Dog Bite Site
Stream Restoration Plan

Mitchell County, North Carolina

State Contract No. D06056-A

Prepared for:
North Carolina Ecosystem Enhancement Program

July 2008

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KCI Project No. 12065439

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EXECUTIVE SUMMARY

The Dog Bite Site (DBS) is a full-delivery stream mitigation project located in central Mitchell County, North Carolina. The project site is situated within the French Broad Basin in the 06010108 8-digit hydrologic unit code and the North Carolina Division of Water Quality Subbasin 04-03-06. The project watershed is located in a rural setting within the Southern Crystalline Ridges and Mountains ecoregion of the Blue Ridge physiographic province.

The DBS is made up of 3,718 existing linear feet of stream. The primary hydrologic feature on the site is White Oak Creek (WOC), of which there is 3,068 existing linear feet. The site also includes two tributaries to WOC. Tributary 1 (T1) is 431 existing linear feet and enters WOC on the eastern side of the site. Tributary 2 (T2) is 219 existing linear feet and enters WOC near the center of the site from the south. WOC drains to Cane Creek, which then flows into the North Toe River. The project watershed is 0.54 square mile (342 acres).

Historic aerial photographs are available for the site from the years 1956, 1982, 1993, and 1998. Prior to 1956 the site had been partially cleared along the project streams. From 1956 to 1982, the DBS was further cleared for pasture. Between 1982 and 1993, two ponds were created to support the dairy operation, but there was no further forest clearing.

The site was a dairy farm in the past and is now used for both Christmas tree farming and livestock grazing. The construction of two ponds on the site resulted in WOC being channelized around the ponds. All of the project streams have been impacted by livestock, land clearing, and channelization. These impacts have resulted in portions of the project streams having bank erosion, areas of incision, poor bed variability, and low sinuosity. Certain project reaches have at least a partially vegetated riparian zone, while other reaches do not have a riparian zone at all. Overall, the DBS streams are in varying degrees of instability.

The DBS offers the opportunity to restore a significant headwater system. By developing a healthy, interconnected riparian corridor, the site will also help to reduce nutrient and excess sediment inputs. This is especially significant, because the site is classified as a Trout Water stream and is a tributary to Cane Creek. The proposed project reaches were designed as restoration or enhancement based on the level of departure from a stable stream system. The streams at the DBS will be restored to B channels, although C channels will exist in isolated areas where there is an existing floodplain. Riparian vegetation at the DBS site will be restored using Montane Oak-Hickory Forest species.

The project goals are to:

- Improve water quality with reduced nutrient and sediment levels.
- Create high-quality aquatic and terrestrial habitat.

In order to meet these goals, the following objectives must be accomplished:

- Plant a functional Montane Alluvial Forest community along with a Montane Oak-Hickory Forest to create an effective riparian buffer.
- Arrest bed elevation lowering and stream widening.
- Create in-stream habitat by restoring a profile with defined pools and adding dead woody debris habitat structures.
- Stop bank erosion by developing the appropriate channel dimension and by stabilizing with vegetation.
- Remove the livestock waste pond adjacent to the stream.
- Exclude livestock from the riparian areas with fencing.

Project success will be assessed by utilizing measurements of stream dimension, pattern, and profile; site photographs, and vegetation sampling. The monitoring report format will be similar to that set out in the most recent EEP monitoring protocol. Monitoring shall be conducted annually for a total period of five years or until the project meets its success criteria.

Mitigation Summary

Reach	Existing Stationing	Proposed Stationing	Mitigation Type	Priority Approach	Existing Linear Footage	Designed Linear Footage
WOC-1	10+00-12+54	10+00-12+54	Enhancement I	-	254	254
WOC-2	12+71-19+19	12+71-19+25	Restoration	P3	633	639
WOC-3	19+19-22+68	19+25-22+74	Enhancement I	-	349	349
WOC-4	22+82-36+71	22+88-36+31	Restoration	P3	1,374	1,325
WOC-5	36+71-41+29	36+31-40+89	Enhancement I	-	458	458
T1-1	50+00-50+95	50+00-50+95	Enhancement I	-	95	95
T1-2	50+95-54+48	50+95-54+69	Restoration	P3	336	359
T2	60+00-62+19	60+00-62+57	Restoration	P3	219	257
				Total	3,718	3,736
					Total Proposed Stream Enhancement I	**1,156**
					Total Proposed Stream Restoration	**2,580**

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1.0 INTRODUCTION

The Dog Bite Site (DBS) is a full-delivery stream mitigation project being developed for the North Carolina Ecosystem Enhancement Program (EEP). This restoration plan presents detailed information about the existing site and watershed conditions, the morphological design criteria, and the project design parameters based upon natural channel restoration methodologies.

2.0 PROJECT SITE IDENTIFICATION AND LOCATION

2.1 Directions to Project Site

The DBS is located southeast of Bakersville in central Mitchell County and its location is shown in Figure 1. The center of the site is situated at approximately 35.9956 degrees north and –82.1302 degrees west (WGS1984). The project area is located at the center of the United States Geological Survey (USGS) Quadrangles Bakersville, Carvers Gap, Spruce Pine, and Micaville.

To reach the site from Raleigh, begin by proceeding west on I-40 for approximately 200 miles. Then take Exit 86 for NC-226 toward Shelby/Marion. Take a right onto NC-226, traveling north. Follow NC-226 through Marion and Spruce Pine. Just before reaching Bakersville, make a right onto White Oak Road. Follow White Oak Road for approximately 1.5 miles and then make a left onto Wilson Dairy Road. The road will dead end at the Wilson property and the DBS is on the left.

2.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

The project site is situated within the French Broad Basin in the 06010108 8-digit hydrologic unit code (HUC) and the 06010108040010 14-digit HUC. This 14-digit HUC is not a Targeted Local Watershed as identified by the EEP. The site is found within the North Carolina Division of Water Quality (DWQ) Subbasin 04-03-06.

3.0 WATERSHED CHARACTERIZATION

The project watershed is located in a rural setting within the Southern Crystalline Ridges and Mountains ecoregion of the Blue Ridge physiographic province (Figure 2). The topography within this ecoregion is characterized by rough dissected ridges and valleys (Griffith et al. 2002). Elevations within the project watershed range from 4,000 feet above mean sea level (AMSL) at the top of the drainage to 2,700 feet AMSL where WOC leaves the project site.

3.1 Project Drainage Area

The project streams all drain into White Oak Creek (WOC) (Figure 3), which then flows into Cane Creek and ultimately into the North Toe River. Tributaries 1 and 2 have 0.08 square mile (48 acres) and 0.07 square mile (46 acres) drainages, respectively. The DBS has a total drainage area of 0.54 square mile (342 acres) and shares a portion of its southern boundary with the 14-digit HUC.

3.2 Water Surface Classification/Water Quality

The NCDWQ assigns surface waters a classification in order to help protect, maintain, and preserve water quality. WOC from its source to Cane Creek has a classification of Class C with a supplemental classification of Trout Waters (NCDENR DWQ, 2008a).

- **Class C Waters** in North Carolina are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and other uses suitable for Class C. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner. There are no restrictions on watershed development or types of discharges.
- **Trout Waters** is a supplemental classification intended to protect freshwaters for natural trout propagation and survival of stocked trout. This designation affects wastewater quality but not the type

of discharges and there are no watershed development restrictions except stream buffer zone requirements by the NC Division of Land Resources (NCDENR DWQ, 2008b).

None of the project streams or streams immediately downstream of the site are currently designated as impaired under Section 303(d) of the Clean Water Act (NCDENR, DWQ 2008c).

3.3 Geology and Soils

The underlying rocks at the site include metamorphic rocks of the Ashe Metamorphic Suite and Tallulah Falls Formation. The member of the group present at the site is the Muscovite-biotite gneiss, which is described as locally sulfidic; interlayed and gradational with mica schist, minor amphibolite and hornblende gneiss (NCDENR, NCGS 1985).

The Soil Survey of Mitchell County shows that the primary soil series at the project site are Bandana, Dellwood-Reddies and Thunder-Saunook as shown in Figure 4 (USDA, NRCS 2004). Bandana sandy loam is described as a deep, somewhat poorly drained soil that occurs within valleys of mountains and intermountain hills on floodplains. Dellwood-Reddies complex is a very deep, moderately well drained soil that occurs within valleys of mountains and intermountain hills on floodplains dominantly at the upper end of mountain valleys. The third soil series present is the Thunder-Saunook complex that has 15 to 30 percent slopes and is very bouldery. The soil is very deep and well drained. The Thunder-Saunook occurs on intermountain hills and low intermediate mountains on coves, colluvial fans, drainageways and benches.

3.4 Historical Land Use and Development Trends

3.4.1 Historical Resources

Historic aerial photographs were obtained from the Mitchell County Natural Resources Conservation Service (NRCS) office, the USGS Earth Explorer, and USGS digital orthoquadrangles in order to assess the existing and historic site conditions. A review of the site history helps to understand the chronology of land disturbance and aid in the development of an appropriate restoration strategy. The historic aerial photographs are located in Appendix A.

Historic aerial photographs are available for the site from the years 1956, 1982, 1993, and 1998. By 1956, most of the forest surrounding the stream had been cleared and there was a thin riparian buffer left along some parts of the stream. From 1956 to 1982, the DBS was further cleared for pasture, with most of the clearing taking place on the eastern side of the site. At this point all of the forest along the project reaches had been cleared. Between 1982 and 1993, two ponds were created to support the dairy operation, but there was no further forest clearing. The 1998 aerial shows the site looking similar to the previous aerial. Overall, the watershed has changed minimally from 1956 to 1998, remaining mostly forested.

3.4.2 Land Use and Development Potential

The DBS site is located solely on one property. In the past the property had been used as a dairy farm. Dairy operations ended in 1996 and since then most of the property has been put into Christmas tree cultivation. Using an Anderson Level I classification, the predominate land uses in the project watershed consist of 2% agriculture, 80% forest, 17% pasture, and less then 1% wetland, open water, and urban or built-up land (See Table 2 and Figure 5) (McKerrow 2003). The surrounding area is rural with low development pressure.

3.5 Endangered/Threatened Species

A formal review by the North Carolina Natural Heritage Program (NHP) was requested in July 2006 to identify the presence of rare species, critical habitats, and priority natural areas on the project site and to determine the potential impact of the proposed project on these resources. In their letter dated August 1,

2006, the NHP indicated "no record of rare species, significant natural communities, or significant natural heritage areas at the site nor within a mile of the project area". In addition, no threatened or endangered species were identified in the project area during the existing conditions site assessment.

3.6 Cultural Resources

To evaluate the presence of significant cultural resources on the subject property and any potential to impact these properties, KCI requested in July 2006 a formal review by the North Carolina Department of Cultural Resources, State Historic Preservation Office (SHPO). The formal SHPO review letter dated August 30, 2006 determined that "the project as proposed will not affect any historic structures." SHPO also recommended that KCI conduct a formal archeological survey of the site. The site survey conducted by a KCI archeologist concluded that "the site has a very low likelihood of impacting any intact archeological resources." Following the archeological site survey, SHPO's letter dated October 23, 2006 recommended that no further archeological investigation be conducted.

3.7 Potential Constraints

The site was evaluated for any site constraints that have the potential to hinder a successful mitigation project. Below is a description of any potential issues that may affect the project's success.

3.7.1 Property Ownership and Boundary

The proposed restoration project is located on one parcel (Mitchell County PIN 0873-00-61-3570) owned by June Wilson. KCI has facilitated the purchase of a conservation easement on the site, which has been transferred to the State of North Carolina (see Appendix B). The conservation easement will protect the project streams in perpetuity.

3.7.2 Site Access

The site is located on Wilson Dairy Road as shown in Figure 1. Once on Wilson Dairy Road, the site can be accessed at the end of the road where there is a house and horse stables.

3.7.3 Utilities

There are no utilities mapped on the project site.

3.7.4 FEMA/Hydrologic Trespass

No portion of the site is located in a significant flood hazard area as recognized by the Federal Emergency Management Agency (FEMA). A portion of WOC is found on FEMA Map 37121C0076 C (Mitchell County Flood Insurance Study, Effective September 2, 1988) and is shown as Zone X.

The proposed restoration is not anticipated to produce hydrologic trespass conditions on the existing property or on any neighboring properties.

4.0 PROJECT SITE STREAMS (EXISTING CONDITIONS)

The DBS is made up of 3,718 existing linear feet of WOC and its two tributaries (T1 and T2). WOC has 3,068 existing linear feet on the project site and flows from east to west across the property. There are 431 existing linear feet in T1 and 219 existing linear feet in T2. T1 enters WOC toward the eastern end of the project and T2 enters WOC near the middle of the project. The existing site conditions and site assessment locations for cross-sections and longitudinal profiles are shown in Figure 6. The project site photographs (Appendix C) show the current conditions at the DBS and the existing conditions data (Appendix D) summarize the site assessment.

4.1 General Site Description

The project streams have been impacted in a number of different ways. Cattle impacts from the closed dairy operation and channelization have created varying levels of unstable stream conditions throughout

the site. At the beginning of the project, just downstream of a stable ford crossing, Reach 1 of WOC (WOC-1) begins where WOC flows out of the forest. This reach is characterized by a long series of riffles and runs and lacks stable pool features. WOC-1 has been modified as indicated by the spoil piles running adjacent to both sides of the stream. The reach appears vertically stable with a gravel and cobble bed, but the banks along this reach exhibit varying levels of stability, with some banks being undercut and actively eroding. This reach ends at a stable ford crossing near Station 12+54. After the ford crossing, Reach 2 begins (WOC-2). WOC-2 has also been channelized and spoil piles run parallel to the channel along both banks. This portion of the stream feeds an irrigation pond that is located in the relict stream channel. There is a six-inch gravity fed PVC pipe that enters the pond from the stream at Station 13+55. When the pond was constructed the stream was channelized around the right side of the pond. This section of stream has become incised and has an artificially low width to depth ratio. WOC-2 also does not have a well vegetated riparian buffer and lacks a natural stream pattern. Similar to WOC-1, WOC-2 is dominated by riffle and run features and does not have any pools to provide aquatic habitat diversity. The pond flows out of a riser that is built immediately downstream of the pond. The flow from the riser spills out onto a concrete slab and then flows back into WOC-2 at Station 17+50. Downstream of the pond, WOC-2 is still characterized by a sparse riparian buffer and lacks a natural stream pattern; the stream has also become more incised than at the beginning of the reach.

Reach 3 (WOC-3) begins at Station 19+19 where WOC flows into a slightly more wooded area that is characterized by small groups of tag alder (*Alnus serrulata*) and some larger trees that provide shade to the channel. This reach is confined by the valley wall on the north side of the stream. WOC-3 is less incised than the previous reach and also has a larger width to depth ratio, indicating that it is slightly more stable than WOC-2. The unstable areas of WOC-3 are characterized by poorly defined banks in some areas and eroding banks in others. Like the previous reaches, this reach lacks any deep water habitat that would be provided by pools. There is a seep entering from the southern hillside that contributes a small amount of flow to the stream near Station 21+85. The downstream half of WOC-3 leaves the cover of the canopy and ends at a ford crossing.

Reach 4 (WOC-4) begins after the ford crossing at Station 22+82. After the ford, livestock have unrestricted livestock access to the stream. WOC-4 has experienced considerable bank and bed damage. There is no riparian vegetation and sediment and nutrient inputs to the stream are high. At the beginning of the reach, the stream steepens and is constrained between a pond berm on the left and the valley wall on the right. The pond on the left side of the stream is a waste lagoon from the former dairy operation. This portion of the reach has been channelized, is incised, lacks a riparian buffer, and has poor aquatic habitat diversity. Downstream of the pond there is another ford crossing and WOC-4 flows into a wider valley bottom. Here WOC-4 has two well defined, but unstable meanders. The first meander is characterized by a steep grade with cascading drops over the cobble bed. The second meander is confined by a twelve-foot tall shear embankment as the stream flows into the valley wall. After these two meanders, the stream alternates between sections where it is confined and incised to sections where the valley bottom is wider and the stream is adjacent to an abandoned terrace. The riparian buffer of WOC-4 becomes brushier and widely-spaced large trees become more frequent as the stream flows west.

The last reach of the project stream (WOC-5) begins at Station 36+71. The valley becomes wider at the downstream end of the project and there is a terrace that is present throughout most of this reach. The riparian buffer is also more developed in this reach as it is interspersed with trees that provide partial shade to the stream. WOC-5 exhibits some variability in the stream pattern, but lacks a diverse stream bed. The stream cross-section is not well defined in areas and its dimension is not consistent throughout the reach. In some instances, WOC-5 has become over-widened as evidenced by large mid-channel bars. WOC-5 is the last reach along WOC and the stream exits the project site at Station 41+25.

In addition to WOC, the DBS has two tributaries, both first order perennial hydrologic features. T1's first reach (T1-1) begins at Station 50+00 in a sparsely forested area. This reach is incised and lacks pool habitat. T1-1 quickly leaves the forest canopy and the second reach (T1-2) begins at Station 50+95. This reach was channelized through high ground to the current location of its confluence with WOC at Station 14+40. As the channel has begun to fill in over the years, T1-2 has developed diffuse flow and there is not a defined channel until approximately 90 feet before the confluence with WOC. Some of the flow coming down T1 diverges from the channelized path and seeps to the location of T1's original flowpath, which has its confluence with WOC near Station 16+00. Due to the lack of a defined channel on T1-2, there is no stream habitat connection between T1-1 and WOC. There is also no riparian buffer along T1-2; the reach is in an overgrown field without any canopy cover.

T2 begins at Station 60+00. This tributary enters the DBS from a pipe under Wilson Dairy Road. As the stream exits the pipe, it enters an active livestock grazing area where there is no riparian vegetation and the stream banks have been trampled and have eroded away. The reach quickly flows from an area with minimal stream banks to an incised channel with eroding banks and no riparian vegetation. T2 is a steep reach that loses significant elevation as it flows down the side of the valley and joins WOC at Station 27+44.

4.2 Channel Stability Assessment

A qualitative stability assessment was performed to estimate the level of departure from a stable stream system and determine the likely causes of any channel disturbance. This assessment facilitates the decision-making process with respect to restoration alternatives and establishing goals for successful restoration.

At the start of WOC-1, the stream is not incising, due to the compact cobble bed, but it is experiencing areas of bank erosion as the stream widens. Erosion has primarily been caused by the lack of floodprone area, a result of berms along both sides of the channel. Riffles and runs are evident features along this reach, but there are no pools. The lack of pools along all of WOC does not allow for adequate energy dissipation from the normal flow, which ultimately causes more bank erosion and unstable flows. The bank height ratios along this reach are between 3.0 and 4.0.

WOC-2 exhibits more instability than WOC-1 because it has been straightened and channelized and there is less riparian vegetation. Where the stream was channelized around the irrigation pond, the stream has a bank height ratio of between 1.6 and 2.6, is narrow, deep and slowly widening, leading to eroding banks. Downstream of WOC-2, WOC-3 has the stabilizing benefit of dispersed riparian vegetation, but is still undergoing isolated areas of widening and incision and lacks a defined riffle-pool sequence. WOC-3 has a bank height ratio of 3.8.

Portions of WOC-4 have unrestricted livestock access, which has contributed to bank and bed degradation. The reach's instability is also due to the fact that the upper portion of WOC-4 is confined in a narrow portion of the valley and is channelized around a steep pond berm. The stream continues down the valley where there is riparian vegetation, but still a natural stream pattern. While these two factors would normally contribute to stability, the steep grade of the valley and lack of pools continues to cause instability, leading to bank erosion and poor habitat diversity. This reach has a range of bank height ratios between 1.8 and 3.7.

WOC-5 has a more established riparian buffer and a larger width to depth ratio than the previous reaches. As a result, WOC-5 has less bank erosion and a slightly more stable cross-section. However, due to the increased channel width, poorly defined banks, and a lower channel slope, there is a greater accumulation of fine materials, which has created mid-channel bars. The bank height ratio of this reach ranges from 1.4 to 3.1.

The two tributaries are both unstable, but they are in different evolutionary stages. T1 and T2 have bank height ratios of 3.6 and 4.2, respectively. T1-1, while in a more forested area, is experiencing incision and widening, as evidenced by the undercut trees on the stream banks. Once T1 leaves the tree line, the channelized stream has filled in and does not have a defined flow path. The instability on T2 has been caused by livestock and the lack of riparian vegetation. T2 has extensive bed and bank degradation due to these two disturbances.

4.3 Bankfull Verification

The standard methodology used in natural channel design is based on the ability to select the appropriate bankfull discharge and generate the corresponding bankfull hydraulic geometry from a stable reference system. The determination of bankfull stage is the most critical component of the natural channel design process.

Bankfull can be defined as "the stage at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of the channels" (Dunne and Leopold 1978). Several characteristics that commonly indicate the bankfull stage include breaks in slope, changes in vegetation, highest depositional features (i.e. point bars), and highest scour line. The identification of bankfull stage, especially in a degraded system, can be difficult. Therefore, the following verification measures were undertaken to facilitate the correct identification of the bankfull stage on the DBS.

Using pressure transducer stream gauges, stream stage data were collected at two locations on the DBS: Gauge 1 immediately upstream of WOC-1 at a stable riffle and Gauge 2 on WOC-2 at Station 20+90. Data were collected for 10 months (July 2007 through April 2008.) Water levels were correlated to an estimated discharge using a rating curve generated for each gauged section. Over the course of the monitoring period the stream gauges showed that the stream stage changed minimally. These data reveal the consistency of the baseflow. The minor variations in the stream discharge indicate that bankfull events occur less frequently at the DBS than in comparable watersheds. This can be attributed to the strong influence of groundwater in this system and the well forested watershed upstream that intercepts a large amount of the precipitation.

Regional geometry relationships are typically utilized in ungauged areas to approximate bankfull discharge, area, width, and depth as a function of drainage area based on interrelated variables from other similar streams in the same hydrophysiographic province. The regional relationships for the rural mountains of North Carolina were used to verify the bankfull discharges in the project reaches (Harman et al. 2000). Based on the project's drainage areas, the following bankfull discharges were calculated for the project streams: 63 cfs for WOC, 14 cfs for T1, and 14 cfs for T2. However, these calculations should be used with caution because the smallest drainage area used in the regional geometry regression to relate drainage area and discharge was 2 square miles. Also, only one of the streams used in the regression had a slope greater than 2.5%.

A HEC-HMS (Hydrologic Modeling System) model was developed for the DBS watershed. This type of model is designed to simulate the precipitation-runoff processes of dendritic watershed systems. For the DBS, four subbasins were delineated for the model. Various rain events were simulated within the model to evaluate the discharge associated with each event. For design purposes, a two-year rain event was used to approximate an event that would create bankfull conditions. This event generated much lower discharges than the regional curve relationships, 23 cfs for WOC and 3 cfs for both T1 and T2. These discharges were used to evaluate the design discharge.

These bankfull verification methods produced a range of bankfull discharge estimates for the DBS. Each of these methods were examined and evaluated to ascertain which data were the most reliable and consistent with our knowledge of the site. The methods that were site specific - the on-site gauges, the HEC-HMS model, and the in-stream bankfull indicators - had the most influence when determining the design discharges. A combination of these methods produced a design discharge for WOC of approximately 40 cfs and for the two tributaries of 14 cfs.

4.4 Vegetation

The immediate valley surrounding the project streams has been cleared of trees; woody vegetation remains along riparian corridors in varying age classes and densities. Because of previous impacts to the existing forest stands, no distinct vegetative communities exist on the site. Below is a description of the distribution of common plant species across the DBS.

Along WOC, the riparian corridor contains a mixed community of northern red oak (*Quercus rubra*), sycamore (*Plantanus occidentalis*), black walnut (*Juglans nigra*), white oak (*Quercus alba*), tulip poplar (*Liriodendron tulipifera*), pussy willow (*Salix discolor*), black willow (*Salix nigra*), river birch (*Betula nigra*), black birch (*Betula lenta*), yellow birch (*Betula alleghaniensis*), eastern white pine (*Pinus strobus*), yellow buckeye (*Aesculus octandra*), red maple (*Acer rubrum*), wild hydrangea (*Hydrangea arborescens*), multiflora rose (*Rosa multiflora*), tag alder (*Alnus serrulata*), and green ash (*Fraxinus pennsylvanica*).

During construction, the number of mature trees removed from the existing riparian areas will be minimized as much as possible. Any valuable trees that may provide immediate shade to the restored channel will be left in place if feasible. In the enhancement areas, certain trees may be able to remain on one bank if the opposite bank can be reshaped to accommodate the appropriate dimension for the stream.

5.0 REFERENCE SITES

A reference reach is a channel with a stable dimension, pattern, and profile within a particular valley morphology. The reference reach is used to develop dimensionless morphological ratios (based on bankfull stage) that can be extrapolated to disturbed/unstable streams to restore a stream of the same type and disposition as the reference stream (Rosgen 1998). For this project, two reference reaches were used to design the proposed restoration reaches: an unnamed tributary to Fisher River in Surry County, North Carolina (see Appendix E for detailed reference reach data) and an onsite reference. The stable cross-sections immediately upstream of the project stream will serve as dimensional references. In addition to working within the existing site constraints, UT to Fisher River will serve as the basis for designing the planform of the restored stream.

5.1 UT to Fisher River Reference Site

An unnamed tributary to Fisher River (UTFR), a first order rural stream in Surry County, was selected as a reference reach for the restoration of the project streams (Figure 7). The reference reach is located on Fisher Valley Road off of Exit 93 from Interstate 77. The valley slope is approximately 1.6%. The sediment distribution and transport are similar to the project streams. The local topography is characterized by rolling hills. Approximately 300 linear feet of UTFR was surveyed and was classified as a B4c channel.

UTFR flows northeast into Fisher River and drains approximately 0.38 square mile of predominantly forested land with a small section of rangeland (Figure 8). The reference reach watershed is within the Northern Inner Piedmont ecoregion in the Piedmont physiographic province. The site is in the 14-digit hydrologic unit 03040101090010 in the Yadkin Basin and is in the DWQ Subbasin 03-07-02. The reference reach watershed elevations range from 1,420 feet AMSL at the headwaters of the site to 1,210 at the bottom of the reference reach.

5.2 White Oak Creek Reference Site

A short reach of White Oak Creek, upstream of the project site, was surveyed by KCI in August 2007 (Appendix H). The valley slope is approximately 8.0%. The sediment distribution and transport are the same as the project streams. A stable riffle cross-section was surveyed and classified as a B4a channel to be used as a dimensional reference.

5.3 Reference Vegetative Communities

There are two communities described by Schafale and Weakley that are representative of reference systems appropriate for the DBS site (1990).

The natural community identified as representative of the streamside areas was the Montane Alluvial Forest. This community type is described as existing along river and stream floodplains at moderate to high elevations in more isolated patches when compared to broader floodplain forests. The canopy species that are typically found within a Montane Alluvial Forest include eastern hemlock (*Tsuga canadensis*), sycamore, yellow birch, white oak, red maple, tulip poplar, and river birch. Species that dominate the understory are ironwood (*Carpinus caroliniana*), witch hazel (*Hamamelis virginiana*), and black willow. Typical shrubs include rhododendron (*Rhododendron maximum*), tag alder, and doghobble (*Leucothoe fontanesiana*) (Schafale and Weakley 1990).

Montane Oak-Hickory Forest was identified as the community type appropriate for stream valleys and slopes leading away from small stream floodplains. Typical species found in the Montane Oak-Hickory Forest canopy include white oak, northern red oak, chestnut oak (*Quercus prinus*), mockernut hickory (*Carya alba*), pignut hickory (*Carya glabra*), tulip poplar, and red maple. The understory layer commonly has flowering dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), red maple, black gum (*Nyssa sylvatica*) and serviceberry (*Amelanchier arborea*). Typical shrubs include rhododendron (*Rhododendron maximum*), *Vaccinium spp.*, maple leaf viburnum (*Viburnum acerifolium*) and witch hazel (Schafale and Weakley 1990).

6.0 PROJECT SITE RESTORATION PLAN

6.1 Restoration Project Goals and Objectives

The DBS has experienced degradation along all of its reaches from livestock, the removal of upland and riparian vegetation, pond construction, and channelization. These impacts have left the streams with unstable banks, incised streambeds, inappropriate planform, and poor bed variability. There is considerable potential to improve and protect this headwater system and provide an interconnected assemblage of aquatic and terrestrial habitat upstream of important trout waters.

Based on these site-specific conditions, the restoration goals for the DBS are as follows:

- Improve water quality with reduced nutrient and sediment levels.
- Create high-quality aquatic and terrestrial habitat.

In order to meet these goals, the following objectives must be accomplished:

- Plant a functional Montane Alluvial Forest community along with a Montane Oak-Hickory Forest to create an effective riparian buffer.
- Arrest bed elevation lowering and stream widening.
- Create in-stream habitat by restoring a profile with defined pools and adding dead woody debris habitat structures.
- Stop bank erosion by developing the appropriate channel dimension and by stabilizing with vegetation.
- Remove the livestock waste pond adjacent to the stream.

- Exclude livestock from the riparian areas with fencing.

6.1.1 Design Approach

When approaching the design for the DBS, the project objectives were balanced against the existing site constraints. Below is a description of the site-specific approach used for the design for the DBS.

One of the major site constraints is the valley topography at the DBS. The valley slope varies in steepness and in many places confines the existing and potential restored planform. The overall approach to the design of WOC is a combination of Priorities 2 and 3 restoration (Rosgen 1997). This will involve creating a new stream profile and dimension and a bankfull bench that will tie into the valley side. Where WOC currently is confined by the upstream pond, the new planform will move the stream away from the pond to allow for a greater flood prone area on both sides of the stream. To account for the steep slopes of the reaches on WOC (from 3.3% to 7.5%), the design will include frequent grade control structures that will mimic the natural step pool sequences found in streams of this type. These step pools will create the deep water habitat that the stream is currently lacking. While there will be planform adjustments in the restoration reaches, many of these adjustments will be minor due to confinement within the valley and the low sinuosity typical of this type of mountain stream. The restored planform will be of a similar beltwidth as the existing stream, but with more defined meanders. Similar to stable step pool dominated mountain streams, the planform of the restored stream will not solely dictate the riffle and pool sequence. Many of the step pools will be located in straight sections of the channel and will be associated with rock or wood drop structures.

Another component of the restoration of WOC will be the addition of habitat features. These habitat structures will primarily be composed of dead woody debris to narrow the flow path of the channel in areas where the stream has over-widened. Adding these structures will provide diverse habitat niches within the stream and buffer areas. The in-stream structures will primarily be in pools to enhance the deep water habitat that does not currently exist at the site. Some log grade control structures will be installed at grade changes in the middle of riffles. These sections of grade change will create bed diversity within the riffles, as some riffles will have some steeper sections and some less steep sections within the same riffle. The enhancement sections of WOC will have their profiles altered, with some existing high quality riffles being preserved and new pools being created with structures. The cross-sections will also be altered, creating a bankfull channel that will match the restoration reaches.

T1 will be restored in a similar fashion, but the tributary will be relocated from where it was historically channelized back to its approximate original location. The bankfull bench will tie into the existing terrace in the stream's former location. This restoration approach will be Priority 3. T2 will be restored by creating a stable cross-section, adjusting the current planform, and building a bankfull bench (Priority 3). Grade control structures will be incorporated into the design for T2 to stabilize the tributary's steep slope.

For this project, the two reference reaches described in Section 5.0 will be used to guide the design of the cross-sections, profile, and planform. However, an ideal reference reach was not found for the DBS. The UT to Fisher River Reference Site has a slope lower than 2%. In the mountain region of North Carolina, stable B3/4 streams with slopes ranging from 3-7% are scarce. KCI has conducted numerous reference reach searches throughout North Carolina and has not been able to find stable B3/4 channels within this slope range.

6.1.2 Designed Channel Classification

The mainstem and tributaries are divided into eight separate reaches based on the restoration or enhancement approach applied to the portions of the channels (Table 1). The project reaches are identified in Figure 9. The morphological design criteria for each of the reaches are found in Tables 4a through 4c. The streams at the DBS will generally be restored to B channels, with the first four reaches of WOC

restored and enhanced to B4a streams, and the last reach enhanced to a B4 stream. The two tributaries will also be restored and enhanced to B4a stream types. Channels in isolated areas where the streams are not entrenched in a valley and have access to a floodplain will function as C channels. As WOC flows through the property, the stream slope decreases. This changing slope affects the restoration design, so that the proposed cross-sections were adjusted differently for each reach. The designed cross-sections for the DBS streams are typically designed to have a width to depth ratio of just over 12 and entrenchment ratios between 2 and 2.2. These cross-sections will be stable and self maintaining, but it is expected that due to site constraints and relatively small cross-section, these ratios on the constructed channel may vary slightly and fall into another channel classification. Even if this is the case, the designed channel classification will most likely still be maintained as B4a and B4 channels due to the continuum of physical variables within stream reaches (Rosgen 1996).

WOC-1 runs from Station 10+00 to 12+54 and ends at a 15-foot wide easement exception where there is a rock ford crossing. WOC-1 will be improved as Enhancement I, which involves adjusting the stream to have the appropriate profile and dimension (USACE et. al 2003). Work on WOC-1 will also involve keeping as many of the trees in the existing riparian buffer as possible. The second reach on WOC will be restored. WOC-2 begins at the easement exception at Station 12+71 and will be slightly meandered away from the berm that surrounds the irrigation pond on the left side of the channel, where T1-2 will join WOC. Then WOC-2 will cross a 15-foot rock ford crossing easement exception and flow back to its existing location in the valley before WOC-3 begins at Station 19+25. The restoration of WOC-2 will also maintain and stabilize the irrigation pond inlet and outlet. Like WOC-1, the mitigation type of WOC-3 will be Enhancement I. This reach begins at Station 19+25 where there is a more developed riparian buffer and ends at Station 22+73 where there is a 15-foot wide easement exception with another rock ford crossing. From the easement exception at Station 22+88, the restoration of WOC-4 will involve constructing a more appropriate planform and a stable cross-section and profile. The old cattle lagoon to the left of the stream will be removed. The designed length of WOC-4 is shorter than the existing length due to the elimination of two unstable meanders that currently run into steep valley walls. In this section the channel will be brought back towards the center of the valley with slightly shorter meanders, thereby reducing the length of this reach. WOC-4 will cross the last 15-foot rock ford crossing easement exception on WOC and end at Station 36+31, where WOC-5 begins. WOC-5 has a stable planform, but will be improved as Enhancement I and flows from the end of WOC-4 to the end of the project at Station 36+31.

Tributary 1 is separated into two reaches. The mitigation type for T1-1 is Enhancement I. This reach begins in a wooded area at Station 50+00 and ends at Station 50+95, where the stream enters a clearing. T1-2 will have a defined channel restored back to the old stream location. This reach begins at the end of T1-1, crosses a 15-foot rock ford crossing easement exception and will be restored until it ends at the confluence with WOC at Station 54+69. T2 will be restored for its entire length, beginning at Station 60+00 and ending at the confluence with WOC at Station 62+57.

6.1.3 Targeted Buffer Communities

Once all of the work on the project streams has been completed, livestock exclusion fencing will be installed along the easement boundary on the lower half of the site where livestock will still be kept on the project parcel. In the areas where there will not be any cattle, the easement boundaries will be marked with metal posts.

The project will restore a Montane Alluvial Forest community within the floodprone area and low-lying parts of the valley with a Montane Oak-Hickory Forest community along the valley slopes throughout the rest of the site. These communities will fit into the natural topography and setting created by the newly restored channels (Schafale and Weakley 1990).

6.2 Sediment Analysis

The sediment competency of the DBS was studied in detail and the assessment data are available in Appendix D. Pebble counts and bulk samples were taken throughout the project reaches. Based on this analysis, the majority of the project reaches are dominated by gravel and cobble material.

As WOC-1 comes onto the project site, it has predominately a gravel bed with sand overwash covering most of the gravel. A pebble count at Station 10+75 (Existing) found the channel to be 41% sand and 34% gravel with a D84 of 79.0 mm. A bulk sample on WOC-1 provided a measured D84 of 29.1 mm and 78% gravel in the pavement. The subpavement was composed of slightly finer material with a D84 of 16.9 mm.

WOC-2 is more clearly dominated by gravel as demonstrated by the measured D84 from the two cross-section pebble counts of 60.0 mm and 150.0 mm. The bulk sample also found that the pavement and sub-pavements were primarily gravel with D84 values of 51.0 mm and 27.7 mm, respectively.

The gravel bed continues through WOC-3. This is reflected in the 67% gravel in the pebble count and the D84 of 64.0 mm. WOC-3 also reflects the trend of coarse pavement and slightly less course sub-pavement. The pavement D84 was 42.0 mm and the sub-pavement D84 was 29.0 mm. The data in Appendix D also indicate the same trends in the pebble counts and bulk samples for WOC-4 and WOC-5.

T1-1 has a similar gravel bed as the mainstem with a pebble count with a D84 of 160 mm, 46% gravel, and 35% cobble. When T1 loses its defined channel and T1-2 begins, the channel becomes a vegetated swale dominated by fine sediments. These fine sediments are a result of the relic channel being filled when the stream was relocated. Aggradation has also occurred as fine materials become trapped by the vegetation and there is no concentrated flow to wash out these materials. The pebble count from this reach reflected this, being composed entirely of sand and silt. T2 has been so impacted by cattle that the bed is primarily composed of silt from the eroding banks and adjacent grazing area. The pebble count of this compacted bed was made up of 90% silt.

The sediment sampling found that the streambed of the DBS streams are predominately compacted with gravels and sands cemented between larger cobbles. These streams are threshold channels, which are defined as streams where the bed material inflow is negligible and the channel boundary is immobile even at high flows (Shields et al. 2003). At the DBS, there is a lack of incoming bed material from the small surrounding forested watershed and cattle have hardened the bed with tightly packed gravel and cobble. While the bulk of the streambed is made up of compacted gravel, there is a large amount of cobble material that is scattered throughout the stream and acts to armor many of the steep riffles. This is especially typical of the enhancement reaches where there are more stable riffles than in the restoration reaches. As opposed to an active bed system, a threshold channel never achieves full sediment transport; the system only achieves partial sediment transport. Therefore, threshold mobility evaluation of these streams is not appropriate for the site.

To verify that the restored and enhanced streams would not aggrade and collect excessive fine materials, the shear stresses of the proposed riffle cross-sections were calculated. These shear stresses were validated for the design riffle cross-sections and channel gradient using the equation:

$$\tau = \gamma R s$$

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

All of the shear stresses calculated were greater than is necessary to move the fine wash load that has been found in the stream. This should promote a stable channel bottom without excessive aggradation of fine materials.

6.3 Natural Plant Community Restoration

Riparian plantings shall consist of native woody species. To achieve a mature survivability of 260 stems per acre, 680 stems per acre (8 feet by 8 feet spacing) will be planted. Plant placement and groupings will be randomized during installation in order to develop a more naturalized appearance. Woody vegetation planting will take place during dormancy. Species to be planted in the bankfull bench and low-lying areas as Montane Alluvial Forest may consist of the following:

Tag Alder	*Alnus serrulata*	Sycamore	*Platanus occidentalis*
River Birch	*Betula nigra*	Tulip Poplar	*Liriodendron tulipifera*
Yellow Birch	*Betula alleghaniensis*	White Oak	*Quercus alba*
Witch Hazel	*Hamamelis virginiana*	Winterberry	*Ilex verticillata*
Spicebush	*Lindera benzoin*		

The valley slopes will be planted as Montane Oak-Hickory Forest and may consist of the following species:

Sweetshrub	*Calycanthus florida*	Mockernut Hickory	*Carya alba*
Chestnut Oak	*Quercus prinus*	Tulip Poplar	*Liriodendron tulipifera*
White Oak	*Quercus alba*	Serviceberry	*Amelanchier arborea*
Witch Hazel	*Hamamelis virginiana*	Black Gum	*Nyssa sylvatica*
Black Walnut	*Juglans nigra*	Spicebush	*Lindera benzoin*

On the restored stream banks, live stakes will be used to provide natural stabilization. Appropriate species identified for live staking include:

Silky Dogwood	*Cornus amomum*	Silky Willow	*Salix sericea*
Black Willow	*Salix nigra*	Elderberry	*Sambucus canadensis*

A herbaceous seed mix composed of appropriate native species will also be developed and used to further stabilize and restore the riparian and bank zones following construction.

In addition to planting the proposed community types, vegetative restoration will also include eliminating invasive species that have taken over portions of the site. The most prevalent invasive species at the DBS is multiflora rose (*Rosa multiflora*).

7.0 PERFORMANCE CRITERIA

Monitoring shall consist of the collection and analysis of stream stability and riparian/stream bank vegetation survivability data to support the evaluation of the project in meeting established restoration objectives. Specifically, project success will be assessed utilizing measurements of stream dimension, pattern, and profile; site photographs, and vegetation sampling.

7.1 Stream Stability

The purpose of monitoring is to evaluate the stability of the restored stream. Following the procedures established in the USDA Forest Service Manual, *Stream Channel Reference Sites* (Harrelson et al. 1994) and the methodologies utilized in the Rosgen stream assessment and classification system (1994 and

1996), data collected will consist of detailed dimension and pattern measurements, longitudinal profiles, and bed materials sampling.

Dimension – Permanent cross-sections will be established at 5 riffle and 4 pool locations along the restored project reaches. The following cross-sections will be used to evaluate stream dimension:

- 2 riffles and 2 pools on WOC-2
- 3 riffles and 2 pools on WOC-4

Permanent monuments will be established by conventional survey. The cross-section surveys shall provide a detailed measurement of the stream and banks and will include points on the adjacent floodplain or valley, at the top of bank, bankfull, at all breaks in slope, the edge of water, and thalweg. Width/depth and entrenchment ratios will be calculated for each cross-section based on the survey data.

Cross-section measurements should show little or no change from the as-built cross-sections. If changes do occur, they will be evaluated to determine whether they are minor adjustments associated with settling and increased stability or whether they indicate movement toward an unstable condition.

Profile – A detailed longitudinal profile will be conducted along the entire length of WOC. Measurements will include slopes (average, pool, and riffle) as well as calculations of pool-to-pool spacing. Annual measurements should indicate that bedform features are stable with little change from the as-built survey. The pools should maintain their depth with lower water surface slopes, while the riffles should remain shallower and steeper than the average values for the stream.

Pattern - Measurements associated with the channel pattern shall be taken on the restored sections of the stream included in the longitudinal profiles after the as-built survey. These data will include belt width, meander length, and radius of curvature. Subsequently, sinuosity, meander width ratios, radius of curvature, and meander length/bankfull width ratios will be calculated. Pattern data will only be calculated again if visual monitoring indicates that significant changes have occurred to the stream planform.

Bed Materials – Pebble counts will be conducted at each monitored cross-section for the purpose of repeated classification and to evaluate sediment transport.

Verification of Bankfull Events – During the monitoring period, a minimum of two bankfull events must be recorded within the five-year monitoring period. These two bankfull events must occur in separate monitoring years. Bankfull events will be verified using on-site gauges.

Photograph Reference Points – Twenty photograph reference points will be established to assist in characterizing the site and to allow qualitative evaluation of the site conditions. The location and bearing/orientation of each photo point will be documented to allow for repeated use.

Cross-section Photograph Reference Points – Each cross-section will be photographed to show the form of the channel with the tape measure stretched over the channel for reference in each photograph. An effort will be made to consistently show the same area in each photograph.

Visual Assessment – An annual site walk will be conducted at the end of each monitoring period to document any stream problem areas. Particular attention will be paid to the enhancement reaches and the two tributaries. Specific problem areas that could arise include excessive bank erosion, bed deposition or aggradation, or problems with the installed structures. The findings of the visual assessment as well as any recommended corrective actions for problem areas will be summarized in the monitoring reports by way of a Current Conditions Plan View figure.

7.2 Vegetation

The success of the riparian buffer plantings will be evaluated using seven ten-by-ten meter vegetative sampling plots and will use the CVS-EEP stream vegetation monitoring protocol (Lee et al. 2006). The corners of each monitoring plot will be permanently marked in the field. The coordinates of the plot corners will be recorded using conventional survey. The monitoring will consist of the following data inventory: composition and number of surviving species, total number of stems per acre, diameter at decimeter height, diameter at breast height for trees greater than 5 feet in height, and vigor. Additionally, a photograph will be taken of each plot that will be replicated each monitoring year. Riparian vegetation must meet a minimum survival success rate of 320 stems/acre after three years, 288 stems/acre after four years, and 260 stems/acre after five years. If monitoring indicates that the specified survival rate is not being met, appropriate corrective actions will take place, which may include invasive species control, the removal of dead/dying plants and replanting.

7.3 Schedule/Reporting

The first scheduled monitoring will be conducted during the first full growing season following project completion. Monitoring shall subsequently be conducted annually for a total period of five years or until the project meets its success criteria.

Annual monitoring reports will be prepared and submitted after all monitoring tasks for each year are completed. The report will document the monitored components of the restoration plan and include all collected data, analyses, and photographs. Each report will provide the new monitoring data and compare the most recent results against previous findings. The monitoring report format will be similar to that set out in the most recent EEP monitoring protocol.

Variations from the designed project reaches can be anticipated due to unknown site conditions, inputs from outside the restoration site, regional climatic variations, or acts of God, etc. Regular management activities will be implemented as necessary to ensure that the goals and objectives of the project are met. These activities will be conducted throughout the year and may include invasive species control or other management activities. If the monitoring identifies failures in the project site, a remedial action plan will be developed to investigate the causes of the failure and propose actions to rectify the problem.

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Tables

Table 1. Project Restoration Components

Reach	Existing Stationing	Proposed Stationing	Mitigation Type	Priority Approach	Existing Linear Footage	Designed Linear Footage	Comments
WOC-1	10+00-12+54	10+00-12+54	Enhancement I	-	254	254	Excludes 15-ft crossing
WOC-2	12+71-19+19	12+71-19+25	Restoration	P3	633	639	Excludes 15-ft crossing
WOC-3	19+19-22+68	19+25-22+73	Enhancement I	-	349	349	Excludes 15-ft crossing
WOC-4	22+82-36+71	22+88-36+31	Restoration	P3	1,374	1,325	Excludes 15-ft crossing
WOC-5	36+71-41+29	36+31-40+89	Enhancement I	-	458	458	
T1-1	50+00-50+95	50+00-50+95	Enhancement I	-	95	95	
T1-2	50+95-54+48	50+95-54+69	Restoration	P3	336	359	Excludes 15-ft crossing
T2	60+00-62+19	60+00-62+57	Restoration	P3	219	257	
				Total	3,718	3,736	
						Total Proposed Stream Enhancement I	**1,156**
						Total Proposed Stream Restoration	**2,580**

Table 2. Project Watershed Land Use

Land Use	Acerage	Percentage of Watershed
Agriculture	6.8	2%
Forest land	273.6	80%
Rangeland	58.1	17%
Wetland	0.7	< 1%
Water	1.3	< 1%
Urban or built-up	1.5	< 1%

Table 3. Project Drainage Areas

Reach	Drainage Area (Acres)	Drainage Areas (Square Miles)
WOC	342.4	0.535
T1	48.4	0.076
T2	45.8	0.072

Table 4A. Morphological Criteria for WOC-1, WOC-2, and WOC-3

Variables		Existing WOC-1*	Existing WOC-2**	Existing WOC-3+	Ref. Reach UTFR	Ref. Reach WOC	Proposed WOC-1++	Proposed WOC-2	Proposed WOC-3
Rosgen Stream Type		F5b	E/B4a	B4a	B4c	B4a	B4a	B4a	B4a
Mitigation Type		Enh. I	Restoration	Enh.1	N/A	N/A	Enh. I	Restoration	Enh. I
Drainage Area (mi^2)		0.23	0.36	0.38	0.38	0.23	0.23	0.36	0.38
Bankfull Width (W_{bkf}) (ft)		8.8-9.7	5.0-8.3	14.2	9.0-10.0	8.8	8.6	8.6	9.0
Bankfull Mean Depth (d_{bkf}) (ft)		0.5-0.6	0.6-0.9	0.5	1.1-1.2	0.6	0.7	0.7	0.7
Bankfull Cross-Sectional area (A_{bkf}) (ft^2)		4.9-5.0	4.6-6.7	7.1	10.4-10.7	5.1	6.3	6.3	6.6
Width/depth Ratio (W_{bkf}/d_{bkf})		15.8-18.8	5.4-13.8	28.4	8.0-10.0	15.2	12.3	12.3	12.3
Maximum Depth (d_{mbkf}) (ft)		0.7	0.8-1.4	0.8	1.3-1.5	0.9	0.9	0.9	0.9
Width of flood prone area (W_{fpa}) (ft)		10-11	9-11	25	13-21	12	19	19	19
Entrenchment Ratio (ER)		1.1-1.2	1.2-2.1	1.8	1.3-2.3	1.4	2.2	2.2	2.1
Sinuosity (stream length/valley length) (K)		1.0	1.0	1.0	1.2	-	1.0	1.0	1.0
Dimension	Pool Depth (ft)	-	-	0.7	1.2-1.4	-	1.0	1.0	1.1
	Riffle Depth (ft)	0.5-0.6	0.6-0.9	0.5	1.1-1.2	0.6	0.7	0.7	0.7
	Max Pool Depth (ft)	-	-	1.3	2.1-2.4	-	1.6	1.6	1.6
	Pool Width (ft)	-	-	19.8	8.4-11.6	-	10.2	10.2	10.6
	Riffle Width (ft)	8.8-9.7	5.0-8.3	14.2	9.0-9.9	8.8	8.6	8.6	9.0
	Pool XS Area (sf)	-	-	14.2	11.6-13.4	-	10.1	10.1	11.4
	Riffle XS Area (sf)	4.9-5.0	4.6-6.7	7.1	10.4-10.7	5.1	6.3	6.3	6.6
	Pool depth/mean riffle depth	-	-	1.4	1.0-1.3	-	1.4	1.4	1.6
	Pool width/riffle width	-	-	1.4	0.8-1.3	-	1.2	1.2	1.2
	Pool area/riffle area	-	-	2.0	1.1-1.3	-	1.6	1.6	1.7
	Max pool depth/d_{bkf}	-	-	2.6	1.9-2.0	-	2.3	2.3	2.3
	Bank Height Ratio (BHR)	3.3-4.2	1.6-2.6	3.8	1.0	1.1	1.0	1.0	1.0
	Mean Bankfull Velocity (V) (fps)	6.3-6.7	6.2-7.9	4.6-5.4	4.1-4.5	6.7	7.1	6.4	5.2
	Bankfull Discharge (Q) (cfs)	31-33	31-53	33	42-46	34	40	40	40
Pattern	Meander length (L_m) (ft)	-	32-45	39	93-136	-	-	80-140	39
	Radius of curvature (R_c) (ft)	-	8-15	8	13-42	-	-	15-30	8
	Belt width (W_{blt}) (ft)	20	21	18	45	-	20	15-30	18
	Meander width ratio (W_{blt}/W_{bkf})	2.1-2.3	2.5-4.2	1.3	4.5-5.0	-	2.1-2.3	1.7-3.5	1.3
	Radius of curvature/bankfull width	-	1.0-3.0	0.6	1.3-4.4	-	-	1.7-3.5	0.9
	Meander length/bankfull width	-	3.9-9.0	2.7	9.0-15.0	-	-	9.3-16.3	4.3
Profile	Valley slope	0.0780	0.0585	0.0440	0.0160	-	0.0780	0.0585	0.0440
	Average water surface slope	0.0754	0.0617	0.0406	0.0130	-	0.0754	0.0593	0.0405
	Riffle slope	0.0440-0.0989	0.0301-0.0898	0.0407-0.0571	0.013-0.028	-	0.0549-0.1071	0.0430-0.0741	0.0229-0.0504
	Pool slope	-	-	-	0-0.0010	-	0-0.0030	0-0.0030	0-0.0030
	Pool to pool spacing	-	-	117	30-59	-	45-52	25-78	42-80
	Pool length	-	-	-	3-25	-	6-8	5-8	8-10
	Riffle slope/avg water surface slope	0.58-1.31	0.49-1.46	1.00-1.41	1.00-2.20	-	0.73-1.42	0.73-1.25	0.57-1.24
	Pool slope/avg water surface slope	-	-	-	0	-	0-0.04	0-0.05	0-0.07
	Pool length/bankfull width	-	-	-	0.3-2.5	-	0.7-0.9	0.6-0.9	0.9-1.1
	Pool to pool spacing/bankfull width	-	-	8.2	3.3-6.0	-	5.2-6.0	2.9-9.1	4.7-8.9

*WOC-1 is not a meandering channel and is only composed of riffles and runs, therefore no pattern data or pool data were collected.

