Executive Summary of Restoration Plan

Purlear Creek Phase II

Stream and Wetland Restoration Project
Wilkes County, North Carolina
Project ID No. 010559701

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

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Kimley-Horn
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1.0 Introduction

The Purlear Creek Stream Restoration project is located in Wilkes County, North Carolina approximately 8 miles northwest of the Town of Wilkesboro (Figure 1). The project area includes Purlear Creek and numerous unnamed tributaries located on the Hayes property (Figure 3), which is currently managed for livestock.

Purlear Creek was identified as a potential stream restoration/mitigation opportunity by the North Carolina Department of Environment and Natural Resources (NCDENR) Ecosystem Enhancement Program (EEP) based on an evaluation by EEP staff and on work done by the Wilkes County Soil and Water Conservation Service.

Kimley-Horn and Associates, Inc. (KHA) was retained to provide feasibility/planning, design, construction observation, and post-construction documentation services for Purlear Creek and its tributaries on the Hayes property. 11,500 linear feet of Purlear Creek and its tributaries were restored under a previous project Phase. This Phase was called Phase I and construction was completed in December 2003. The restoration plan and design methodologies for Phase I was documented in "Purlear Creek Stream Restoration Project, Project ID No. 010547501" prepared by KHA and dated October 2002. The methodologies used in the design of that project will be followed in this project (Phase II). This document summarizes the background investigation, fatal flaw analysis, fieldwork, property owner input, and methodologies used in preparing the design of Phase II.

2.0 Existing Conditions

2.1 Watershed

Purlear Creek is located within USGS hydrologic unit 0304010110090 in the Yadkin River Basin. The headwaters of Purlear Creek originate approximately 2 miles upstream of the northern property boundary on Rendezvous Mountain within the Blue Ridge physiographic province. Purlear Creek discharges into the North Prong of Lewis Fork approximately 1.5 miles downstream of the property boundary. The project area is located near the mountain/piedmont physiographic province boundary. Elevation of the

channel ranges from 2,200 feet at the headwaters, to 1,200 feet at the confluence with the North Prong of Lewis Fork. See figure 2 for a map of the watershed.

Approximately 3,075 feet of reaches 1 (STA 62+00 to 73+25), 4 (STA 300+00 to 323+13.83), and form the border between the Hayes property and a neighboring property. These reach designations are consistent with the original document submitted with Phase I. Existing wetlands with potential restoration opportunities are located adjacent to reach 4. Phase II includes restoration of the tributaries 1, 4, and adjacent wetland areas.

The drainage area for the most downstream point of Purlear Creek within the project area (at the bridge at New Hope Road) is approximately 3 square miles. Most of the headwaters within the watershed are forested, and owned by the State of North Carolina as educational forest (Rendezvous Mountain). There are other farms/pasture upstream of the project site, which may present future opportunities for restoration. GIS analysis of watershed landuse using the National Landcover Data derived in 1991 by the United States Geological Service (USGS NLCD 1991) shows approximately 76% of watershed area in forested cover, approximately 24% in cultivation or pasture, and less than 1% as wetlands. From a windshield survey of the watershed, it appears that a small portion of the watershed area surrounding a the offsite portion of reach 4 east and northeast of the project area has been converted from forest and farmland to low density residential use. A significant increase in development for the watershed is not expected because a large portion of the watershed is state forest land. Drainage area by stream segment is shown in Table 1. Figure 3 shows the location of the stream segments. In Appendix I, photo 1 shows the land use and land cover of the watershed.

Table 1

Approximate Stream Segment Length and Drainage Area

Segment	Segment Length (linear feet)	Drainage Area (square mile)
1	1,030	3.0
4	2,314	0.15-0.4
Total Length	3,344	--

2.2 Cultural and Environmental Database Searches

Environmental Data Resources (EDR) Report

In June 2002, Environmental Data Resources (EDR), Inc. conducted an environmental database search to identify potential or actual environmental concerns listed in the federal, state, or local regulatory agency databases. EDR did not identify any potential or actual environmental concerns within the project watershed. Appendix H contains the full database search report.

A Phase 1 Site Environmental Assessment was not performed. However, during field investigation/geomorphic assessment, hazardous materials were not observed, neither were fatal flaws due to hazardous materials identified.

State Historical Preservation Office (SHPO) and Archeology Office Database

KHA staff reviewed historical/archeological records for the project site in August 2002. No national, state, or locally listed or eligible historic structures or archaeology sites in the project area were listed in the State's files.

Natural Heritage Database Search

A database search of natural resources was performed by KHA through the North Carolina Natural Heritage Program. The following natural communities are located

within the Purlear Creek watershed upstream from the project area in the vicinity of the Rendezvous Mountain State Forest.

- Chestnut-Oak Forest
- Acidic Cove Forest
- Dry-Mesic Oak-Hickory Forest
- Low Elevation Rocky Summit
- Pine-Oak Heath
- Rich Cove Forest

These communities are located upstream from the project. Therefore, it is anticipated that there would be no adverse impacts to the existing natural communities from the restoration project.

The wet pasture adjacent to the project (stream segment 4, see figure 3) may provide potential habitat for the bog turtle (*Clemmy muhlenbergii*) which is listed by the state as a threatened species due to similarity in appearance. According to the North Carolina Natural Heritage Program (NCNHP), "the southern population of the bog turtle has this designation due to similarity of appearance to bog turtles in the threatened northern population." This designation "does not affect land management activities of private landowners in the southern states". (U.S. Fish and Wildlife Service, November 5, 1997 press release. http://www.nc-es.fws.gov/reptile,bogtur.htm) The NCNHP has not noted bog turtle occurrence for the project site USGS Quadrangle. According to the NCNHP, the habitat of the bog turtle consists of shallow, spring-fed fens, sphagnaceous bogs, marshy meadows, and pastures, with thick grassy cover, and crossed by slow, muddy bottomed streams and swamps with aquatic and semi-aquatic plants.

Chris McGrath, a certified biologist with the U.S. Fish and Wildlife Service, was on-site in May 2003 to review the project area for potential bog turtle occurrences and to evaluate potential habitat for the threatened species. No bog turtles were identified however, in follow-up conversations with Mr. McGrath, he stated that the project area may provide high quality bog turtle habitat in the area of wetland restoration once the site hydrology is restored and cattle are excluded.

Summary of Environmental, Cultural and Natural Resource Database Search

According to the database review, Phase I (completed in December 2003) and Phase II work performed on the sites described in the attached Preliminary Restoration Plan section (Section 6.0) will not affect threatened and endangered species, critical habitats, listed historical sites, or known archeological sites. No protected species issues were observed during the stream assessment field efforts for Phase I (completed December 2003) and Phase II.

2.3 Site Description

Overview

KHA evaluated Purlear Creek and its four tributaries, as identified for restoration by EEP (Figure 3). All project reaches are located within open cattle pasture. The entire length of stream within the property was evaluated. Two valley types exist within the project area. Steeper valleys, 1.5% to 3% slopes, are located in the northwestern and northern portion of the project area and the southeastern portion lies within a broader valley, 0.7% to 1.5% slopes. Roughly corresponding to the valleys, two stream types, as identified by Rosgen, are present onsite with generally B stream types in the steeper valleys and generally C stream types located in the broader valleys. The average stream gradient is 1% for C stream types and 1.5% for the B stream types.

Figure 3 shows the location of the stream in relation to roads and existing structures/utilities within the study area.

Farm Facilities, Structures, and Utilities

Structures and utilities within the project corridor are shown on the attached Preliminary Restoration Plan.

Vegetation

The project area is predominantly pasture grass. Along the stream banks are common riparian hardwood trees (Red maple, Sycamore, River birch, Yellow poplar, etc.). The understory is dominated by invasive Chinese privet. The existing riparian buffer is

generally limited to a single line of trees along the stream banks (Appendix I – Photos 2, 3, and 4). In areas where the existing buffer is greater, the vegetation is severely disturbed due to cattle intrusion.

The areas proposed for wetland mitigation are dominated by fescue and pasture grasses (Appendix I – Photo 2, and 4). There are wetter areas where Juncus and Polygonum wetland species are mixed in with the fescue. These areas are also severely disturbed from cattle intrusion and hoof shear.

Soils

Based on the North Carolina Soil Survey (Wilkes County, 1997), the soils at the site are mapped as Masada sandy clay loam, Chewacla loam, Pacolet sandy clay loam, and Braddock clay loam. Within the Chewalca mapped areas are likely inclusions of Wedhadkee loam in areas that are more frequently flooded. The following is a description of the individual soil types mapped within the project area.

Chewacla loam (CkA),:0 to2 percent slopes. The Chewacla series consists of very deep, somewhat poorly drained moderately permeable soils on nearly level floodplains in the piedmont.

Pacolet sandy clay loam (PcC2): 8-15 percent slopes, eroded. The Pacolet series consists of very deep, well drained, moderately permeable soils on piedmont uplands.

Pacolet sandy loam (PaD): 15-25 percent slopes. The Pacolet series consists of very deep, well drained, moderately permeable soils on moderately steep sideslopes in the piedmont.

Wehadkee loam (WhA): 0 to 2 percent slopes, frequently flooded. The Wehadkee series consists of very deep, poorly drained, moderately permeable soils on nearly level floodplains in the piedmont.

See Figure 5 for soil mapping.

2.4 Channel Description

Horizontal and Vertical Stability

The main channel of Purlear Creek, which includes the reaches $2A_2$, 2A, 1A and 1 (in order from upstream to downstream) exhibits both vertical and horizontal instability. The degree of instability declines from the upper sections to the lower sections of the main channel to reach 1A. Reach 1 has a vegetated buffer of medium sized hardwoods that range in width from 10 to 40 feet, and is more stable than the other reaches.

Purlear Creek (Phase I: reaches 2, 1A, and Phase II: 1) appears to have been modified to accommodate cattle operations. All streams contained on the property are accessible to cattle. The hoof shear from the cattle has accelerated bank erosion and channel degradation.

Channel dimensions and profile data for each reach is presented in Appendix A. Entrainment calculations and material measurements for each reach are presented in Appendix C and D. A summary of morphological data for reaches 1 and 4 is included in the Project Morphological Table in the attached Restoration plans.

Reach 4 (Phase II) is located along the eastern edge of the project area and flows from the northeast corner of the property due south until it joins the main channel. The upper section of the reach forms the border between the project property and an adjacent property. This section has a vegetated buffer of mature hardwoods ranging from 10 to 40 feet. The remaining downstream length is dominated by a thin discontinuous buffer of immature trees except where the stream borders a riparian wetland (Appendix I, photo 2). A portion of the riparian wetland is forested and provides more than 40 feet of vegetative buffer on the left bank of the stream. The lower section of the stream above the confluence with a smaller order stream (labeled reach 4a on Figure 3) has likely been relocated and placed against the valley wall. The field team observed a shallow swale that departed from the reach 4a channel from within the adjacent forested wetland that traveled through the base of the valley until it rejoined the channel near the confluence of the smaller order stream, reach 4a. The swale appears to be a relic channel that is surrounded by a potential relic wetland (Appendix I, photos 2, and 4).

Entrainment calculations (Appendix D) predict that the reach will continue to degrade the channel. The BEHI score for the reach is Very High. Additionally, with active cattle grazing in the area, the channel will continue to receive impacts. The segment stream type is F4 and will likely continue to widen, resulting in high sediment loads and impaired habitat.

Channel Materials

The stream substrate varies by section along the stream network. Modified Wolman Pebble Counts were performed to classify the materials in the stream channel. Because of the absence of channel bars, sub-pavement samples were taken in place of bar samples (Appendix C for plots of the particle size distribution of surface and sub-pavement materials). A bimodal distribution of cobble and silt is representative of channel materials of the project reaches. The abundance of silt can be attributed to high erosion rates from channel instability and hoof shear from cattle. Because of the bank disturbance, particle sizes may be underestimated in the particle size distribution plots. The table below summarizes the channel materials based on the pebble counts for each stream reach surveyed.

TABLE 2
Channel Material

Stream Segment	1	4
Sand/Silt (%)	11	67
Gravel (%)	38	33
Cobble (%)	6	0
Boulder (%)	0	0
Bedrock (%)	0	0
D16 (mm)	0.08	N/A
D35 (mm)	0.19	0.25
D50 (mm)	1.0	0.5
D84 (mm)	35	5.2
D95 (mm)	70	7.6

Vegetation as Bank Protection

Three general types of vegetative stream buffers exist throughout the project area. The first type of vegetative buffer is 10 feet wide and comprised of mature hardwoods. This buffer provides the greatest bank protection onsite and is found in the upper portions of reach 4 and most of reach 1. The second buffer type has sparser tree cover, limited widths not exceeding 10 feet, and is made up of younger and smaller hardwoods. This buffer provides limited bank protection and many of the trees along the bank are falling into the stream due to accelerated erosion. The third buffer type lacks any woody vegetation and consisting of only herbaceous vegetation providing the least bank protection of the three. The second and third buffer types are found in downstream portions of reach 4.

Water Quality

NCDENR Division of Water Quality (DWQ) has designated Purlear Creek as a Classification C and Classification WS-IV. The C classification applies to freshwaters that are protected for secondary recreation, fishing, propagation, and survival of aquatic life and wildlife. The WS-IV classification applies to streams that are water supply streams to heavily developed areas. The upper reaches of Purlear Creek are designated as Class C. Two miles of Purlear Creek, upstream of the confluence with the North Prong of Lewis Fork, are designated as Class WS-IV.

The upper reaches of the restored (Phase I) stream segments now have good clarity. Water clarity decreases in the downstream direction along reach 1 and 4. Cattle have unlimited access to a large portion of reach 4 and the lack of a buffer produces thermal pollution. Fish, snails, aquatic invertebrates, and salamanders were observed on the upper reaches of the stream. No water quality sampling was performed as a part of KHA's assessment.

Habitat

Habitat quality varied by stream segment with habitat quality generally decreasing in the downstream direction. Because the upland area adjacent to the streams is used primarily for cattle pasture, stream influenced terrestrial habitat is poor.

Flood Hazard

The FEMA FIRM Panel 370256 150B shows the project area is within Zone X, "an area that is determined to be outside the 1% and 0.2% annual chance floodplains."

3.0 Restoration Goals and Objectives

3.1 Definition of Restoration

For the purposes of this project, stream restoration is defined as "the process of converting an unstable, altered or degraded stream corridor, including adjacent riparian zone and flood-prone areas to its natural or referenced, stable conditions considering recent and future watershed conditions. This process also includes restoring the geomorphic dimension, pattern and profile as well as biological and chemical integrity, including transport of water and sediment produced by the stream's watershed in order to achieve dynamic equilibrium" (*Internal Technical Guide for Stream Work in North Carolina*. April 2001 v.3.0). Wetland Restoration is defined as "the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural or historical functions to a former or degraded wetland." (US Army Corp of Engineers Regulatory Guidance Letter No 02-2, December 24, 2002.)

3.2 Objectives

The objective of this project is to design adjustments to the stream reaches and wetlands that will increase their long-term stability and create a more functional riparian ecological community. The design will adjust the stream's geomorphic dimensions, patterns, and profiles. The proposed changes will reflect the reference reaches' stable conditions and their current geomorphic conditions. Additionally, vegetated buffers that match proximal natural ecological communities found in similar physiographic and climatic regions will be planted. The reach will be designed to maximize natural design and natural parameters, and to account for physical constraints within the project area.

A mix of Priority I (Reach 4 (Station 300+00 to 323+00)) and Priority II (Reach 1 (Station 62+00 to 73+25)) restoration approaches will be used for this project. Where applicable

the Priority I restoration process will return stream channels to relic channels to return water table levels to historic values. In all applicable areas both Priority I and Priority II will be used to re-establish an active floodplain and stabilize the stream banks (Rosgen 1997). This method will decrease stream bank erosion, establish an active floodplain, reduce channel stress during floods, improve aquatic habitat, and reduce fine sediment.

A Priority I approach will be used for the stream segment (Reach 4) adjacent to the wetland. The re-establishment of the historical channel bed elevation will raise the water table in the area adjacent to the stream, and will provide form more frequent flooding of the adjacent floodplain/riparian wetland. Therefore, hydrology restoration in the riparian wetland is twofold:

- Extended hydroperiod duration and degree of saturation in the upper surface of the wetland through a raised water table during the growing season.
- Frequent flooding and over-bank flow in the riparian wetland areas through raising the channel bed and reducing bank heights adjacent to the wetland areas. The new priority one channel dimension will increase frequency and duration of over-bank/flood events.

In evaluation of the design approach, a single section, one-dimensional analysis was performed to evaluate the existing and proposed frequency of flooding. Currently, the channel is incised and only over-tops its banks during an approximately 25-year storm event (4 % chance of occurring in a given year). The low bank height at the evaluated riffle cross section is 3.1 feet, and Bank Height Ratio (BHR) is greater than 4.0. The proposed channel will have low bank height (riffle) of 0.7 feet and a BHR of 1.0. The design storm event for over-bank flow (also bank-full flow) is the 1.5-year storm event (66.7% chance of occurring in a given year).

Appendix K shows the single section hydraulic analysis and the stream hydrology (blue ridge rural regression) results.

Appendix J contains baseline water table monitoring data for the project area. The data demonstrates that during the monitoring period, water table elevation was at or near the

surface. To date, the site has received excessive rainfall and the data may not be indicative of normal circumstances of the existing condition. When first evaluated, the site was severely degraded from drought and cattle intrusion and grazing. Since restoration of the Phase I of the Purlear was initiated (May 2003), the wetland hydrology has recovered under wet conditions, but the function of the system is still extremely limited. The area now appears to have wetland hydrology typical of a seep. However, this area is still impacted by the cattle, and has limited connectivity with the surface hydrology of the stream.

Therefore, the restoration of the wetland will be to re-establish the riparian wetland system through restoring the surface and subsurface hydrodynamics of the wetland in relation to the stream. The objective will be to restore the function of the wetland as a riparian wetland system.

The raised water table and more frequent over bank flooding will alter the hydrology, rehabilitating existing wetlands and re-establishing other wet area by expanding the existing wetland fringe. "Re-establishment" and "rehabilitation" are both defined by the Corp as "restoration" in Regulatory Guidance Letter No. 02-2.

4.0 Methodology/Design Considerations

The design methodology for Purlear Creek and its tributaries follows guidelines set forth in NCDENR's *Internal Technical Guide for Stream Work in North Carolina*, April 2001 v.3.0. A summary of the analysis and coordination performed includes:

- Reference reach geomorphic survey (Rosgen Level III)
- Assessment of natural communities (both existing and reference)
- Assessment of the watershed's condition and potential
- Rosgen Level III classification of the stream
- Geomorphic field measurements
- Identification of constraints and opportunities
- Detailed topographic and geomorphic survey of the project corridor

A preliminary plan was developed using the above analysis (see the attached Restoration Plan).

Preliminary investigations of the site concluded that an area adjacent to Reach 4 contained hydric soils, however, through down cutting of the stream, disturbance by the cattle, and dominance of fescue and grasses, the area was a potential wetland restoration opportunity. Therefore, the wetland restoration approach would include:

- Restore the wetland hydrology and improve water table hydroperiod to support a wetland community through raising the local groundwater and increasing over bank flow through restoration of the stream channel,
- Restore vegetation and manage invasive species to restore the wetland biological community,
- Exclude cattle to protect the wetland biological community.

Baseline, or pre-construction, water table data collection was initiated in January 2003 at two locations in the wetland restoration area. The area proposed for restoration contains hydric soil, however within the restoration area, there were different hydrology and vegetation signatures. The downstream monitoring location (RDS-W1) appeared to be somewhat wetter with evidence of ponding in the disturbed soil (hoof shear depressions) and had wetland plants (Juncus spp. and Polygonum spp.) mixed with the fescue. The upstream monitoring location (RDS-W2) did not have hydrology indicators and had few wetland plants, dominated by the fescue. Figure 6 shows the monitoring locations.

The restoration design approach is to correlate the water table in the wetland restoration area to the improved stream channel elevation adjacent to the wetland. The water table monitoring gages will continue to collect daily water table measurements through the monitoring period to evaluate wetland hydrology correlated to the restored stream channel bed elevation.

In addition to the restoration of wetland hydrology in the adjacent wetlands, the biological function and vegetation community will be restored through the exclusion of cattle in the

wetlands, vegetation planting of native wetland plants, and control of invasive plant species (Fescue, Chinese privet, Multiflora rose).

4.1 Reference Stream Reaches and Reference Wetland

Four reference stream reaches and one reference wetland were identified and chosen to serve as a blueprint for design. Two reference reaches were used as templates for the B stream types and two reference reaches were used for C stream types and the reference wetland was used for the wetland areas. One B stream reference reach is located upstream of the project's reach 3 within an adjacent property located north of the project property. The other B stream reference is located on Upper Big Warrior Creek southeast of the town of Wilkesboro. Both C stream reference reaches are located within Basin Creek north of the project area. The locations of the reference reaches are shown in Figure 4.

The B stream type reference reach upstream of the Hayes Property appears to have been relocated and straightened in the past. The stream now has well established bank vegetation, stable banks, and appears to be neither degrading nor aggrading. The stream has built a floodplain within a confined valley and has stable pattern and profile with low sinuosity and established pools and riffles. Based on the Rosgen classification system, this section of Purlear Creek is classified as a B4c stream type. The information gained from the reference was used to design the proposed stream's restoration pattern and profile. This reference reach was chosen as an excellent example of a stable stream within a limited corridor (low belt width and sinuosity). Due to a limited easement, the restoration of Purlear Creek (reach 1) will require the construction of a stream with a low meander width ratio and a low sinuosity.

The remaining reference reaches were surveyed by other groups for other stream restoration projects. Reference data for Upper Big Warrior Creek was developed by Micky Clemmons and Brent Burgess of the North Carolina Wildlife Resources Commission. The Natural Resource Conservation Service (NRCS) developed reference reach data for Basin Creek. The reference reaches were selected for this project

because of their proximity to the project site and similarity to the stream types of the project reaches.

The complete morphologic measurements of all reference reaches are provided in the Preliminary Restoration Plan. This morphologic measurement table is per Appendix B of the *Internal Technical Guide for Stream Work in North Carolina*, April 2001 v.3.0. Additional information pertaining to the reference reaches is located in Appendix F.

The reference wetland site is being monitored by North Carolina State University. The site is located in Wilkes County in the Doughton Recreation Area south of the Blue Ridge Parkway (National Park Service) along the floodplain of Basin Creek (see Figure 4).

The site is a low-elevation seep dominated by gramiods and forbs with scatter shrubs. The herbaceous layer includes *Juncus* spp., *Carex* spp., *Osmunda regalis*, *Osmunda cinnamomea*, *Boehmeria cylindrica*, and *Impatiens capensis*. The woody component includes *Acer rubrum*, *Liriodendron tulipifera*, *Tsuga canadensis*, *Betula lutea*, *Pinus strobus*, *Alnus serrulata*, *Lindera benzoin*, *Kalmia latifolia*, and *Rhododendron* spp.

The hydrology is dominated by groundwater discharge with the water table at the surface for most of the year. The hydrology is being monitored by two Ecotone wells recording on 12-hour intervals.

The soil series appears to be Nikwasi. It is classified as Cumulic Humaquepts.

Although the soil type of the reference wetland may not be the same as the restoration wetland along the Purlear Creek tributary, the physiographic location and landscape position of the reference site is similar to the restoration wetland site. The intent of using the reference wetland as a guide for the restoration site is to provide a vegetation species comparison, as well as to document and compare hydrodynamics (groundwater-stream hydrologic relationship in the wetland) of the reference to the restoration wetland for determining success of the wetland restoration.

4.2. Regional Curves and Regime Equations

Due to the project area's location (at the boundary of the piedmont and mountain physiographic regions), the North Carolina Piedmont Rural and Mountain Rural Regional Curves were used to check the primary stream's bankfull characteristics (width, depth, cross-sectional area, and discharge). Local curves showing the relationship between channel dimensions and drainage areas were developed using data from the reference reaches discussed in section 4.1. The local curve's width and cross-sectional area values were lower than those of both the piedmont and mountain regional curves. The Piedmont and Mountain Regional Curves and locally derived curves are provided in Appendix E for reference.

4.3 Natural Communities

The project area is located within active pasture that has not been identified as a natural community of concern. Restoration activities will not impact any identified natural communities of concern and the resulting restoration may enhance upstream communities identified in Section 2.2.

4.4 Watershed Assessment

The watershed's conditions, as described in Section 2.1 of this report, were assessed by field reconnaissance and aerial photography. For the purpose of this design, it was assumed that there would be no major future commercial/industrial development or significant clear cutting timber operations.

4.5 Survey (Topographic and Geomorphic)

A detailed survey of the site showed minimal physical limitations to restoration design. However, a limited easement (25 feet from bankfull) for construction is likely. Cattle access and stream crossings will be coordinated with the property owner and NRCS. Alternative water sources for the cattle have been constructed by NRCS, and fencing will eliminate cattle access to the restored streams and wetlands. A detailed description of the corridor's existing conditions is included in Sections 2.2 and 2.3 of this report. The morphology of Purlear Creek in the project area is provided in the Morphology Measurement Table in the attached Preliminary Restoration Plan.

5.0 Preliminary Restoration Plan

The preliminary stream and wetland restoration plan for Purlear Creek involves restoring the altered stream corridor (including adjacent riparian zones and wetlands) to their referenced, stable condition. The design is intended to account for the property owners' needs as well as physical constraints (utilities/roads/limited easement) within the project area. Restoration will modify the stream's dimension, pattern, and profile to stable conditions. The restoration of reach 4, adjacent to the wetland restoration area, will raise the adjacent water table and base flow elevation of the channel. This approach will re-connect the groundwater-surface hydrology of the wetland to the stream and will increase the frequency of over bank flow and flooding in the riparian wetland area. In addition to the hydrologic restoration of the wetland, the area will be planted with riparian wetland vegetation and cows will be excluded to protect the vegetation community.

Priority I and II restoration approaches (Rosgen, 1997) will be used to convert the existing G or F streams to stable B or C stream types with active floodplains at either historic channel elevation (Priority I) or the existing channel elevation (Priority II). For some sections of the stream, using the Priority I process the channel will be re-established on its previous floodplain using relic channel or construction of a new bankfull channel. The existing incised channel will be filled and/or converted to a wetland. For the remaining portions of the stream, Priority II will modify the existing banks and channel. In addition, in-stream structures will be used to protect stream banks, provide habitat, control grade, and protect facilities and riparian buffers. A vegetated woody buffer (excluded from cattle) will be included in the restoration plan. The buffer will be a minimum of 20 feet along Purlear Creek and 15 feet along its tributaries. The easement and buffer widths will be greater along a portion of reach 4 to include the adjacent riparian wetlands. The buffers and easements are shown in the attached restoration plan.

In-stream structures such as rock cross vanes, root wads, rock vanes, and log vanes will be incorporated into the mitigation project. For additional details on the in-stream structures and locations of structures, refer to the attached Preliminary Restoration Plan.

Some in-stream structures may need to be eliminated from or added to the restoration plan during final design and/or construction.

5.1 Vegetation/Buffer Plantings

Prior to the establishing a riparian buffer, the area will be sprayed with an aerial systemic herbicide approved for wetland use. The application of herbicide will occur during the growing season.

The riparian buffer will consist of three zones. Zone 1 is the stream bank zone consisting of tree and shrub species and native herbaceous seeding typically found along stream banks in the region. Zone 2 is a forested riparian area consisting of selected tree and shrub species, with varying tolerances of inundation and saturation, to be selectively planted based on microtopography and moisture regime. Zone 3 is a grass filter strip designed to promote dispersed flow into the forested riparian zone (Zone 2).

Zones 1 and 2 will be planted with transplants, livestakes, and bare root seedlings (depending on available stock) design plans, climate, and cost. Planting spacing will be determined according to planting type and will be included in final design plans. The entire easement will be planted.

A preliminary species list and plan view riparian buffer schematic is included in the attached Preliminary Restoration Plan.

In addition, a separate vegetation plan/species list for the wetland restoration area is included with the Preliminary Restoration Plan. It is believed that the long-term vegetation community of the wetland will be dominated by herbaceous wetland plants. Also, the site appears to have a significant seed bank available (existing wetland herbaceous plants, and upstream seed sources). Therefore, the planting plan for the wetland restoration will be considered a supplemental planting/seeding plan for the area. The challenge for the wetland restoration site with regards to vegetation will not be the establishment of wetland species, but rather the control and management of the

vegetation to produce a diverse herbaceous community without dominance of invasive species.

5.2 Dimension, Pattern, and Profile

Much of the stream is a G or F channel with some sections that have been straightened and are now linear. These sections will be modified through Priority I and II restoration (Rosgen, 1997) to the appropriate stable/referenced B or C stream for the existing valley types and channel slopes.

Proposed channel dimensions, patterns, and profiles were created using dimensionless ratios from reference reaches and equations derived from locally generated geomorphic curves (see section 4.2). Each proposed channel dimension was based on an initial bankfull cross-sectional area and bankfull width. For a typical reach, the cross-sectional area and width were calculated using the locally derived geomorphic equation and the drainage area of that reach. Bankfull mean depth and width to depth ratios were calculated from the cross-sectional area and width. For each typical reach, the resulting bankfull cross-sectional area, width, and depth were verified with entrainment calculations. The remaining morphological dimensions of the typical reaches were calculated using the calculated bankfull width, bankfull depth, and valley slopes with reference reach ratios from the appropriate set of "B" type or "C" type reference reaches. Using professional judgment, some morphological ratios used for the proposed channels were modified or deviating slightly from the reference ratio. The modifications are presented below:

- For "B" stream type proposed low bank height to max bank height ratio, the value was set to 1.0 disregarding the value of 2.8 from the reference reach. The adjusted value better represents a non-incised "B" stream type
- For "C" stream type proposed ratio of riffle slope to average slope, the reference value 3.6 was disregarded in determining the proposed value because the value 3.6 for this stream/valley type is likely too high.

To match the proposed plan features and reference condition, the stream's profile will be modified with grade control structures. The profile will create the appropriate local grade changes that are necessary to create the features (riffles, runs, pools, and glides) associated with B or C stream types.

The stream's new dimension will provide the appropriate cross-sectional area and width to depth ratio to transport sediment and the bankfull discharge. In areas using Priority I restoration, the new channel will be established on the previous floodplain using relic channel and a newly constructed bankfull channel. The existing incised channel will be filled and converted to a wetland. For areas using Priority II restoration, the existing channel will be modified to an appropriate cross sectional area and to establish an active floodplain bench.

The stream's pattern will be modified, where possible, to add stream length and to provide appropriate (reference) geometry. This geometry includes meander length, radius of curvature, belt width, and amplitude.

The proposed Priority I and II stream restoration plan (Rosgen, 1997) is shown in the attached Preliminary Restoration Plan.

5.3 Fencing and Stream Crossing Plan

Exclusionary fencing will be installed along the length of the easement. KHA has coordinated with NRCS and the property owner to determine the number and location of stream crossings and fencing. NRCS's guidelines for exclusionary fencing and cattle crossings will be followed.

6.0 Stream Monitoring and Success Criteria

The restoration design will be monitored for success through photographs, a channel stability assessment, and an evaluation of plant survival.

6.1 Reference Photographs

Monitoring: Photographs will be taken throughout the monitoring period to evaluate vegetative growth and the stability of in-stream structures along the restored stream's

corridor. The location of the photograph points will be established and marked with stakes and a map with notations of the photo reference points will be generated. Photo-monitoring will include lateral (taken looking at the channel banks) as well as longitudinal photographs (taken looking upstream and downstream).

Success Criteria: The photographs will be used to subjectively evaluate the aggradation/degradation of the channel, bank erosion, structure stability, the growth of riparian vegetation, and the effectiveness of erosion control measures. The longitudinal photos should indicate the absence of mid-channel bars or an excessive increase in channel depth. The lateral photos should not indicate excessive erosion or continuing degradation of the bank over time. The successional maturation of riparian vegetation should be observed in a series of photos taken over time.

6.2 Channel Stability

Monitoring: For each Rosgen classified stream types/ stream segments, permanent cross-sections, longitudinal profiles, and pebble counts will be established and monitored along the restored streams' corridor. Cross-sections will be placed to monitor structures and/or features that may have an increased risk of failure. Longitudinal profiles will be a minimal of twenty bank-full widths. A pebble counts will be taken along each longitudinal profile. The location of each cross-section and long profile will be marked to establish the exact transect location. Common benchmarks will be used. These benchmarks will be used consistently to facilitate the comparison of year-to-year data.

Success Criteria: Judgment of success or failure of restoration activities using this data will be based on geomorphic stability. If there are no or minimal changes to the cross-sections of the "as-built" during the monitored years, the restoration will be considered successful. Any minimal changes to the cross-sections during the monitoring period will be evaluated to determine whether they represent a movement toward a more unstable condition (down-cutting, deposition, erosion, increase in bank height ratios) or whether they are minor changes that represent an increase in stability (settling, vegetative changes, decrease in width/depth ratio, bank height ratios less than 1.2). Pool riffle sequencing should remain fairly constant and pools should not be significantly filling.

