Stream Restoration Plan

Unnamed Tributary to Cane Creek
(Pickard Property)
Alamance County, North Carolina
SCO File #020594101

Prepared for:

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

Final Restoration Plan
February 13, 2006

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EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (NCEEP) has identified three unnamed tributaries (UTs) to Cane Creek in southwest Alamance County, North Carolina for potential stream restoration. The streams are located in the upper portion of the Cape Fear River Basin in the Cane Creek watershed (US Geological Survey 14-digit Hydrologic Unit Code 03030002050050 and NC Division of Water Quality subbasin 03-06-04).

The drainage area for the site is rural, with primary land uses of agriculture, forest, and rural residential. The project site is dominated by active pasturelands, and has been heavily impacted by unrestricted livestock access, riparian and bank vegetation removal, and poor water quality due to nutrient loading from the surrounding pastures (nutrient application) or from livestock waste. In addition, the project reach is characterized by severe bank erosion. The combination of streambank erosion, little riparian vegetation, cattle management practices, and degraded water quality make this an excellent restoration site.

Stream restoration, buffer restoration, and wetland preservation and enhancement will help improve the water quality of the stream by reducing bank and streambed erosion and runoff of pollutants directly into the stream. Restoration of a degraded system also leads to improvements in the aquatic and terrestrial communities that depend on it.

The goals and objectives of the UT to Cane Creek Stream (Pickard Property) Restoration Project focus on improving local water quality, enhancing flood attenuation and restoring aquatic and riparian habitat. These goals will be accomplished by:

- Reestablishing stream stability and capacity to transport watershed flows and sediment load by restoring stable channel morphology supported by natural instream habitat and grade/bank stabilization structures;
- Reducing nonpoint source sedimentation and nutrient inputs into the identified project reaches through the elimination of accelerated bank erosion, exclusion of livestock, and reestablishment of native riparian buffers greater than 50 feet in width, and
- Enhancing the capacity of the site to mitigate flood flows by improving the connection of the stream to its floodplain.

The proposed restoration design will be a combination of Priority 1 and Priority 2 approach. The proposed stream dimension, pattern, and profile will be based on the detailed morphological criteria and hydraulic geometry relationships developed from two reference reaches identified near the project site. The existing length of all tributaries designated for restoration is approximately 6,330 linear feet. The proposed stream length after restoration will be approximately 6,440 linear feet. Additionally, 3.25 acres of existing wetlands will be enhanced. The 51-acre site will be protected in perpetuity by a conservation easement.

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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION AND LOCATION INFORMATION

The North Carolina Ecosystem Enhancement Program (NCEEP) has identified three unnamed tributaries (UTs) to Cane Creek in southwest Alamance County, North Carolina for potential stream restoration (Figure 1: Vicinity Map and Figure 2: Project Location Map). Streambank erosion, limited riparian vegetation, cattle management practices, and degraded water quality make this an excellent restoration site. The total existing length of stream to be restored is approximately 6,330 linear feet. The proposed complete length of the restored stream will be approximately 6,440 linear feet. The proposed restoration will provide a stable dimension, profile, and pattern, and reconnect the stream to its floodplain. This restoration is based on analyses of current watershed hydrologic conditions, field evaluation of the project site (Site), and assessment of stable reference reaches. This Restoration Plan presents detailed information regarding the existing Site and watershed conditions, the morphological design criteria developed from two selected reference reaches, and the project design parameters based upon natural channel restoration methodologies. Additionally, 3.25 acres of existing wetlands will be enhanced. Refer to Table 1 Project Restoration Structure and Objectives.

The Site is located in southwest Alamance County, North Carolina on Old Dam Road (SR 2370), just south of Snow Camp. Directions to the site from the Raleigh area are as follows:

US-64 West to NC-87 Exit 381 toward Spring Lake and Fayetteville,
turn right on NC-87/Graham Road,
turn slight left onto Silk Hope Gum Springs Road/Silk Hope Road,
turn right on Snow Camp Road,
turn Left on Old Dam Road,
end at stream crossing between Wild Rose Road and Cocoa Road.

The Site consists of three contiguous properties, owned by Thomas H. and Bonnie J. Fogelman, Pickard Farms Inc., and Harold Williams Wright. NCEEP has acquired a conservation easement consisting of 51 acres. The UTs flow in a northerly direction and join Cane Creek approximately 1.5 miles downstream of the Site.

The streams designated for restoration have been divided into five distinct reaches, Reach A through E (Figure 3: Project Reach Locations). Collectively, these reaches will be referred to as the project reach. The project reach was subdivided according to the confluence of tributaries that changed the contributing drainage area significantly (Reach D and E).

Reaches A, B, and C are located on the primary UT to Cane Creek and reaches D and E are two contributing tributaries. The confluence of Reach D with Reach A is approximately 470 feet downstream (north) of Old Dam Road near the Fogelman/Pickard Farms, Inc. property line. The confluence of Reach E with Reach B occurs at the Fogelman/Wright property line. Reach A is a perennial, first-order stream, Reach E is a perennial, second-order stream, and Reaches B, C, and D are perennial, third-order streams.

These reaches have been impacted by riparian and bank vegetation removal, the introduction of agricultural ditch inputs, channel straightening, unrestricted livestock access, and the increasing development of the contributing drainage area. Existing land use within the Site consists of forested areas and pasture. Past land management activities have included timber harvest with resulting land clearing for pastoral uses.

1.1.1 USGS and NCDWQ River Basin Designations

The project reach is located in the Cane Creek watershed of the Cape Fear River Basin (United States Geological Survey [USGS] 14-digit Hydrologic Unit 03030002050050) within the North Carolina Division of Water Quality (NCDWQ) subbasin 03-06-04. The 03-06-04 subbasin contains all of the Cane Creek drainage area as well as a portion of the Haw River to the Jordan Reservoir Haw River Arm. This subbasin is primarily forested, although agriculture accounts for a significant portion of land use.

1.1.2 NCDWQ Surface Water Classification

The NCDWQ assigns surface waters a classification in order to help protect, maintain, and preserve water quality. Cane Creek and its UTs are classified as Class C; NSW waters (Index No. 16-28) according to the 1983 NCDWQ rating (NCDENR 2005a). Class C protects freshwaters for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. In addition, the subject reach carries the supplemental classification of Nutrient Sensitive Waters (NSW), which are waters subject to growths of microscopic and macroscopic vegetation requiring limitations on nutrient outputs.

1.2 PROJECT GOALS AND OBJECTIVES

The goals and objectives of the UT to Cane Creek Stream (Pickard Site) Restoration Project focus on improving local water quality, enhancing flood attenuation and restoring aquatic and riparian habitat. These goals will be accomplished by:

- Reestablishing stream stability and capacity to transport watershed flows and sediment load by restoring stable channel morphology supported by natural instream habitat and grade/bank stabilization structures;
- Reducing nonpoint source sedimentation and nutrient inputs into the identified project reaches through the elimination of accelerated bank erosion, exclusion of livestock, and reestablishment of native riparian buffers greater than 50 feet in width, and
- Enhancing the capacity of the site to mitigate flood flows by improving the connection of the stream to its floodplain.

2.0 WATERSHED CHARACTERIZATION

2.1 GENERAL DESCRIPTION

The Site is located in a rural, agricultural setting within the Carolina Slate Belt Ecoregion of the Piedmont physiographic province of North Carolina (Griffith et al. 2002). Topography is characterized by gently rolling hills with elevations in the contributing drainage area ranging from 720 feet above mean sea level (AMSL) to 580 feet AMSL. The Site is at an elevation just around 600 feet AMSL (USGS 1974). There are several dendritic drainage patterns upstream of the Site. Many of these tributaries have small farm ponds located upstream.

2.2 DRAINAGE AREA

The total drainage area for the Site covers approximately 1,640 acres (2.56 square miles) (Figure 4: Project Watershed). Reach A contributes approximately 390 acres to the total drainage area. Reach B has a 1,333-acre watershed. Reach D contributes approximately 892 acres, and Reach E contributes approximately 282 acres. The most downstream reach receiving the 1,640 acres is Reach C. Refer to Table 2 Drainage Areas.

2.3 LAND USE AND DEVELOPMENT POTENTIAL

The primary land uses in the project drainage area are agriculture and forest, with some residential development and secondary surface transportation routes. Land cover in the drainage area consists primarily of mixed upland forest and managed herbaceous cover (Figure 5: Watershed Land Cover).

Alamance County experienced a population growth of approximately 21% from 1990 to 2000 and is predicting a 14% increase by 2010 (NCSD 2005). However, the majority of this growth is expected to occur in the northern half of the county, primarily in the existing urban areas along the I-40 corridor. The project watershed and surrounding area is largely undeveloped, and contains no major roadways likely to induce growth. In addition, no transportation projects are listed on the North Carolina Department of Transportation (NCDOT) Transportation Improvement Program (TIP) in the vicinity of the project area (NCDOT 2005). Therefore, the development pressures in the watershed are relatively low, and land use is not expected to change drastically in the near future. Refer to Table 3 Land Use of Watershed.

2.4 WATER QUALITY

The prevalence of agricultural land uses in the watershed can have negative implications for water quality. Agricultural watersheds are subject to streambank erosion resulting from removal of riparian buffers and livestock access to streams. Products such as fertilizers, herbicides, pesticides, and animal waste products can be major pollutants if allowed to enter waterways.

According to the Draft 2005 Cape Fear River Basinwide Water Quality Plan, several waters in Subbasin 03-06-04 are Impaired for their best use classifications. Implementing the UT to Cane Creek Stream Restoration Project will reduce sediment and nutrient pollution inputs from the

Site and will potentially improve the aquatic life function of the Site and immediate downstream waters, most of which are rated as Impaired by the NCDWQ (NCDENR 2005b).

2.5 SIGNIFICANT CULTURAL AND NATURAL RESOURCES

2.5.1 Historical Resources

A review of available records and initial coordination with the North Carolina Department of Cultural Resources – State Historic Preservation Office (SHPO) indicates that no historical resources have been identified within the project vicinity.

2.5.2 Archaeological Resources

A review of available records and initial coordination with the State Office of Archaeology indicates that no archaeological sites have been identified within the project vicinity.

2.5.3 Rare/Threatened/Endangered Species and Critical Habitats

Species with the federal status of endangered, threatened, proposed endangered, and proposed threatened are protected under provisions of the Endangered Species Act of 1973 (as amended 16 USC 1531 et. seq.). Any action likely to adversely affect a federally protected species will be subject to review by the US Fish and Wildlife Service (USFWS). A review of online databases indicated that the USFWS and North Carolina National Heritage Program (NCNHP) have not identified any federally listed threatened or endangered species occurring in Alamance County (USFWS 2003 and NCNHP 2005). In addition, a physical file review at the NCNHP office was conducted and no occurrences have been documented within the project vicinity. Therefore, it is very unlikely that this project will have any effect on federally protected species.

3.0 PROJECT SITE EXISTING CONDITIONS

3.1 GENERAL SITE DESCRIPTION

The Site is located in rural Alamance County, south of Snow Camp, North Carolina. The total acreage encompassed in the conservation easement is 51.05 acres. The Fogelman and Pickard property easements are dominated by open fields of grasses currently used for pasture. The Wright property easement is dominated by woody vegetation (Figure 6: Project Site Aerial Photograph).

The project reach designated for restoration is approximately 6,330 linear feet and is divided into five smaller reaches. Reach A is approximately 1,430 linear feet, Reach B is approximately 2,065 linear feet, Reach C approximately is 1,435 linear feet, Reach D is approximately 1,100 linear feet, and Reach E is approximately 300 linear feet. The upstream limit of the project is approximately 850 feet upstream of Old Dam Road. The downstream limit of the project is approximately 1,435 feet downstream of the confluence with Reach B and E. Generally, all streams flow north and meet the mainstem of Cane Creek approximately 1.5 miles downstream of the project reach.

Reaches A, B, and C are located on the primary UT to Cane Creek and Reaches D and E are located on two contributing UTs. The confluence of Reach D with Reach A is approximately 500 feet downstream (north) of Old Dam Road. The confluence of Reach E with Reach B occurs at the Fogelman/Wright property line. Reach A is perennial, first-order, Reach E is perennial, second-order, and Reaches B, C, and D are perennial, third-order streams.

Reaches A, B, and D are located within the Fogelman and Pickard property easements and are typical pasture streams, with low sinuosity, multiple cattle access points, and little to no riparian and floodplain vegetation. The banks are actively eroding due to the lack of vegetation and cattle hoof shear. The banks in Reach D were especially erodable due to a higher proportion of sand component in the banks. The majority of Reach A and Reach D appear to have been straightened between February 1951 and November 1966 (NRCS 1951, 1966). Reach B has fairly high sinuosity in the upper portions, but is mostly straight in the lower portions. Reach C, located entirely within the Wright Property, has a fully forested floodplain and has more sinuosity than the reaches in the Fogelman and Pickard property easements; however, the banks in this reach also show signs of erosion. Reach E enters the Site from the west at the Fogelman/Wright property line and is a characteristic pasture stream with little to no sinuosity, several cattle access points, and some riparian and floodplain vegetation. Site Photographs are provided in Appendix A.

With the exception of Reach C, the Site is heavily impacted by cattle accessing the stream. The cattle repeatedly use the same pathways to the water, destroying vegetation and forming gullies in the banks. These conditions have created highly erosive areas where sediment can enter the channel and cover the natural substrate. Further, livestock waste products are deposited directly into the stream channel, causing substantial nutrient and fecal coliform loading.

3.2 GEOLOGY AND SOILS

The Site is located within the Carolina Slate Belt of the Piedmont physiographic province of North Carolina. Parts of the Carolina Slate Belt are rugged and hilly, while other areas have hills and linear ridges. The silty and silty clay soils of the Carolina Slate Belt contrast with the loam and sandy loam soils often found in the rest of the Piedmont. Trellised drainage patterns occur in parts of the region. Streams tend to dry up and well water yields are low, as this region contains some of the lowest water-yielding rock units in North Carolina (Griffith et al. 2002). The topography of the region is predominantly rolling with some steep and rugged areas near larger creeks and rivers. Mainly because of the rolling and hilly relief, the soils of the county generally have moderate to rapid natural drainage (Kaster 1960).

According to the Soil Survey of Alamance County (Kaster 1960), soil series found within the Site include Tirzah silt loam (TaB2, TaC2, TaD2), Georgeville silt loam (GaB2, GaC, GaC2, GaD2), Starr loam (Sb), Colfax silt loam (Cf), Herndon silt loam (HdC and HdC2), and mixed alluvial land, poorly drained (Mc), as seen in Figure 7 (Project Site Soils Map).

Tirzah silt loam is a well drained, moderately acidic soil that generally occurs in the southern and eastern sections of the county on smooth or hilly uplands. They were derived from dark gray or dark green, very fine grained volcanic slate that contains basic materials. These soils are important to the agriculture of the county, because they are well suited to all crops commonly grown except tobacco. Tirzah soils have four to eight inches of silt loam or silty clay loam over silty clay. Depth to the seasonal high water table is over eight feet. Depth to bedrock can range from four to twenty feet. Permeability of the subsoil is moderate.

Georgeville silt loam is a well drained, strongly acidic soil on uplands. These soils occur in the southern and eastern parts of the county on ridges and side slopes. They developed from the products of gray to light gray, fine-grained volcanic rocks. Georgeville soils are more extensive and more important to the agriculture of the county than are the soils in any other series that were derived from volcanic slates. These soils have two to ten inches of silt loam over silty clay or clay. Depth to the seasonal high water table is over eight feet. Depth to bedrock can range from four to eight feet. Permeability of the subsoil is moderate.

Starr loam is a well drained soil found on bottomlands along small streams or drainage ways. The soil is mainly an accumulation of topsoil that is washed from the surrounding residual soils and is rich in nutrients. Depth to the local alluvial material varies from 10 to more than 26 inches. Runoff is slow and permeability is moderate.

Colfax silt loam is a very deep, somewhat poorly drained soil formed in materials weathered from granitic rocks. Underlying the silt loam surface, the upper subsoil is a yellowish-brown friable to firm silty clay loam. The lower subsoil is firm silty clay. This soil is rather slowly permeable and low in fertility.

Herndon silt loam is a light brownish-gray, very acid, well drained soil that occurs on uplands. These soils occur in the southern and eastern parts of the county in the volcanic slate region.

They developed from the products of rhyolitic and other volcanic slates and from quartzite schist. Runoff is medium and permeability is moderate.

The remaining soils are classified as mixed alluvial land, poorly drained. This category encompasses land that occurs on lowest floodplain steps bordering meandering streams that have shallow banks. In many places remnant stream channels and natural levees are found. The land is somewhat poorly drained to poorly drained. Its fertility is fairly high, and its content of organic matter is medium. The reaction is medium acid to strongly acid.

3.3 RIPARIAN BUFFER AND NATURAL COMMUNITIES

The Site is in a rural, agricultural setting with cattle pastures and croplands in close proximity. Two vegetative communities were identified onsite, Agricultural Grass and Piedmont/Mountain Bottomland Forest (Schafale and Weakley 1990).

The existing stream buffer in the pasture area is not considered a naturally occurring system, but is a result of human-induced disturbance. The pastured areas bordering the project channels are primarily vegetated with typical field grasses such as fescue (*Festuca* sp.) and other herbs and shrubs. Other herbaceous species include chickweed (*Stellaria media*), curly dock (*Rumex crispus*), white clover (*Trifolium repens*), Japanese stiltgrass (*Microstegium vimineum*), and dog fennel (*Eupatorium capillifolium*). Scattered individuals or small clumps of shrubs or trees were also noted in these areas, predominantly sweetgum (*Liquidambar styraciflua*), black walnut (*Juglans nigra*), eastern red cedar (*Juniperus virginiana*), Chinese privet (*Ligustrum sinense*), and multiflora rose (*Rosa multiflora*).

The canopy above the Wright property easement contains species indicative of a Piedmont/Mountain Bottomland Forest. The dominant canopy species in this area were black walnut, eastern red cedar, honey locust (*Gleditsia triacanthos*), hackberry (*Celtis occidentalis*), black oak (*Quercus velutina*), sweetgum, green ash (*Fraxinus pennsylvanica*), American beech (*Fagus grandifolia*), tulip poplar (*Liriodendron tulipifera*), and willow oak (*Q. phellos*). The shrub level was dominated by Chinese privet and multiflora rose. Poison ivy (*Toxicodendron radicans*) and Japanese honeysuckle (*Lonicera japonica*) were present throughout. Large individual trees existing within 50 feet of the stream were recognized as significant and documented in order to facilitate their incorporation into the proposed restoration design.

3.4 WETLANDS

Information from the USFWS National Wetlands Inventory (NWI) mapping identified one wetland (PFO1Ad) along Reach C (USFWS 1994).

Four jurisdictional wetlands were delineated within the Site by URS Corporation: TY, WF, WG, WJ (Figure 8: Wetlands). TY, WF, WG, WJ are nomenclature utilized by URS Field Staff to identify wetlands. These wetlands total 3.25 acres in size. Wetlands within the Site are primarily palustrine in nature, as defined in Cowardin et al. (1979).

Wetlands WG and WF are predominantly herbaceous and are classified as Palustrine Emergent (PEM) wetlands. These wetlands are located on the Fogelman property, upstream of Old Dam Road, WG in the east floodplain and WF in the west floodplain. Wetland WG is approximately 0.11 acres in size and WF is approximately 0.48 acres. The main source of hydrology for these wetlands is runoff from the surrounding hillside. The dominant vegetation of WG is common elderberry (*Sambucus canadensis*), joe-pye-weed (*Eupatorium fistulosum*), false nettle (*Boehmeria cylindrica*), spider wort (*Commelina communis*), knotweed (*Polygonum* sp.), nutsedge (*Carex* sp.), and black willow (*Salix nigra*). The dominant vegetation of WF is button bush (*Cephalanthus occidentalis*), joe-pye-weed, tag alder (*Alnus serrulata*), soft rush (*Juncus effusus*), narrow-leaved sunflower (*Helianthus angustifolius*), arum (*Peltandra virginica),* elderberry, and knotweed. Both wetlands are invaded with multiflora rose and WG contains a large population of Chinese privet.

Wetland TY is also a PEM wetland. This wetland is located on the Pickard Property, downstream of the barn in the east floodplain and is approximately 0.70 acres. The main source of hydrology for this wetland is a seep, which becomes channelized as it outlets closer to the stream. The plant community is dominated by sweet flag (*Acorus calamus*). It appears that the size of this wetland has been affected by the channelization of the seep and the deterioration of Reach B. Relic hydric soils were noted along the margins of this wetland, indicating that, in the past, this wetland was larger in size.

Wetland WJ is a Palustrine Forested wetland (PFO). It is located on the Wright property just downstream of Reach E and is approximately 1.96 acres. This wetland was delineated in the area identified by the NWI map as PFO1Ad. The main source of hydrology for the wetland is overflow from Reach E. Dominant vegetation includes American sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), Chinese privet, and multiflora rose.

3.5 STREAM CHARACTERISTICS

Information on stream morphology and classification from *Applied River Morphology* (Rosgen 1996) was used to evaluate and classify the stream. Required data include width-to-depth (W/D) ratio, entrenchment ratio, slope, sinuosity, and dominant type of channel material. All five of the criteria are interrelated and were used to determine the current condition of the channel, classify the stream, and to aid in the design process.

W/D ratio is the ratio of the bankfull width to the mean depth of the bankfull channel. The W/D ratio indicates the channel's ability to dissipate energy and transport sediment. The entrenchment ratio is the vertical containment of the stream and the degree to which the channel is incised in the valley floor. The entrenchment ratio indicates if the stream is able to access its floodplain. The flood-prone width divided by the bankfull width yields the entrenchment ratio. The slope is the change in water surface elevation per unit of stream length. The slope is analyzed over the entire reach, and over sections, to determine the condition of pools and riffles. Sinuosity is the ratio of stream length to valley length. Extremely low sinuosity channels in the Piedmont of North Carolina typically indicate a straightened channel. Channel bed and bank materials indicate the channel's resistance to hydraulic stress and ability to transport sediment (Rosgen 1996).

These measurements helped to classify the existing and reference stream and are used in the design process. Once the values are known, a design may be proposed based on the geomorphic processes occurring within the channel.

3.5.1 Morphological Description

A Rosgen Level II morphological assessment and classification was conducted in August 2004 to gather existing stream dimension, pattern, and profile data, develop morphological parameters, and determine the potential for restoration.

Elevation measurements for the longitudinal profile survey and pool and riffle cross-sections included: thalweg, edge of water, water surface, bankfull, top of low bank, and inner berm. Additional channel measurements included bankfull width, width of flood prone area, belt width, meander length, radius of curvature, valley length, pool-to-pool spacing, and particle sizes of the bankfull channel.

Data developed from this assessment are summarized in Table 4 and detailed data records are provided in Appendix B (Project Site Existing Conditions Data).

3.5.2 Channel Evolution Stage

The existing channels are classified as degraded E4 streams. The bed lacks profile diversity in the form of well developed riffle-pool sequences and has an inappropriate meandering planform. The channel lacks the ability to transport its sediment supply efficiently.

The impacts associated with unrestricted cattle access to the stream and the absence of riparian and bank vegetation are the most significant factors contributing to stream degradation onsite. Grazing of livestock near stable streams generally leads to channel adjustments, including increases in bank erosion, sediment supply, and W/D ratio. Onsite hoof shear and a lack of sufficient stabilizing vegetation have resulted in a high rate of bank erosion and collapse. This bank instability has initiated the process of incision, overwidening and straightening to varying degrees. The large amount of fine-grained particles contributed by the eroding banks is causing excessive sediment accumulation because the channel dimensions are not appropriate to transport the sediment efficiently. This silt and sediment buildup appears to be the main aquatic habitat-limiting factor as it clogs the substrate and creates conditions unsuitable to support diverse bivalve, benthic macroinvertebrate, and fish habitat.

It is important to consider this process of channel evolution where incision, widening, and aggrading is occurring when evaluating the potential of the existing degraded channel to naturally stabilize over time. Without intervention, it is expected that bank materials will continue to erode at an accelerated rate. The channels are expected to continue degrading, causing the stream to migrate from a degraded E-type to an incised G-type and then overwiden into an F-type stream. Without restoration, the channel evolutionary process is expected to take many years and result in a significant loss of usable land onsite and produce large amounts of sediment pollution downstream.

3.5.3 Stability Assessment

The current 'stream state or condition' was further analyzed using Rosgen Level III methodologies to assess stability through an examination of parameters such as channel dimension, vertical stability, lateral stability, and sediment supply/transport (Rosgen 1996).

The W/D ratios in the project reach range between 7.8-10.5, compared to 7.5-12.4 in the reference reaches. Bank height ratios in the project reach range from 1.1-1.6, indicating varying degrees of incision have occurred, and a high potential for continued bank erosion and subsequent channel widening. Additionally, the eroding banks contribute a substantial amount of sediment to the stream. The existing channel also exhibits long straightened reaches, lack of riffle-pool sequence, insufficient pool depth, and some entrenchment. Collectively, these factors indicate both vertical and lateral instability through channel incision and widening, respectively, in significant portions of the project reach.

To better understand the existing condition of the project reach, qualitative stability assessments of distinct stream sections were developed based upon measured stream dimensional characteristics (i.e., entrenchment ratio, bank height ratio) and visual observations using the Pfankuch Channel Stability and Bank Erosion Hazard Index (BEHI) methodologies. The BEHI values ranged from 35 to 45, yielding BEHI ratings of High and Very High. The Pfankuch Channel Stability Evaluation yielded scores ranging from 104 to 119, indicating poor reach conditions. These evaluations confirm that the project reach is in a poor state of stability and exhibits high potential for continued bank erosion. Refer to Appendix C for BEHI and Pfankuck forms.

3.5.4 Bankfull Verification

The accepted methodology for natural channel design is based on the ability to select the appropriate bankfull discharge and generate the corresponding bankfull hydraulic geometry from a stable reference reach. Thus, the determination of bankfull stage is a critical component of the natural channel design process.

Observable bankfull stage indicators in North Carolina can include the incipient point of flooding (top of bank), upper breaks in bank slope, the back of the highest depositional feature (i.e. point bars and benches), and the highest scour line and vegetation. In the project reach, the most consistent field indicator of bankfull stage proved to be a discernable change in bank slope. Photographs of typical bankfull indicators and related morphological features at the Site are provided in Appendix D.

The identification of bankfull stage can be problematic, especially in a degraded system. Therefore, verification measures must be taken to ensure the accurate identification of the bankfull stage. The field indicated bankfull stage was verified using a combination of tools and data, including regional hydraulic geometry relationships called regional curves (Harmon et al. 1999).

The bankfull cross-sectional area for each project reach is consistent with the bankfull area regressed power function curve from the North Carolina Piedmont Rural Regional Curve; plotting within the 95% confidence limits (Figure 9: NC Rural Piedmont Regional Curve). The closest USGS gauging station is on the Rocky River near Crutchfield Crossroads. However, this gauge does not appropriately correlate with the Site due to lack of proximity and stream characteristics.

3.6 CONSTRAINTS

The presence of constraints that have the potential to hinder restoration activities on the Site were evaluated. This evaluation focused primarily on the presence of hazardous wastes, utilities, restrictive easements, rare/threatened/endangered species or critical habitats, existing infrastructure and buildings, construction access, existing or planned activities, local development and drainage design requirements, historical/archaeological sites, the potential for hydrologic trespass, and any site conditions that have the potential to restrict the restoration design and implementation.

The restoration design was required to incorporate the presence and structural requirements associated with the culvert under Old Dam Road. The Old Dam Road right-of-way dictates limitations in stream planform adjustment and riparian revegetation parameters adjacent to the road. Overhead telephone lines were observed above Old Dam Road; however, these utilities are not anticipated to be a constraint.

The Federal Emergency Management Agency (FEMA) has conducted a preliminary flood study for the Site. Restoration activities will require a flood study for the proposed study reach.

The enhancement of existing wetlands will be constrained by the current limits of wetland hydrology and hydric soils. While the stream restoration will allow the project reach to access its floodplain more frequently, it is not expected that the size of the wetlands will increase following restoration.

No other conditions, natural or man-made, were identified as having the potential to impede the proposed restoration activities.

4.0 REFERENCE REACH ANALYSIS

A reference reach is a channel with a stable dimension, pattern, and profile within a particular valley morphology. The reference reach is used to develop dimensionless morphological ratios (based on bankfull stage) that can be extrapolated to disturbed/unstable streams to restore a stream of the same type and disposition as the reference stream (Rosgen 1998).

The search for a stable reference reach began with the stream segments immediately upstream and downstream of the project reach. However, these streams were impacted by historical channelization and vegetation removal and were not in stable condition. An extensive search for a reference reach off-site yielded two appropriate streams nearby, both of which are also UTs to Cane Creek. For the purpose of reporting, these sites will be referred to as Site A1 and Site A3. Both tributaries lie in the Cape Fear River Basin in Alamance County in the same USGS hydrologic unit and NCDWQ subbasin as the project reach. They are also located in the same ecoregion as the project reach and are less than one mile from the Site (Figure 10: Reference Reach Location Map).

Detailed morphological data were collected for each reference reach, including cross-section survey, longitudinal profile, meander geometry, and bed materials. The data were used to develop dimensionless ratios that were utilized for the stream design. Reference reach evaluations also included qualitative assessments of stream stability, bank erodibility, habitat diversity, and floodplain vegetation. As previously described, the restoration design uses these stable stream reaches and buffer composition as reference conditions for developing a stable design stream.

4.1 UT TO CANE CREEK REFERENCE REACH (A1)

The A1 reference reach is a second-order stream with a watershed of approximately 179 acres. The stream flows into the same UT to Cane Creek as the project site, approximately 1,700 feet downstream of the project reach. The selected reach is a stable, undisturbed meandering E-type channel located in a broad, gently sloping valley type similar to the project reach. The reach meanders through a mature forested floodplain with stable streambanks and no signs of active erosion. The stream bed is also stable, with well-developed pools in the outside meander bends and riffles in the straight reaches, and no evidence of aggradation or degradation. Photographs of the A1 reference reach are included in Appendix E.

A reach of approximately 228 feet (greater than 20 bankfull widths) was surveyed in January 2005. The A1 reference reach was classified as an E4 stream type based upon the survey data and particle size distribution. The bankfull width of the stream channel is 11.2 feet, with a bankfull depth of 0.9 feet and bank height ratio of 1.0. The reference reach has a sinuosity of 1.24 and a radius of curvature of 8.6 to 25.8 feet. The channel substrate is a combination of sand and gravel. The reach provides a stable template to serve as the basis for the design reaches. Detailed data records for the A1 reference reach are included in Appendix E, and key parameters and dimensionless ratios are summarized in the Morphological Table provided in Section 5.

4.2 UT TO CANE CREEK REFERENCE REACH (A3)

The A3 reference reach is also an UT to Cane Creek, and is a second-order stream with a watershed of approximately 563 acres. This stream flows easterly into the mainstem of Cane Creek, and is located in a different headwater system of Cane Creek than the project reach. The selected reach is a stable, undisturbed meandering E-type channel located in a broad, gently sloping valley type similar to the project reach. The reach meanders through a mature forested floodplain with stable streambanks and no signs of active erosion. The stream bed is also stable, with well-developed pools in the outside meander bends and riffles in the straight reaches, and no evidence of aggradation or degradation. Photographs of the A3 reference reach are included in Appendix F.

A reach of approximately 253 feet (23 bankfull widths) was surveyed in January 2005. The A3 reference reach was classified as an E4 stream type based upon the survey data. Bankfull width of the stream is approximately 11.0 feet and bankfull depth is approximately 1.5 feet. The reference reach has a sinuosity of 1.62 and a radius of curvature of 11.3 to 27.1 feet. The channel substrate is a combination of sand and gravel. The reach provides a stable template to serve as the basis for the design reaches. Detailed data records for the A3 reference reach are included in Appendix F, and key parameters and dimensionless ratios are summarized in the Morphological Table provided in Section 5.

5.0 STREAM RESTORATION DESIGN

5.1 PROPOSED CONDITIONS FOR NATURAL CHANNEL DESIGN

The restoration design is based on a combination of a Priority 1 and Priority 2 approach, as described in *A Geomorphological Approach to Restoration of Incised Rivers* (Rosgen 1997). For clarity and convenience, the definitions of Priority 1 and Priority 2 Restoration are provided in Table 5.

The proposed stream dimension, pattern, and profile are based on detailed morphological criteria and hydraulic geometry relationships developed from the reference reaches. Table 6 is the morphological characteristics table summarizing the existing conditions, reference reach parameters, and proposed design values. The establishment of a stable planform (pattern) and bedform (profile) involves providing an effective geometry (dimension) which has the ability to transport the stream's sediment supply without aggrading or degrading over time. The geometry is set by bankfull area, width, mean depth, max depth, and bank height ratio. The planform is primarily determined by meeting meander length, radius of curvature, belt width, and sinuosity criteria as well as the avoidance of large trees. Bedform provides energy dissipation through a riffle-pool sequence. The proposed bedform or profile is based on providing the appropriate slopes (average, riffle, and pool), feature depths, and pool-to-pool spacing. These criteria are combined with the appropriate entrenchment ratio and width of flood-prone area to form a stable stream.

In-stream structures such as cross-vanes, rock vanes, and rootwads will be incorporated in the stream design to reduce the burden of energy dissipation on the channel geometry, provide grade control, and enhance in-stream habitat. These structures are designed to reduce bank erosion and the influence of secondary circulation in the near-bank region of stream bends. The structures further promote efficient sediment transport and produce/enhance in-stream habitat. Cross-vanes will serve as grade control in the restored channel. The confluence of tributaries with the restored stream will be stabilized with grade control structures and step sequences, where necessary, to match the proposed grade of the restored main channel.

The construction contractor will be instructed, "Tree removal shall be minimized." Additionally, the riparian zone will be restored to a fully forested buffer based on reference conditions. Live stakes will be planted on the stream banks to provide rapid vegetative growth. Biodegradable coir fiber matting and native herbaceous seed mix will be used to provide temporary stabilization on the newly graded streambanks until the woody vegetation becomes established. Refer to Appendix G for Typicals, Details, Restoration Plan Sheets, and Planting Plan.

Excavated materials from the design channel will be used to backfill the abandoned channel sections. However, shallow linear depressions within the existing channel belt width may be incorporated to provide additional flood storage and valuable aquatic habitat in the floodplain.

Cattle exclusion fencing will be installed along the outer boundary of the restored riparian buffer/permanent conservation easement area. Excluding cattle will prevent continued bank erosion and collapses caused by hoof shear as well as reduce the input of animal waste products to the stream.

5.1.1 Proposed Channel Description and Stream Classification

The proposed design will restore all the project tributaries to stable E4 stream types. As previously discussed, the existing channel contains minimal variation in pattern, profile, or dimension. The proposed pattern utilizes areas where the channel has adequate meandering pattern and enhances the pattern in areas that have been straightened. The proposed pattern will be further enhanced by a more effective profile form. Riffles, runs, pools, and glides will oscillate with the meanders providing energy dissipation. Furthermore, the dimension will vary as the channel transitions between riffles and pools. The channel will be able to access the floodplain more efficiently in the proposed design to reduce stress on the streambanks. E4 channels having the appropriate dimension, pattern, and profile along with the ability to access the floodplain are very efficient and stable channels.

5.1.2 Sediment Transport

A stream's ability to transport the sediment load without aggrading or degrading is the threshold of a stream's stability. This stability is evaluated through an evaluation of channel competency. Competency is the channel's ability to move particles of a certain size, expressed as units of lbs/ft^2.

Shear stress is the force required to initiate the general movement of particles in a streambed. This entrainment of particles must have the ability to move the largest particle from the bar sample (D_i) to prevent aggradation of particles. In order to move the D_i particle, the stream design must meet a critical depth and slope. The shear stress analysis indicates whether a stream has the ability to move its bedload.

To validate this theory-based explanation, shear stress was calculated for the design riffle cross-sections for all five reaches using the equation:

$$\tau = \gamma R s$$

τ = shear stress (lbs/ft^2)
γ = specific gravity of water (62.4 lbs/ft^3)
R = hydraulic radius (ft)
s = average water slope (ft/ft)

The particle size of concern for the stream is four millimeters; thus the allowable shear stress is in the 0.04 – 0.07 lbs/ft^2 range. Each reach of the proposed design falls within this range.

5.1.3 Discharge Analysis

The methodology used to evaluate the hydrologic analysis required the evaluation of the existing stream's bankfull discharge. The bankfull discharge was determined by evaluating the North Carolina Rural Piedmont Discharge Curve (Harman et al. 1999).

A flood study will be conducted to evaluate the need for a No-Rise, Letter of Map Revision (LOMR) and Certified Letter of Map Revision (CLOMR), and to assure no hydrologic trespass issues. The project is expected to require No-Rise and LOMR documentation and produce no hydrologic trespass.

5.1.4 Structures Used for Natural Channel Design

A variety of different structures will be used to control grade and stabilize the channel. These structures may include, but are not limited to: rock cross-vanes, rock vanes, log-vanes, rootwads, floodplain interceptors, matting, and planting materials. These structures provide grade control and bank stabilization such that the proper dimension, pattern, and profile are maintained while providing various habitats for aquatic organisms. The structures provide a substrate for benthic macroinvertebrates to feed, hide under, and attach. They also provide shelter and create eddies for fish to rest and feed near. The majority of the materials for the structures will come from off-site. Refer to Appendix G for Details.

Rock cross-vanes and rock vanes will be used to direct flow away from the bank and toward the center of the channel. Rootwads will be used for bank stabilization and to introduce woody material into the channel. Without this introduction, it would be many years before the planted saplings would be able to provide the stream with this habitat feature.

Rock Cross-Vanes - Rock cross-vanes direct flow away from the streambanks and into the middle of the channel. The structure creates a scour pool below, while maintaining the grade for the upstream reach. These structures will also provide a stable drop in the stream profile. Boulders are used to build these structures and filter fabric and smaller rock will be used to further strengthen it by solidifying gaps between the boulders.

