Mitigation Plan

Suck Creek
Stream Restoration Project
Moore County, North Carolina

Prepared for:
North Carolina Ecosystem Enhancement Program
Raleigh, North Carolina

July 2004

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Mitigation Plan
Moore County, North Carolina

1. Introduction

The Suck Creek Restoration project lies within the Richardson Farm in Moore County, North Carolina located south of SR1261 and East of SR1210. The stream drains a portion of the Deep River Subbasin (USGS Hydrologic Unit 03030003) and North Carolina Department of Water Quality (NCDWQ) Subbasin 03-06-10 of the Cape Fear River Basin. Figure 1 shows the project area.

The restoration effort has the goal to transform the pre-existing altered stream corridor to a more stable and biologically active form. The objectives for this goal include:

- Restore stream geomorphology to referenced, stable dimension, profile, and pattern
- Establish adjacent riparian ecological community

2. Mitigation Details

Restoration of Suck Creek involved restoring the altered stream corridor including adjacent riparian zones to a referenced, stable condition. In addition, the design accounted for the needs of the surrounding cattle pasture, public safety, local agencies, and physical constraints within the project area. Construction modified the stream's dimension, pattern, and profile to stable conditions. In-stream structures were used to protect stream banks and riparian buffers; provide habitat; control grade; and stabilize crossings that allow the property owner and cattle to travel to separate sections of pasture. Vegetation representing local riparian communities was planted to provide additional stability to the stream banks and establish a riparian buffer. Refer to the Executive Summary of Design for more details concerning the mitigation details (Kimley-Horn and Associates 2002).

A Priority I Restoration (Rosgen 1997) was performed on the project reach. The previously existing channel was incised with unstable banks. Using reference data from regional curves and appropriate reference reaches, the channel geometry was modified to a more stable C4 stream type – as defined by Rosgen (Rosgen 1994). In accordance with the Priority I Restoration method, the stream bed was elevated to reconnect to its abandoned terrace increasing available flood prone area to near pre-existing conditions. The result of the restoration effort is an increase of the width to depth ratio and reduced bank height ratios thus improving channel stability. The sinuosity of the reach was also increased that resulted in a decreased mean slope. The decreased mean slope reduces the stream velocities of bankfull events that should also increase stream stability. In-stream structures including rock cross vanes, root wads, and log vanes were incorporated into the channel. A vegetative buffer was planted along the stream corridor that should further stabilize the stream banks, improve habitat conditions, and reduce ambient water temperature. Stream channel construction was completed in April of 2003 with the vegetated buffers planted in February 2004. Restoration areas including stream and buffer are surrounded by fencing and protect by a conservation easement. Refer to the attached As-Built Plan Sheets for mitigation details.

3. Mitigation Results

Results of the mitigation effort are as follows:

- 3,260 linear feet of Priority I Restoration
- 7.8 acres of Riparian Buffer Establishment

4. Monitoring

The progress of the mitigation effort will be monitored for five years from 2004 to 2008. Monitoring will proceed according to recommendations outlined in the 2003 Stream Mitigation Guidelines (McLendon, Fox et al. 2003). Refer to the initial monitoring report for monitoring details (Kimley-Horn and Associates 2004)

References

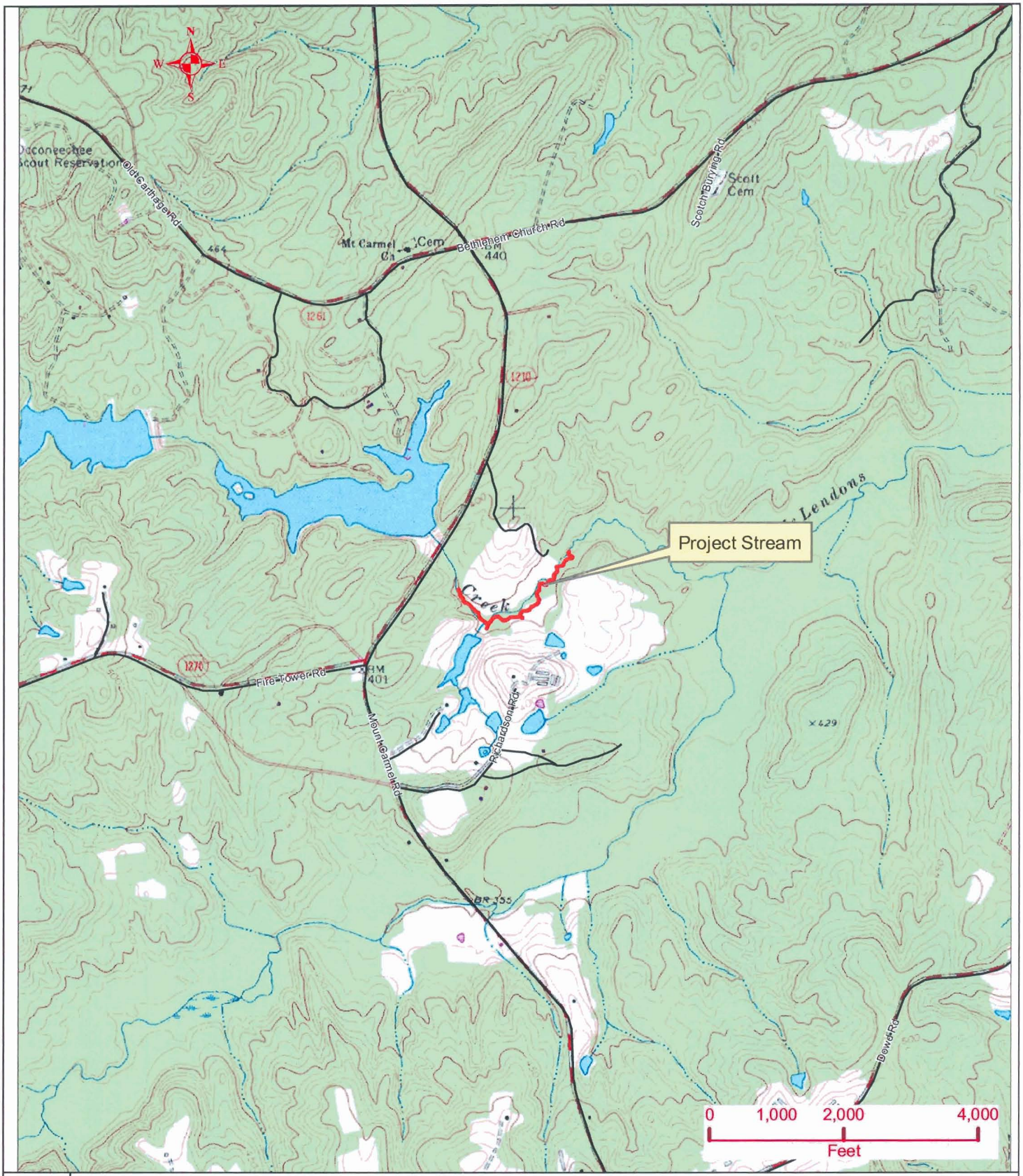
Kimley-Horn and Associates, I. (2002). Suck Creek Stream Restoration Project: Moore County, NC - Executive Summary of Design. Raleigh, NC.

Kimley-Horn and Associates, I. (2004). Suck Creek - Moore County, NC: Restoration Initial Monitoring Report 2004. Raleigh, NC.