**WOC-2 is only composed of riffles and runs, therefore no pool data were collected.

+ A pool cross-section was surveyed for WOC-3 but there were no pools in the representative profile, therefore no pool profile data were collected.

++ Since WOC-1 will be enhanced there will not be any pattern adjustments so the proposed pattern data is the same as the exisiting pattern data.

Table 4B. Morphological Criteria for WOC-4 and WOC-5

Variables		Existing WOC-4*	Existing WOC-5*	Ref. Reach UTFR	Ref. Reach WOC	Proposed WOC-4	Proposed WOC-5
Rosgen Stream Type		G/F4b	C/B4	B4c	B4a	B4a	B4
Mitigation Type		Restoration	Enh. I	N/A	N/A	Restoration	Enh. I
Drainage Area (mi^2)		0.5	0.5	0.4	0.2	0.5	0.5
Bankfull Width (W_{bkf}) (ft)		9.2-10.6	13.7-27.2	9.0-10.0	8.8	9.8	10.6
Bankfull Mean Depth (d_{bkf}) (ft)		0.6-0.9	0.4-0.6	1.1-1.2	0.6	0.8	0.8
Bankfull Cross-Sectional area (A_{bkf}) (ft^2)		6.4-7.9	8.1-11.7	10.4-10.7	5.1	7.7	8.9
Width/depth Ratio (W_{bkf}/d_{bkf})		10.7-17.2	23.2-63.2	8.0-10.0	15.2	12.5	12.6
Maximum Depth (d_{mbkf}) (ft)		0.9-1.3	1.0-1.5	1.3-1.5	0.9	1.0	1.1
Width of flood prone area (W_{fpa}) (ft)		12-21	18-97	13-21	12	20	22
Entrenchment Ratio (ER)		1.1-2.0	1.3-3.6	1.3-2.3	1.4	2.0	2.1
Sinuosity (stream length/valley length) (K)		1.1	1.0	1.2	-	1.1	1.0
Dimension	Pool Depth (ft)	-	-	1.2-1.4	-	1.2	1.3
	Riffle Depth (ft)	0.6-0.9	0.4-0.6	1.1-1.2	0.6	0.8	0.8
	Max Pool Depth (ft)	-	-	2.1-2.4	-	1.8	2.0
	Pool Width (ft)	-	-	8.4-11.6	-	11.0	11.8
	Riffle Width (ft)	9.2-10.6	13.7-27.2	9.0-9.9	8.8	9.8	10.6
	Pool XS Area (sf)	-	-	11.6-13.4	-	13.5	15.8
	Riffle XS Area (sf)	6.4-7.9	8.1-11.7	10.4-10.7	5.1	7.7	8.9
	Pool depth/mean riffle depth	-	-	1.0-1.3	-	1.5	1.6
	Pool width/riffle width	-	-	0.8-1.3	-	1.1	1.1
	Pool area/riffle area	-	-	1.1-1.3	-	1.8	1.8
	Max pool depth/d_{bkf}	-	-	1.9-2.0	-	2.3	2.5
	Bank Height Ratio (BHR)	1.8-3.7	1.4-3.1	1.0	1.1	1.0	1.0
	Mean Bankfull Velocity (V) (fps)	5.1-6.9	3.8-4.7	4.1-4.5	6.7	5.5	5.0
	Bankfull Discharge (Q) (cfs)	33-51	38-45	42-46	34	40	40
Pattern	Meander length (L_m) (ft)	81-244	84-106	93-136	-	95-160	84-106
	Radius of curvature (R_c) (ft)	14-52	20-24	13-42	-	20-40	20-24
	Belt width (W_{blt}) (ft)	31-80	34	45	-	15-40	34
	Meander width ratio (W_{blt}/W_{bkf})	2.9-8.7	1.3-2.5	4.5-5.0	-	1.5-4.1	3.2
	Radius of curvature/bankfull width	1.3-5.7	0.7-1.8	1.3-4.4	-	2.0-4.1	1.9-2.3
	Meander length/bankfull width	7.6-26.5	3.1-7.7	9.0-15.0	-	9.7-16.3	7.9-10.0
Profile	Valley slope	0.0434	0.0331	0.0160	-	0.0434	0.0331
	Average water surface slope	0.0399	0.0335	0.0130	-	0.0405	0.0323
	Riffle slope	0.0410-0.0767	0.0357-0.0653	0.013-0.028	-	0.0321-0.0638	0.0152-0.0667
	Pool slope	0	0-0.0022	0-0.0010	-	0-0.0030	0-0.0030
	Pool to pool spacing	231	27-35	30-59	-	30-83	32-83
	Pool length	7-14	5-9	3-25	-	5-16	7-9
	Riffle slope/avg water surface slope	1.03-1.92	1.07-1.95	1.00-2.20	-	0.79-1.58	0.47-2.10
	Pool slope/avg water surface slope	0	0-0.07	0	-	0-0.07	0-0.09
	Pool length/bankfull width	0.7-1.5	0.2-0.7	0.3-2.5	-	0.5-1.6	0.7-0.8
	Pool to pool spacing/bankfull width	21.8-25.1	1.0-2.6	3.3-6.0	-	3.1-8.5	3.0-7.8

* No pool cross-sections were surveyed, but pools were identified on the longitudinal survey.

Table 4C. Morphological Criteria for T1 and T2

Variables		Existing T1-1*	Existing T1-2**	Existing T2+	Ref. Reach UTFR	Ref. Reach WOC	Proposed T1-1++	Proposed T1-2	Proposed T2
Rosgen Stream Type		B/G4	B5a	B/G5	B4c	B4a	B4a	B4a	B4a
Mitigation Type		Enh. I	Restoration	Restoration	N/A	N/A	Enh. I	Restoration	Restoration
Drainage Area (mi^2)		0.08	0.08	0.07	0.38	0.23	0.08	0.08	0.07
Bankfull Width (W_{bkf}) (ft)		5.7	19.5	6.6	9.0-10.0	8.8	6.6	6.6	6.2
Bankfull Mean Depth (d_{bkf}) (ft)		0.4	0.3	0.4	1.1-1.2	0.6	0.5	0.5	0.5
Bankfull Cross-Sectional area (A_{bkf}) (ft^2)		2.3	6.5	2.5	10.4-10.7	5.1	3.2	3.2	3.0
Width/depth Ratio (W_{bkf}/d_{bkf})		14.1	58.5	17.4	8.0-10.0	15.2	13.6	13.6	12.4
Maximum Depth (d_{mbkf}) (ft)		0.6	0.8	0.6	1.3-1.5	0.9	0.6	0.6	0.6
Width of flood prone area (W_{fpa}) (ft)		8	38	10	13-21	12	14	14	13
Entrenchment Ratio (ER)		1.4	1.9	1.5	1.3-2.3	1.4	2.1	2.1	2.1
Sinuosity (stream length/valley length) (K)		1.1	1.0	1.1	1.2	-	1.1	1.1	1.1
Dimension	Pool Depth (ft)	-	-	-	1.2-1.4	-	0.8	0.8	0.8
	Riffle Depth (ft)	0.4	0.3	0.4	1.1-1.2	0.6	0.5	0.5	0.5
	Max Pool Depth (ft)	-	-	-	2.1-2.4	-	1.2	1.2	1.2
	Pool Width (ft)	-	-	-	8.4-11.6	-	7.4	7.4	6.8
	Riffle Width (ft)	5.7	19.5	6.6	9.0-9.9	8.8	6.6	6.6	6.2
	Pool XS Area (sf)	-	-	-	11.6-13.4	-	5.8	5.8	5.3
	Riffle XS Area (sf)	2.3	6.5	2.5	10.4-10.7	5.1	3.2	3.2	3.0
	Pool depth/mean riffle depth	-	-	-	1.0-1.3	-	1.6	1.6	1.6
	Pool width/riffle width	-	-	-	0.8-1.3	-	1.1	1.1	1.1
	Pool area/riffle area	-	-	-	1.1-1.3	-	1.8	1.8	1.8
	Max pool depth/d_{bkf}	-	-	-	1.9-2.0	-	2.4	2.4	2.4
	Bank Height Ratio (BHR)	3.6	-	4.2	1.0	1.1	1.0	1.0	1.0
	Mean Bankfull Velocity (V) (fps)	5.9	-	6.5	4.1-4.5	6.7	5.2	4.9	5.9
	Bankfull Discharge (Q) (cfs)	14	-	16.4	42-46	34	14	14	14
Pattern	Meander length (L_m) (ft)	-	-	-	93-136	-	-	70-105	75-96
	Radius of curvature (R_c) (ft)	-	-	-	13-42	-	-	10-25	15-25
	Belt width (W_{blt}) (ft)	-	-	-	45	-	-	15-30	16-24
	Meander width ratio (W_{blt}/W_{bkf})	-	-	-	4.5-5.0	-	-	2.3-4.5	2.6-3.9
	Radius of curvature/bankfull width	-	-	-	1.3-4.4	-	-	1.5-3.8	2.4-4.0
	Meander length/bankfull width	-	-	-	9.0-15.0	-	-	10.6-15.9	12.1-15.5
Profile	Valley slope	0.0737	0.0583	0.1153	0.016	-	0.0750	0.0590	0.1153
	Average water surface slope	0.0681	0.0601	0.1129	0.013	-	0.0750	0.0590	0.1012
	Riffle slope	0.0721-0.0874	-	-	0.013-0.028	-	0.0764-0.0876	0.0497-0.0579	0.0900-0.1407
	Pool slope	-	-	-	0-0.0010	-	0-0.0030	0-0.0030	0-0.0030
	Pool to pool spacing	-	-	-	30-59	-	76	35-45	34-45
	Pool length	-	-	-	3-25	-	9	5-17	6-10
	Riffle slope/avg water surface slope	1.06-1.28	-	-	1.00-2.20	-	1.02-1.17	0.84-0.98	0.89-1.39
	Pool slope/avg water surface slope	-	-	-	0	-	0-0.04	0-0.05	0-0.03
	Pool length/bankfull width	-	-	-	0.3-2.5	-	1.4	0.8-2.6	1.0-1.6
	Pool to pool spacing/bankfull width	-	-	-	3.3-6.0	-	11.5	5.3-6.8	5.5-7.3

*T1-1 is not a meandering channel and is only composed of riffles and runs, therefore no pattern data or pool data were collected.

**T1-2 is not a meandering channel and does not have a well defined channel with distinct bed features, therefore no pattern data were collected and only limited dimension and profile data were collected.

+T2 is not a meandering channel and does not have distinct bed features, therefore no pattern data were collected and only limited dimension and profile data were collected.

++ Since T1-1 will be enhanced there will not be any pattern adjustments so the proposed pattern data is the same as the exisiting pattern data.

Figures

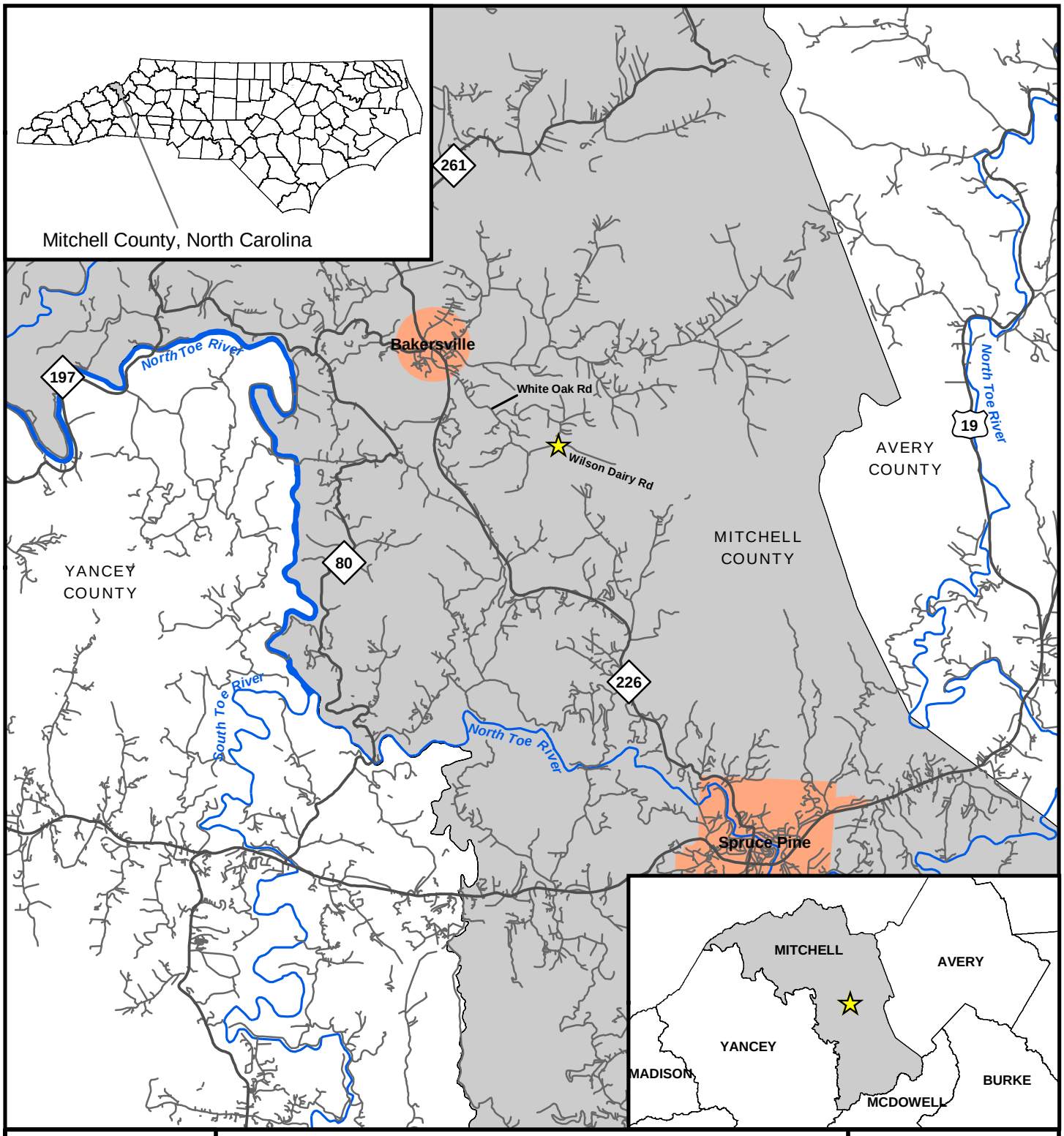

Figure 1. Vicinity Map

- Project Site Location
- Major Roads
- Other Roads
- Major Rivers
- Cities and Towns

1:126,720

1 inch equals 2 miles

2 1 0 2 Miles

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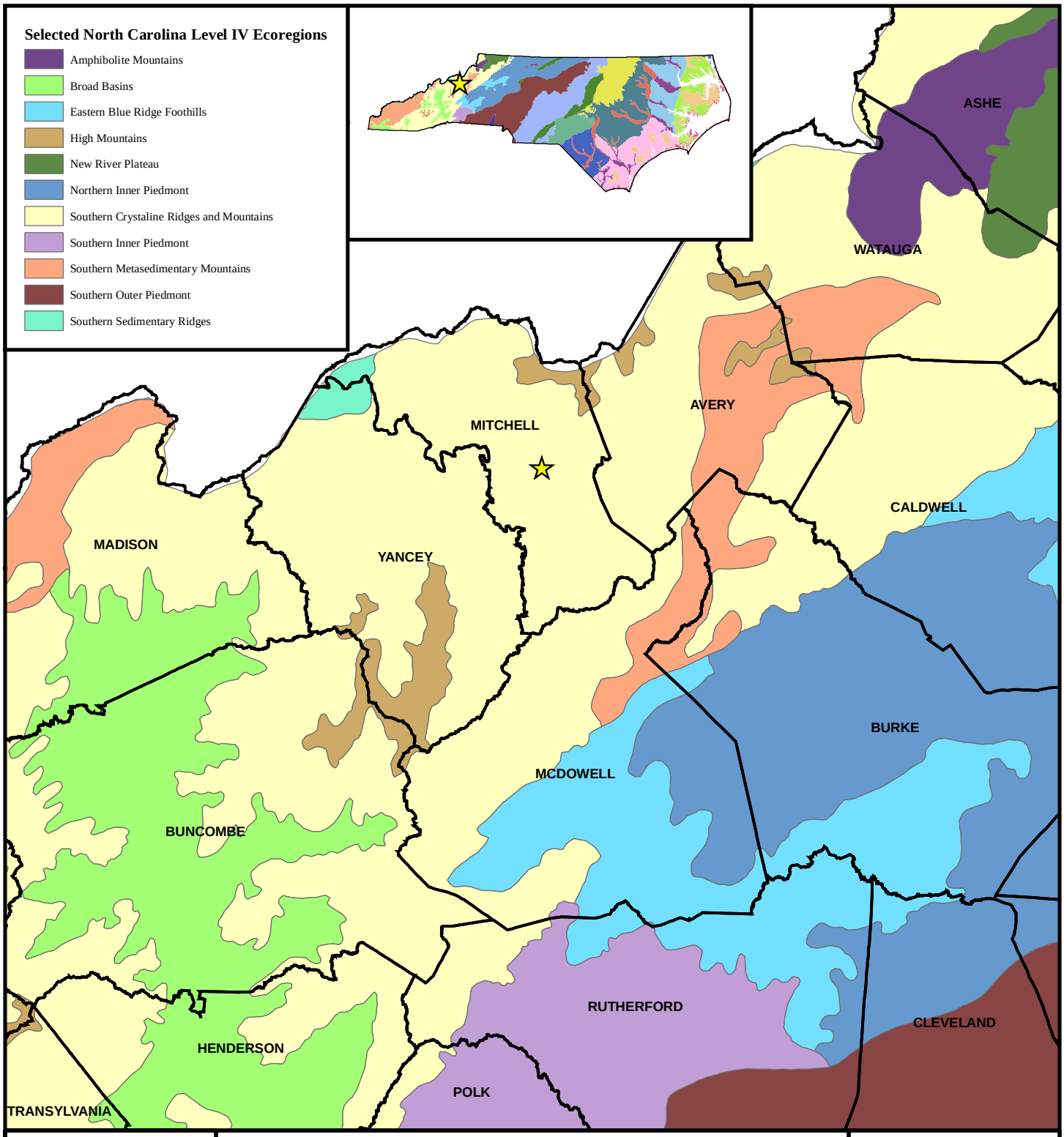

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Figure 2. North Carolina Ecoregions

Project Site Location

County Boundaries

N
W E
S

1:633,600

1 inch equals 10 miles

10 5 0 10 Miles

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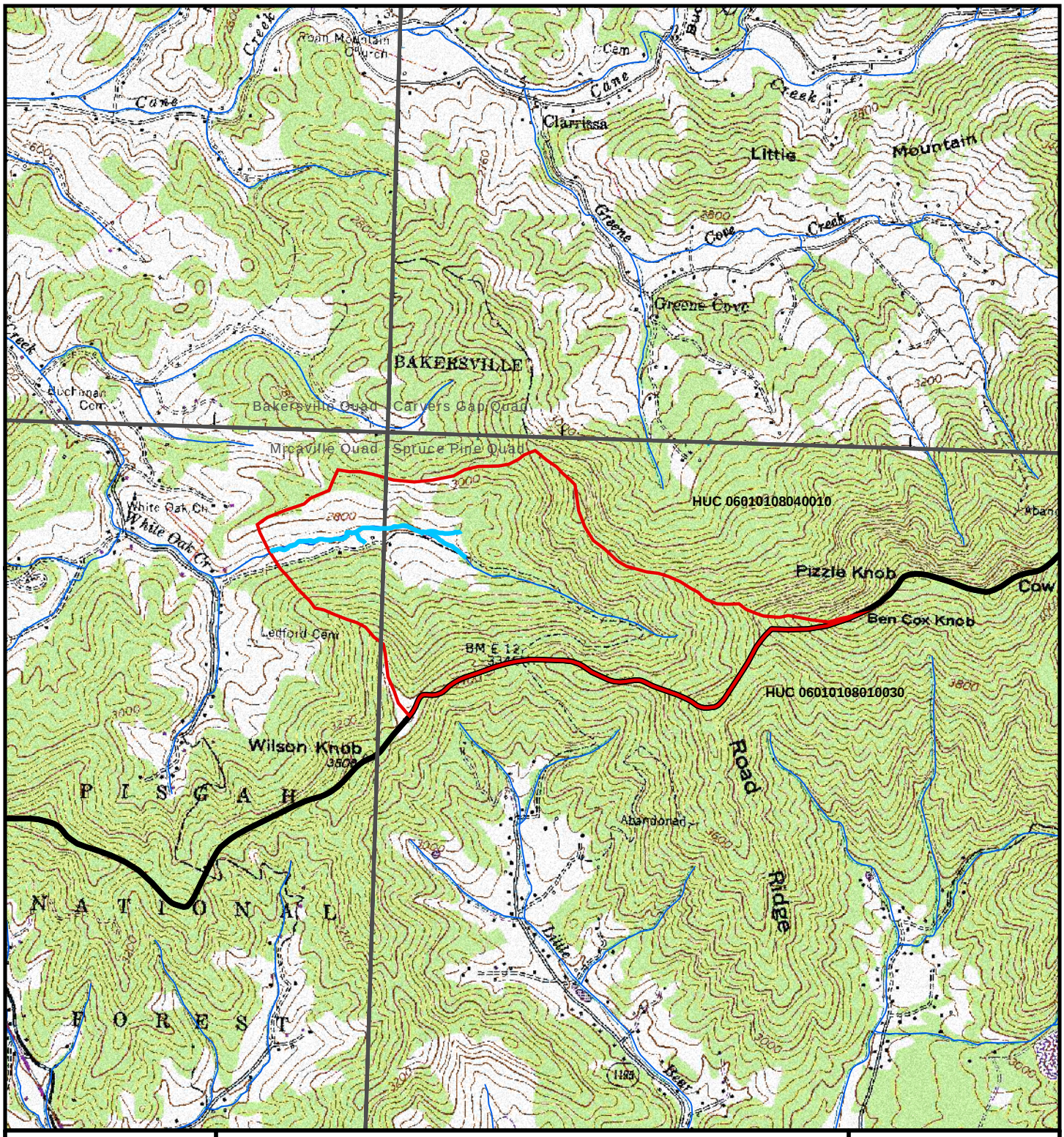

Figure 3. Project Watershed

- Project Watershed (0.53 sq. mile)
- 14-digit HUC Boundaries
- Project Streams
- Other Streams
- Quadrangle Boundaries

Source: USGS Topographic Quadrangles Bakersville (1978), Carvers Gap (1960), Micaville (1978), and Spruce Pine (1978)

N
W E
S

1:24,000
1 inch equals 2,000 feet

2,000 1,000 0 2,000 Feet

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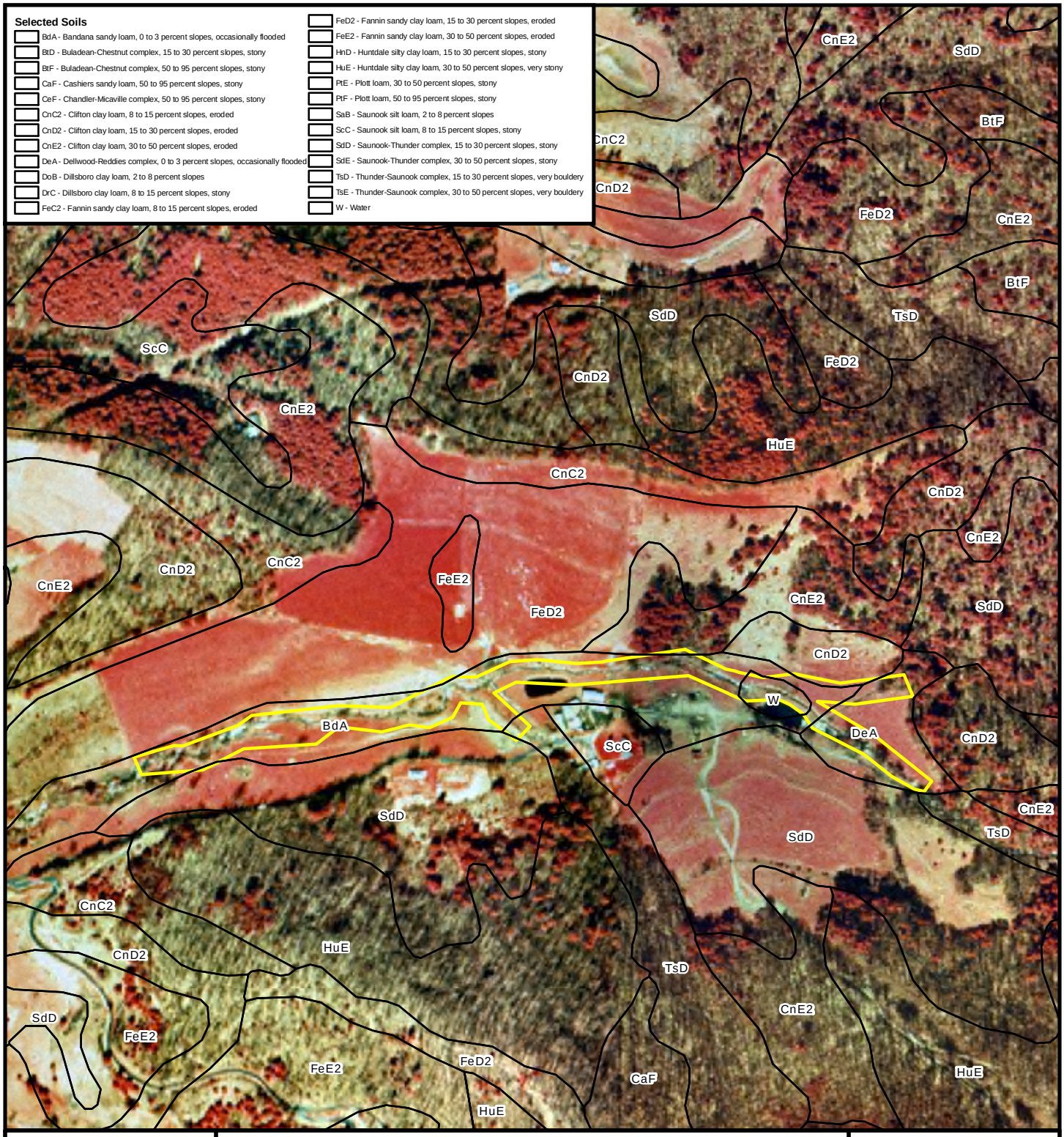

Figure 4. Project Site NRCS Soil Survey

Project Easement Boundary

N
W E
S

1:6,000
1 inch equals 500 feet

500 250 0 500 Feet

Source: SSURGO Dataset for Mitchelll County based on Soil Survey of Mitchell County, NC, USDA NRCS, 2004; imagery from USGS DOQs 1998.

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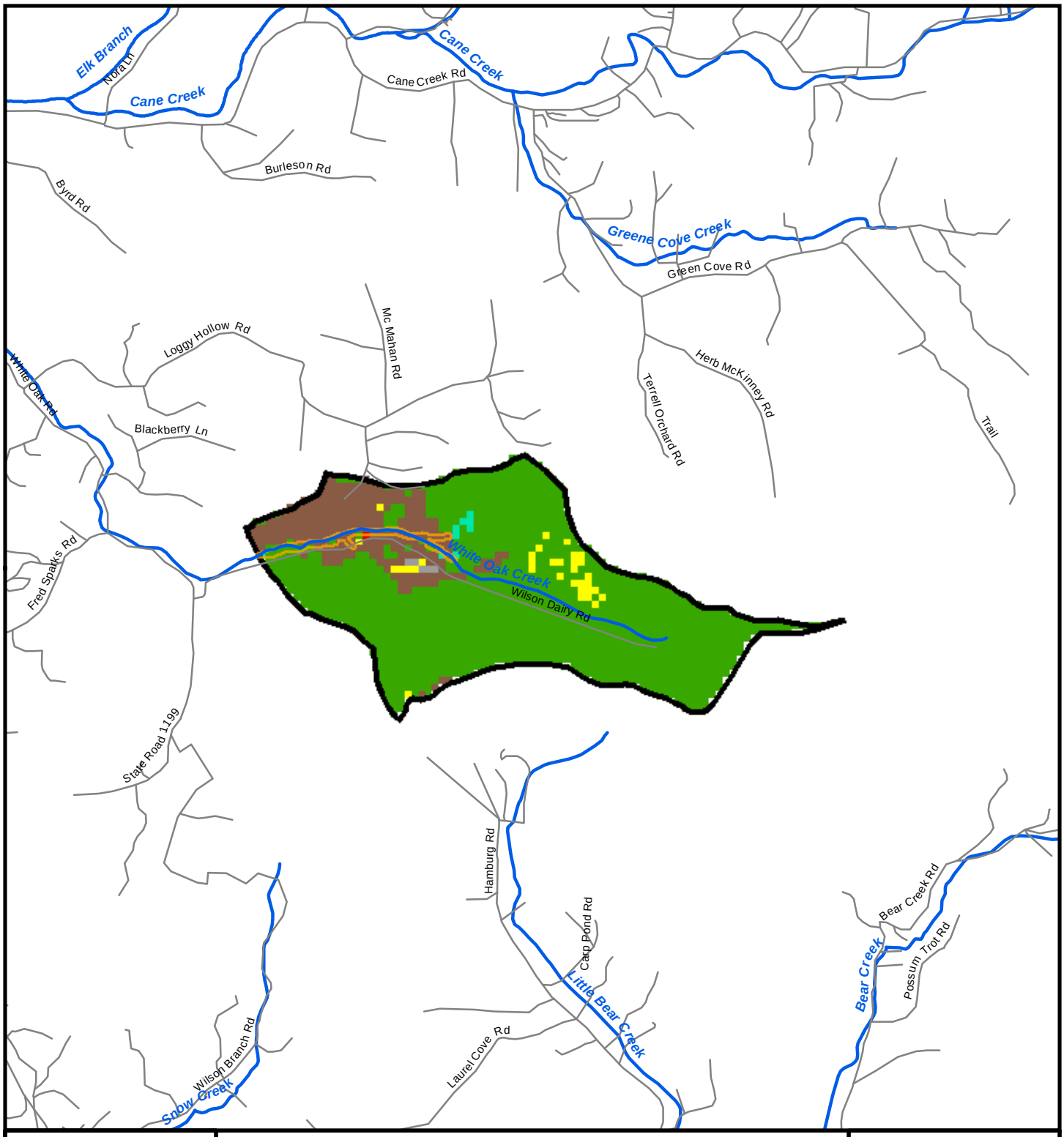

Figure 5. Project Watershed Land Use

- Urban or Built-Up Land
- Agriculture
- Rangeland
- Forest Land
- Wetland
- Barren Land
- Project Watershed
- Project Easement Boundary
- Roads
- Streams

1:24,000

1 inch equals 2,000 feet

2,000 1,000 0 2,000 Feet

Source: NC GAP Land Cover Dataset Using Anderson I Classification Scheme

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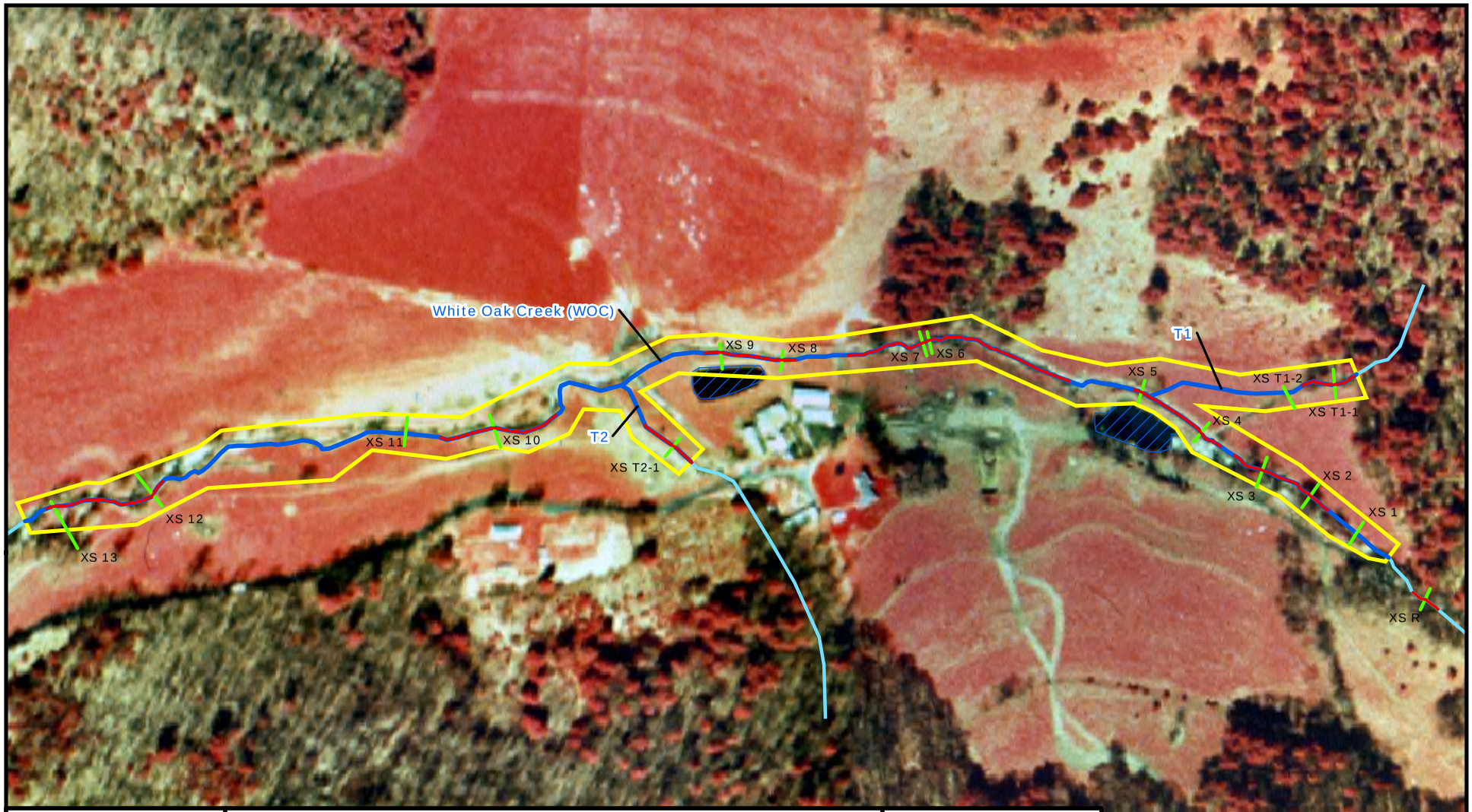

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Figure 6. Existing Conditions

Project Easement Boundary

Surveyed Longitudinal Profile

Surveyed Cross-Section

Pond

Project Streams

Other Streams

N
W
E
S

1:3,600

1 inch equals 300 feet

300 150 0 300 Feet

Source: USGS DOQQs, Micaville and Spruce Pine Quadrangles, 1998

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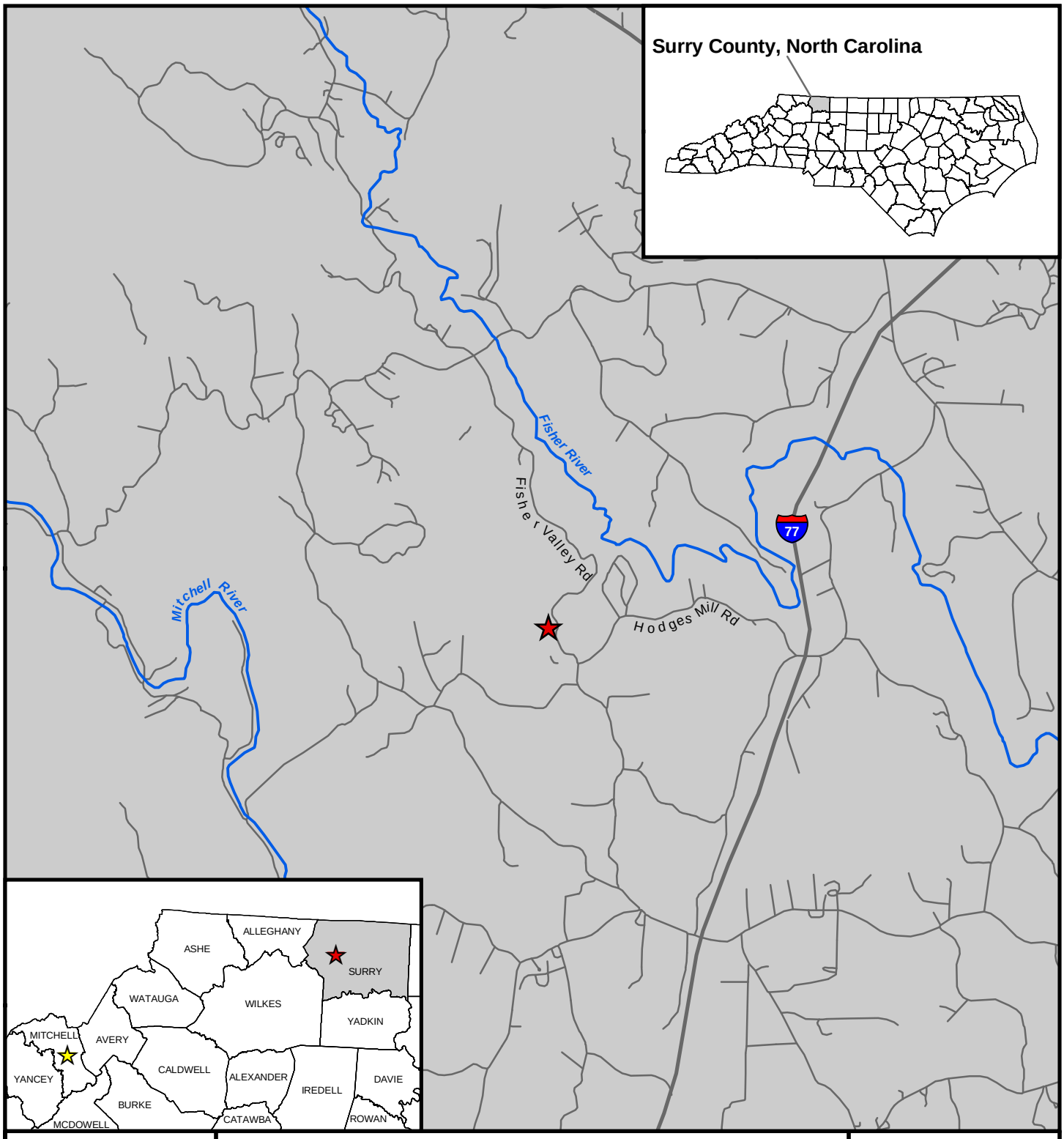

Figure 7. Reference Site Vicinity Map (UT to Fisher River)

- Project Site
- Reference Site (UT to Fisher River)
- Major Streams
- Major Roads
- Other Roads
- County Boundaries

1:63,360
1 inch equals 1 miles

1 0.5 0 1 Miles

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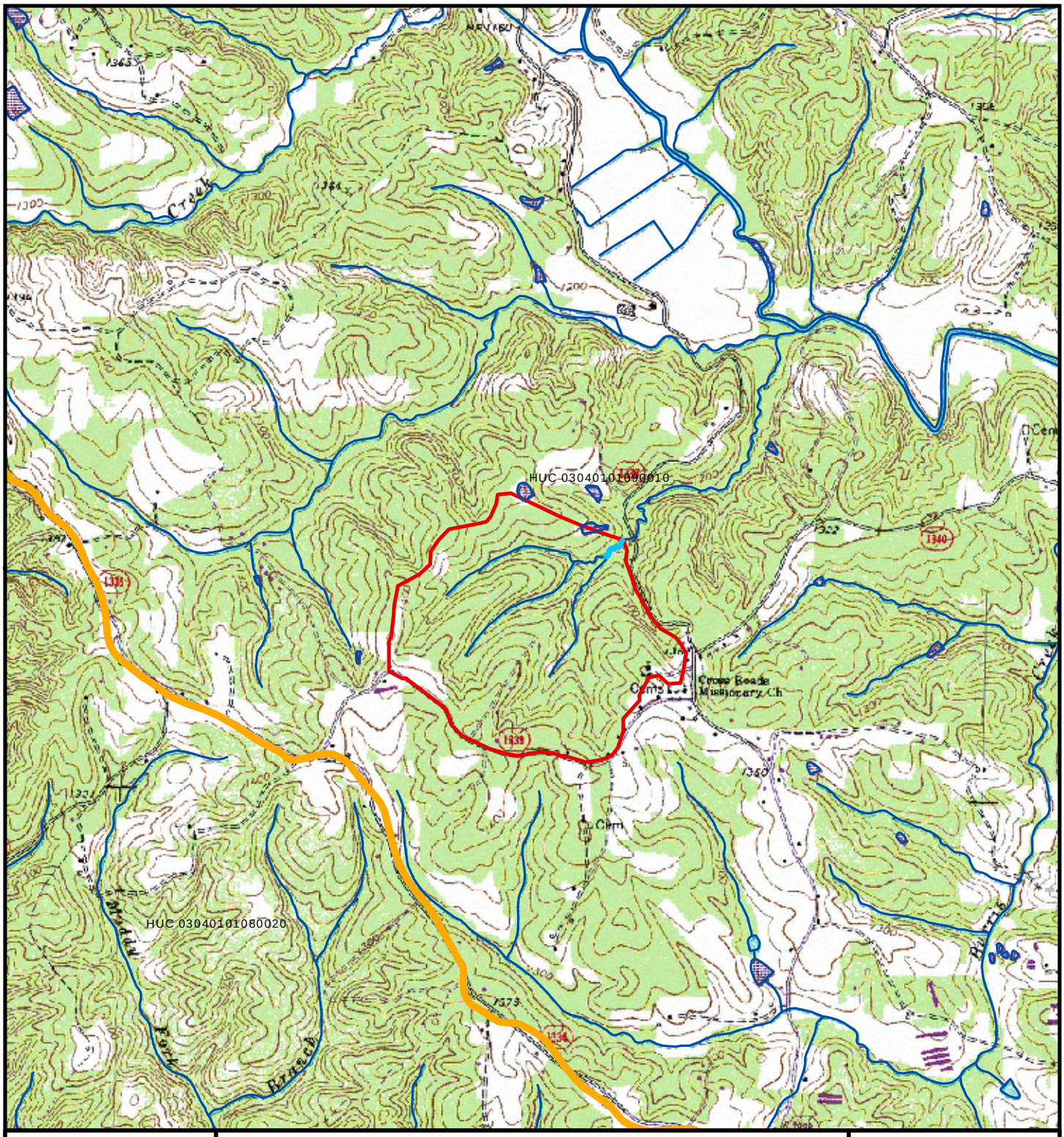

Figure 8. Reference Site Watershed (UT to Fisher River)

Reference Reach Watershed (0.38 sq. mile)

14-digit HUC boundaries

Reference Reach (UT to Fisher River)

Other Streams

N
W E
S

1:24,000

1 inch equals 2,000 feet

2,000 1,000 0 2,000 Feet

Source: USGS Topographic Quadrangle Bottom (1971)

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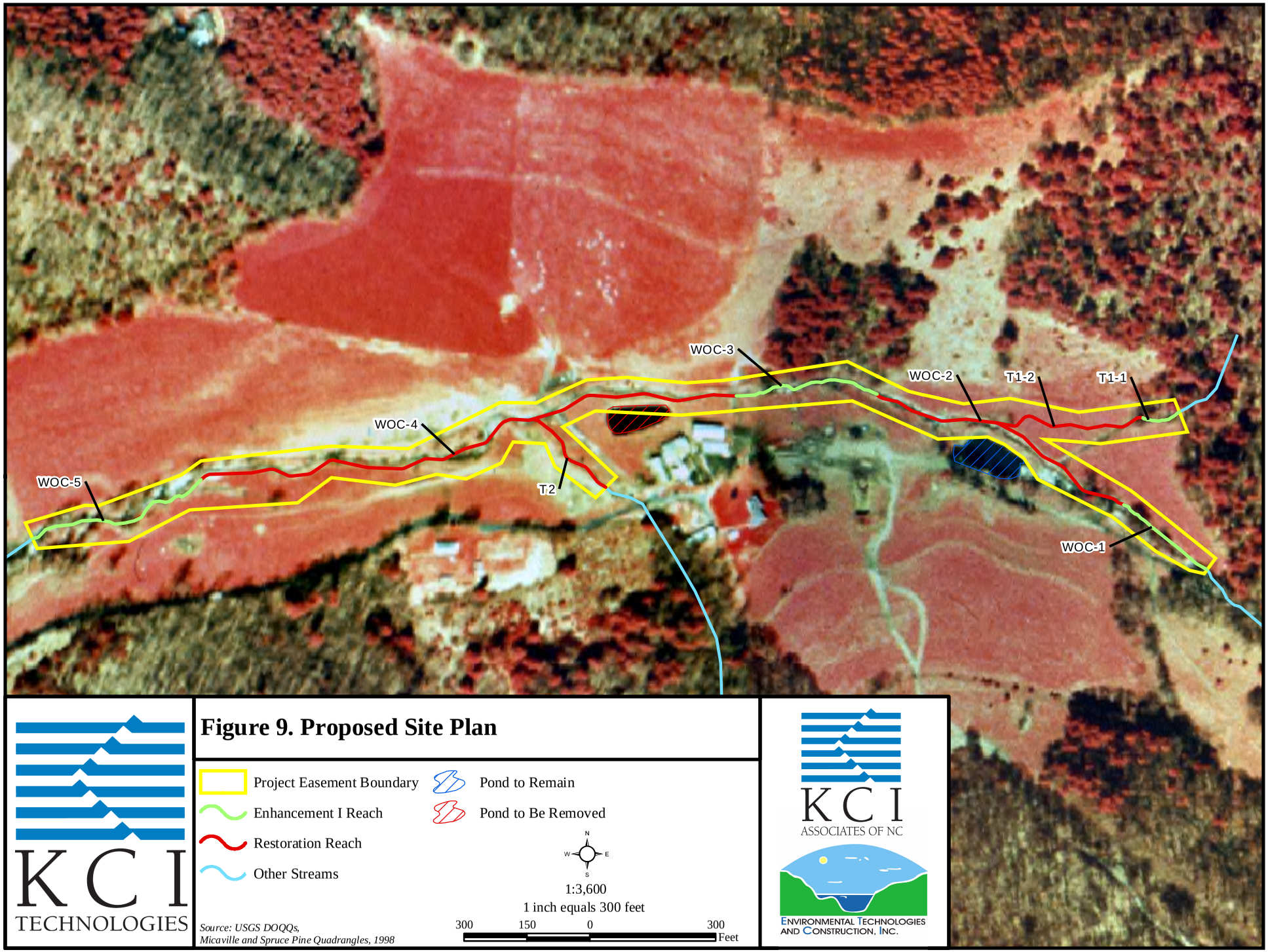

Figure 9. Proposed Site Plan

Project Easement Boundary

Enhancement I Reach

Restoration Reach

Other Streams

Pond to Remain

Pond to Be Removed

N
W E
S

1:3,600

1 inch equals 300 feet

300 150 0 300 Feet

Source: USGS DOQQs, Micaville and Spruce Pine Quadrangles, 1998

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ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.

Stream Plan Sheets

KCI JOB# : 12065439

CONTRACT #: D06056-A

STATE OF NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

STATE	CONTRACT NUMBER	SHEET NO.	TOTAL SHEETS
N.C.	D06056-A	1	19

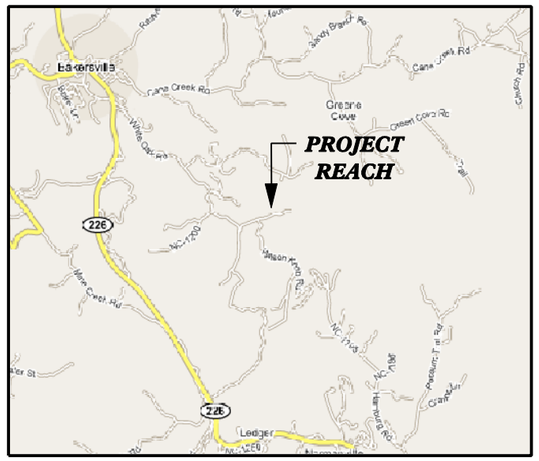
A	SUBMITTED WITH RESTORATION PLAN	JULY 2008	
SYM.	DESCRIPTION	DATE	APPROVED

REVISIONS

MITCHELL COUNTY

LOCATION: DOG BITE SITE
WHITE OAK CREEK
BAKERSVILLE, NORTH CAROLINA

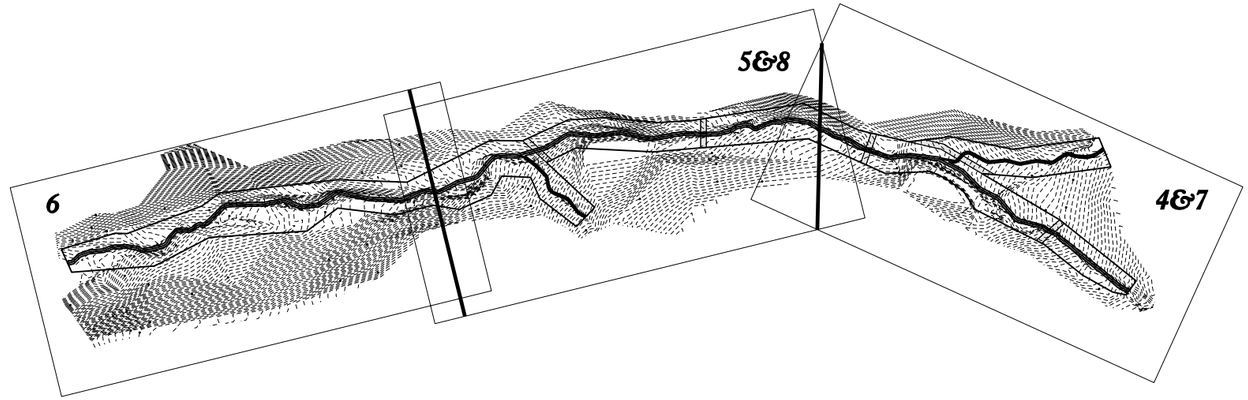
TYPE OF WORK: STREAM RESTORATION AND ENHANCEMENT



VICINITY MAP
NOT TO SCALE

DIRECTIONS TO SITE

TO REACH THE SITE FROM RALEIGH, BEGIN BY PROCEEDING WEST ON I-40 FOR APPROXIMATELY 200 MILES. THEN TAKE EXIT 86 FOR NC-226 TOWARD SHELBY/MARION. TAKE A RIGHT ONTO NC-226, TRAVELING NORTH. FOLLOW NC-226 THROUGH MARION AND SPRUCE PINE. JUST BEFORE REACHING BAKERSVILLE, MAKE A RIGHT ONTO WHITE OAK ROAD. FOLLOW WHITE OAK ROAD FOR APPROXIMATELY 1.5 MILE AND THEN MAKE A LEFT ONTO WILSON DAIRY ROAD. THE ROAD WILL DEAD END AT THE WILSON PROPERTY AND THE DOG BITE SITE IS ON THE LEFT.



