LYLE CREEK MITIGATION SITE
Catawba County, NC
DENR Contract No. 003241

Mitigation Plan
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LYLE CREEK MITIGATION SITE
Mitigation Plan

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EXECUTIVE SUMMARY

The Lyle Creek Mitigation Site is a full-delivery stream and wetland restoration project for the North Carolina Ecosystem Enhancement Program (NCEEP) in Catawba County, NC. The project includes work on and adjacent to several unnamed tributaries (UTs) to Lyle Creek: restoration of 4,961 existing linear feet (LF) of perennial stream, restoration of 1,141 existing LF of intermittent stream, enhancement of 1,455 existing LF of intermittent stream, restoration of 6.6 acres of wetlands, and creation of 2.9 acres of wetlands. Buffer restoration will also take place but is not intended for mitigation credit at this time.

The streams proposed for restoration and enhancement include one second order UT and four first order UTs to Lyle Creek. Lyle Creek is a tributary to the Catawba River. The project is located in the Catawba River Basin Hydrologic Unit Code (HUC) 03050101140010, which is a NCEEP Targeted Local Watershed. This HUC qualifies as a service area for an adjacent HUC; therefore, the Lyle Creek Mitigation Site is being submitted for mitigation credit in the Catawba River Basin HUC 03050103.

The proposed project will provide numerous benefits within the Catawba River Basin. While many of these benefits are limited to the project area, others, such as pollutant removal and improved aquatic and terrestrial habitat have more far-reaching effects. Expected improvements to water quality and ecological processes are outlined below in Table ES.1. This table is broken into two sections, Monitored Project Goals, which include goals that will be monitored for success, and Expected Project Benefits, which include project benefits that are not directly monitored for success but are associated with restoration activities.

Table ES.1. Project Goals and Objectives
Lyle Creek Mitigation Site

	Goal/Benefit	How project will seek to reach goal/benefit
Monitored Project Goals	Improve hydrologic connectivity	Wetland areas will be disked to increase surface roughness and better capture rainfall which will improve connection with the water table for groundwater recharge. Adjacent streams will be stabilized and established with a floodplain elevation to promote hydrologic transfer between wetland and stream.
	Create appropriate in-stream habitat	A channel with riffle-pool sequences and some rock structures will be created in the steeper project reaches and a channel with run-pool sequences and woody debris structures will be created in the low sloped project reaches for macroinvertebrate and fish habitat. Introduction of wood including brush toe, root wads, and woody 'riffles' along with native stream bank vegetation will substantially increase habitat value. Gravel areas will be added as appropriate to further diversify available habitats.
	Decrease sediment input	Sediment input from eroding stream banks will be reduced by installing bioengineering and in-stream structures while creating a stable channel form using geomorphic design principles.
	Create appropriate terrestrial habitat	Adjacent buffer areas will be restored by removing invasive vegetation and planting native vegetation. These areas will be allowed to receive more regular and inundating flows. Riparian wetland areas will be restored and enhanced to provide wetland habitat.
Expected Project Benefits	Decrease water temperature and increase dissolved oxygen concentrations	Restored riffle/step-pool sequences on the upper reach of UT1a, where distinct points of re-aeration can occur, will allow for oxygen levels to be maintained in the perennial reaches. Small log steps on the upstream portion of UT1b and UT1 Reach 1 Upper will also provide re-aeration points. Creation of deep pool zones will lower temperature, helping to maintain dissolved oxygen concentrations. Pools will form below drops on the steeper project reaches and around areas of woody debris on the low-sloped project reaches. Establishment and maintenance of riparian buffers will create long-term shading of the channel flow to minimize thermal heating.
	Decrease nutrient and adverse chemical levels	Chemical fertilizer and pesticide levels will be decreased by filtering runoff from adjacent tree farm operations through restored native buffer zones and wetlands. Offsite nutrient input will be absorbed onsite by filtering flood flows through restored floodplain areas and wetlands, where flood flows can disperse through native vegetation and be captured in vernal pools. Increased surface water residency time will provide contact treatment time and groundwater recharge potential.
	Decrease sediment input	Sediment from offsite sources will be captured during bankfull or greater flows by deposition on restored floodplain areas where native vegetation will slow overland flow velocities.

Table ES.2a Project Components
Lyle Creek Mitigation Site

Project Reach	Existing Length/ Area	Mitigation Level	Approach	Proposed Mitigation Length/ Area	Proposed Mitigation Stationing	Buffer Acreage[2]	Proposed Mitigation Ratio	Proposed Mitigation Credits
UT1	4,071 LF	Restoration	Priority 1/2	3,950 LF[1]	100+00-141+50	14.2	1:1	3,950 SMU
UT1a	1,141 LF	Restoration	Priority 1	615 LF[3]	300+00-306+15[3]	3.2	1:1	615 SMU
UT1b	890 LF	Restoration	Priority 1/2	845 LF[4]	201+52-209+97[4]	4.6	1:1	845 SMU
UT1c	695 LF	Enhancement II	in-stream structures, grading, planting	630 LF	400+00-406+30	1.8	2.5:1	252 SMU
UT1d	760 LF	Enhancement II	in-stream structures, grading, planting	707 LF	500+00-507+07	1.7	2.5:1	283 SMU
RW1	N/A	Restoration	grading, planting	5.8 AC	N/A	N/A	1:1	5.8 WMU
RW1	N/A	Creation	grading, planting	1.1 AC	N/A	N/A	3:1	0.4 WMU
RW2	N/A	Restoration	grading, planting	0.8 AC	N/A	N/A	1:1	0.8 WMU
RW2	N/A	Creation	grading, planting	1.8 AC	N/A	N/A	3:1	0.6 WMU

[1] Excludes 200 LF in crossings
[2] Buffer restoration will take place but is not intended for mitigation
[3] Excludes downstream 306 LF of UT1a that is in the anastomosed wetland complex
[4] Excludes downstream 243 LF of UT1b that is in the anastomosed wetland complex

Table ES.2b Summary of Mitigation Levels
Lyle Creek Mitigation Site

Mitigation Level	Proposed Stream Length	Proposed Wetland Area	Upland Area	Buffer Acreage**	Proposed Mitigation Ratio	Proposed Mitigation Credits
Stream Restoration	5,410 LF*			23.1 AC	1:1	5,410 SMU
Stream Enhancement	1,337 LF			3.5 AC	2.5:1	535 SMU
Stream Preservation	N/A			N/A	5:1	N/A
Wetland Restoration		6.6 AC			1:1	6.6 WMU
Wetland Creation		2.9 AC			3:1	1.0 WMU
Wetland Preservation		N/A			5:1	N/A
TOTAL	6,747 LF	9.5 AC	N/A	26.6 AC		5,945 SMU, 7.6 WMU

*Excludes 200 LF in crossings, 306 LF of UT1a and 243 LF of UT1b in the anastomosed wetlands complex
** Buffer restoration will take place but is not intended for mitigation

This document is consistent with the requirements of the federal rule for compensatory mitigation project sites as described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section 332.8 paragraphs (c) (2) through (c) (14). Specifically the document addresses the following requirements of the federal rule:

(2) *Objectives*. A description of the resource type(s) and amount(s) that will be provided, the method of compensation (i.e., restoration, establishment, enhancement, and/or preservation), and the manner in which the resource functions of the compensatory mitigation project will address the needs of the watershed, Ecoregion, physiographic province, or other geographic area of interest.

(3) *Site selection*. A description of the factors considered during the site selection process. This should include consideration of watershed needs, onsite alternatives where applicable, and the practicability of accomplishing ecologically self-sustaining aquatic resource restoration, establishment, enhancement, and/or preservation at the compensatory mitigation project site (see §332.3(d)).

(4) *Site protection instrument*. A description of the legal arrangements and instrument, including site ownership, that will be used to ensure the long-term protection of the compensatory mitigation project site (see §332.7(a)).

(5) *Baseline information*. A description of the ecological characteristics of the proposed compensatory mitigation project site and, in the case of an application for a DA permit, the impact site. This may include descriptions of historic and existing plant communities, historic and existing hydrology, soil conditions, a map showing the locations of the impact and mitigation site (s) or the geographic coordinates for those sites (s), and other site characteristics appropriate to the type of resource proposed as compensations. The baseline information should also include a delineation of waters of the United States on the proposed compensatory mitigation project site. A prospective permittee planning to secure credits from an approved mitigation bank or in-lieu fee program only needs to provide baseline

information about the impact site, not the mitigation bank or in-lieu fee project site.

(6) *Determination of credits.* A description of the number of credits to be provided, including a brief explanation of the rationale for this determination (see §332.3(f)).

(7) *Mitigation work plan.* Detailed written specifications and work descriptions for the compensatory mitigation project; construction methods, timing, and sequence; source(s) of water, including connections to existing waters and uplands; methods for establishing the desired plant community; plans to control invasive plant species; the proposed grading plan, including elevations and slopes of the substrate; soil management; and erosion control measures. For stream compensatory mitigation projects, the mitigation work plan may also include other relevant information, such as plan form geometry, channel form (e.g. typical channel cross-sections), watershed size, design discharge, and riparian area plantings.

(8) *Maintenance plan.* A description and schedule of maintenance requirements to ensure the continued viability of the resource once initial construction is completed.

(9) *Performance standards.* Ecologically-based standards that will be used to determine whether the compensatory mitigation project is achieving its objectives (see §332.5).

(10) *Monitoring requirements.* A description of parameters to be monitored in order to determine if the compensatory mitigation project is on track to meet performance standards and if adaptive management is needed. A schedule for monitoring and reporting on monitoring results to the district engineer must be included (see §332.6).

(11) *Long-term management plan.* A description of how the compensatory mitigation project will be managed after performance standards have been achieved to ensure the long-term sustainability of the resource, including long-term financing mechanisms and the party responsible for long-term management (see §332.7(d)).

(12) *Adaptive management plan.* A management strategy to address unforeseen changes in site conditions or other components of the compensatory mitigation project, including the party or parties responsible for implementing adaptive management measures. The adaptive management plan will guide decisions for management measures. The adaptive management plan will guide decisions for revising compensatory mitigation plans and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect compensatory mitigation success (see §332.7(c)).

(13) *Financial assurances.* A description of financial assurances that will be provided and how they are sufficient to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with its performance standards (see §332.3(n)).

1.0 Project Site Identification and Location

The Lyle Creek Mitigation Site is a full-delivery stream and wetland restoration project for the North Carolina Ecosystem Enhancement Program (NCEEP) in Catawba County, NC. The project includes work on and adjacent to several unnamed tributaries (UTs) to Lyle Creek: restoration of 4,961 existing linear feet (LF) of perennial stream, restoration of 1,141 existing LF of intermittent stream, enhancement of 1,455 existing LF of intermittent stream, restoration of 6.6 acres of wetlands, and creation of 2.9 acres of wetlands. Buffer restoration will also take place but is not intended for mitigation credit at this time.

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Photographs of the project site are included in Appendix 1.

1.1 Directions to Project Site

The Lyle Creek Mitigation Site is located west of NC Highway 10/ North Main Street in the Town of Catawba, NC (Figure 1). The site is 18 miles east of Hickory, 15 miles southwest of Statesville, and approximately 2 miles south of I-40. The site is located on an active tree farm surrounded by woods and residential land use. The site is bounded by Lyle Creek to the north, NC Highway 10/ North Main Street to the east, and an elevated railroad right-of-way to the south.

From I-40 exit 138, follow Oxford School Road south for 2.2 miles. Oxford School Road becomes North Main Street (NC Highway 10) after a bridge crossing at Lyle Creek. From North Main Street, turn right onto 3rd Avenue NW. Follow 3rd Avenue NW around and to the right to approach the Catawba Tree Farm gate.

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

The Lyle Creek Mitigation Site is located within the NCEEP targeted watershed for the Catawba River Basin (HUC 03050101140010) and North Carolina Division of Water Quality (NCDWQ) Subbasin 03-08-32. Lyle Creek flows into the Catawba River less than a mile downstream of the proposed mitigation site.

The NCDWQ assigns best usage classifications to State Waters that reflect water quality conditions and potential resource usage. Lyle Creek (NCDWQ Index No. 11-76-4.5) is the main receiving tributary of the project reaches and has been classified as Class WS-IV; CA waters. Class WS-IV waters are used as sources of water supply for drinking or food processing purposes where a more restrictive WS-I, WS-II, or WS-III classification is not feasible. These waters are also protected for Class C uses such as secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, and agriculture. WS-IV waters are generally in moderately to highly-developed watersheds or Protected Areas. This portion of Lyle Creek is also located within the Critical Area (CA) of the Catawba River/ Lake Norman.

1.3 Project Components and Structure

Table 1a Project Components
Lyle Creek Mitigation Site

Project Reach	Existing Length/ Area	Mitigation Level	Approach	Proposed Mitigation Length/ Area	Proposed Mitigation Stationing	Buffer Acreage[2]	Proposed Mitigation Ratio	Proposed Mitigation Credits
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RW2	N/A	Restoration	grading, planting	0.8 AC	N/A	N/A	1:1	0.8 WMU
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[1] Excludes 200 LF in crossings
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Table 1b. Summary of Mitigation Levels
Lyle Creek Mitigation Site

Mitigation Level	Proposed Stream Length	Proposed Wetland Area	Upland Area	Buffer Acreage**	Proposed Mitigation Ratio	Proposed Mitigation Credits
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2.0 Watershed Characterization

The following sections describe the existing conditions at the Lyle Creek Mitigation Site in terms of stream and wetland jurisdiction, stream position in the valley, watershed conditions, soils, geology, cultural resources, species of concern, regulated floodplain zones, and site constraints.

2.1 Project Area and Easement Acreage

The Lyle Creek Mitigation Site is located within a 111-acre tract of land west of NC Highway 10 and the Town of Catawba in the Catawba River Basin. The parcel is owned by Joseph S. and Kathy T. Garmon (PIN 3782-1710-3129) and a conservation easement was recorded on December 29, 2010 on 26.62 acres of the tract, defining the limits of the project area (Deed Book 03057, Page Number 1320 and Plat Book 70, Page Number 90). The conservation easement excludes two specified easement crossing areas and one utility right-of-way/easement crossing area. The conservation easement allows for the stream and wetland restoration work to occur and protects the project area in perpetuity. Figure 2 depicts the conservation easement and the project streams.

2.2 Surface Water Classification and Water Quality

On February 26, 2010, Wildlands Engineering, Inc. (WEI) investigated onsite jurisdictional waters of the U.S. using the U.S. Army Corps of Engineers (USACE) Routine Onsite Determination Method. This method is defined in the 1987 Corps of Engineers Wetlands Delineation Manual. Determination methods included stream classification utilizing the NCDWQ Stream Identification Form and the USACE Stream Quality Assessment Worksheet. Potential jurisdictional wetland areas as well as typical upland areas were classified using the USACE Routine Wetland Determination Data Form. Onsite jurisdictional wetland areas were also assessed using the North Carolina Wetland Assessment Method (NCWAM). All stream and wetland data forms, representative of onsite jurisdictional waters are included in Appendix 2.

The results of the onsite field investigation indicate that five channels including UT1 to Lyle Creek, UT1a, UT1b, UT1c, and UT1d are jurisdictional within the project limits (Figures 5 and 6). Past maintenance and ditching efforts throughout the project area have resulted in large sections of these onsite channels exhibiting linear wetland indicators, specifically a domination of herbaceous vegetation, low flow velocities, and a lack of stream substrate. Onsite channels exhibiting these indicators include UT1a, UT1c, UT1d, and portions of UT1. These channels continue to function as linear conveyances, exhibit intermittent to perennial flow, and act as key drainages to the site during storm flow events. Additionally there are five jurisdictional wetland areas (WL-1, WL-2, WL-3, WL-4, and WL-5) located within the proposed project area. These wetlands are typically ditched features located in conjunction with onsite jurisdictional channels and function to drain adjacent upland areas. Each of the described tributaries and wetland features are protected under the conservation easement that was placed on the property. A copy of the Jurisdictional Determination is included in Appendix 2.

2.3 Onsite Stream Position and Watershed Drainage Area

Figure 4 depicts the Catawba USGS 7.5-minute topographic quadrangle and the project area. The project lies predominately within the low-slope floodplain of Lyle Creek with some areas of steeper topography along the southern project boundary. Within the project boundaries, UT1 flows from the southwestern corner of the project north, then turns east and runs parallel to Lyle Creek for the length of the project. At the downstream extent of the project area, UT1 turns north to join Lyle Creek. UT1a, UT1b, and UT1c flow from the south and join UT1 within the project limits. UT1d flows from the western project boundary to join UT1. Figure 4 suggests that UT1 was once mapped as running perpendicular into Lyle Creek. During site investigations, WEI looked for a remnant channel path that would support the alignment suggested by the USGS hydrography. The area has been heavily farmed and no alignment was observed; however, WEI did note a levee along the length of Lyle Creek within the project boundaries. Because of the project's history of agricultural use, it is difficult to know if this formation is natural or man-made. Vegetation on the levee is at least 30 years old. If the levee was formed by Lyle Creek, UT1's alignment may have historically flowed parallel to Lyle Creek. WEI also reviewed historic aerial photography to gain more information about the streams' historic placement in the valley. The oldest available aerial, dated 1938, depicts all of the tributaries in a similar landscape position as they are today. Historic aerials are included in Appendix 5.

A reference reach identified just upstream of the project area, UT to Lyle Creek reference, exhibits a similar stream position as UT1. This stream drains a small portion of the left valley of Lyle Creek. A levee is present along the banks of Lyle Creek, and UT to Lyle Creek flows down the hillside, then turns and flows parallel to Lyle Creek for approximately 2,000 LF before it joins the main stem (Figure 13). This small tributary may not have the stream power to maintain a path through the levee. Instead, it flows through the floodplain until the valley pinches, forcing it to join Lyle Creek. This suggests that a tributary with an alignment parallel to the main stem is not unusual in the Lyle Creek watershed. See Section 4.0 for further discussion of the reference reach.

Drainage areas for the project reaches were delineated using the Catawba County topographic mapping (Figure 3). Current aerial imagery and a watershed walk were used to confirm watershed land uses. The watershed areas and land uses are summarized in Table 2.

Table 2. Drainage Areas
Lyle Creek Mitigation Site

Project Reach	Drainage Area (acres)	Predominant Land Use
UT1	315	Forested 50%, Developed 20%, Agriculture 17%, Shrubland 8%, and Herbaceous Upland 5%
UT1a	56	Forested 46%, Developed 38%, Agriculture 8%, Shrubland 6%, and Herbaceous Upland 2%
UT1b	78	Forested 58%, Developed 15%, Agriculture 18%, Shrubland 4%, and Herbaceous Upland 5%
UT1c	26	Forested 58%, Agriculture 15%, Shrubland 15%, and Herbaceous Upland 12%
UT1d	9	Forested 50%, Agriculture 25%, and Shrubland 25%

2.4 Watershed Assessment

On July 15, 2011, WEI conducted a watershed walk to verify land uses observed from the aerial photography and to identify potential sediment sources.

Consistent with that depicted in aerial photography, watersheds to UT1, UT1a, UT1b, and UT1c upstream of the project site are predominately forested. Development within the watersheds exists in the headwaters and consists primarily of residential lots with homes from the 1940's and 1950's. No areas of floodplain or overland erosion were noted within the watersheds. Stream banks throughout the watershed are eroded and appear to be the sole source of sediment to the downstream reaches.

The project's watershed is bisected by the Norfolk Southern Railroad (Figure 3 and 4). The railroad embankment is approximately 20 feet high and culverts through the embankment are approximately 3 feet high by 2.5 feet wide. The watershed above the railroad embankment primarily drains to UT1 and UT1b. Upstream of the railroad embankment, stream bed substrate is colluvial cobble, fractured bedrock, and some finer sands. UT1b is impounded just upstream of the railroad culvert. A pump was observed on the bank of the impoundment and a spillway or riser was not evident. An accumulation of fines at the inlet of the impounded area and a distinct decrease in coarse stream bed substrate below the pond suggest that most of the sediment generated from the upstream watershed settles out in the pond. Downstream of the railroad embankment, there is noticeable substrate fining on both UT1 and UT1b. Substrate shifts to primarily sand with few small cobbles and some coarse gravels. The railroad embankment and culverts appear to act as a barrier to sediment transport.

Within the Lyle Creek project site but outside of the easement, a gravel road follows the southern edge of the fields. UT1 flows under this road through a 36" RCP culvert to enter the easement area. Just upstream of this culvert, there is a large sediment bar of coarse gravels. One isolated sand bar is present just downstream of this culvert, beyond which UT1's bed is dominated by silts and organic detritus. UT1b flows under the road through an approximate 30" CMP culvert and follows the right valley wall before entering another 24" RCP culvert just upstream of the project easement. UT1b's bed is also dominated by silts and organics below both farm culverts.

Based on watershed conditions observed during the assessment, it appears that the project streams have low sediment supply primarily due to blockage from the railroad and the farm culverts.

The USEPA's STEPL pollutant loading watershed model was used to estimate sediment load from the watershed. The model uses the revised Universal Soil Loss Equation, rainfall data for the county, watershed stream conditions, and land use data to estimate sediment load from the watershed. The model estimates that the watershed supplies 7.4 tons of sediment per year. A significant portion of this supply is trapped at the railroad embankment, dropping out of the system before the channels reach the project site. This sediment supply will be further considered in the sediment transport analysis of the project site.

2.5 Historical Land Use and Development Trends

The Catawba 03050101 watershed includes developing areas such as the cities of Conover, Hickory, Lenoir and Morganton as well as the I-40 transportation corridor. Population growth and the associated development and infrastructure projects create the necessity for mitigation projects in this region.

The project site includes three first-order streams (UT1a, UT1c, and UT1d), one second-order stream (UT1b), and one stream which changes from first- to second- to third-order through the project site (UT1). The offsite watersheds are small and provide a limited footprint where development could impact the site. The watershed area is partially located in the Town of Catawba and partially outside the town limits in Catawba County. Land use within the watershed is historically rural and dominated by forest and agriculture and is approximately 50% forested, 20% developed, and 17% agricultural. WEI interviewed Mr. John R. Kinley, the Town Planner for the Western Piedmont Council of Governments, which includes the Town of Catawba, to determine whether development plans were in place for the surrounding areas. While a small amount of development is occurring in Catawba County along the I-40 corridor between Hickory and Statesville, there is no evidence of increased development pressure in the project watershed. Mr. Kinley stated that downtown Catawba is not on the verge of a re-development effort, and that while a future land-use plan was published in 2000, it is now outdated and no further planning documents are available (2011).

The Lyle Creek site is also located in the mapped 100-year floodplain of Lyle Creek, which will discourage future development on the site due to associated flooding risks.

2.6 Watershed Planning

NCEEP develops local watershed plans (LWP) for specific priority areas where critical watershed issues need to be addressed. These LWPs describe projects and management strategies to restore, enhance, or protect local water resources. The Lyle Creek Mitigation Site is not currently located within an area covered by an LWP. However, Lyle Creek is listed as a

Protection Priority within the Upper Lake Norman watershed according to the 2010 Catawba River Basinwide Water Quality Plan. Biological communities within Lyle Creek have been stable and of moderate quality over the last decade with recent macrobenthic communities scoring Good-Fair (2007) and fish communities scoring Excellent (2004). Despite the stable in-stream habitat, Lyle Creek is considered a Protection Priority due to the chain of lakes into which it drains and the potential for accumulation of pollutants to these downstream waters.

