

**LITTLE PINE – BRUSH CREEK  
AS-BUILT REPORT (MY0)**

**HDR ENGINEERING**

**JUNE 2002**

**Little Pine Creek/Brush Creek  
Monitoring Methodology Report  
Alleghany County, North Carolina  
HDR Project No. 09177-010-018**

**1.0 INTRODUCTION**

**1.1 Review**

This report is intended for use by the North Carolina Department of Environment and Natural Resources (NCDENR) Wetland Restoration Program (NCWRP) for post-construction monitoring assessment on Little Pine Creek/Brush Creek, Alleghany County (County), North Carolina. This report was prepared pursuant to NCWRP's request to HDR Engineering, Inc. of the Carolinas (HDR), HDR Project No. 09177-010-018.

**1.2 Purpose**

HDR personnel conducted field reconnaissance to establish a procedure for post-construction monitoring of the Little Pine Creek/Brush Creek project site. Field reconnaissance of the project site included the establishment of permanent cross-sections at riffles and pools and permanent photograph stations. This report documents monitoring procedures for the assessment of stream bank stability and stream morphology for the Little Pine Creek/ Brush Creek project site, enabling replication of field reconnaissance and follow-up monitoring efforts over the next five years.

**2.0 SUMMARY**

**2.1 Site Characteristics**

The project site is located in Alleghany County, in the Blue Ridge Province of the Appalachian Mountains. At this site, Little Pine Creek, a third-order perennial stream draining a watershed of 4.3 square miles, enters Brush Creek, a fourth-order perennial stream draining a watershed area of 26.3 square miles (Figure 1). Brush Creek is a tributary to the Little River. These streams are part of the New River watershed, United States Geologic Survey (USGS) Hydrologic Unit 05050001, and North Carolina Division of Water Quality (NCDWQ) Subbasin 05-07-03. Streams have been assigned a best usage classification by NCDWQ that reflects water quality conditions and potential resource usage. The classification for Brush Creek is C TR. Waters classified as C TR are used for secondary recreation and protected for the intent of trout propagation and survival (NCDENR, 2000).

In 1969, Little Pine Creek was channelized upstream of its confluence with Brush Creek. In the recent past, approximately 340 feet of Brush Creek stream bank, downstream of the Little Pine Creek confluence, experienced significant bank collapse. This collapse may be linked to a variety of factors, including the steep angle of the Little Pine Creek confluence, deflection of Brush Creek streamflow by point bar formation downstream of

the confluence, the unconsolidated alluvial composition of the collapsing Brush Creek streambank, and limited riparian vegetation.

In response to landowner desires to restore Little Pine Creek and Brush Creek to a condition of natural stability, restoration of these streams occurred from April to July 2001, as shown in Figures 2 and 3. Riparian planting was completed in January 2002. Approximately 600 linear feet of altered Little Pine Creek channel were replaced with a new, 950-linear foot meandering channel reconnected to the flood plain and designed to maintain stable dimension, pattern, and profile while effectively transporting anticipated streamflow and sediment load. A vegetated riparian corridor was established along Little Pine Creek in order to improve water quality and increase aquatic and terrestrial habitat resources. In addition, 340 linear feet of Brush Creek were stabilized to eliminate existing severe bank collapse problems. Another 2,300 feet of degraded Brush Creek riparian corridor were enhanced in an effort to stabilize unstable banks, increase instream aquatic habitat, and improve the riparian buffer.

The lower 700 feet of Brush Creek, which is included in the conservation easement, does not include cross-section or permanent photograph station establishment. No grading work or planting was performed in this stable reach. Two boulder clusters were placed in the stream in this section to augment existing riffle sections.



**Lower 700' of Brush Creek**

This project site must be monitored for a five-year period, or for two documented bankfull events, to determine restoration success. The following is a discussion of the methodologies used in field reconnaissance (Rosgen Level II) and summary report documentation. The geomorphology of the stream should be assessed using the Rosgen classification system. The morphology of the stream is to be monitored a minimum of once per year for five years after construction. Project construction was completed in 2001, with monitoring planned for 2002 through 2006. It is also recommended to survey the streams after bankfull, or greater, storm events during this monitoring period.

## **2.2 Stream Geomorphology**

Cross-section geometry data were gathered during field reconnaissance. Three cross-sections were established on each stream, capturing both riffles and pools. These locations are shown on Figure 2. Monitoring data will be included in the first year monitoring report.

Minimum equipment needed includes the following:

- Tape (at least 100 feet) for cross-sections.
- Tape (at least 300 feet) for profile.
- Surveyor's Level (Optical or Laser).

- Surveyor's Rod.
- Camera.
- Bank Pins.
- Record Drawings.
- Monitoring Report.

### 2.2.1 Dimension

#### *Monitoring*

Permanent cross-sections were established, at one per 20 bankfull-width lengths, along the stream corridors of the restoration site. Little Pine Creek and Brush Creek each have three established cross-sections, as shown in Figure 2.

Stakes, wrapped with pink tape, were used to mark the established location of each cross-section. In addition, rebar was added to aid in future location of these markers.

#### *Procedure*

The following steps should be executed to ensure successful replication of cross-section location and surveying parameters. Data will be collected once per year for five years. Cross-sections should be plotted over that of the previous year(s) for comparison.

Locate each cross-section on plan sheets and in the field. Locate end points on banks marked with rebar and pull tape (100' tape) from left bank to right bank (looking downstream) at cross-section location between the two rebar points. The end of the tape (0'0") should be directly over the left rebar. Set up level/surveying equipment in a location to limit visual constraints. Survey any permanent benchmarks (Figure 2). Measure all significant breaks of slope that occur across the channel. Outside the channel, measure important features including the active flood plain, bankfull elevations, and stream terraces.

<b>Cross-Section</b>	<b>Benchmark</b>	<b>Cross-Section Type</b>
LPC 1	Bridge	Riffle
LPC 2	Spike in Tree	Riffle
LPC 3	Spike in Tree	Pool
BC 1	Spike in Tree	Riffle
BC 2	Spike in Tree	Riffle
BC 3	Spike in Tree	Pool

All cross-section locations are shown on Figure 2.

All elevations are based on the benchmark set in the bridge, which has been assigned an arbitrary elevation of 100 feet. Subsequently, the relative benchmark elevation of the spike in the tree is 89.9 feet.

Table 2 shows measurements that should be taken while monitoring the cross-sections and longitudinal profiles of Little Pine Creek and Brush Creek. Calculations based on these measurements include width to depth ratio, entrenchment ratio, and low bank height ratio. The cross-sections for Little Pine Creek are in Appendix A, while the cross-sections for Brush Creek are in Appendix B.

<b>Attribute</b>	<b>Little Pine Creek</b>	<b>Brush Creek</b>
Bankfull width (ft)	20	56
Mean Bankfull depth (ft)	2.14	4.25
Belt width (ft)	20	
Meander width ratio	1.25	
Radius of curvature (ft)	50.5	
Sinuosity	1.7	
Pool-to-pool spacing (ft)	73	300-350
Flood prone area width (ft)	200	127
Average low bank height (ft)	4.69	7.71
Maximum bankfull depth (ft)	5.5	9.6
Low bank height ratio	0.85	0.80

### **2.2.2 Pattern**

Based on the plan view of the project site, measurements to be taken are sinuosity, meander width ratio, and radius of curvature. Radius of curvature is required only for the first year of monitoring of newly constructed meanders.

### **2.2.3 Profile**

Longitudinal profile measurements include average slope, pool slope, and riffle slope. In addition, pool-to-pool spacing is to be measured. Pool-to-pool spacing in Little Pine Creek is calculated by taking the distance between the beginning of one pool and the beginning of the next pool. These profiles can be measured using previously discussed conventional surveying methods. In Little Pine Creek, it is difficult to segregate between the runs and pools. Where runs are discernable, run slope should be measured. For each stream, pool slope is measured by taking the attributes of the adjacent upstream and downstream features. For example, in Brush Creek, the slope of Pool 1 is calculated by using the attributes of the bottom of Riffle 1 and the top of Riffle 2.

### ***Monitoring***

A longitudinal profile is necessary for the lengths of Little Pine Creek and Brush Creek within the project site. These profiles capture the riffle and pool sequences of the stream.

### ***Procedure***

Surveys of the longitudinal profiles of Little Pine Creek and Brush Creek should be conducted at the same time as the cross-section surveys. Run tape beginning at each established "STA 0" point and continue downstream for the established length of each stream. At a minimum, survey locations should be at the start and end of each riffle and pool and should include a channel bottom elevation in the thalweg and water surface elevation. Data will be collected once per year for five years or for two documented bankfull events. Longitudinal profiles should be plotted over that of previous year(s) for comparison.

Calculations based on these measurements include average slope and slopes of the pools and riffles. The longitudinal profile for Little Pine Creek is in Appendix A, while the longitudinal profile for Brush Creek is in Appendix B.

### **2.2.4 Materials**

A pebble count provides a quantitative characterization of streambed material. This composition information is used as an indicator of changes in stream character, channel form, hydraulics, erosion rates, and sediment supply.

### ***Monitoring***

Pebble counts will be performed at each of the three cross-sections along Little Pine Creek and Brush Creek. Each pebble count consists of 100 counts at each location along the streams.

### ***Procedure***

Follow the basic steps for the Modified Wolman Pebble Count (Rosgen, 1996). Perform count at each of the four areas along the stream channel. Measure a minimum of 100 particles to obtain a representative size distribution. Data will be collected once per year for five years. Pebble counts should be plotted over that of the previous year(s) for comparison. Over time, established d50 and d85 should be compared. Data from pebble counts for Little Pine Creek are in Appendix A, while pebble count data for Brush Creek are in Appendix B.

## 2.2.5 Reference Photographs

### *Monitoring*

Photograph points were established at all cross-section locations and at distinguishing points, including all instream structures, along Little Pine Creek and Brush Creek. Each photograph point was established and either marked with a wooden stake or referenced by cross-section or stream feature (e.g., rock vane). All photograph points are labeled on Figure 2.

<b>Stream</b>	<b>Station Number</b>	<b>Bearing (° from N)</b>
Little Pine Creek	1	105, 180
	2	40, 80, 120
	3	20, 60, 100
	4	0, 280, 320
	5	260
Brush Creek	1	235, 275
	2	10, 310, 330
	3	0, 80, 120, 160
	4	55, 95, 145
	5	40
	6	5, 55, 115, 150
	7	90, 335
	8	140, 180, 220
	9	130, 170, 230, 270, 310, 340
	10	30, 50, 85, 120

### *Procedure*

Photographs should be taken standing at the initial location of each of the 15 established photograph stations. A compass bearing is included for each reference photograph to aid in replication efforts (Table 3). Photographs will be taken throughout the monitoring period and compared to those from previous year(s) photographs to evaluate channel evolution and vegetation growth along the stream corridors within the project site. Photographs of Little Pine Creek are in Appendix A, while photographs of Brush Creek are in Appendix B.

## 2.2.6 Vegetation

### *Monitoring*

Vegetation planting included a seed mix, live stakes, and bare root trees. The seed mix (Table 4) was spread throughout the buffer area. Live stakes (Table 5) were

planted from the edge of water to the top of slope on the banks of Little Pine Creek. Approximately 11,275 square feet of Little Pine Creek banks were planted. Additional live stakes were planted on the flood plain bench, along the rock vane area, and throughout various areas of Brush Creek. These areas comprise approximately 11,150 square feet of live staking. Bare root plantings (Table 5) occurred in the buffer areas from the top of slope out 50 feet.