NC GRID NAD '83

INDEX OF SHEETS

** INCLUDED IN RESTORATION PLAN*

GRAPHIC SCALES

–40 –20 0 40 80
PLANS

–40 –20 0 40 80
PROFILE (HORIZONTAL)

–4 –2 0 4 8
PROFILE (VERTICAL)

PROJECT DATA

STREAM RESTORATION LENGTH = 2,580 FEET

STREAM ENHANCEMENT LENGTH = 1,156 FEET

Prepared In the Office of:

KCI TECHNOLOGIES
ENGINEERS•PLANNERS•ECOLOGISTS
SUITE 220 LANDMARK CENTER II
4601 SIX FORKS RD., RALEIGH, NC

GARY M. MRYNCZA, PE
PROJECT ENGINEER

ADAM SPILLER
NATURAL CHANNEL DESIGN

PROJECT ENGINEER

SIGNATURE: ***P.E.***

Prepared for:

Ecosystem Enhancement PROGRAM

GUY PEARCE
CONTRACT ADMINISTRATOR

PROJECT LEGEND

STREAM RESTORATION

Proposed Stationed Thalweg w/Approximate Bankfull Limits 

Proposed Offset Rock Cross Vane 

Log Sill Grade Control 

J–Hook /Log Vane /Root Wad 

Proposed Log Step or Step Pool 

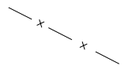
Proposed Channel Block 

Proposed Riffle Grade Control 

Proposed Rock Ford Crossing 

Proposed Stone Stabilization 

MISCELLANEOUS

Barbed Wire Fence 

TOPOGRAPHY

Minor Contour Line

Major Contour Line

SEDIMENT & EROSION CONTROL

Stabilized Construction Entrance 

Silt Fence

Limits of Disturbance

Temporary Stream Crossing 

Silt Fence Rock Outlet 

Rock Silt Screen (Std. Drawing 1636.01) 

A	SUBMITTED WITH RESTORATION PLAN	JULY 2008	
SYM.	DESCRIPTION	DATE	APPROVED

REVISIONS

Ecosystem Enhancement Program

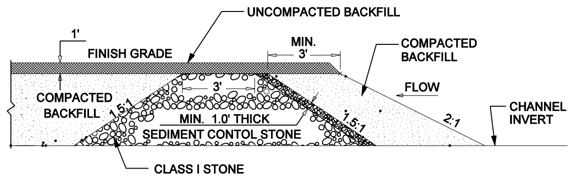
KCI TECHNOLOGIES
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

DOG BITE
STREAM RESTORATION PROJECT
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA

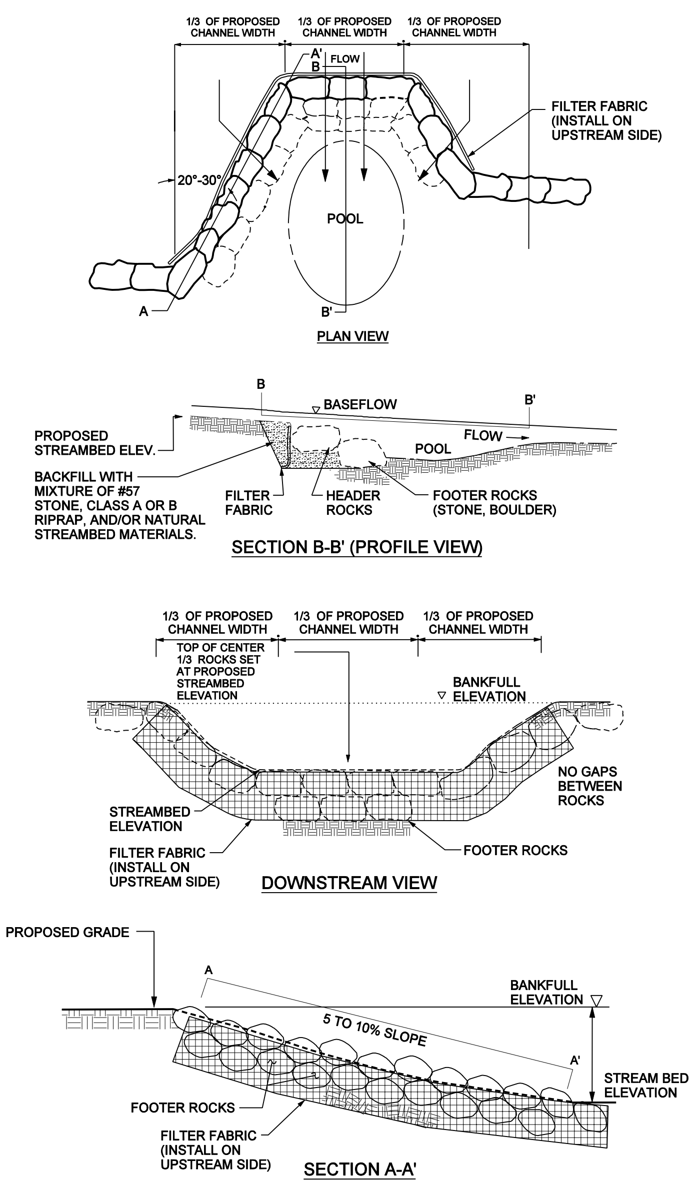
DATE: JULY 2008
SCALE: N.T.S.

PROJECT LEGEND

SHEET 1A OF 16

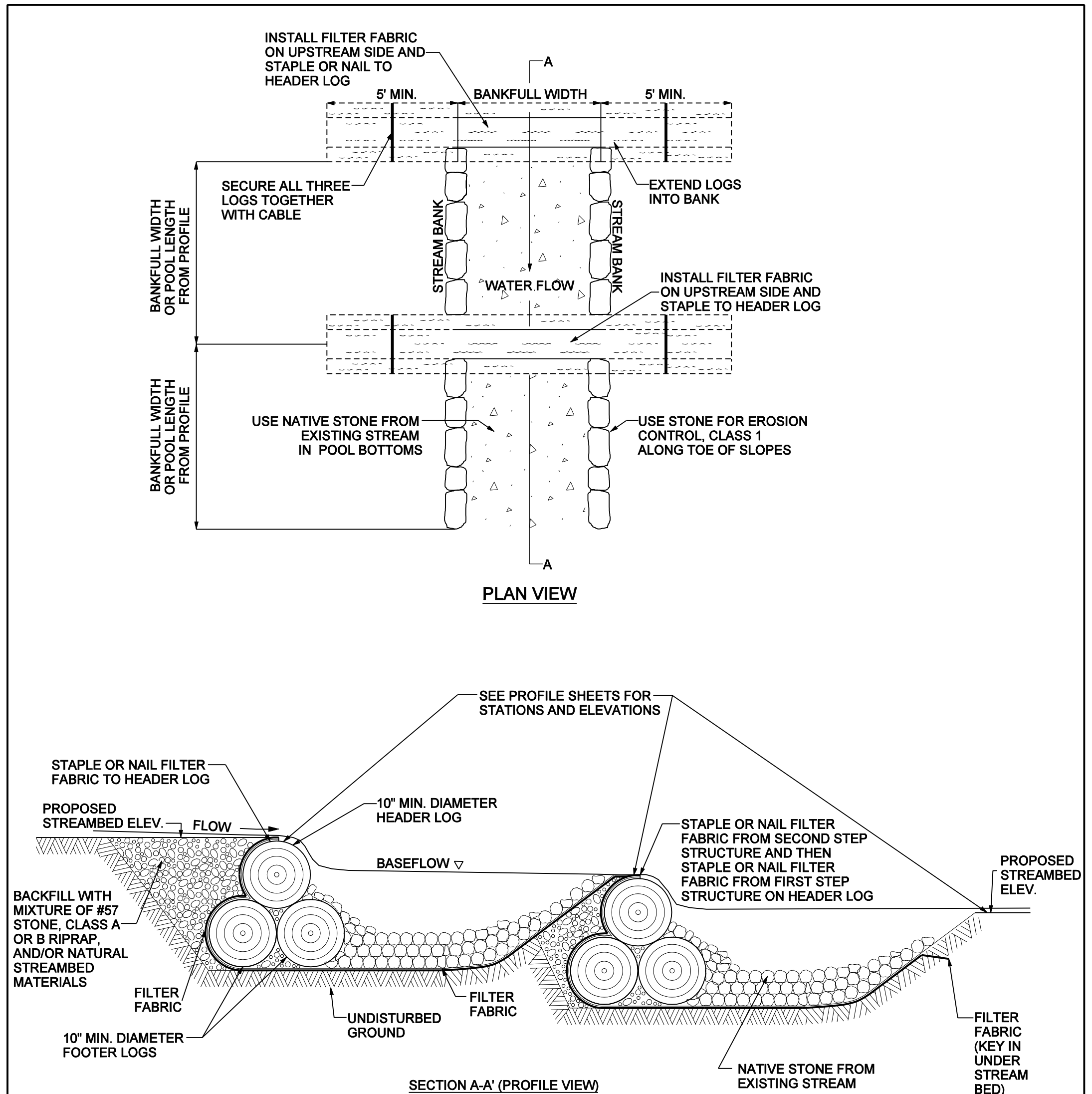


CHANNEL BLOCK
SCALE: NTS



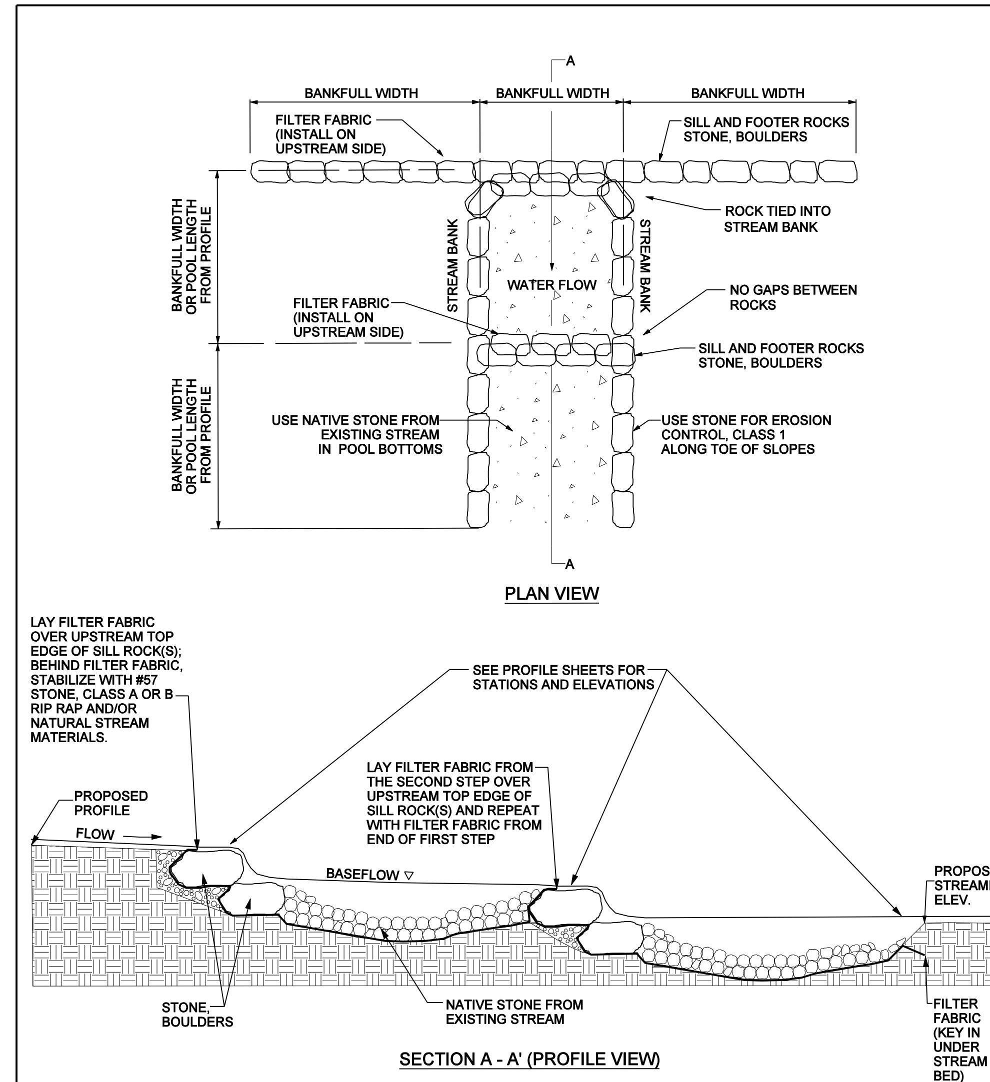
OFFSET ROCK CROSS VANE
SCALE: NTS

NOTE: (1) ALL ROCKS OR STONES IN THE VANE STRUCTURE ARE STONE BOULDERS.
(2) SHORT CROSS VANE ARM TO BE HALF THE SLOPE OF THE FULL ARM SLOPE.



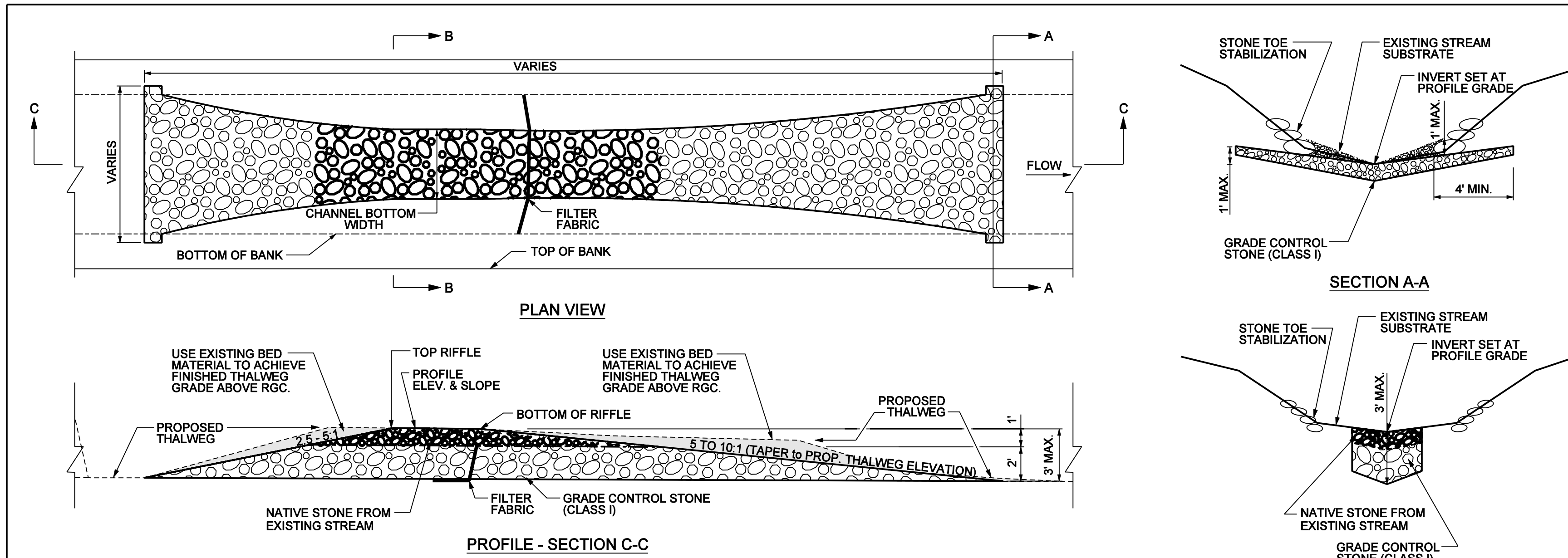
DOUBLE LOG STEP DETAIL
SCALE: NTS

NOTES: - DETAIL SHOWN IS FOR A DOUBLE LOG STEP.
ADJUST ACCORDINGLY FOR SINGLE AND TRIPLE LOG STEPS.
(SEE PROFILE SHEET TO DETERMINE AMOUNT OF STEPS)



DOUBLE STEP POOL
SCALE: NTS

NOTES: - ALL SILL OR FOOTER ROCKS ARE STONE, BOULDERS.
- DETAIL SHOWN IS FOR A DOUBLE STEP POOL.
ADJUST ACCORDINGLY FOR SINGLE AND TRIPLE STEP POOLS.
(SEE PROFILE SHEET TO DETERMINE AMOUNT OF STEPS)



RIFFLE GRADE CONTROL
SCALE: NTS

A	SUBMITTED WITH RESTORATION PLAN	JULY 2008		
SYM.	DESCRIPTION	DATE	APPROVED	

REVISIONS

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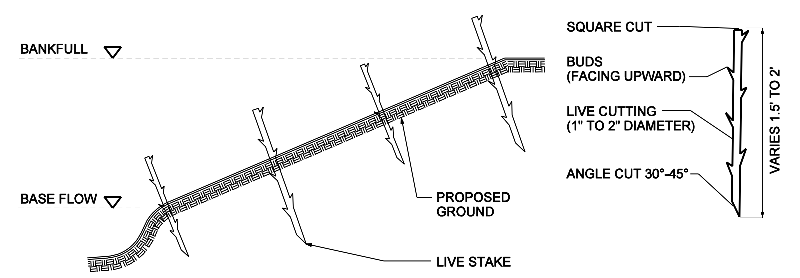
DOG BITE
STREAM RESTORATION PROJECT
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA

DATE: JULY 2008
SCALE: N.T.S.

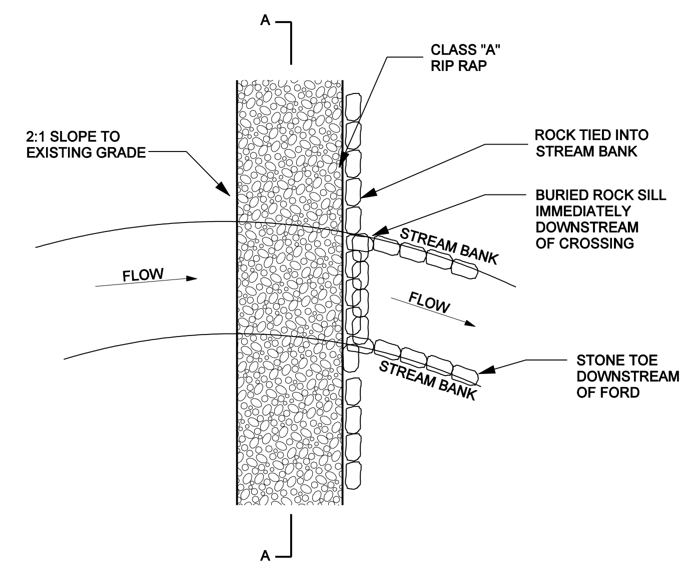
DETAILS:
STABILIZATION

SHEET 2 OF 16

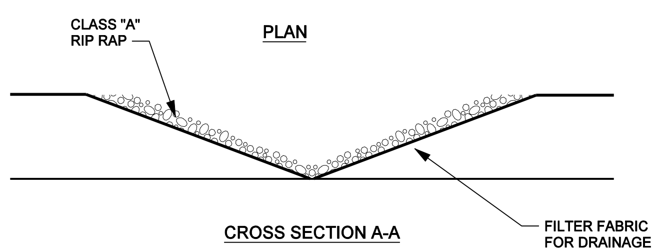


LIVE STAKES

SCALE: NTS



PLAN

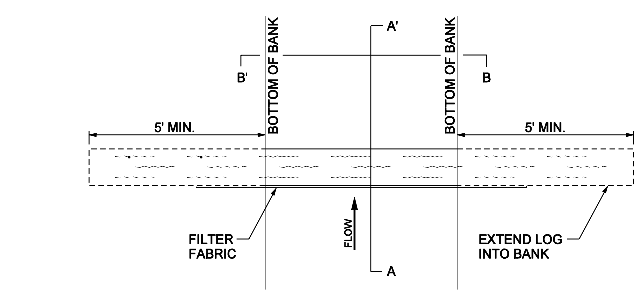


CROSS SECTION A-A

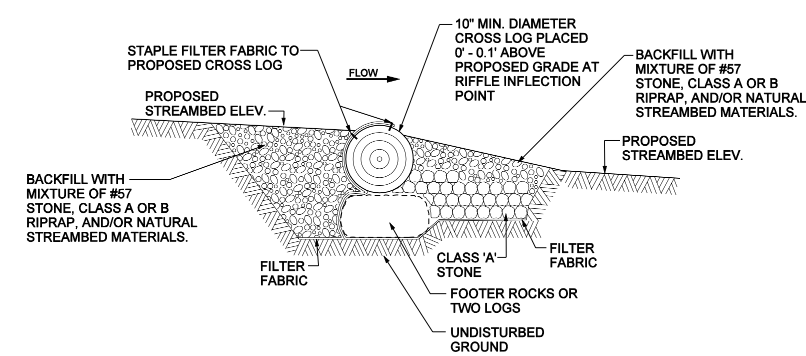
1. A STABILIZED PAD OF CLASS "A" RIP RAP, 18 INCHES THICK, LINED WITH FILTER FABRIC SHALL BE LOCATED WHERE FARM EQUIPMENT AND LIVESTOCK WILL BE CROSSING THE RESTORED STREAM CHANNEL.
2. EXCLUSION FENCING SHALL BE INSTALLED ON ALL APPROACHES TO AND ADJACENT TO THE CROSSING.
3. THE CROSSING SHALL BE BUILT TO THE DIMENSIONS SPECIFIED ON THE PLANS.
4. THE DESIGNER SHALL DETERMINE AN APPROPRIATE RAMP ANGLE FOR THE STREAM CROSSING ACCORDING TO THE CHANNEL MORPHOLOGY.
5. THE CROSSING LOCATIONS ARE DEPICTED IN THE PLANS.

ROCK FORD CROSSING

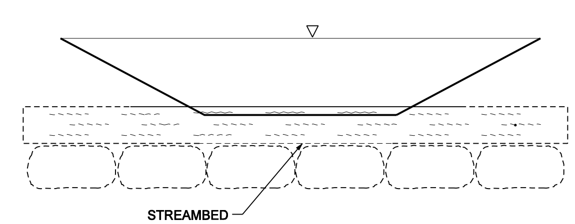
SCALE: NTS



PLAN VIEW



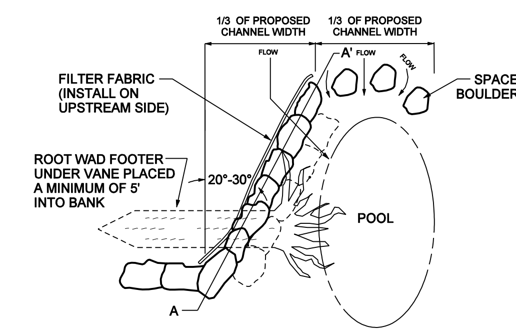
SECTION B-B' (PROFILE VIEW)



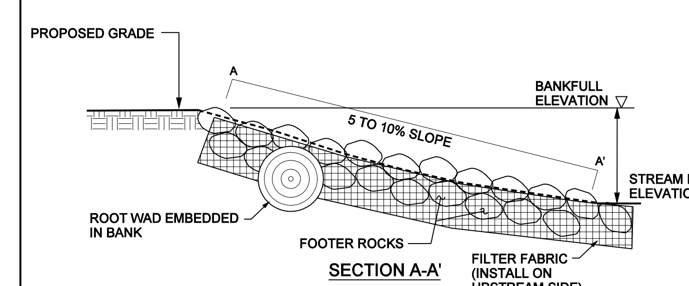
SECTION A-A' (CROSS SECTION VIEW)

LOG DROP DETAIL

SCALE: NTS



PLAN VIEW



SECTION A-A'

J-HOOK / LOG VANE / ROOT WAD

SCALE: NTS

NOTE: (1) ALL ROCKS OR STONES IN THE VANE STRUCTURE ARE STONE, BOULDERS.
(2) A LOG VANE ANCHORED INTO THE BED AND BANK MAY BE SUBSTITUTED FOR VANE BOULDERS AT THE DIRECTION OF THE DESIGNER.

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN	JULY 2008	

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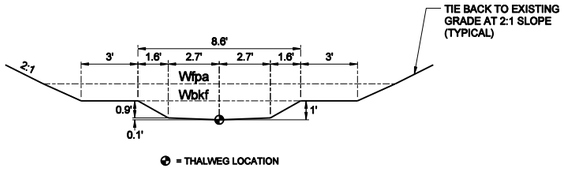
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA

DATE: JULY 2008
SCALE: N.T.S.

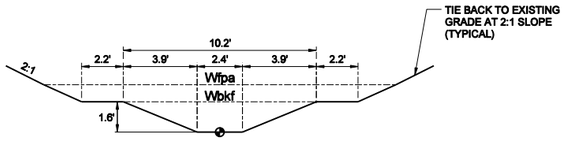
DETAILS:
STABILIZATION

SHEET 2A OF 16

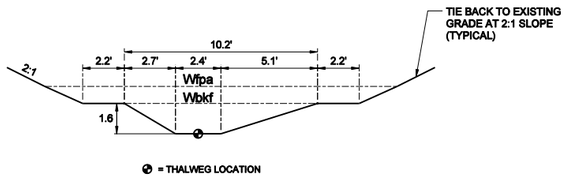
WOC-1 AND WOC-2
STATION 10+00 TO STATION 19+25
"B4a" STREAM TYPE
ENHANCEMENT 1 AND RESTORATION



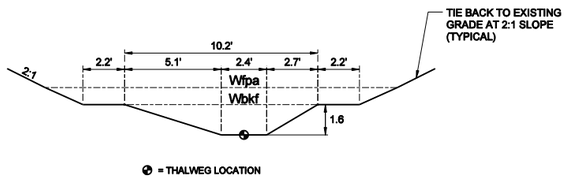
TYPICAL RIFFLE



TYPICAL STEP POOL

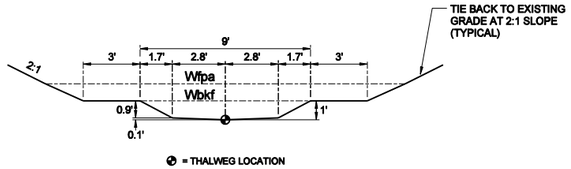


TYPICAL POOL - LEFT MEANDER

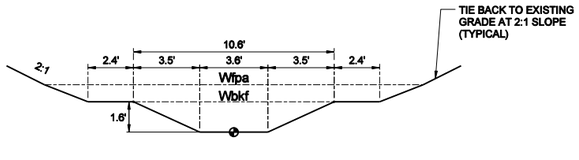


TYPICAL POOL - RIGHT MEANDER

WOC-3
STATION 19+25 TO STATION 22+74
"B4a" STREAM TYPE
ENHANCEMENT I

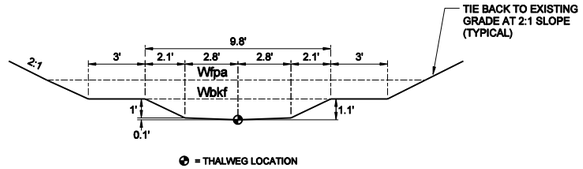


TYPICAL RIFFLE

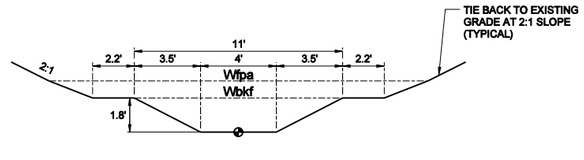


TYPICAL STEP POOL

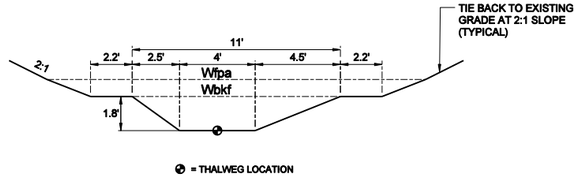
WOC-4
STATION 22+88 TO STATION 36+31
"B4a" STREAM TYPE
RESTORATION



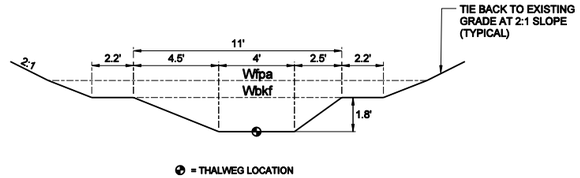
TYPICAL RIFFLE



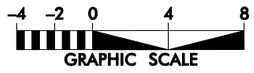
TYPICAL STEP POOL



TYPICAL POOL - LEFT MEANDER



TYPICAL POOL - LEFT MEANDER



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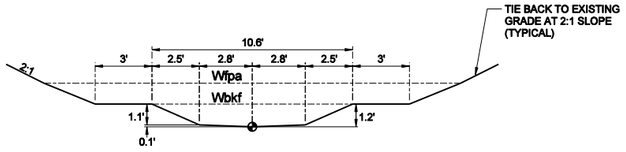
DOG BITE
STREAM RESTORATION PROJECT
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA

DATE: JULY 2008
SCALE: N.T.S.

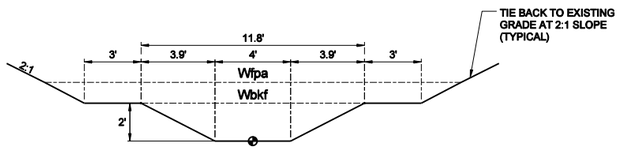
DETAILS:
TYPICAL XS

WOC-5
STATION 36+31 TO STATION 40+89
"B4" STREAM TYPE
ENHANCEMENT I



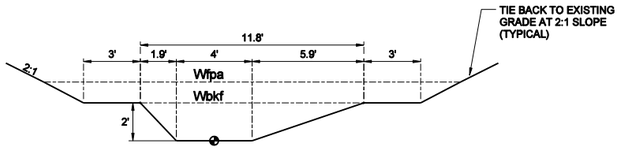
⊘ = THALWEG LOCATION

TYPICAL RIFFLE



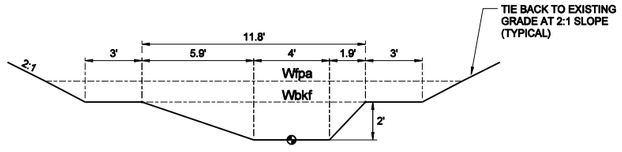
⊘ = THALWEG LOCATION

TYPICAL STEP POOL



⊘ = THALWEG LOCATION

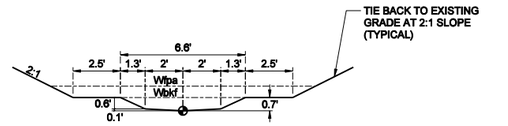
TYPICAL POOL - LEFT MEANDER



⊘ = THALWEG LOCATION

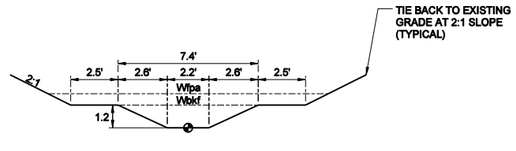
TYPICAL POOL - RIGHT MEANDER

T1-1 AND T1-2
STATION 50+00 TO STATION 54+69
"B4a" STREAM TYPE
ENHANCEMENT II AND RESTORATION



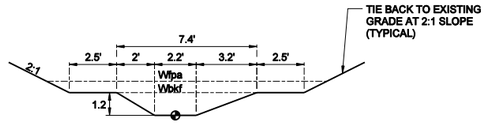
⊘ = THALWEG LOCATION

TYPICAL RIFFLE



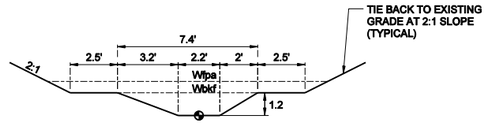
⊘ = THALWEG LOCATION

TYPICAL STEP POOL



⊘ = THALWEG LOCATION

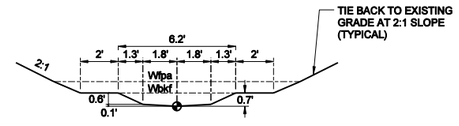
TYPICAL POOL - LEFT MEANDER



⊘ = THALWEG LOCATION

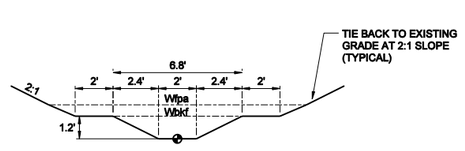
TYPICAL POOL - RIGHT MEANDER

T2
STATION 60+00 TO STATION 62+57
"B4a" STREAM TYPE
RESTORATION



⊘ = THALWEG LOCATION

TYPICAL RIFFLE



⊘ = THALWEG LOCATION

TYPICAL STEP POOL

GRAPHIC SCALE
–4 –2 0 4 8

REVISIONS			
STAL	DESCRIPTION	DATE	APPROVED
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STREAM RESTORATION PROJECT
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA

DATE: JULY 2008
SCALE: N.T.S.

DETAILS:
TYPICAL XS

GRAPHIC SCALE
–40 –20 0 40 80

SEE SHEET 5 FOR CONTINUATION

MATCHLINE - SEE SHEET 5 AND 8

EASEMENT EXCEPTION INSTALL 15' WIDE FORD CROSSING

INSTALL PROPOSED RIFFLE GRADE CONTROL

EASEMENT EXCEPTION INSTALL 15' WIDE FORD CROSSING

NOTE:
ALL RIFFLES ARE TO BE ENHANCED WITH NATIVE MATERIAL STOCKPILED FROM EXISTING STREAM OR WITH CLASS "B" STONE.

STABILIZE EXISTING STREAM CONFLUENCE AND TIE INTO PROPOSED CHANNEL

CONSERVATION EASEMENT BOUNDARY

POND

POND OUTLET PIPE

STABILIZE EXISTING DRAINAGE FEATURE AND TIE INTO PROPOSED CHANNEL

FILL OLD STREAM CHANNEL

MAINTAIN AND STABILIZE EXISTING POND INTAKE PIPE

INSTALL PROPOSED RIFFLE GRADE CONTROL

EASEMENT EXCEPTION INSTALL 15' WIDE FORD CROSSING

CONSERVATION EASEMENT BOUNDARY

EXISTING FARM ROAD

WOC-1
ENHANCEMENT I

WOC-2
RESTORATION

WOC-3
ENHANCEMENT I

EXISTING GRADE

PROPOSED GRADE

2860
2856
2852
2848
2844
2840
2836
2832
2828
2824
2820
2816
2812
2808
2804
2800
2796

10+00 11+00 12+00 13+00 14+00 15+00 16+00 20+00

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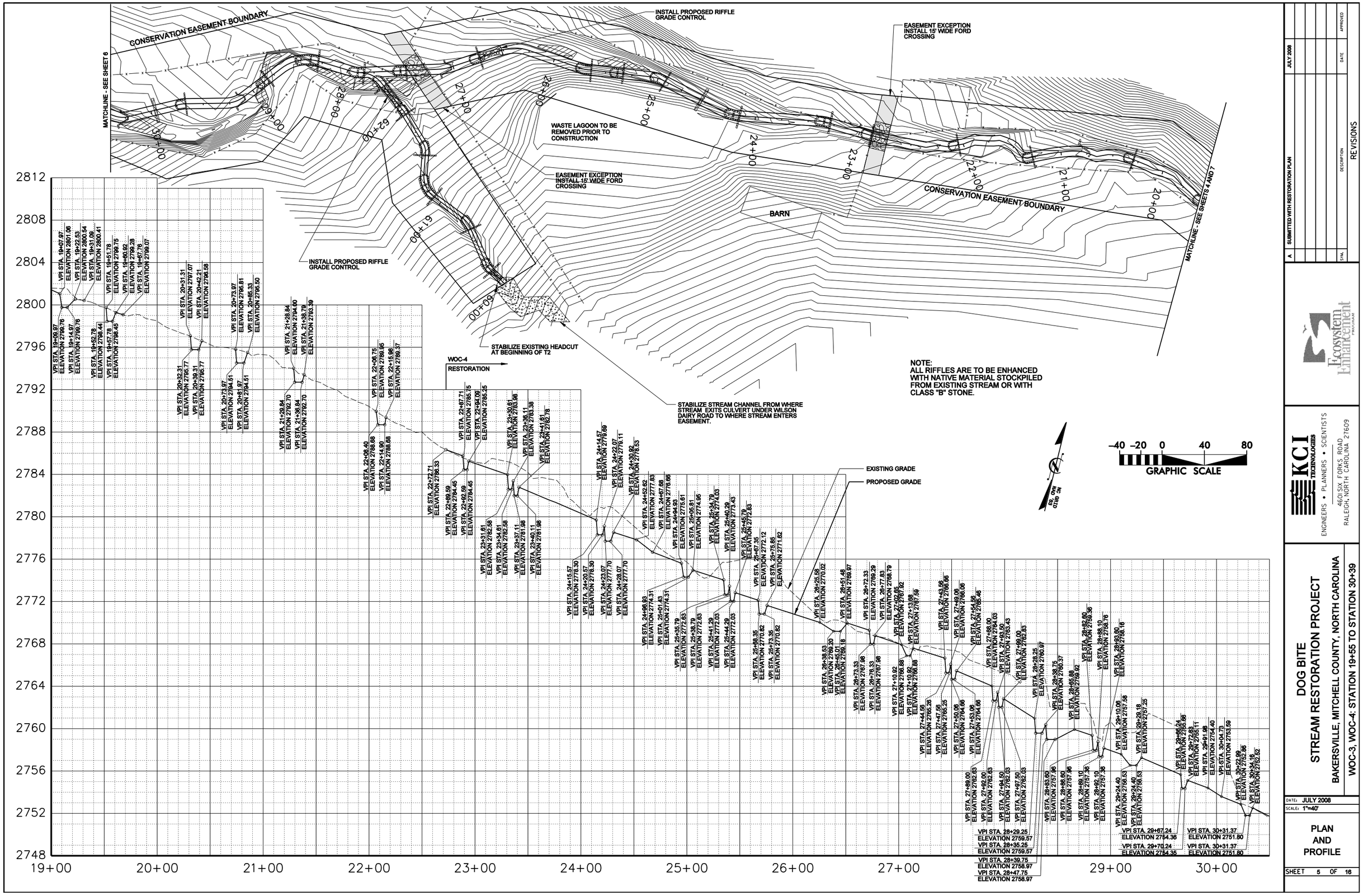
DOG BITE
STREAM RESTORATION PROJECT
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA
WOC-1, WOC-2, WOC-3: STATION 10+00 TO STATION 19+55

DATE: JULY 2008
SCALE: 1"=40'

PLAN AND PROFILE

SHEET 4 OF 16



A	SUBMITTED WITH RESTORATION PLAN				JULY 2008	
				SYM.	DATE	APPROVED
				DESCRIPTION	REVISIONS	

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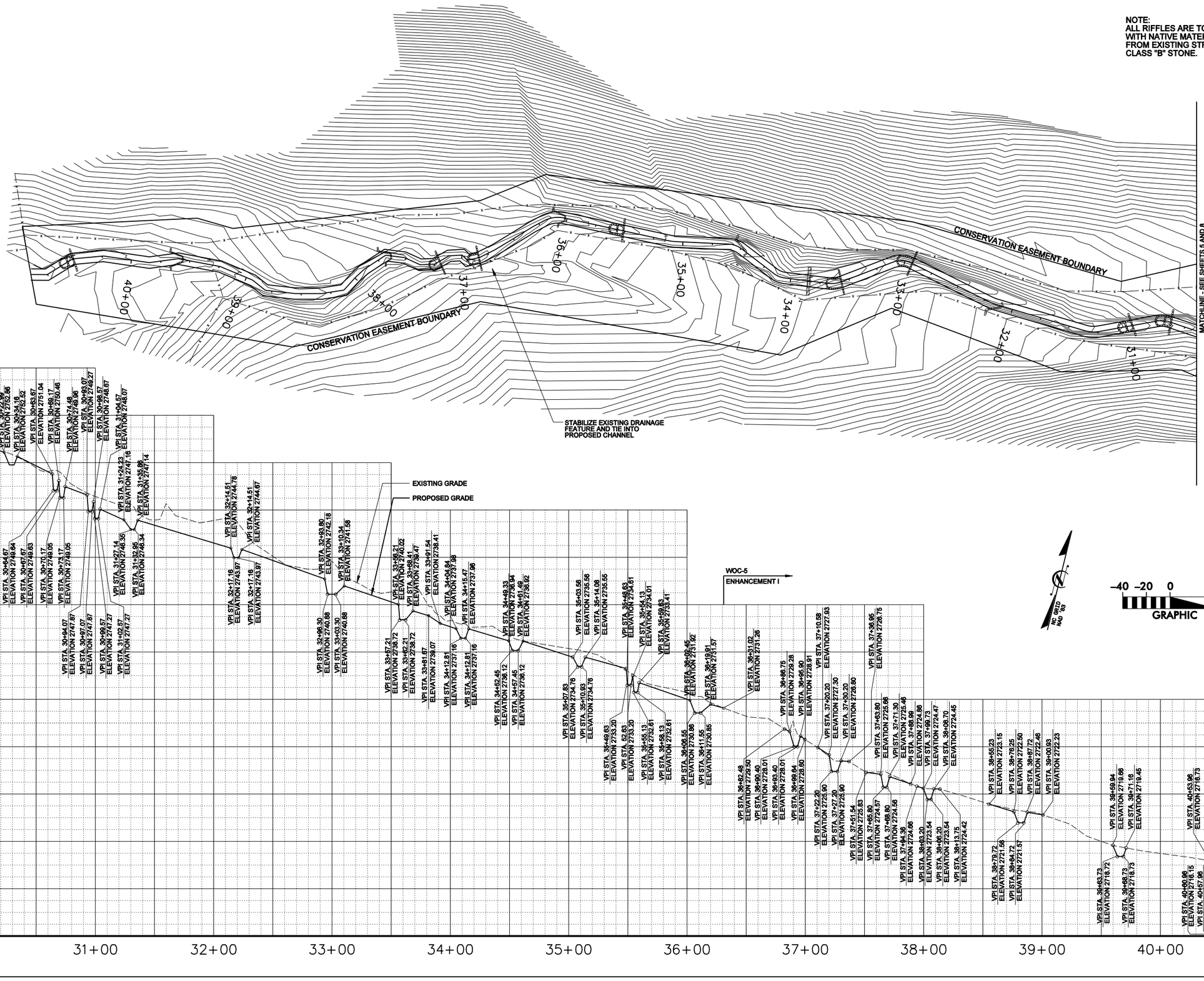
DOG BITE
STREAM RESTORATION PROJECT
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA
WOC-3, WOC-4: STATION 19+55 TO STATION 30+39

DATE: JULY 2008
SCALE: 1"=40'

PLAN AND PROFILE

SHEET 5 OF 16

NOTE:
ALL RIFFLES ARE TO BE ENHANCED WITH NATIVE MATERIAL STOCKPILED FROM EXISTING STREAM OR WITH CLASS "B" STONE.



A	SUBMITTED WITH RESTORATION PLAN				JULY 2008	
			DESCRIPTION	SYM.	DATE	APPROVED

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STREAM RESTORATION PROJECT

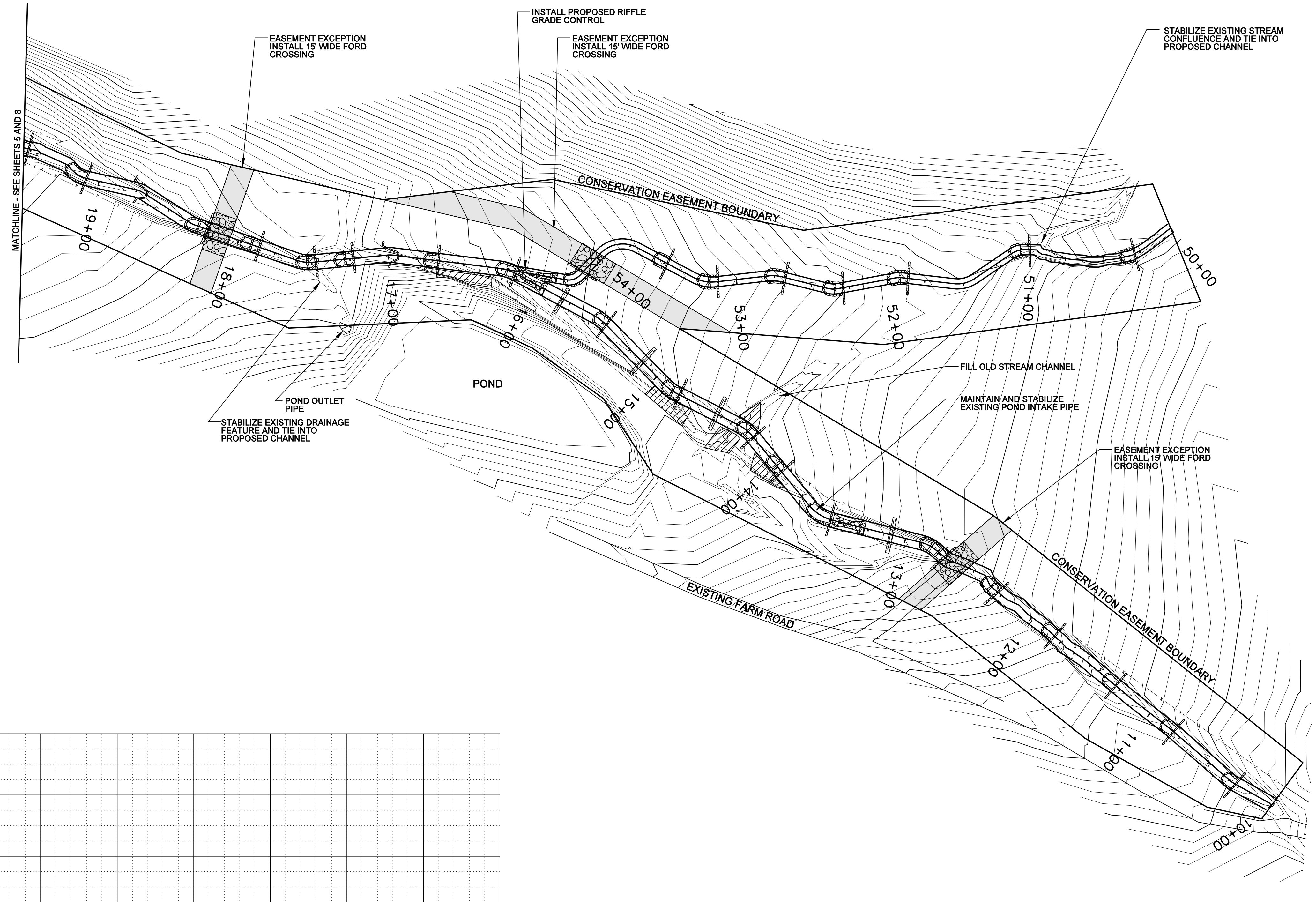
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA

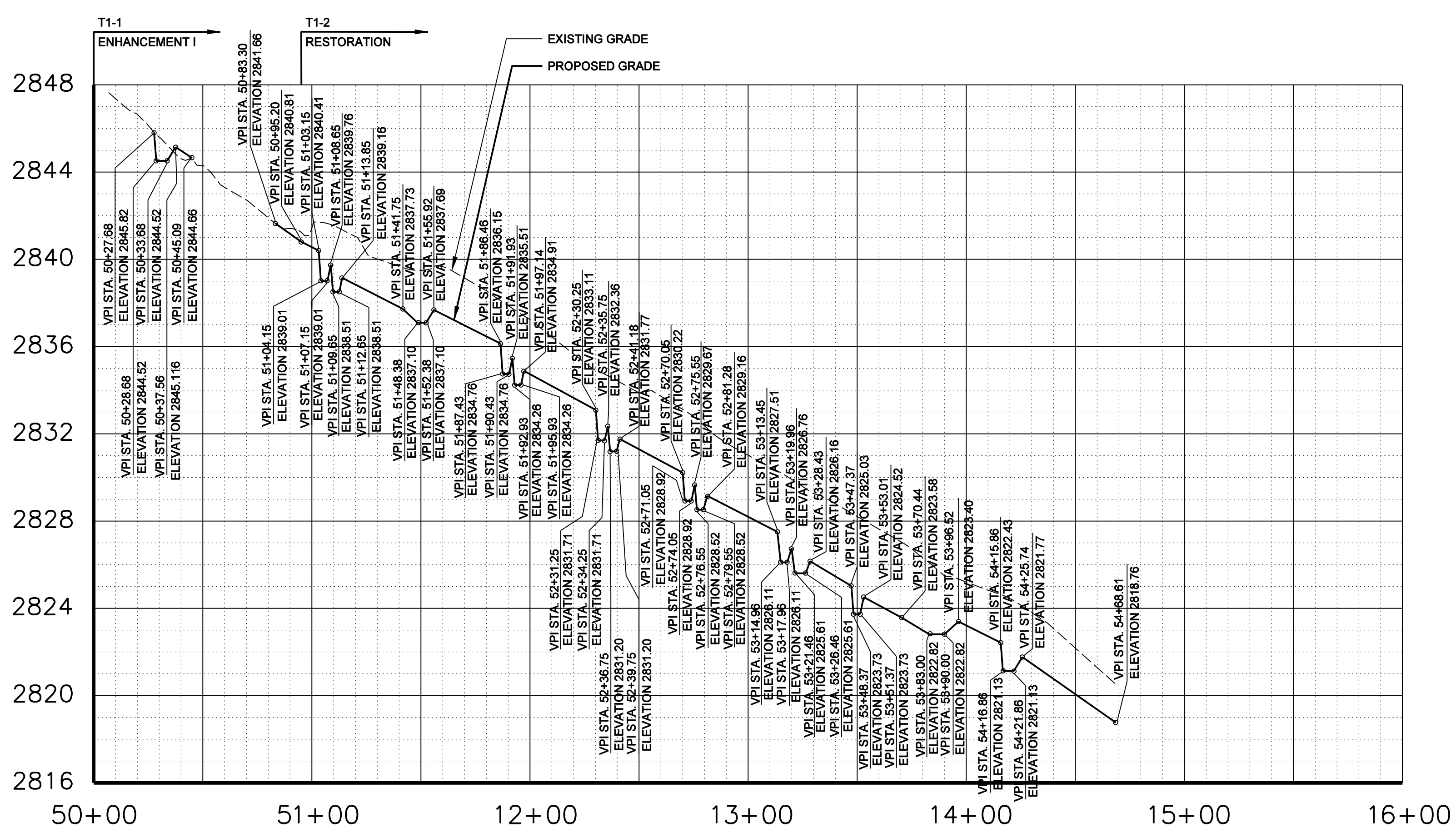
WOC-4, WOC-5: STATION 30+39 TO STATION 40+89

DATE: JULY 2008

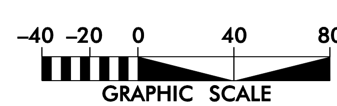
SCALE: 1"=40'

PLAN AND PROFILE





NOTE:
ALL RIFFLES ARE TO BE ENHANCED WITH NATIVE MATERIAL STOCKPILED FROM EXISTING STREAM OR WITH CLASS "B" STONE.