NCEEP also develops River Basin Restoration Priorities (RBRP) to guide its restoration activities within each of the State's 54 cataloging units. RBRPs delineate specific watersheds that exhibit both the need and opportunity for wetland, stream and riparian buffer restoration. These watersheds are called Targeted Local Watersheds (TLWs) and receive priority for NCEEP planning and restoration project funds. The 2004 and 2007 Catawba River Basin RBRP identified HUC 03050101140010 as a TLW, which contains the Lyle Creek Mitigation Project. The main goals of the RBRP are to protect and enhance water quality, wildlife habitat, recreational opportunities, and flood prevention. The restoration of the UTs to Lyle Creek will correspond with the goals identified in the RBRP by increasing bank stability, reducing erosion, and eliminating a direct sediment source to the stream and downstream recreational areas by establishing riparian vegetation, and enhancing aquatic and terrestrial habitat.

2.7 Physiography, Geology, and Soils

The Lyle Creek Mitigation Site is located in the Kings Mountain Belt of the Piedmont physiographic province. The Piedmont province is characterized by gently rolling, well-rounded hills and long, low ridges ranging in elevation from 300 to 1,500 feet above sea level. The Kings Mountain Belt consists of moderately deformed and metamorphosed volcanic and sedimentary rocks, approximately 400 to 500 million years old. The lithium deposits found within the belt provide raw materials for chemical compounds, ceramics, glass, greases, batteries, and television glass. Specifically, the project site is located in the Battleground Formation (Zbt) mapped unit of the Kings Mountain Belt. This mapped unit consists of quartz-sericite schist with metavolcanic rock, quartz-pebble metaconglomerate, kyanite-sillimanite quartzite, and garnet-quartz rock.

The floodplain areas of the proposed project are mapped by the Catawba County Soil Survey. Soils in the project area floodplain are primarily mapped as Chewacla loam, Congaree complex, and Wehadkee fine sandy loam. These soils are described in Table 3 and depicted in Figure 7. Soil borings were performed in the proposed wetland zones by an NC registered soil scientist. The soil profiles and a boring location map are included in Appendix 2. Additional soil profiles and boring locations within the proposed wetland areas, performed by WEI, have also been included.

Borings taken by the soil scientist vary in depth from 14 to 36 inches. Borings taken by WEI vary in depth up to 24 inches. No bedrock was encountered during boring activities. The landowners have not encountered shallow bedrock while farming the site. Based on this information, shallow bedrock does not appear to be present within the project areas.

Table 3. Project Soil Types and Descriptions
Lyle Creek Mitigation Site

Soil Name	Description
Chewacla loam	Chewacla soils are found in valleys and floodplains. They are nearly level and somewhat poorly drained. Shrink-swell potential is low. These soils are frequently flooded.
Congaree complex	Congaree soils are nearly level and moderately well drained. Shrink-swell potential is low. These soils are frequently flooded.
Wehadkee fine sandy loam	Wehadkee loam soils are typically found on valleys and depressions on floodplains. Slopes are 0 to 2 percent. The drainage class for these soils is poorly drained. Shrink swell potential is low. These soils are frequently flooded.
Notes: Source: Catawba County Soil Survey, USDA-NRCS, http://efotg.nrcs.usda.gov	

2.8 Endangered and Threatened Species

2.8.1 Site Evaluation Methodology

The Endangered Species Act (ESA) of 1973, amended (16 U.S.C. 1531 et seq.), defines protection for species with the Federal Classification of Threatened (T) or Endangered (E). An “Endangered Species” is defined as “any species which is in danger of extinction throughout all or a significant portion of its range” and a “Threatened Species” is defined as “any species which is likely to become an Endangered Species within the foreseeable future throughout all or a significant portion of its range” (ESA, 1973).

WEI utilized the U.S. Fish and Wildlife Service (USFWS) and North Carolina Natural Heritage Program (NHP) databases in order to identify federally listed Threatened and Endangered plant and animal species for Catawba County, NC (USFWS, 2008 and NHP, 2009). Two federally listed species, the bald eagle (*Haliaeetus leucocephalus*) and dwarf-flowered heartleaf (*Hexastylis naniflora*), are currently listed in Catawba County (Table 4).

Table 4. Listed Threatened and Endangered Species in Catawba County, NC
Lyle Creek Mitigation Site

Species	Federal Status	Habitat
Vertebrate		
Bald eagle (*Haliaeetus leucocephalus*)	BGPA	Near large open water bodies: lakes, marshes, seacoasts, and rivers
Vascular Plant		
Dwarf-flowered heartleaf (*Hexastylis naniflora*)	E	North facing slopes, bluffs, boggy areas with acidic sandy loam soils in deciduous forests
E = Endangered; T=Threatened; BGPA=Bald & Golden Eagle Protection Act		

2.8.2 Threatened and Endangered Species

2.8.2.1 Species Description

Bald Eagle

The bald eagle is a very large raptor species, typically 28 to 38 inches in length. Adult individuals are brown in color with a very distinctive white head and tail. Bald eagles typically live near large bodies of open water with suitable fish habitat including: lakes, marshes, seacoasts, and rivers. This species generally requires tall, mature tree species for nesting and roosting. Bald eagles were de-listed from the Endangered Species List in June 2007; however, this species remains under the protection of the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGPA). This species is known to occur in every U.S. state except Hawaii.

Dwarf-Flowered Heartleaf

Dwarf-flowered heartleaf is a low-growing, evergreen perennial herb that spreads via rhizomes. This herb exhibits heart-shaped, leathery leaves supported by long thin petioles. These plants are found along north-facing slopes, bluffs, and boggy areas containing acidic sandy loam soils within deciduous forests. Known population occurrences of dwarf-flowered heartleaf have been observed in Catawba County within the past 20 years.

2.8.2.2 Biological Conclusion

A pedestrian survey of the site was performed on February 26, 2010. Onsite habitats include active pastures and streamside thickets. There is no suitable nesting or breeding habitat for bald eagles located within the site, as they require tall, mature trees. There is also no suitable habitat for the Dwarf-flowered heartleaf in the project area.

Based on a pedestrian survey of the project area, no individual species, critical habitat, or suitable habitat was found to exist on the site. It is WEI's position that in regard to the federally-listed species for Catawba County, the Lyle Creek Mitigation Site will have "no effect."

2.8.3 USFWS Concurrence

WEI requested review and comment from the United States Fish and Wildlife Service (USFWS) on July 12, 2010, regarding the results of the site investigation of the Lyle Creek Mitigation Site and its potential impacts on threatened or endangered species. Since no response was received from the USFWS within a 30-day time frame, it is assumed that the site determination is correct and that no additional, relevant information is available for this site. A further review of the North Carolina Natural Heritage Program's (NCNHP) element occurrence GIS data layer shows that no natural heritage elements occur within two miles of the proposed project area. All correspondence is included in Appendix 3.

2.9 Cultural Resources

2.9.1 Site Evaluation Methodology

The National Historic Preservation Act (NHPA) of 1966, amended (16 U.S.C. 470), defines the policy of historic preservation to protect, restore, and reuse districts, sites, structures, and objects significant in American history, architecture, and culture. Section 106 of the NHPA mandates that federal agencies take into account the effect of an undertaking on any property, which is included in, or eligible for inclusion in, the National Register of Historic Places. Letters were sent to the North Carolina State Historic Preservation Office (SHPO) and to the Tribal Historic Preservation Office (THPO) on July 12, 2010, requesting review and comment for the potential of cultural resources potentially affected by the Lyle Creek Mitigation Site.

2.9.2 SHPO/THPO Concurrence

In a letter dated August 11, 2010 (see Appendix 3), the SHPO stated that they have conducted a review of the project and are, "…aware of no historic resources which would be affected by the project." Additionally, no response has been received from the THPO within a 30-day time frame and it is assumed that no cultural resources will be affected by this project.

2.10 Physical Constraints

2.10.1 Property Ownership, Boundary, and Utilities

The recorded easement allows the mitigation project to occur, and restricts the land use of the site in perpetuity.

Within the project area, there is an overhead electric line with no recorded utility easement. The conservation easement was designed to exclude a 30-foot wide area under this line in anticipation of potential future maintenance requirements. Irrigation lines that serve the tree farm will be relocated outside the easement area. There are no additional utilities onsite.

2.10.2 Site Access

The project area is accessed from 3rd Avenue NW off North Main Street (NC Highway 10), as shown in Figure 2.

Within the site, there will be three easement breaks with crossings over UT1 to maintain access to all portions of the parent tract. One of these easement breaks is associated with the 30-foot wide overhead electric line. These easement breaks are shown on Figure 17.

2.10.3 FEMA and Hydrologic Trespass

The project stream channels do not have an associated regulated floodplain; however, the project reaches and wetland areas are located within the floodway and flood fringe of Lyle Creek (Figure 8). Lyle Creek is a mapped Zone AE floodplain with an associated floodway. A detailed hydraulic study was originally performed by the Soil Conservation Service, but this model is no longer available in the local, state, or federal repositories. The most recent FIRM panel is a re-delineation of the original flood elevations. The site is located on Panels

3781 and 3782 of the Catawba County FIRM panels. The site is primarily under backwater effects from Lake Norman on the Catawba River. The project grading is being designed so that there is no net fill in the regulated floodplain of Lyle Creek. Earthwork calculations and grading plans will be submitted with a no-rise certification for the Town of Catawba floodplain administrator. The NC Emergency Management (NCEM) Floodplain Mapping Program Engineer has approved this approach for the Lyle Creek Mitigation Site. Appendix 6 contains the NCEEP Floodplain Requirements Checklist.

3.0 Project Site Streams – Existing Conditions

The following sections describe the existing conditions at the Lyle Creek Mitigation Site in terms of geomorphology, discharge, channel evolution and stability, and the existing vegetated community.

3.1 Existing Conditions Survey

The onsite existing conditions data were collected by WEI in August 2010. This survey included the assessment of approximately 7,557 LF of UTs to Lyle Creek. The locations of the project reaches and surveyed cross-sections are shown in Figure 5. Existing geomorphic survey data is included in Appendix 4. Tables 5a and 5b summarize the attributes of the overall project and of the project reaches.

Table 5a. Project Attributes
Lyle Creek Mitigation Site

Project County	Catawba County
Physiographic Region	Kings Mountain Belt of the Piedmont Physiographic Province
Ecoregion	Piedmont
River Basin	Catawba
USGS HUC (14 digit)	03050101140010
NCDWQ Sub-basin	Catawba River Subbasin 03-08-32
Within NCEEP Watershed Plan?	No, however, Lyle Creek is located in an EEP targeted watershed.
WRC Class	Warm
Percent of Easement Fenced or Demarcated	The easement has been recorded and will be demarcated with witness posts and signage. No fencing is necessary since the surrounding area is a tree farm.
Beaver Activity Observed During Design Phase?	No

Table 5b. Mitigation Component Attributes
Lyle Creek Mitigation Site

(onsite streams are tributaries to Lyle Creek)

	UT1	UT1a	UT1b	UT1c	UT1d	RW1	RW2
Drainage Area (acres)	315	56	78	26	9	96	134
Stream Order	Reach 1 – 1st Reach 2 - 2nd Reach 3 - 3rd	1st	2nd	1st	1st	N/A	N/A
Restored Length (LF)	3,950 [1]	615 [2]	845 [3]	630	707	N/A	N/A
Perennial (P) or Intermittent (I)	P	I	P	I	I	N/A	N/A
Watershed Type	Rural						
Watershed Land Use							
Forested	50%	46%	58%	58%	50%	65%	52%
Developed	20%	38%	15%	0%	0%	5%	24%
Agricultural	17%	8%	18%	15%	25%	5%	12%
Shrubland	8%	6%	4%	15%	25%	0%	4%
Herbaceous Upland	5%	2%	5%	12%	0%	23%	3%
Watershed Impervious Cover	5%	10%	4%	0%	0%	2%	5%
NCDWQ Index Number	Lyle Creek - 11-76-(4.5)						
NCDWQ Classification	Lyle Creek - WS-IV;CA						
303d Listed	No						
Upstream of 303d Stream	No						
303d Listing Reason	N/A						
Total Acreage of Easement	26.62 acres						
Total Existing Vegetated Acreage within Easement	26.0 acres (excludes existing roads)						
Total Planted Acreage as part of Restoration	26.3 acres (excludes stream beds)						
Rosgen Classification of Pre-Existing	F5 [4], F6 [4], G6 [4]	F6 [4]	F6 [4]	F6 [4]	F6 [4]	N/A	N/A
Rosgen Classification of Design	B5c, C6	B6c, C6	C6	C6	C6	N/A	N/A
Valley Type	Alluvial	Colluvial /alluvial	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial
Valley Slope (feet/ foot)	Reach 1 Upper: 0.0153 Reach 1 Lower: 0.0017 Reach 2: 0.0063	0.0115 to 0.0324	0.0037 to 0.0185	0.0006	0.0041	0.0017	0.01
Cowardin Classification	N/A	N/A	N/A	N/A	N/A	Palustrine	Palustrine
Trout Waters Designation	No						
Endangered or Threatened Species	No Effect						
Dominant Soil Series and Characteristics	Chewacla loam, 0-2% slopes	Chewacla loam, 0-2% slopes	Wehadkee fine sandy loam, 0-2% slopes	Chewacla loam, 0-2% slopes	Congaree complex, 0-2% slopes	Chewacla loam and Wehadkee fine sandy	Chewacla loam, 0-2% slopes

[1] Excludes 200 LF of crossings

[2] Excludes 306 LF of UT1a in the anastomosed wetlands complex

[3] Excludes 243 LF of UT1b in the anastomosed wetlands complex

[4] The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicable. These classifications are provided for illustrative purposes only.

3.2 Channel Classification

The site consists of one main tributary (UT1 to Lyle Creek) fed by four smaller tributaries (UT1a, UT1b, UT1c, and UT1d). Each of the UTs on the Lyle Creek Mitigation Site have been continuously maintained as straightened, ditched channels to assist with irrigation and drainage of the surrounding commercial tree farm. Past maintenance and ditching efforts of these tributaries have resulted in large, overly wide channel cross-sections, contributing to extremely low flow velocities and a buildup of fine sediments and plant detritus within the channel bottom. Over time, these linear conveyances have become choked out with herbaceous vegetation and more closely resemble linear wetlands with no substrate or bed form, and little to no aquatic habitat. Historical aerials of the site, provided in Appendix 5, show active channel maintenance since at least 1961. A reproduction of a 1938 historical aerial also suggests that channel was in its current alignment in the 1930's as well, although due to the age of this aerial, whether the channel was actively maintained or not is difficult to decipher.

It is important to note that Rosgen's natural channel classification system (1994) cannot be fully and accurately applied to such manipulated channels. Sinuosity cannot be used as a valid classification characteristic because the channels are straightened. All of the streams are incised with bank height ratios ranging from 1.4 to 3.4. These maintained channels also have low bank slopes which often allow for entrenchment ratios greater than 2.2. High entrenchment ratios lead to classification of stream types with good floodplain connectivity; however, these channels have minimal access to an actual floodplain because bankfull is so far below the true top of bank. For this reason, entrenchment ratio also cannot be used as a valid classification characteristic. For determining an illustrative classification for the onsite channels, bank height ratio was used as an indicator for floodplain access as opposed to entrenchment ratio.

The following sections discuss the reaches proposed for restoration including UT1, UT1a, and UT1b, as well as the reaches proposed for enhancement including UT1c and UT1d. A photo log of the project reaches is included in Appendix 1.

3.2.1 Restoration Reaches

UT1 is a perennial channel that flows onto the site from a steep, wooded area to the southwest. UT1 was divided into three separate reaches for classification due to slight differences in stream morphology and drainage area sizes. Please note that the reach breaks established for classification purposes (Reach 1, Reach 2, and Reach 3) differ from the reach breaks established for restoration (Reach 1 Upper, Reach 1 Lower, and Reach 2). This section reviews reaches established for classification. Figure 5 shows the reach locations.

Reach 1 of UT1 is 1,522 LF long and drains an approximate 0.16-square mile watershed. This portion of the channel is located in an area of the project with a slightly steeper valley. Ditching and maintenance has created an overly wide channel, which is reflected in the width-to-depth ratios of 35 to 50. The section is incised with bank height ratios ranging from 1.6 to 3.0. Very fine sand and silt dominate the substrate. Due to the high width-to-depth ratio and deep incision, Reach 1 shows some similarities to a Rosgen F stream type.

Reach 2 of UT1 is 1,729 LF long and extends from the confluence with UT1d downstream to the confluence with UT1b. Reach 2 drains a 0.35-square mile watershed. This reach is somewhat deeper than Reach 1 with narrower bankfull widths, resulting in a lower width-to-depth ratio of 21. This section is incised with bank height ratios ranging from 1.4 to 2.3. Flow velocities are very low on this reach and silt dominates the substrate. Reach 2, like Reach 1, shows similarities to a Rosgen F stream type.

Reach 3 of UT1 is approximately 820 LF and extends from the confluence of UT1b downstream to the confluence with Lyle Creek. This portion of UT1 exhibited narrowed bankfull widths resulting in a low width-to-depth ratio of 9.5. The section is incised with bank height ratios ranging from 1.7 to 2.4. Silt dominates the substrate. The lower width-depth ratio combined with incision is similar to a Rosgen G stream type.

UT1a is an intermittent channel that enters the site from the steep, wooded property to the south. UT1a is approximately 1,141 LF and drains a 0.08 square mile watershed. UT1a, despite being an intermittent drainage, exhibits strong flow conditions. This channel has been heavily ditched and maintained and exhibits a width-to-depth ratio of 16.5 and bank height ratios ranging from 2.3 to 3.4. Silt dominates the substrate. The high width-to-depth ratio combined with deep incision is similar to a Rosgen F stream type.

UT1b is a perennial channel that enters the project area from the steep, wooded property south of the site, flowing north into UT1. UT1b has a drainage area of approximately 0.12 square miles. UT1b is similar to the other onsite streams in that it has been heavily ditched and maintained in the past making accurate classification difficult. This channel is relatively shallow with wide bankfull widths resulting in a width-to-depth ratio of 33.6. Bank height ratios range from 2.0 to 2.5. Silt dominates the substrate. UT1b, like UT1a, shows similarities to a Rosgen F stream type.

Existing geomorphic conditions for UT1, UT1a, and UT1b to Lyle Creek are summarized in Table 6a.

Table 6a. Restoration Reaches Existing Conditions
Lyle Creek Stream Mitigation Project

			UT1 Reach 1		UT1 Reach 2		UT1 Reach 3		UT1b		UT1a	
	Notation	**Units**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**
stream type			F5 ^{1}		F6 ^{1}		G6 ^{1}		F6 ^{1}		F6 ^{1}	
drainage area	DA	sq mi	0.10	0.16	0.16	0.35	0.35	0.49	0.12		0.08	
Discharge												
Q- NC Rural Regional Curve	Q	cfs	17	24	24	42	42	52	20		14	
Q_{2-yr} NFF regression	Q	cfs	37		65		79		30		23	
Q- USGS extrapolation (1.2yr-1.5yr)	Q	cfs	8	15	15	31	31	49	9	17	6	13
selected bankfull design discharge	Q_{bkf}	cfs	14		15		28		13		9	
Cross-Section Features												
bankfull cross-sectional area	A_{bkf}	SF	14.9	19.2	18.1		10.5		7.9		4.6	
average velocity during bankfull event	v_{bkf}	fps	0.7	0.9	0.8		2.7		1.6		2.0	
width at bankfull	w_{bkf}	feet	23.1	31.5	19.4		10.0		16.3		8.7	
maximum depth at bankfull	d_{max}	feet	1.1		1.5		1.7		1.0		0.8	
mean depth at bankfull	d_{bkf}	feet	0.65		0.93		1.05		0.48		0.53	
bankfull width-to-depth ratio	w_{bkf}/d_{bkf}		35.8	48.8	20.8		9.5		33.6		16.5	
depth ratio	d_{max}/d_{bkf}		1.6		1.6		1.7		2.1		1.5	
low bank height			1.7	3.1	2.1	3.5	3.0	4.2	2.1	2.6	1.8	2.7
bank height ratio	BHR		1.6	3.0	1.4	2.3	1.7	2.4	2.0	2.5	2.3	3.4
floodprone area width	w_{fpa}	feet	43	48	62		34		42		21	
entrenchment ratio	ER		1.5	1.8	3.2		3.4		2.6		2.4	
Valley and Channel Slope												
valley slope^{2}	S_{valley}	feet/ foot	0.0137		0.0020		0.0020		0.0124		0.0110	
channel slope	$S_{channel}$	feet/ foot	0.0120		0.0011		0.0036^{3}		0.0085		0.0106	
Run/Riffle Features												
run/riffle slope	S_{riffle}	feet/ foot	0.003	0.026	0.0033	0.006	0.0030	0.011	0.0056	0.016	0.0035	0.032
run/riffle slope ratio	$S_{riffle}/S_{channel}$		0.3	2.2	3.0	5.4	0.8	2.9	0.7	1.9	0.3	3.1
Pool Features												
pool slope	S_{pool}	feet/ foot	0.0005	0.0035	0.002	0.003	0.000	0.005	0.001	0.004	0.001	0.004
pool slope ratio	$S_{pool}/S_{channel}$		0.0	0.3	1.9	2.5	0.1	1.4	0.2	0.5	0.1	0.4
pool-to-pool spacing	L_{p-p}	feet	50	100	49	115	41	56	28	87	35	68
pool spacing ratio	L_{p-p}/w_{bkf}		2.2	3.2	2.5	5.9	4.1	5.6	1.7	5.3	4.0	7.8
maximum pool depth at bankfull	d_{pool}	feet	1.9	2.3	3.1		2.8		1.6		1.1	
pool depth ratio	d_{pool}/d_{bkf}		3.0	3.6	3.3		2.7		3.2		2.0	
pool width at bankfull	w_{pool}	feet	13.8	29.6	23.7		12.2		14.9		10.3	
pool width ratio	w_{pool}/w_{bkf}		0.6	0.9	1.2		1.2		0.9		1.2	
pool cross-sectional area at bankfull	A_{pool}	SF	11.3	17.8	27.0		20.0		7.8		4.9	
pool area ratio	A_{pool}/A_{bkf}		0.8	0.9	1.5		1.9		1.0		1.1	

			UT1 Reach 1		UT1 Reach 2		UT1 Reach 3		UT1b		UT1a	
	Notation	**Units**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**
Pattern Features												
belt width	w_{blt}	feet	N/A^5		N/A^5		N/A^5		N/A^5		N/A^5	
meander width ratio	w_{blt}/w_{bkf}		N/A^5		N/A^5		N/A^5		N/A^5		N/A^5	
meander length	L_m	feet	N/A^5		N/A^5		N/A^5		N/A^5		N/A^5	
meander length ratio	L_m/w_{bkf}		N/A^5		N/A^5		N/A^5		N/A^5		N/A^5	
radius of curvature	R_c	feet	N/A^5		N/A^5		N/A^5		N/A^5		N/A^5	
radius of curvature ratio	R_c/ w_{bkf}		N/A^5		N/A^5		N/A^5		N/A^5		N/A^5	
Sinuosity^4	K		1.2		1.0		1.1		1.0		1.0	
Sediment												
% Composition from Bulk Sample												
		d_{50}	Very fine sand		Silt		Silt^5		Silt^5		Silt^5	
Clay	<0.004 mm	%	11		24		-		-		-	
Silt	0.004-0.062 mm	%	19		47		-		-		-	
Very Fine Sand	0.062-0.125 mm	%	20		12		-		-		-	
Fine Sand	0.125-0.25 mm	%	30		12		-		-		-	
Medium Sand	0.25-0.50 mm	%	10		4		-		-		-	
Coarse Sand	0.50-1.0 mm	%	4		1		-		-		-	
Very Coarse Sand	1.0-2.0 mm	%	2		0		-		-		-	
Very Fine Gravel	2.0-4.0 mm	%	4		0		-		-		-	

[1] The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicable. These classifications are provided for illustrative purposes only.

[2] Reported valley slopes are specific to the representative section of longitudinal profile survey only.