Rock Vanes - The rock vane directs flow away from the stream bank and into the center of the channel. The rock vane structure creates a scour pool immediately downstream, which provides a habitat feature. Boulders are used to build these structures and will be used on the outside meander bend.

Rootwads - Rootwads will be used for streambank protection, habitat for fish, habitat for terrestrial insects, cover, and introduction of woody material into the stream. Rootwads act as a deflection device to the stream's flow. The roots buffer the streambank and aid in deflecting the stream's erosive forces away from the streambank.

Floodplain Interceptor - Floodplain interceptors will provide water on the floodplain with a stabilized access point to flow back into the channel. The floodplain interceptors shall be placed in low swale type areas on the floodplain where floodwater is expected to re-enter the stream channel.

Matting and Planting - Matting, live staking, and vegetation planting will be used to stabilize the project. Matting will provide immediate protection to the streambanks while the plantings develop a root mass and aid in protecting against shear stress. Vegetation transplanting may be used. The plantings will develop into mature trees that will be capable of providing the stream with shade and wildlife habitat. The streambed and point bars of the stream channel will not be matted or planted. The detailed planting plan is discussed in Section 7.2 of this report.

6.0 RIPARIAN BUFFER REVEGETATION DESIGN

Reestablishing a riparian buffer composed of native woody and herbaceous species is critical to the success of a stream restoration project. This is a multi-step process involving Site preparation (including eradicating exotic species), acquisition and installation of appropriate plant species, and post-project monitoring. At this Site, riparian buffer revegetation will also include enhancing existing wetlands adjacent to the project reach. Native wetland vegetation will be planted in these areas.

6.1 ERADICATION OF EXOTIC SPECIES

Prior to the revegetation phase of the project, removal of non-native floral species will be necessary. Exotic species currently occurring at the Site include Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), and Japanese stilt grass (*Microstegium vimineum*). Invasive species eradication and management shall commence in conjunction with Site preparation and will continue through the one-year monitoring period at a minimum. Proposed management procedures described below are based upon recommendations taken from the Southeast Exotic Pest Plant Council Invasive Plant Manual (SE-EPPC 2003).

Personnel applying herbicide will be licensed to do so, as required by the North Carolina Pesticide Board and all work will comply with the North Carolina Pesticide Law of 1971 and applicable federal laws (G.S. 143-434, Article 52). Environmental conditions including weather, wind, temperature, and period of the growing season will be evaluated prior to initiation of management efforts. The sequence of removal procedures will be coordinated with planned seeding and planting tasks such that treatment methods do not affect planted species.

The first step of the invasive species removal process will consist of an application of Rodeo® or equal herbicide (glyphosate – aquatic label) designated as suitable for extermination of trees and shrubs in riparian and wetland areas. Ideally, application will occur late in the growing season, but prior to dormancy. Ambient air temperature at the time of application will be above 40°F. The herbicide will be applied at the recommended rate in accordance with label instructions. This application will be completed a minimum of two weeks prior to planting activities. The herbicide will be applied on all identified invasive plants using appropriate application methods to prevent drift into adjacent areas.

Two weeks after spraying, all woody vegetation will be removed by cutting stems and stumps to a maximum height of two inches above ground. A 25% glyphosate herbicide solution approved for aquatic applications shall be immediately applied to completely cover the cut surface of each individual stem or stump. After an additional two-week period, woody remnants will be removed, separated from the soil, and disposed of properly (i.e. burning).

The Site shall be observed throughout the monitoring period to evaluate invasive management effectiveness. If required, additional control steps may be implemented.

6.2 WETLAND ENHANCEMENT

As part of this restoration project, approximately 3.25 acres of existing wetlands will be enhanced. Four wetlands were delineated within the project area: TY (PEM), WF (PEM), WG (PEM), WJ (PFO). Wetland TY is located on the Pickard property easement, wetland WF and WG are located on the Fogelman property easement, and wetland WJ on the Wright property easement. These wetlands will be enhanced by exotic species eradication and supplemental planting of native wetland species. These wetlands currently sustain populations of native herbaceous vegetation; therefore, plantings will consist of native shrub and tree species. Proposed species for wetland enhancement areas are listed in Table 4. Plant placement will be further defined during the design process. Disking or ripping will not be part of the bed preparation in wetland areas.

6.3 PLANTING PLAN

Native woody and herbaceous species will be used to establish a minimum 50-foot wide riparian buffer on both sides of the restored reach. In some areas the buffer will extend well beyond 50 feet, as the riparian buffer plantings will encompass the entire conservation easement. The area adjacent to the stream reach was divided into four planting zones as follows: Streamside, Floodplain, Wetland Enhancement, and Upland Slope. Refer to Appendix G for Planting Plan.

Species selected for planting will be dependent upon availability of local seedling sources. Advance notification and coordination with local nurseries will facilitate timely acquisition of various noncommercial elements.

The proposed plantings will cover the entire conservation easement, including the constructed streambanks, floodplain, wetland enhancement areas, and uplands. Throughout the majority of the Site, the target natural community will be a Piedmont/Mountain Bottomland Forest. Where the project area encompasses portions of upland slopes adjacent to the floodplain areas, the target natural community will be a Mixed Mesic Hardwood Forest (Schafale and Weakley 1990).

Some remnant areas of the target natural communities currently exist with mature individuals of the desired species. Larger individual trees existing within 50 feet of the stream were recognized as significant and documented in order to facilitate their incorporation into the proposed restoration design. Species identified included eastern red cedar (*Juniperus virginiana*), honey locust (*Gleditsia triacanthos*), hackberry (*Celtis occidentalis*), black oak (*Quercus velutina*), sweetgum (*Liquidambar styraciflua*), and American beech (*Fagus grandifolia*). These trees will provide an onsite seed source. In these areas, and in particular Reach C, the zone of construction activity will be limited to lessen damage to individual stems and root systems and tree removal will be kept to a minimum. Reach C is an undisturbed area and has a good, intact canopy of natural vegetation. Retaining mature existing trees with intact root masses will contribute to post-construction slope soil and stream bank stability. Areas with existing tree canopy will receive primarily herbaceous and shrub plantings.

Existing trees shall be transplanted when available and those individuals will be moved to new positions along the constructed project reach; however, these specimens will not be considered substitutions for plants required by the planting plan. Individuals considered candidates for transplanting should not be larger than 1.5 inches in diameter at breast height (dbh).

Bare-root seedlings will be planted within the specified areas at a density of 436 stems per acre (based on an average 10' x 10' spacing), to achieve a mature survivability of 320 trees per acre after three years and 260 trees per acre after five years in the riparian zone (NCDENR 2001). To provide structural diversity, native shrubs will also be incorporated in the buffers at a density of 680 stems per acre (based on an average 8' x 8' spacing). Shrubs will typically be installed in small groupings of two to three, individuals with overall placement of both the individual stems and the groupings to be randomized in order to develop a more naturalized appearance in the buffer zones.

On the restored stream banks (Streamside Zone), live stakes and/or bare-root seedlings will be used in conjunction with the native herbaceous seed mix to provide natural stabilization. Appropriate species identified for live staking include elderberry, silky willow (*Salix sericea*), silky dogwood (*Cornus amomum*), and black willow (*Salix nigra*). Live stakes or seedlings will be placed on the outside of meander bends and along straight reaches at a density of two to four stakes per square yard and in random fashion to give a natural appearance. Plant placement will be further defined during the design process.

Within the floodplain (Floodplain Zone) bare-root seedlings will be used in conjunction with the native herbaceous seed mix. The tree species will be evenly interspersed with shrub species. Appropriate species include willow oak (*Qercus phellos*), water oak (*Quercus nigra*), river birch (*Betula nigra*), tag alder (*Alnus serrulata*), and buttonbush (*Cephalanthus occidentalis*).

The Wetland Enhancement Zone will be planted with bare-root native wetland species. Such species include American sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), and tag alder.

The Upland Slope Zone will be planted with bare-root seedlings and act as a natural transition into the adjacent forested upland outside of the conservation easement. The native herbaceous seed mix will be used at the time of planting. Bare-root species will include American beech, white ash (*Fraxinus americana*), redbud (*Cercis canadensis*), and deciduous holly (*Ilex deciduas*).

Herbaceous vegetation seeded within the buffer shall consist of a native grass, herb, and forb mixture that may include: swamp milkweed (*Asclepias* incarnate), Joe Pye weed (*Eupatorium* fistulosum), swamp sunflower (*Helianthus* angustifolius), big bluestem (*Andropogon gerardii*), purple love grass (*Eragrostis spectabilis*), deertongue (*Panicum clandestinum*), Eastern gama grass (*Tripsacum dactyloides*), river oats (*Chasmanthium latifolium*), and Virginia wild rye (*Elymus virginicus*). In addition, rye grain (*Secale cereale*), annual rye (*Lolium multiflorum*), or oats (*Avena sativa*) will be used for temporary stabilization, depending upon the construction season and schedule. The planting zones and species are listed in Table 7.

7.0 MONITORING PLAN AND SUCCESS CRITERIA

The stream restoration monitoring protocol will follow that outlined within the EEP Site Specific Mitigation Plan and detailed in the U.S. Army Corps of Engineers (USACE) Stream Mitigation Guidelines (USACE et al. 2003). Monitoring shall consist of the collection and analysis of stream stability and riparian/stream bank vegetation survivability data to support the evaluation of the project in meeting established restoration objectives. Specifically, project monitoring will include measurements of stream dimension, profile, pattern, and bed materials, photo documentation, vegetation survivability sampling, and stream bankfull return interval.

7.1 DURATION

Monitoring will be performed each year for a five-year period, with no less than two bankfull flow events documented through the monitoring period. If less than two events occur during the first five years, monitoring will continue until the second bankfull event is documented.

7.2 REPORTING

URS will prepare a Project Mitigation Plan in accordance with EEP standards and will include the following sections: introduction, summary, success criteria, monitoring schedule, mitigation type and extent, maintenance/contingency plans and references. Existing data developed during the assessment and design phases of the project will be utilized to the fullest extent possible.

Following construction, URS will install four stream monitoring gauges and establish permanent stream monitoring cross sections, vegetation plots, and photo reference points on the project site, marked using rebar and cap, for utilization during subsequent monitoring phases of the project. The selected Construction Contractor will survey these points during the execution of the as-built field survey. The Contractor shall supply URS with a complete and properly sealed Project As-built Survey for inclusion in the Mitigation Plan (11"x17" format). The Mitigation Plan will be formatted and submitted in three-ring binder format to allow the later inclusion of yearly project monitoring reports.

The first year monitoring will be conducted and reported in accordance with the requirements established in the Project Restoration Plan. The following data will be collected:

- One (1) longitudinal profile from each of the five (5) restored stream reaches. Linear footage of each stream profile will be equal to 20 bankfull widths of the restored stream reach.
- One (1) riffle and one (1) pool cross-section in *each* profile (10 cross-sections total).
- Modified Wolman pebble counts at each cross section.
- Photo documentation at each cross-section.
- Photo documentation at 20 other locations to characterize stream and general site conditions.

- Photo documentation will be collected from the center of each of the vegetative sampling plots. These photos will be collected in a sequential fashion, starting from due north, to provide a 360-degree view from each sample site.
- Randomly placed tenth-acre vegetative sampling plots distributed to provide coverage of a total of 2% of the replanted riparian and streambank area.
- Stream gauge data collection – once a month for twelve (12) months.
- Rain gauge data collection – once a month for twelve (12) months.

Collected monitoring data will be analyzed to evaluate the project status in relation to the established success criteria, summarizing observations of the stream and overall site conditions. A monitoring report will be produced in 8½"x11" format containing appropriate documentation, field data information, engineering computations and photographs. Supporting illustrations and plan sheets in 11"x17" format will be included as necessary.

The yearly project monitoring reports will be prepared and submitted each year after monitoring tasks are completed. The report will provide the new monitoring data and compare the new data against the previously existing conditions. Data tables, cross-sections, profiles, photographs, and other graphics will be included in the report as necessary. The report will include a discussion of any significant deviations from the as-built survey, as well as evaluations as to whether the changes indicate a stabilizing or de-stabilizing conditions.

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Table 1. Project Restoration Structure and Objectives

REACH	LOCATION	RESTORATION TYPE	PRIORITY APPROACH	EXISTING LINEAR FOOTAGE/ ACREAGE	DESIGNED LINEAR FOOTAGE/ ACREAGE	COMMENT
Reach A	Fogleman Property – Eastern Trib, Upstream end of Project to confluence with Reach D	Restoration	Priority 1 & 2	1,430 LF	1,737 LF	Priority 1 approach is expected for the majority of the site; however, final cross sections and longitudinal profile may show a need for Priority 2 in some locations.
Reach B	Pickard Farms Property, From confluence with Reach A and D to confluence with E	Restoration	Priority 1 & 2	2,065 LF	1,984 LF	
Reach C	Stutts, Jr Property, From confluence of Reach B and E to downstream end of project	Restoration	Priority 1 & 2	1,435 LF	1,174 LF	
Reach D	Fogleman Property – Western Trib, Upstream end of Project to confluence with Reach A	Restoration	Priority 1 & 2	1,100 LF	1,322 LF	
Reach E	Pickard/Wright Properties, From upstream end to confluence with Reach B	Restoration	Priority 1 & 2	300 LF	320 LF	
Wetlands		Enhancement	--	3.25 AC	3.25 AC	

Table 2. Drainage Areas

REACH	DRAINAGE AREA (ACRES)
Reach A	390
Reach B	1,333
Reach C	1,640
Reach D	892
Reach E	282
TOTAL	1,640

Table 3. Land Use of Watershed

LAND USE	ACREAGE	PERCENTAGE
Managed Herbaceous Cover	817.3	49.8
Mixed Upland Hardwoods	515.5	31.4
Cultivated	161.6	9.9
Southern Yellow Pine	76.0	4.6
Deciduous Shrubland	32.1	2.0
Mixed Hardwoods/Conifers	12.6	0.9
Unmanaged Herbaceous Upland	10.2	0.6
Evergreen Shrubland	7.0	0.4
Water Bodies	7.2	0.4

Table 4. Existing Channel Morphology by Reach

PARAMETER	REACH A	REACH B	REACH C	REACH D	REACH E
Drainage Area (ac)	390	1333	1640	892	282
Bankfull Width (ft)	11.6	16.0	20.3	13.8	11.9
Bankfull Mean Depth (ft)	1.2	2.1	2.1	2.0	1.1
Width/Depth Ratio	9.5	7.8	9.6	6.9	10.5
Bankfull Area (ft^2)	14.3	34.2	42.9	27.4	13.4
Entrenchment Ratio	5.6	18.8	14.8	10.9	8.4
Bank Height Ratio	1.2	1.3	1.6	1.1	1.4
Average Slope (ft/ft)	0.0080	0.0031	0.0035	0.0044	0.0152
Sinuosity	1.04	1.34	1.29	1.04	1.03
Bankfull Discharge (cfs)	62.4	150.9	175.2	112.9	49.3
Rosgen Stream Type	Degraded E4	Degraded E4	Degraded E4	Degraded E4	Degraded E4

Table 5. Priority 1 and 2 Restoration

DESCRIPTION	METHODS	ADVANTAGES
Priority 1 Convert G, F and degraded E/C stream types to C or E stream types at previous elevation with floodplain.	Reestablish channel on previous floodplain using relic channel or construction of new bankfull discharge channel. Design of stable dimension, pattern, and profile based upon morphological criteria developed from reference reach with similar watershed, valley, land use, and sediment supply. Fill in existing incised channel or create discontinuous oxbow lakes level with new floodplain elevation.	Reestablishment of floodplain and stable channel: ▪ Reduces bank height and streambank erosion, ▪ Reduces land loss, ▪ Raises water table, ▪ Reconnects stream to floodplain providing flood attenuation ▪ Decreases sediment, ▪ Improves aquatic and terrestrial habitats, ▪ Improves land productivity, and ▪ Improves aesthetics.
Priority 2 Convert F and/or G stream types to C or E. Reestablishment of floodplain at existing level or higher, but not at original level.	If belt width provides for the minimum meander width ratio for C and E stream types, construct channel in bed of existing channel, convert existing bed to new floodplain. If belt width is too narrow, excavate streambank walls. End-haul material or place in streambed to raise bed elevation and create new floodplain in the deposition.	▪ Decreases bank height and streambank erosion, ▪ Allows for riparian vegetation to help stabilize banks, ▪ Establishes floodplain to help take stress off of channel during flood, ▪ Improves aquatic habitat ▪ Prevents wide-scale flooding of original land surface, ▪ Reduces sediment, and ▪ Downstream grade transition for grade control is easier.

Table 7. Planting Zones and Species

STREAMSIDE	COMMON NAME	SCIENTIFIC NAME
Shrubs	Black willow	*Salix nigra*
	Elderberry	*Sambucus canadensis*
	Silky dogwood	*Cornus amomum*
	Silky willow	*Salix sericea*
Herbs/Seed Mixture	Swamp sunflower	*Helianthus angustifolius*
	Ironweed	*Veronica noveboracensis*
	Swamp milkweed	*Asclepias incarnate*
	Joe-pye-weed	*Eupatorium fistulosum*
	Tearthumb	*Polygonum sagittatum*
	Bushy beard grass	*Andropogon glomeratus*
	Deertongue	*Panicum clandestimum*
	Switchgrass	*Panicum virgatum*
FLOODPLAIN	**COMMON NAME**	**SCIENTIFIC NAME**
Trees	American sycamore	*Platanus occidentalis*
	American elm	*Ulmus americana*
	Green ash	*Fraxinus pennsylvanica*
	River birch	*Betula nigra*
	Sugarberry	*Celtis laevigata*
	Willow oak	*Quercus phellos*
	Water oak	*Quercus nigra*
	Tulip poplar	*Liriodendron tulipifera*
	Black walnut	*Juglans nigra*
	Shagbark hickory	*Carya ovata*
	Bitternut hickory	*Carya cordiformis*
	Honey locust	*Gleditsia triacanthos*
	Hackberry	*Celtis occidentalis*
	Sweetgum	*Liquidambar styraciflua*
Shrubs	Spicebush	*Lindera benzoin*
	Witch hazel	*Hamamelis virginiana*
	Tag alder	*Alnus serrulata*
	Virginia willow	*Itea virginica*
	Buttonbush	*Cephalanthus occidentalis*
	Strawberry bush	*Euonymus americanus*
	American beautyberry	*Callicarpa americana*
	Ninebark	*Physocarpus opulifolius*
	Highbush blueberry	*Vaccinium corymbosum*
	American hazelnut	*Corylus americana*

FLOODPLAIN (continued)	COMMON NAME	SCIENTIFIC NAME
Herbs/Seed Mixture	Swamp sunflower	*Helianthus angustifolius*
	Ironweed	*Veronica noveboracensis*
	Swamp milkweed	*Asclepias incarnate*
	Joe-pye-weed	*Eupatorium fistulosum*
	Tearthumb	*Polygonum sagittatum*
	Bushy beard grass	*Andropogon glomeratus*
	Deertongue	*Panicum clandestimum*
	Switchgrass	*Panicum virgatum*
	Soft rush	*Juncus effusus*
WETLAND ENHANCEMENT	**COMMON NAME**	**SCIENTIFIC NAME**
Trees	American sycamore	*Platanus occidentalis*
	Sweetgum	*Liduidambar styraciflua*
	Red Maple	*Acer rubrum*
	American elm	*Ulmus americana*
	Green ash	*Fraxinus pennsylvanica*
Shrubs	Tag alder	*Alnus serrulata*
	American beautyberry	*Callicarpa americana*
	Buttonbush	*Cephalanthus occidentalis*
UPLAND SLOPE	**COMMON NAME**	**SCIENTIFIC NAME**
Trees	American beech	*Fagus grandifolia*
	American elm	*Ulmus americana*
	White ash	*Fraxinus americana*
	Bitternut hickory	*Carya cordiformis*
	Black oak	*Quercus velutina*
	American beech	*Fagus grandifolia*
	Eastern red cedar	*Juniperus virginiana*
	Black gum	*Nyssa sylvatica*
Shrubs	Serviceberry	*Amelanchier arborea*
	Redbud	*Cercis canadensis*
	Alternate leaf dogwood	*Cornus alternifolia*
	Hazelnut	*Corylus americana*
	Deciduous holly	*Ilex deciduas*
Herbs/Seed Mixture	Big blue stem	*Andropogon gerardii*
	Ironweed	*Veronica noveboracensis*
	Joe-pye-weed	*Eupatorium fistulosum*
	Indian grass	*Sorghastrum nutans*
	Switchgrass	*Panicum virgatum*

Table 1. Project Restoration Structure and Objectives

REACH	LOCATION	RESTORATION TYPE	PRIORITY APPROACH	EXISTING LINEAR FOOTAGE/ ACREAGE	DESIGNED LINEAR FOOTAGE/ ACREAGE	COMMENT
Reach A	Fogleman Property – Eastern Trib, Upstream end of Project to confluence with Reach D	Restoration	Priority 1 & 2	1,430 LF	1,737 LF	Priority 1 approach is expected for the majority of the site; however, final cross sections and longitudinal profile may show a need for Priority 2 in some locations.
Reach B	Pickard Farms Property, From confluence with Reach A and D to confluence with E	Restoration	Priority 1 & 2	2,065 LF	1,984 LF	
Reach C	Stutts, Jr Property, From confluence of Reach B and E to downstream end of project	Restoration	Priority 1 & 2	1,435 LF	1,174 LF	
Reach D	Fogleman Property – Western Trib, Upstream end of Project to confluence with Reach A	Restoration	Priority 1 & 2	1,100 LF	1,322 LF	
Reach E	Pickard/Wright Properties, From upstream end to confluence with Reach B	Restoration	Priority 1 & 2	300 LF	320 LF	
Wetlands		Enhancement	--	3.25 AC	3.25 AC	

Table 2. Drainage Areas

REACH	DRAINAGE AREA (ACRES)
Reach A	390
Reach B	1,333
Reach C	1,640
Reach D	892
Reach E	282
TOTAL	**1,640**

Table 3. Land Use of Watershed

LAND USE	ACREAGE	PERCENTAGE
Managed Herbaceous Cover	817.3	49.8
Mixed Upland Hardwoods	515.5	31.4
Cultivated	161.6	9.9
Southern Yellow Pine	76.0	4.6
Deciduous Shrubland	32.1	2.0
Mixed Hardwoods/Conifers	12.6	0.9
Unmanaged Herbaceous Upland	10.2	0.6
Evergreen Shrubland	7.0	0.4
Water Bodies	7.2	0.4

Table 4. Existing Channel Morphology by Reach

PARAMETER	REACH A	REACH B	REACH C	REACH D	REACH E
Drainage Area (ac)	390	1333	1640	892	282
Bankfull Width (ft)	11.6	16.0	20.3	13.8	11.9
Bankfull Mean Depth (ft)	1.2	2.1	2.1	2.0	1.1
Width/Depth Ratio	9.5	7.8	9.6	6.9	10.5
Bankfull Area (ft^2)	14.3	34.2	42.9	27.4	13.4
Entrenchment Ratio	5.6	18.8	14.8	10.9	8.4
Bank Height Ratio	1.2	1.3	1.6	1.1	1.4
Average Slope (ft/ft)	0.0080	0.0031	0.0035	0.0044	0.0152
Sinuosity	1.04	1.34	1.29	1.04	1.03
Bankfull Discharge (cfs)	62.4	150.9	175.2	112.9	49.3
Rosgen Stream Type	Degraded E4	Degraded E4	Degraded E4	Degraded E4	Degraded E4

Table 5. Priority 1 and 2 Restoration

DESCRIPTION	METHODS	ADVANTAGES
<u>Priority 1</u> Convert G, F and degraded E/C stream types to C or E stream types at previous elevation with floodplain.	Reestablish channel on previous floodplain using relic channel or construction of new bankfull discharge channel. Design of stable dimension, pattern, and profile based upon morphological criteria developed from reference reach with similar watershed, valley, land use, and sediment supply. Fill in existing incised channel or create discontinuous oxbow lakes level with new floodplain elevation.	Reestablishment of floodplain and stable channel: ▪ Reduces bank height and streambank erosion, ▪ Reduces land loss, ▪ Raises water table, ▪ Reconnects stream to floodplain providing flood attenuation ▪ Decreases sediment, ▪ Improves aquatic and terrestrial habitats, ▪ Improves land productivity, and ▪ Improves aesthetics.
<u>Priority 2</u> Convert F and/or G stream types to C or E. Reestablishment of floodplain at existing level or higher, but not at original level.	If belt width provides for the minimum meander width ratio for C and E stream types, construct channel in bed of existing channel, convert existing bed to new floodplain. If belt width is too narrow, excavate streambank walls. End-haul material or place in streambed to raise bed elevation and create new floodplain in the deposition.	▪ Decreases bank height and streambank erosion, ▪ Allows for riparian vegetation to help stabilize banks, ▪ Establishes floodplain to help take stress off of channel during flood, ▪ Improves aquatic habitat ▪ Prevents wide-scale flooding of original land surface, ▪ Reduces sediment, and ▪ Downstream grade transition for grade control is easier.

Table 6. Morphological Characteristics of Project Stream Channel

Site Name: **UT to Cane Creek (Pickard Property), Alamance County, NC**
Watershed: **Cape Fear**

Design by: **Kathleen McKeithan, PE, CPESC, CPSWQ**

SITE NAME	UNITS	UT to Cane Creek (Pickard Site)	UT to Cane Creek (Pickard Site)	UT to Cane Creek (Pickard Site)	UT to Cane Creek (Pickard Site)	UT to Cane Creek (Pickard Site)	Design A	Design B	Design C	Design D	Design E	UT to Cane Creek Reference A1	UT to Cane Creek Reference A3
WATERSHED		Cape Fear	Cape Fear	Cape Fear	Cape Fear	Cape Fear	Cape Fear	Cape Fear	Cape Fear	Cape Fear	Cape Fear	Cape Fear	Cape Fear
REACH DESCRIPTION		Reach A	Reach B	Reach C	Reach D	Reach E	Reach A	Reach B	Reach C	Reach D	Reach E	Snow Camp quadrangle, off of Pleasant Hill Rd and Walnut Grove Lane.	Snow Camp Quadrangle. Off of Rural View Road
STREAM TYPE		Degraded E4	Degraded E4	Degraded E4	Degraded E4	Degraded E4	E4	E4	E4	E4	E4	E4	E4
DRAINAGE AREA (DA)	Ac	390	1333	1640	892	282	390	1333	1640	892	282	179	563
BANKFULL WIDTH (W_{bkf})	ft	11.6	16.0	20.3	13.8	11.9	10.0	16.0	18.0	14.0	10.0	11.2	11.0
BANKFULL MEAN DEPTH (d_{bkf})	ft	1.2	2.1	2.1	2.0	1.1	1.0	1.6	1.8	1.4	1.1	0.9	1.5
LOWEST BANK HEIGHT RATIO		1.2	1.3	1.6	1.1	1.4	1.0	1.0	1.0	1.0	1.0	1.0	1.4
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})		9.5	7.8	9.6	6.9	10.5	10.0	10.0	10.0	10.0	9.0	12.4	7.5
BANKFULL X-SECTION AREA (A_{bkf})	ft^2	14.3	34.2	42.9	27.4	13.4	11.0	32.0	38.0	24.0	12.0	10.1	16.2
BANKFULL MEAN VELOCITY, ft/s	f/s	4.4	4.4	4.1	4.1	3.7	5.7	4.7	4.6	4.7	4.1	3.5	5.0
BANKFULL DISCHARGE, cfs	ft^3/s	62.4	150.9	175.2	112.9	49.3	62.3	151.0	175.3	113.0	49.3	35.6	81.2
BANKFULL MAX DEPTH (d_{max})	ft	1.6	3.3	2.9	2.9	2.4	1.5	2.4	2.7	2.1	1.7	1.7	2.0
WIDTH Flood-Prone Area (W_{fpa})	ft	65	300	300	150	100	65.0	200.0	300.0	100.0	100.0	100	105
ENTRENCHMENT RATIO (ER)		5.6	18.8	14.8	10.9	8.4	6.5	12.5	16.7	7.1	10.0	8.9	9.5
MEANDER LENGTH (Lm)	ft	80 - 460	120 - 340	99 - 150	80 - 540	40 - 200	40 - 140	64 - 160	72 - 180	56 - 140	40 - 100	29 - 57	29 - 96
RATIO OF Lm TO W_{bkf}		6.9 - 39.6	7.5 - 21.3	4.9 - 7.4	5.8 - 39.1	3.4 - 16.8	4.0 - 14.0	4.0 - 10.0	4.0 - 10.0	4.0 - 10.0	4.0 - 10.0	2.6 - 5.1	2.6 - 8.7
RADIUS OF CURVATURE	ft	40.0 - 385.0	23.0 - 32.1	19.4 - 34.3	22.0 - 70.0	20.0 - 69.0	23 - 42	37 - 66	41 - 75	32 - 58	23 - 42	8.6 - 25.8	11.3 - 27.1
RATIO OF Rc TO W_{bkf}		3.4 - 33.1	1.4 - 2.0	1.0 - 1.7	1.6 - 5.1	1.7 - 5.8	2.3 - 4.2	2.3 - 4.2	2.3 - 4.2	2.3 - 4.2	2.3 - 4.2	0.8 - 2.3	1.0 - 2.5
BELT WIDTH	ft	20 - 50	18 - 148	23 - 91	20 - 40	15 - 20	35 - 70	56 - 112	63 - 126	49 - 98	35 - 70	15 - 50	50 - 77
MEANDER WIDTH RATIO		1.7 - 4.3	1.1 - 9.2	1.1 - 4.5	1.4 - 2.9	1.3 - 1.7	3.5 - 7.0	3.5 - 7.0	3.5 - 7.0	3.5 - 7.0	3.5 - 7.0	1.3 - 4.5	4.5 - 7.0
SINUOSITY (K)		1.04	1.34	1.29	1.04	1.03	1.26	1.27	1.09	1.26	1.04	1.24	1.62
VALLEY SLOPE	ft/ft	0.0083	0.0041	0.0045	0.0046	0.0156	0.0083	0.0041	0.0045	0.0046	0.0226	0.0057	0.0130
AVERAGE SLOPE (S)	ft/ft	0.0080	0.0031	0.0035	0.0044	0.0152	0.0043	0.0032	0.0041	0.0037	0.0025	0.0046	0.0078
RIFFLE SLOPE	ft/ft	0.0080	0.0070	0.0029	0.0044	0.0152	0.0065	0.0049	0.0063	0.0055	0.0038	0.0073	0.0112
POOL SLOPE	ft/ft	0.0000	-0.0011	0.0005	0.0002	NA	0.0005	0.0004	0.0005	0.0004	0.0003	0.0003	0.0013
RATIO OF POOL SLOPE TO AVERAGE SLOPE	ft/ft	0.0	-0.4	0.1	0.1	NA	0.12	0.12	0.12	0.12	0.12	0.1	0.2
MAX POOL DEPTH	ft	2.68	4.19	4.21	4.00	NA	2.15	3.44	3.87	3.01	2.39	2.28	2.58
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH		2.18	2.04	1.99	2.01	NA	2.15	2.15	2.15	2.15	2.15	2.53	1.76
POOL WIDTH	ft	6.8	14.2	19.2	17.4	NA	12.0	19.2	21.6	16.8	12.0	11.8	12.3
RATIO OF POOL WIDTH TO BANKFULL WIDTH		0.59	0.89	0.95	1.26	NA	1.20	1.20	1.20	1.20	1.20	1.06	1.12
POOL TO POOL SPACING	ft	100.0 - 240.0	29.0 - 395.0	73.6 - 220.0	31.0 - 295.0	NA	13.2 - 66.2	21.2 - 105.9	23.8 - 119.2	18.5 - 92.7	13.2 - 66.2	14.8 - 87.0	1.6 - 95.0
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH		8.6 - 20.7	1.8 - 24.7	3.6 - 10.9	2.2 - 21.4	NA	1.3 - 6.6	1.3 - 6.6	1.3 - 6.6	1.3 - 6.6	1.3 - 6.6	1.3 - 7.8	0.1 - 8.6

Note average slope of existing conditions were taken over a specific reach surveyed, thus they may not coorespond with valley slopes taken over the entire reach. Proposed average slopes may exclude controlled grade drops (average slope between niche points).