<b>Common Name</b>	<b>Scientific Name</b>	<b>Percent</b>
Annual rye	<i>Lolium multiflorum</i>	25
Blue vervain	<i>Verbena hastata</i>	5
Bur-marigold	<i>Bidens aristosa</i>	10
Deertongue "Tioga"	<i>Dichanthelium clandestinum</i>	15
Eastern gamma grass	<i>Tripsacum dactyloides</i>	5
Partridge pea	<i>Chamaecrista fasciculata</i>	10
Pennsylvania smartweed	<i>Polygonum pennsylvanicum</i>	10
River oats	<i>Chasmanthium latifolium</i>	5
Soft rush	<i>Juncus effusus</i>	5
Virginia wild rye	<i>Elymus virginicus</i>	10

<b>Common Name</b>	<b>Scientific Name</b>	<b>Planting Type</b>
River birch	<i>Betula nigra</i>	Bare root
Black walnut	<i>Juglans nigra</i>	Bare root
Tulip poplar	<i>Liriodendron tulipifera</i>	Bare root
White oak	<i>Quercus alba</i>	Bare root
Persimmon	<i>Diospyros virginiana</i>	Bare root
Sycamore	<i>Platanus occidentalis</i>	Bare root
Sugar maple	<i>Acer saccharum</i>	Bare root
Silky dogwood	<i>Cornus amomum</i>	Live stake
Silky willow	<i>Salix sericea</i>	Live stake
Virginia willow	<i>Itea virginica</i>	Live stake
Elderberry	<i>Sambucus canadensis</i>	Live stake
White alder	<i>Clethra acuminata</i>	Live stake
Ninebark	<i>Physocarpus opulifolius</i>	Live stake

Survival of vegetation within the riparian buffer will be evaluated using survival plots (Figure 2). Survival of live stakes will be evaluated along the stream corridor of the restoration site. Woody vegetation will be monitored for five years, or for two bankfull events, before success or failure is assessed. Plants should be replaced per the contract documents. Two vegetation plots were established along Little Pine Creek. One vegetation plot was established along Brush Creek.

## ***Procedure***

Vegetation survival inside the riparian buffer will be documented through evaluation at three pre-established plot areas, as shown on Figure 2, and through photograph documentation of the length of the corridor in which buffers were planted. Documentation will occur at the pre-established plot areas. Vegetation survival of target dominant species will be confirmed. The Brush Creek plot is to be located atop the bankfull bench into the riparian buffer.

Plots are each 1/50<sup>th</sup> of an acre, with a radius of 16.7 feet. Secure a tape at the stake and conduct a survey radially from this center point (Figure 2). Herbaceous cover can be incorporated into the plot. Vegetation sampling should be completed before the end of the initial growing season from August 1 to October 31. Record the number of live woody stems per plot by species for both stakes and bare roots. Also, record the estimated coverage of herbaceous vegetation and the dominant species present.

### **2.3 Contact Information**

HDR and HARP provided the design services and vegetative planting for the stream restoration of Little Pine Creek and Brush Creek. A & D Environmental and Industrial Services constructed the project. Jeff Jurek of NCWRP conducted project oversight of these activities.

## **3.0 SUCCESS CRITERIA**

Restoration of Little Pine Creek and Brush Creek will be determined a success after the monitoring period is complete and the following criteria are met. The stream channels should maintain their dimension, pattern, and profile over time. Additionally, instream structures should remain secure and stable during the monitoring period.

Judgments on success or failure of restoration activities using these data will be subjective. It is expected that there will be some minimal changes in the cross-sections, profile, and/or substrate composition. Changes that may occur during the monitoring period will be evaluated to determine if they represent a movement toward a more unstable condition (e.g. down-cutting, deposition, and/or erosion) or if they are minor changes that represent an increase in stability (e.g. settling, vegetative changes, and/or decrease in width/depth ratio). Unstable conditions that require remediation will indicate failure of restoration activities.

### **3.1 Dimension**

Cross-section changes can indicate changes in the width to depth ratio of a stream. Some change is expected over time; however, cross-section changes should not show excessive erosion or degradation of the channel dimensions over time. Bank slopes should remain stable. Photographs can also provide visual references to channel cross-section changes.

### **3.2 Pattern**

The plan view of the project site should remain consistent with the designed Rosgen valley and stream type. Success of the design is indicated by no change in sinuosity.

### **3.3 Profile**

Comparison of longitudinal profiles during the monitoring period will indicate excessive changes in channel slope, riffle and pool sequences, and developing bars within the channel. Channel aggradation or degradation can be analyzed from longitudinal profile information. Longitudinal photographs can also document stream channel changes over time.

### **3.4 Materials**

Pebble count data can be used to interpret the movement of materials in the stream channels. Established d50 and d85 sizes should increase in coarseness in riffles and increase in fineness in pools.

### **3.5 Photographs**

Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of in-stream structures and erosion control measures. A series of photographs can also indicate channel or bank erosion problems over time. If necessary, actions can be taken to remedy these problems.

### **3.6 Vegetation**

Review of photograph documentation should make evident the establishment and maturation of vegetated riparian buffer zones (Figure 4). Native vegetation, as determined by reference reach vegetation inventories, was planted at the project site. Five years after project construction completion, tree species comparable to those at the reference site must have a survival rate of 320 stems per acre.

## **4.0 MONITORING SCHEDULE**

Annual monitoring is required for a five-year period beginning in 2002 and ending in December 2006. Reports will be submitted in 2002, 2004, and 2006 to U.S. Army Corps of Engineers, North Carolina Division of Water Quality, and North Carolina Wildlife Resources Commission (NCWRC). Submittal to NCWRC is necessary because Brush Creek is rated as a trout stream, as discussed in Section 2.0. In 2002, HDR personnel will conduct first-year monitoring.

## **5.0 MITIGATION**

[WRP]

## 6.0 MAINTENANCE AND CONTINGENCY PLANS

All maintenance and contingency costs are built into Wetlands Restoration Program Fee Schedule (\$125/linear foot). NCWRP will be fully responsible for meeting yearly performance criteria. For each criterion missed, NCWRP will provide an explanation for problem and institute a plan to correct problem.

If success criteria have not been met after the five-year monitoring period, NCWRP and the U.S. Army Corps of Engineers will mutually agree upon a plan to correct the problem. If the problem cannot be corrected, NCWRP will institute a new project to fulfill the outstanding mitigation obligation.

## 7.0 REFERENCES

North Carolina Division of Land Resources and North Carolina Division of Water Quality, 2000. "Draft Internal Technical Guide for Stream Work in North Carolina."

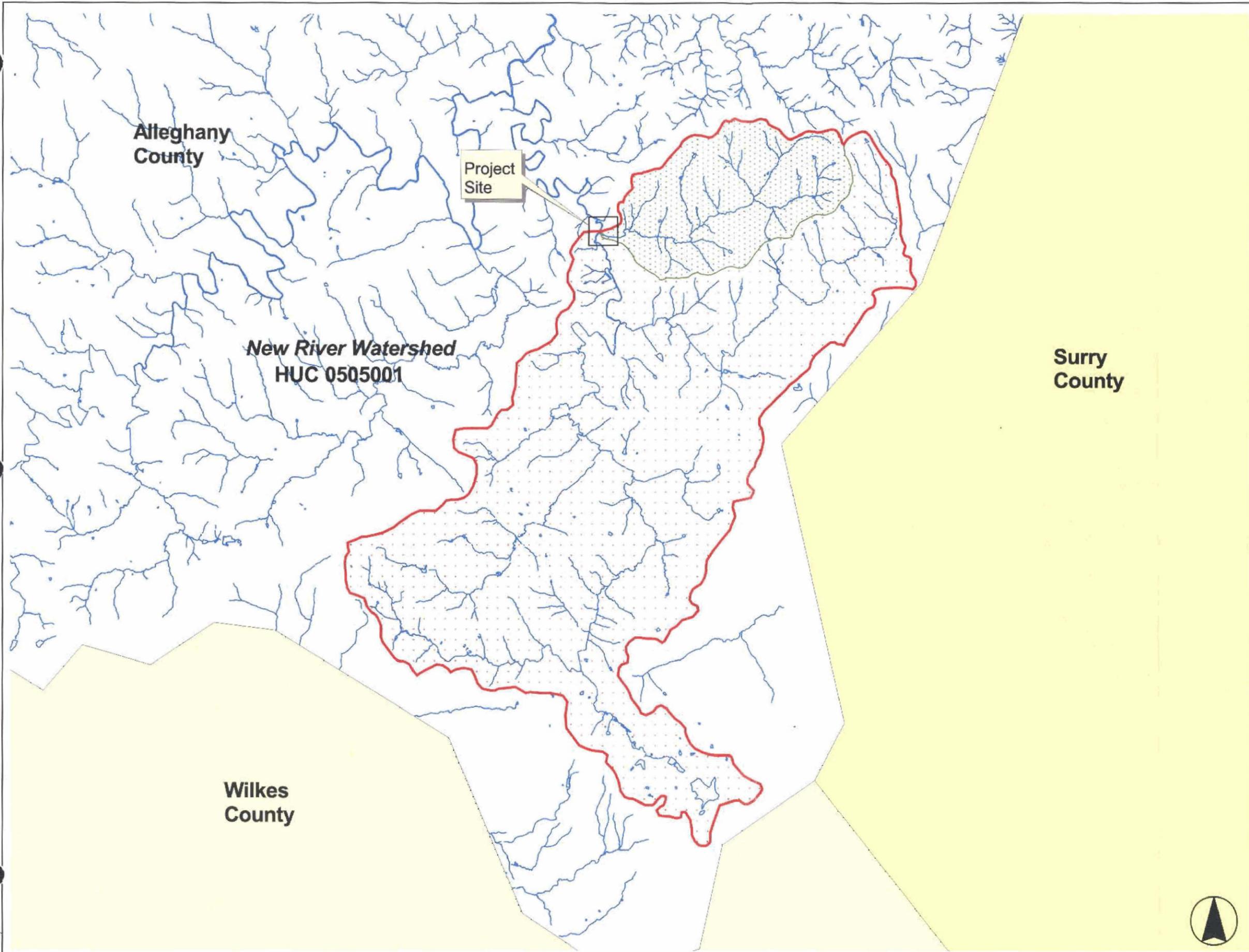
North Carolina Department of Environment and Natural Resources. 2000. *New River Basinwide Water Quality Plan*. Division of Water Quality. Raleigh, NC.

Rosgen, David L. 1997. "A Geomorphological Approach to Restoration of Incised Rivers," Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision.

Rosgen, David L. 1996. *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, CO.

**Figure 1: Project Site Location**

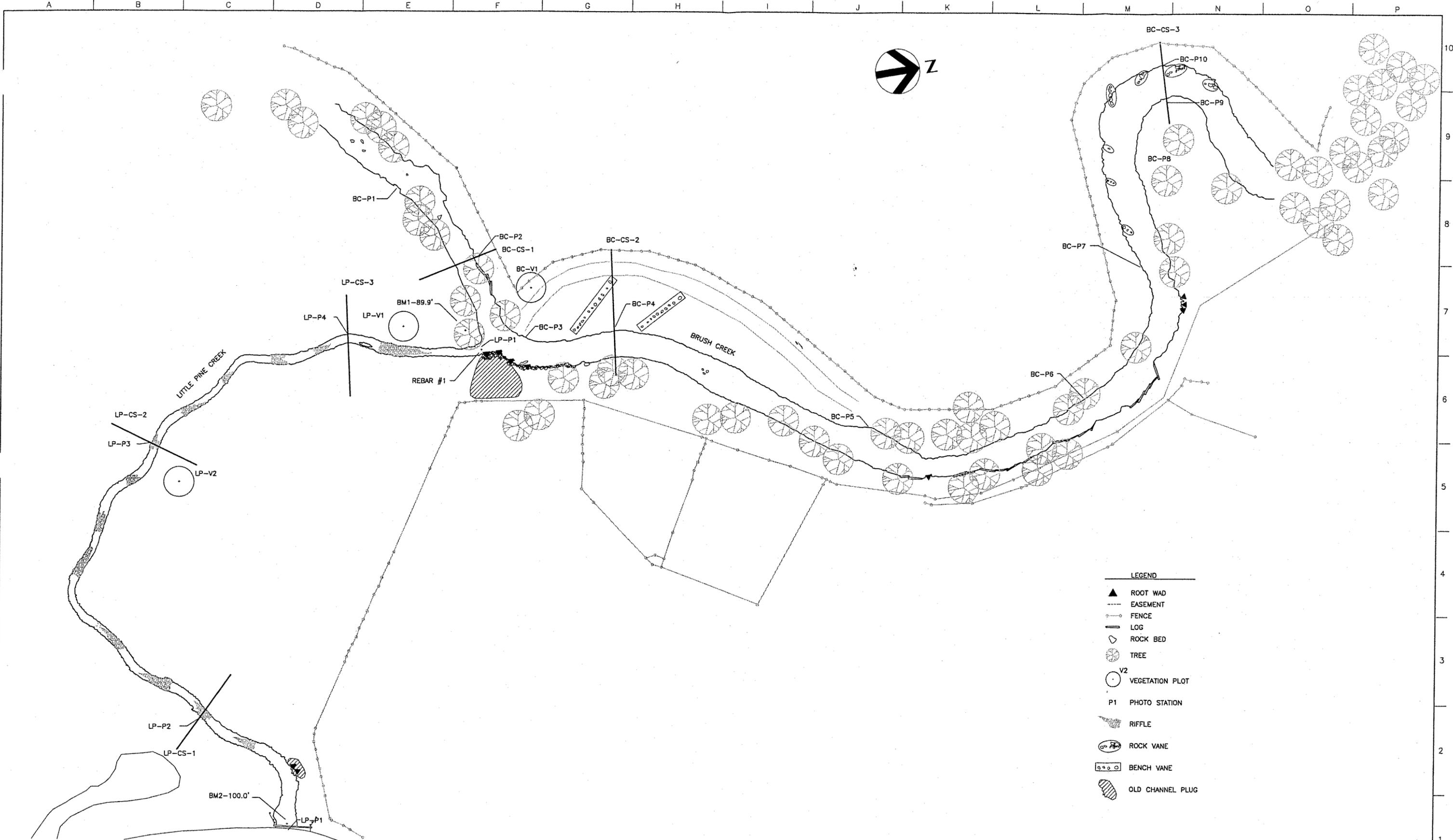
**Allegheny County, North Carolina**



**Legend**

-  Hydrology
-  Brush Creek Watershed
-  Little Pine Creek Watershed





**LEGEND**

- ▲ ROOT WAD
- - - EASEMENT
- FENCE
- LOG
- ◇ ROCK BED
- ⊗ TREE
- V2 VEGETATION PLOT
- P1 PHOTO STATION
- ⊃ RIFFLE
- ⊖ ROCK VANE
- BENCH VANE
- ▨ OLD CHANNEL PLUG

Issue No.	Description	Date	Drawn	Chkd.	Resp. Engr.	Proj. Mgr.

