87	4.38	0.88
Main	67799.13	50 yr	1610.00	1265.72	1272.17	0.002739	0.40	5.60	1.00	5.58	1.08
Main	67799.13	100 yr	2480.00	1265.72	1273.25	0.002593	0.40	6.09	1.11	6.78	1.41
Main	67586.76	BKF	190.00	1265.08	1267.53	0.003820	0.40	3.15	0.46	1.44	1.22
Main	67586.76	2 yr	400.00	1265.08	1268.63	0.003594	0.41	4.11	0.67	2.77	1.68
Main	67586.76	10 yr	930.00	1265.08	1270.03	0.004598	0.50	5.98	1.25	7.48	1.55
Main	67586.76	50 yr	1610.00	1265.08	1271.11	0.004935	0.54	7.16	1.67	11.96	2.25
Main	67586.76	100 yr	2480.00	1265.08	1272.14	0.005004	0.56	8.08	2.01	16.24	3.10
Main	67117.21	BKF	190.00	1262.37	1265.55	0.004512	0.42	3.40	0.53	1.81	1.81
Main	67117.21	2 yr	400.00	1262.37	1266.70	0.004511	0.45	4.46	0.80	3.58	2.08
Main	67117.21	10 yr	930.00	1262.37	1267.98	0.004512	0.47	5.51	1.10	6.07	1.17
Main	67117.21	50 yr	1610.00	1262.37	1269.04	0.004510	0.48	6.37	1.37	8.73	1.85
Main	67117.21	100 yr	2480.00	1262.37	1270.07	0.004511	0.50	7.16	1.63	11.70	2.69

Summary

Stream:	Toms Creek
Watershed:	Forested
Location:	Pisgah National Forest, 5.4 Miles North of Marion, NC. US 221 N, Old Toms Creek Road.
Latitude:	35.74889
Longitude:	82.06083
State:	North Carolina
County:	McDowell
Date:	July 6, 2011
Observers:	Grant Ginn, Chris Engle, Megan Mailloux, Kevin Mitchell
Channel type:	C4
Drainage area (sq.mi.):	3.33
notes:	Channel Disturbances u/s and d/s, some channel incision

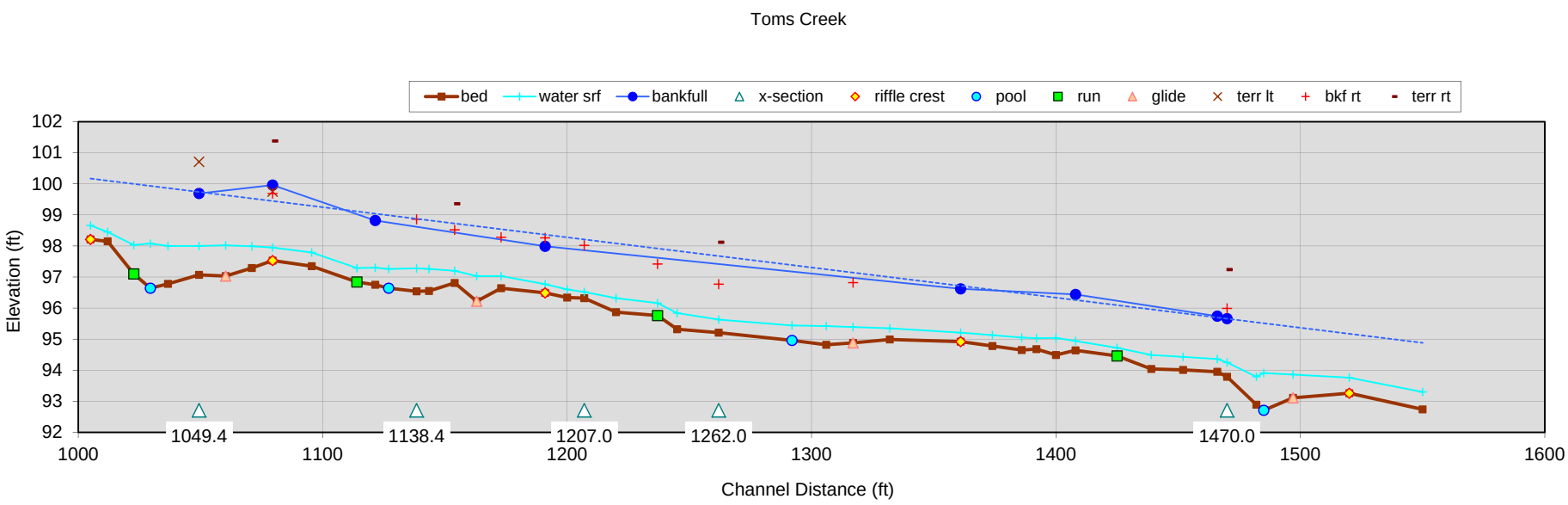
Dimension		bankfull channel typical	min	max
floodplain:	width flood prone area (ft)	55.0	30.0	65.0
	low bank height (ft)	2.2	2.0	2.4
riffle-run:	x-area bankfull (sq.ft.)	36.6	30.2	36.6
	width bankfull (ft)	23.4	19.4	23.4
	mean depth (ft)	1.56	1.6	1.6
	max depth (ft)	2.0	2.0	2.2
	hydraulic radius (ft)	1.5		
pool:	x-area pool (sq.ft.)	33.3	32.5	33.3
	width pool (ft)	17.7	17.0	17.7
	max depth pool (ft)	2.9	2.3	2.9
	hydraulic radius (ft)	1.7		
dimensionless ratios:		typical	min	max
	width depth ratio	15.0	12.3	14.9
	entrenchment ratio	2.4	1.3	2.8
	riffle max depth ratio	1.3	1.3	1.4
	bank height ratio	1.1	1.0	1.2
	pool area ratio	0.9	0.9	0.9
	pool width ratio	0.8	0.7	0.8
	pool max depth ratio	1.9	1.5	1.9
hydraulics:		typical	min	max
	discharge rate (cfs)	143.0	127.9	158.1
	channel slope (%)	0.93		
		riffle-run	min	max	pool
	velocity (ft/s)	3.9	4.2	4.4	4.3
	Froude number	0.57	0.62	0.63	0.34
	shear stress (lbs/sq.ft.)	0.857	0.827	0.891	0.967
	shear velocity (ft/s)	0.665	0.653	0.678	0.706
	stream power (lb/s)	83.0	74.2	91.7	
	unit stream power (lb/ft/s)	3.546	3.835	4.230	
	relative roughness	16.4	---	---	
	friction factor u/u*	5.9	7.8	7.9	
	threshold grain size (t*=0.06) (mm)	47.5	40.7	43.8	
	Shield's parameter	0.087			

Pattern	typical	min	max
meander length (ft)	300.0	---	---
belt width (ft)	100.0	---	---
amplitude (ft)	---	---	---
radius (ft)	---	32.0	514.0
arc angle (degrees)	---	---	---
stream length (ft)	600.0		
valley length (ft)	550.0		
Sinuosity	1.1		
Meander Length Ratio	12.8	---	---
Meander Width Ratio	4.3	---	---
Radius Ratio	---	1.4	22.0

Profile	typical	min	max
pool-pool spacing (ft)	151.8	97.5	193.0
riffle length (ft)	40.6	17.7	64.0
pool length (ft)	26.0	12.0	36.0
run length (ft)	33.7	6.8	60.0
glide length (ft)	28.6	19.2	44.0
channel slope (%)	0.93		
riffle slope (%)	1.9	0.77	3.6
pool slope (%)	0.36	0.19	0.64
run slope (%)	0.54	0	1.4
glide slope (%)	0.53	0.36	0.93
measured valley slope (%)	---		
valley slope from sinuosity (%)	1.0		
Riffle Length Ratio	1.7	0.8	2.7
Pool Length Ratio	1.1	0.5	1.5
Run Length Ratio	1.4	0.3	2.6
Glide Length Ratio	1.2	0.8	1.9
Riffle Slope Ratio	2	0.8	3.9
Pool Slope Ratio	0.4	0.2	0.7
Run Slope Ratio	0.6	0	1.5
Glide Slope Ratio	0.6	0.4	1
Pool Spacing Ratio	6.5	4.2	8.2

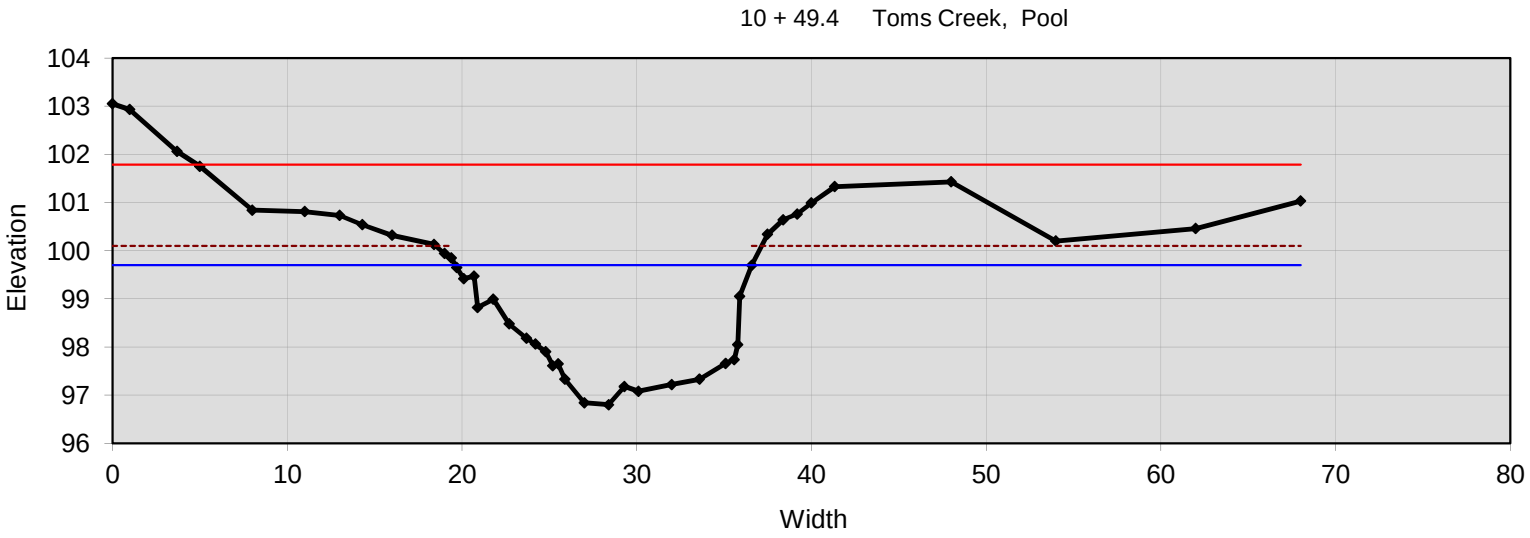
Channel Materials	Riffle Surface		Point Bar	BkF Channel
D16 (mm)	7.2	---	---	11
D35 (mm)	20	---	4.7	19
D50 (mm)	29	---	10	31
D65 (mm)	42	---	19	45
D84 (mm)	69	---	35	71
D95 (mm)	120	---	52	94
mean (mm)	22.3			27.9
dispersion	3.2			2.6
skewness	-0.1			-0.1
Shape Factor	---			
% Silt/Clay	1%	---	0%	0%
% Sand	8%	---	100%	4%
% Gravel	72%	---	0%	76%
% Cobble	17%	---	0%	20%
% Boulder	1%	---	0%	0%
% Bedrock	1%	---		
% Clay Hardpan		---		
% Detritus/Wood		---		
% Artificial		---		
Largest Mobile (mm)	760			

Longitudinal Slope Profile



	slope (%)		slope ratio		length (ft)		length ratio		pool-pool spacing (ft)		p-p ratio	
reach	0.93		---		1550.0	(66.2 channel widths)	---		---		---	
riffle	1.9	(0.77 - 3.6)	2	(0.8 - 3.9)	40.6	(17.7 - 64)	1.7	(0.8 - 2.7)	---		---	
pool	0.36	(0.19 - 0.64)	0.4	(0.2 - 0.7)	26.0	(12 - 36)	1.1	(0.5 - 1.5)	151.8	(97.5 - 193)	6.5	(4.2 - 8.2)
run	0.54	(0 - 1.4)	0.6	(0 - 1.5)	33.7	(6.8 - 60)	1.4	(0.3 - 2.6)	---		---	
glide	0.53	(0.36 - 0.93)	0.6	(0.4 - 1)	28.6	(19.2 - 44)	1.2	(0.8 - 1.9)	---		---	

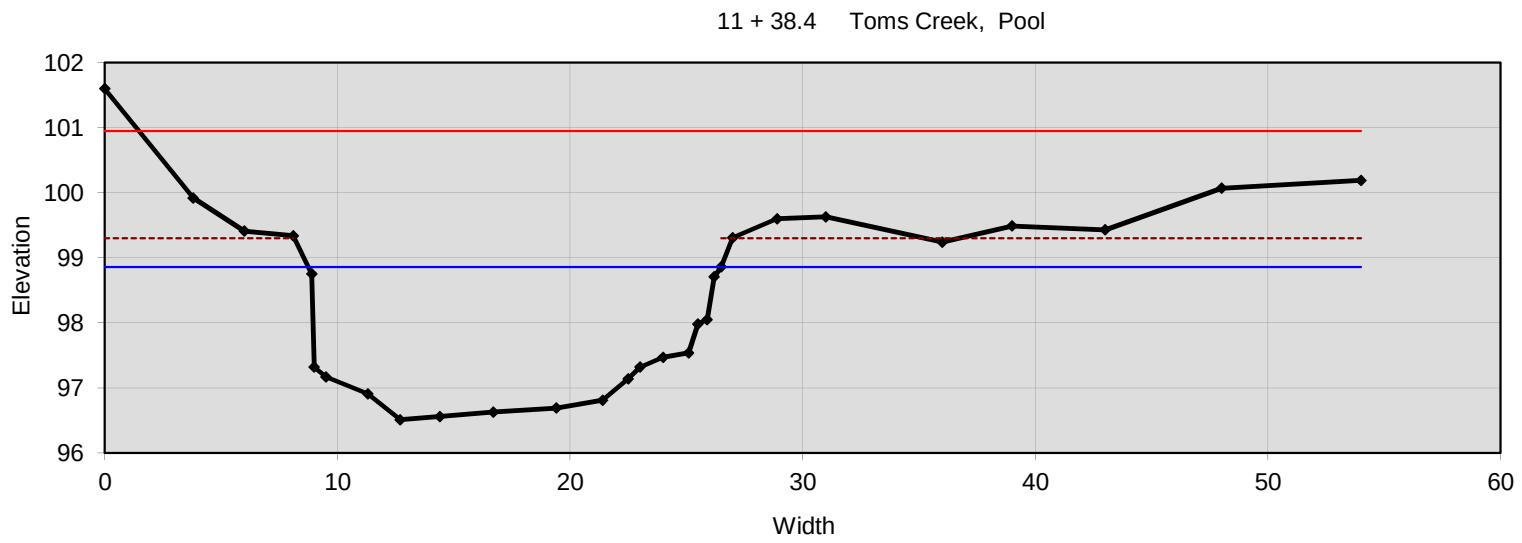
Cross Section 1



Bankfull Dimensions		Flood Dimensions		Materials	
32.5	x-section area (ft.sq.)	90.0	W flood prone area (ft)	29	D50 Riffle (mm)
17.0	width (ft)	5.3	entrenchment ratio	69	D84 Riffle (mm)
1.9	mean depth (ft)	3.3	low bank height (ft)	47	threshold grain size (mm):
2.9	max depth (ft)	1.1	low bank height ratio		
19.5	wetted parimeter (ft)				
1.7	hyd radi (ft)				
8.9	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
4.7	velocity (ft/s)	0.043	Manning's roughness	0.93	channel slope (%)
152.6	discharge rate (cfs)	0.18	D'Arcy-Weisbach fric.	0.97	shear stress (lb/sq.ft.)
0.64	Froude number	8.3	resistance factor u/u*	0.71	shear velocity (ft/s)
		8.5	relative roughness	5.2	unit strm power (lb/ft/s)

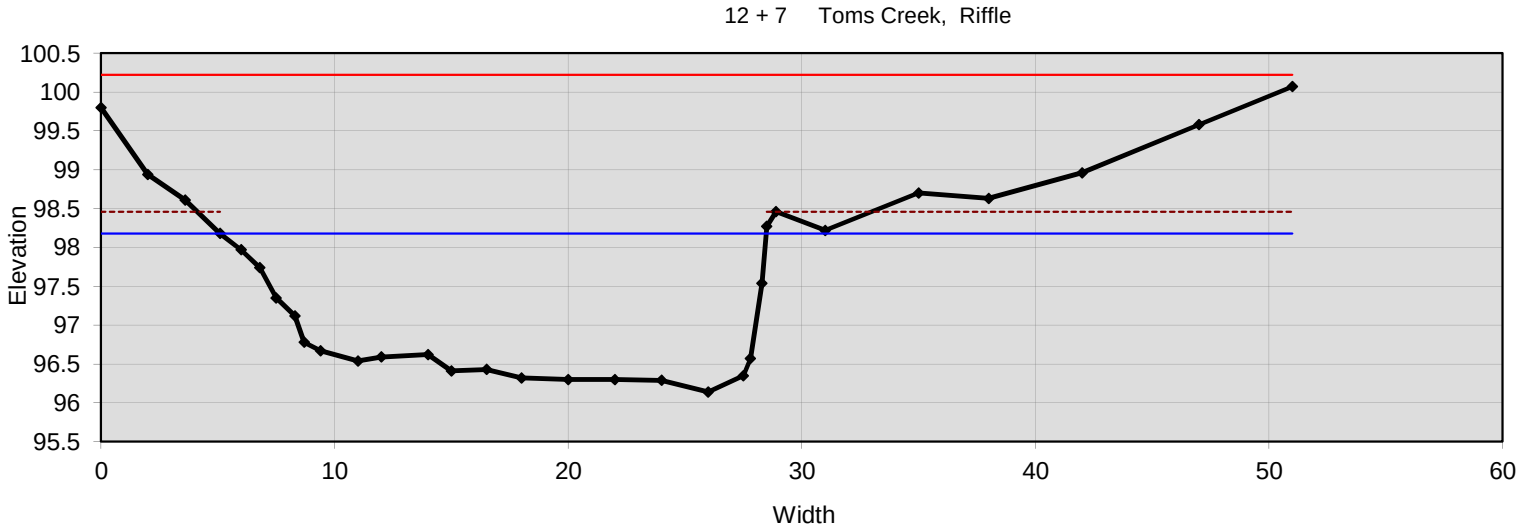
Cross Section 2



Bankfull Dimensions		Flood Dimensions		Materials	
33.3	x-section area (ft.sq.)	80.0	W flood prone area (ft)	29	D50 Riffle (mm)
17.7	width (ft)	4.5	entrenchment ratio	69	D84 Riffle (mm)
1.9	mean depth (ft)	2.8	low bank height (ft)	48	threshold grain size (mm):
2.3	max depth (ft)	1.2	low bank height ratio		
20.0	wetted parimeter (ft)				
1.7	hyd radi (ft)				
9.5	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
4.7	velocity (ft/s)	0.043	Manning's roughness	0.93	channel slope (%)
156.4	discharge rate (cfs)	0.18	D'Arcy-Weisbach fric.	0.97	shear stress (lb/sq.ft.)
0.64	Froude number	8.1	resistance factor u/u*	0.71	shear velocity (ft/s)
		8.3	relative roughness	5.1	unit strm power (lb/ft/s)

Cross Section 3



Bankfull Dimensions	
36.6	x-section area (ft.sq.)
23.4	width (ft)
1.6	mean depth (ft)
2.0	max depth (ft)
24.9	wetted parimeter (ft)
1.5	hyd radi (ft)
14.9	width-depth ratio

Flood Dimensions	
55.0	W flood prone area (ft)
2.4	entrenchment ratio
2.3	low bank height (ft)
1.1	low bank height ratio

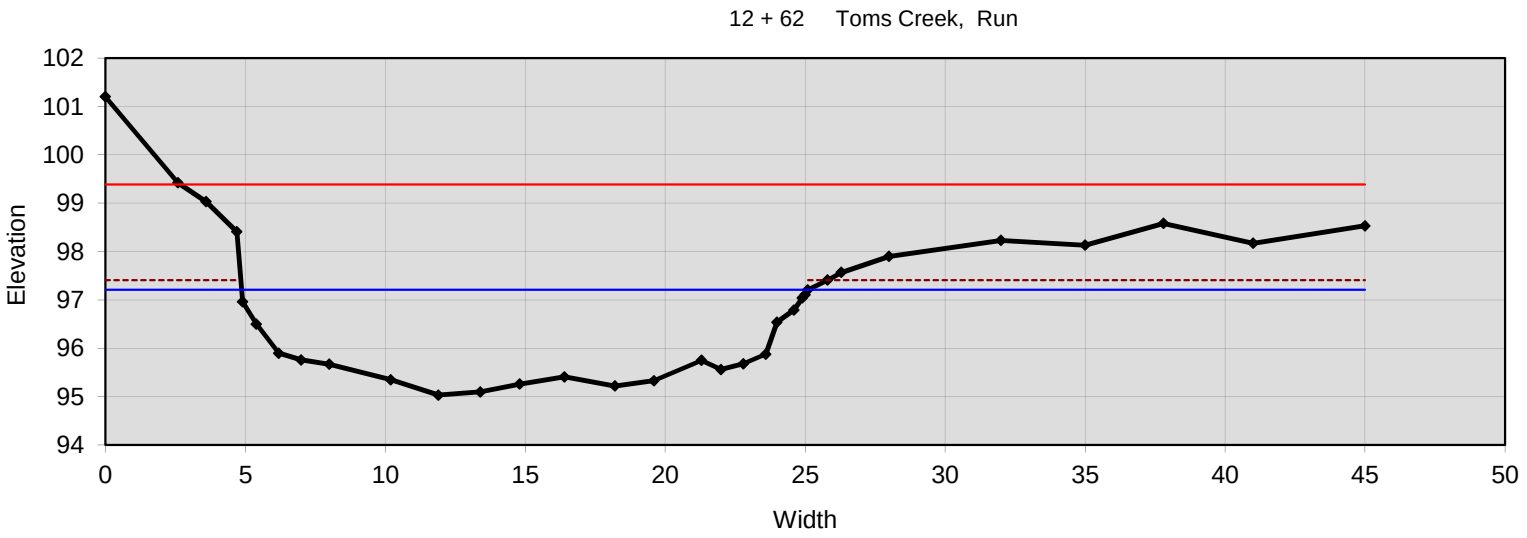
Materials	
29	D50 Riffle (mm)
69	D84 Riffle (mm)
42	threshold grain size (mm):

Bankfull Flow	
4.3	velocity (ft/s)
158.1	discharge rate (cfs)
0.63	Froude number

Flow Resistance	
0.043	Manning's roughness
0.19	D'Arcy-Weisbach fric.
7.8	resistance factor u/u*
6.9	relative roughness

Forces & Power	
0.93	channel slope (%)
0.85	shear stress (lb/sq.ft.)
0.66	shear velocity (ft/s)
3.9	unit strm power (lb/ft/s)

Cross Section 4



Bankfull Dimensions	
33.2	x-section area (ft.sq.)
20.2	width (ft)
1.6	mean depth (ft)
2.2	max depth (ft)
21.6	wetted parimeter (ft)
1.5	hyd radi (ft)
12.3	width-depth ratio

Flood Dimensions	
65.0	W flood prone area (ft)
3.2	entrenchment ratio
2.4	low bank height (ft)
1.1	low bank height ratio

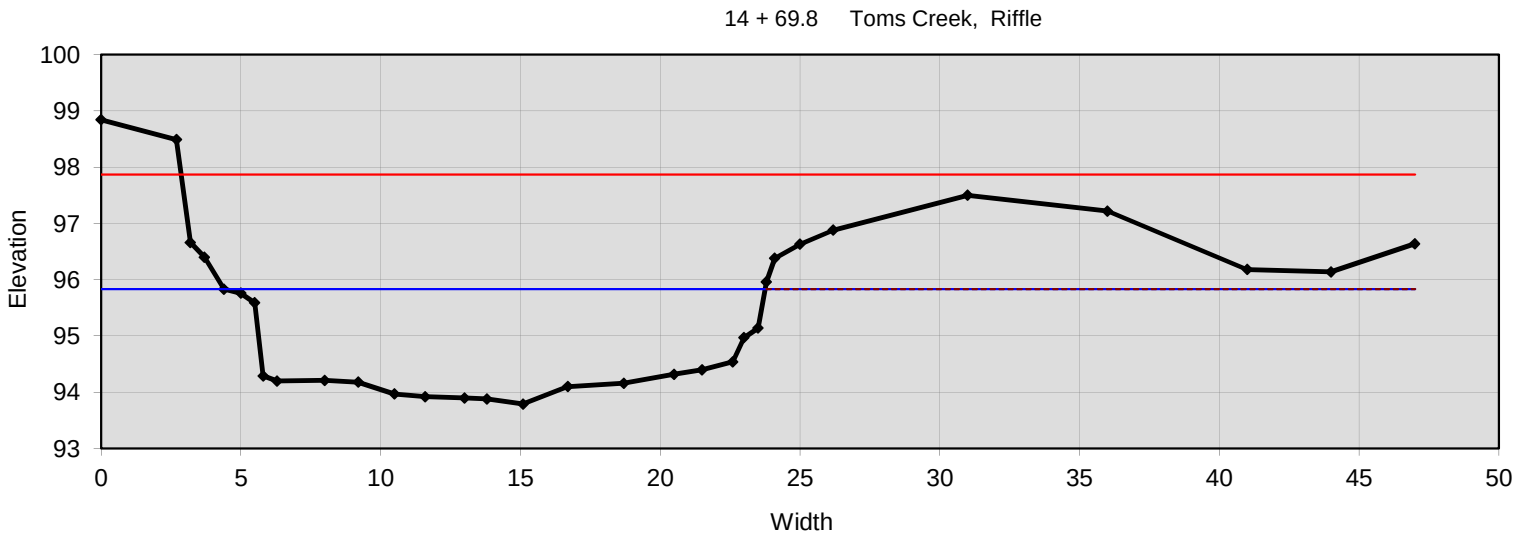
Materials	
29	D50 Riffle (mm)
69	D84 Riffle (mm)
44	threshold grain size (mm):