Table 7. Planting Zones and Species

STREAMSIDE	COMMON NAME	SCIENTIFIC NAME
Shrubs	Black willow	*Salix nigra*
	Elderberry	*Sambucus canadensis*
	Silky dogwood	*Cornus amomum*
	Silky willow	*Salix sericea*
Herbs/Seed Mixture	Swamp sunflower	*Helianthus angustifolius*
	Ironweed	*Veronica noveboracensis*
	Swamp milkweed	*Asclepias incarnate*
	Joe-pye-weed	*Eupatorium fistulosum*
	Tearthumb	*Polygonum sagittatum*
	Bushy beard grass	*Andropogon glomeratus*
	Deertongue	*Panicum clandestimum*
	Switchgrass	*Panicum virgatum*
FLOODPLAIN	**COMMON NAME**	**SCIENTIFIC NAME**
Trees	American sycamore	*Platanus occidentalis*
	American elm	*Ulmus americana*
	Green ash	*Fraxinus pennsylvanica*
	River birch	*Betula nigra*
	Sugarberry	*Celtis laevigata*
	Willow oak	*Quercus phellos*
	Water oak	*Quercus nigra*
	Tulip poplar	*Liriodendron tulipifera*
	Black walnut	*Juglans nigra*
	Shagbark hickory	*Carya ovata*
	Bitternut hickory	*Carya cordiformis*
	Honey locust	*Gleditsia triacanthos*
	Hackberry	*Celtis occidentalis*
	Sweetgum	*Liquidambar styraciflua*
Shrubs	Spicebush	*Lindera benzoin*
	Witch hazel	*Hamamelis virginiana*
	Tag alder	*Alnus serrulata*
	Virginia willow	*Itea virginica*
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	Strawberry bush	*Euonymus americanus*
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	Highbush blueberry	*Vaccinium corymbosum*
	American hazelnut	*Corylus americana*

FLOODPLAIN (continued)	COMMON NAME	SCIENTIFIC NAME
Herbs/Seed Mixture	Swamp sunflower	*Helianthus angustifolius*
	Ironweed	*Veronica noveboracensis*
	Swamp milkweed	*Asclepias incarnate*
	Joe-pye-weed	*Eupatorium fistulosum*
	Tearthumb	*Polygonum sagittatum*
	Bushy beard grass	*Andropogon glomeratus*
	Deertongue	*Panicum clandestimum*
	Switchgrass	*Panicum virgatum*
	Soft rush	*Juncus effusus*
WETLAND ENHANCEMENT	**COMMON NAME**	**SCIENTIFIC NAME**
Trees	American sycamore	*Platanus occidentalis*
	Sweetgum	*Liduidambar styraciflua*
	Red Maple	*Acer rubrum*
	American elm	*Ulmus americana*
	Green ash	*Fraxinus pennsylvanica*
Shrubs	Tag alder	*Alnus serrulata*
	American beautyberry	*Callicarpa americana*
	Buttonbush	*Cephalanthus occidentalis*
UPLAND SLOPE	**COMMON NAME**	**SCIENTIFIC NAME**
Trees	American beech	*Fagus grandifolia*
	American elm	*Ulmus americana*
	White ash	*Fraxinus americana*
	Bitternut hickory	*Carya cordiformis*
	Black oak	*Quercus velutina*
	American beech	*Fagus grandifolia*
	Eastern red cedar	*Juniperus virginiana*
	Black gum	*Nyssa sylvatica*
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	Redbud	*Cercis canadensis*
	Alternate leaf dogwood	*Cornus alternifolia*
	Hazelnut	*Corylus americana*
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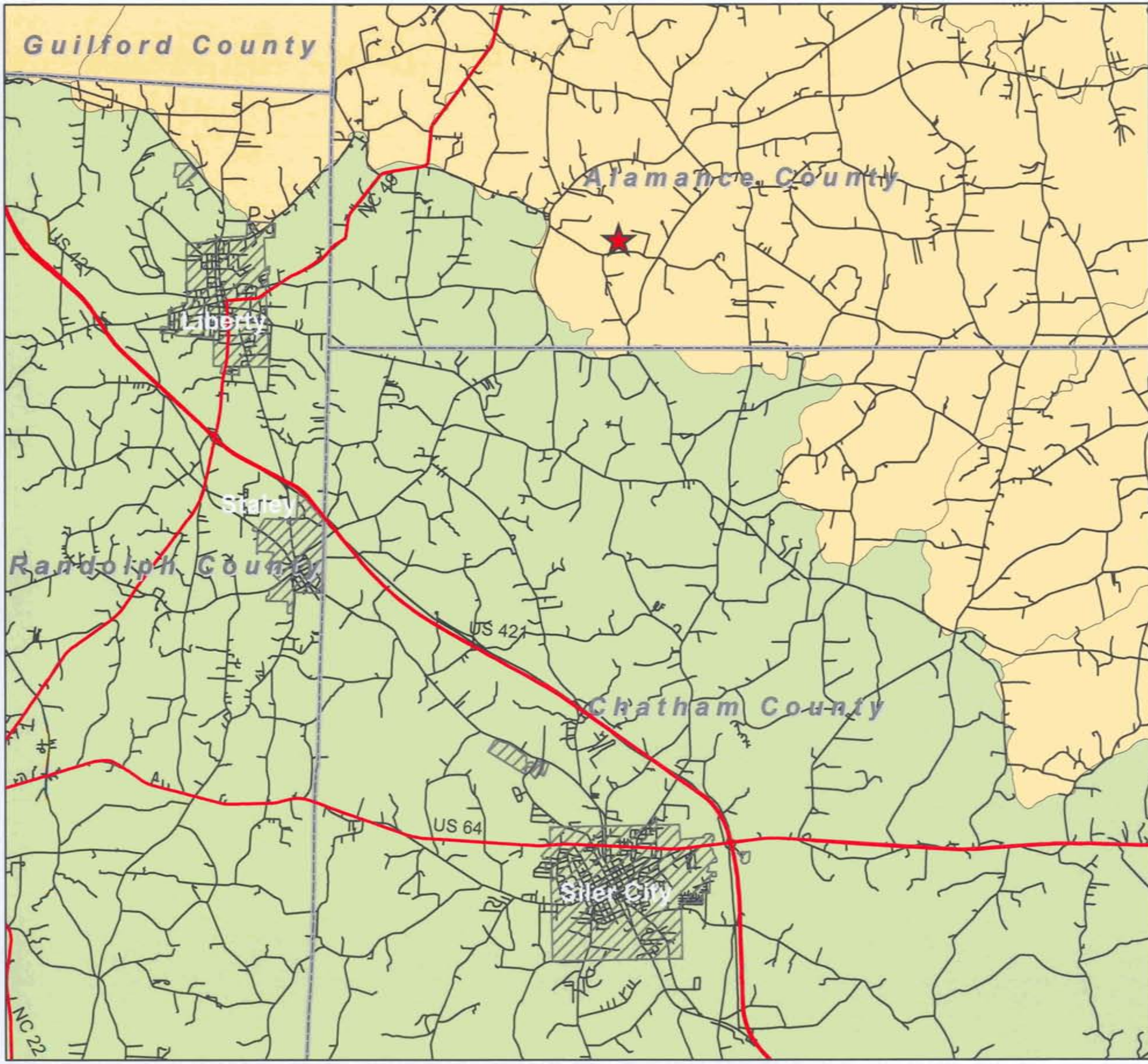
	Indian grass	*Sorghastrum nutans*
	Switchgrass	*Panicum virgatum*



Ecosystem Enhancement Program

UT to Cane Creek (Pickard Site) Stream Restoration Project

NC River Basins
Cape Fear River Basin

NC Counties
HUC 03030002
Cape Fear River Basin
COUNTY
Alamance
Project Reach

Legend

- Primary Roads
- Municipal Boundaries
- NC Counties
- Project Reach
- Secondary Roads
- HUC 03030002
- Cape Fear River Basin

N

0 1 2
Miles

FIGURE 1
Vicinity Map

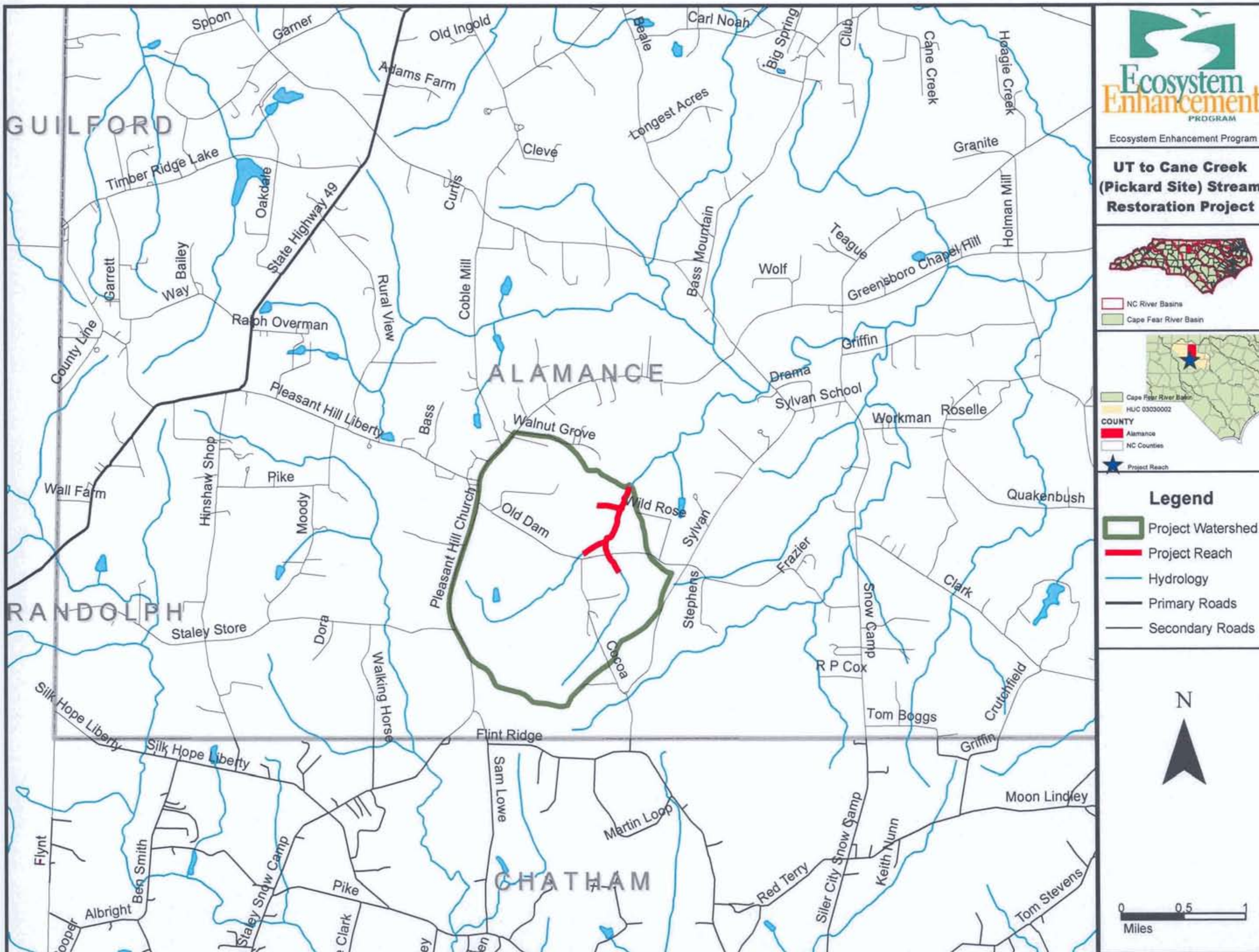
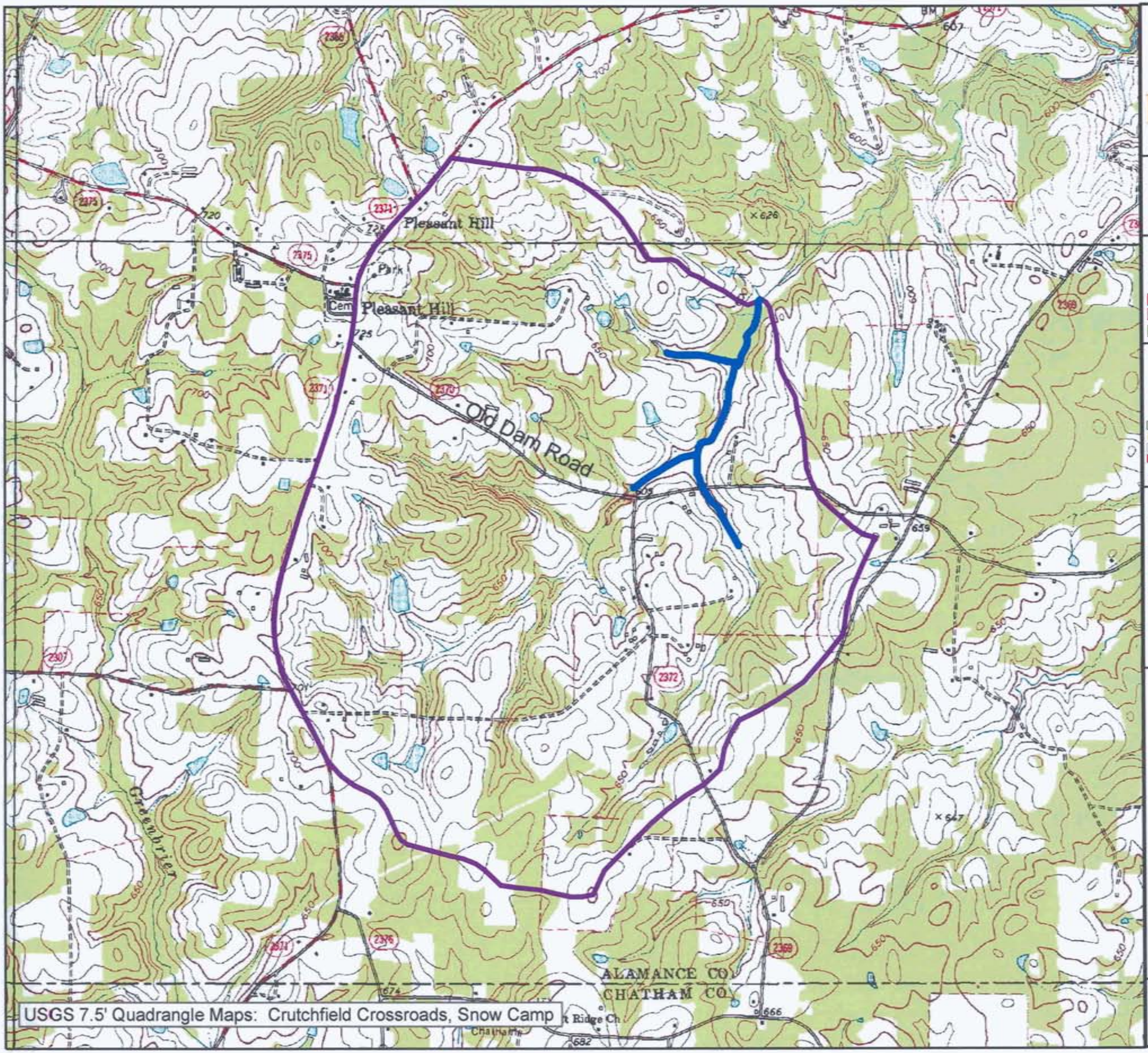


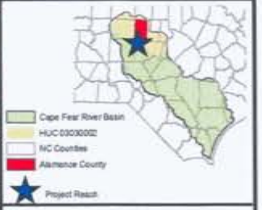
FIGURE 2
Project Location Map

FIGURE 3
Project Reach Locations



Ecosystem Enhancement Program

UT to Cane Creek (Pickard Site) Stream Restoration Project



Legend

Project Watershed

Project Reach

N

0 1,000 2,000

Feet

FIGURE 4

Project Watershed

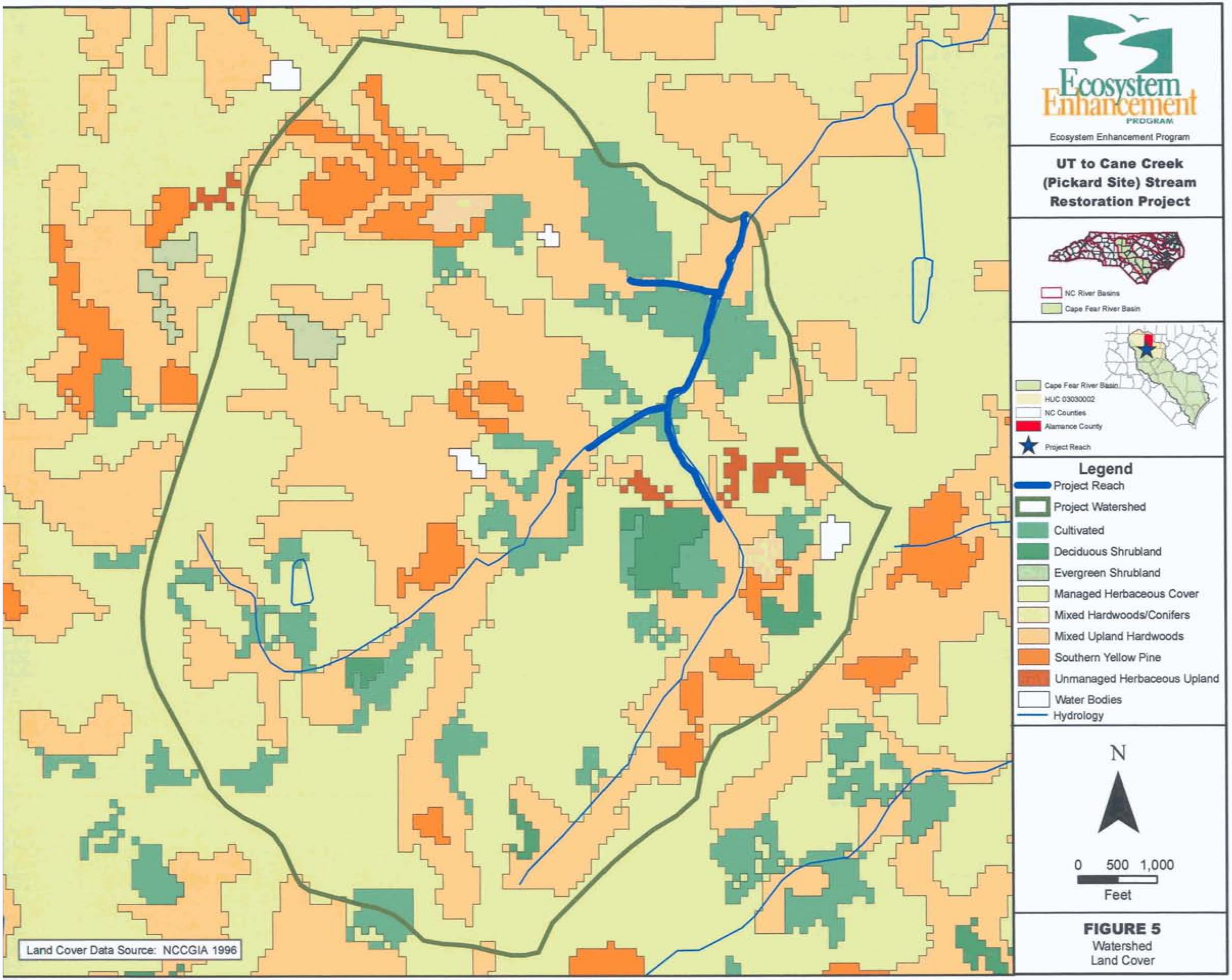


FIGURE 5
Watershed
Land Cover

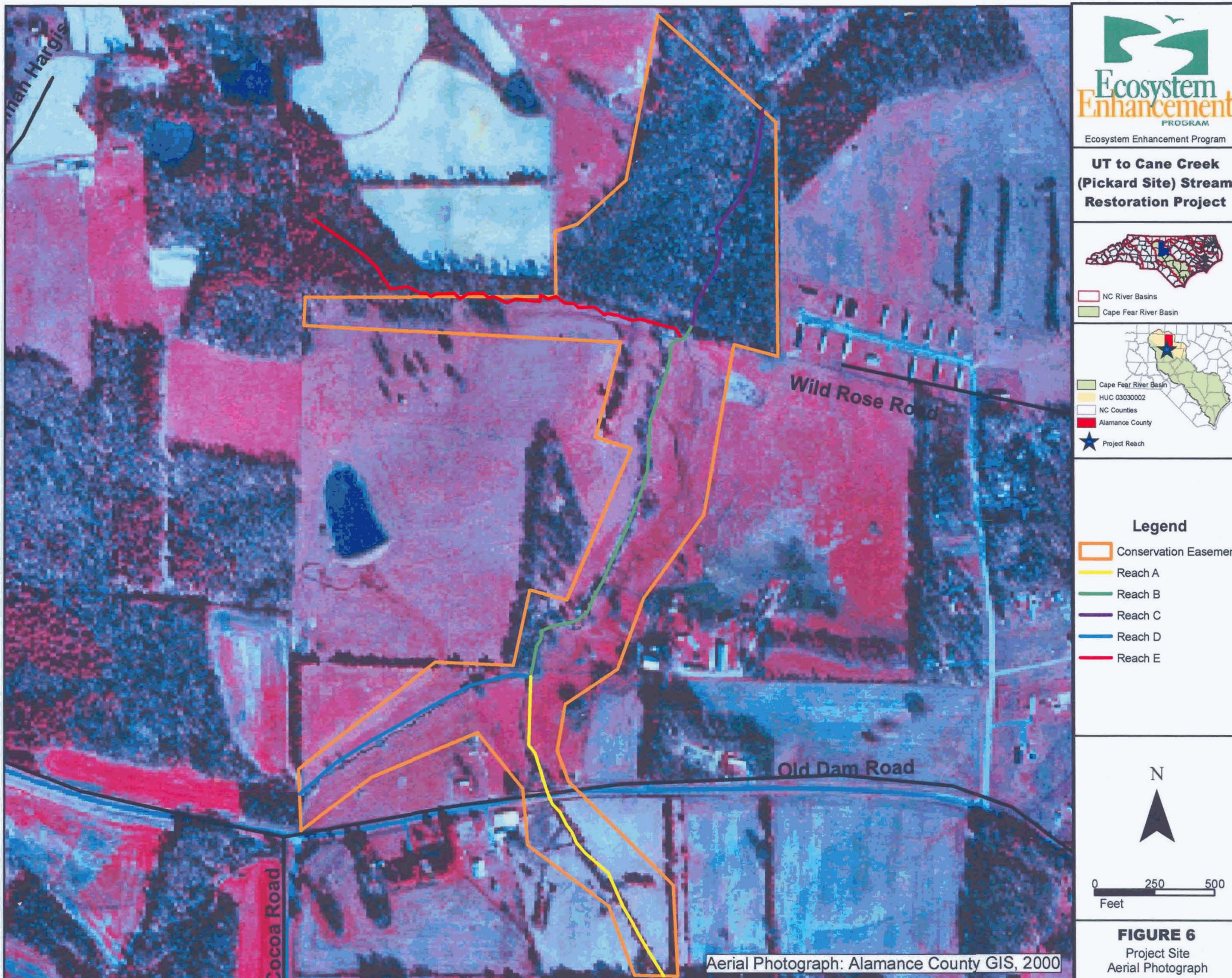


FIGURE 6
Project Site
Aerial Photograph

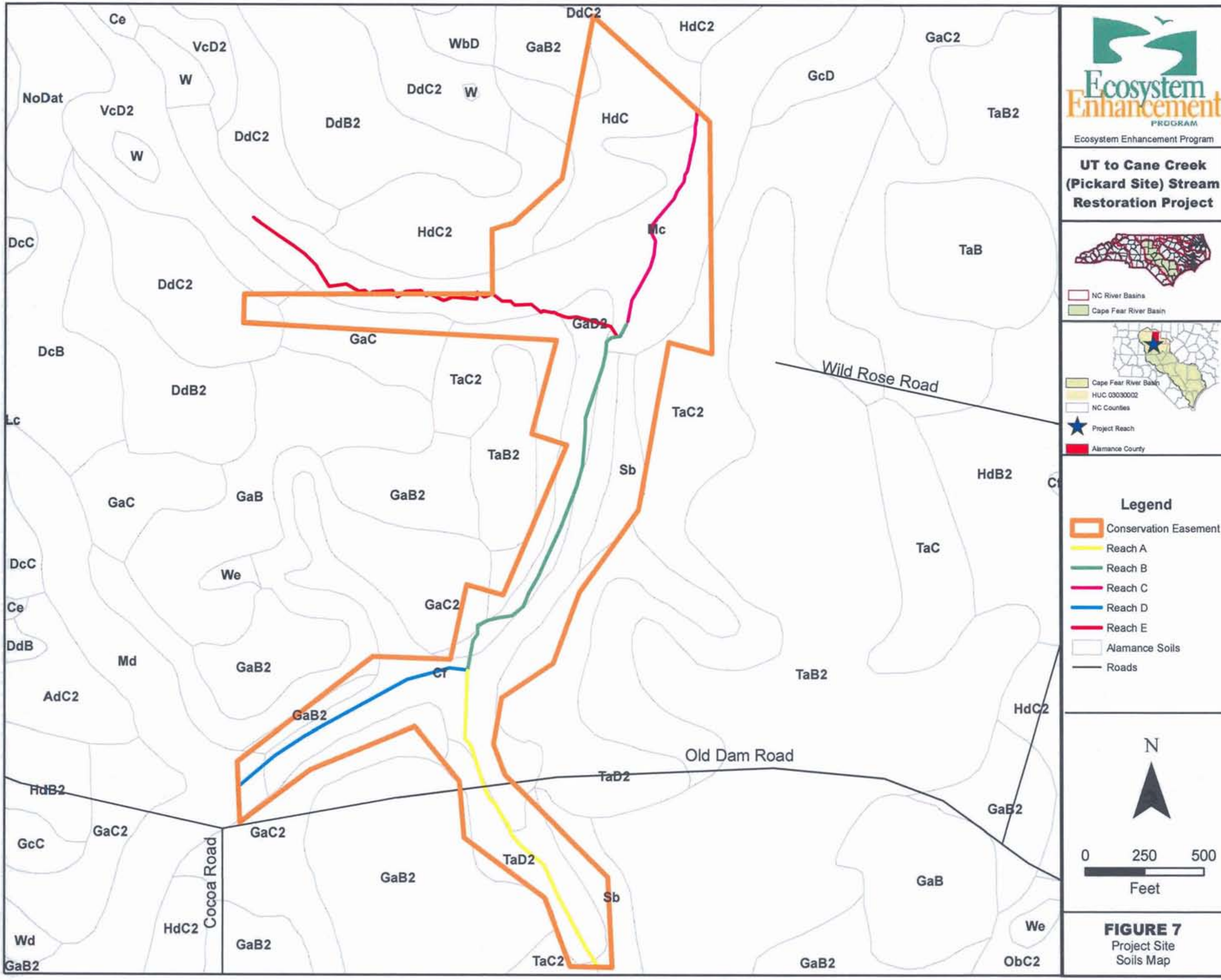


FIGURE 7
Project Site
Soils Map

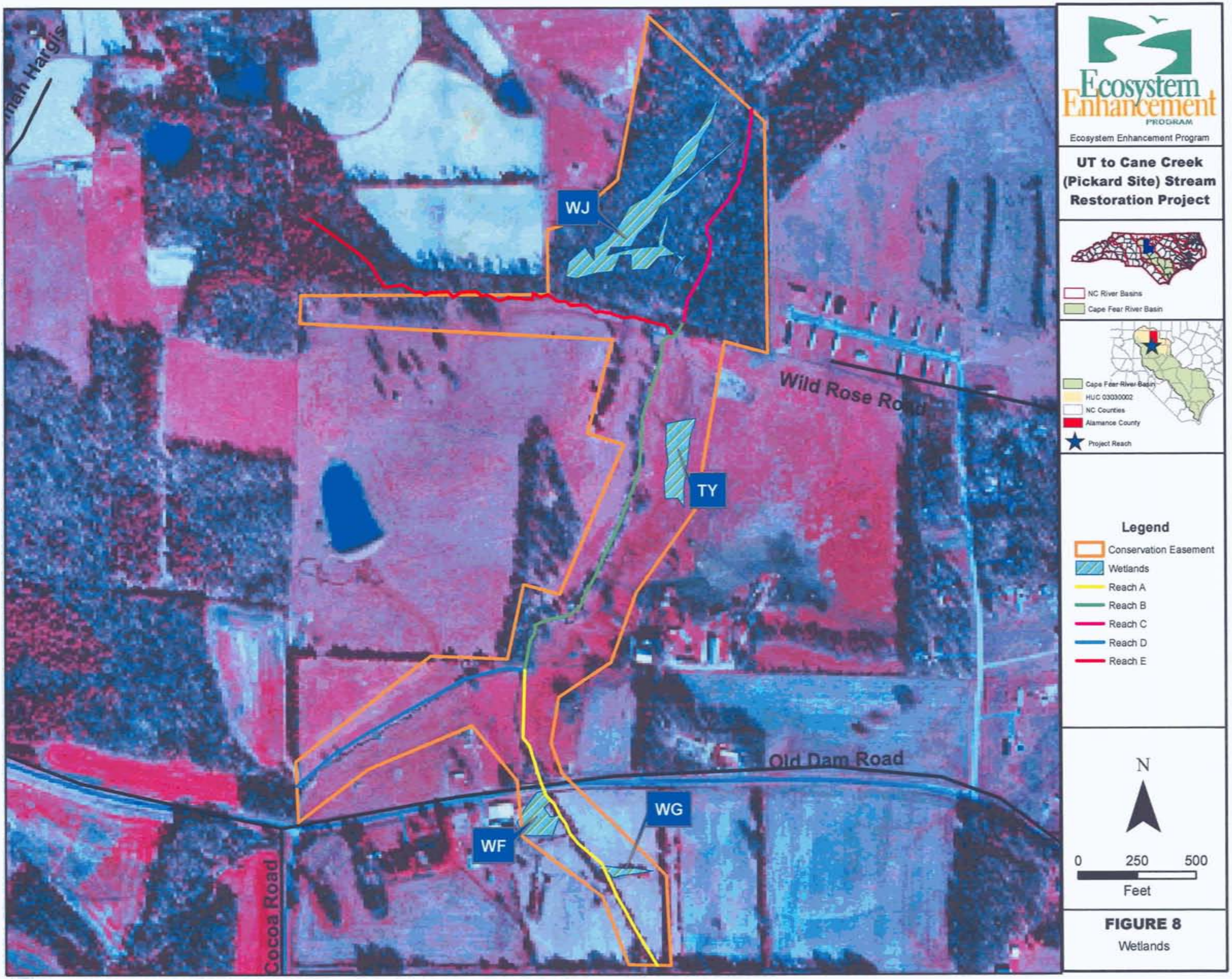
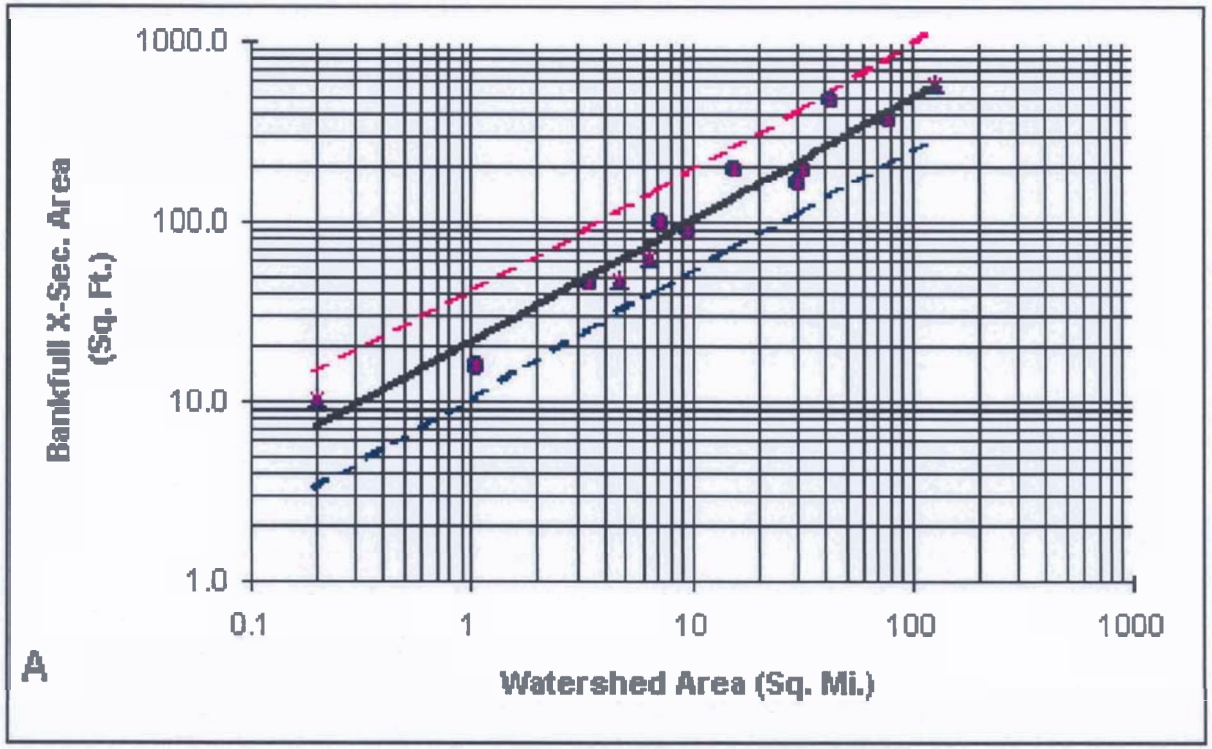


FIGURE 8

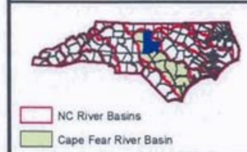
Wetlands



Bankfull hydraulic geometry relationships for rural Piedmont North Carolina Streams. The circles represent gauge stations and the triangles represent ungauged streams. The outside dashed lines are the 95% confidence intervals for all the data points.

Ecosystem Enhancement Program

UT to Cane Creek (Pickard Site) Stream Restoration Project



NOT TO SCALE

FIGURE 9

NC Rural Piedmont Regional Curve (Cross-Sectional Area)

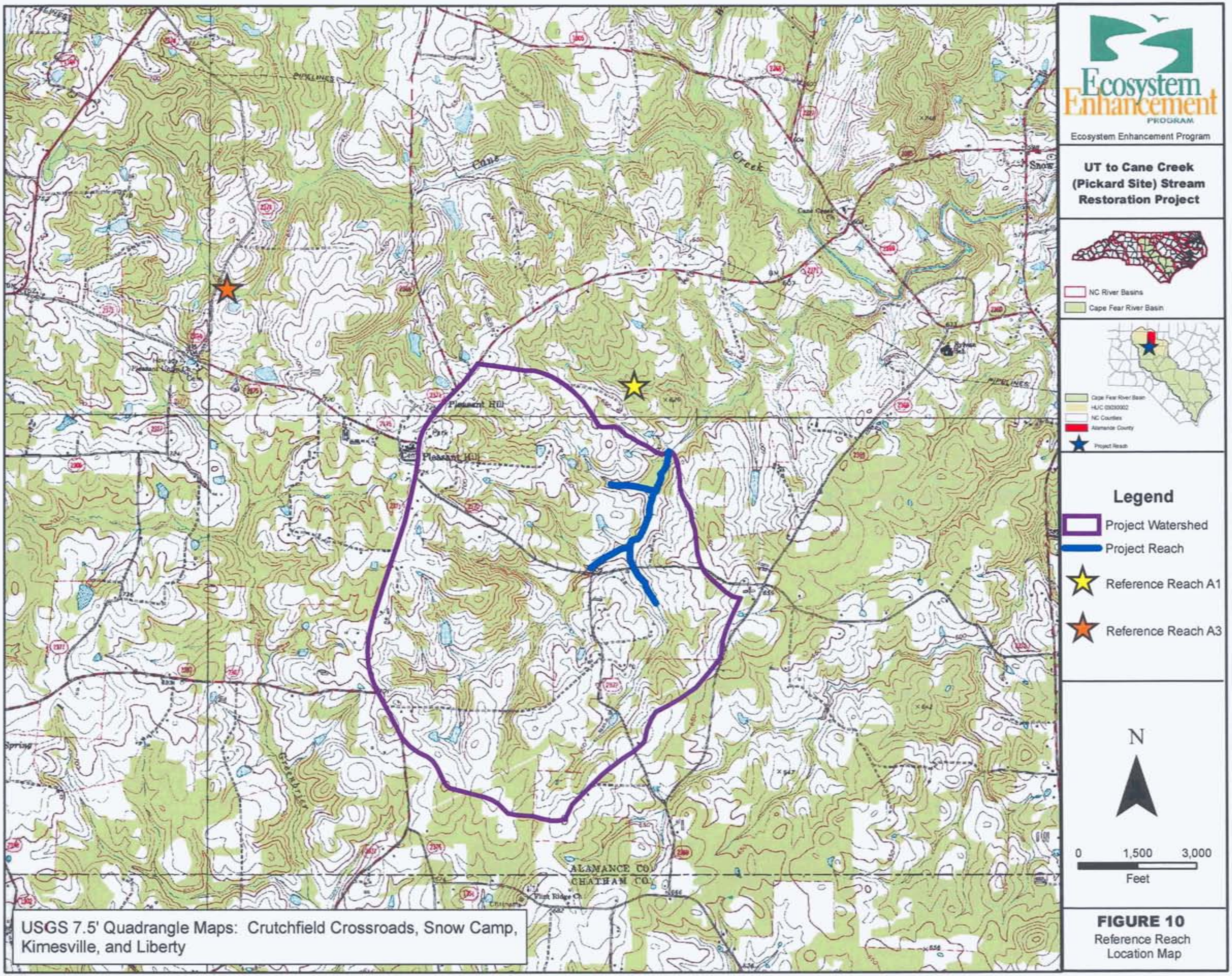


FIGURE 10
Reference Reach Location Map

APPENDIX A

Project Site Existing Conditions Photographs

Appendix A – Unnamed Tributary to Cane Creek Site Photographs

Photo 1 – UT to Cane Creek Reach A, upstream of Old Dam Road

Photo 2 – UT to Cane Creek Reach A, downstream of Old Dam Road

Photo 3 – UT to Cane Creek Reach A, downstream of Old Dam Road

Photo 4 – UT to Cane Creek Reach A, cattle crossing

Photo 5 – Reach A riffle cross-section, looking downstream (upstream of Old Dam Road)

Photo 6 – Reach A pool cross-section, looking downstream (downstream of Old Dam Road)


Photo 7 – UT to Cane Creek, Reach B, looking downstream


Photo 8 – Reach B riffle cross section, looking downstream


Photo 9 – Reach B pool cross section, looking upstream


Photo 10 – Reach B riffle cross section, looking downstream


Photo 11 – Reach B pool cross section, looking downstream


Photo 12 – Reach C, looking downstream

Photo 13 – Reach C riffle cross section, looking downstream

Photo 14 – Reach C pool cross section, looking downstream

Photo 15 – Reach D, looking upstream

Photo 16 – Reach D riffle cross section, looking downstream

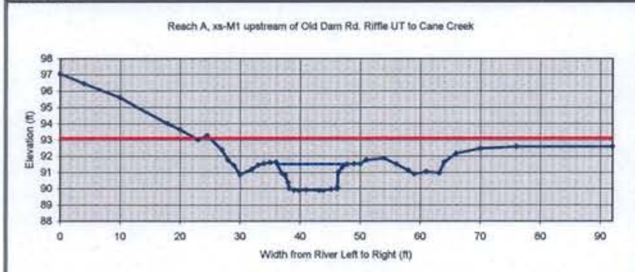
Photo 17 – Reach D pool cross section, looking downstream

Photo 18 – Cattle in Reach E, looking upstream

APPENDIX B

Project Site Existing Conditions Data

Cross Section



section:	Reach A, xs-M1 upstream of Old Dam Rd.
	Riffle
	UT to Cane Creek
	Cape Fear
description:	watershed area = 0.59 sq. mi
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☑	0	2.95	97.05
	☑	4	3.55	96.45
	☑	10	4.41	95.59
	☑	18	6.00	94
	☑	20	6.36	93.64
	☑	23	6.99	93.01
	☑	24.5	6.74	93.26
	☑	27	7.63	92.37
	☑	28	8.25	91.75
PBF	☑	29	8.57	91.43
side chanr	☑	30	9.13	90.87
	☑	32	8.81	91.19
	☑	33	8.55	91.45
	☑	34	8.45	91.55
PBF	☑	35	8.40	91.6
	☐	36	8.37	91.63
	☐	37	9.07	90.93
	☐	37.5	9.18	90.82
	☐	38	9.63	90.37
LEW	☐	38.2	10.00	90
	☐	39	10.09	89.91
	☐	39.8	10.10	89.9
	☐	41	10.07	89.93
	☐	43.2	10.11	89.89
thalweg	☐	43.9	10.11	89.89
	☐	45.2	10.03	89.97
REW bed	☐	46.2	9.99	90.01
REW wate	☐	46.2	9.94	90.06
	☐	46.3	8.99	91.01
PBF	☐	47	8.68	91.32
PBF	☐	47.8	8.50	91.5
	☑	49	8.48	91.52
	☑	50	8.47	91.53
	☑	51	8.23	91.77
	☑	54	8.15	91.85
	☑	56	8.50	91.5
	☑	58	8.88	91.12
	☑	59	9.09	90.91
	☑	61	8.95	91.05
	☑	63.2	9.03	90.97
	☑	64	8.38	91.62
	☑	66	7.82	92.18
	☑	70	7.54	92.46
	☑	76	7.42	92.58
	☑	92	7.42	92.58
	☐			

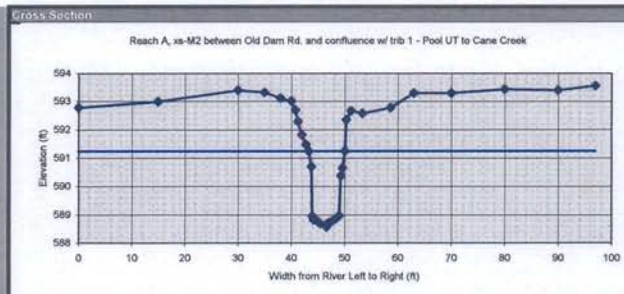
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.5	8.23	65.0	1.7	0.03
91.5	91.77			

dimensions			
14.3	x-section area	1.2	d mean
11.6	width	13.2	wet P
1.6	d max	1.1	hyd radi
1.9	bank ht	9.5	w/d ratio
65.0	W flood prone area	5.6	ent ratio

hydraulics	
6.8	velocity (ft/sec)
96.9	discharge rate, Q (cfs)
1.15	shear stress ((lbs/ft sq)
0.77	shear velocity (ft/sec)
8.852	unit stream power (lbs/ft/sec)
1.17	Froude number
8.8	friction factor u/u*
94.5	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	Reach A, xs-M2 between Old Dam Rd. and confluence w/ trib 1 -
	Pool
	UT to Cane Creek
	Cape Fear
description:	watershed area = 0.62
height of instrument (ft):	601.69