**HDR**  
 HDR Engineering, Inc.  
 of the Carolinas  
 9970-14 Beach Drive  
 Colaboshy, NC 28487  
 (910) 575-5880

Project Manager  
 C. MATTHEWS  
 Designed  
 Designed  
 Checked  
 J. HENKELS  
 Drawn  
 J. McCLURE

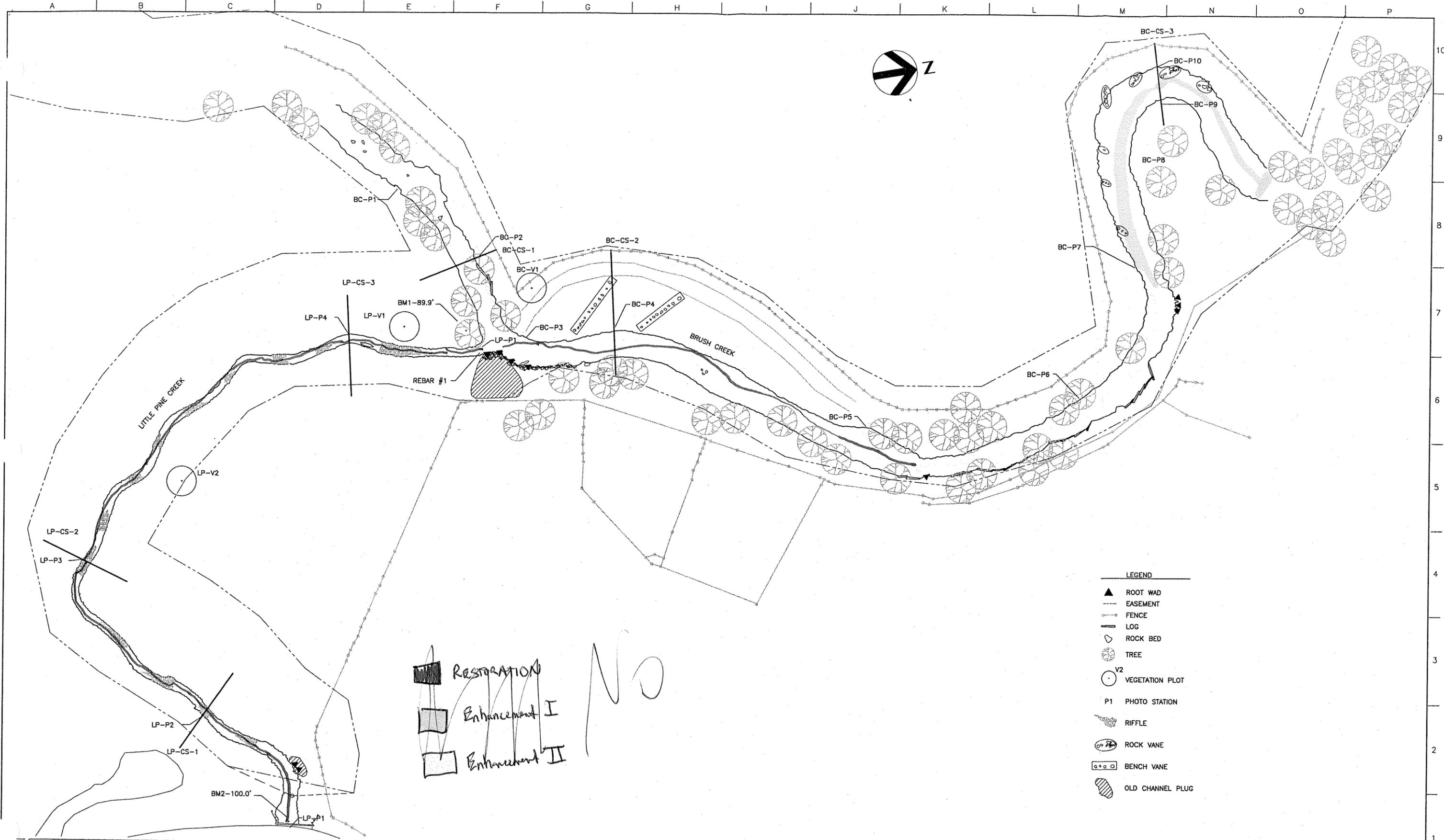
**NCWRP - BRUSH CREEK  
 LITTLE PINE CREEK RESTORATION**

ALLEGHANY COUNTY NORTH CAROLINA

**MONITORING LOCATIONS  
 LITTLE PINE CREEK AND  
 BRUSH CREEK**

Date MAY, 2002	Project No. 09177-010-018	Drawing No. <b>FIG. 2</b>	Issue <b>A</b>
Scale 1"=100'	File Name SPARTA.DWG		

E:\09177004\SPARTA.DWG  
05/17/02



E:\09177004\SPARTA.DWG  
05/16/02

Issue No.	Description	Date	Drawn	Chkd.	Resp. Engr.	Proj. Mgr.

**HDR**  
HDR Engineering, Inc.  
of the Carolinas  
9970-14 Beach Drive  
Colts Neck, NC 28427  
(910) 575-5880

Project Manager  
**C. MATTHEWS**

Designed

Designed

Checked  
**J. HENKELS**

Drawn  
**J. McCLURE**

**NCWRP - BRUSH CREEK  
LITTLE PINE CREEK RESTORATION**

ALLEGHANY COUNTY      NORTH CAROLINA

**MONITORING LOCATIONS  
LITTLE PINE CREEK AND  
BRUSH CREEK**

Date MAY, 2002	Project No. 09177-010-018	Drawn No. <b>FIG. 2</b>	Issue <b>A</b>
Scale 1"=100'	File Name SPARTA.DWG		

# NCWRP Project Mitigation Report

# Brush Creek

## Wetlands

Type:		<u>Credits</u>
Acreage:	Restoration-	
	Creation-	
	Enhancement-	
	Preservation-	

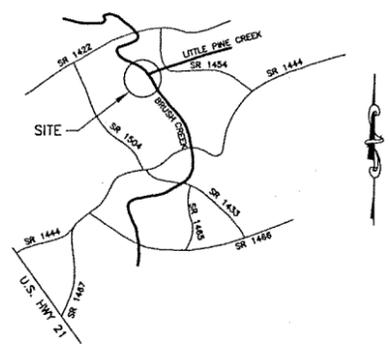
**Total Credit=**

## Streams

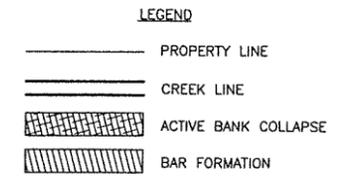
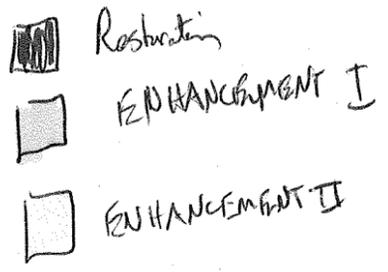
Temperature: Cold		<u>Credits</u>
Linear Footage:	Restoration- 1350 ft.	1350
	Enhancement I- 490 ft	245
	Enhancement II- 1750 ft	583
	Preservation-	

**Total Credit= 2178**

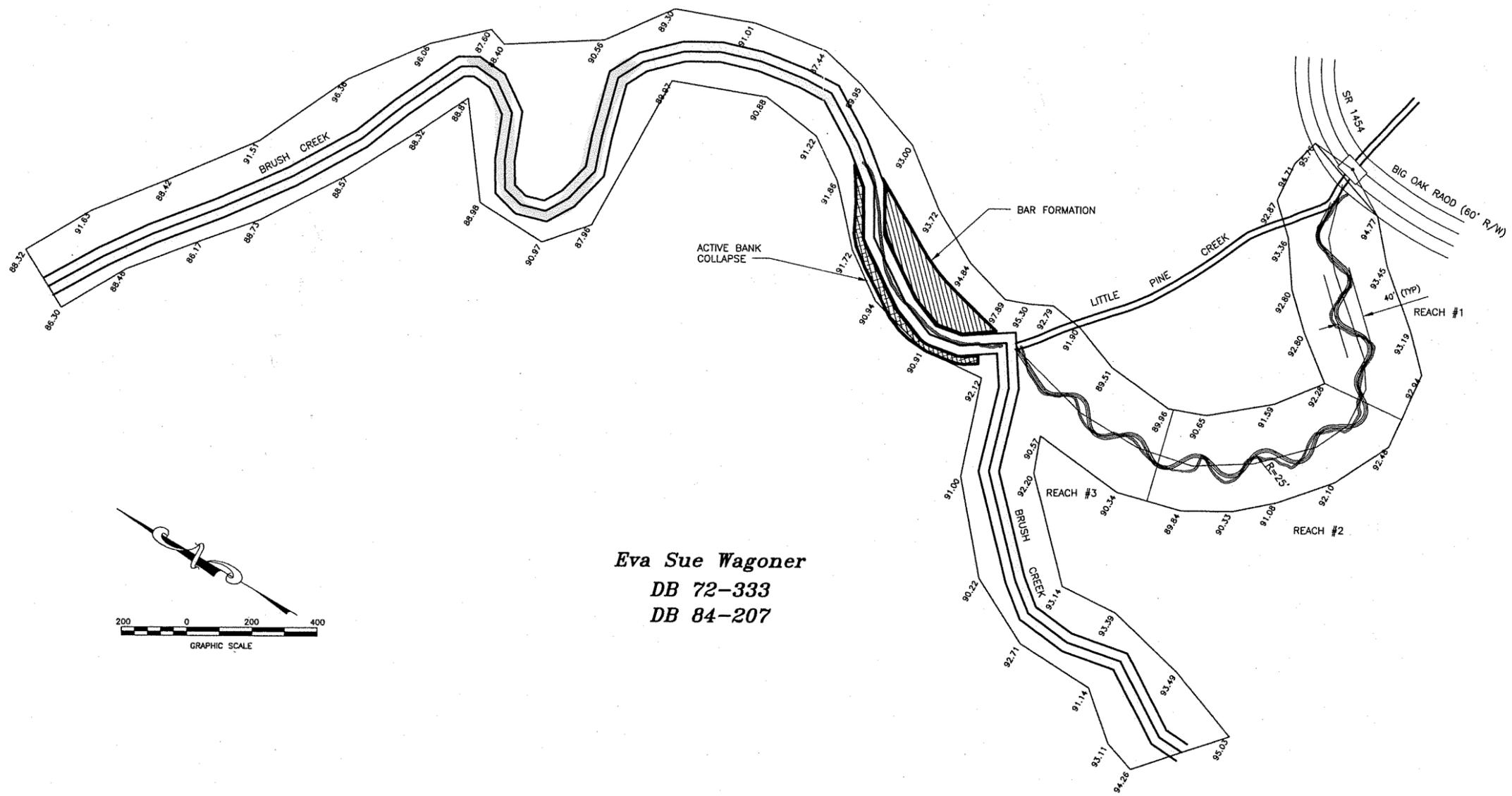
Summary: 950 feet (Little Pine Creek) was involved in priority I restoration, where a straightened stream was restored meandering through the floodplain. 400 feet of Brush Ck. was also restored by building a large bankfull bench, using rock vanes to help form profile, narrowing the width, and re-patterning the stream. Dimension and profile were properly restored to a 490 foot section using rock vanes, j-hooks, and grading the banks. 1750 feet had cattle fenced out and also pool-riffle sequence was restored for Trout population. Entire site was planted in riparian area.