Bankfull Flow	
4.4	velocity (ft/s)
147.5	discharge rate (cfs)
0.63	Froude number

Flow Resistance	
0.043	Manning's roughness
0.19	D'Arcy-Weisbach fric.
7.9	resistance factor u/u*
7.2	relative roughness

Forces & Power	
0.93	channel slope (%)
0.89	shear stress (lb/sq.ft.)
0.68	shear velocity (ft/s)
4.2	unit strm power (lb/ft/s)

Cross Section 5



Bankfull Dimensions	
30.2	x-section area (ft.sq.)
19.4	width (ft)
1.6	mean depth (ft)
2.0	max depth (ft)
21.2	wetted parimeter (ft)
1.4	hyd radi (ft)
12.4	width-depth ratio

Flood Dimensions	
30.0	W flood prone area (ft)
1.6	entrenchment ratio
2.0	low bank height (ft)
1.0	low bank height ratio

Materials	
29	D50 Riffle (mm)
69	D84 Riffle (mm)
41	threshold grain size (mm):

Bankfull Flow	
4.2	velocity (ft/s)
127.9	discharge rate (cfs)
0.62	Froude number

Flow Resistance	
0.043	Manning's roughness
0.19	D'Arcy-Weisbach fric.
7.8	resistance factor u/u*
6.9	relative roughness

Forces & Power	
0.93	channel slope (%)
0.83	shear stress (lb/sq.ft.)
0.65	shear velocity (ft/s)
3.8	unit strm power (lb/ft/s)

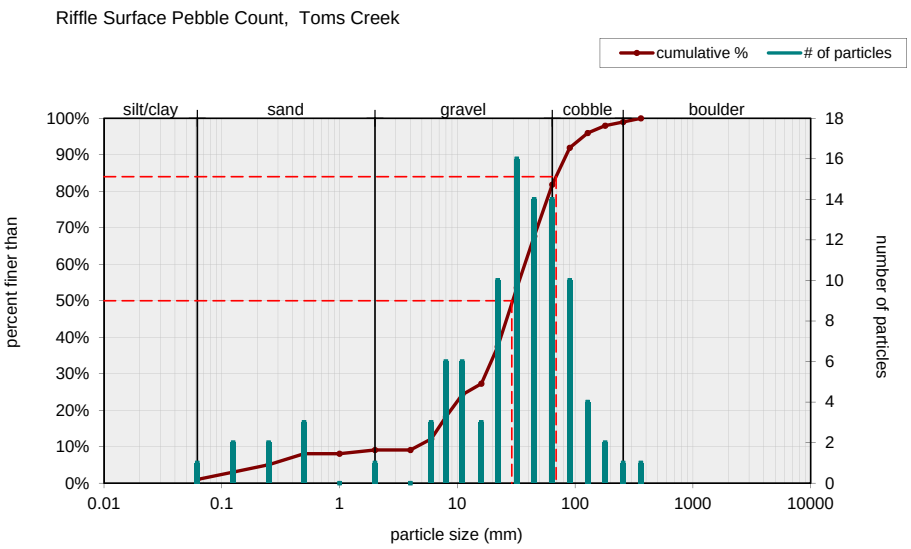
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	2
fine sand	0.125 - 0.25	2
medium sand	0.25 - 0.5	3
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	1
very fine gravel	2 - 4	0
fine gravel	4 - 6	3
fine gravel	6 - 8	6
medium gravel	8 - 11	6
medium gravel	11 - 16	3
coarse gravel	16 - 22	10
coarse gravel	22 - 32	16
very coarse gravel	32 - 45	14
very coarse gravel	45 - 64	14
small cobble	64 - 90	10
medium cobble	90 - 128	4
large cobble	128 - 180	2
very large cobble	180 - 256	1
small boulder	256 - 362	1
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		99
bedrock	----------	1
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:



Size (mm)	
D16	7.2
D35	20
D50	29
D65	42
D84	69
D95	120

Size Distribution	
mean	22.3
dispersion	3.2
skewness	-0.12

Type			
silt/clay	1%	bedrock	1%
sand	8%		
gravel	72%		
cobble	17%		
boulder	1%		

2) Weighted Pebble Count

Feature Percent of Reach

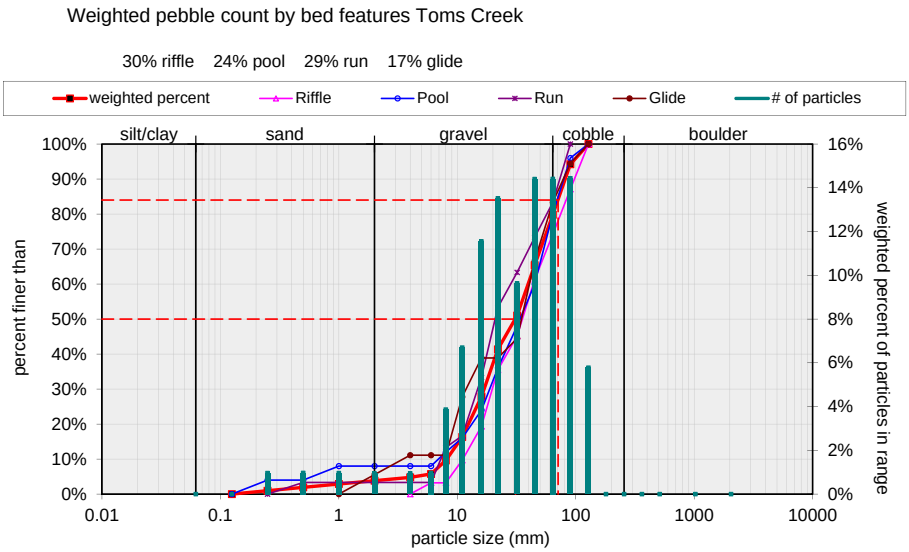
Riffle, Pool, Run, Glide

Riffle	29.8 %	Run	28.8 %
Pool	24 %	Glide	17.3 %

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	0.0
very fine sand	0.062 - 0.125	0.0
fine sand	0.125 - 0.25	1.0
medium sand	0.25 - 0.5	1.0
coarse sand	0.5 - 1	1.0
very coarse sand	1 - 2	0.9
very fine gravel	2 - 4	0.9
fine gravel	4 - 6	1.0
fine gravel	6 - 8	3.9
medium gravel	8 - 11	6.7
medium gravel	11 - 16	11.5
coarse gravel	16 - 22	13.5
coarse gravel	22 - 32	9.6
very coarse gravel	32 - 45	14.4
very coarse gravel	45 - 64	14.4
small cobble	64 - 90	14.4
medium cobble	90 - 128	5.8
large cobble	128 - 180	0.0
very large cobble	180 - 256	0.0
small boulder	256 - 362	0.0
small boulder	362 - 512	0.0
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock		0.0
clay hardpan		0.0
detritus/wood		0.0
artificial		0.0
total weighted count:		100.0

Note:



Size (mm)	
D16	11
D35	19
D50	31
D65	45
D84	71
D95	94

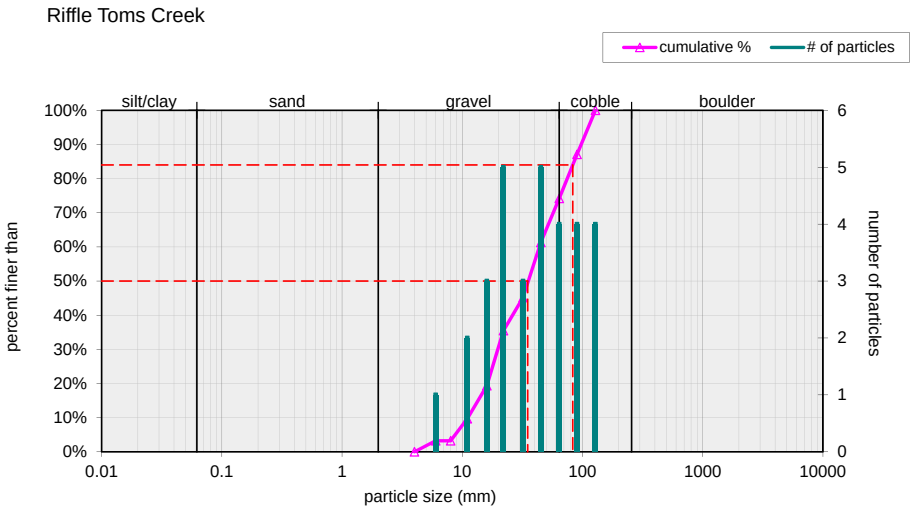
Size Distribution	
mean	27.9
dispersion	2.6
skewness	-0.05

Type	
silt/clay	0%
sand	4%
gravel	76%
cobble	20%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	1
fine gravel	6 - 8	
medium gravel	8 - 11	2
medium gravel	11 - 16	3
coarse gravel	16 - 22	5
coarse gravel	22 - 32	3
very coarse gravel	32 - 45	5
very coarse gravel	45 - 64	4
small cobble	64 - 90	4
medium cobble	90 - 128	4
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		31
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		31

Note:



Size (mm)	
D16	14
D35	22
D50	35
D65	50
D84	83
D95	110

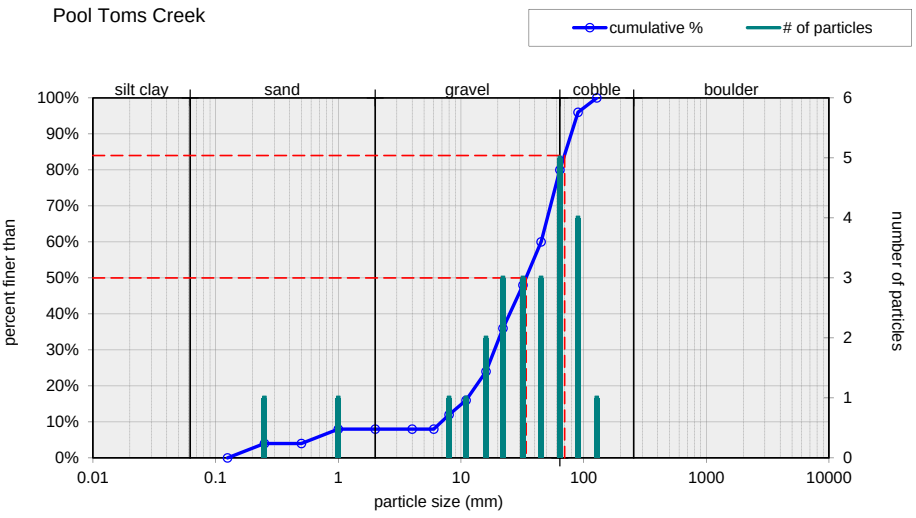
Size Distribution	
mean	34.1
dispersion	2.4
skewness	-0.01

Type	
silt/clay	0%
sand	0%
gravel	74%
cobble	26%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	1
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	1
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	1
medium gravel	8 - 11	1
medium gravel	11 - 16	2
coarse gravel	16 - 22	3
coarse gravel	22 - 32	3
very coarse gravel	32 - 45	3
very coarse gravel	45 - 64	5
small cobble	64 - 90	4
medium cobble	90 - 128	1
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		25
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		25

Note:



Size (mm)	
D16	11
D35	21
D50	34
D65	49
D84	70
D95	88

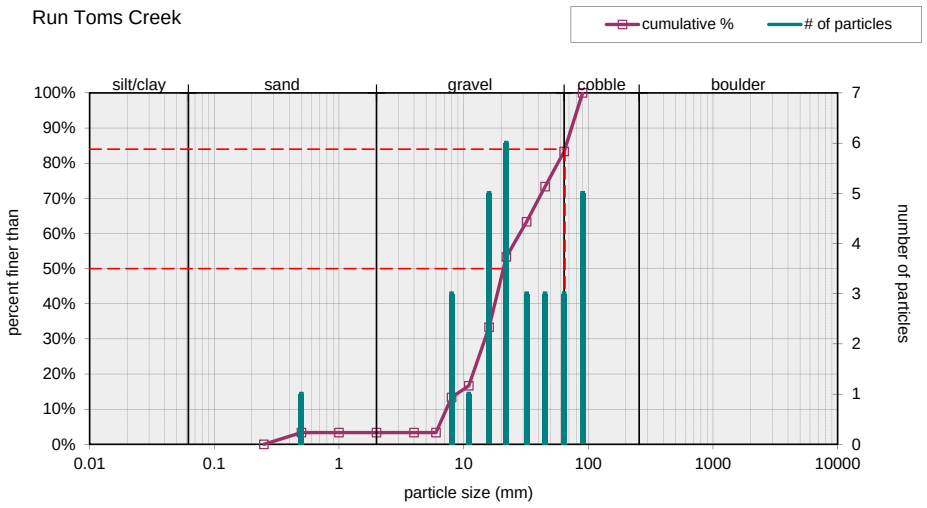
Size Distribution	
mean	27.7
dispersion	2.6
skewness	-0.10

Type	
silt/clay	0%
sand	8%
gravel	72%
cobble	20%
boulder	0%

Run

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	3
medium gravel	8 - 11	1
medium gravel	11 - 16	5
coarse gravel	16 - 22	6
coarse gravel	22 - 32	3
very coarse gravel	32 - 45	3
very coarse gravel	45 - 64	3
small cobble	64 - 90	5
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
	total particle count:	30
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
	total count:	30

Note:



Size (mm)	
D16	10
D35	16
D50	21
D65	34
D84	65
D95	81

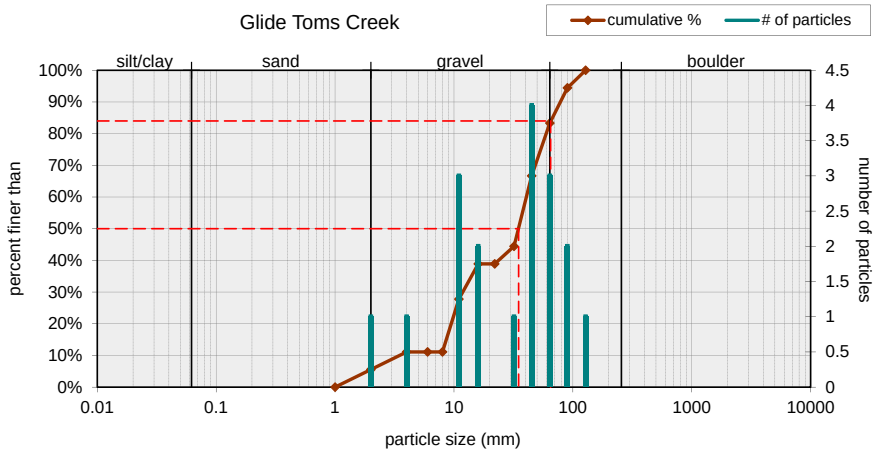
Size Distribution	
mean	25.5
dispersion	2.6
skewness	0.09

Type	
silt/clay	0%
sand	3%
gravel	80%
cobble	17%
boulder	0%

Glide

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	1
very fine gravel	2 - 4	1
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	3
medium gravel	11 - 16	2
coarse gravel	16 - 22	
coarse gravel	22 - 32	1
very coarse gravel	32 - 45	4
very coarse gravel	45 - 64	3
small cobble	64 - 90	2
medium cobble	90 - 128	1
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
	total particle count:	18
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
	total count:	18

Note:



Size (mm)	
D16	8.8
D35	14
D50	35
D65	44
D84	65
D95	93

Size Distribution	
mean	23.9
dispersion	2.9
skewness	-0.18

Type	
silt/clay	0%
sand	6%
gravel	78%
cobble	17%
boulder	0%

3) Bulk Sample Sieve Analysis

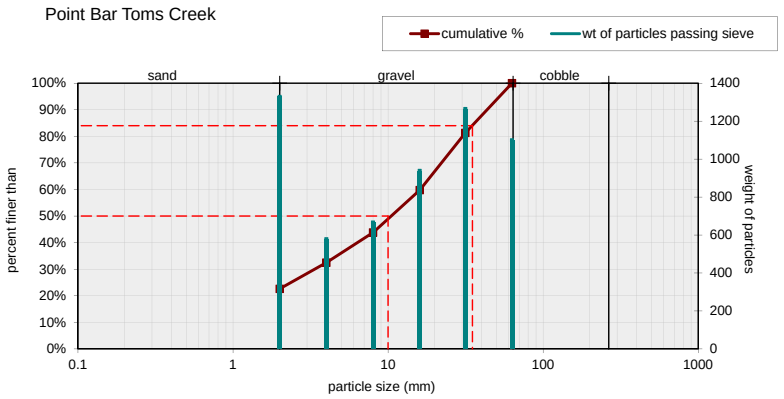
Two samples may be entered below. Select sample type for each.

Point Bar

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
1		1328	1328	23%	---	---
2		578	578	10%	23%	23%
4		666	666	11%	10%	32%
8		938	938	16%	11%	44%
16		1264	1264	22%	16%	60%
31.5		1099	1099	19%	22%	81%
63		0	0	0%	19%	100%

total wt retained in sieves: 5873

Note: sub pavement



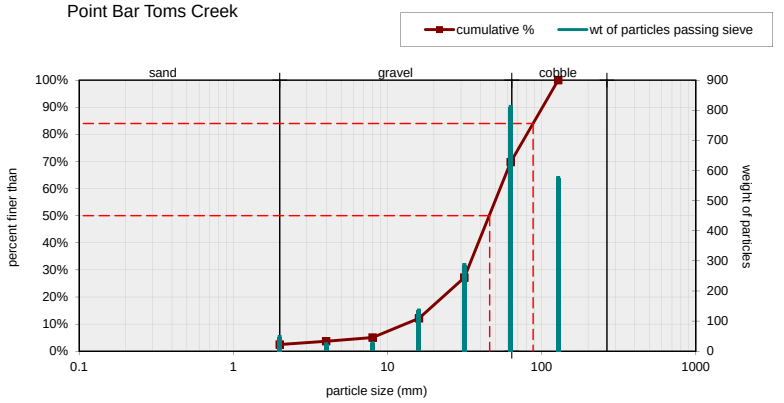
Size (mm)				
D16	---	D65	19	sand 100%
D35	4.7	D84	35	
D50	10	D95	52	

Point Bar

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
1		47	47	2%	---	---
2		23	23	1%	2%	2%
4		26	26	1%	1%	4%
8		135	135	7%	1%	5%
16		286	286	15%	7%	12%
31.5		811	811	43%	15%	27%
63		575	575	30%	43%	70%
128		0	0	0%	30%	100%

total: 1903

Note: Pavement (largest particles 110mm & 88mm)



Size (mm)			
D16	19	D65	58
D35	36	D84	88
D50	46	D95	110

Photo No. 1

Pool Section @ Sta 10+49.4 facing d/s 7/6/11

Photo No. 2

Pool Section @ Sta 11+38.4 facing d/s 7/6/11

Photo No. 3

Riffle Section @ Sta 12+7 facing d/s 7/6/11

Photo No. 4

Run Section @ Sta 12+62 facing d/s 7/6/11

Photo No. 5

Riffle Section @ Sta 14+69.8 facing d/s 7/6/11

Summary

Stream:	Cold Springs Creek
Watershed:	Pigeon River
Location:	Pisgah National Forest, Harmon Den, I-40 Exit 7
Latitude:	35.76352
Longitude:	82.97678
State:	North Carolina
County:	Haywood
Date:	October 25, 2007
Observers:	SGG & CME
Channel type:	B4
Drainage area (sq.mi.):	2.77
notes:	---

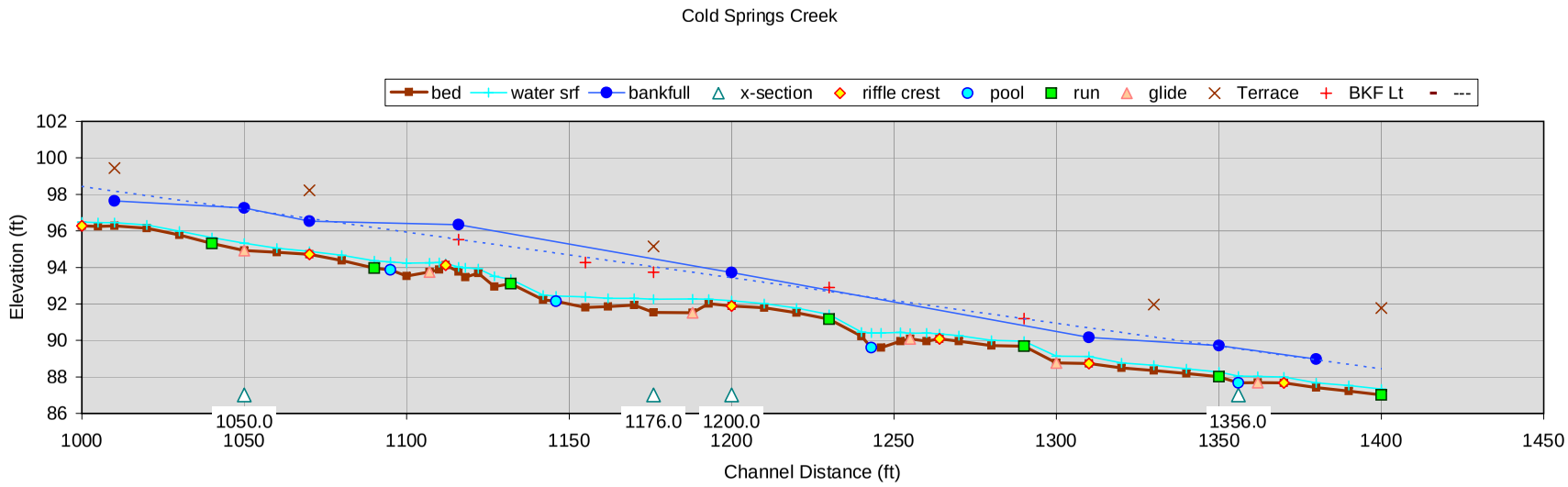
Dimension		bankfull channel typical	min	max	
floodplain:	width flood prone area (ft)	48.0	43.0	52.0	
	low bank height (ft)	3.3	3.1	3.5	
riffle-run:	x-area bankfull (sq.ft.)	34.6	33.4	34.6	
	width bankfull (ft)	23.4	23.4	24.7	
	mean depth (ft)	1.48	1.3	1.5	
	max depth (ft)	2.2	1.8	2.2	
	hydraulic radius (ft)	1.3			
pool:	x-area pool (sq.ft.)	33.4	30.0	33.4	
	width pool (ft)	29.6	25.2	29.6	
	max depth pool (ft)	2.3	2.3	2.3	
	hydraulic radius (ft)	1.1			
dimensionless ratios:		typical	min	max	
	width depth ratio	15.8	15.8	18.4	
	entrenchment ratio	2.1	1.8	2.2	
	riffle max depth ratio	1.5	1.2	1.5	
	bank height ratio	1.5	1.4	1.6	
	pool area ratio	1.0	0.9	1.0	
	pool width ratio	1.3	1.1	1.3	
	pool max depth ratio	1.6	1.5	1.6	
hydraulics:		typical	min	max	
	discharge rate (cfs)	210.0	202.1	218.6	
	channel slope (%)	2.4			
		riffle-run	min	max	pool
	velocity (ft/s)	6.1	6.1	6.3	6.3
	Froude number	0.94	0.94	0.95	1.12
	shear stress (lbs/sq.ft.)	1.947	1.920	2.043	1.647
	shear velocity (ft/s)	1.002	0.995	1.027	0.922
	stream power (lb/s)	314.5	302.7	327.4	
	unit stream power (lb/ft/s)	13.440	12.131	13.866	
	relative roughness	10.0	---	---	
	friction factor u/u*	6.1	5.9	6.2	
	threshold grain size (t*=0.06) (mm)	100.4	94.3	100.4	
	Shield's parameter	0.128			

Pattern	typical	min	max
meander length (ft)	100.0	---	---
belt width (ft)	43.0	---	---
amplitude (ft)	---	---	---
radius (ft)	75.0	44.0	103.0
arc angle (degrees)	---	---	---
stream length (ft)	400.0		
valley length (ft)	380.0		
Sinuosity	1.1		
Meander Length Ratio	4.3	---	---
Meander Width Ratio	1.8	---	---
Radius Ratio	3.2	1.9	4.4

Profile	typical	min	max
pool-pool spacing (ft)	87.0	51.0	113.0
riffle length (ft)	28.0	20.0	40.0
pool length (ft)	18.0	6.0	42.0
run length (ft)	9.7	5.0	14.0
glide length (ft)	10.7	5.0	20.0
channel slope (%)	2.38		
riffle slope (%)	2.5	1.5	4.3
pool slope (%)	0.25	0.083	0.4
run slope (%)	5.1	1.4	8.1
glide slope (%)	0.81	0.2	2.3
measured valley slope (%)	---		
valley slope from sinuosity (%)	2.5		
Riffle Length Ratio	1.2	0.9	1.7
Pool Length Ratio	0.8	0.3	1.8
Run Length Ratio	0.4	0.2	0.6
Glide Length Ratio	0.5	0.2	0.9
Riffle Slope Ratio	1.1	0.6	1.8
Pool Slope Ratio	0.1	0	0.2
Run Slope Ratio	2.1	0.6	3.4
Glide Slope Ratio	0.3	0.1	1
Pool Spacing Ratio	3.7	2.2	4.8