Pebble counts should show a coarsening of the bed material during the first few years and then a consistence in composition.

6.3 Plant Survival

To establish vegetation in restoration areas, riparian and upland mixes, seeds, bare root, and live stake vegetation will be planted, as shown on the Preliminary Restoration Plan or as required in the contract's Special Provisions and Technical Specifications.

Monitoring: The survival of vegetation will be evaluated using survival plots or direct counts. The survival of plantings will be evaluated along the stream corridor of the restoration site.

Success Criteria: For the plantings to be considered successful, the planting density will need to be a minimum of 320 stems per acre after 5 years, with a minimum of five species with no one species comprising more than 20% of the community. Restoration should mimic reference reaches.

7.0 Wetland Monitoring and Success Criteria

7.1 Plant Survival

Once planting has been completed, an initial evaluation will be conducted to verify planting methods and to verify initial species composition and density. Supplemental plantings and additional site modifications will be implemented, if necessary. Quantitative sampling (stem counts) of the vegetation will be conducted near the end of each growing season for five years.

Monitoring: Two sample plots will be established to determine plant survival and percent cover within the restoration area. Each of these plots will be approximately 10 square meters in area. Direct counts of tree plantings will be made within the plots, and a visual observation of percent coverage of herbaceous species will be made.

Success Criteria: Success for plant survival will be achieved with 80% herbaceous/shrub coverage, and 320 stems per acre for the wetland area after 5 years with a minimal of

five species and no one species comprising more than 20% of the community. Restoration should mimic reference reaches.

7.2 Wetland Hydrology

The intent of hydrology monitoring is to demonstrate that the degree and duration of saturation within the upper 12 inches of the soil has been raised by restoring the base flow elevation of the adjacent stream channel and raising local water table elevations. In addition, duration and frequency of flooding/inundation in the floodplain wetland will be increased through reconnecting the stream to the active floodplain and the adjacent wetland area.

The hydrologic success of the wetland restoration site will be determined by evaluation of water table data within the wetland area collected daily at the two monitoring locations (Figure 6), and comparison the Basin Creek reference wetland (Figure 4). Success will be determined as:

- Saturation/inundation of the soil surface for 12.5 percent of the growing season
- Hydroperiod within 50 percent of the reference wetland during the first three years, and 20 percent during the fourth and fifth year of monitoring.

The first success criterion for hydrology is determined as achieving inundation and/or saturation within the upper 12 inches of the soil, for consecutive days totaling 12.5% of the growing season. According to the Wilkes County Soil Survey, the growing season is determined as April 11 to October 26 (dates of 28° F in 5 of 10 years, approximating frost-free days). The 1987 Corps of Engineers Wetland Delineation Manual states that areas irregularly inundated or saturated for 5 to 12.5 percent of the growing season generally support wetland hydrology. Therefore, success criteria for hydrology of the wetland restoration will be to achieve 25 consecutive days (12.5%) of saturation in the upper 12 inches of soil,.

Water table data collection of the reference wetland will continue (North Carolina State University) and will be compared to the restoration wetland data to evaluate seasonal conditions and fluctuations (hydroperiod) through the monitoring period. The second

criterion will be to achieve a hydroperiod within 50 percent of the reference wetland within the first three years of monitoring, and within 20 percent within the fourth and fifth years.

Rainfall data from the W. Kerr Scott Reservoir weather station, and the North Wilkesboro Airport weather station (approximately 5 and 7 miles from the restoration site) will be used to evaluate rainfall through the monitoring period (Figure 7).

8.0 Maintenance

The contractor will guarantee all vegetation for one year from the time of planting, per the contract's Special Provisions and Technical Specifications.

Invasive exotic plant species should be identified and treated for a minimum of five years. For woody invasive plants, the stem should be cut off at ground level and a 25 percent solution of appropriate herbicide for riparian and wetland areas applied directly to the cut stump. Early fall is the best time to apply this treatment. For herbaceous weeds, use a herbicide and follow the manufacturer's suggested application rates.

9.0 References

The Division of Land Resources (DLR) and The Division of Water Quality (DWQ), 2001 v.3.0. *Internal Technical Guide for Stream Work in North Carolina.*

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

North Carolina Natural Heritage Program, *Explanation of Codes for County and Quad Status Lists.* http://www.ncsparks.net/nhp/codes.html.

North Carolina Stream Restoration Institute, *Rural-Piedmont Regional Curves.* www5.bae.ncsu.edu/programs/extension/wqg/sri/urbanpiedmont.html.

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

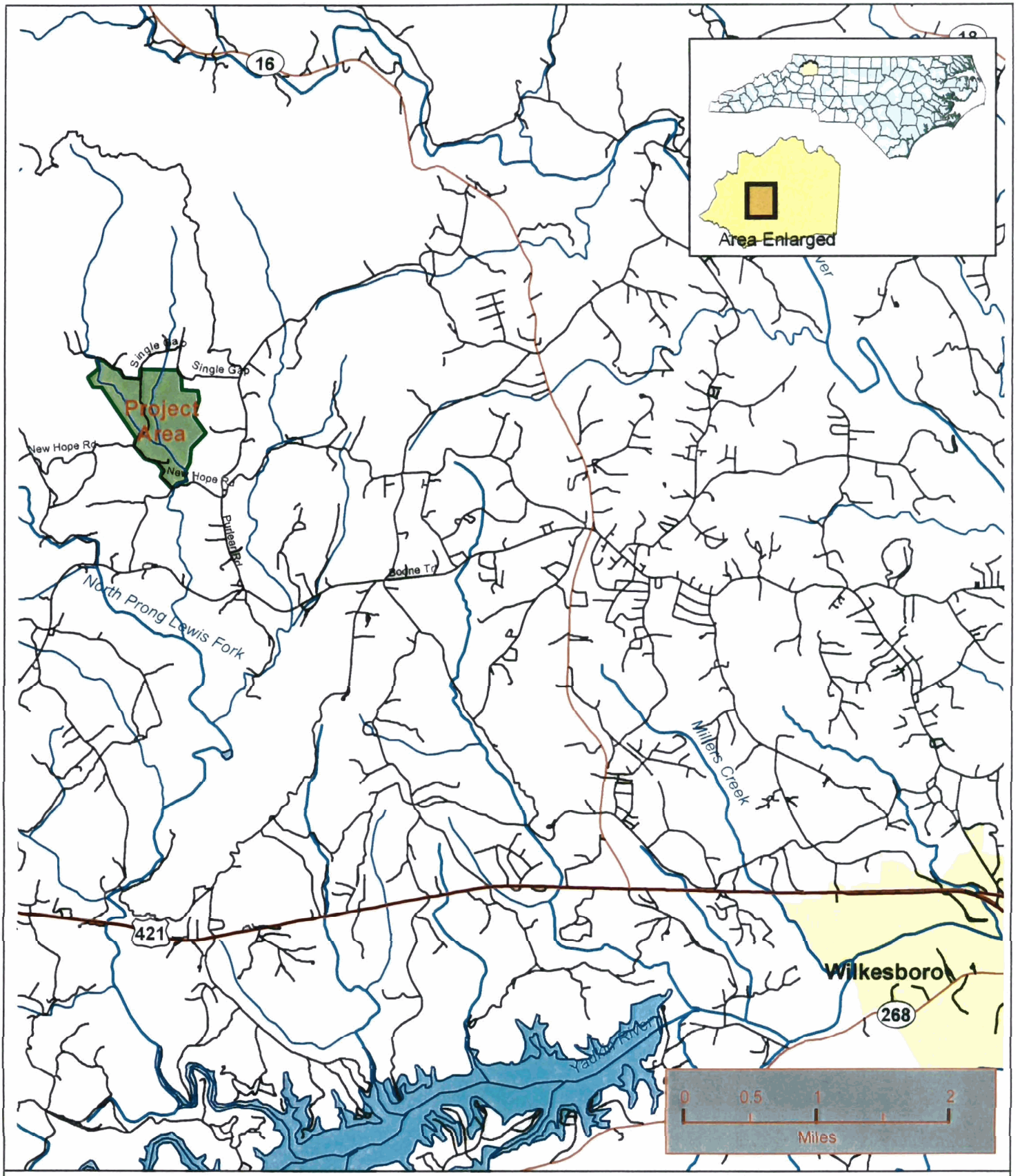
Rosgen, David L. 1997. A Geomorphologic Approach To Restoration Of Incised Rivers, Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision.

United State Geological Survey. 1966. USGS 7.5 Minute Series Topographical Maps Purlear, NC Quadrangle. US Geological Survey. Reston, Virginia.

US Army Corps of Engineers Regulatory Guidance Letter No. 02-02 Decmeber 24, 2002.

USDA Natural Resource Conservation Service. 1993. Wilkes County Soil Survey

US Army Corps of Engineers. 1987. Corps of Engineers Wetland Delineation Manual.

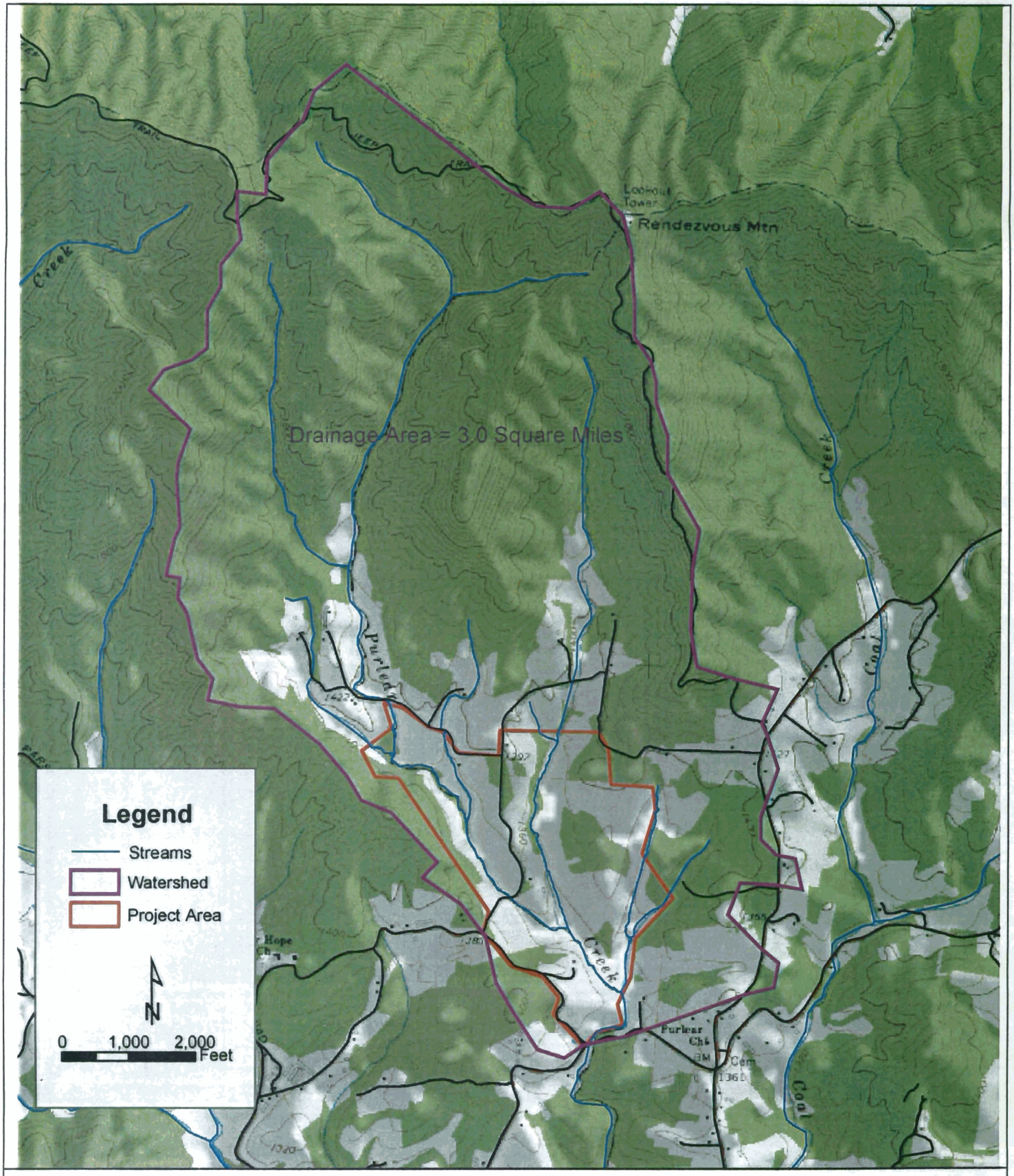


Title: **Vicinity Map**

Kimley-Horn and Associates, Inc.

Project: Purlear Creek Phase II
Stream and Wetland Restoration
Wilkes County @ Hayes Farm

Date:	Scale:	Project No.	Figure:
3/3/2004	1 inch = 1 mile	011795011	1

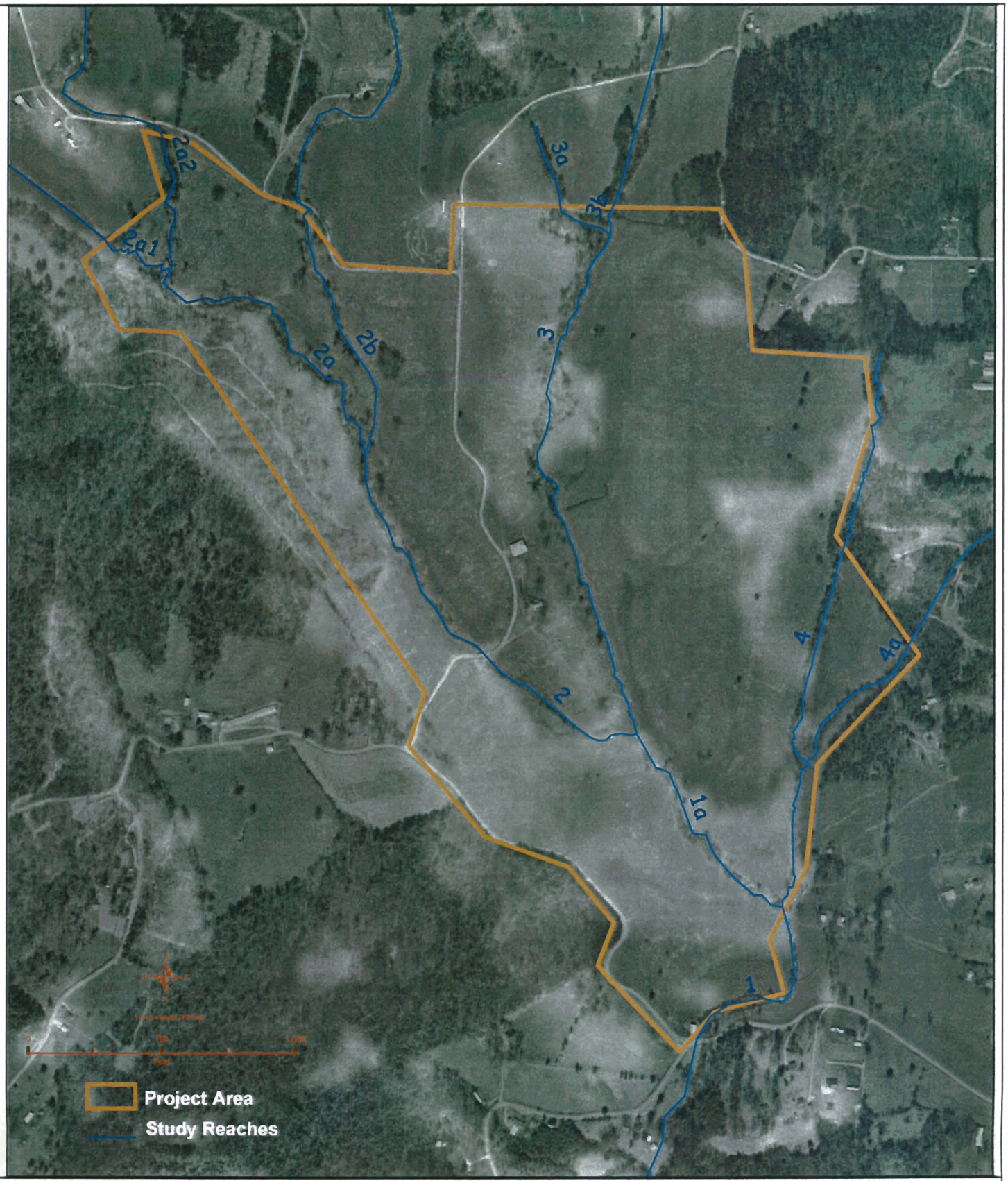


Title: **USGS Topographic Map and Watershed Boundary (1966)**

Kimley-Horn and Associates, Inc.

Project: Purlear Creek Phase II
Stream snd Wetland Restoration
Wilkes County @ Hayes Farm

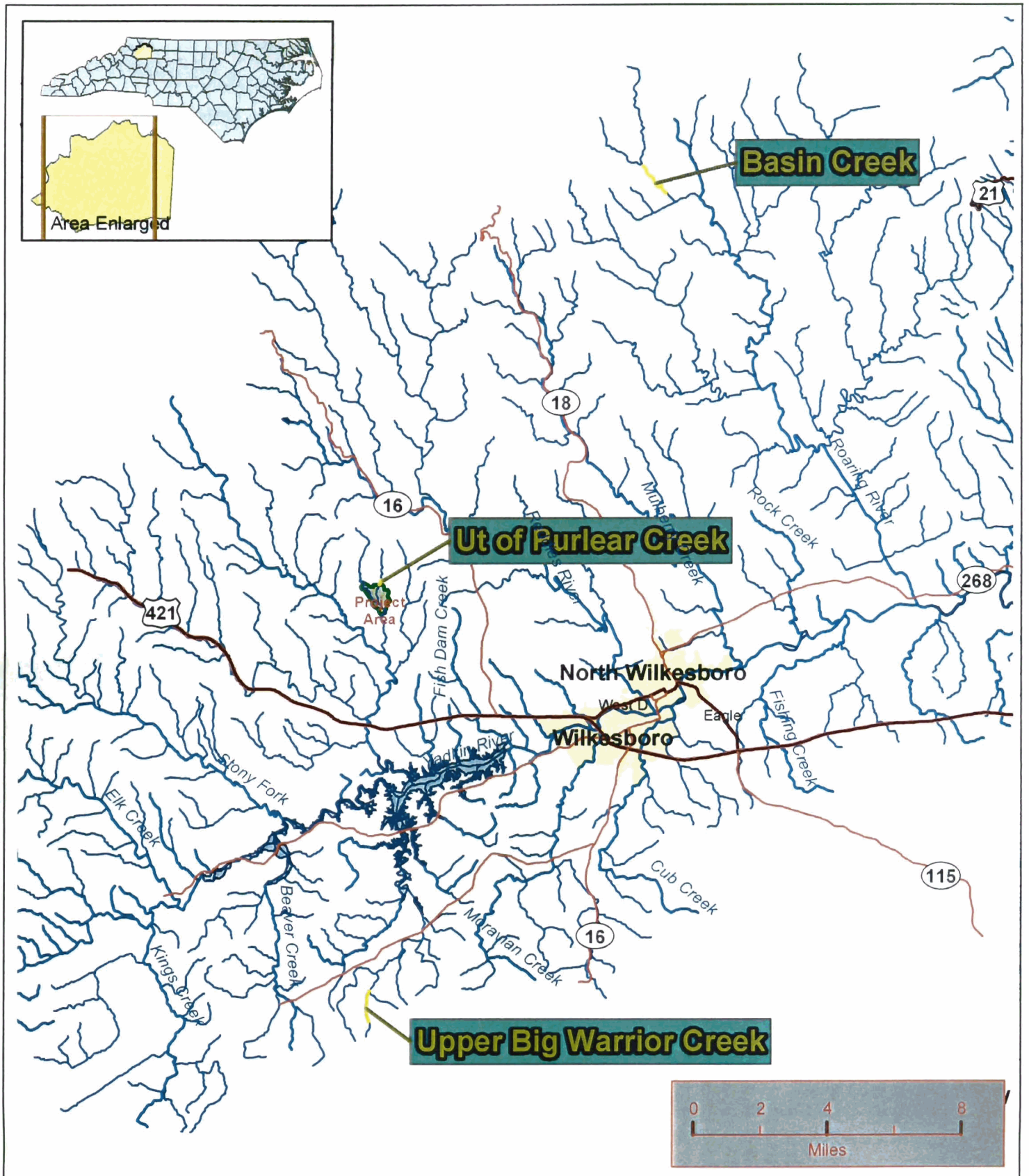
Date:	Scale:	Project No.	Figure:
3/3/2004	1 inch = 1,000	011795011	2



Title: **Project Aerial**

Kimley-Horn and Associates, Inc.

Project:	Purlear Creek Restoration, Wilkes County @ Hayes Farm		
Date: 3/3/2004	**Scale:** 1 inch = 750 feet	**Project No.** 011795011	**Figure:** 3

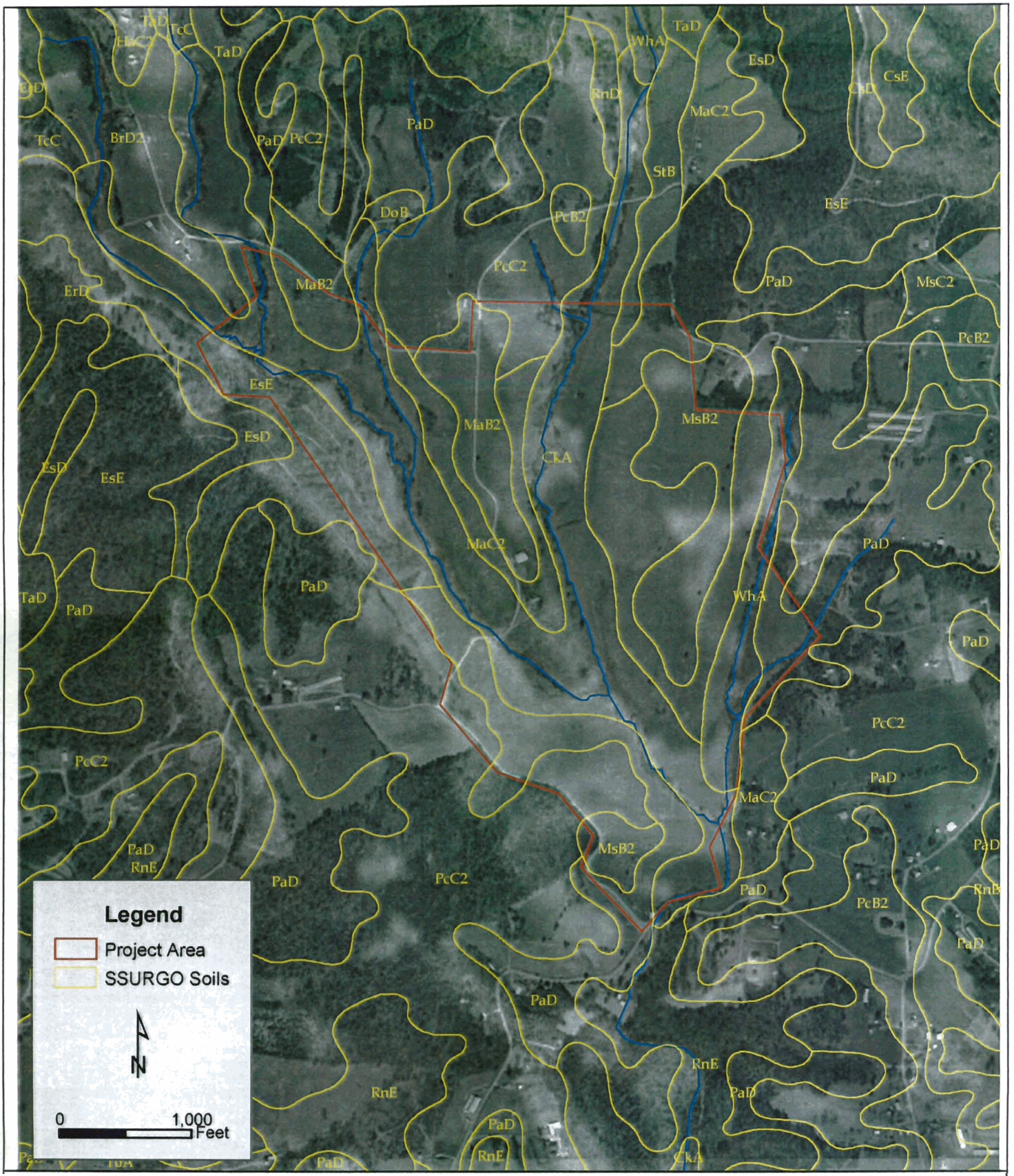


Title: **Reference Reach/Wetland Locations**

Kimley-Horn and Associates, Inc.

Project: Purlear Creek Phase II
Stream and Wetland Restoration
Wilkes County @ Hayes Farm

Date:	Scale:	Project No.	Figure:
3/3/2004	1 inch = 4 miles	01 179501 1	4

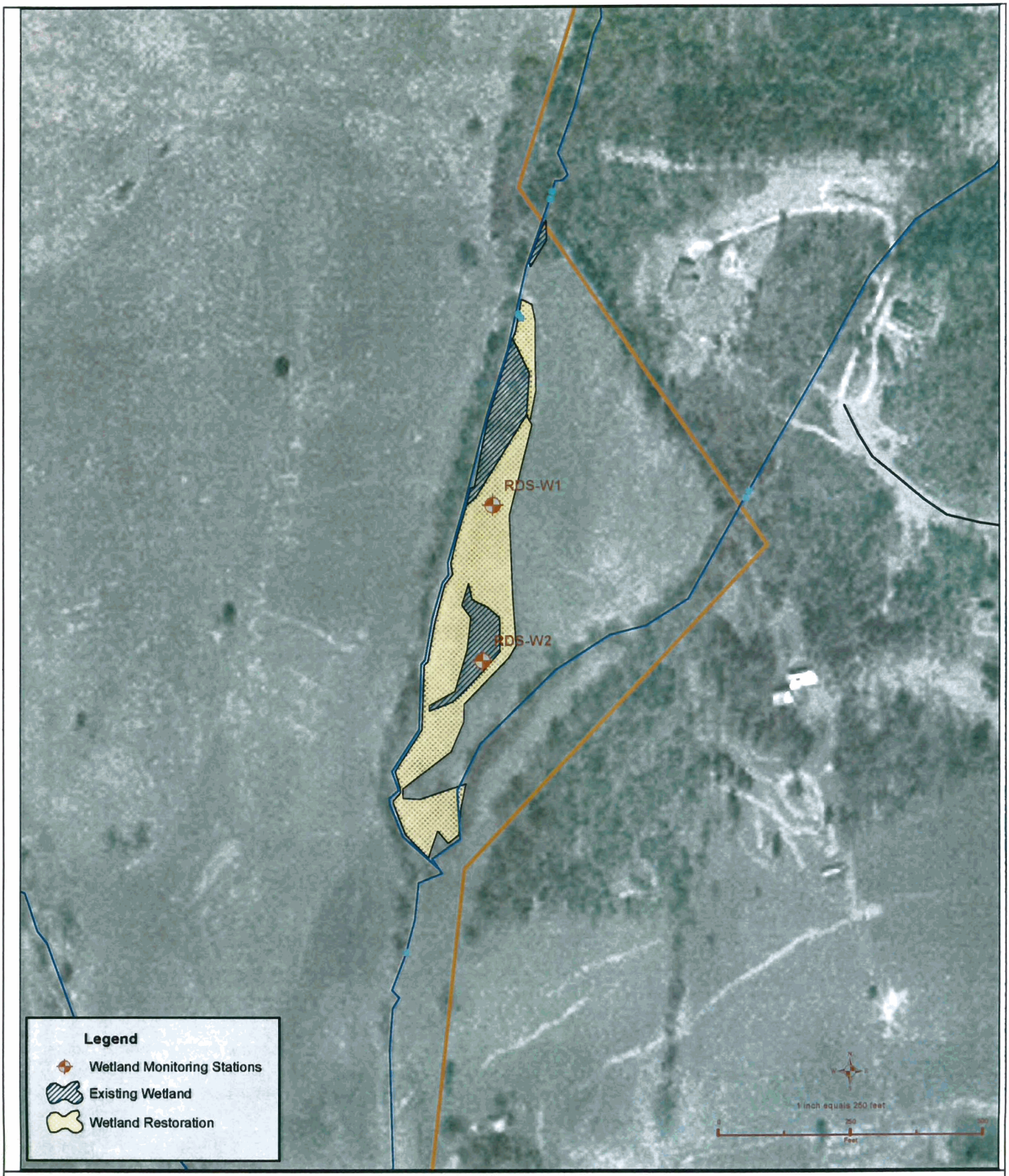


Title: Soils Map

Kimley-Horn and Associates, Inc.

Project: Purlear Creek Phase II
Stream and Wetland Restoration
Wilkes County @ Hayes Farm

Date:	Scale:	Project NO.	Figure:
3/3/2004	1 inch = 1,000 feet	01179501	5

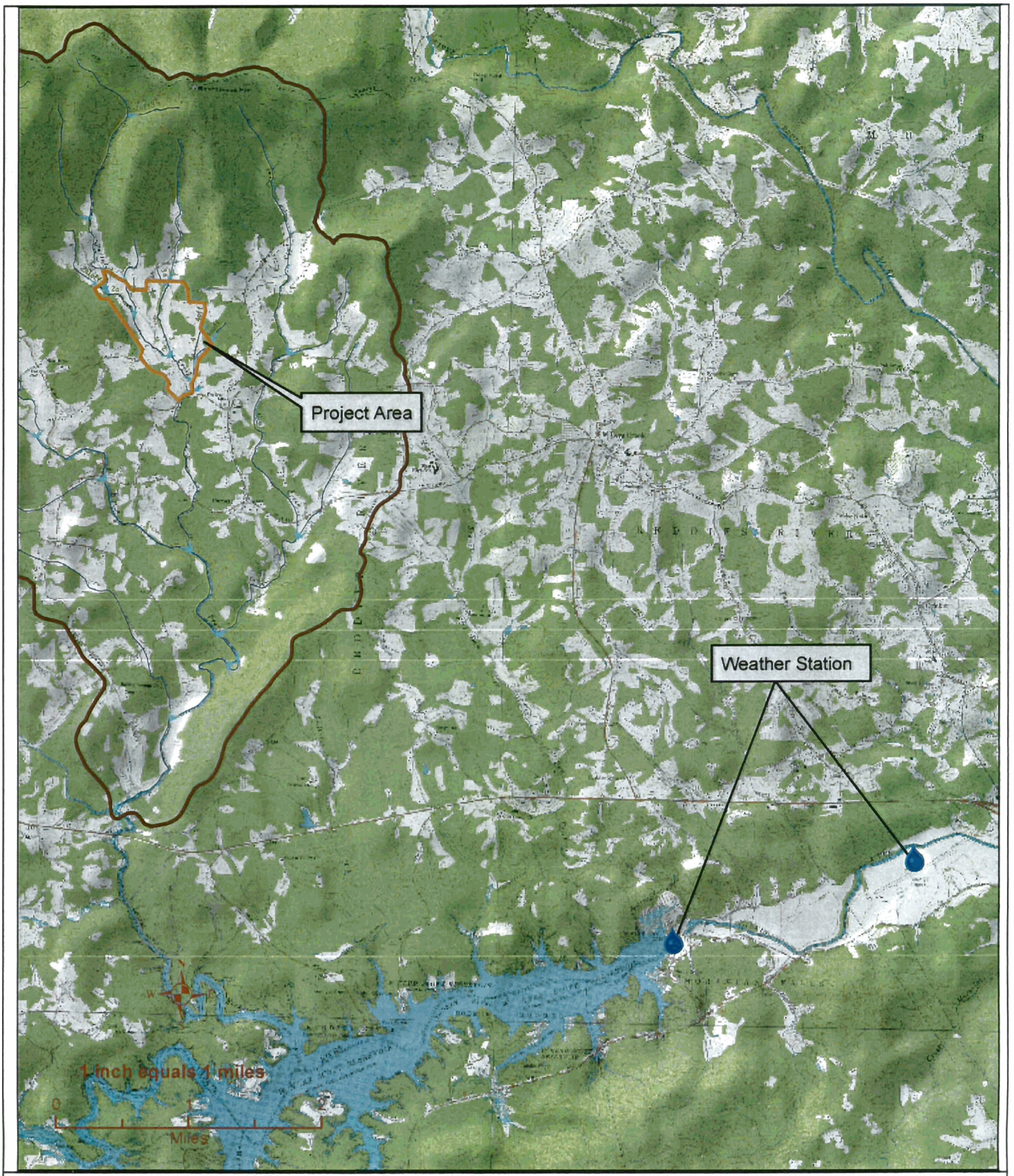


Title: **Wetland Area Monitoring Locations**

Kimley-Horn and Associates, Inc.