McLendon, S., B. Fox, et al. (2003). Stream Mitigation Guidelines, United States Army Corps of Engineers - Wilmington District; United States Environmental Protection Agency; North Carolina Wildlife Resources Commission; North Carolina Department of Natrual Resources - Division of Water Quality.

Rosgen, D. L. (1994). "A classification of natural rivers." Catena **22**: 169-199.

Rosgen, D. L. (1997). A Geomorhpic Approach to Restoration of Incised Rivers. Management of Landscapes Disturbed by Channel Incision.



Title	Site Map

Prepared For: Ecosystem Enhancement Program

Project	Suck Creek Mitigation Plan Moore County, North Carolina		
	Date	**Project Number**	**Figure**
	7/2/04	0117950008	1

RECORD DRAWINGS FOR

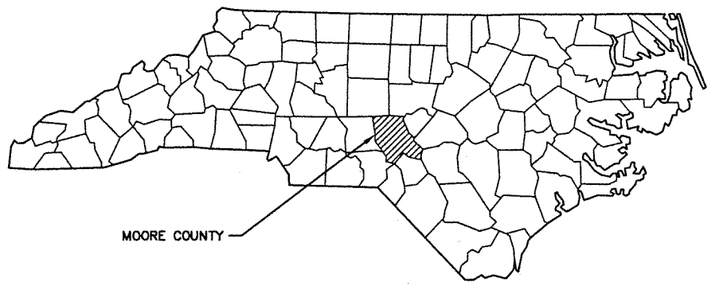
SUCK CREEK

STREAM RESTORATION PROJECT

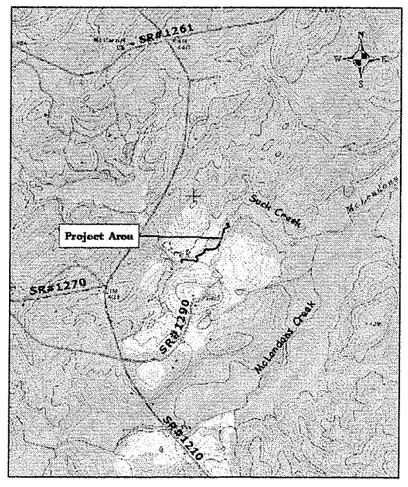
RICHARDSON FARMS

MOORE COUNTY, NORTH CAROLINA
PROJECT ID NO. 000530501

ECOSYSTEM ENHANCEMENT PROGRAM
NCDENR



STATE OF NORTH CAROLINA



LOCATION MAP

INDEX OF SHEETS

SURVEY PREPARED BY:

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ECOSYSTEM ENHANCEMENT PROGRAM
NCDENR

TITLE:
COVER SHEET

NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WILKINS
SEAL:

DATE: 6-05-03
HORIZONTAL SCALE: NTS
VERTICAL SCALE: NA
DRAWN BY: SES
DESIGNED BY: SES/AK/WW
CHECKED BY: WW

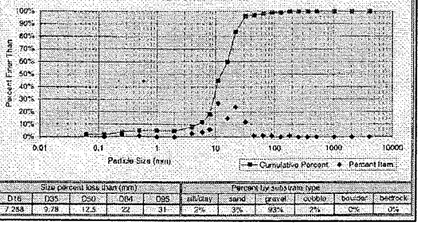
PROJECT:
SUCK CREEK
MOORE COUNTY

ATTACHED REFERENCE FILES:
JOB NUMBER: 011795008
SHEET NUMBER: 1 OF 10

PAVEMENT SAMPLE

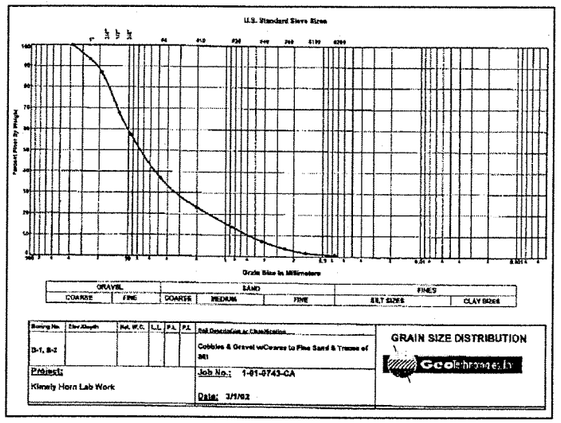
Material	Size Range (mm)		Count
silt/clay	0	0.062	2
very fine sand	0.062	0.13	1
fine sand	0.13	0.25	2
medium sand	0.25	0.5	11
coarse sand	0.5	1	7
very coarse sand	1	2	7
very fine gravel	2	4	17
fine gravel	4	6	9
fine gravel	6	8	5
medium gravel	8	11	7
medium gravel	11	16	11
coarse gravel	16	22	4
coarse gravel	22	32	1
very coarse gravel	32	45	1
very coarse gravel	45	64	1
small cobble	64	90	1
medium cobble	90	128	0
large cobble	128	180	0
very large cobble	180	256	0
small boulder	256	362	0
small boulder	362	512	0
medium boulder	512	1024	0
large boulder	1024	2048	0
very large boulder	2048	4096	0
bedrock			0
Total Particle Count:			100

Pebble Count
Suck Creek
Notes:



Size percent less than (mm)						Percent by subclass type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
7.258	9.78	12.5	22	31	2%	3%	93%	2%	0%	0%

SUB-PAVEMENT SAMPLE



SEDIMENT TRANSPORT CALCULATIONS

Critical Dimensionless Shear Stress:

$$\tau_{ci} = 0.0834(d_i/d_{50})^{-0.872}$$

Value	Variable	Definition
10.3	d_i (mm)	D50 Bed Material (D50 from riffle pebble count)
7.5	d_{50} (mm)	Bar Sample D50 or Sub-pavement D50
0.063	τ_{ci}	**Critical Dimensionless Shear Stress**

Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample:

$$d_r = (\tau_{ci} * 1.65 * D_i)/S_e$$

Value	Variable	Definition
0.063	τ_{ci}	Critical Dimensionless Shear Stress
0.098	D_i (feet)	Largest particle from bar sample
0.005	S_e (ft/ft)	Existing Bankfull Water Surface Slope
2.045	d_r (ft)	**Bankfull Mean Depth Required**
1.4	d_e (ft)	**Existing Bankfull Mean Depth (from riffle cross section)**

Circle: Stable (d_e/d_r=1) (Aggrading (d_e/d_r<1)) Degrading (d_e/d_r>1)

MORPHOLOGY CHARACTERISTICS

Restoration Site: Suck Creek
USGS Station: N/A
Reference Reach: Reference Reach I: Richland Creek, Reference Reach II: Suck Creek Upstream of Project Area