[3] UT1 Reach 3 drops down to meet the Lyle Creek water surface elevation, which accounts for a channel slope steeper than the valley slope.

[4] K calculated from channel and valley lengths; channel slopes are actively maintained by dredging and therefore valley slope/channel slope overestimates sinuosity.

N/A^5: Channel has been straightened, moved, and/or maintained to prevent pattern formation.

[6] Composition of bulk samples for these reaches were similar to the UT1 Reach 2 sample.

3.2.2 Enhancement Reaches

UT1c and UT1d are small intermittent drainages to UT1 with small drainage areas (0.04 to 0.01 square mile in size, respectively). While Rosgen classification is not considered suited for drainage areas of this small size or for channels this manipulated, these streams have some similarities to the Rosgen F stream type. These relatively shallow channels exhibited wide bankfull widths with very high width-to-depth ratios ranging from 27 to 46.5. The streams are incised with bank height ratios ranging from 1.9 to 2.0. Existing geomorphic conditions for UT1c and UT1d to Lyle Creek are summarized below in Table 6b.

Table 6b. Enhancement Reaches Existing Conditions
Lyle Creek Stream Mitigation Project

	Notation	Units	UT1c	UT1d
stream type			F6 [1]	F5/6 [1]
drainage area	DA	sq mi	0.04	0.01
bankfull cross-sectional area	A_{bkf}	SF	10.8	5.6
width at bankfull	w_{bkf}	feet	22.4	12.3
mean depth at bankfull	d_{bkf}	feet	0.5	0..5
bankfull width-to-depth ratio	w_{bkf}/d_{bkf}		46.5	27.0
bank height ratio	BHR		2.0	1.9
entrenchment ratio	ER	feet/foot	2.2	3.6

[1] The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicable. These classifications are provided for illustrative purposes only.

3.3 Valley Classification

Lyle Creek flows along the northern edge of the project limits and the majority of the Lyle Creek project area is located within the larger alluvial floodplain of Lyle Creek. As Trimble notes, Piedmont streams and floodplains in this region were filled with erosional runoff from agricultural fields in the watershed after the Civil War (1974). The erosional debris may have filled the Lyle Creek floodplain. Active tree farming activities in the floodplain have further manipulated the valley with tilling, grading, and filling. Slightly entrenched and meandering Rosgen C or E channels are the typical stream types found in lower gradient alluvial valleys (Rosgen, 1996). Historical straightening, dredging, adjacent tree farm activities, and channel modifications of project streams have resulted in a total departure from natural stream form on the site. The valley steepens towards the southern project limits. The upper reach of UT1a flows through this steeper valley before entering the alluvial valley formed by Lyle Creek.

3.4 Discharge

Several methods were used to evaluate bankfull discharge and choose a design discharge for each of the separate restoration reaches. The regional curve relating bankfull discharge to drainage area for rural watersheds in the Piedmont region of North Carolina were used to provide an estimate the bankfull discharge for each reach (Harman, et al., 1999) (Figure 9). In addition, WEI evaluated several nearby gages to determine their bankfull return interval. Three gages that were part of the original NC Piedmont Regional curve were selected; the Norwood Creek near Troutman, NC gage (USGS #0214253830), the Jacob Fork near Ramsey, NC gage (USGS #2143040), and the Humpy Creek near Fork, NC gage (USGS #2117030). Using the bankfull discharge established in the regional curve dataset, the bankfull return intervals for these gages are 1.24-year, 1.42-year, and 1.85-yr, respectively. WEI then used the U.S. Geological Survey (USGS) flood frequency equations for rural watersheds in the North Carolina Piedmont to estimate peak discharges for floods with a recurrence interval of two years for each of the project reaches (Weaver, et al., 2009). Based on the distribution of bankfull return intervals for the nearby gages, the 2-year discharge provides a reasonable upper limit of bankfull discharge, but is generally larger than the discharge predicted by the appropriate regional curve. Due to this higher estimation, WEI extrapolated the 1.2- and 1.5-year discharges for each reach using the 2-, 5-, 10-, and 25-year USGS flow predictions. This was accomplished by plotting the USGS flow predictions for each reach on a logarithmic scale and fitting a linear regression, which was then used to estimate the smaller return interval storms.

The lack of either reliable bankfull features along the project reach or an onsite gaging station makes selection of a design bankfull discharge difficult. The rationale for selecting the design discharges shown in Table 7 was developed based on the best available information as well as the experience and professional judgments of the designers. Due to the lack of smaller-sized drainage areas among the NC rural Piedmont regional curve channels, this data was not heavily relied upon for accurate determination of bankfull discharge. Based on the return intervals for the three gage stations evaluated, better estimates of a bankfull discharge are provided by the USGS flood frequency linear regression equations for 1.2- to 1.5-year peak flows. Therefore, the design discharges for the restoration reaches were selected near those predicted by the USGS rural regression models, but lower than those predicted by the rural regional curve. WEI also used the bankfull discharge calculated for the UT to Lyle Creek reference site, which has a drainage area of 0.25 square miles and is fully connected to its floodplain, to inform the bankfull discharge selection for the site. See Section 4.0 for more information about the UT to Lyle Creek reference site.

Table 7 summarizes the results of each of the discharge analyses described in this section and includes the bankfull discharge for the UT to Lyle Creek reference site.

Table 7. Summary of Design Discharge Analysis
Lyle Creek Mitigation Site

	UT1 Reach 1 Upper	UT1 Reach 1 Lower	UT1 Reach 2	UT1b	UT1a	UT to Lyle Creek Reference
Drainage Area (mi^2)	0.15	0.25	0.49	0.13	0.05	0.25
Rural Piedmont Regional Curve (cfs)	23.0	33.0	53.0	20.0	10.0	33.0
Rural USGS 1.2-year Extrapolation (cfs)	11	18	32	10	4	18
Rural USGS 1.5-year Extrapolation (cfs)	20	30	51	18	9	30
Selected Bankfull Discharge (cfs)	14	15	28	13	9	14

3.5 Channel Morphology

Due to on-going modification of the channels by mechanical straightening and dredging, the channels are incised and lack bedform features such as riffles and defined pools. The channels are each a consistent width and depth without developed in-stream habitat. Although meander geometry is expected for these streams, it has not been allowed to form. Vegetation is consistently mechanically removed or sprayed on the banks, so no woody habitat is available from bank vegetation. The channels are each very flat due to the location of the site in the wide, flat Lyle Creek floodplain. Due to the low slope of each channel, stream power is low and vertical incision has not been a problem.

3.6 Channel Evolution

Onsite stream channels are being maintained at *Stage II – Channelized* of Simon's evolution model (1989), illustrated in Figure 10. Ditching of the project's channels resulted in deep, overly-wide channel cross-sections which have filled in with dense, herbaceous vegetation growth and fine silts. The ditching maintenance has resulted in wider channels than represented in the Simon model. Due to the low slope, if maintenance stopped on these reaches, the streams would likely remain vertically stable but would slowly aggrade with fines and dead organic material. *Stage III – Degradation* and *Stage IV – Degradation and Widening* would be circumvented and the stream would move directly to evolutionary *Stage V- Aggradaton and Widening*. During this stage, pattern may form through stream erosion and deposition as the stream advances towards equilibrium. Because of the low sediment supply observed during the watershed analysis, the onsite streams would likely remain in *Stage V* for a long time before achieving *Stage VI – Quasi Equilibrium.*

3.7 Channel Stability Assessment

The onsite UTs to Lyle Creek are regularly modified and maintained and therefore lack bedform diversity, habitat, and riparian buffer. The primary impacts to the project channels are the result of mowing, ditching, and vegetation maintenance (dredging) associated with tree farming activities. UT1 exhibits incision throughout its length and in large part, artificially maintained vertical and horizontal stability through constant maintenance. Despite this, the banks are well vegetated and exhibit low to moderate erosion. The discontinuation of riparian maintenance and the establishment of a stable cross-section and woody vegetation for bank protection will help to protect these reaches from further bank erosion.

3.8 Bankfull Verification

Bankfull stage on the UTs to Lyle Creek was attributed to a slight break in slope on the stream banks. However, due to extensive modifications of onsite streams, bankfull field indicators were not strong. Throughout the majority of the project reaches, the break in slope may be remnant from past grading activities and not from natural stream processes. In an attempt to verify the bankfull field calls, the surveyed bankfull cross-sectional areas for the project reaches were overlain on the NC rural regional curve (Figure 9). Bankfull cross-sectional areas for the project reaches consistently plotted at or just above the NC rural Piedmont regional curve data, except for the intermittent streams UT1c and UT1d, which plotted higher than predicted by the regional curve regression equation. It is important to note that the data used to develop the regional curve is predominately larger drainage-area streams. Only one stream surveyed for the regional curve has a drainage area less than 1 square mile, and the average drainage area for the data set is 27.7 square miles (median is 9.6 square miles, maximum is 128 square miles). Because of this, the regional curve is not a reliable tool for verifying bankfull cross-sectional area or discharge for streams this size. To further verify bankfull field indicators, WEI developed a HEC-RAS model to route the estimated bankfull discharge (determined from regression relationships) through the UT1 existing conditions cross-sections. The modeled bankfull stage and the identified field indicators were within a few tenths of a foot. The largest deviation was found in XS 2 at the upstream project extent. This steep section is subject to supercritical flows and an upstream boundary is difficult to accurately define in the hydraulic model. These data were considered in combination with gage discharge and USGS regression equation determined bankfull flow. Model results and field-called bankfull elevations are presented in Table 8.

Table 8. HEC-RAS Bankfull Elevations
Lyle Creek Mitigation Site

Reach Name	Existing Cross-section	Discharge	HEC-RAS Bankfull Elevation	Field Called Bankfull Elevation
		cfs	ft	ft
Reach 1 – Upper	XS 2	14	766.71	767.26
Reach 1 – Lower	XS 4	15	762.18	762.29
	XS 7	15	760.63	760.94
Reach 2	XS 15	28	758.28	758.13

3.9 Vegetation Community Types Descriptions

Vegetation habitats within the project area are comprised of open pastures dominated by various graminoid species, in addition to adjacent planted hardwood species for tree farming. The project stream beds are dominated by herbaceous species including rice cutgrass (*Leersia oryzoides*) and pockets of cattail (*Typha latifolia*). The remaining riparian vegetation areas are of poor quality and are heavily maintained and devoid of any shrub or tree species. Typical farmed hardwood tree species include red maple (*Acer rubrum*), willow oak (*Quercus phellos*), water oak (*Quercus nigra*), laurel oak (*Quercus laurifolia*), American holly (*Ilex opaca*), and southern magnolia (*Magnolia grandiflora*).

Vegetation habitat adjacent to the proposed project easement includes Bottomland Hardwood Forests of moderate to good quality. Typical canopy tree species within these areas include red oak (*Quercus rubra*), white oak (*Quercus alba*), shagbark hickory (*Carya ovata*), tuliptree (*Liriodendron tulipifera*), and red maple. Sub-canopy and shrub species include sassafras (*Sassafras albidum*), red elm (*Ulmus rubra*), ironwood (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*), paw paw (*Asimina triloba*), red maple, sweetgum (*Liquidambar styraciflua*), and Chinese privet (*Ligustrum sinense*). Typical species within the herbaceous stratum include poison ivy (*Toxicodendron radicans*), Japanese honeysuckle (*Lonicera japonica*), Nepalese browntop (*Microstegium vimineum*), giant river cane (*Arundinaria gigantea*), dogfennel (*Eupatorium capillifolium*), and wingstem (*Verbesina alternifolia*).

Lyle Creek exhibits a very narrow, wooded stream bank zone across the north end of the property boundary. This sparse forested area is of moderate to poor quality and includes box elder (*Acer negundo*), persimmon (*Diospyros virginiana*), American sycamore (*Platanus occidentalis*), black cherry (*Prunus serotina*), black walnut (*Juglans nigra*), winged elm (*Ulmus alata*), tag alder (*Alnus serrulata*), sweetgum, willow oak, and red maple.

4.0 Reference Streams

Two (2) reference reach sites were evaluated and surveyed for the Lyle Creek Mitigation Site, the UT to Lyle Creek and the UT to Catawba River site. These reference streams were chosen because of their proximity to the project site (Figure 11) and similarities to the project streams including drainage area, valley slope, and landscape position. Dimensionless ratios were developed from these surveyed reference reaches and used to verify selected design parameters. The riparian vegetation communities observed at these sites were also used to develop the riparian planting plan.

In addition to conducting site searches, WEI also conducted a review of published reference reach sources and published NCEEP mitigation plans. Two additional sites surfaced that informed the Lyle Creek mitigation design. These sites include the UT to Lake Wheeler site presented in the Lowther review of geomorphic relationships for reference reaches throughout the North Carolina Piedmont (2008) and the Westbrook Lowgrounds site presented in the Environmental Bank and Exchange Neu-Con MBI (Westbrook) site (2002). Full watershed assessments and stream surveys were not performed by WEI for either the UT to Lake Wheeler or the Westbrook Lowgrounds site.

4.1 Watershed Characterization

The UT to Lyle Creek watershed is located approximately 3 miles upstream of the Lyle Creek project area, just north of Interstate 40 (Figure 11). At the downstream limits of this unnamed tributary, the drainage area is 160 acres (0.25 square miles). Topography within this area exhibits a distinct similarity to the Lyle Creek project conditions where the smaller tributary flows across the top of the floodplain of a much larger river. Land uses within this watershed are approximately 70% forested and 30% open pasture and active agriculture.

The UT to Catawba River watershed is located north of Interstate 40 and east of NC Highway 10 in the Catawba River Basin. At the downstream extent of this reference reach, where the stream joins the Catawba River, the drainage area is 1,024 acres (1.6 square miles). Topography within this area is similar to the Lyle Creek project area with moderately steep topography dropping into a low-slope floodplain of a larger drainage system. The land use within this watershed is predominately forested with small areas of active agricultural fields.

The UT to Lake Wheeler watershed is located in Wake County within the Neuse 01 basin and is reported to have approximately 52% forested, 37% developed, 9% active pasture, and 2% herbaceous cover with an overall 5.5% impervious cover. The drainage area is 0.40 square miles. UT to Lake Wheeler empties into a lake approximately one quarter mile downstream of the reference site (Lowther, 2008). This is similar to the Lyle Creek Mitigation site, which joins a portion of Lyle Creek that is backwatered from Lake Norman. The Westbrook Lowgrounds watershed is located on the Coastal Plain/Piedmont fall line and is described as predominately forested with some agriculture in the uplands. The drainage area is 0.9 square miles. This reach is similar to the Lyle Creek Mitigation site because of the low valley slope of 0.0027 ft/ft (Environmental Bank and Exchange, 2002).

4.2 Channel Classification

UT to Lyle Creek is a perennial stream located in the floodplain of Lyle Creek. Similar to the project reaches, the stream receives drainage from the adjacent wooded uplands (Figure 12). This stream is fully connected to the floodplain with a bank height ratio of 1.0 and an entrenchment ratio over 2.5. The width-to-depth ratio is 31.7 and the overall channel slope is approximately 0.4%. UT to Lyle Creek has a sinuosity of 1.7. In-stream habitat structures within this reach included short, shallow pools and small sections of tree roots. This channel classifies as a Rosgen C5 stream type (1994). UT to Lyle has a similar particle size distribution, including percent silt/clay, to UT1 to Lyle Creek Reach 1 as seen in Tables 6a and 9.

UT to Catawba River is a perennial stream that flows into the relatively flat Catawba River floodplain from the adjacent steep wooded valley, east of NC Highway 10 (Figure 13). The channel is well connected to the floodplain with an entrenchment ratio over 5.8 and a bank height ratio of 1.0. This reach exhibited a sinuosity of 1.3, well-established pools at the outside of channel bends, several well-developed riffles, and habitat features such as woody debris jams, fallen logs across the channel (log ‘sills’), and root mats along the banks. This stream classifies as a Rosgen E5 stream type.

UT to Lake Wheeler is a perennial, low slope (0.6%) stream that flows into a lake approximately one quarter mile downstream from the reference site and experiences backwater effects similar to the UTs to Lyle Creek (Figure 14). This stream is very well connected to its floodplain with an entrenchment ratio of 15.7. The stream exhibits a low bankfull width-to-depth ratio of 6.5 and a high sinuosity of 1.6. UT to Lake Wheeler has a d50 of 2.6 mm, which corresponds to very fine gravel. Despite the difference in bed material from this site to the project site, WEI included UT to Lake Wheeler in the reference reach review because of its excellent pattern including broad meanders. This stream classified as a Rosgen E4 stream type (Lowther, 2008).

Westbrook Lowlands is a perennial, very low slope (0.2%) stream (Figure 15). The stream flows through a very flat valley (0.0027 ft/ft) similar to the UT to Lyle Creek site. The stream is well connected to the floodplain with a bank height ratio of 1.0. The stream has a width-to-depth ratio of 12.0. Westbrook Lowlands is classified as a Rosgen E/C5 stream type (EBX, 2002).

Geomorphic conditions for all the reference sites are summarized below in Table 9.

Table 9. Summary of Reference Reach Geomorphic Parameters
Lyle Creek Stream Mitigation Project

	Notation	Units	UT to Lyle Creek		UT to Catawba River		UT to Lake Wheeler		Westbrook Lowlands	
			min	max	min	max	min	max	min	max
stream type			C5		E5		E4		E/C5	
drainage area	DA	sq mi	0.25		1.60		0.40		0.9	
Discharge										
Q- NC Rural Regional Curve	Q	cfs	33		119		N/A[3]		N/A[5]	
$Q_{2\text{-}yr}$ NFF regression	Q	cfs	51		188		N/A[3]		N/A[5]	
Q- USGS extrapolation (1.2-yr – 1.5-yr)	Q	cfs	18	30	85	125	N/A[3]		N/A[5]	
Q Manning's	Q_{bkf}	cfs	14		73		N/A[3]		N/A[5]	
Cross-Section Features										
bankfull cross-sectional area	A_{bkf}	SF	7.3		20.8		17.4		8.0	
average velocity during bankfull event	$v_{bkf} = Q_{bkf}/A_{bkf}$	fps	1.9		3.5		N/A[4]		N/A[5]	
width at bankfull	w_{bkf}	feet	15.2		13.8		10.6		9.7	
maximum depth at bankfull	d_{max}	feet	1.4		2.0		2.2		1.1	
mean depth at bankfull	d_{bkf}	feet	0.5		1.5		1.6		0.8	
bankfull width-to-depth ratio	w_{bkf}/d_{bkf}		31.7		9.1		6.5		12.0	
depth ratio	d_{max}/d_{bkf}		2.8		1.3		1.4		1.4	
low bank height			1.4		2.0		N/A[4]		1.1	
bank height ratio	BHR		1.0		1.0		N/A[4]		1.0	
floodprone area width	w_{fpa}	feet	38+		80+		N/A[4]		100+	
entrenchment ratio	ER		2.5+		5.8+		15.7		2.2+	
Valley and Channel Slope										
valley slope	S_{valley}	feet/ foot	0.0082		0.0060		0.0100		0.0027	
channel slope	$S_{channel}$	feet/ foot	0.0048		0.0046		0.0060		0.0022	
Run/Riffle Features										
run/riffle slope	S_{riffle}	feet/ foot	0.0055	0.0597	0.011	0.060	0.0430		N/A[5]	
run/riffle slope ratio	$S_{riffle}/S_{channel}$		1.1	12.4	2.5	13.3	7.2		N/A[5]	
Pool Features										
pool slope	S_{pool}	feet/ foot	0.0000	0.0013	0.0012	0.0030	0.000		0.0005	
pool slope ratio	$S_{pool}/S_{channel}$		0.0	0.3	0.3	0.7	0.0		0.2	
pool-to-pool spacing	$L_{p\text{-}p}$	feet	15	28	31	60	42		16	59
pool spacing ratio	$L_{p\text{-}p}/w_{bkf}$		1.0	1.8	2.8	5.4	4.0		1.6	6.1
maximum pool depth at bankfull	d_{pool}	feet	1.7		2.9		1.40		1.5	
pool depth ratio	d_{pool}/d_{bkf}		3.4		1.9		0.9		1.9	
pool width at bankfull	w_{pool}	feet	8.6		21.8		15.4		8.0	10.0
pool width ratio	w_{pool}/w_{bkf}		0.6		1.6		1.5		0.8	1.0
pool cross-sectional area at bankfull	A_{pool}	SF	6.9		24.5		20.6		N/A[5]	
pool area ratio	A_{pool}/A_{bkf}		0.9		1.2		1.2		N/A[5]	

	Notation	Units	UT to Lyle Creek		UT to Catawba River		UT to Lake Wheeler		Westbrook Lowlands	
			min	max	min	max	min	max	min	max
Pattern Features										
belt width	w_{blt}	feet	21		55		26	64	14	20
meander width ratio	w_{blt}/w_{bkf}		1.3		4.0		6.0	11.0	1.4	2.1
meander length	L_m	feet	39	44	65	107	40	191	50	
meander length ratio	L_m/w_{bkf}		2.6	2.9	4.7	7.8	3.8	18.0	5.2	
radius of curvature	R_c	feet	19	32	31	56	8	34	15	27
radius of curvature ratio	R_c/ w_{bkf}		1.3	2.1	2.2	4.1	0.8	3.2	1.5	2.8
sinuosity	K		1.7		1.3		1.6		1.2	
Sediment		d_{50}	Fine Sand		V. Coarse Sand		V. Fine Gravel		Coarse Sand	
Reach wide	d_{16}	mm	-		0.3		N/A[4]		N/A[5]	
	d_{35}	mm	0.1		0.4		N/A[4]		N/A[5]	
	d_{50}	mm	0.2		1.8		2.6		0.7	
	d_{84}	mm	0.5		12.8		N/A[4]		N/A[5]	
	d_{94}	mm	4.0		25.2		N/A[4]		N/A[5]	
	d_{99}	mm	8.0		90.0		N/A[4]		N/A[5]	
Percent composition from reach wide	Silt/Clay	%	32		4		N/A[4]		N/A[5]	
	Very Fine Sand	%	12		1		N/A[4]		N/A[5]	
	Fine Sand	%	14		10		N/A[4]		N/A[5]	
	Medium Sand	%	25		25		N/A[4]		N/A[5]	
	Coarse Sand	%	9		4		N/A[4]		N/A[5]	
	V. Coarse Sand	%	0		8		N/A[4]		N/A[5]	
	Very Fine Gravel	%	3		2		N/A[4]		N/A[5]	
	Fine Gravel	%	5		14		N/A[4]		N/A[5]	
	Medium Gravel	%	0		21		N/A[4]		N/A[5]	
	Coarse Gravel	%	0		9		N/A[4]		N/A[5]	
	V. Coarse Gravel	%	0		2		N/A[4]		N/A[5]	
	Small Cobble	%	0		1		N/A[4]		N/A[5]	
Pavement					X2	X3				
	d_{16}	mm	N/A[2]		1.4	0.4	N/A[4]		N/A[5]	
	d_{35}	mm	N/A[2]		4.7	4.0	N/A[4]		N/A[5]	
	d_{50}	mm	N/A[2]		6.7	5.9	N/A[4]		N/A[5]	
	d_{84}	mm	N/A[2]		11.0	11.0	N/A[4]		N/A[4]	
	d_{95}	mm	N/A[2]		14.8	14.8	N/A[4]		N/A[4]	
	d_{100}	mm	N/A[2]		22.6	32.0	N/A[4]		N/A[4]	
Sub-pavement	d_{16}	mm	N/A[2]		0.4	0.5	N/A[4]		N/A[4]	
	d_{35}	mm	N/A[2]		0.9	1.2	N/A[4]		N/A[4]	
	d_{50}	mm	N/A[2]		1.3	2.1	N/A[4]		N/A[4]	
	d_{84}	mm	N/A[2]		6.0	9.5	N/A[4]		N/A[4]	
	d_{94}	mm	N/A[2]		10.3	14.3	N/A[4]		N/A[4]	
	d_{99}	mm	N/A[2]		22.6	32.0	N/A[4]		N/A[4]	

N/A[1]: Pool cross-section not surveyed for this reach.