Project: Purlear Creek Phase II
Stream and Wetland Restoration
Wilkes County @ Hayes Farm

Date:	Scale:	Project No.	Figure:
3/2/04	1 inch=250 feet	011795013	6



Title: Weather Stations Location Map

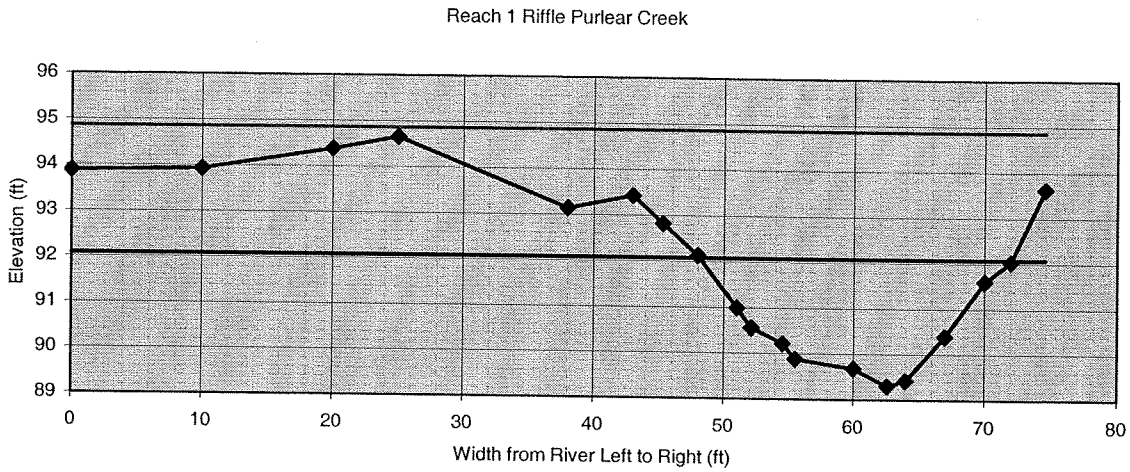
Kimley-Horn and Associates, Inc.

Project: Purlear Creek Phase II
Stream and Wetland Restoration
Wilkes County @ Hayes Farm

Date:	Scale:	Project No.	Figure:
3/1/04	1 inch=1 mile	011795013	7

Reference Reach					Hints
Stream:	Purlear Creek				
Watershed:	Upper Yadkin (03040101010090) - 03-07-01				
Location:	Reach 1				
Latitude:	---				
Longitude:	---				
County:	Wilkes				
Date:	August 13, 2003				
Observers:	Andy Kiley, Tom Cousins, Ian McMillian				
Channel Type:	C5 --> F5 w/ Bedrock Sections				
Drainage Area (sq mi):	3				
Dimension		typical	min	max	
Riffle:	x-area bankfull	40.3			
	width bankfull	23.9			
	hydraulic radius	1.6			
	max depth	2.8			
	bank ht	4.1			
	width flood prone area	50.0			
	mean depth	1.69			
Pool:	x-area pool	36.5			
	width pool	20.5			
	hydraulic radius	1.6			
	max depth pool	3.6			
	bank ht	4.3			
Run:	x-area run				
	width run				
	hydraulic radius				
	max depth run				
	bank ht				
Glide:	x-area glide				
	width glide				
	max depth glide				
Dimensionless Ratios:		typical	min	max	
	Width/Depth Ratio	14.2			
	Entrenchment Ratio	2.1			
	Riffle Max Depth Ratio	1.7	---	---	
	Pool Area Ratio	0.9	---	---	
	Pool Width Ratio	0.9	---	---	
	Pool Max Depth Ratio	2.1	---	---	
	Bank Height Ratio	1.5			
	Run Area Ratio	---	---	---	
	Run Width Ratio	---	---	---	
	Run Max Depth Ratio	---	---	---	
	Glide Area Ratio	---	---	---	
	Glide Width Ratio	---	---	---	
	Glide Max Depth Ratio	---	---	---	
Hydraulics:		riffle	pool	run	
	channel slope (%)	0.500			
	discharge rate, Q (cfs)				
	velocity (ft/sec)	0.0	0.0	---	
	shear stress @ max depth (lbs/ft sq)	0.874	1.123	---	
	shear stress (lbs/ft sq)	0.499	0.499	---	
	shear velocity (ft/sec)	0.508	0.508	---	
	stream power (lbs/sec)	---	---	---	
	unit stream power (lbs/ft/sec)	---	---	---	
	relative roughness	14.7	15.5	---	
	friction factor u/u*	0.0	0.0	---	
	threshold grain size @ max depth (mm)	56	91	---	
	threshold grain size (mm)	30.6	30.6	---	

Cross Section



section: **Reach 1**
Riffle
Purlear Creek
Upper Yadkin (03040101010090) - 03-07-01
description: X1
height of instrument (ft): 100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
	# #	0	6.12	93.88
	# #	10	6.07	93.93
	# #	20	5.62	94.38
	# #	25	5.35	94.65
	# #	38	6.86	93.14
TOB-L	# #	43	6.58	93.42
	# #	45.3	7.18	92.82
BKF-L	# #	48	7.87	92.13
	# #	51	9.01	90.99
	# #	52.1	9.44	90.56
WE-L	# #	54.5	9.78	90.22
	# #	55.5	10.12	89.88
	# #	60	10.32	89.68
	# #	62.6	10.7	89.3
	# #	64	10.58	89.42
WE-R	# #	67	9.61	90.39
	# #	70	8.4	91.6
BKF-R	# #	72	7.96	92.04
TOB-R	# #	74.6	6.38	93.62
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			

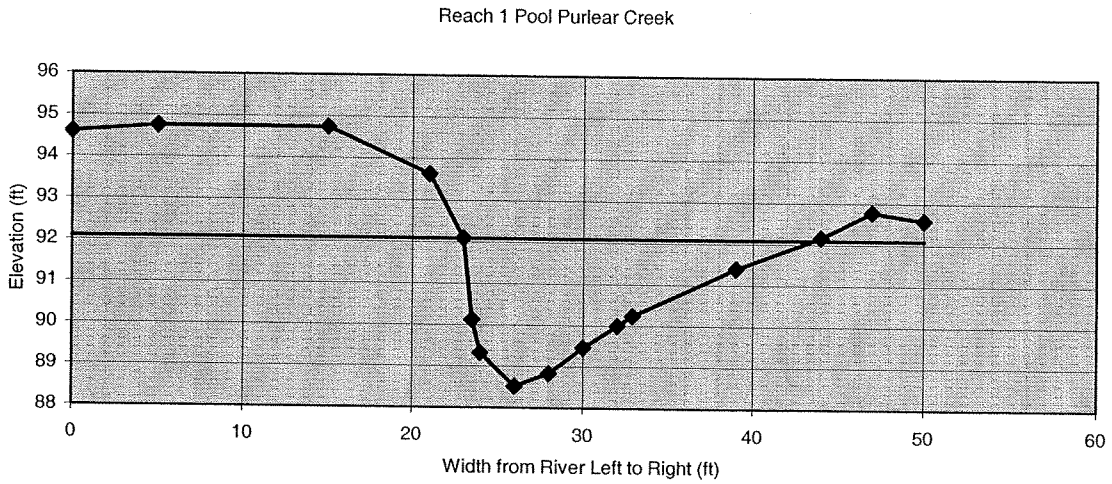
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
7.92	6.58	50.0	0.24	
92.08	93.42			

dimensions			
40.3	x-section area	1.7	d mean
23.9	width	24.8	wet P
2.8	d max	1.6	hyd radi
4.1	bank ht	14.2	w/d ratio
50.0	W flood prone area	2.1	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			
35	measured D84 (mm)		
14.7	relative roughness	9.5	fric. factor
0.030	Manning's n from channel material		

Cross Section



section: **Reach 1**
Pool
Purlear Creek
Upper Yadkin (03040101010090) - 03-07-01
description: X2
height of instrument (ft): 100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
	# #	0	5.4	94.6
	# #	5	5.25	94.75
	# #	15	5.26	94.74
	# #	21	6.37	93.63
	# #	23	7.91	92.09
EOW-L	# #	23.5	9.88	90.12
	# #	24	10.68	89.32
T	# #	26	11.48	88.52
	# #	28	11.17	88.83
	# #	30	10.54	89.46
	# #	32	10	90
EOW-R	# #	32.9	9.76	90.24
	# #	39	8.6	91.4
	# #	44	7.84	92.16
	# #	47	7.23	92.77
	# #	50	7.42	92.58
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			

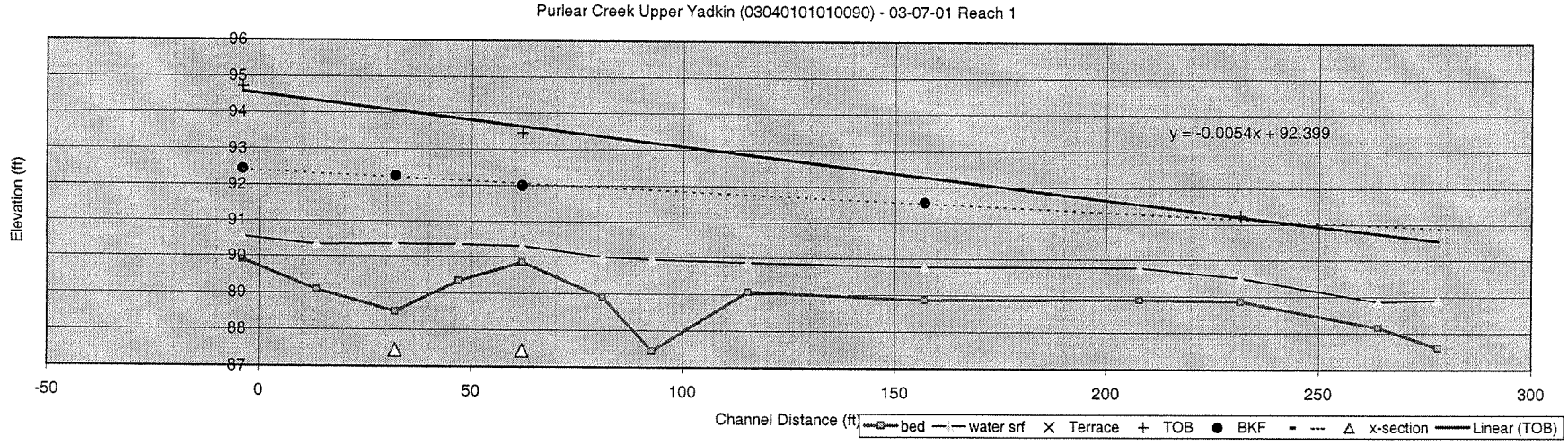
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
7.91	7.23		0.24	
92.09	92.77			

dimensions			
36.5	x-section area	1.8	d mean
20.5	width	23.1	wet P
3.6	d max	1.6	hyd radi
4.3	bank ht	~~11.5~~	w/d ratio
~~0.0~~	W flood prone area	~~0.0~~	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*
13.4	threshold grain size (mm)

check from channel material			
~~35~~	measured D84 (mm)		
~~15.5~~	relative roughness	~~9.6~~	fric. factor
~~0.029~~	Manning's n from channel material		

Slope Profile



					100	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 ---
					100														
H-Rf		4			100		10.1	0.65	7.56		5.29			89.9	90.55	92.44		94.71	
H-Po		13.5			100		10.92	1.25						89.08	90.33				
C-Po	Pool	32			100		11.5	1.85	7.75					88.5	90.35	92.25			
H-Gd		47			100		10.66	1						89.34	90.34				
H-Rf	Riffle	62			100		10.15	0.45	8		6.54			89.85	90.3	92		93.46	
H-Po		81			100		11.1	1.1						88.9	90				
C-Po		92.7			100		12.56	2.5						87.44	89.94				
H-Rn		115.3			100		10.93	0.8						89.07	89.87				
					100	5.7													
				5.1	99.4										#N/A	#N/A	#N/A	#N/A	#N/A
M-Rn		157			99.4		10.54	0.91	7.83					88.86	89.77	91.57			
T-Rn		207.8			99.4		10.51	0.88						88.89	89.77				
H-Rf		231.6			99.4		10.55	0.65			8.15			88.85	89.5			91.25	
T-Rf		264			99.4		11.25	0.7						88.15	88.85				
C-Po		278			99.4		11.8	1.3						87.6	88.9				
					99.4														

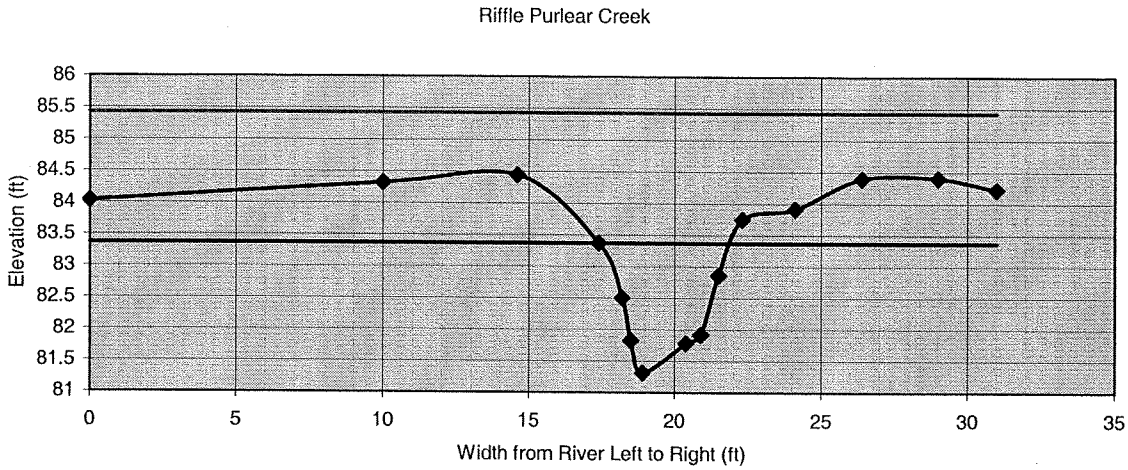
Reference Reach				Hints
Stream:	Purlear Creek			
Watershed:	Upper Yadkin (03040101010090) - 03-07-01			
Location:	Reach 4			
Latitude:	---			
Longitude:	---			
County:	Wilkes			
Date:	August 13, 2003			
Observers:	Andy Kiley, Tom Cousins, Ian McMillian			
Channel Type:	E4 --> G4			
Drainage Area (sq mi):	0.4			

Dimension		typical	min	max
Riffle:	x-area bankfull	5.6		
	width bankfull	4.6		
	hydraulic radius	0.9		
	max depth	2.1		
	bank ht	3.1		
	width flood prone area	50.0		
	mean depth	1.22		
Pool:	x-area pool			
	width pool			
	hydraulic radius			
	max depth pool			
	bank ht			
Run:	x-area run			
	width run			
	hydraulic radius			
	max depth run			
	bank ht			
Glide:	x-area glide			
	width glide			
	max depth glide			

Dimensionless Ratios:	typical	min	max
Width/Depth Ratio	3.8		
Entrenchment Ratio	10.9		
Riffle Max Depth Ratio	1.7	---	---
Pool Area Ratio	---	---	---
Pool Width Ratio	---	---	---
Pool Max Depth Ratio	---	---	---
Bank Height Ratio	1.5		
Run Area Ratio	---	---	---
Run Width Ratio	---	---	---
Run Max Depth Ratio	---	---	---
Glide Area Ratio	---	---	---
Glide Width Ratio	---	---	---
Glide Max Depth Ratio	---	---	---

Hydraulics:	riffle	pool	run
channel slope (%)	0.040		
discharge rate, Q (cfs)			
velocity (ft/sec)	0.0	---	---
shear stress @ max depth (lbs/ft sq)	0.052	---	---
shear stress (lbs/ft sq)	0.022	---	---
shear velocity (ft/sec)	0.108	---	---
stream power (lbs/sec)	---	---	---
unit stream power (lbs/ft/sec)	---	---	---
relative roughness	8.4	---	---
friction factor u/u*	0.0	---	---
threshold grain size @ max depth (mm)	4	---	---
threshold grain size (mm)	1.9	---	---

Cross Section



section:	
	Riffle Purlear Creek Upper Yadkin (03040101010090) - 03-07-01
description:	X2 Reach 4 near road
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
	# #	0	15.97	84.03
	# #	10	15.68	84.32
TOB-L	# #	14.6	15.56	84.44
BKF-L	# #	17.4	16.63	83.37
	# #	18.2	17.5	82.5
WE-L	# #	18.5	18.18	81.82
TOB-L	# #	18.9	18.69	81.31
WE-R	# #	20.4	18.22	81.78
	# #	20.9	18.08	81.92
	# #	21.5	17.14	82.86
	# #	22.3	16.25	83.75
	# #	24.1	16.09	83.91
TOB-R	# #	26.4	15.61	84.39
	# #	29	15.6	84.4
	# #	31	15.78	84.22
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			
	# #			

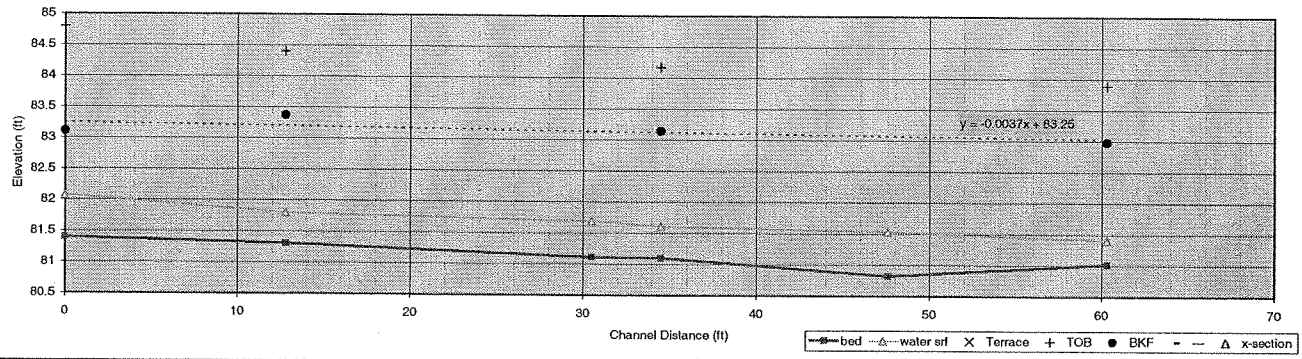
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
16.63	15.61	50.0	0.56	
83.37	84.39			

dimensions			
5.6	x-section area	1.2	d mean
4.6	width	6.5	wet P
2.1	d max	0.9	hyd radi
3.1	bank ht	3.7	w/d ratio
50.0	W flood prone area	11.0	ent ratio

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

check from channel material			
44	measured D84 (mm)		
8.6	relative roughness	8.1	fric. factor
0.032	Manning's n from channel material		

Slope Profile



					100	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
H-Rf		0			100		18.6	0.68	16.89		15.2			81.4	82.08	83.11		84.8	
C-Po		12.8			100		18.69	0.49	16.63		15.6			81.31	81.8	83.37		84.4	
C-Po		30.5			100		18.89	0.58						81.11	81.69				
H-Rf		34.5			100		18.9	0.51	16.86		15.83			81.1	81.61	83.14		84.17	
C-Po		47.6			100		19.18	0.71						80.82	81.53				
H-Rf		60.3			100		18.98	0.38	17.02		16.11			81.02	81.4	82.98		83.89	
					100														
					100														

Reference Reach

Stream:	Purlear Creek
Watershed:	Yadkin River Basin (03040101010090)
Location:	Wilkes County (Hayes Farm)
Latitude:	---
Longitude:	---
County:	Wilkes
Date:	6-24 to 6-26-2002
Observers:	CWE, NW, CD, ARK, PTR, SS
Channel Type:	F4
Drainage Area (sq mi):	0.15

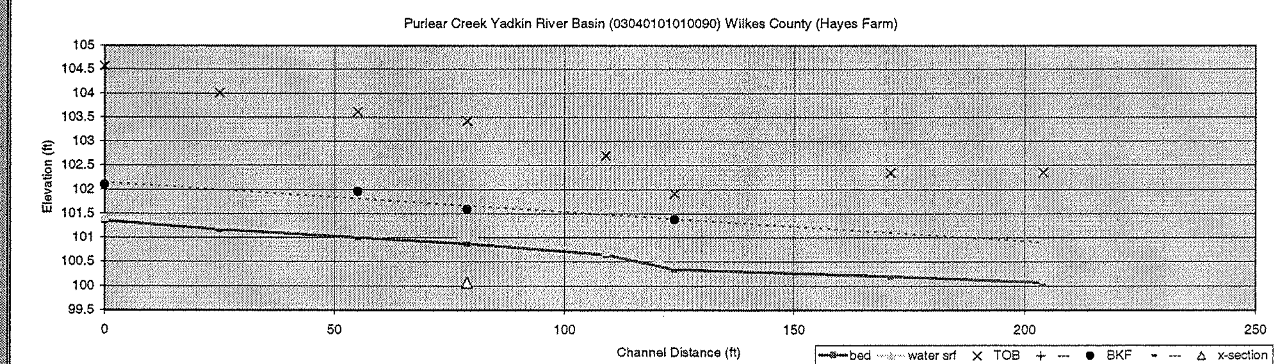
Pattern

	typical	min	max
bankfull width (ft)	0		
meander length (ft)			
belt width (ft)			
amplitude (ft)			
radius (ft)			
arc angle (degrees)			
straight length (ft)			
stream length			
valley length			
Sinuosity	0.00		
Meander Width Ratio	---	---	---
Amplitude Ratio	---	---	---
Meander Length Ratio	---	---	---
Straight Length Ratio	---	---	---
Radius Ratio	---	---	---

Profile

	typical	min	max
bankfull width (ft)	0		
pool-pool spacing (ft)			
riffle length (ft)			
pool length (ft)			
run length (ft)			
glide length (ft)			
channel slope (%)	1.1		
riffle slope (%)			
pool slope (%)			
run slope (%)			
glide slope (%)			
measured valley slope (%)	2.8		
valley slope (%)	0.0		
Riffle Length Ratio	---	---	---
Pool Length Ratio	---	---	---
Run Length Ratio	---	---	---
Glide Length Ratio	---	---	---
Riffle Slope Ratio	---	---	---
Pool Slope Ratio	---	---	---
Run Slope Ratio	---	---	---
Glide Slope Ratio	---	---	---
Pool Spacing Ratio	---	---	---

Slope Profile



110.76 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 ---
		0			110.76		9.4	0.06	8.66	6.19				101.36	101.42	102.1	104.57		
		25			110.76		9.59	0.1		6.75				101.17	101.27		104.01		
		55			110.76		9.76	0.1	8.8	7.15				101	101.1	101.96	103.61		
	Riffle	78.8			110.76		9.89	0.14	9.17	7.34				100.87	101.01	101.59	103.42		
		109			110.76		10.12	0.06		8.06				100.64	100.7		102.7		
		124			110.76		10.42	0.1	9.38	8.85				100.34	100.44	101.38	101.91		
		171			110.76		10.56	0.12		8.42				100.2	100.32		102.34		
		204			110.76		10.69	0.07		8.41				100.07	100.14		102.35		
					110.76														
					110.76														
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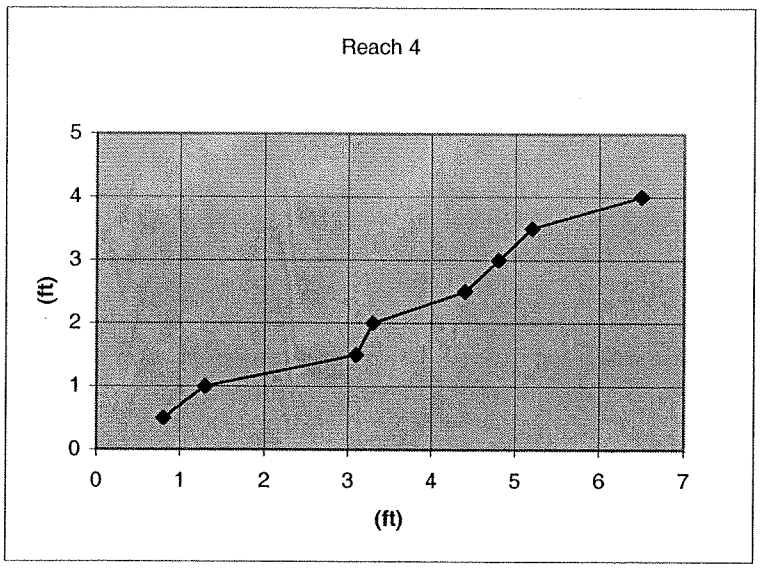
Purlear Creek
Reach 4 - Bank Erosion Hazard Index

Reach 4

	BEHI Variables	Measurement	Hazard Rating
A	Highest Bank	5	
B	Max Bankfull	1.45	
C	A/B	**3.448275862**	10
D	Root Depth	1	
E	Study Bankheight	4.9	
F	D/E	**0.204081633**	7
G	Root Density	**20**	7
H	G*F	4.081632653	
I	Bank Angle	**32**	2.5
J	Bank Height Protection	1	
K	Surface Protection	**60**	3.5
	Hazard Subtotal		**30**
	Bank Material Adjustment	Sand	10
	Stratification Adjustment	No Stratification	0
	BEHI Rating		**40**
	BEHI Description		**High-Very High**



Horizontal	Vertical
0.8	0.5
1.3	1
3.1	1.5
3.3	2
4.4	2.5
4.8	3
5.2	3.5
6.5	4

Reference Reach						Hints
Stream:	Purlear Creek					
Watershed:	Upper Yadkin (03040101010090) - 03-07-01					
Location:	Reach 1					
Latitude:	---					
Longitude:	---					
County:	Wilkes					
Date:	August 13, 2003					
Observers:	Andy Kiley, Tom Cousins, Ian McMillian					
Channel Type:	C5 --> F5 w/ Bedrock Sections					
Drainage Area (sq mi):	3					
Channel Materials						
	total	riffle	pool	run	glide	bar sample
D16	0.078	0.125	0.067	0.000	0.000	11.229
D35	0.19	1.04	0.11	0.00	0.00	18.34
D50	1.0	14.6	0.2	0.0	0.0	27.7
D84	35	47	7	0	0	66
D95	70	73	40	0	0	105
Largest of Bar Sample						
% Silt/Clay	11%	10%	13%	---	---	---
% Sand	45%	29%	68%	---	---	9%
% Gravel	38%	54%	15%	---	---	74%
% Cobble	6%	7%	4%	---	---	17%
% Boulder	0%	0%	0%	---	---	---
% Bedrock	0%	0%	0%	---	---	

Bar Material Size
1.5"
1.1"

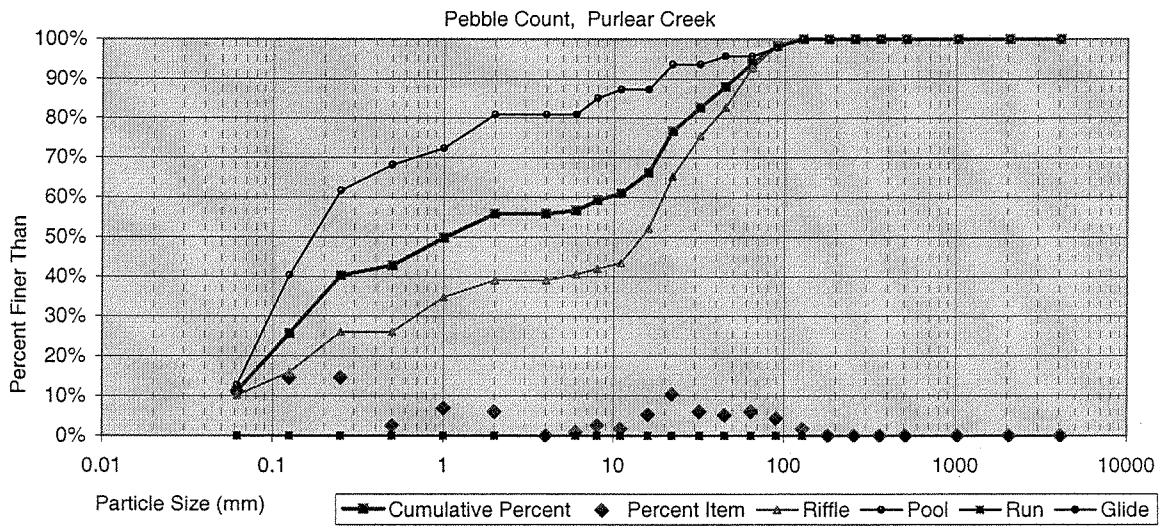
Weighted Pebble Count

Percent Riffle:	60	Percent Run:	
Percent Pool:	40	Percent Glide:	

Pebble Count,

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	11.2	# #
very fine sand	0.062	0.13	14.5	# #
fine sand	0.13	0.25	14.6	# #
medium sand	0.25	0.5	2.6	# #
coarse sand	0.5	1	6.9	# #
very coarse sand	1	2	6.0	# #
very fine gravel	2	4	0.0	# #
fine gravel	4	6	0.9	# #
fine gravel	6	8	2.6	# #
medium gravel	8	11	1.7	# #
medium gravel	11	16	5.2	# #
coarse gravel	16	22	10.4	# #
coarse gravel	22	32	6.1	# #
very coarse gravel	32	45	5.2	# #
very coarse gravel	45	64	6.1	# #
small cobble	64	90	4.3	# #
medium cobble	90	128	1.7	# #
large cobble	128	180	0.0	# #
very large cobble	180	256	0.0	# #
small boulder	256	362	0.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	116	

	Purlear Creek
	Upper Yadkin (03040101010090) - 03-07-01
	Reach 1
Note:	**Reach 1**



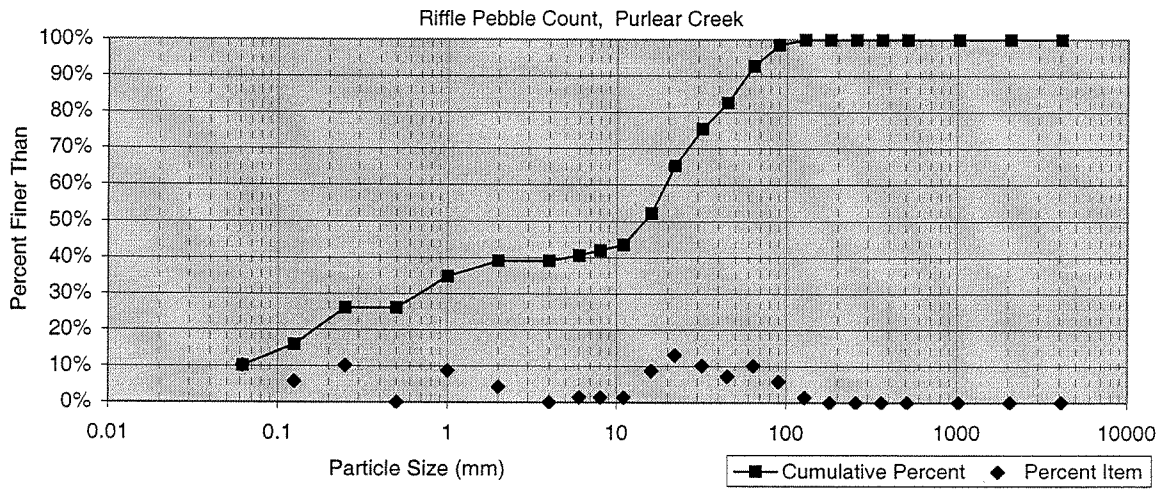
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.078	0.19	1.0	35	70	11%	45%	38%	6%	0%	0%

Riffle Pebble Count

Material	Size Range (mm)		Count	
silt/clay	0	0.062	7	# #
very fine sand	0.062	0.13	4	# #
fine sand	0.13	0.25	7	# #
medium sand	0.25	0.5		# #
coarse sand	0.5	1	6	# #
very coarse sand	1	2	3	# #
very fine gravel	2	4		# #
fine gravel	4	6	1	# #
fine gravel	6	8	1	# #
medium gravel	8	11	1	# #
medium gravel	11	16	6	# #
coarse gravel	16	22	9	# #
coarse gravel	22	32	7	# #
very coarse gravel	32	45	5	# #
very coarse gravel	45	64	7	# #
small cobble	64	90	4	# #
medium cobble	90	128	1	# #
large cobble	128	180		# #
very large cobble	180	256		# #
small boulder	256	362		# #
small boulder	362	512		# #
medium boulder	512	1024		# #
large boulder	1024	2048		# #
very large boulder	2048	4096		# #
bedrock				#
	Total Particle Count:		69	

Riffle Pebble Count,

	Purlear Creek
	Upper Yadkin (03040101010090) - 03-07-01
	Reach 1
Note:	**Reach 1**