VARIABLES	EXISTING CHANNEL*		PROPOSED CHANNEL		REFERENCE REACH I CHANNEL		REFERENCE REACH II CHANNEL**		REGIONAL CURVES RURAL PIEDMONT***	
1. Stream Type (Rosgen)	G4 -> F4		C4		C4		B4		C4	
2. Drainage Area (sq. mile)	4.8		4.8		1.0		4.8		4.8	
3. Bankfull Width (W_{bkf})	Mean:	13.9	Mean:	20.0	Mean:	16.5	Mean:	17.0	Mean:	23.5
	Range:	12.3 - 15.8	Range:	15 - 20	Range:	16.2 - 16.7	Range:	15 - 20	Range:	
4. Bankfull Mean depth (d_{bkf})	Mean:	1.1	Mean:	1.5	Mean:	0.9	Mean:	1.3	Mean:	2.5
	Range:	1.0 - 1.4	Range:	1.2 - 1.8	Range:	.9 - .9	Range:	1.2 - 1.8	Range:	
5. Width/Depth Ratio (W_{bkf}/d_{bkf})	Mean:	12.6	Mean:	13.3	Mean:	17.8	Mean:	13.1	Mean:	9.4
	Range:	8.8 - 15.8	Range:	8.3 - 16.7	Range:	17.5 - 18.0	Range:	8.3 - 16.7	Range:	
6. Bankfull cross-sectional Area (A_{bkf})	Mean:	16.5	Mean:	29.5	Mean:	15.2	Mean:	22.1	Mean:	63.0
	Range:	12.8 - 22.8	Range:	18 - 36	Range:	15.0 - 15.2	Range:	18 - 36	Range:	
7. Bankfull Mean Velocity (V_{bkf})	Mean:	4.5	Mean:	4.34	Mean:	5.4	Mean:	6.3	Mean:	4.4
	Range:	3.32-5.73	Range:	4.33-4.35	Range:	5.05-5.81	Range:	5.68-6.82	Range:	
8. Bankfull Discharge, cfs (Q_{bkf})[1]	Mean:	-	Mean:	-	Mean:	82.5	Mean:	-	Mean:	279.6
	Range:		Range:		Range:	75.8-88.3	Range:		Range:	
9. Bankfull Maximum Depth (d_{max})	Mean:	1.6	Mean:	2.2	Mean:	1.5	Mean:	2.0	Mean:	-
	Range:	1.3 - 1.5	Range:	1.8-2.9	Range:	1.4 - 1.5	Range:	1.9 - 2.1	Range:	
10. Max d_{bkf}/d_{bkf} ratio	Mean:	1.4	Mean:	1.5	Mean:	1.6	Mean:	-	Mean:	-
	Range:	1.3 - 1.5	Range:	1.1 - 1.8	Range:	1.1 - 1.6	Range:		Range:	
11. Low Bank Height to max d_{bkf} ratio	Mean:	1.8	Mean:	1.0	Mean:	1.0	Mean:	-	Mean:	-
	Range:	1.1 - 2.3	Range:	1.0 - 1.2	Range:		Range:		Range:	
12. Width of Flood Prone Area (W_{fpa})	Mean:	19.3	Mean:	64.0	Mean:	51.7	Mean:	-	Mean:	-
	Range:	18.0 - 21.0	Range:	60-66	Range:	50 - 53.3	Range:		Range:	
13. Entrenchment Ratio (W_{fpa}/W_{bkf})	Mean:	1.4	Mean:	3.2	Mean:	3.2	Mean:	1.5	Mean:	5.3
	Range:	1.3 - 1.4	Range:	3.0 - 3.3	Range:	3.0 - 3.3	Range:	1.3 - 1.6	Range:	2.7-31.65
14. Meander Length (L_m)	Mean:	99.5	Mean:	180.0	Mean:	92.0	Mean:	-	Mean:	-
	Range:	75 - 129	Range:	112-280	Range:	90 - 94	Range:		Range:	
15. Ratio of Meander Length to Bankfull Width (L_m/W_{bkf})	Mean:	7.2	Mean:	9.0	Mean:	5.6	Mean:	-	Mean:	-
	Range:	4.7 - 10.5	Range:	5.6 - 14.0	Range:		Range:		Range:	9-14
16. Radius of Curvature (R_c)	Mean:	38.0	Mean:	50.0	Mean:	19.0	Mean:	-	Mean:	-
	Range:	24.4- 52.0	Range:	24-60	Range:	14 - 26	Range:		Range:	
17. Ratio of Radius of Curvature to Bankfull Width (R_c/W_{bkf})	Mean:	2.7	Mean:	2.5	Mean:	1.2	Mean:	-	Mean:	-
	Range:	1.5 - 4.2	Range:	1.2- 3.0	Range:	.87 - 1.59	Range:		Range:	2.5-3
18. Belt Width (W_{blt})	Mean:	25.0	Mean:	80.0	Mean:	31.0	Mean:	-	Mean:	-
	Range:	15 - 35	Range:	30-400	Range:	25 - 40	Range:		Range:	
19. Meander Width Ratio (W_{blt}/W_{bkf})	Mean:	1.8	Mean:	4.0	Mean:	1.9	Mean:	-	Mean:	-
	Range:	1.1 - 2.5	Range:	1.52 - 20	Range:	1.52 - 2.43	Range:		Range:	
20. Sinuosity (k) (Stream Length / Valley Length)	1.2		Mean: 1.33 Range: 1.0 - 1.6		1.2		-		Mean: 1.9 Range:	1.43-2.8
21. Valley Slope (S_{valley}) (ft/ft)	0.0040		0.0040		0.0136		-		-	
22. Average Stream Slope (S_{avg}) = (S_{valley}/k)	0.0030		Mean: 0.003 Range: .0025 - .004		0.0133		0.0180		Mean: 0.005 Range:	.00011-.0184
23. Riffle Slope (S_{rff})	Mean:	0.0106	Mean:	0.0050	Mean:	0.03	Mean	-	Mean:	-
	Range:	0 - 1.6	Range:	.0045 - .0096	Range:	.014 - .041	Range:		Range:	
24. Ratio of Riffle Slope to Avg. Slope (S_{rffle}/S_{avg})	Mean:	3.5	Mean:	2.0	Mean:	2.4	Mean:	-	Mean:	-
	Range:	0-3.5	Range:	1.8 - 3.2	Range:		Range:		Range:	1.5-2
25. Pool Slope (S_{pool})	Mean:	0.0020	Mean:	0.0006	Mean:	0.0005	Mean:	-	Mean:	-
	Range:	.0003-.003	Range:	0.00009 - 0.0012	Range:	.0 - .0014	Range:		Range:	
26. Ratio of Pool Slope to Avg. Slope (S_{pool}/S_{avg})	Mean:	0.7	Mean:	0.200	Mean:	0.0338	Mean:	-	Mean:	-
	Range:	.1-1	Range:	.036-.4	Range:		Range:		Range:	.2-.3
27. Maximum Pool Depth (d_{pool})	Mean:	1.7	Mean:	4.5	Mean:	2.5	Mean:	-	Mean:	-
	Range:	1.3 - 1.9	Range:	3.9 - 6.3	Range:		Range:		Range:	
28. Ratio of Pool Depth to Avg. Depth (d_{pool}/d_{avg})	Mean:	1.5	Mean:	3.0	Mean:	2.8	Mean:	-	Mean:	3.0
	Range:	0.9 - 1.9	Range:	2.6-4.2	Range:		Range:		Range:	2.5-3.5
29. Pool Width (W_{pool})	Mean:	11.8	Mean:	26.0	Mean:	11.1	Mean	-	Mean:	-
	Range:	9.4 - 15.6	Range:	14-34	Range:		Range:		Range:	
30. Ratio of Pool Width to Bankfull Width (W_{pool}/W_{bkf})	Mean:	0.8	Mean:	1.3	Mean:	0.7	Mean:	-	Mean:	1.5
	Range:	0.6 - 1.3	Range:	0.7 - 1.7	Range:		Range:		Range:	1.3-1.7
31. Ratio of Pool Area to Bankfull Area (A_{pool}/A_{bkf})	Mean:	0.8	Mean:	1.2	Mean:	1.3	Mean	-	Mean:	-
	Range:	0.8 - 0.8	Range:		Range:		Range:		Range:	
32. Pool to Pool Spacing (p - p)	Mean:	95.9	Mean:	100.0	Mean:	76.3	Mean	-	Mean:	-
	Range:	37 - 245	Range:	60-140	Range:	37.3 - 95.8	Range:		Range:	
33. Ratio of Pool to Pool Spacing to Bankfull Width (p-p/Wbkf)	Mean:	6.9	Mean:	5.0	Mean:	4.6	Mean:	-	Mean:	-
	Range:	2.3 - 20	Range:	3.0 - 7.0	Range:	2.26 - 5.82	Range:		Range:	5-7

* Existing channel severly impacted by cattle. Bankfull field indicators not clear.
** Reference Reach II is a stable section of Suck Creek, upstream of project area.
***Regional Curve data incorporated with Rosgen Reference data.