N/A[2]: Pavement and subpavement analysis not performed on this reach.

N/A[3]: Lowther reported a range of possible discharges from 46.8 to 108.9 cfs based on different Manning's 'n' estimation techniques (Lowther, 2008).

N/A[4]: Data not provided in reference reach report (Lowther, 2008).

N/A[5]: Data not provided in Neu-Con Umbrella Wetland and Stream Mitigation Bank Westbrook Lowgrounds Site Specific Mitigation Plan (Environmental Bank and Exchange, 2002).

4.3 Discharge

Regional curves relating bankfull discharge to drainage area for rural watersheds in the Piedmont region of North Carolina were used to estimate the bankfull discharge for each reference reach (Harman, et al., 1999). In addition, the U.S. Geological Survey (USGS) flood frequency equations for rural watersheds in the North Carolina Piedmont were used to estimate peak discharges for floods with a recurrence interval of two years (Weaver, et al., 2009). The two-year discharge provides a reasonable upper limit of bankfull discharge, but is generally larger than the discharge predicted by the appropriate regional curve. Due to this higher estimation, the 1.2- and 1.5-year recurrence interval flows were extrapolated as described in Section 3.4. Manning's equation was ultimately utilized to estimate the bankfull discharge for the reference reaches since the streams are stable and connected to their floodplains. As with the onsite project reaches, the discharges for the reference reaches were identified near the predicted USGS rural regression models, but lower than those predicted by the rural regional curve. Table 10 summarizes the results of the discharge analyses described in this section.

Table 10. Summary of Reference Reach Discharge Analysis
Lyle Creek Mitigation Site

	UT to Lyle Creek	UT to Catawba River
Drainage Area (mi^2)	0.25	1.60
Rural Piedmont Regional Curve (cfs)	32.7	119.3
Rural USGS 1.2-year Extrapolation (cfs)	18	85
Rural USGS 1.5-year Extrapolation (cfs)	30	125
Bankfull (Manning's) discharge (cfs)	14	73

4.4 Channel Morphology

UT to Lyle Creek is also located entirely within a mature forested area. This stream has sinuous pattern and is vertically and laterally stable. Riffle structures were primarily comprised of small woody debris jams with shallow, interspersed pools. These structures, in conjunction with the adjacent wetland system, create an excellent aquatic floodplain habitat.

The UT to Lyle Creek reference stream occupies a remarkably similar landscape position to UT1 to Lyle on the Lyle Creek mitigation site. As seen in Figure 12, UT to Lyle Creek reference flows out of the steep valley onto Lyle's floodplain and then turns to flow down valley parallel to Lyle for approximately 2,000 linear feet before joining Lyle. A levee was observed along the bank of Lyle Creek, similar to that seen on the project reach. The landscape positioning of UT to Lyle Creek (reference) within Lyle's floodplain suggests that UT1 to Lyle Creek's (project) landscape position may be close to the historic placement, prior to disturbance.

UT to Catawba River is located in a mature, forested area with 20-to 50-year-old forest growth. The stream exhibited vertical and horizontal stability, a sinuosity of 1.3, established pools in the outside of bends, aeration points in the form of both riffles and woody debris jams, and overall diverse habitat. Similar to UT to Lyle Creek, this stream demonstrates the placement of a small stream within the floodplain of a larger stream system.

Despite the difference in bed material, UT to Lake Wheeler is a valuable reference site due to its landscape position upstream of an impoundment and excellent pattern morphology including a high sinuosity of 1.6, broad meander widths ranging up to 11.0, radius of curvature ratios from 0.8 to 3.2 and meander lengths ranging from 3.8 to 18.0. WEI recognizes the influence of bed material on channel form, and therefore the UT to Lake Wheeler data was used to inform pattern parameters while more appropriate sites, such as UT to Lyle Creek, were weighted more heavily in the parameter selection process.

The Westbrook Lowgrounds site was included as a reference for single thread morphology in a very low sloped valley (0.27%). The radius of curvature ratio range of 1.5 to 2.8 and the meander width ratio range of 1.4 to 2.1 indicates that the Westbrook Lowlands has tight, sinuous pattern. The EBX 2002 report stated that the floodplain appeared relatively undisturbed with vegetation over 50 years old. The tight pattern may be influenced by the mature vegetation. This report also stated that the stream had shallow pools in meander bends and deeper pools below woody debris and around roots, which is ideal reference morphology for the onsite streams.

4.5 Channel Stability Assessment

UT to Lyle Creek and UT to Catawba River both exhibit excellent stream bed and bank stability. Stream banks are heavily supported by mature canopy tree roots and shrub species. An overall Bank Erosion Hazard Index for these reaches would be considered low with minimal sedimentation and low Near Bank Stress. The channel bed within UT to Catawba River is supported with stable riffle cross-sections and no aggradation or degradation is occurring within the pools. UT to Lyle Creek is a predominately sandy substrate system and shows no signs of vertical incision or bank erosion from high flow events.

4.6 Bankfull Verification

Bankfull stage was equal to the top of bank for UT to Lyle Creek and UT to Catawba River. Bankfull data for the project reaches were compared with the NC rural Piedmont regional curves. The surveyed cross-sectional areas for the reference reaches are shown overlaid with the NC rural regional curve in the attached Figure 9. Analysis of the bankfull cross-sectional areas for the reference reaches reveal plotting of the data just below the NC rural Piedmont regional curve data, indicating that bankfull stage was adequately selected throughout the reference reach sites.

4.7 Vegetation Community Types Description

Vegetation surrounding the two surveyed reference reaches includes mature Bottomland Hardwood Forests of good quality, which is typical habitat for forested Piedmont floodplains. Typical canopy tree species within these areas include American sycamore, red oak, water oak, shagbark hickory, tuliptree, sweetgum, and red maple. Sub-canopy and shrub species include red elm, ironwood, flowering dogwood, red maple, sweetgum, and a small amount of Chinese privet. Typical species within the herbaceous and vine stratum include poison ivy, green catbriar (*Smilax rotundifolia*), giant river cane, wingstem, and Christmas fern (*Polystichum acrostichoides*).

5.0 Project Site Wetlands – Existing Conditions and Model Development

5.1 Jurisdictional Wetlands

On February 26, 2010 and August 24, 2010, WEI delineated jurisdictional waters of the U.S. within the project easement area. Jurisdictional areas were delineated using the USACE Routine Onsite Determination Method. This method is defined by the 1987 Corps of Engineers Wetlands Delineation Manual and the Eastern Mountain and Piedmont Regional Supplement Guide. The results of the onsite jurisdictional determination indicate that there are 5 jurisdictional wetland areas (WL-1, WL-2, WL-3, WL-4, and WL-5) located within the floodplain of Lyle Creek within the project easement. These wetland areas are primarily the result of past ditching activities associated with the tree farming operation (Figure 6). These jurisdictional areas exhibited low chroma soils (2.5Y 4/1 and 10YR 4/2), many distinct mottles (7.5YR 4/6), strong inundation (1-12 inches) from groundwater sources, high water marks, water-stained leaves, and oxidized root channels. Dominant hydrophytic vegetation includes rice cutgrass (*Leersia oryzoides*), woolgrass (*Scirpus cyperinus*), smartweed (*Polygonum pensylvanicum*), soft stem rush (*Juncus effusus*), strawcolored flatsedge (*Cyperus strigosus*), and broadleaf cattail (*Typha latifolia*). Wetland Determination Data Forms representative of these jurisdictional wetland areas have been enclosed in Appendix 2 (DP1 – DP9).

Based on the nearby reference area, it was determined that portions of the project site, including these jurisdictional areas, historically functioned as a Bottomland Hardwood Forest prior to the site's conversion to a tree farm. An assessment of these wetlands was performed according to the recent North Carolina Wetland Assessment Method (NCWAM) in order to determine their level of hydrologic function, water quality, and habitat condition. Due to heavy tree-farming activities over the past several decades along with aggressive vegetation management, these wetland areas scored out as low functioning systems when compared to reference conditions. Particularly low scoring parameters include the effects from grading and ditching on decreased surface and subsurface hydrology. Additionally, vegetation management has reduced aquatic and terrestrial habitat along with eliminating the systems' connections to adjacent natural habitats. NCWAM Wetland Rating Sheets representative of these jurisdictional wetland areas are enclosed in Appendix 2 (WL-1 – WL-5).

5.2 Hydrological Characterization

In order to develop a wetland restoration and creation design for the Lyle Creek Site, an analysis of the existing and proposed conditions groundwater hydrology was necessary. DrainMod (version 6.0) was used to model existing and proposed groundwater hydrology at the site. DrainMod simulates water table depth over time and produces statistics describing long term water table characteristics and an annual water budget. DrainMod was selected for this application because it is a well documented modeling tool for assessing wetland hydrology (NCSU, 2010) and is commonly used in wetland creation/restoration projects. For more information on DrainMod and its application to high water table soils, see Skaggs (1980).

5.2.1 Groundwater Modeling

For the Lyle Creek Mitigation Site, three total models were developed and calibrated to represent the existing and proposed conditions at three different well locations across the site. Resulting model output was used to validate and refine the proposed grading plan for wetland restoration and creation onsite and to develop a water budget for the site. The modeling procedures are described below.

5.2.1.1 Data Collection

DrainMod models are built using site hydrology, soil, climate, and crop data. Prior to building the models, soil cores were taken to validate existing mapped soils across the site. Further explanation of the site soils can be found in Section 5.3 of this report. Appropriate soil input files for the models were obtained from North Carolina State University (NCSU) and were selected and modified by NCSU based on Natural Resources Conservation Service (NRCS) soils mapping. Rainfall and temperature data were obtained from nearby weather stations. Short term rainfall and temperature data for model calibration were obtained from station KNCCONOV4 from the Weather Underground website (http://www.wunderground.com/). This weather station was used for calibration because it was the only nearby station with available data extending through the 2010 groundwater monitoring period. Long term weather data were used for simulations of the proposed conditions. Rainfall data from nearby station 311579: Catawba 3 NNW – operated by the National Oceanic and Atmospheric Administration (NOAA) National Weather Service – were used for the proposed conditions models; however no temperature data were available for this station. The nearest long term temperature data were obtained from NOAA station 318292 in Statesville. The data sets for these stations were obtained from the North Carolina State Climate Office for August of 1975 (the first month of rainfall record) through November of 2010. Information to develop model inputs for crops previously grown on the site was obtained through interviews with the landowner.

5.2.1.2 Existing Conditions Base Model Set up and Calibration

Models were created to represent three monitoring well locations on the site at as shown on Figure 6. The models were developed using the conventional drainage water management option with contributing surface water runoff to best simulate the drainage of the site. Each of the three wells was installed in July 2010 and recorded groundwater depth twice per day with In-situ Level TROLL® 100 or 300 pressure transducers through early December 2010. This period during which the wells were active was used as the calibration period for the groundwater models.

The first step in developing the model was to prepare input files from various data sources. The soil input files obtained from NCSU, which have similar characteristics to the soils on the site, were used as a base soil input file for each model. The soil files were refined by adjusting the lateral saturated conductivity values for each of the mapped soils found onsite from published soil survey data (NRCS, 2010). Temperature and precipitation data from nearby weather stations, described above, were used to produce weather input files for each model.

Once the necessary input files were created, the project settings were adjusted for this application and then calibration runs were conducted. To calibrate the model, parameters not measured in the field were adjusted within the limits typically encountered under similar soil and geomorphic conditions until model simulation results closely matched observed well data. After calibration of each of the models was complete, the calibrated models were used as the basis for the proposed conditions models. Plots showing the calibration results are included in Appendix 2. Trends in the observed data are well-represented by the calibration simulations. Although hydrographs between plots of observed and simulated data do not match exactly, relative changes in water table hydrology as a result of precipitation events correspond well between observed data and model results.

5.2.1.3 Proposed Conditions Model Setup

The proposed conditions models were developed based on the calibrated existing conditions models to predict whether wetland criteria would be met over a long period of recorded climate data. Proposed plans for the site include grading portions of the site to lower elevations, removing multiple existing ditches that currently drain portions of the site, raising the bed of four existing channels so that they flood the wetlands more frequently, planting native wetland plants, and roughing the surface soil to increase surface water storage through disking. Proposed grading is shown in the plans. Areas proposed for wetland restoration credit will have less than 6 inches of excavation, except in isolated areas where berms and spoil piles will be removed. These proposed plans were developed to increase the wetland hydrology onsite and settings for the proposed conditions models were altered to reflect these changes to the site. Filling of the existing ditches on the site was simulated by increasing the surface storage for the nearby well rather than increasing ditch spacing. This method was used because most of the existing ditches to be filled are very shallow and do not likely contribute significantly to subsurface drainage. Surface storage values were also increased at all wells to account for proposed disking to the site. The drain depths were decreased to account for raising the elevations of the channel beds. Changes in the vegetation on the site were simulated by altering the rooting depth of plants on the site from relatively shallow for grasses and sedges to deeper values representative of hardwood tree species. Once the proposed conditions models were developed, each model was run for a 35-year period from October 1975 through October 2010.

5.2.1.4 Modeling Results and Conclusions

DrainMod was used to compare calibrated existing conditions models with proposed conditions scenarios to determine the effect of proposed practices onsite hydrology. Each well location was evaluated to establish how often annual wetland criteria would be met over the 35-year simulation period. The wetland criteria are that the water table must be within 12 inches of the ground surface at each well for a minimum of 7% of the growing season (April 7 through October 28). The modeling results show that Well 1 would meet that criteria 26 years out of the 35-year period following restoration activities. Well 2 would meet criteria 31 of the 35 years simulated and Well UW would meet criteria 29 of 35 years. Wells 1 and UW represent wetland restoration zones of the site and Well 2 is located in a creation zone.

5.2.2 Surface Water Modeling at Restoration Site

No surface water modeling was performed for the wetland design analysis.

5.2.3 Hydrologic Budget for Restoration Site

DrainMod computes daily water balance information and outputs summaries that describe the loss pathways for rainfall over the model simulation period. Tables 11a, 11b, and 11c summarize the average annual amount of rainfall, infiltration, drainage, runoff, and evapotranspiration estimated for the three modeled locations onsite. Infiltration represents the amount of water that percolates into the soil. Runoff is water that flows overland and reaches the drainage ditches before infiltration. Evapotranspiration is water that is lost by the direct evaporation of water from the soil or through the transpiration of plants. Drainage is the loss of infiltrated water that travels through the soil profile and is discharged to the drainage ditches or to underlying aquifers. The water balance results in Tables 11a, 11b, and 11c are similar for each well. From these results, it is clear that most rainfall on the existing site is lost via evapotranspiration and drainage rather than runoff. Once the project is complete, runoff will decrease and corresponding values of infiltration will increase. A smaller portion of the infiltrated water will leave through subsurface drainage, which will be slowed by the removal of some of the ditches and decrease in depth of others. Evapotranspiration will increase because trees planted on the site will consume more water than the grasses and sedges currently growing in the proposed wetland areas.

Table 11a. Water Balance for Well 1
Lyle Creek Mitigation Site

Hydrologic Parameter	Existing Conditions		Proposed Conditions	
	Average Annual Amount	Average Annual Amount	Average Annual Amount	Average Annual Amount
	(cm of water)	(% of rainfall)	(cm of water)	(% of rainfall)
Precipitation	109.17	100.0%	109.17	100.0%
Infiltration	103.93	95.2%	106.62	97.7%
Evapotranspiration	55.11	50.5%	70.16	64.3%
Drainage	50.78	46.5%	37.2	34.1%
Runoff	5.24	4.8%	2.49	2.3%

Table 11b. Water Balance for Well 2
Lyle Creek Mitigation Site

Hydrologic Parameter	Existing Conditions		Proposed Conditions	
	Average Annual Amount	Average Annual Amount	Average Annual Amount	Average Annual Amount
	(cm of water)	(% of rainfall)	(cm of water)	(% of rainfall)
Precipitation	109.17	100.0%	109.17	100.0%
Infiltration	103.93	95.2%	106.23	97.3%
Evapotranspiration	55.11	50.5%	68.81	63.0%
Drainage	50.78	46.5%	38.23	35.0%
Runoff	5.24	4.8%	2.87	2.6%

Table 11c. Water Balance for Well UW
Lyle Creek Mitigation Site

Hydrologic Parameter	Existing Conditions		Proposed Conditions	
	Average Annual Amount	Average Annual Amount	Average Annual Amount	Average Annual Amount
	(cm of water)	(% of rainfall)	(cm of water)	(% of rainfall)
Precipitation	109.17	100.0%	109.17	100.0%
Infiltration	104.31	95.5%	106.2	97.3%
Evapotranspiration	59.3	54.3%	70.5	64.6%
Drainage	47	43.1%	36.36	33.3%
Runoff	4.85	4.4%	2.9	2.7%

5.3 Soil Characterization

An investigation of the existing soils within the proposed wetland restoration/creation areas was performed by WEI staff on August 24, 2010. This investigation supplemented the soils analysis performed by a licensed soil scientist (LSS) on March 3, 2010, prior to the full delivery proposal. Soil cores were collected at locations across the site to provide data to refine NRCS soils mapping units, establish areas suitable for wetland restoration and creation, and aid in developing a wetland grading plan. 45 soil cores were taken at approximately 100- to 200-foot grid spacing across the site at varying depths. Additionally, 6 soil cores were taken by the licensed soil scientist in March. The cores were taken to a depth at which either hydric soil features or groundwater was encountered. Soil texture; Munsell chart hue, chroma, and value; and hydric soil characteristics were recorded for each core. The depth to hydric indicators and groundwater table was then measured at each core. Soil boring locations and mapped soil units are shown in Figures 6 and 7. The data for each core is also included in Appendix 2 along with the soil core profiles from the March investigation.

5.3.1 Taxonomic Classification

Two soils are mapped within the boundaries of the proposed wetland areas in the NRCS Soil Survey (NRCS, 2009). Much of the site is mapped as Chewacla loam (Cw) and Wehadkee fine sandy loam (Wd). The taxonomic class of Chewacla soils is fine-loamy, mixed, active, thermic Fluvaquentic Dystrudepts while the taxonomic class of Wehadkee soils is fine-loamy, mixed, active, nonacid, thermic Fluvaquentic Endoaquepts. Analysis of the soil core samples collected from the project site along with consideration of site topography indicated that the soils classified at the 51 core locations agreed with the mapped soil units. The Chewacla and Wehadkee soil types are both listed on the NC hydric soils list. These soil types are found in valleys, depressions, and floodplains, are frequently flooded, and are poor to somewhat poorly-drained.

5.3.2 Profile Description

The Chewacla series is described by the NRCS official series description as a Piedmont floodplain soil that is very deep, somewhat poorly-drained found on 0 to 2 percent slopes. The typical texture profile for Chewacla soil is a medium granular loam at 0 to 4 inches, a silty clay loam at 4 to 14 inches, a clay loam from 14 to 26 inches, and a loam from 26 to 38 inches. Low chroma iron depletions become common throughout the profile at depths below

4 inches. The Wehadkee series is similarly described as a Piedmont floodplain and lower valley soil that is also very deep and poorly-drained. The typical texture profile for Wehadkee soil is a low chroma fine sandy loam from 0 to 8 inches, a dark gray loam from 8 to 17 inches, and a sandy clay loam from 17 to 40 inches. A low chroma matrix of 1 and 2 is typical of this soil profile with higher chroma soft masses of iron exhibited at depths of 8 inches and deeper.

5.3.3 Hydraulic Conductivity

The Chewacla series has a moderately high to high Ksat value ranging from 0.57 to 1.98 in/hr. This soil is somewhat poorly-drained with water table depths ranging from 6 to 24 inches. The Wehadkee series has a similar moderately high to high Ksat value ranging from 0.57 to 1.98 in/hr. The drainage class for this soil is poorly-drained and typically exhibits water table depths of 0 to 12 inches.

5.4 Vegetation Community Type and Disturbance History

The existing wetlands are heavily ditched and maintained systems primarily comprised of various graminoid and low growth herbaceous species. Due to this heavy maintenance, a natural wetland classification can be difficult to assign, however these systems most nearly represent a Palustrine Emergent system (Cowardin, 1979). Based on historical aerial photographs, tree-farming and associated activities have been prevalent in this area since at least 1961 (Appendix 5). Dominant hydrophytic vegetation includes rice cutgrass (*Leersia oryzoides*), woolgrass (*Scirpus cyperinus*), smartweed (*Polygonum pennsylvanicum*), soft stem rush (*Juncus effusus*), strawcolored flatsedge (*Cyperus strigosus*), and pockets of broadleaf cattail (*Typha latifolia*).

6.0 Reference Wetlands

A reference wetland was identified immediately adjacent to the reference channel UT to Lyle Creek (Figure 12). The property is a good condition, mature Piedmont Bottomland Forest (Schafale & Weakley, 1990) and is located within the floodplain of Lyle Creek. Because this reference site is located within close proximity to the project area and is located within the Lyle Creek watershed, it provides the best reference information to use in restoring and creating wetlands on the project site. Exhibiting the same soil types and similar topographic form, this area may represent the original condition of the project site. The vegetation at the reference site will be used as a basis to develop the planting plan for the wetland restoration and creation on the project site. A groundwater monitoring gage has also been installed on the reference site to document the reference wetland hydrology. This information will be used during the design of the wetland restoration and creation and to provide a comparison for the restored and created wetland hydrology throughout the monitoring period.

6.1 Hydrological Characterization

The two-inch diameter reference groundwater monitoring gage was installed on November 11, 2010, and continually recorded groundwater levels through April 20, 2011 (time of data analysis). The reference site is a jurisdictional wetland and is therefore expected to meet the established wetland hydrology criteria for the project site: water table elevation within 12 inches of the soil surface for a continuous 7% of the growing season. The gage utilizes a LevelTroll™ pressure transducer to measure and record water table depth twice a day. Although the gage continues to record data, at the time this report, approximately five months of groundwater level data were available for review for the reference wetland of which 14 days were during the growing period. Analysis of the gage data collected shows that the portion of the reference site represented by the gage met wetland hydrology criteria for the 14 days of the growing period, April 7, 2011, through April 20, 2011. The 14-day period represents 7% of the growing season, which is the minimum number of consecutive days that the well must meet criteria to verify wetland hydrology. Therefore, the reference well has already met criteria for the year as of the end of April. These data confirm that the reference site has the appropriate hydrologic regime to serve as the reference condition. The reference gage as well as the groundwater monitoring gages on the project site will continue to record water table depth throughout the post-construction monitoring period. In the event of unusual weather during the post-construction monitoring period, the reference well performance will be used as a check for the mitigation site performance.

6.2 Soil Characterization

The soils on the reference site are mapped the same as those on the project site according to the NRCS soil mapping. The wetland areas of the property are predominately Chewacla series soils. The soils immediately adjacent to Lyle Creek, which include the natural levee features within this floodplain, are comprised of Buncombe loamy sand (Bn). The areas mapped as Buncombe soils are largely comprised of silt and deposition from large flooding events and are not likely to be jurisdictional; the areas mapped as Chewacla series will be the prime reference wetland.

6.2.1 Taxonomic Classification (including series)

The dominant soil on the reference wetland site is Chewacla loam which is listed on the NC hydric soils list. As described in Section 5.3.1, the taxonomic class of Chewacla loam is fine-loamy, mixed, active, thermic Fluvaquentic Dystrudepts.

6.2.2 Profile Description

A detailed profile description of the Chewacla series is described in Section 5.3.2.