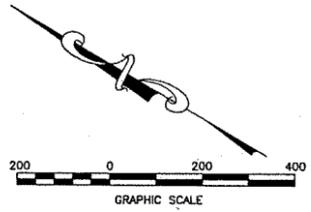
VICINITY MAP  
NO SCALE



A. Anderson Huber  
DB 169-125



Eva Sue Wagoner  
DB 72-333  
DB 84-207



re-3.DWG  
05/10/02

Issue No.	Description	Date	Dwn.	Chkd.	Resp. Engr.	Proj. Mgr.

**HDR**  
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Project Manager	C. MATTHEWS
Designed	
Designed	
Checked	J. HENKELS
Drawn	J. McCLURE

**NCWRP - BRUSH CREEK  
LITTLE PINE CREEK RESTORATION**  
ALLEGHANY COUNTY NORTH CAROLINA

**OVERALL EASEMENTS  
LITTLE PINE CREEK AND  
BRUSH CREEK**

Date	MAY, 2002	Project No.	09177-010-018	Drawing No.	FIG. 3	Issue	A
Scale	1"=200'	File Name	FIGURE-3.DWG				

RIPARIAN ZONE 1 SPECIES		
COMMON NAME	SCIENTIFIC NAME	DENSITY (#/AC)
SILKY DOGWOOD	<i>CORNUS AMOMUM</i>	125
BLACK WILLOW	<i>SALIX NIGRA</i>	125
SILKY WILLOW	<i>SALIX SERICEA</i>	125
AMERICAN ELDER	<i>SAMBUCUS CANADENSIS</i>	50
CORALBERRY	<i>SYMPHORICARPOS ORBICULATUS</i>	50
HOBBLEBUSH	<i>VIBURNUM ALNIFOLIUM</i>	50
YELLOW-ROOT	<i>XANTHORHIZA SIMPLICISSIMA</i>	50
TOTAL		575

RIPARIAN ZONE 2 SPECIES		
COMMON NAME	SCIENTIFIC NAME	DENSITY (#/AC)
RED MAPLE	<i>ACER RUBRUM</i>	75
SUGAR MAPLE	<i>ACER SACCHARUM</i>	50
HAZEL ALDER	<i>ALNUS SERRULATA</i>	75
RIVER BIRCH	<i>BETULA NIGRA</i>	75
GREEN ASH	<i>FRAXINUS PENNSYLVANICA</i>	50
POSSUMHAW	<i>ILEX DECIDUA</i>	50
MOUNTAIN WINTERBERRY	<i>ILEX MONTANA</i>	50
BLACK WALNUT	<i>JUCLANS NIGRA</i>	25
YELLOW POPLAR	<i>LIRIODENDRON TULIPIFERA</i>	75
BLACK GUM	<i>NYSSA SYLVATICA</i>	50
WHITE OAK	<i>QUERCUS ALBA</i>	50
TOTAL		650

**LEGEND**

- BELT WIDTH
- BASEFLOW CHANNEL
- BANKFULL
- POOL
- RIFFLE
- RIPARIAN ZONE 1
- RIPARIAN ZONE 2

10 0 10 20  
GRAPHIC SCALE

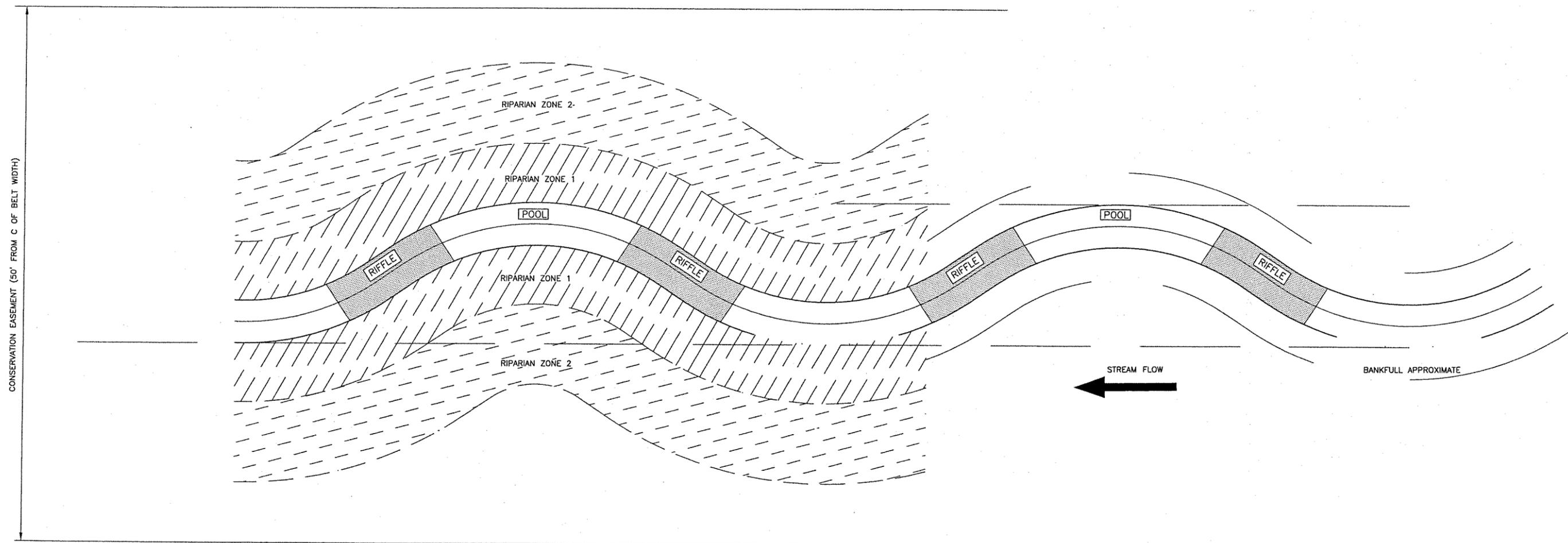


FIGURE-4.DWG

Issue No.	Description	Date	Drawn	Chkd.	Resp. Engr.	Proj. Mgr.

**HDR**  
HDR Engineering, Inc.  
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(910) 575-5880

Project Manager	C. MATTHEWS
Designed	
Checked	J. HENKELS
Drawn	J. McCLURE

**NCWRP - BRUSH CREEK  
LITTLE PINE CREEK RESTORATION**

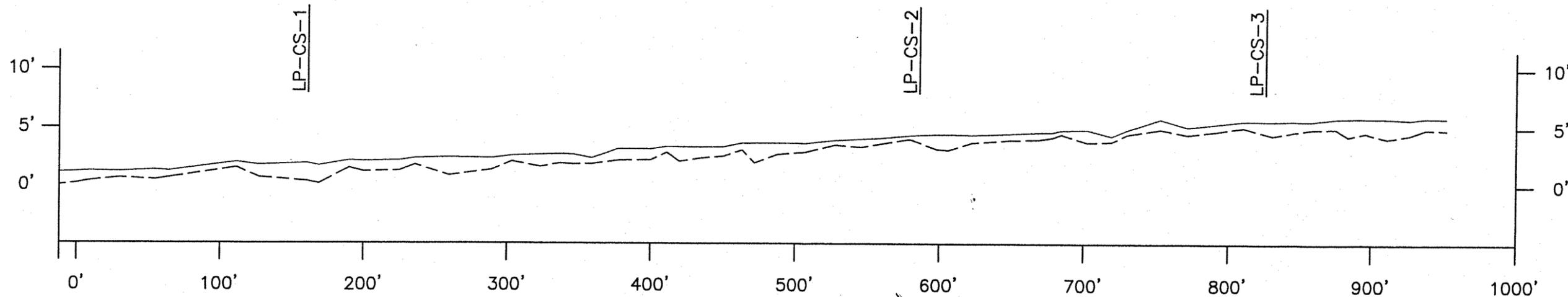
ALLEGHANY COUNTY      NORTH CAROLINA

**RIPARIAN VEGETATION  
LITTLE PINE CREEK AND  
BRUSH CREEK**

Date	MAY, 2002	Project No.	09177-010-018	Drawing No.	FIG. 4	Issue	A
Scale	1"=10'	File Name	FIGURE-4.DWG				

**LITTLE PINE CREEK**

## **LONGITUDINAL PROFILE**



Slope and Maximum Water Depth - Little Pine Creek Alleghany County, North Carolina		
Feature	Slope	Max. H2O depth (ft)
Riffle 1	0.0030	0.86
Riffle 2	0.0176	0.65
Riffle 3	0.0194	0.48
Riffle 4	0.0459	0.45
Riffle 5	0.0207	0.50
Riffle 6	0.0288	0.75
Riffle 7	0.0425	0.80
Riffle 8	0.0587	0.92
Riffle 9	0.0032	0.84
Riffle 10	0.0518	1.00
Riffle 11	0.0472	0.88
Riffle 12	0.0634	1.54
Riffle 13	0.0184	0.58
Riffle 14	0.0123	0.90
<b>Average Riffle</b>	<b>0.0309</b>	
Pool 1	-0.0008	1.72
Pool 2	-0.0025	1.22
Pool 3	-0.0045	0.86
Pool 4	0.0002	1.10
Pool 5	-0.0067	1.34
Pool 6	-0.0036	1.72
Pool 7	-0.0082	1.25
Pool 8	0.0085	1.00
Pool 9	-0.0058	1.05
Pool 10	-0.0080	1.56
Pool 11	-0.0065	0.90
Pool 12	-0.0238	1.54
Pool 13	0.0006	0.85
<b>Average Pool</b>	<b>-0.0047</b>	
Run 1	-0.0057	1.00
Run 2	0.0063	0.65
Run 3	0.0029	0.70
<b>Average Run</b>	<b>0.0012</b>	
<b>Average Slope</b>	<b>0.0125</b>	

**LEGEND**

- WATER SURFACE ELEVATION
- EXISTING CREEK BED

LPC-LP.DWG

Issue No.	Description	Date	Drawn	Chkd.	Appr. Engr.	Proj. Mgr.



HDR Engineering, Inc.  
of the Carolinas  
9970-14 Beach Drive  
Colesburg, NC 28427  
(910) 575-5880

Project Manager	C. MATTHEWS
Designed	
Checked	J. HENKELS
Drawn	J. McCLURE

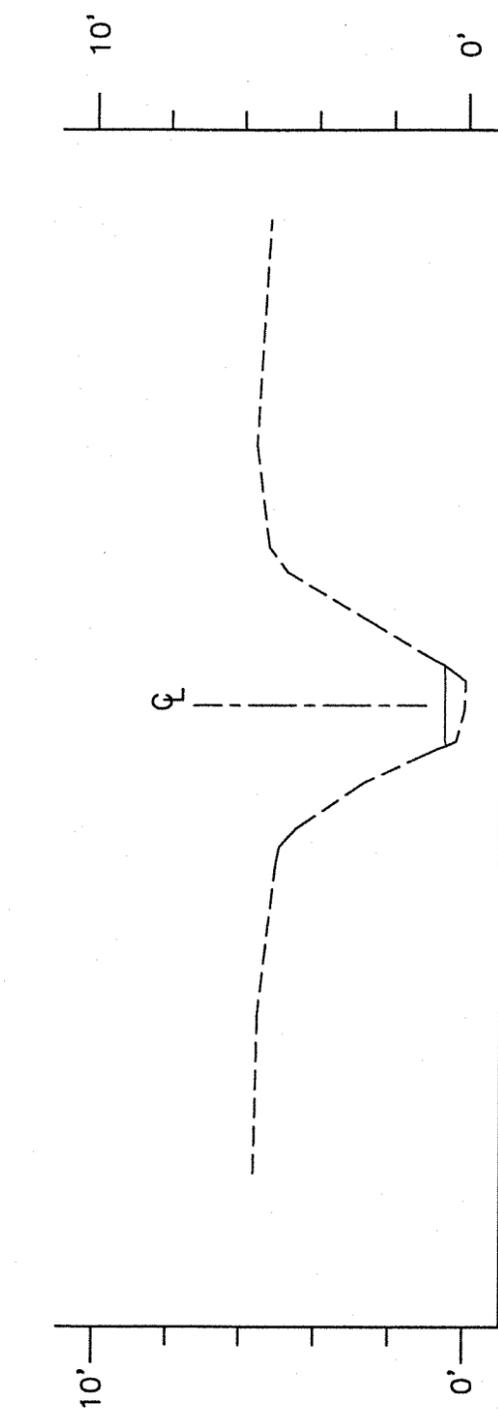
**NCWRP - BRUSH CREEK  
LITTLE PINE CREEK RESTORATION**