NC GRID NAD '83

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN	JULY 2008	

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DOG BITE
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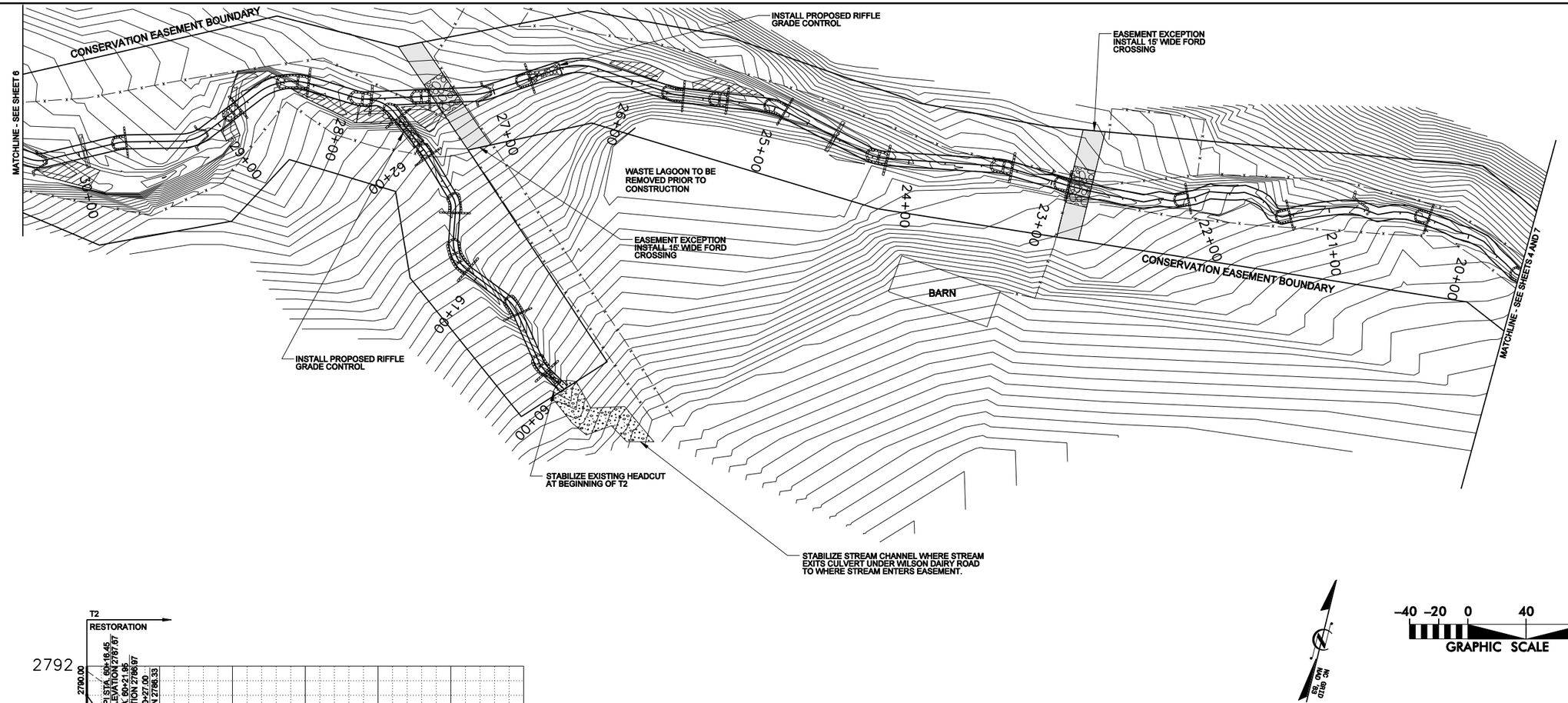
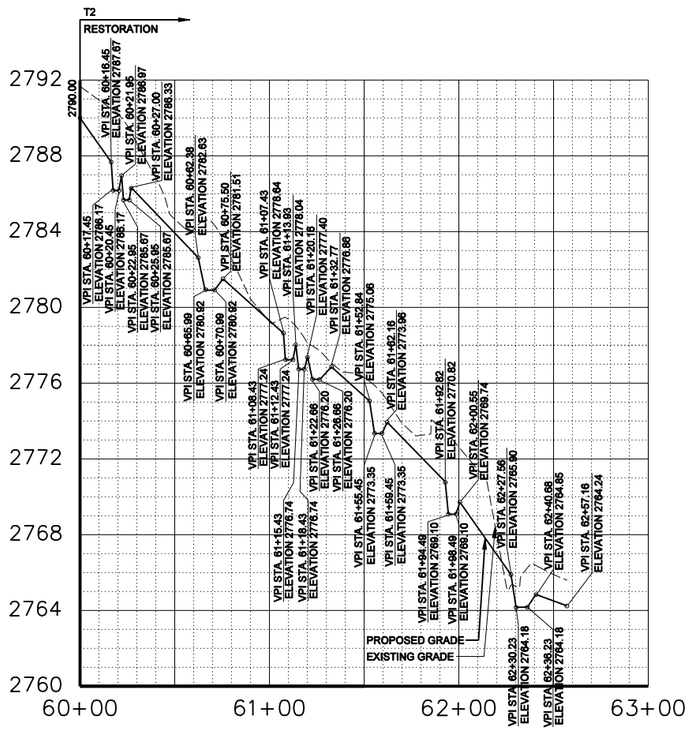
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA
T1: STATION 50+00 TO STATION 54+69

DATE: JULY 2008
SCALE: 1"=40'

PLAN AND PROFILE

SHEET 7 OF 16





NOTE:
ALL RIFFLES ARE TO BE ENHANCED WITH NATIVE MATERIAL STOCKPILED FROM EXISTING STREAM OR WITH CLASS "B" STONE.

A	SUBMITTED WITH RESTORATION PLAN	JULY 2008		
		SYM.	DESCRIPTION	DATE

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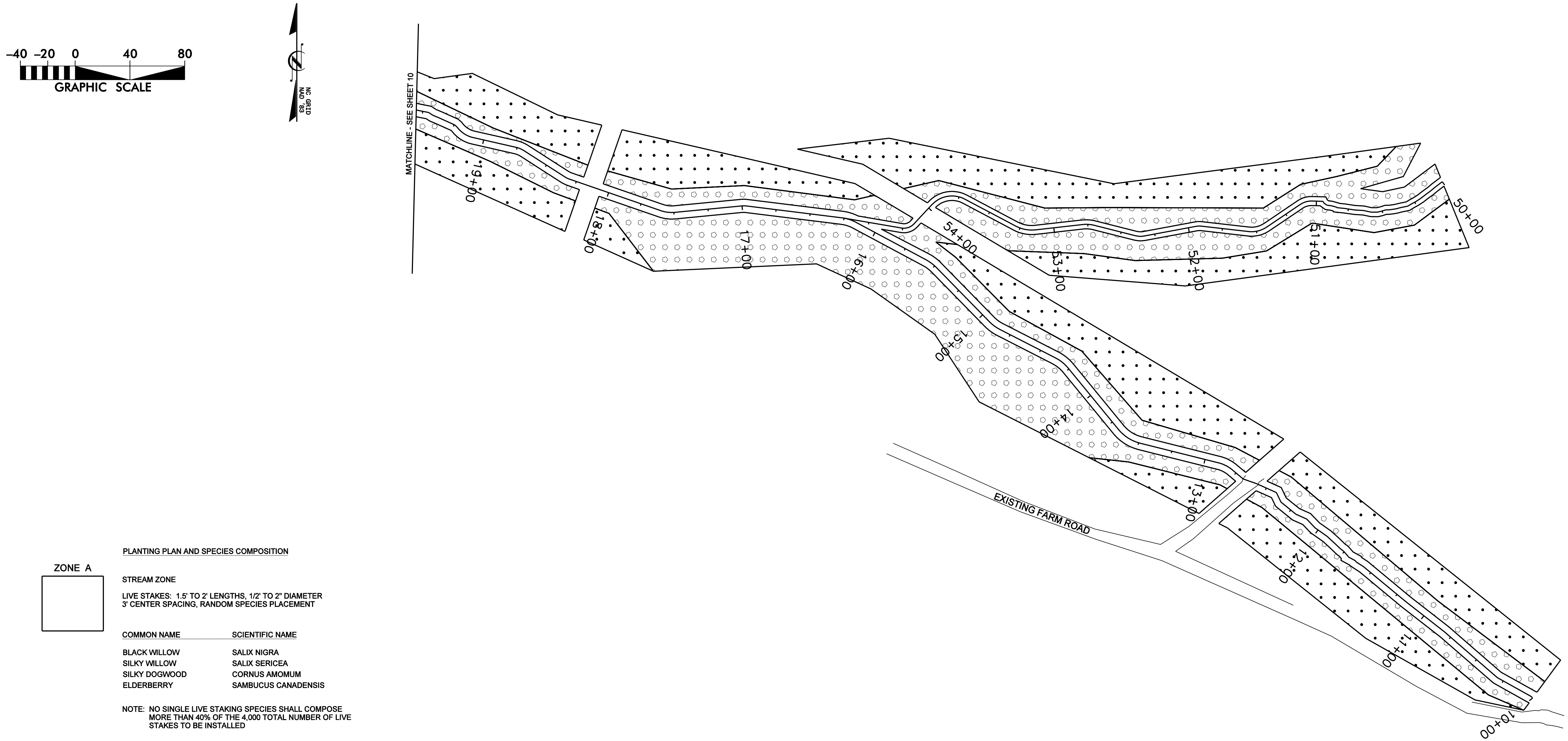
T2: STATION 60+00 TO STATION 62+57

DATE: JULY 2008
SCALE: 1"=40'

PLAN AND PROFILE



PLANTING PLAN AND SPECIES COMPOSITION

ZONE A

STREAM ZONE

LIVE STAKES: 1.5' TO 2' LENGTHS, 1/2' TO 2" DIAMETER
3' CENTER SPACING, RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME
BLACK WILLOW	SALIX NIGRA
SILKY WILLOW	SALIX SERICEA
SILKY DOGWOOD	CORNUS AMOMUM
ELDERBERRY	SAMBUCUS CANADENSIS

NOTE: NO SINGLE LIVE STAKING SPECIES SHALL COMPOSE MORE THAN 40% OF THE 4,000 TOTAL NUMBER OF LIVE STAKES TO BE INSTALLED

ZONE B

MONTANE ALLUVIAL FOREST PLANTING AREA = 2.37 ACRES

12" - 18" BARE ROOT MATERIAL
680 STEMS/ACRE (8' X 8' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	% OF TOTAL	# OF PLANTS
WINTERBERRY	ILEX VERTICILLATA	10	165
SPICEBUSH	LINDERA BENZOIN	10	165
TAG ALDER	ALNUS SERRULATA	15	240
WITCH HAZEL	HAMAMELIS VIRGINIANA	10	165
SYCAMORE	PLATANUS OCCIDENTALIS	15	240
RIVER BIRCH	BETULA NIGRA	15	240
YELLOW BIRCH	BETULA ALLEGHANIENSIS	5	85
TULIP POPLAR	LIRIODENDRON TULIPIFERA	15	240
WHITE OAK	QUERCUS ALBA	5	85
		100	1,625

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

ZONE C

MONTANE OAK-HICKORY FOREST PLANTING AREA = 3.64 ACRES

12" - 18" BARE ROOT MATERIAL
680 STEMS/ACRE (8' X 8' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	% OF TOTAL	# OF PLANTS
SWEETSHRUB	CALYCANTHUS FLORIDA	5	125
SPICEBUSH	LINDERA BENZOIN	10	250
SERVICEBERRY	AMELANCHIER ARBOREA	10	250
WITCH HAZEL	HAMAMELIS VIRGINIANA	5	125
BLACK WALNUT	JUGLANS NIGRA	10	250
MOCKERNUT HICKORY	CARYA ALBA	10	250
TULIP POPLAR	LIRIODENDRON TULIPIFERA	15	375
BLACK GUM	NYSSA SYLVATICA	10	250
WHITE OAK	QUERCUS ALBA	15	375
CHESTNUT OAK	QUERCUS PRINUS	10	250
		100	2,500

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN	JULY 2008	

REVISIONS

Ecosystem Enhancement PROGRAM

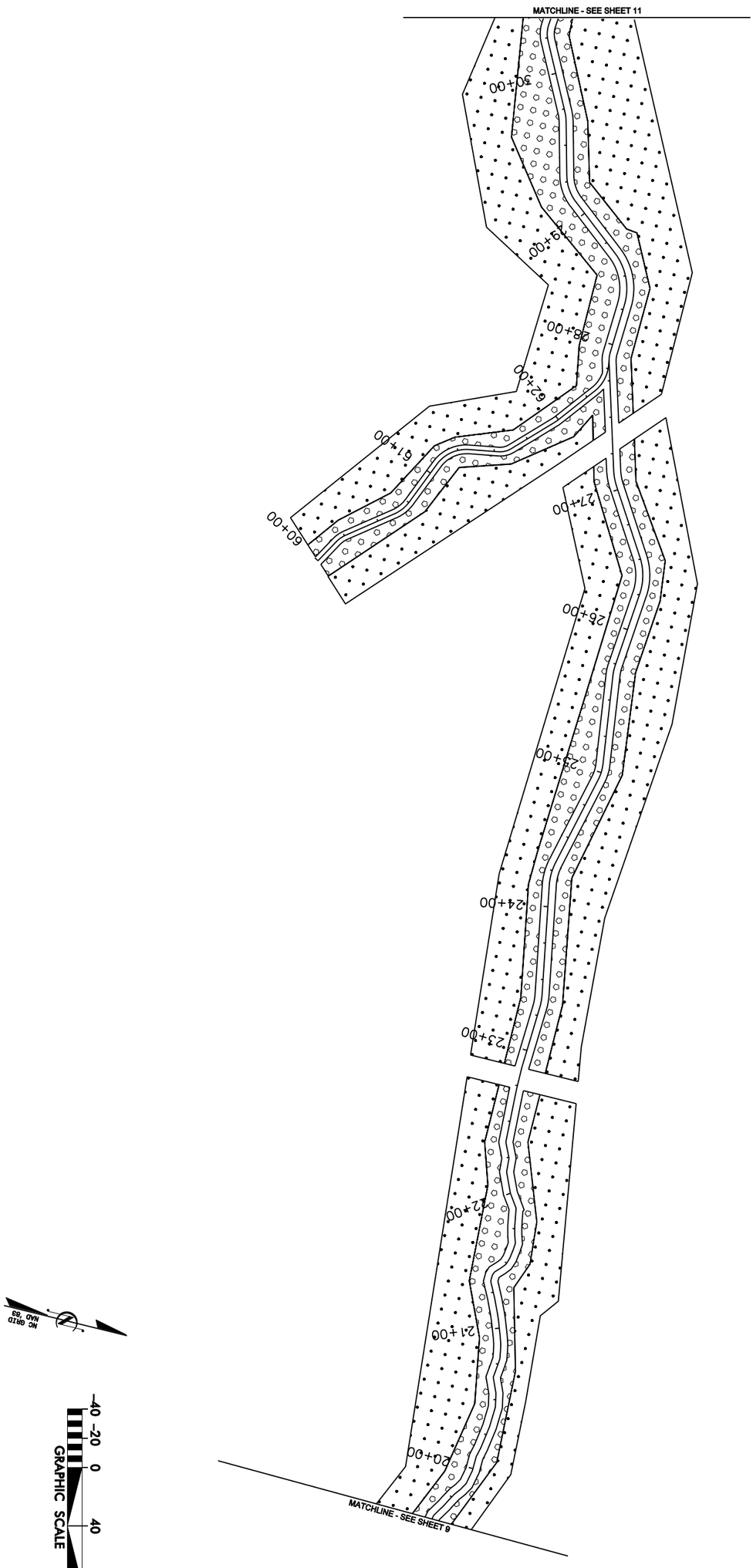
KCI TECHNOLOGIES
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

DOG BITE
STREAM RESTORATION PROJECT
BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA
WOC-1, WOC-2, WOC-3: STATION 10+00 TO STATION 19+55

DATE: JULY 2008
SCALE: 1"=40'

PLANTING PLAN

SHEET 9 OF 16



SHEET 10 OF 16

PLANTING PLAN

DATE: JULY 2008

SCALE: 1"=40'

DOG BITE
STREAM RESTORATION PROJECT

BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA

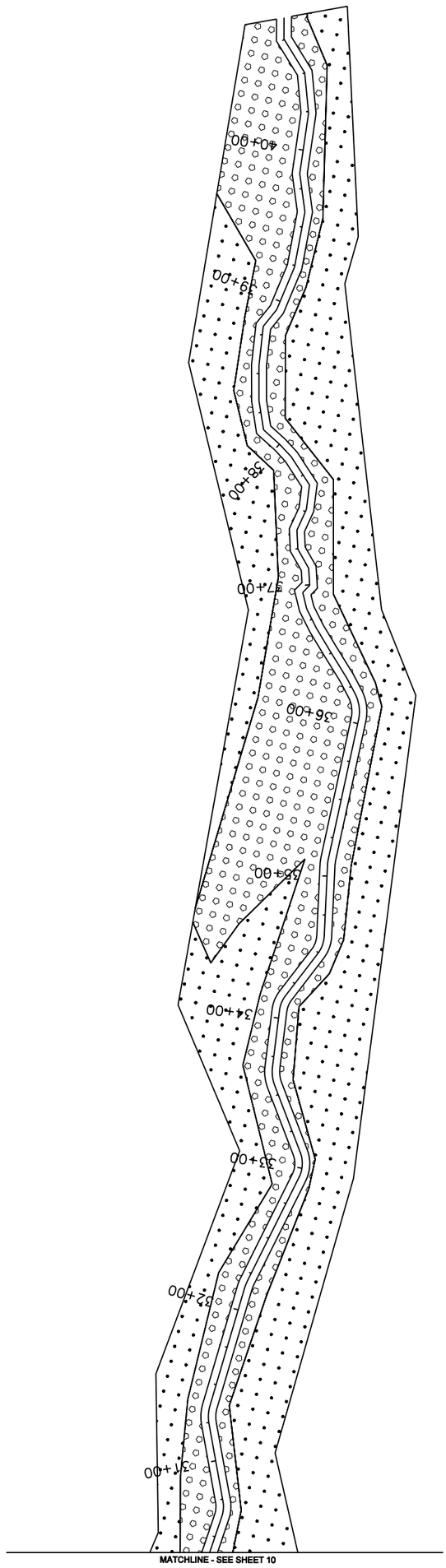
WOC-3, WOC-4: STATION 19+55 TO STATION 30+39

KCI TECHNOLOGIES
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

Ecosystem Enhancement PROGRAM

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN	JULY 2008	

REVISIONS



SHEET 11 OF 16

PLANTING PLAN

DATE: JULY 2008

SCALE: 1"=40'

DOG BITE
STREAM RESTORATION PROJECT

BAKERSVILLE, MITCHELL COUNTY, NORTH CAROLINA

WOC-4, WOC-5: STATION 30+39 TO STATION 40+89

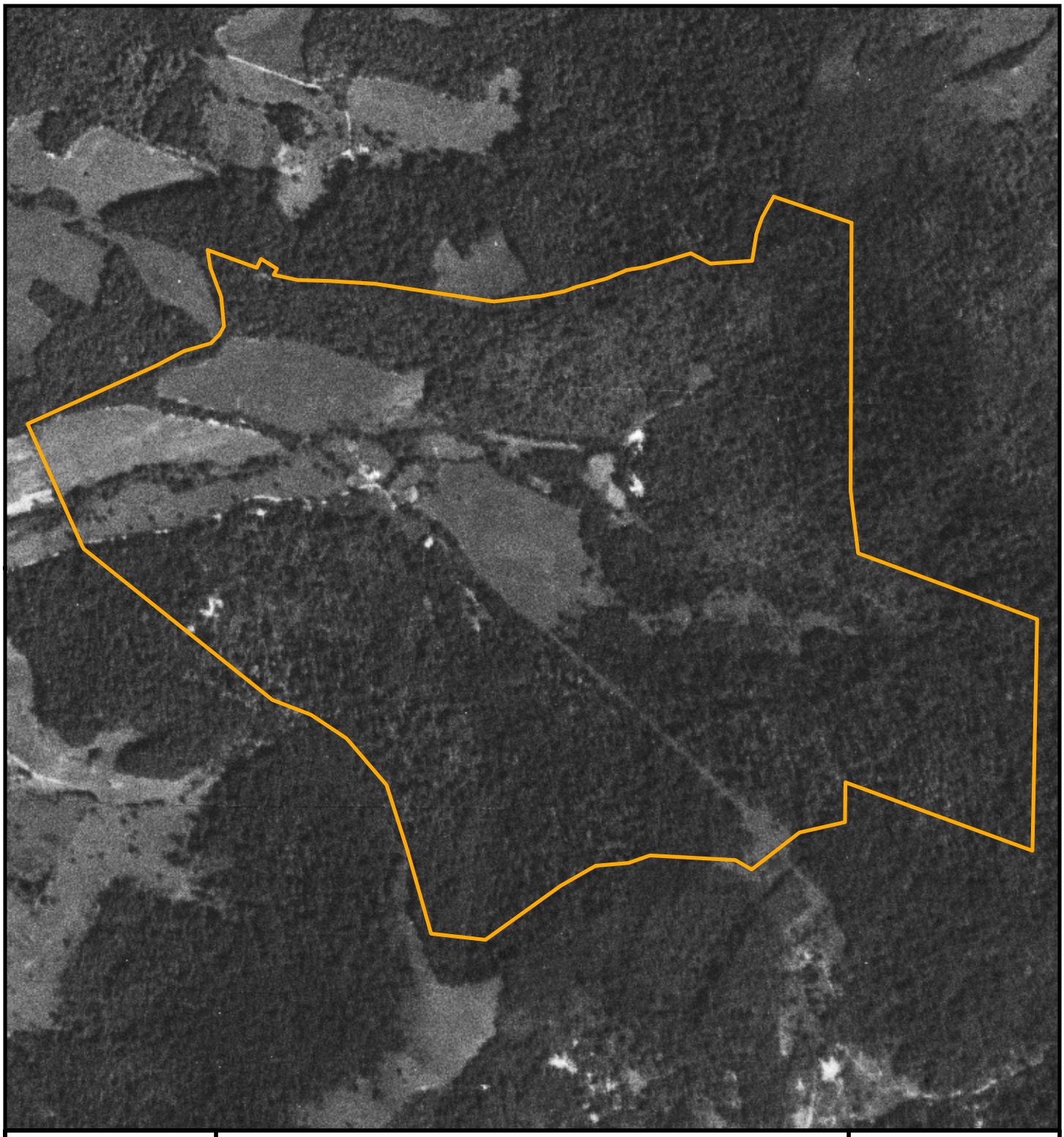
KCI TECHNOLOGIES
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN	JULY 2008	

REVISIONS

Appendix A
Historic Aerial Photographs



Historic Aerial Photograph - 1956

KCI TECHNOLOGIES

Limits of Project Parcel

N
W E
S

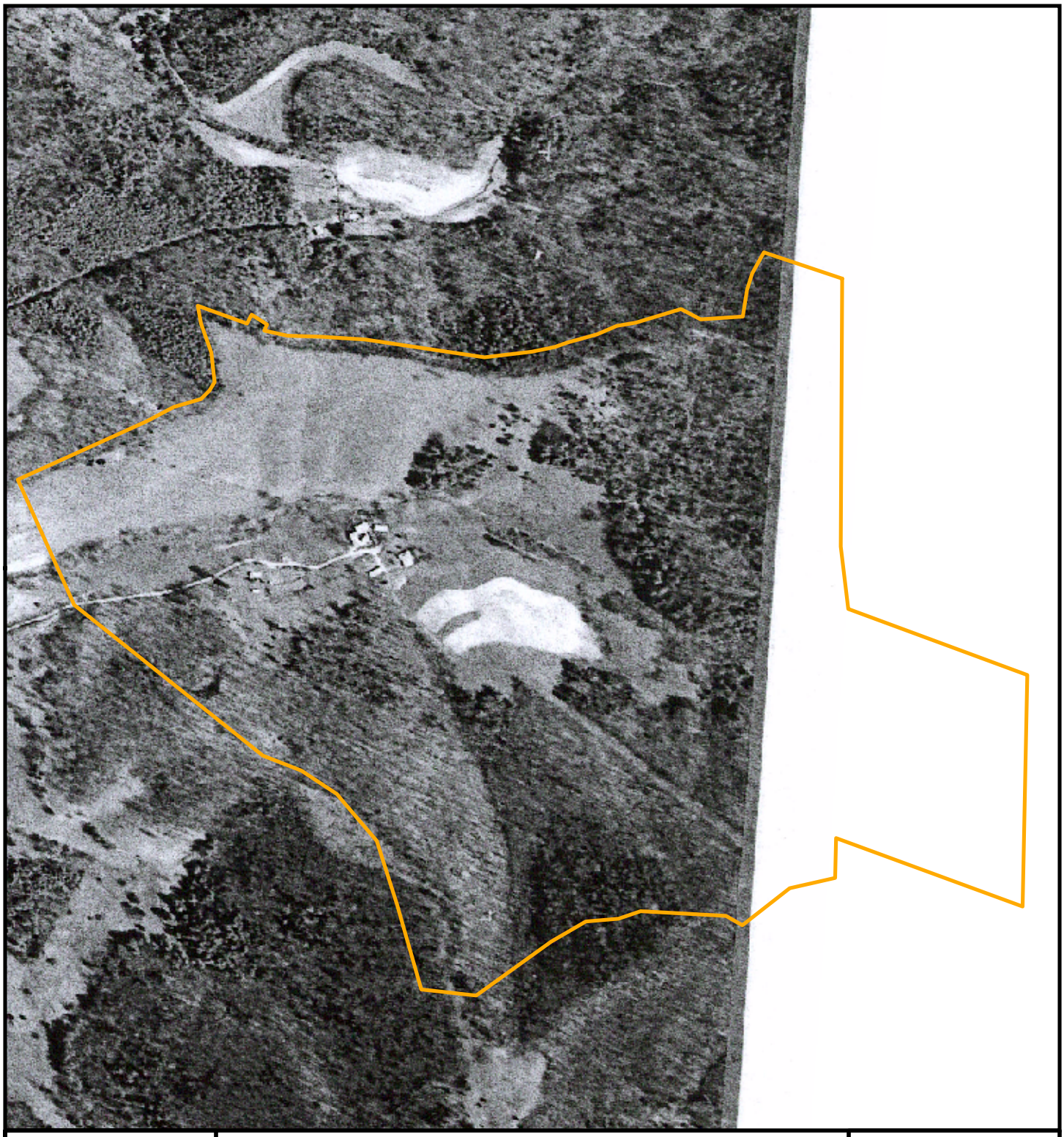
1:8,400
1 inch equals 700 feet

700 350 0 700 Feet

Source: USGS Aerial Photography, August 1956

KCI ASSOCIATES OF NC

ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.



Historic Aerial Photograph - 1982

Limits of Project Parcel

N
W E
S

1:8,400
1 inch equals 700 feet

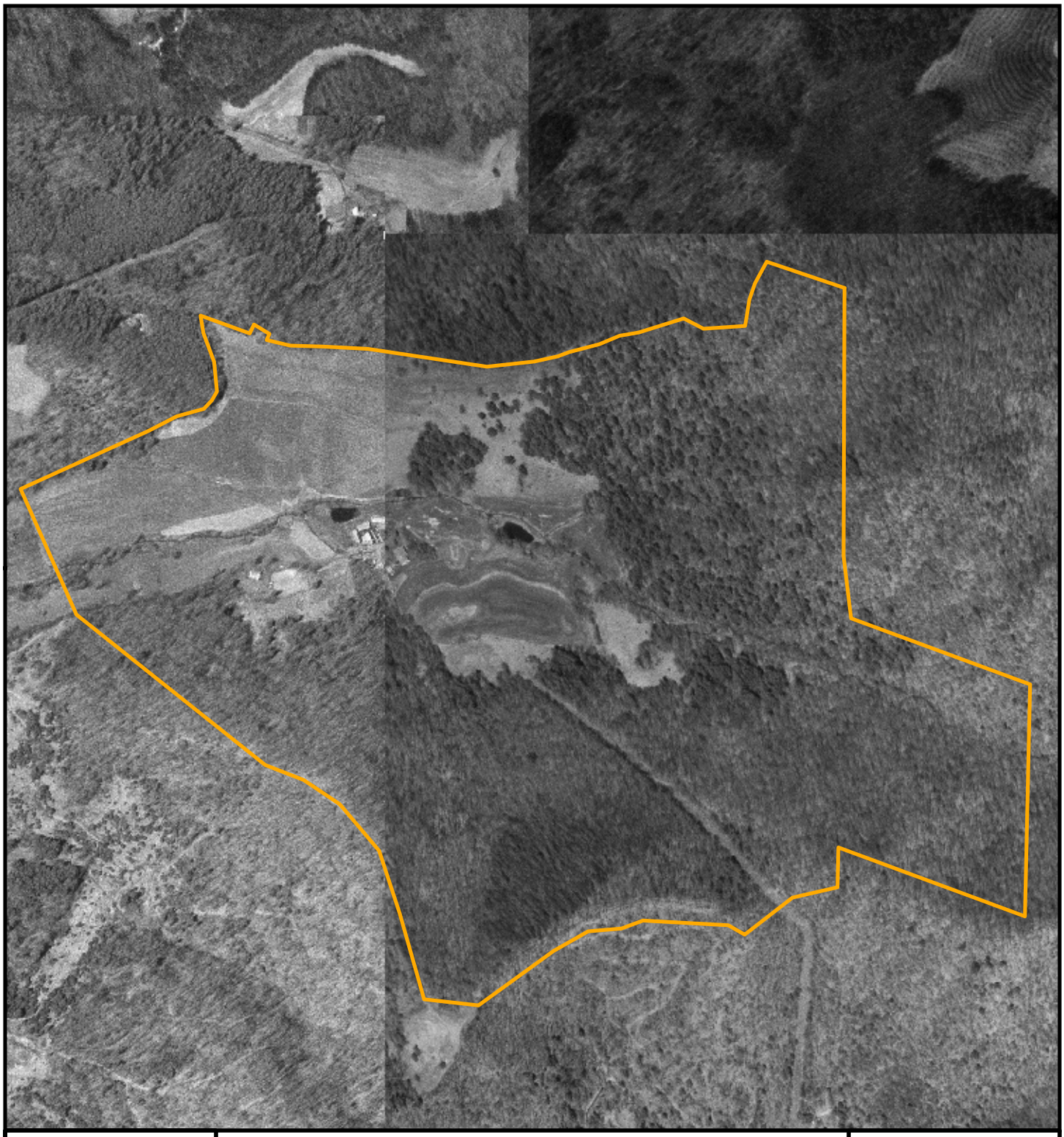
700 350 0 700 Feet

Source: USDA, NRCS Mitchell County, 1982

KCI TECHNOLOGIES

KCI ASSOCIATES OF NC

ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.



Historic Aerial Photograph - 1993

Limits of Project Parcel

N
W E
S

1:8,400
1 inch equals 700 feet

700 350 0 700 Feet

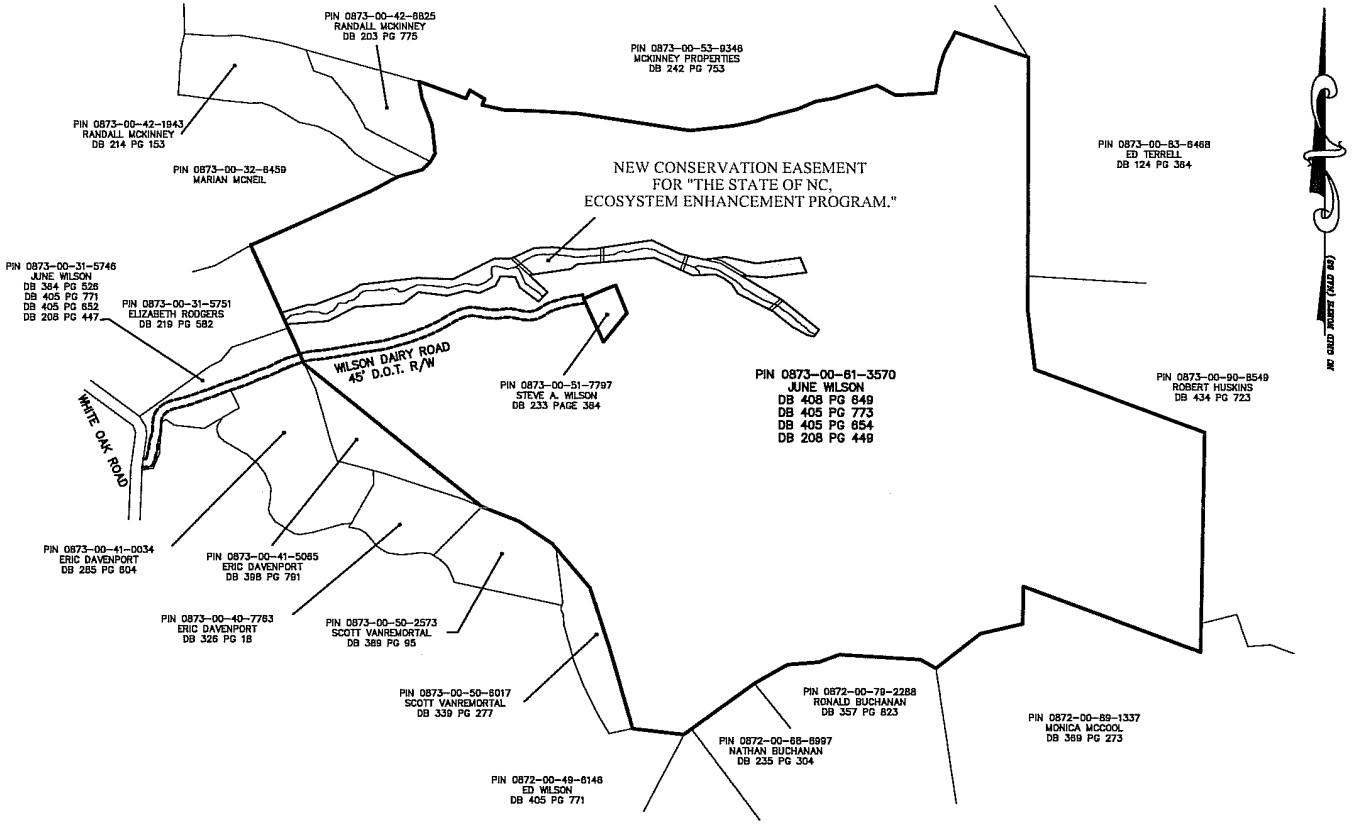
Source: USGS DOQs, 1993

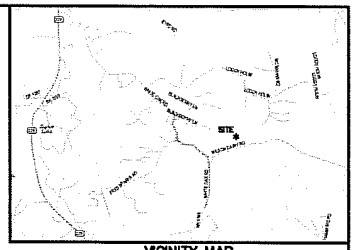
KCI TECHNOLOGIES

KCI ASSOCIATES OF NC

ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.

Appendix B
Conservation Easement





VICINITY MAP
(NOT TO SCALE)

NOTES:

THIS PLAT DOES NOT REPRESENT A BOUNDARY SURVEY.

THIS PLAN HAS BEEN PREPARED WITHOUT THE BENEFIT OF A REPORT OF TITLE.

THIS PLAN REPRESENTS A SURVEY OF THE NEW CONSERVATION EASEMENT ONLY.

THE BASIS OF THE MERIDIANS AND COORDIANTES FOR THIS PLAT IS THE NORTH CAROLINA STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM 1983 (N.C.S.P.C.S. NAD 83), BASED ON DIFFERENTIAL GPS OBSERVATIONS PERFORMED IN AUGUST 2006 ALL DISTANCES ARE GROUND UNLESS OTHERWISE NOTED.

DEED REFERENCE: AS SHOWN.

SUBJECT PROPERTIES KNOWN AS PARCEL IDENTIFICATION NUMBER 0873-00-61-3570.

LANDOWNER INFORMATION:
JUNE H. WILSON
PO BOX 192
BAKERSVOLLE, NC 28705

NO NORTH CAROLINA GEODETIC CONTROL MONUMENTS WERE RECOVERED WITHIN 2000 FEET OF THE SUBJECT PROPERTY.

SUBJECT PROPERTY DOES NOT LIE WITHIN A SPECIAL FLOOD HAZARD ZONE. SUBJECT PROPERTY LIES WITHIN THE AREA DESIGNATED AS ZONE "X", BASED ON FEDERAL FLOOD INSURANCE RATE MAP, COMMUNITY PANEL NUMBER 370161 0100 C; MAP NUMBER 37121C0100C; EFFECTIVE DATE: SEPT. 2, 1988.

LEGAL DESCRIPTION OF THE CONSERVATION EASEMENT AND THE EXCEPTIONS ARE LOCATED ON SHEET 4 OF 4.

THE GRANTEE AND RECIPIENT OF THE CONSERVATION EASEMENT IS "THE STATE OF NC, ECOSYSTEM ENHANCEMENT PROGRAM."

I, ROBERT C. BAUMGARTNER, HEREBY DECLARE THAT THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM A SURVEY MADE UNDER MY SUPERVISION, THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED, AS DRAWN FROM INFORMATION AS SHOWN HEREON; THAT THE RATIO OF PRECISION AS CALCULATED IS GREATER THAN 1:10,000; THAT THIS MAP DOES REPRESENT AN OFFICIAL BOUNDARY SURVEY AND HAS BEEN PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 28TH DAY OF NOVEMBER, 2006.

NORTH CAROLINA REGISTRATION NUMBER L-4531
ROBERT C. BAUMGARTNER

I HEREBY CERTIFY THAT I AM THE OWNER OF THE PROPERTY SHOWN AND DESCRIBED HEREON, WHICH IS LOCATED IN MITCHELL COUNTY; THAT I HEREBY ACCEPT AND ADOPT THIS PLAN OF EASEMENT, WITH MY FREE CONSENT, ESTABLISH AND DEDICATE THE CONSERVATION EASEMENT(S), AS DEPICTED HEREON, TO THE STATE OF NORTH CAROLINA.

SIGNATURE
PRINTED NAME DATE

SIGNATURE
PRINTED NAME DATE

NORTH CAROLINA, COUNTY
I, ______________ A NOTARY PUBLIC OF THE COUNTY AND STATE AFORESAID, CERTIFY THAT
____
PERSONALLY APPEARED BEFORE ME THIS DAY AND ACKNOWLEDGED THE EXECUTION OF THE FOREGOING INSTRUMENT.
WITNESS MY HAND AND OFFICIAL STAMP OR SEAL THIS
______ DAY OF ______________, 2006.
NOTARY PUBLIC
MY COMMISION EXPIRES

NORTH CAROLINA, COUNTY
I, ______________ A NOTARY PUBLIC OF THE COUNTY AND STATE AFORESAID, CERTIFY THAT
____
PERSONALLY APPEARED BEFORE ME THIS DAY AND ACKNOWLEDGED THE EXECUTION OF THE FOREGOING INSTRUMENT.
WITNESS MY HAND AND OFFICIAL STAMP OR SEAL THIS
______ DAY OF ______________, 2006.
NOTARY PUBLIC
MY COMMISION EXPIRES

SIGNATURE
PRINTED NAME DATE

SIGNATURE
PRINTED NAME DATE

NORTH CAROLINA, COUNTY
I, ______________ A NOTARY PUBLIC OF THE COUNTY AND STATE AFORESAID, CERTIFY THAT
____
PERSONALLY APPEARED BEFORE ME THIS DAY AND ACKNOWLEDGED THE EXECUTION OF THE FOREGOING INSTRUMENT.
WITNESS MY HAND AND OFFICIAL STAMP OR SEAL THIS
______ DAY OF ______________, 2006.
NOTARY PUBLIC
MY COMMISION EXPIRES

NORTH CAROLINA, COUNTY
I, ______________ A NOTARY PUBLIC OF THE COUNTY AND STATE AFORESAID, CERTIFY THAT
____
PERSONALLY APPEARED BEFORE ME THIS DAY AND ACKNOWLEDGED THE EXECUTION OF THE FOREGOING INSTRUMENT.
WITNESS MY HAND AND OFFICIAL STAMP OR SEAL THIS
______ DAY OF ______________, 2006.
NOTARY PUBLIC
MY COMMISION EXPIRES

GRAPHIC SCALE
400 0 200 400 800 1600
(IN FEET)
1 inch = 400 ft.

COVER SHEET

DRAWN BY CDR

KCI ASSOCIATES OF N.C.
ENGINEERS, SURVEYORS AND PLANNERS
4601 SIX FORKS ROAD, SUITE 220
RALEIGH, NC 27609
PHONE (919) 783-9214 * FAX (919) 783-9266

KCI
ASSOCIATES OF
NORTH CAROLINA

FINAL PLAT
CONSERVATION EASEMENT
FOR
DOG BITE STREAM RESTORATION
TOWN OF BAKERSVILLE
MITCHELL COUNTY, NORTH CAROLINA

DATE:	SCALE:	SHEET:
NOV. 28, 2006	1" = 400'	1 OF 4

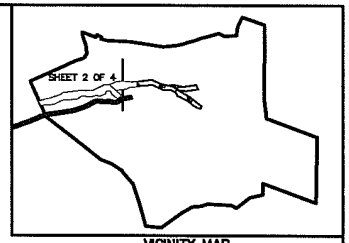
12065439

NOTES:

1. FOR GENERAL NOTES SEE THE NOTE SECTION ON THE COVER SHEET.

I, ROBERT C. BAUMGARTNER, HEREBY DECLARE THAT THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM A SURVEY MADE UNDER MY SUPERVISION, THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED, AS DRAWN FROM INFORMATION AS SHOWN HEREON; THAT THE RATIO OF PRECISION AS CALCULATED IS GREATER THAN 1:10,000; THAT THIS MAP DOES REPRESENT AN OFFICIAL BOUNDARY SURVEY AND HAS BEEN PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 25TH DAY OF NOVEMBER, 2008.

NORTH CAROLINA REGISTRATION NUMBER L-4531
ROBERT C. BAUMGARTNER



VICINITY MAP
(NOT TO SCALE)

SHEET 3 OF 4

SHEET 2 OF 4

MATCHLINE

PIN 0873-00-42-1943
RANDALL MCKINNEY
DB 214 PG 153

PIN 0873-00-32-8459
MARIAN MCNEIL

FD NAIL

PIN 0873-00-31-5751
ELIZABETH RODGERS
DB 219 PG 582

PIN 0873-00-31-5746
JUNE WILSON
DB 408 PG 649
DB 405 PG 773
DB 405 PG 654
DB 208 PG 449

PIN 0873-00-41-0034
ERIC DAVENPORT
DB 285 PG 604

PIN 0873-00-41-5085
ERIC DAVENPORT
DB 398 PG 791

PIN
0873-00-51-7797
STEVE A. WILSON
DB 233 PAGE 384

TEMPORARY BENCHMARK (SET IRON PIN)
N=832098.045
E=1075014.044
ELEV=2771.56'

TEMPORARY BENCHMARK (SET IRON PIN)
N=831746.978
E=1074480.010
ELEV=2742.09'

Point "A"
Exception "A"
Point "B"
Exception

WILSON DAIRY ROAD
45' D.O.T. R/W

NC GRID NORTH (NAD 83)

LINE TABLE			LINE TABLE		
LINE	LENGTH	BEARING	LINE	LENGTH	BEARING
E1	147.99	N73°28'30"E	E53	130.63	S49°31'24"E
E2	31.37	S87°50'12"E	E54	70.00	S43°40'33"W
E3	210.48	N69°45'39"E	E55	121.89	N52°33'46"W
E4	59.36	N54°22'29"E	E56	80.35	N23°24'47"W
E5	312.55	N83°32'28"E	E57	76.18	N67°07'29"W
E6	153.25	S87°53'07"E	E58	57.92	S29°13'56"W
E7	244.72	N63°17'00"E	E59	92.43	S65°56'57"W
E8	85.91	S89°33'49"E	E60	71.07	N80°49'39"W
E9	16.34	N85°24'25"E	E61	101.84	S79°18'05"W
E10	115.73	N65°24'25"E	E62	152.92	N83°13'27"W
E11	97.76	N86°28'25"E	E63	101.82	S63°17'15"W
E12	140.51	S84°40'01"E	E64	257.46	S86°16'27"W
E13	89.52	N86°29'27"E	E65	163.30	S62°37'17"W
E14	23.81	N81°20'30"E	E66	219.89	S85°36'59"W
E15	15.17	N81°20'30"E	E67	66.89	N24°00'42"W
E48	15.05	S85°08'45"W	E74	75.98	N00°00'00"E
E49	125.72	S85°08'45"W	E75	75.84	N00°00'00"E
E50	36.35	S80°35'11"W	E76	134.75	N47°55'45"W
E51	202.86	S81°34'23"W	E77	128.85	N47°55'45"W
E52	19.44	S81°34'23"W	T1	388.31	S24°00'42"E
			T2	216.21	N24°00'42"W

LEGEND

- EXISTING IRON PIPE
- IRON PIPE SET
- TEMPORARY BENCHMARK (SET IRON PIN)
- EXISTING NAIL

GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)
1 inch = 100 ft.

12065439

DRAWN BY CDR

KCI ASSOCIATES OF N.C.
ENGINEERS, SURVEYORS AND PLANNERS
4601 SIX FORKS ROAD, SUITE 220
RALEIGH, NC 27609
PHONE (919) 783-9214 * FAX (919) 783-9258

KCI ASSOCIATES OF NORTH CAROLINA

FINAL PLAT
CONSERVATION EASEMENT
FOR
DOG BITE STREAM RESTORATION
TOWN OF BAKERSVILLE
MITCHELL COUNTY, NORTH CAROLINA

DATE:	SCALE:	SHEET:
NOV. 26, 2008	1" = 100'	2 OF 4

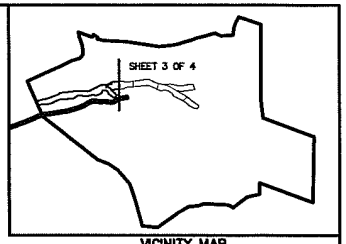
NOTES:

1. FOR GENERAL NOTES SEE THE NOTE SECTION ON THE COVER SHEET.

I, ROBERT C. BAUMGARTNER, HEREBY DECLARE THAT THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM A SURVEY MADE UNDER MY SUPERVISION, THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED, AS DRAWN FROM INFORMATION AS SHOWN HEREON; THAT THE RATIO OF PRECISION AS CALCULATED IS GREATER THAN 1:10,000; THAT THIS MAP DOES REPRESENT AN OFFICIAL BOUNDARY SURVEY AND HAS BEEN PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 28TH DAY OF NOVEMBER, 2006.

NORTH CAROLINA REGISTRATION NUMBER L-4531
ROBERT C. BAUMGARTNER

PIN 0673-00-53-9348
MCKINNEY PROPERTIES
DB 242 PG 753



VICINITY MAP
(NOT TO SCALE)

LINE TABLE			LINE TABLE		
LINE	LENGTH	BEARING	LINE	LENGTH	BEARING
E8	65.91	S89°33'46"E	E39	179.99	N63°06'59"W
E9	16.34	N85°24'25"E	E40	59.05	N33°15'11"W
E10	115.73	N85°24'25"E	E41	57.13	N54°39'50"W
E11	97.79	N86°26'25"E	E42	43.77	N85°13'48"W
E12	140.51	S84°40'01"E	E43	119.15	S87°23'46"W
E13	89.52	N86°29'27"E	E44	55.82	N65°46'34"W
E14	23.51	N81°20'30"E	E45	15.06	N65°46'34"W
E15	15.17	N81°20'30"E	E46	152.38	N65°46'34"W
E16	260.29	N81°20'30"E	E47	270.18	S85°09'46"W
E17	161.80	S84°04'54"E	E48	15.06	S85°09'46"W
E18	33.13	S77°00'18"E	E49	125.72	S85°09'46"W
E19	15.09	S77°00'18"E	E50	36.35	S50°35'11"W
E20	86.58	S77°00'18"E	E51	202.86	S81°34'23"W
E21	43.88	N53°00'21"E	E52	19.44	S81°34'23"W
E22	67.40	N53°12'39"E	E53	130.83	S46°51'24"E
E23	167.48	S78°55'35"E	E54	70.00	S43°40'33"W
E24	156.26	N82°34'56"E	E55	121.89	N52°33'46"W
E25	73.68	N82°10'01"E	E56	60.35	N32°24'47"W
E26	83.00	S22°13'03"E	E57	76.18	N87°07'26"W
E27	209.00	S82°18'19"W	E58	57.92	S29°13'56"W
E28	99.78	N89°32'08"W	E59	48.93	S77°00'18"E
E29	33.83	N89°32'08"W	E69	158.45	S59°13'07"E
E30	238.65	S59°13'07"E	E70	125.77	N59°13'07"W
E31	15.24	S81°23'22"E	E71	87.82	N77°00'18"W
E32	243.32	S81°23'22"E	E72	85.12	N19°10'20"E
E33	46.48	S36°19'06"W	E73	82.17	N19°10'20"E
E34	36.28	N78°00'35"W	E74	76.86	N00°00'00"E
E35	91.54	N60°37'15"W	E75	75.84	N00°00'00"E
E36	129.22	N51°23'20"W	E76	134.75	N47°56'48"W
E37	7.14	N63°06'59"W	E77	128.55	N47°56'48"W
E38	16.16	N63°06'59"W	E78	79.04	N48°43'09"E
			E79	82.37	N48°43'09"E
			E82	203.29	N63°06'59"W
			E83	223.25	N65°46'34"W
			E84	410.93	S85°09'46"W

SHEET 2 OF 4
SHEET 3 OF 4
MATCHLINE

Point "A" Exception "A" Point "B" Exception "B" Point "C" Point "D" Exception "D" Point "E" Exception "E" Exception "C"

WILSON DAIRY ROAD
45' D.O.T. R/W

PIN
0673-00-51-7797
STEVE A. WILSON
DB 233 PAGE 384

PIN 0673-00-61-3570
JUNE WILSON
DB 408 PG 849
DB 405 PG 773
DB 405 PG 654
DB 208 PG 449

NC GRID NORTH (NAD 83)

LEGEND

- ● EXISTING IRON PIPE
- ○ IRON PIPE SET
- △ TEMPORARY BENCHMARK (SET IRON PIN)

GRAPHIC SCALE

100 0 50 100 200 400
(IN FEET)
1 inch = 100 ft.

DRAWN BY CDR

KCI ASSOCIATES OF N.C.
ENGINEERS, SURVEYORS AND PLANNERS
4601 SIX FORKS ROAD, SUITE 220
RALEIGH, NC 27609
PHONE (919) 783-9214 * FAX (919) 783-9266

FINAL PLAT
CONSERVATION EASEMENT
FOR
DOG BITE STREAM RESTORATION
TOWN OF BAKERSVILLE
MITCHELL COUNTY, NORTH CAROLINA

DATE:	SCALE:	SHEET:
NOV. 28, 2006	1" = 100'	3 OF 4

12065439

NOTES:

1. FOR GENERAL NOTES SEE THE NOTE SECTION ON THE COVER SHEET.

I, ROBERT C. BAUMGARTNER, HEREBY DECLARE THAT THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM A SURVEY MADE UNDER MY SUPERVISION, THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED, AS DRAWN FROM INFORMATION AS SHOWN HEREON; THAT THE RATIO OF PRECISION AS CALCULATED IS GREATER THAN 1:10,000; THAT THIS MAP DOES REPRESENT AN OFFICIAL BOUNDARY SURVEY AND HAS BEEN PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 28TH DAY OF NOVEMBER, 2008.