6.3 Vegetative Community Type

Historical aerials reveal no recent disturbances to the reference property and no disturbances were observed in the field. The existing vegetation communities are typical of a Bottomland Hardwood Forest and include mature canopy tree species, moderate subcanopy and shrub species, as well as a somewhat sparse herbaceous layer. Dominant canopy species include willow oak, water oak, red oak, sweetgum, American sycamore, tuliptree, and red maple. Sub-canopy and shrub species include ironwood, red elm, red maple, sweetgum, and few small pockets of Chinese privet along perimeter upland areas. The herbaceous layer through the wetland is relatively sparse due to dense overhead canopy and sub-canopy species, however the reference wetland maintained small amounts of strawcolored flatsedge, soft stem rush, and green arrow arum (*Peltandra virginica*).

7.0 Project Site Mitigation Plan

7.1 Overarching Goals and Applications of Mitigation Plans

The intent of this Mitigation Plan is to present project information to achieve the following objectives:

- Outline the goals and objectives of the project.
- Link project specific goals to goals identified in watershed planning documents.
- Address how project goals and objectives address stressors identified in watershed characterization section of this mitigation plan (which includes those stressors identified in the watershed planning documents).
- Provide a pre-restoration baseline for comparing to future monitoring data and demonstrating achievement of goals and objectives.
- Articulate that the proposed design/approach is both proportional to the existing deficiencies and optimized to deliver a timely, cost effective project.
- Demonstrate that identified factors of influence both onsite and in the watershed (stressors) and observed deficiencies in the onsite streams converge, and justify the project design/approach.
- Provide information necessary to obtain regulatory permits for the project, including potential impacts to onsite waters.
- Document whether or not the project will result in a rise in flood elevations.

7.2 Mitigation Project Goals and Objectives

The major goals of the proposed stream mitigation project are to provide ecological and water quality enhancements to the Catawba River Basin while creating a functional riparian corridor at the site level, providing wetland habitat and ecological function, and restoring a Piedmont Bottomland Forest as described by Schafale and Weakley (1990). Monitored enhancements to water quality and ecological processes are outlined below, followed by expected project benefits which are associated with restoration, but will not be monitored as part of this project:

Monitored Project Goals

- Wetland areas will be disked to increase surface roughness and better capture rainfall which will improve connection with the water table for groundwater recharge. Adjacent streams will be stabilized and established with a floodplain elevation to promote hydrologic transfer between wetland and stream.
- A channel with riffle-pool sequences and some rock and wood structures will be created in the steeper project reaches and a channel with run-pool sequences and woody debris structures will be created in the low sloped project reaches for macroinvertebrate and fish habitat. Introduction of wood including brush toe, root wads, and woody 'riffles' along with native stream bank vegetation will substantially increase habitat value. Gravel areas will be added as appropriate to further diversify available habitats.
- Adjacent buffer areas will be restored by removing invasive vegetation and planting native vegetation. These areas will be allowed to receive more regular and inundating flows. Riparian wetland areas will be restored and enhanced to provide wetland habitat.

- Sediment input from eroding stream banks will be reduced by installing bioengineering and in-stream structures while creating a stable channel form using geomorphic design principles.

Expected Project Benefits

- Chemical fertilizer and pesticide levels will be decreased by filtering runoff from adjacent tree farm operations through restored native buffer zones and wetlands. Offsite nutrient input will be absorbed onsite by filtering flood flows through restored floodplain areas and wetlands, where flood flows can disperse through native vegetation and be captured in vernal pools. Increased surface water residency time will provide contact treatment time and groundwater recharge potential.
- Sediment from offsite sources will be captured during bankfull or greater flows by deposition on restored floodplain areas where native vegetation will slow overland flow velocities.
- Restored riffle/step-pool sequences on the upper reach of UT1a, where distinct points of re-aeration can occur, will allow for oxygen levels to be maintained in the perennial reaches. Small log steps on the upstream portion of UT1b and UT1 Reach 1 Upper will also provide re-aeration points.
- Creation of deep pool zones will lower temperature, helping to maintain dissolved oxygen concentrations. Pools will form below drops on the steeper project reaches and around areas of woody debris on the low-sloped project reaches. Establishment and maintenance of riparian buffers will create long-term shading of the channel flow to minimize thermal heating.

7.2.1 Designed Channel Classification

The design streams and wetlands will be restored to the appropriate type based on the surrounding landscape, climate, and natural vegetation communities but with also strong consideration to existing watershed conditions and trajectory. The specific proposed stream and wetland types are described below.

7.2.1.1 Designed Channel Classification

The stream restoration portion of this project includes seven reaches (Figure 17):

UT1 - Reach 1 Upper: UT1 from the southwestern corner of the project to the break in valley slope and beginning of RW2 (sta: 100+00 to 108+15, design length = 815 LF)

UT1 – Reach 1 Lower: UT1 from the upstream extent of RW2 to the confluence with UT1a and UT1b (sta: 108+15 to 132+69, design length = 2,454 LF, 118 LF of which is outside the easement for crossings)

UT1 – Reach 2: UT1 from the confluence with UT1a and UT1b to the confluence with Lyle Creek (sta: 132+69 to 141+50, design length = 881 LF, 82 LF of which is outside the easement for a crossing and the downstream connection to Lyle Creek)

UT1a – Upper: UT1a from the southern project limits to the break in valley slope and beginning of RW1 (sta: 300+00 to 302+01, design length = 201 LF))

UT1a – Lower: UT1a from upstream extent of RW1 to the beginning of anastomosed wetland complex in RW1 (sta: 302+01 to 306+15, design length = 414 LF)

UT1b: UT1b from southern project limits to the beginning of anastomosed wetland complex in RW1 (sta: 200+00 to 209+97, design length = 997 LF, 152 LF of which is outside the easement)

UT1c: UT1c from the outfall of a farm culvert to the confluence with UT1 (sta: 400+00 to 406+30, design length = 630 LF)

UT1d: UT1d from the outfall of a farm culvert on the western project limit to the confluence with UT1 (sta: 500+00 to 507+07, design length = 707 LF)

All stream reaches have been designed as the optimal stream type for their valley types and slopes. UT1 – Reach 1 Upper flows through a slightly steeper valley before entering the larger alluvial floodplain of Lyle Creek. This reach will be constructed as a Bc type stream according to Rosgen's classification system (1994). Bc stream types have dimensions and patterns similar to B stream types; however they have the lower slope of C stream types. UT1a – Upper flows through a steep valley before entering the Lyle Creek floodplain and will be constructed as a B type stream. B stream types are moderately entrenched, have low channel sinuosity and higher channel slopes, and have bedforms dominated by steep riffles and debris constrictions. Due to the high channel slope on this reach (2.8%) and low watershed sediment supply, these structures will be constructed as immobile grade control structures, mimicking geologic grade control. UT1 – Reach 1 Lower, UT1 – Reach 2, UT1a – Lower, and UT1b all flow through the larger alluvial floodplain of Lyle Creek and will be constructed as C type streams according to Rosgen's classification system. Type C streams are slightly entrenched, meandering streams with well developed floodplains and gentle gradients of 2% or less. UT1c will be enhanced by modifying the channel dimension. Alternate banks will be filled to create a narrower, more diverse channel. Logs and rock sills will also be installed to provide habitat diversity. By filling alternate banks, some pattern will be restored to this stream as well. UT1d will be enhanced in place by installing instream structures to raise the bed, reconnecting the stream with the left floodplain. A bankfull bench will be constructed on the right bank, and the buffer will be planted.

The morphologic design parameters for the design reaches fall within the ranges specified for Rosgen's B, Bc, and C stream types. The specific values for the design parameters were selected based on designer experience and judgment. Selected ratios were compared to the reference reaches to ensure they were within the range seen in similar, natural streams. Finally, existing conditions stream power was compared to design stream power. Each of the design restoration reaches will be reconnected with the existing floodplain (Priority 1) except along portions of the design reaches where excavation of a new floodplain at a lower level is necessary due to stream and floodplain grade transitions (Priority 2). In either case, the restored C channels will have entrenchment ratios of greater than 2.2.

7.2.1.2 Designed Wetland Type

The wetland elements of this project include the following (Figure 17):

RW1: This wetland component of the project is located in the eastern portion of the project area and is fed by the drainage areas of UT1a and UT1b. RW1 will encompass the lower floodplain area of these newly restored reaches and consists of 5.8 acres of wetland restoration and 1.1 acres of wetland creation. This wetland area will be restored to a Piedmont Bottomland Hardwood Forest (Schafale and Weakley, 1990).

RW2: This wetland component is located in the western portion of the project area and will receive the majority of its hydrology from the newly restored UT1 Reach 1 Lower. RW2 will include a small portion of the adjacent UT1 floodplain area and will consist of 0.8 acre of wetland restoration and 1.8 acres of wetland creation. As with RW1, RW2 will also be restored to a Piedmont Bottomland Hardwood Forest.

Vernal Pools and Pocket Wetlands: The restoration of the streams described above will include reconnecting the stream to the natural floodplain in some sections and creating a new lower floodplain for other sections. This will allow for some wetlands to be created or restored, including vernal pool features where portions of the existing channel will be filled to an elevation lower than that of the surrounding floodplain. Other pocket wetlands are likely to be created or enhanced simply by raising the existing stream beds to a degree that the floodplain will be frequently inundated. No mitigation credit will be claimed for either of these conditions. Communities planted in these zones will be appropriate for Piedmont Bottomland Hardwood Forests.

7.2.2 Target Buffer Communities

The target communities for the restored and created wetlands (including RW1, RW2, and the vernal pools and pocket wetlands) and riparian buffer zones will be based on reference conditions. The main reference site is a Piedmont Bottomland Hardwood Forest located upstream on Lyle Creek. Because most of the wetland restoration and creation areas as well as the riparian buffer will have hydrology similar to the Piedmont Bottomland Hardwood Forest, that community will be the primary target. Stream buffers will also be restored to a Piedmont Bottomland Hardwood Forest community as described in the natural plant community restoration plan in Section 7.4.

7.3 Stream Project and Design Justification

The existing conditions assessment of the onsite streams revealed incised streams that are periodically dredged and maintained. Dredging activities left the onsite streams overly wide with shallow flow. As a result, many of the onsite streams are unable to maintain channel form and have filled in with sediment, organic matter, and vegetation. In-stream bedform diversity is extremely poor and the longitudinal profile is dominated by shallow runs. The lack of bedform diversity combined with continued anthropogenic disturbance has resulted in degraded aquatic habitat, altered hydrology (related to loss of floodplain connection and lowered water table), and water quality concerns such as lower dissolved oxygen levels (due to shallow flow with few re-aeration points). Continued maintenance (mowing) has also prevented woody growth along the stream banks. A maintained, herbaceous riparian zone does not provide adequate shade to the channel, which can result in higher in-stream temperatures. Additionally, nutrients from fertilizer application on the adjacent farm may be able to runoff to the stream channel more quickly due to the lack of mature buffer vegetation. Direct sun exposure combined with high nutrient levels creates suitable conditions for algal blooms. Algal blooms can further deplete dissolved oxygen as algae die and decompose. In addition to direct water quality issues, these streams also contribute some sediment to Lyle Creek each year from their actively maintained banks.

Due to active maintenance, the onsite streams are not free-formed or self-maintaining. As discussed in detail in Section 3.6, the onsite reaches are currently in Simon's evolutionary *Stage II – Constructed*. The streams have been excavated so that they are incised and overly wide with shallow flow. Left alone, these streams would likely move into *Stage V- Aggradation and Widening* where the banks would erode and sediment bars would develop until a stable channel with a lower floodplain and base level formed (*Stage VI – Quasi-Equilibrium*). Due to the low observed sediment supply from these watersheds, the sediment accumulation necessary to reform a stable channel at a lower elevation may take a very long time.

The objectives described in Section 7.2 were partially developed to deal with the issues described in the paragraphs above. The key factors driving the need for this intervention are:

- Without intervention, lateral erosion and deposition cycles on all project reaches will occur until quasi-equilibrium is reached, resulting in downstream sedimentation.
- Treatment and storage of farm runoff is needed. The restored floodplain and created and restored wetland complex will help provide the necessary treatment.
- Restoration of aquatic habitat is needed. Restored bedform diversity will increase available habitats as well as nutrient retention in the stream.

Geomorphic design parameters for UT1 are detailed in Table 12a.

Table 12a. Design Geomorphic Data – UT1
Lyle Creek Mitigation Site

	Notation	Units	UT1 Reach 1 Upper		UT1 Reach 1 Lower		UT1 Reach 2	
			min	max	min	max	min	max
stream type			B5c		C6		C6	
drainage area	DA	sq mi	0.15		0.25		0.49	
bankfull design discharge	Q_{bkf}	cfs	14		15		28	
Cross-Section Features								
bankfull cross-sectional area	A_{bkf}	SF	4.6		12.4		11.5	
average bankfull velocity	$v_{bkf} = Q_{bkf}/A_{bkf}$	fps	3.0		1.2		2.4	
width at bankfull	w_{bkf}	ft	8.0		15.2		12.4	
max depth at bankfull	d_{max}	ft	1.0		1.2		1.4	
mean depth at bankfull	d_{bkf}	ft	0.6		0.8		0.9	
bankfull width-to-depth ratio	w_{bkf}/d_{bkf}		13.9		18.6		13.4	
depth ratio	d_{max}/d_{bkf}		1.7		1.5		1.5	
low bank height		ft	1.0		1.2		1.4	
bank height ratio	BHR		1.0		1.0		1.0	
floodprone area width	w_{fpa}	ft	17.6+		33.4+		27.3+	

	Notation	Units	UT1 Reach 1 Upper		UT1 Reach 1 Lower		UT1 Reach 2	
			min	max	min	max	min	max
entrenchment ratio	ER		2.2+		2.2+		2.2+	
Valley and Channel Slope								
valley slope	S_{valley}	ft/ft	0.0153		0.0017		0.0063	
channel slope	$S_{channel}$	ft/ft	0.0142		0.0013		0.0047	
Riffle/Run Features								
riffle/run slope	S_{riffle}	ft/ft	0.0167	0.0283	0.0025	0.0032	0.0079	0.0132
riffle/run slope ratio	$S_{riffle}/S_{channel}$		1.2	2.0	1.9	2.5	1.7	2.8
Pool Features								
pool slope	S_{pool}	ft/ft	0.0000	0.0000	0.0000	0.0003	0.0000	0.0005
pool slope ratio	$S_{pool}/S_{channel}$		0.0	0.0	0.0	0.1	0.0	0.11
pool-to-pool spacing	L_{p-p}	ft	14.0	41.0	55.6	114.2	62.2	96.1
pool spacing ratio	L_{p-p}/w_{bkf}		1.8	5.1	3.7	7.5	5.0	7.8
max pool depth at bankfull	d_{pool}	ft	1.2	1.8	1.6	2.4	1.8	2.7
pool depth ratio	d_{pool}/d_{bkf}		2.0	3.0	2.0	3.0	2.0	3.0
pool width at bankfull	w_{pool}	ft	11.0		17.1		17.0	
pool width ratio	w_{pool}/w_{bkf}		1.4		1.1		1.4	
Pattern Features								
belt width	w_{blt}	ft	N/A	N/A	35.9	78.3	40.8	65.2
meander width ratio	w_{blt}/w_{bkf}		N/A	N/A	2.4	5.2	3.3	5.3
meander length	L_m	ft	N/A	N/A	99.6	165.8	113.4	160.9
meander length ratio	L_m/w_{bkf}		N/A	N/A	6.6	10.9	9.1	13.0
radius of curvature	R_c	ft	N/A	N/A	27.4	47.6	27.4	34
radius of curvature ratio	R_c/w_{bkf}		N/A	N/A	1.8	3.1	2.2	2.7
sinuosity	K		1.1		1.3		1.3	
Note: Values presented in this table are rounded; however, ratios are calculated before rounding.								

Geomorphic design parameters for UT1a are detailed in Table 12b.

Table 12b. Design Geomorphic Data – UT1a
Lyle Creek Mitigation Site

	Notation	Units	UT1a 300+00 to 302+01		UT1a 302+01 to 306+15	
			min	max	min	max
stream type			B6		C6	
drainage area	DA	sq mi	0.05			
bankfull design discharge	Q_{bkf}	cfs	9			
Cross-Section Features						
bankfull cross-sectional area	A_{bkf}	SF	3.2			

	Notation	Units	UT1a 300+00 to 302+01		UT1a 302+01 to 306+15	
			min	**max**	**min**	**max**
average bankfull velocity	v_{bkf}	fps	2.8			
width at bankfull	w_{bkf}	ft	6.5			
max depth at bankfull	d_{max}	ft	0.75			
mean depth at bankfull	d_{bkf}	ft	0.5			
bankfull width-to-depth ratio	w_{bkf}/d_{bkf}		13.3			
depth ratio	d_{max}/d_{bkf}		1.5			
low bank height		ft	0.75			
bank height ratio	BHR		1.0			
floodprone area width	w_{fpa}	ft	14.3+			
entrenchment ratio	ER		2.2+			
Valley and Channel Slope						
valley slope	S_{valley}	ft/ft	0.0324		0.0115	
channel slope	$S_{channel}$	ft/ft	0.0284		0.0095	
Riffle/Run Features						
riffle/run slope	S_{riffle}	ft/ft	0.0350	0.0571	0.0156	0.0192
riffle/run slope ratio	$S_{riffle}/S_{channel}$		1.2	2.0	1.6	2.0
Pool Features						
pool slope	S_{pool}	ft/ft	0.0000	0.0000	0.0000	0.0004
pool slope ratio	$S_{pool}/S_{channel}$		0.0	0.0	0.0	0.04
pool-to-pool spacing	L_{p-p}	ft	13.0	30.0	31.4	52.1
pool spacing ratio	L_{p-p}/w_{bkf}		2.0	4.6	4.8	8.0
max pool depth at bankfull	d_{pool}	ft	1.25	1.45	1.05	1.45
pool depth ratio	d_{pool}/d_{bkf}		2.5	2.9	2.1	2.9
pool width at bankfull	w_{pool}	ft	9.2		9.2	
pool width ratio	w_{pool}/w_{bkf}		1.4		1.4	
Pattern Features						
belt width	w_{blt}	ft	N/A	N/A	25.4	34.8
meander width ratio	w_{blt}/w_{bkf}		N/A	N/A	3.9	5.4
meander length	L_m	ft	N/A	N/A	53.0	81.6
meander length ratio	L_m/w_{bkf}		N/A	N/A	8.2	12.6
radius of curvature	R_c	ft	N/A	N/A	13.9	19.9
radius of curvature ratio	R_c/w_{bkf}		N/A	N/A	2.1	3.1
sinuosity	K		1.1		1.2	
Note: Values presented in this table are rounded; however, ratios are calculated before rounding.						

Geomorphic design parameters for UT1b are detailed in Table 12c.

Table 12c. Design Geomorphic Data – UT1b
Lyle Creek Mitigation Site

	Notation	Units	UT1b 200+00 to 203+20		UT1b 203+20 to 207+18		UT1b 207+18 to 209+97	
			min	max	min	max	min	max
stream type			C6					
drainage area	DA	sq mi	0.13					
bankfull design discharge	Q_{bkf}	cfs	13					
Cross-Section Features								
bankfull cross-sectional area	A_{bkf}	SF	5.0					
average bankfull velocity	v_{bkf}	fps	2.6					
width at bankfull	w_{bkf}	ft	8.0					
max depth at bankfull	d_{max}	ft	1.0					
mean depth at bankfull	d_{bkf}	ft	0.6					
bankfull width-to-depth ratio	w_{bkf}/d_{bkf}		12.8					
depth ratio	d_{max}/d_{bkf}		1.6					
low bank height		ft	1.0					
bank height ratio	BHR		1.0					
floodprone area width	w_{fpa}	ft	11.0+					
entrenchment ratio	ER		2.2+					
Valley and Channel Slope								
valley slope	S_{valley}	ft/ft	0.0185		0.0105		0.0037	
channel slope	$S_{channel}$	ft/ft	0.0161		0.0086		0.0032	
Riffle Features								
riffle slope	S_{riffle}	ft/ft	0.0263	0.0309	0.0145	0.0218	0.0045	0.0079
riffle slope ratio	$S_{riffle}/S_{channel}$		1.6	1.9	1.7	2.5	1.4	2.5
Pool Features								
pool slope	S_{pool}	ft/ft	0.0000	0.0000	0.0000	0.0010	0.0005	0.0007
pool slope ratio	$S_{pool}/S_{channel}$		0.0	0.0	0.0	0.1	0.2	0.2
pool-to-pool spacing	L_{p-p}	ft	48.6	62.5	36.8	57.6	49.2	56.7
pool spacing ratio	L_{p-p}/w_{bkf}		6.1	7.8	4.6	7.2	6.2	7.1
max pool depth at bankfull	d_{pool}	ft	1.6	1.8	1.2	1.8	1.4	1.7
pool depth ratio	d_{pool}/d_{bkf}		2.7	3.0	2.0	3.0	2.3	2.8
pool width at bankfull	w_{pool}	ft	11.6					
pool width ratio	w_{pool}/w_{bkf}		1.5					
Pattern Features								
belt width	w_{blt}	ft	34.6	38.9	23.0	38.6	28.6	41.4
meander width ratio	w_{blt}/w_{bkf}		4.3	4.9	2.9	4.8	3.6	5.2
meander length	L_m	ft	83.3	105.7	78.1	86.3	79.1	90.3
meander length ratio	L_m/w_{bkf}		10.4	13.2	9.8	10.8	9.9	11.3
radius of curvature	R_c	ft	19.0	26.6	16.3	25.5	19.1	25.7
radius of curvature ratio	R_c/w_{bkf}		2.4	3.3	2.0	3.2	2.4	3.2

	Notation	Units	UT1b 200+00 to 203+20		UT1b 203+20 to 207+18		UT1b 207+18 to 209+97	
			min	max	min	max	min	max
sinuosity	K		1.1		1.2		1.2	
Note: Values presented in this table are rounded; however, ratios are calculated before rounding.								

As depicted in the grading plans, UT1a and UT1b are designed to discharge into an anastomosed wetland complex upstream of their confluence with UT1. Upon completion of the adjacent wetland restoration/creation, this area will most closely resemble a Valley Type XI (Rosgen, 1996) and WEI anticipates a stable DA stream type will naturally form through this area over time. Several stabilized low flow outlet points are designed along the right bank of UT1 to carry flow from this complex and protect against potential degradation at the outlets. Because a baseflow channel will not be defined through this area, this area is not proposed for stream mitigation credit.

7.3.1 Sediment Transport Analysis

Sediment transport analyses are performed to evaluate the stability of the proposed channel. Two separate questions should be addressed with sediment transport studies:

1) What size bed material particles will become entrained at flows at or near the bankfull discharge (competence) and
2) Does the stream have the ability to pass the sediment load supplied to it (capacity)?

7.3.1.1 Competence

Sediment competence is an extremely important analysis to perform for stream channels with larger sized particles (gravels, cobbles, and boulders); however, streams with predominately fine grained particles generally have enough competence to move the supplied sediment. Because some of the onsite reaches have very low slopes, WEI analyzed sediment competence despite the fine-grained nature of the onsite substrate to ensure that the stream could mobilize the particles.

One way to analyze sediment competence is to look at the dimensional shear stress of a channel. Dimensional shear stress (τ) is equal to the specific weight of water ($\gamma = 62.4$ lbs/ft^3) times the hydraulic radius of the bankfull channel (R (ft)) times the average water surface slope of the reach (S (ft/ft)):

$$\tau = \gamma * R * S$$

The Shield’s curve describes the critical shear stress required to mobilize particles of a particular size. Flume studies with homogenous bed particles were used to develop the original Shield’s curve. This curve has since been supplemented by others, including Dave Rosgen with the Colorado data from natural, heterogeneous bedded streams (Rosgen, 2006). The Colorado data suggests that natural, heterogeneous bedded rivers can move larger particles than homogeneous bedded flumes with the same amount of shear stress. Because of the relatively homogeneous sized sediment found in the onsite stream beds, WEI used the calculated shear stresses for the onsite channels with the more conservative Leopold, Wolman, and Miller 1964 Shield's relationship presented in the National Engineering Handbook to predict the largest mobile particle size during a bankfull event (USDA, 2007). This size was then compared to the largest particle size of the bulk samples to determine if the channel has enough shear stress to mobilize the sediment supplied by the watershed and observed in the channel.