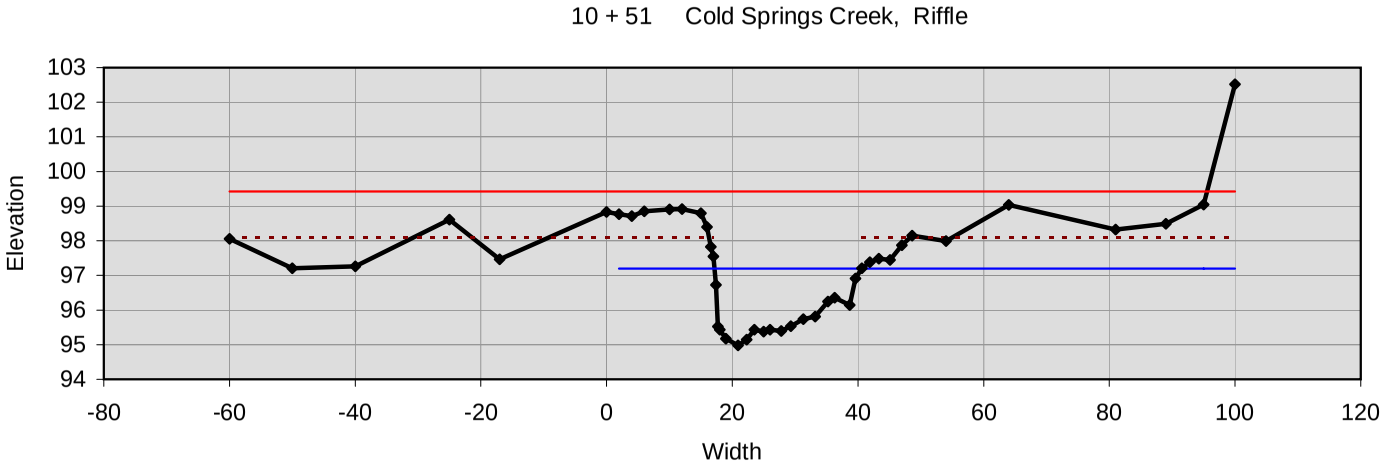
Channel Materials	Riffle Surface		Point Bar	BkF Channel
D16 (mm)	5.2	---	30	3.3
D35 (mm)	22	---	71	15
D50 (mm)	45	---	79	31
D65 (mm)	75	---	87	62
D84 (mm)	130	---	99	120
D95 (mm)	190	---	110	170
mean (mm)	26.0			19.9
dispersion	5.8			6.6
skewness	-0.2			-0.2
Shape Factor	---			
% Silt/Clay	1%	---	0%	2%
% Sand	10%	---	100%	9%
% Gravel	48%	---	0%	53%
% Cobble	41%	---	0%	33%
% Boulder	0%	---	0%	0%
% Bedrock	1%	---		4%
% Clay Hardpan		---		
% Detritus/Wood		---		
% Artificial		---		
Largest Mobile (mm)	91			

Longitudinal Slope Profile



	slope (%)		slope ratio		length (ft)		length ratio		pool-pool spacing (ft)		p-p ratio	
reach	2.38		---		1400.0 (59.8 channel widths)		---		---		---	
riffle	2.5	(1.5 - 4.3)	1.1	(0.6 - 1.8)	28.0	(20 - 40)	1.2	(0.9 - 1.7)	---		---	
pool	0.25	(0.083 - 0.4)	0.1	(0 - 0.2)	18.0	(6 - 42)	0.8	(0.3 - 1.8)	87.0	(51 - 113)	3.7	(2.2 - 4.8)
run	5.1	(1.4 - 8.1)	2.1	(0.6 - 3.4)	9.7	(5 - 14)	0.4	(0.2 - 0.6)	---		---	
glide	0.81	(0.2 - 2.3)	0.3	(0.1 - 1)	10.7	(5 - 20)	0.5	(0.2 - 0.9)	---		---	

Cross Section XS 1



Bankfull Dimensions	
34.6	x-section area (ft.sq.)
23.4	width (ft)
1.5	mean depth (ft)
2.2	max depth (ft)
25.2	wetted parimeter (ft)
1.4	hyd radi (ft)
15.8	width-depth ratio

Flood Dimensions	
52.0	W flood prone area (ft)
2.2	entrenchment ratio
3.1	low bank height (ft)
1.4	low bank height ratio

Materials	
45	D50 Riffle (mm)
130	D84 Riffle (mm)
100	threshold grain size (mm):

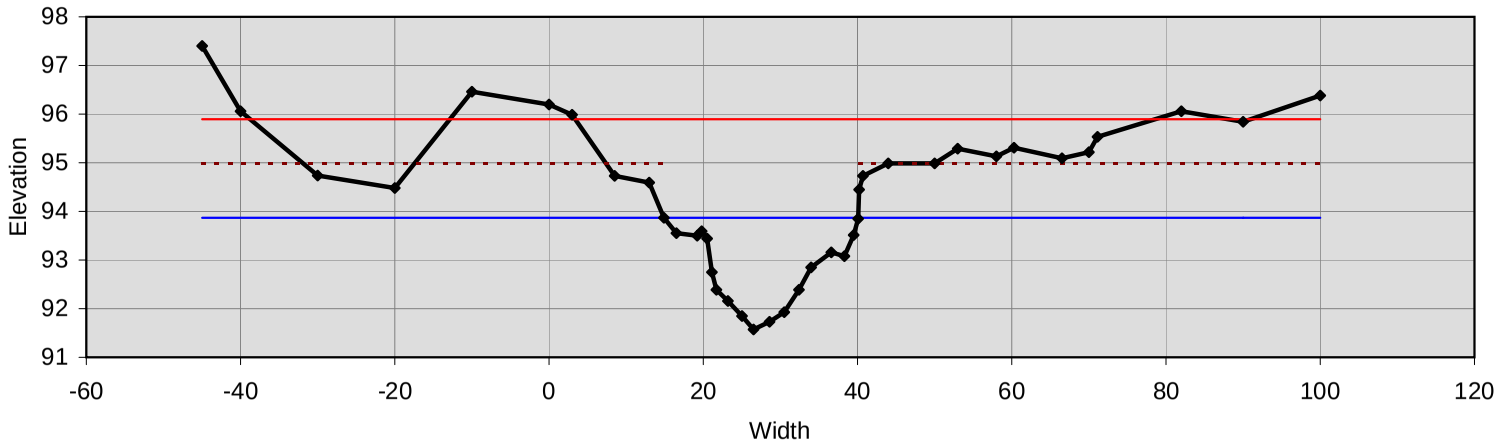
Bankfull Flow	
6.3	velocity (ft/s)
218.6	discharge rate (cfs)
0.95	Froude number

Flow Resistance	
0.045	Manning's roughness
0.21	D'Arcy-Weisbach fric.
6.2	resistance factor u/u*
3.5	relative roughness

Forces & Power	
2.38	channel slope (%)
2.04	shear stress (lb/sq.ft.)
1.03	shear velocity (ft/s)
13.9	unit strm power (lb/ft/s)

Cross Section XS 2

11 + 78 Cold Springs Creek, Pool



Bankfull Dimensions	
30.0	x-section area (ft.sq.)
25.2	width (ft)
1.2	mean depth (ft)
2.3	max depth (ft)
26.1	wetted parimeter (ft)
1.1	hyd radi (ft)
21.2	width-depth ratio

Flood Dimensions	
80.0	W flood prone area (ft)
3.2	entrenchment ratio
3.4	low bank height (ft)
1.5	low bank height ratio

Materials	
45	D50 Riffle (mm)
130	D84 Riffle (mm)
84	threshold grain size (mm):

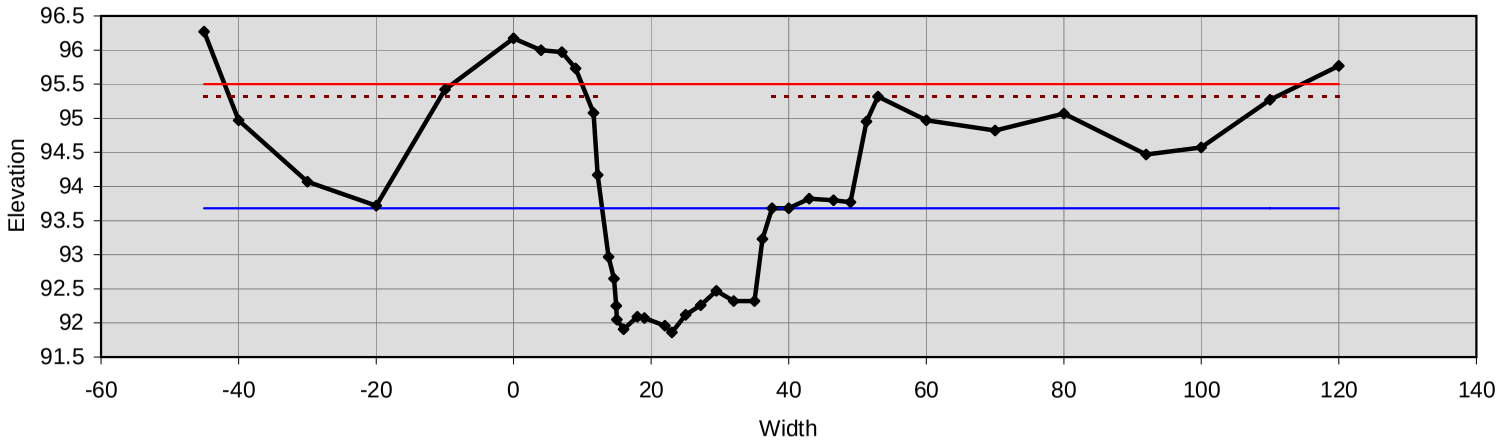
Bankfull Flow	
5.6	velocity (ft/s)
168.0	discharge rate (cfs)
0.92	Froude number

Flow Resistance	
0.045	Manning's roughness
0.22	D'Arcy-Weisbach fric.
5.9	resistance factor u/u*
2.8	relative roughness

Forces & Power	
2.38	channel slope (%)
1.71	shear stress (lb/sq.ft.)
0.94	shear velocity (ft/s)
9.9	unit strm power (lb/ft/s)

Cross Section XS 3

12 + 1 Cold Springs Creek, Riffle

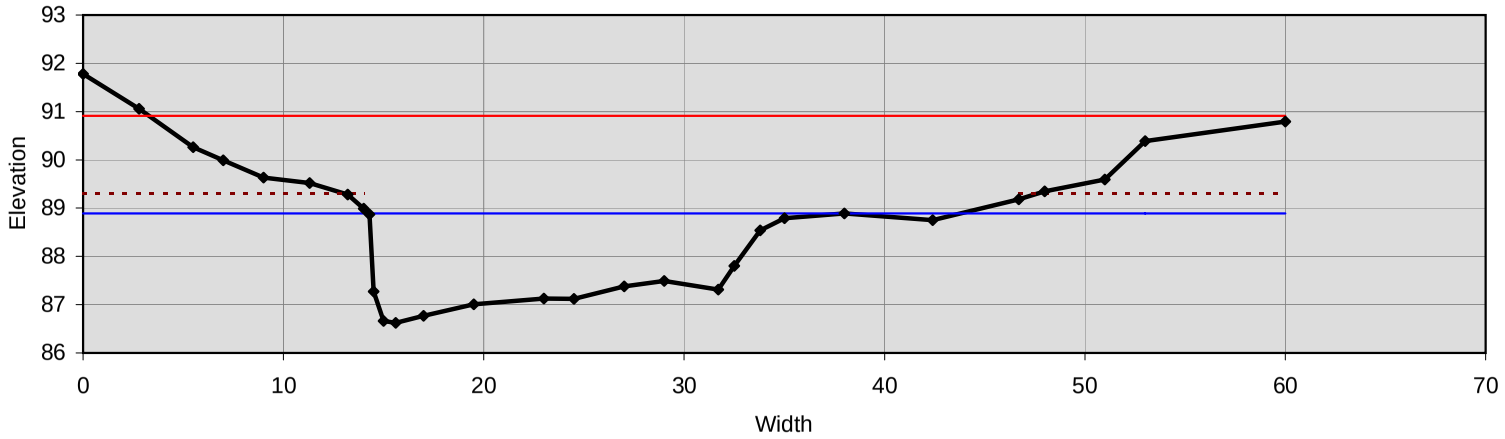


Bankfull Dimensions		Flood Dimensions		Materials	
33.4	x-section area (ft.sq.)	43.0	W flood prone area (ft)	45	D50 Riffle (mm)
24.7	width (ft)	1.7	entrenchment ratio	130	D84 Riffle (mm)
1.3	mean depth (ft)	3.5	low bank height (ft)	94	threshold grain size (mm):
1.8	max depth (ft)	1.9	low bank height ratio		
25.8	wetted parimeter (ft)				
1.3	hyd radi (ft)				
18.4	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
6.1	velocity (ft/s)	0.045	Manning's roughness	2.38	channel slope (%)
202.1	discharge rate (cfs)	0.22	D'Arcy-Weisbach fric.	1.92	shear stress (lb/sq.ft.)
0.94	Froude number	5.9	resistance factor u/u*	1.00	shear velocity (ft/s)
		3.2	relative roughness	12.1	unit strm power (lb/ft/s)

Cross Section XS 4

13 + 58 Cold Springs Creek, Pool



Bankfull Dimensions	
33.4	x-section area (ft.sq.)
29.6	width (ft)
1.1	mean depth (ft)
2.3	max depth (ft)
31.7	wetted parimeter (ft)
1.1	hyd radi (ft)
26.1	width-depth ratio

Flood Dimensions	
49.0	W flood prone area (ft)
1.7	entrenchment ratio
2.7	low bank height (ft)
1.2	low bank height ratio

Materials	
45	D50 Riffle (mm)
130	D84 Riffle (mm)
77	threshold grain size (mm):

Bankfull Flow	
5.3	velocity (ft/s)
177.0	discharge rate (cfs)
0.91	Froude number

Flow Resistance	
0.045	Manning's roughness
0.23	D'Arcy-Weisbach fric.
5.7	resistance factor u/u*
2.7	relative roughness

Forces & Power	
2.38	channel slope (%)
1.57	shear stress (lb/sq.ft.)
0.90	shear velocity (ft/s)
8.9	unit strm power (lb/ft/s)

2) Weighted Pebble Count

Feature Percent of Reach

Riffle, Pool, Run, Glide

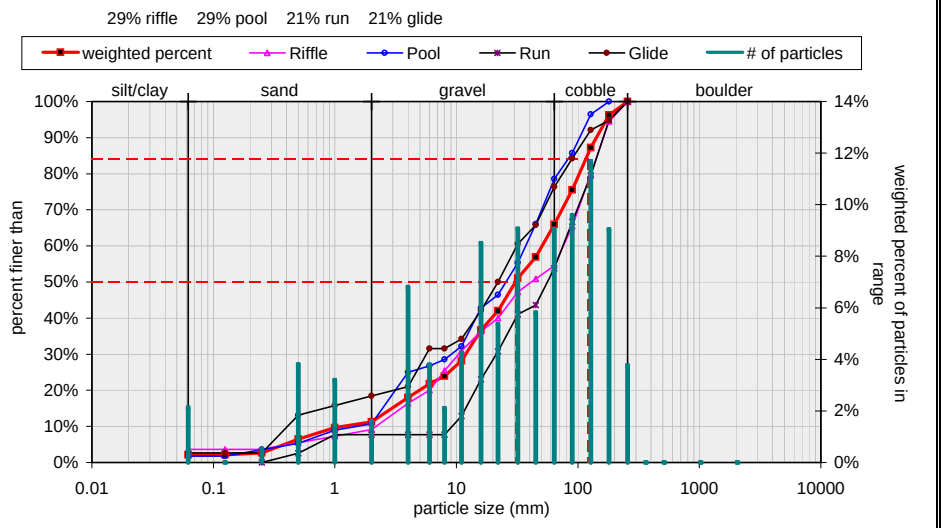
Riffle	29	%	Run	21	%
Pool	29	%	Glide	21	%

Weighted pebble count by bed features

Material	Size Range (mm)		weighted
silt/clay	0	- 0.062	2.1
very fine sand	0.062	- 0.125	0.0
fine sand	0.125	- 0.25	0.5
medium sand	0.25	- 0.5	3.8
coarse sand	0.5	- 1	3.2
very coarse sand	1	- 2	1.6
very fine gravel	2	- 4	6.8
fine gravel	4	- 6	3.8
fine gravel	6	- 8	2.1
medium gravel	8	- 11	4.2
medium gravel	11	- 16	8.5
coarse gravel	16	- 22	5.4
coarse gravel	22	- 32	9.1
very coarse gravel	32	- 45	5.8
very coarse gravel	45	- 64	9.0
small cobble	64	- 90	9.6
medium cobble	90	- 128	11.7
large cobble	128	- 180	9.0
very large cobble	180	- 256	3.8
small boulder	256	- 362	0.0
small boulder	362	- 512	0.0
medium boulder	512	- 1024	0.0
large boulder	1024	- 2048	0.0
very large boulder	2048	- 4096	0.0

total particle weighted count:	100
bedrock ----------	3.8
clay hardpan ----------	0.0
detritus/wood ----------	0.0
artificial ----------	0.0
total weighted count:	103.8

Note:



Size (mm)	
D16	3.3
D35	15
D50	31
D65	62
D84	120
D95	170

Size Distribution	
mean	19.9
dispersion	6.6
skewness	-0.15

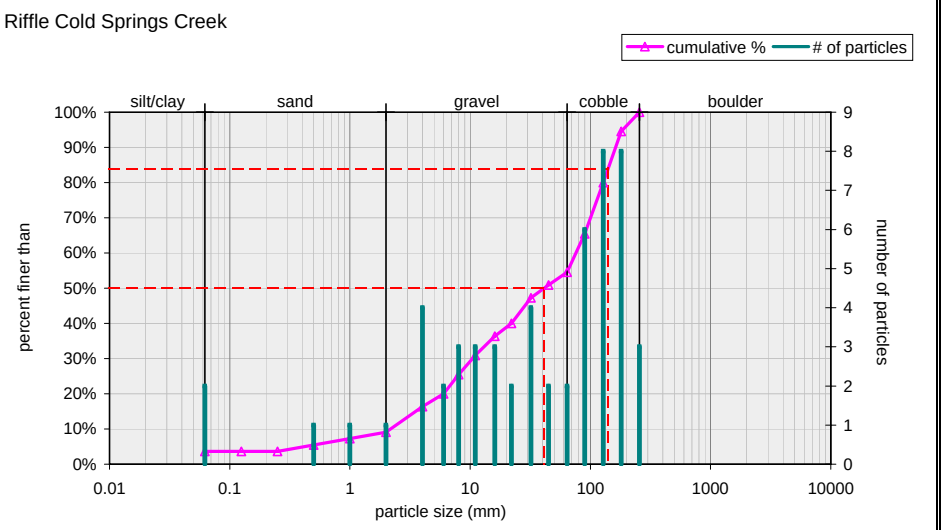
Type			
silt/clay	2%	bedrock	4%
sand	9%		
gravel	53%		
cobble	33%		
boulder	0%		

Riffle

Material	Size Range (mm)		Count
silt/clay	0	- 0.062	**2**
very fine sand	0.062	- 0.125	
fine sand	0.125	- 0.25	
medium sand	0.25	- 0.5	**1**
coarse sand	0.5	- 1	**1**
very coarse sand	1	- 2	**1**
very fine gravel	2	- 4	**4**
fine gravel	4	- 6	**2**
fine gravel	6	- 8	**3**
medium gravel	8	- 11	**3**
medium gravel	11	- 16	**3**
coarse gravel	16	- 22	**2**
coarse gravel	22	- 32	**4**
very coarse gravel	32	- 45	**2**
very coarse gravel	45	- 64	**2**
small cobble	64	- 90	**6**
medium cobble	90	- 128	**8**
large cobble	128	- 180	**8**
very large cobble	180	- 256	**3**
small boulder	256	- 362	
small boulder	362	- 512	
medium boulder	512	- 1024	
large boulder	1024	- 2048	
very large boulder	2048	- 4096	

total particle count:	55
bedrock ----------	**1**
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	56

Note:



Size (mm)	
D16	3.9
D35	15
D50	41
D65	89
D84	140
D95	190

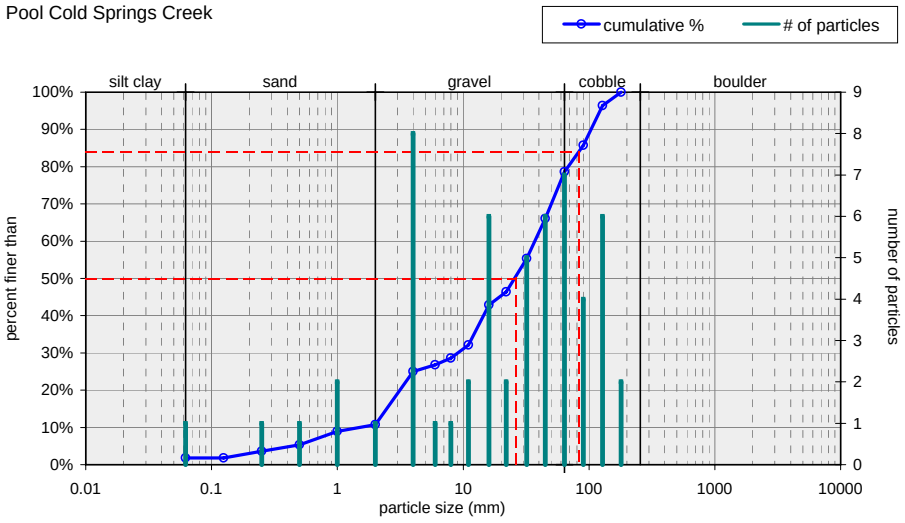
Size Distribution	
mean	23.4
dispersion	7.0
skewness	-0.20

Type			
silt/clay	4%	bedrock	2%
sand	5%		
gravel	45%		
cobble	45%		
boulder	0%		

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	1
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	2
very coarse sand	1 - 2	1
very fine gravel	2 - 4	8
fine gravel	4 - 6	1
fine gravel	6 - 8	1
medium gravel	8 - 11	2
medium gravel	11 - 16	6
coarse gravel	16 - 22	2
coarse gravel	22 - 32	5
very coarse gravel	32 - 45	6
very coarse gravel	45 - 64	7
small cobble	64 - 90	4
medium cobble	90 - 128	6
large cobble	128 - 180	2
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		56
bedrock ----------		1
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		57

Note:



Size (mm)	
D16	2.6
D35	12
D50	26
D65	43
D84	83
D95	120

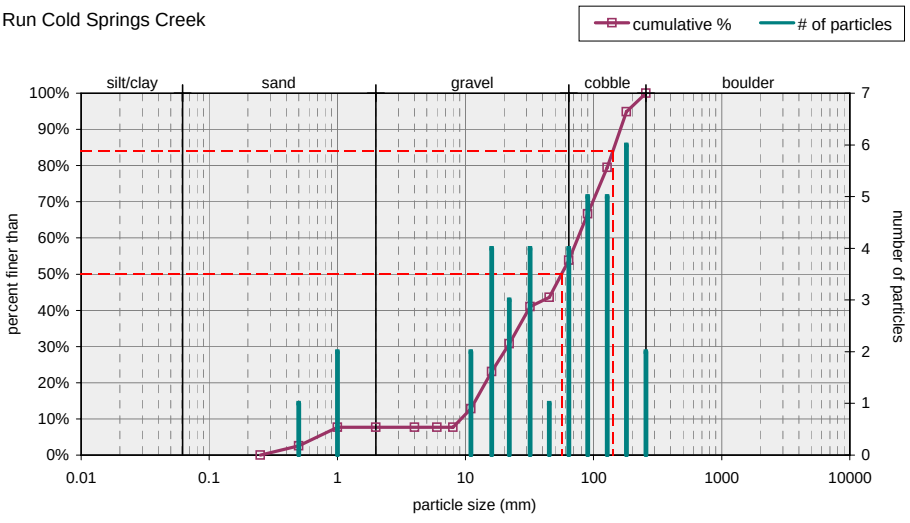
Size Distribution	
mean	14.7
dispersion	6.6
skewness	-0.20

Type			
silt/clay	2%	bedrock	2%
sand	9%		
gravel	67%		
cobble	21%		
boulder	0%		

Run

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	2
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	2
medium gravel	11 - 16	4
coarse gravel	16 - 22	3
coarse gravel	22 - 32	4
very coarse gravel	32 - 45	1
very coarse gravel	45 - 64	4
small cobble	64 - 90	5
medium cobble	90 - 128	5
large cobble	128 - 180	6
very large cobble	180 - 256	2
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		39
bedrock ----------		3
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		42

Note:



Size (mm)	
D16	12
D35	26
D50	56
D65	86
D84	140
D95	180

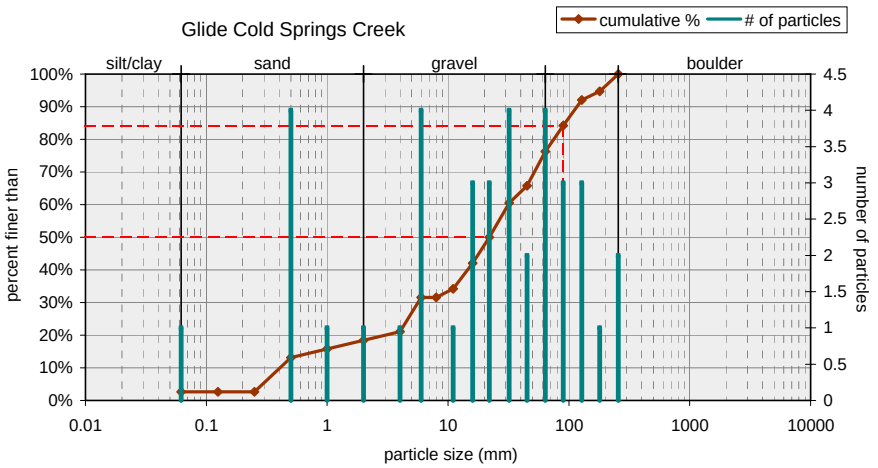
Size Distribution	
mean	41.0
dispersion	3.6
skewness	-0.13