Note:
[1] Q value from Regional Curves. Q not applicable due to upstream impoundments. V calculated from Mannings and u/u*.

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REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

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CLIENT: ECOSYSTEM ENHANCEMENT PROGRAM NCDENR

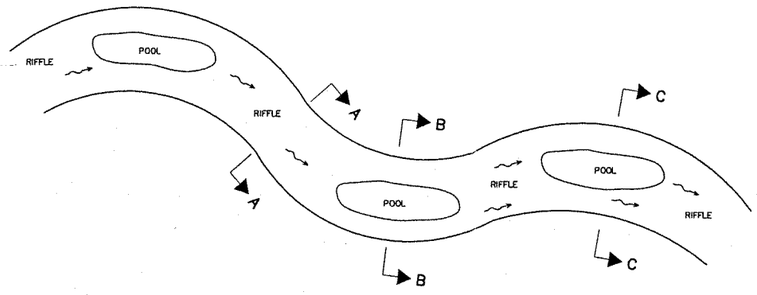
TITLE: STREAM MORPHOLOGY AND SEDIMENT TRANSPORT DATA

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WILKERSON

DATE: 6-05-03
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA
DRAWN BY: SES
DESIGNED BY: SES/AK/WW
CHECKED BY: WW

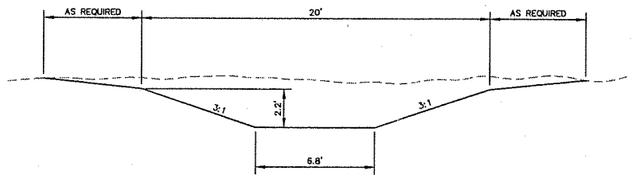
PROJECT: SUCK CREEK MOORE COUNTY

ATTACHED REFERENCE FILES:
JOB NUMBER: 011795008
SHEET NUMBER: 2 of 10



TYPICAL PLAN VIEW SCHEMATIC

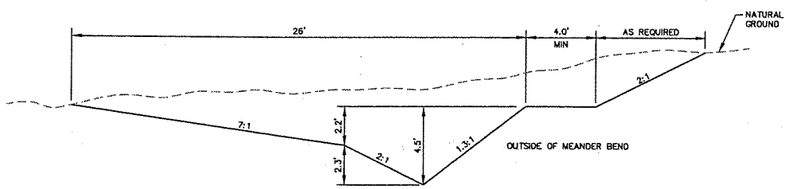
NTS



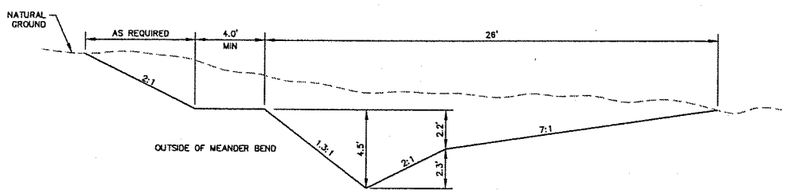
RIFFLE SECTION A-A

NOTES:

TYPICAL SECTIONS ARE PROVIDED TO GIVE THE GENERAL DIMENSIONS OF THE CHANNEL. FINAL GRADING WILL GIVE THE CHANNEL A MORE "NATURAL" APPEARANCE AND ALLOW A SMOOTH TRANSITION FROM EXISTING CHANNEL TO NEW CHANNEL.



POOL SECTION B-B



POOL SECTION C-C

RESTORED BANKFULL CHANNEL TYPICAL SECTIONS

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ECOSYSTEM ENHANCEMENT PROGRAM
NCDENR

TITLE:
TYPICAL SECTIONS

SEAL:
NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WILCUM

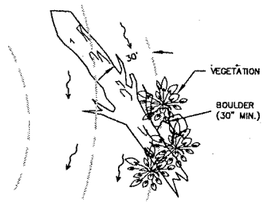
DATE:	6-05-03
HORIZONTAL SCALE:	NTS
VERTICAL SCALE:	NTS
DRAWN BY:	SES
DESIGNED BY:	SES/AK/WW
CHECKED BY:	WW

PROJECT:
SUCK CREEK
MOORE COUNTY

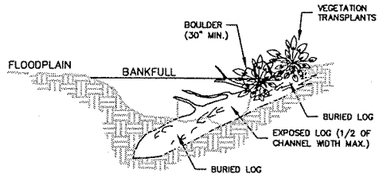
ATTACHED REFERENCE FILES:

JOB NUMBER: 011795008

SHEET NUMBER: 3 OF 10



PLAN VIEW

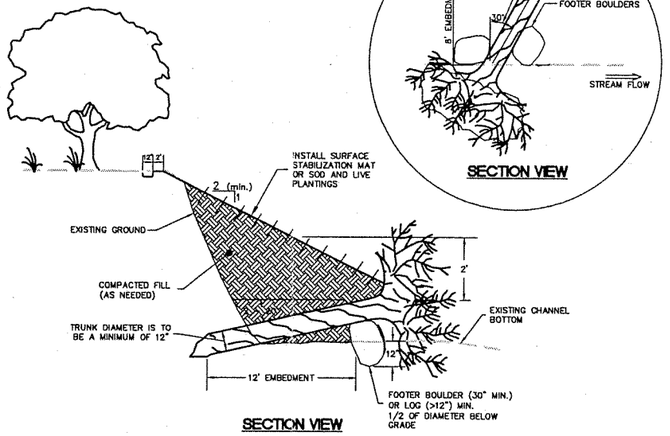


SECTION VIEW

LOG DIAMETER 15"+

LOG VANE STRUCTURE

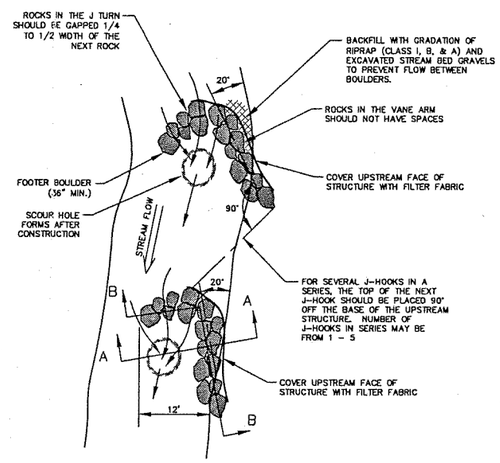
NTS

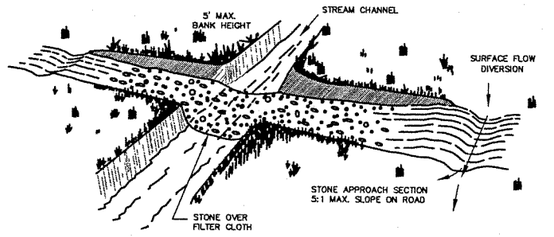


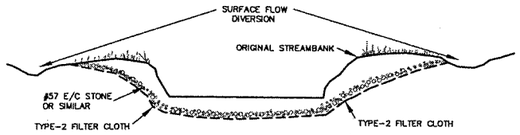
SECTION VIEW

ROOT WAD INSTALLATION

NTS



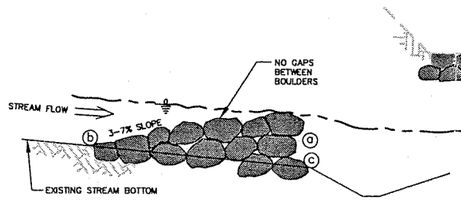




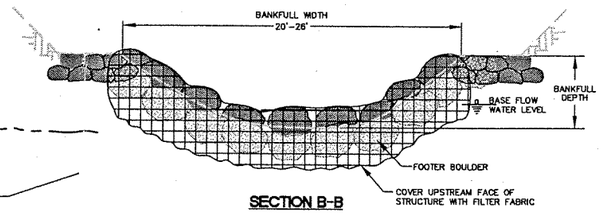
* CONSTRUCTION AND MAINTENANCE PER SECTION 6.70 OF NCDENR EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

STREAM CROSSING/FORD

NTS



PROFILE VIEW



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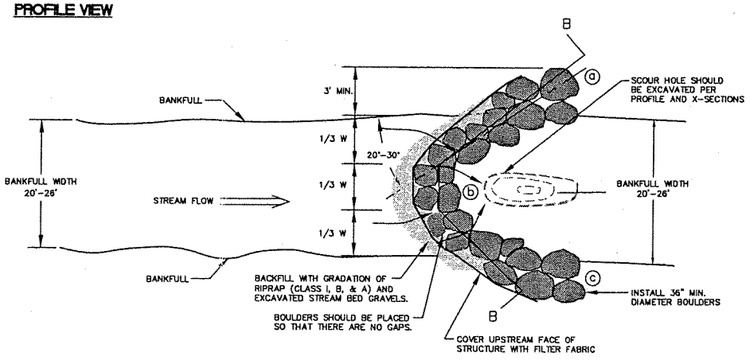

CROSS VANE

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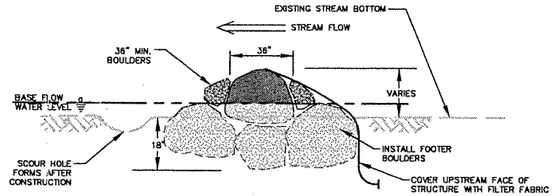

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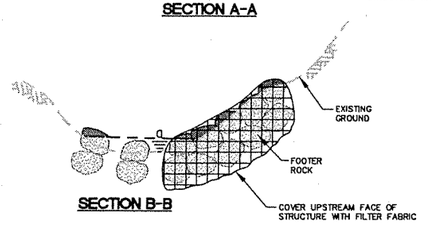

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J-HOOK VANE

NTS

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REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:
1	REVISED PER DWQ COMMENTS (DEC. 19, 2001) PER NCDENR LAND QUALITY COMMENTS			

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
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CLIENT: ECOSYSTEM ENHANCEMENT PROGRAM NCDENR

TITLE: DETAILS

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WITHROW

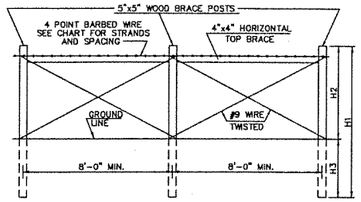
DATE:	6-05-03
HORIZONTAL SCALE:	NTS
VERTICAL SCALE:	NTS
DRAWN BY:	SES
DESIGNED BY:	SES/AK/WW
CHECKED BY:	WW

PROJECT: SUCK CREEK MOORE COUNTY

ATTACHED REFERENCE FILES:

JOB NUMBER: 011795008

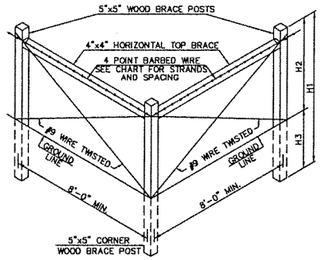
SHEET NUMBER: 4 OF 10



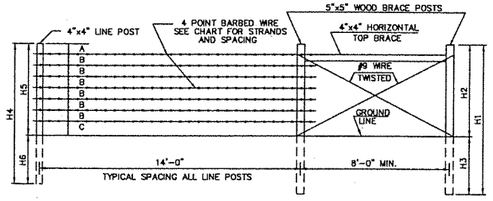
LINE BRACES
(MAXIMUM SPACING 330')

ALTERNATE TYPES OF STAPLES
USE ONE #9 STAPLE OR TWO #16 STAPLES AT EACH POINT OF ATTACHMENT.

BARBED WIRE FENCE CHART			
NUMBER OF BARBED WIRE STRANDS			5
STRAND SPACING		A	3"
		B	12"
		C	8"
BRACE POSTS	LENGTH	H1	8'-0"
	EXPOSED	H2	4'-11"
	EMBEDMENT	H3	3'-1"
LINE POSTS	LENGTH	H4	7'-8"
	EXPOSED	H5	4'-11"
	EMBEDMENT	H6	2'-7"
HORIZONTAL BRACE		---	8'-0"



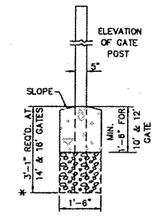
CORNER BRACE
USE WHEN CORNER ANGLE IS 15° OR GREATER



END OR GATE BRACES

BARBED WIRE FENCE WITH WOOD POSTS

NTS



DETAIL OF
GATE POST ANCHOR

USE CLASS "B" CONCRETE AT GATE POSTS OR WHERE REQUIRED BY SOIL CONDITIONS. CONCRETE MAY ALSO BE USED IN LIEU OF SETTING POSTS TO THEIR MAXIMUM DEPTH.

GENERAL NOTES:

ALL POSTS AND BRACES MAY BE EITHER ROUND OR SQUARE AT THE OPTION OF THE CONTRACTOR, PROVIDED THE SAME TYPE IS USED THROUGHOUT THE PROJECT. DIMENSIONS SHOWN ARE THE DIAMETER OF ROUND OR EDGE DIMENSIONS OF SQUARE POSTS AND BRACES.

ERECT LINE BRACES BETWEEN END, CORNER OR GATE POSTS. PLACE LINE BRACES AT INTERVALS NOT EXCEEDING 330' AND AT THE END OF THE BARBED WIRE ROLL.

THE 330' INTERVAL MAY BE REDUCED BY THE ENGINEER ON CURVES WHERE THE DEGREE OF CURVATURE IS GREATER THAN 3 DEGREES.

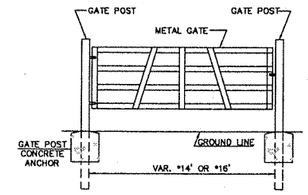
NOTCH BRACE POSTS 1" MINIMUM FOR HORIZONTAL BRACES. PLACE TWO GALVANIZED 12d OR THREE GALVANIZED 10d NAILS AT EACH END OF ALL BRACES.