NORTH CAROLINA REGISTRATION NUMBER L-4531
ROBERT C. BAUMGARTNER

LEGAL DESCRIPTION OF CONSERVATION EASEMENT

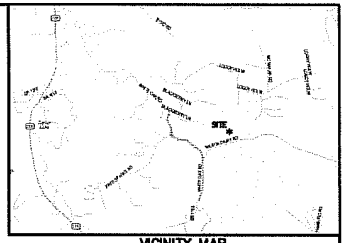
A parcel of land to be used for Conservation Easement purposes located in Bakersville Township, Mitchell County, North Carolina, and being more particularly described as follows:

Commencing at an existing nail at a Northwesterly corner of lands, now or formerly owned by June H. Wilson (Deed Book 205 Page 447) said point also being the Northeasterly corner of lands, now or formerly, owned by Elizabeth Rodgers (Deed Book 219 Page 582);

Thence South 24°00'42" East, on the Easterly line of said lands, now or formerly, owned by Elizabeth Rodgers, a distance of 388.31 feet to a set iron pin, said point being the POINT OF BEGINNING of the parcel herein described;

Thence North 73°28'30" East, a distance of 147.99 feet to a set iron pin;
Thence South 87°50'12" East, a distance of 31.37 feet to a set iron pin;
Thence North 69°45'39" East, a distance of 210.48 feet to a set iron pin;
Thence North 54°25'29" East, a distance of 59.38 feet to a set iron pin;
Thence North 83°32'28" East, a distance of 312.55 feet to a set iron pin;
Thence South 87°53'07" East, a distance of 183.25 feet to a set iron pin;
Thence North 83°17'00" East, a distance of 244.72 feet to a set iron pin;
Thence South 89°33'49" East, a distance of 85.91 feet to a set iron pin, said point known as Point "A";
Thence North 65°24'25" East, a distance of 132.07 feet to a set iron pin;
Thence North 66°28'25" East, a distance of 97.76 feet to a set iron pin;
Thence South 84°40'01" East, a distance of 140.61 feet to a set iron pin;
Thence North 86°29'27" East, a distance of 86.52 feet to a set iron pin;
Thence North 01°20'30" East, a distance of 23.81 feet to a set iron pin, said point known as Point "B";
Thence continuing North 81°20'30" East, a distance of 275.46 feet to a set iron pin;
Thence South 64°04'54" East, a distance of 161.80 feet to a set iron pin;
Thence South 77°00'16" East, a distance of 33.13 feet to a set iron pin, said point known as Point "C";
Thence continuing South 77°00'16" East, a distance of 101.77 feet to a set iron pin, said point known as Point "D";
Thence North 83°00'21" East, a distance of 43.88 feet to a set iron pin;
Thence North 83°12'39" East, a distance of 67.40 feet to a set iron pin;
Thence South 78°33'33" East, a distance of 167.46 feet to a set iron pin;
Thence North 82°34'56" East, a distance of 156.26 feet to a set iron pin;
Thence North 82°10'01" East, a distance of 73.68 feet to a set iron pin;
Thence South 22°13'03" East, a distance of 83.00 feet to a set iron pin;
Thence South 82°15'19" West, a distance of 209.00 feet to a set iron pin;
Thence North 86°32'06" West, a distance of 133.61 feet to a set iron pin;
Thence South 59°13'07" East, a distance of 238.65 feet to a set iron pin, said point known as Point "E";
Thence South 51°23'22" East, a distance of 258.56 feet to a set iron pin;
Thence South 36°16'05" West, a distance of 46.46 feet to a set iron pin;
Thence North 78°00'33" West, a distance of 36.28 feet to a set iron pin;
Thence North 60°37'15" West, a distance of 91.54 feet to a set iron pin;
Thence North 51°23'20" West, a distance of 129.22 feet to a set iron pin;
Thence North 63°05'59" West, a distance of 203.29 feet to a set iron pin;
Thence North 33°15'11" West, a distance of 59.05 feet to a set iron pin;
Thence North 54°39'50" West, a distance of 57.13 feet to a set iron pin;
Thence North 85°13'45" West, a distance of 43.77 feet to a set iron pin;
Thence South 87°23'45" West, a distance of 119.15 feet to a set iron pin;
Thence North 66°46'34" West, a distance of 223.26 feet to a set iron pin;
Thence South 85°09'45" West, a distance of 410.93 feet to a set iron pin;
Thence South 50°36'11" West, a distance of 36.35 feet to a set iron pin;
Thence South 81°34'23" West, a distance of 222.30 feet to a set iron pin;
Thence South 48°51'24" East, a distance of 130.63 feet to a set iron pin;
Thence North 43°40'33" West, a distance of 70.00 feet to a set iron pin;
Thence North 52°33'45" West, a distance of 121.89 feet to a set iron pin;
Thence North 23°24'47" West, a distance of 60.35 feet to a set iron pin;
Thence North 87°07'25" West, a distance of 76.18 feet to a set iron pin;
Thence South 29°13'56" West, a distance of 57.92 feet to a set iron pin;
Thence South 65°55'57" West, a distance of 92.43 feet to a set iron pin;
Thence North 80°46'39" West, a distance of 71.07 feet to a set iron pin;
Thence South 78°18'05" West, a distance of 101.84 feet to a set iron pin;
Thence North 83°13'27" West, a distance of 152.92 feet to a set iron pin;
Thence South 83°17'15" West, a distance of 101.62 feet to a set iron pin;
Thence South 86°16'27" West, a distance of 257.48 feet to a set iron pin;
Thence South 82°37'17" West, a distance of 163.30 feet to a set iron pin;
Thence South 85°38'59" West, a distance of 219.89 feet to a set iron pin;
Thence North 24°00'42" West, a distance of 66.69 feet to the POINT OF BEGINNING.

LESS AND EXCEPT THE FOLLOWING DESCRIBED PARCELS:



VICINITY MAP
(NOT TO SCALE)

LEGAL DESCRIPTION OF EXCEPTION "A"

Beginning at said Point "A";
Thence North 65°24'25" East, a distance of 16.34 feet to a set iron pin;
Thence South 47°55'45" East, a distance of 134.75 feet to a set iron pin;
Thence South 81°34'23" West, a distance of 19.44 feet to a set iron pin;
Thence North 47°55'45" West, a distance of 128.85 feet to the POINT OF BEGINNING, containing 1,977 square feet or 0.045 acres, more or less.

LEGAL DESCRIPTION OF EXCEPTION B

Beginning at said Point "B";
Thence North 81°20'30" East, a distance of 15.17 feet to a set iron pin;
Thence South 00°00'00" East, a distance of 75.86 feet to a set iron pin;
Thence South 85°06'45" West, a distance of 15.06 feet to a set iron pin;
Thence North 00°00'00" East, a distance of 75.84 feet to the POINT OF BEGINNING, containing 1,145 square feet or 0.026 acres, more or less.

LEGAL DESCRIPTION OF EXCEPTION "C"

Beginning at said Point "C";
Thence South 77°00'16" East, a distance of 15.09 feet to a set iron pin;
Thence South 19°10'20" West, a distance of 85.12 feet to a set iron pin;
Thence North 65°48'34" West, a distance of 15.06 feet to a set iron pin;
Thence North 19°10'20" East, a distance of 82.17 feet to the POINT OF BEGINNING, containing 1,254 square feet or 0.029 acres, more or less.

LEGAL DESCRIPTION OF EXCEPTION "D"

Beginning at said Point "D";
Thence North 83°00'21" East, a distance of 43.88 feet to a set iron pin;
Thence South 77°00'16" East, a distance of 48.93 feet to a set iron pin;
Thence South 59°13'07" East, a distance of 158.45 feet to a set iron pin;
Thence North 86°32'06" West, a distance of 33.83 feet to a set iron pin;
Thence North 59°13'07" West, a distance of 125.77 feet to a set iron pin;
Thence North 77°00'16" West, a distance of 67.82 feet to the POINT OF BEGINNING, containing 3,157 square feet or 0.073 acres, more or less.

LEGAL DESCRIPTION OF EXCEPTION "E"

Beginning at said Point "E";
Thence South 51°23'22" East, a distance of 15.24 feet to a set iron pin;
Thence South 48°43'09" West, a distance of 79.04 feet to a set iron pin;
Thence North 63°05'59" West, a distance of 18.16 feet to a set iron pin;
Thence North 48°43'09" East, a distance of 82.37 feet to the POINT OF BEGINNING, containing 1,210 square feet or 0.029 acres, more or less.

The residual acreage of the Conservation Easement is 309,430 square feet or 7.10 acres, more or less

DRAWN BY CDR

KCI ASSOCIATES OF NORTH CAROLINA
KCI ASSOCIATES OF N.C.
ENGINEERS, SURVEYORS AND PLANNERS
4801 SIX FORKS ROAD, SUITE 220
RALEIGH, NC 27609
PHONE (919) 783-9214 * FAX (919) 783-9258

12065439

FINAL PLAT
CONSERVATION EASEMENT
FOR
DOG BITE STREAM RESTORATION
TOWN OF BAKERSVILLE
MITCHELL COUNTY, NORTH CAROLINA

DATE:	SCALE:	SHEET:
NOV. 28, 2008	1" = 100'	4 OF 4

Appendix C
Project Site Photographs

Looking downstream at a long riffle/run sequence that characterizes WOC-1.

Poor riparian buffer and an eroding bank near the beginning of WOC-2.

Immediately upstream of the outlet into the irrigation pond on WOC-2.

The end of WOC-2. WOC-3 begins under the trees in the background.

A long riffle/run sequence and eroding bank near the beginning of WOC-3.

Looking upstream at the beginning of WOC-4 with the livestock barn in the background.

The waste lagoon, which will be removed, with WOC-4 at the base of the berm on the right side of the lagoon.

Upstream view of WOC-4 after it passes the waste lagoon; there have been extensive livestock impacts in this location. The lagoon berm is on the right side in this photo.

WOC-4 immediately before it becomes further entrenched in the valley.

Bank erosion along WOC-4 after the confluence with T2.

Looking down at WOC-4, which is entrenched within the valley in this section.

Bank erosion along WOC-4.

WOC-5 near the end of the project site.

The beginning of T1-1 where a headcut has developed and the stream has become incised.

Looking downstream along T1-1 where the stream is incised.

Looking downstream at the beginning of T1-2 where the channel has filled in; the tributary flows diffusely until its confluence with WOC.

Looking upstream along T2 towards Wilson Dairy Road, where there are heavy cattle impacts.

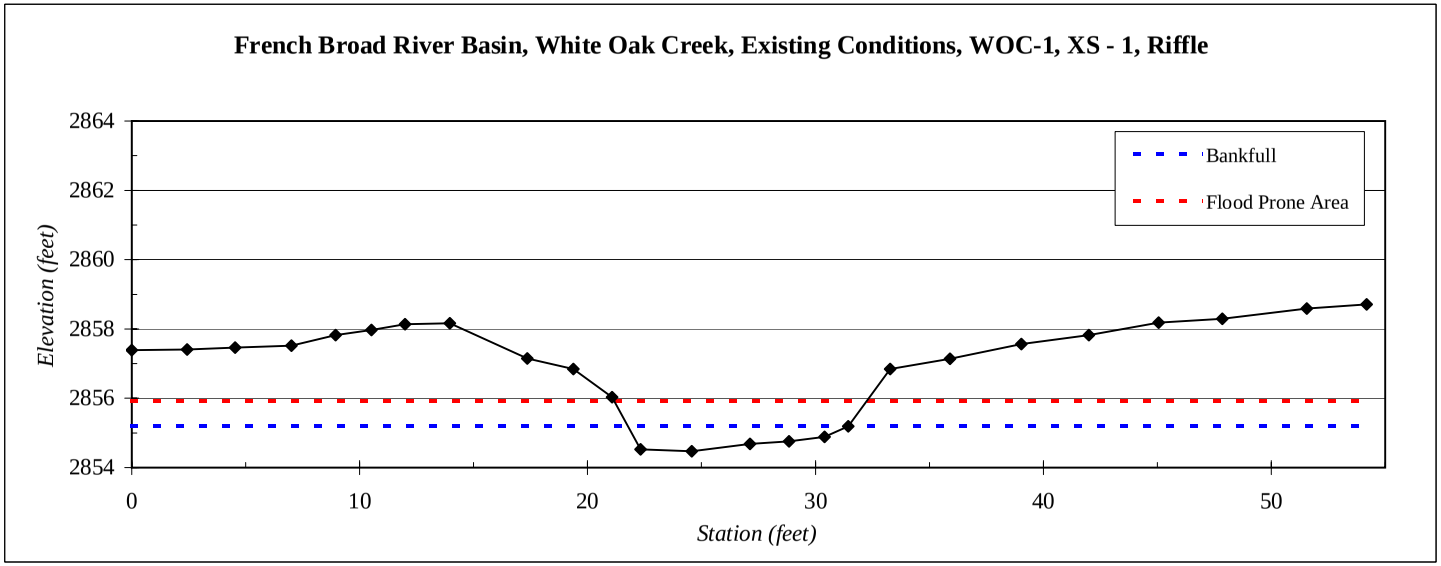
Looking upstream along T2 immediately before the confluence with WOC.

Appendix D
Existing Conditions Data

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-1
XS ID	XS - 1, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2857.39
2.4	2857.41
4.5	2857.46
7.0	2857.52
8.9	2857.82
10.5	2857.97
12.0	2858.13
14.0	2858.17
17.4	2857.15
19.4	2856.85
21.1	2856.03
22.3	2854.52
24.6	2854.47
27.1	2854.68
28.8	2854.75
30.4	2854.89
31.4	2855.19
33.3	2856.85
35.9	2857.14
39.0	2857.56
42.0	2857.82
45.1	2858.19
47.9	2858.30
51.6	2858.59
54.2	2858.71

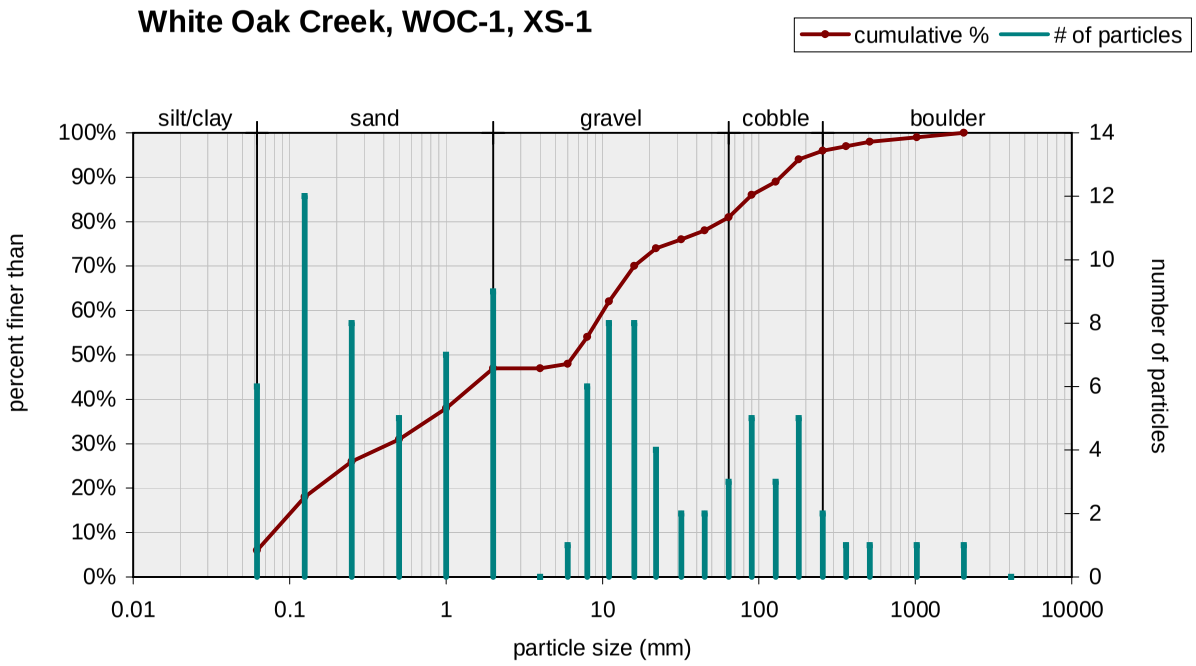
SUMMARY DATA	
Bankfull Elevation:	2855.2
Bankfull Cross-Sectional Area:	5.0
Bankfull Width:	9.7
Flood Prone Area Elevation:	2855.9
Flood Prone Width:	11
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.5
W / D Ratio:	18.8
Entrenchment Ratio:	1.1
Bank Height Ratio:	3.3



Riffle Surface

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

Note: XS-1



Size (mm)	
D16	0.11
D35	0.74
D50	6.6
D65	13
D84	79
D95	210

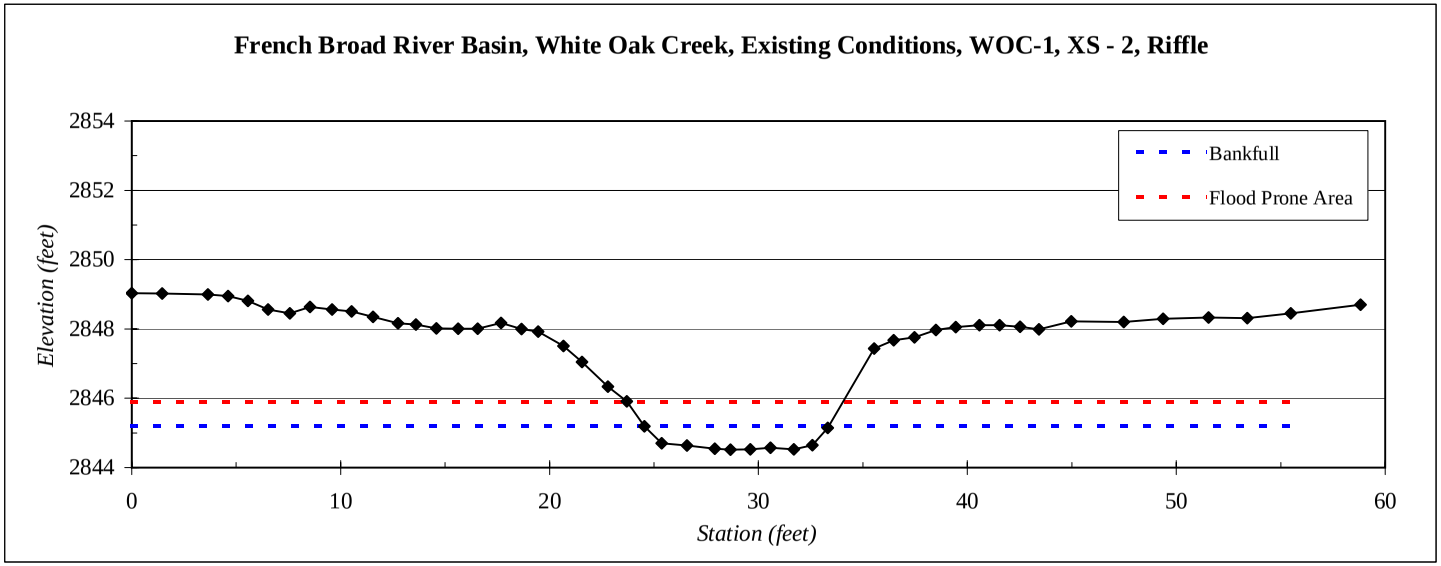
Size Distribution	
mean	2.9
dispersion	36.0
skewness	-0.21

Type	
silt/clay	6%
sand	41%
gravel	34%
cobble	15%
boulder	4%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-1
XS ID	XS - 2, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2849.03
1.5	2849.03
3.6	2848.99
4.6	2848.95
5.6	2848.81
6.5	2848.57
7.6	2848.45
8.5	2848.63
9.6	2848.56
10.5	2848.50
11.5	2848.35
12.7	2848.16
28.7	2844.52
29.6	2844.53
30.6	2844.58
31.7	2844.52
32.6	2844.64
33.3	2845.14
35.5	2847.44
36.5	2847.68
37.5	2847.76
43.4	2847.99
45.0	2848.22
47.5	2848.20
49.4	2848.29
51.5	2848.33
53.4	2848.31
55.5	2848.45

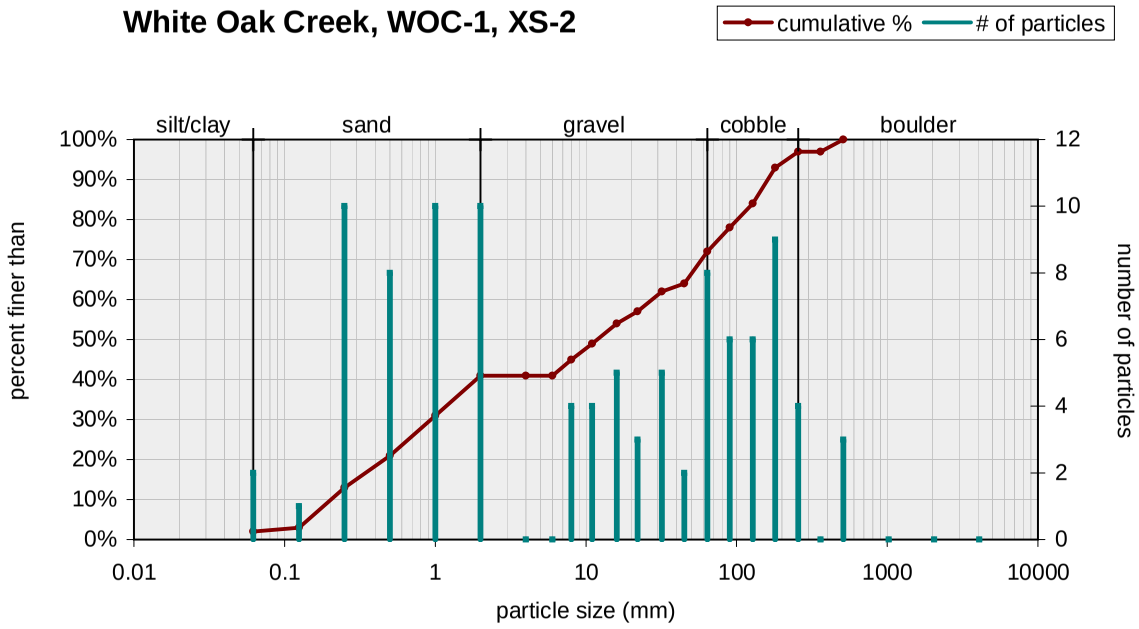
SUMMARY DATA	
Bankfull Elevation:	2845.2
Bankfull Cross-Sectional Area:	4.9
Bankfull Width:	8.8
Flood Prone Area Elevation:	2845.9
Flood Prone Width:	10
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.6
W / D Ratio:	15.8
Entrenchment Ratio:	1.2
Bank Height Ratio:	4.2



Riffle Surface

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

Note: XS-2



Size (mm)	
D16	0.32
D35	1.3
D50	12
D65	47
D84	130
D95	210

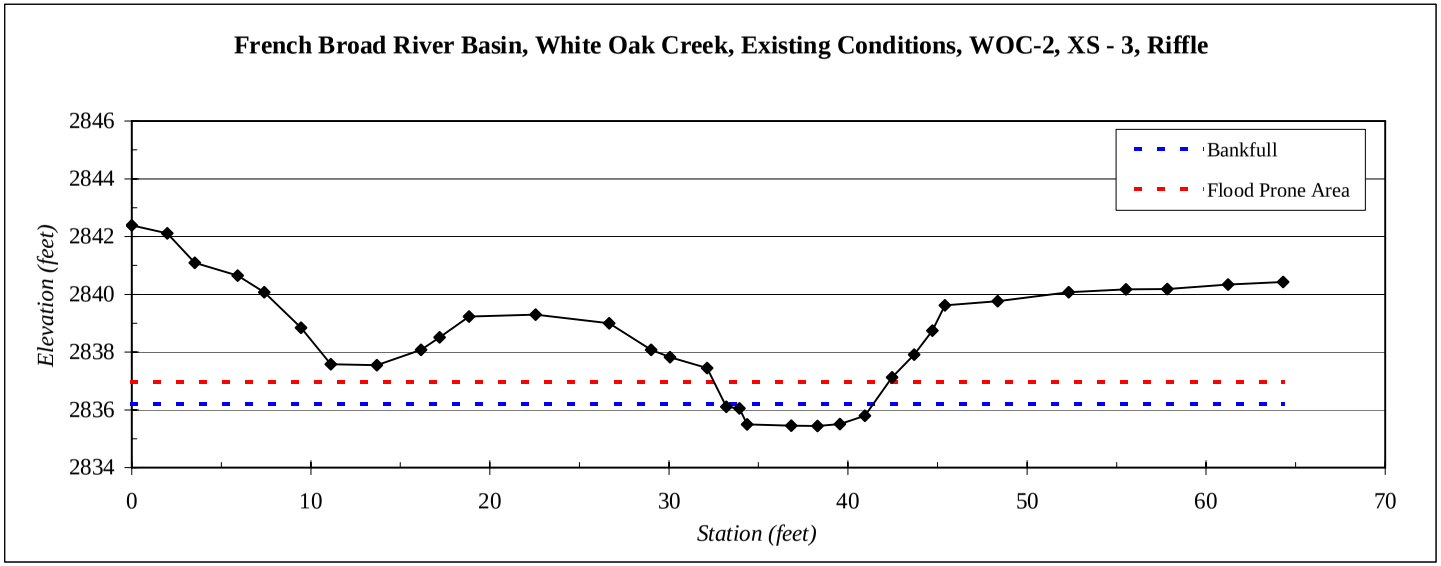
Size Distribution	
mean	6.4
dispersion	24.2
skewness	-0.17

Type	
silt/clay	2%
sand	39%
gravel	31%
cobble	25%
boulder	3%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-2
XS ID	XS - 3, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2842.38
2.0	2842.11
3.5	2841.09
5.9	2840.65
7.4	2840.07
9.4	2838.85
11.1	2837.58
13.7	2837.54
16.2	2838.08
17.2	2838.51
18.8	2839.23
22.6	2839.29
26.7	2839.00
29.0	2838.07
30.1	2837.82
32.1	2837.45
33.2	2836.10
33.9	2836.05
34.4	2835.49
36.8	2835.45
38.3	2835.44
39.5	2835.50
40.9	2835.80
42.5	2837.12
43.7	2837.91
44.7	2838.75
45.4	2839.62
48.4	2839.76
52.3	2840.08
55.5	2840.17
57.8	2840.18
61.2	2840.34
64.3	2840.43

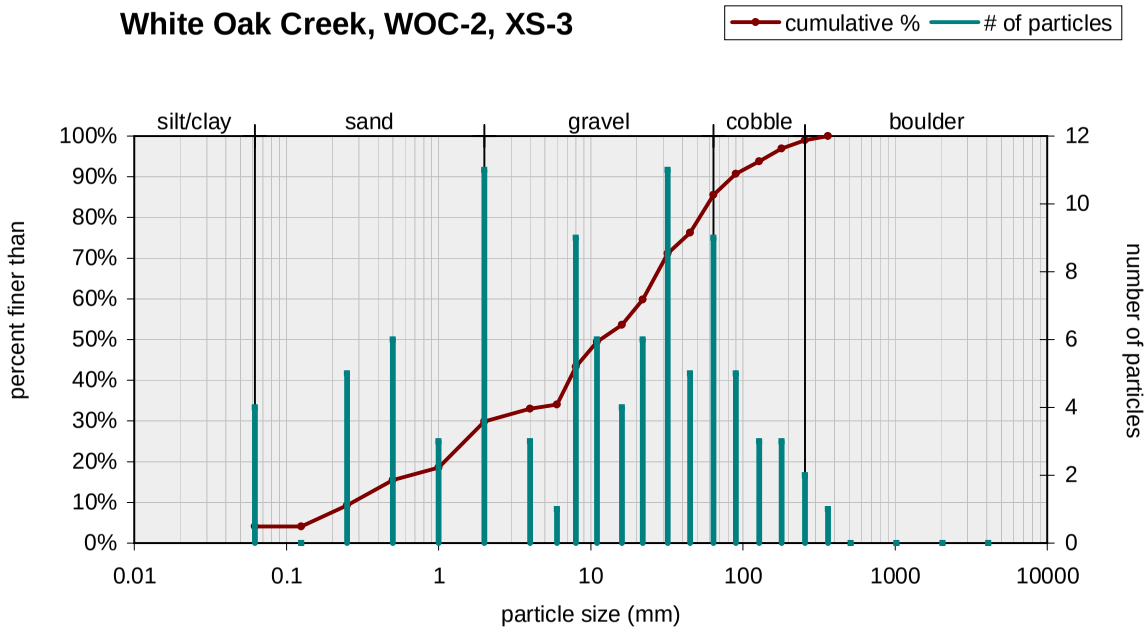
SUMMARY DATA	
Bankfull Elevation:	2836.2
Bankfull Cross-Sectional Area:	5.0
Bankfull Width:	8.3
Flood Prone Area Elevation:	2837.0
Flood Prone Width:	10
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.6
W / D Ratio:	13.8
Entrenchment Ratio:	1.2
Bank Height Ratio:	2.6



Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	4
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	5
medium sand	0.25 - 0.5	6
coarse sand	0.5 - 1	3
very coarse sand	1 - 2	11
very fine gravel	2 - 4	3
fine gravel	4 - 6	1
fine gravel	6 - 8	9
medium gravel	8 - 11	6
medium gravel	11 - 16	4
coarse gravel	16 - 22	6
coarse gravel	22 - 32	11
very coarse gravel	32 - 45	5
very coarse gravel	45 - 64	9
small cobble	64 - 90	5
medium cobble	90 - 128	3
large cobble	128 - 180	3
very large cobble	180 - 256	2
small boulder	256 - 362	1
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		97
bedrock ----------		
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		97

Note: XS-3



Size (mm)	
D16	0.56
D35	6.2
D50	12
D65	26
D84	60
D95	150

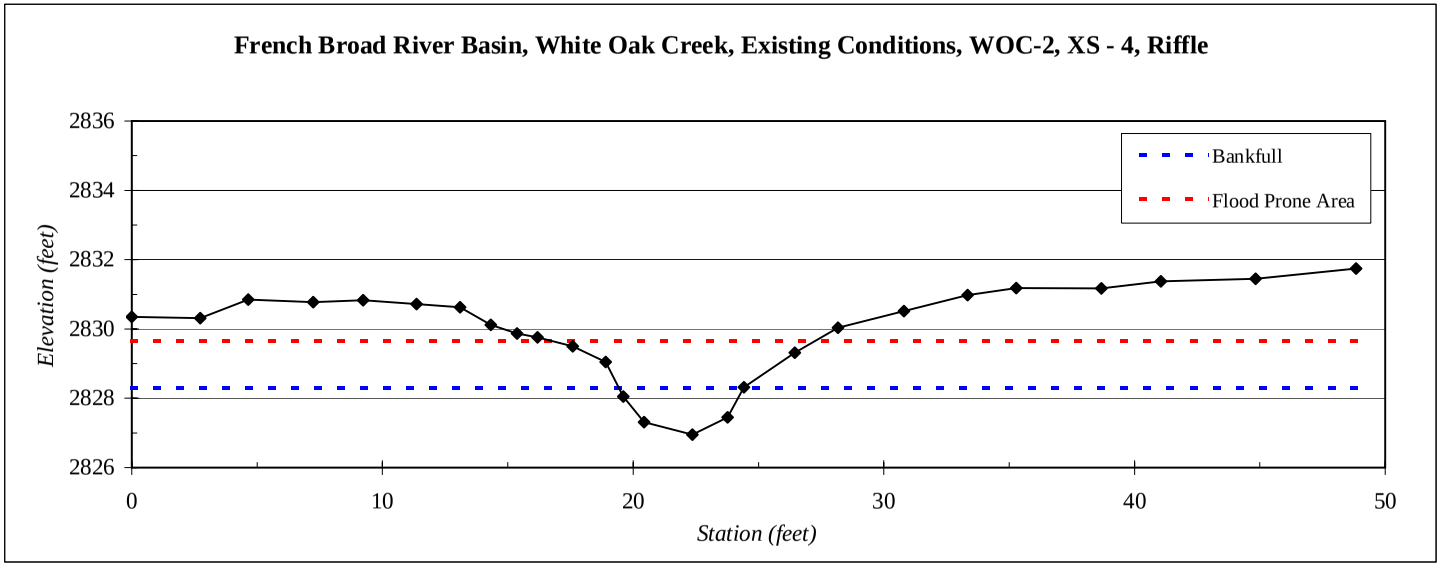
Size Distribution	
mean	5.8
dispersion	13.2
skewness	-0.22

Type	
silt/clay	4%
sand	26%
gravel	56%
cobble	13%
boulder	1%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-2
XS ID	XS - 4, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2830.35
2.7	2830.32
4.6	2830.85
7.2	2830.78
9.2	2830.82
11.4	2830.72
13.1	2830.63
14.3	2830.12
15.4	2829.87
16.2	2829.76
17.6	2829.50
18.9	2829.05
19.6	2828.05
20.4	2827.31
22.4	2826.95
23.8	2827.45
24.4	2828.32
26.4	2829.32
28.2	2830.04
30.8	2830.51
33.3	2830.98
35.3	2831.18
38.7	2831.17
41.0	2831.37
44.8	2831.45
48.8	2831.75

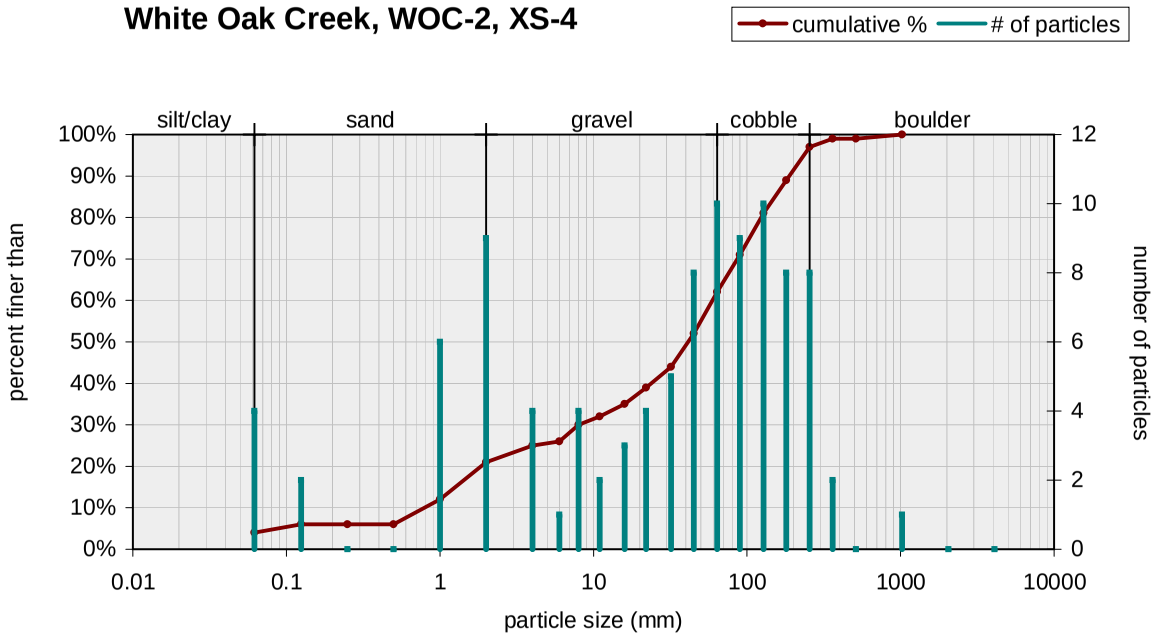
SUMMARY DATA	
Bankfull Elevation:	2828.3
Bankfull Cross-Sectional Area:	4.6
Bankfull Width:	5.0
Flood Prone Area Elevation:	2829.7
Flood Prone Width:	11
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	0.9
W / D Ratio:	5.4
Entrenchment Ratio:	2.1
Bank Height Ratio:	1.6



Riffle Surface

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

Note: XS-4



Size (mm)	
D16	1.4
D35	16
D50	41
D65	72
D84	150
D95	230

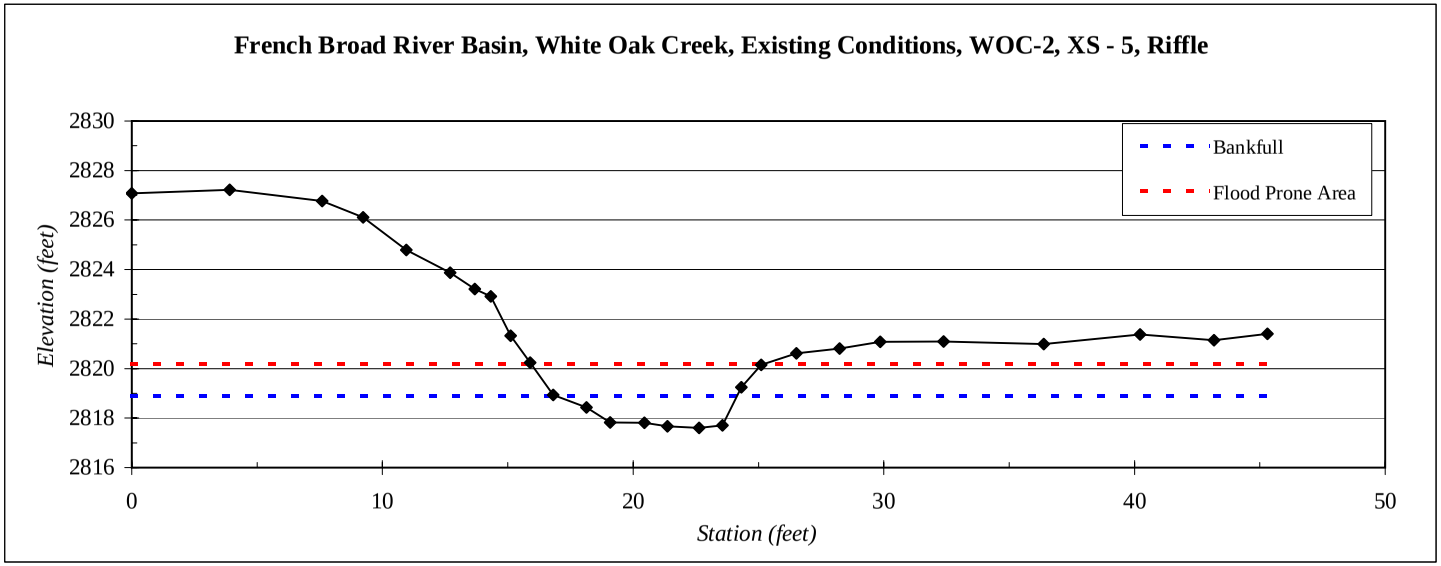
Size Distribution	
mean	14.5
dispersion	16.5
skewness	-0.32

Type	
silt/clay	4%
sand	17%
gravel	41%
cobble	35%
boulder	3%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-2
XS ID	XS - 5, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2827.08
3.9	2827.22
7.6	2826.76
9.2	2826.11
11.0	2824.79
12.7	2823.88
13.7	2823.22
14.3	2822.92
15.1	2821.32
15.9	2820.24
16.8	2818.93
18.1	2818.44
19.1	2817.82
20.5	2817.81
21.4	2817.67
22.6	2817.60
23.6	2817.71
24.3	2819.24
25.1	2820.15
26.5	2820.61
28.2	2820.80
29.9	2821.08
32.4	2821.10
36.4	2820.99
40.2	2821.38
43.2	2821.15
45.3	2821.40

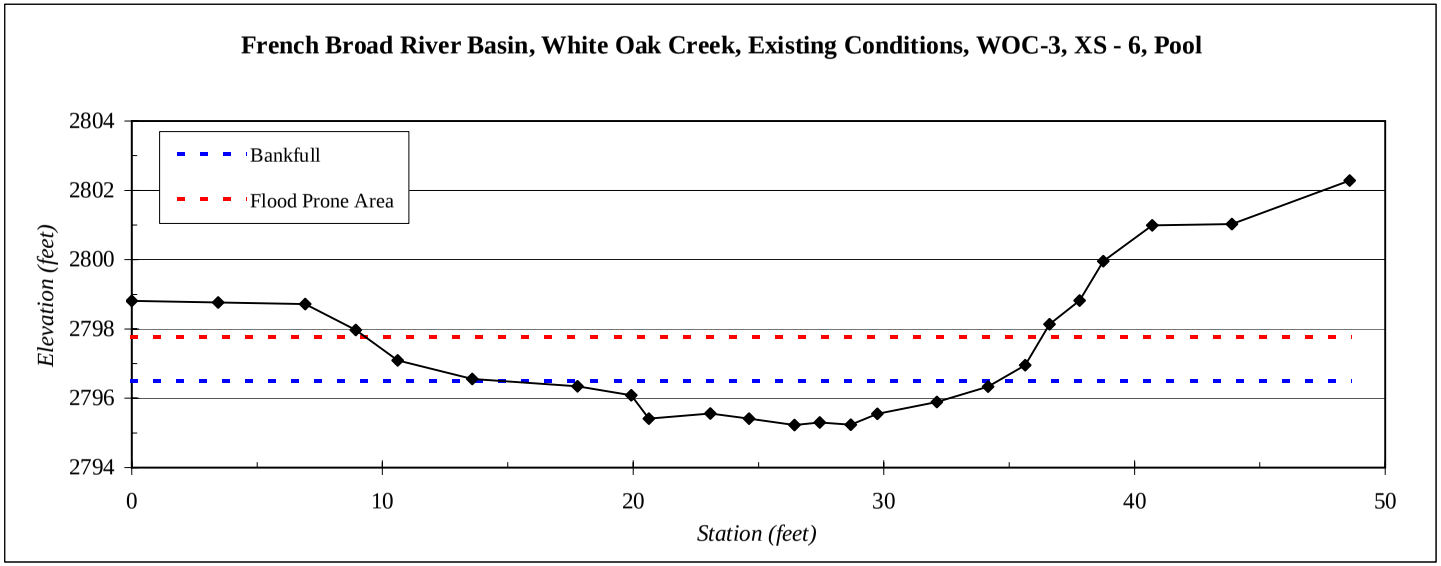
SUMMARY DATA	
Bankfull Elevation:	2818.9
Bankfull Cross-Sectional Area:	6.7
Bankfull Width:	7.3
Flood Prone Area Elevation:	2820.2
Flood Prone Width:	9
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.9
W / D Ratio:	8.0
Entrenchment Ratio:	1.3
Bank Height Ratio:	2.0



River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-3
XS ID	XS - 6, Pool
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2798.81
3.4	2798.77
6.9	2798.72
8.9	2797.97
10.6	2797.09
13.6	2796.56
17.8	2796.34
19.9	2796.09
20.6	2795.41
23.1	2795.56
24.6	2795.41
26.4	2795.23
27.4	2795.30
28.7	2795.24
29.7	2795.55
32.1	2795.89
34.2	2796.33
35.6	2796.95
36.6	2798.14
37.8	2798.82
38.7	2799.95
40.7	2800.99
43.9	2801.02
48.6	2802.29

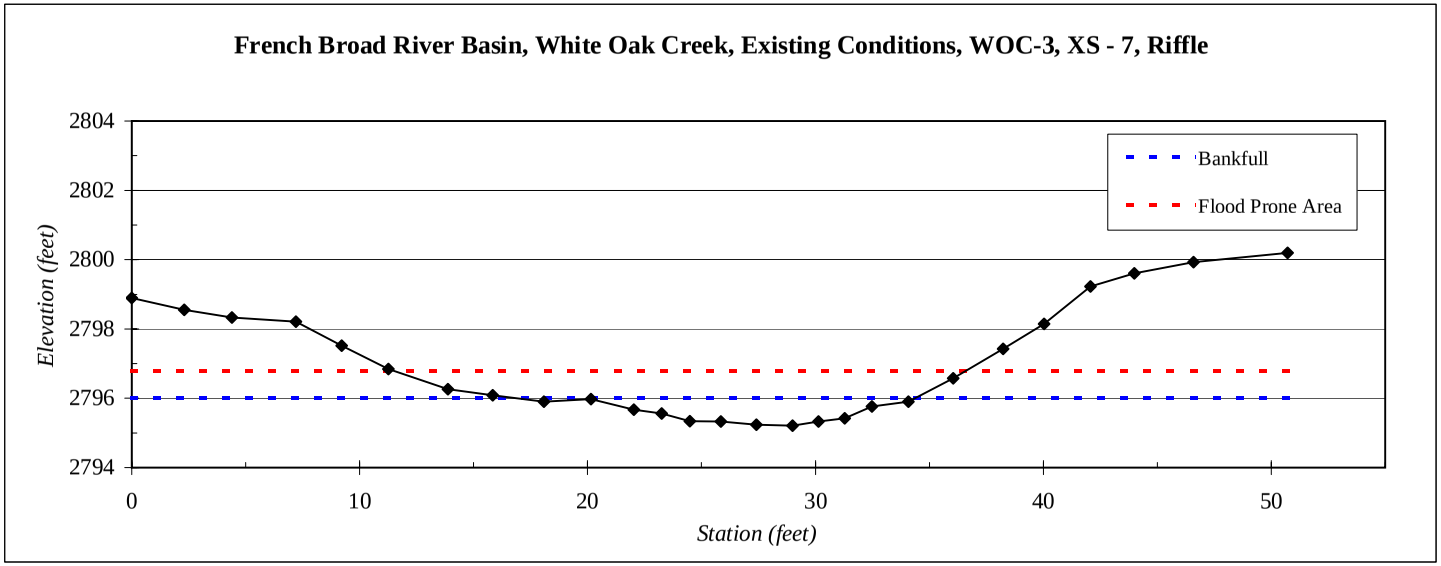
SUMMARY DATA	
Bankfull Elevation:	2796.5
Bankfull Cross-Sectional Area:	14.2
Bankfull Width:	19.8
Flood Prone Area Elevation:	2797.8
Flood Prone Width:	26
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.7
W / D Ratio:	27.6
Entrenchment Ratio:	1.3
Bank Height Ratio:	2.7



River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-3
XS ID	XS - 7, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2798.90
2.3	2798.55
4.4	2798.33
7.2	2798.21
9.2	2797.52
11.3	2796.84
13.9	2796.26
15.8	2796.08
18.1	2795.90
20.1	2795.98
22.0	2795.67
23.3	2795.56
24.5	2795.34
25.9	2795.33
27.4	2795.24
29.0	2795.21
30.1	2795.33
31.3	2795.42
32.5	2795.77
34.1	2795.90
36.1	2796.57
38.2	2797.43
40.0	2798.15
42.1	2799.23
44.0	2799.61
46.6	2799.92
50.7	2800.19

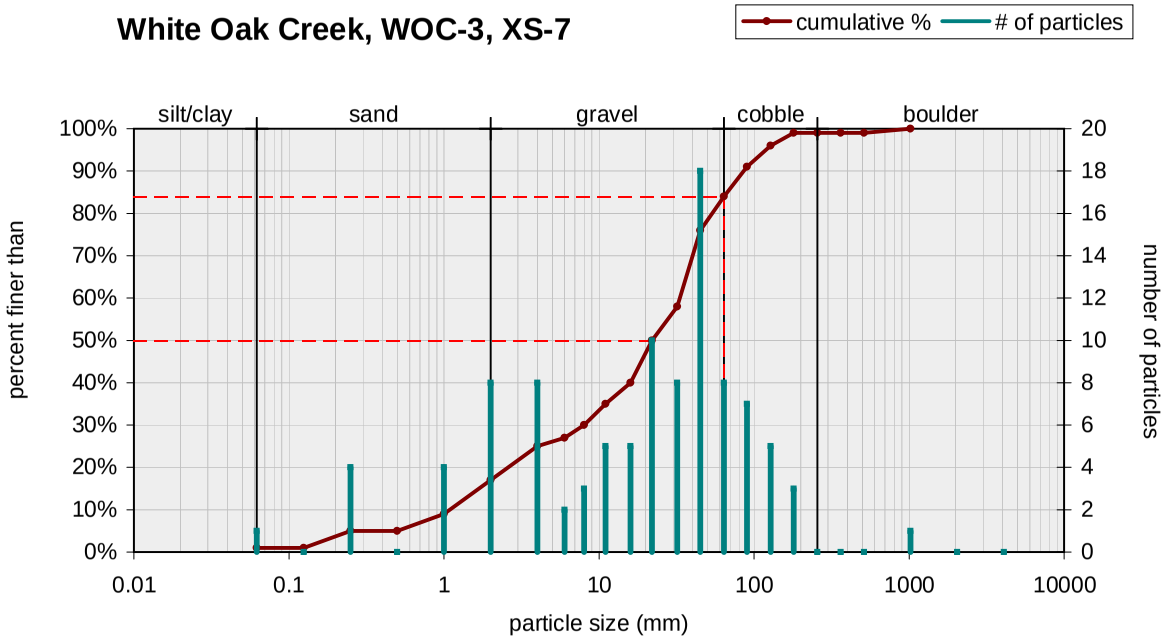
SUMMARY DATA	
Bankfull Elevation:	2796.0
Bankfull Cross-Sectional Area:	7.1
Bankfull Width:	14.2
Flood Prone Area Elevation:	2796.8
Flood Prone Width:	25
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.5
W / D Ratio:	28.4
Entrenchment Ratio:	1.8
Bank Height Ratio:	3.8



Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	4
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	4
very coarse sand	1 - 2	8
very fine gravel	2 - 4	8
fine gravel	4 - 6	2
fine gravel	6 - 8	3
medium gravel	8 - 11	5
medium gravel	11 - 16	5
coarse gravel	16 - 22	10
coarse gravel	22 - 32	8
very coarse gravel	32 - 45	18
very coarse gravel	45 - 64	8
small cobble	64 - 90	7
medium cobble	90 - 128	5
large cobble	128 - 180	3
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	1
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		100
bedrock ----------		
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		100

Note: XS-7



Size (mm)	
D16	1.8
D35	11
D50	22
D65	37
D84	64
D95	120

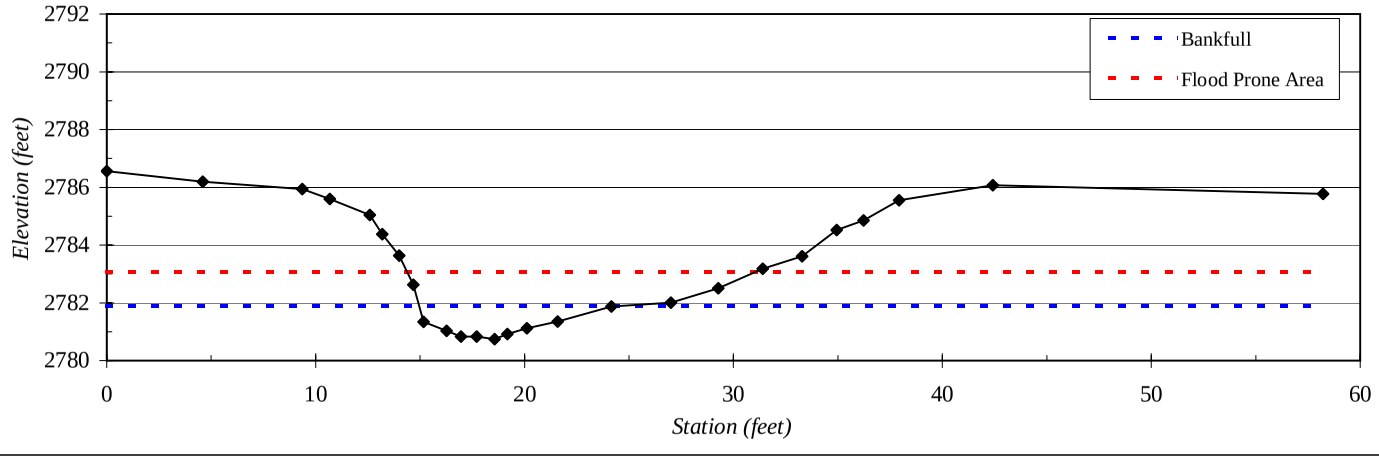
Size Distribution	
mean	10.7
dispersion	7.6
skewness	-0.25

Type	
silt/clay	1%
sand	16%
gravel	67%
cobble	15%
boulder	1%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-4
XS ID	XS - 8, Riffle
Drainage Area (sq mi):	0.5
Date:	2/18/2008
Field Crew:	B. Hemel, Z. Mryncza, B. Roberts, A. Spiller