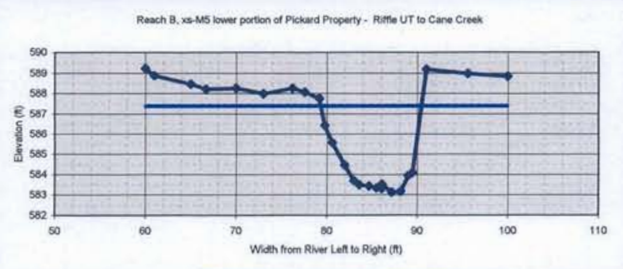
notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	8.91	592.78
	☐	15	8.70	592.99
	☐	30	8.29	593.4
	☐	35	8.37	593.32
	☐	38	8.57	593.12
	☐	40	8.67	593.02
TOB Left	☐	40.8	9.00	592.69
	☐	41.3	9.40	592.29
	☐	42	9.87	591.82
	☐	42.8	10.22	591.47
PBF	☐	43.3	10.46	591.23
PBF	☐	43.8	10.99	590.7
	☐	43.95	12.74	588.95
LEW	☐	44.2	12.87	588.82
	☐	45	12.93	588.76
	☐	45.55	13.01	588.68
Thalweg	☐	46.7	13.12	588.57
	☐	47	12.97	588.72
	☐	47.4	12.95	588.74
	☐	48.2	12.85	588.84
	☐	48.6	12.80	588.89
REW	☐	49	12.72	588.97
PBF	☐	49.3	11.32	590.37
PBF	☐	49.6	11.04	590.65
PBF	☐	50.1	10.44	591.25
	☐	50.3	9.34	592.35
	☐	51.2	9.02	592.67
	☐	53.3	9.11	592.58
	☐	58.6	8.91	592.78
	☐	63	8.39	593.3
	☐	70	8.40	593.29
	☐	80	8.26	593.43
	☐	90	8.30	593.39
	☐	97	8.14	593.55
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

FS bankfull	FS top of bank		channel slope (%)	
10.44	9.02			
591.25	592.67			

dimensions			
13.8	x-section area	2.0	d mean
6.8	width	10.3	wet P
2.7	d max	1.3	hyd radi
4.1	bank ht		

hydraulics	
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.0	threshold grain size (mm)

Cross Section



section:	Reach B. xs-M5 lower portion of Pickard Property - Riffle UT to Cane Creek Cape Fear
description:	watershed area = 2 sq. miles
height of instrument (ft):	592.19

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	60	2.96	589.23
	☐	61	3.32	588.87
	☐	65	3.74	588.45
cattle path	☐	66.7	3.98	588.21
	☐	70	3.94	588.25
	☐	73	4.20	587.99
	☐	76.2	3.94	588.25
	☐	77.6	4.12	588.07
TOB Left	☐	79.2	4.44	587.75
	☐	79.8	5.77	586.42
PBF	☐	80.6	6.64	585.55
	☐	82	7.74	584.45
	☐	83	8.51	583.68
LEW	☐	83.6	8.71	583.48
	☐	84.7	8.77	583.42
	☐	85.5	8.87	583.32
Thalweg	☐	86.1	8.90	583.29
WS	☐	86.1	8.68	583.51
	☐	87.2	9.07	583.12
REW	☐	88.2	9.02	583.17
	☐	89	8.26	583.93
	☐	89.5	8.10	584.09
TOB Right	☐	91	3.00	589.19
	☐	95.6	3.20	588.99
	☐	100	3.34	588.85

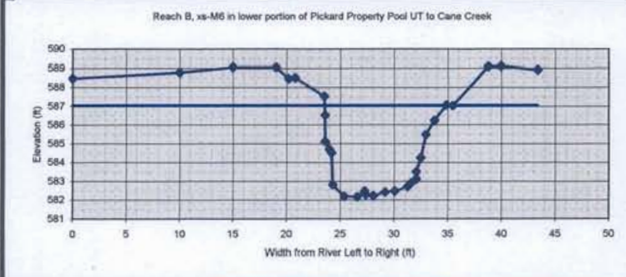
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
4.8	3.94	350.0	0.43	0.035
587.39	588.25			

dimensions			
35.4	x-section area	3.2	d mean
11.1	width	15.9	wet P
4.3	d max	2.2	hyd radi
5.1	bank ht	3.5	w/d ratio
350.0	W flood prone area	31.5	ent ratio

hydraulics	
4.7	velocity (ft/sec)
168.0	discharge rate, Q (cfs)
0.60	shear stress ((lbs/ft sq)
0.56	shear velocity (ft/sec)
4.058	unit stream power (lbs/ft/sec)
0.22	Froude number
8.6	friction factor u/u*
37.4	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	Reach B, xs-M6 in lower portion of Pickard Property Pool UT to Cane Creek Cape Fear
description:	watershed area = 2
height of instrument (ft):	592.19

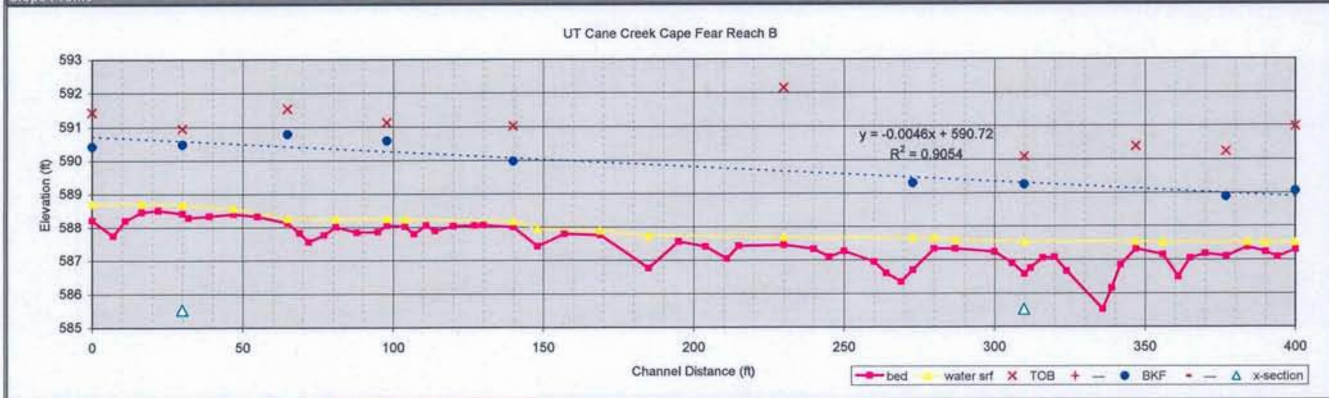
notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	3.71	588.48
	☐	10	3.41	588.78
	☐	15	3.15	589.04
	☐	19	3.15	589.04
TOB Left	☐	20.2	3.74	588.45
	☐	20.8	3.68	588.51
	☐	23.5	4.65	587.54
Top of unc	☑	23.6	5.68	586.51
PBF	☐	23.6	7.07	585.12
On steep l	☐	24	7.50	584.69
	☐	24.2	7.68	584.51
LEW	☐	24.3	9.37	582.82
	☐	25.4	10.00	582.19
	☐	26.6	10.01	582.18
	☐	27.3	9.71	582.48
	☐	27.4	9.91	582.28
	☐	28.1	9.97	582.22
	☐	29.2	9.77	582.42
	☐	30.1	9.72	582.47
	☐	31.3	9.47	582.72
	☐	31.6	9.30	582.89
REW	☐	32.1	9.07	583.12
WS	☐	32.1	8.68	583.51
	☐	32.5	7.95	584.24
	☐	33	6.72	585.47
	☐	33.8	5.97	586.22
	☐	34.9	5.13	587.06
	☐	35.5	5.17	587.02
TOB Right	☐	38.8	3.12	589.07
	☐	40	3.10	589.09
	☐	43.4	3.29	588.9

FS bankfull	FS top of bank		channel slope (%)	
5.13	3.15		0.43	
587.06	589.04			

dimensions			
41.6	x-section area	3.5	d mean
12.0	width	16.6	wet P
4.9	d max	2.5	hyd radi
6.9	bank ht		

hydraulics	
0.67	shear stress ((lbs/ft sq)
0.59	shear velocity (ft/sec)
42.7	threshold grain size (mm)

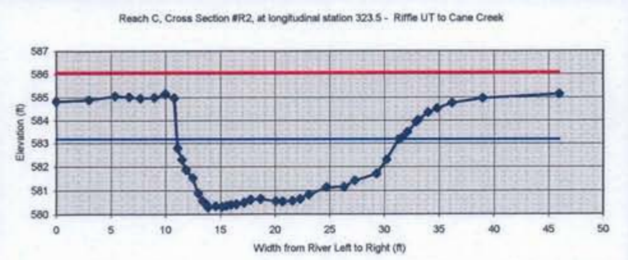
Slope Profile



592.39 :Elevation BM

notes	cross section	station		BS	HI	FS TP	FS bed	depth water	FS BKF	FS TOB	FS	FS	AZ azimuth	ELEV bed	ELEV water srf	ELEV BKF	ELEV TOB	ELEV ---	ELEV ---
				5.41	597.8														
Head of Pool		0			597.8		9.58	0.49	7.39	6.38				588.22	588.71	590.41	591.42		
Dmax		7			597.8		10.05							587.75					
Glide		11			597.8		9.59							588.21					
Top of Riffle		16.5			597.8		9.33	0.24						588.47	588.71				
Mid Riffle		22			597.8		9.29							588.51					
Bottom of I	xs-M7	30			597.8		9.38	0.26	7.33	6.86				588.42	588.68	590.47	590.94		
Run		32			597.8		9.5							588.3					
Run		39			597.8		9.46							588.34					
Top of Riffle		47			597.8		9.39	0.16						588.41	588.57				
Mid Riffle		55			597.8		9.47							588.33					
Bottom of Riffle		65			597.8		9.66	0.13	7.02	6.27				588.14	588.27	590.78	591.53		
Head of Pool		69			597.8		9.98							587.82					
Dmax		72			597.8		10.24							587.56					
Glide		77			597.8		10.03							587.77					
Top of Riffle / Run		81			597.8		9.79	0.25						588.01	588.26				
Pool		88			597.8		9.96							587.84					
Glide		95			597.8		9.94							587.86					
Top of Riffle		98			597.8		9.74	0.2	7.22	6.68				588.06	588.26	590.58	591.12		
Bottom of Riffle		104			597.8		9.78	0.22						588.02	588.24				
Run		107			597.8		10							587.8					
Run		111			597.8		9.74							588.06					
Run		114			597.8		9.91							587.89					
Run		120			597.8		9.76							588.04					
Run		127			597.8		9.74							588.06					
Run		130			597.8		9.73							588.07					
Begin of Sm. Debris		140			597.8		9.8	0.18	7.82	6.78				588	588.18	589.98	591.02		
Mid of Sm. Debris Ja		148			597.8		10.37	0.52						587.43	587.95				
End of Sm Debris Ja		157			597.8		10							587.8					
Begin of Lg. Debris		169			597.8		10.04	0.13						587.76	587.89				
End of Lg. Debris Ja		185			597.8		11.03	0.97						586.77	587.74				
Run		195			597.8		10.24							587.56					
Begin of Sm. Debris		204			597.8		10.39							587.41					
End of Sm Debris Ja		211			597.8		10.75							587.05					
Run		215			597.8		10.37							587.43					
Run		230			597.8		10.34	0.22		5.66				587.46	587.68		592.14		
Run		240			597.8		10.47							587.33					
Run		245			597.8		10.7							587.1					
Run		250			597.8		10.53							587.27					
Run		260			597.8		10.85							586.95					
Head of Scour Pool		264			597.8		11.19							586.61					
Dmax		269			597.8		11.45							586.35					
					597.8	5.83													
				6.31	598.28														
Glide		273			598.28		11.58	0.96	8.98					586.7	587.66	589.3			
Top of Riffle		280			598.28		10.95	0.33						587.33	587.66				
Bottom of Riffle		287			598.28		10.95	0.26						587.33	587.59				
Run		300			598.28		11.04							587.24					
Head of pool		306			598.28		11.38							586.9					
Dmax	xs-M8	310			598.28		11.7	0.96	9.03	8.2				586.58	587.54	589.25	590.08		
Glide		312			598.28		11.52							586.76					
Run / Pool		316			598.28		11.22							587.06					
Big Rock		320			598.28		11.2							587.08					
Big Rock		324			598.28		11.62							586.66					
Glide		336			598.28		12.75							585.53					
Glide		339			598.28		12.12							586.16					
Glide		342			598.28		11.43							586.85					
Top of Riffle		347			598.28		10.96	0.22		7.9				587.32	587.54		590.38		
Bottom of Riffle / He		356			598.28		11.13	0.38						587.15	587.53				
Dmax		361			598.28		11.79							586.49					
Glide		365			598.28		11.23							587.05					
Run		370			598.28		11.1							587.18					
Run		377			598.28		11.17		9.4	8.05				587.11		588.88	590.23		
Top of Riffle		384			598.28		10.9	0.15						587.38	587.53				
Bottom of Riffle		390			598.28		11.04	0.28						587.24	587.52				
Run		394			598.28		11.19							587.09					
Top of Riffle		400			598.28		10.98	0.22	9.23	7.31				587.3	587.52	589.05	590.97		
					598.28														

Cross Section



section: [illegible]
Riffle
UT to Cane Creek
Cape Fear
description: watershed area = 2.54 sq. mi
height of instrument (ft): 590.42

notes	omit pt.	distance (ft)	FS (ft)	elevation
Left Bank	☐	0	5.60	584.82
	☐	3	5.53	584.89
	☐	5.4	5.37	585.05
	☐	6.7	5.41	585.01
	☐	7.7	5.47	584.95
	☐	9	5.44	584.98
	☐	10	5.28	585.14
TOB Left	☐	10.8	5.46	584.96
PBF	☐	11.1	7.64	582.78
	☐	11.5	8.11	582.31
	☐	11.9	8.55	581.87
	☐	12.5	8.89	581.53
	☐	13	9.55	580.87
	☐	13.4	9.87	580.55
LEW / WS	☐	13.7	9.98	580.44
	☐	13.9	10.13	580.29
	☐	14.6	10.08	580.34
	☐	15.2	10.10	580.32
	☐	15.6	10.06	580.36
	☐	16	10.02	580.4
REW / WS	☐	16.5	10.00	580.42
	☐	17.2	9.93	580.49
	☐	17.8	9.81	580.61
	☐	18.7	9.78	580.64
	☐	20.1	9.87	580.55
	☐	20.7	9.89	580.53
	☐	21.6	9.86	580.56
	☐	22.3	9.78	580.64
	☐	23.1	9.60	580.82
	☐	24.7	9.29	581.13
	☐	26.3	9.27	581.15
	☐	27.3	9.00	581.42
	☐	29.3	8.72	581.7
	☐	30.2	8.12	582.3
PBF	☐	31.3	7.24	583.18
	☐	31.6	7.17	583.25
	☐	32.1	6.92	583.5
	☐	33.1	6.41	584.01
TOB Right	☐	32.9	6.49	583.93
	☐	34	6.08	584.34
	☐	34.8	5.91	584.51
	☐	36.2	5.67	584.75
	☐	39	5.47	584.95
	☐	46	5.29	585.13
	☐			

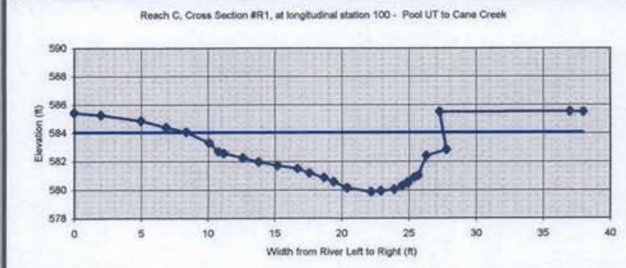
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
7.24	5.46	300.0		
583.18	584.96			

dimensions			
42.9	x-section area	2.1	d mean
20.3	width	22.2	wet P
2.9	d max	1.9	hyd radi
4.7	bank ht	9.6	w/d ratio
300.0	W flood prone area	14.8	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section: Reach C, Cross Section #R1, at longitudinal station 100 -
Pool
UT to Cane Creek
Cape Fear
description: watershed area = 2.54 sq. mi
height of instrument (ft): 590.42

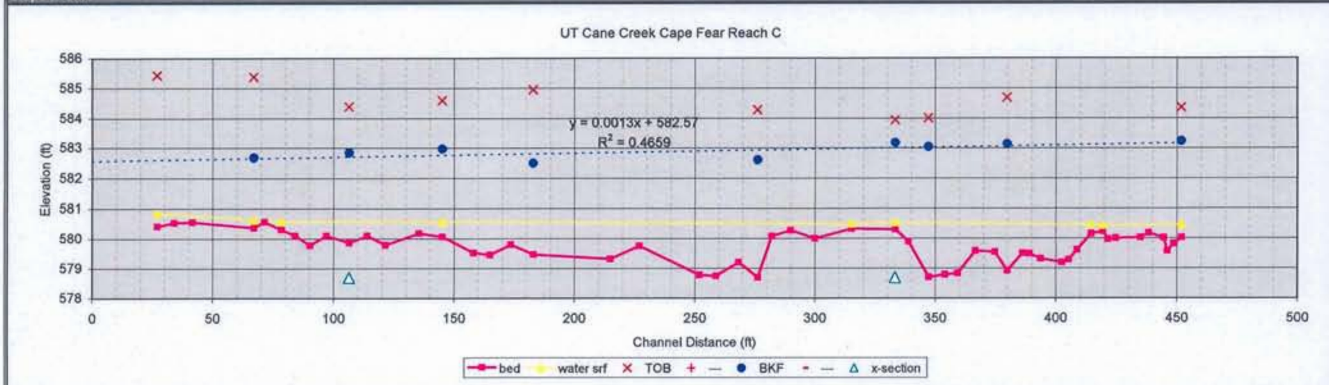
notes	omit pt.	distance (ft)	FS (ft)	elevation
Left Bank	☐	0	5.02	585.4
	☐	2	5.17	585.25
	☐	5	5.58	584.84
TOB Left	☐	6.9	6.03	584.39
	☐	8.4	6.35	584.07
Left PBF	☐	10.1	7.12	583.3
	☐	10.8	7.73	582.69
Back of Ben	☐	11.2	7.85	582.57
	☐	12.6	8.17	582.25
	☐	13.8	8.46	581.96
	☐	15.2	8.70	581.72
	☐	16.7	8.93	581.49
	☐	17.6	9.24	581.18
	☐	18.7	9.58	580.84
	☐	19.4	9.87	580.55
LEW	☐	20.4	10.29	580.13
	☐	22.2	10.56	579.86
	☐	22.9	10.50	579.92
	☐	23.9	10.38	580.04
	☐	24.5	10.13	580.29
REW	☐	24.9	9.96	580.46
WS	☐	24.9	9.88	580.54
	☐	25.4	9.55	580.87
	☐	25.7	9.42	581
	☐	26.3	8.02	582.4
Right PBF	☐	27.8	7.58	582.84
TOB Right	☐	27.3	4.95	585.47
	☐	37	4.92	585.5
	☐	38	4.97	585.45

FS bankfull	FS top of bank		channel slope (%)	
6.35	4.95			
584.07	585.47			

dimensions			
49.7	x-section area	2.6	d mean
19.2	width	22.7	wet P
4.2	d max	2.2	hyd radi
5.6	bank ht		

hydraulics	
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.0	threshold grain size (mm)

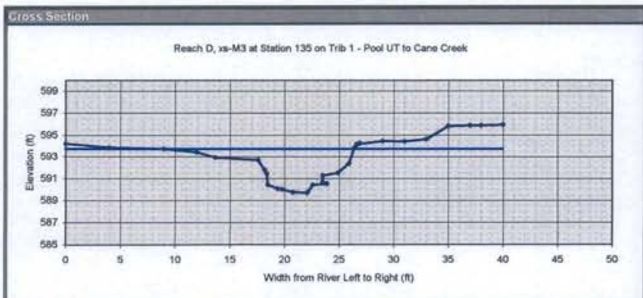
Slope Profile



585.02 :Elevation BM

notes	cross section	station		BS	HI	FS TP	FS bed	depth water	FS BKF	FS TOB	FS	FS	AZ azimuth	ELEV bed	ELEV water srf	ELEV BKF	ELEV TOB	ELEV ---	ELEV ---
				5.4	590.42														
End of Riffle / Head		27			590.42		10	0.43		5				580.42	580.85		585.42		
		34			590.42		9.89							580.53					
47-63 is under debri		41.6			590.42		9.87							580.55					
		67			590.42		10.06	0.27	7.73	5.05				580.36	580.63	582.69	585.37		
		71.4			590.42		9.86							580.56					
		78.4			590.42		10.12	0.27						580.3	580.57				
		84.1			590.42		10.32							580.1					
		90.2			590.42		10.65							579.77					
		97.2			590.42		10.32							580.1					
	xs-R1	106.6			590.42		10.56		7.58	6.03				579.86		582.84	584.39		
		114			590.42		10.32							580.1					
		121.5			590.42		10.64							579.78					
		135.5			590.42		10.25							580.17					
		145.3			590.42		10.36	0.5	7.45	5.83				580.06	580.56	582.97	584.59		
		158.1			590.42		10.9							579.52					
		165			590.42		10.96							579.46					
		173.6			590.42		10.63							579.79					
		183			590.42		10.95		7.91	5.48				579.47		582.51	584.94		
		215			590.42		11.1							579.32					
234-252 Debris Jam		227			590.42		10.67							579.75					
		252			590.42		11.64							578.78					
		259			590.42		11.67							578.75					
		268.4			590.42		11.22							579.2					
		276.3			590.42		11.72		7.81	6.15				578.7		582.61	584.27		
		282.2			590.42		10.35							580.07					
		290			590.42		10.16							580.26					
		300			590.42		10.42							580					
		315.3			590.42		10.11	0.17						580.31	580.48				
	xs-R2	333.4			590.42		10.13	0.23	7.24	6.49				580.29	580.52	583.18	583.93		
		338.8			590.42		10.53							579.89					
		347.2			590.42		11.71		7.38	6.43				578.71		583.04	583.99		
		353.9			590.42		11.63							578.79					
		359.2			590.42		11.59							578.83					
		366.5			590.42		10.84							579.58					
		374.6			590.42		10.88							579.54					
		379.8			590.42		11.5		7.28	5.74				578.92		583.14	584.68		
		386.1			590.42		10.91							579.51					
		389			590.42		10.93							579.49					
		393.6			590.42		11.1							579.32					
		402.4			590.42		11.23							579.19					
		405.2			590.42		11.13							579.29					
		408.7			590.42		10.81							579.61					
		414.5			590.42		10.28	0.31						580.14	580.45				
		419.4			590.42		10.2	0.2						580.22	580.42				
		421.6			590.42		10.46							579.96					
		424.7			590.42		10.43							579.99					
		434.9			590.42		10.4							580.02					
		438.4			590.42		10.26							580.16					
		444.6			590.42		10.41							580.01					
		446			590.42		10.85							579.57					
		448.7			590.42		10.6							579.82					
		452			590.42		10.4	0.42	7.19	6.08				580.02	580.44	583.23	584.34		

Cross Section



section:	Reach D, xs-M3 at Station 135 on Trib 1 -
	Pool UT to Cane Creek Cape Fear
description:	watershed area = 1.34
height of instrument (ft):	600.57

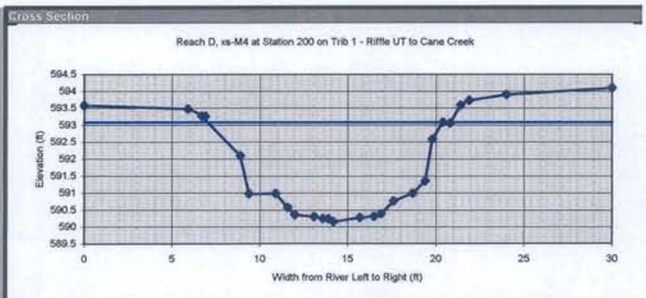
notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	6.36	594.21
	☐	4	6.72	593.85
	☐	9	6.86	593.71
	☐	12	7.18	593.39
	☐	13.7	7.65	592.92
TOB left P	☐	17.6	7.89	592.68
	☐	18.2	8.80	591.77
Undercut	☐	18.4	9.15	591.42
LEW	☐	18.5	10.16	590.41
	☐	19.4	10.50	590.07
	☐	19.8	10.58	589.99
	☐	20.8	10.83	589.74
	☐	22.1	10.86	589.71
Water Surf	☐	22.6	10.15	590.42
REW	☐	23.9	10.07	590.5
	☐	23.5	9.90	590.67
	☐	23.5	9.33	591.24
	☐	24.9	9.07	591.5
	☐	25.9	8.22	592.35
	☐	26.4	6.77	593.8
TOB Right	☐	26.9	6.34	594.23
	☐	26.6	6.41	594.16
	☐	29	6.12	594.45
	☐	31	6.15	594.42
	☐	33	5.94	594.63
	☐	35	4.77	595.8
	☐	37	4.69	595.88
	☐	38	4.71	595.86
	☐	40	4.65	595.92
	☐			

FS bankfull	FS top of bank		channel slope (%)	
6.86	6.41		0.23	
593.71	594.16			

dimensions			
30.4	x-section area	1.7	d mean
17.4	width	22.2	wet P
4.0	d max	1.4	hyd radi
4.5	bank ht		

hydraulics	
0.20	shear stress ((lbs/ft sq)
0.32	shear velocity (ft/sec)
11.4	threshold grain size (mm)

Cross Section



section:	Reach D, xs-M4 at Station 200 on Trib 1 -
	Riffle UT to Cane Creek Cape Fear
description:	watershed area = 1.34
height of instrument (ft):	600.57

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	6.99	593.58
	☐	5.9	7.10	593.47
	☐	6.9	7.31	593.26
TOB Left	☐	6.7	7.31	593.26
PBF	☐	8.9	8.48	592.09
	☐	9.4	9.60	590.97
	☐	10.9	9.59	590.98
LEW	☐	11.6	10.00	590.57
	☐	12	10.21	590.36
	☐	13.1	10.27	590.3
	☐	13.6	10.32	590.25
	☐	13.9	10.33	590.24
	☐	14.2	10.42	590.15
	☐	15.7	10.30	590.27
	☐	16.5	10.26	590.31
REW	☐	16.9	10.18	590.39
	☐	17.6	9.81	590.76
	☐	18.7	9.58	590.99
	☐	19.4	9.22	591.35
	☐	19.8	7.99	592.58
	☐	20.4	7.49	593.08
	☐	20.8	7.52	593.05
TOB Right	☐	21.4	6.98	593.59
	☐	21.9	6.84	593.73
	☐	24	6.68	593.89
	☐	30	6.48	594.09
	☐			
	☐			
	☐			
	☐			

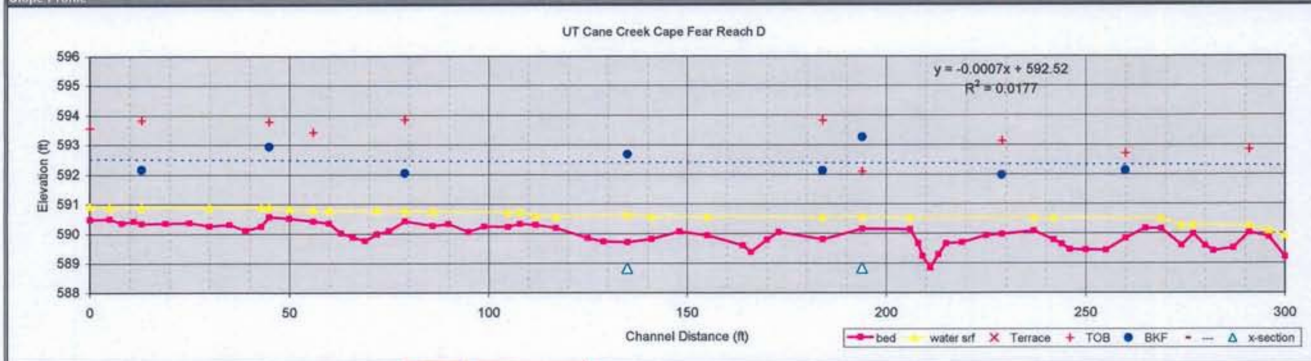
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
7.49	7.31	150.0	0.23	
593.08	593.26			

dimensions			
27.4	x-section area	2.0	d mean
13.8	width	16.3	wet P
2.9	d max	1.7	hyd radi
3.1	bank ht	6.9	w/d ratio
150.0	W flood prone area	10.9	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.24	shear stress ((lbs/ft sq)
0.35	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
13.6	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

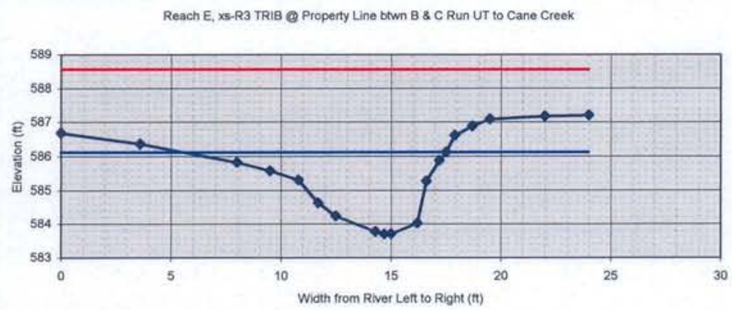
Slope Profile



598.41 Elevation BM

notes	cross section	station		BS	HI	FS TP	FS bed	depth water	FS BKF	FS Terrace	FS TOB	FS	AZ azimuth	ELEV bed	ELEV water srf	ELEV BKF	ELEV Terrace	ELEV TOB	ELEV —
				2.16	600.57														
					600.57														
Top of riffle		0			600.57		10.08	0.43			7			590.49	590.92			593.57	
Bottom of riffle		5			600.57		10.05	0.38						590.52	590.9				
Run		8			600.57		10.2							590.37					
Run		11			600.57		10.13							590.44					
Run		13			600.57		10.21	0.54	8.4		6.74			590.36	590.9	592.17		593.83	
Run		19			600.57		10.2							590.37					
Run		25			600.57		10.18							590.39					
Run		30			600.57		10.3	0.63						590.27	590.9				
Head of pool		35			600.57		10.25							590.32					
Dmax		39			600.57		10.45							590.12					
Glide		43			600.57		10.31	0.64						590.26	590.9				
Top of riffle		45			600.57		9.99	0.32	7.63		6.79			590.58	590.9	592.94		593.78	
Mid riffle		50			600.57		10.04	0.32						590.53	590.85				
Bottom of riffle		56			600.57		10.14	0.38			7.15			590.43	590.81			593.42	
Run		60			600.57		10.21	0.43						590.36	590.79				
Run		63			600.57		10.55							590.02					
Run		66			600.57		10.69							589.88					
Dmax		69			600.57		10.8							589.77					
Run / head of pool		72			600.57		10.58	0.8						589.99	590.79				
Glide		75			600.57		10.47							590.1					
Top of riffle		79			600.57		10.14	0.35	8.52		6.72			590.43	590.78	592.05		593.85	
		86			600.57		10.3	0.49						590.27	590.76				
		90			600.57		10.24							590.33					
		95			600.57		10.5							590.07					
		99			600.57		10.32							590.25					
Cattle crossing		105			600.57		10.33	0.49						590.24	590.73				
Top of riffle		108			600.57		10.24	0.4						590.33	590.73				
		112			600.57		10.27	0.31						590.3	590.61				
Bottom of riffle		117			600.57		10.37	0.38						590.2	590.58				
Run		125			600.57		10.72							589.85					
Head of pool		129			600.57		10.83							589.74					
Dmax	xs-M3	135			600.57		10.86	0.94	7.89		7.89			589.71	590.65	592.68		592.68	
Glide		141			600.57		10.75	0.76						589.82	590.58				
Top of riffle		148			600.57		10.5							590.07					
Bottom of riffle		155			600.57		10.63	0.63						589.94	590.57				
Run / head of pool		164			600.57		10.97							589.6					
Dmax		166			600.57		11.2							589.37					
Glide		170			600.57		10.78							589.79					
		173			600.57		10.52							590.05					
Run		184			600.57		10.77	0.75	8.45		6.75			589.8	590.55	592.12		593.82	
Top of riffle (Riffle XS-M4 at	xs-M4	194			600.57		10.42	0.41	7.31		8.48			590.15	590.56	593.26		592.09	
Bottom of riffle		206			600.57		10.44	0.4						590.13	590.53				
Run		208			600.57		10.91							589.66					
Pool		209			600.57		11.34							589.23					
Dmax		211			600.57		11.73							588.84					
Pool		213			600.57		11.28							589.29					
Pool		215			600.57		10.91							589.66					
Pool		219			600.57		10.88							589.69					
Pool		225			600.57		10.64							589.93					
Pool		229			600.57		10.6		8.6		7.44			589.97		591.97		593.13	
Top of riffle		237			600.57		10.49	0.45						590.08	590.53				
Bottom of riffle		242			600.57		10.79	0.74						589.78	590.52				
Head of pool		244			600.57		10.93							589.64					
Dmax		246			600.57		11.11							589.46					
End pool		250			600.57		11.12							589.45					
Run		255			600.57		11.13							589.44					
run, 9.32 PIB		260			600.57		10.74		8.45		7.87			589.83		592.12		592.7	
		265			600.57		10.41							590.16					
Top of riffle, cattle crossing		269			600.57		10.43	0.37						590.14	590.51				
small debris jam		274			600.57		10.97	0.65						589.6	590.25				
small debris jam		277			600.57		10.6	0.3						589.97	590.27				
		280			600.57		10.98							589.59					
Dmax		282			600.57		11.16							589.41					
		287			600.57		11.06							589.51					
Top of riffle		291			600.57		10.55	0.23			7.73			590.02	590.25			592.84	
		296			600.57		10.7	0.22						589.87	590.09				
		300			600.57		11.36	0.72						589.21	589.93				

Cross Section



section: Reach E, xs-R3 TRIB @ Property Line btwn B & C

Run
UT to Cane Creek
Cape Fear

description: watershed area = 0.44

height of instrument (ft): 592.59

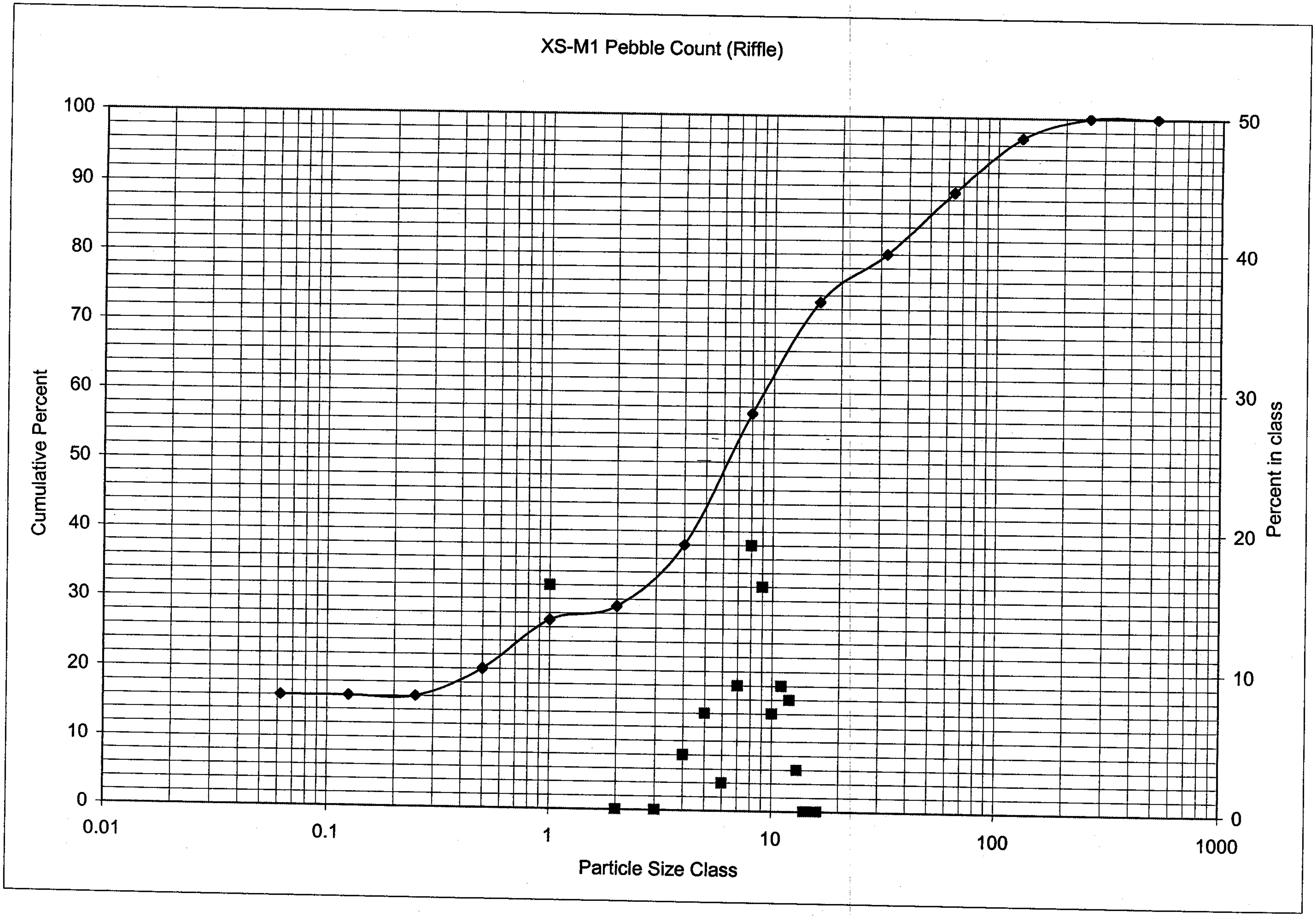
notes	omit pt.	distance (ft)	FS (ft)	elevation
		0	5.91	586.68
		3.6	6.22	586.37
		8	6.77	585.82
		9.5	7.02	585.57
TOB Left		10.8	7.29	585.3
		11.7	7.96	584.63
		12.5	8.35	584.24
LEW / WS		14.3	8.82	583.77
Thalweg		14.7	8.90	583.69
REW / WS		15	8.89	583.7
		16.2	8.57	584.02
Right PBF		16.6	7.33	585.26
TOB Right		17.2	6.71	585.88
		17.5	6.47	586.12
		17.9	5.98	586.61
		18.7	5.71	586.88
		19.5	5.50	587.09
		22	5.42	587.17
		24	5.39	587.2

FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
6.47	5.5	100.0		
586.12	587.09			

dimensions			
13.4	x-section area	1.1	d mean
11.9	width	13.6	wet P
2.4	d max	1.0	hyd radi
3.4	bank ht	10.5	w/d ratio
100.0	W flood prone area	8.4	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		


XS-M1 Pebble Count (Riffle)
Cumulative Percent
Percent in class
Particle Size Class
0
10
20
30
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1000

STREAM EVALUATION WORKBOOK

DATE: 3-Aug-04
OBSERVER(S): MRW, RCB, VMM, TLR
STREAM: UT to Cane Creek
USGS QUAD:
REACH:
LAT:
REACH LENGTH: 100 ft
LONG:
REACH LOCATION: Upstream of Old Dam Road (Riffle)

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 68
Sample Reach Length: 100 (ft)
Typical Sample Reach Width: 10 (ft)

Sample Reach Flow Type Proportions: ____ % Riffle ____ % Run ____ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

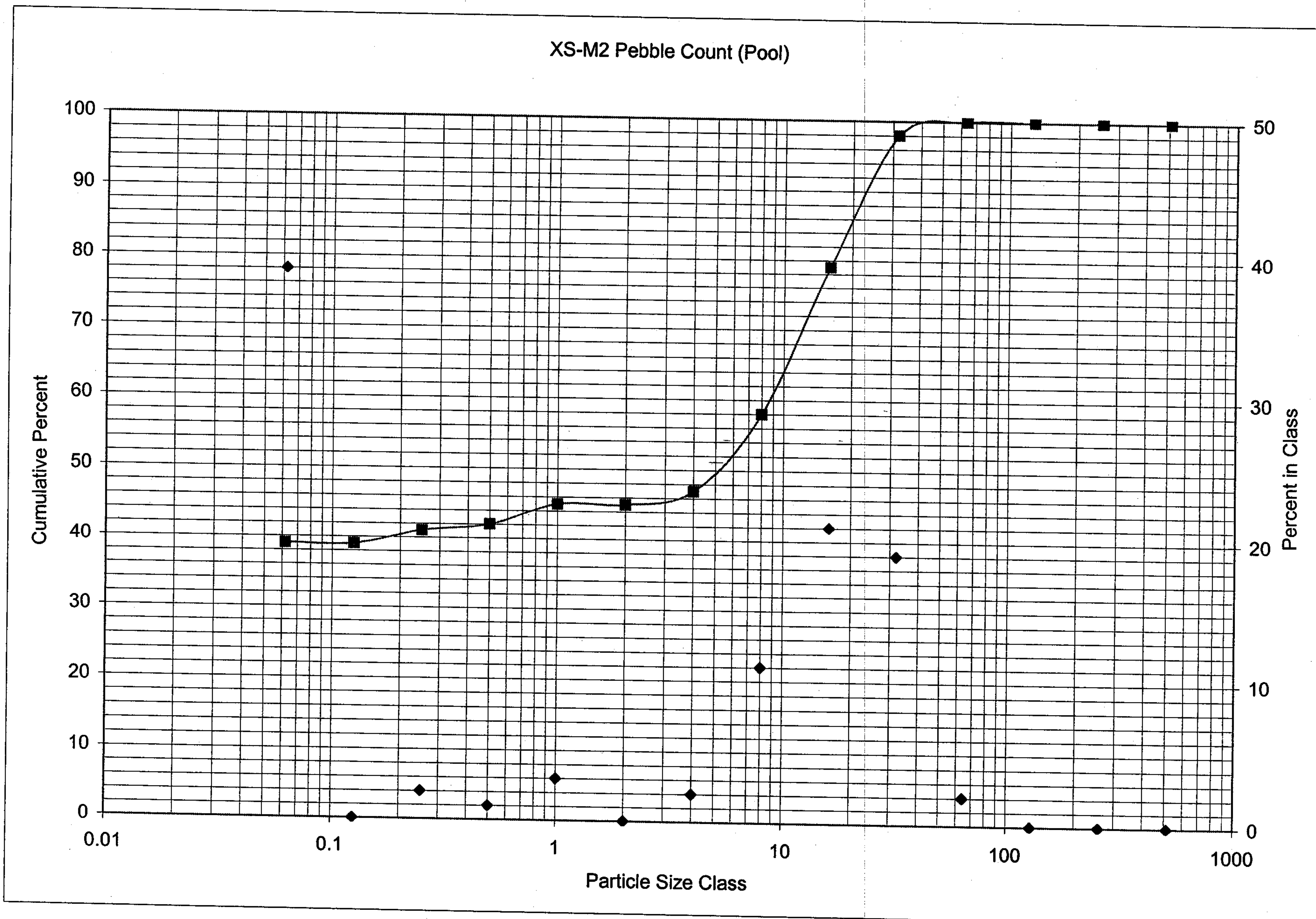
PARTICLE SIZE DATA:

Particle/Size (mm)	Transect Number and Pebble Count Tallies 1	2	3	4	5	6	7	8	9	10	Count Totals Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	16														
VF Sand .062<.125	0														
F Sand .125<.25	0														
M Sand .25<.50	4														
C Sand .50<1.0	7														
VC Sand 1.0<2.0	2														
VF Gravel 2<4	9														
F Gravel 4<8	19														
M Gravel 8<16	16														
C Gravel 16<32	7														
VC Gravel 32<64	9														
S Cobble 64<128	8														
L Cobble 128<256	3														
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
	101														
TOTALS:															

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	168
D25	0.8
D50	6.3
D84	44


XS-M2 Pebble Count (Pool)
Cumulative Percent
Percent in Class
Particle Size Class
0
10
20
30
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1000

STREAM EVALUATION WORKBOOK

DATE: 3-Aug-04
OBSERVER(S): MRW, RCB, VMM, TLR
STREAM: UT to Cane Creek
USGS QUAD:
REACH:
LAT:
REACH LENGTH: 100 ft
LONG:
REACH LOCATION: Downstream of Old Dam Road (Pool)

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 44
Sample Reach Length: 100 ft (ft)
Typical Sample Reach Width: 5 (ft)

Sample Reach Flow Type Proportions: ____ % Riffle ____ % Run ____ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

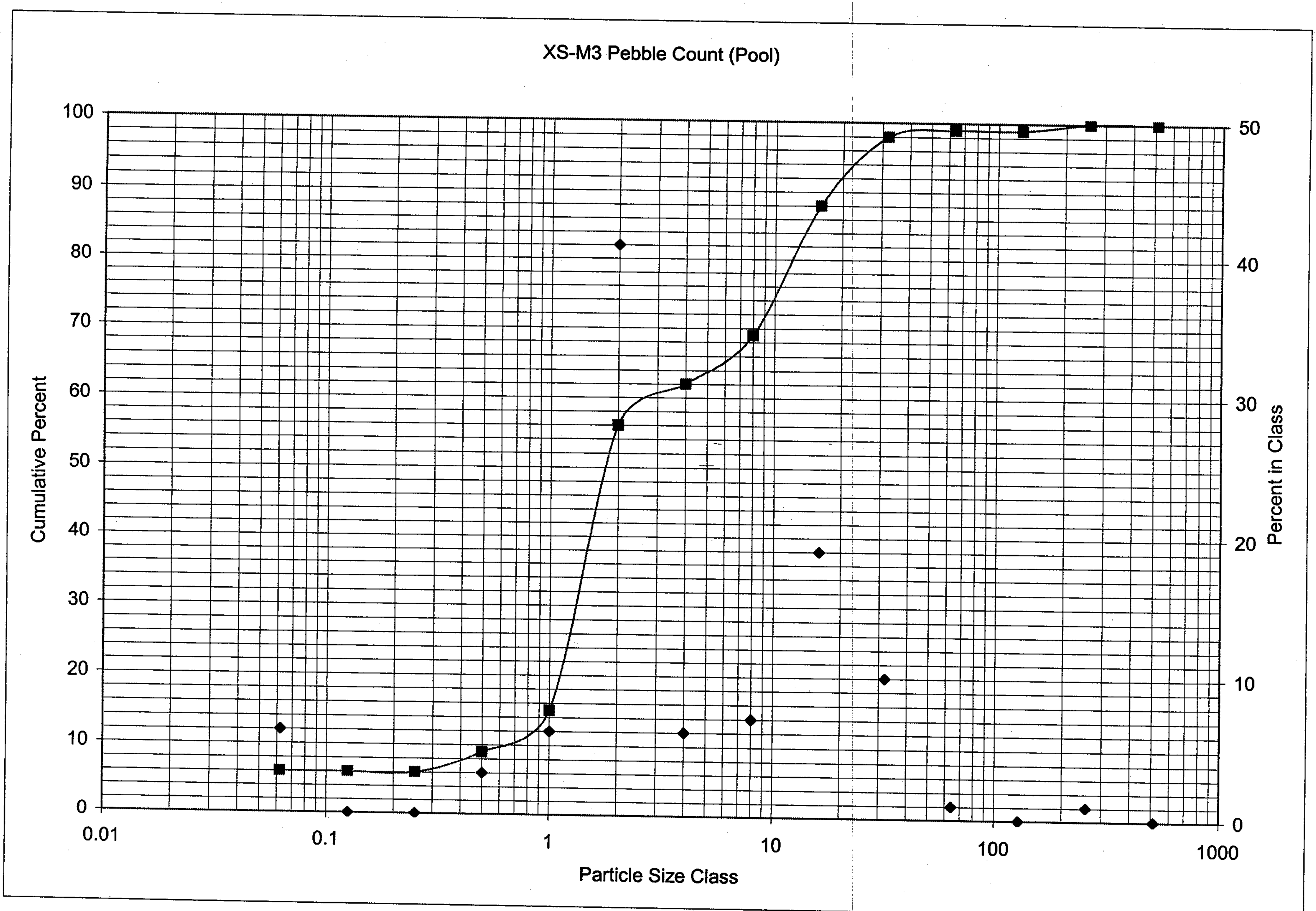
PARTICLE SIZE DATA:

	Transect Number and Pebble Count Tallies										Count Totals				
Particle/Size (mm)	1	2	3	4	5	6	7	8	9	10	Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	39														
VF Sand .062<.125	0														
F Sand .125<.25	2														
M Sand .25<.50	1														
C Sand .50<1.0	3														
VC Sand 1.0<2.0	0														
VF Gravel 2<4	2														
F Gravel 4<8	11														
M Gravel 8<16	21														
C Gravel 16<32	19														
VC Gravel 32<64	2														
S Cobble 64<128															
L Cobble 128<256															
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
										TOTALS:					

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	39
D25	--
D50	5.1
D84	19



XS-M3 Pebble Count (Pool)
Cumulative Percent
Percent in Class
Particle Size Class
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
50
40
30
20
10
0

STREAM EVALUATION WORKBOOK

DATE: 4-Aug-04
STREAM: Trib 1 to UT to Cane Creek
REACH:
REACH LENGTH: 300 ft
REACH LOCATION: On Trib 1 (Pool)

OBSERVER(S): RCB, VMM
USGS QUAD:
LAT:
LONG:

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 135
Sample Reach Length: 300 (ft)
Typical Sample Reach Width: 5 (ft)

Sample Reach Flow Type Proportions: ______ % Riffle ______ % Run ______ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

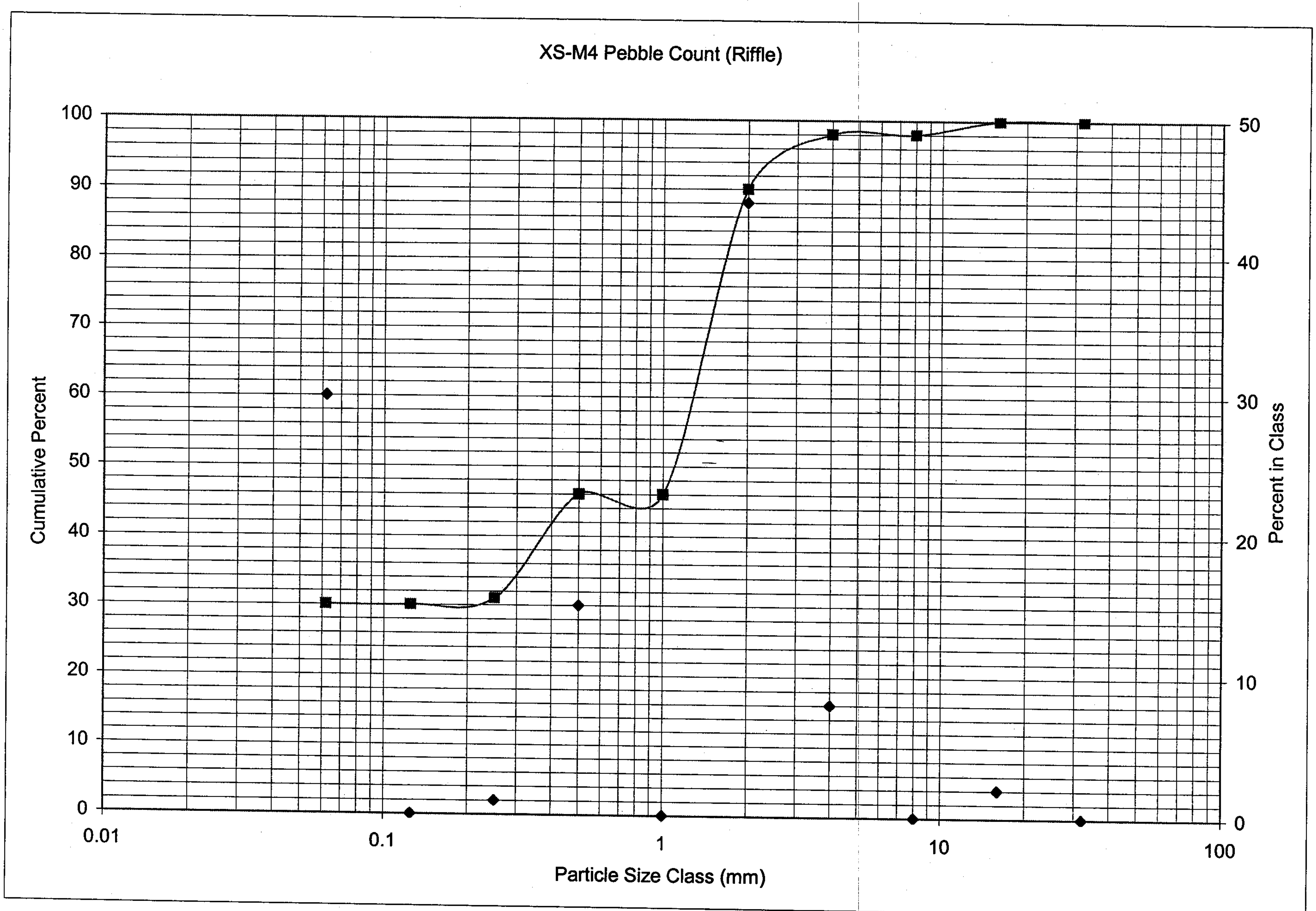
PARTICLE SIZE DATA:

Particle/Size (mm)	Transect Number and Pebble Count Tallies 1	2	3	4	5	6	7	8	9	10	Count Totals Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	6														
VF Sand .062<.125															
F Sand .125<.25															
M Sand .25<.50	3														
C Sand .50<1.0	6														
VC Sand 1.0<2.0	41														
VF Gravel 2<4	6														
F Gravel 4<8	7														
M Gravel 8<16	19														
C Gravel 16<32	10														
VC Gravel 32<64	1														
S Cobble 64<128															
L Cobble 128<256	1														
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
TOTALS:															

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	230
D25	1.3
D50	1.8
D84	14


XS-M4 Pebble Count (Riffle)
Cumulative Percent
Percent in Class
Particle Size Class (mm)
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100

STREAM EVALUATION WORKBOOK

DATE: 4-Aug-04
STREAM: Trib 1 to UT to Cane
REACH:
REACH LENGTH: 300 ft
REACH LOCATION: On Trib 1(Riffle)

OBSERVER(S): RCB, VMM
USGS QUAD:
LAT:
LONG:

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 199.7
Sample Reach Length: 300 (ft)
Typical Sample Reach Width: 5 (ft)

Sample Reach Flow Type Proportions: ____% Riffle ____% Run ____% Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

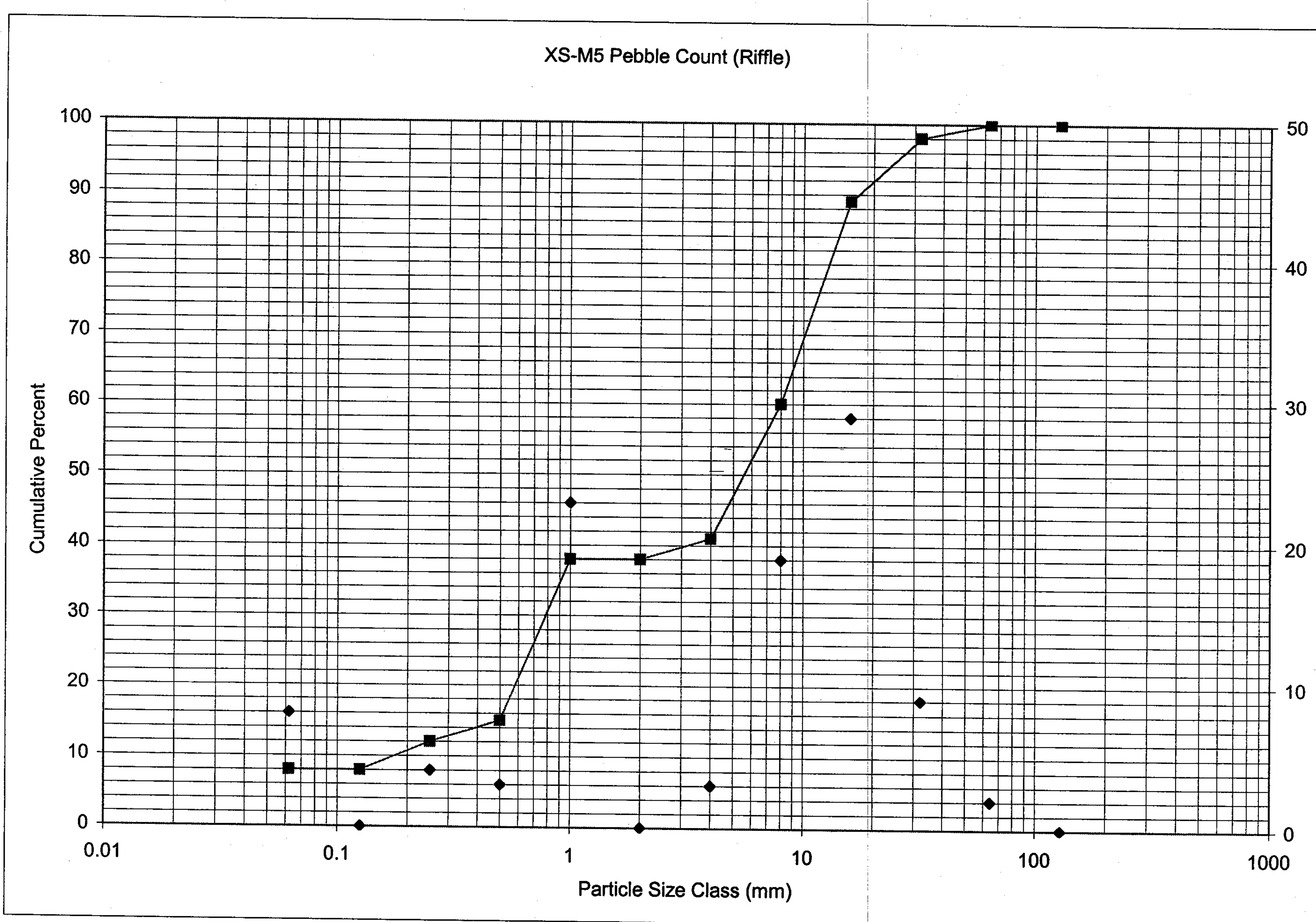
PARTICLE SIZE DATA:

	Transect Number and Pebble Count Tallies										Count Totals				
Particle/Size (mm)	1	2	3	4	5	6	7	8	9	10	Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	30														
VF Sand .062<.125															
F Sand .125<.25	1														
M Sand .25<.50	15														
C Sand .50<1.0															
VC Sand 1.0<2.0	44														
VF Gravel 2<4	8														
F Gravel 4<8															
M Gravel 8<16	2														
C Gravel 16<32															
VC Gravel 32<64															
S Cobble 64<128															
L Cobble 128<256															
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
										TOTALS:					

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	
D25	--
D50	1.2
D84	1.8


XS-M5 Pebble Count (Riffle)
Cumulative Percent
100
90
80
70
60
50
40
30
20
10
0
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
Particle Size Class (mm)

STREAM EVALUATION WORKBOOK

DATE: 4-Aug-04
STREAM: UT to Cane Creek
REACH:
REACH LENGTH: 100 ft
REACH LOCATION: Mainstem above Trib 2 (Riffle)

OBSERVER(S): MRW, TLR
USGS QUAD:
LAT:
LONG:

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 98.4
Sample Reach Length: 100 (ft)
Typical Sample Reach Width: 5 (ft)

Sample Reach Flow Type Proportions: ____ % Riffle ____ % Run ____ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

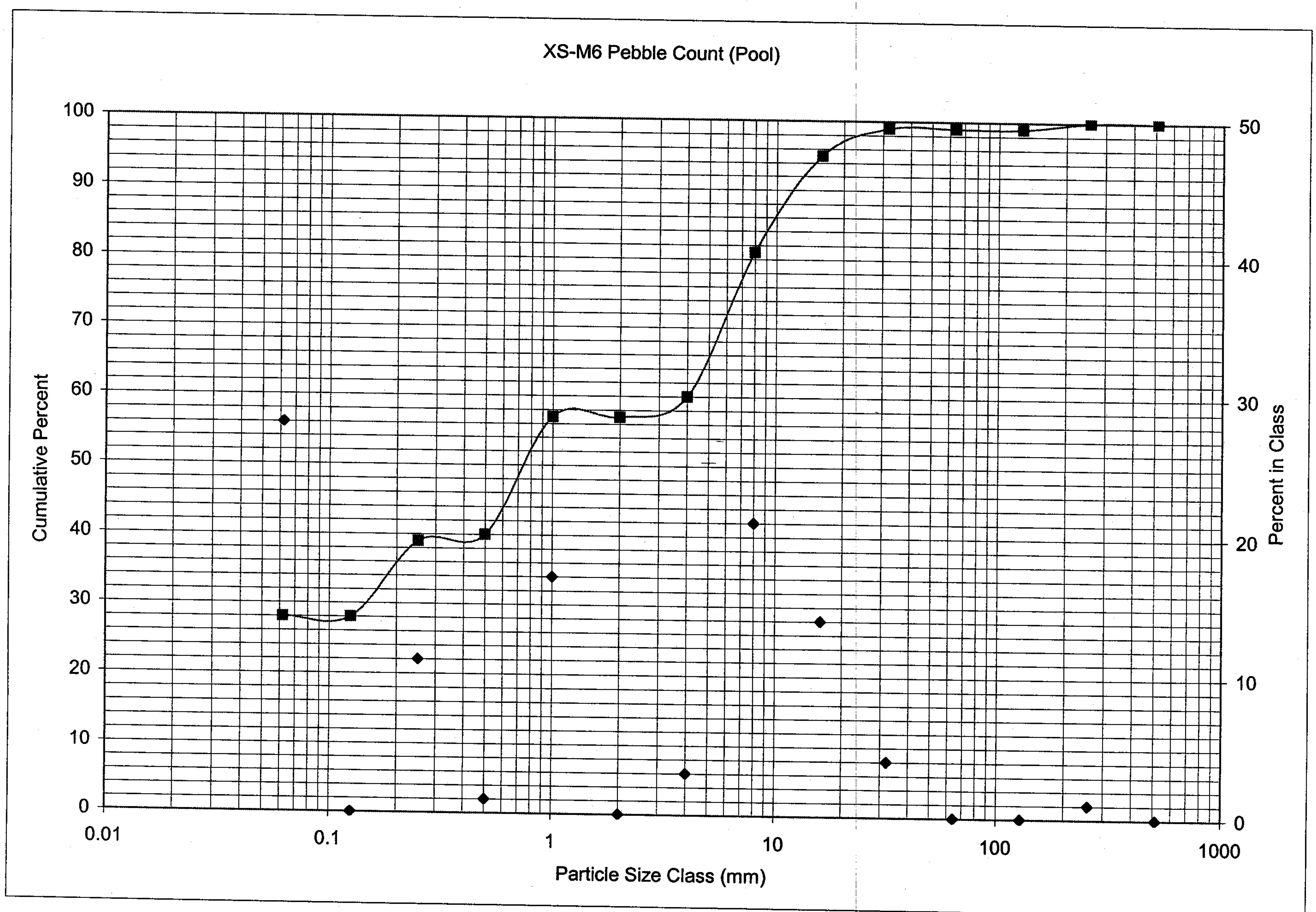
PARTICLE SIZE DATA:

	Transect Number and Pebble Count Tallies										Count Totals				
Particle/Size (mm)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	8														
VF Sand .062<.125															
F Sand .125<.25	4														
M Sand .25<.50	3														
C Sand .50<1.0	23														
VC Sand 1.0<2.0															
VF Gravel 2<4	3														
F Gravel 4<8	19														
M Gravel 8<16	29														
C Gravel 16<32	9														
VC Gravel 32<64	2														
S Cobble 64<128															
L Cobble 128<256															
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
										TOTALS:					

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	
D25	**0.7**
D50	**5.5**
D84	**15**


XS-M6 Pebble Count (Pool)
Cumulative Percent
Percent in Class
Particle Size Class (mm)
0
10
20
30
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1000

STREAM EVALUATION WORKBOOK

DATE: 4-Aug-04 OBSERVER(S): RCB, VMM
STREAM: UT to Cane Creek USGS QUAD:
REACH: LAT:
REACH LENGTH: 100 ft LONG:
REACH LOCATION: Mainstem above Trib 2 (pool)

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 136.5
Sample Reach Length: 100 (ft)
Typical Sample Reach Width: 8 (ft)

Sample Reach Flow Type Proportions: ____ % Riffle ____ % Run ____ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

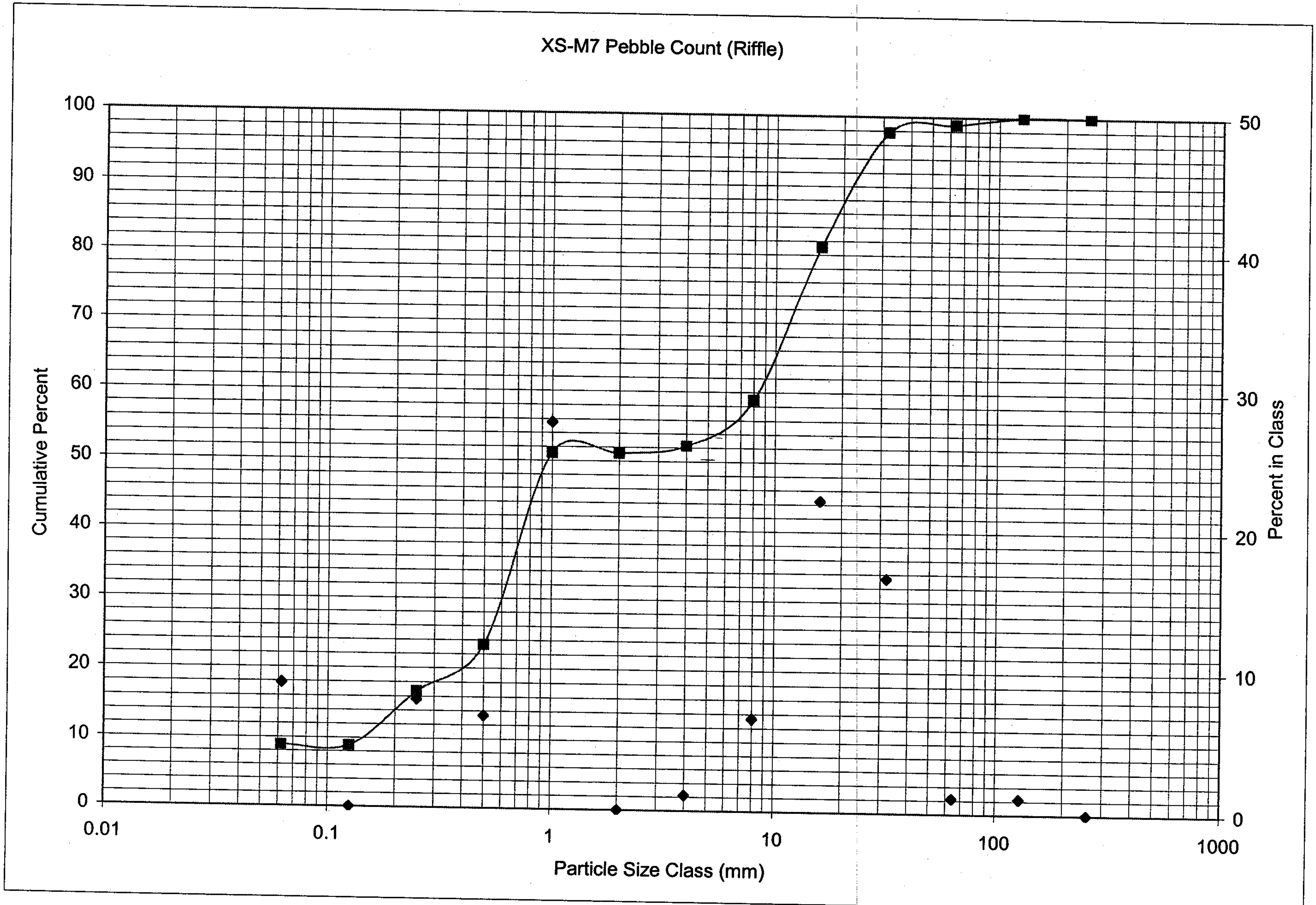
PARTICLE SIZE DATA:

	Transect Number and Pebble Count Tallies										Count Totals				
Particle/Size (mm)	1	2	3	4	5	6	7	8	9	10	Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	28														
VF Sand .062<.125	0														
F Sand .125<.25	11														
M Sand .25<.50	1														
C Sand .50<1.0	17														
VC Sand 1.0<2.0	0														
VF Gravel 2<4	3														
F Gravel 4<8	21														
M Gravel 8<16	14														
C Gravel 16<32	4														
VC Gravel 32<64															
S Cobble 64<128															
L Cobble 128<256	1														
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
TOTALS:															

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	
D25	--
D50	0.73
D84	9



XS-M7 Pebble Count (Riffle)
Cumulative Percent
Percent in Class
Particle Size Class (mm)
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
50
40
30
20
10
0

STREAM EVALUATION WORKBOOK

DATE: 5-Aug-04
OBSERVER(S): MRW, VMM
STREAM: UT to Cane Creek
USGS QUAD:
REACH:
LAT:
REACH LENGTH: 400 ft
LONG:
REACH LOCATION: Mainstem just below confluence of Trib 1 (Riffle)

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 28
Sample Reach Length: 400 (ft)
Typical Sample Reach Width: 3 (ft)

Sample Reach Flow Type Proportions: ____ % Riffle ____ % Run ____ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

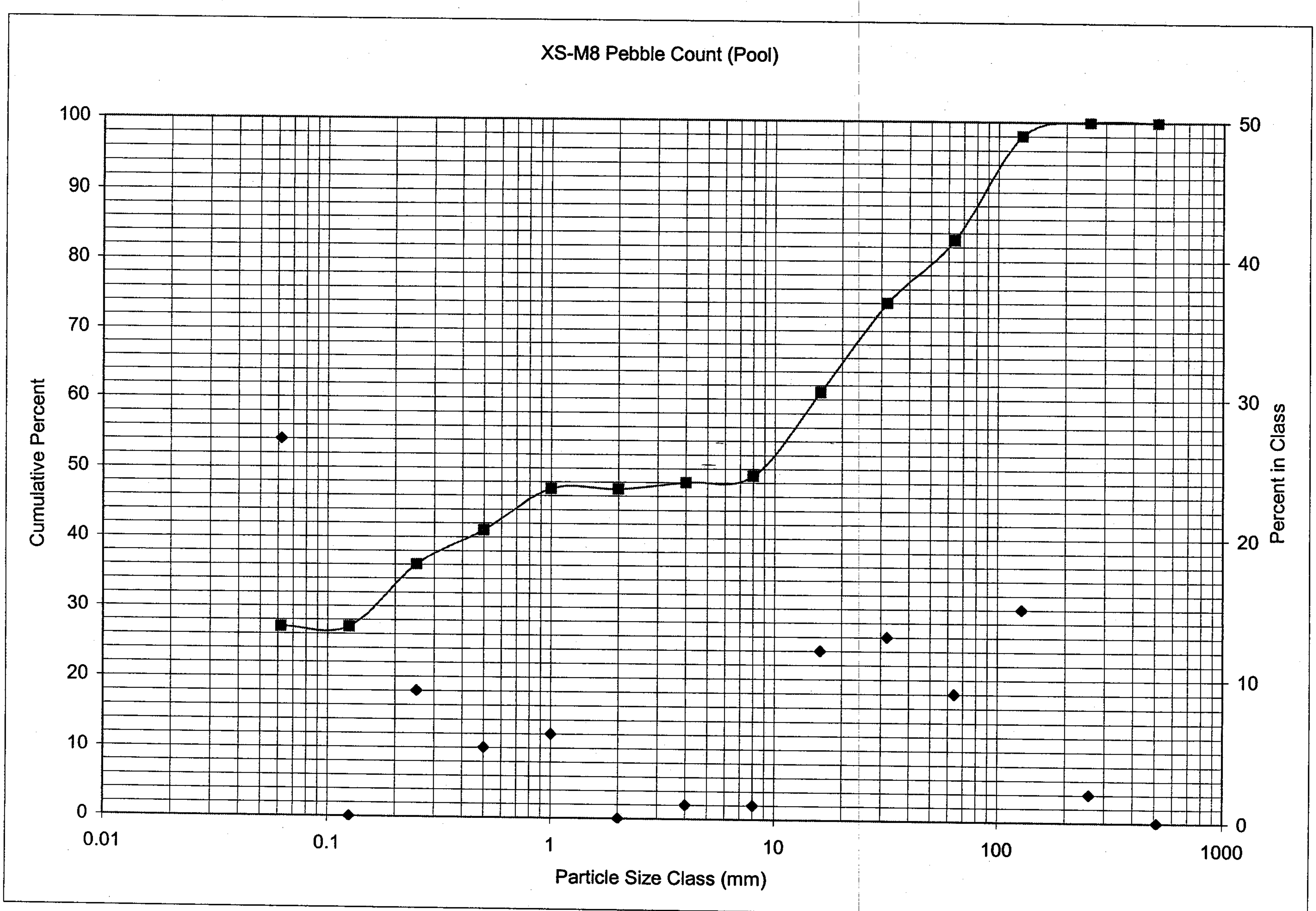
PARTICLE SIZE DATA:

	Transect Number and Pebble Count Tallies										Count Totals				
Particle/Size (mm)	1	2	3	4	5	6	7	8	9	10	Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	8														
VF Sand .062<.125															
F Sand .125<.25	7														
M Sand .25<.50	6														
C Sand .50<1.0	25														
VC Sand 1.0<2.0															
VF Gravel 2<4	1														
F Gravel 4<8	6														
M Gravel 8<16	20														
C Gravel 16<32	15														
VC Gravel 32<64	1														
S Cobble 64<128	1														
L Cobble 128<256															
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
										TOTALS:					

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	
D25	0.53
D50	0.95
D84	18



XS-M8 Pebble Count (Pool)
Cumulative Percent
Percent in Class
Particle Size Class (mm)
0
10
20
30
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1000

STREAM EVALUATION WORKBOOK

DATE: 5-Aug-04
OBSERVER(S): MRW, TLR
STREAM: UT to Cane Creek
USGS QUAD:
REACH:
LAT:
REACH LENGTH: 400 ft
LONG:
REACH LOCATION: Mainstem just below confluence of Trib 1 above big rock (Pool)

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 310
Sample Reach Length: 400 (ft)
Typical Sample Reach Width: 8 (ft)

Sample Reach Flow Type Proportions: _____ % Riffle _____ % Run _____ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