PLACE THE BRACE WIRE AROUND THE POST. DRAW ALL BRACE WIRE TAUT BY TWISTING BETWEEN EACH POST.

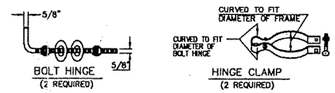
INSTALL THE FENCE FACING THE PROPERTY OWNER EXCEPT THAT ON HORIZONTAL CURVES GREATER THAN THREE DEGREES (3°) INSTALL THE FENCE TO PULL AGAINST ALL POSTS. SEE NCDOT STD. 866.02 FOR FENCING AT DITCH CROSSINGS, BREAKS IN GRADES AND R/W BREAKS.

USE LATCH DEVICE APPROVED BY THE ENGINEER. HINGE ASSEMBLY AS SHOWN IS SUGGESTED. SUBSTITUTION MAY BE SUBJECT TO APPROVAL BY THE ENGINEER. USE 19' DIAMETER GALVANIZED STEEL PIPE FOR GATE FRAME EXCEPT AS SHOWN HERE.

ANY COMBINATION OF GATE AND FENCE TYPE MEETING THE APPROVAL OF THE ENGINEER IS ACCEPTABLE AND IS NOT LIMITED TO THE EXAMPLES SHOWN HEREON.



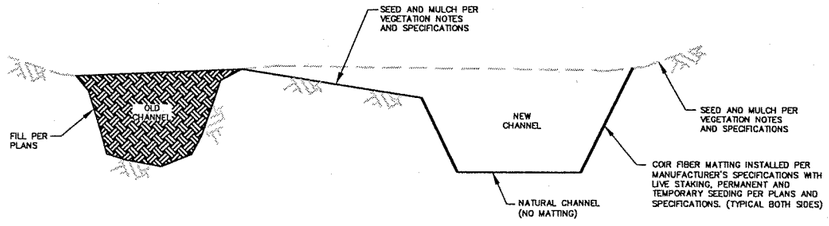
CATTLE GATE



HINGE ASSEMBLY

BARBED WIRE FENCE WITH WOOD POSTS

NTS



MATTING INSTALLATION GUIDE

NTS

FILE: H:\PN\011795008\DWG\RECORD-DWGS\AB-DETAILS.DWG

REV. No.	REVISION:	DATE:	DRAWN BY:	CHECKED BY:
1	REVISED PER DWQ COMMENTS (DEC. 19, 2001)			

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CLIENT:
ECOSYSTEM ENHANCEMENT PROGRAM
NCDENR

TITLE:
DETAILS

SEAL:
NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WILKINS

DATE:	6-05-03
HORIZONTAL SCALE:	NTS
VERTICAL SCALE:	NTS
DRAWN BY:	SES
DESIGNED BY:	SES/AK/WW
CHECKED BY:	WW

PROJECT:
SUCK CREEK
MOORE COUNTY

ATTACHED REFERENCE FILES:

JOB NUMBER: 011795008

SHEET NUMBER: 5 OF 10

BUFFER ZONES

Riparian Buffer- Planted easement area with bare root vegetation. Little or no maintenance except for hazard reduction to diseased or dying trees and shrubs.

Grass Filter Strip- Areas adjacent to fence to be maintained in herbaceous cover.

BARE ROOT VEGETATION:

1.General: In order to establish vegetation in restoration areas, such as bankfull benches and slopes, bareroot and herbaceous vegetation will be planted as shown on the plans or required in the Special Conditions.

2.Materials:

a) Initial vegetation material will be provided by the contractor. The contractor is responsible for correctly installing and maintaining vegetation material.

b) Vegetation material will consist of bare root trees and/or shrubs. Vegetation to be installed in areas shown on the plan labeled "**Riparian Buffer**" includes, but is not limited to the following:

RIPARIAN BUFFER TREES/SHRUBS

Trees[1]
Celtis laevigata (sugarberry)
Diospyros virginiana (persimmon)
Fraxinus pennsylvanica (green ash)
Nyssa sylvatica (blackgum)
Platanus occidentalis (sycamore)
Quercus phellos (willow oak)
Salix nigra (black willow)

Shrubs[1]
Amelanchier arborea (serviceberry)
Aronia arbutifolia (red chokeberry)
Asimina triloba (common pawpaw)
Calycanthus floridus (sweet-shrub)
Cephalanthus occidentalis (buttonbush)
Cornus amomum (silky dogwood)
Corylus americana (hazel-nut)
Lindera benzoin (spicebush)

3. Composition:
The composition of the riparian buffer trees/shrubs will be 70% trees and 30% shrubs from list above of riparian buffer trees/shrubs. At least seven different tree species with no more than 25% and not less than 5% of any one species. At least eight different shrub species with no more than 25% and not less than 5% of any one species.

4.Preparation:

a) Planting shall take place in **winter** (December – March). Immediately following delivery to the project site, all plants with bare roots, if not promptly planted, shall be heeled-in in constantly moist soil or sawdust in an acceptable manner corresponding to generally accepted horticultural practices.

b) While plants with bare roots are being transported to and from heeling-in beds, or are being distributed in planting beds, or are awaiting planting after distribution, the contractor shall protect the plants from drying out by means of wet canvas, burlap, or straw, or by other means acceptable to Engineer/Project Manager and appropriate to weather conditions and the length of time the roots will remain out of the

1. Recommended Native Plant Species for Stream Restoration in North Carolina, Karen Hall, NC Stream Restoration Institute NCSU January 2001

5.Installation:

a) Soil in the area of shrub and tree plantings shall be loosened to a depth of at least 5 inches. This is necessary only on compacted soil.
b) Bare root vegetation may be planted in hole made by a mattock, dibble, planting bar, or other means approved by Engineer/Project Manager. Rootstock shall be planted in a vertical position with the root collar approximately ½ inch below the soil surface. The planting trench or hole shall be deep and wide enough to permit the roots to spread out and down without J-rooting. The plant stem shall remain upright.
c) Soil shall be replaced around the transplanted vegetation and tamped around the shrub or tree firmly to eliminate air pockets.
d) The space guidelines of rooted shrubs and trees will be 10 feet between rows on 6-foot centers within rows.

SHRUB AND TREE TRANSPLANTS

1.General: Vegetation to be transplanted will be identified by the Engineer/Project Manager. Shrub and trees less than 3 inches in diameter shall be salvaged onsite in areas designated for construction, access areas, and other sites that will necessarily be disturbed.

2.Installation:

a) Transplanted vegetation shall carefully be excavated with rootballs and surrounding soil remaining intact. Care shall be given not to rip limbs or bark from the shrub and tree transplants. Vegetation should be transplanted immediately, if possible. Otherwise, transplanted vegetation shall be carefully transported to designated stockpile areas and heeled-in in constantly moist soil or sawdust in an acceptable manner appropriate to weather or seasonal conditions. The solidity of the plants shall be carefully preserved.
b) Installation of shrub and tree transplants shall be located in designated areas along the stream bank above bankfull elevation or in floodplain restoration areas as directed by Engineer/Project Manager. Soil in the area of vegetation transplants shall be loosened to a depth of at least 1 foot. This is only necessary on compacted soil. Transplants shall be replanted to the same depth as they were originally growing. The planting trench or hole shall be deep and wide enough to permit the roots to spread out and down without J-rooting. The plant stem shall remain upright.
c) Soil shall be replaced around the transplanted vegetation and tamped around the shrub or tree firmly to eliminate air pockets.
d) Spacing of vegetation transplants will be determined onsite by the Engineer/ Project Manager.