Type			
silt/clay	0%	bedrock	7%
sand	7%		
gravel	43%		
cobble	43%		
boulder	0%		

Glide

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**1**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**4**
coarse sand	0.5 - 1	**1**
very coarse sand	1 - 2	**1**
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	**3**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	**4**
small cobble	64 - 90	**3**
medium cobble	90 - 128	**3**
large cobble	128 - 180	**1**
very large cobble	180 - 256	**2**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		38
bedrock ----------		**2**
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		40

Note:



Size (mm)	
D16	1.1
D35	11
D50	22
D65	43
D84	89
D95	180

Size Distribution	
mean	9.9
dispersion	12.0
skewness	-0.25

Type			
silt/clay	3%	bedrock	5%
sand	15%		
gravel	55%		
cobble	23%		
boulder	0%		

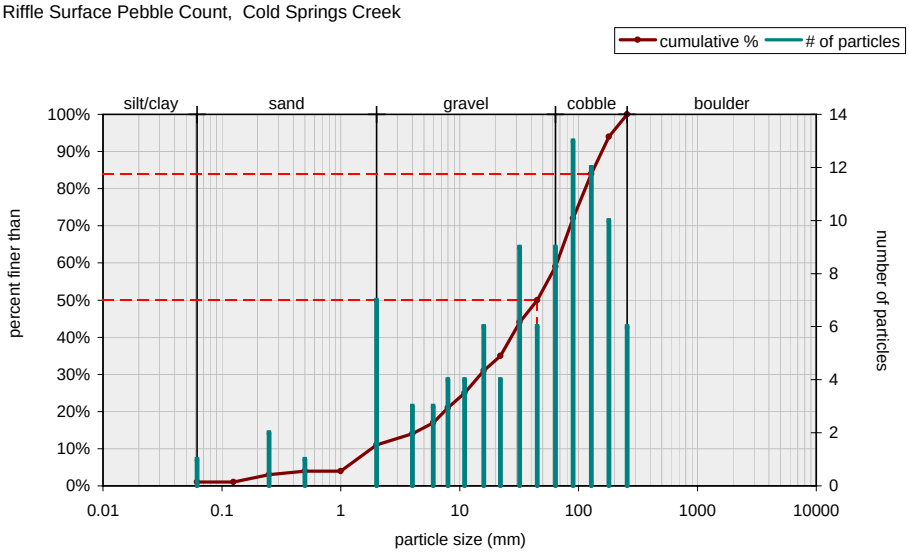
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**1**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**2**
medium sand	0.25 - 0.5	**1**
coarse sand	0.5 - 1	
very coarse sand	1 - 2	**7**
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**4**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**6**
coarse gravel	16 - 22	**4**
coarse gravel	22 - 32	**9**
very coarse gravel	32 - 45	**6**
very coarse gravel	45 - 64	**9**
small cobble	64 - 90	**13**
medium cobble	90 - 128	**12**
large cobble	128 - 180	**10**
very large cobble	180 - 256	**6**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock ----------		**1**
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		101

Note: Upstream End of Profile



Size (mm)	
D16	5.2
D35	22
D50	45
D65	75
D84	130
D95	190

Size Distribution	
mean	26.0
dispersion	5.8
skewness	-0.20

Type			
silt/clay	1%	bedrock	1%
sand	10%		
gravel	48%		
cobble	41%		
boulder	0%		

3) Bulk Sample Sieve Analysis

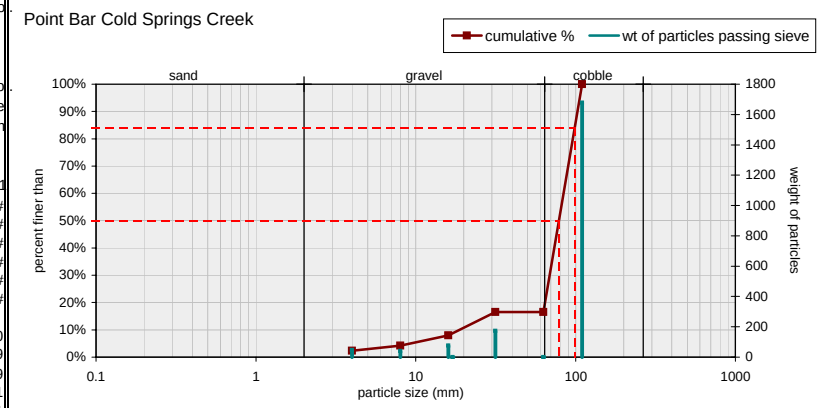
Two samples may be entered below. Select sample type for each.

Point Bar

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
2	**682**	**728**	46	2%	---	---
4	**739**	**779**	40	2%	2%	2%
8	**739**	**814**	75	4%	2%	4%
16	**811**	**983**	172	9%	4%	8%
31.5	**820**	**820**	0	0%	9%	17%
63	**706**	**2383**	1677	83%	0%	17%
110			0	0%	83%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%

total wt retained in sieves: 2010

Note: Pavement Largest Particles: 95 and 110 mm



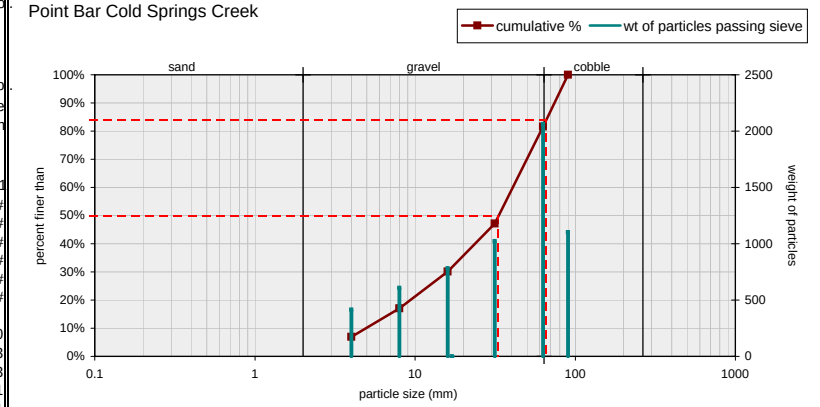
Size (mm)				
D16	30	D65	87	sand 100%
D35	71	D84	99	
D50	79	D95	110	

Point Bar

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
2	**682**	**1097**	415	7%	---	---
4	**739**	**1346**	607	10%	7%	7%
8	**739**	**1520**	781	13%	10%	17%
16	**811**	**1835**	1024	17%	13%	30%
31.5	**820**	**2883**	2063	34%	17%	47%
63	**706**	**1807**	1101	18%	34%	82%
90			0	0%	18%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%
			0	0%	0%	100%

total: 5991

Note: Sub-Pavement Largest Particles: 68 and 90 mm



Size (mm)			
D16	7.4	D65	45
D35	19	D84	66
D50	33	D95	82

Cold Springs Creek Cross Section 1 – Riffle

Cold Springs Creek Cross Section 2 – Pool

Cold Springs Creek Cross Section 3 – Riffle

Cold Springs Creek Cross Section 4 – Pool

APPENDIX D
PROJECT PLAN SHEETS (11”x17”)

NC EEP PROJECT # 93875

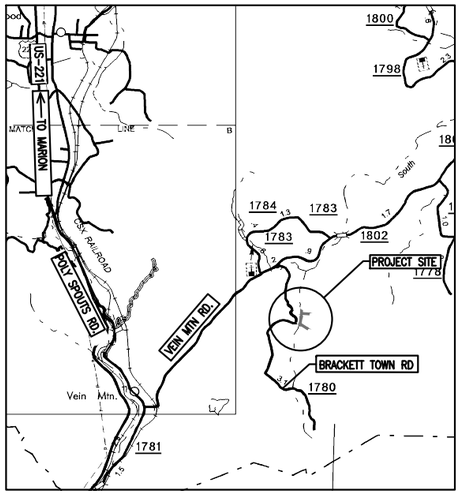
N.C. ECOSYSTEM ENHANCEMENT PROGRAM

STATE	EEP PROJECT NO.	SHEET NO.	TOTAL SHEETS
NC	93875	1	20

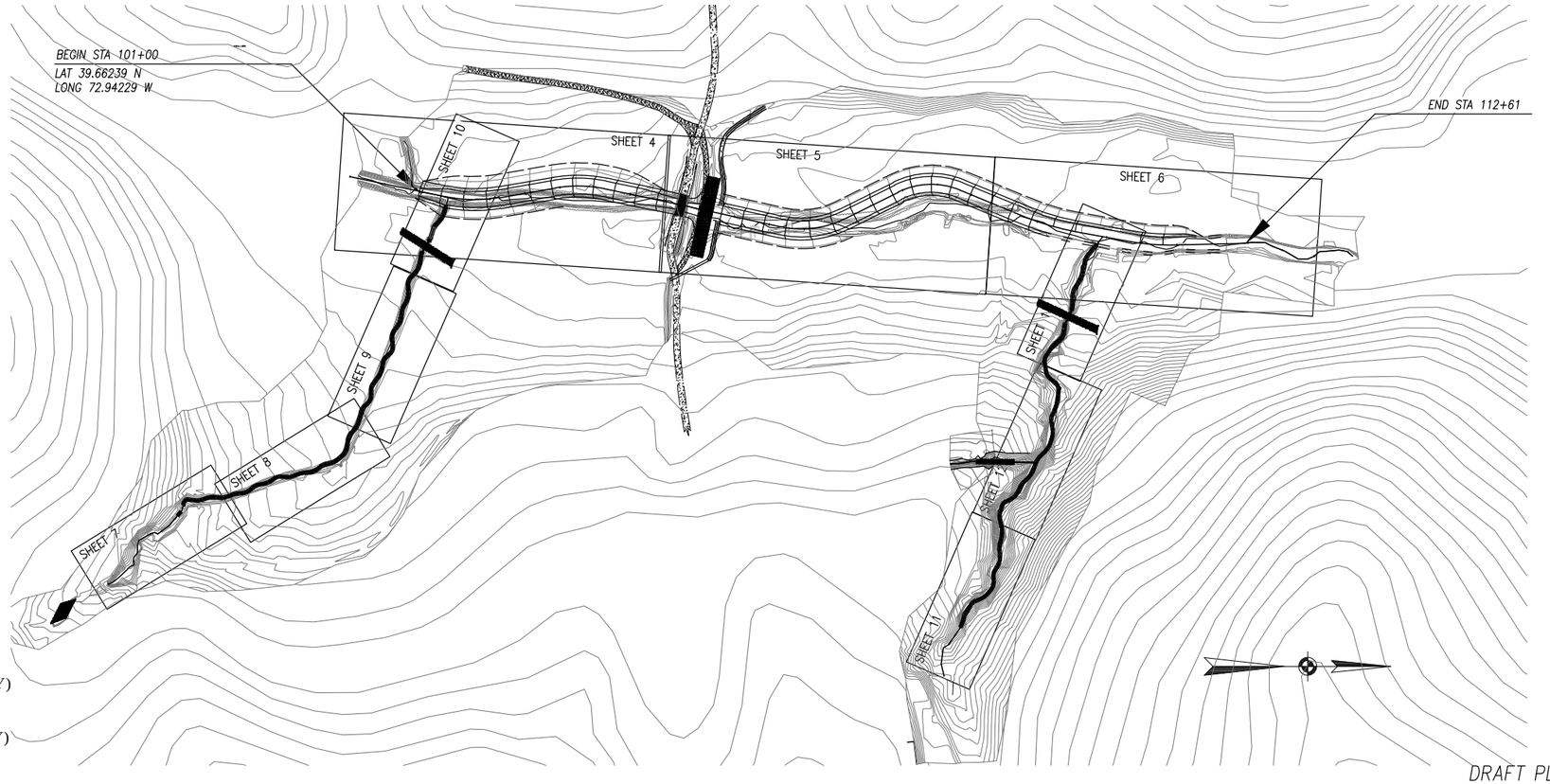
A	PRELIMINARY PLANS	11/16/2011	
	DRAFT PLANS	3/20/2012	
STR.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

MIDDLE SOUTH MUDDY CREEK STREAM RESTORATION PROJECT

SOUTH MUDDY CREEK
McDOWELL COUNTY, NORTH CAROLINA



VICINITY MAP
NOT TO SCALE



SHEET INDEX

SHEET NO.	DESCRIPTION
1	TITLE SHEET
1A	SITE PLAN
2	TYPICAL SECTIONS
3-3B	DETAILS
~~3C~~	~~SUMMARY OF QUANTITIES~~ (*FINAL ONLY*)
4-14	PLAN AND PROFILE
P1-P3	PLANTING PLAN
~~EC1-EC5~~	~~EROSION CONTROL PLANS~~ (*FINAL ONLY*)
~~XS-1 - XS-16~~	~~CROSS SECTIONS~~ (*FINAL ONLY*)

DRAFT PLANS

GRAPHIC SCALES (SCALE IN FEET)

20 0 20 60
PLANS (SHEETS 4-6)

10 0 10 30
PLANS (SHEETS 7-14)

20 0 20 60
HORIZONTAL PROFILE (SHEETS 4-6)

10 0 10 30
HORIZONTAL PROFILE (SHEETS 7-14)

2 0 2 6
VERTICAL PROFILE

PROJECT LENGTHS

PROPOSED RESTORATION:

SOUTH MUDDY CREEK	= 916 FT
MIDDLE SPROUSE BRANCH	= 177 FT
LOWER SPROUSE BRANCH	= 434 FT
UPPER IVA BRANCH	= 326 FT
LOWER IVA BRANCH	= 137 FT

PROPOSED ENHANCEMENT:

SOUTH MUDDY CREEK	= 171 FT
UPPER SPROUSE BRANCH	= 24 FT
TOTAL LENGTH	= 2,185 FT

Prepared by:

Wolf Creek Engineering, Pllc
License No. P-0417
7 Florida Avenue
Weaverville, North Carolina 28787
Phone: 828-658-3649
www.wolfcreekeng.com

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

PROJECT ENGINEER

Prepared for:

Ecosystem Enhancement PROGRAM

PROJECT MANAGER

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

Wolf Creek Engineering
ENGINEERING & ENVIRONMENTAL CONSULTING
LICENSE NO. P-0417
7 Florida Ave Weaverville, NC 28787
PHONE: (828) 658-3649 WWW.WOLFCREEKENG.COM

PROJECT: MIDDLE SOUTH MUDDY CREEK
OWNER: NC EEP
TITLE: SITE PLAN

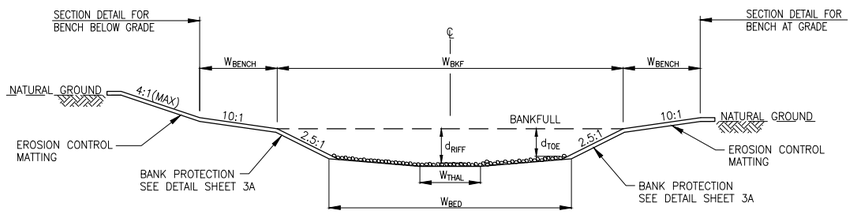
SCALE	AS NOTED	DRWN. BY	cme	PROJECT NO.	DRAWING NUMBER
DATE	3/20/2012	CHKD. BY	SGG	1049	1A

DATE	BY	REV.	DESCRIPTION

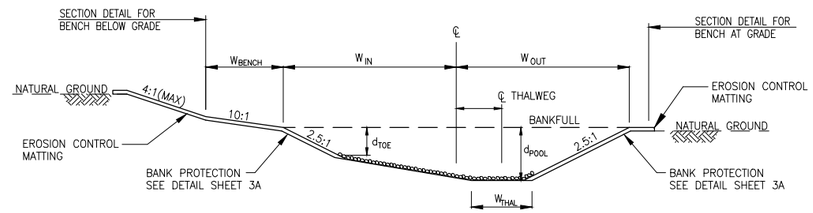
LOCATION KEY

BRACKET TOWN ROAD
SOUTH MUDDY CREEK
PROPOSED PERMANENT STREAM CROSSING (PIPE)
ABANDON EXISTING 24" CMP
PROPOSED 24" CMP
LOWER IVA BRANCH
PROPOSED PERMANENT STREAM CROSSING (PIPE)
LOWER SPROUSE BRANCH
IVA DITCH
UPPER IVA BRANCH
EXISTING FENCE TO BE REMOVED
MIDDLE SPROUSE BRANCH
UPPER SPROUSE BRANCH
PROPOSED PERMANENT STREAM CROSSING (FORD)

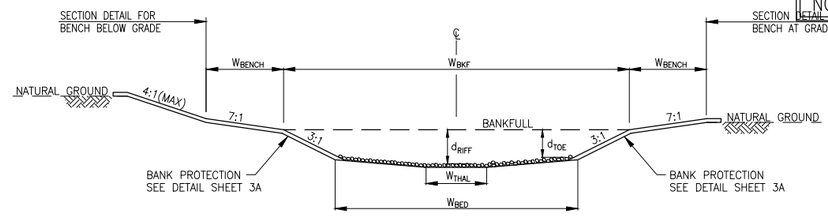
60 0 60 180
SCALE IN FEET



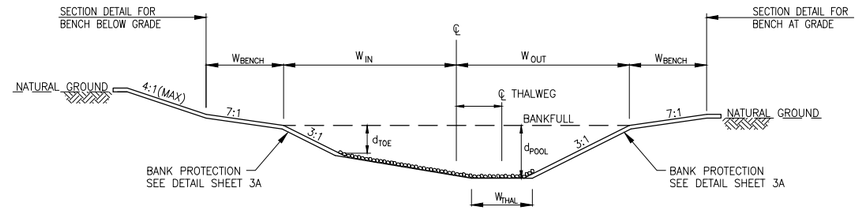
SECTION 1
TYPICAL RIFFLE
NOT TO SCALE



SECTION 1
TYPICAL POOL
NOT TO SCALE



SECTION 2
TYPICAL RIFFLE
NOT TO SCALE



SECTION 2
TYPICAL POOL
NOT TO SCALE

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

Wolf Creek Engineering
ENGINEERING & ENVIRONMENTAL CONSULTING
LICENSE NO. P-0417
7 Florida Ave Weaverville, NC 28787
PHONE: (828) 658-3649 WWW.WOLFCREEKENG.COM

PROJECT: MIDDLE SOUTH MUDDY CREEK
OWNER: NC EEP
TITLE: **TYPICAL SECTIONS**

SCALE	AS NOTED	DRWN. BY	MAM	PROJECT NO.	DRAWING NUMBER
DATE	3/20/2012	CHKD. BY	SGG	1049	2

DATE	BY	REV.	DESCRIPTION

GENERAL NOTES:
1. CONTRACTOR SHALL PERFORM ALL NECESSARY SUBSURFACE UTILITY INVESTIGATIONS PRIOR TO COMMENCING CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR FIELD VERIFICATION OF EXISTING CONDITIONS, OBSTRUCTIONS, AND UTILITIES WHICH MAY AFFECT PROPOSED WORK. CONSTRUCTION SHALL BEGIN AT THE UPSTREAM END OF EACH CHANNEL REACH AND PROCEED DOWNSTREAM UNLESS APPROVED OTHERWISE BY THE ENGINEER.
2. ALL MECHANIZED EQUIPMENT OPERATED IN OR NEAR THE STREAM OR ITS TRIBUTARIES SHALL BE INSPECTED REGULARLY AND MAINTAINED TO PREVENT CONTAMINATION OF STREAM WATERS FROM FUELS, LUBRICANTS, HYDRAULIC FLUIDS, OR OTHER TOXIC MATERIALS.
3. CLEARING AND GRUBBING SHALL BE LIMITED TO THAT WHICH IS NECESSARY FOR CONSTRUCTION OF THE PROPOSED CHANNEL AND SHALL BE APPROVED BY THE ENGINEER.
4. CONTRACTOR IS RESPONSIBLE FOR PROVIDING SAFE INGRESS AND EGRESS FROM SITE FOR ALL VEHICLES, INCLUDING BUT NOT LIMITED TO, TRAFFIC ON ADJACENT PUBLIC ROADS AFFECTED BY CONSTRUCTION TRAFFIC.
5. CONTRACTOR SHALL DISPOSE OF ALL WASTE MATERIALS GENERATED BY CONSTRUCTION ACTIVITIES IN ACCORDANCE WITH ALL FEDERAL, STATE, AND LOCAL REGULATIONS.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO EXISTING FACILITIES FROM DAMAGES OCCURRING AS A RESULT OF CONSTRUCTION ACTIVITIES.
7. THE INSTALLATION OF EROSION CONTROL MEASURES AND PRACTICES SHALL OCCUR PRIOR TO LAND DISTURBING ACTIVITIES.

TABLE 1: SECTION DIMENSIONS

REACH	TYPICAL SECTION	STATION	RIFFLE DIMENSIONS						POOL DIMENSIONS		
			W_{BKF} (ft)	W_{BED} (ft)	W_{THAL} (ft)	W_{FP} (ft)	d_{RIFF} (ft)	d_{TOE} (ft)	W_{IN} (ft)	W_{OUT} (ft)	d_{POOL} (ft)
SOUTH MUDDY CREEK	1	100+00 TO 112+61	30.8	22.1	6.6	10	2.17	1.74	18.5	15.4	3.26
MIDDLE SPROUSE BRANCH	2	201+74 TO 203+51	4.8	2.3	0.7	2	0.52	0.41	2.9	2.4	0.78
LOWER SPROUSE BRANCH	2	203+51 TO 208+04	5.2	2.6	0.8	3	0.55	0.44	3.1	2.6	0.83
UPPER IVA BRANCH	2	302+14 TO 305+40	4.8	2.3	0.7	2	0.52	0.41	2.9	2.4	0.78
LOWER IVA BRANCH	2	305+40 TO 306+96	5.5	2.8	0.8	3	0.57	0.46	3.3	2.8	0.86

NOTE: IN LOCATIONS WHERE MATURE VEGETATION EXISTS ADJACENT TO PROPOSED CHANNEL, THE FLOODPLAIN WIDTH (W_{FP}) SHALL BE REDUCED AS DIRECTED BY THE ENGINEER

TABLE 2: SUPPLEMENTAL BED MATERIAL

REACH	PERCENT OF TOTAL MAX					
	Sand/Clay	1/2" stone (No 57)	3/4" stone (No 5)	2" stone (Surge)	6" stone	12" stone
SOUTH MUDDY CREEK	10%	30%	–	30%	30%	–
MIDDLE SPROUSE BRANCH	100%	–	–	–	–	–
LOWER SPROUSE BRANCH	100%	–	–	–	–	–
UPPER IVA BRANCH	100%	–	–	–	–	–
LOWER IVA BRANCH	100%	–	–	–	–	–

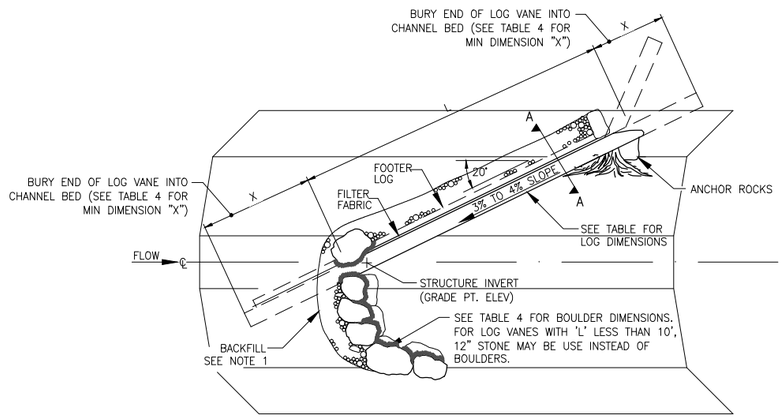
TABLE 3: MORPHOLOGIC TABLE

REACH	SOUTH MUDDY CREEK	MIDDLE SPROUSE BRANCH	LOWER SPROUSE BRANCH	UPPER IVA BRANCH	LOWER IVA BRANCH
STREAM TYPE	C4	B5	B5c	B5	B5c
DRAINAGE AREA (mi^2)	4.7	0.03	0.04	0.03	0.046
W_{BKF} (ft)	30.8	4.8	5.2	4.8	5.5
XS_{BKF} (ft^2)	52.2	1.6	1.9	1.6	2.1
d_{MEAN} (ft)	1.7	0.34	0.37	0.34	0.38
d_{MAX} (ft)	2.17	0.52	0.55	0.52	0.57
S_{AVG} (ft/ft)	0.003	0.031	0.014	0.058	0.026
S_{VALLEY} (ft/ft)	0.006	0.043	0.022	0.043	0.060
W/D RATIO	18.1	14.1	14.3	14.1	14.4
ENTRENCHMENT RATIO	2.1	3.2	2.9	3.2	2.7
SINUOSITY	1.03	1.07	1.07	1.09	1.02
POOL-TO-POOL RATIO	5-7.2	3.3-4.8	3.4-4.9	3.3-4.8	3.5-5.0
MEANDER WIDTH RATIO	3.2	2.3	3.1	2.5	2.2

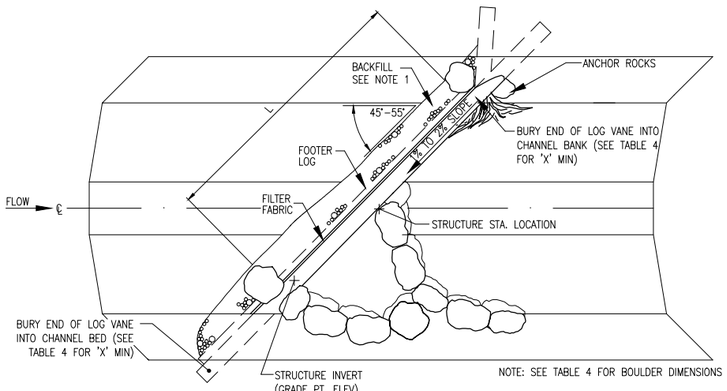
SURVEY:
THE COORDINATE SYSTEM IS THE NAD83 STATE PLANE GRID.