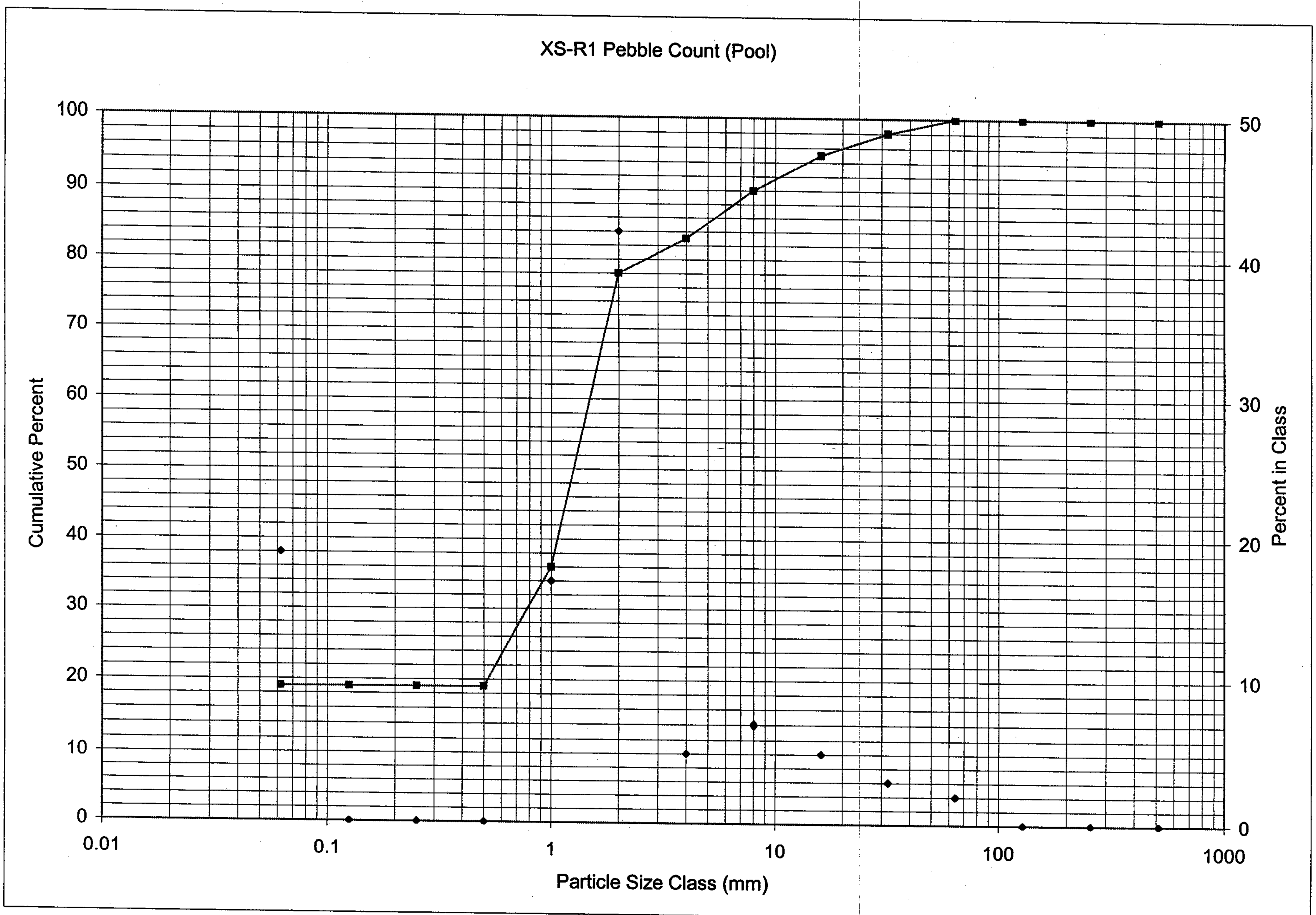
PARTICLE SIZE DATA:

	Transect Number and Pebble Count Tallies										Count Totals				
Particle/Size (mm)	1	2	3	4	5	6	7	8	9	10	Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	27														
VF Sand .062<.125															
F Sand .125<.25	9														
M Sand .25<.50	5														
C Sand .50<1.0	6														
VC Sand 1.0<2.0															
VF Gravel 2<4	1														
F Gravel 4<8	1														
M Gravel 8<16	12														
C Gravel 16<32	13														
VC Gravel 32<64	9														
S Cobble 64<128	15														
L Cobble 128<256	2														
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
										TOTALS:					

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	
D25	--
D50	8.8
D84	68



XS-R1 Pebble Count (Pool)
Cumulative Percent
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
Particle Size Class (mm)
Percent in Class
50
40
30
20
10
0

STREAM EVALUATION WORKBOOK

DATE: 5-Aug-04
OBSERVER(S): RCB, VMM
STREAM: UT to Cane Creek
USGS QUAD:
REACH:
LAT:
REACH LENGTH: 400 ft
LONG:
REACH LOCATION: Mainstem - Forested Area (Pool)

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 100
Sample Reach Length: 400 (ft)
Typical Sample Reach Width: 5 (ft)

Sample Reach Flow Type Proportions: _____ % Riffle _____ % Run _____ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

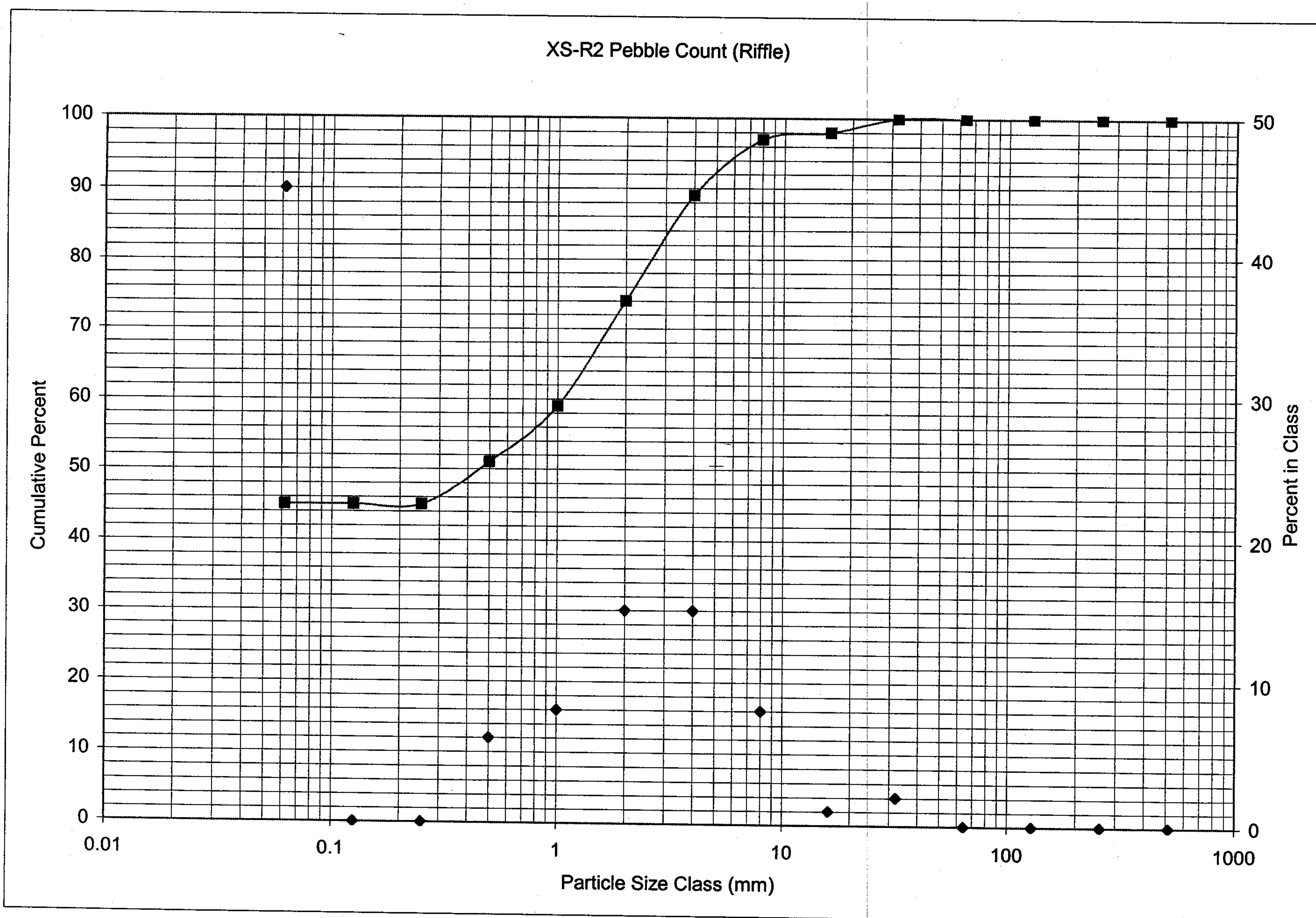
PARTICLE SIZE DATA:

Particle/Size (mm)	Transect Number and Pebble Count Tallies 1	2	3	4	5	6	7	8	9	10	Count Totals Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	19														
VF Sand .062<.125															
F Sand .125<.25															
M Sand .25<.50															
C Sand .50<1.0	17														
VC Sand 1.0<2.0	42														
VF Gravel 2<4	5														
F Gravel 4<8	7														
M Gravel 8<16	5														
C Gravel 16<32	3														
VC Gravel 32<64	2														
S Cobble 64<128															
L Cobble 128<256															
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
										TOTALS:					

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	
D25	0.65
D50	1.4
D84	4.5


XS-R2 Pebble Count (Riffle)
Cumulative Percent
Percent in Class
Particle Size Class (mm)
100
90
80
70
60
50
40
30
20
10
0
50
40
30
20
10
0
0.01
0.1
1
10
100
1000

STREAM EVALUATION WORKBOOK

DATE: 5-Aug-04
OBSERVER(S): RCB, VMM
STREAM: UT to Cane Creek
USGS QUAD:
REACH:
LAT:
REACH LENGTH: 400 ft
LONG:
REACH LOCATION: Maintstem - Forested Area (Riffle)

SUBSTRATE ANALYSIS

QUALITATIVE SAMPLE SITE DESCRIPTION:

Sample Reach Station: Sta. 323.5
Sample Reach Length: 400 (ft)
Typical Sample Reach Width: 4 (ft)

Sample Reach Flow Type Proportions: _____ % Riffle _____ % Run _____ % Pool

Obvious Situations which might affect the Particle Size Distribution: (i.e., fallen logs or debris, bank erosion, construction, etc)

PARTICLE SIZE DATA:

	Transect Number and Pebble Count Tallies										Count Totals				
Particle/Size (mm)	1	2	3	4	5	6	7	8	9	10	Riffle	Run	Pool	Total	%Cum Total
Silt/Clay <.062	45														
VF Sand .062<.125															
F Sand .125<.25															
M Sand .25<.50	6														
C Sand .50<1.0	8														
VC Sand 1.0<2.0	15														
VF Gravel 2<4	15														
F Gravel 4<8	8														
M Gravel 8<16	1														
C Gravel 16<32	2														
VC Gravel 32<64															
S Cobble 64<128															
L Cobble 128<256															
S Boulder 256<512															
M Boulder 512<1024															
L Boulder 1024<2048															
Bedrock															
										TOTALS:					

TRANSECT CHARACTERISTICS:

	1	2	3	4	5	6	7	8	9	10
Riffle (R), Run (U), Pool (P)										
Embeddedness (H,M,L)										
Sediment Coating (H,M,L)										
Proportion Wet (%)										

	MM
Dmax	
D25	
D50	0.45
D84	3.1

APPENDIX C

BEHI and Pfankuch Forms

Bank Erodibility Hazard Rating Guide

Stream: UTCC **Reach:** Wright Property XS Pool RT Bank **Date:** Aug 6 '04 **Crew:** MRW/TLR

Bank Erosion Potential	Bank Height (ft): 6 Bankfull Height (ft): 3.5	Bank Height/ Bankfull Ht	Root Depth/ Bank Height	Root Density %	Bank Angle (Degrees)	Surface Protection%
VERY LOW	Value Range	1.0 1.1	1.0 0.9	80 100	0.0 20.0	80 100
	Index Range	1.0 1.9	1.0 1.9	1.0 1.9	1.0 1.9	1.0 1.9
	Choice	V: I:	V: I:	V: I:	V: I:	V: I:
LOW	Value Range	1.11 1.19	0.5 0.89	55 79	21.0 60.0	55 79
	Index Range	2.0 3.9	2.0 3.9	2.0 3.9	2.0 3.9	2.0 3.9
	Choice	V: I:	V: I:	V: I:	V: I:	V: I:
MODERATE	Value Range	1.2 1.5	0.3 0.49	30 54	61.0 80.0	30 54
	Index Range	4.0 5.9	4.0 5.9	4.0 5.9	4.0 5.9	4.0 5.9
	Choice	V: I:	V: 0.30 I: 4.0	V: I:	V: I:	V: I:
HIGH	Value Range	1.6 2.0	0.15 0.29	15 29	81.0 90.0	15 29
	Index Range	6.0 7.9	6.0 7.9	6.0 7.9	6.0 7.9	6.0 7.9
	Choice	V: 1.7 I: 6.5	V: I:	V: I:	V: I:	V: I:
VERY HIGH	Value Range	2.1 2.8	0.05 0.14	5 14	91.0 119.0	10 14
	Index Range	8.0 9.0	8.0 9.0	8.0 9.0	8.0 9.0	8.0 9.0
	Choice	V: I:	V: I:	V: 10.0 I: 8.6	V: I:	V: I:
EXTREME	Value Range	>2.8	<0.05	<5	>119	<10
	Index Range	10	10	10	10	10
	Choice	V: I:	V: I:	V: I:	V: 120.0 I: 10.0	V: 10.0 I: 10.0
	V = value, I = index				SUB-TOTAL (Sum one index from each column)	39.0

Bank Material Description:

Silt Clay (+ 0: no adjustment)

Bank Materials

- **Bedrock** (Bedrock banks have very low bank erosion potential)
- **Boulders** (Banks composed of boulders have low bank erosion potential)
- **Cobble** (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
- **Gravel** (Add 5-10 points depending percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt Clay** (+ 0: no adjustment)

Bank Sketch

BANK MATERIAL ADJUSTMENT 0

Stratification Comments:

No Stratification

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT 0

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.9	10-19.9	20-29.9	30-39.9	40-45.9	46-50

Bank location description (check one)

Straight Reach [ ] Outside of Bend [X]

GRAND TOTAL 39.0

BEHI RATING HIGH

Bank Erodibility Hazard Rating Guide

Stream: UTCC **Reach:** Pickard Property XS Pool LT Bank **Date:** Aug 6 '04 **Crew:** MRW/TLR

Bank Erosion Potential

Bank Height (ft): 5 Bankfull Height (ft): 2		Bank Height/ Bankfull Ht	Root Depth/ Bank Height	Root Density %	Bank Angle (Degrees)	Surface Protection%
VERY LOW	Value Range	1.0 1.1	1.0 0.9	80 100	0.0 20.0	80 100
	Index Range	1.0 1.9	1.0 1.9	1.0 1.9	1.0 1.9	1.0 1.9
	Choice	V: I:	V: I:	V: I:	V: I:	V: I:
LOW	Value Range	1.11 1.19	0.5 0.89	55 79	21.0 60.0	55 79
	Index Range	2.0 3.9	2.0 3.9	2.0 3.9	2.0 3.9	2.0 3.9
	Choice	V: I:	V: 0.60 I: 2.5	V: I:	V: I:	V: I:
MODERATE	Value Range	1.2 1.5	0.3 0.49	30 54	61.0 80.0	30 54
	Index Range	4.0 5.9	4.0 5.9	4.0 5.9	4.0 5.9	4.0 5.9
	Choice	V: I:	V: I:	V: I:	V: I:	V: I:
HIGH	Value Range	1.6 2.0	0.15 0.29	15 29	81.0 90.0	15 29
	Index Range	6.0 7.9	6.0 7.9	6.0 7.9	6.0 7.9	6.0 7.9
	Choice	V: I:	V: I:	V: 15.0 I: 6.0	V: I:	V: I:
VERY HIGH	Value Range	2.1 2.8	0.05 0.14	5 14	91.0 119.0	10 14
	Index Range	8.0 9.0	8.0 9.0	8.0 9.0	8.0 9.0	8.0 9.0
	Choice	V: 2.5 I: 8.6	V: I:	V: I:	V: 100.0 I: 8.3	V: I:
EXTREME	Value Range	>2.8	<0.05	<5	>119	<10
	Index Range	10	10	10	10	10
	Choice	V: I:	V: I:	V: I:	V: I:	V: 10.0 I: 10.0
V = value, I = index					SUB-TOTAL (Sum one index from each column)	35.4

Bank Material Description:

Silt Clay (+ 0: no adjustment)

Bank Materials

- **Bedrock** (Bedrock banks have very low bank erosion potential)
- **Boulders** (Banks composed of boulders have low bank erosion potential)
- **Cobble** (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
- **Gravel** (Add 5-10 points depending percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt Clay** (+ 0: no adjustment)

Bank Sketch

BANK MATERIAL ADJUSTMENT 0

Stratification Comments:

No Stratification

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT 0

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.9	10-19.9	20-29.9	30-39.9	40-45.9	46-50

Bank location description (check one)

Straight Reach [ ] Outside of Bend [X]

GRAND TOTAL 35.4

BEHI RATING HIGH

Bank Erodibility Hazard Rating Guide

Stream: UTCC **Reach:** XS Pool RT Bank **Date:** Aug 6 '04 **Crew:** MRW/TLR

Bank Erosion Potential

Bank Height (ft): 5 Bankfull Height (ft): 2		Bank Height/ Bankfull Ht		Root Depth/ Bank Height		Root Density %		Bank Angle (Degrees)		Surface Protection%	
VERY LOW	Value Range	1.0	1.1	1.0	0.9	80	100	0.0	20.0	80	100
	Index Range	1.0	1.9	1.0	1.9	1.0	1.9	1.0	1.9	1.0	1.9
	Choice	V:	I:	V:	I:	V:	I:	V:	I:	V:	I:
LOW	Value Range	1.11	1.19	0.5	0.89	55	79	21.0	60.0	55	79
	Index Range	2.0	3.9	2.0	3.9	2.0	3.9	2.0	3.9	2.0	3.9
	Choice	V:	I:	V:	I:	V:	I:	V:	I:	V:	I:
MODERATE	Value Range	1.2	1.5	0.3	0.49	30	54	61.0	80.0	30	54
	Index Range	4.0	5.9	4.0	5.9	4.0	5.9	4.0	5.9	4.0	5.9
	Choice	V:	I:	V:	I:	V:	I:	V:	I:	V:	I:
HIGH	Value Range	1.6	2.0	0.15	0.29	15	29	81.0	90.0	15	29
	Index Range	6.0	7.9	6.0	7.9	6.0	7.9	6.0	7.9	6.0	7.9
	Choice	V:	I:	V: 0.20	I: 6.7	V:	I:	V: 90.0	I: 7.9	V:	I:
VERY HIGH	Value Range	2.1	2.8	0.05	0.14	5	14	91.0	119.0	10	14
	Index Range	8.0	9.0	8.0	9.0	8.0	9.0	8.0	9.0	8.0	9.0
	Choice	V: 2.5	I: 8.6	V:	I:	V: 6.0	I: 8.1	V:	I:	V: 12.0	I: 8.5
EXTREME	Value Range	>2.8		<0.05		<5		>119		<10	
	Index Range	10		10		10		10		10	
	Choice	V:	I:	V:	I:	V:	I:	V:	I:	V:	I:

V = value, I = index

SUB-TOTAL (Sum one index from each column) 39.8

Bank Material Description:

Clay with significant sand and silt

Bank Materials

- **Bedrock** (Bedrock banks have very low bank erosion potential)
- **Boulders** (Banks composed of boulders have low bank erosion potential)
- **Cobble** (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
- **Gravel** (Add 5-10 points depending percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt Clay** (+ 0: no adjustment)

Bank Sketch

BANK MATERIAL ADJUSTMENT 5

Stratification Comments:

No Stratification

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT 0

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.9	10-19.9	20-29.9	30-39.9	40-45.9	46-50

Bank location description (check one)

Straight Reach [X] Outside of Bend [ ]

GRAND TOTAL 44.8

BEHI RATING VERY HIGH

PFANKUCH CHANNEL STABILITY EVALUATION

Reach Location	UTCC (Wright Property)	Observers	RB/VMM	Date	Aug 5 '04	Stream Type	Degraded E

	Category	Excellent	Score	Good	Score	Fair	Score	Poor	Score
Upper Banks	1 Landform Slope	Bank slope <30%	2	Bank slope 30-40%	4	Bank slope 40-60%	6	Bank slope >60%	8
	2 Mass Wasting	No evidence of past or future mass wasting	3	Infrequent, healed over, low future potential	6	Frequent / large; year long sediment input	9	Frequent / large; year long sediment input, or imminent danger of same	12
	3 Debris Jam Potential	Essentially absent from channel	2	Present; most twigs/limbs	4	Moderate-heavy amounts	6	Moderate-heavy; predom. large sizes	8
	4 Veg. Bank Protection	90%+ Plant density; Dense binding root mass	3	70-90% density; less dense/deep root mass	6	<50-70% density; shallow discontinuous root mass	9	<50% density; shallow discontinuous root mass	12
Lower Banks	5 Channel Capacity	Ample for present; peak flows contained. W/D ratio <7	1	Adequate; bank overflow rare. W/D ratio 8-15	2	Barely contain peaks; occas. overbank. W/D ratio 15-25	3	Inadequate; overbank flow common. W/D ratio >25	4
	6 Bank Rock Content	65%+, lg boulders (12"+)	2	40-65%, 6-12" rocks	4	20-40%, 3-6" rocks	6	<20%, rocks 1-3" or less	8
	7 Obstructions to Flow	Rocks/logs embedded; flow w/o cutting/deposition; stable bed	2	Some, new; causing minor erosion/deposition	4	Moderate; frequent, unstable; erosion/dep. at high flow	6	Frequent obstructions cause erosion year-long; channel migration	8
	8 Cutting	Little or none; infrequent; raw banks >6"	4	Some; intermittent; raw banks up to 12"	6	Significant; overhangs & sloughing; cuts 12-24" high	12	Almost continuous cuts; overhang failure frequent; some cuts >24" high	16
	9 Deposition	Little or no enlargement of channel or point bars	4	Some new bar increase, mostly from coarse gravel	8	Mod. dep. of new gravel & sand on old & new bars	12	Extensive deposits or pred. fine particles; accel. bar development	16
Bottom	10 Rock Angularity	Sharp; plane surfaces rough	1	Rounded; surfaces smooth	2	Well rounded in 2 dimensions	3	Well rounded in all dimensions	4
	11 Brightness	Surfaces dull, dark, or stained	1	Mostly dull; <35% bright surf.	2	Mixture; 35-65% range	3	Pred. bright; 65% bright surfaces	4
	12 Particle Consolidation	Many sizes; packed/overlapping	2	Mod. packed; some overlap	4	Mostly loose; no overlap	6	Loose; no packing	8
	13 Size Distribution	No size change; 80-100% stable	4	Little size chg; 50-80% stable	8	Mod. size chg; 20-50% stable	12	Marked size chg; 0-20% stable	16
	14 Scouring and Deposition	<5% of bottom affected by scour & deposition	6	5-30% affected; scour at constrictions, depos. in pools	12	30-50% affected; deposits & scour common; some pool filling	18	More than 50% of bottom in flux, or change nearly year-long	24
	15 Aquatic Vegetation	Abundant; growth moss-like, dark green, perrenial	1	Common; algal forms in low vel. & pool areas; moss.	2	Present but spotty; seasonal algal growth makes rocks slick	3	Perrenials sparse/absent; Yellow-green, short-term bloom may occur	4
		Totals	1		30		9		64

Sediment Supply		Stream Bed Stability		Width/Depth Ratio	
Extreme		Aggrading	X	Normal	
Very High		Degrading		High	X
High	X	Stable		Very High	
Moderate					
Low		[illegible]	104		

Remarks: ______________________________

Stream Type: E

Pfankuch Rating: 104

Reach Condition: Fair

(from table)

PFANKUCH CHANNEL STABILITY EVALUATION

Reach Location	UTCC Pickard Property (Confluence with Trib 1 to Big Rock)	Observers	MRW/TLR	Date	Aug 6 '04	Stream Type	Degraded E

	Category	Excellent	Score	Good	Score	Fair	Score	Poor	Score
Upper Banks	1 Landform Slope	Bank slope <30%	2	Bank slope 30-40%	4	Bank slope 40-60%	6	Bank slope >60%	8
	2 Mass Wasting	No evidence of past or future mass wasting	3	Infrequent, healed over; low future potential	6	Frequent / large; year long sediment input	9	Frequent / large; year long sediment input, or imminent danger of same	12
	3 Debris Jam Potential	Essentially absent from channel	2	Present; most twigs/limbs	4	Moderate-heavy amounts	6	Moderate-heavy; predom. large sizes	8
	4 Veg. Bank Protection	90%+ Plant density; Dense binding root mass	3	70-90% density; less dense/deep root mass	6	<50-70% density; shallow discontinuous root mass	10	<50% density; shallow discontinuous root mass	12
Lower Banks	5 Channel Capacity	Ample for present; peak flows contained. W/D ratio <7	1	Adequate; bank overflow rare. W/D ratio 8-15	[illegible]	Barely contain peaks; occas. overbank. W/D ratio 15-25	3	Inadequate; overbank flow common. W/D ratio >25	4
	6 Bank Rock Content	65%+, lg boulders (12"+)	2	40-65%, 6-12" rocks	4	20-40%, 3-6" rocks	6	<20%, rocks 1-3" or less	7
	7 Obstructions to Flow	Rocks/logs embedded; flow w/o cutting/deposition; stable bed	2	Some, new; causing minor erosion/deposition	4	Moderate; frequent, unstable; erosion/dep. at high flow	6	Frequent obstructions cause erosion year-long; channel migration	8
	8 Cutting	Little or none; infrequent; raw banks >6"	4	Some; intermittent; raw banks up to 12"	6	Significant; overhangs & sloughing; cuts 12-24" high	12	Almost continuous cuts; overhang failure frequent; some cuts >24" high	16
	9 Deposition	Little or no enlargement of channel or point bars	4	Some new bar increase, mostly from coarse gravel	8	Mod. dep. of new gravel & sand on old & new bars	12	Extensive deposits or pred. fine particles; accel. bar development	16
Bottom	10 Rock Angularity	Sharp; plane surfaces rough	1	Rounded; surfaces smooth	2	Well rounded in 2 dimensions	3	Well rounded in all dimensions	4
	11 Brightness	Surfaces dull, dark, or stained	1	Mostly dull; <35% bright surf.	2	Mixture; 35-65% range	3	Pred. bright; 65% bright surfaces	4
	12 Particle Consolidation	Many sizes; packed/overlapping	2	Mod. packed; some overlap	4	Mostly loose; no overlap	6	Loose; no packing	8
	13 Size Distribution	No size change; 80-100% stable	4	Little size chg; 50-80% stable	8	Mod. size chg; 20-50% stable	12	Marked size chg; 0-20% stable	16
	14 Scouring and Deposition	<5% of bottom affected by scour & deposition	6	5-30% affected; scour at constrictions, depos. in pools	12	30-50% affected; deposits & scour common; some pool filling	18	More than 50% of bottom in flux, or change nearly year-long	24
	15 Aquatic Vegetation	Abundant; growth moss-like, dark green, perrenial	1	Common; algal forms in low vel. & pool areas; moss.	2	Present but spotty; seasonal algal growth makes rocks slick	3	Perrenials sparse/absent; Yellow-green, short-term bloom may occur	4
		Totals	2		4		97		7

Sediment Supply		Stream Bed Stability		Width/Depth Ratio	
Extreme		Aggrading	X	Normal	
Very High		Degrading		High	X
High	X	Stable		Very High	
Moderate					
Low					

TOTAL SCORE [illegible]: 110

Remarks:

Stream Type: E

Pfankuch Rating: 110

Reach Condition: Fair

(from table)

PFANKUCH CHANNEL STABILITY EVALUATION

Reach Location	UTCC Trib 1	Observers	MRW/TLR	Date	Aug 6 '04	Stream Type	Degraded E

	Category	Excellent	Score	Good	Score	Fair	Score	Poor	Score
Upper Banks	1 Landform Slope	Bank slope <30%	2	Bank slope 30-40%	4	Bank slope 40-60%	6	Bank slope >60%	8
	2 Mass Wasting	No evidence of past or future mass wasting	3	Infrequent, healed over; low future potential	6	Frequent / large; year long sediment input	9	Frequent / large; year long sediment input, or imminent danger of same	[illegible]
	3 Debris Jam Potential	Essentially absent from channel	3	Present; most twigs/limbs	4	Moderate-heavy amounts	6	Moderate-heavy; predom. large sizes	8
	4 Veg. Bank Protection	90%+ Plant density; Dense binding root mass	3	70-90% density; less dense/deep root mass	6	<50-70% density; shallow discontinuous root mass	9	<50% density; shallow discontinuous root mass	12
Lower Banks	5 Channel Capacity	Ample for present; peak flows contained. W/D ratio <7	1	Adequate; bank overflow rare. W/D ratio 8-15	[illegible]	Barely contain peaks; occas. overbank. W/D ratio 15-25	3	Inadequate; overbank flow common. W/D ratio >25	4
	6 Bank Rock Content	65%+, lg boulders (12"+)	2	40-65%, 6-12" rocks	4	20-40%, 3-6" rocks	6	<20%, rocks 1-3" or less	8
	7 Obstructions to Flow	Rocks/logs embedded; flow w/o cutting/deposition; stable bed	[illegible]	Some, new; causing minor erosion/deposition	4	Moderate; frequent, unstable; erosion/dep. at high flow	6	Frequent obstructions cause erosion year-long; channel migration	8
	8 Cutting	Little or none; infrequent; raw banks >6"	4	Some; intermittent; raw banks up to 12"	6	Significant; overhangs & sloughing; cuts 12-24" high	12	Almost continuous cuts; overhang failure frequent; some cuts >24" high	14
	9 Deposition	Little or no enlargement of channel or point bars	4	Some new bar increase, mostly from coarse gravel	8	Mod. dep. of new gravel & sand on old & new bars	12	Extensive deposits or pred. fine particles; accel. bar development	16
Bottom	10 Rock Angularity	Sharp; plane surfaces rough	1	Rounded; surfaces smooth	2	Well rounded in 2 dimensions	3	Well rounded in all dimensions	4
	11 Brightness	Surfaces dull, dark, or stained	1	Mostly dull; <35% bright surf.	2	Mixture; 35-65% range	3	Pred. bright; 65% bright surfaces	4
	12 Particle Consolidation	Many sizes; packed/overlapping	2	Mod. packed; some overlap	4	Mostly loose; no overlap	6	Loose; no packing	8
	13 Size Distribution	No size change; 80-100% stable	4	Little size chg; 50-80% stable	8	Mod. size chg; 20-50% stable	12	Marked size chg; 0-20% stable	16
	14 Scouring and Deposition	<5% of bottom affected by scour & deposition	6	5-30% affected; scour at constrictions, depos. in pools	12	30-50% affected; deposits & scour common; some pool filling	18	More than 50% of bottom in flux, or change nearly year-long	24
	15 Aquatic Vegetation	Abundant; growth moss-like, dark green, perennial	1	Common; algal forms in low vel. & pool areas; moss.	[illegible]	Present but spotty; seasonal algal growth makes rocks slick	3	Perrenials sparse/absent; Yellow-green, short-term bloom may occur	4
		Totals	10		8		0		101

Sediment Supply		Stream Bed Stability		Width/Depth Ratio	
Extreme		Aggrading		Normal	X
Very High		Degrading	X	High	
High	X	Stable		Very High	
Moderate					
Low					

TOTAL SCORE [illegible]: 119

Remarks:

Stream Type: E

Pfankuch Rating: 119

Reach Condition: Poor

(from table)

APPENDIX D

Bankfull Indicators

Appendix D –Bankfull Indicators

Reach A (Fogelman Property) Bankfull Indicator (looking downstream)

Reach B (Pickard Property) Bankfull Indicator (looking downstream)

Reach C (Wright Property) Bankfull Indicator (looking downstream)

Reach D (Tributary 1) Bankfull Indicator (looking downstream)

APPENDIX E

Unnamed Tributary to Cane Creek Reference Reach (A1) Photographs and Data

Appendix E –Unnamed Tributary to Cane Creek Reference Reach (A1) Site Photographs


Photo 1 –A1, looking downstream


Photo 2 –A1, looking upstream


Photo 3 – A1, Floodplain

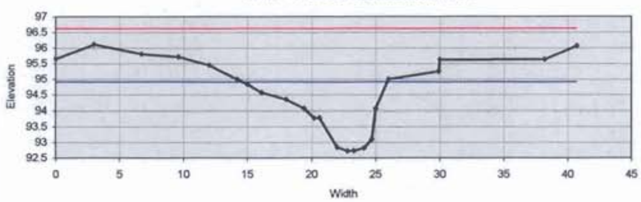

Photo 4 – A1, Floodplain


Photo 5 – A1, riffle cross section


Photo 6 – A1, pool cross section

Cross Section 1

0 + 40 UT to Cane Creek reference A1, Pool



Bankfull Dimensions	
12.0	x-section area (ft.sq.)
11.2	width (ft)
1.1	mean depth (ft)
2.2	max depth (ft)
12.8	wetted parimeter (ft)
0.9	hyd radi (ft)
10.6	width-depth ratio

Flood Dimensions	
—	W flood prone area (ft)
—	entrenchment ratio
—	low bank height (ft)
—	low bank height ratio

Materials	
0.94	D50 Riffle (mm)
3.5	D84 Riffle (mm)
13	threshold grain size (mm):

Bankfull Flow	
5.4	velocity (ft/s)
64.8	discharge rate (cfs)
0.99	Froude number

Flow Resistance	
0.018	Manning's roughness
0.04	D'Arcy-Weisbach fric.
14.5	resistance factor u/u*
92.7	relative roughness

Forces & Power	
0.46	channel slope (%)
0.27	shear stress (lb/sq.ft.)
0.37	shear velocity (ft/s)
1.65	unit strm power (lb/ft/s)

Cross Section

reference ID	1	
instrument height	100	100
longitudinal station	40	40.0

Bankfull Stage

FS		---
elevation		94.90

Low Bank Height

FS		---
elevation		

Flood Prone Area

width fpa		40.7

Channel Slope

percent slope		0.46

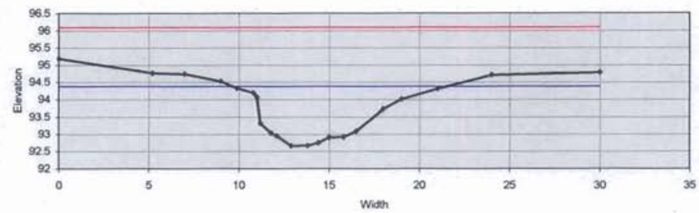
Flow Resistance

Manning's "n"		0.018
D'Arcy - Weisbach "f"		0.04

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0		100	4.35	95.65	☐	Left bank
3		100	3.89	96.11	☐	
6.7		100	4.2	95.8	☐	
9.6		100	4.29	95.71	☐	
12		100	4.56	95.44	☐	
14.2		100	5.01	94.99	☐	
15		100	5.17	94.83	☐	LTOB/BKF
16.1		100	5.44	94.56	☐	
18		100	5.66	94.34	☐	
19.4		100	5.94	94.06	☐	
20.2		100	6.23	93.77	☐	
20.6		100	6.22	93.78	☐	LEW / WS
22		100	7.17	92.83	☐	
22.8		100	7.28	92.72	☐	Thalweg
23.3		100	7.27	92.73	☐	
24.1		100	7.18	92.82	☐	
24.7		100	6.91	93.09	☐	REW
25		100	5.94	94.06	☐	
26		100	5	95	☐	RTOB / PE
29.9		100	4.75	95.25	☐	
30		100	4.38	95.62	☐	
38.2		100	4.37	95.63	☐	
40.7		100	3.94	96.06	☐	

Cross Section 2

0 + 93 UT to Cane Creek reference A1, Riffle



Bankfull Dimensions	
10.7	x-section area (ft.sq.)
11.8	width (ft)
0.9	mean depth (ft)
1.7	max depth (ft)
12.8	wetted parimeter (ft)
0.8	hyd radi (ft)
13.1	width-depth ratio

Flood Dimensions	
—	W flood prone area (ft)
—	entrenchment ratio
—	low bank height (ft)
—	low bank height ratio

Materials	
0.94	D50 Riffle (mm)
3.5	D84 Riffle (mm)
12	threshold grain size (mm):

Bankfull Flow	
5.0	velocity (ft/s)
53.2	discharge rate (cfs)
0.96	Froude number

Flow Resistance	
0.018	Manning's roughness
0.04	D'Arcy-Weisbach fric.
14.1	resistance factor u/u*
78.7	relative roughness

Forces & Power	
0.46	channel slope (%)
0.24	shear stress (lb/sq.ft.)
0.35	shear velocity (ft/s)
1.29	unit strm power (lb/ft/s)

Cross Section

reference ID	2	
instrument height	100	100
longitudinal station	93	93.0

Bankfull Stage

FS		—
elevation		94.37

Low Bank Height

FS		—
elevation		

Flood Prone Area

width fpa		30.0

Channel Slope

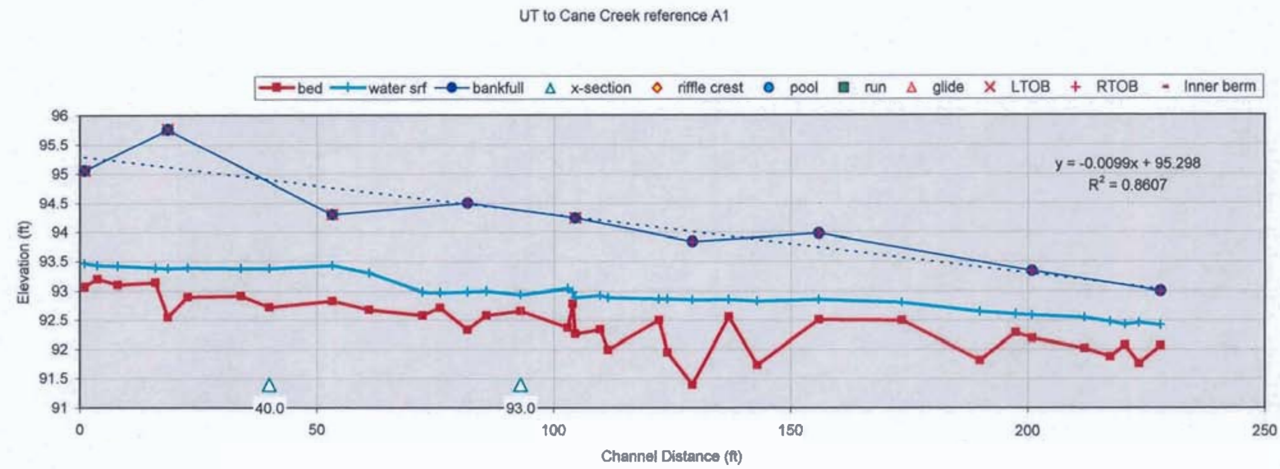
percent slope		0.46

Flow Resistance

Manning's "n"		0.018
D'Arcy - Weisbach "f"		0.04

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0		100	4.82	95.18	☐	
5.2		100	5.24	94.76	☐	
7		100	5.27	94.73	☐	
9		100	5.48	94.52	☐	
9.9		100	5.68	94.32	☐	LTOB/BKF
10.8		100	5.82	94.18	☐	
11		100	5.94	94.06	☐	
11.2		100	6.69	93.31	☐	
11.8		100	6.97	93.03	☐	
12.1		100	7.06	92.94	☐	LEW/ WS
12.9		100	7.34	92.66	☐	thalweg
13.8		100	7.33	92.67	☐	
14.4		100	7.25	92.75	☐	sand bar
15		100	7.09	92.91	☐	
15.8		100	7.08	92.92	☐	
16.5		100	6.91	93.09	☐	
18		100	6.28	93.72	☐	
19		100	5.99	94.01	☐	RTOB/BKF
21		100	5.69	94.31	☐	
24		100	5.3	94.7	☐	
30		100	5.22	94.78	☐	
					☐	
					☐	