Existing and proposed dimensional shear stresses for the project reaches are presented in Table 13a. In all cases, both the existing and the proposed stream channels are able to mobilize the largest particles sampled at the site; therefore, aggradation due to lack of competence is not a concern. Existing and proposed shear stresses are close in value for the entire length of UT1. There is no evidence of bed degradation in the existing channel. Because the design shear stress is nearly the same as the existing shear stress, degradation is not expected to be a concern. Grade control structures will be built along the reach to protect against degradation as a conservative measure of safety.

Table 13a. Summary of Existing and Proposed Dimensional Critical Shear Stress
Lyle Creek Mitigation Site

		Hydraulic Radius	**Channel Slope**	**Shear Stress**	**Largest Particle in Rep. Bulk Sample**	**Movable Particle Per Shield's Curve***
Reach		**R (ft)**	**S (ft/ft)**	**τ (lbs/ft^2)**	**d_{100} (mm)**	**(mm)**
UT1 Reach 1 Upper	**Existing**	0.65	0.0120	0.48	4	30
	Proposed	0.56	0.0142	0.49	4	30
UT1 Reach 1 Lower	**Existing**	0.93	0.0011	0.06	0.9	4
	Proposed	0.80	0.0013	0.07	0.9	5
UT1 Reach 2	**Existing**	1.05	0.0036	0.24	0.9	15
	Proposed	0.89	0.0047	0.26	0.9	16
UT1a 300+00 – 302+01 (Upper)	**Existing**	0.53	0.0106	0.35	0.9	20
	Proposed	0.47	0.0284	0.84	0.9	60
UT1a 302+01 – 306+15 (Lower)	**Existing**	0.53	0.0106	0.35	0.9	20
	Proposed	0.47	0.0095	0.28	0.9	17
UT1b 200+00 - 203+20 (Upper)	**Existing**	N/A	N/A	N/A	N/A	N/A
	Proposed	0.60	0.0161	0.60	0.9	38
UT1b 203+20 – 207+18 (Middle)	**Existing**	0.48	0.0020	0.06	0.9	4
	Proposed	0.60	0.0086	0.32	0.9	20
UT1b 207+18 – 209+97 (Lower)	**Existing**	0.48	0.0020	0.06	0.9	4
	Proposed	0.60	0.0032	0.12	0.9	7

*Drawn from best-fit line for Leopold, Wolman, and Miller 1964 data on Shield's curve (Figure 11-11) presented in the Rosgen Geomorphic Channel Design section of the National Engineering Handbook (USDA, 2007).

7.3.1.2 Capacity

Unit Stream Power

Sediment capacity can be looked at as unit stream power. Unit stream power (ω) is equal to shear stress (τ) times mean velocity (v_{bkf}):

$$\Omega = \tau * v_{bkf}$$

Bledsoe et al.'s 2002 study on sand bed stream equilibrium notes, "Specific stream power appears to be an excellent predictor of channel stability, with most streams attaining a relative stability at specific stream power less than 30 W/m^2" for the two-year recurrence interval storm. As discussed in Section 3.4, the two-year return interval is a reasonable upper limit for potential bankfull discharges, which suggests that 30 W/m^2 may also be an upper limit for stable bankfull sand bed channels. To verify, WEI calculated the stream powers for the two surveyed reference reach sites, which are stable streams with similar bed material, to get a range of stable stream powers for comparison to the project design reaches. Table 13b presents the results, which fall below the 30 W/m^2 value and range from 3.8 to 18.1 W/m^2. In addition, from the HEC-RAS hydraulic model developed for the site, stream power during the two-year event was noted to be in the range of 1.5 to 2 times the bankfull event stream power. This observation indicates that stream power can be expected to decrease with smaller, more frequent storm events and so the Bledsoe finding of stability at 30 W/m^2 during the two-year event may have a related lower stream power for lesser storm flow events.

Table 13b. Summary of Existing Dimensional Critical Shear Stress and Unit Stream Power Calculations – Reference Sites

Site	Cross Section	Hydraulic Radius	Channel Slope	Shear Stress	Average Bankfull Velocity	Stream Power
		R (ft)	S (ft/ft)	τ (lbs/ft^2)	V_{bkf} (ft/s)	ω (W/m^2)
UT to Lyle Creek Reference	**XS1**	0.45	0.0048	0.14	1.9	3.8
UT to Catawba River	**XS2**	1.2	0.0046	0.36	3.5	18.1

Table 13c shows the calculated bankfull shear stress and unit stream power values for the designed stream reaches.

Table 13c. Summary of Proposed Unit Stream Power Calculations – Project Reaches

	Bankfull Shear Stress	Average Bankfull Velocity	Stream Power
Reach	τ (lbs/ft^2)	V_{bkf} (ft/s)	ω (W/m^2)
UT1 Reach 1 Upper	0.49	3.0	21.9
UT1 Reach 1 Lower	0.07	1.2	1.2
UT1 Reach 2	0.26	2.4	9.3
UT1a 300+00 – 302+01 (Upper)	0.84	2.8	34.5

	Bankfull Shear Stress	Average Bankfull Velocity	Stream Power
Reach	τ (lbs/ft^2)	V_{bkf} (ft/s)	ω (W/m^2)
UT1a 302+01 – 306+15 (Lower)	0.28	2.8	11.6
UT1b 200+00 - 203+20 (Upper)	0.60	2.6	22.9
UT1b 203+20 – 207+18 (Middle)	0.32	2.6	12.2
UT1b 207+18 – 209+97 (Lower)	0.12	2.6	4.5

The proposed design stays under the 30 W/m^2 upper limit for all reaches except UT1a upper, which is the highest sloped reach on the project site (2.8%). This reach has been designed with many log steps to prevent against degradation. The proposed stream power on UT1 Reach 1 Lower is near but slightly below the stable stream power for the UT to Lyle Creek reference site. The existing conditions assessments and analysis do not indicate a high sediment supply to any of the onsite reaches, and sediment competency analysis indicates that the stream has the ability to move the sediment supplied. Despite this, the low gradient of both the existing and the proposed channel cause low stream power so the potential for sediment deposition over time may be a concern. Therefore, WEI designed a two-stage riffle/run cross-section with inner berms on both sides. The inner berms provide a place for sediment to accumulate over time while maintaining a low flow channel. As riffle/runs transition to meander pools, the inner berm feature will be maintained on the outside of the bends while the inner berm will taper into the point bar on the interior of the bends. The low flow channel is 1.2 SF in area and carries the baseflow. Low flow channel dimensions have been designed with the climax stream form in mind. As deposition occurs on the inner berm features and as vegetation establishes on the banks, UT1 Reach 1 Lower may narrow, which would result in a lower width-to-depth ratio. As floodplain and bank vegetation matures it will be able to withstand the more frequent floodplain interaction expected with a smaller cross-sectional area. Excavated ephemeral pools may also provide additional sediment storage during large storm events.

Sediment Transport Capacity from HEC-RAS Model

Using the HEC-RAS hydraulic model developed for the site, the sediment transport capacity computations using the Laursen (Copeland) or Yang equations are most applicable to the sediment and channel characteristics of the Lyle Creek site. A bankfull storm runoff hydrograph was developed in HMS using watershed characteristics resulting in a peak flow equal to bankfull design discharge at the upstream project extent. This representative hydrograph was routed through the RAS model to estimate the design reach's available capacity for sediment transport during a bankfull event.

A representative water year was selected from a nearby USGS gage station. Flows for this gage were transformed to the project site based on a ratio of drainage areas. The sum of flows provides a representation of the volume of water per year that is moving sediment through the watershed. The Reach 1 Upper watershed sediment supply is estimated at 7.4 tons per year, but this supply was reduced by 30% to account for sediment storage due to the railroad embankment and culverts upstream of the site. A sediment rating curve was developed from the range of flows in the watershed. The available capacity based on the design channel parameters in the RAS model exceeds the supply of sediment from the watershed. The channel will be protected from degradation with bank vegetation and in-stream log and rock structures.

7.3.2 HEC-RAS Floodplain Analysis

7.3.2.1 No-Rise in Regulated Floodplain

The project stream channels do not have an associated regulated floodplain; however, the project reaches and wetland areas are located within the floodway and flood fringe of Lyle Creek (Figure 8). Lyle Creek is a mapped Zone AE floodplain with an associated floodway. A detailed hydraulic study was originally performed by the Soil Conservation Service, but this model is no longer available in the local, state, or federal repositories. The most recent FIRM panel is a re-delineation of the original flood elevations. The site is located on Panels 3781 and 3782 of the Catawba County FIRM panels. The site is primarily under backwater effects from Lake Norman on the Catawba River. The project grading is being designed so that there is no net fill in the regulated floodplain of Lyle Creek. Earthwork calculations and grading plans will be submitted with a no-rise certification for the Town of Catawba floodplain administrator. The NC Emergency Management (NCEM) Floodplain Mapping Program Engineer has approved this approach for the Lyle Creek Mitigation Site. Appendix 6 contains the NCEEP Floodplain Requirements Checklist.

7.3.2.2 Hydrologic Trespass

HEC-RAS modeling is being performed as part of the design iterations and floodplain grading to ensure that flooding will not be worsened on adjacent farm fields or other upstream property owners.

7.4 Site Construction

7.4.1 Site Grading, Structure Installation and Other Project Related Construction

7.4.1.1 Narrative

For restoration components requiring new channel alignment, the channel will be constructed off-line and stabilized with seed, mulch, and matting prior to the introduction of water into the restoration reach. For restoration components requiring modification of the existing alignment, the channel will be dewatered as necessary to construct and stabilize the reach prior to reintroduction of water into the restoration reach. Through the duration of construction, the site will be protected with erosion and sedimentation control measures, consistent with the requirements of the NC Sedimentation and Pollution Control Act of 1973, as regulated by the NCDENR Division of Land Resources Land Quality Section.

7.4.1.2 Scaled Schematic of Grading

The proposed grading is included in the 60% plan set. The Priority 2 floodplain bench on UT1 Reach 1 Upper, UT1 Reach 2, and UT1b will be excavated below existing grade. These reaches are transitional zones to/from Priority 1 restoration reaches. The project as a whole has been designed so that no net fill will be placed within the larger floodplain of Lyle Creek. The remainder of the project streams will be constructed as a Priority 1 restoration. Wetland grading along the restoration reaches will be performed concurrently with channel construction. Wetland areas will be disked as preparation for planting, and furrows will not exceed 6 to 9 inches in depth.

7.4.1.3 In-Stream Structures and Other Construction Elements

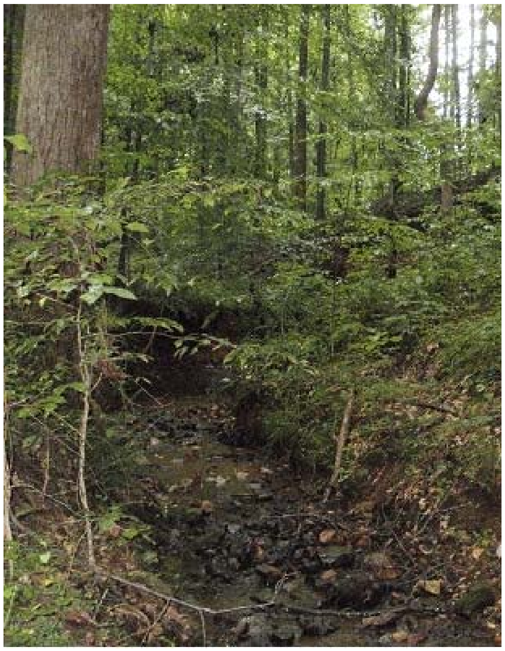
Naturally formed log step (background) and wood debris sill (foreground) at UT to Lyle Reference Site

The in-stream structures proposed on the Lyle Creek project are designed to mimic natural habitat features found in mature streams, particularly on the reference sites after which the project streams were designed. Habitat features observed on reference sites included log steps, root mats, undercut banks, debris jams, and riffles dominated by woody material. In an effort to mimic these structures, log, brush, and rock sills, constructed riffles, and brush toe are proposed on the Lyle Creek site. Log vanes will be used in select locations on UT1 to help turn water and protect the bank while vegetation establishes. Rock and log cross vanes are also proposed in select locations to protect against bed degradation. There are no mature trees to be removed within the construction area; therefore, trees may be selectively harvested from the adjacent hillside outside of the easement area to use in the stream system.

The addition of wood provides habitat and cover for fish and macroinvertebrates, in addition to adding a carbon source to the stream system. Structures, including brush toe, will increase the channel roughness and provide areas for leaf packs to catch and form over time. These leaf packs provide habitat for shredders and scrapers, important feeders in the continuum of the ecological community. WEI anticipates that the structures will provide an initial ecological uplift to the newly constructed stream channel.

Log step at UT to Catawba River

WEI noted colluvial cobble riffles upstream of the project reach on UT1 (see Section 2.4). The substrate does not reach the project site because of the railroad embankment/culverts and the farm culverts; however, some of the smaller gravels would naturally occur on steeper reaches of the project were these man-made obstructions not in place. To provide this habitat, some rock riffles will be built in the upstream reaches of the project to recreate the habitat. Because upstream supply is limited, these structures will be sized appropriately so they remain in place as grade control. These structures will mimic geologic grade control.



Colluvial riffle, UT1 upstream of railroad culvert

Other construction elements on the UT to Lyle Creek Mitigation Site include three culvert crossings to be installed on UT1 at easement breaks. Additionally, irrigation lines that currently run through the conservation easement will be relocated outside of the easement boundaries. Several planted ornamental trees are currently within the conservation easement, and these will also be relocated prior to earth moving activities in these areas.

7.4.2 Natural Plant Community Restoration

7.4.2.1 Narrative of Plant Community Restoration

As a final stage of construction, riparian stream buffers will be planted and restored to the dominant natural plant community that exists in the floodplain of Lyle Creek. This natural community within and adjacent to the project easement is classified as Piedmont Bottomland Forest and was determined based on existing canopy and herbaceous species (Schafale and Weakley, 1990). Proposed plant and seed materials will be placed on stream banks and bench areas as well as from the tops of banks out to the projects easement limits. These areas will be planted with bare root trees and live stakes. A permanent seed mixture of native herbaceous and grass species will be applied to all disturbed areas within the project easement. Temporary seed will be applied at the same time as the permanent seed as a nurse crop. The temporary seed will germinate quickly to stabilize the soil and provide shade while the permanent seed germinates. Proposed herbaceous species are shown in Table 14.

Table 14. Permanent Herbaceous Seed Mixture
Lyle Creek Mitigation Site

Scientific Name	Common Name
Permanent Seeding	
Elymus virginicus	Virginia wild rye
Panicum virgatum	Switchgrass
Agrostis stolonifera	Creeping bentgrass
Rudbeckia hirta NC ecotype	Black-eyed susan

Scientific Name	Common Name
Coreopsis lanceolata	Coreopsis
Panicum clandestinum	Deer tongue
Andropogon gerardii	Big bluestem
Juncus effusus	Soft rush
Echinochloa muricata	Awned barnyard grass
Schizachyrium scoparium	Little bluestem
Sorghastrum nutans	Indian grass
Tripsacum dactyloides	Gamma
Temporary Seeding	
Lolium multiflorum	Rye Grain (Nov 1 – Apr 30)
Panicum ramosum	Browntop Millet (May 1 – Oct 31)

Individual tree and shrub species will be planted throughout the project easement including stream banks, benches, tops of banks, floodplain, and wetland zones. These species will be planted as bare roots and live stakes and will provide additional stabilization to the outside of constructed meander bends and side slopes. Bare roots will be planted to achieve the year three targeted density of 320 woody stems per acre. Live stakes will be planted at 3 to 5 feet on center on most channel banks throughout the project, and will be planted at 2 to 3 feet on center on select meander bends on UT1a and UT1b. Proposed tree and shrub species, shown in Table 15, are representative of Lyle Creek's floodplain vegetation communities and are typical of Piedmont Bottomland Forest.

Table 15. Riparian and Wetland Woody Vegetation
Lyle Creek Mitigation Site

Scientific Name	Common Name
Stream Bank Live Stakes	
Cornus amomum	Silky Dogwood
Sambucus canadensis	Elderberry
Salix sericea	Silky Willow
Riparian and Wetland Bare Roots	
Plantanus occidentalis	Sycamore
Nyssa sylvatica	Blackgum
Diospyros virginiana	Persimmon
*Quercus michauxii**	Swamp Chestnut Oak*
Fraxinus pennsylvanica	Green Ash
Quercus phellos	Willow Oak
Liriodendron tulipfera	Tulip Poplar
Carpinus caroliniana	Ironwood
Alnus serrulata	Tag Alder
Celtis laevigata	Sugarberry
Betula nigra	River Birch
Acer negundo	Box Elder
*Species may be substituted with *Quercus bicolor*, Swamp White Oak, if *Quercus michauxii* is not available.	

7.4.2.2 Narrative of Invasive Species Management

During the onsite field investigation, few occurrences of invasive species were identified throughout the project reaches. Kudzu (*Pueraria montana var. lobata*) was observed along UT1a just upstream of the project easement and cattails (*Typha latifolia*) were observed sporadically along streams throughout the site. Kudzu is an aggressive trailing semi-woody perennial vine that was originally planted in the 1930's for soil erosion control. Kudzu grows quickly in a wide range of conditions and can choke out competing vegetation in sunny areas. Cattails are a native species; however they can dominate in recently disturbed, wet environments and can threaten the viability of planted wetland seeds. Herbicide will be applied to both kudzu and cattails during the growing season of 2011, and mechanical extraction of kudzu and cattails within the project area will be performed in tandem with stream restoration activities. Much of the existing channel areas dominated by cattails will be abandoned and backfilled after new channels are constructed, thus burying the seed supply of cattail plants. Long term management of these species with herbicide should be applied prior to the fruiting season of adjacent native shrubs and trees to avoid damage.

8.0 Monitoring Plan

A baseline monitoring plan report and an as-built record drawing of the project documenting the stream and wetland restoration, enhancement, and creation will be developed within 60 days of the planting completion and monitoring installation on the restored site. Monitoring reports will be prepared in the fall of each year of monitoring and submitted to NCEEP. These reports will be based on the NCEEP Monitoring Report Template (version 1.3, 1/15/2010). The monitoring period will extend five years beyond completion of construction or until performance criteria have been met. Monitoring for wetland vegetation will extend seven years beyond completion of construction.

8.1 Streams

8.1.1 Dimension

In order to monitor the channel dimension, a total of 10 permanent cross-sections will be installed along the UT to Lyle Creek; 6 on UT1, 2 on UT1a, and 2 on UT1b. Cross-sections will be located at representative riffle/run and pool sections on each monitored reach. Each cross-section will be permanently marked with pins to establish its location. Cross-section surveys will be performed annually and will include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.

8.1.2 Pattern and Profile

A longitudinal profile will be completed for the 4,460 LF of the restoration reaches (3,000 LF on UT1, and 615 LF on UT1a, and 845 LF on UT1b) on the Lyle Creek Mitigation Site immediately post-construction and annually throughout the five year monitoring period. The initial as-built survey will be used for baseline comparisons. Measurements in the survey will include thalweg, water surface, bankfull, and top of low bank. These profile measurements will be taken at the head of each riffle, run, pool, and glide, as well as at the maximum pool depth. The survey will be tied to a permanent benchmark and NC State Plane coordinates.

8.1.3 Photo Documentation

Approximately 40 permanent photographs will be established within the project stream and wetland areas after construction. Photographs will be taken once a year to visually document stability for five years following construction. Permanent markers will be established so that the same locations and view directions on the site are monitored each year. Photographs will be used to monitor restoration, enhancement, and creation stream and wetland areas as well as vegetation plots. The photographer will make every effort to maintain the same area in each photo over time. Reference photos will also be taken for each of the vegetation plots and cross-sections. The representative digital photo(s) will be taken on the same day the surveys are conducted.

8.1.4 Substrate

Because the streams through the project site are dominated by sand and silt-size particles, pebble count and/or bulk sampling procedures would not show a significant change in bed material size or distribution over the monitoring period; therefore, bed material analyses will not be conducted for this project. Channel substrate distribution will not be a component of project success criteria.

8.1.5 Bankfull Events

Bankfull events will be documented using a crest gage, photographs, and visual assessments such as debris lines. Three crest gages will be installed; one on UT1, one on UT1a, and the other gage on UT1b. The crest gages will be installed onsite in a riffle cross-section floodplain of the restored channels at a central site location. The gages will be checked at each site visit to determine if a bankfull event has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition.

8.2 Vegetation

A total of 35 vegetation monitoring plots will be installed and evaluated within the restoration, enhancement, and creation areas to measure the survival of the planted trees. The number of monitoring quadrants required is based on the NCEEP monitoring guidance documents (version 2.0, 10/14/10). The size of individual quadrants will be 100 square meters for woody tree species and shrubs. Vegetation assessments will be conducted following the Carolina Vegetation Survey (CVS) Level 2 Protocol for Recording Vegetation (Lee et al., 2008).

The initial baseline survey will be conducted within 21 days from completion of site planting and used for subsequent monitoring year comparisons. The first annual vegetation monitoring activities will commence at the end of the first growing season, during the month of September. The restoration and enhancement sites will then be evaluated each subsequent year between June 1 and September 31. Species composition, density, and survival rates will be evaluated on an annual basis by plot and for the entire site. Individual plot data will be provided and will include diameter, height, density, vigor, damage (if any), and survival. Planted woody stems will be marked annually as needed and given a coordinate, based off of a known origin, so they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living planted stems and the current year's living planted stems.

8.3 Wetlands

Groundwater monitoring gages will be established throughout the wetland restoration, enhancement, and creation areas. Generally, the gages will be installed at appropriate locations so that the data collected will provide an indication of groundwater levels throughout the wetland project area.

9.0 Performance Criteria

The stream restoration success criteria for the project site will follow approved performance criteria presented in the NCEEP Mitigation Plan Template (version 1.0, 11/20/2009) and the Stream Mitigation Guidelines issued in April 2003 by the USACE and NCDWQ. Annual monitoring and quarterly site visits will be conducted to assess the condition of the finished project for five years, or until success criteria are met. The stream restoration reaches (UT1, UT1a, and UT1b) of the project will be assigned specific performance criteria components for stream morphology, hydrology, and vegetation. The enhancement reaches (UT1c and UT1d) will be documented through photographs and visual assessments to verify that no significant degradational changes are occurring in the stream channel or riparian corridor. The wetland restoration and creation sections will be assigned specific performance criteria for hydrology and vegetation. These success criteria are covered in detail as follows.

9.1 Streams

9.1.1 Dimension

Riffle/run cross-sections on the restoration reaches should remain relatively stable; however, due to the sand/silt nature of the substrate throughout the project reaches, fluctuations of the riffle/run bed elevation over time are expected plus or minus 6 inches. These fluctuations should be temporary and will likely correspond to storm events. Riffle/run cross-sectional ratios (width-to-depth, depth ratio, and bank height ratio) should fall within the parameters defined for channels of the appropriate Rosgen stream type. If persistent changes are observed, these changes will be evaluated to assess whether the stream channel is showing signs of long term instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Changes in the channel that indicate a movement toward stability or enhanced habitat include a decrease in the width-to-depth ratio in meandering channels or an increase in pool depth. Remedial action would not be taken if channel changes indicate a movement toward stability.