ALLEGHANY COUNTY NORTH CAROLINA

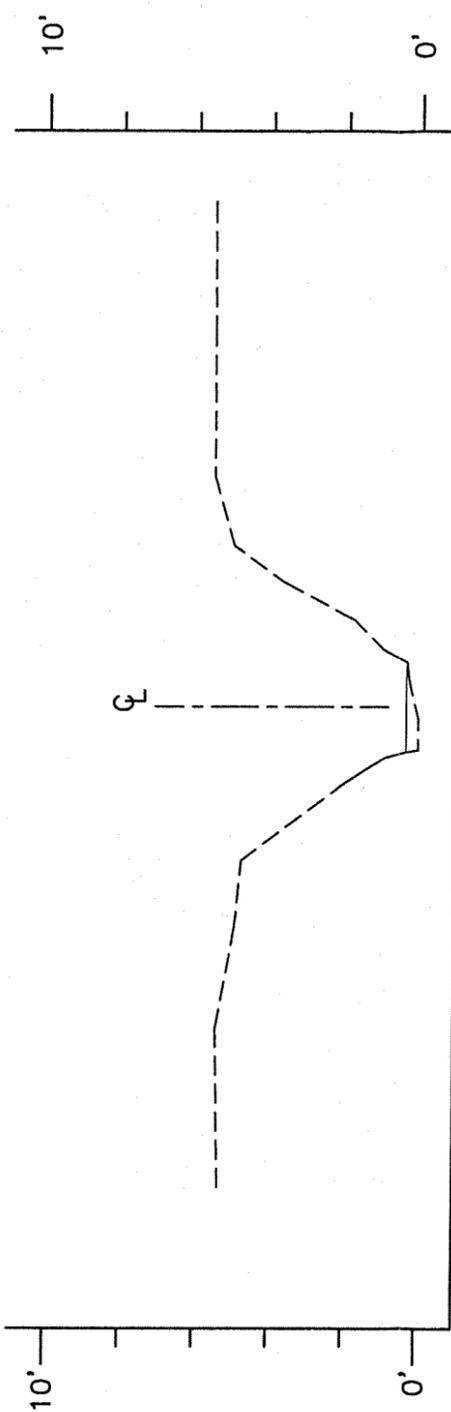
**LITTLE PINE CREEK  
LONGITUDINAL PROFILE**

Date	JUNE, 2002	Project No.	09177-010-018	Drawing No.	FIGURE 1	Issue	A
Scale	NOT TO SCALE	File Name	LPC-LP.DWG				

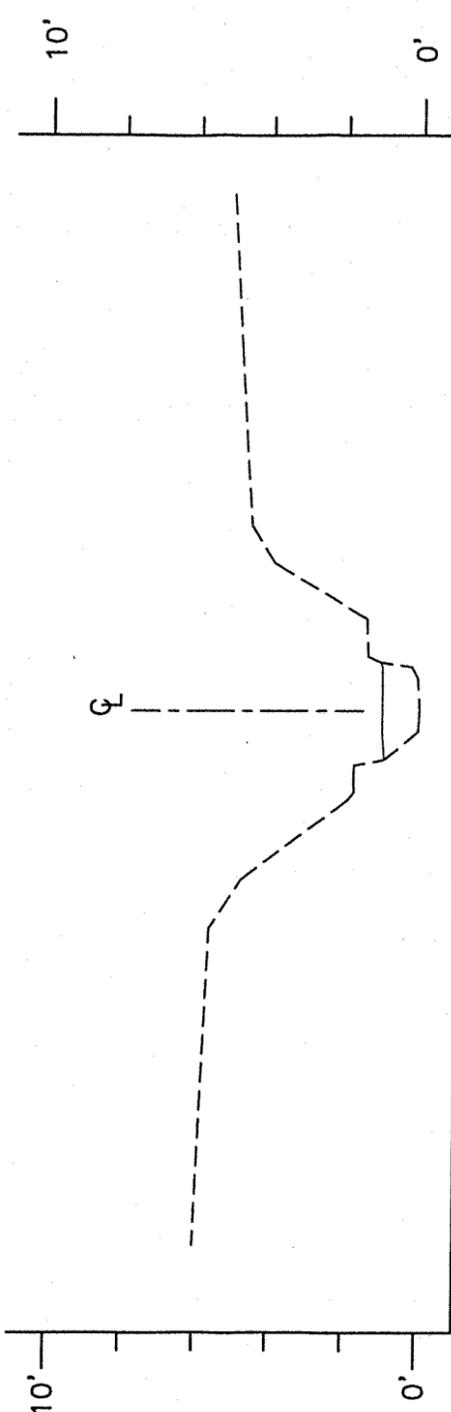
## **CROSS-SECTIONS**



LP-CS-1



LP-CS-2



LP-CS-3

LEGEND

- WATER SURFACE ELEVATION
- - - EXISTING CREEK BED

Issue No.	Description	Date	Drawn	Checked	Responsible Eng.	Project Mgr.

**HDR**  
 HDR Engineering, Inc.  
 of the Carolinas  
 9970-14 Beach Drive  
 Raleigh, NC 27667  
 (910) 575-5880

Project Manager  
**C. MATTHEWS**  
 Designed  
 Designed  
 Checked  
**J. HENKELS**  
 Drawn  
**P. BARRY**

**NCWRP - BRUSH CREEK**  
**LITTLE PINE CREEK RESTORATION**  
 ALLEGHANY COUNTY NORTH CAROLINA

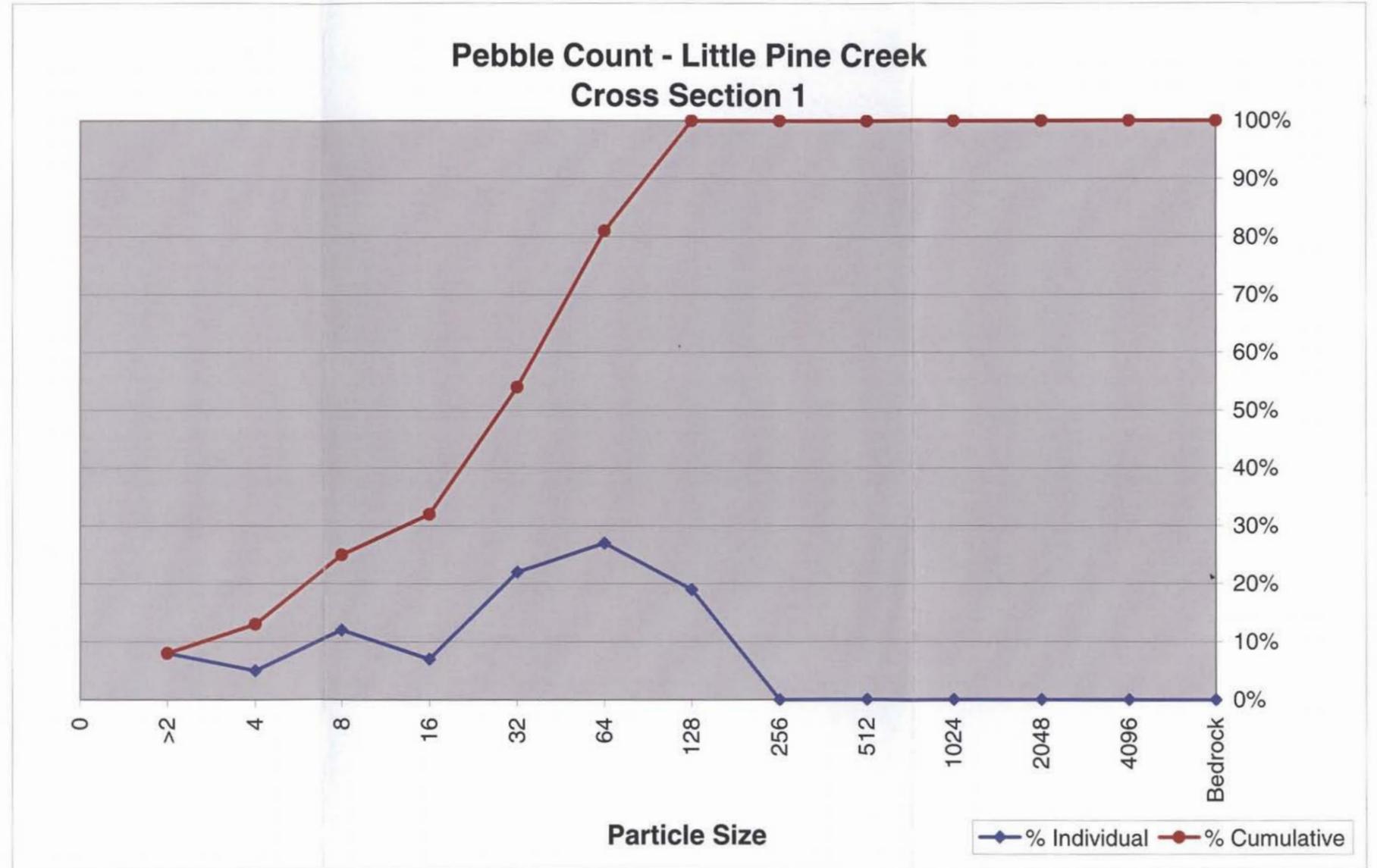
**LITTLE PINE CREEK CROSS SECTIONS**

Date JUNE, 2002	Project No. 09177-010-018	Drawing No. <b>FIGURE 2</b>	Issue <b>A</b>
Scale NOT TO SCALE	File Name LPC-CS.DWG		

**PEBBLE COUNT DATA**

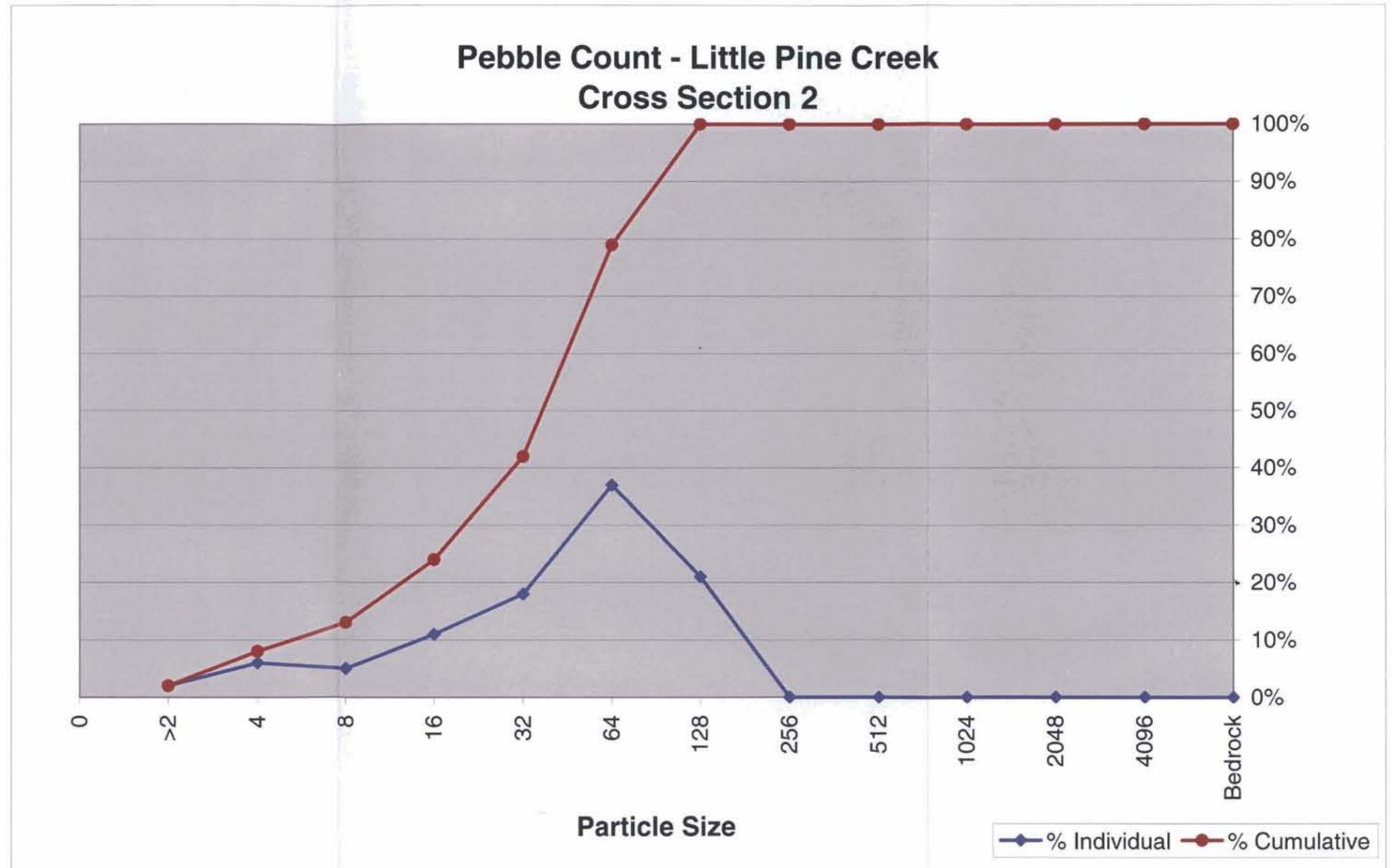
Little Pine Creek Cross Section 1			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
<2	8	8.0%	8%
2-4	5	5.0%	13%
4-8	12	12.0%	25%
8-16	7	7.0%	32%
16-32	22	22.0%	54%
32-64	27	27.0%	81%
64-128	19	19.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
<b>Total</b>	<b>100</b>	<b>100%</b>	<b>100%</b>