Size percent less than (mm)				
D16	D35	D50	D84	D95
0.125	1.04	14.6	47	73

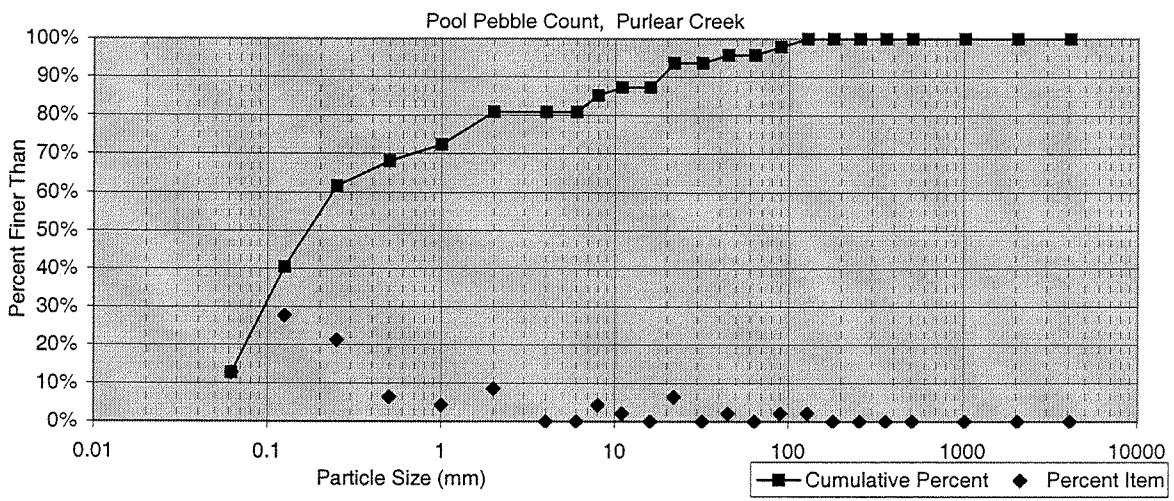
Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
10%	29%	54%	7%	0%	0%

Pool Pebble Count

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**6**	# #
very fine sand	0.062	0.13	**13**	# #
fine sand	0.13	0.25	**10**	# #
medium sand	0.25	0.5	**3**	# #
coarse sand	0.5	1	**2**	# #
very coarse sand	1	2	**4**	# #
very fine gravel	2	4		# #
fine gravel	4	6		# #
fine gravel	6	8	**2**	# #
medium gravel	8	11	**1**	# #
medium gravel	11	16		# #
coarse gravel	16	22	**3**	# #
coarse gravel	22	32		# #
very coarse gravel	32	45	**1**	# #
very coarse gravel	45	64		# #
small cobble	64	90	**1**	# #
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		# #
bedrock				#
	Total Particle Count:		47	

Pool Pebble Count,

	Purlear Creek
	Upper Yadkin (03040101010090) - 03-07-01
	Reach 1
Note:	**Reach 1**



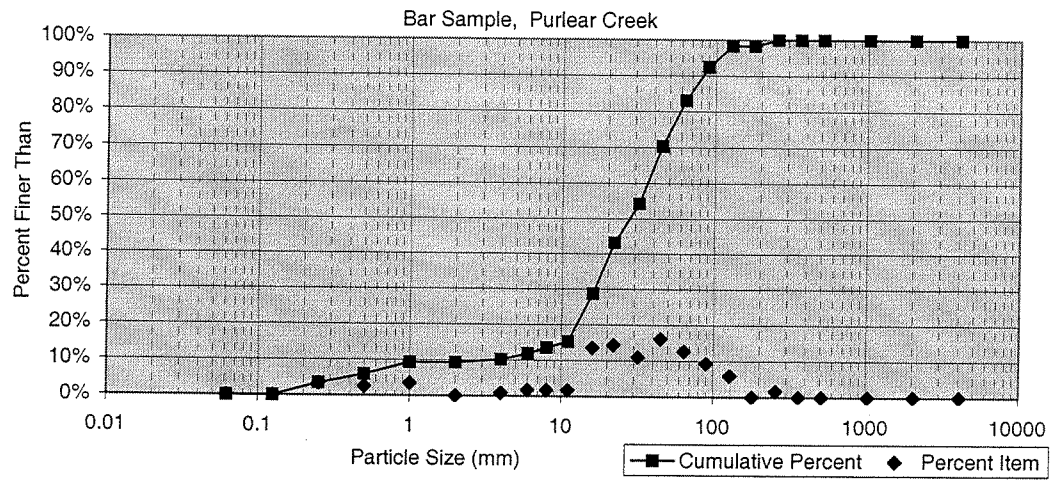
Size percent less than (mm)				
D16	D35	D50	D84	D95
0.067	0.11	0.2	7	40

Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
13%	68%	15%	4%	0%	0%

Bar Sample

Material	Size Range (mm)		Count
silt/clay	0	0.062	
very fine sand	0.062	0.13	
fine sand	0.13	0.25	**4**
medium sand	0.25	0.5	**3**
coarse sand	0.5	1	**4**
very coarse sand	1	2	
very fine gravel	2	4	**1**
fine gravel	4	6	**2**
fine gravel	6	8	**2**
medium gravel	8	11	**2**
medium gravel	11	16	**16**
coarse gravel	16	22	**17**
coarse gravel	22	32	**13**
very coarse gravel	32	45	**19**
very coarse gravel	45	64	**15**
small cobble	64	90	**11**
medium cobble	90	128	**7**
large cobble	128	180	
very large cobble	180	256	**2**
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
Total Particle Count:			118

Bar Sample,
Purlear Creek
Upper Yadkin (03040101010090) - 03-07-01
Reach 1
Note: **Reach 1 Entrainment**



Size percent less than (mm)				
D16	D35	D50	D84	D95
11.229	18.34	27.7	66	105

Percent by substrate type				
silt/clay	sand	gravel	cobble	boulder
0%	9%	74%	17%	0%

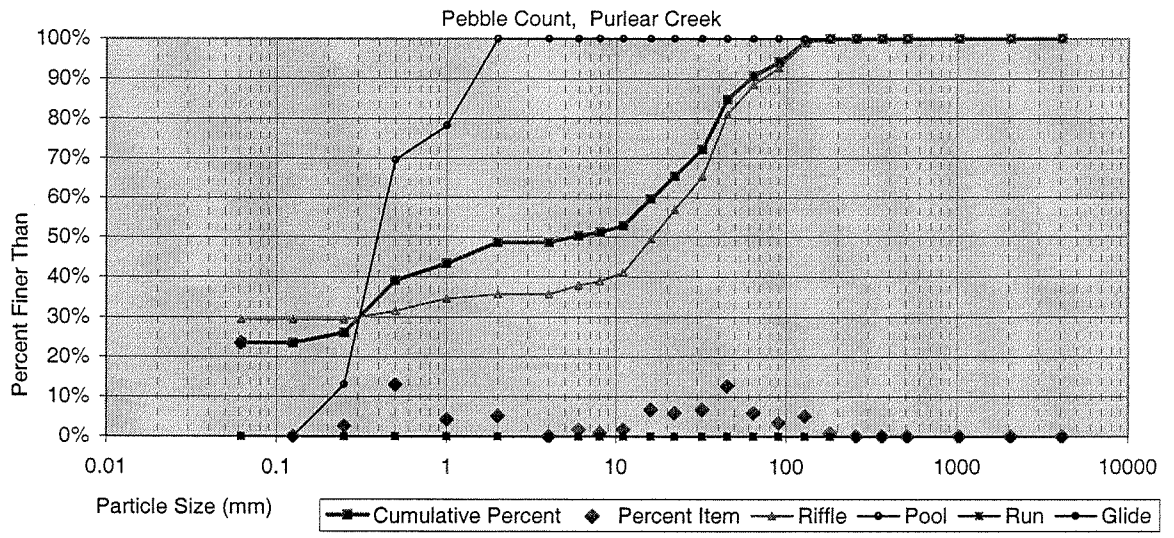
Reference Reach						Hints
Stream:	Purlear Creek					
Watershed:	Upper Yadkin (03040101010090) - 03-07-01					
Location:	Reach 4					
Latitude:	---					
Longitude:	---					
County:	Wilkes					
Date:	August 13, 2003					
Observers:	Andy Kiley, Tom Cousins, Ian McMillian					
Channel Type:	E4 --> G4					
Drainage Area (sq mi):	0.4					
Channel Materials						
	total	riffle	pool	run	glide	bar sample
D16	#N/A	#N/A	0.259	0.000	0.000	---
D35	0.40	1.19	0.33	0.00	0.00	---
D50	5.6	16.4	0.4	0.0	0.0	---
D84	44	52	1	0	0	---
D95	96	103	2	0	0	---
Largest of Bar Sample						
% Silt/Clay	24%	29%	0%	---	---	---
% Sand	25%	6%	100%	---	---	---
% Gravel	42%	53%	0%	---	---	---
% Cobble	9%	12%	0%	---	---	---
% Boulder	0%	0%	0%	---	---	---
% Bedrock	0%	0%	0%	---	---	

Weighted Pebble Count

Percent Riffle:	80	Percent Run:	
Percent Pool:	20	Percent Glide:	

Pebble Count,
Purlear Creek
Upper Yadkin (03040101010090) - 03-07-01
Reach 4
Note:

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	23.6	#
very fine sand	0.062	0.13	0.0	#
fine sand	0.13	0.25	2.6	#
medium sand	0.25	0.5	13.0	#
coarse sand	0.5	1	4.3	#
very coarse sand	1	2	5.2	#
very fine gravel	2	4	0.0	#
fine gravel	4	6	1.7	#
fine gravel	6	8	0.8	#
medium gravel	8	11	1.7	#
medium gravel	11	16	6.7	#
coarse gravel	16	22	5.9	#
coarse gravel	22	32	6.7	#
very coarse gravel	32	45	12.6	#
very coarse gravel	45	64	5.9	#
small cobble	64	90	3.4	#
medium cobble	90	128	5.1	#
large cobble	128	180	0.8	#
very large cobble	180	256	0.0	#
small boulder	256	362	0.0	#
small boulder	362	512	0.0	#
medium boulder	512	1024	0.0	#
large boulder	1024	2048	0.0	#
very large boulder	2048	4096	0.0	#
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	118	



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.40	5.6	44	96	24%	25%	42%	9%	0%	0%

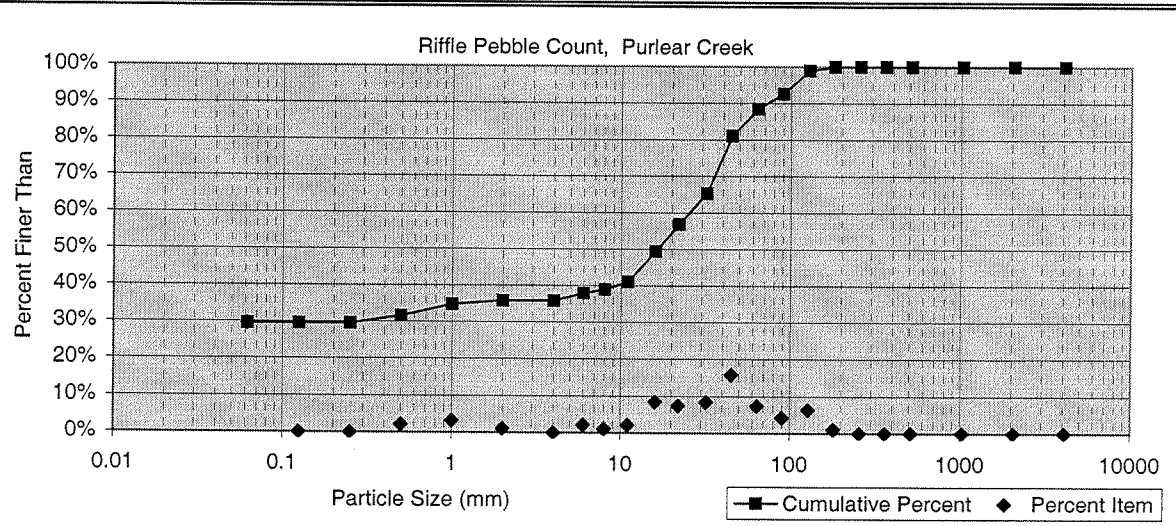
Riffle Pebble Count

Material	Size Range (mm)		Count
silt/clay	0	0.062	**28**
very fine sand	0.062	0.13	
fine sand	0.13	0.25	
medium sand	0.25	0.5	**2**
coarse sand	0.5	1	**3**
very coarse sand	1	2	**1**
very fine gravel	2	4	
fine gravel	4	6	**2**
fine gravel	6	8	**1**
medium gravel	8	11	**2**
medium gravel	11	16	**8**
coarse gravel	16	22	**7**
coarse gravel	22	32	**8**
very coarse gravel	32	45	**15**
very coarse gravel	45	64	**7**
small cobble	64	90	**4**
medium cobble	90	128	**6**
large cobble	128	180	**1**
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
Total Particle Count:		95	

Riffle Pebble Count,

Purlear Creek
Upper Yadkin (03040101010090) - 03-07-01
Reach 4

Note:



Size percent less than (mm)				
D16	D35	D50	D84	D95
#N/A	1.19	16.4	52	103

Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
29%	6%	53%	12%	0%	0%

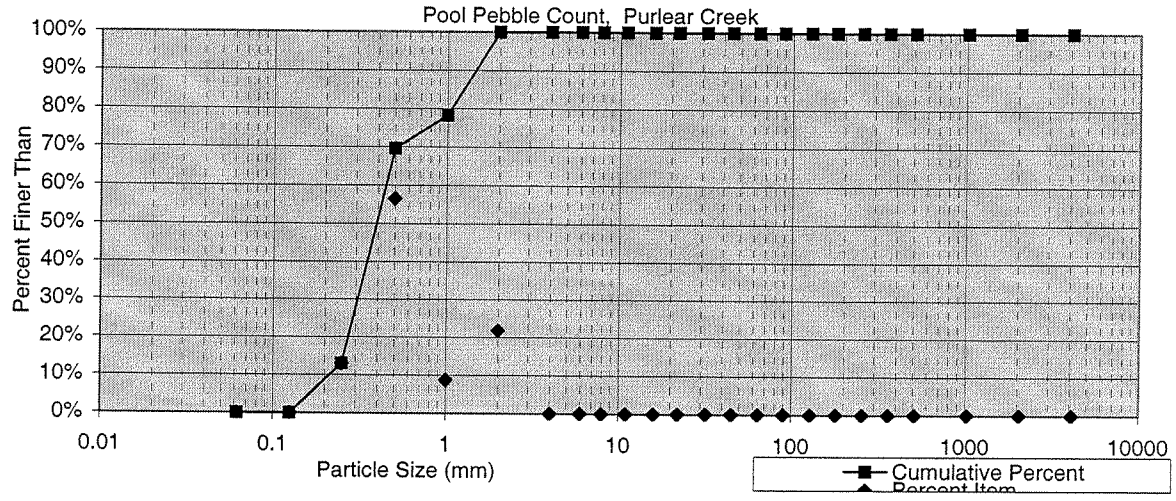
Pool Pebble Count

Material	Size Range (mm)		Count
silt/clay	0	0.062	
very fine sand	0.062	0.13	
fine sand	0.13	0.25	**3**
medium sand	0.25	0.5	**13**
coarse sand	0.5	1	**2**
very coarse sand	1	2	**5**
very fine gravel	2	4	
fine gravel	4	6	
fine gravel	6	8	
medium gravel	8	11	
medium gravel	11	16	
coarse gravel	16	22	
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	
bedrock			
Total Particle Count:			23

Pool Pebble Count,

Purlear Creek
Upper Yadkin (03040101010090) - 03-07-01
Reach 4

Note:



Size percent less than (mm)				
D16	D35	D50	D84	D95
0.259	0.33	0.4	1	2

Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
0%	100%	0%	0%	0%	0%

Entrainment Calculation Form

Sample A

Site: Purlear Creek Reach 4
Crew: CWE, NW, CD, ARK, PTR, SS
Date: 6-24 to 6-28-2002

Critical Dimensionless Shear Stress:		
$\tau_{ci} = 0.0834(d_i/d_{50})^{-0.872}$	<-- 1 Eq. 2 -->	$\tau_{ci} = 0.0384(D_i/d_i)^{-0.887}$
Value	**Variable**	**Definition**
1.1	d_i (mm)	D50 Bed Material (D50 from riffle pebble count)
0.3	d_{50} (mm)	Bar Sample D50 or Sub-pavement D50
9	D_i (mm)	Largest particle from bar sample (or subpavement)
Equation 1		
0.027	τ_{ci}	**Critical Dimensionless Shear Stress**

* Eliminated silt/clay from pebble count as cattle bank erosion influence which caused an adjustment of value from 0.5 to 1.1

Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample:		
$d_r = (\tau_{ci}*1.65*D_i)/S_e$	1.65=submerged specific weight of sediment	
Value	**Variable**	**Definition**
0.027	τ_{ci}	Critical Dimensionless Shear Stress
0.029529	D_i (feet)	Largest particle from bar sample
0.011	S_e (ft/ft)	Existing Bankfull Water Surface Slope
0.119	d_r (ft)	**Bankfull Mean Depth Required**
0.5	d_e (ft)	**Existing Bankfull Mean Depth (from riffle cross section)**
Degrading		
Stable (d_e/d_r=1)	Aggrading (d_e/d_r<1)	Degrading (d_e/d_r>1)

Bankfull Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample:		
$S_r = (\tau_{ci}*1.65*D_i)/d_e$	1.65=submerged specific weight of sediment	
Value	**Variable**	**Definition**
0.027	τ_{ci}	Critical Dimensionless Shear Stess
0.029529	D_i (feet)	Largest particle from bar sample
0.5	d_e (ft)	Existing Bankfull Mean Depth (from riffle cross section)
0.003	S_r (ft/ft)	Bankfull Water Surface Slope Required
Degrading		
Stable (S_e/S_r=1)	Aggrading (S_e/S_r<1)	Degrading (S_e/S_r>1)

Sediment Transport Validation

9	Largest Particle in Bar Sample D_i (mm)
0.34	Bankfull Shear Stress $\tau_c=\gamma RS$ (lb/ft^2)
35	Moveable particle size (mm) at bankfull shear stress (predicted by the Shields Diagram: Blue field book: p238, Red field book: p190)
0.9	Predicted shear stress required to initiate movement of D_i (mm) (see Shields Diagram: Blue field book: p238, Red field book: p190)

Velocity Comparison Form

Site: Purlear Creek Reach 4
Crew: CWE, NW, CD, ARK, PTR, SS
Date: 6-24 to 6-28-2002

Input Variable			Output Variables		
Bankfull Cross Sectional Area (A_{BKF})	3.5	ft^2	Bankfull Mean Depth $D_{BKF} = (A_{BKF}/W_{BKF})$	0.5	ft
Bankfull Width (W_{BKF})	7.4	ft	Wetted Perimeter (WP) $(-(2*D_{BKF})+W_{BKF})$	6.5	ft
D_{84}	5	mm	D_{84} (mm/304.8)	0.016	ft
Bankfull Slope	0.011	ft/ft	Hydraulic Radius (R) (A_{BKF}/WP)	0.54	ft
Gravity	32.13	ft/s^2	R/D_{84} (use D_{84} in FEET)	33.06	ft/ft

R/D84, u/u*, Mannings n		
u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book: p233)	11.25	ft/s/ ft/s
Mannings n: (Reference Reach Field Book: p189, River Field Book, p236)	0.025	$ft^{1/6}$
Velocity: from Manning's equation: $u=(1.49R^{2/3}S^{1/2})/n$	4.16	ft/s

$u/u^* = 2.83+ 5.7\log R/D_{84}$		
u*: $u^*=(gRS)^{0.5}$	0.438	ft/s
Velocity: $u=u^*(2.83+5.7\log(R/D_{84})$	5.03	ft/s

Mannings n by Stream Type		
Stream Type		
Mannings n: (Reference Reach Field Book: p 187, River Field Book: p237)	0.036	$ft^{1/6}$
Velocity: from Manning's equation: $u=(1.49R^{2/3}S^{1/2})/n$	2.89	ft/s

Continuity Equation		
Q_{BKF} (cfs) from regional curve or stream gage calibration	23.2	cfs
Velocity: (u=Q/A or from stream gage hydraulic geometry	6.63	ft/s

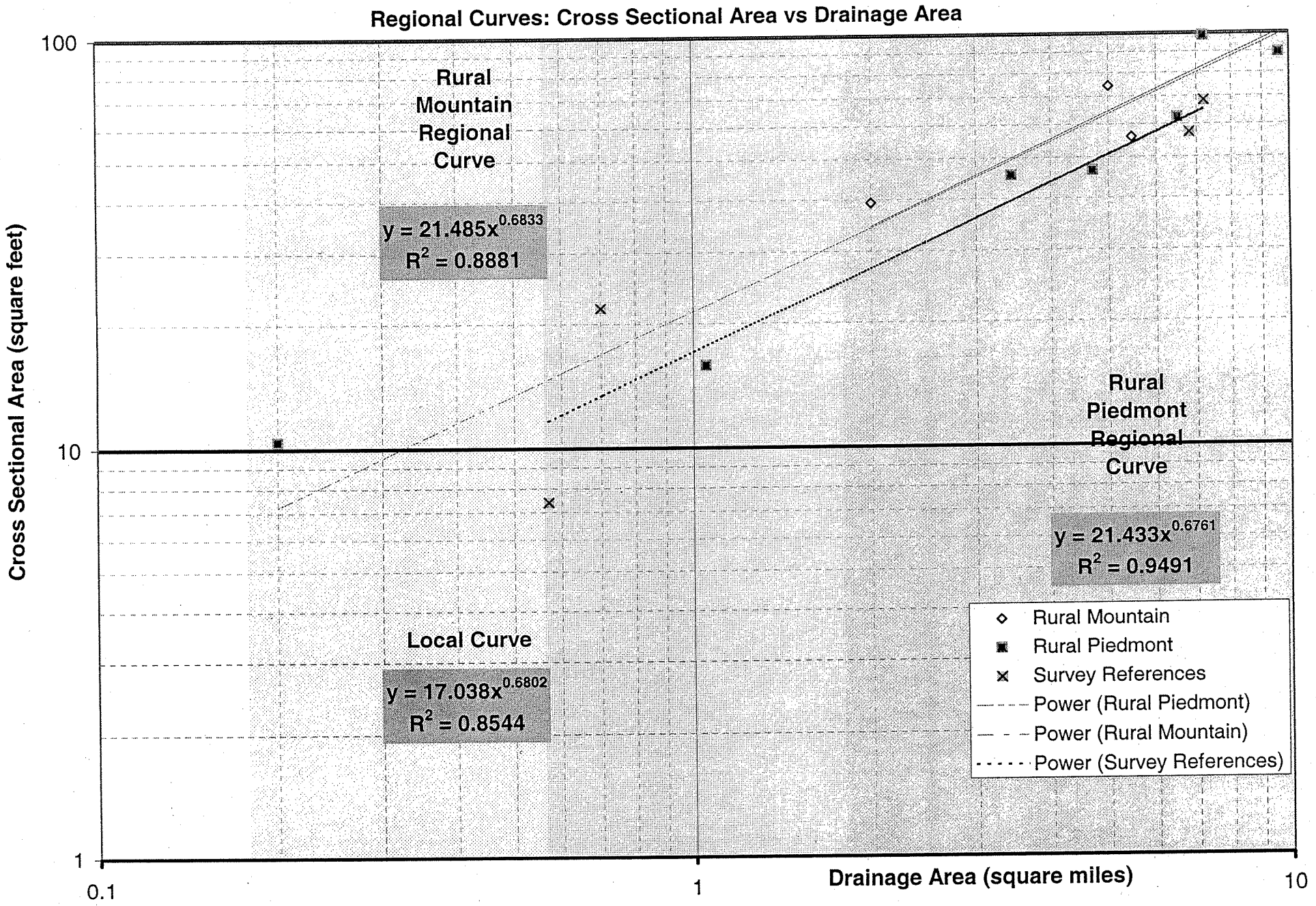

Regional Curves: Cross Sectional Area vs Drainage Area
Cross Sectional Area (square feet)
100
10
1
0.1
1
10
Drainage Area (square miles)
Rural Mountain Regional Curve
y = 21.485x^0.6833
R^2 = 0.8881
Rural Piedmont Regional Curve
y = 21.433x^0.6761
R^2 = 0.9491
Local Curve
y = 17.038x^0.6802
R^2 = 0.8544
Rural Mountain
Rural Piedmont
Survey References
Power (Rural Piedmont)
Power (Rural Mountain)
Power (Survey References)

Table 1: Hydraulic geometry, survey summary, and flood frequency analyses for gaged and ungaged stream reaches.

Stream Name	Gage Station ID	Drainage Area (mi^2)	Stream Type (Rosgen)	Bankfull Discharge (cfs)	Bankfull Xsec Area (ft^2)	Bankfull Width (ft)	Bankfull Mean Depth (ft)	Water Surface Slope (ft/ft)	Return Interval (Years)	Exceedence Probability (%)
Sal's Branch	Reference Reach	0.2	E4	55.4	10.4	8.7	1.2	0.0109	n/a	n/a
Humpy Creek	02117030	1.05	E5	83.0	15.8	12.0	1.3	0.0060	1.7	59
Dutchmans	02123567	3.44	C5	85.1	45.6	23.5	1.9	0.0170	1	100
Mill Creek	Reference Reach	4.7	E4	277	46.7	24.5	1.9	0.0080	n/a	n/a
Upper Mitchell River	Reference Reach	6.5	B4c	356	62.5	29.2	2.1	0.0095	n/a	n/a
Norwood Creek	0214253830	7.18	E5	253.7	98.8	32.0	3.1	0.0008	1.1	91
North Pott's Creek	02121180	9.6	E5	507.2	89.6	25.4	3.5	0.0012	1.7	59
Tick Creek	02101800	15.5	E	655.3	194	40.5	4.8	0.0005	1.3	77
Moon Creek	02075160	29.9	E5	708.8	162	33.0	4.9	0.0015	1.8	56
Long Creek	02144000	31.8	E5	1041	195	40.0	4.9	0.0010	1.4	71
Little Yadkin River	02114450	42.8	G5	2236	469	77.5	6.1	0.0018	1.4	71
Mitchell River	02112360	78.8	C	2681	377	77.0	4.9	0.0030	1.6	63
Fisher River	02113000	128	C3	3687	578	101	5.7	0.0023	1.4	71

Equations

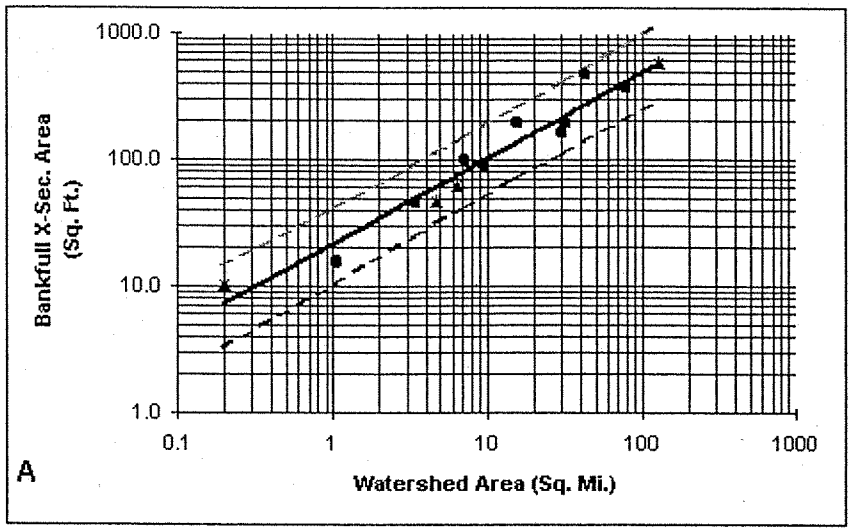
Bankfull Cross-Sectional Area vs. Drainage Area: $y = 21.43x^{0.68}$

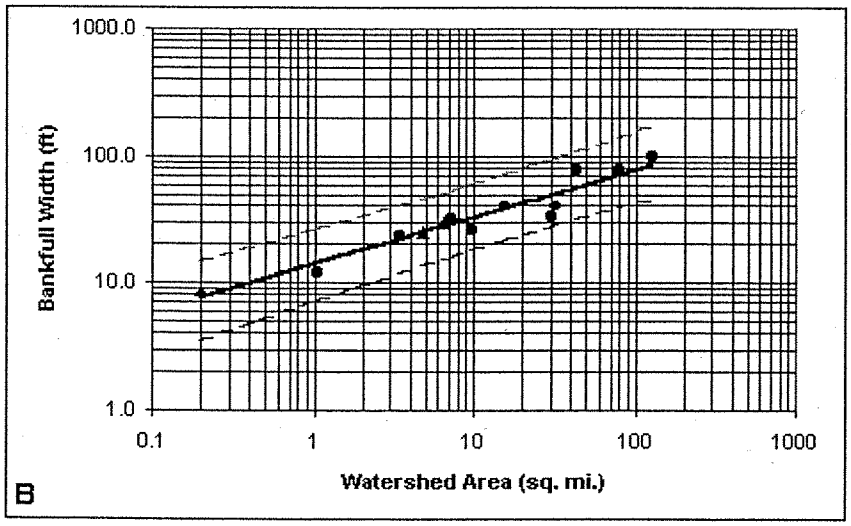
Bankfull Discharge vs. Drainage Area: $y = 89.04x^{0.72}$

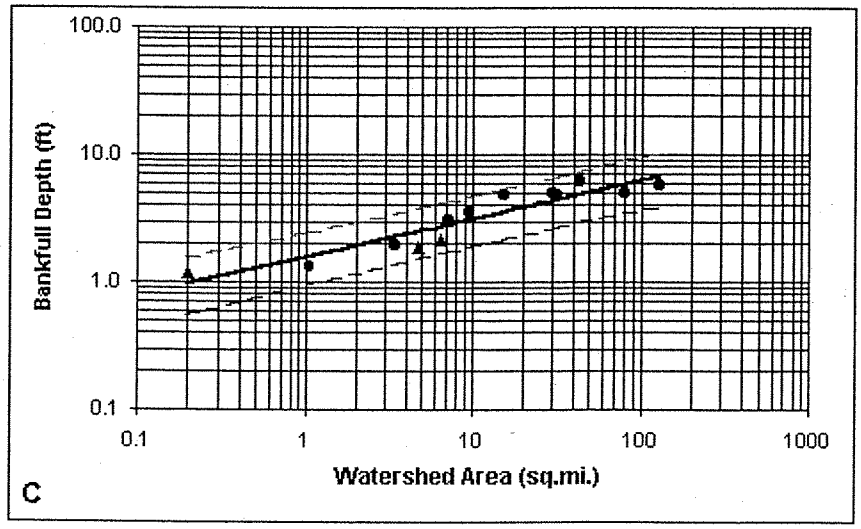
Bankfull Width vs. Drainage Area: $y = 11.89x^{0.43}$

Bankfull Mean Depth vs. Drainage Area: $y = 1.5x^{0.32}$

Bankfull hydraulic geometry relationships for rural Piedmont North Carolina Streams. The four graphs represent: a) cross sectional area, b) width, c) depth, and d) discharge. The circles represent gage stations and the triangles represent ungaged streams. The outside dashed lines are the 95% confidence intervals for all the data points.