CHANNEL CONSTRUCTION NOTES:
1. BED MATERIAL ON RIFFLE SECTIONS SHALL CONSIST OF BED MATERIAL EXCAVATED FROM EXISTING CHANNEL. WHERE INSUFFICIENT BED MATERIAL IS PRESENT IT SHALL BE SUPPLEMENTED WITH MATERIAL ACCORDING TO TABLE 2 AND AS DIRECTED BY THE ENGINEER.
2. THE CHANNEL BANKS SHALL BE STABILIZED ACCORDING TO THE BANK PROTECTION DETAILS ON SHEET 3A. PRIORITY SHALL BE GIVEN TO IMPLEMENTATION OF METHOD 1. IF SUITABLE TRANSPLANT MATERIAL IS NOT AVAILABLE, THEN METHODS 2 AND 3 SHALL BE IMPLEMENTED AS DIRECTED BY THE ENGINEER.
3. DIMENSION TOLERANCES SHALL BE AS FOLLOWS:
   WIDTH: +/- 0.5 FT
   DEPTH: +/- 0.2 FT
   RIFFLE ELEVATIONS: +/- 0.1 FT
   POOL ELEVATIONS: + 0.1 FT, - 0.5 FT
   STRUCTURE ELEVATIONS: +/- 0.1 FT
4. EXISTING CHANNEL INDICATED TO BE FILLED ON PLANS SHALL BE BACKFILLED WITH 2-FOOT LIFTS AND COMPACTED TO IN-SITU SOIL DENSITY. CHANNEL SHALL BE FREE FROM BRUSH AND ORGANIC DEBRIS PRIOR TO BACKFILLING.
5. PUMP AROUND OPERATION SHALL BE USED TO DIVERT FLOW DURING CONSTRUCTION EXCEPT AS ALLOWED BY THE ENGINEER. ALL EXCAVATION SHALL BE PERFORMED IN THE DRY OR IN ISOLATED REACHES EXCEPT AS ALLOWED BY THE ENGINEER.

TREE SURVEY/HARVEST/PROTECTION NOTES:
1. WOODY MATERIAL WILL BE HARVESTED ON-SITE FOR USE AS IN-STREAM STRUCTURES FOR STREAMBANK STABILITY, GRADE CONTROL, AND AQUATIC HABITAT ENHANCEMENT/RESTORATION. WOODY MATERIAL INCLUDES BOTH LARGE AND SMALL SIZE DIAMETER TREES INCLUDING STEM AND ROOT MASS. TREES WILL BE HARVESTED FROM UPLAND AREAS AS WELL AS ALONG RECONSTRUCTED STREAM BANKS DURING THE RESTORATION CONSTRUCTION PROCESS.
2. PREFERRED HARVEST TREES TO BE SELECTED FOR RESTORATION PURPOSES SHALL FIRST INCLUDE ALL DISEASED, DAMAGED, HAZARD, AND UNDESIRABLE TREE SPECIES UNTIL THE QUANTITIES NEEDED FOR STREAM RESTORATION ARE MET. AREAS SELECTED FOR HARVEST SHALL OCCUR WITHIN THE LIMITS OF DISTURBANCE AND DELINEATED BY A CERTIFIED ARBORIST OR OTHER PROFESSIONAL ECOLOGIST/BIOLOGIST.
3. ALL WOODY MATERIALS WILL BE STOCKPILED IN THE APPROVED STAGING AND STOCKPILE AREAS.
4. IN ALL AREAS WHERE TREES ARE HARVESTED PROPER BMP AND EROSION AND SEDIMENT CONTROL WILL BE IMPLEMENTED AND THE AREA IMMEDIATELY STABILIZED WITH TEMPORARY AND PERMANENT SEEDING/MULCH AS HARVESTING OCCURS.



LOG J-HOOK
PLAN VIEW
NOT TO SCALE

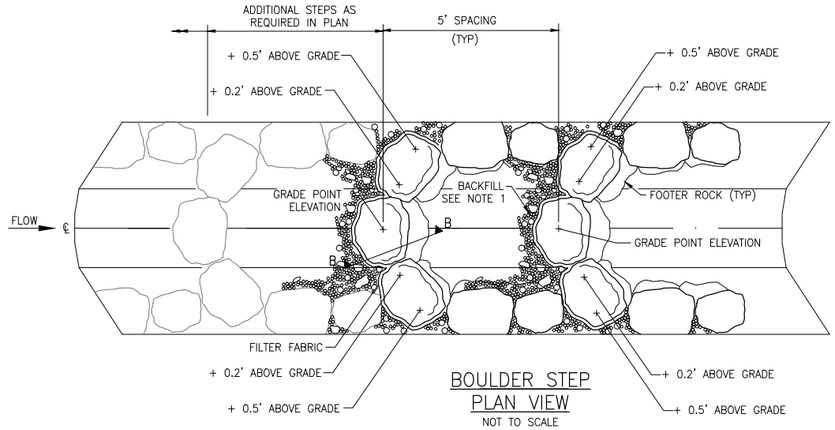


LOG SILL (L > 8')
PLAN VIEW
NOT TO SCALE

TABLE 4: STRUCTURE DIMENSIONS							
REACH	STRUCTURES			BOULDERS			TOTAL LOG LENGTH (FT)
	L (FT)	W (FT)	X (FT)	LENGTH (FT)	WIDTH (FT)	DEPTH (FT)	
SOUTH MUDDY CREEK	35	10	8	3	2	1.5	51
SPROUSE BRANCH 1	4	2	3	2	1.5	1	10
SPROUSE BRANCH 2	4	2	3	2	1.5	1	10
IVA BRANCH 1	4	2	3	2	1.5	1	10
IVA BRANCH 2	4	2	3	2	1.5	1	10

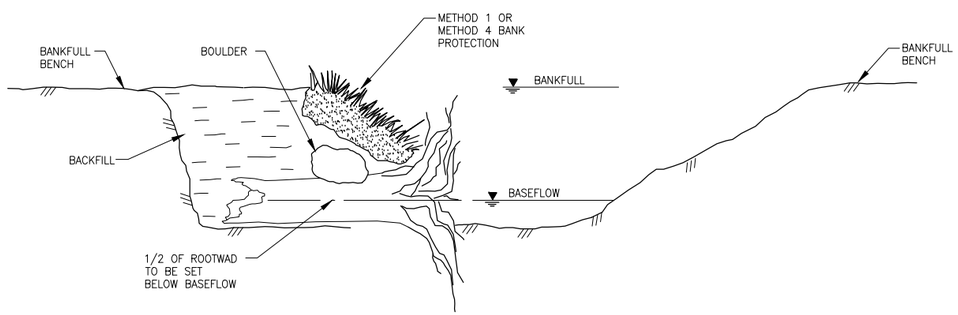
NOTE: TOTAL LOG LENGTH INCLUDES THE ROOTBALL

TABLE 5: LOG DIAMETERS		
TOTAL LOG LENGTH (FT)	MIN DIAMETER (IN)	MAX DIAMETER (IN)
< 20	12	18
20-40	18	24
40-60	24	30

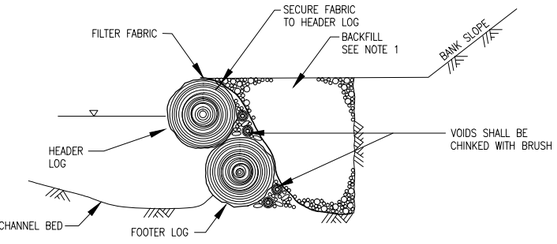


BOULDER STEP
PLAN VIEW
NOT TO SCALE

LOG SILL (L ≤ 8')
PLAN VIEW
NOT TO SCALE



ROOTWAD
SECTION
NOT TO SCALE



SECTION A-A
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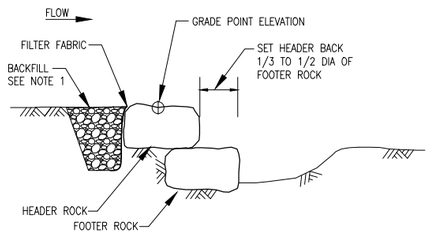

SECTION B-B
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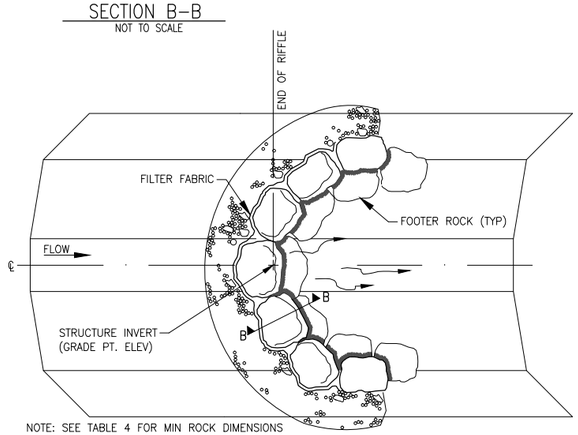

BOULDER ARCH
PLAN VIEW
NOT TO SCALE

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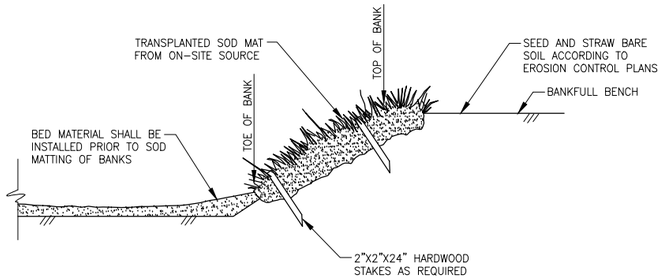
PROJECT: MIDDLE SOUTH MUDDY CREEK
OWNER: NC EEP
TITLE: DETAILS

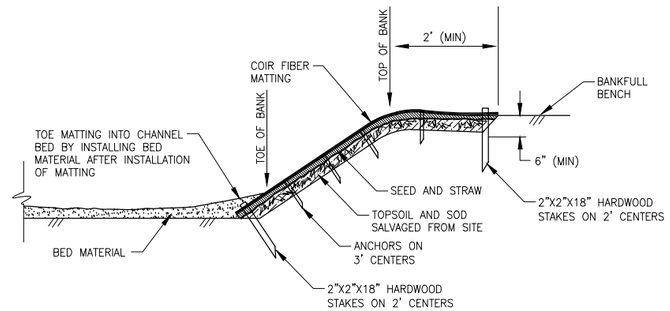
SCALE	DRWN. BY	PROJECT NO.	DRAWING NUMBER
AS NOTED	MAM	1049	3
DATE 3/20/2012	CHKD. BY SGG		

DATE	BY	REV.	DESCRIPTION

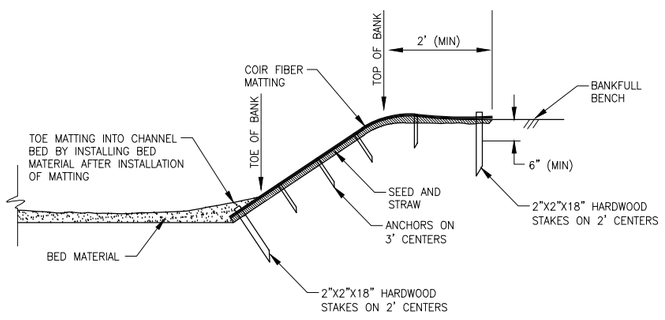
NOTES:
1. STRUCTURE BACKFILL MATERIAL SHALL CONSIST OF NO. 57 STONE MIXTED WITH 30% SOIL. WHERE EXISTING BED MATERIAL IS AVAILABLE AND OF SUFFICIENT SIZE IT MAY BE USED IN PLACE OF QUARRY STONE, AS APPROVED BY THE ENGINEER.



BANK PROTECTION – METHOD 1
SOD MATTING
NOT TO SCALE



BANK PROTECTION – METHOD 2
SOD AND MAT
NOT TO SCALE



BANK PROTECTION – METHOD 3
COIR MATTING
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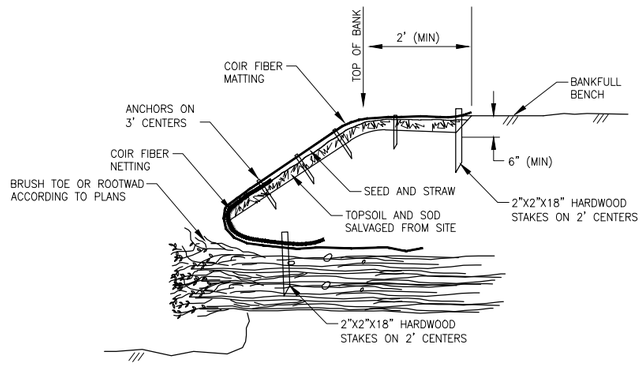
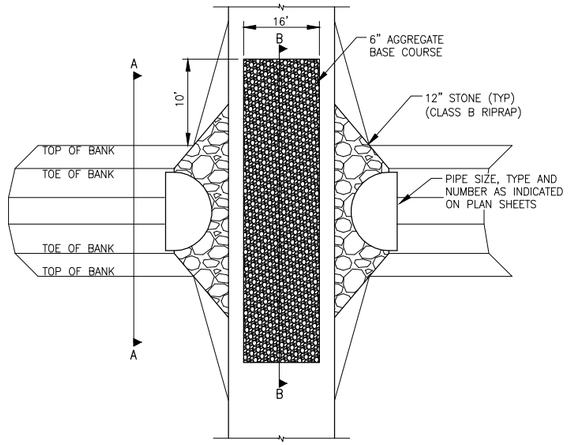
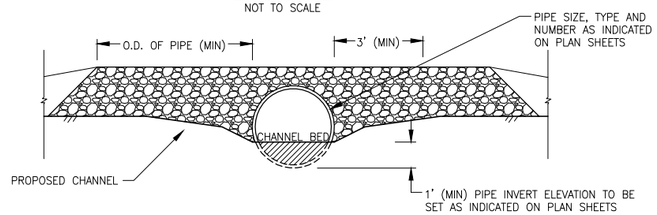


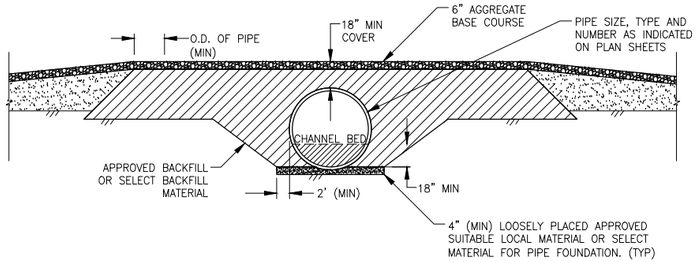
BANK PROTECTION – METHOD 4
NOT TO SCALE



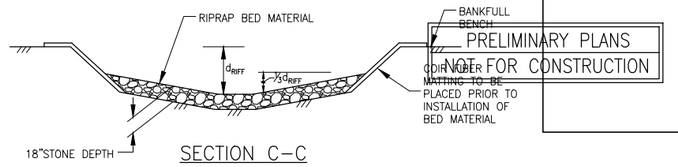
PERMANENT CROSSING (PIPE)
PLAN VIEW
NOT TO SCALE



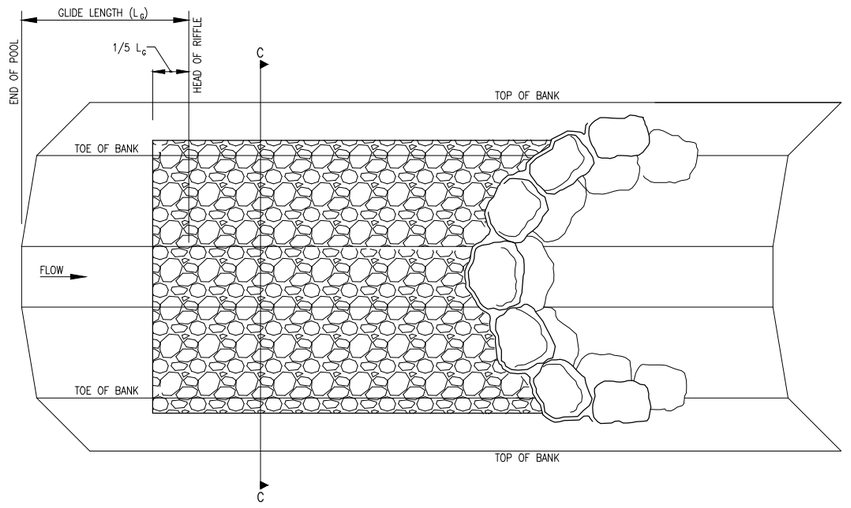
PERMANENT CROSSING (PIPE)
ELEVATION A–A
NOT TO SCALE



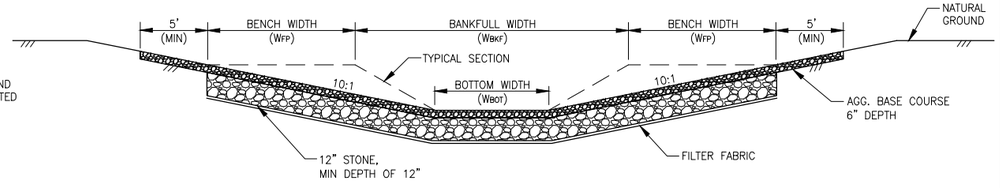
PERMANENT CROSSING (PIPE)
SECTION B–B
NOT TO SCALE



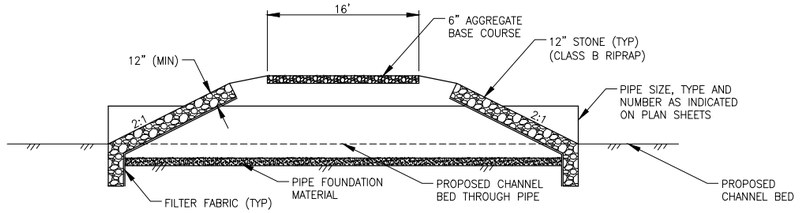
SECTION C–C
NOT TO SCALE



ARMORED RIFFLE DETAIL
NOT TO SCALE



PERMANENT STREAM CROSSING (FORD)
NOT TO SCALE



PERMANENT CROSSING (PIPE)
SECTION
NOT TO SCALE

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OWNER NC EEP
TITLE **DETAILS**

SCALE	AS NOTED	DRWN. BY	MAM	PROJECT NO.	DRAWING NUMBER
DATE	3/20/2012	CHKD. BY	SGG	1049	3A

DATE	BY	REV.	DESCRIPTION

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OWNER	NC EEP
TITLE	DETAILS

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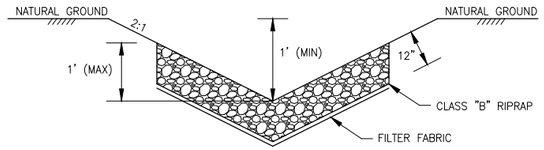
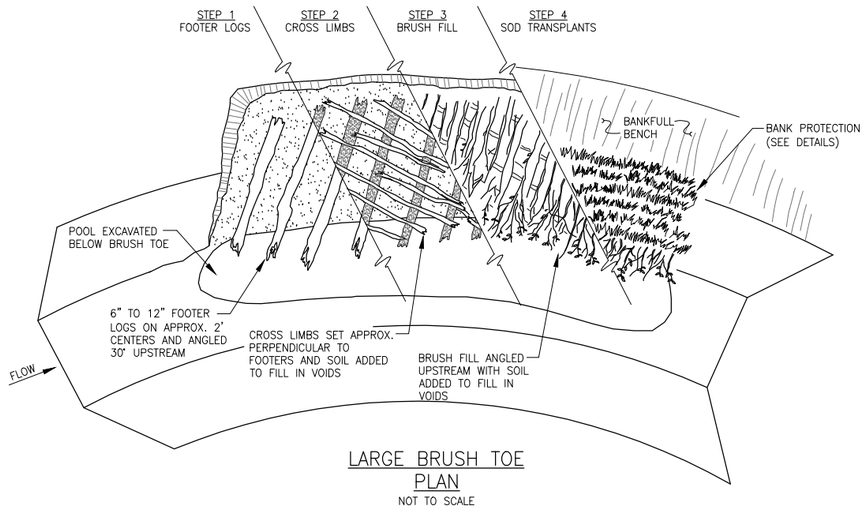
DATE 3/20/2012	CHKD. BY SGG		

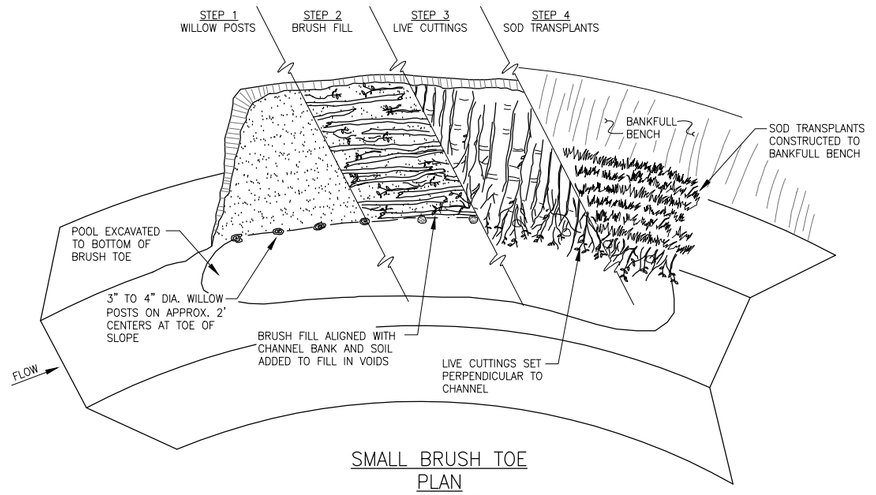
DATE	BY	REV.	DESCRIPTION



STANDARD "V" DITCH
NOT TO SCALE



LARGE BRUSH TOE
PLAN
NOT TO SCALE



SMALL BRUSH TOE
PLAN
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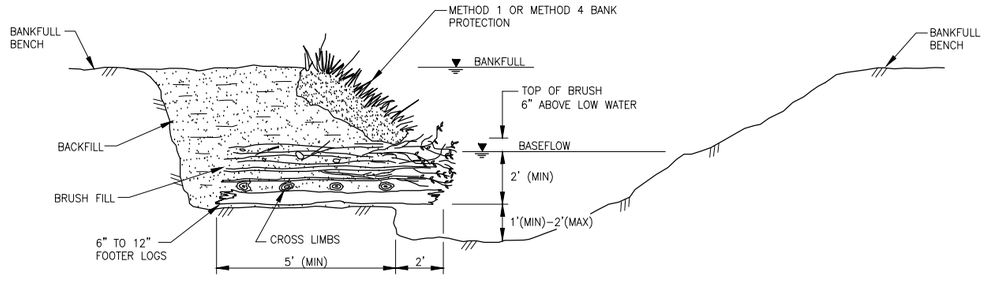

LARGE BRUSH TOE
SECTION
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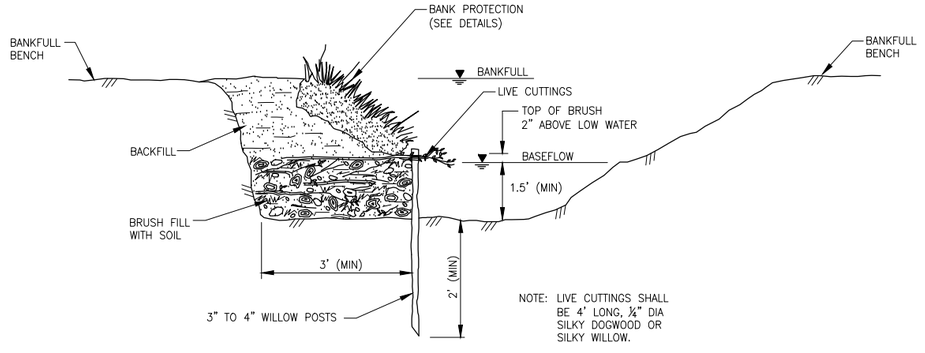