d50 = 29.1 mm, d85 = 77.5 mm



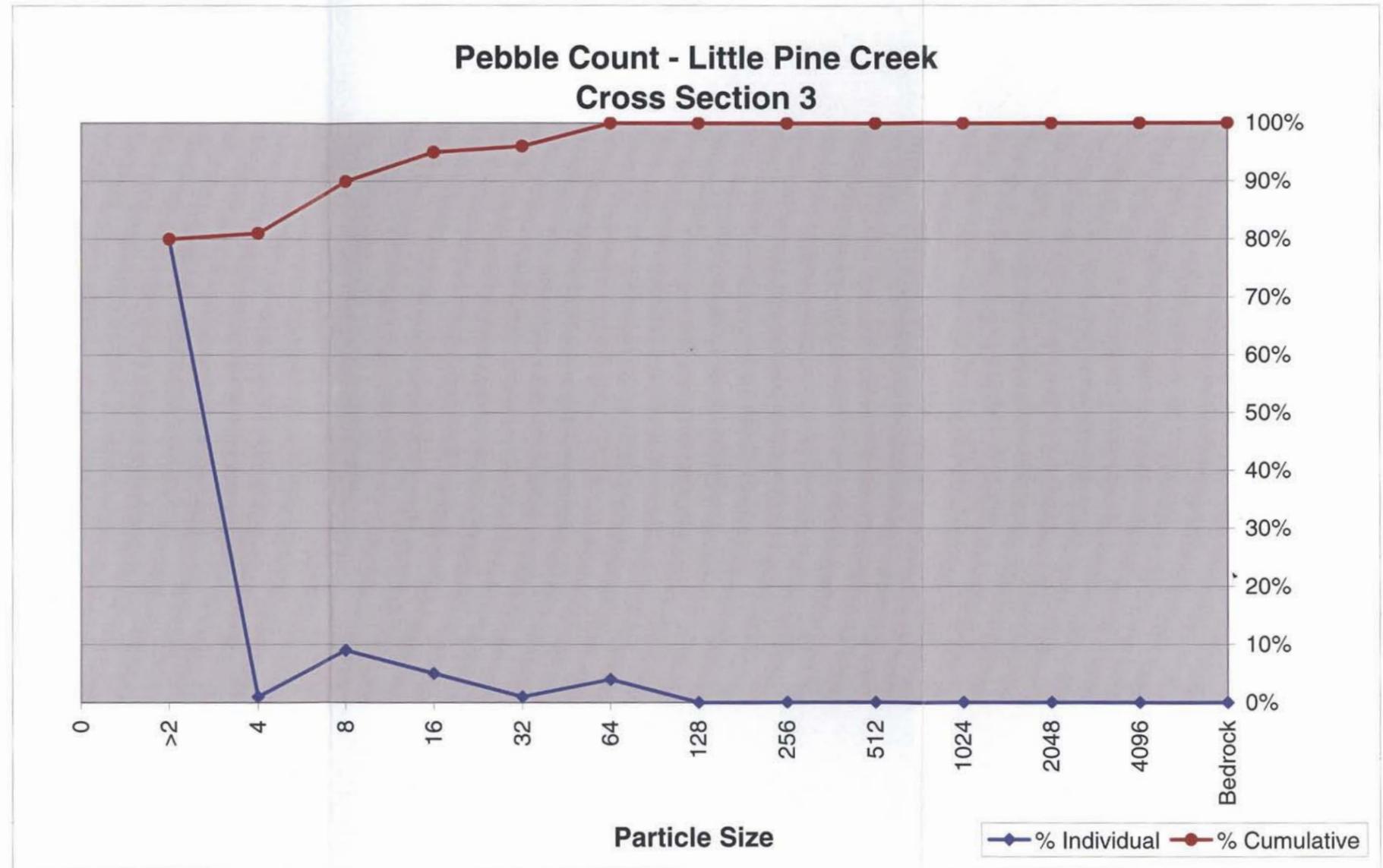
Little Pine Creek Cross Section 2			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
<2	2	2.0%	2%
2-4	6	6.0%	8%
4-8	5	5.0%	13%
8-16	11	11.0%	24%
16-32	18	18.0%	42%
32-64	37	37.0%	79%
64-128	21	21.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
<b>Total</b>	<b>100</b>	<b>100%</b>	<b>100%</b>

d50 = 38.9 mm, d85 = 82.3 mm



Little Pine Creek Cross Section 3			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
<2	80	80.0%	80%
2-4	1	1.0%	81%
4-8	9	9.0%	90%
8-16	5	5.0%	95%
16-32	1	1.0%	96%
32-64	4	4.0%	100%
64-128		0.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
<b>Total</b>	<b>100</b>	<b>100%</b>	<b>100%</b>

d50 < 2 mm, d85 = 5.8 mm



## **PHOTOGRAPHS**



**Little Pine Creek Photograph Station 1**  
**260° from North**



**Little Pine Creek Photograph Station 2**  
**North**



**Little Pine Creek Photograph Station 2**  
**320° from North**



**Little Pine Creek Photograph Station 2**  
**320° from North**



**Little Pine Creek Photograph Station 2**  
**280° from North**



**Little Pine Creek Photograph Station 3**  
**100° from North**



**Little Pine Creek Photograph Station 3**  
**60° from North**



**Little Pine Creek Photograph Station 3**  
**60° from North**



**Little Pine Creek Photograph Station 3**  
**20° from North**



**Little Pine Creek Photograph Station 4**  
**120° from North**



**Little Pine Creek Photograph Station 4  
80° from North**



**Little Pine Creek Photograph Station 4  
80° from North**



**Little Pine Creek Photograph Station 4**  
**40° from North**



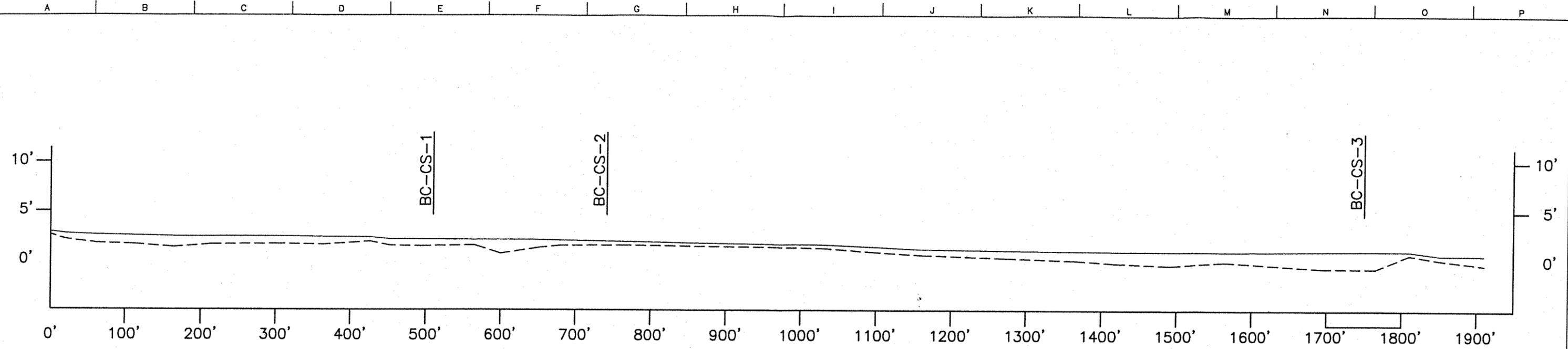
**Little Pine Creek Photograph Station 5**  
**180° from North**



**Little Pine Creek Photograph Station 5**  
**105° from North**

**BRUSH CREEK**

## **LONGITUDINAL PROFILE**



Slope and Maximum Water Depth - Brush Creek Alleghany County, North Carolina		
Feature	Slope	Max. H2O depth (ft)
Riffle 1	0.0380	0.96
Riffle 2	0.0256	1.05
Riffle 3	0.0024	0.85
Riffle 4	0.0203	0.75
<b>Average Riffle</b>	<b>0.0216</b>	
Pool 1	0.0007	1.80
Pool 2	-0.0001	2.30
Pool 3	-0.0022	2.90
Pool 4	0.0143	1.60
<b>Average Pool</b>	<b>0.0032</b>	
Run 1	0.0042	1.50
<b>Average Slope</b>	<b>0.0115</b>	

**LEGEND**

- WATER SURFACE ELEVATION
- - - - - EXISTING CREEK BED

7/18/02 BC-LPr.DWG

Name	Description	Date	Drawn	Checked	Resp. Engr.	Proj. Mgr.