PERMANENT SEEDING SPECIFICATIONS

Permanent seeding will be used in combination with woody plantings on the up-slope side of the riparian areas and down to the bankfull elevation. Permanent seeding will occur in conjunction with temporary seeding where applicable. This mixture will also be used in any terrestrial (areas not inundated) riparian area that has been disturbed by construction, is designated as wetland and/or riparian enhancement, or as directed by Engineer/Project Manager. This mixture shall be planted in late fall in combination with the temporary seeding operation and woody plant installations. Seeding should be done evenly over the area using a mechanical or hand seeder. A drag should be used to cover the seed with no more than ½ inch of soils. Where a drag cannot safely be utilized, the seed should be covered by hand raking.

Seedbed Preparation

On sites where equipment can be operated safely, the seedbed shall be adequately loosened. Disking may be needed in areas where soil is compacted. Steep banks my require roughening, either by hand scarifying or by equipment, depending on site conditions. Engineer/Project Manager will determine condition needs onsite. If seeding is done immediately following construction, seedbed preparation may not be required except on compacted, polished or freshly cut areas. If permanent seeding is performed in conjunction with temporary seeding, seedbed preparation only needs to be executed once.

Seeding

A riparian seed mix at the rate of ¼ lb per 1,000 sq ft or 10 lbs per acre shall be used for seeding. The following table lists herbaceous, permanent seed mixture labeled "riparian seed mix"

Common Name	Scientific Name	%
Rice Cut Grass	*Leersia oryzoides*	5
Soft Rush	*Juncus effusus*	10
Deertongue	*Panicum clandestinum*	20
Switchgrass	*Panicum virgatum*	50
Ironweed	*Vernonia noveboracensis*	5
Swamp Sunflower	*Helianthus angustifolius*	5
Joe Pye Weed	*Eupatorium fistulosum*	5

GRASS FILTER STRIP

Seeds:
Panicum virgatum (switchgrass)
Tripsacum dactyloides (Eastern gama grass)
Andropogon gerardii (big blue stem)
Sorghastrum nutans (Indian grass)

Apply 10 lbs/acre using same seed bed preparation and seeding methods as the permanent seed mix. Use three of the four species with no more than 40% of any one of the three selected species.

LIVE STAKES

Live stakes are to be installed on exposed stream banks to bankfull elevation of the designed stream. The stakes are to be installed at a density of 2 to 4 live stakes per square yard. The species to be used for live staking are listed in the following Species List. The Supervising Engineer reserves the right to reject any "stakes" that do not meet the above mentioned criteria. The Contractor shall replace rejected work at no additional cost to the owner.

Live stakes are to be dormant (cut fall or winter), and either gathered locally or purchased from a commercial supplier.

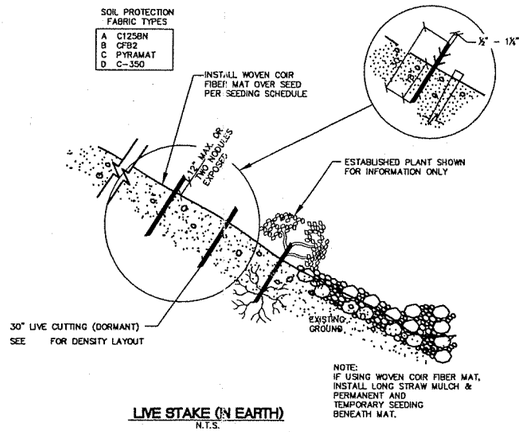
Collection/Preparation
- Stakes must be freshly cut with side branches removed, but with bark in tact (ensure that the bark is not stripped during the cutting, preparation, or installation of the stake).
- Cuttings are to be collected using a saw (not an ax).
- One end must be cut at an angle for insertion into the soil, and the other must be cut square for tamping.
- Cuttings must be kept fresh and moist prior to installation.
- Cuttings must be prepared from 0.5 to 2-inch diameter stock and approximately 2 to 3 feet in length.

Installation
- Install stakes the same day they are prepared.
- Start the installation nearest to the stream and work up the bank/floodplain.
- Cuttings must be installed right side up with the buds pointing upward.
- Cuttings should be tamped into the ground at right angles to the slope and angled downstream.
- They are to be tamped into the ground for approximately 4/5 of their length.
- Cuttings that split or become "mushroomed" must be replaced.
- Stakes are to be spaced at such that there are 2 to 4 stakes per square yard.

Stakes should be installed in a random configuration to prevent gullies and promote a more natural effect in the re-vegetated area.

Species List and Composition

Live Stakes	Percent Composition
Cornus amomum (silky dogwood)	25
Populus deltoides (cottonwood)	0-25
Salix nigra (black willow)	50
Sambucus canadensis (elder berry)	0-25
Viburnum dentatum (arrow wood)	0-25



LIVE STAKE (IN EARTH)
N.T.S.

TEMPORARY SEEDING FOR
LATE WINTER AND EARLY SPRING

Seeding mixture

Species	Rate (lb/acre)
Rye (Secale cereale)	120

Soil amendments
Follow recommendations of soil tests or apply 2,000 lb/acre ground agricultural limestone and 700 lb/acre 10-10-10 fertilizer.

Mulch
Apply 4,000 lb/acre straw. Anchor straw by netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.

Maintenance
Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

Note: Ground cover shall be established on exposed slopes within 30 working days following completion of any phase of grading.

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CLIENT:
ECOSYSTEM ENHANCEMENT PROGRAM
NCDENR

TITLE:
VEGETATION NOTES AND DETAILS

SEAL:
NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R WILLIAMS

DATE	6-05-03
HORIZONTAL SCALE	NTS
VERTICAL SCALE	NTS
DRAWN BY	SES
DESIGNED BY	SES/AK/WW
CHECKED BY	WW

PROJECT:
SUCK CREEK
MOORE COUNTY

ATTACHED REFERENCE FILES:
JOB NUMBER: 011795008
SHEET NUMBER: 6 OF 10

NORTH BASED ON DESIGN PLANS BY KIMLEY-HORN AND ASSOCIATES, INC. ENTITLED "SUCK CREEK - MOORE COUNTY"

LEGEND

- BOULDER CLUSTER
- ROOT WAD
- BOULDER
- ROCK CROSS VANE
- LOG VANE
- FENCE
- ℄ SUCK CREEK
- EDGE OF WATER
- J-HOOK VANE

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WK DICKSON
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Columbia, SC
Hickory, NC
Raleigh, NC
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	DAYSTAMP			

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Kimley-Horn and Associates, Inc.
P.O. BOX 33068 - RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: ECOSYSTEM ENHANCEMENT PROGRAM NCDENR