Station	Elevation
0.0	2786.56
4.6	2786.19
9.4	2785.94
10.7	2785.60
12.6	2785.04
13.2	2784.37
14.0	2783.63
14.7	2782.63
15.2	2781.34
16.3	2781.03
17.0	2780.83
17.7	2780.83
18.6	2780.75
19.2	2780.92
20.1	2781.12
21.6	2781.35
24.2	2781.87
27.0	2782.01
29.3	2782.50
31.4	2783.18
33.3	2783.61
34.9	2784.52
36.2	2784.85
37.9	2785.55
42.4	2786.07
58.2	2785.78

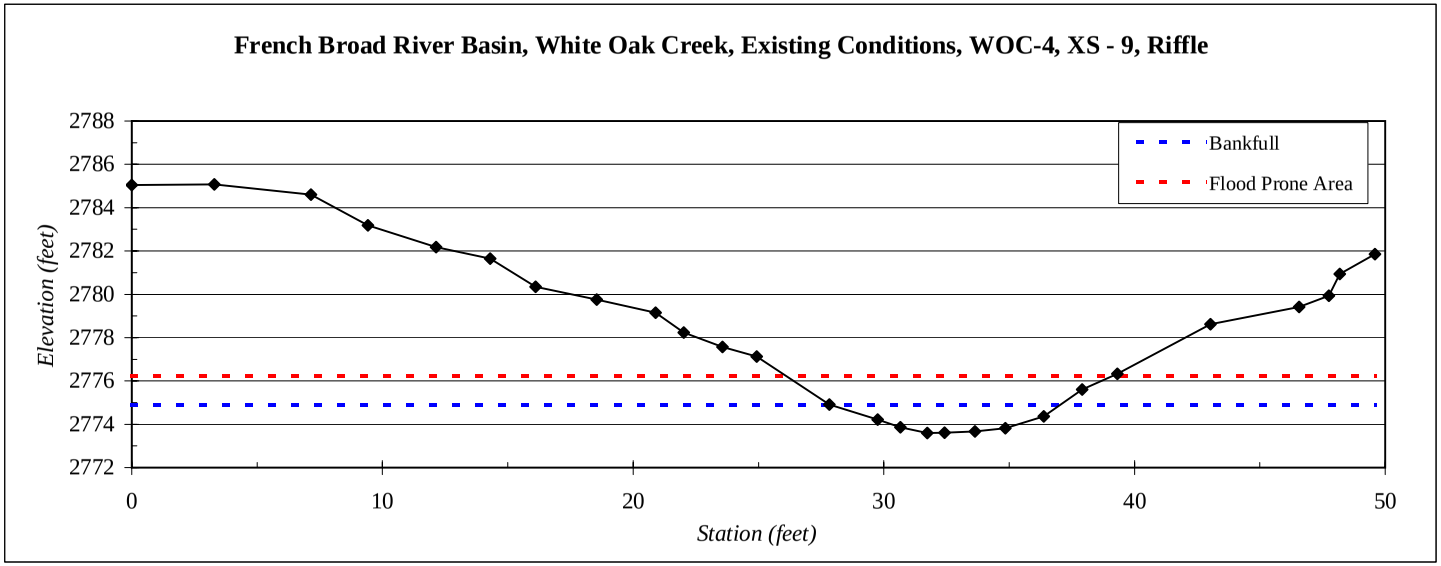
SUMMARY DATA	
Bankfull Elevation:	2781.9
Bankfull Cross-Sectional Area:	6.5
Bankfull Width:	9.8
Flood Prone Area Elevation:	2783.1
Flood Prone Width:	17
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.7
W / D Ratio:	14.8
Entrenchment Ratio:	1.7
Bank Height Ratio:	3.7



River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-4
XS ID	XS - 9, Riffle
Drainage Area (sq mi):	0.5
Date:	2/18/2008
Field Crew:	B. Hemel, Z. Mryncza, B. Roberts, A. Spiller

Station	Elevation
0.0	2785.05
3.3	2785.07
7.1	2784.60
9.4	2783.18
12.1	2782.18
14.3	2781.65
16.1	2780.35
18.5	2779.75
20.9	2779.14
22.0	2778.24
23.6	2777.58
24.9	2777.13
27.8	2774.91
29.8	2774.22
30.7	2773.86
31.7	2773.59
32.4	2773.61
33.6	2773.67
34.8	2773.81
36.4	2774.37
37.9	2775.60
39.3	2776.33
43.0	2778.61
46.6	2779.41
47.7	2779.94
48.2	2780.94
49.6	2781.86

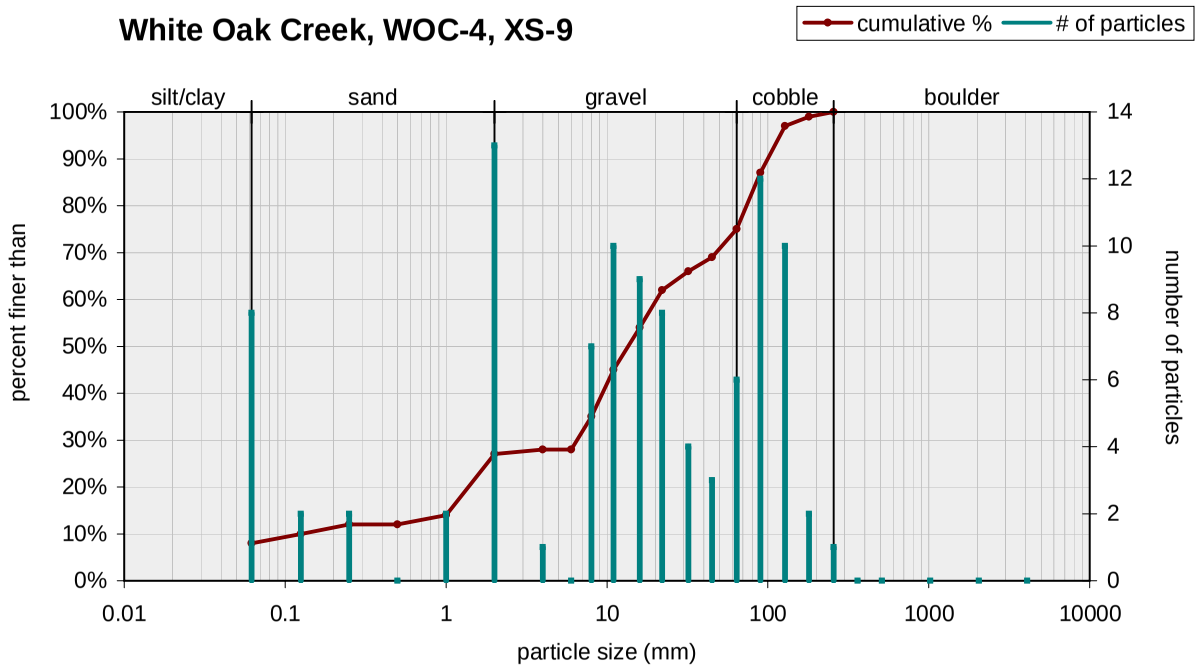
SUMMARY DATA	
Bankfull Elevation:	2774.9
Bankfull Cross-Sectional Area:	7.9
Bankfull Width:	9.2
Flood Prone Area Elevation:	2776.2
Flood Prone Width:	13
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.9
W / D Ratio:	10.7
Entrenchment Ratio:	1.4
Bank Height Ratio:	2.7



Riffle Surface

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

Note: XS-9



Size (mm)	
D16	1.1
D35	8
D50	14
D65	29
D84	83
D95	120

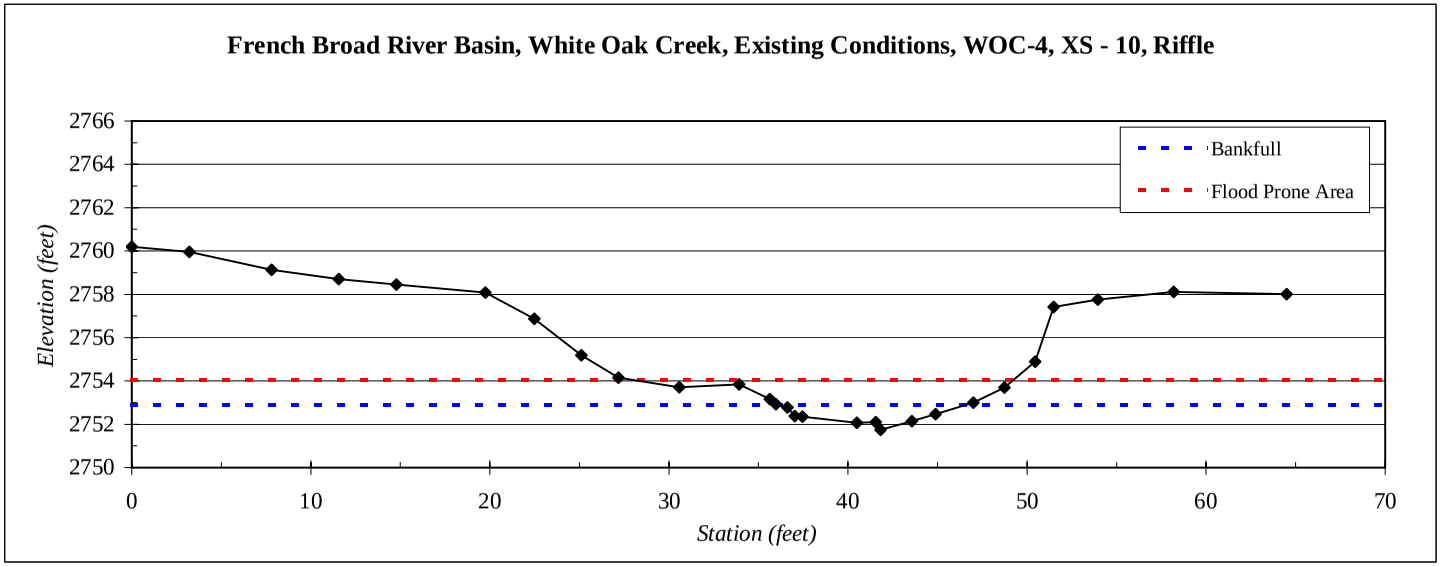
Size Distribution	
mean	9.6
dispersion	9.3
skewness	-0.12

Type	
silt/clay	8%
sand	19%
gravel	48%
cobble	25%
boulder	0%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-4
XS ID	XS - 10, Riffle
Drainage Area (sq mi):	0.5
Date:	2/18/2008
Field Crew:	B. Hemel, Z. Mryncza, B. Roberts, A. Spiller

Station	Elevation
0.0	2760.20
3.2	2759.96
7.8	2759.13
11.6	2758.70
14.8	2758.45
19.7	2758.07
22.5	2756.87
25.1	2755.19
27.2	2754.15
30.6	2753.71
33.9	2753.84
35.6	2753.15
36.0	2752.92
36.6	2752.78
37.0	2752.38
37.5	2752.35
40.5	2752.07
41.6	2752.09
41.8	2751.75
43.6	2752.14
44.9	2752.47
47.0	2753.00
48.7	2753.69
50.5	2754.88
51.5	2757.42
53.9	2757.75
58.2	2758.11
64.5	2758.00
69.7	2758.71

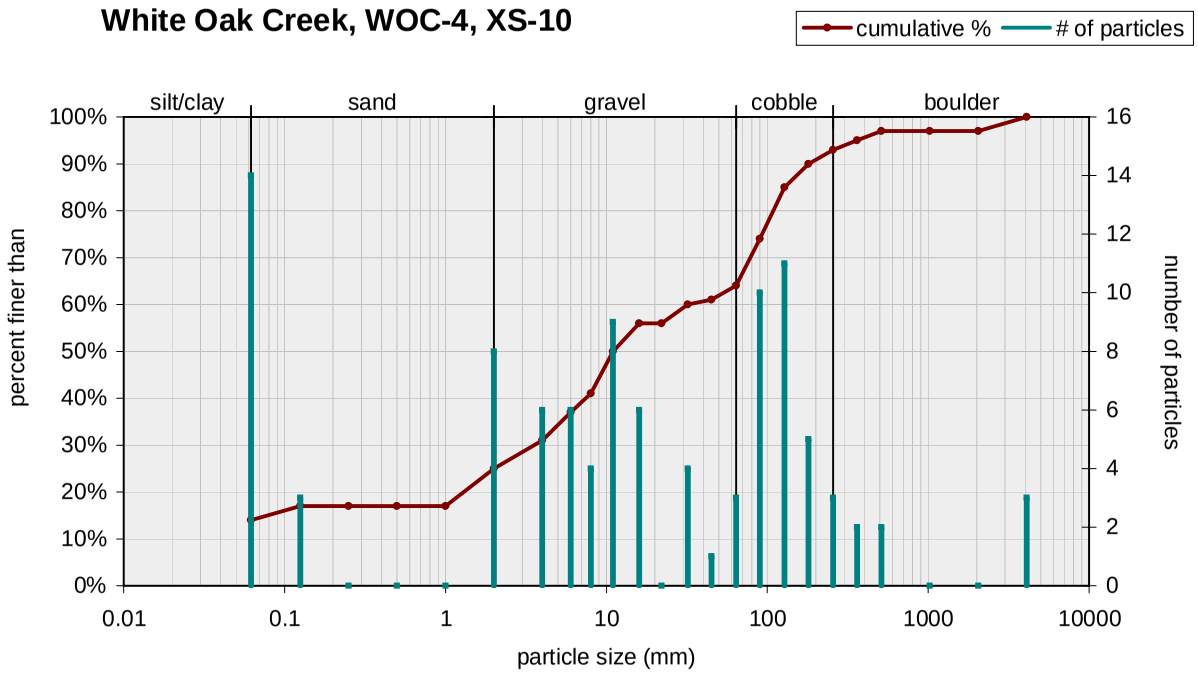
SUMMARY DATA	
Bankfull Elevation:	2752.9
Bankfull Cross-Sectional Area:	6.4
Bankfull Width:	10.5
Flood Prone Area Elevation:	2754.1
Flood Prone Width:	21
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.6
W / D Ratio:	17.2
Entrenchment Ratio:	2.0
Bank Height Ratio:	1.8



Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	14
very fine sand	0.062 - 0.125	3
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	8
very fine gravel	2 - 4	6
fine gravel	4 - 6	6
fine gravel	6 - 8	4
medium gravel	8 - 11	9
medium gravel	11 - 16	6
coarse gravel	16 - 22	0
coarse gravel	22 - 32	4
very coarse gravel	32 - 45	1
very coarse gravel	45 - 64	3
small cobble	64 - 90	10
medium cobble	90 - 128	11
large cobble	128 - 180	5
very large cobble	180 - 256	3
small boulder	256 - 362	2
small boulder	362 - 512	2
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	3
total particle count:		100
bedrock ----------		
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		100

Note: XS-10



Size (mm)	
D16	0.099
D35	5.2
D50	11
D65	66
D84	120
D95	360

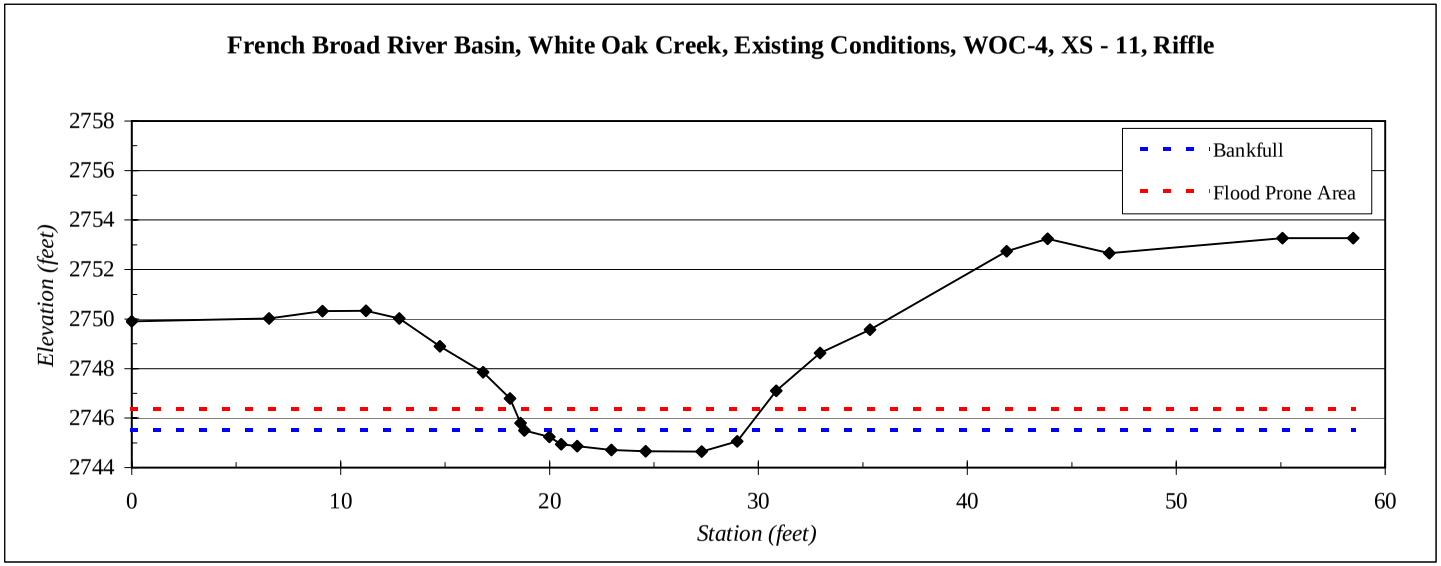
Size Distribution	
mean	3.4
dispersion	61.0
skewness	-0.29

Type	
silt/clay	14%
sand	11%
gravel	39%
cobble	29%
boulder	7%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-4
XS ID	XS - 11, Riffle
Drainage Area (sq mi):	0.5
Date:	2/18/2008
Field Crew:	B. Hemel, Z. Mryncza, B. Roberts, A. Spiller

Station	Elevation
0.0	2749.91
6.6	2750.03
9.1	2750.32
11.2	2750.33
12.8	2750.03
14.8	2748.89
16.8	2747.85
18.1	2746.79
18.6	2745.80
18.8	2745.50
20.0	2745.25
20.6	2744.94
21.3	2744.87
23.0	2744.71
24.6	2744.66
27.3	2744.65
29.0	2745.06
30.8	2747.10
32.9	2748.63
35.3	2749.58
41.9	2752.74
43.8	2753.24
46.8	2752.66
55.1	2753.26
58.5	2753.27

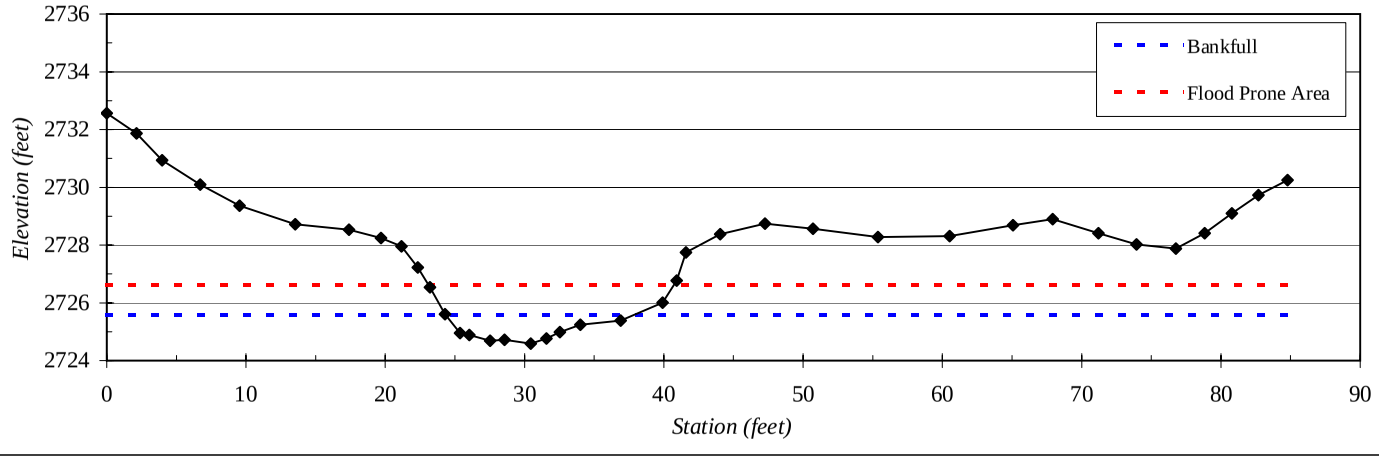
SUMMARY DATA	
Bankfull Elevation:	2745.5
Bankfull Cross-Sectional Area:	6.8
Bankfull Width:	10.6
Flood Prone Area Elevation:	2746.4
Flood Prone Width:	12
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.6
W / D Ratio:	16.5
Entrenchment Ratio:	1.1
Bank Height Ratio:	2.9



River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-5
XS ID	XS - 12, Riffle
Drainage Area (sq mi):	0.5
Date:	2/18/2008
Field Crew:	B. Hemel, Z. Mryncza, B. Roberts, A. Spiller

Station	Elevation
0.0	2732.57
2.1	2731.86
4.0	2730.93
6.7	2730.09
9.5	2729.36
13.5	2728.72
17.4	2728.53
19.7	2728.25
21.2	2727.95
22.3	2727.23
23.2	2726.54
24.3	2725.60
25.4	2724.96
26.0	2724.89
27.5	2724.69
28.6	2724.72
30.4	2724.59
31.6	2724.77
32.5	2724.99
34.0	2725.24
36.9	2725.38
39.9	2726.00
40.9	2726.77
41.6	2727.75
44.1	2728.37
47.3	2728.74
50.7	2728.57
55.4	2728.28
76.8	2727.88
78.8	2728.41
80.8	2729.10
82.7	2729.72
84.8	2730.24

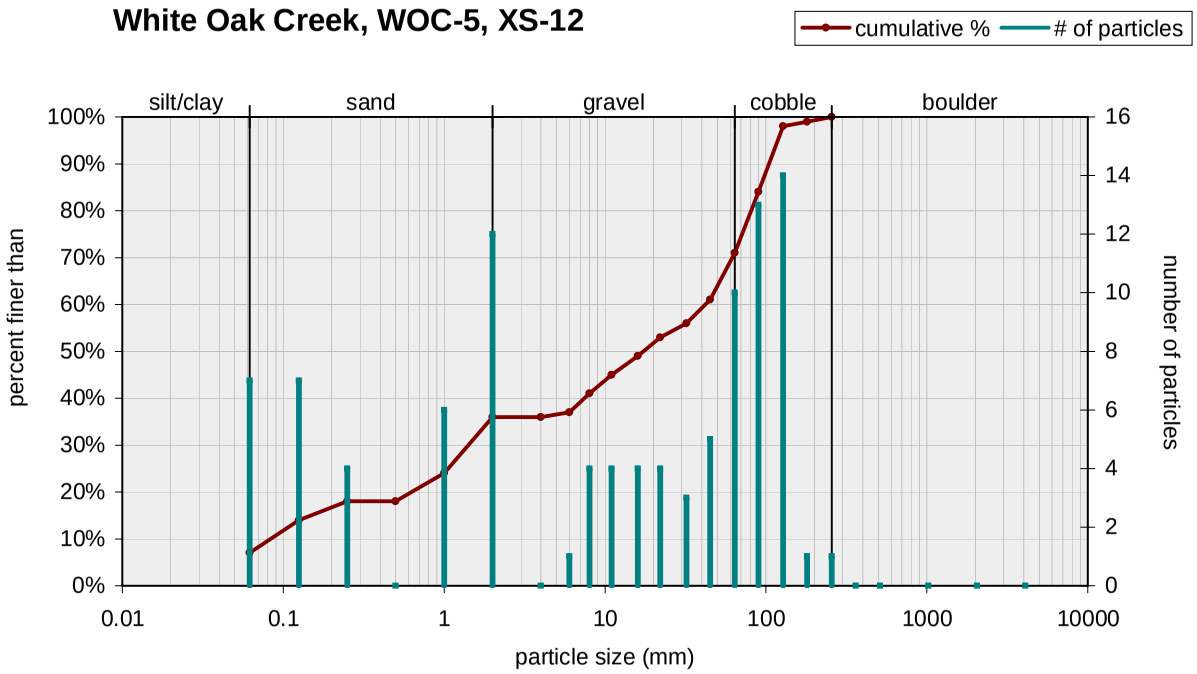
SUMMARY DATA	
Bankfull Elevation:	2725.6
Bankfull Cross-Sectional Area:	8.1
Bankfull Width:	13.7
Flood Prone Area Elevation:	2726.6
Flood Prone Width:	18
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.6
W / D Ratio:	23.2
Entrenchment Ratio:	1.3
Bank Height Ratio:	3.1



Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	7
very fine sand	0.062 - 0.125	7
fine sand	0.125 - 0.25	4
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	6
very coarse sand	1 - 2	12
very fine gravel	2 - 4	0
fine gravel	4 - 6	1
fine gravel	6 - 8	4
medium gravel	8 - 11	4
medium gravel	11 - 16	4
coarse gravel	16 - 22	4
coarse gravel	22 - 32	3
very coarse gravel	32 - 45	5
very coarse gravel	45 - 64	10
small cobble	64 - 90	13
medium cobble	90 - 128	14
large cobble	128 - 180	1
very large cobble	180 - 256	1
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS-12



Size (mm)	
D16	0.18
D35	1.9
D50	17
D65	52
D84	90
D95	120

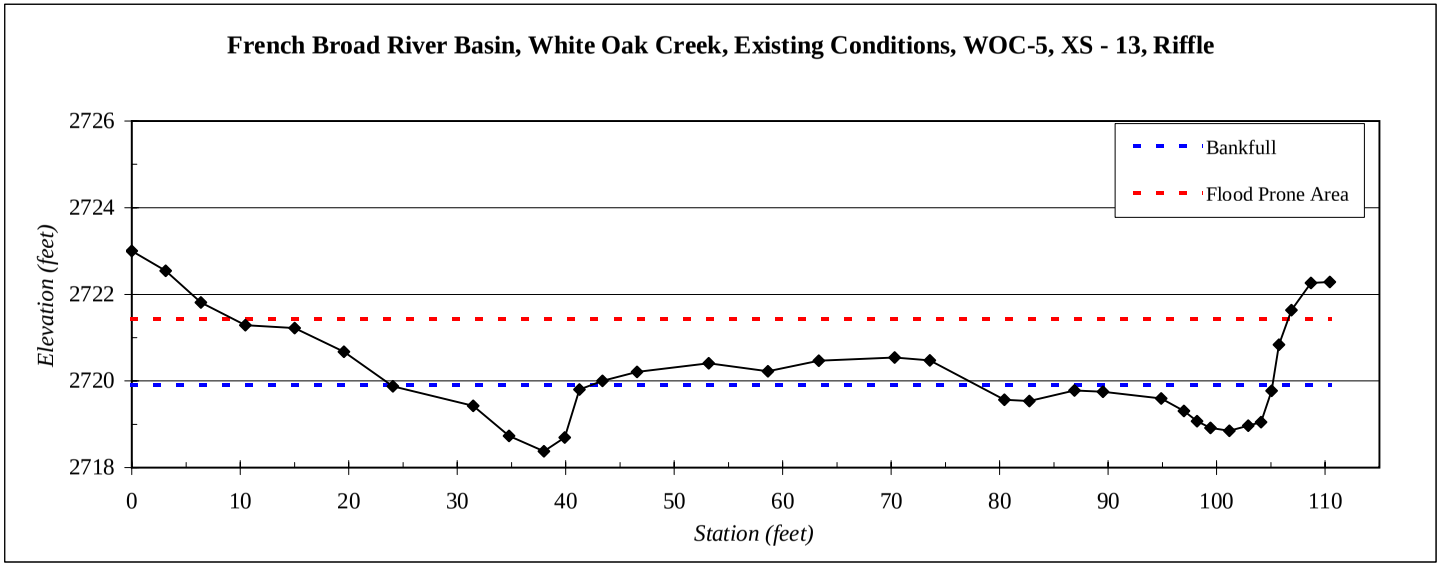
Size Distribution	
mean	4.0
dispersion	49.9
skewness	-0.38

Type	
silt/clay	7%
sand	29%
gravel	35%
cobble	29%
boulder	0%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions, WOC-5
XS ID	XS - 13, Riffle
Drainage Area (sq mi):	0.5
Date:	2/18/2008
Field Crew:	B. Hemel, Z. Mryncza, B. Roberts, A. Spiller

Station	Elevation
0.0	2723.00
3.1	2722.54
6.4	2721.81
10.5	2721.29
15.0	2721.22
19.6	2720.67
24.1	2719.88
31.5	2719.43
34.8	2718.73
38.0	2718.38
39.9	2718.70
41.3	2719.80
43.4	2720.00
46.6	2720.21
53.2	2720.41
58.6	2720.22
63.3	2720.47
70.3	2720.54
73.6	2720.48
80.4	2719.56
82.7	2719.54
86.9	2719.78
89.5	2719.75
94.9	2719.59
97.0	2719.31
98.2	2719.07
99.4	2718.92
101.2	2718.85
106.9	2721.64
108.7	2722.26
110.4	2722.29

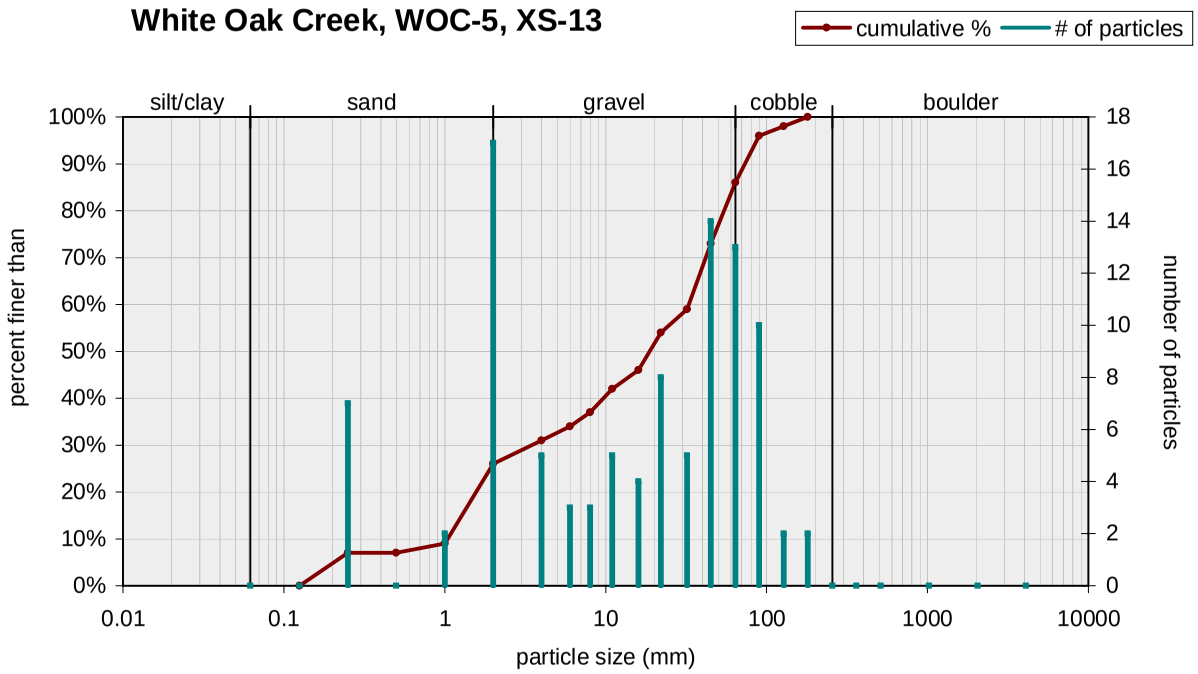
SUMMARY DATA	
Bankfull Elevation:	2719.9
Bankfull Cross-Sectional Area:	11.7
Bankfull Width:	27.2
Flood Prone Area Elevation:	2721.4
Flood Prone Width:	97
Max Depth at Bankfull:	1.5
Mean Depth at Bankfull:	0.4
W / D Ratio:	63.2
Entrenchment Ratio:	3.6
Bank Height Ratio:	1.4



Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	0
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	7
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	2
very coarse sand	1 - 2	17
very fine gravel	2 - 4	5
fine gravel	4 - 6	3
fine gravel	6 - 8	3
medium gravel	8 - 11	5
medium gravel	11 - 16	4
coarse gravel	16 - 22	8
coarse gravel	22 - 32	5
very coarse gravel	32 - 45	14
very coarse gravel	45 - 64	13
small cobble	64 - 90	10
medium cobble	90 - 128	2
large cobble	128 - 180	2
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS-13



Size (mm)	
D16	1.3
D35	6.6
D50	19
D65	37
D84	61
D95	87

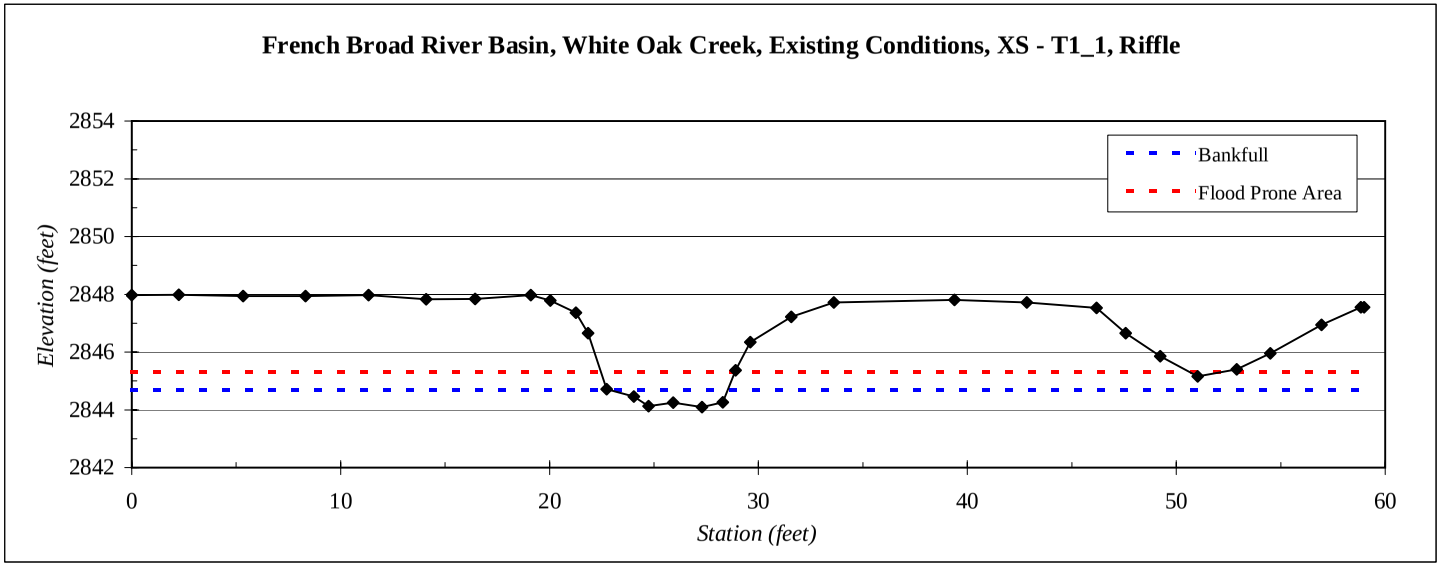
Size Distribution	
mean	8.9
dispersion	8.9
skewness	-0.25

Type	
silt/clay	0%
sand	26%
gravel	60%
cobble	14%
boulder	0%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions
XS ID	XS - T1_1, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2847.98
2.3	2847.98
5.3	2847.93
8.3	2847.94
11.3	2847.97
14.1	2847.83
16.4	2847.84
19.1	2847.97
20.0	2847.78
21.3	2847.36
21.8	2846.65
22.7	2844.71
24.0	2844.46
24.7	2844.13
25.9	2844.25
27.3	2844.09
28.3	2844.26
28.9	2845.37
29.6	2846.34
31.6	2847.22
33.6	2847.71
39.4	2847.80
42.8	2847.71
46.2	2847.52
47.6	2846.65
49.2	2845.86
51.0	2845.16
52.9	2845.40
54.5	2845.95
57.0	2846.94
58.8	2847.56
59.0	2847.56

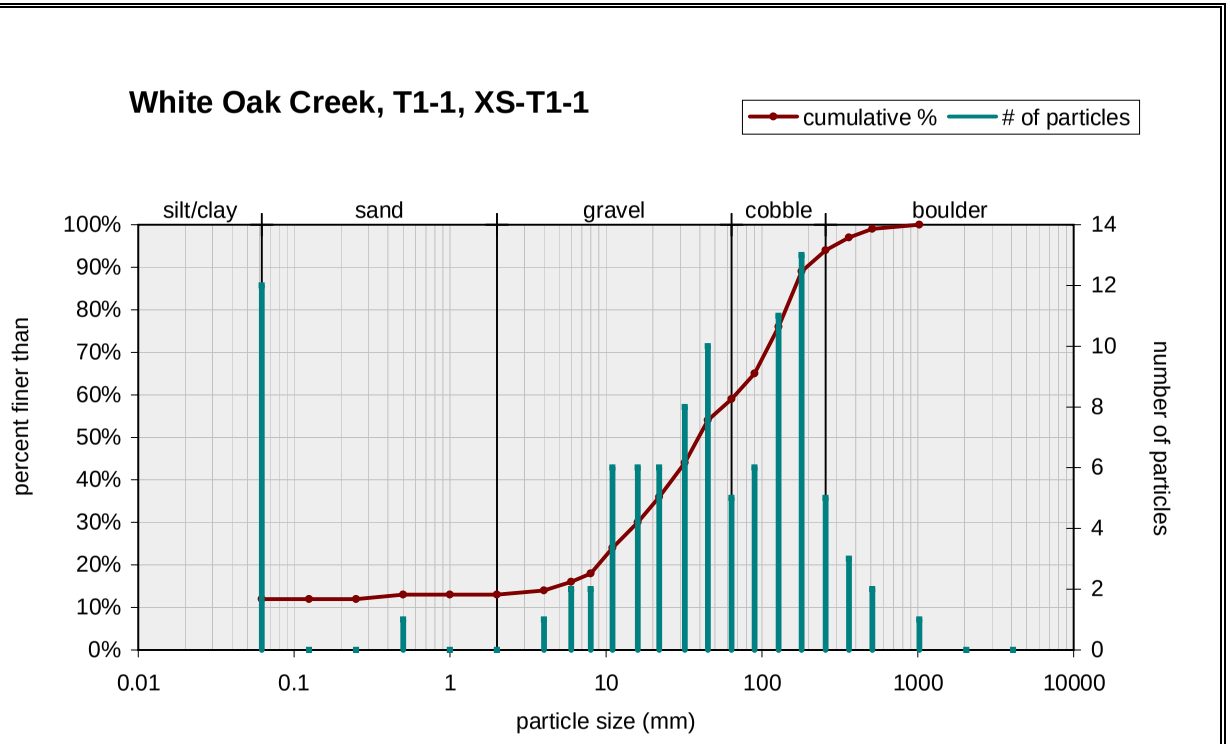
SUMMARY DATA	
Bankfull Elevation:	2844.7
Bankfull Cross-Sectional Area:	2.3
Bankfull Width:	5.7
Flood Prone Area Elevation:	2845.3
Flood Prone Width:	8
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.4
W / D Ratio:	14.1
Entrenchment Ratio:	1.4
Bank Height Ratio:	3.6



Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	12
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	1
fine gravel	4 - 6	2
fine gravel	6 - 8	2
medium gravel	8 - 11	6
medium gravel	11 - 16	6
coarse gravel	16 - 22	6
coarse gravel	22 - 32	8
very coarse gravel	32 - 45	10
very coarse gravel	45 - 64	5
small cobble	64 - 90	6
medium cobble	90 - 128	11
large cobble	128 - 180	13
very large cobble	180 - 256	5
small boulder	256 - 362	3
small boulder	362 - 512	2
medium boulder	512 - 1024	1
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		100
bedrock ----------		
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		100

Note: XS-T1-1



Size (mm)	
D16	6
D35	21
D50	39
D65	90
D84	160
D95	290

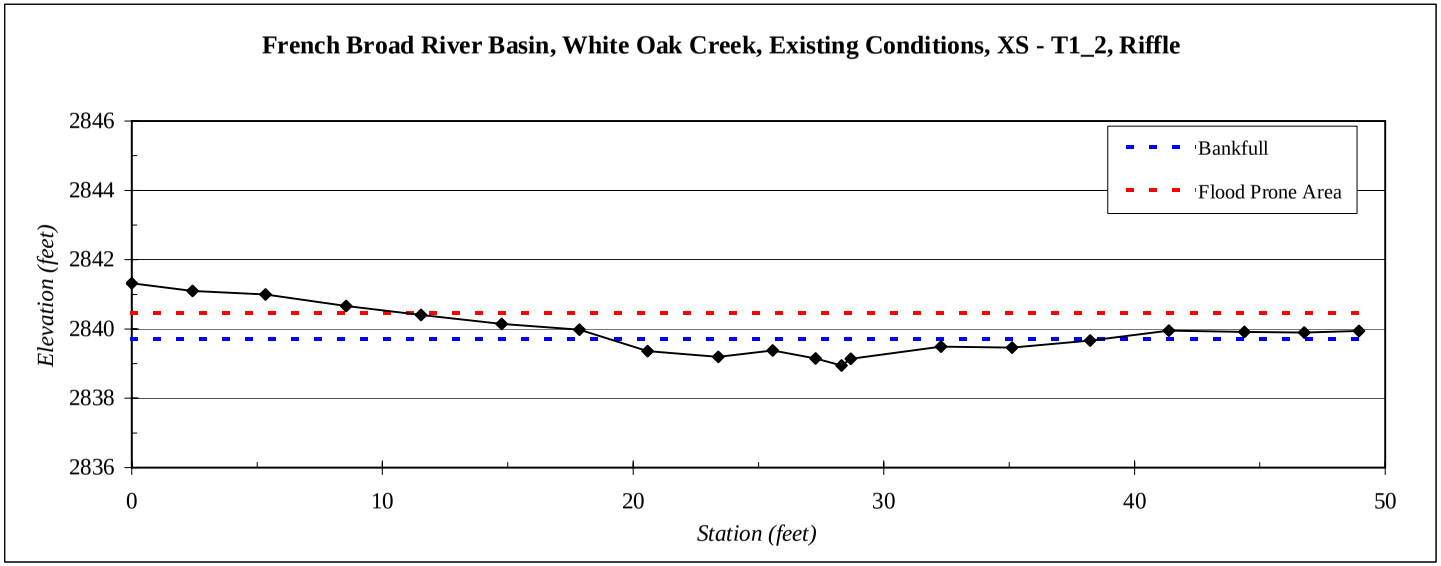
Size Distribution	
mean	31.0
dispersion	5.3
skewness	-0.08

Type	
silt/clay	12%
sand	1%
gravel	46%
cobble	35%
boulder	6%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions
XS ID	XS - T1_2, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2841.32
2.4	2841.10
5.3	2840.99
8.5	2840.66
11.5	2840.40
14.8	2840.15
17.9	2839.98
20.6	2839.36
23.4	2839.19
25.6	2839.38
27.3	2839.15
28.3	2838.94
28.7	2839.14
32.3	2839.49
35.1	2839.46
38.2	2839.67
41.4	2839.95
44.4	2839.92
46.8	2839.90
49.0	2839.95

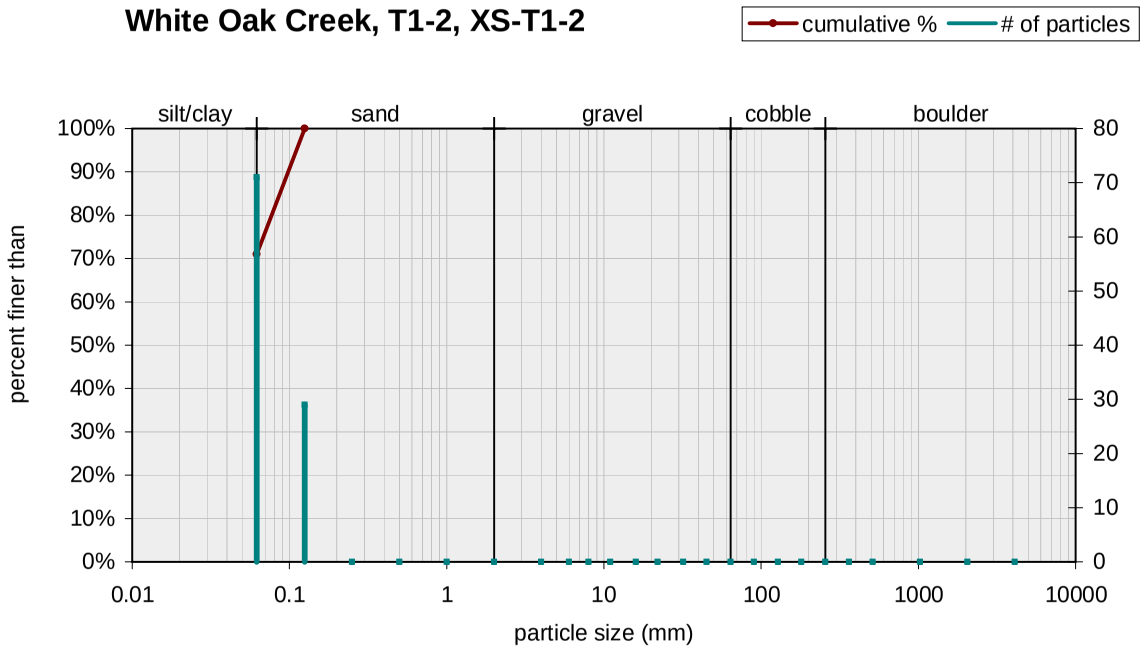
SUMMARY DATA	
Bankfull Elevation:	2839.7
Bankfull Cross-Sectional Area:	6.5
Bankfull Width:	19.5
Flood Prone Area Elevation:	2840.5
Flood Prone Width:	38
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.3
W / D Ratio:	58.5
Entrenchment Ratio:	1.9
Bank Height Ratio:	1.4



Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	71
very fine sand	0.062 - 0.125	29
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	0
fine gravel	4 - 6	0
fine gravel	6 - 8	0
medium gravel	8 - 11	0
medium gravel	11 - 16	0
coarse gravel	16 - 22	0
coarse gravel	22 - 32	0
very coarse gravel	32 - 45	0
very coarse gravel	45 - 64	0
small cobble	64 - 90	0
medium cobble	90 - 128	0
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS-T1-2



Size (mm)	
D16	0.062
D35	0.062
D50	0.062
D65	0.062
D84	0.085
D95	0.11

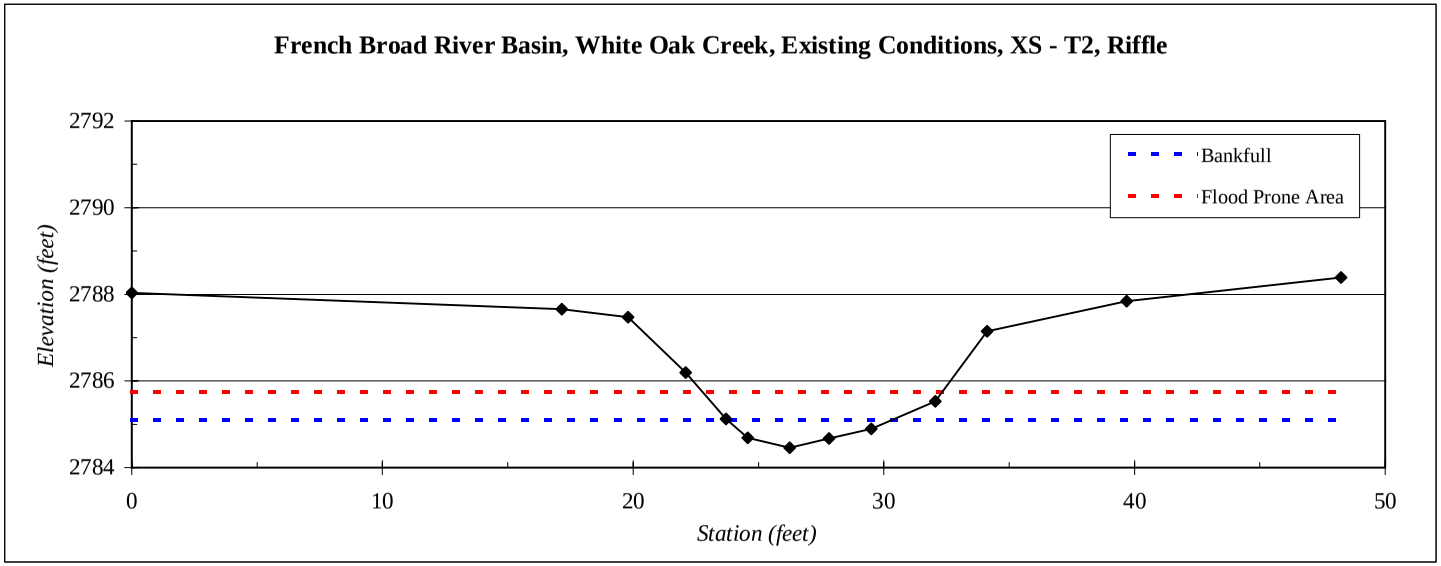
Size Distribution	
mean	0.1
dispersion	1.2
skewness	0.19

Type	
silt/clay	71%
sand	29%
gravel	0%
cobble	0%
boulder	0%

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions
XS ID	XS - T2, Riffle
Drainage Area (sq mi):	0.5
Date:	2/18/2008
Field Crew:	B. Hemel, Z. Mryncza, B. Roberts, A. Spiller

Station	Elevation
0.0	2788.03
17.2	2787.66
19.8	2787.47
22.1	2786.20
23.7	2785.12
24.6	2784.69
26.2	2784.45
27.8	2784.67
29.5	2784.89
32.0	2785.53
34.1	2787.15
39.7	2787.84
48.2	2788.39

SUMMARY DATA	
Bankfull Elevation:	2785.1
Bankfull Cross-Sectional Area:	2.5
Bankfull Width:	6.6
Flood Prone Area Elevation:	2785.7
Flood Prone Width:	10
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.4
W / D Ratio:	17.4
Entrenchment Ratio:	1.5
Bank Height Ratio:	4.2