9.1.2 Pattern and Profile

Longitudinal profile data for the stream restoration reaches should show that the bedform features remain relatively stable however they may fluctuate some due to the fine nature of sediments from the watershed. The riffles/runs should be steeper and shallower than the pools. Pools in meander bends are expected to be deeper than riffles however the bed elevation may fluctuate up or down over time depending on the amount of sand contributed from the watershed. Deeper pools will likely develop in areas with woody debris or below step structures. Adjustments in length and slope of run and glide features are expected and will not be considered a sign of instability. The longitudinal profile should show that the bank height ratio remains very near to 1.0 for the majority of the restoration reaches.

9.1.3 Photo Documentation

Photographs should illustrate the site's vegetation and morphological stability on an annual basis. Cross-section photos should demonstrate no excessive erosion or degradation of the banks. Longitudinal photos should indicate the absence of vertical incision or bank erosion. Grade control structures should remain stable. Deposition of sediment on the bank side of vane arms is preferable. Maintenance of scour pools on the channel side of vane arms is expected. Reference photos will also be taken for each of the vegetation plots.

9.1.4 Bankfull Events

Two bankfull flow events in separate years must be documented on the project within the five-year monitoring period. Bankfull events will be documented using a crest gage, photographs, and visual assessments such as debris lines.

9.2 Vegetation

The final vegetative success criteria will be the survival of 260 planted stems per acre in the riparian corridor along restored and enhanced reaches at the end of year five monitoring, and 200 planted stems per acre within the wetland restoration and creation areas at the end of year seven monitoring. The interim measure of vegetative success for the entire site will be the survival of at least 320 planted stems per acre at the end of the third monitoring year. The extent of invasive species coverage will also be monitored and controlled as necessary throughout the five-year monitoring period for streams and seven-year monitoring period for wetlands.

9.3 Wetlands

The final performance criteria for wetland hydrology will be a free groundwater surface within 12 inches of the ground surface for 7 percent of the growing season, which is measured on consecutive days under typical precipitation conditions. This success criteria was determined through model simulations of post restoration conditions and comparison to an immediately adjacent existing wetland system. If a particular well does not meet this criteria for a given monitoring year, rainfall patterns will be analyzed and the hydrograph will be compared to that of the reference well to assess whether atypical weather conditions occurred during the monitoring period.

10.0 Site Protection and Adaptive Management Strategy

The Lyle Creek Mitigation Site is located on one parcel owned by the Garmon Family. A Conservation Easement held by the State of North Carolina has been recorded with the Catawba County Register of Deeds on the 26.62-acre Lyle Creek project study area within the Garmon parcel. The conservation easement allows the restoration work to occur and protects the project area in perpetuity. Signage and demarcation will be placed along the easement per current NCEEP guidance at the time the proposal was submitted.

Upon completion of site construction, WEI shall monitor the project in keeping with the monitoring plan. Post-construction monitoring activities will be conducted to evaluate site performance, to identify maintenance and/or repair concerns, and to maintain the integrity of the project boundaries. If during the post-construction monitoring period it is determined project compliance is jeopardized, WEI shall take the necessary action to resolve the project concerns and bring the project back into compliance. At the conclusion of the post-construction monitoring period, the project shall be presented to the regulatory authority for project acceptance and close-out. Upon close-out, the project shall be transferred to the NCDENR Division of Natural Resource Planning and Conservation and Stewardship Program for long-term management and stewardship.

11.0 Financial Assurances

Pursuant to Section IV H and Appendix III of the Ecosystem Enhancement Program's In-Lieu Fee Instrument dated July 28, 2010, the NCDENR has provided the USACE-Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by NCEEP. This commitment provides financial assurance for all mitigation projects implemented by the program.

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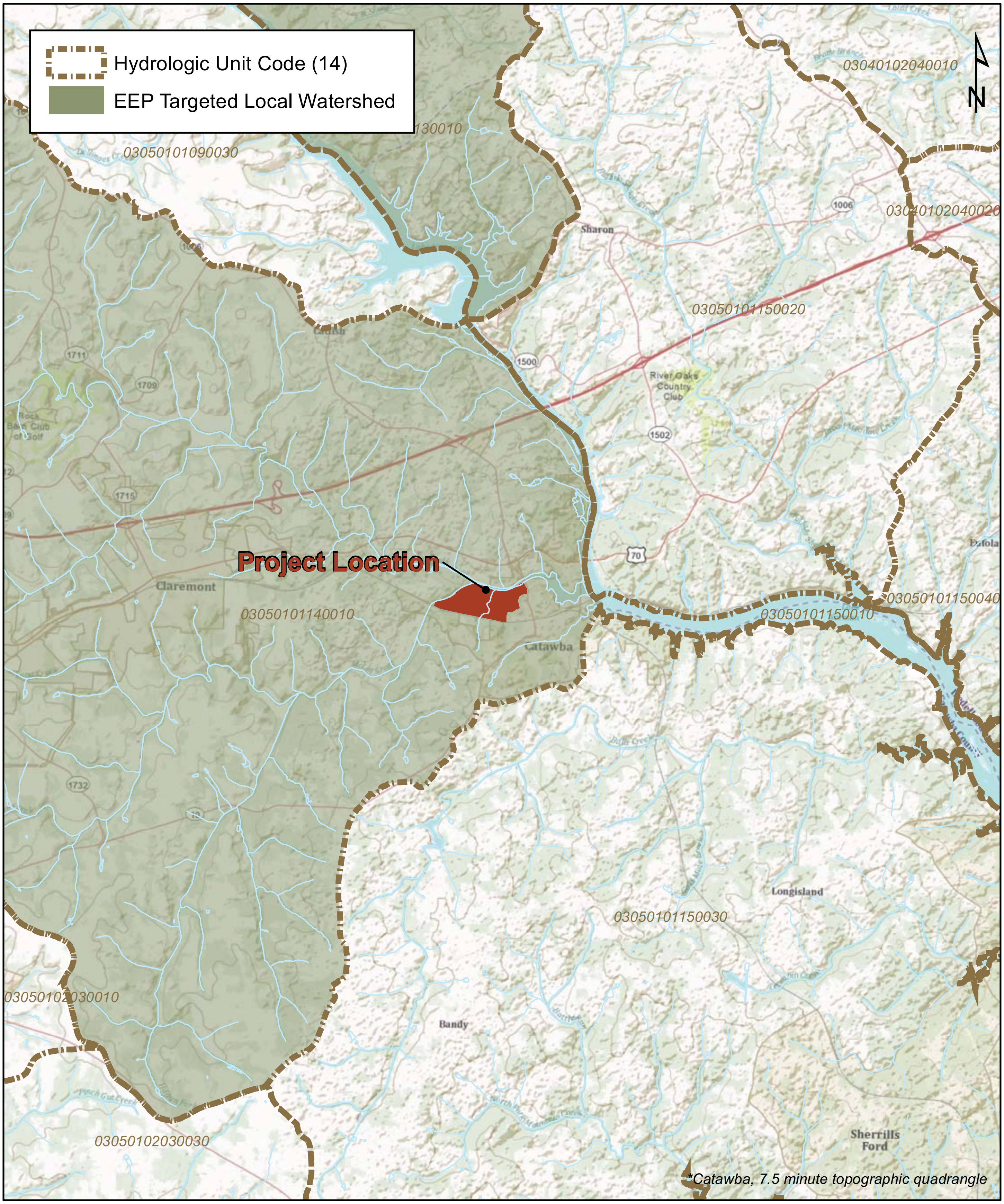


WILDLANDS ENGINEERING

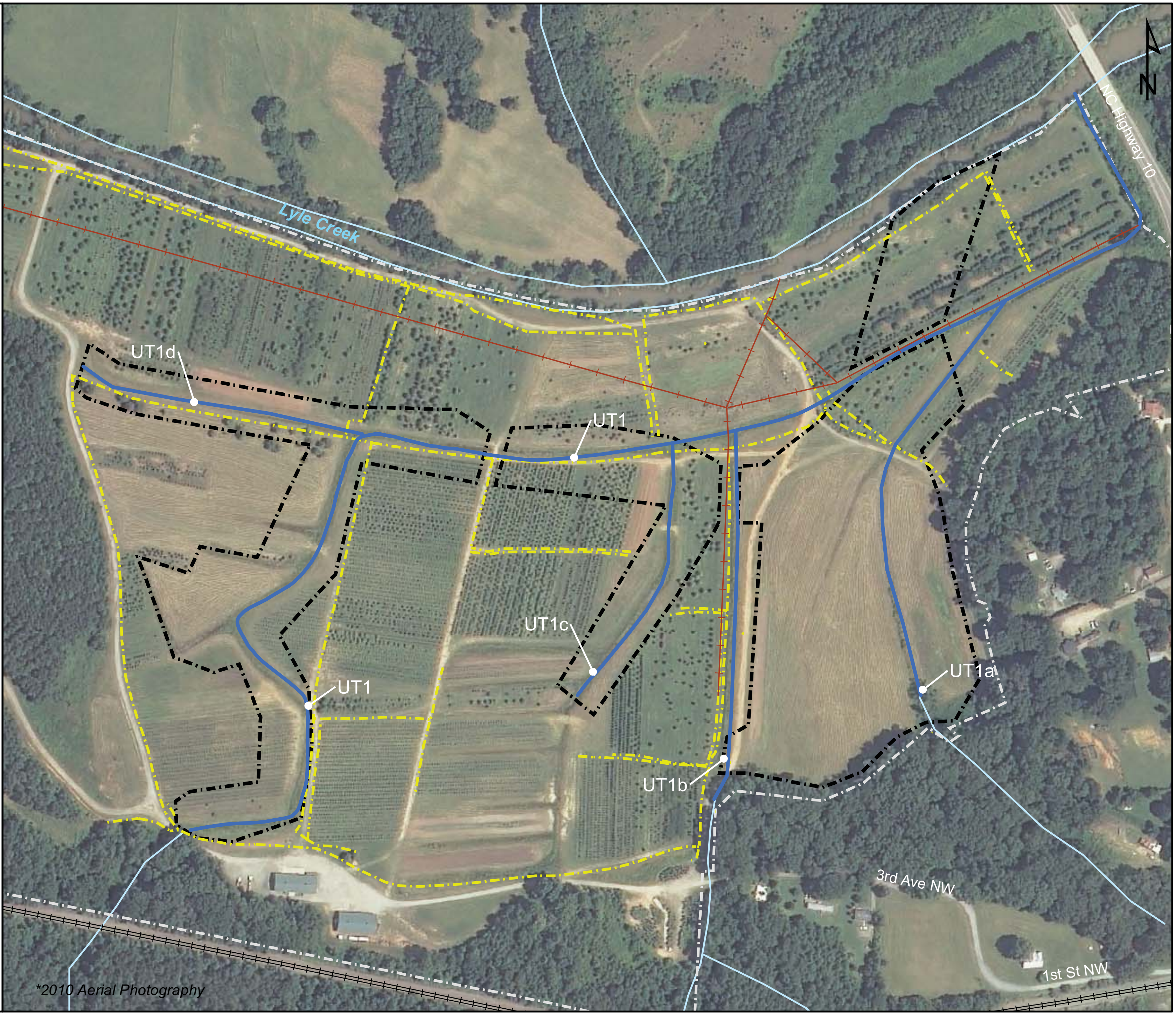
0 0.75 1.5 Miles

Figure 1 Vicinity Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC

Figure 2
Site Map
Lyle Creek
Mitigation Site
Catawba River Basin
(03050101)

Catawba County, NC



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ENGINEERING

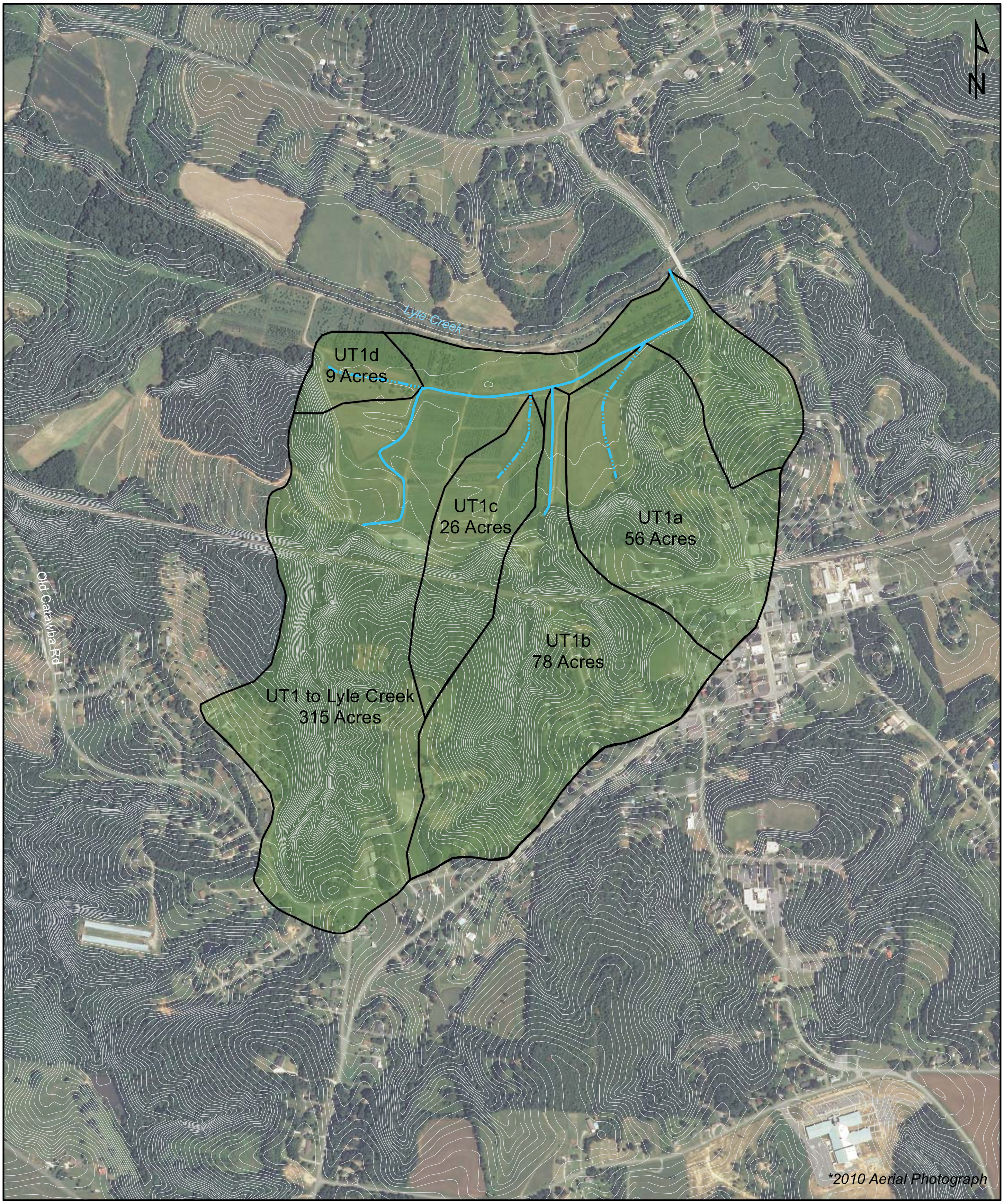

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Figure 3 Aerial Watershed Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC

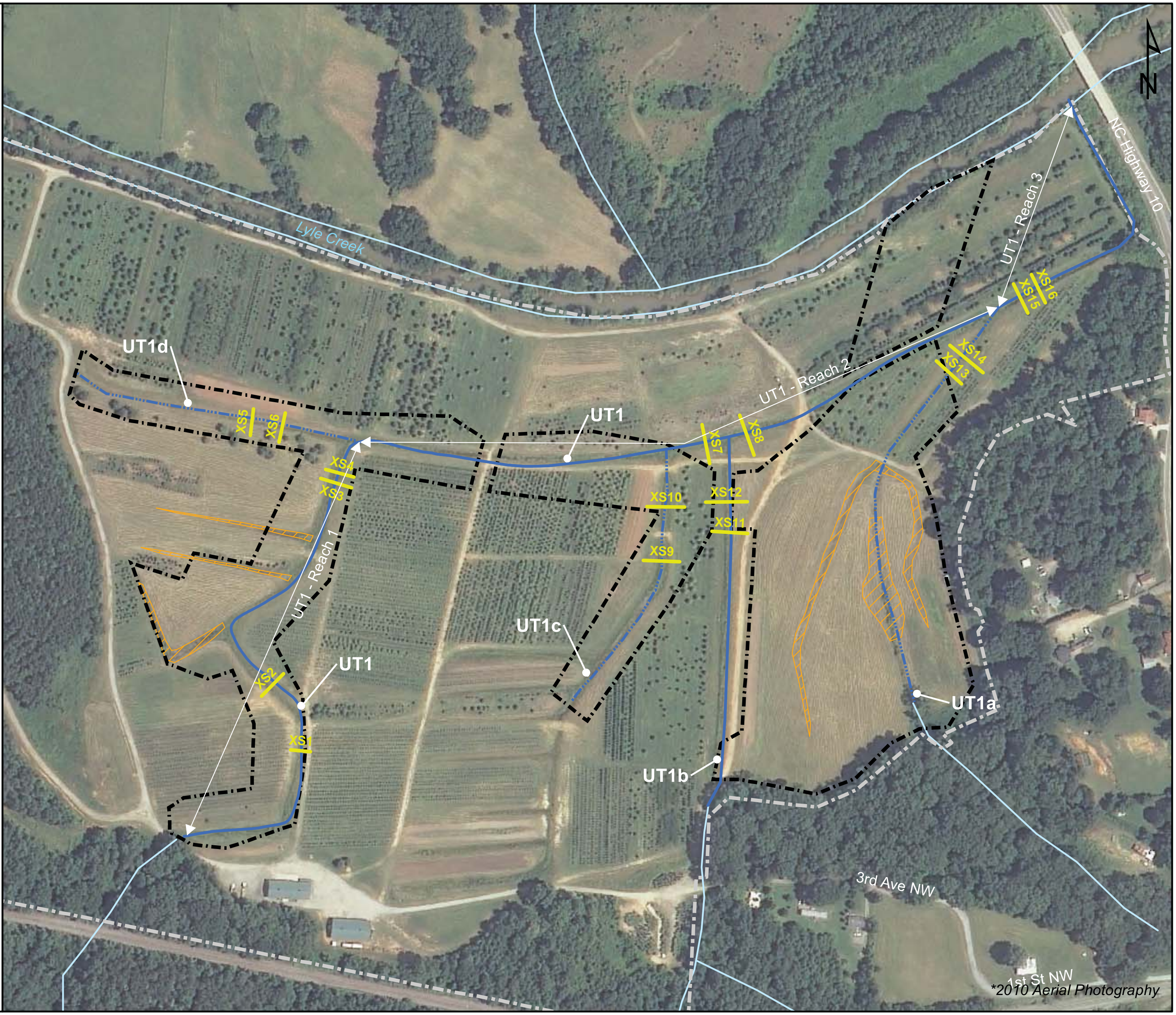
WILDLANDS ENGINEERING

Figure 4 USGS Watershed Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC

Figure 5
Hydrologic Features
Lyle Creek
Mitigation Site
Catawba River Basin
(03050101)

Catawba County, NC



- ▭ Easement Area
- ━ Cross Sections
- ─··─ Intermittent Drainage
- ━ Perennial Drainage
- ▨ Ditched Wetland
- ▭ Property Boundary
- ─ Streams

0 175 350 ft

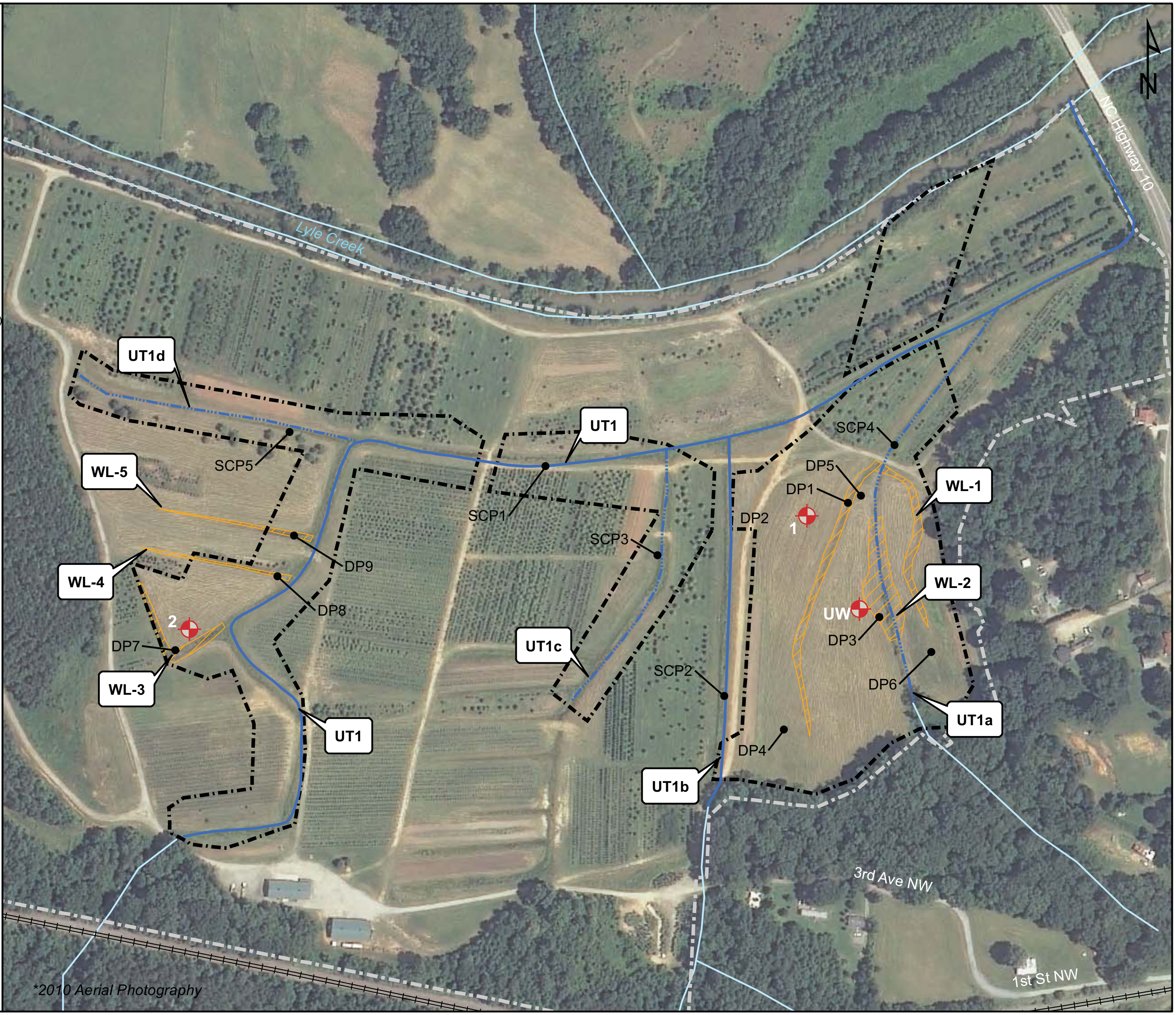
WILDLANDS ENGINEERING

Figure 6
Wetland Delineation
Lyle Creek
Mitigation Site
Catawba River Basin
(03050101)