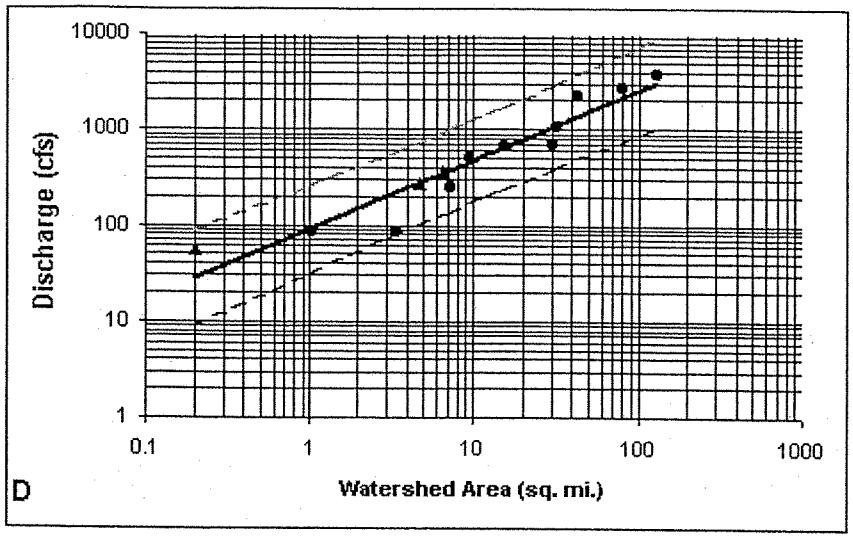

10000
1000
100
10
1
Discharge (cfs)
0.1
1
10
100
1000
Watershed Area (sq. mi.)
D

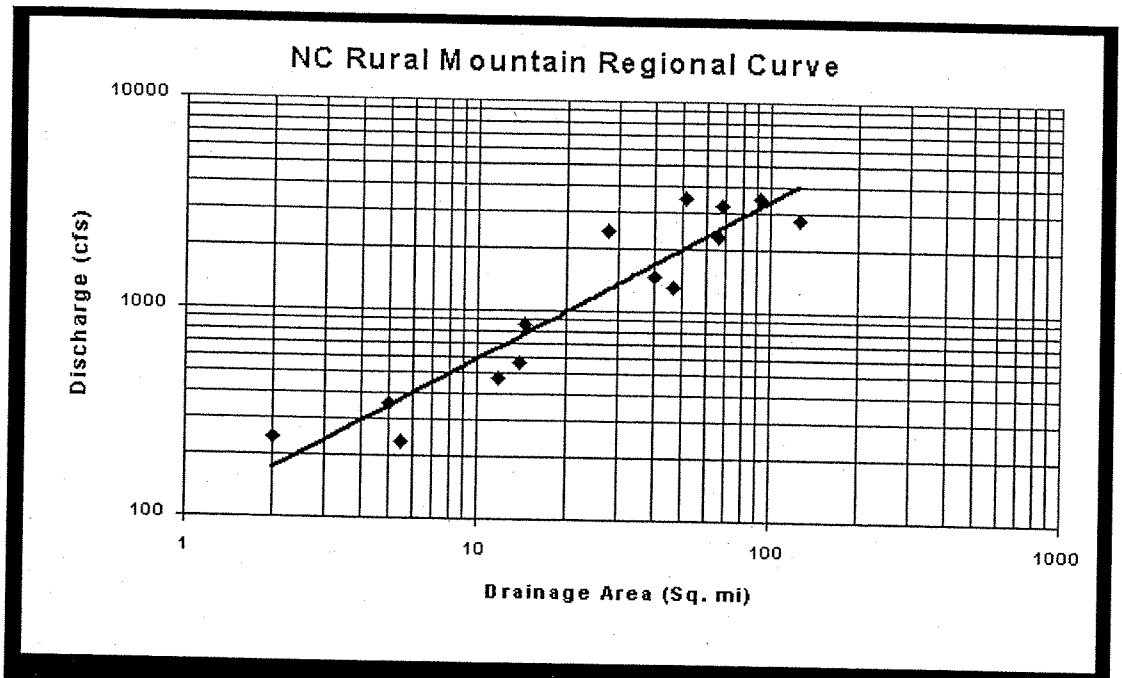
Table of Regional Curve data for the Mountain region:

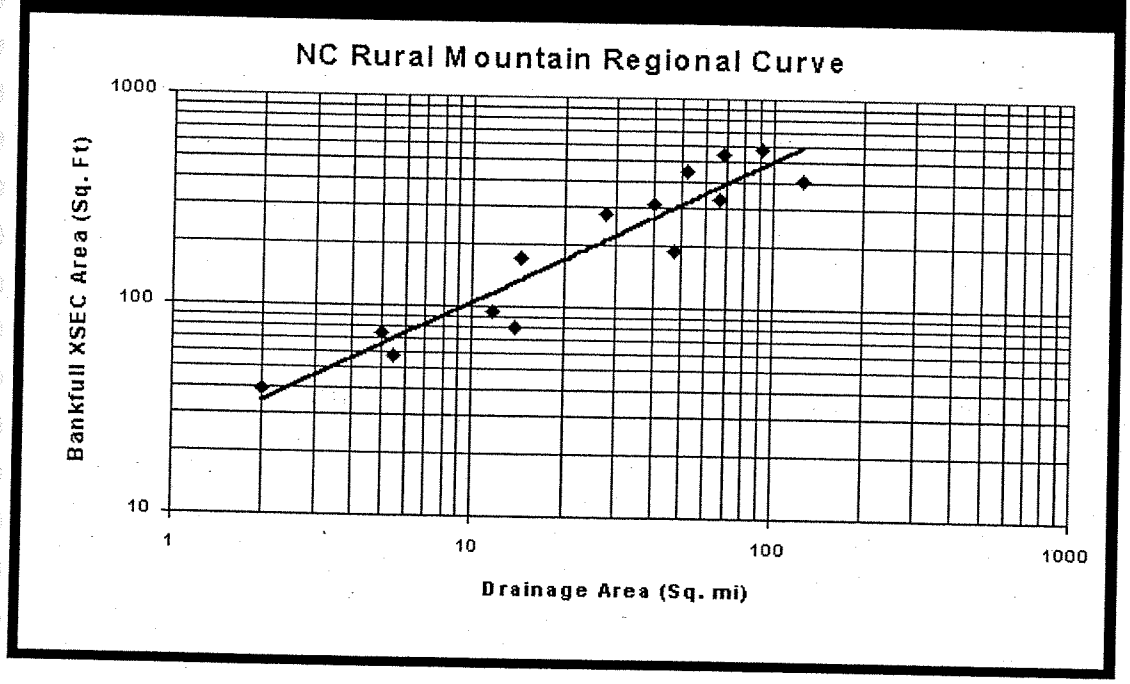
Stream Name	Gage Station ID	Stream Type (Rosgen)	Drainage Area (mi2)	Bankfull Discharge (cfs)	Bankfull Xsec Area (ft2)	Bankfull Width (ft)	Bankfull Mean Depth (ft)	Water Surface Slope (ft/ft)	Return Interval (Years)	Exceedence Probability (%)	Mean Rainfa (Inches
French Broad at Rosman	3439000	E4	67.9	3226	544.9	82.4	6.6	0.0009	1.3	0.77	98
Mills River	3446000	C4	66.7	2263	333	74.3	4.5	0.0035	1.9	0.53	90
Davidson River	3441000	B4c	40.4	1457	316	87.6	3.6	0.004	1.1	0.91	94
Catheys Creek near Brevard	344000	B4c	11.7	470	94.2	38	2.5	0.013	1.67	0.60	94
West Fork of the Pigeon	3455500	B3c	27.6	2433	277.9	80.6	3.4	0.0077	1.10	0.91	70
East Fork Pigeon River	3456500	B	51.5	3450	446.3	107	4.2	incomplete	1.59	0.63	70
Watauga River	3479000	B4c	92.1	3492	572	140.3	4.1	0.0033	1.25	0.80	56
Big Laurel	3454000	B4	126	2763	406	110.8	3.7	0.0045	1.59	0.63	42
East Fork Hickey Fork Creek	n/a	B3a	2.0	242	39.3	27.4	1.4	0.045	n/a	n/a	48
Cold Spring Creek	n/a	B4	5.0	352	74.4	42.9	1.7	0.025	n/a	n/a	50
Caldwell Fork	n/a	B	13.8	560	79.3	39.4	2.0	0.02	n/a	n/a	74
Cataloochee	3460000	B4c	46.9	1320	186.9	58.7	3.2	0.008	1.60	0.63	74
Bee Tree	3450000	B3	5.46	231.5	56	32.1	1.7	incomplete	1.85	0.54	
North Fork Swannanoa	344894205	C3	14.5	855.7	170.6	69.3	2.5	incomplete			

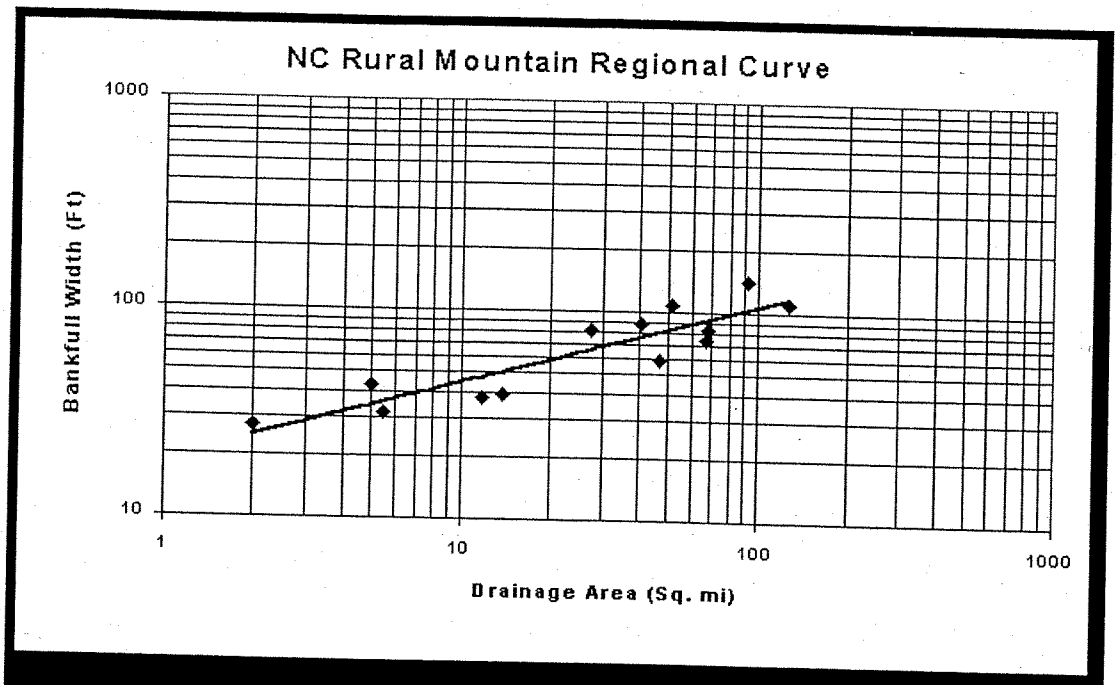
Equations for the Regional Curve Relationships:

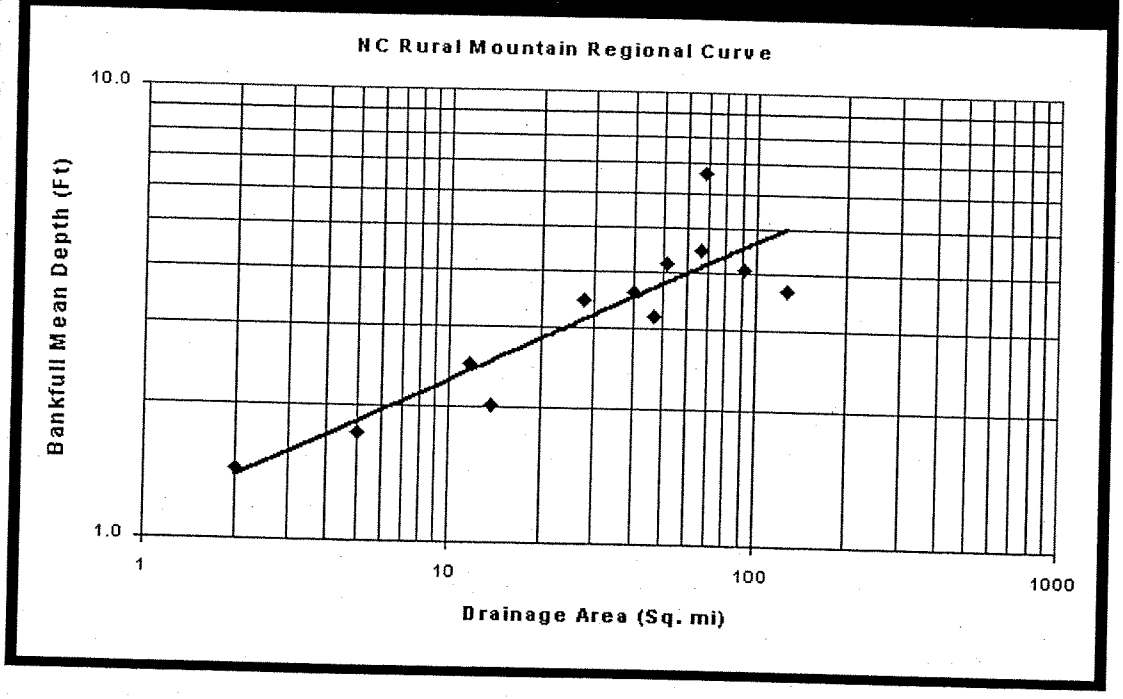
Bankfull Cross-Sectional Area vs. Drainage Area: $y = 21.61x^{0.68}$
Bankfull Discharge vs. Drainage Area: $y = 100.64x^{0.76}$
Bankfull Width vs. Drainage Area: $y = 19.05x^{0.37}$
Bankfull Mean Depth vs. Drainage Area: $y = 1.11x^{0.31}$

* where x = drainage area


NC Rural Mountain Regional Curve
10000
1000
100
Discharge (cfs)
1
10
100
1000
Drainage Area (Sq. mi)


NC Rural Mountain Regional Curve
1000
100
10
Bankfull XSEC Area (Sq. Ft)
1
10
100
1000
Drainage Area (Sq. mi)


NC Rural Mountain Regional Curve
1000
100
10
Bankfull Width (Ft)
1
10
100
1000
Drainage Area (Sq. mi)


NC Rural Mountain Regional Curve
10.0
1.0
Bankfull Mean Depth (Ft)
1
10
100
1000
Drainage Area (Sq. mi)

Purlear Creek
Upstream Reference Reach - Cross Section

Reference Reach				Hints
Stream:	Reference Reach 1 - Upstream of Reach 3			
Watershed:	Purlear Creek, Yadkin River Basin			
Location:	---			
Latitude:	---			
Longitude:	---			
County:	Wilkes			
Date:	June 26, 2002			
Observers:	CWE, NW, CD, ARK, PTR, SS			
Channel Type:	B4c			
Drainage Area (sq mi):	0.57			

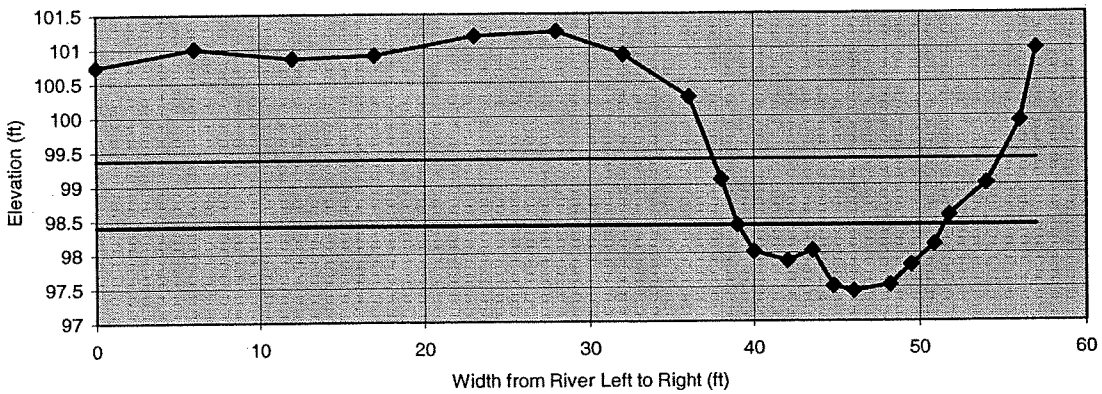
Dimension		typical	min	max
Riffle:	x-area bankfull	7.4		
	width bankfull	11.9		
	hydraulic radius	0.6		
	max depth	1.0		
	bank ht	2.8		
	width flood prone area	12.5		
	mean depth	0.62		
Pool:	x-area pool	8		
	width pool	12.5		
	hydraulic radius	0.6		
	max depth pool	1.3		
	bank ht	2.7		
Run:	x-area run			
	width run			
	hydraulic radius			
	max depth run			
	bank ht			
Glide:	x-area glide			
	width glide			
	max depth glide			

Dimensionless Ratios:	typical	min	max
Width/Depth Ratio	19.1		
Entrenchment Ratio	1.1		
Riffle Max Depth Ratio	1.6	---	---
Pool Area Ratio	1.1	---	---
Pool Width Ratio	1.1	---	---
Pool Max Depth Ratio	2.1	---	---
Bank Height Ratio	2.7		
Run Area Ratio	---	---	---
Run Width Ratio	---	---	---
Run Max Depth Ratio	---	---	---
Glide Area Ratio	---	---	---
Glide Width Ratio	---	---	---
Glide Max Depth Ratio	---	---	---

Hydraulics:	riffle	pool	run
channel slope (%)	1.600		
discharge rate, Q (cfs)	61.3		
velocity (ft/sec)	8.3	7.7	---
shear stress @ max depth (lbs/ft sq)	0.998	1.298	---
shear stress (lbs/ft sq)	0.599	0.599	---
shear velocity (ft/sec)	0.556	0.556	---
stream power (lbs/sec)	61.2	61.2	61.2
unit stream power (lbs/ft/sec)	5.143	5.143	5.143
relative roughness	2.2	2.2	---
friction factor u/u*	14.9	13.8	---
threshold grain size @ max depth (mm)	72	~~121~~	---
threshold grain size (mm)	37.5	37.5	---

Cross Section

Riffle Reference Reach 1 - Upstream of Reach 3



section: Riffle
Reference Reach 1 - Upstream of Reach 3
Purlear Creek, Yadkin River Basin

description:

height of instrument (ft): 104.68

notes	omit pt.	distance (ft)	FS (ft)	elevation
		0	3.94	100.74
		6	3.68	101
		12	3.82	100.86
		17	3.78	100.9
		23	3.5	101.18
		28	3.44	101.24
		32	3.78	100.9
TOB-L		36	4.4	100.28
		38	5.6	99.08
BKF-L		39	6.27	98.41
		40	6.66	98.02
		42	6.8	97.88
		43.5	6.65	98.03
EW-L		44.8	7.17	97.51
TW		46	7.24	97.44
		48.2	7.15	97.53
		49.5	6.86	97.82
		50.9	6.56	98.12
		51.8	6.13	98.55
		54	5.67	99.01
		56	4.76	99.92
		57	3.7	100.98

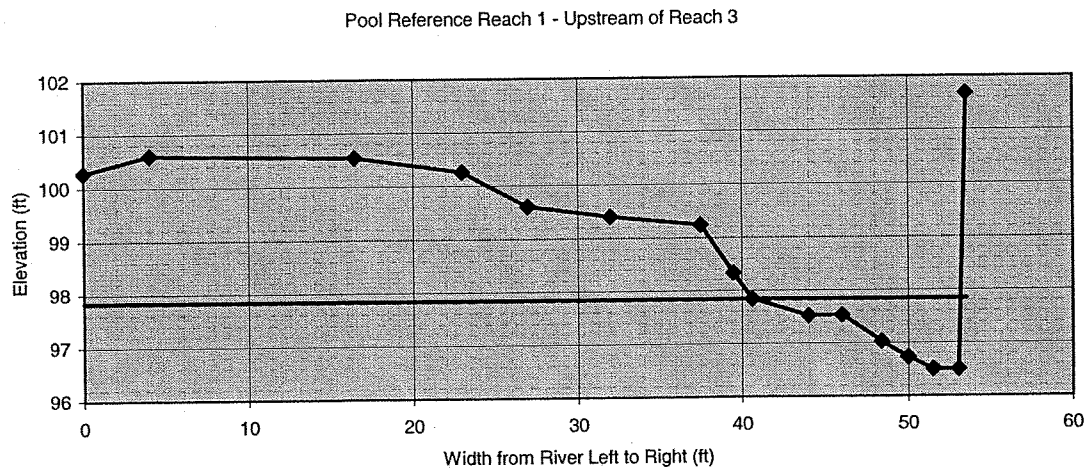
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
6.27	4.4	18.0	1.6	0.04
98.41	100.28			

dimensions			
7.4	x-section area	0.6	d mean
12.5	width	12.8	wet P
1.0	d max	0.6	hyd radi
2.8	bank ht	21.0	w/d ratio
18.0	W flood prone area	1.4	ent ratio

hydraulics	
3.3	velocity (ft/sec)
24.4	discharge rate, Q (cfs)
0.58	shear stress ((lbs/ft sq)
0.55	shear velocity (ft/sec)
1.945	unit stream power (lbs/ft/sec)
0.56	Froude number
6.0	friction factor u/u*
36.1	threshold grain size (mm)

check from channel material			
87	measured D84 (mm)		
2.1	relative roughness	4.6	fric. factor
0.052	Manning's n from channel material		

Cross Section



section:	Pool Reference Reach 1 - Upstream of Reach 3 Purlear Creek, Yadkin River Basin
description:	
height of instrument (ft):	104.68

notes	omit pt	distance (ft)	FS (ft)	elevation
		0	4.4	100.28
		4	4.08	100.6
		16.5	4.14	100.54
		23	4.42	100.26
		27	5.08	99.6
		32	5.28	99.4
TOB-L		37.5	5.44	99.24
		39.5	6.35	98.33
BKF-L		40.6	6.84	97.84
		44	7.16	97.52
		46	7.15	97.53
		48.4	7.65	97.03
EW-L		50	7.95	96.73
TW		51.5	8.18	96.5
		53	8.18	96.5
		53.5	3	101.68

FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
6.84	5.44		0.016	
97.84	99.24			

dimensions			
8.0	x-section area	0.6	d mean
12.5	width	13.9	wet P
1.3	d max	0.6	hyd radi
2.7	bank ht	~~19.7~~	w/d ratio
~~0.0~~	W flood prone area	~~0.0~~	ent ratio

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

check from channel material			
~~87~~	measured D84 (mm)		
~~2.2~~	relative roughness	~~4.8~~	fric. factor
~~0.050~~	Manning's n from channel material		

Reference Reach — Rifle

Stream:	Reference Reach 1 - Upstream of Reach 3
Watershed:	Purlear Creek, Yadkin River Basin
Location:	---
Latitude:	---
Longitude:	---
County:	Wilkes
Date:	June 26, 2002
Observers:	CWE, NW, CD, ARK, PTR, SS
Channel Type:	B4c
Drainage Area (sq mi):	0.57

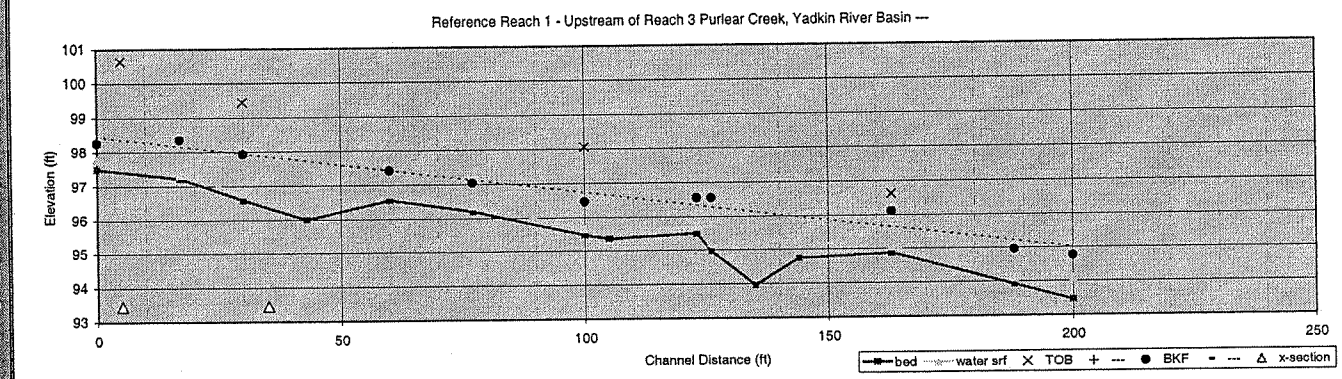
Pattern

	typical	min	max
bankfull width (ft)	11.9		
meander length (ft)	100		
belt width (ft)	21		
amplitude (ft)	74		
radius (ft)	20.6		
arc angle (degrees)			
straight length (ft)			
stream length	200		
valley length	185		
Sinuosity	1.08		
Meander Width Ratio	1.8	---	---
Amplitude Ratio	6.2	---	---
Meander Length Ratio	8.4	---	---
Straight Length Ratio	---	---	---
Radius Ratio	1.7	---	---

Profile

	typical	min	max
bankfull width (ft)	11.9		
pool-pool spacing (ft)	100		
riffle length (ft)	37	25	57
pool length (ft)	30	23	37
run length (ft)			
glide length (ft)			
channel slope (%)	1.6		
riffle slope (%)	2.9	1.6	3.8
pool slope (%)	0.17	0.1	0.4
run slope (%)			
glide slope (%)			
measured valley slope (%)	2.7		
valley slope (%)	1.7		
Riffle Length Ratio	3.1	2.1	4.8
Pool Length Ratio	2.5	1.9	3.1
Run Length Ratio	---	---	---
Glide Length Ratio	---	---	---
Riffle Slope Ratio	1.8	1.0	2.4
Pool Slope Ratio	0.1	0.1	0.3
Run Slope Ratio	---	---	---
Glide Slope Ratio	---	---	---
Pool Spacing Ratio	8.4	---	---

Slope Profile



notes	cross section	distance	station	BS	100 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 ---
				4.68	Elevation BM														
Head Rif.			0		104.68		7.19	0.27	6.42					97.49	97.76	98.26			
	Riffle	5	5		104.68					4.04							100.64		
		12	17		104.68		7.46	0.11	6.33					97.22	97.33	98.35			
End Rif.		13	30		104.68		8.1	0.2	6.76	5.24				96.58	96.78	97.92	99.44		
	Pool	5	35		104.68														
Head Gl.		8	43		104.68		8.68	0.6						96	96.6				
Head Rif.		17	60		104.68		8.12	0.19	7.26					96.56	96.75	97.42			
Mid Rif.		17	77		104.68		8.47	0.18	7.65					96.21	96.39	97.03			
End Rif.		23	100		104.68		9.21	0.2	8.22	6.63				95.47	95.67	96.46	98.05		
		5	105		104.68		9.32	0.3						95.36	95.66				
Head Rif.		18	123		104.68		9.18	0.2	8.13					95.5	95.7	96.55			
			0		104.68	8.73													
			0	5.55	101.5										#N/A	#N/A	#N/A	#N/A	#N/A
End Rif.		3	126		101.5		6.54	0.25	4.95					94.96	95.21	96.55			
Cent. Pl		9	135		101.5		7.65	1.28						93.95	95.23				
End Pl		9	144		101.5		6.77	0.5						94.73	95.23				
Head Rif.		19	163		101.5		6.64	0.2	5.38	4.88				94.86	95.06	96.12	96.62		
End Rif.		25	188		101.5		7.56	0.18	6.55					93.92	94.1	94.95			
Run		12	200		101.5		8.05	0.63	6.75					93.45	94.08	94.75			
			0		101.5	2.64													
			0	3.3	107.16										#N/A	#N/A	#N/A	#N/A	#N/A
			0		107.16	7.05													
			0		107.16														
			0		107.16														
			0		107.16														
			0		107.16														

Reference Reach						Hints
Stream:	Reference Reach 1 - Upstream of Reach 3					
Watershed:	Purlear Creek, Yadkin River Basin					
Location:	---					
Latitude:	---					
Longitude:	---					
County:	Wilkes					
Date:	June 26, 2002					
Observers:	CWE, NW, CD, ARK, PTR, SS					
Channel Type:	B4c					
Drainage Area (sq mi):	0.57					
Channel Materials	total	riffle	pool	run	glide	bar sample
D16	0.354	4.907	#N/A	0.000	0.000	---
D35	3.06	22.56	0.23	0.00	0.00	---
D50	16.8	50.6	0.3	0.0	0.0	---
D84	87	99	1	0	0	---
D95	118	123	19	0	0	---
Largest of Bar Sample						
% Silt/Clay	6%	0%	20%	---	---	---
% Sand	28%	10%	70%	---	---	---
% Gravel	37%	49%	10%	---	---	---
% Cobble	29%	42%	0%	---	---	---
% Boulder	0%	0%	0%	---	---	---
% Bedrock	0%	0%	0%	---	---	

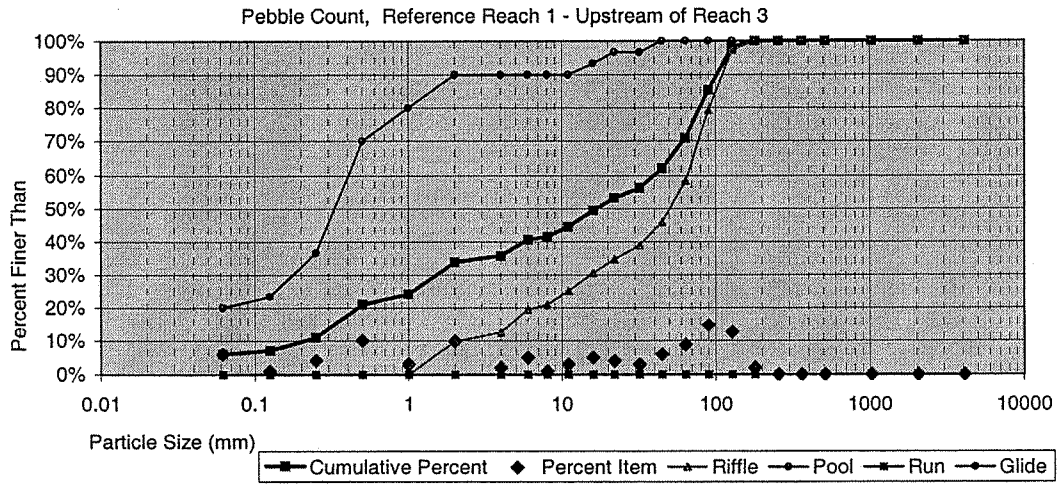
Weighted Pebble Count

Percent Riffle:	70	Percent Run:	
Percent Pool:	30	Percent Glide:	

Pebble Count,
Reference Reach 1 - Upstream of Reach 3
Purlear Creek, Yadkin River Basin

Note:

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	6.0	#
very fine sand	0.062	0.13	1.0	#
fine sand	0.13	0.25	4.0	#
medium sand	0.25	0.5	10.0	#
coarse sand	0.5	1	3.0	#
very coarse sand	1	2	9.8	#
very fine gravel	2	4	1.9	#
fine gravel	4	6	4.9	#
fine gravel	6	8	1.0	#
medium gravel	8	11	2.9	#
medium gravel	11	16	4.9	#
coarse gravel	16	22	3.9	#
coarse gravel	22	32	2.9	#
very coarse gravel	32	45	5.9	#
very coarse gravel	45	64	8.8	#
small cobble	64	90	14.6	#
medium cobble	90	128	12.6	#
large cobble	128	180	1.9	#
very large cobble	180	256	0.0	#
small boulder	256	362	0.0	#
small boulder	362	512	0.0	#
medium boulder	512	1024	0.0	#
large boulder	1024	2048	0.0	#
very large boulder	2048	4096	0.0	#
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	102	



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.354	3.06	16.8	87	118	6%	28%	37%	29%	0%	0%

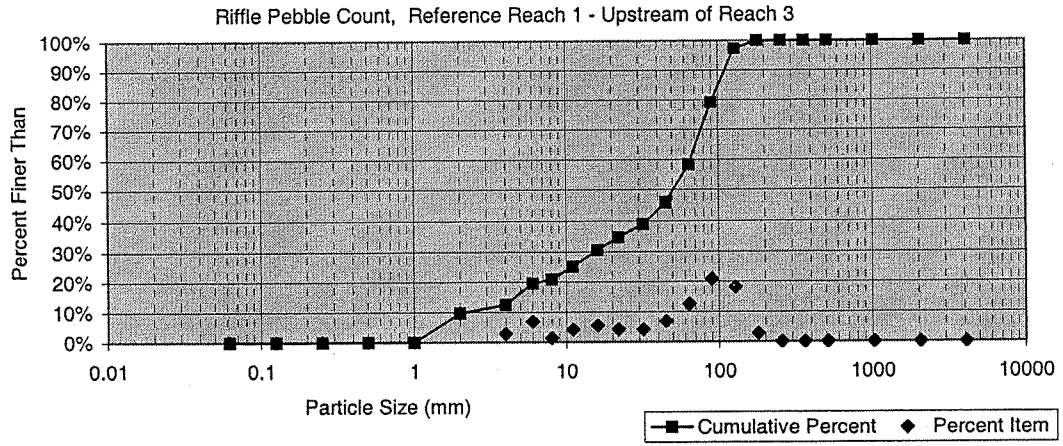
Riffle Pebble Count

Material	Size Range (mm)		Count
silt/clay	0	0.062	
very fine sand	0.062	0.13	
fine sand	0.13	0.25	
medium sand	0.25	0.5	
coarse sand	0.5	1	
very coarse sand	1	2	7
very fine gravel	2	4	2
fine gravel	4	6	5
fine gravel	6	8	1
medium gravel	8	11	3
medium gravel	11	16	4
coarse gravel	16	22	3
coarse gravel	22	32	3
very coarse gravel	32	45	5
very coarse gravel	45	64	9
small cobble	64	90	15
medium cobble	90	128	13
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	
bedrock			
Total Particle Count:			72

Riffle Pebble Count,

	Reference Reach 1 - Upstream of Reach 3
	Purlear Creek, Yadkin River Basin

Note:	