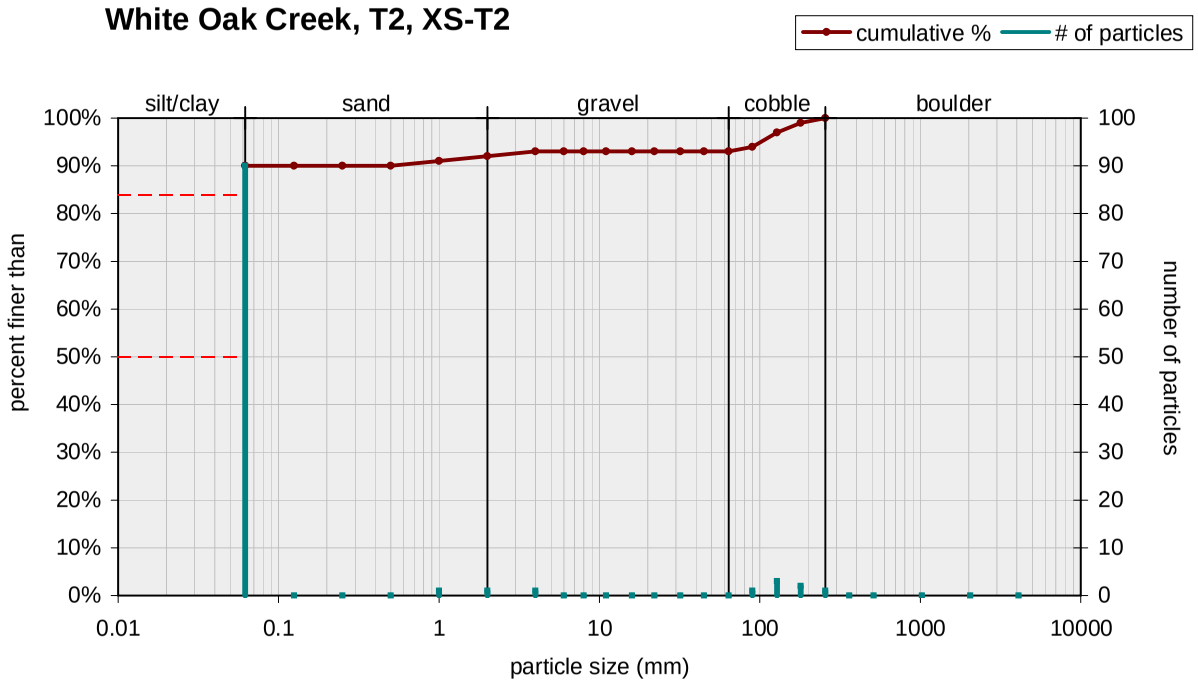
Riffle Surface

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

bedrock	----------
clay hardpan	----------
detritus/wood	----------
artificial	----------

total count:	100

Note: XS-T2



Size (mm)	
D16	0.062
D35	0.062
D50	0.062
D65	0.062
D84	0.062
D95	100

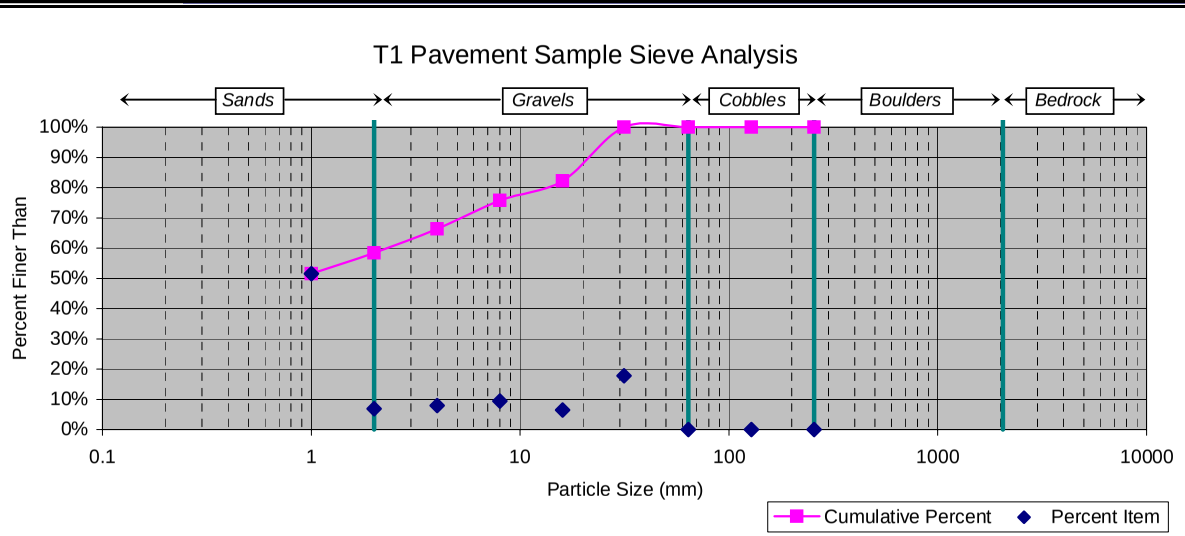
Size Distribution	
mean	0.1
dispersion	1.0
skewness	---

Type	
silt/clay	90%
sand	2%
gravel	1%
cobble	7%
boulder	0%

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	52	51.5%	51.5%
2.0	7.0	6.9%	58.4%
4.0	8.0	7.9%	66.3%
8.0	9.5	9.4%	75.7%
16.0	6.5	6.4%	82.2%
31.5	18.0	17.8%	100.0%
64.0	0.0	0.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	101.0	100%	

Stream:	T1
Watershed:	
Location:	Bakersville, Wilson Dairy Rd
Note:	Sample Taken on 12/14/07 by B Hemel and Z Mryncza

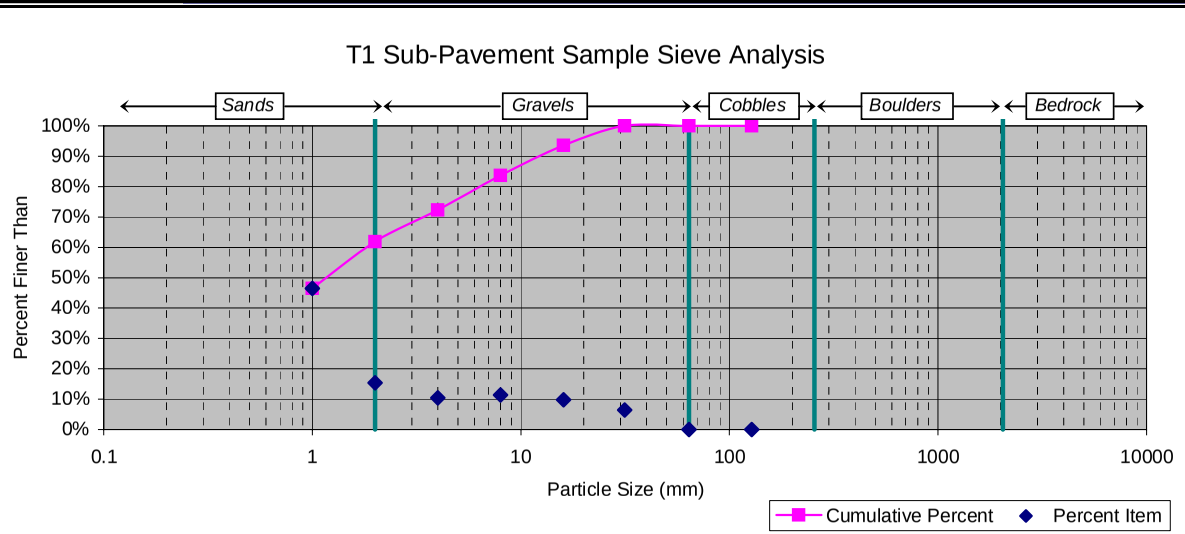


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
17.1	17.1	17.1	17.1	26.0	0%	58%	42%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	75.5	46.5%	46.5%
2.0	25.0	15.4%	61.8%
4.0	17.0	10.5%	72.3%
8.0	18.5	11.4%	83.7%
16.0	16.0	9.8%	93.5%
31.5	10.5	6.5%	100.0%
64.0	0.0	0.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	162.5	100%	

Stream:	T1
Watershed:	
Location:	Bakersville - Wilson Dairy Rd.
Note:	Sample Taken on 12/14/07 by B Hemel and Z Mryncza

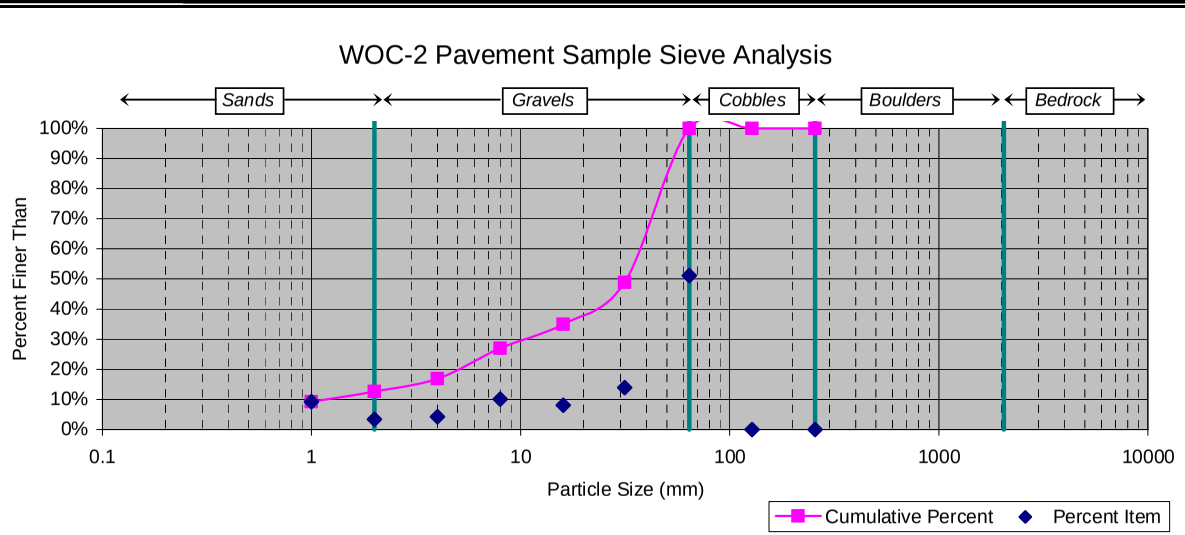


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
1.2	1.2	1.2	8.2	18.6	0%	62%	38%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	36	9.2%	9.2%
2.0	13.5	3.4%	12.6%
4.0	16.5	4.2%	16.9%
8.0	39.5	10.1%	26.9%
16.0	31.5	8.0%	35.0%
31.5	54.5	13.9%	48.9%
64.0	200.0	51.1%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	391.5	100%	

Stream:	WOC-2
Watershed:	
Location:	Bakersville, Wilson Dairy Rd
Note:	Sample Taken on 12/14/07 by B Hemel and Z Mryncza

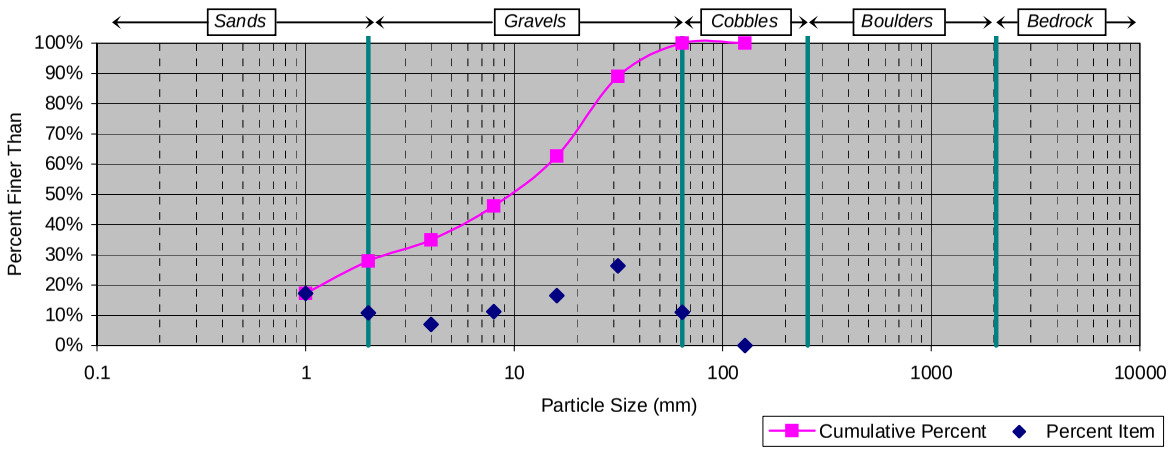


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
3.5	16.0	32.0	51.3	59.7	0%	13%	87%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	89	17.2%	17.2%
2.0	55.5	10.7%	28.0%
4.0	36.0	7.0%	34.9%
8.0	58.0	11.2%	46.2%
16.0	85.0	16.5%	62.6%
31.5	136.0	26.3%	89.0%
64.0	57.0	11.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	516.5	100%	

Stream:	WOC-2
Watershed:	
Location:	Bakersville - Wilson Dairy Rd.
Note:	Sample Taken on 12/14/07 by B Hemel and Z Mryncza

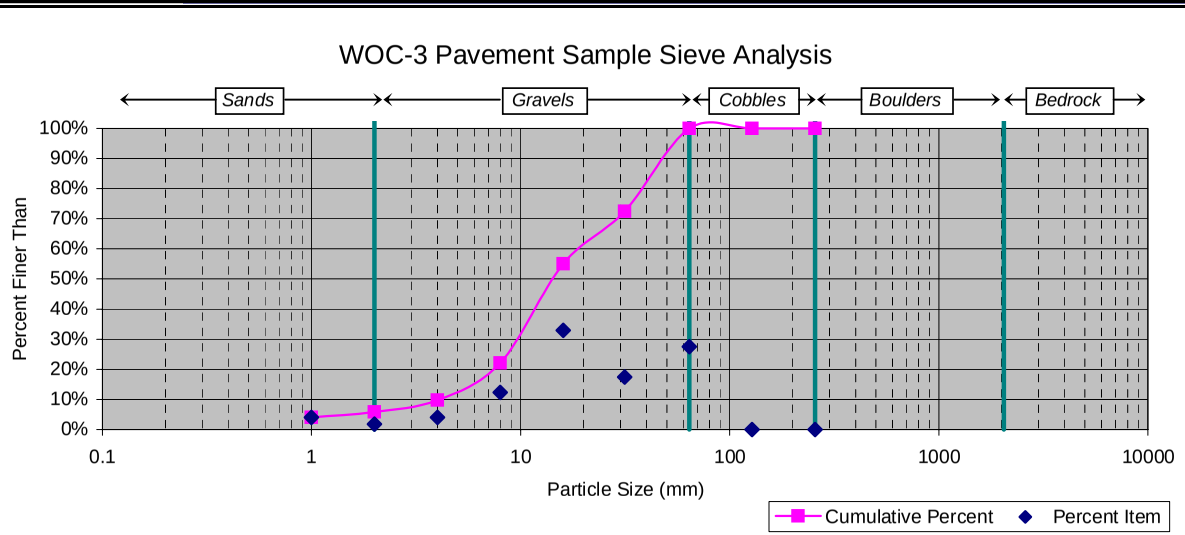


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
4.0	4.0	9.4	27.7	46.4	0%	28%	72%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	5.5	4.0%	4.0%
2.0	2.5	1.8%	5.8%
4.0	5.5	4.0%	9.8%
8.0	17.0	12.3%	22.1%
16.0	45.5	33.0%	55.1%
31.5	24.0	17.4%	72.5%
64.0	38.0	27.5%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	138.0	100%	

Stream:	WOC-3
Watershed:	
Location:	Bakersville, Wilson Dairy Rd
Note:	Sample Taken on 2/18/08 by B Hemel and Z Mryncza

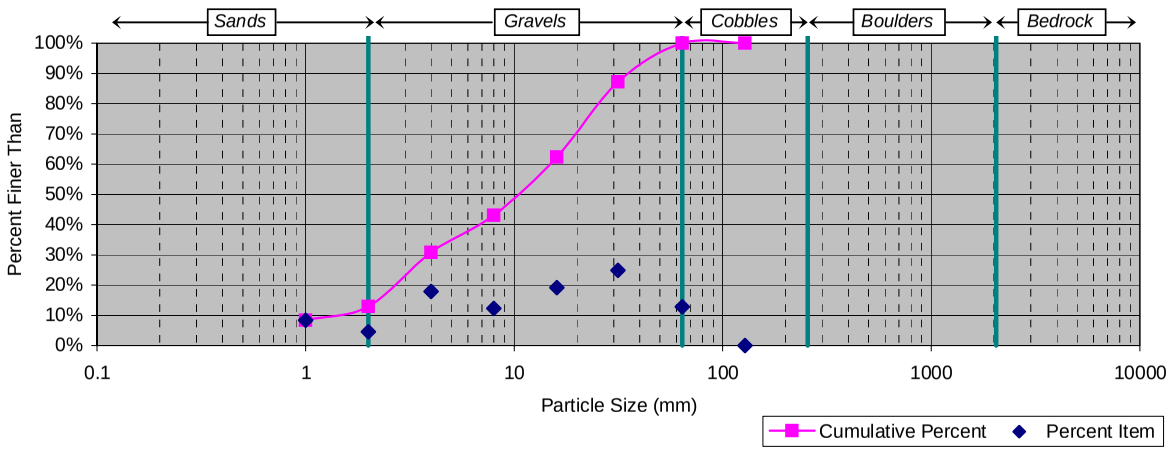


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
5.7	10.5	14.4	42.4	56.3	0%	6%	94%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	25.5	8.4%	8.4%
2.0	14.0	4.6%	13.0%
4.0	54.5	17.9%	30.8%
8.0	37.5	12.3%	43.1%
16.0	58.5	19.2%	62.3%
31.5	76.0	24.9%	87.2%
64.0	39.0	12.8%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	305.0	100%	

Stream:	WOC-3
Watershed:	
Location:	Bakersville - Wilson Dairy Rd.
Note:	Sample Taken on 2/18/08 by B Hemel and Z Mryncza

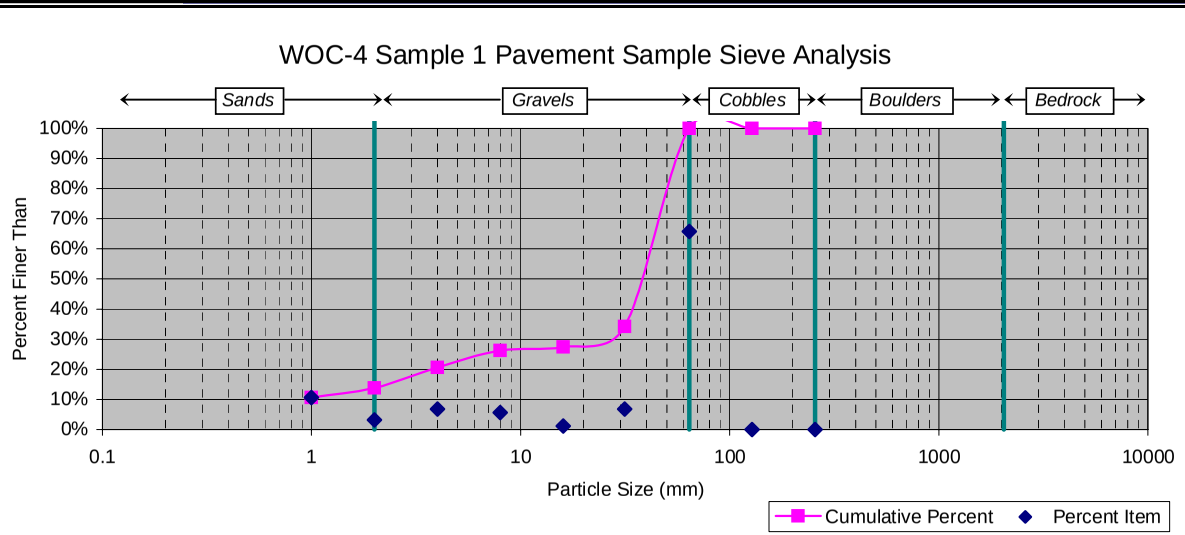


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.3	5.1	10.3	28.9	48.5	0%	13%	87%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	22	10.7%	10.7%
2.0	6.5	3.2%	13.8%
4.0	14.0	6.8%	20.6%
8.0	11.5	5.6%	26.2%
16.0	2.5	1.2%	27.4%
31.5	14.0	6.8%	34.2%
64.0	135.5	65.8%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	206.0	100%	

Stream:	WOC-4, sample 1
Watershed:	
Location:	Bakersville, Wilson Dairy Rd
Note:	Sample Taken on 2/19/08 by B Hemel and Z Mryncza

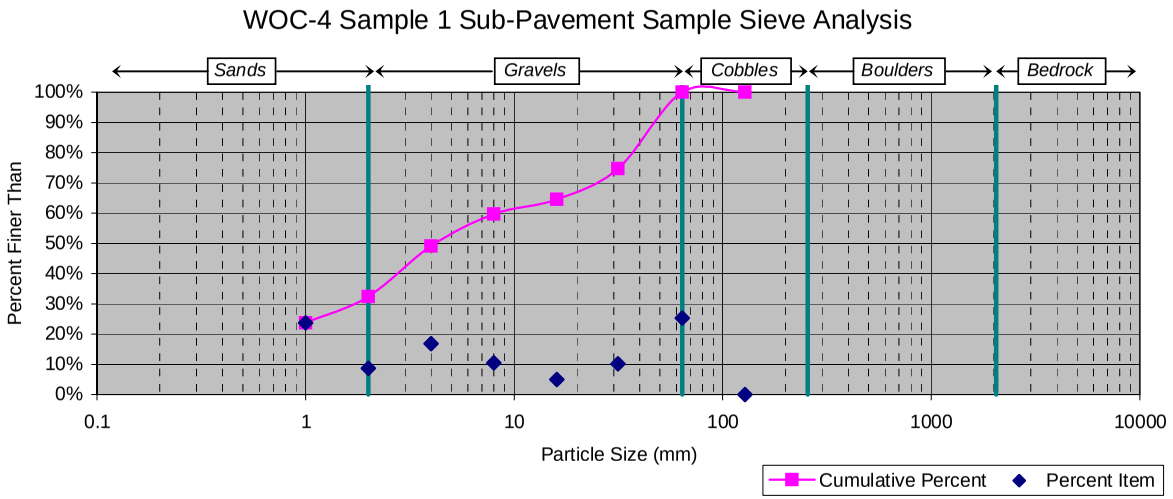


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.5	31.8	37.3	53.9	60.6	0%	14%	86%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	77	23.7%	23.7%
2.0	28.0	8.6%	32.4%
4.0	54.5	16.8%	49.2%
8.0	34.0	10.5%	59.6%
16.0	16.0	4.9%	64.6%
31.5	33.0	10.2%	74.7%
64.0	82.0	25.3%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	324.5	100%	

Stream:	WOC-4, sample 1
Watershed:	
Location:	Bakersville - Wilson dairy Rd.
Note:	Sample Taken on 2/19/08 by B Hemel and Z Mryncza

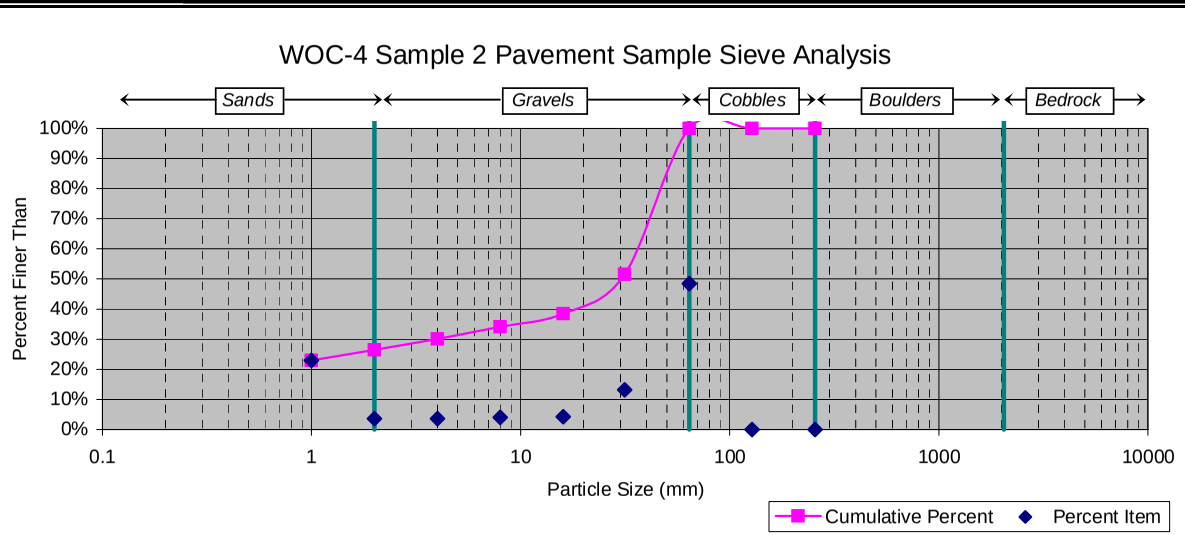


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.2	2.2	4.2	40.9	55.6	0%	32%	68%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	48	22.9%	22.9%
2.0	7.5	3.6%	26.5%
4.0	7.5	3.6%	30.1%
8.0	8.5	4.1%	34.1%
16.0	9.0	4.3%	38.4%
31.5	27.5	13.1%	51.6%
64.0	101.5	48.4%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	209.5	100%	

Stream:	WOC-4, sample 2
Watershed:	
Location:	Bakersville, Wilson Dairy Rd
Note:	Sample Taken on 2/19/08 by B Hemel and Z Mryncza

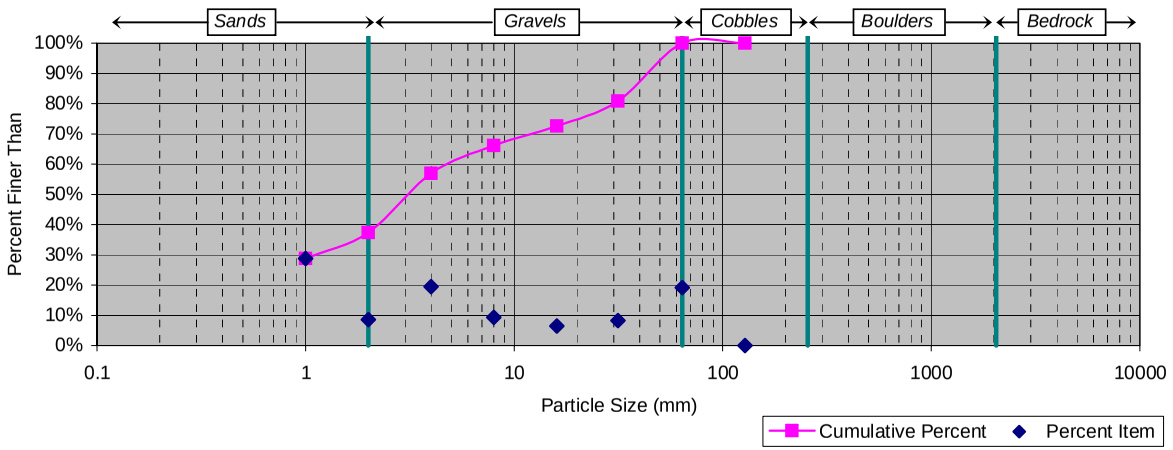


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
9.2	9.2	29.1	50.6	59.5	0%	26%	74%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	80.5	28.8%	28.8%
2.0	24.0	8.6%	37.4%
4.0	54.5	19.5%	56.9%
8.0	26.0	9.3%	66.2%
16.0	18.0	6.4%	72.6%
31.5	23.0	8.2%	80.9%
64.0	53.5	19.1%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	279.5	100%	

Stream:	WOC-4, sample 2
Watershed:	
Location:	Bakersville - Wilson Dairy Rd.
Note:	Sample Taken on 2/19/08 by B Hemel and Z Mryncza

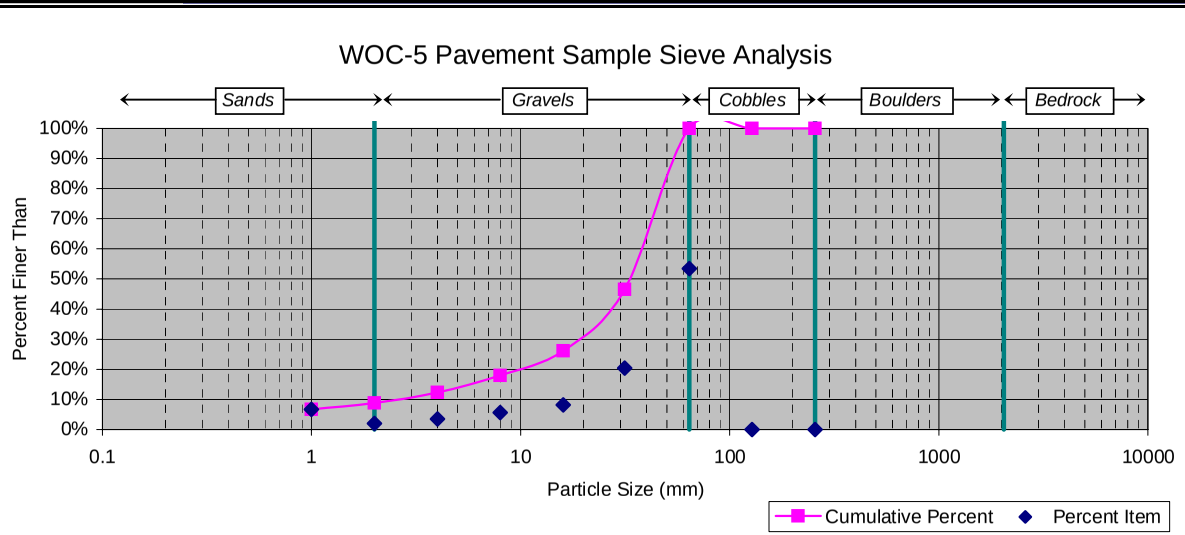


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
1.6	1.6	3.1	35.4	53.2	0%	37%	63%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	18	6.7%	6.7%
2.0	5.5	2.1%	8.8%
4.0	9.5	3.6%	12.3%
8.0	15.0	5.6%	17.9%
16.0	22.0	8.2%	26.2%
31.5	54.5	20.4%	46.5%
64.0	143.0	53.5%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	267.5	100%	

Stream:	WOC-5
Watershed:	
Location:	Bakersville, Wilson Dairy Rd
Note:	Sample Taken on 2/19/08 by B Hemel and Z Mryncza

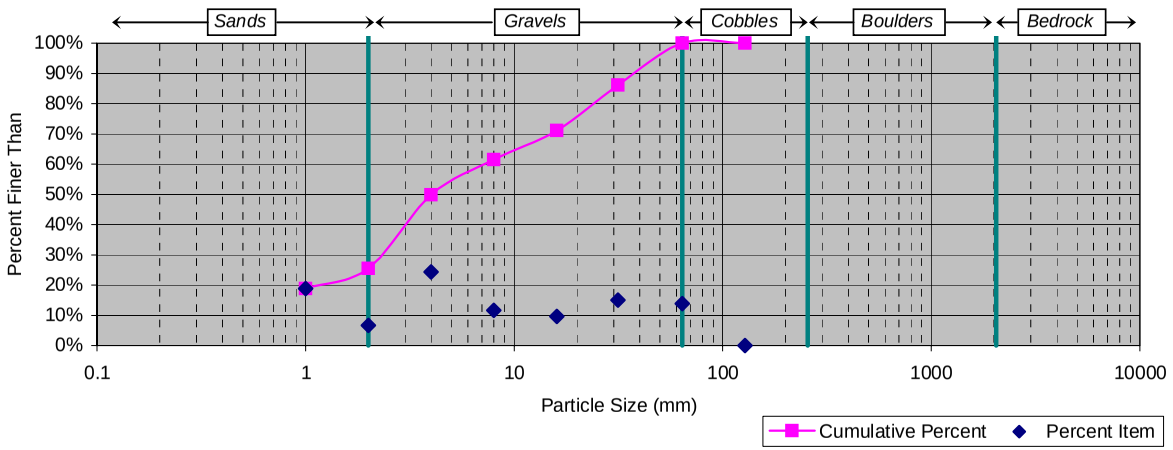


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
6.3	21.5	33.0	51.8	59.9	0%	9%	91%	0%	---	---

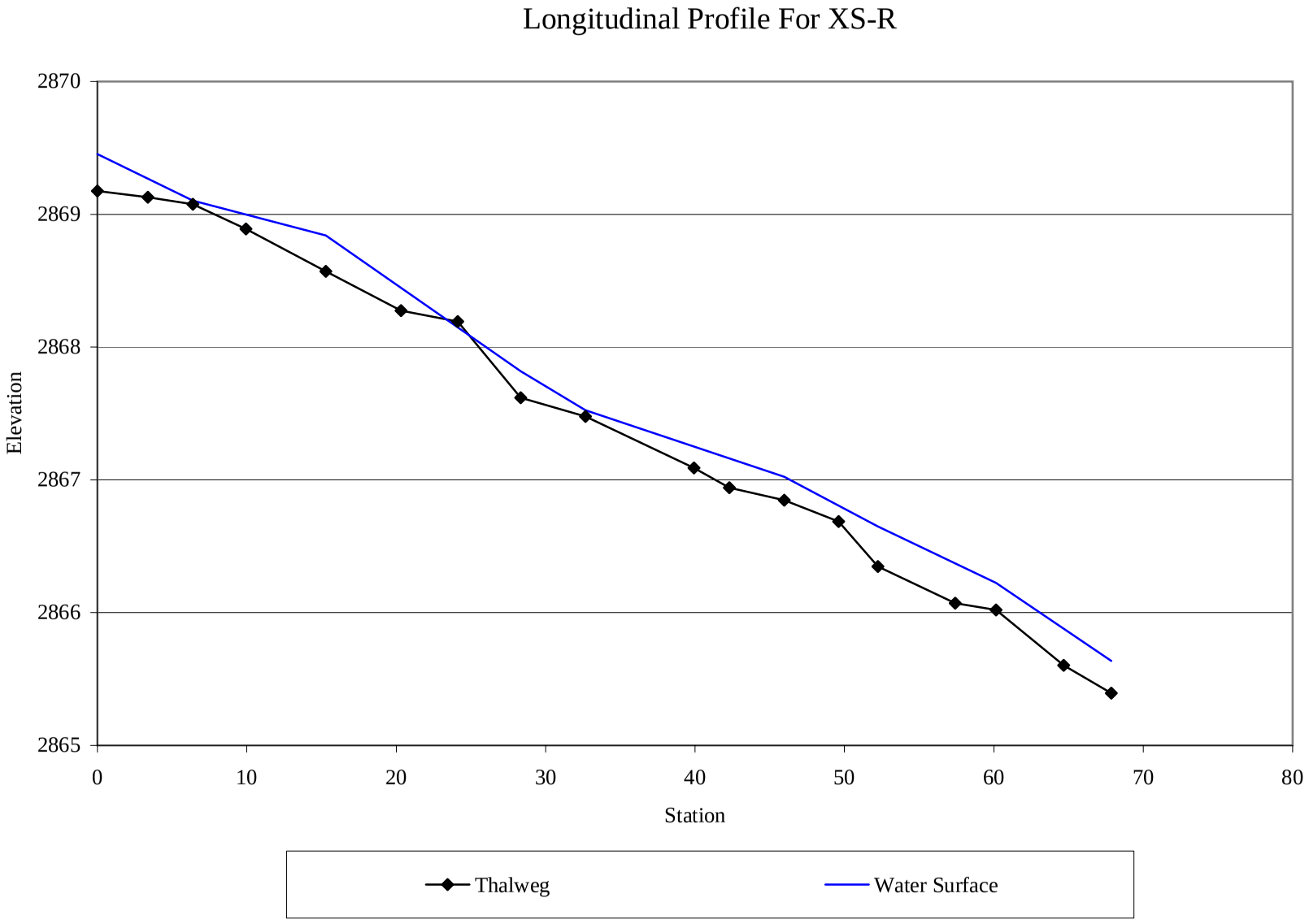
Bar Sample Sieve Analysis

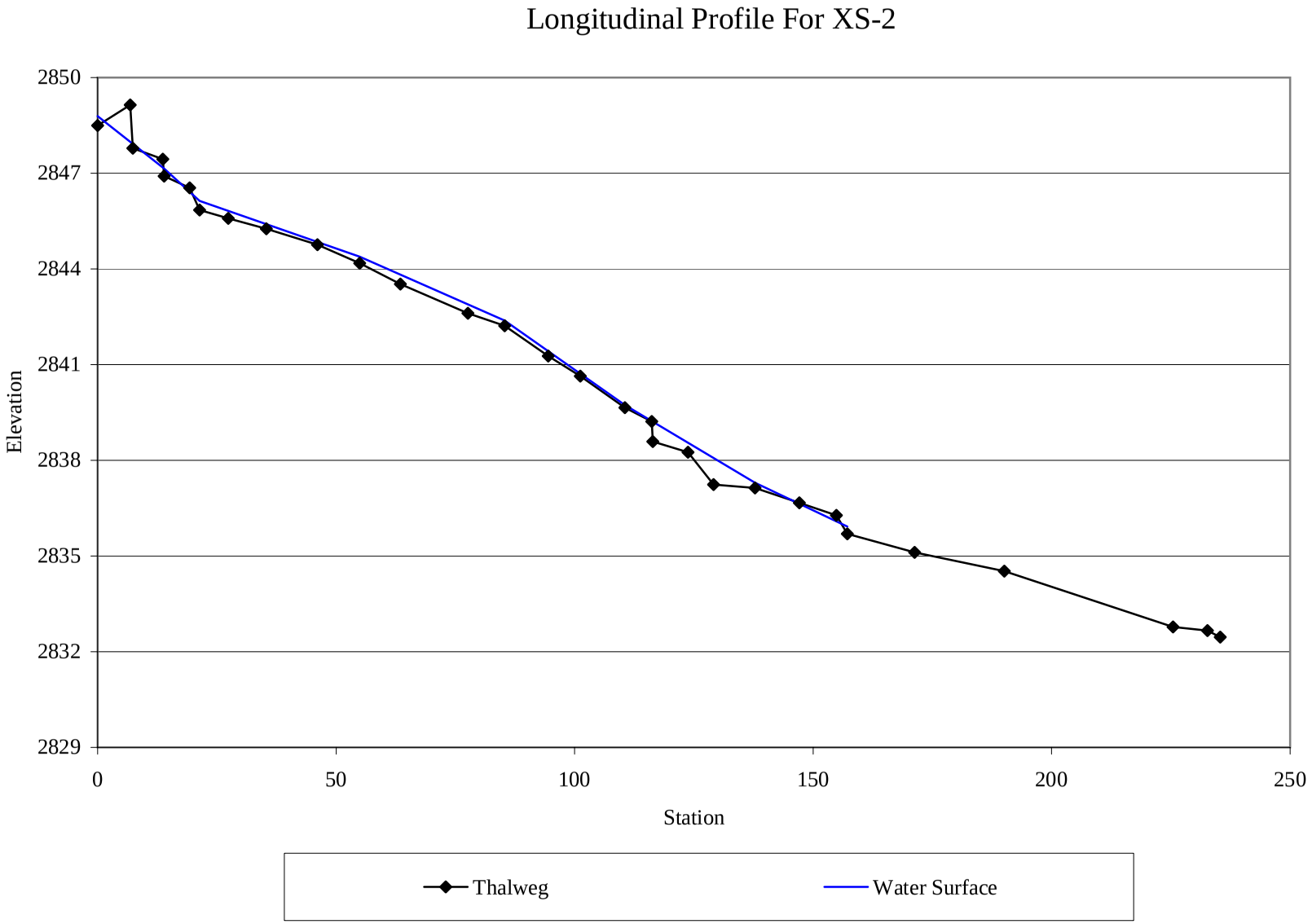
Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
1.0	42	18.8%	18.8%
2.0	15.0	6.7%	25.5%
4.0	54.5	24.4%	49.9%
8.0	26.0	11.6%	61.5%
16.0	21.5	9.6%	71.1%
31.5	33.5	15.0%	86.1%
64.0	31.0	13.9%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
Total:	223.5	100%	

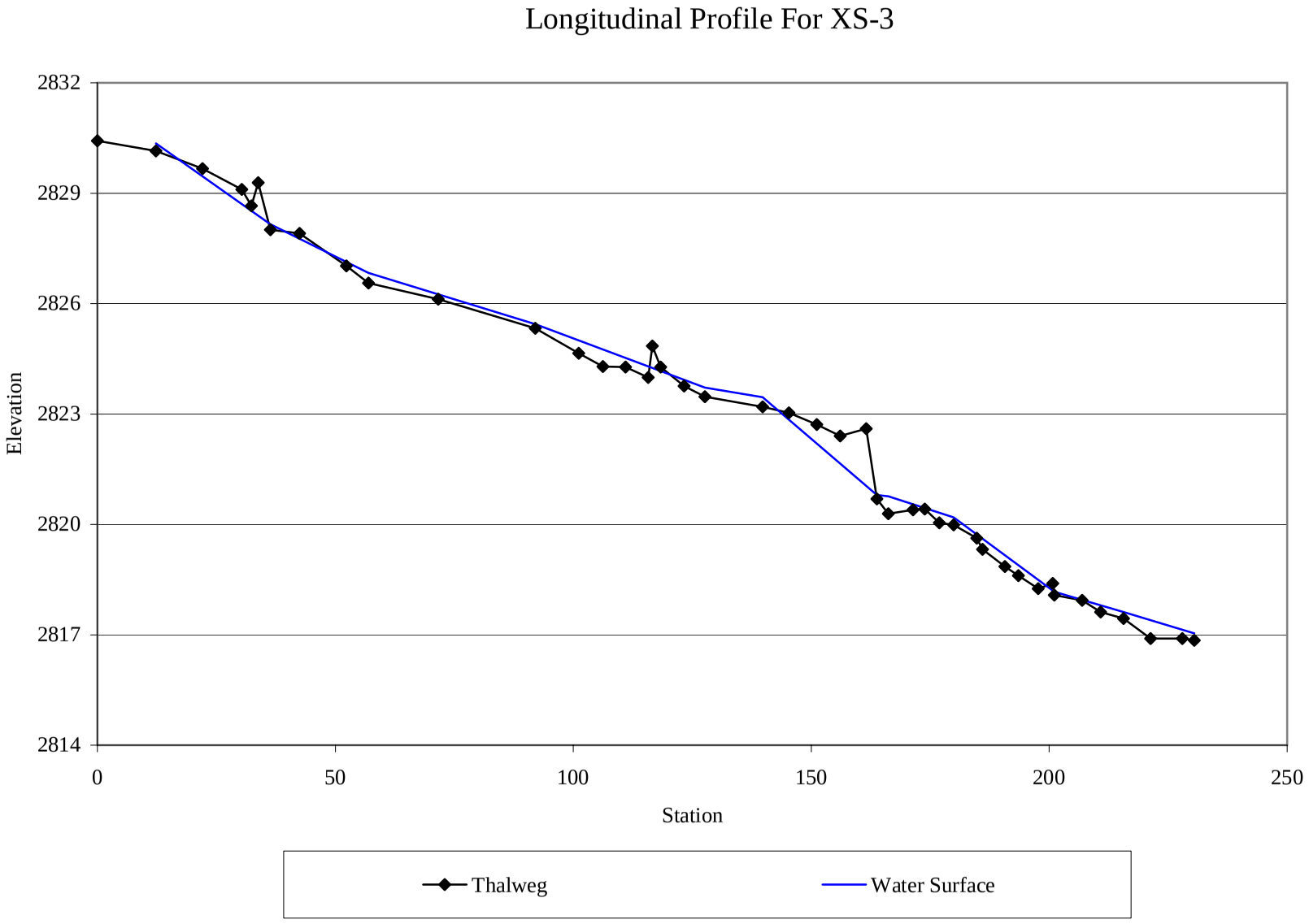
Stream:	WOC-5
Watershed:	
Location:	Bakersville - Wilson Dairy Rd.
Note:	Sample Taken on 2/19/08 by B Hemel and Z Mryncza



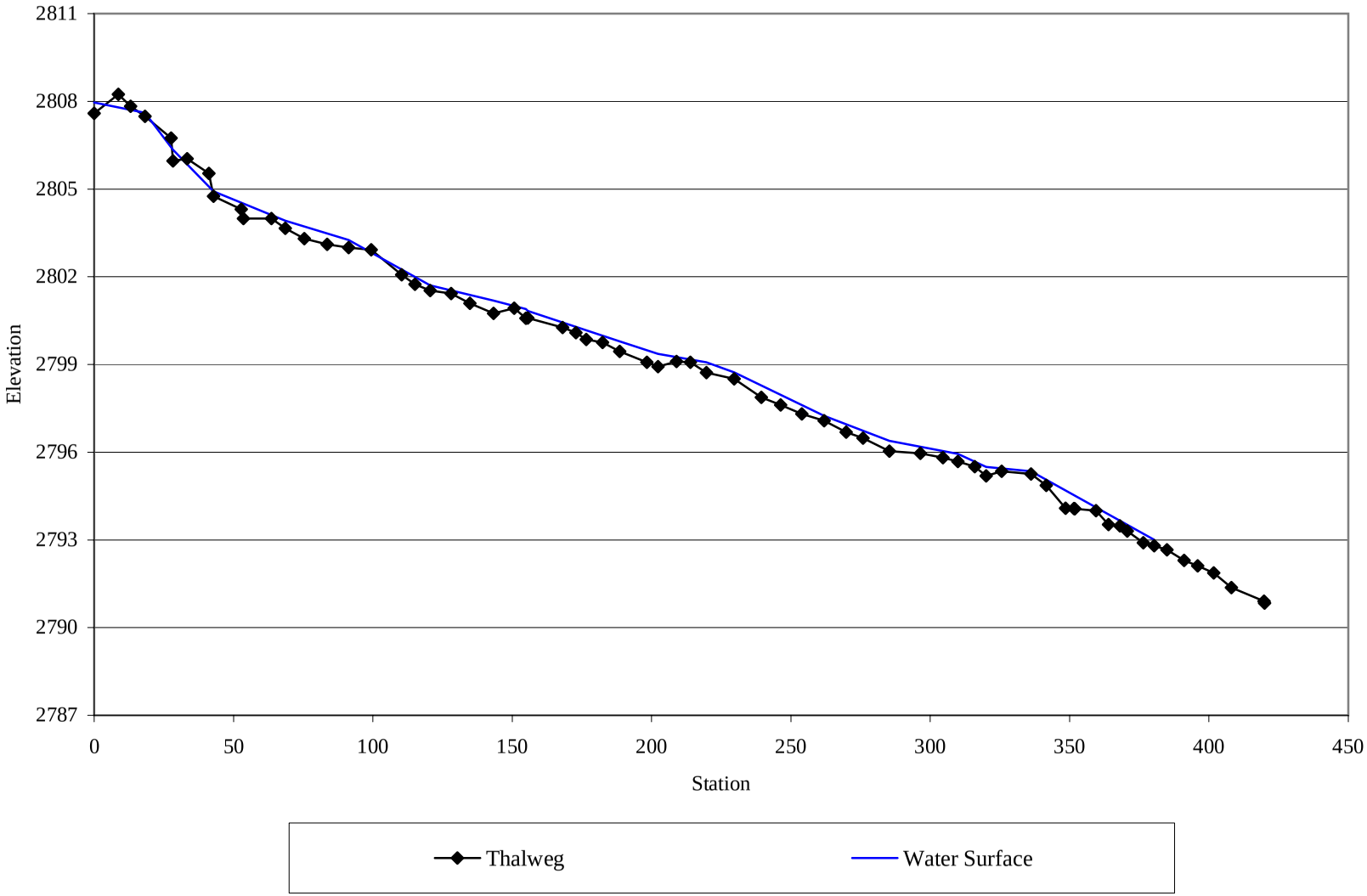
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.6	2.6	4.0	28.6	49.6	0%	26%	74%	0%	---	---


Longitudinal Profile For XS-R
2870
2869
2868
2867
2866
2865
Elevation
0
10
20
30
40
50
60
70
80
Station
Thalweg
Water Surface

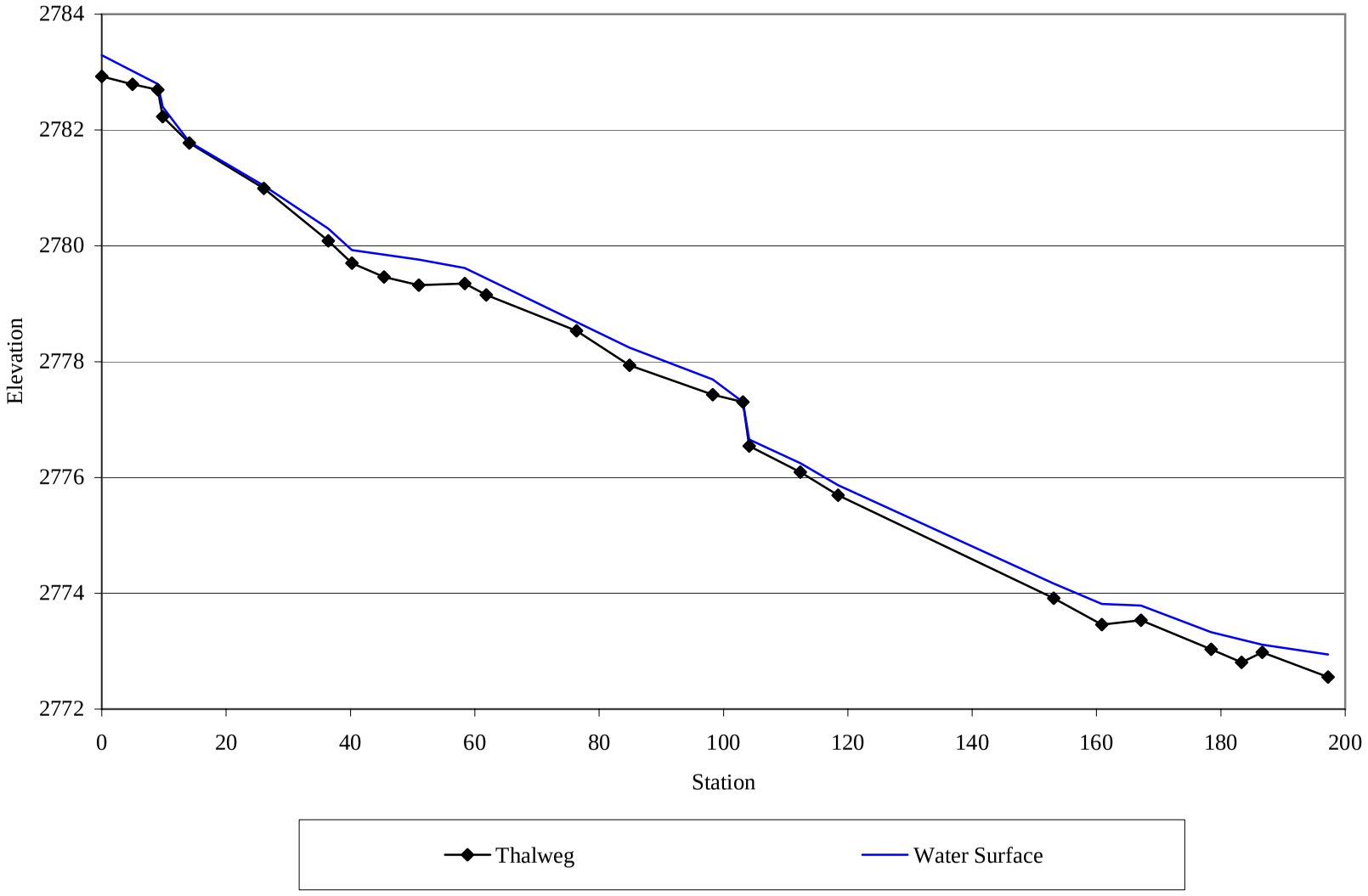

Longitudinal Profile For XS-2
2850
2847
2844
2841
2838
2835
2832
2829
Elevation
0
50
100
150
200
250
Station
Thalweg
Water Surface