SMALL BRUSH TOE
SECTION
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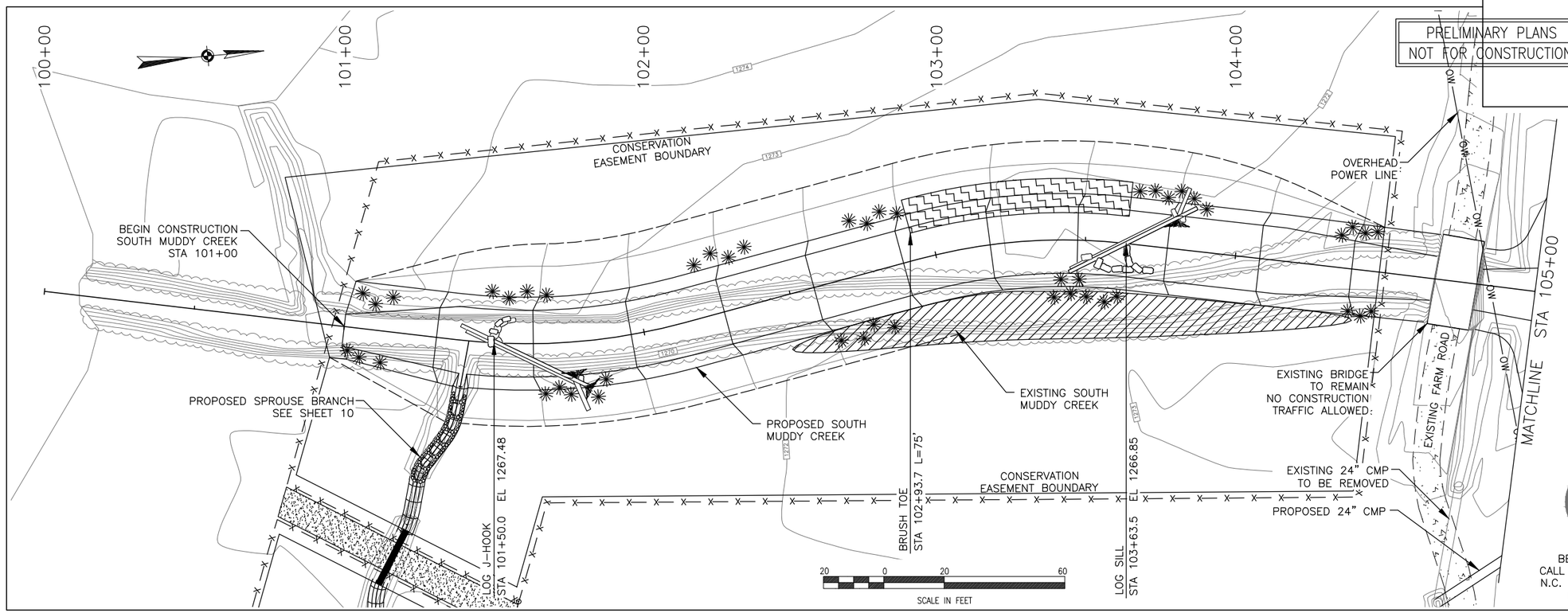
OWNER NC EEP
TITLE **PLAN & PROFILE**

SCALE AS NOTED	DRWN. BY cme	PROJECT NO.	SHEET NUMBER
DATE 3/20/2012	CHKD. BY SGG	1049	4

DATE	BY	REV.	DESCRIPTION



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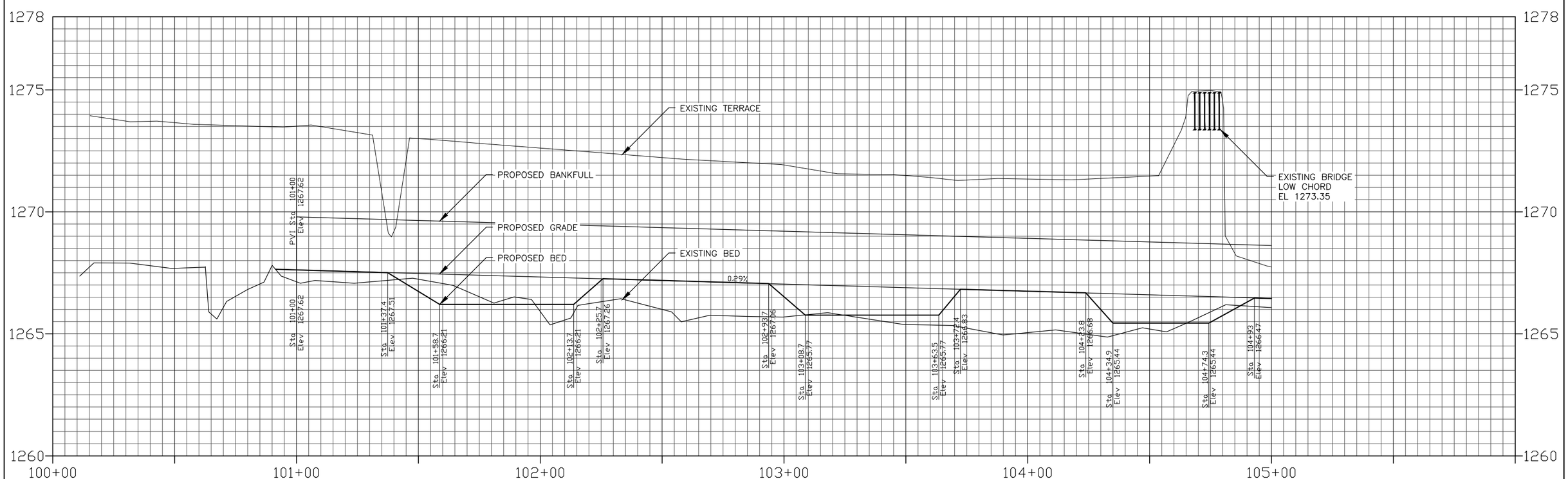
LOCATION KEY

LEGEND

- CUT
- FILL
- TRANSPLANTS
- EXISTING TRANSPLANT MATERIAL
- EXISTING BANKS TO REMAIN
- PROPOSED HIGH-TENSILE FENCE



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'
HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL:1" = 4'

SOUTH MUDDY CREEK

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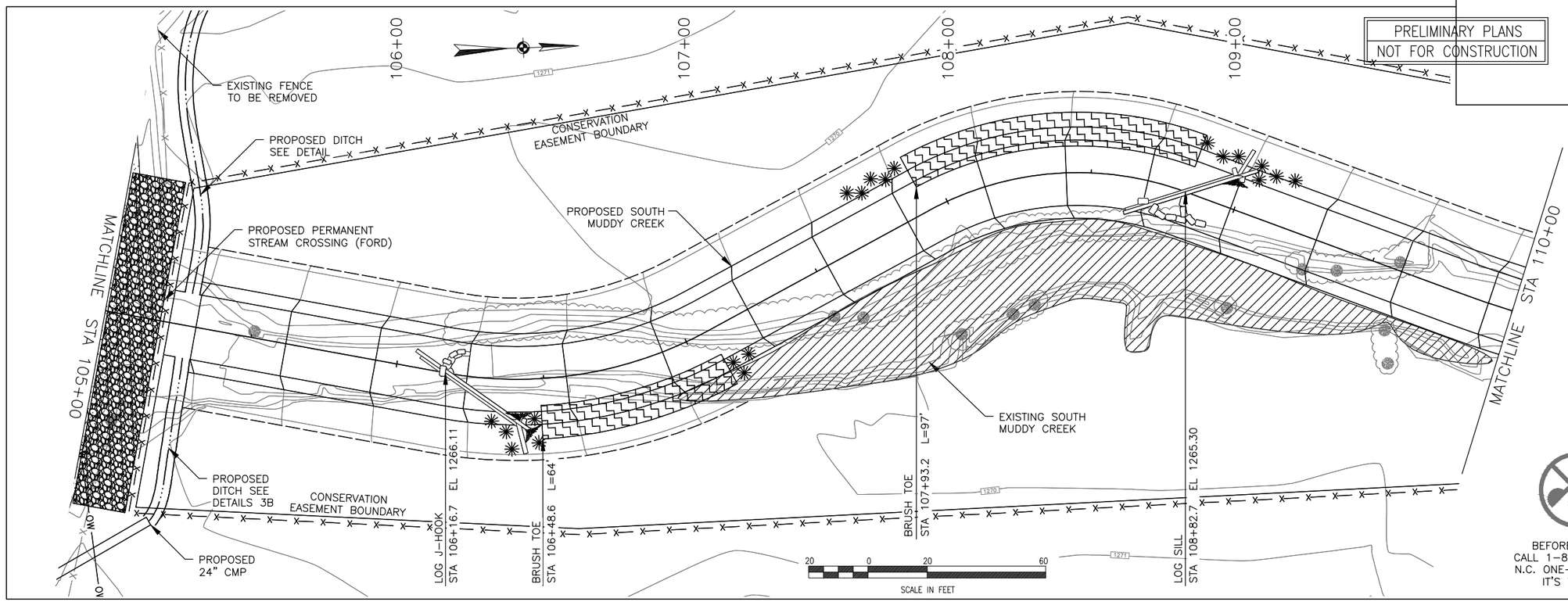
SCALE AS NOTED	DRWN. BY cme	PROJECT NO.	SHEET NUMBER
DATE 3/20/2012	CHKD. BY SGG	1049	5

DATE	BY	REV.	DESCRIPTION



LOCATION KEY

LEGEND
- CUT
- FILL
- TRANSPLANTS
- EXISTING TRANSPLANT MATERIAL
- EXISTING BANKS TO REMAIN
- PROPOSED HIGH-TENSILE FENCE

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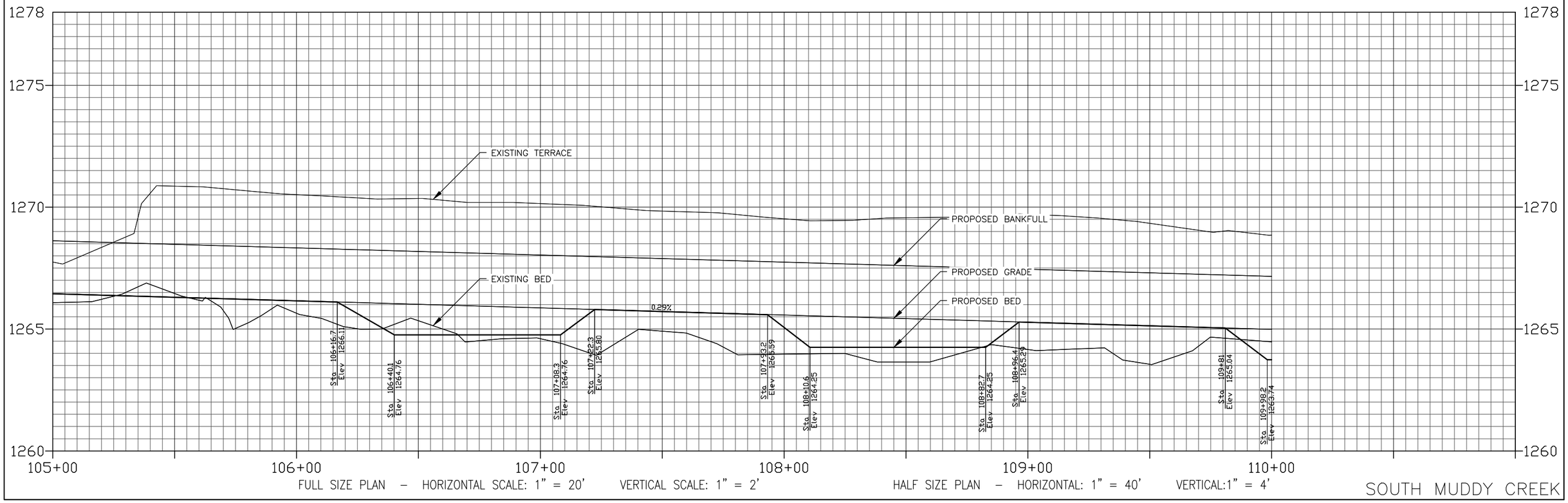

FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'
HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL:1" = 4'

SOUTH MUDDY CREEK

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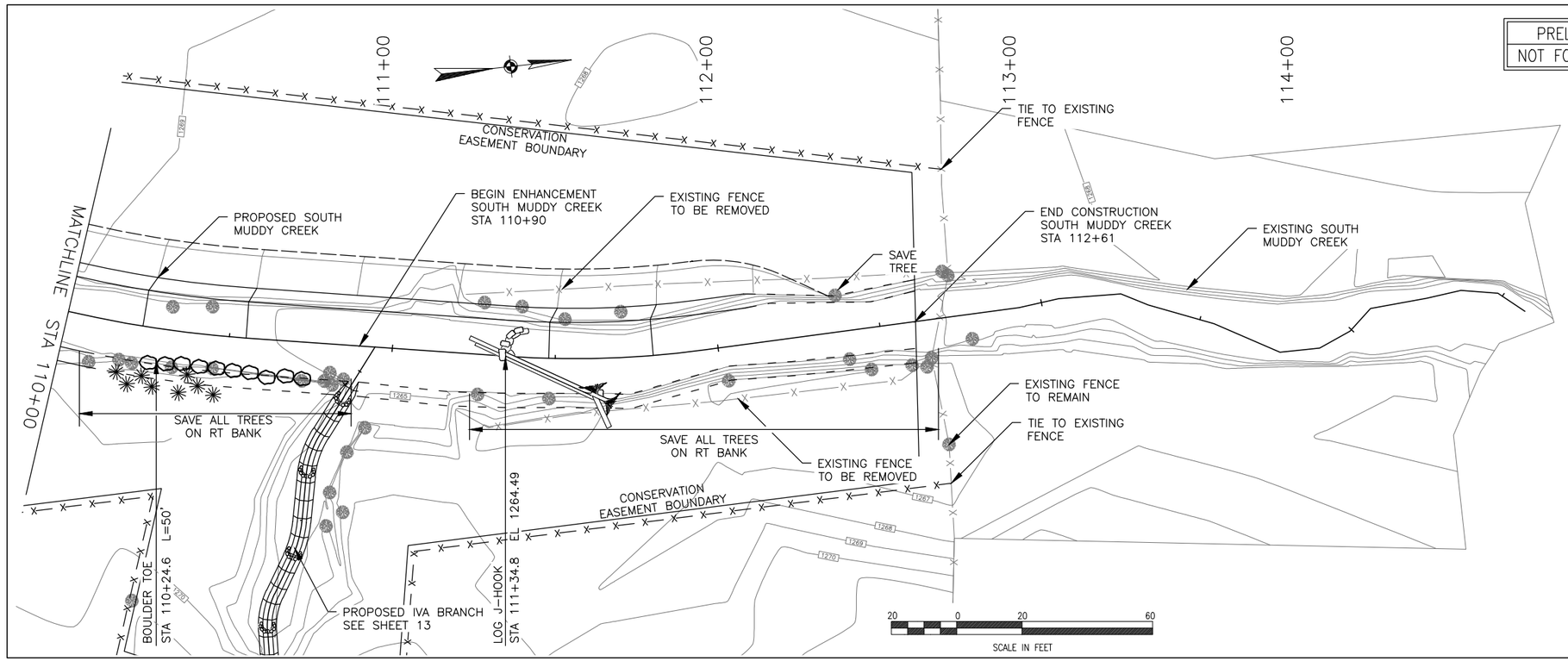
SCALE AS NOTED	DRWN. BY cme	PROJECT NO.	SHEET NUMBER
DATE 3/20/2012	CHKD. BY SGG	1049	6

DATE	BY	REV.	DESCRIPTION



LOCATION KEY

LEGEND
- CUT
- FILL
- TRANSPLANTS
- EXISTING TRANSPLANT MATERIAL
- EXISTING BANKS TO REMAIN
- PROPOSED HIGH-TENSILE FENCE

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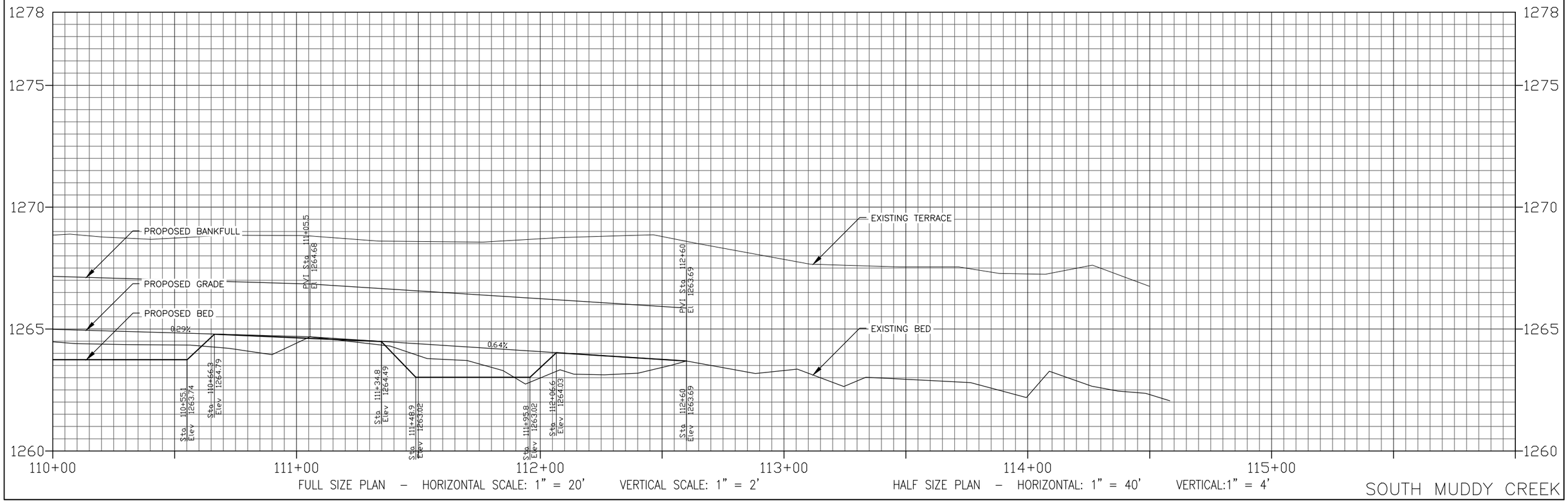
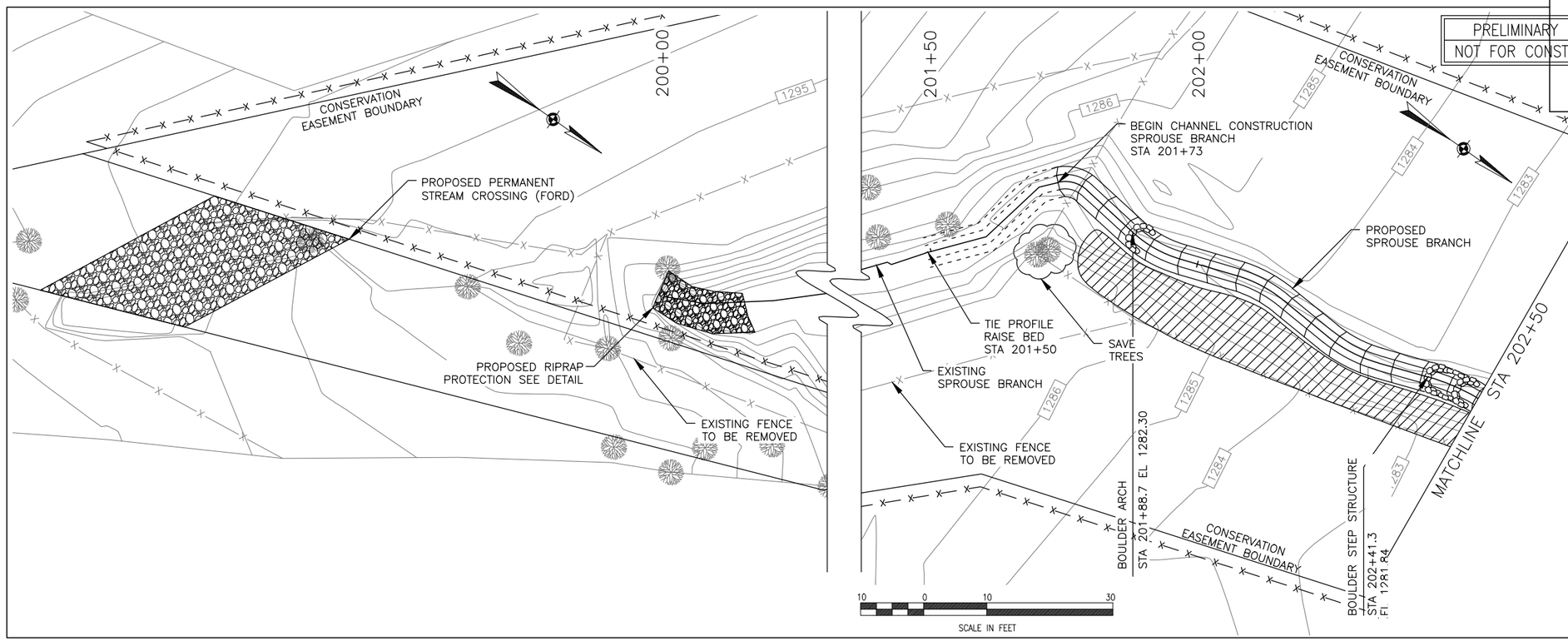


FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'
HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL:1" = 4'

SOUTH MUDDY CREEK



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OWNER NC EEP
TITLE **PLAN & PROFILE**

SCALE	AS NOTED	DRWN. BY	cme	PROJECT NO.	SHEET NUMBER
DATE	3/20/2012	CHKD. BY	SGG	1049	7

DATE	BY	REV.	DESCRIPTION

LOCATION KEY

LEGEND
- CUT
- FILL
- TRANSPLANTS
- EXISTING TRANSPLANT MATERIAL
- EXISTING BANKS TO REMAIN
- PROPOSED HIGH-TENSILE FENCE

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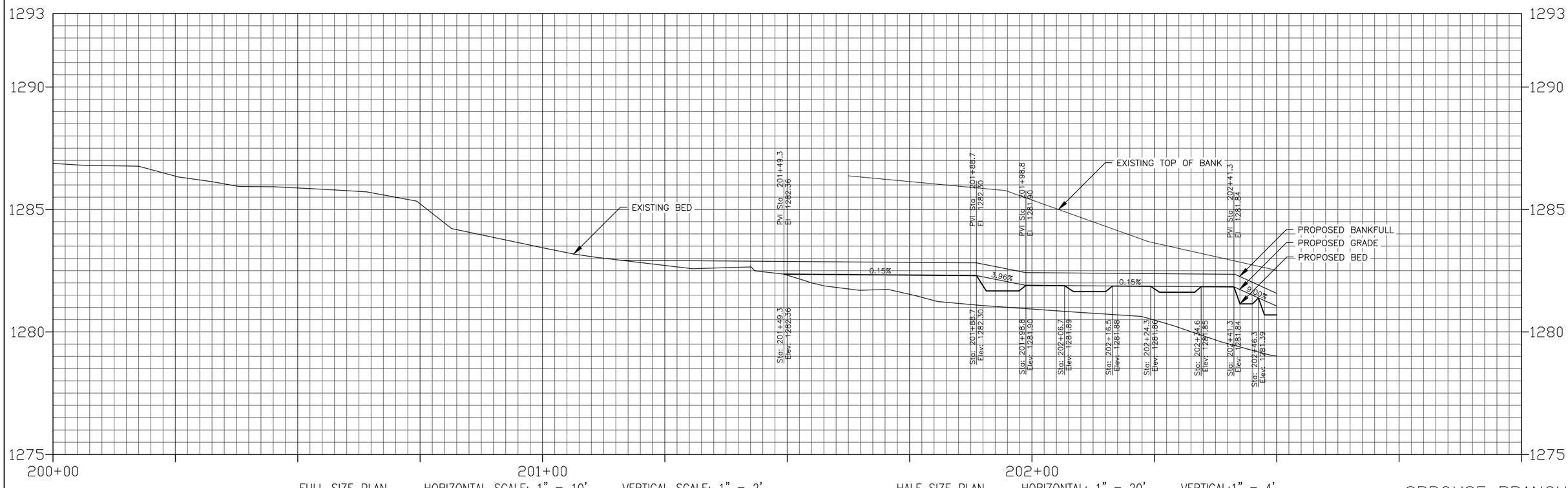

FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 2'
HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL:1" = 4'

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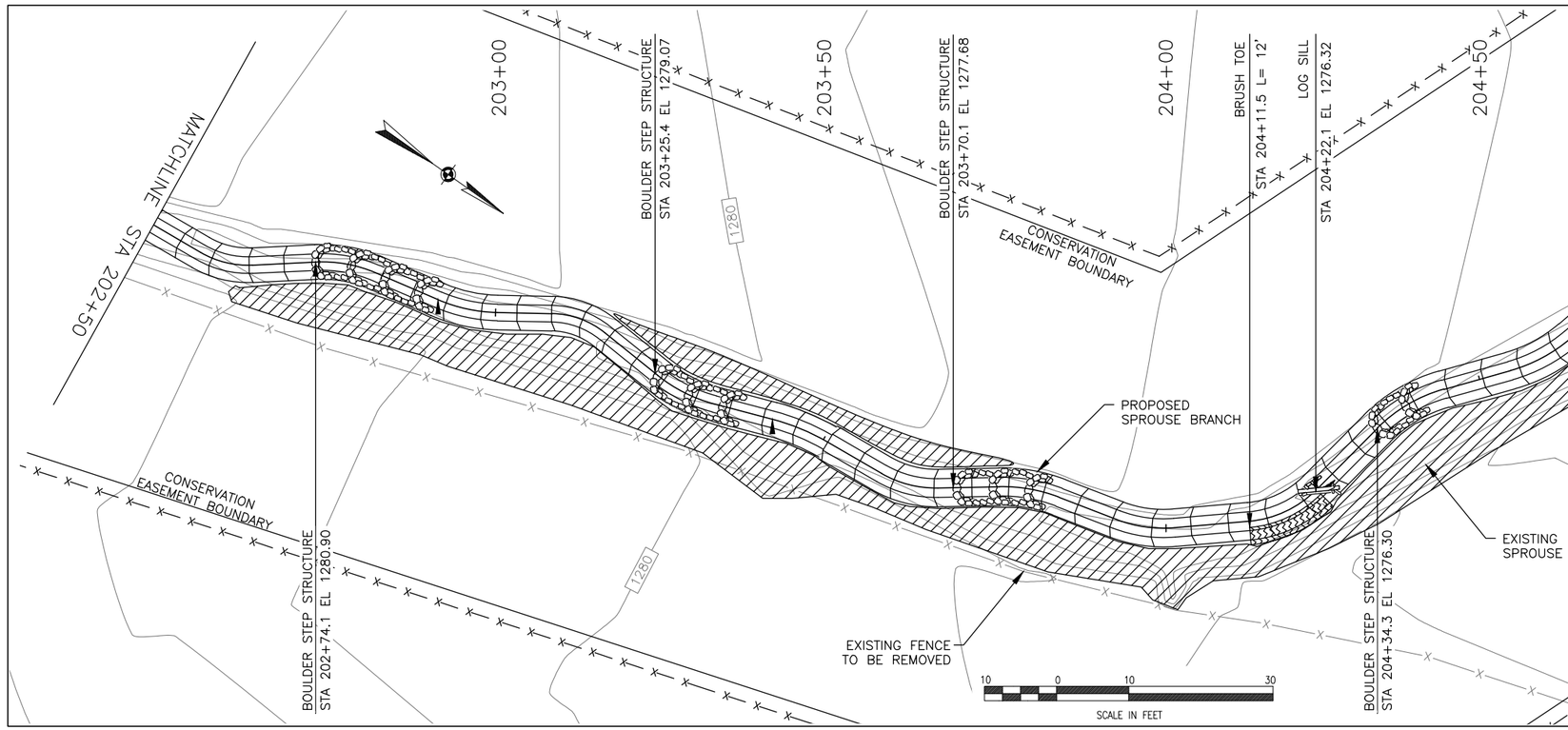
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