Size percent less than (mm)				
D16	D35	D50	D84	D95
4.907	22.56	50.6	99	123

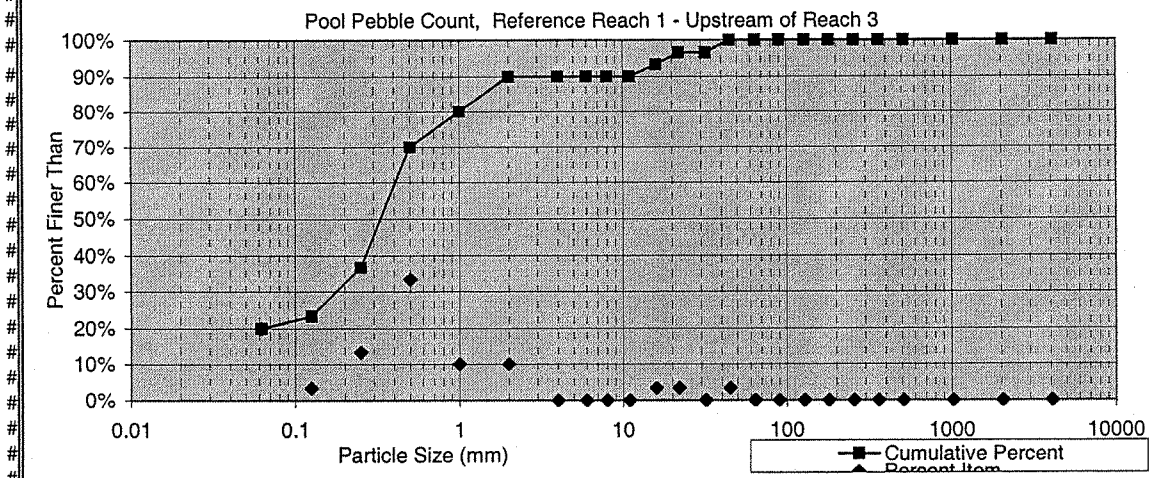
Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
0%	10%	49%	42%	0%	0%

Pool Pebble Count

Material	Size Range (mm)		Count
silt/clay	0	0.062	**6**
very fine sand	0.062	0.13	**1**
fine sand	0.13	0.25	**4**
medium sand	0.25	0.5	**10**
coarse sand	0.5	1	**3**
very coarse sand	1	2	**3**
very fine gravel	2	4	
fine gravel	4	6	
fine gravel	6	8	
medium gravel	8	11	
medium gravel	11	16	**1**
coarse gravel	16	22	**1**
coarse gravel	22	32	
very coarse gravel	32	45	**1**
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	
bedrock			
Total Particle Count:			30

Pool Pebble Count,
Reference Reach 1 - Upstream of Reach 3
Purlear Creek, Yadkin River Basin

Note:



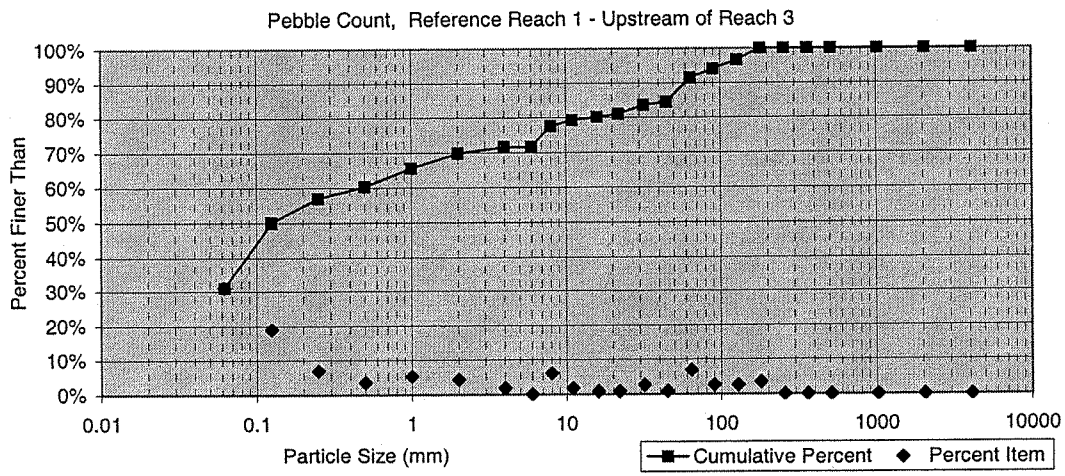
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.23	0.3	1	19	20%	70%	10%	0%	0%	0%

Pebble Count

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**36**	# #
very fine sand	0.062	0.13	**22**	# #
fine sand	0.13	0.25	**8**	# #
medium sand	0.25	0.5	**4**	# #
coarse sand	0.5	1	**6**	# #
very coarse sand	1	2	**5**	# #
very fine gravel	2	4	**2**	# #
fine gravel	4	6		# #
fine gravel	6	8	**7**	# #
medium gravel	8	11	**2**	# #
medium gravel	11	16	**1**	# #
coarse gravel	16	22	**1**	# #
coarse gravel	22	32	**3**	# #
very coarse gravel	32	45	**1**	# #
very coarse gravel	45	64	**8**	# #
small cobble	64	90	**3**	# #
medium cobble	90	128	**3**	# #
large cobble	128	180	**4**	# #
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		# #
bedrock				#
	Total Particle Count:		116	

Pebble Count,
Reference Reach 1 - Upstream of Reach 3
Purlear Creek, Yadkin River Basin

Note: **Entrainment PB at Riffle X-Section**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.07	0.1	37	104	31%	39%	22%	9%	0%	0%

Entrainment Calculation Form

Sample A

Site: Purlear Creek Upstream Reference Reach
Crew: CWE, NW, CD, ARK, PTR, SS
Date: 6-24 to 6-28-2002

Critical Dimensionless Shear Stress: $\tau_{ci} = 0.0834(d_i/d_{50})^{-0.872}$		
Value	**Variable**	**Definition**
50	d_i (mm)	D50 Bed Material (D50 from riffle pebble count)
9.5	d_{50} (mm)	Bar Sample D50 or Sub-pavement D50
0.020	τ_{ci}	**Critical Dimensionless Shear Stress**

Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample: $d_r = (\tau_{ci}*1.65*D_i)/S_e$ 1.65=submerged specific weight of sediment		
Value	**Variable**	**Definition**
0.020	τ_{ci}	Critical Dimensionless Shear Stress
0.28	D_i (feet)	Largest particle from bar sample
0.016	S_e (ft/ft)	Existing Bankfull Water Surface Slope
0.566	d_r (ft)	**Bankfull Mean Depth Required**
0.6	d_e (ft)	**Existing Bankfull Mean Depth (from riffle cross section)**
Circle:	**Stable (d_e/d_r=1)**	Aggrading (d_e/d_r<1) Degrading (d_e/d_r>1)

Bankfull Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample: $S_r = (\tau_{ci}*1.65*D_i)/d_e$ 1.65=submerged specific weight of sediment		
Value	**Variable**	**Definition**
0.020	τ_{ci}	Critical Dimensionless Shear Stess
0.28	D_i (feet)	Largest particle from bar sample
0.6	d_e (ft)	Existing Bankfull Mean Depth (from riffle cross section)
0.015	S_r (ft/ft)	Bankfull Water Surface Slope Required
Circle:	**Stable (S_e/S_r=1)**	Aggrading (S_e/S_r<1) Degrading (S_e/S_r>1)

Sediment Transport Validation

88.4	Largest Particle in Bar Sample D_i (mm)
0.6	Bankfull Shear Stress $\tau_c=\gamma RS$ (lb/ft^2)
35	Moveable particle size (mm) at bankfull shear stress (predicted by the Shields Diagram: Blue field book: p238, Red field book: p190)
1.1	Predicted shear stress required to initiate movement of D_i (mm) (see Shields Diagram: Blue field book: p238, Red field book: p190)

Velocity Comparison Form

Site: Purlear Creek Upstream Reference Reach
Crew: CWE, NW, CD, ARK, PTR, SS
Date: 6-24 to 6-28-2002

Input Variable			Output Variables		
Bankfull Cross Sectional Area (A_{BKF})	7.4	ft^2	Bankfull Mean Depth $D_{BKF} = (A_{BKF}/W_{BKF})$	0.6	ft
Bankfull Width (W_{BKF})	11.9	ft	Wetted Perimeter (WP) $(-(2*D_{BKF})+W_{BKF})$	10.7	ft
D_{84}	87	mm	D_{84} (mm/304.8)	0.285	ft
Bankfull Slope	0.016	ft/ft	Hydraulic Radius (R) (A_{BKF}/WP)	0.69	ft
Gravity	32.13	ft/s^2	R/D_{84} (use D_{84} in FEET)	2.43	ft/ft

R/D84, u/u*, Mannings n		
u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book: p233)	7.25	ft/s/ ft/s
Mannings n: (Reference Reach Field Book: p189, River Field Book, p236)	0.033	$ft^{1/6}$
Velocity: from Manning's equation: $u=(1.49R^{2/3}S^{1/2})/n$	4.48	ft/s

$u/u^* = 2.83+ 5.7\log R/D_{84}$		
u*: $u^*=(gRS)^{0.5}$	0.597	ft/s
Velocity: $u=u^*(2.83+5.7\log(R/D_{84})$	3.01	ft/s

Mannings n by Stream Type		
Stream Type		
Mannings n: (Reference Reach Field Book: p 187, River Field Book: p237)	0.04	$ft^{1/6}$
Velocity: from Manning's equation: $u=(1.49R^{2/3}S^{1/2})/n$	3.70	ft/s

Continuity Equation		
Q_{BKF} (cfs) from regional curve or stream gage calibration	61.3	cfs
Velocity: (u=Q/A or from stream gage hydraulic geometry)[1]	8.28	ft/s

BASIN CREEK REFERENCE REACH - Rosgen Type C4
Location: Wilkes County, NC - Take Traphill Road to Long Bottom Road (SR 1737)
Reach: Station 0+00 at confluence of Basin and Cove Creeks
Quad Sheet: Whitehead, NC **Drainage Area:** 7.2 sq. mi.

Length	Riffles	Runs	Glides	Pools	
	42	10	13	17	
	43	18	15	38	
	30	32	16	42	
	32	45	23	53	
	175	64			
	245				
Total	567	169	67	150	953
Avg	94.5	33.8	16.8	37.5	
%	59%	18%	7%	16%	
%Riffles & Glides =	84%				

Channel Dimensions:

Riffle Depth (ft)	2.1	Riffle Width (ft)	33.2 Riffle Area (sq ft)	68.4
Run Depth (ft)	2.2	Run Width (ft)	44.8 Run Area (sq ft)	97.7
Glide Depth (ft)	2.7	Glide Width (ft)	38.3 Glide Area (sq ft)	98.7
Pool Depth (ft)	2.7	Pool Width (ft)	50.3 Pool Area (sq ft)	109.6

Ratios:

Pool Depth/Riffle Depth =	1.3	
Pool Width/Riffle Width =	1.5	
Pool Area/Riffle Area =	1.6	
Max Pool Depth/Mean Bankfull Depth =	2.3	
Lowest Bank Height/Max Bankfull Depth=	1.0 to 1.3	Mean value 1.2

Streamflow:

Est Mean Velocity @ BKF (ft/sec) =	5.5
Est Discharge @ BKF (cfs) =	375

Channel Pattern:

Meander Length (ft)	350	Belt Width (ft)	60	Radius of Curvature (ft)	44.3
			59		69.3
			75		40.1
Total	350	Total	194	Total	153.7
Average	350	Average	64.7	Average	51.2

Ratios:

MWR = belt width/bkf width =	1.9
Rc/bkf width =	1.5
Lm/bkf width =	10.5

Channel Profile:

Valley Slope (ft/ft) =		Avg Water Surface Slope (ft/ft) =	0.01437
Riffle Slope (ft/ft) =	0.02082	Pool Slope (ft/ft) =	0.001942
Run Slope (ft/ft) =	0.003064	Glide Slope (ft/ft) =	0.006473

Pool to Pool Spacing (ft)	334	Pool Length (ft)	17
	310		38
	271		42
			53
Sum	915	Sum	150
Average	305.0	Average	37.5

Ratios:

Riffle slope/Avg WS slope =	1.4
Run slope/Avg WS slope =	0.2
Pool slope/Avg WS slope=	0.1
Glide slope/Avg WS slope=	0.5
Glide depth/mean bkf depth =	1.3
Pool length/bkf width =	1.1
Pool to Pool spacing/bkf width =	9.2

Pebble Count

Date: 10/28/1998
Party: Dick Everhart, Jerry Pate, Greg Goings and Joe Mickey

	Particle	Size(mm)	Total #	% Cum.	Cumulative (finer than)
	Silt/Clay	<0.062	2	2	0.062
SAND	Very Fine	0.062-0.125	8	10	0.125
	Fine	0.125-0.25	12	22	0.25
	Medium	0.25-0.50	4	26	0.5
	Course	0.50-1.0	0	26	1
	Very Course	1.0-2.0	0	26	2
GRAVEL	Very Fine	2-4	1	27	4
	Fine	4-5.7	0	27	5.7
	Fine	5.7-8	1	28	8
	Medium	8-11.3	1	29	11.3
	Medium	11.3-16	2	31	16
	Course	16-22.6	1	32	22.6
	Course	22.6-32	4	36	32
	Very Course	32-45	11	47	45
	Very Course	45-64	6	53	64
COBB	Small	64-90	12	65	90
	Small	90-128	9	74	128
	Large	128-180	10	84	180
	Large	180-256	8	92	256
BOULD	Small	256-362	4	96	362
	Small	362-512	2	98	512
	Medium	512-1024	0	98	1024
	Large-Vry Lrg	1024-2048	0	98	2048
	Bedrock	>2048	2	100	3000
				100	

Channel Materials:

% Sand = 26
% Gravel = 27
% Cobble = 39
% Boulder = 6
% Bedrock = 2

D16 = 0.17 mm
D35 = 29 mm
D50 = 58 mm
D84 =180 mm
D95 = 300 mm

DESIGN FOR: Big Warrior Creek - A, H, & W Farm

Parameter	Existing	Reference	Design	Existing	Reference	Reference	Design
Reach Name or Info Source	BWC-upper	BWC-upper	BWC-upper	BWC-lower	Basin Creek	Basin Creek	BWC-lower
Stream Type	B	B	B	Bc4	C4	C4	C
Drainage Area (sq mi)	0.7	0.7	0.7	1.17	6.8	7.2	1.2
Bankfull Width, Wbkf (ft)	17.3	15.7	15.0	19	30.7	33.2	20.0
Bkf Cross Sec Area, Abkf (sq ft)	18.5	21.9	18.0	32.73	57.4	68.4	25.000
Bankfull Mean Depth, Dbkf (ft)	1.1	1.40	1.2	1.72	1.9	2.1	1.4
Bankfull Max Depth, Dmax (ft)	1.5	1.79	1.8	2.29	2.5	3.1	*1.9*
Width Flood Prone Area, Wfpa (ft)	20	30	30	49	85	329	*50*
Width/Depth Ratio, Wbkf/Dbkf	16.1	11.24	12.50	11.0	16.16	15.8	*14.3*
Abkf/Wbkf					1.87	2.06	
Riffle Length			40.0		73		*60.0*
Riffle Slope, (ft/ft)			0.042		0.0509	0.02082	*0.0365*
Mean Riffle to Riffle Spacing, (ft)	19.0		60.0		143		*93.2*
Min. Riffle to Riffle Spacing					48.5		*31.6*
Max. Riffle to Riffle Spacing					238		*155.0*
Pool Depth			2.0		2.7	2.7	*2.0*
Pool Width			21.0		40.6	50.3	*26.4*
Max. Pool Depth			3.0		3.1	5.2	*3.5*
Pool x-sect. Area			20.2		64.4	109.6	*28.0*
Mean Pool length			20.0				*22.0*
Min. Pool Length			7.7			17	*10.2*
Max. Pool Length			25.0		84	53	*31.9*
Pool Slope, (ft/ft)	0.0075		0.0129		0.0055	0.001942	*0.0039*
Min Pool Spacing, Lps (ft)	6				224	271	*163.25*
Max Pool Spacing, Lps (ft)	82					334	*201.20*
Avg. Pool to Pool Spacing							*184.00*
Riffle to Pool Spacing					91.8		*59.8*
Meander Length, Lm (ft)				180	350	350	*270*
Min Radius of Curvature, Rc (ft)				45	76.7	44.1	*27*
Max Radius of Curvature, Rc (ft)					133.8	69.3	*50*
Min Belt Width, Wblt (ft)				52	105	59	*35.54*
Max Belt Width, Wblt (ft)						75	*45.18*
Sinuosity, K	1.02		1.2	1.15	1	1	
Valley slope, Sval (ft/ft)	0.0338			0.0116	0.0139		
Channel Slope, Schan=Sval/K (ft/ft)	0.0333			0.0101	0.01		
Valley Length, Lval (ft)	2580.0			1220			
Channel Length, Lcha (ft)	2701.0			1440			
RATIOS							
Entrenchment Ratio, Wfpa/Wbkf	1.2	1.9	1.9	2.6	2.8	8.9	2.5
Width Flood Prone Area/Wbkf (ft)					2.77		
Riffle length/Wbkf					2.38		
Max. riffle Depth/Dbkf					1.34	1.48	
Mean Riffle to Riffle Spacing, Wbkf	1.1				4.658		
Min. Riffle-Riffle spacing/Wbkf					1.580		
Max. Riffle-Riffle spacing/Wbkf					7.752		
Riffle Slope Ratio, Srif./Schan					3.61		
Pool length/Wbkf					2.28	1.1	
Min. Pool Length/Wbkf						0.512	
Max. Pool Length/Wbkr					2.736	1.596	
Pool Depth/Dbkf					1.4	1.3	
Max. pool Depth/Dbkf					1.6	2.476	
Pool-Pool spacing/Wbkf					7.3	9.2	
Pool Slope Ratio, Spool/Schan	0.23				0.388		
Min Pool Spacing Ratio, Lps/Wbkf	0.3				7.296	8.163	

Min Rc Ratio, Rc/Wbkf				2.4	2.5	1.328	
Max Rc Ratio, Rc/Wbkf					4.66	2.087	
Meander Len Ratio, Lm/Wbkf				0.0	11.4	10.5	
Min MW Ratio, Wblt/Wbkf (ft)				2.7	3.42	1.777	
Max MW Ratio, Wblt/Wbkf (ft)						2.259	
Bankfull Discharge, Qbkf (cfs)	80*					375	
Bankfull Mean Velocity, vbkf (ft/s)	3.85		5.5			5.5	

* Regional curve predicts this value; however, WinXSPRO model predicted 45 cfs.

Italicised numbers are for parameters that were determined using ratios from reference reachs.

MORPHOLOGY CHARACTERISTICS

Restoration Site: Purlear Creek, Wilkes County @ Hayes Farm
Nearest USGS Station: Elk Creek
Reference Reach: Purlear Creek, Upper Big Warrior Creek, and Basin Creek

VARIABLES	EXISTING (STA 62+00 -73+00)		PROPOSED (STA 62+00 -73+00)		EXISTING (STA 300+00 -323+00)		PROPOSED (STA 300+00 -315+00)		REFERENCE REACH REACH Upstream 1		REFERENCE Upper Big Warrior Creek		REFERENCE REACH Basin Creek 2		REFERENCE REACH Basin Creek		REGIONAL CURVES MOUNTAIN		REGIONAL CURVES PIEDMONT	
1. Stream Type																				
(Rosgen)	B4c/1		C4/1		F4		C4		B4c		B		C4		C4					
2. Drainage Area																				
(sq. mile)	3.0		3.0		0.05-0.4		0.15		0.57		0.70		6.80		7.20		3.0		3.0	
3. Bankfull Width	Mean:	23.9	Mean:	24.2	Mean:	7.4		8.0	Mean:	12.5	Mean:	15.7	Mean:	30.7	Mean:	33.2	Mean:	28.6	Mean:	19.0
(W_{bkf})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
4. Bankfull Mean	Mean:	1.7	Mean:	1.8	Mean:	0.5	Mean:	0.5	Mean:	0.6	Mean:	1.4	Mean:	1.9	Mean:	2.1	Mean:	1.6	Mean:	2.1
depth (d_{bkf})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
5. Width/Depth Ratio	Mean:	14.2	Mean:	13.5	Mean:	15.5	Mean:	16.0	Mean:	20.8	Mean:	11.2	Mean:	16.2	Mean:	15.8	Mean:	17.9	Mean:	9.0
(W_{bkf}/d_{bkf})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
6. Bankfull cross-sectional	Mean:	40.3	Mean:	43.5	Mean:	3.5	Mean:	4.1	Mean:	7.4	Mean:	21.9	Mean:	57.4	Mean:	68.4	Mean:	45.6	Mean:	45.0
Area (Abkf)	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
7. Bankfull Mean Velocity[2]	Mean:	5.3	Mean:	4.9	Mean:	2.6	Mean:	2.6	Mean:	3.7	Mean:		Mean:		Mean:	5.5	Mean:	5.1	Mean:	4.3
(V_{bkf})	Range:		Range:		Range:		Range:		Range:	3.0 - 8.28	Range:		Range:		Range:		Range:		Range:	
8. Bankfull Discharge, cfs[3]	Mean:	214.0	Mean:	214.0	Mean:	9.1	Mean:	9.1	Mean:	27.4	Mean:		Mean:		Mean:	375.0	Mean:	231.0	Mean:	196.0
(Q_{bkf})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
9. Bankfull Maximum Depth	Mean:	2.8	Mean:	2.7	Mean:	0.7	Mean:	0.7	Mean:	1.0	Mean:	1.8	Mean:	2.5	Mean:	3.1	Mean:		Mean:	
(d_{max})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
10. Max d_{mf}/d_{bkf}	Mean:	1.6	Mean:	1.6	Mean:	1.4	Mean:	1.4	Mean:	1.7	Mean:	1.3	Mean:	1.3	Mean:	1.5	Mean:		Mean:	
ratio	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
11. Low Bank Height to max	Mean:	1.8	Mean:	1.0	Mean:	3.4	Mean:	1.0	Mean:	2.8	Mean:		Mean:		Mean:	1.2	Mean:		Mean:	
d_{bkf} ratio	Range:		Range:		Range:		Range:	1.0-1.2	Range:		Range:		Range:		Range:		Range:		Range:	
12. Width of Flood Prone	Mean:	50.0	Mean:	62min	Mean:	9.5	Mean:	55min	Mean:	18.0	Mean:	30.0	Mean:	85.0	Mean:	329.0	Mean:		Mean:	
Area (W_{fpa})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
13. Entrenchment Ratio	Mean:	2.1	Mean:	2.56 min	Mean:	1.3	Mean:	6.8min	Mean:	1.4	Mean:	1.9	Mean:	2.8	Mean:	9.9	Mean:		Mean:	
(W_{fpa}/W_{bkf})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
14. Meander Length	Mean:	200.0	Mean:	200.0	Mean:		Mean:		Mean:	100.0	Mean:		Mean:	350.0	Mean:	350.0	Mean:		Mean:	
(L_m)	Range:		Range:		Range:	50-60	Range:	60-80	Range:		Range:		Range:		Range:		Range:		Range:	
15. Ratio of Meander Length to	Mean:	8.4	Mean:	8.3	Mean:		Mean:		Mean:	8.0	Mean:	0.0	Mean:	11.4	Mean:	10.5	Mean:		Mean:	
Bankfull Width (L_m/W_{bkf})	Range:		Range:		Range:	6.8-8.1	Range:	7.5-10	Range:		Range:		Range:		Range:		Range:		Range:	
16. Radius of Curvature	Mean:	75.0	Mean:		Mean:		Mean:	24.0	Mean:	20.6	Mean:		Mean:	105.3	Mean:	51.2	Mean:		Mean:	
(R_c)	Range:		Range:	48-83	Range:	10-40	Range:		Range:		Range:		Range:	76.7 - 133.8	Range:	40.1 - 69.3	Range:		Range:	
17. Ratio of Radius of Curvature	Mean:	3.1	Mean:	3.0	Mean:	1.3-5.4	Mean:	3.0	Mean:	1.6	Mean:		Mean:	3.4	Mean:	1.5	Mean:		Mean:	
to Bankfull Width (R_c/W_{bkf})	Range:		Range:	2.0-4.4	Range:		Range:	2.0-4.4	Range:		Range:		Range:	2.5 - 4.4	Range:		Range:		Range:	
18. Belt Width	Mean:	N/A	Mean:		Mean:	40.0	Mean:	80.0	Mean:	21.0	Mean:		Mean:	105.0	Mean:	64.7	Mean:		Mean:	
(W_{blt})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	59 - 75	Range:		Range:	
19. Meander Width Ratio	Mean:	N/A	Mean:		Mean:	5.4	Mean:	10.0	Mean:	1.7	Mean:	0.0	Mean:	3.4	Mean:	1.9	Mean:		Mean:	
(W_{blt}/W_{bkf})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
20. Sinuosity (k)																				
(Stream Length / Valley Length)	1.1		1.1		1.1		1.2		1.06				1.4		0.0					
21. Valley Slope (S_{valley})**																				
(ft/ft)	0.0060		0.0060		0.0183		0.0183		0.0170				0.0140							
22. Average Stream Slope																				
(S_{avg}) = (S_{valley}/k)	0.0050		0.0050		0.0165		0.0165		0.0160				0.0100		0.0140					
23. Riffle Slope	Mean:	0.015	Mean:	0.009	Mean:	0.010	Mean:	0.027	Mean:	0.0290	Mean:		Mean:	0.0510	Mean:	0.0210	Mean:		Mean:	
(S_{riff})	Range:	0.011-0.02	Range:		Range:	0.007-0.020	Range:	0.015-0.027	Range:		Range:		Range:	-	Range:		Range:		Range:	
24. Ratio of Riffle Slope to Avg.	Mean:	3.000	Mean:	1.700	Mean:	0.600	Mean:	1.700	Mean:	1.813	Mean:		Mean:	5.100	Mean:	1.500	Mean:		Mean:	
Slope (S_{riffle}/S_{avg})	Range:		Range:	1.5-2	Range:	0.4-1.2	Range:	0.9-1.6	Range:		Range:		Range:		Range:		Range:		Range:	
25. Pool Slope	Mean:	0.002	Mean:	0.002	Mean:	0.002	Mean:	0.001	Mean:	0.002	Mean:		Mean:	0.0055	Mean:	0.0020	Mean:		Mean:	
(S_{pool})	Range:	0.001-0.003	Range:	0.001-0.003	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
26. Ratio of Pool Slope to Avg.	Mean:	0.4	Mean:	0.4	Mean:	0.1	Mean:	0.1	Mean:	0.1	Mean:		Mean:	0.6	Mean:	0.1	Mean:		Mean:	
Slope (S_{pool}/S_{avg})	Range:		Range:	0.1-0.3	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
27. Maximum Pool	Mean:	2.1	Mean:	3.4	Mean:	2.0	Mean:	1.5	Mean:	1.3	Mean:		Mean:	3.1	Mean:	4.8	Mean:		Mean:	
Depth (d_{pool})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
28. Ratio of Pool Depth to Avg.	Mean:	3.8	Mean:	3.0	Mean:	4.0	Mean:	2.1	Mean:	2.2	Mean:		Mean:	1.6	Mean:	2.3	Mean:		Mean:	
Depth (d_{pool}/d_{avg})	Range:		Range:	2.0-4.0	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
29. Pool Width	Mean:	20.5	Mean:	33.9	Mean:	8.0	Mean:	12.0	Mean:	12.5	Mean:		Mean:	40.6	Mean:	50.3	Mean:		Mean:	
(W_{pool})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
30. Ratio of Pool Width to	Mean:	0.9	Mean:	1.4	Mean:	1.1	Mean:	1.5	Mean:	1.0	Mean:		Mean:	1.3	Mean:	1.5	Mean:		Mean:	
Bankfull Width (W_{pool}/W_{bkf})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
31. Pool Area	Mean:	36.5	Mean:	59.0	Mean:	5.3	Mean:	8.3	Mean:	8.0	Mean:		Mean:	64.4	Mean:	109.6	Mean:		Mean:	
(A_{pool})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
32. Ratio of Pool Area to	Mean:	0.9	Mean:	1.3	Mean:	1.5	Mean:	2.0	Mean:	1.1	Mean:		Mean:	1.1	Mean:	1.6	Mean:		Mean:	
Bankfull Area (A_{pool}/A_{bkf})	Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:		Range:	
33. Pool to Pool Spacing[4]	Mean:	121.0	Mean:	145.0	Mean:	70.0	Mean:	47.0	Mean:	100.0	Mean:		Mean:	224.0	Mean:	305.0	Mean:		Mean:	
(p - p)	Range:	60.7-181	Range:	127-200	Range:		Range:	31-78	Range:		Range:		Range:		Range:	271 - 334	Range:		Range:	
34. Ratio of Pool to Pool Spacing	Mean:	5.1	Mean:	8.0	Mean:	9.5	Mean:	5.9	Mean:	8.0	Mean:		Mean:	7.3	Mean:	9.2	Mean:		Mean:	
to Bankfull Width (p-p/Wbkf)	Range:		Range:	5-8	Range:		Range:	3.9-9.8	Range:		Range:		Range:		Range:		Range:		Range:	

Notes

1 Refer to Figure x for location
2 Bankfull velocities estimated using Manning methods
3 Based on Continuity Equation (Q = A x U)
4 No discernable features in profile or plan due to bank erosion and channel degradation

The EDR Radius Map
with GeoCheck®

WRP-Purlear Creek
CC Hayes Road
Purlear, NC 28665

Inquiry Number: 802027.3s

June 20, 2002

Environmental Data Resources, Inc.

The Source For Environmental Risk Management Data

3530 Post Road
Southport, Connecticut 06490

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com

TABLE OF CONTENTS

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR). The report meets the government records search requirements of ASTM Standard Practice for Environmental Site Assessments, E 1527-00. Search distances are per ASTM standard or custom distances requested by the user.

TARGET PROPERTY INFORMATION

ADDRESS

CC HAYES ROAD
PURLEAR, NC 28665

COORDINATES

Latitude (North):	36.198600 - 36° 11' 55.0"
Longitude (West):	81.296700 - 81° 17' 48.1"
Universal Tranverse Mercator:	Zone 17
UTM X (Meters):	473325.7
UTM Y (Meters):	4005816.2

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property:	2436081-B3 PURLEAR, NC
Source:	USGS 7.5 min quad index

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the ASTM E 1527-00 search radius around the target property for the following databases:

FEDERAL ASTM STANDARD

NPL ---- National Priority List
Proposed NPL ---- Proposed National Priority List Sites
CERCLIS ---- Comprehensive Environmental Response, Compensation, and Liability Information System
CERC-NFRAP ---- CERCLIS No Further Remedial Action Planned
CORRACTS ---- Corrective Action Report
RCRIS-TSD ---- Resource Conservation and Recovery Information System
RCRIS-LQG ---- Resource Conservation and Recovery Information System
RCRIS-SQG ---- Resource Conservation and Recovery Information System
ERNS ---- Emergency Response Notification System

STATE ASTM STANDARD

SHWS ---- Inactive Hazardous Sites Inventory
SWF/LF ---- List of Solid Waste Facilities
LUST ---- Incidents Management Database
AST ---- AST Database

EXECUTIVE SUMMARY

FEDERAL ASTM SUPPLEMENTAL

CONSENT..... Superfund (CERCLA) Consent Decrees
ROD..... Records Of Decision
Delisted NPL..... National Priority List Deletions
FINDS..... Facility Index System/Facility Identification Initiative Program Summary Report
HMIRS..... Hazardous Materials Information Reporting System
MLTS..... Material Licensing Tracking System
MINES..... Mines Master Index File
NPL Liens..... Federal Superfund Liens
PADS..... PCB Activity Database System
RAATS..... RCRA Administrative Action Tracking System
TRIS..... Toxic Chemical Release Inventory System
TSCA..... Toxic Substances Control Act
FTTS..... FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

STATE OR LOCAL ASTM SUPPLEMENTAL

LUST TRUST..... State Trust Fund Database
IMD..... Incident Management Database

EDR PROPRIETARY HISTORICAL DATABASES

Coal Gas..... Former Manufactured Gas (Coal Gas) Sites

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified.

Elevations have been determined from the USGS 1 degree Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. EDR's definition of a site with an elevation equal to the target property includes a tolerance of +/- 10 feet. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property (by more than 10 feet). Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

STATE ASTM STANDARD

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the Department of Environment, Health, & Natural Resources' Petroleum Underground Storage Tank Database.

A review of the UST list, as provided by EDR, and dated 03/08/2002 has revealed that there is 1 UST site within approximately 2 miles of the target property.

Lower Elevation	Address	Dist / Dir	Map ID	Page
PURLEAR GROCERY	8172 BOONE TRAIL	1 - 2 SSW	2	5

STATE OR LOCAL ASTM SUPPLEMENTAL

HSDS: The Hazardous Substance Disposal Sites list contains locations of uncontrolled and unregulated hazardous waste sites. The file contains sites on the national priority list as well as the state priority list. The data source is the North Carolina Center for Geographic Information and Analysis.