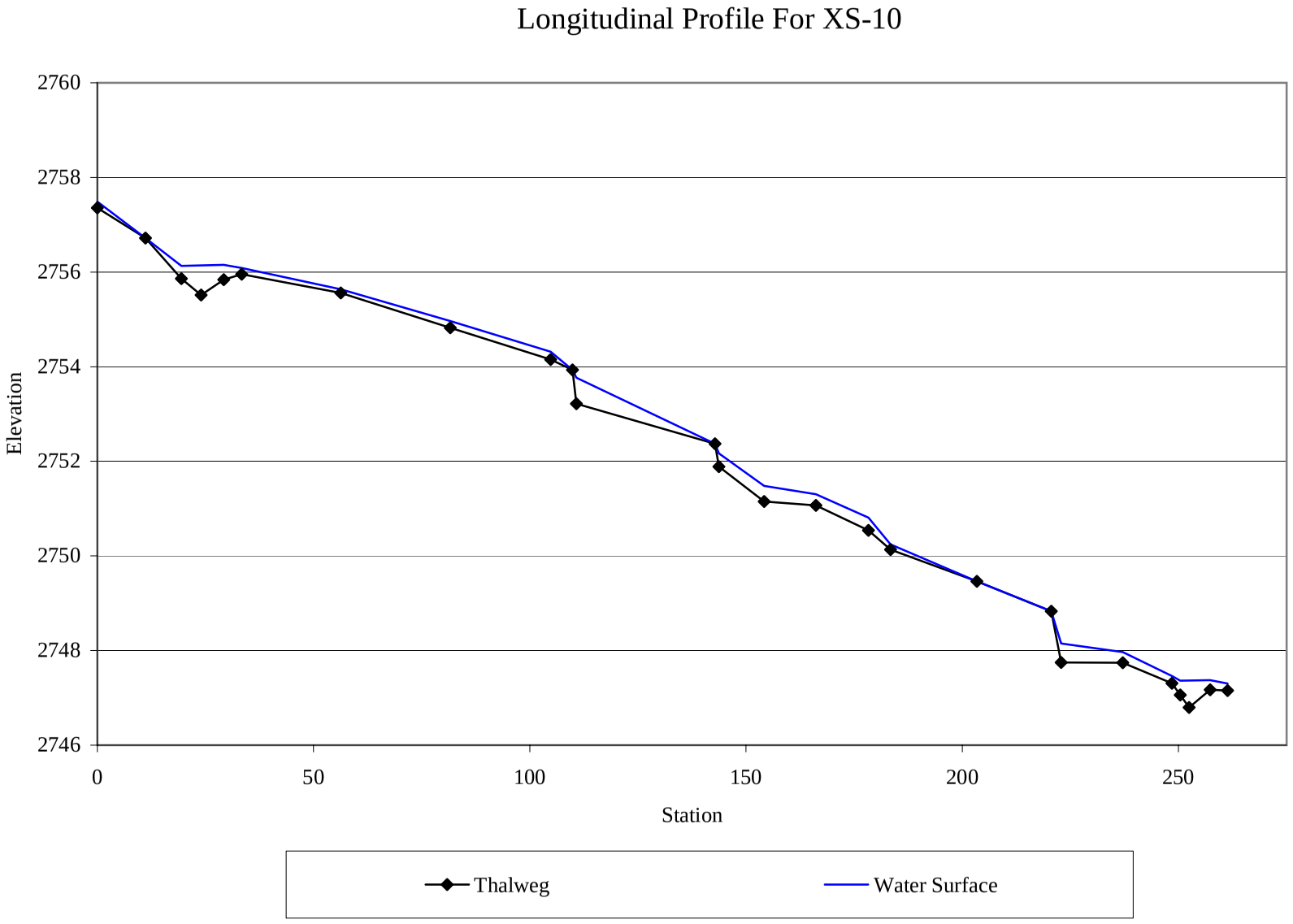

Longitudinal Profile For XS-3
2832
2829
2826
2823
2820
2817
2814
Elevation
0
50
100
150
200
250
Station
Thalweg
Water Surface

Longitudinal Profile For XS-6 and XS-7

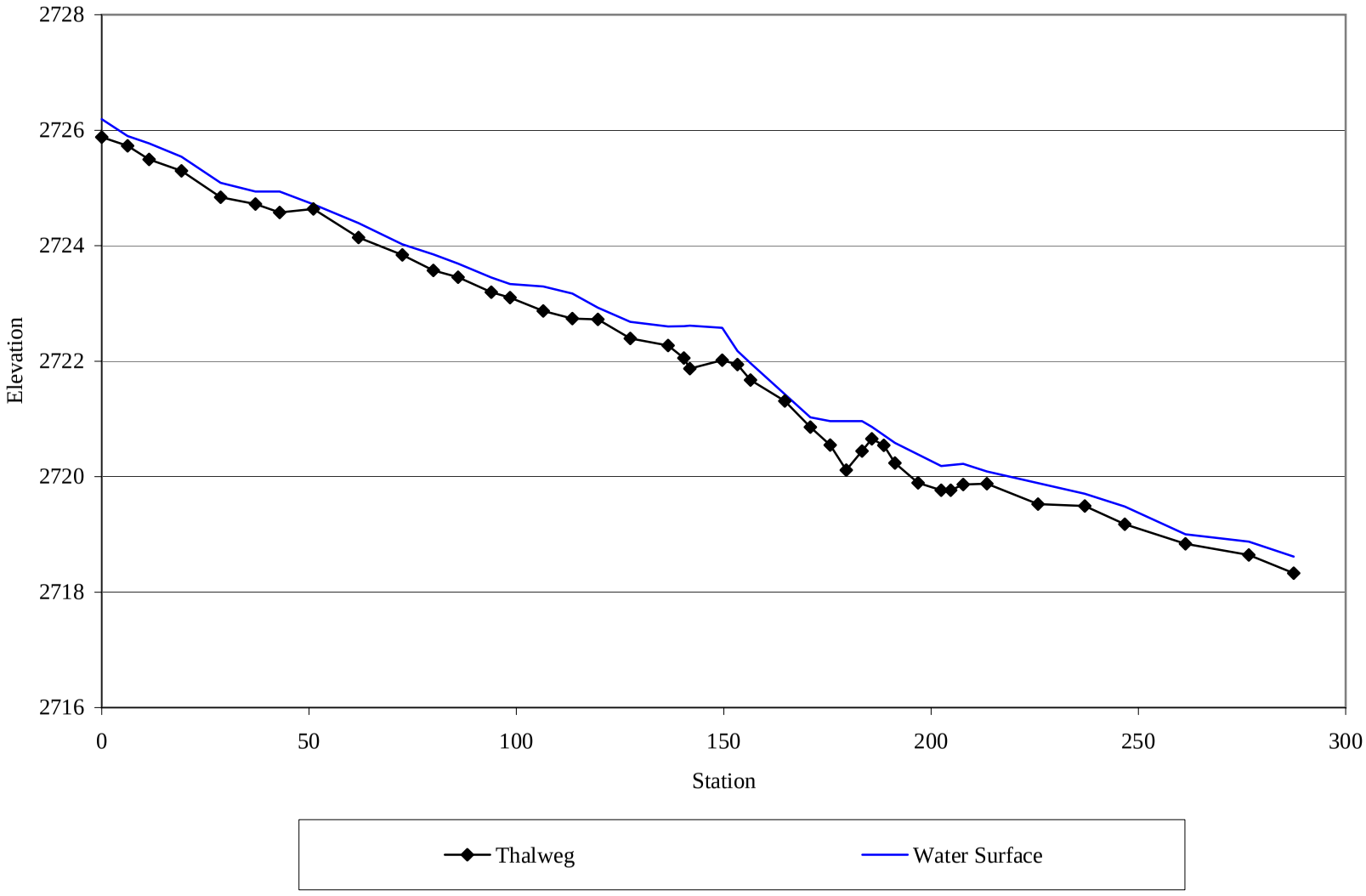


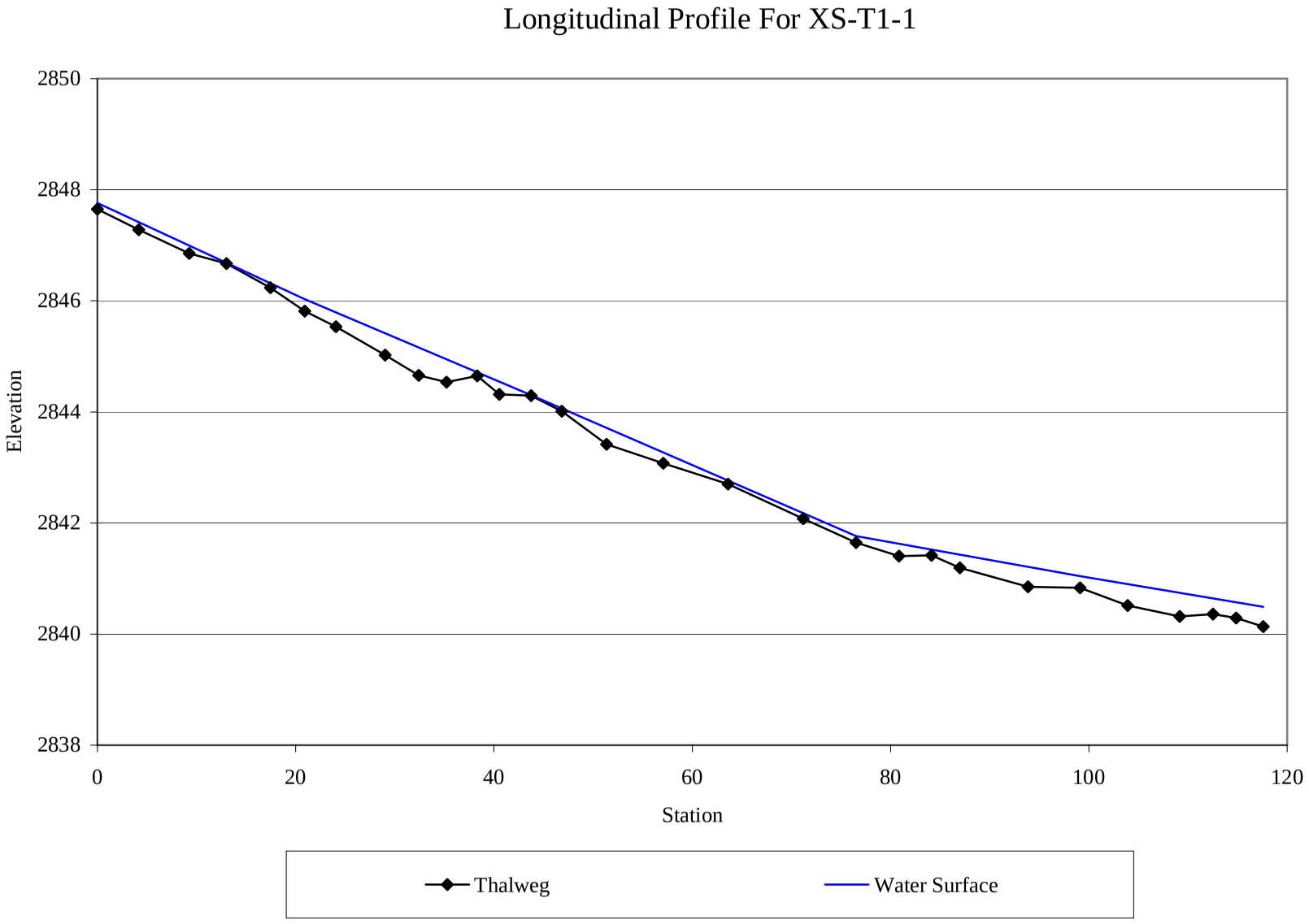
Longitudinal Profile For XS-8 and XS-9

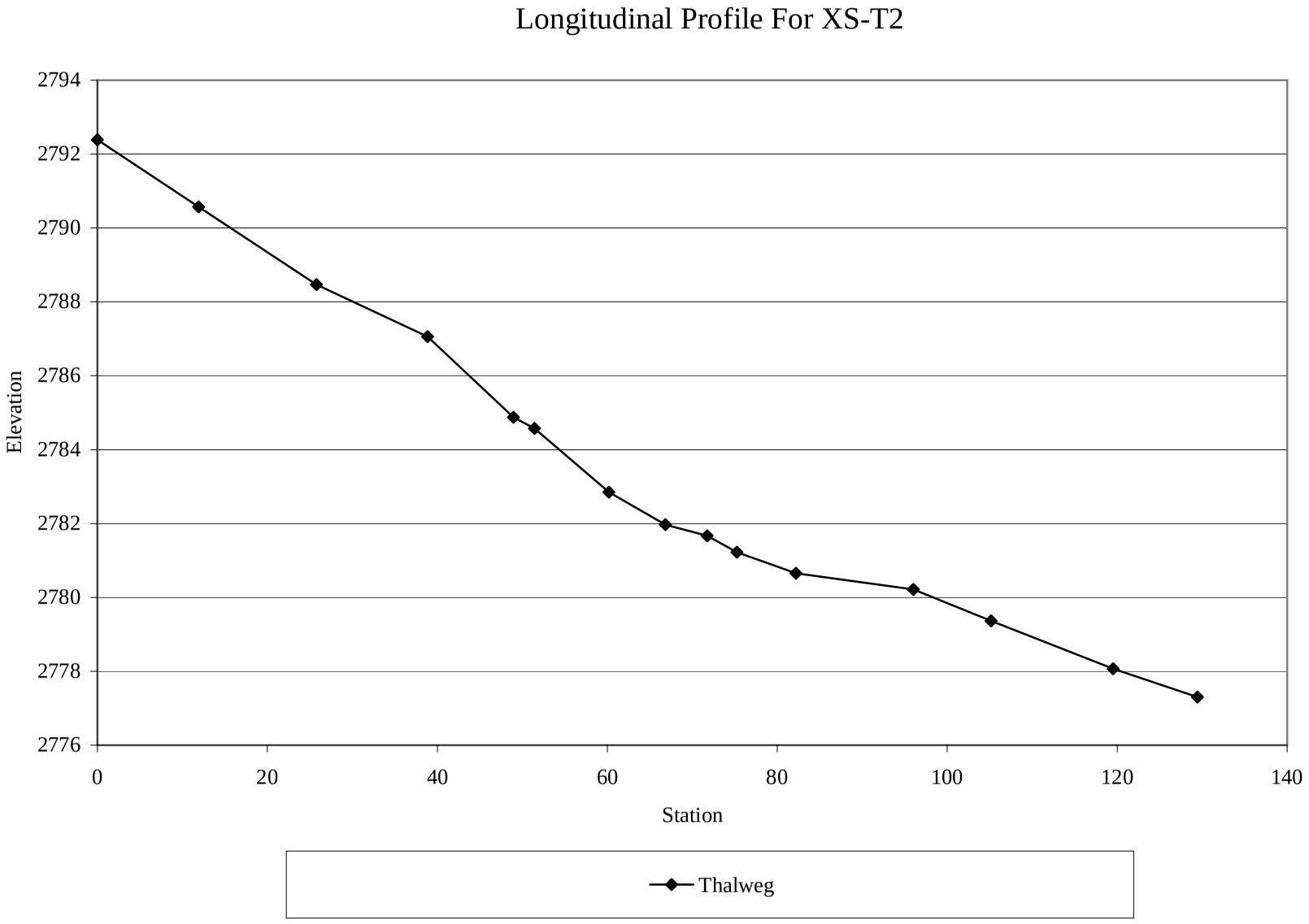



Longitudinal Profile For XS-10
2760
2758
2756
2754
2752
2750
2748
2746
Elevation
0
50
100
150
200
250
Station
Thalweg
Water Surface

Longitudinal Profile For XS-12 and XS-13




Longitudinal Profile For XS-T1-1
2850
2848
2846
2844
2842
2840
2838
Elevation
0
20
40
60
80
100
120
Station
Thalweg
Water Surface


Longitudinal Profile For XS-T2
Elevation
2794
2792
2790
2788
2786
2784
2782
2780
2778
2776
0
20
40
60
80
100
120
140
Station
Thalweg

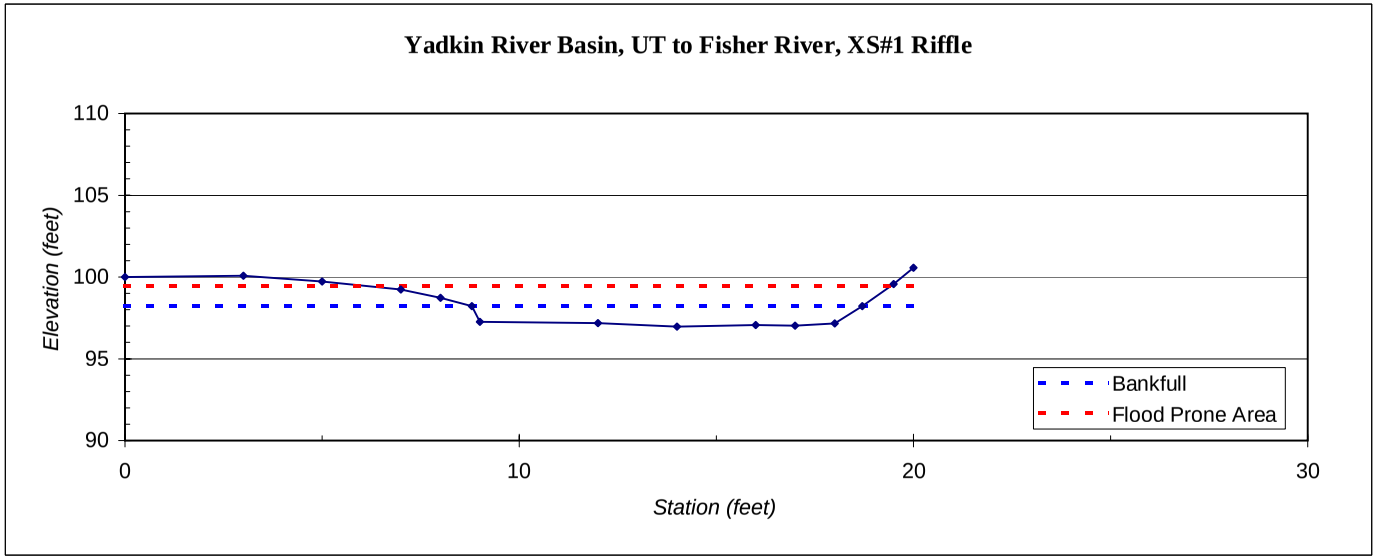
Appendix E
Reference Reach Data

River Basin:	Yadkin
Watershed:	UT to Fisher River
XS ID	XS#1 Riffle
Drainage Area (sq mi):	0.38
Date:	6/9/2005
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	2.22	100.00
3.0	2.15	100.07
5.0	2.50	99.72
7.0	2.98	99.24
8.0	3.49	98.73
8.8	4.00	98.22
9.0	4.96	97.26
12.0	5.03	97.19
14.0	5.25	96.97
16.0	5.16	97.06
17.0	5.20	97.02
18.0	5.06	97.16
18.7	4.00	98.22
19.5	2.65	99.57
20.0	1.66	100.56

SUMMARY DATA	
Bankfull Elevation:	98.22
Bankfull Cross-Sectional Area:	10.40
Bankfull Width:	10.00
Flood Prone Area Elevation:	99.47
Flood Prone Width:	13.10
Max Depth at Bankfull:	1.25
Mean Depth at Bankfull:	1.04
W / D Ratio:	9.6
Entrenchment Ratio:	1.30
Bank Height Ratio:	2.08
Slope (ft/ft):	0.013
Discharge (cfs)	42

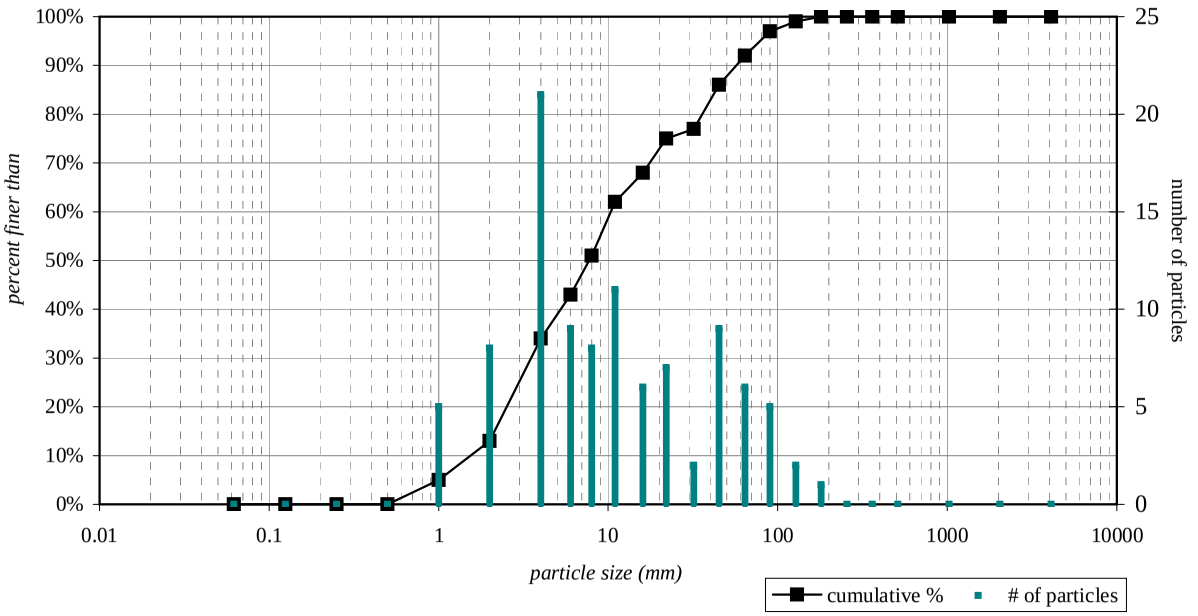
Stream Type:	B4c



Pebble Count

Material	Size Range (mm)		Count
silt/clay	0	0.062	**0**
very fine sand	0.062	0.13	**0**
fine sand	0.13	0.25	**0**
medium sand	0.25	0.5	**0**
coarse sand	0.5	1	**5**
very coarse sand	1	2	**8**
very fine gravel	2	4	**21**
fine gravel	4	6	**9**
fine gravel	6	8	**8**
medium gravel	8	11	**11**
medium gravel	11	16	**6**
coarse gravel	16	22	**7**
coarse gravel	22	32	**2**
very coarse gravel	32	45	**9**
very coarse gravel	45	64	**6**
small cobble	64	90	**5**
medium cobble	90	128	**2**
large cobble	128	180	**1**
very large cobble	180	256	**0**
small boulder	256	362	**0**
small boulder	362	512	**0**
medium boulder	512	1024	**0**
large boulder	1024	2048	**0**
very large boulder	2048	4096	**0**
		total particle count:	100

	UT to Fsher River
	Surry County, NC
	Riffle #1 (Sta. 01+00)
Note:	



bedrock		
clay hardpan		
detritus/wood		
artificial		
total count:	100	

based on sediment particles only	size percent less than (mm) D16	D35	D50	D65	D84	D95	particle size distribution gradation	geo mean	std dev
	2.208	4.18	7.7	13	42	79	4.5	9.6	4.3

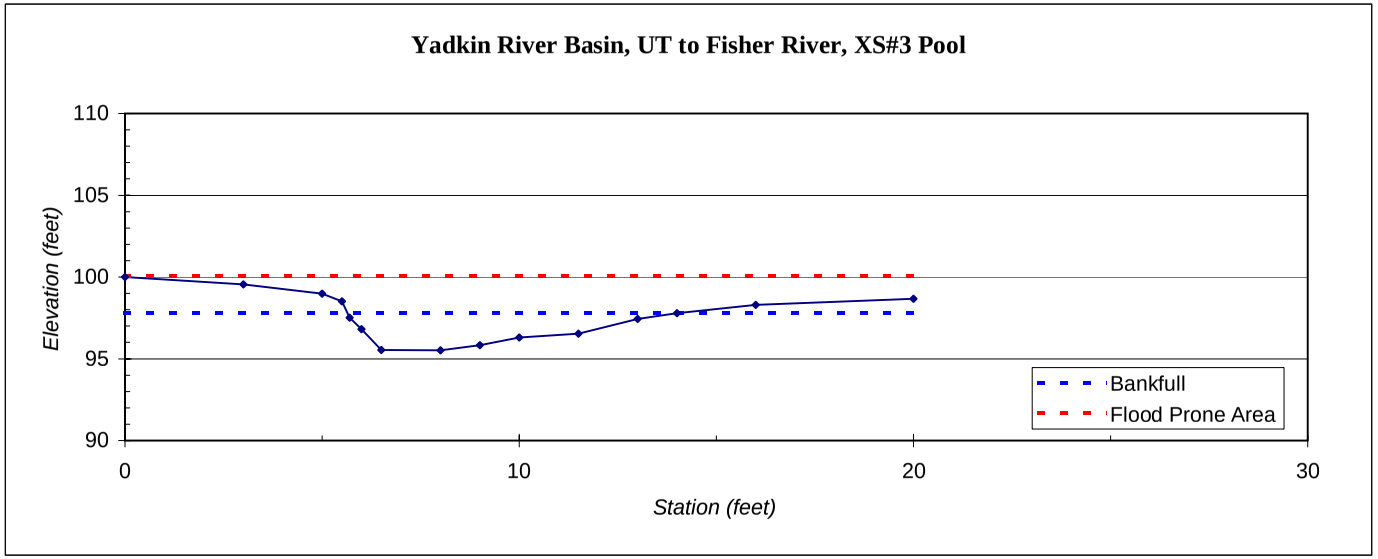
based on total count	percent by substrate type silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	0%	13%	79%	8%	0%	0%	0%	0%	0%

River Basin:	Yadkin
Watershed:	UT to Fisher River
XS ID	XS#3 Pool
Drainage Area (sq mi):	0.38
Date:	6/9/2005
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	1.33	100.00
3.0	1.78	99.55
5.0	2.35	98.98
5.5	2.82	98.51
5.7	3.81	97.52
6.0	4.52	96.81
6.5	5.79	95.54
8.0	5.82	95.51
9.0	5.50	95.83
10.0	5.02	96.31
11.5	4.80	96.53
13.0	3.90	97.43
14.0	3.55	97.78
16.0	3.03	98.30
20.0	2.66	98.67

SUMMARY DATA	
Bankfull Elevation:	97.78
Bankfull Cross-Sectional Area:	11.60
Bankfull Width:	8.35
Flood Prone Area Elevation:	100.05
Flood Prone Width:	
Max Depth at Bankfull:	2.27
Mean Depth at Bankfull:	1.39
W / D Ratio:	6.0
Entrenchment Ratio:	
Bank Height Ratio:	0.85
Slope (ft/ft):	0.001
Discharge (cfs)	52

Stream Type:	B4c

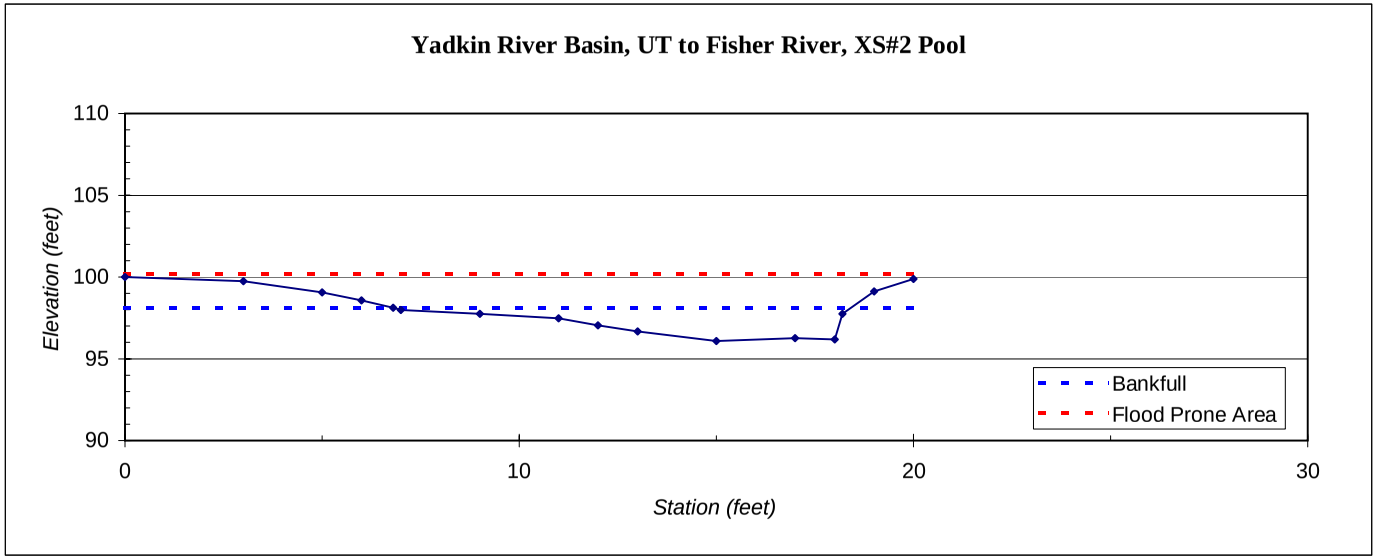


River Basin:	Yadkin
Watershed:	UT to Fisher River
XS ID	XS#2 Pool
Drainage Area (sq mi):	0.38
Date:	6/9/2005
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	2.68	100.00
3.0	2.94	99.74
5.0	3.61	99.07
6.0	4.10	98.58
6.8	4.56	98.12
7.0	4.70	97.98
9.0	4.94	97.74
11.0	5.21	97.47
12.0	5.64	97.04
13.0	6.00	96.68
15.0	6.59	96.09
17.0	6.42	96.26
18.0	6.50	96.18
18.2	4.93	97.75
19.0	3.56	99.12
20.0	2.80	99.88

SUMMARY DATA	
Bankfull Elevation:	98.12
Bankfull Cross-Sectional Area:	13.40
Bankfull Width:	11.62
Flood Prone Area Elevation:	100.15
Flood Prone Width:	
Max Depth at Bankfull:	2.03
Mean Depth at Bankfull:	1.15
W / D Ratio:	10.1
Entrenchment Ratio:	
Bank Height Ratio:	0.81
Slope (ft/ft):	0.001
Discharge (cfs)	56

Stream Type:	B4c

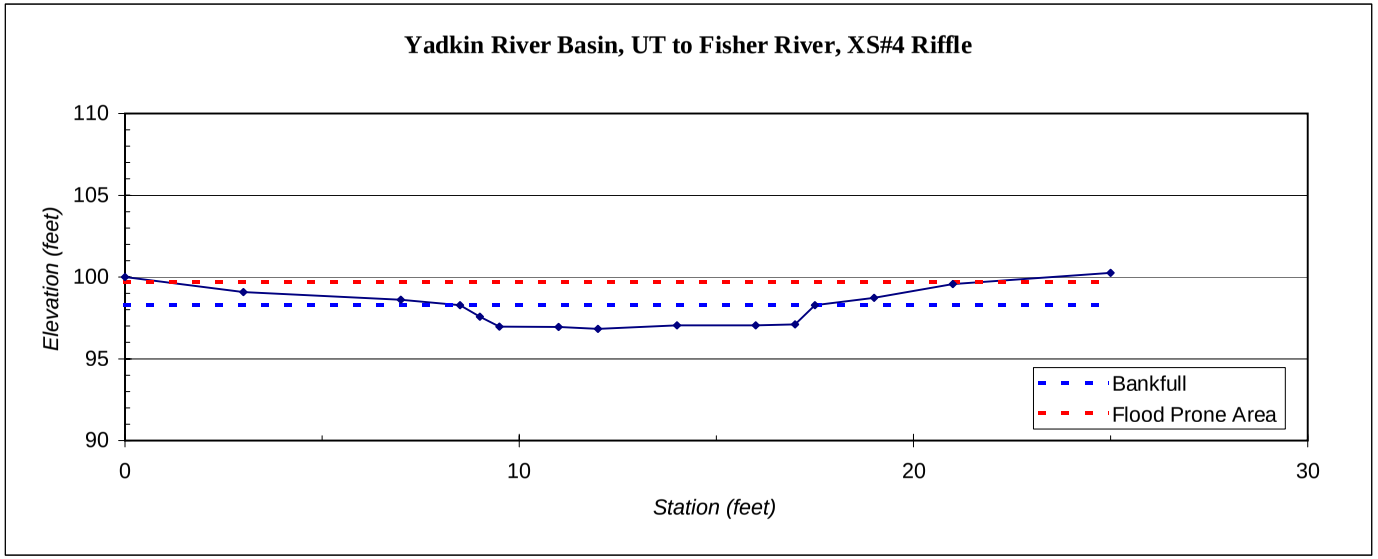


River Basin:	Yadkin
Watershed:	UT to Fisher River
XS ID	XS#4 Riffle
Drainage Area (sq mi):	0.38
Date:	6/9/2005
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	4.62	100.00
3.0	5.54	99.08
7.0	6.01	98.61
8.5	6.34	98.28
9.0	7.04	97.58
9.5	7.66	96.96
11.0	7.67	96.95
12.0	7.79	96.83
14.0	7.58	97.04
16.0	7.57	97.05
17.0	7.51	97.11
17.5	6.34	98.28
19.0	5.90	98.72
21.0	5.06	99.56
25.0	4.37	100.25

SUMMARY DATA	
Bankfull Elevation:	98.28
Bankfull Cross-Sectional Area:	10.70
Bankfull Width:	9.00
Flood Prone Area Elevation:	99.73
Flood Prone Width:	20.50
Max Depth at Bankfull:	1.45
Mean Depth at Bankfull:	1.19
W / D Ratio:	7.6
Entrenchment Ratio:	2.30
Bank Height Ratio:	1.00
Slope (ft/ft):	0.013
Discharge (cfs)	46

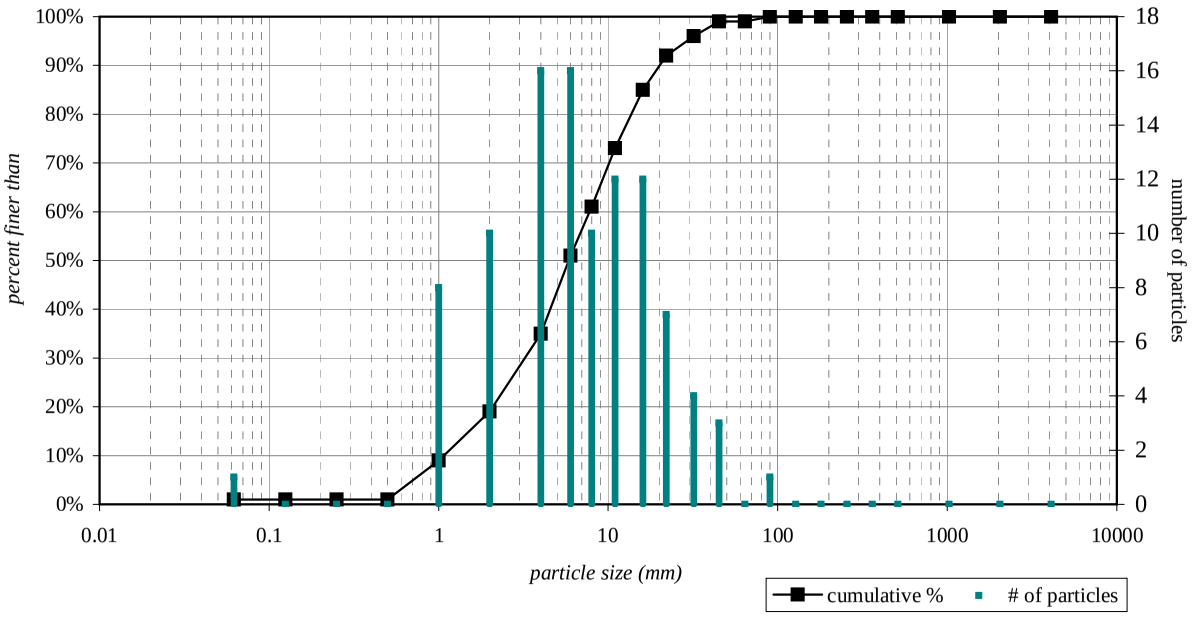
Stream Type:	B4c



Pebble Count

Material	Size Range (mm)		Count
silt/clay	0	0.062	**1**
very fine sand	0.062	0.13	**0**
fine sand	0.13	0.25	**0**
medium sand	0.25	0.5	**0**
coarse sand	0.5	1	**8**
very coarse sand	1	2	**10**
very fine gravel	2	4	**16**
fine gravel	4	6	**16**
fine gravel	6	8	**10**
medium gravel	8	11	**12**
medium gravel	11	16	**12**
coarse gravel	16	22	**7**
coarse gravel	22	32	**4**
very coarse gravel	32	45	**3**
very coarse gravel	45	64	**0**
small cobble	64	90	**1**
medium cobble	90	128	**0**
large cobble	128	180	**0**
very large cobble	180	256	**0**
small boulder	256	362	**0**
small boulder	362	512	**0**
medium boulder	512	1024	**0**
large boulder	1024	2048	**0**
very large boulder	2048	4096	**0**
	total particle count:		100

	UT to Fsher River
	Surry County, NC
	Riffle #2 (Sta. 02+55)
Note:	



bedrock		
clay hardpan		
detritus/wood		
artificial		
total count:		100

based on	size percent less than (mm)						particle size distribution		
sediment	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
particles only	1.625	4.00	5.8	9	16	29	3.1	5.0	3.1

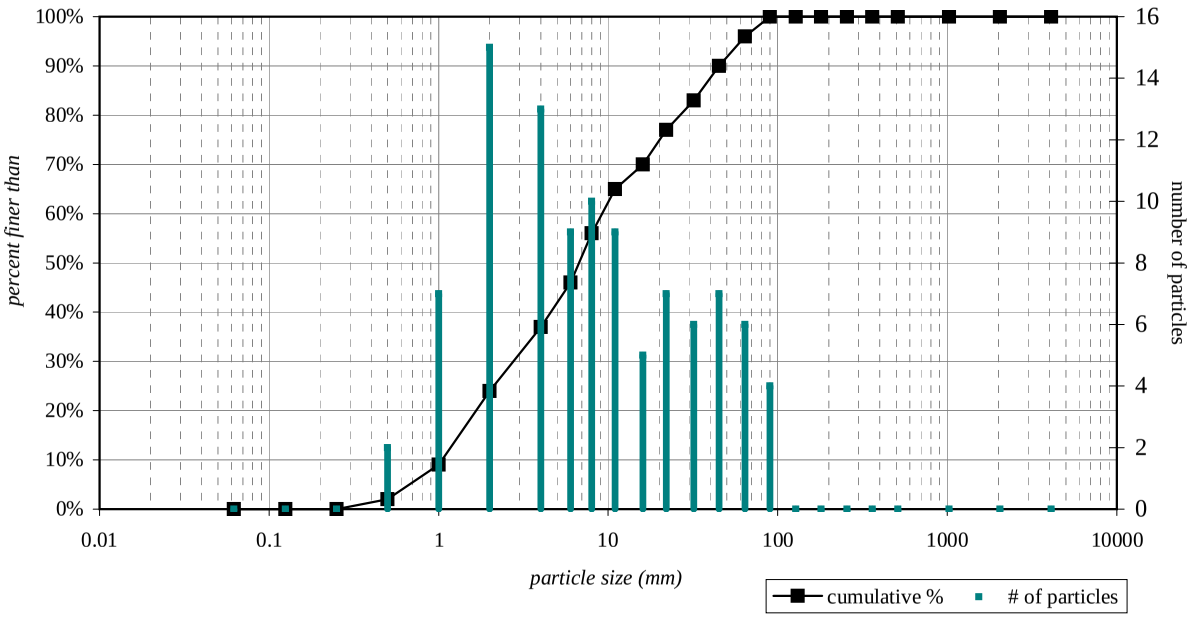
based on	percent by substrate type								
total count	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	1%	18%	80%	1%	0%	0%	0%	0%	0%

Pebble Count

Material	Size Range (mm)		Count
silt/clay	0	0.062	**0**
very fine sand	0.062	0.13	**0**
fine sand	0.13	0.25	**0**
medium sand	0.25	0.5	**2**
coarse sand	0.5	1	**7**
very coarse sand	1	2	**15**
very fine gravel	2	4	**13**
fine gravel	4	6	**9**
fine gravel	6	8	**10**
medium gravel	8	11	**9**
medium gravel	11	16	**5**
coarse gravel	16	22	**7**
coarse gravel	22	32	**6**
very coarse gravel	32	45	**7**
very coarse gravel	45	64	**6**
small cobble	64	90	**4**
medium cobble	90	128	**0**
large cobble	128	180	**0**
very large cobble	180	256	**0**
small boulder	256	362	**0**
small boulder	362	512	**0**
medium boulder	512	1024	**0**
large boulder	1024	2048	**0**
very large boulder	2048	4096	**0**
		total particle count:	100

UT to Fsher River
Surry County, NC

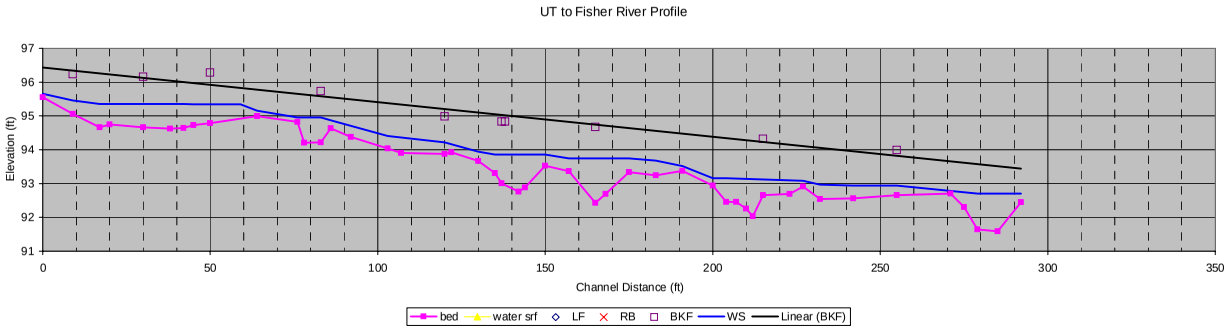
Note: **Reach Pebble Count**



bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100

based on	size percent less than (mm)						particle size distribution		
sediment	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
particles only	1.382	3.60	6.7	11	34	60	4.9	6.8	4.9

based on	percent by substrate type								
total count	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	0%	24%	72%	4%	0%	0%	0%	0%	0%



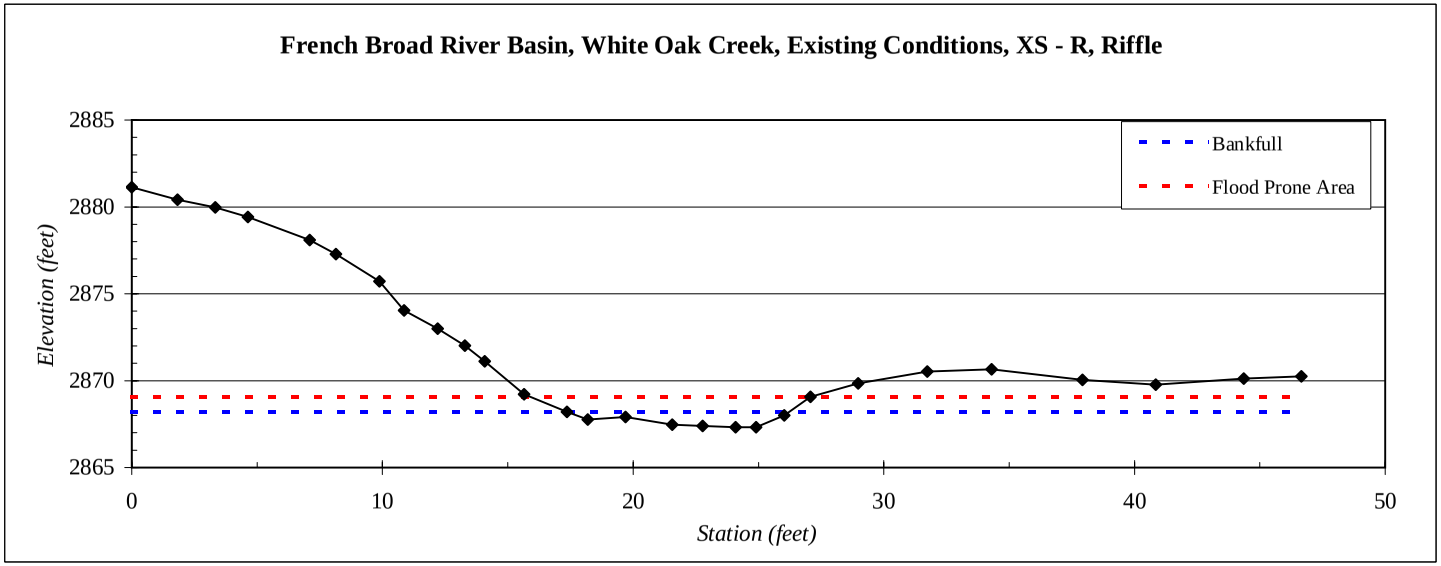
Elevation BM: 100

notes	inc distance	station	BS	HI	FS TP	FS bed	depth water	FS LB	FS RB	FS BKF	FS WS	AZ azimuth	ELEV bed	ELEV water srf	ELEV LF	ELEV RB	ELEV BKF	ELEV WS
		5	0	100		4.45					4.34		95.55					95.66
	9	14		100		4.94				3.77	4.54		95.06				96.23	95.46
	8	22		100		5.34					4.65		94.66					95.35
	3	25		100		5.25							94.75					
	10	35		100		5.34				3.84	4.65		94.66				96.16	95.35
	8	43		100		5.38							94.62					
	4	47		100		5.36					4.65		94.64					95.35
	3	50		100		5.27					4.66		94.73					95.34
	5	55		100		5.21				3.72			94.79				96.28	
	9	64		100							4.66							95.34
	5	69	-0.53	99.47		4.48					4.32		94.99					95.15
	12	81		99.47		4.65					4.51		94.82					94.96
	2	83		99.47		5.26							94.21					
	5	88		99.47		5.25				3.74	4.51		94.22				95.73	94.96
	3	91		99.47		4.84					4.6		94.63					94.87
	6	97		99.47		5.09							94.38					
	11	108		99.47		5.43					5.06		94.04					94.41
	4	112		99.47		5.56							93.91					
	13	125		99.47		5.59				4.49	5.25		93.88				94.98	94.22
	18	143		99.47						4.64							94.83	
	-16	127		99.47		5.55							93.92					
	8	135		99.47		5.8					5.53		93.67					93.94
	5	140		99.47		6.16					5.61		93.31					93.86
	2	142		99.47		6.46				4.64			93.01				94.83	
	5	147		99.47		6.71							92.76					
	2	149		99.47		6.59					5.61		92.88					93.86
	6	155		99.47		5.94					5.61		93.53					93.86
	7	162		99.47		6.1					5.73		93.37					93.74
	8	170		99.47		7.04				4.8	5.73		92.43				94.67	93.74
	3	173		99.47		6.78							92.69					
	7	180		99.47		6.13					5.73		93.34					93.74
	8	188	-1.56	97.91		4.67					4.23		93.24					93.68
	8	196		97.91		4.53					4.39		93.38					93.52
	9	205		97.91		4.97					4.75		92.94					93.16
	4	209		97.91		5.45					4.75		92.46					93.16
	3	212		97.91		5.45							92.46					
	3	215		97.91		5.65							92.26					
	2	217		97.91		5.88							92.03					
	3	220		97.91		5.25				3.59			92.66				94.32	
	8	228		97.91		5.22							92.69					
	4	232		97.91		5					4.83		92.91					93.08
	5	237		97.91		5.37					4.94		92.54					92.97
	10	247		97.91		5.35					4.97		92.56					92.94
	13	260	2.46	100.37		7.71				6.38	7.43		92.66				93.99	92.94
	16	276		100.37		7.67							92.7					
	4	280		100.37		8.06							92.31					
	4	284		100.37		8.73					7.67		91.64					92.7
	6	290		100.37		8.78					7.67		91.59					92.7
	7	297		100.37		7.92					7.67		92.45					92.7

River Basin:	French Broad
Watershed:	White Oak Creek, Existing Conditions
XS ID	XS - R, Riffle
Drainage Area (sq mi):	0.5
Date:	8/26/2007
Field Crew:	B. Hemel, Z. Mryncza

Station	Elevation
0.0	2881.13
1.8	2880.41
3.3	2879.98
4.6	2879.43
7.1	2878.10
8.1	2877.28
9.9	2875.73
10.9	2874.05
12.2	2872.99
13.3	2872.02
14.1	2871.11
15.6	2869.22
17.4	2868.20
18.2	2867.77
19.7	2867.91
21.6	2867.47
22.8	2867.39
24.1	2867.32
24.9	2867.31
26.0	2868.00
27.1	2869.07
29.0	2869.84
31.7	2870.53
34.3	2870.65
37.9	2870.04
40.9	2869.77
44.4	2870.12
46.7	2870.25

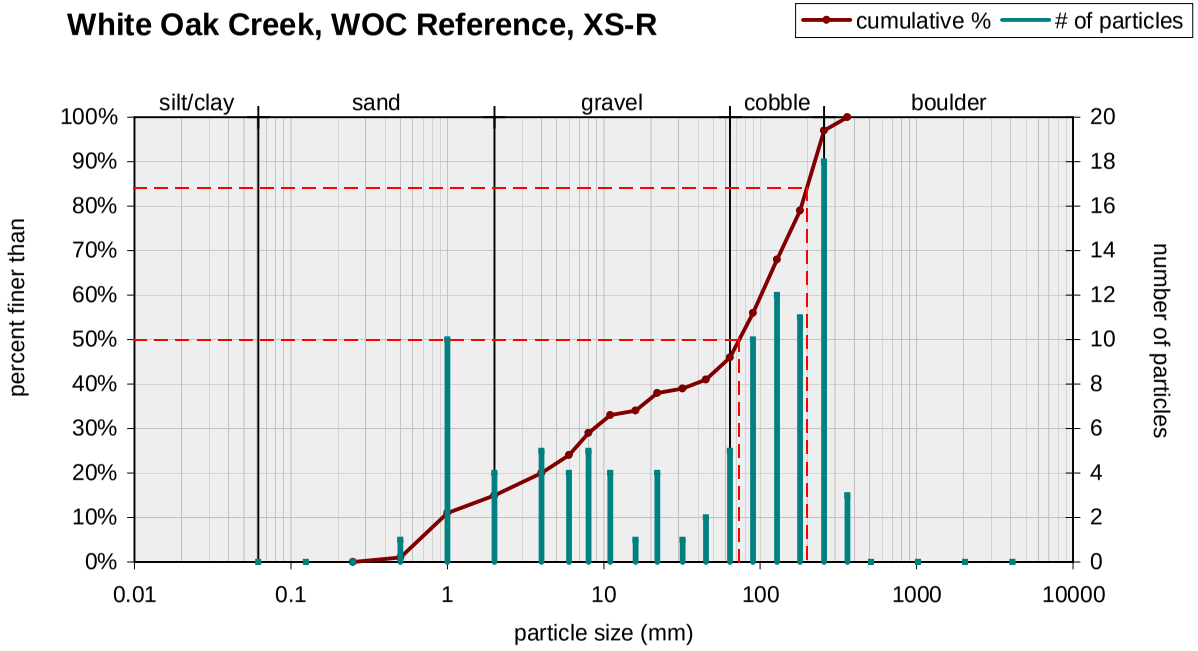
SUMMARY DATA	
Bankfull Elevation:	2868.2
Bankfull Cross-Sectional Area:	5.1
Bankfull Width:	8.8
Flood Prone Area Elevation:	2869.1
Flood Prone Width:	11
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.6
W / D Ratio:	15.2
Entrenchment Ratio:	1.3
Bank Height Ratio:	1.1



Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**0**
very fine sand	0.062 - 0.125	**0**
fine sand	0.125 - 0.25	**0**
medium sand	0.25 - 0.5	**1**
coarse sand	0.5 - 1	**10**
very coarse sand	1 - 2	**4**
very fine gravel	2 - 4	**5**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**1**
coarse gravel	16 - 22	**4**
coarse gravel	22 - 32	**1**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	**5**
small cobble	64 - 90	**10**
medium cobble	90 - 128	**12**
large cobble	128 - 180	**11**
very large cobble	180 - 256	**18**
small boulder	256 - 362	**3**
small boulder	362 - 512	**0**
medium boulder	512 - 1024	**0**
large boulder	1024 - 2048	**0**
very large boulder	2048 - 4096	**0**
total particle count:		100
bedrock ----------		
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		100

Note: XS-R



Size (mm)	
D16	2.3
D35	17
D50	73
D65	120
D84	200
D95	250

Size Distribution	
mean	21.4
dispersion	17.2
skewness	-0.38

Type	
silt/clay	0%
sand	15%
gravel	31%
cobble	51%
boulder	3%