Project Manager  
**C. MATTHEWS**

Designed

Checked  
**K. SNYDER**

Drawn  
**J. McCLURE**

**NCWRP - BRUSH CREEK  
LITTLE PINE CREEK RESTORATION**

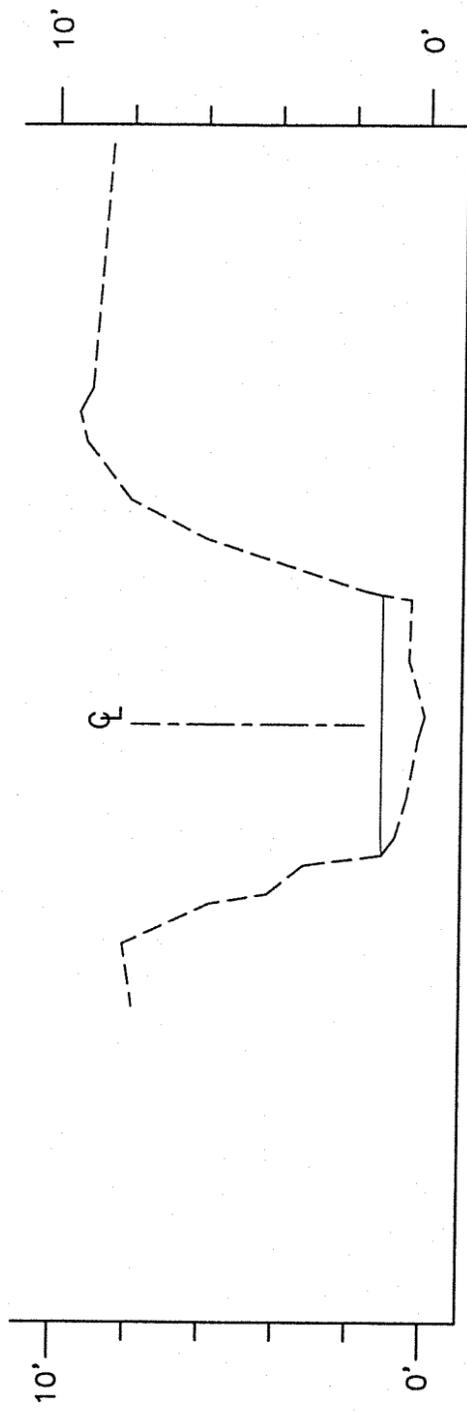
ALLEGHANY COUNTY NORTH CAROLINA

**BRUSH CREEK  
LONGITUDINAL PROFILE**

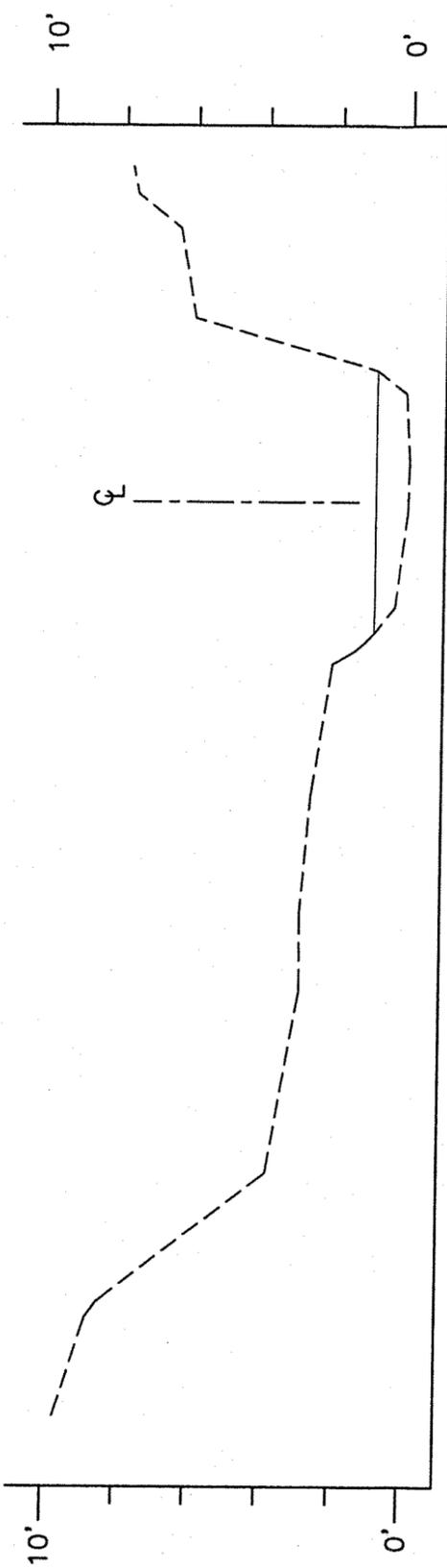
Date JUNE, 2002	Project No. 09177-027-018	Drawing No. <b>FIGURE 1</b>	Issue <b>A</b>
Scale NOT TO SCALE	File Name BC-LPr.DWG		

## **CROSS-SECTIONS**

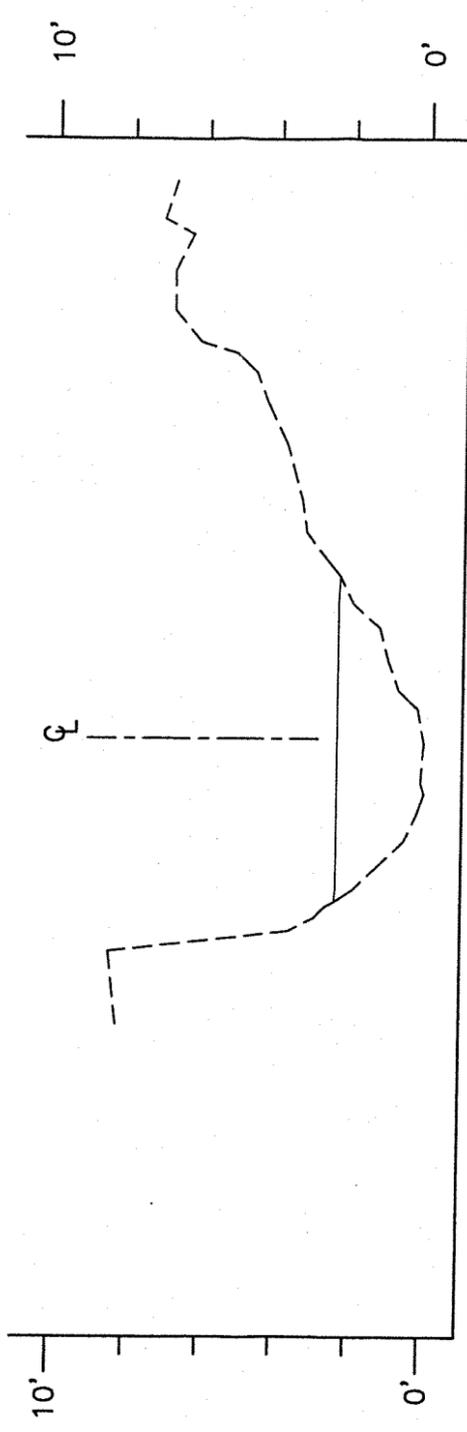
7/20/04/BC-CS.DWG



BC-CS-1



BC-CS-2



BC-CS-3

LEGEND

- WATER SURFACE ELEVATION
- - - EXISTING CREEK BED

Issue No.	Description	Date	Drawn	Checked	Project Eng.	Project Mgr.

**HDR**  
 HDR Engineering, Inc.  
 of the Carolinas  
 9970-14 Beach Drive  
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Project Manager  
**C. MATTHEWS**

Designed

Checked  
**K. SNYDER**

Drawn  
**P. BARRY**

**NCWRP - BRUSH CREEK  
 LITTLE PINE CREEK RESTORATION**

ALLEGHANY COUNTY      NORTH CAROLINA

**BRUSH CREEK  
 CROSS SECTIONS**

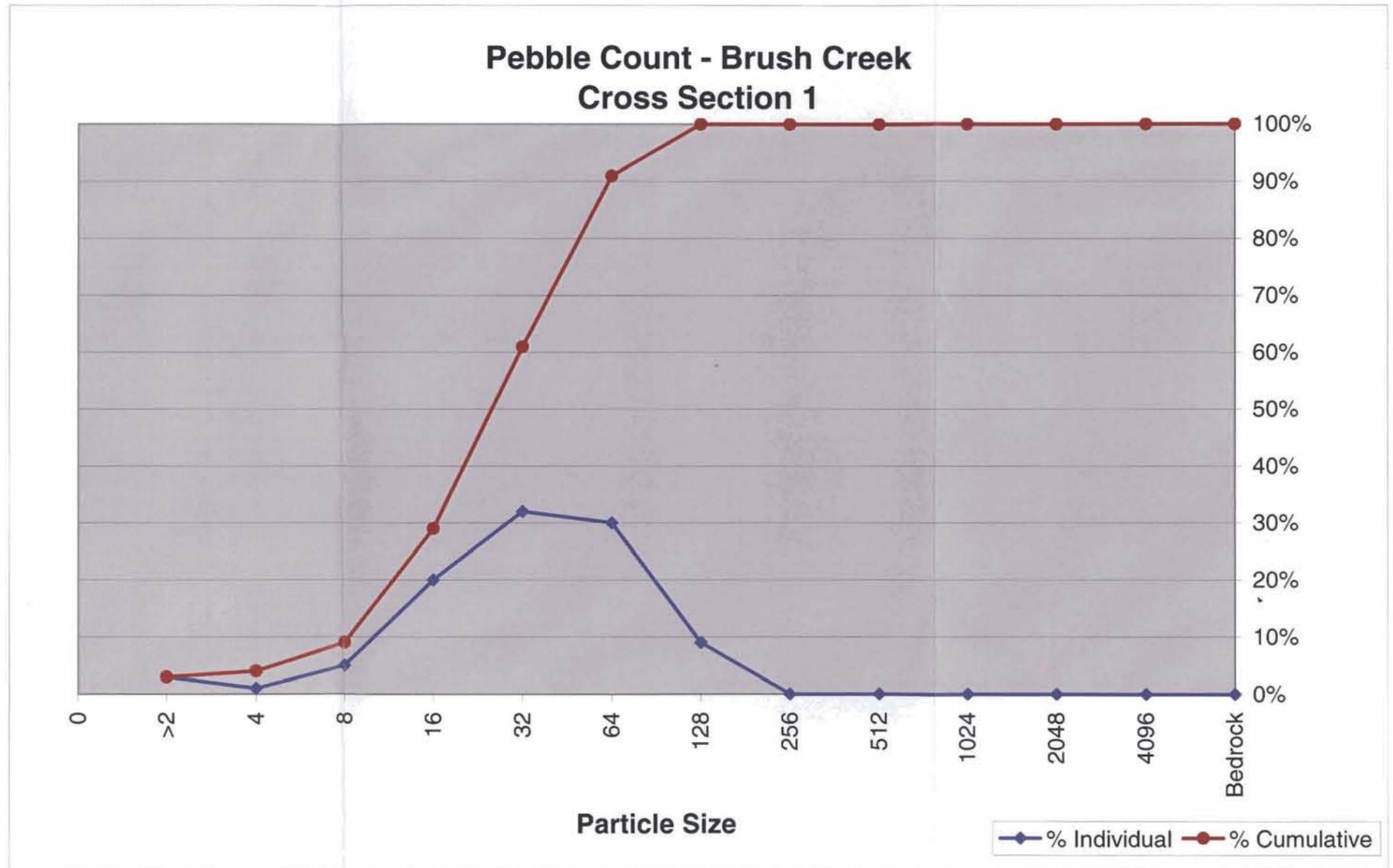
Date: **JUNE, 2002**      Project No.: **09177-010-018**      Drawing No.: **FIGURE 2**      Issue: **A**

Scale: **NOT TO SCALE**      File Name: **BC-CS.DWG**

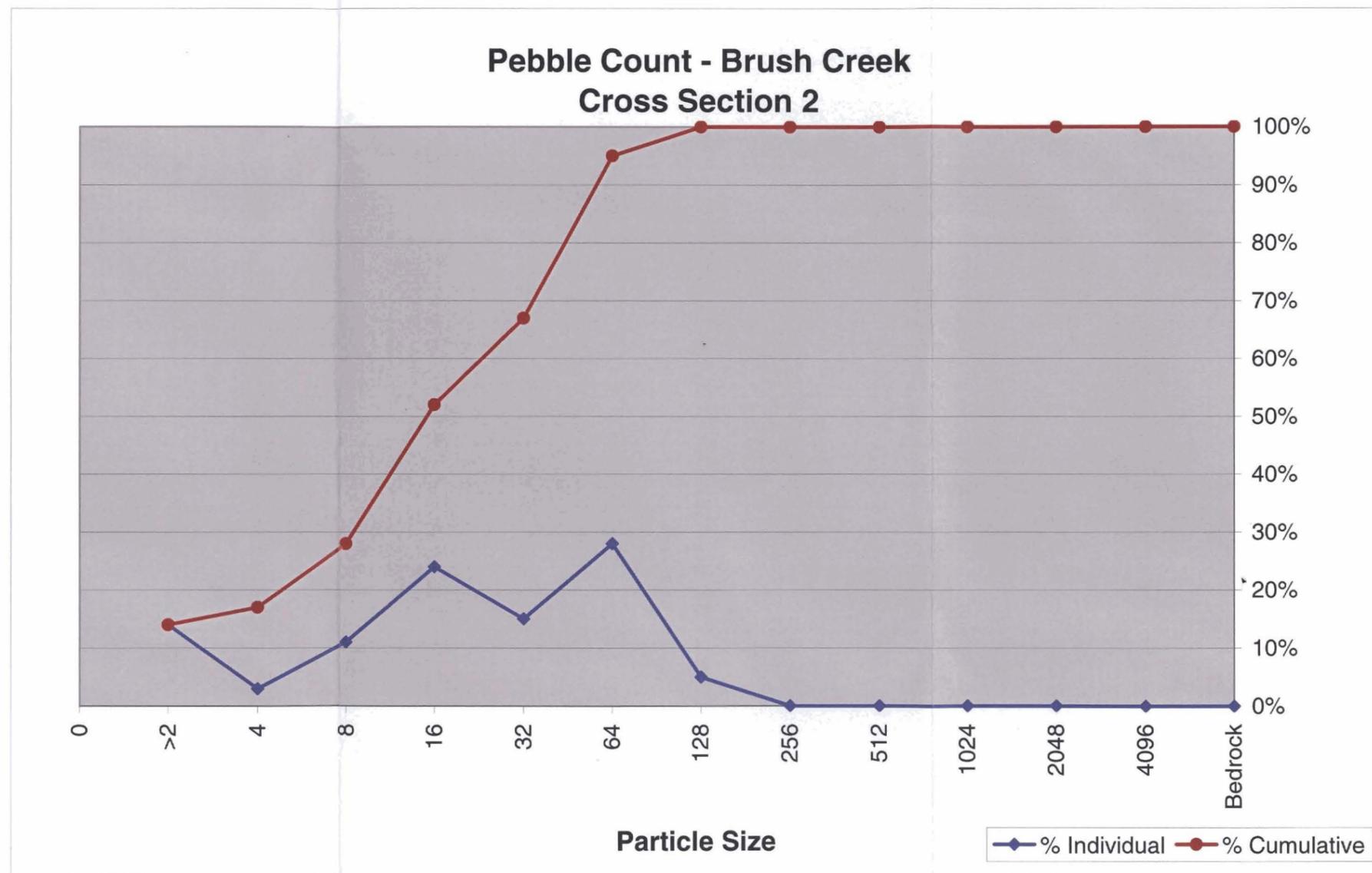
**PEBBLE COUNT DATA**

Brush Creek			
Cross Section 1			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
<2	3	3.0%	3%
2-4	1	1.0%	4%
4-8	5	5.0%	9%
8-16	20	20.0%	29%
16-32	32	32.0%	61%
32-64	30	30.0%	91%
64-128	9	9.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
<b>Total</b>	<b>100</b>	<b>100%</b>	<b>100%</b>