PROJECT MIDDLE SOUTH MUDDY CREEK
OWNER NC EEP
TITLE **PLAN & PROFILE**

SCALE AS NOTED	DRWN. BY cme	PROJECT NO.	SHEET NUMBER
DATE 3/20/2012	CHKD. BY SGG	1049	8

DATE	BY	REV.	DESCRIPTION



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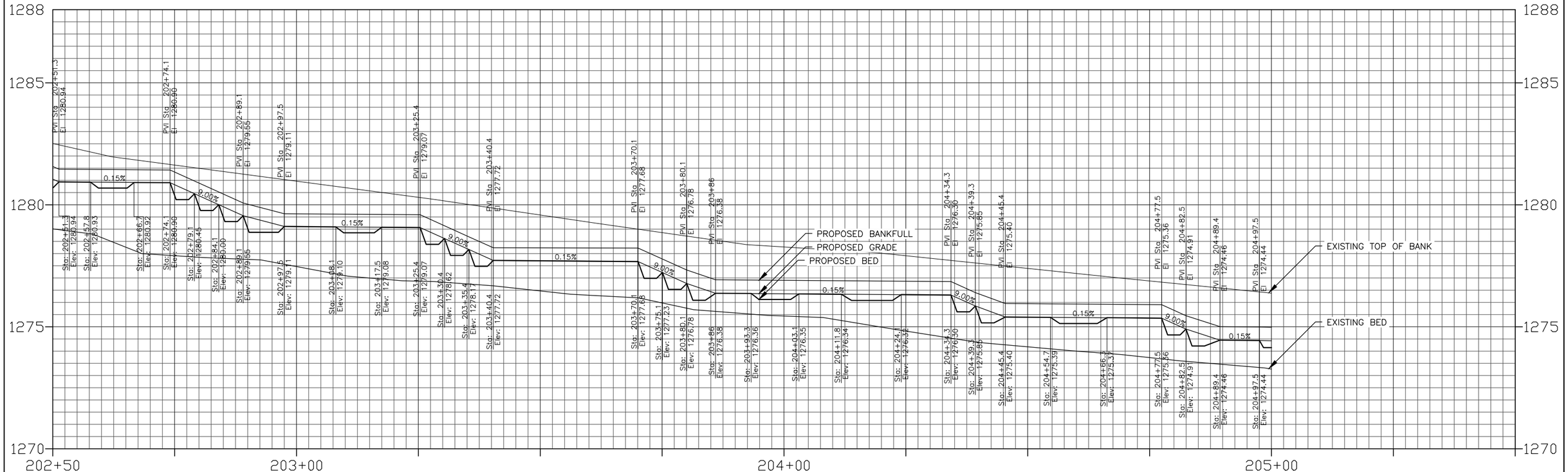
LOCATION KEY

LEGEND

- CUT
- FILL
- TRANSPLANTS
- EXISTING TRANSPLANT MATERIAL
- EXISTING BANKS TO REMAIN
- PROPOSED HIGH-TENSILE FENCE



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PRELIMINARY PLANS
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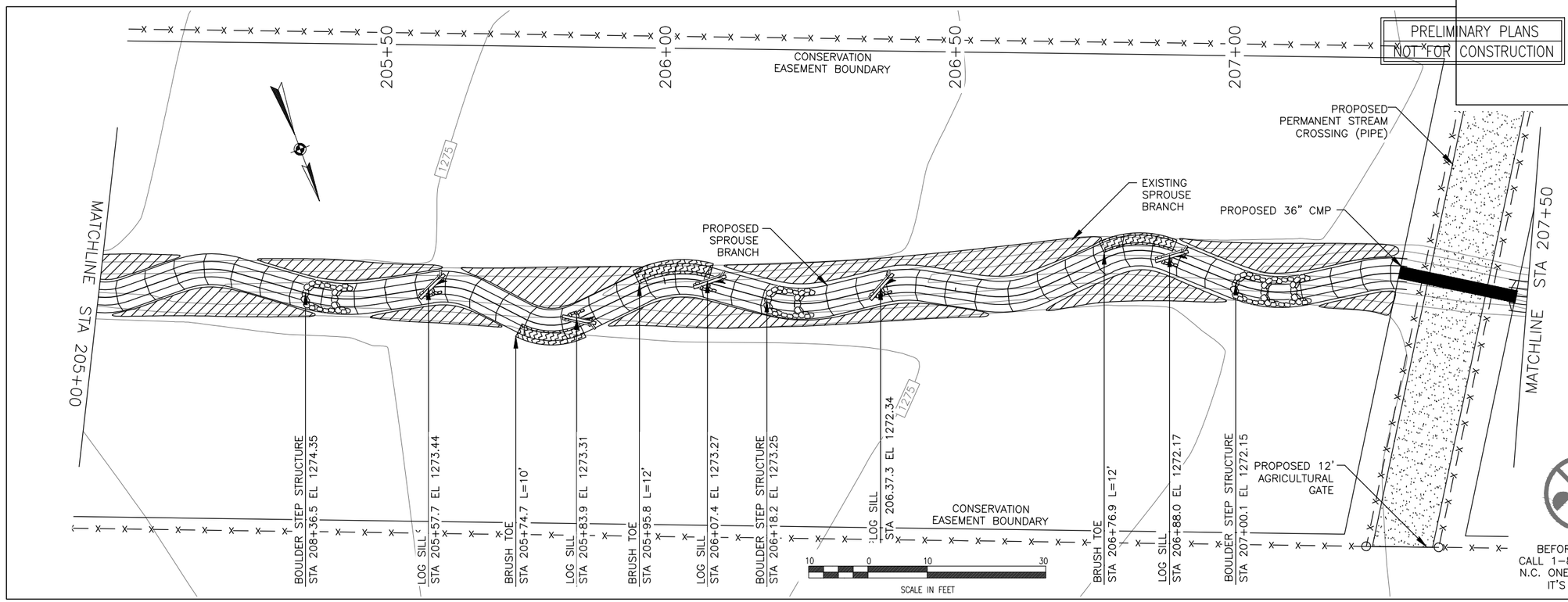
PROJECT: MIDDLE SOUTH MUDDY CREEK
OWNER: NC EEP
TITLE: **PLAN & PROFILE**

SCALE	DRWN. BY	PROJECT NO.	SHEET NUMBER
AS NOTED	cme	1049	9
DATE 3/20/2012	CHKD. BY SGG		

DATE	BY	REV.	DESCRIPTION



LOCATION KEY

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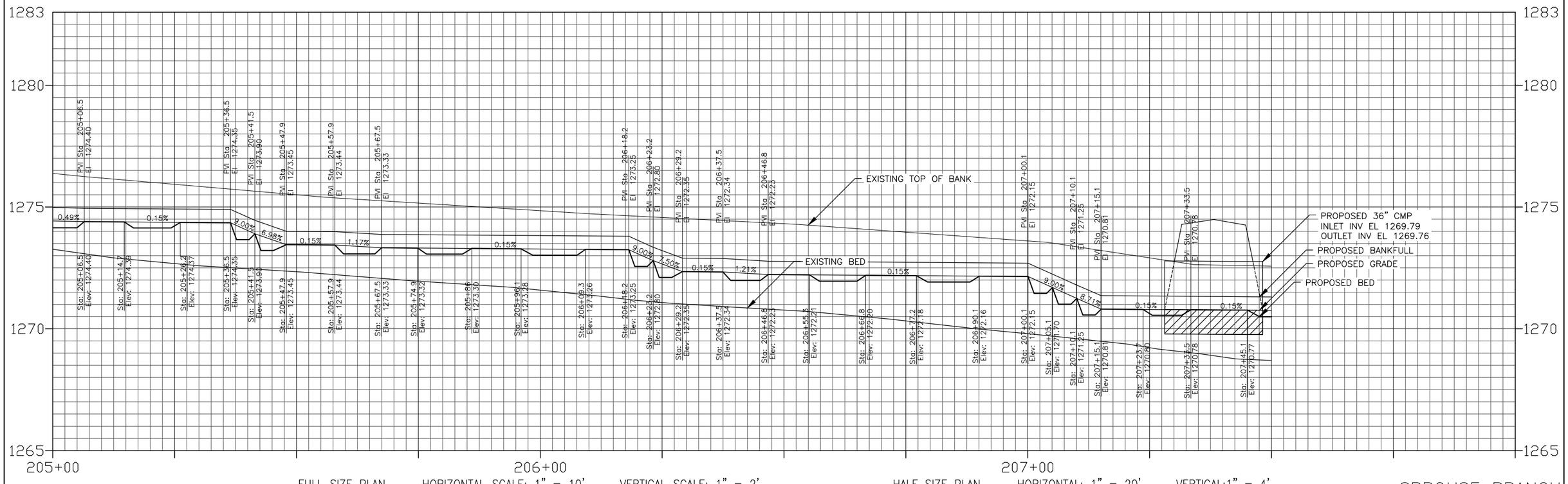

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DATE 3/20/2012	CHKD. BY SGG	1049	10

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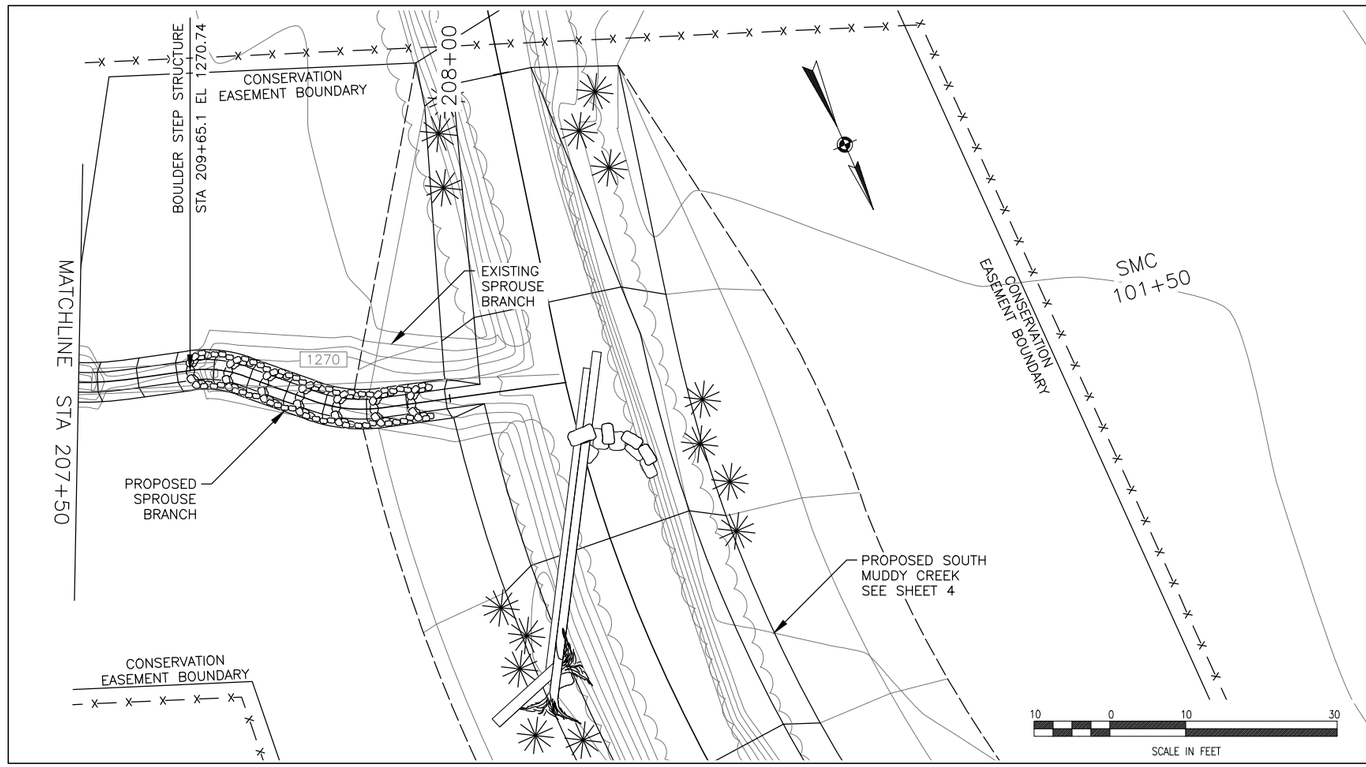

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LOCATION KEY

LEGEND

- CUT
- FILL
- TRANSPLANTS
- EXISTING TRANSPLANT MATERIAL
- ARMORED RIFFLE
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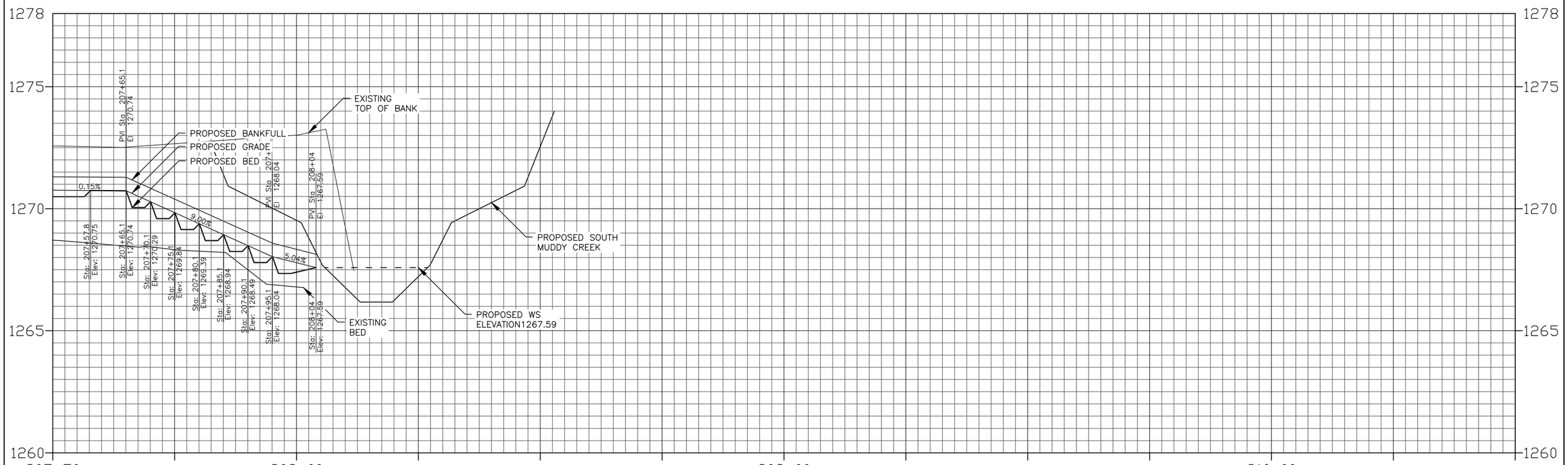

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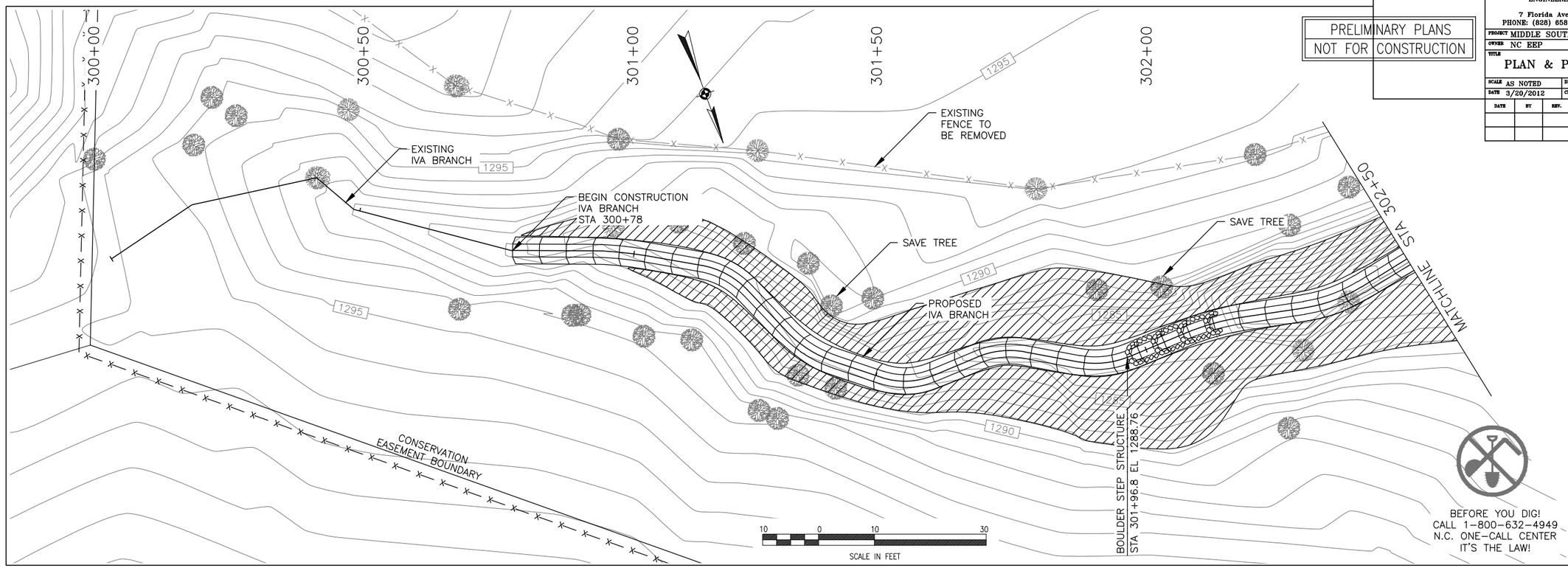
DATE	3/20/2012	CHKD. BY	SGG	1049	11

DATE	BY	REV.	DESCRIPTION



LOCATION KEY

LEGEND

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- EXISTING BANKS TO REMAIN
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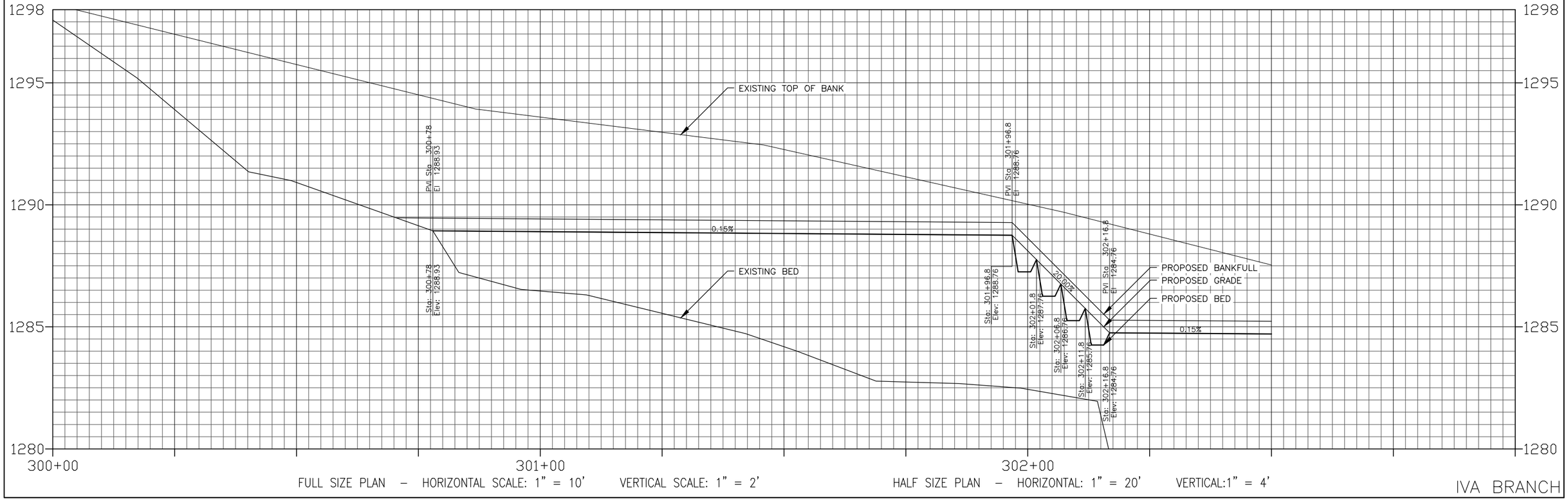

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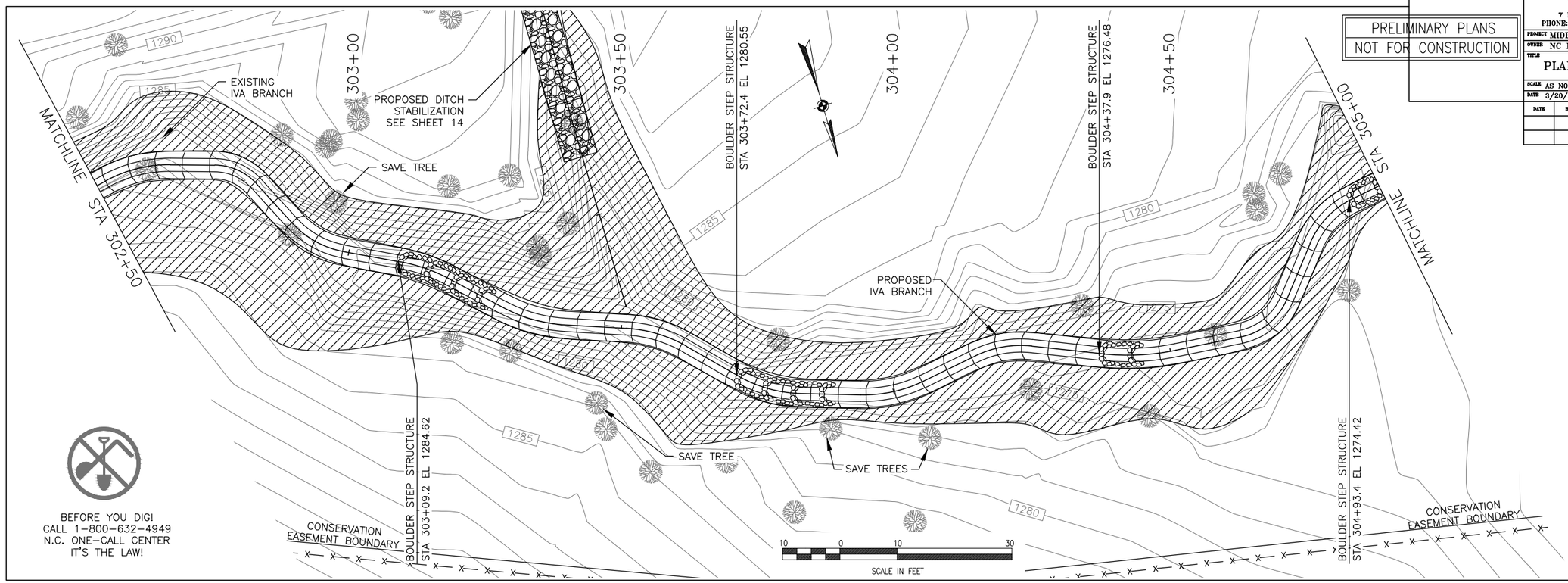
OWNER NC EEP
TITLE **PLAN & PROFILE**

SCALE AS NOTED	DRWN. BY cme	PROJECT NO.	SHEET NUMBER
DATE 3/20/2012	CHKD. BY SGG	1049	12

DATE	BY	REV.	DESCRIPTION



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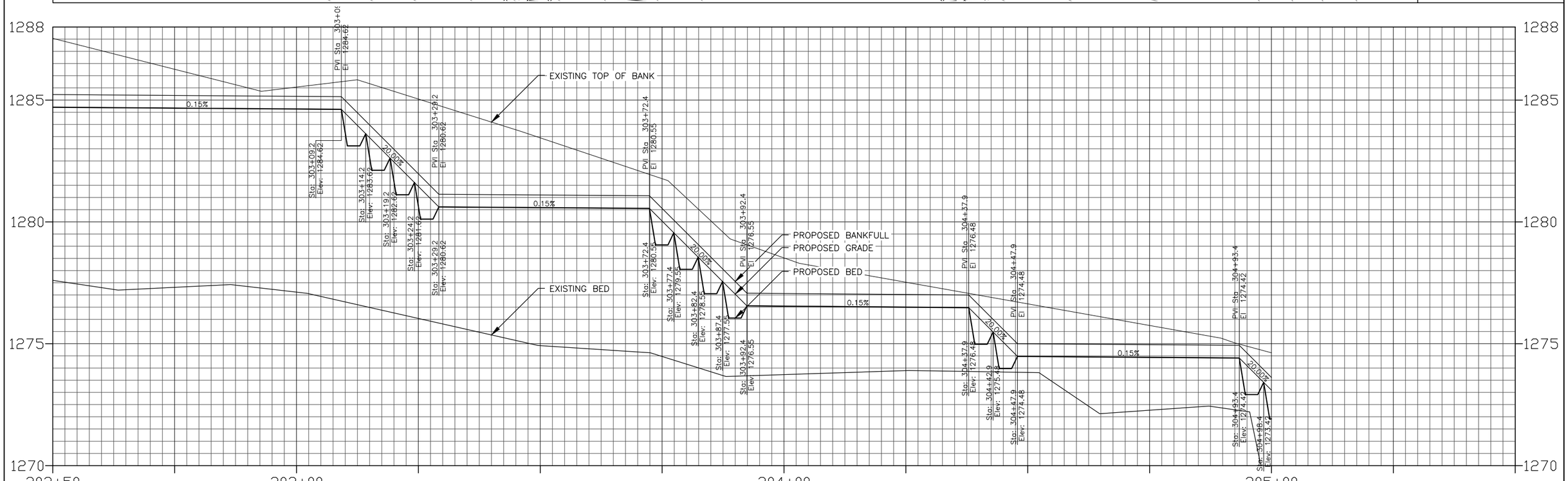