A review of the NC HSDS list, as provided by EDR, and dated 06/21/1995 has revealed that there is 1 NC HSDS site within approximately 2 miles of the target property.

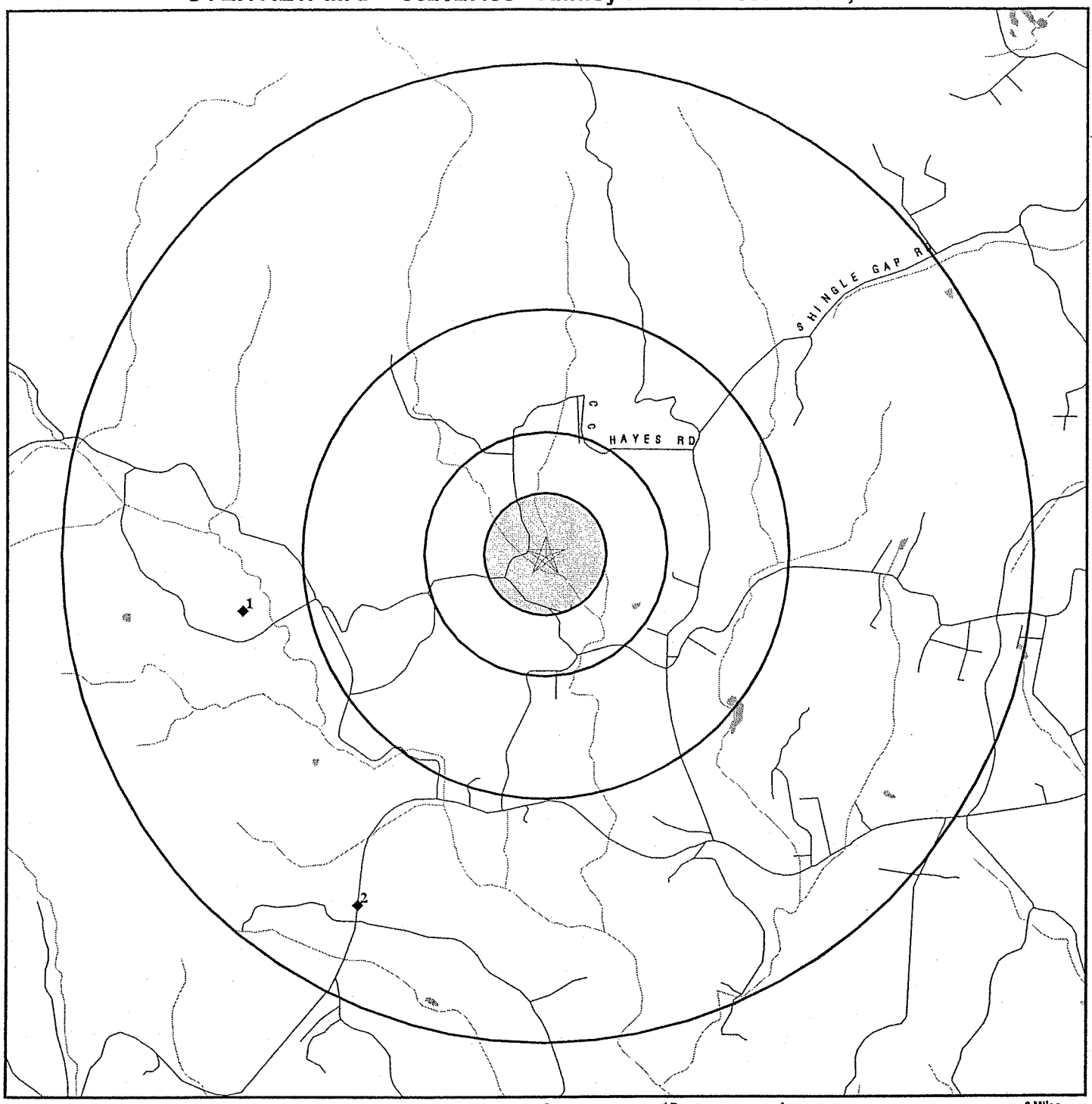
Lower Elevation	Address	Dist / Dir	Map ID	Page
RADIATION PHYSICS CONSULTANTS		1 - 2 W	1	5

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
RADIATION PHYSICS CONSULTANTS	SHWS
MILLERS CREEK GULF	UST
TRADERS II	UST
B & B QUICK STOP	UST
OAK FOREST 76	UST, IMD
ROYALS PACKAGE STORE	UST
WEST WILKES HIGH SCHOOL	UST
DEEP FORD MARKET	UST
FAST TRACK #141	UST
DOLLAR MART #24	UST
MILLERS CREEK FARM	UST
BOB SHEPHERD LOGGING CO.. INC	UST
MORAVIAN FALLS EXPRESS #23726	UST
MAPLE SPRINGS GROCERY	UST
WILBAR 76	UST
STALEY RESIDENCE, WILLIAM	IMD

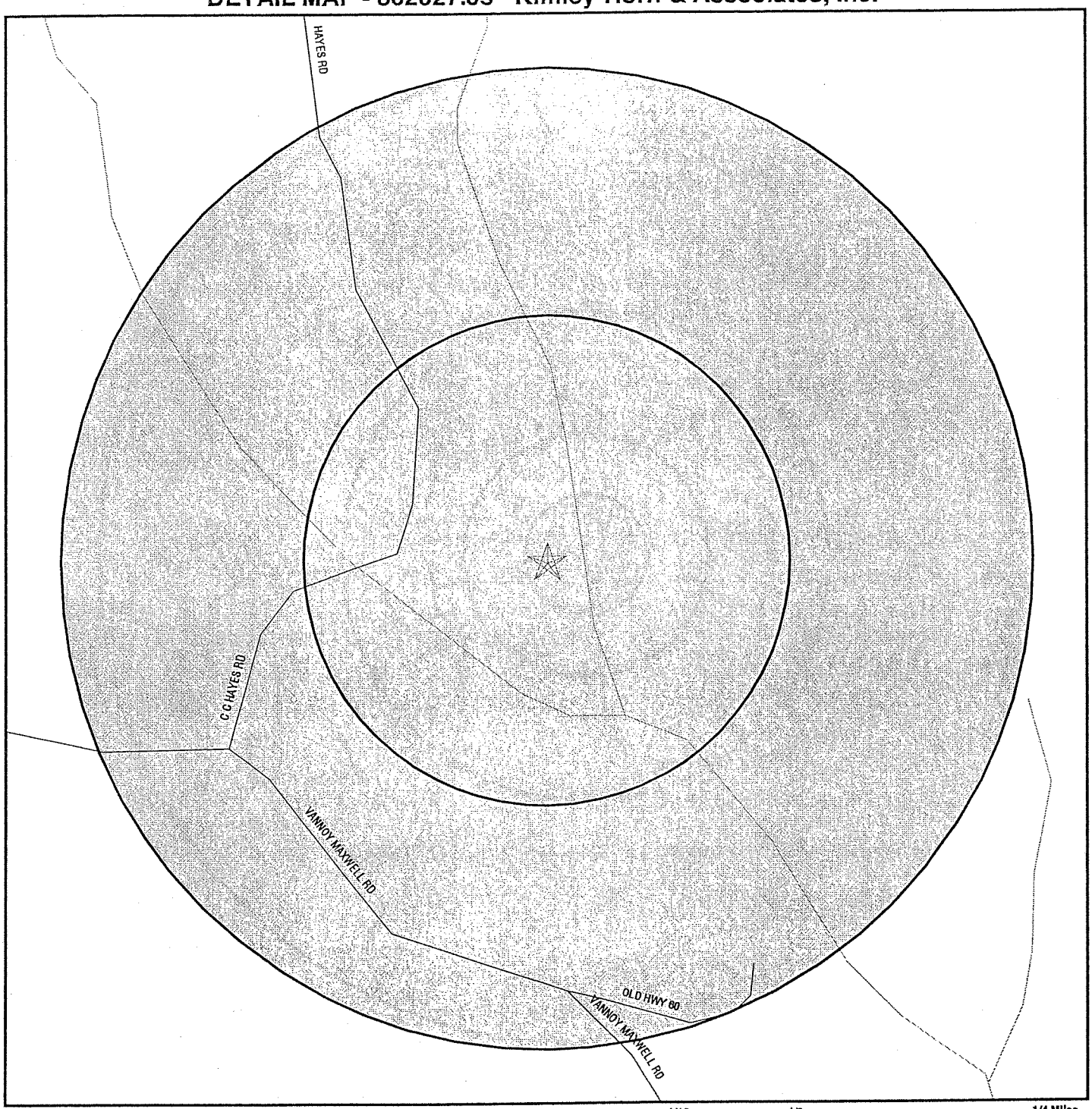
OVERVIEW MAP - 802027.3s - Kimley-Horn & Associates, Inc.



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- National Priority List Sites
- Landfill Sites
- Power transmission lines
- Oil & Gas pipelines
- Wetlands
- Hazardous Substance Disposal Sites

TARGET PROPERTY:	WRP-Purlear Creek	CUSTOMER:	Kimley-Horn & Associates, Inc.
ADDRESS:	CC Hayes Road	CONTACT:	Andrew Kiley
CITY/STATE/ZIP:	Purlear NC 28665	INQUIRY #:	802027.3s
LAT/LONG:	36.1986 / 81.2967	DATE:	June 20, 2002 2:38 pm

DETAIL MAP - 802027.3s - Kimley-Horn & Associates, Inc.



- ★ Target Property
- ▲ Sites at elevations higher than or equal to the target property
- ◆ Sites at elevations lower than the target property
- Coal Gasification Sites
- Sensitive Receptors
- National Priority List Sites
- Landfill Sites
- Power transmission lines
- Oil & Gas pipelines
- Hazardous Substance Disposal Sites

TARGET PROPERTY:	WRP-Purlear Creek	CUSTOMER:	Kimley-Horn & Associates, Inc.
ADDRESS:	CC Hayes Road	CONTACT:	Andrew Kiley
CITY/STATE/ZIP:	Purlear NC 28665	INQUIRY #:	802027.3s
LAT/LONG:	36.1986 / 81.2967	DATE:	June 20, 2002 2:38 pm

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FEDERAL ASTM STANDARD								
NPL		2.000	0	0	0	0	0	0
Proposed NPL		2.000	0	0	0	0	0	0
CERCLIS		2.000	0	0	0	0	0	0
CERC-NFRAP		2.000	0	0	0	0	0	0
CORRACTS		2.000	0	0	0	0	0	0
RCRIS-TSD		2.000	0	0	0	0	0	0
RCRIS Lg. Quan. Gen.		2.000	0	0	0	0	0	0
RCRIS Sm. Quan. Gen.		2.000	0	0	0	0	0	0
ERNS		2.000	0	0	0	0	0	0
STATE ASTM STANDARD								
State Haz. Waste		2.000	0	0	0	0	0	0
State Landfill		2.000	0	0	0	0	0	0
LUST		2.000	0	0	0	0	0	0
UST		2.000	0	0	0	0	1	1
AST		2.000	0	0	0	0	0	0
FEDERAL ASTM SUPPLEMENTAL								
CONSENT		2.000	0	0	0	0	0	0
ROD		2.000	0	0	0	0	0	0
Delisted NPL		2.000	0	0	0	0	0	0
FINDS		2.000	0	0	0	0	0	0
HMIRS		2.000	0	0	0	0	0	0
MLTS		2.000	0	0	0	0	0	0
MINES		2.000	0	0	0	0	0	0
NPL Liens		2.000	0	0	0	0	0	0
PADS		2.000	0	0	0	0	0	0
RAATS		2.000	0	0	0	0	0	0
TRIS		2.000	0	0	0	0	0	0
TSCA		2.000	0	0	0	0	0	0
FTTS		2.000	0	0	0	0	0	0
STATE OR LOCAL ASTM SUPPLEMENTAL								
NC HSDS		2.000	0	0	0	0	1	1
LUST TRUST		2.000	0	0	0	0	0	0
IMD		2.000	0	0	0	0	0	0
EDR PROPRIETARY HISTORICAL DATABASES								
Coal Gas		2.000	0	0	0	0	0	0

AQUIFLOW - see EDR Physical Setting Source Addendum

TP = Target Property

NR = Not Requested at this Search Distance

* Sites may be listed in more than one database

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

Coal Gas Site Search: No site was found in a search of Real Property Scan's ENVIROHAZ database.

1
West
> 1
6695 ft.
Lower

RADIATION PHYSICS CONSULTANTS
, NC

NC HSDS **S102442152**
N/A

NC HSDS:

Facility Name:	RADIATION PHYSICS CONSULTANTS		
Latitude:	36 11 42.309636	Longitude:	81 19 9.264229
Site Type:	Federal	Superfund ID #:	980 559 397

2
SSW
> 1
8594 ft.
Lower

PURLEAR GROCERY
8172 BOONE TRAIL
PURLEAR, NC 28665

UST **U001189790**
N/A

UST:

Facility ID:	0-006264
Telephone:	(704) 667-9453
Owner name :	TAR HEEL OIL CO.. INC.
Owner Address:	PO BOX 608/1225 D ST.
	NORTH WILKESBORO, NC 28659
Owner Phone :	(919) 662-9453
Tank capacity :	4000
Comment :	Not reported
Tank product :	Gasoline, Gasoline Mixture
Tank material :	Steel
Interior Protection:	Cathodic Protection
Exterior Protection:	Cathodic Protection
Piping material :	Steel
Certify Type :	Not reported
Leak Detection Type :	Not reported
Leak Detection Piping :	Not reported
Corrosn Protec Tank:	Sacrificial annonde
Corrosn Protec Pipe:	Sacrificial annonde
Spill and Overfill :	Catchment basins
Financial Responsiblity :	Not reported
Region:	04
Tank ID:	A
Date installed:	09/22/1988
Date removed:	Not reported
Status:	Currently In Use
Facility ID:	0-006264
Telephone:	(704) 667-9453
Owner name :	TAR HEEL OIL CO.. INC.
Owner Address:	PO BOX 608/1225 D ST.
	NORTH WILKESBORO, NC 28659
Owner Phone :	(919) 662-9453
Tank capacity :	4000
Comment :	Not reported
Tank product :	Gasoline, Gasoline Mixture
Tank material :	Steel
Interior Protection:	Cathodic Protection

PURLEAR GROCERY (Continued) **U001189790**

Exterior Protection:	Cathodic Protection
Piping material :	Steel
Certify Type :	Not reported
Leak Detection Type :	Not reported
Leak Detection Piping :	Not reported
Corrosn Protec Tank:	Sacrificial annonde
Corrosn Protec Pipe:	Sacrificial annonde
Spill and Overfill :	Catchment basins
Financial Responsiblity :	Not reported
Region:	04
Tank ID:	B
Date installed:	09/22/1988
Date removed:	Not reported
Status:	Currently In Use
Facility ID:	0-006264
Telephone:	(704) 667-9453
Owner name :	TAR HEEL OIL CO.. INC.
Owner Address:	PO BOX 608/1225 D ST.
	NORTH WILKESBORO, NC 28659
Owner Phone :	(919) 662-9453
Tank capacity :	4000
Comment :	Not reported
Tank product :	Gasoline, Gasoline Mixture
Tank material :	Steel
Interior Protection:	Cathodic Protection
Exterior Protection:	Cathodic Protection
Piping material :	Steel
Certify Type :	Not reported
Leak Detection Type :	Not reported
Leak Detection Piping :	Not reported
Corrosn Protec Tank:	Sacrificial annonde
Corrosn Protec Pipe:	Sacrificial annonde
Spill and Overfill :	Catchment basins
Financial Responsiblity :	Not reported
Region:	04
Tank ID:	C
Date installed:	09/22/1988
Date removed:	Not reported
Status:	Currently In Use
Facility ID:	0-006264
Telephone:	(704) 667-9453
Owner name :	TAR HEEL OIL CO.. INC.
Owner Address:	PO BOX 608/1225 D ST.
	NORTH WILKESBORO, NC 28659
Owner Phone :	(919) 662-9453
Tank capacity :	1000
Comment :	Not reported
Tank product :	Kerosene, Kerosene Mixture
Tank material :	Steel
Interior Protection:	Cathodic Protection
Exterior Protection:	Cathodic Protection
Piping material :	Steel
Certify Type :	Not reported

PURLEAR GROCERY (Continued) **U001189790**

Leak Detection Type :	Not reported
Leak Detection Piping :	Not reported
Corrosn Protec Tank:	Sacrificial annonde
Corrosn Protec Pipe:	Sacrificial annonde
Spill and Overfill :	Catchment basins
Financial Responsiblity :	Not reported
Region:	04
Tank ID:	D
Date installed:	09/22/1988
Date removed:	Not reported
Status:	Currently In Use
Facility ID:	0-006264
Telephone:	(704) 667-9453
Owner name :	TAR HEEL OIL CO.. INC.
Owner Address:	PO BOX 608/1225 D ST.
	NORTH WILKESBORO, NC 28659
Owner Phone :	(919) 662-9453
Tank capacity :	1000
Comment :	Not reported
Tank product :	Diesel, Diesel Mixture
Tank material :	Steel
Interior Protection:	Cathodic Protection
Exterior Protection:	Cathodic Protection
Piping material :	Steel
Certify Type :	Not reported
Leak Detection Type :	Not reported
Leak Detection Piping :	Not reported
Corrosn Protec Tank:	Sacrificial annonde
Corrosn Protec Pipe:	Sacrificial annonde
Spill and Overfill :	Catchment basins
Financial Responsiblity :	Not reported
Region:	04
Tank ID:	E
Date installed:	09/22/1988
Date removed:	Not reported
Status:	Currently In Use
Facility ID:	0-006264
Telephone:	(704) 667-9453
Owner name :	TAR HEEL OIL CO.. INC.
Owner Address:	PO BOX 608/1225 D ST.
	NORTH WILKESBORO, NC 28659
Owner Phone :	(919) 662-9453
Tank capacity :	2000
Comment :	Not reported
Tank product :	Gasoline, Gasoline Mixture
Tank material :	Steel
Interior Protection:	None
Exterior Protection:	None
Piping material :	Steel
Certify Type :	Not reported
Leak Detection Type :	Not reported
Leak Detection Piping :	Not reported
Corrosn Protec Tank:	Not reported

PURLEAR GROCERY (Continued) **U001189790**

Corrosn Protec Pipe:	Not reported
Spill and Overfill :	Not reported
Financial Responsiblity :	Not reported
Region:	04
Tank ID:	1
Date installed:	04/28/1961
Date removed:	06/01/1988
Status:	Permanent Closed
Facility ID:	0-006264
Telephone:	(704) 667-9453
Owner name :	TAR HEEL OIL CO.. INC.
Owner Address:	PO BOX 608/1225 D ST.
	NORTH WILKESBORO, NC 28659
Owner Phone :	(919) 662-9453
Tank capacity :	1000
Comment :	Not reported
Tank product :	Gasoline, Gasoline Mixture
Tank material :	Steel
Interior Protection:	None
Exterior Protection:	None
Piping material :	Steel
Certify Type :	Not reported
Leak Detection Type :	Not reported
Leak Detection Piping :	Not reported
Corrosn Protec Tank:	Not reported
Corrosn Protec Pipe:	Not reported
Spill and Overfill :	Not reported
Financial Responsiblity :	Not reported
Region:	04
Tank ID:	2
Date installed:	04/28/1961
Date removed:	06/01/1988
Status:	Permanent Closed
Facility ID:	0-006264
Telephone:	(704) 667-9453
Owner name :	TAR HEEL OIL CO.. INC.
Owner Address:	PO BOX 608/1225 D ST.
	NORTH WILKESBORO, NC 28659
Owner Phone :	(919) 662-9453
Tank capacity :	1000
Comment :	Not reported
Tank product :	Gasoline, Gasoline Mixture
Tank material :	Steel
Interior Protection:	None
Exterior Protection:	None
Piping material :	Steel
Certify Type :	Not reported
Leak Detection Type :	Not reported
Leak Detection Piping :	Not reported
Corrosn Protec Tank:	Not reported
Corrosn Protec Pipe:	Not reported
Spill and Overfill :	Not reported
Financial Responsiblity :	Not reported

PURLEAR GROCERY (Continued) **U001189790**

Region:	04
Tank ID:	3
Date installed:	04/24/1976
Date removed:	06/01/1988
Status:	Permanent Closed

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
MILLERS CREEK	U001187231	MILLERS CREEK GULF	HWY 16 NORTH RT 2 BOX 611	28651	UST
MILLERS CREEK	U001204505	TRADERS II	HWY 16	28651	UST
MILLERS CREEK	U003563056	B & B QUICK STOP	HIGHWAY 16 NORTH	28651	UST
MILLERS CREEK	U003563123	OAK FOREST 76	HWY 16 N	28651	UST, IMD
MILLERS CREEK	U001205345	ROYALS PACKAGE STORE	RT 2, BOX 31	28651	UST
MILLERS CREEK	U001204378	WEST WILKES HIGH SCHOOL	6958 BOONE TRAIL ROAD	28651	UST
MILLERS CREEK	U003563428	DEEP FORD MARKET	5968 NORTH HIGHWAY 16	28651	UST
MILLERS CREEK	U003766239	FAST TRACK #141	3009 N HWY 16	28651	UST
MILLERS CREEK	U003561968	DOLLAR MART #24	2976 NORTH NC HWY 16	28651	UST
MILLERS CREEK	U001189875	MILLERS CREEK FARM	OLD HIGHWAY 421 NORTH	28651	UST
MILLERS CREEK	U001189877	BOB SHEPHERD LOGGING CO., INC	OLD HIGHWAY 16 NORTH	28651	UST
MORAVIAN FALLS	U003091865	MORAVIAN FALLS EXPRESS #23726	2037 HIGHWAY 18	28651	UST
PURLEAR	S103554514	RADIATION PHYSICS CONSULTANTS	SR 1353	28665	SHWS
PURLEAR	U001188021	MAPLE SPRINGS GROCERY	HIGHWAY 421 NORTH--ROUTE 1	28665	UST
PURLEAR	S104913813	STALEY RESIDENCE, WILLIAM	13442 BOONE TRAIL ROAD	28665	IMD
WILBAR	U003146329	WILBAR 76	HWY 16 N	28651	UST

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Elapsed ASTM days: Provides confirmation that this EDR report meets or exceeds the 90-day updating requirement of the ASTM standard.

FEDERAL ASTM STANDARD RECORDS

NPL: National Priority List
Source: EPA
Telephone: N/A
National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 01/29/02
Date Made Active at EDR: 02/25/02
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 02/04/02
Elapsed ASTM days: 21
Date of Last EDR Contact: 05/06/02

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 3
Telephone 215-814-5418

EPA Region 4
Telephone 404-562-8033

EPA Region 6
Telephone: 214-655-6659

EPA Region 8
Telephone: 303-312-6774

Proposed NPL: Proposed National Priority List Sites
Source: EPA
Telephone: N/A

Date of Government Version: 01/17/02
Date Made Active at EDR: 02/25/02
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 02/04/02
Elapsed ASTM days: 21
Date of Last EDR Contact: 05/06/02

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System
Source: EPA
Telephone: 703-413-0223
CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 02/12/02
Date Made Active at EDR: 06/03/02
Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 03/25/02
Elapsed ASTM days: 70
Date of Last EDR Contact: 03/25/02

CERCLIS-NFRAP: CERCLIS No Further Remedial Action Planned
Source: EPA
Telephone: 703-413-0223
As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

Date of Government Version: 02/14/02
Date Made Active at EDR: 06/03/02
Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 03/25/02
Elapsed ASTM days: 70
Date of Last EDR Contact: 03/25/02

CORRACTS: Corrective Action Report
Source: EPA
Telephone: 800-424-9346
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 11/14/01
Date Made Active at EDR: 01/14/02
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 11/14/01
Elapsed ASTM days: 61
Date of Last EDR Contact: 06/10/02

RCRIS: Resource Conservation and Recovery Information System
Source: EPA/NTIS
Telephone: 800-424-9346
Resource Conservation and Recovery Information System. RCRIS includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA).

Date of Government Version: 03/22/02
Date Made Active at EDR: 06/03/02
Database Release Frequency: Varies

Date of Data Arrival at EDR: 03/28/02
Elapsed ASTM days: 67
Date of Last EDR Contact: 03/04/02

ERNS: Emergency Response Notification System
Source: EPA/NTIS
Telephone: 202-260-2342
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 12/31/00
Date Made Active at EDR: 06/03/02
Database Release Frequency: Varies

Date of Data Arrival at EDR: 03/05/02
Elapsed ASTM days: 90
Date of Last EDR Contact: 04/29/02

FEDERAL ASTM SUPPLEMENTAL RECORDS

BRS: Biennial Reporting System
Source: EPA/NTIS
Telephone: 800-424-9346
The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/99
Database Release Frequency: Biennially

Date of Last EDR Contact: 06/17/02
Date of Next Scheduled EDR Contact: 09/16/02

CONSENT: Superfund (CERCLA) Consent Decrees
Source: EPA Regional Offices
Telephone: Varies
Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: N/A
Database Release Frequency: Varies

Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

ROD: Records Of Decision
Source: EPA
Telephone: 703-416-0223
Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 09/30/01
Database Release Frequency: Annually

Date of Last EDR Contact: 04/09/02
Date of Next Scheduled EDR Contact: 07/08/02

DELISTED NPL: National Priority List Deletions
Source: EPA
Telephone: N/A
The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 01/29/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 05/06/02
Date of Next Scheduled EDR Contact: 08/05/02

FINDS: Facility Index System/Facility Identification Initiative Program Summary Report
Source: EPA
Telephone: N/A
Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 03/21/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 04/08/02
Date of Next Scheduled EDR Contact: 07/08/02

HMIRS: Hazardous Materials Information Reporting System
Source: U.S. Department of Transportation
Telephone: 202-366-4555
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 09/30/01
Database Release Frequency: Annually

Date of Last EDR Contact: 04/22/02
Date of Next Scheduled EDR Contact: 07/22/02

MLTS: Material Licensing Tracking System
Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/12/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 04/08/02
Date of Next Scheduled EDR Contact: 07/08/02

MINES: Mines Master Index File
Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959

Date of Government Version: 12/14/01
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 04/01/02
Date of Next Scheduled EDR Contact: 07/01/02

NPL LIENS: Federal Superfund Liens
Source: EPA
Telephone: 205-564-4267
Federal Superfund Liens. Under the authority granted the USEPA by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/91
Database Release Frequency: No Update Planned

Date of Last EDR Contact: 05/28/02
Date of Next Scheduled EDR Contact: 08/26/02

PADS: PCB Activity Database System
Source: EPA
Telephone: 202-564-3887
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 12/01/01
Database Release Frequency: Annually

Date of Last EDR Contact: 05/14/02
Date of Next Scheduled EDR Contact: 08/12/02

RAATS: RCRA Administrative Action Tracking System
Source: EPA
Telephone: 202-564-4104
RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/95
Database Release Frequency: No Update Planned

Date of Last EDR Contact: 06/10/02
Date of Next Scheduled EDR Contact: 09/09/02

TRIS: Toxic Chemical Release Inventory System
Source: EPA
Telephone: 202-260-1531
Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/99
Database Release Frequency: Annually

Date of Last EDR Contact: 03/25/02
Date of Next Scheduled EDR Contact: 06/24/02

TSCA: Toxic Substances Control Act
Source: EPA
Telephone: 202-260-5521
Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/98
Database Release Frequency: Every 4 Years

Date of Last EDR Contact: 06/10/02
Date of Next Scheduled EDR Contact: 09/09/02

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA
Telephone: 202-564-2501

Date of Government Version: 01/14/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 03/25/02
Date of Next Scheduled EDR Contact: 06/24/02

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-564-2501
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 01/11/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 03/25/02
Date of Next Scheduled EDR Contact: 06/24/02

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

STATE OF NORTH CAROLINA ASTM STANDARD RECORDS

SHWS: Inactive Hazardous Sites Inventory
Source: Department of Environment, Health and Natural Resources
Telephone: 919-733-2801
State Hazardous Waste Sites. State hazardous waste site records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. Available information varies by state.

Date of Government Version: 03/22/02
Date Made Active at EDR: 05/27/02
Database Release Frequency: Annually
Date of Data Arrival at EDR: 04/15/02
Elapsed ASTM days: 42
Date of Last EDR Contact: 04/15/02

SWF/LF: List of Solid Waste Facilities
Source: Department of Environment, Health and Natural Resources
Telephone: 919-733-0692
Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 04/01/02
Date Made Active at EDR: 06/07/02
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 04/30/02
Elapsed ASTM days: 38
Date of Last EDR Contact: 04/29/02

LUST: Incidents Management Database
Source: Department of Environment, Health and Natural Resources
Telephone: 919-733-1315
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 06/07/02
Date Made Active at EDR: 06/20/02
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 06/10/02
Elapsed ASTM days: 10
Date of Last EDR Contact: 06/10/02

UST: Petroleum Underground Storage Tank Database
Source: Department of Environment, Health and Natural Resources
Telephone: 919-733-1308
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 03/08/02
Date Made Active at EDR: 03/22/02
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 03/11/02
Elapsed ASTM days: 11
Date of Last EDR Contact: 06/10/02

AST: AST Database
Source: Department of Environment, Health & Natural Resources
Telephone: 919-715-6170
Facilities with aboveground storage tanks that have a capacity greater than 21,000 gallons.

Date of Government Version: 01/02/02
Date Made Active at EDR: 02/04/02
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 01/22/02
Elapsed ASTM days: 13
Date of Last EDR Contact: 04/22/02

STATE OF NORTH CAROLINA ASTM SUPPLEMENTAL RECORDS

HSDS: Hazardous Substance Disposal Site
Source: North Carolina Center for Geographic Information and Analysis
Telephone: 919-733-2090
Locations of uncontrolled and unregulated hazardous waste sites. The file includes sites on the National Priority List as well as those on the state priority list.

Date of Government Version: 06/21/95
Database Release Frequency: Biennially

Date of Last EDR Contact: 06/03/02
Date of Next Scheduled EDR Contact: 09/02/02

LUST TRUST: State Trust Fund Database
Source: Department of Environment, Health & Natural Resources
Telephone: 919-733-1315
This database contains information about claims against the State Trust Funds for reimbursements for expenses incurred while remediating Leaking USTs.

Date of Government Version: 05/10/02
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 05/13/02
Date of Next Scheduled EDR Contact: 08/12/02

IMD: Incident Management Database
Source: Department of Health and Natural Resources
Telephone: 919-733-1315
Groundwater and/or soil contamination incidents

Date of Government Version: 04/26/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 04/29/02
Date of Next Scheduled EDR Contact: 07/29/02

EDR PROPRIETARY HISTORICAL DATABASES

Former Manufactured Gas (Coal Gas) Sites: The existence and location of Coal Gas sites is provided exclusively to EDR by Real Property Scan, Inc. ©Copyright 1993 Real Property Scan, Inc. For a technical description of the types of hazards which may be found at such sites, contact your EDR customer service representative.

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

Oil/Gas Pipelines/Electrical Transmission Lines: This data was obtained by EDR from the USGS in 1994. It is referred to by USGS as GeoData Digital Line Graphs from 1:100,000-Scale Maps. It was extracted from the transportation category including some oil, but primarily gas pipelines and electrical transmission lines.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

STREET AND ADDRESS INFORMATION

GEOCHECK ®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

WRP-PURLEAR CREEK
CC HAYES ROAD
PURLEAR, NC 28665

TARGET PROPERTY COORDINATES

Latitude (North):	36.198601 - 36° 11' 55.0"
Longitude (West):	81.296700 - 81° 17' 48.1"
Universal Tranverse Mercator:	Zone 17
UTM X (Meters):	473325.7
UTM Y (Meters):	4005816.2

EDR's GeoCheck Physical Setting Source Addendum has been developed to assist the environmental professional with the collection of physical setting source information in accordance with ASTM 1527-00, Section 7.2.3. Section 7.2.3 requires that a current USGS 7.5 Minute Topographic Map (or equivalent, such as the USGS Digital Elevation Model) be reviewed. It also requires that one or more additional physical setting sources be sought when (1) conditions have been identified in which hazardous substances or petroleum products are likely to migrate to or from the property, and (2) more information than is provided in the current USGS 7.5 Minute Topographic Map (or equivalent) is generally obtained, pursuant to local good commercial or customary practice, to assess the impact of migration of recognized environmental conditions in connection with the property. Such additional physical setting sources generally include information about the topographic, hydrologic, hydrogeologic, and geologic characteristics of a site, and wells in the area.