Longitudinal Slope Profile



	slope (%)	length (ft)	length ratio	pool-pool spacing (ft)	p-p ratio
reach	0.46	228.0 (19.3 channel widths)	---	---	---
riffle	---	---	---	---	---
pool	---	---	---	---	---
	---	---	---	---	---
	---	---	---	---	---

notes	cross section ID	bed feature	station	statio	FS bed	water	FS bankfull	user defined FS LTOB	FS RTOB	FS Inner berm	azimuth AZ	ELEV bed	ELEV water srf	ELEV bankfull	ELEV LTOB	ELEV RTOB	ELEV inner berm
back sight to benchmark																	
			1		6.93	0.4	4.95	4.95				93.07	93.47	95.05	95.05		
			3.7		6.8	0.23						93.2	93.43				
			8		6.9	0.32						93.1	93.42				
			16		6.86	0.25						93.14	93.39				
			18.6		7.45	0.83	4.24	4.24				92.55	93.38	95.76	95.76		
			22.8		7.1	0.49						92.9	93.39				
			34		7.08	0.46						92.92	93.38				
dmax - Pool Cross-section	1		40		7.28	0.66						92.72	93.38				
			53.3		7.17	0.6	5.7	5.7				92.83	93.43	94.3	94.3		
			61		7.32	0.62						92.68	93.3				
downstream of debris jam			72.3		7.42	0.4						92.58	92.98				
			76		7.29	0.26						92.71	92.97				
			81.8		7.67	0.66	5.5		5.5			92.33	92.99	94.5		94.5	
			85.8		7.42	0.42						92.58	93				
Riffle Cross-section	2		93		7.34	0.28						92.66	92.94				
upstream of debris jam			103		7.63	0.67						92.37	93.04				
top of debris jam			104		7.22	0.2						92.78	92.98				
downstream of debris jam			104.5		7.74	0.63	5.76	5.76				92.26	92.89	94.24	94.24		
			109.8		7.66	0.59						92.34	92.93				
dmax			111.5		8.01	0.9						91.99	92.89				
			122.2		7.5	0.37						92.5	92.87				
			124		8.05	0.92						91.95	92.87				
			129.3		8.61	1.46	6.16		6.16			91.39	92.85	93.84		93.84	
			137		7.44	0.3						92.56	92.86				
			143		8.27	1.1						91.73	92.83				
			156		7.49	0.35	6.02		6.02			92.51	92.86	93.98		93.98	
			173.5		7.5	0.31						92.5	92.81				
			190		8.19	0.84						91.81	92.65				
			197.5		7.71	0.32						92.29	92.61				
			201		7.81	0.4	6.66		6.66			92.19	92.59	93.34		93.34	
			212		7.98	0.53						92.02	92.55				
			217.4		8.12	0.6						91.88	92.48				
			220.5		7.93	0.36						92.07	92.43				
			223.5		8.24	0.7						91.76	92.46				
			228		7.94	0.36	7		7			92.06	92.42	93		93	

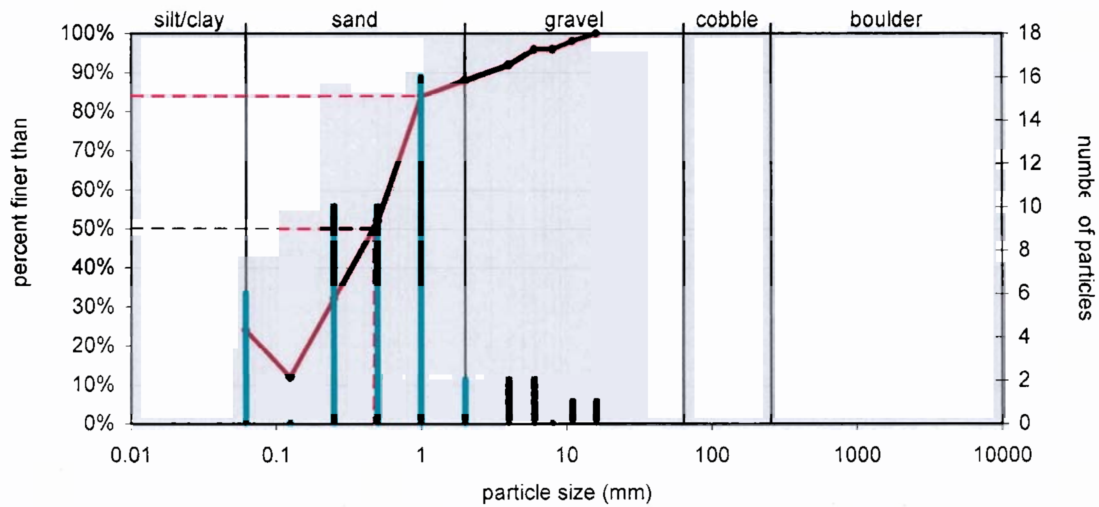
Bed Surface

Material	Size Range (mm	Count
silt/clay	0 - 0.062	6
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	10
medium sand	0.25 - 0.5	10
coarse sand	0.5 - 1	16
very coarse sand	1 - 2	2
very fine gravel	2 - 4	2
fine gravel	4 - 6	2
fine gravel	6 - 8	0
medium gravel	8 - 11	1
medium gravel	11 - 16	1
coarse gravel	16 - 22	
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
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:	50
bedrock	--------------------	
clay hardpan	--------------------	
detritus/wood	--------------------	
artificial	--------------------	
	total count:	50

Note:

Bed Surface Pebble Count, UT to Cane Creek reference A1

cumulative % — # of particles



Size (mm)		
D16	0.062	3.4
D35	0.28	12
D50	0.47	17
D65	0.66	20
D84	1	29
D95	5.4	39

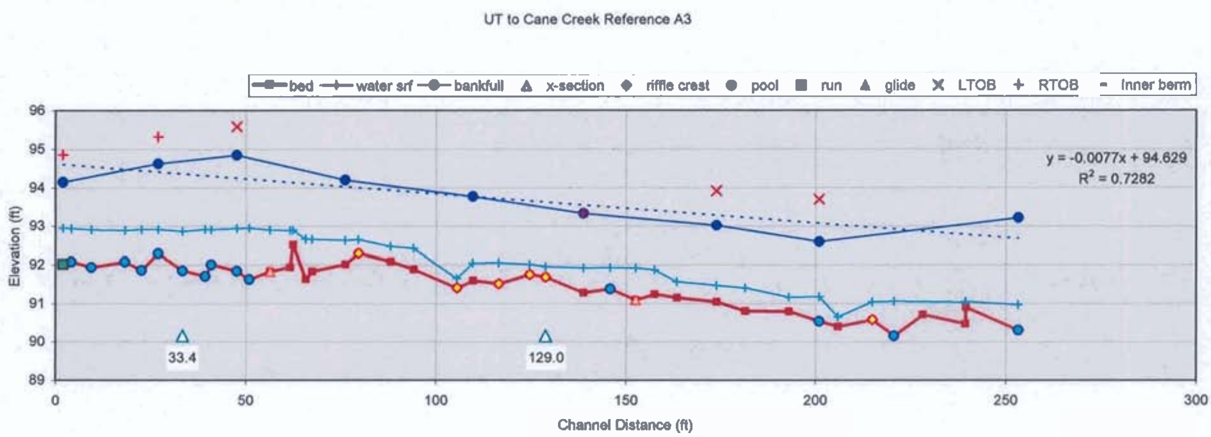
Size Distribution	
mean	**0.2**
dispersion	**4.9**
skewness	**-0.25**

Type	
silt/clay	**12%**
sand	**76%**
gravel	**12%**
cobble	**0%**
boulder	**0%**

APPENDIX F

Unnamed Tributary to Cane Creek Reference Reach (A3)
Photographs and Data

Longitudinal Slope Profile

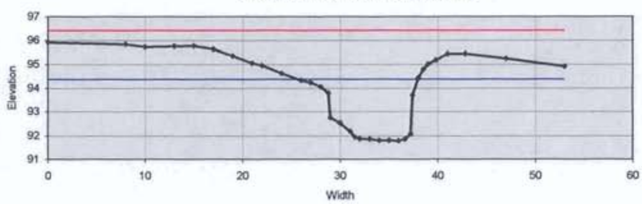


	slope (%)		length (ft)		length ratio		pool-pool spacing (ft)		p-p ratio	
reach	0.78		253.4	(23 channel widths)	---		---		---	
riffle	#DIV/0!		6.9	(0 - 17)	0.6	(--- - 1.5)	---		---	
pool	#DIV/0!		4.5	(0 - 32.7)	0.4	(--- - 3)	19.2	(1.6 - 95)	1.7	(0.1 - 8.6)
run	0.45		2.2		0.2		---		---	
glide	1.3	(1.1 - 1.6)	35.8	(23.3 - 48.3)	3.2	(2.1 - 4.4)	---		---	

notes	cross section ID	bed feature	station	station	FS bed	water	FS bankfull	user defined FS LTOB	user defined FS RTOB	user defined FS Inner berm	azimuth AZ	ELEV bed	ELEV water srf	ELEV bankfull	ELEV LTOB	ELEV RTOB	ELEV inner berm
back sight to benchmark																	
Head of Run		N	2		7.98	0.92	5.85		5.15			92.02	92.94	94.15		94.85	
Head of Pool		P	4.2		7.92	0.85						92.08	92.93				
Pool		P	9.5		8.06	0.96						91.94	92.9				
Pool		P	18.3		7.92	0.8						92.08	92.88				
Pool		P	22.7		8.14	1.05						91.86	92.91				
Pool		P	27		7.71	0.62	5.38		4.68			92.29	92.91	94.62		95.32	
Pool Cross-section	1	P	33.4		8.15	1.01						91.85	92.86				
Pool		P	39.4		8.29	1.2						91.71	92.91				
Pool		P	41		8	0.9						92	92.9				
Pool		P	47.7		8.16	1.09	5.16	4.42				91.84	92.93	94.84	95.58		
Pool Dmax		P	51		8.38	1.32						91.62	92.94				
Head of Glide		G	56.4		8.17	1.06						91.83	92.89				
Upstream of Debris Jam			61.7		8.06	0.94						91.94	92.88				
Debris Jam			62.5		7.49	0.38						92.51	92.89				
Scour Downstream of Debris Jam			65.8		8.37	1.03						91.63	92.66				
			67.5		8.17	0.82						91.83	92.65				
			76.2		7.99	0.62	5.8					92.01	92.63	94.2			
Head of Riffle		R	79.7		7.71	0.35						92.29	92.64				
Slight ponding above bedrock riffle			88.2		7.92	0.39						92.08	92.47				
			94.2		8.12	0.54						91.88	92.42				
Bedrock Riffle		R	105.6		8.6	0.25						91.4	91.65				
			109.8		8.41	0.45	6.23					91.59	92.04	93.77			
Riffle		R	116.6		8.49	0.54						91.51	92.05				
Riffle		R	124.8		8.25	0.26						91.75	92.01				
Riffle Cross-section	2	R	129		8.32	0.27						91.68	91.95				
			139		8.72	0.64	6.67		6.67			91.28	91.92	93.33		93.33	
Head of Pool behind Debris		P	146		8.62	0.55						91.38	91.93				
Head of Glide		G	152.7		8.91	0.83						91.09	91.92				
Head of Debris			157.7		8.76	0.63						91.24	91.87				
			163.6		8.85	0.42						91.15	91.57				
			174		8.96	0.43	6.99	6.09				91.04	91.47	93.01	93.91		
			181.5		9.2	0.6						90.8	91.4				
			193		9.21	0.37						90.79	91.16				
Slight pool around tree		P	201		9.46	0.63	7.41	6.31				90.54	91.17	92.59	93.69		
Head of Bedrock			206		9.6	0.25						90.4	90.65				
Bottom of Riffle		R	215		9.42	0.46						90.58	91.04				
Pool		P	220.7		9.84	0.9						90.16	91.06				
			228.3		9.29							90.71					
			239.5		9.53	0.56						90.47	91.03				
Bedrock			239.6		9.1	0.15						90.9	91.05				
Head of Pool		P	253.4		9.69	0.66	6.79					90.31	90.97	93.21			

Cross Section 1

0 + 33.4 UT to Cane Creek Reference A3, Pool



Bankfull Dimensions	
20.7	x-section area (ft.sq.)
12.3	width (ft)
1.7	mean depth (ft)
2.6	max depth (ft)
15.2	wetted parimeter (ft)
1.4	hyd radi (ft)
7.3	width-depth ratio

Flood Dimensions	
—	W flood prone area (ft)
—	entrenchment ratio
—	low bank height (ft)
—	low bank height ratio

Materials	
8.9	D50 Riffle (mm)
40	D84 Riffle (mm)
33	threshold grain size (mm):

Bankfull Flow	
5.4	velocity (ft/s)
112.2	discharge rate (cfs)
0.82	Froude number

Flow Resistance	
0.030	Manning's roughness
0.09	D'Arcy-Weisbach fric.
9.2	resistance factor u/u*
12.8	relative roughness

Forces & Power	
0.78	channel slope (%)
0.67	shear stress (lb/sq.ft.)
0.59	shear velocity (ft/s)
4.4	unit strm power (lb/ft/s)

Cross Section

reference ID	1
instrument height	100
longitudinal station	33.4

Bankfull Stage

FS	—
elevation	94.37

Low Bank Height

FS	—
elevation	

Flood Prone Area

width fpa	53.0

Channel Slope

percent slope	0.78

Flow Resistance

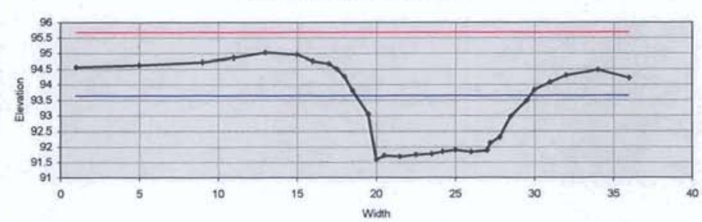
Manning's "n"	0.030
D'Arcy - Weisbach "f"	0.09

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0		100	4.1	95.9		Left Floodp
8		100	4.17	95.83		
10		100	4.28	95.72		
13		100	4.25	95.75		
15		100	4.24	95.76		
17		100	4.38	95.62		
19		100	4.65	95.35		
21		100	4.96	95.04		LTOB
22		100	5.05	94.95		
24		100	5.39	94.61		
26		100	5.68	94.32		
27		100	5.77	94.23		
28		100	5.95	94.05		LPBKF
28.8		100	6.22	93.78		
29		100	7.26	92.74		LEW
30		100	7.48	92.52		
31		100	7.82	92.18		
31.5		100	8.07	91.93		
32		100	8.13	91.87		
33		100	8.15	91.85		
34		100	8.2	91.8		
35		100	8.2	91.8		
36		100	8.21	91.79		Thalweg
36.6		100	8.14	91.86		
37.2		100	7.92	92.08		REW
37.4		100	6.31	93.69		
38		100	5.57	94.43		RPBKF
38.5		100	5.22	94.78		RPBKF
39		100	4.98	95.02		RTOB
39.8		100	4.81	95.19		
41		100	4.56	95.44		
42.8		100	4.56	95.44		
47		100	4.76	95.24		
53		100	5.09	94.91		Right Flood

Cross Section 2

1 + 29 UT to Cane Creek Reference A3, Riffle



Bankfull Dimensions	
16.2	x-section area (ft.sq.)
11.0	width (ft)
1.5	mean depth (ft)
2.0	max depth (ft)
12.9	wetted parimeter (ft)
1.3	hyd radi (ft)
7.5	width-depth ratio

Flood Dimensions	
—	W flood prone area (ft)
—	entrenchment ratio
—	low bank height (ft)
—	low bank height ratio

Materials	
8.9	D50 Riffle (mm)
40	D84 Riffle (mm)
30	threshold grain size (mm):

Bankfull Flow	
5.0	velocity (ft/s)
80.9	discharge rate (cfs)
0.79	Froude number

Flow Resistance	
0.031	Manning's roughness
0.10	D'Arcy-Weisbach fric.
8.9	resistance factor u/u*
11.2	relative roughness

Forces & Power	
0.78	channel slope (%)
0.61	shear stress (lb/sq.ft.)
0.56	shear velocity (ft/s)
3.6	unit strm power (lb/ft/s)

Cross Section

reference ID	2
instrument height	100
longitudinal station	129.0

Bankfull Stage

FS	—
elevation	93.63

Low Bank Height

FS	—
elevation	

Flood Prone Area

width fpa	35.0

Channel Slope

percent slope	0.78

Flow Resistance

Manning's "n"	0.031
D'Arcy - Weisbach "f"	0.10

Note:

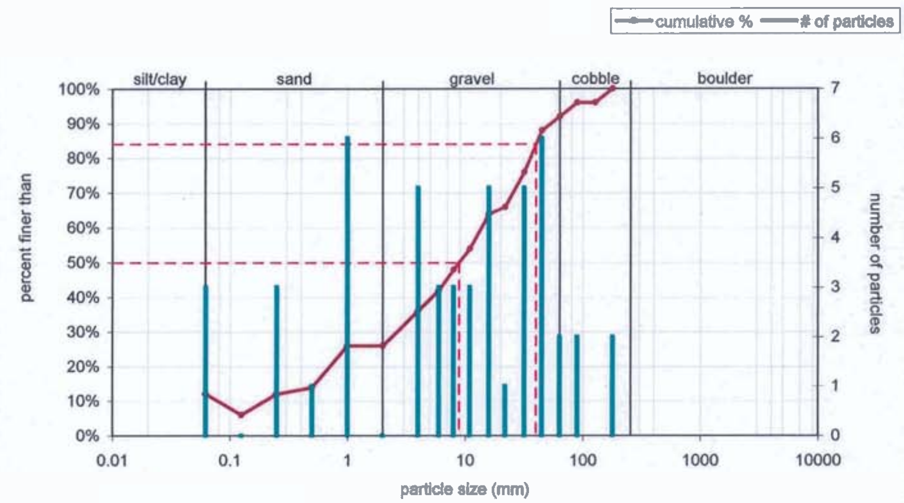
Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
1		100	5.44	94.56		Left Floodp
5		100	5.37	94.63		
9		100	5.28	94.72		
11		100	5.14	94.86		
13		100	4.98	95.02		
15		100	5.05	94.95		
16		100	5.25	94.75		
17		100	5.33	94.67		
17.5		100	5.5	94.5		
18		100	5.75	94.25		LTOB/BKF
18.5		100	6.2	93.8		
19.5		100	6.96	93.04		
20		100	8.41	91.59		LEW
20.5		100	8.29	91.71		
21.5		100	8.32	91.68		Thalweg
22.5		100	8.26	91.74		
23.5		100	8.23	91.77		
24.2		100	8.15	91.85		
25		100	8.1	91.9		
26		100	8.16	91.84		
27		100	8.11	91.89		REW
27.2		100	7.87	92.13		
27.8		100	7.7	92.3		
28.5		100	7.03	92.97		
29.5		100	6.54	93.46		RBKF
30		100	6.17	93.83		RTOB
31		100	5.92	94.08		
32		100	5.7	94.3		
34		100	5.53	94.47		
36		100	5.79	94.21		Right Flood

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	3
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	3
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	6
very coarse sand	1 - 2	0
very fine gravel	2 - 4	5
fine gravel	4 - 6	3
fine gravel	6 - 8	3
medium gravel	8 - 11	3
medium gravel	11 - 16	5
coarse gravel	16 - 22	1
coarse gravel	22 - 32	5
very coarse gravel	32 - 45	6
very coarse gravel	45 - 64	2
small cobble	64 - 90	2
medium cobble	90 - 128	
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:		50
bedrock		
clay hardpan		
detritus/wood		
artificial		
total count:		50

Note:

Riffle Surface Pebble Count, UT to Cane Creek Reference A3



Size (mm)	
D16	0.56
D35	3.7
D50	8.9
D65	19
D84	40
D95	83

Size Distribution	
mean	4.7
dispersion	10.2
skewness	-0.20

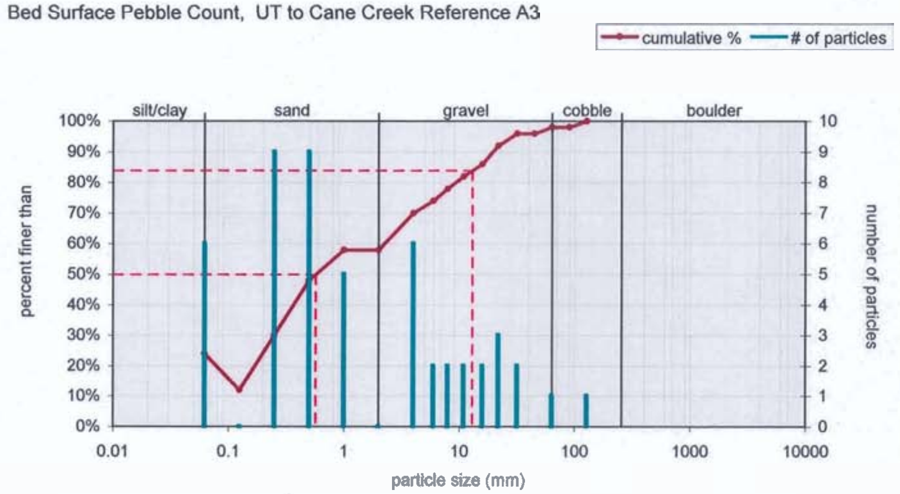
Type	
silt/clay	6%
sand	20%
gravel	66%
cobble	8%
boulder	0%

Bed Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	6
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	9
medium sand	0.25 - 0.5	9
coarse sand	0.5 - 1	5
very coarse sand	1 - 2	0
very fine gravel	2 - 4	6
fine gravel	4 - 6	2
fine gravel	6 - 8	2
medium gravel	8 - 11	2
medium gravel	11 - 16	2
coarse gravel	16 - 22	3
coarse gravel	22 - 32	2
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	1
small cobble	64 - 90	
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:		50
bedrock		
clay hardpan		
detritus/wood		
artificial		
total count:		50

Note:

Bed Surface Pebble Count, UT to Cane Creek Reference A3



Size (mm)		
D16	0.062	3.4
D35	0.3	12
D50	0.57	17
D65	3	20
D84	13	29
D95	29	39

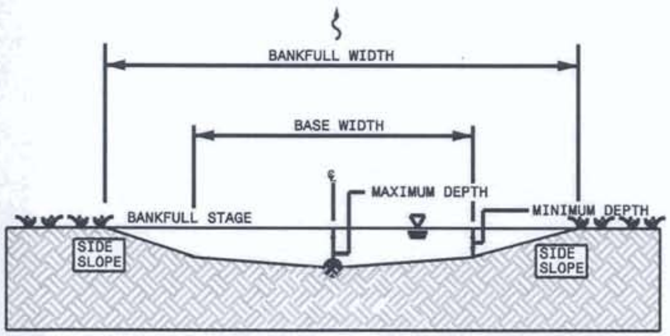
Size Distribution	
mean	0.9
dispersion	16.0
skewness	0.13

Type	
silt/clay	12%
sand	46%
gravel	40%
cobble	2%
boulder	0%

APPENDIX G

Typical Cross Sections, Details, Restoration Plan Sheets, and Planting Plan

TYPICAL SECTION - RIFFLE

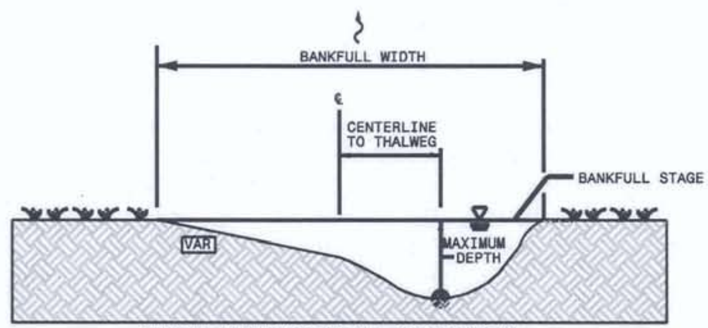


THALWEG (DEEPEST POINT IN CROSS SECTION) IS LOCATED IN CENTER OF CHANNEL IN A RIFFLE.

NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE DOWNSTREAM DIRECTION.
- DIMENSION TOLERANCE TO BE HELD TO +/- 0.2 FT.
- ● - GRADE POINT IS THE ELEVATION SHOWN ON PROFILE.
- ALL SHARP CORNERS SHOULD BE ROUNDED

SCALE: NTS

TYPICAL SECTION - POOL RIGHT



THALWEG (DEEPEST POINT IN A CROSS SECTION)
IS LOCATED IN THE OUTSIDE OF THE MEANDER BEND.

NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE DOWNSTREAM DIRECTION.
- DIMENSION TOLERANCE TO BE HELD TO +/- 0.2 FT.
- ● - GRADE POINT IS THE ELEVATION SHOWN ON THE PROFILE
- ALL SHARP CORNERS SHOULD BE ROUNDED

SCALE: NTS

Ecosystem Enhancement PROGRAM

UT to Cane Creek (Pickard Site)
Stream Restoration Project
Alamance County, NC

NOT TO SCALE

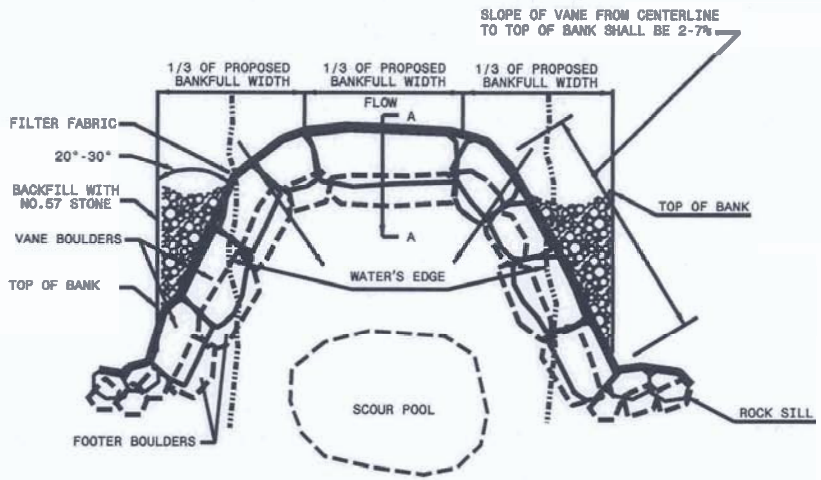
Typical Cross Sections

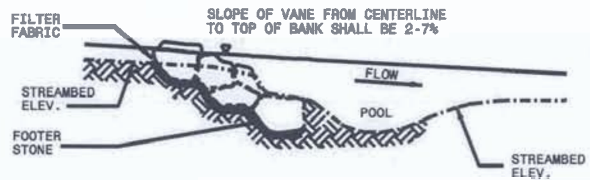
ROCK CROSS VANE

SCALE:NTS

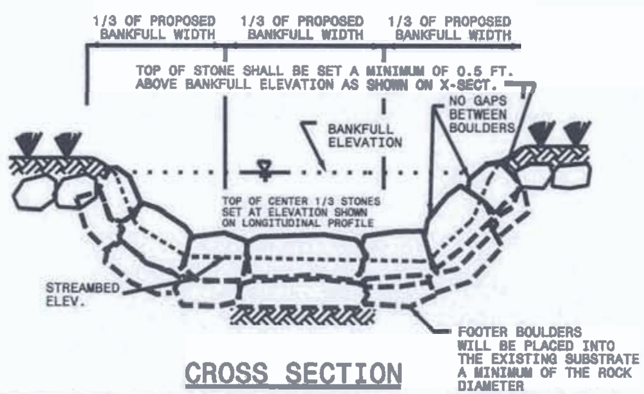
NOTES:
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER, PLUGGING WITH STRUCTURE STONE CLASS A AND NO.57 AND LINING WITH FILTER FABRIC.
3. DIMENSIONS AND SLOPES MAY BE ADJUSTED TO FIT BY THE DESIGNER.
4. A DOUBLE FOOTER BOULDER SHALL BE UTILIZED IN SAND BED MATERIAL.
5. FOOTER BOULDERS AND VANE BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE.

FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.





SECTION A-A



CROSS SECTION

Ecosystem Enhancement PROGRAM

UT to Cane Creek (Pickard Site)
Stream Restoration Project
Alamance County, NC

NOT TO SCALE

Rock Cross Vane

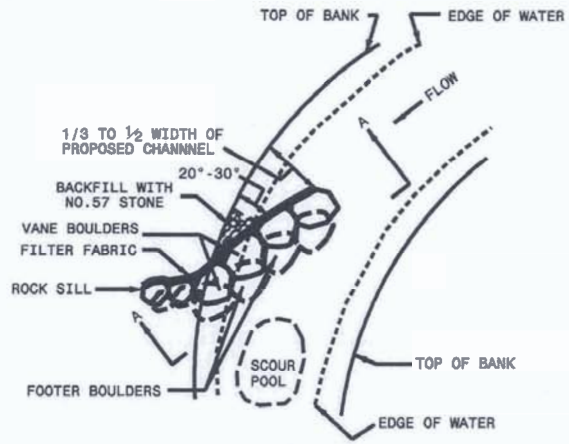
ROCK VANE

SCALE: NTS

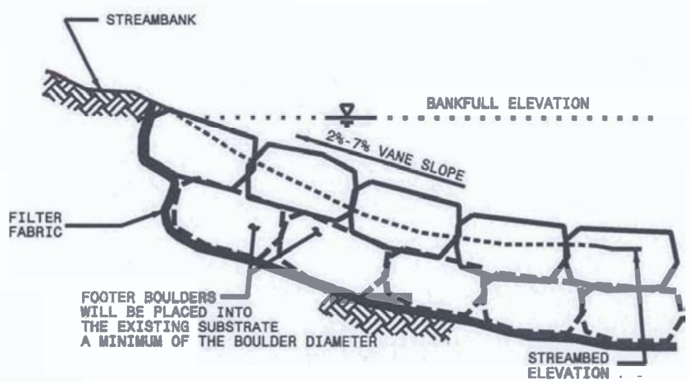
NOTES:
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER, PLUGGING WITH STRUCTURE STONE CLASS A AND NO.57 AND LINING WITH FILTER FABRIC.
3. DIMENSIONS AND SLOPES MAY BE ADJUSTED TO FIT BY THE ENGINEER.
4. A DOUBLE FOOTER BOULDER SHALL BE UTILIZED IN SAND BED MATERIAL.
5. FOOTER BOULDERS AND VANE BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE.

FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.

SLOPE OF VANE FROM CENTERLINE TO TOP OF BANK SHALL BE 2-7%



PLAN VIEW



SECTION A-A

Ecosystem Enhancement PROGRAM

UT to Cane Creek (Pickard Site)
Stream Restoration Project
Alamance County, NC

NOT TO SCALE

Rock Vane

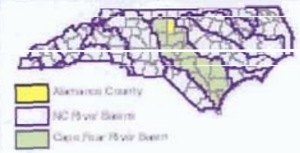
ROOT WAD

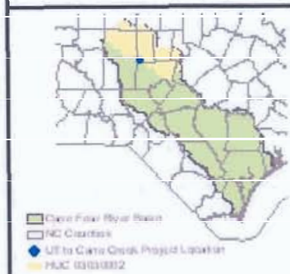
SCALE:NTS

NOTE:
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. SIDE SLOPES WILL BE MATTED.
3. 6" BY 2' WIDE EARTHEN BERM LOCATED ATOP ROOT WADS TO DIRECT SHEET FLOW AWAY FROM ROOT WADS.

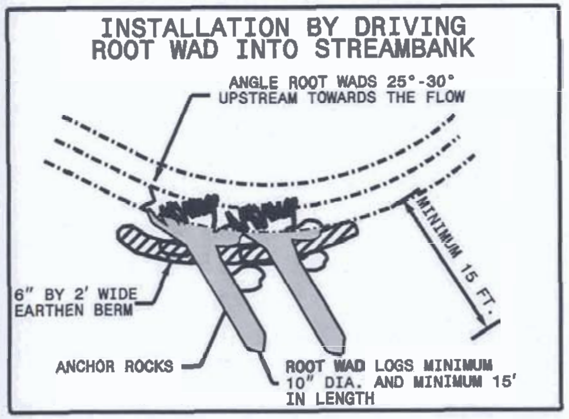
WHEN BACKFILLING OVER AND AROUND ROOT WAD LOGS PACK STONE BETWEEN ALL WADS TO FIRMLY SECURE ALL CONNECTIONS AND GAPS. ROOT WADS TO OVERLAP. STRUCTURE STONE SHALL BE PLACED BETWEEN ROOT WADS. NO GAP BETWEEN BOTTOM OF ROOT WAD & STREAMBED. ROOT WADS ARE HARDWOOD. SEE SPECIAL PROVISIONS FOR STONE SIZE.