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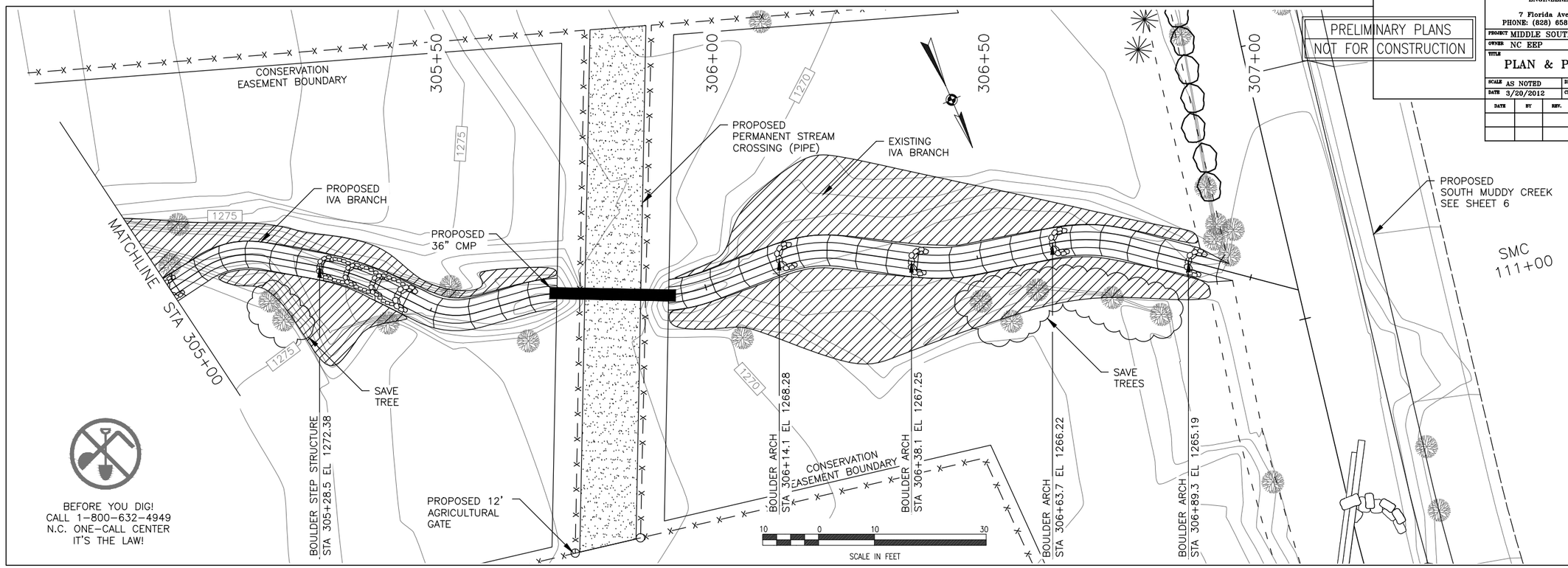
PROJECT MIDDLE SOUTH MUDDY CREEK
OWNER NC EEP
TITLE **PLAN & PROFILE**

SCALE	AS NOTED	DRWN. BY	cme	PROJECT NO.	SHEET NUMBER
DATE	3/20/2012	CHKD. BY	SGG	1049	13

DATE	BY	REV.	DESCRIPTION



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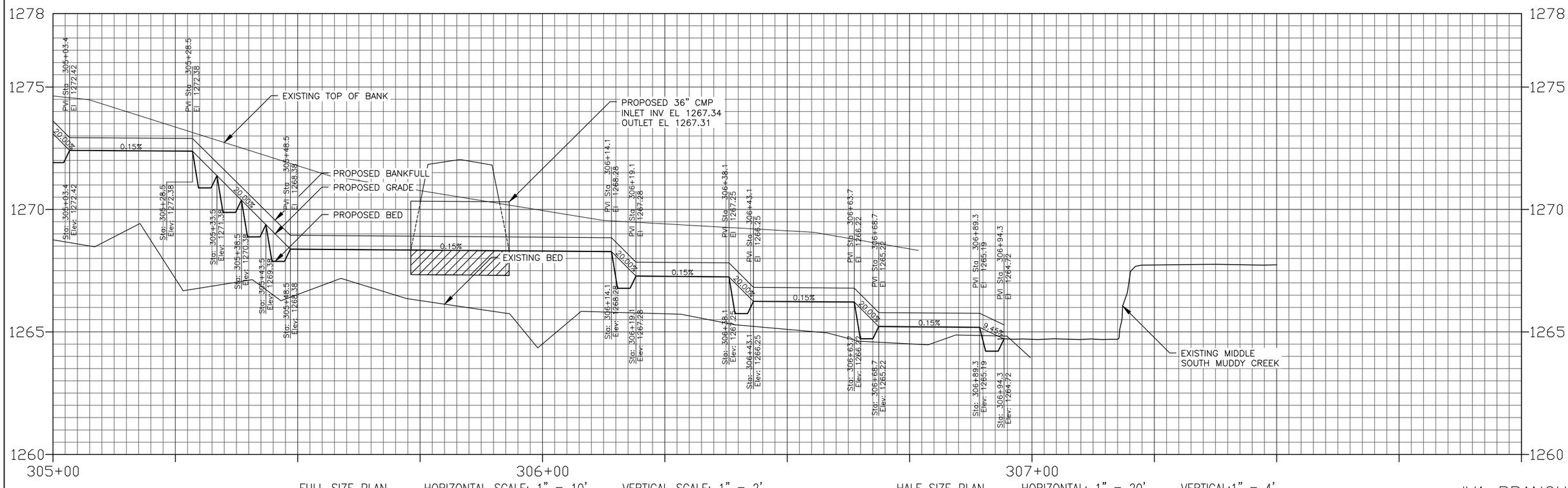

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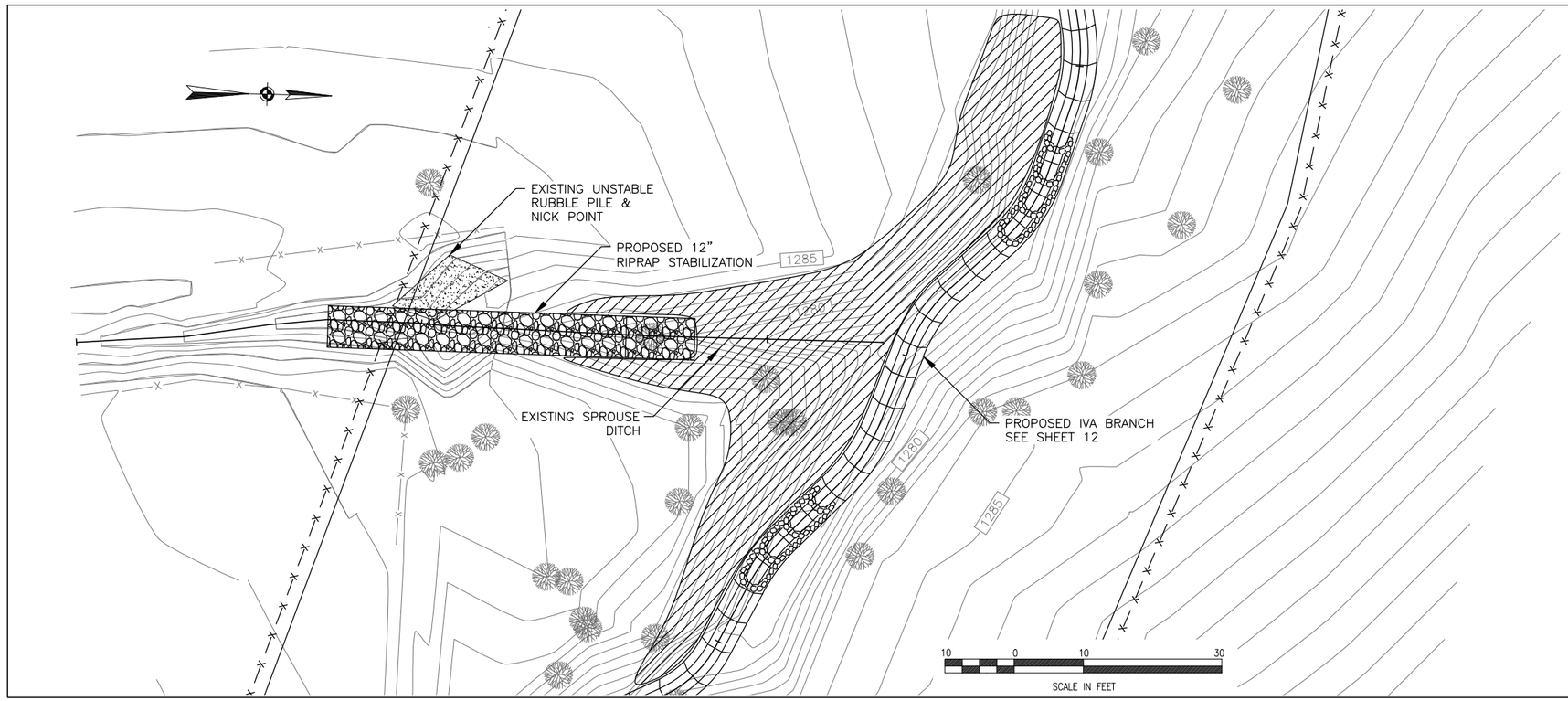

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TITLE **PLAN & PROFILE**

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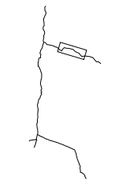
DATE	3/20/2012	CHKD. BY	SGG	1049	14

DATE	BY	REV.	DESCRIPTION



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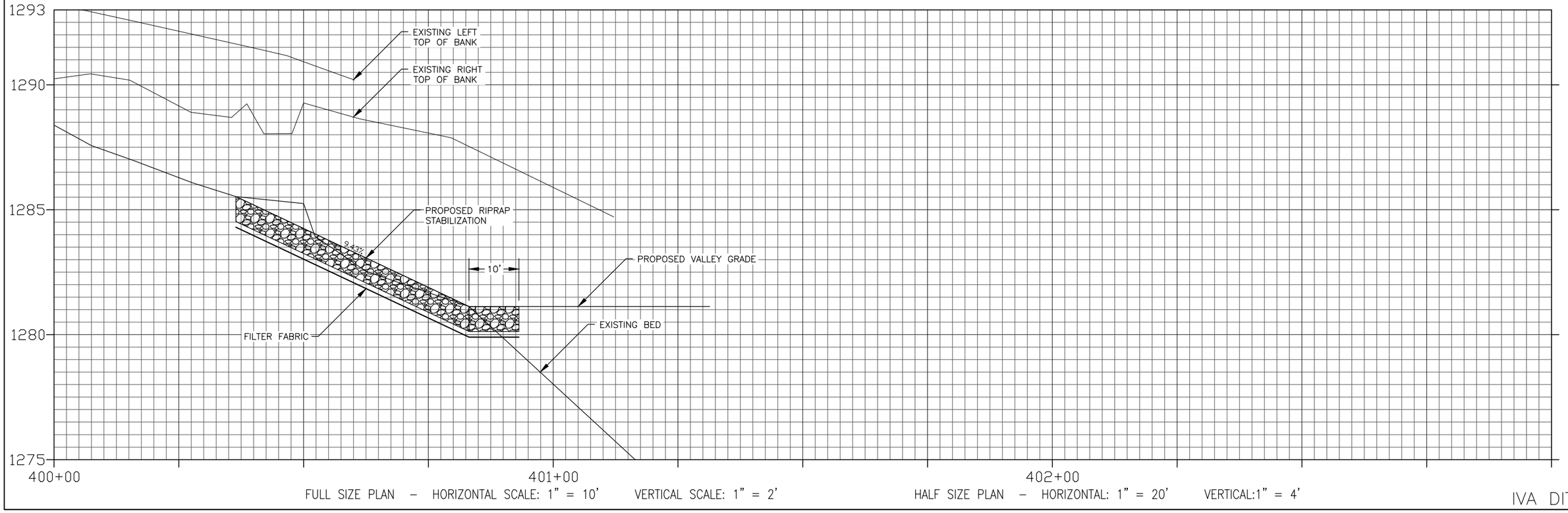

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IVA DITCH

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PROJECT MIDDLE SOUTH MUDDY CREEK
OWNER NC EEP
TITLE

PLANTING DETAILS

SCALE AS NOTED	DRWN. BY cme	PROJECT NO. 1049	DRAWING NUMBER P-1
DATE 3/20/2012	CHKD. BY SGG		

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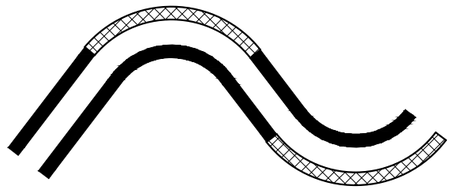
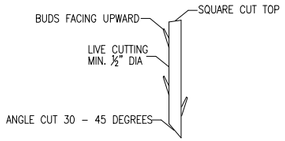
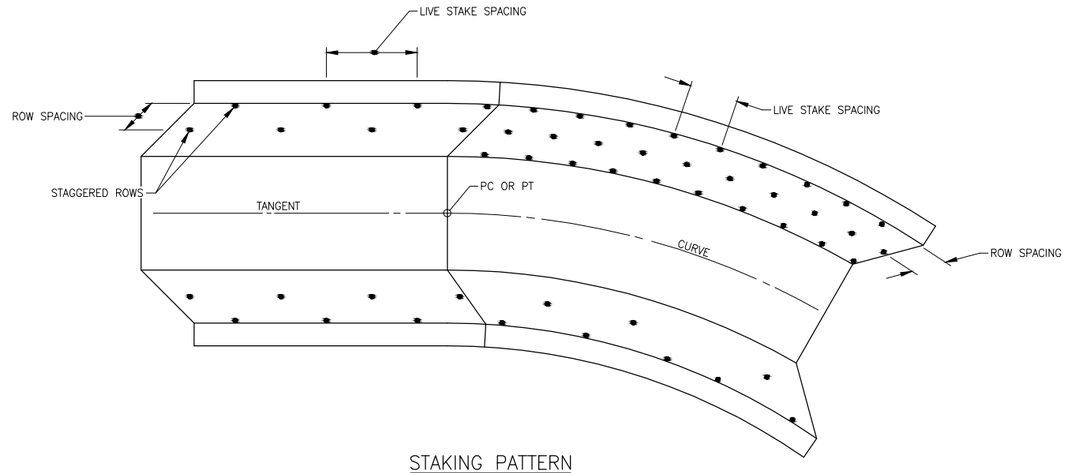


PLAN VIEW



LIVE STAKE DETAIL

NUMBER OF LIVE STAKE ROWS			
CHANNEL DEPTH (FT)	INSIDE OF BEND	TANGENT	OUTSIDE OF BEND
0 - 1.5	1	1	2
1.5 - 2.5	2	2	3
2.5 - 3.5	3	3	4



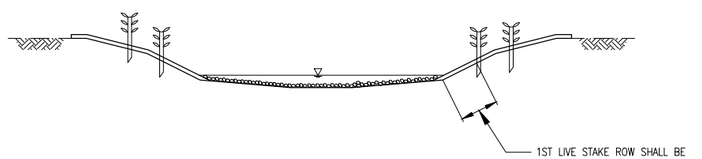
STAKING PATTERN
NOT TO SCALE

PLANTING NOTES:

TEMPORARY AND PERMANENT SEED
1. ALL DISTURBED AREAS WILL BE STABILIZED USING MULCH AND TEMPORARY SEED TO PROVIDE ADEQUATE GROUND COVER AND CONDITION THE SOIL.
2. MULCH MUST BE ADDED TO ACHIEVE 80% COVERAGE (ROUGHLY 2 TONS/ ACRE FOR WHEAT STRAW)
3. A FERTILITY SOIL TEST SHALL BE USED TO DETERMINE FERTILIZER AMOUNTS OR IF NO SOIL TEST IS AVAILABLE, A STANDARD MIXTURE SHALL BE APPLIED OF 2 TONS OF LIME PER ACRE AND 700-1000 LBS OF 10-10-10 FERTILIZER PER ACRE.

BARE ROOT PLANTINGS
1. PLANT BARE ROOT SHRUBS AND TREES IN AREAS IN INDICATED ON THE PLANS.
2. PROVIDE 8' OF SPACING BETWEEN PLANTS.
3. LOOSEN COMPACTED SOIL AND PLANT IN HOLES FORMED WITH A MATTOCK, DIBBLE BAR OR EQUAL.
4. PROVIDE PLANTING HOLE SUFFICIENT IN SIZE AND DEPTH TO PREVENT CROWDING OF ROOTS.
5. ROOTS SHALL BE KEPT MOIST DURING TRANSPORTATION, DISTRIBUTION, AND INSTALLATION.
6. PLANTS SHALL BE HEELED-IN INTO MOIST SOIL IF NOT PROMPTLY PLANTED AFTER DELIVERY TO THE PROJECT SITE.

LIVE STAKES:
1. STAKES SHOULD BE CUT AND INSTALLED ON THE SAME DAY.
2. STAKES THAT ARE SPLIT SHALL NOT BE INSTALLED.
3. STAKES SHALL BE INSTALLED PERPENDICULAR TO THE BANK AND WITH BUDS POINTING UPWARDS.
4. STAKES SHALL BE ½ TO 2 INCHES IN DIAMETER AND 2 TO 3 FEET IN LENGTH.
5. AFTER INSTALLATION, THE TOP PORTION OF STAKES SHALL BE PRUNED WITH A SQUARE CUT LEAVING NO LESS THAN 3 INCHES AND NO MORE THAN 6 INCHES ABOVE THE GROUND.



RIFFLE SECTION
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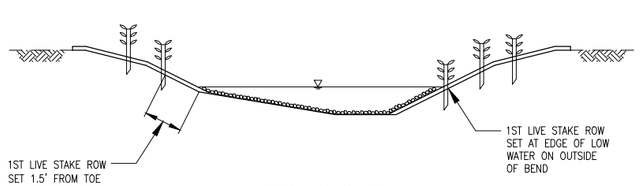

POOL SECTION
NOT TO SCALE

COMMON NAME	SCIENTIFIC NAME	STRATUM	PLANT MATERIAL SIZE	STEMS/ACRE	AREA (Acres)	TOTAL STEMS
STREAMSIDE						
Black Willow	*Salix nigra*	midstory	Live Stake	-	-	-
Buttonbush	*Cephalanthus occidentalis*	understory	Live Stake	-	-	-
Silky Dogwood	*Cornus amomum*	understory	Live Stake	-	-	-
Ninebark	*Physocarpus opulifolius*	understory	Live Stake	-	-	-
TOTAL						
BUFFER						
Black Cherry	*Prunus serotina*	overstory	Bare Root	68	4.97	338
Black Oak	*Quercus velutina*	overstory	Bare Root	68	4.97	338
Dogwood	*Cornus florida*	overstory	Bare Root	68	4.97	338
Green Ash	*Fraxinus pennsylvanica*	overstory	Bare Root	68	4.97	338
Ironwood	*Carpinus caroliniana*	overstory	Bare Root	68	4.97	338
River Birch	*Betula nigra*	overstory	Bare Root	68	4.97	338
Sycamore	*Plantanus occidentalis*	overstory	Bare Root	68	4.97	338
Tulip Poplar	*Liriodendron tulipifera*	overstory	Bare Root	68	4.97	338
White Oak	*Quercus alba*	overstory	Bare Root	68	4.97	338
Witch Hazel	*Hamamelis virginiana*	midstory	Bare Root	68	4.97	338
TOTAL				680		3380

COMMON NAME	SCIENTIFIC NAME	LBS/ ACRE
Temporary Seeding		
August to March (cool season)		
Oats		120
Wheat Grass	*Triticum aestivum*	120
Rye Grain	*Secale cereal*	40
Barley		100

April to August (warm season)		
Millet	*Utochola ramose*	20
Buckwheat	*Fagopyrum esculentum*	40

Permanent seeding		
Dutch white clover	*Trifolium repens*	10
Orchard Grass	*Dactylis glomerata*	30
Creeping Red Fescue	*Festuca rubra*	20
Korean Lespedeza	*Kummerowia striata*	10
Birdsfoot trefoil	*Lotus corniculatus*	10

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PRELIMINARY PLANS
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PROJECT MIDDLE SOUTH MUDDY CREEK
OWNER NC EEP
TITLE **PLANTING PLANS**

SCALE	DRWN. BY	PROJECT NO.	DRAWING NUMBER
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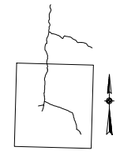

LOCATION KEY

EXISTING DRIVEWAY

PROPOSED SOUTH MUDDY CREEK

MATCHLINE STA 105+00

PROPOSED SPROUSE BRANCH

BUFFER PLANTING AREA

TRANSPLANTS

50 0 50 150
SCALE IN FEET

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SCALE	DRWN. BY	PROJECT NO.	DRAWING NUMBER
AS NOTED	cme	1049	P-3
DATE 3/20/2012	CHKD. BY SGG		

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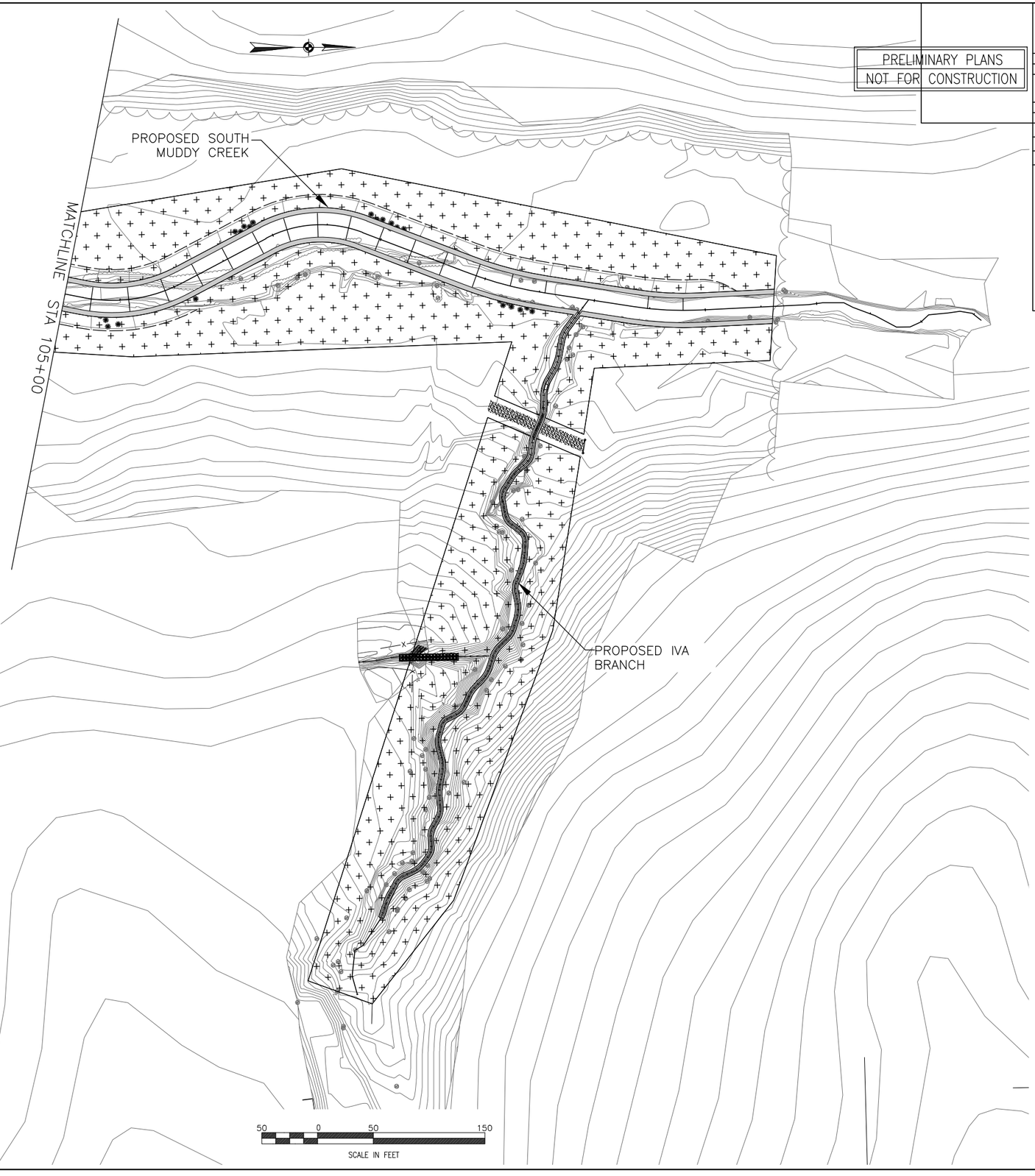

BUFFER PLANTING AREA

TRANSPLANTS