d50 = 26.5 mm, d85 = 57.6 mm

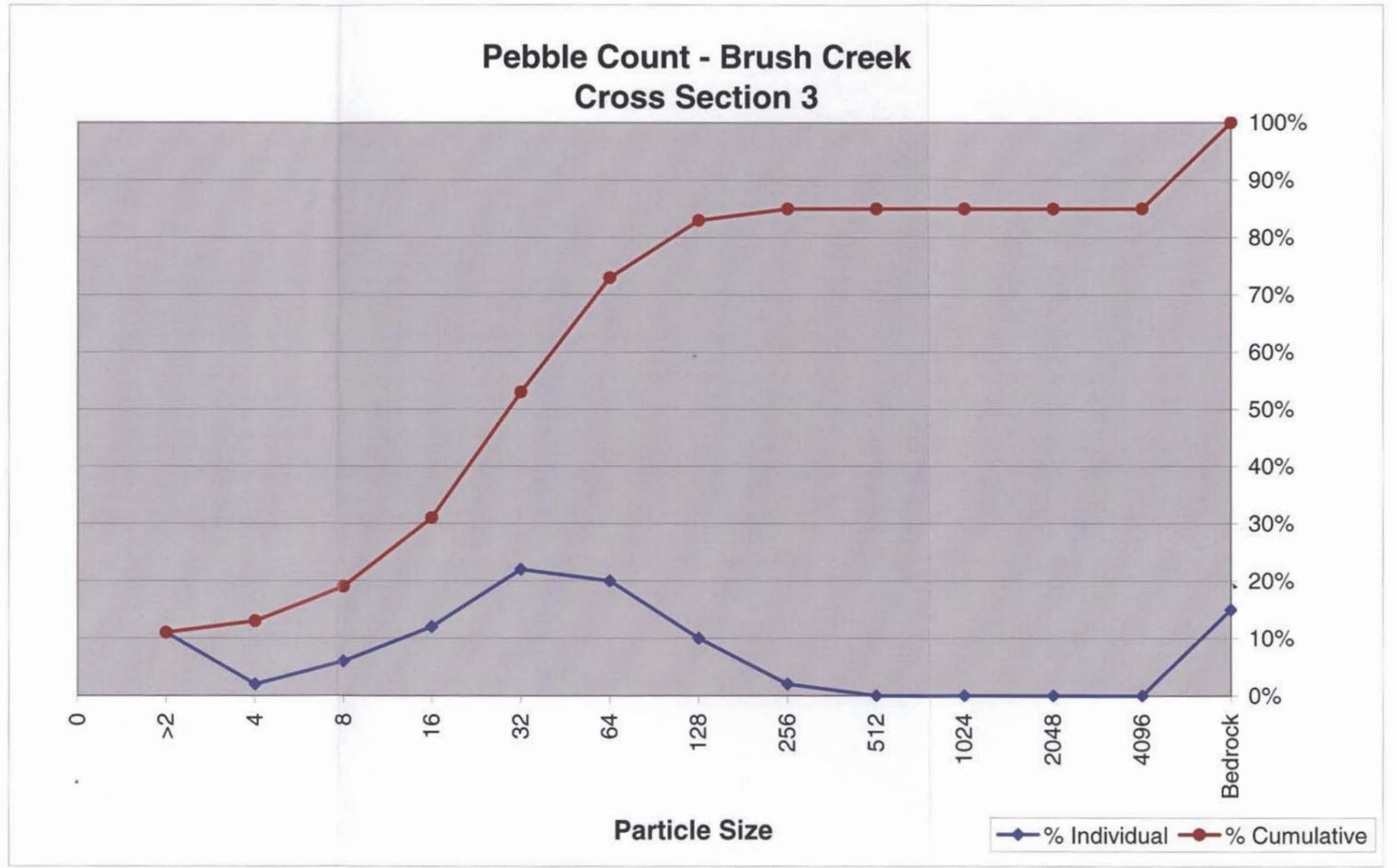


Brush Creek			
Cross Section 2			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
<2	14	14.0%	14%
2-4	3	3.0%	17%
4-8	11	11.0%	28%
8-16	24	24.0%	52%
16-32	15	15.0%	67%
32-64	28	28.0%	95%
64-128	5	5.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
<b>Total</b>	<b>100</b>	<b>100%</b>	<b>100%</b>
d50 = 15.3 mm, d85 = 52.6 mm			



Brush Creek			
Cross Section 3			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
<2	11	11.0%	11%
2-4	2	2.0%	13%
4-8	6	6.0%	19%
8-16	12	12.0%	31%
16-32	22	22.0%	53%
32-64	20	20.0%	73%
64-128	10	10.0%	83%
128-256	2	2.0%	85%
256-512		0.0%	85%
512-1024		0.0%	85%
1024-2048		0.0%	85%
2048-4096		0.0%	85%
Bedrock	15	15.0%	100%
<b>Total</b>	<b>100</b>	<b>100%</b>	<b>100%</b>

d50 = 29.8 mm, d85 = 192 mm



## **PHOTOGRAPHS**



**Brush Creek Photograph Station 1**  
**235° from North**



**Brush Creek Photograph Station 1**  
**275° from North**



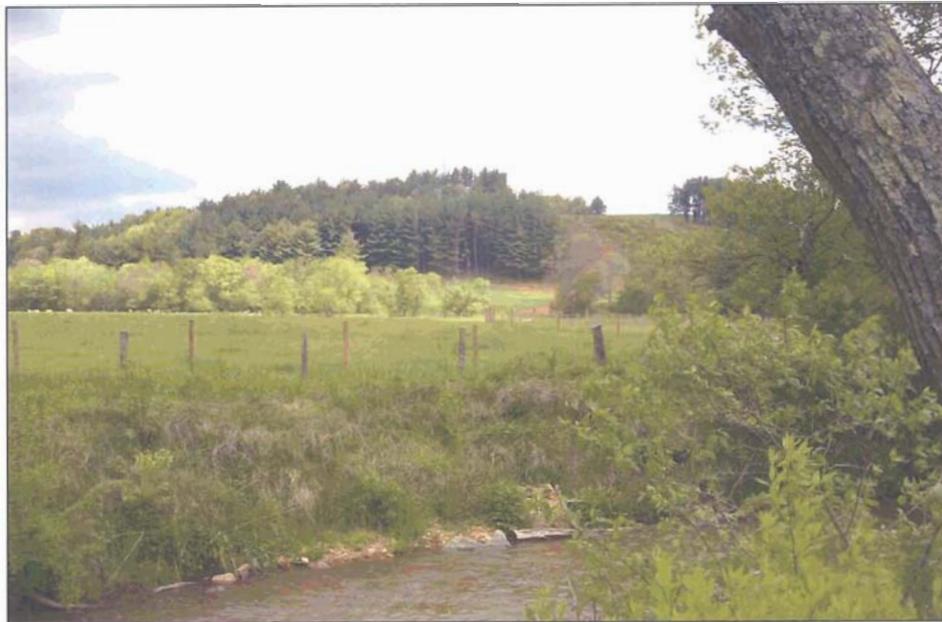
**Brush Creek Photograph Station 2**  
**310° from North**



**Brush Creek Photograph Station 2**  
**330° from North**



**Brush Creek Photograph Station 2**  
**330° from North**



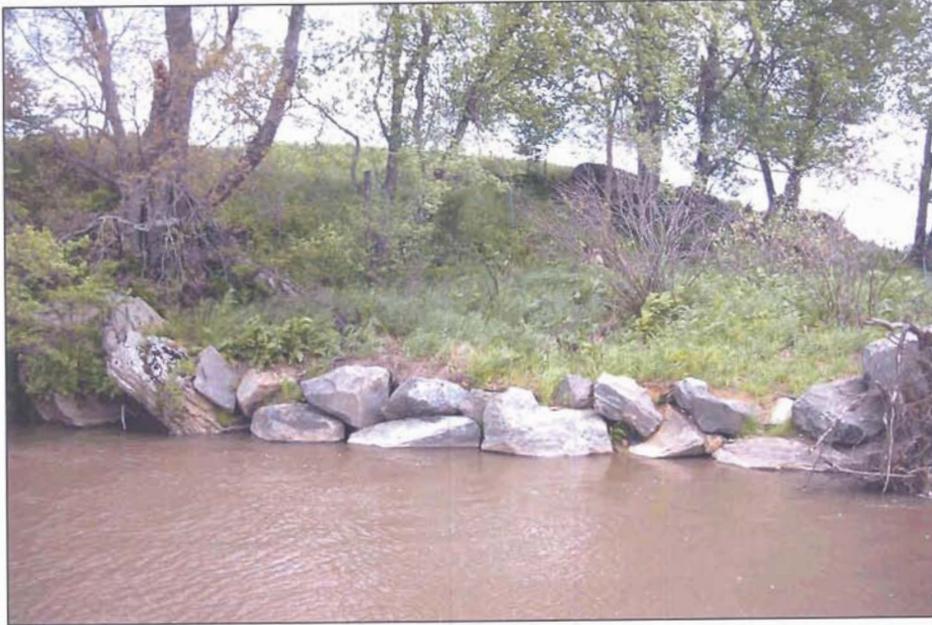
**Brush Creek Photograph Station 2**  
**10° from North**



**Brush Creek Photograph Station 3**  
**160° from North**



**Brush Creek Photograph Station 3**  
**120° from North**



**Brush Creek Photograph Station 3**  
**80° from North**



**Brush Creek Photograph Station 3**  
**North**



**Brush Creek Photograph Station 4**  
**145° from North**



**Brush Creek Photograph Station 4**  
**95° from North**



**Brush Creek Photograph Station 4**  
**55° from North**



**Brush Creek Photograph Station 5**  
**40° from North**



**Brush Creek Photograph Station 6**  
**150° from North**



**Brush Creek Photograph Station 6**  
**115° from North**



**Brush Creek Photograph Station 6**  
**55° from North**



**Brush Creek Photograph Station 6**  
**5° from North**



**Brush Creek Photograph Station 7**  
**90° from North**



**Brush Creek Photograph Station 7**  
**335° from North**



**Brush Creek Photograph Station 8**  
**140° from North**



**Brush Creek Photograph Station 8**  
**180° from North**



**Brush Creek Photograph Station 8**  
**220° from North**



**Brush Creek Photograph Station 9**  
**130° from North**



**Brush Creek Photograph Station 9**  
**170° from North**



**Brush Creek Photograph Station 9**  
**230° from North**



**Brush Creek Photograph Station 9**  
**270° from North**



**Brush Creek Photograph Station 9**  
**310° from North**



**Brush Creek Photograph Station 9**  
**340° from North**



**Brush Creek Photograph Station 10**  
**120° from North**



**Brush Creek Photograph Station 10**  
**85° from North**



**Brush Creek Photograph Station 10**  
**50° from North**



**Brush Creek Photograph Station 10**  
**30° from North**



**Brush Creek Photograph Station 10**  
**30° from North**