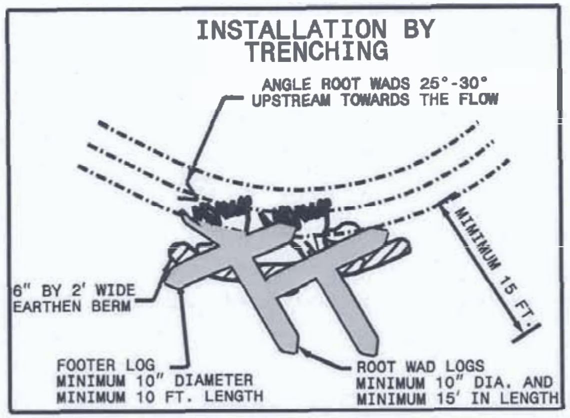
UT to Cane Creek (Pickard Site)
Stream Restoration Project
Alamance County, NC

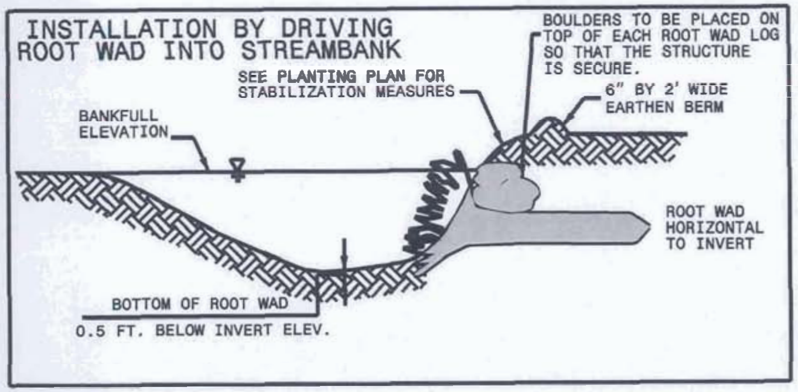


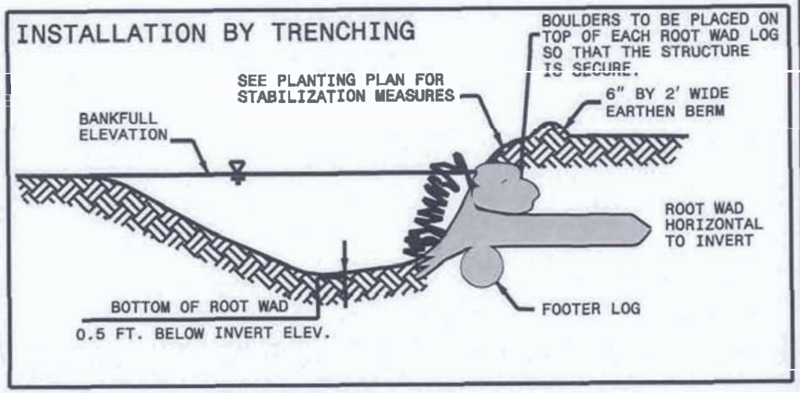


PLAN VIEW





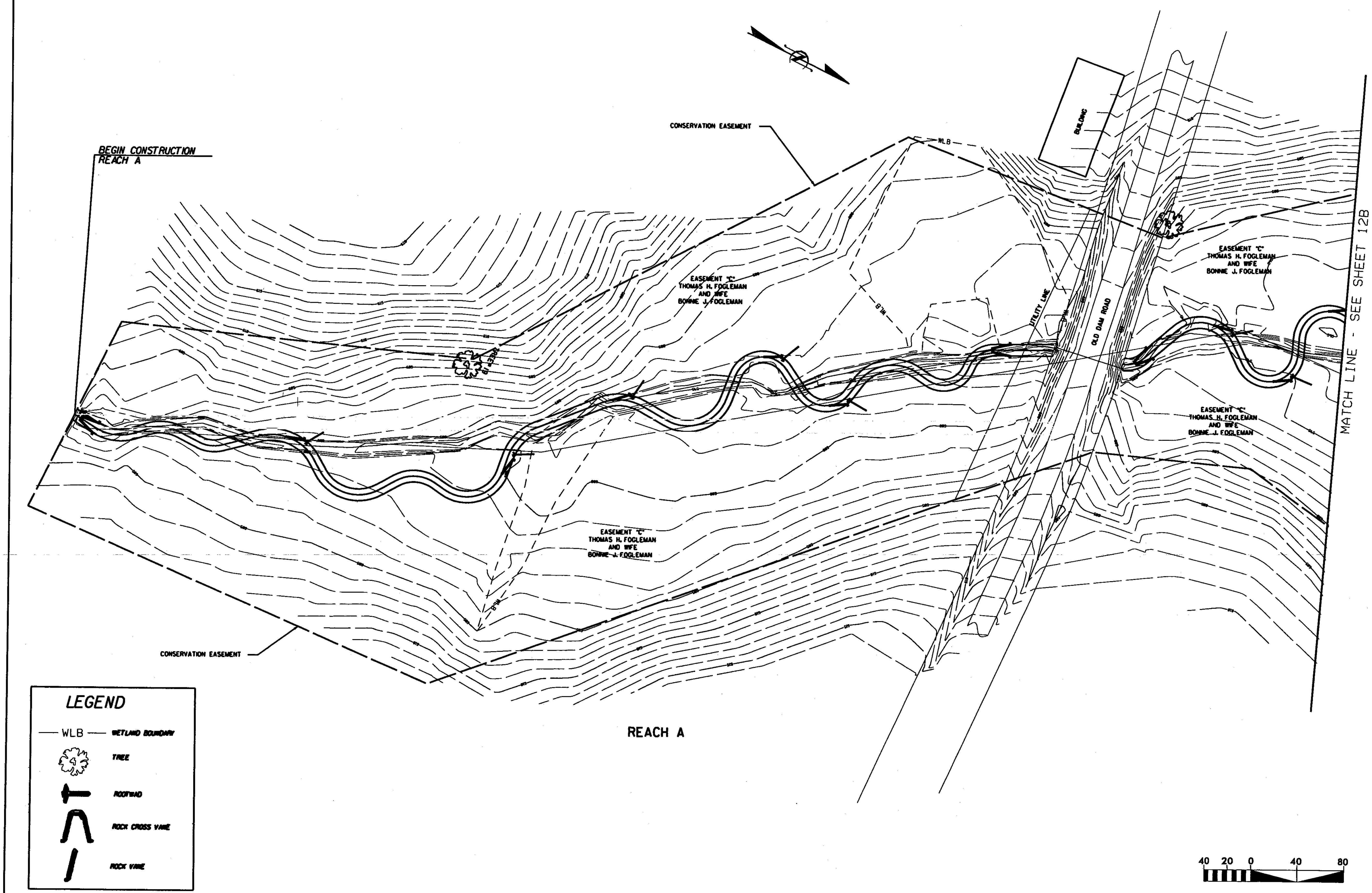




ROOT WADS - CROSS SECTION (CUT)

NOT TO SCALE

Rootwads



REVISIONS

NO.	DATE

Prepared by
URS
URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: UT TO CANE CREEK STREAM RESTORATION PROJECT ALAMANCE COUNTY

TITLE: PLAN SHEET

CLIENT: ECOSYSTEM ENHANCEMENT PROGRAM

Ecosystem Enhancement PROGRAM

SEAL: PRELIMINARY PLANS

DATE: FEB 2006

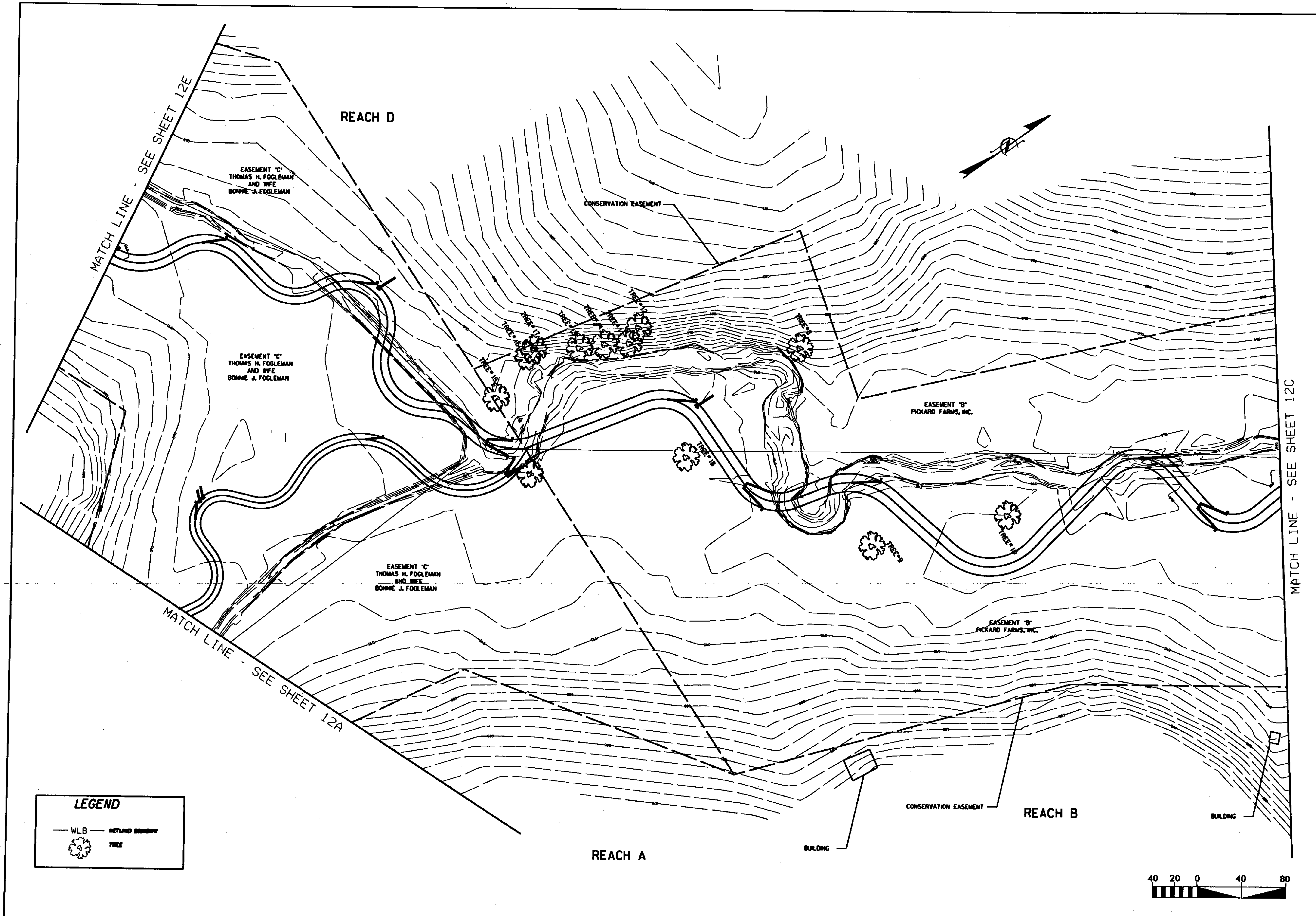
TECHNICIAN: EHJ

CHECKED BY: KM

SCALE
HORIZ.: 1"=80'

PROJ. NO.
SCO FILE #020594101

SHEET NO.
PS1



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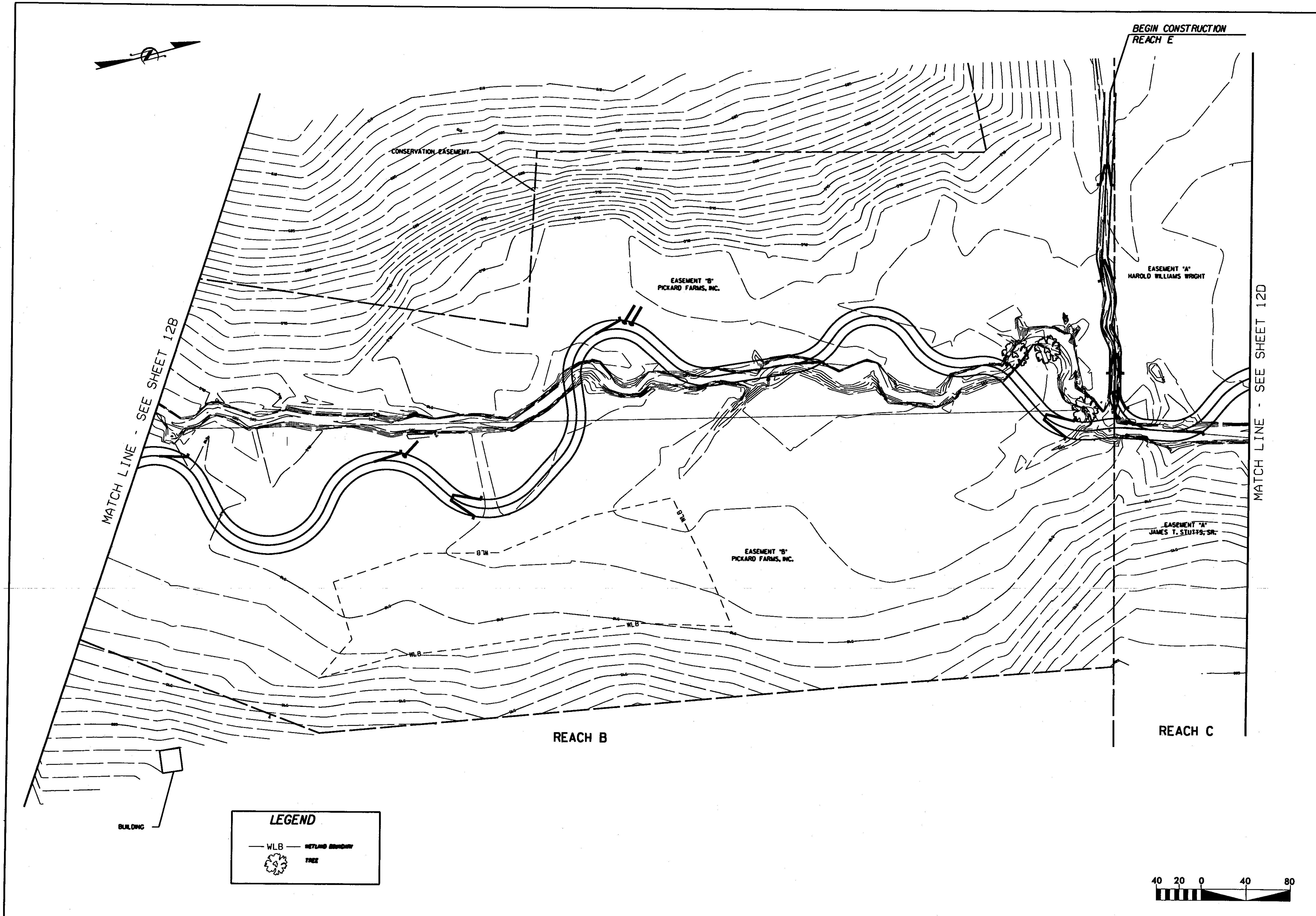

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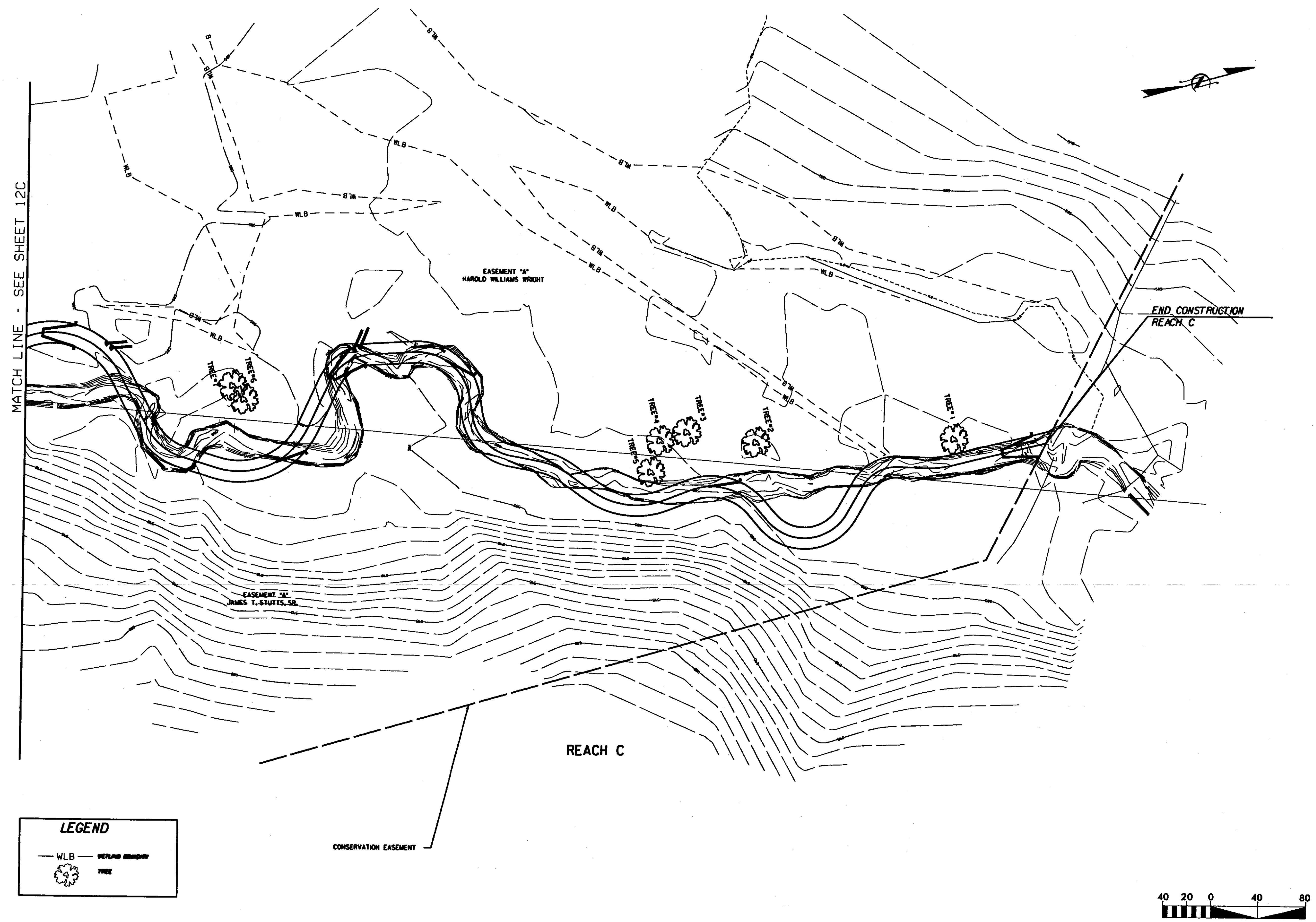

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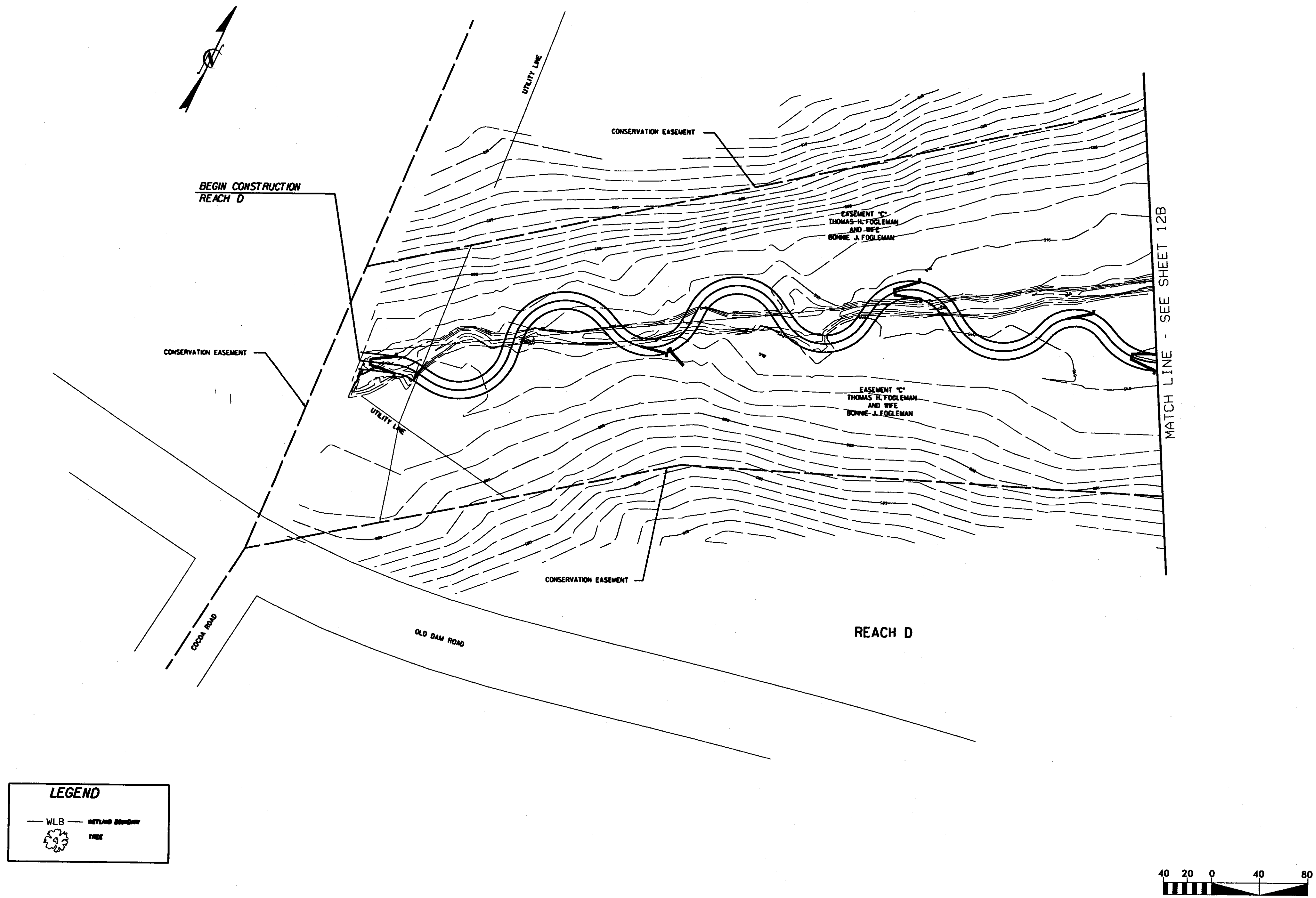

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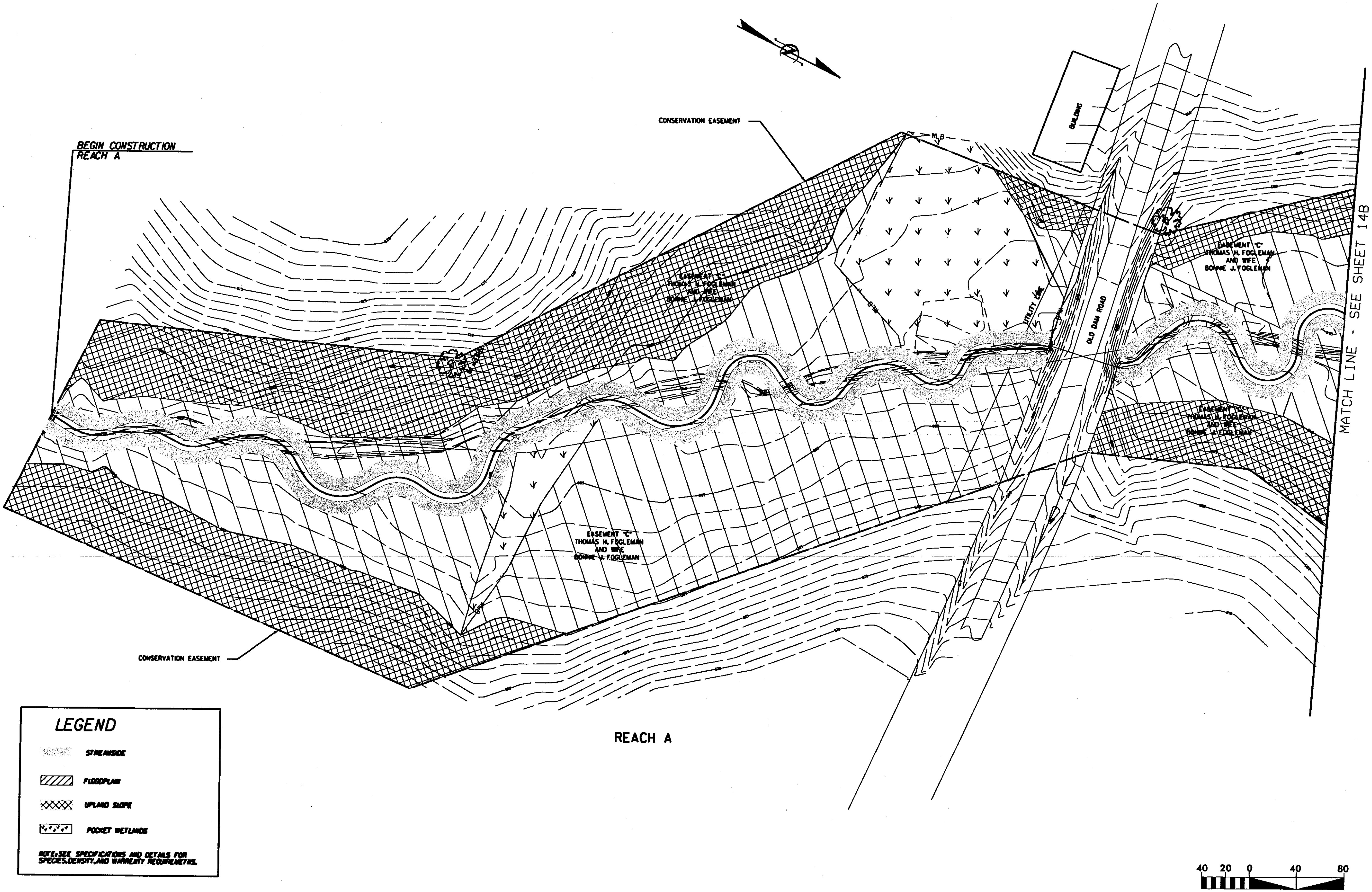
PS5



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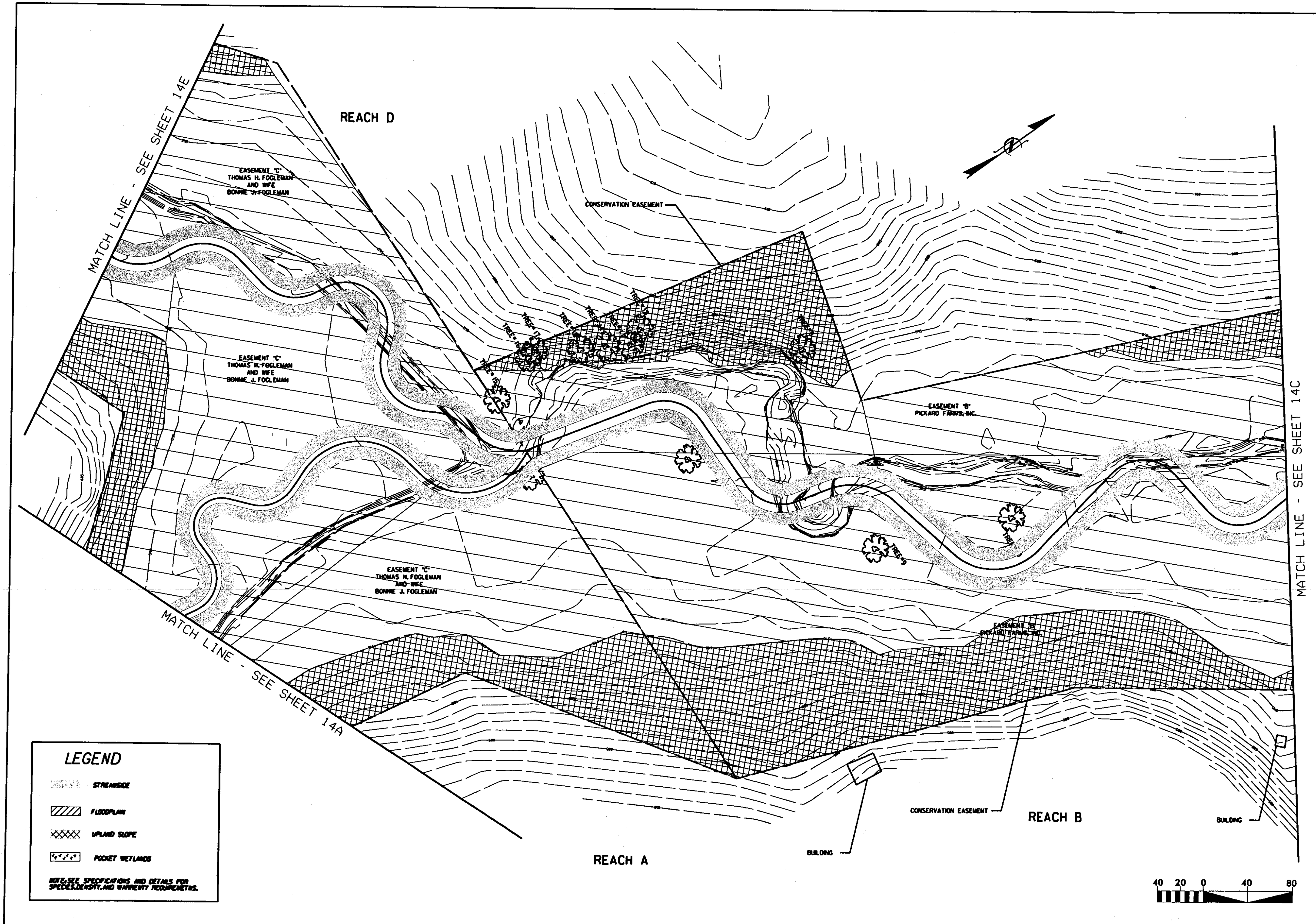

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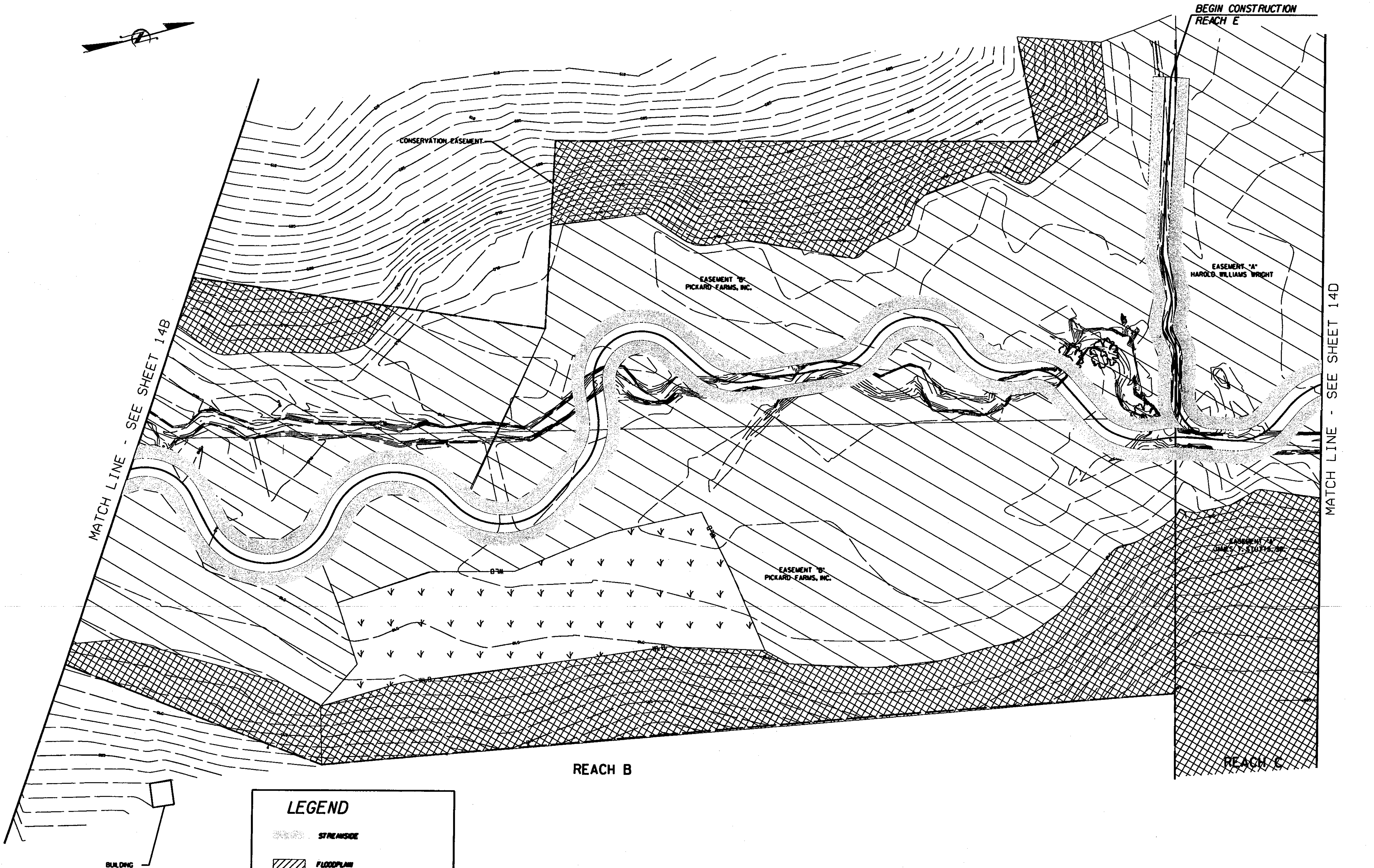

LEGEND

- STREAMSIDE
- FLOODPLAIN
- UPLAND SLOPE
- POCKET WETLANDS

NOTE: SEE SPECIFICATIONS AND DETAILS FOR SPECIES, DENSITY, AND WARRENTY REQUIREMENTS.

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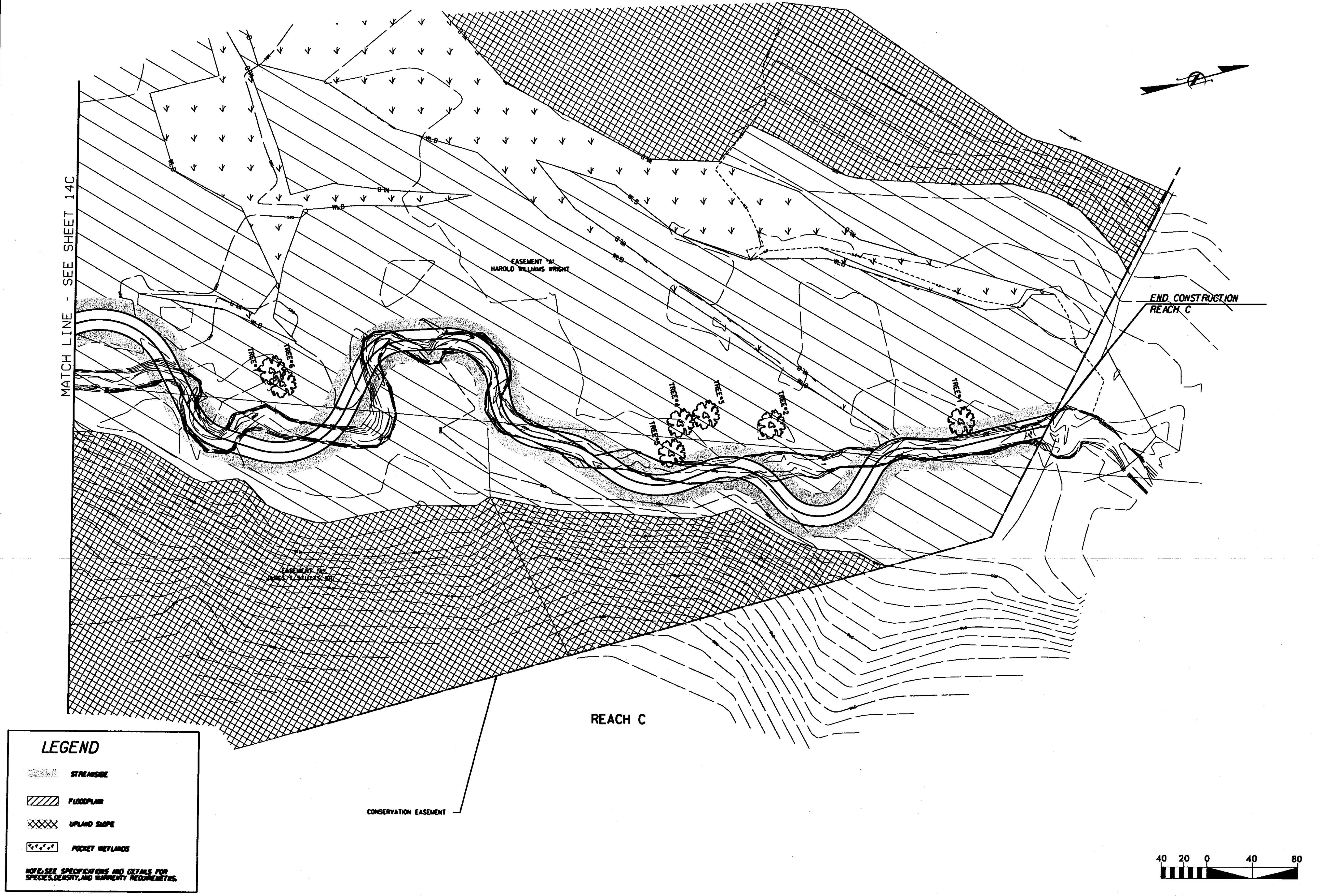
SHEET NO. PP3



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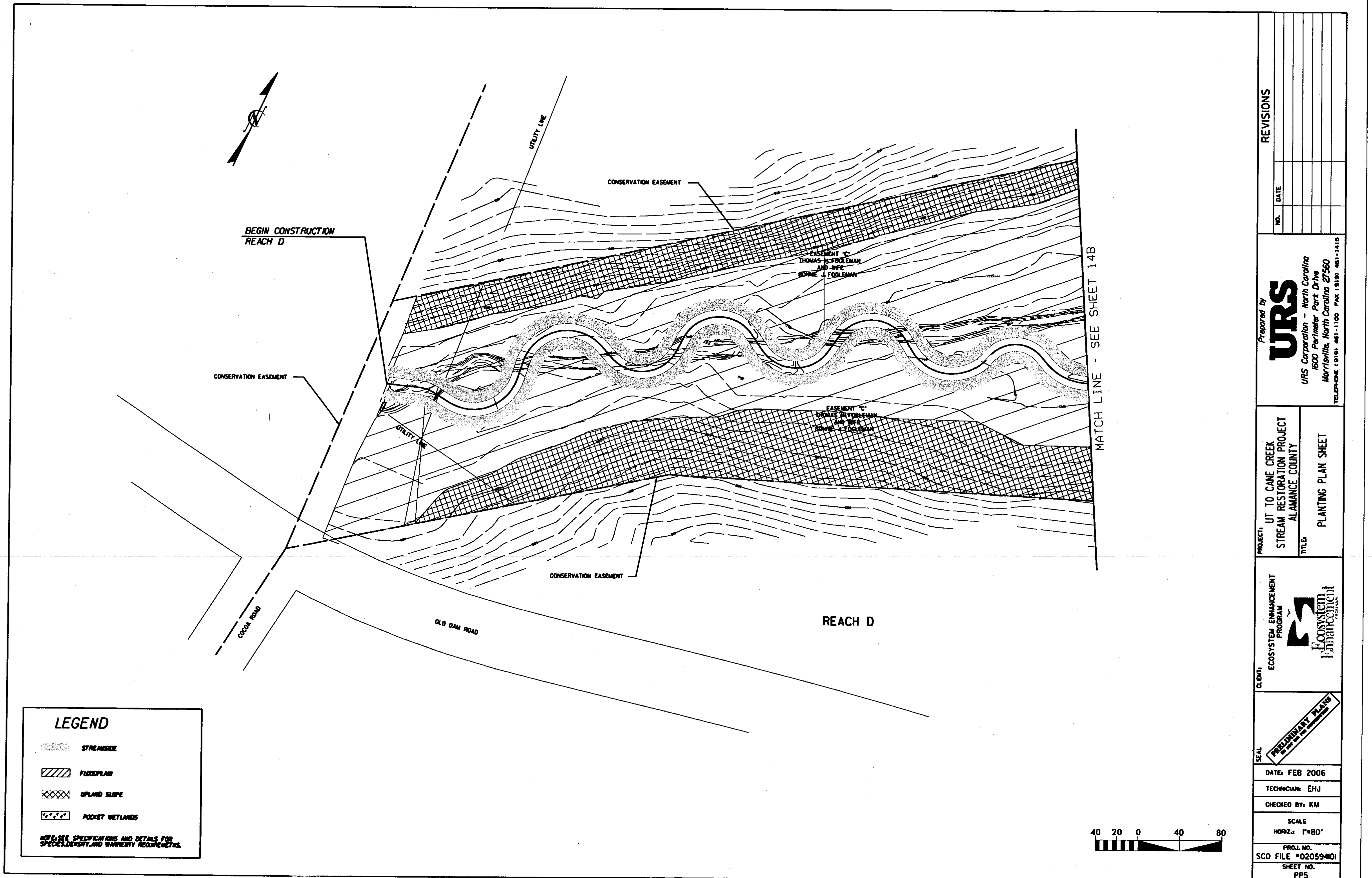

BEGIN CONSTRUCTION
REACH D
CONSERVATION EASEMENT
UTILITY LINE
EASEMENT "C"
THOMAS H. FOGLEMAN
AND WIFE
BONNIE J. FOGLEMAN
MATCH LINE - SEE SHEET 14B
COCOA ROAD
OLD DAM ROAD
REACH D
LEGEND
STREAMSIDE
FLOODPLAIN
UPLAND SLOPE
POCKET WETLANDS
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40 20 0 40 80
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