TITLE: RECORD DRAWING

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM R. WILHELM

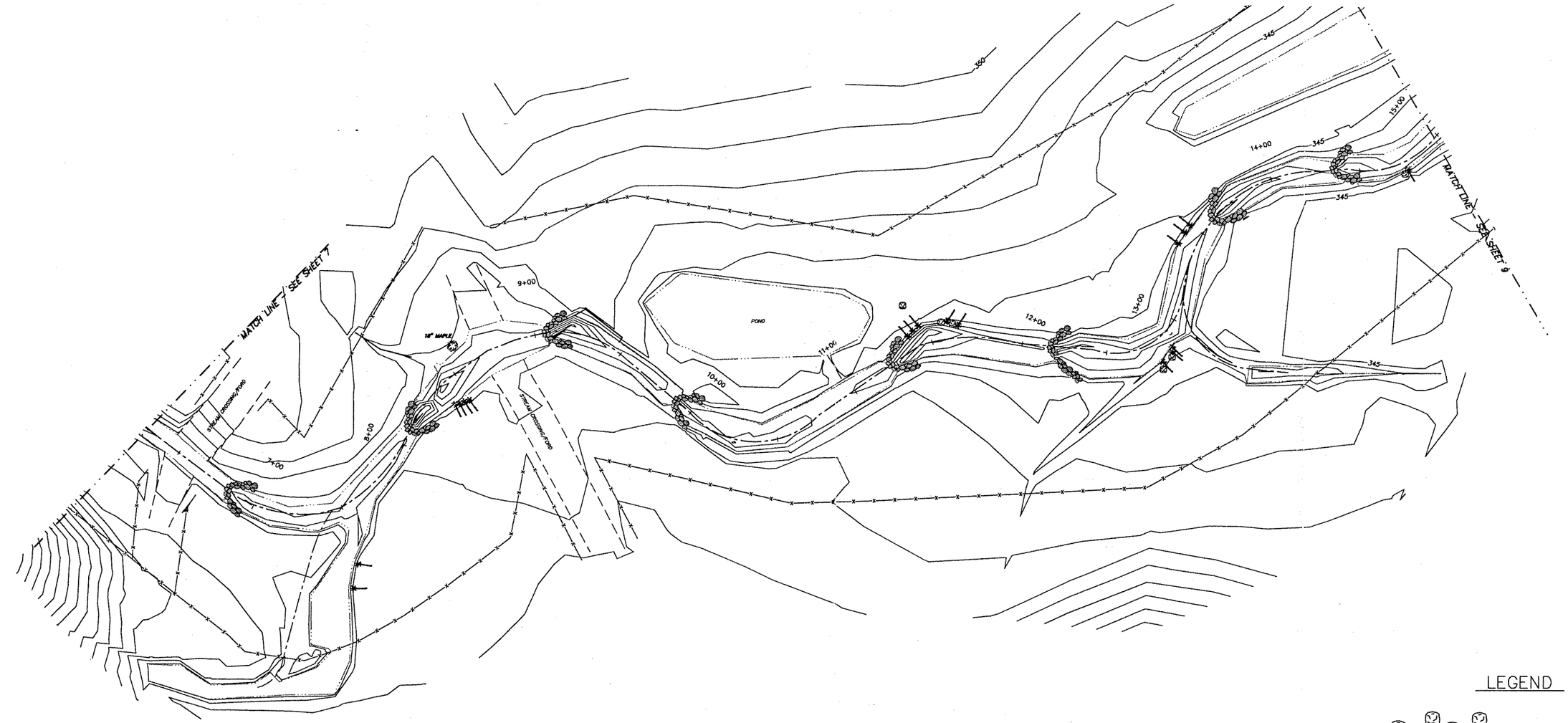
DATE	6-04-03
HORIZONTAL SCALE	30
VERTICAL SCALE	NTS
DRAWN BY	SES
DESIGNED BY	WW
CHECKED BY	JME/SWB

PROJECT: SUCK CREEK MOORE COUNTY

ATTACHED REFERENCE FILES:

JOB NUMBER: 011795008

SHEET NUMBER: 7 OF 10



NORTH BASED ON DESIGN PLANS BY KIMLEY-HORN AND ASSOCIATES, INC. ENTITLED "SUCK CREEK - MOORE COUNTY" AND DATED 9-12-02

LEGEND

- BOULDER CLUSTER
- ROOT WAD
- BOULDER
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Charlotte, NC
Columbia, SC
Hickory, NC
Raleigh, NC
Wilmington, NC

SCALE IN FEET
1" = 30'
15 0 15 30 45

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REV. No.	REVISION:	H:\PN\011795008\DWG\record-dwgs\AB-020506V02-B	DATE:	DRAWN BY:	CHECKED BY:

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CLIENT:
ECOSYSTEM ENHANCEMENT PROGRAM
NCDENR

TITLE:
RECORD DRAWING

SEAL:
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 028484 WILLIAM R. WILHELM

DATE:	6-04-03
HORIZONTAL SCALE:	30
VERTICAL SCALE:	NTS
DRAWN BY:	SES
DESIGNED BY:	WW
CHECKED BY:	JME/SWB

PROJECT:
SUCK CREEK
MOORE COUNTY

ATTACHED REFERENCE FILES:	JOB NUMBER:	SHEET NUMBER:
	011795008	8 OF 10

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NORTH BASED ON DESIGN PLANS BY KIMLEY-HORN AND ASSOCIATES, INC. ENTITLED "SUCK CREEK - MOORE COUNTY" AND DATED 9-12-02

LEGEND

- BOULDER CLUSTER
- ROOT WAD
- BOULDER
- ROCK CROSS VANE
- LOG VANE
- FENCE
- ℄ SUCK CREEK
- EDGE OF WATER
- J-HOOK VANE

SCALE IN FEET
1" = 30'
15 0 15 30 45

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N.C. Registration No. L-3847
JUNE 2, 2003
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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 028484 WILLIAM R. WILKINS
SEAL:

DATE:	6-04-03
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PROJECT: SUCK CREEK MOORE COUNTY

ATTACHED REFERENCE FILES:
JOB NUMBER: 011795008
SHEET NUMBER: 9 OF 10

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NORTH BASED ON DESIGN PLANS BY KIMLEY-HORN AND ASSOCIATES, INC. ENTITLED "SUCK CREEK - MOORE COUNTY" AND DATED 9-12-02

LEGEND

- BOULDER CLUSTER
- ROOT WAD
- BOULDER
- ROCK CROSS VANE
- LOG VANE
- FENCE
- ℄ SUCK CREEK
- EDGE OF WATER
- J-HOOK VANE

SCALE IN FEET
1" = 30'
15 0 15 30 45

Original survey issued and sealed by ROGER D. MORGAN, PLS N.C. Registration No. L-3847 JUNE 2, 2003
This media should not be considered a certified document.

WK DICKSON
Engineers • Planners • Surveyors
Landscape Architects

231 18th AVENUE, NE
HICKORY, NC 28601
(828) 327-8911

Asheville, NC
Atlanta, GA
Charlotte, NC
Columbia, SC
Hickory, NC
Raleigh, NC
Wilmington, NC

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REV. No.:	REVISION:	H:\PN\011795008\DWG\record-dwgs\AB-20506V02-B	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 - RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT:
ECOSYSTEM ENHANCEMENT PROGRAM
NCDENR

TITLE:
RECORD DRAWING

NORTH CAROLINA PROFESSIONAL SEAL 026484 ENGINEER WILLIAM S. WILHELM
SEAL:

DATE:	6-04-03
HORIZONTAL SCALE:	30
VERTICAL SCALE:	NTS
DRAWN BY:	SES
DESIGNED BY:	WW
CHECKED BY:	JME/SWB

PROJECT:
SUCK CREEK
MOORE COUNTY

ATTACHED REFERENCE FILES:
JOB NUMBER: 011795008
SHEET NUMBER: 10 OF 10

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