Assessment of the impact of contaminant migration generally has two principle investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata. EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

TOPOGRAPHIC INFORMATION

Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

USGS TOPOGRAPHIC MAP ASSOCIATED WITH THIS SITE

Target Property: 2436081-B3 PURLEAR, NC
Source: USGS 7.5 min quad index

GENERAL TOPOGRAPHIC GRADIENT AT TARGET PROPERTY

Target Property: General ESE

Source: General Topographic Gradient has been determined from the USGS 1 Degree Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Target Property County	FEMA Flood Electronic Data
WILKES, NC	Not Available

Flood Plain Panel at Target Property: Not Reported

Additional Panels in search area: Not Reported

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
PURLEAR	YES - refer to the Overview Map and Detail Map

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

AQUIFLOW®

Search Radius: 2.000 Miles.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

Era:	Paleozoic
System:	Cambrian
Series:	Cambrian
Code:	Ce *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: Eugeosynclinal Deposits

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps. The following information is based on Soil Conservation Service STATSGO data.

Soil Component Name:	PACOLET
Soil Surface Texture:	fine sandy loam
Hydrologic Group:	Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.
Soil Drainage Class:	Well drained. Soils have intermediate water holding capacity. Depth to water table is more than 6 feet.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Hydric Status: Soil does not meet the requirements for a hydric soil.

Corrosion Potential - Uncoated Steel: HIGH

Depth to Bedrock Min: > 60 inches

Depth to Bedrock Max: > 60 inches

Soil Layer Information							
	Boundary			Classification			
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil	Permeability Rate (in/hr)	Soil Reaction (pH)
1	0 inches	3 inches	fine sandy loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COURSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 6.00 Min: 2.00	Max: 6.50 Min: 4.50
2	3 inches	29 inches	sandy clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 2.00 Min: 0.60	Max: 6.00 Min: 4.50
3	29 inches	52 inches	clay loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), Lean Clay	Max: 2.00 Min: 0.60	Max: 6.00 Min: 4.50
4	52 inches	70 inches	sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COURSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 2.00 Min: 0.60	Max: 6.00 Min: 4.50

OTHER SOIL TYPES IN AREA

Based on Soil Conservation Service STATSGO data, the following additional subordinant soil types may appear within the general area of target property.

Soil Surface Textures: clay loam
gravelly - sandy loam
sandy loam
loam

Surficial Soil Types: clay loam
gravelly - sandy loam
sandy loam
loam

Shallow Soil Types: clay
sandy clay loam

silt loam
clay loam
silty clay loam

Deeper Soil Types: fine sandy loam
weathered bedrock

ADDITIONAL ENVIRONMENTAL RECORD SOURCES

According to ASTM E 1527-00, Section 7.2.2, "one or more additional state or local sources of environmental records may be checked, in the discretion of the environmental professional, to enhance and supplement federal and state sources... Factors to consider in determining which local or additional state records, if any, should be checked include (1) whether they are reasonably ascertainable, (2) whether they are sufficiently useful, accurate, and complete in light of the objective of the records review (see 7.1.1), and (3) whether they are obtained, pursuant to local, good commercial or customary practice." One of the record sources listed in Section 7.2.2 is water well information. Water well information can be used to assist the environmental professional in assessing sources that may impact groundwater flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	2.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	2.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
No Wells Found		

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
No PWS System Found		

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
1	NC00004202	1 - 2 Miles West

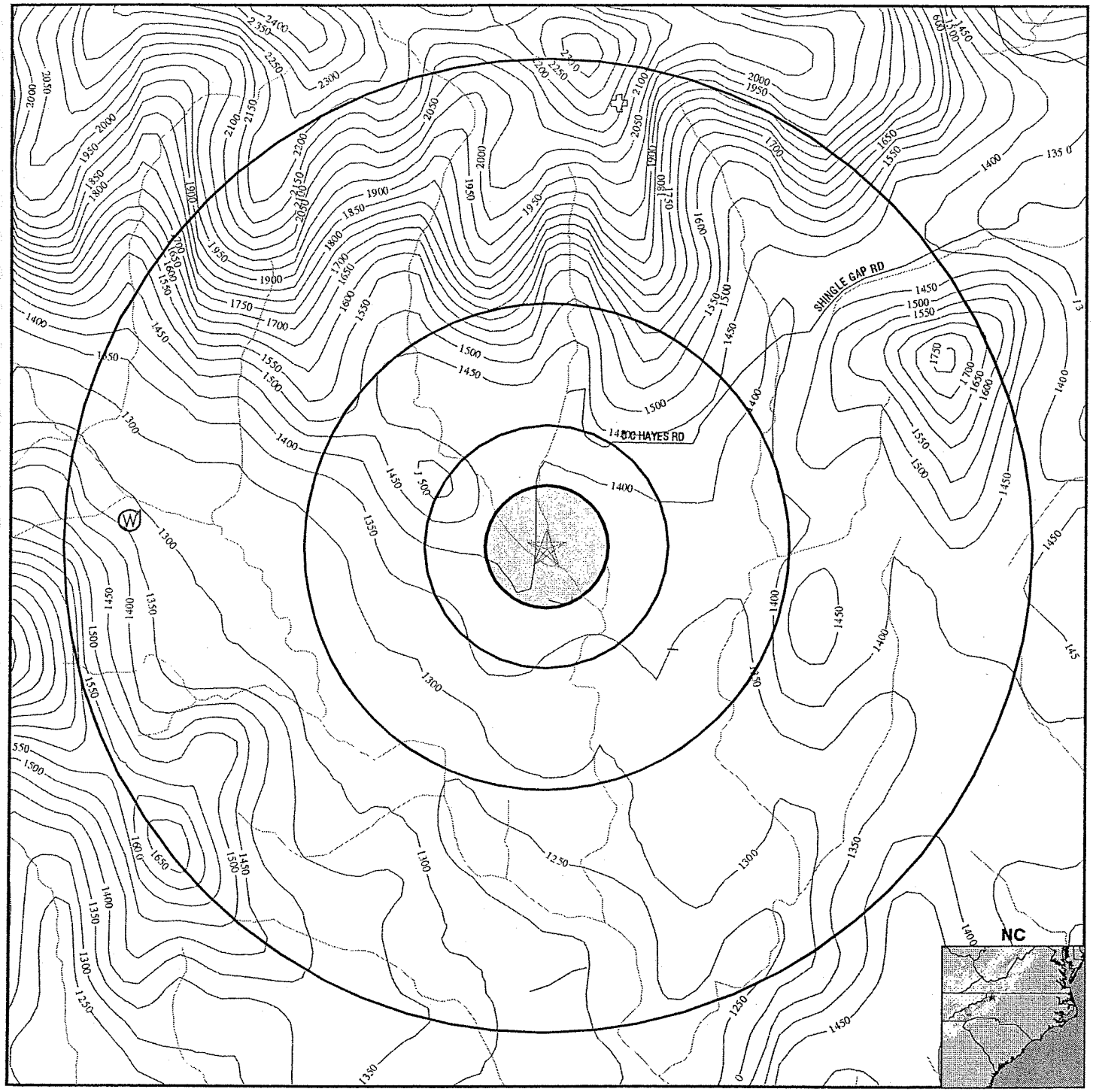
GEOCHECK - PHYSICAL SETTING SOURCE SUMMARY

OTHER STATE DATABASE INFORMATION

NORTH CAROLINA LOCATIONS OF NATURAL HERITAGE DATABASE

ID	Class
0021129	Natural Community Occurrence
0091128	Natural Community Occurrence
0012935	Natural Community Occurrence
0051660	Natural Community Occurrence

PHYSICAL SETTING SOURCE MAP - 802027.3s



0 1/2 1 2 Miles

- Major Roads
- Contour Lines
- Water Wells
- Public Water Supply Wells
- Groundwater Flow Direction
- Indeterminate Groundwater Flow at Location
- Groundwater Flow Varies at Location
- Cluster of Multiple Icons
- Earthquake epicenter, Richter 5 or greater
- Wildlife Areas
- Natural Areas
- Rare & Endangered Species

TARGET PROPERTY:	WRP-Purlear Creek	CUSTOMER:	Kimley-Horn & Associates, Inc.
ADDRESS:	CC Hayes Road	CONTACT:	Andrew Kiley
CITY/STATE/ZIP:	Purlear NC 28665	INQUIRY #:	802027.3s
LAT/LONG:	36.1986 / 81.2967	DATE:	June 20, 2002 2:38 pm

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID
Direction
Distance
Elevation

	Database	EDR ID Number
1 **West** **1 - 2 Miles** **Lower**	**NC WELLS**	**NC00004202**

Site Name:	NEW HOPE BAPT CH		
Public Water Sys. ID:	0197468	PWS Type:	Transient Non-community
Latitude:	361200.000	Longitude:	811940.000
Source Name:	WELL	Source Type:	Ground
Responsible Party Tel.:	(910) 973-4673	Source Availability:	Permanent
Retail Population:	322		

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Direction
Distance | Database | EDR ID Number

NC_NHEO **0021129**

Site ID:	0021129
Latitude / Longitude:	36.2250 / -81.2917
Classification by Type:	Natural Community Occurrence
Degree of Accuracy associated with coordinate:	Minutes
Occurrence Status: Extant	
State Status: Not Reported	

NC_NHEO **0091128**

Site ID:	0091128
Latitude / Longitude:	36.2250 / -81.2917
Classification by Type:	Natural Community Occurrence
Degree of Accuracy associated with coordinate:	Minutes
Occurrence Status: Extant	
State Status: Not Reported	

NC_NHEO **0012935**

Site ID:	0012935
Latitude / Longitude:	36.2250 / -81.2917
Classification by Type:	Natural Community Occurrence
Degree of Accuracy associated with coordinate:	Minutes
Occurrence Status: Extant	
State Status: Not Reported	

NC_NHEO **0051660**

Site ID:	0051660
Latitude / Longitude:	36.2250 / -81.2917
Classification by Type:	Natural Community Occurrence
Degree of Accuracy associated with coordinate:	Minutes
Occurrence Status: Extant	
State Status: Not Reported	

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

Federal EPA Radon Zone for WILKES County: 2

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for Zip Code: 28665

Number of sites tested: 2

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	1.500 pCi/L	100%	0%	0%
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	3.500 pCi/L	100%	0%	0%

PHYSICAL SETTING SOURCE RECORDS SEARCHED

HYDROLOGIC INFORMATION

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

HYDROGEOLOGIC INFORMATION

AQUIFLOW^R Information System

Source: EDR proprietary database of groundwater flow information

EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit

Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the national Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

ADDITIONAL ENVIRONMENTAL RECORD SOURCES

FEDERAL WATER WELLS

PWS: Public Water Systems

Source: EPA/Office of Drinking Water

Telephone: 202-260-2805

Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data

Source: EPA/Office of Drinking Water

Telephone: 202-260-2805

Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: In November 1971 the United States Geological Survey (USGS) implemented a national water resource information tracking system. This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on more than 900,000 wells, springs, and other sources of groundwater.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STATE RECORDS

North Carolina Wildlife Resources/Game Lands
Source: Center for Geographic Information and Analysis
Telephone: 919-733-2090
All publicly owned game lands managed by the North Carolina Wildlife Resources Commission and as listed in Hunting and Fishing Maps for North Carolina Game Lands, 1989-90.

North Carolina Rare/Endangered Species and Natural Areas
Source: Natural Heritage Occurrence Sites Center for Geographic Information and Analysis
Telephone: 919-733-2090

North Carolina Public Water Supply Wells
Source: Department of Environmental Health
Telephone: 919-715-3243

RADON

Area Radon Information
Source: EPA
Telephone: 303-236-1525
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 202-564-9370
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

Photo 1: Project area in (reach 4, foreground) and watershed (background).

Photo 2: View of the wetland restoration area adjacent to reach 4.

Photo 3: Downstream view of reach 4-(RDS-W2 in background), note downcutting and eroding banks

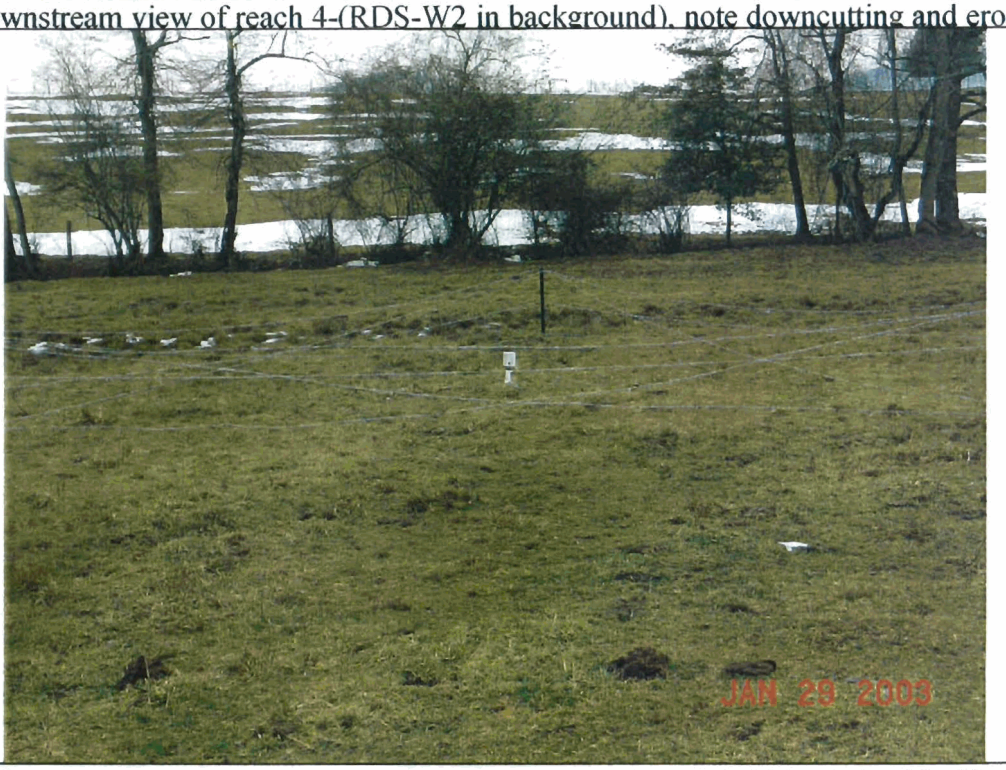


Photo 4: View of RDS-W1 monitoring location. Note straightened stream with minimal buffer in background.

Photo 5: Upstream view of reach 4 – Preservation Area, downstream from the wetland restoration area.

Photo 6: Downstream view of reach 4 – Preservation Area (note wetland seed source)

Photo 7: Wetland monitoring stations (RDS-W1 in foreground, RDS-W2 in background) adjacent to reach 4

Photo 8: Soil profile (hydric) at the RDS-W2 monitoring location.

COE Data Form: Routine Wetland Delineation

Project Site: Purlear Creek Phase II: Reach 4 wetland area Applicant/Owner: NC Wetland Restoration Program Investigator: Kimley-Horn and Associates, Inc.	Date: 1/29/2003 County: Wilkes State: North Carolina
Do Normal Circumstances exist on the site? Yes Is the site significantly disturbed (Atypical Situation)? Yes (cattle) Is the area a potential Problem Area? No (if needed, explain on reverse)	Community ID: Transect ID: Plot ID: RDS-W1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Fescue			9.		
2. Juncus spp.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-) 30 - 50%

Remarks: Area is maintained pasture in a wetter area adjacent to the stream. The vegetation is severely impacted from cattle intrusion and grazing.

HYDROLOGY

N/A
___ Recorded data (Describe in remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

N/A No recorded data available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators:
- X Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: Area was observed in January 2003 after a rainfall/snowmelt event. The area has some hydrology indicators, howev due to the proximity to the stream channel, and base elevation of the stream (down-cut 2 to 3 feet), it is not believed that the si will maintain wetland hydrology during the growing season.

Map Unit Name
(Series and Phase): Wehadkee
Taxonomy (subgroup): Fluvaquentic Endoaquepts

Drainage Class: somewhat poorly drained
Field Observations
Confirm Mapped Type? Yes [No]

Profile Description:

Depth (feet)	Horizon	Matrix Color (Munsell Moist)	Mottle Color (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structures, etc.
0-1.7	A	10 yr 4/1			Clay loam
1.7 – 2.2	B_1	10 yr 3/1			Sandy clay loam
2.2 - 2.8	B_2	10 yr 3/2			Loamy sand
2.8 – 4.0	C	10 yr 5/1			Sandy loam

Hydric Soil Indicators:

Primary Indicators:		Secondary Indicators:	
___	Histosol	___	Concretions
___	Hisoc Epipedon	___	High Organic Content in Surface Layer in Sandy Soils
___	Sulfidic Odor	___	Organic Streaking in Sandy Soils
x	Aquia Moisture Regime	x	Listed on Local Hydric Soils List
x	Reducing Conditions	___	Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors	___	Other (Explain in Remarks)

Remarks: There are many oxidized root channels in the upper surface. It is believed that the soil type is more appropriately described as Chewalca due to observed drainage characteristics (very poorly drained) and landscape position

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [No]
Wetland Hydrology Present? Yes [No]
Hydric Soils Present? [Yes] No

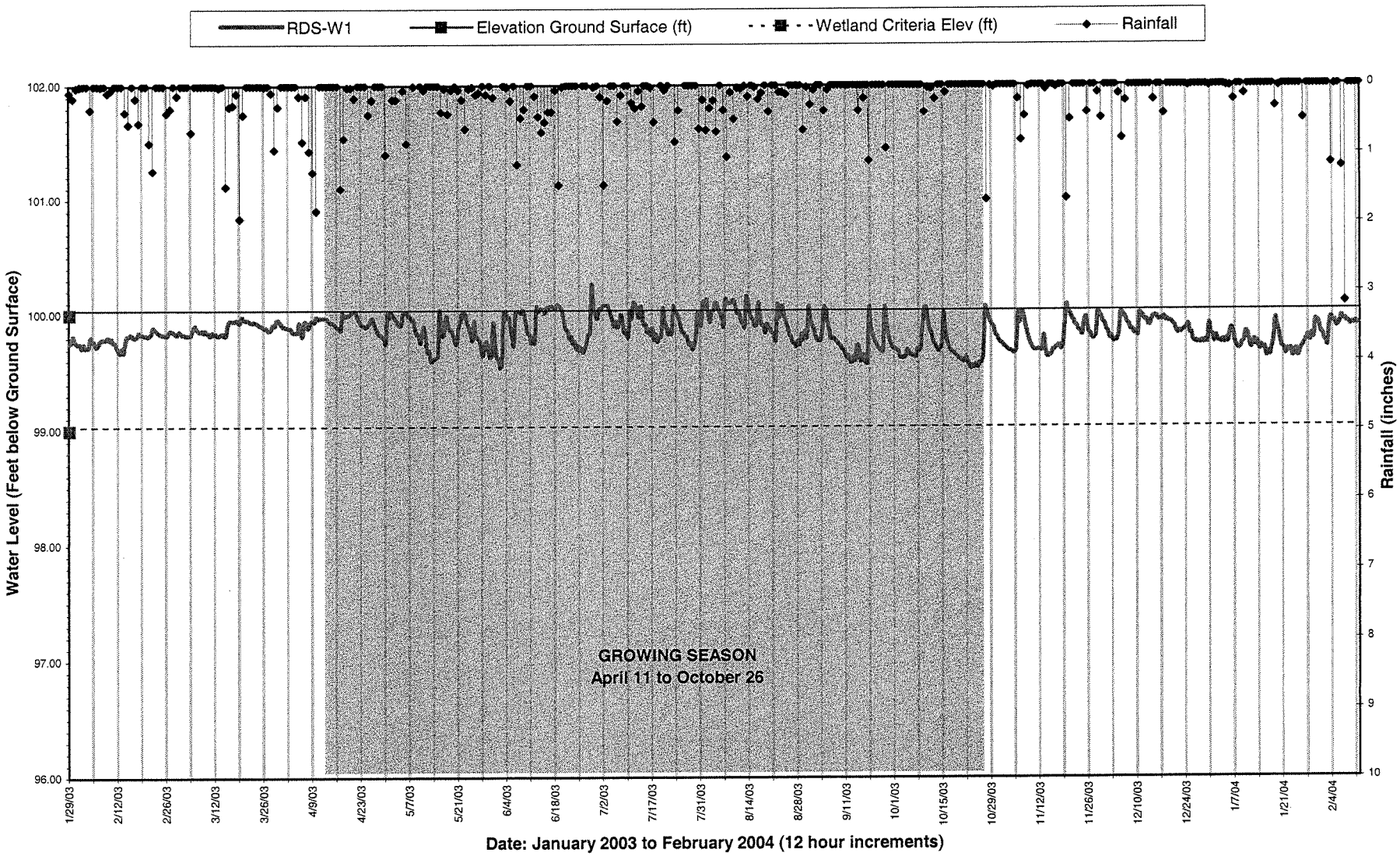
Is this Sampling Point Within a Wetland? Yes [No]

Remarks:

The area is an abandoned riparian wetland. Hydrology has been removed through the downcutting of the adjacent stream and altered soil surface (pasture).

Management for pasture and cattle grazing has removed hydrophytic vegetation.

Purlear Creek Wetland Restoration Monitoring Gage



COE Data Form: Routine Wetland Delineation

Project Site: Purlear Creek Phase II: Reach 4 wetland area Applicant/Owner: NC Wetland Restoration Program Investigator: Kimley-Horn and Associates, Inc.	Date: 1/29/2003 County: Wilkes State: North Carolina
Do Normal Circumstances exist on the site? Yes Is the site significantly disturbed (Atypical Situation)? Yes (cattle) Is the area a potential Problem Area? No (if needed, explain on reverse)	Community ID: Transect ID: Plot ID: RDS-W2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Fescue			9.		
2. Juncus spp.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-) 30 - 50%

Remarks: Area is maintained pasture in a wetter area adjacent to the stream. The vegetation is severely impacted from cattle intrusion and grazing.

HYDROLOGY

N/A Recorded data (Describe in remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

N/A No recorded data available

Field Observations:

Depth of Surface Water: 0 (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators:
- X Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: Area was observed in January 2003 after a rainfall/snowmelt event. The area has some hydrology indicators, howev due to the proximity to the stream channel, and base elevation of the stream (down-cut 2 to 3 feet), it is not believed that the si will maintain wetland hydrology during the growing season.

Map Unit Name (Series and Phase): Wehadkee Taxonomy (subgroup): Fluvaquentic Endoaquepts	Drainage Class: somewhat poorly drained Field Observations Confirm Mapped Type? Yes **No**

Profile Description:

Depth (feet)	Horizon	Matrix Color (Munsell Moist)	Mottle Color (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structures, etc.
0- 0.3	A	10 yr 3/2			Loam
0.3 – 1.0	A_2	10 yr 5/2	5 r 5/6	40%	Sandy loam
1.0 – 3.0	B	10 yr 6/1	10 yr 5/6 5 yr 5/6	20% 20%	Sandy clay
3.0 – 3.5	C	10 yr 6/1			Sandy clay

Hydric Soil Indicators:

Primary Indicators:	Secondary Indicators:
___ Histosol	___ Concretions
___ Hisoc Epipedon	___ High Organic Content in Surface Layer in Sandy Soils
___ Sulfidic Odor	___ Organic Streaking in Sandy Soils
_x_ Aquia Moisture Regime	_x_ Listed on Local Hydric Soils List
_x_ Reducing Conditions	___ Listed on National Hydric Soils List
_x_ Gleyed or Low-Chroma Colors	___ Other (Explain in Remarks)

Remarks: There are many oxidized root channels in the upper surface. It is believed that the soil type is more appropriately described as Chewalca due to observed drainage characteristics (very poorly drained) and landscape position

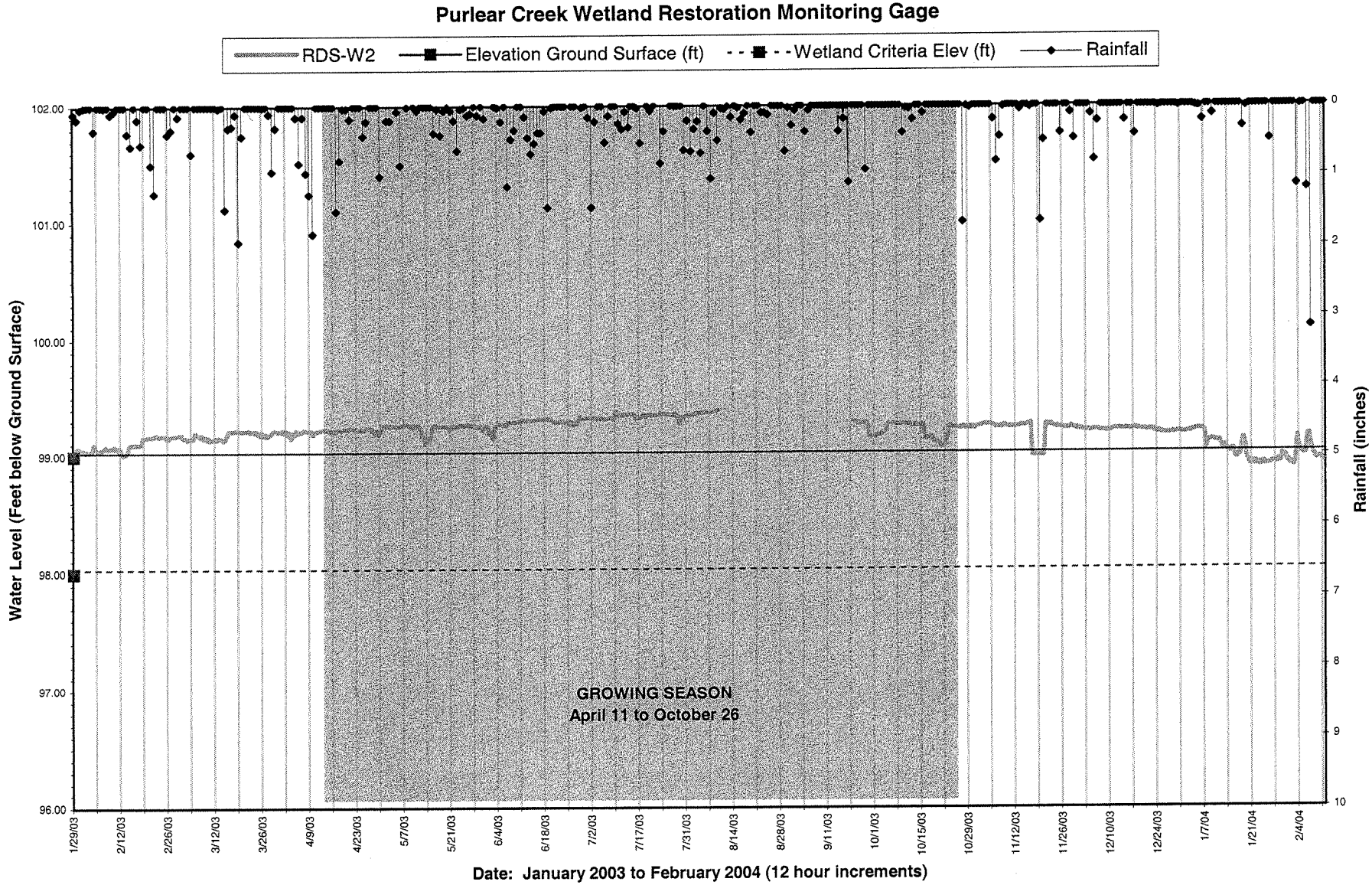
WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes **No**	
Wetland Hydrology Present?	Yes **No**	
Hydric Soils Present?	**Yes** No	Is this Sampling Point Within a Wetland? Yes **No**

Remarks:

The area is an abandoned riparian wetland. Hydrology has been removed through the downcutting of the adjacent stream and altered soil surface (pasture).

Management for pasture and cattle grazing has removed hydrophytic vegetation.


Purlear Creek Wetland Restoration Monitoring Gage
RDS-W2
Elevation Ground Surface (ft)
Wetland Criteria Elev (ft)
Rainfall
Water Level (Feet below Ground Surface)
Rainfall (inches)
102.00
101.00
100.00
99.00
98.00
97.00
96.00
0
1
2
3
4
5
6
7
8
9
10
GROWING SEASON
April 11 to October 26
1/29/03
2/12/03
2/26/03
3/12/03
3/26/03
4/9/03
4/23/03
5/7/03
5/21/03
6/4/03
6/18/03
7/2/03
7/17/03
7/31/03
8/14/03
8/28/03
9/11/03
10/1/03
10/15/03
10/29/03
11/12/03
11/26/03
12/10/03
12/24/03
1/7/04
1/21/04
2/4/04
Date: January 2003 to February 2004 (12 hour increments)

Kimley-Horn and Associates, Inc.

Job Parker Wetland Subject Hydrology Sheet No. ____ of ____
Designed by Will W. Date ____ Checked by ____ Job No. ____ Date ____

HYDROLOGY

Reach #4

D.A = 0.15 sq miles [in restoration Area) = 96 ac

from NCDOT C2002 [attached]

Hydraulic contour = 6

Q_{50} = 80 cfs
Q_{100} = 97 cfs
Q_5 = 31 cfs
Q_{10} = 43 cfs
Q_{25} = 61 cfs

$Q_{Bankfull}$ = 22-23 cfs ↑ may be high

* Based on local curve & field indicators
$Q_{bankfull}$ = 8 - 13 cfs

Using Rural Regression

Blue Ridge Piedmont * ∈ use

Q_2 = 144 DA	0.691	=	38 cfs
Q_5 = 248 DA	0.670	=	69 cfs
Q_{10} = 334 DA	0.665	=	95 cfs
Q_{25} = 467 DA	0.655	=	135 cfs
Q_{50} = 581 DA	0.650	=	170 cfs
Q_{100} = 719 DA	0.643	=	212 cfs

∴ So currently the 25 year storm [4% chance of occuring] inundates the wetlands

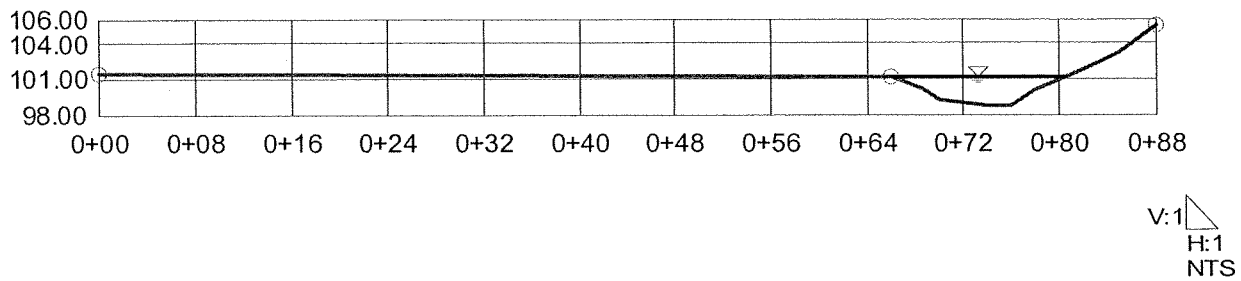
∴ Based on proposed design [priority 1] the ≈ 1.5 year storm will flow out bank and into the wetland the 1.5 year storm event has a 67% chance of happening in a given year

Existing Stream (Reach 4)
Cross Section for Irregular Channel

Project Description	
Worksheet	Wetland Reacl
Flow Element	Irregular Chanı
Method	Manning's Forı
Solve For	Discharge

Section Data		
Mannings Coefficie	0.040	
Channel Slope	0.016500	ft/ft
Water Surface Elev	101.10	ft
Elevation Range	.70 to 105.50	
Discharge	125.26	cfs

← Currently flows greater than 125.2 ≈ 25 yr Storm flow into wetland



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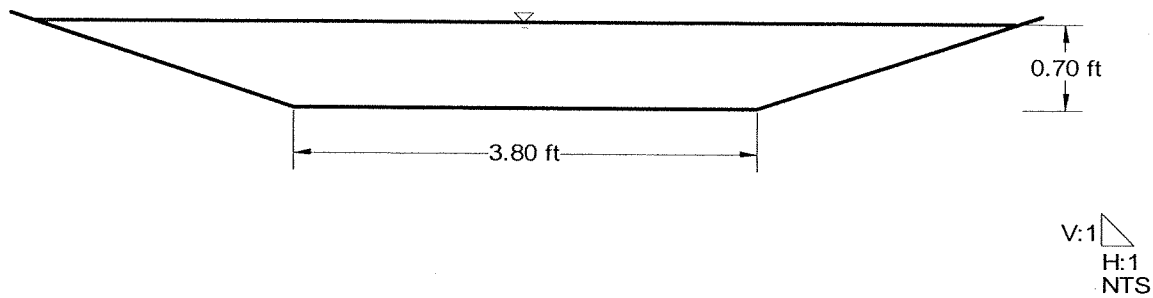
Proposed Bankfull Channel (Priority I)
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Proposed
Flow Element	Trapezoidal Cha
Method	Manning's Formu
Solve For	Discharge

Section Data		
Mannings Coeffic	0.040	
Channel Slope	013000	ft/ft
Depth	0.70	ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	3.80	ft
Discharge	11.05	cfs

← flow above 11.05 [Bankfull Q] will flow into wetland



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