Catawba County, NC

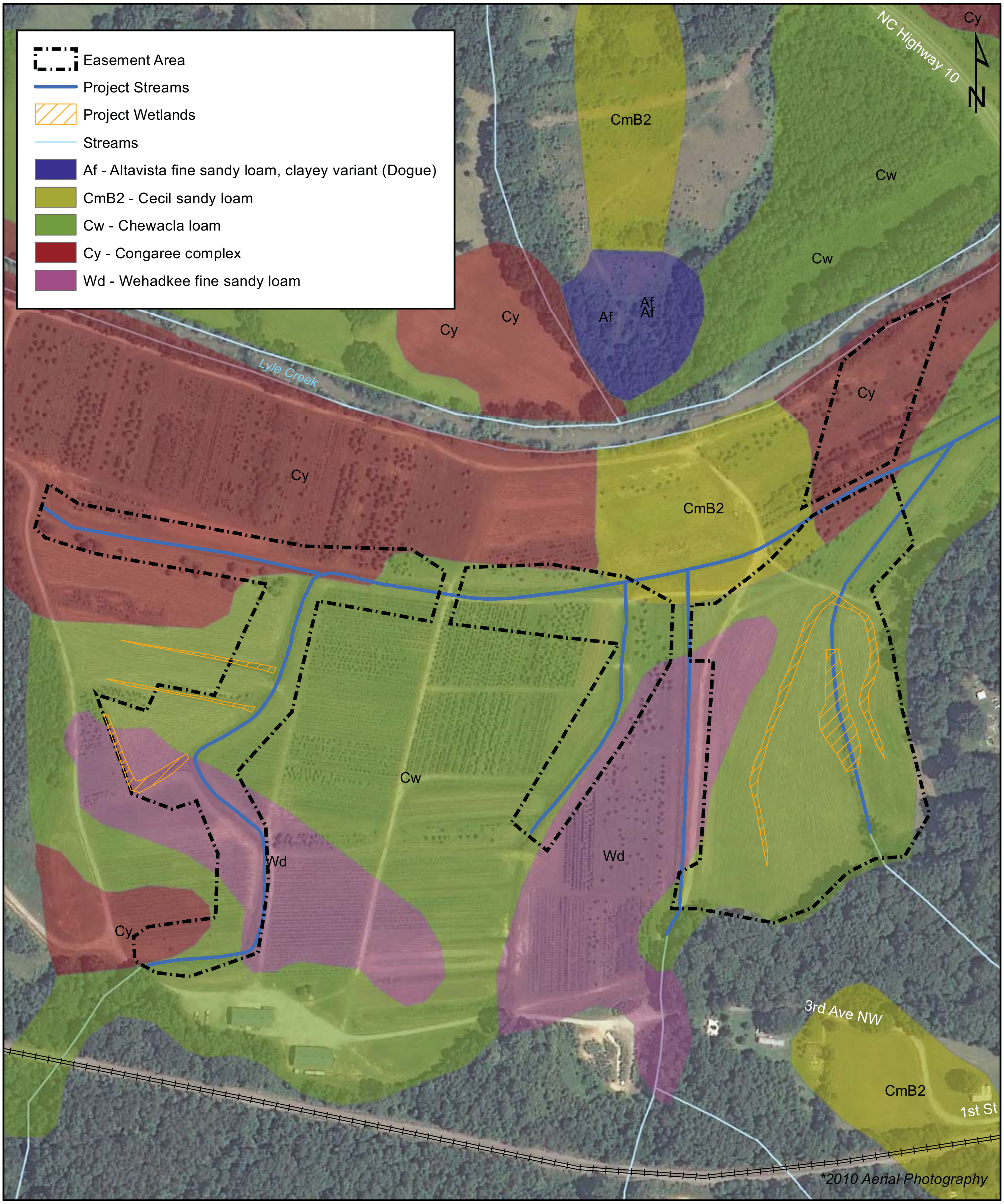
- ▭ Easement Area
- ─·· Intermittent Drainage
- ─ Perennial Drainage
- ▨ Ditched Wetland (1.2 Acres)
- ● SCP1 - Stream Data Point
- ● DP1 - Wetland Data Point
- ⊕ Monitoring Gauges
- ▭ Property Boundary
- ─ Streams

0 175 350 ft



*2010 Aerial Photography

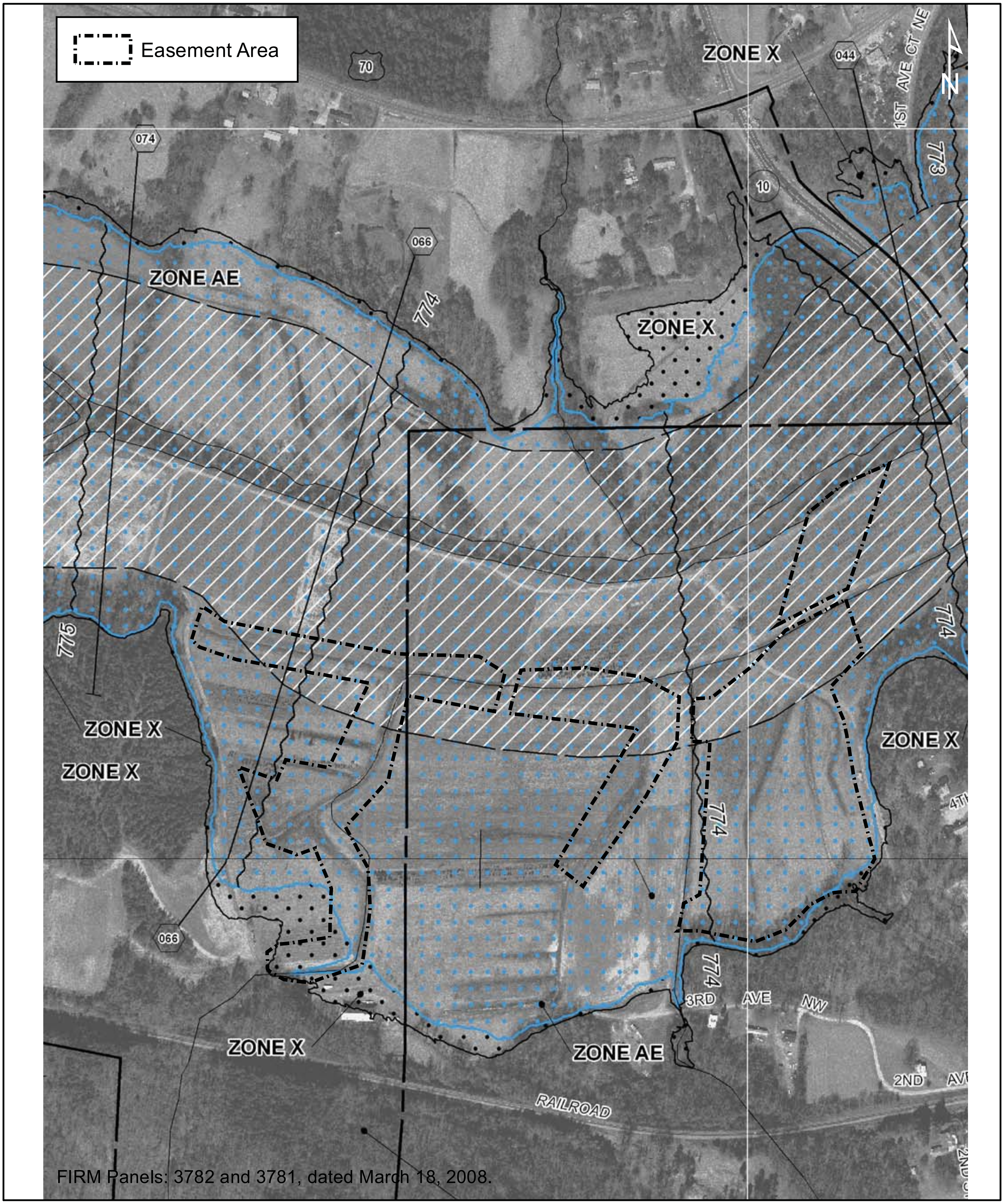
WILDLANDS ENGINEERING



WILDLANDS ENGINEERING

Figure 7 Soils Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC



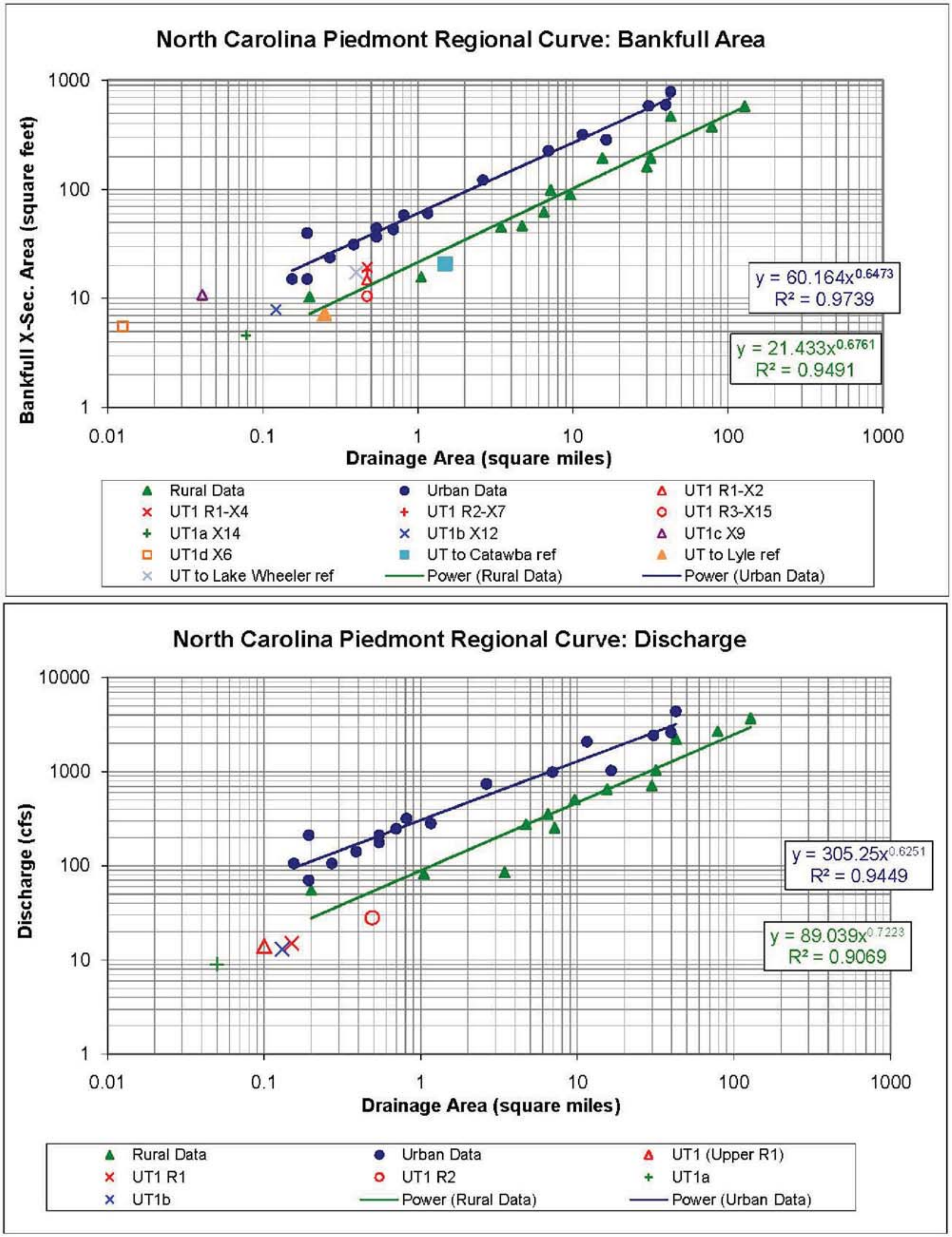
FIRM Panels: 3782 and 3781, dated March 18, 2008.

WILDLANDS ENGINEERING

0 225 450 Feet

Figure 8 FEMA Flood Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

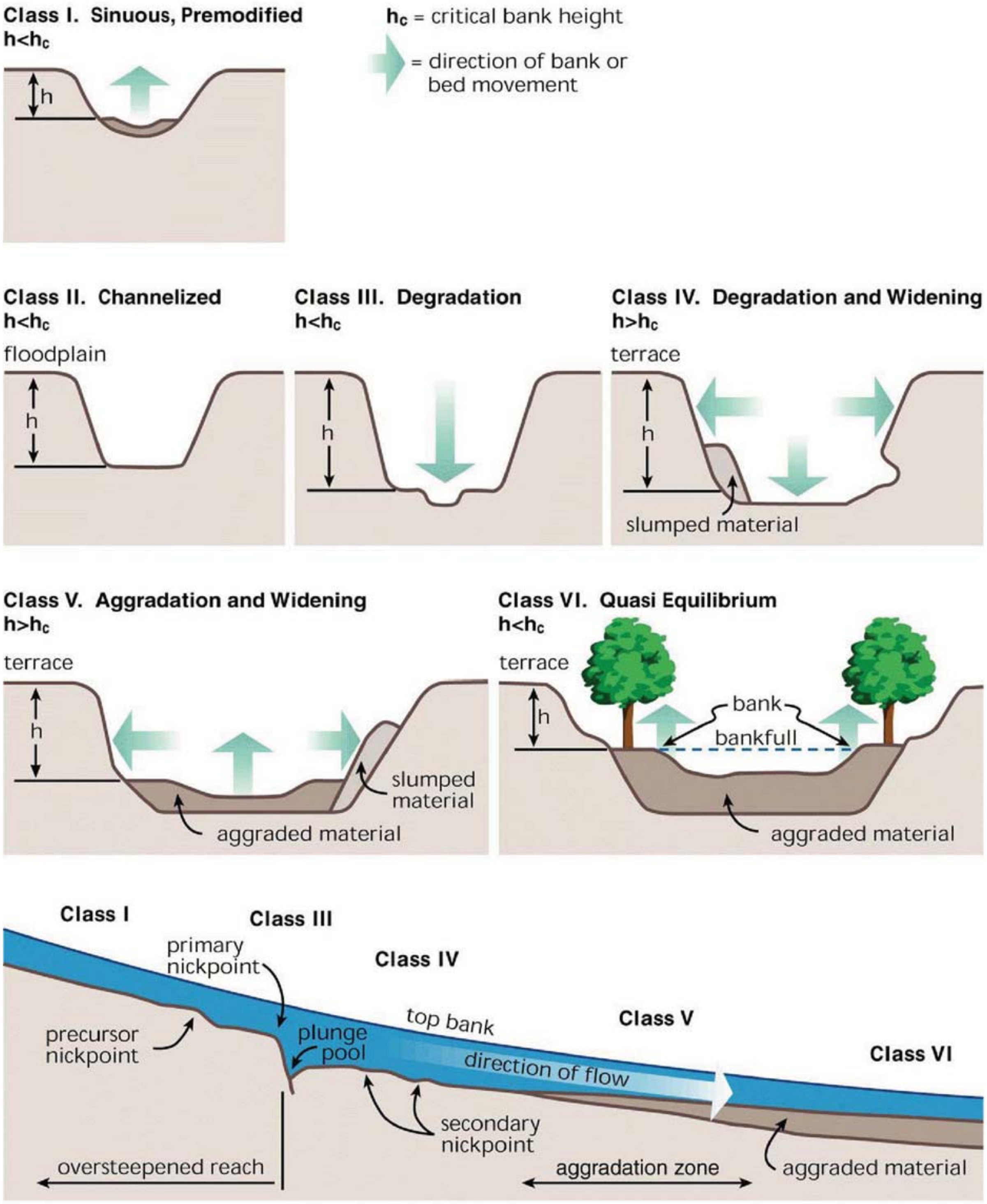
Catawba County, NC


North Carolina Piedmont Regional Curve: Bankfull Area

North Carolina Piedmont Regional Curve: Discharge

Figure 9 Regional Curve Data
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC



Source: Simon, 1989; US Army Corps of Engineers, 1990.
Fig. 7.14 -- Channel evolution model..
In Stream Corridor Restoration: Principles, Processes, and Practices, 10/98.
Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US).

Source: Simon, 1989

Figure 10 Channel Evolution Model
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC

Figure 11
Stream & Wetland
Reference
Vicinity Map
Lyle Creek
Mitigation Site
Catawba River Basin
(03050101)

Catawba County, NC

🟩 EEP Catawba 01 TLWs

0 10 20 Mi

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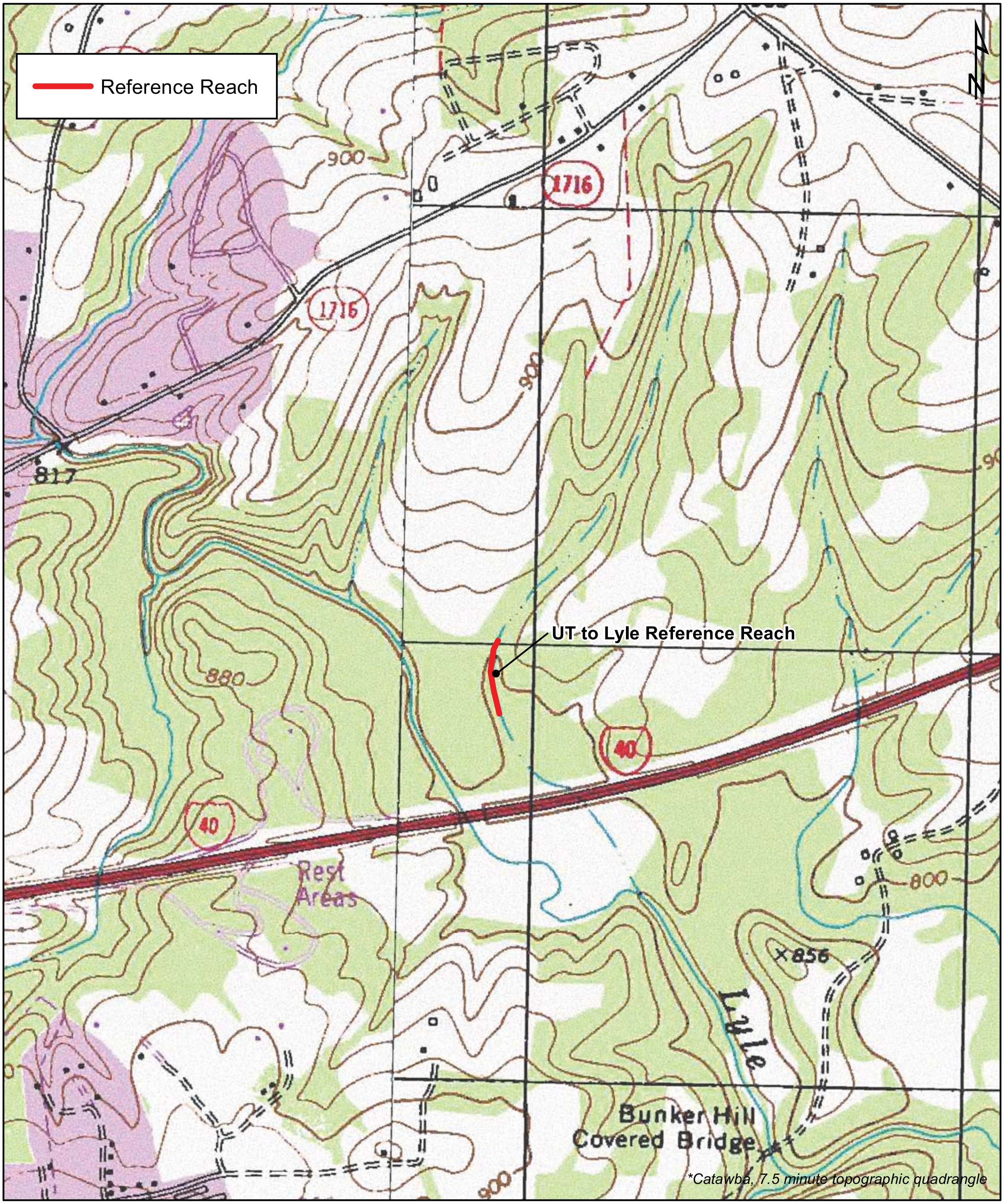
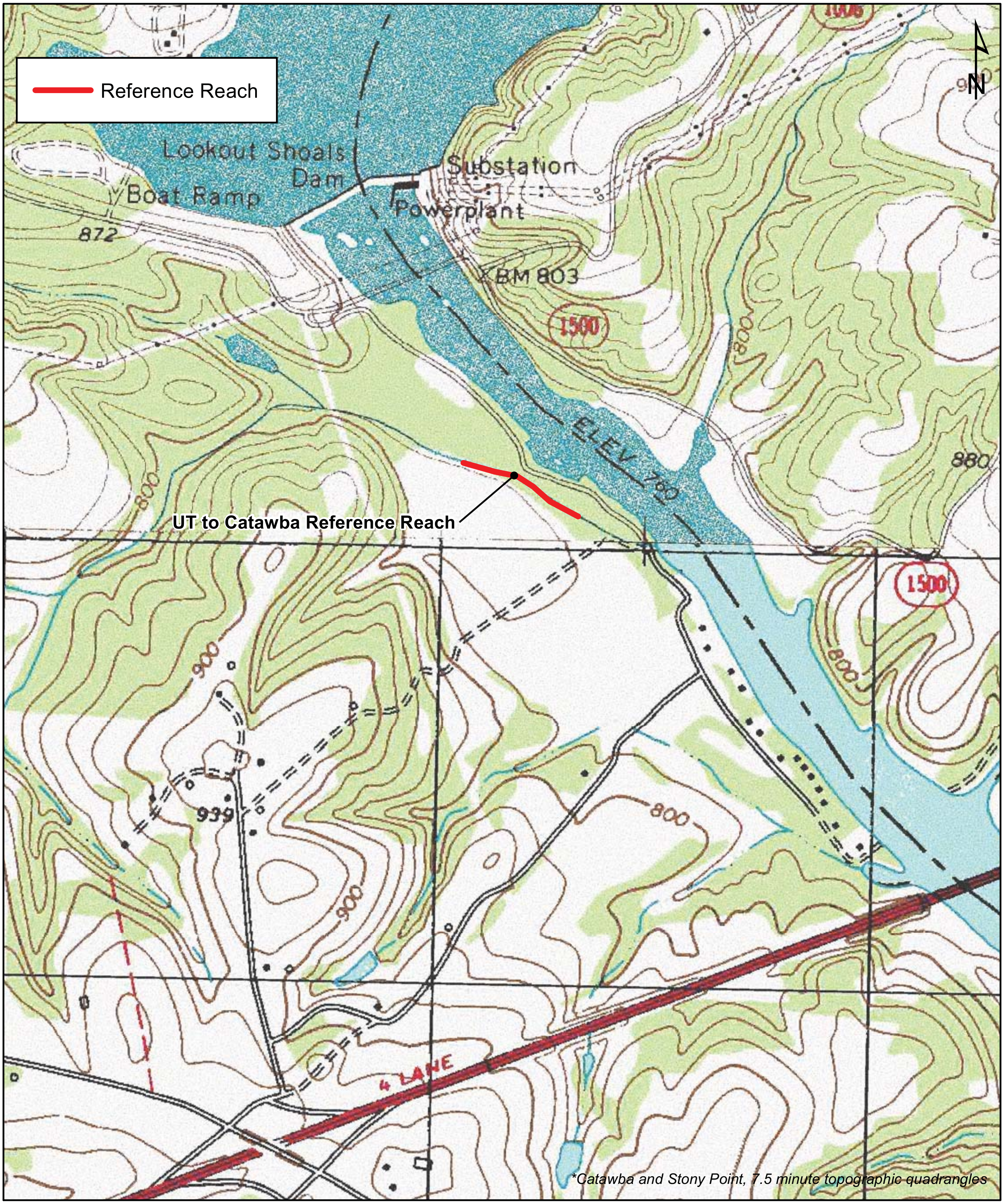


*Catawba, 7.5 minute topographic quadrangle

Figure 12 UT to Lyle Reference Topographic Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

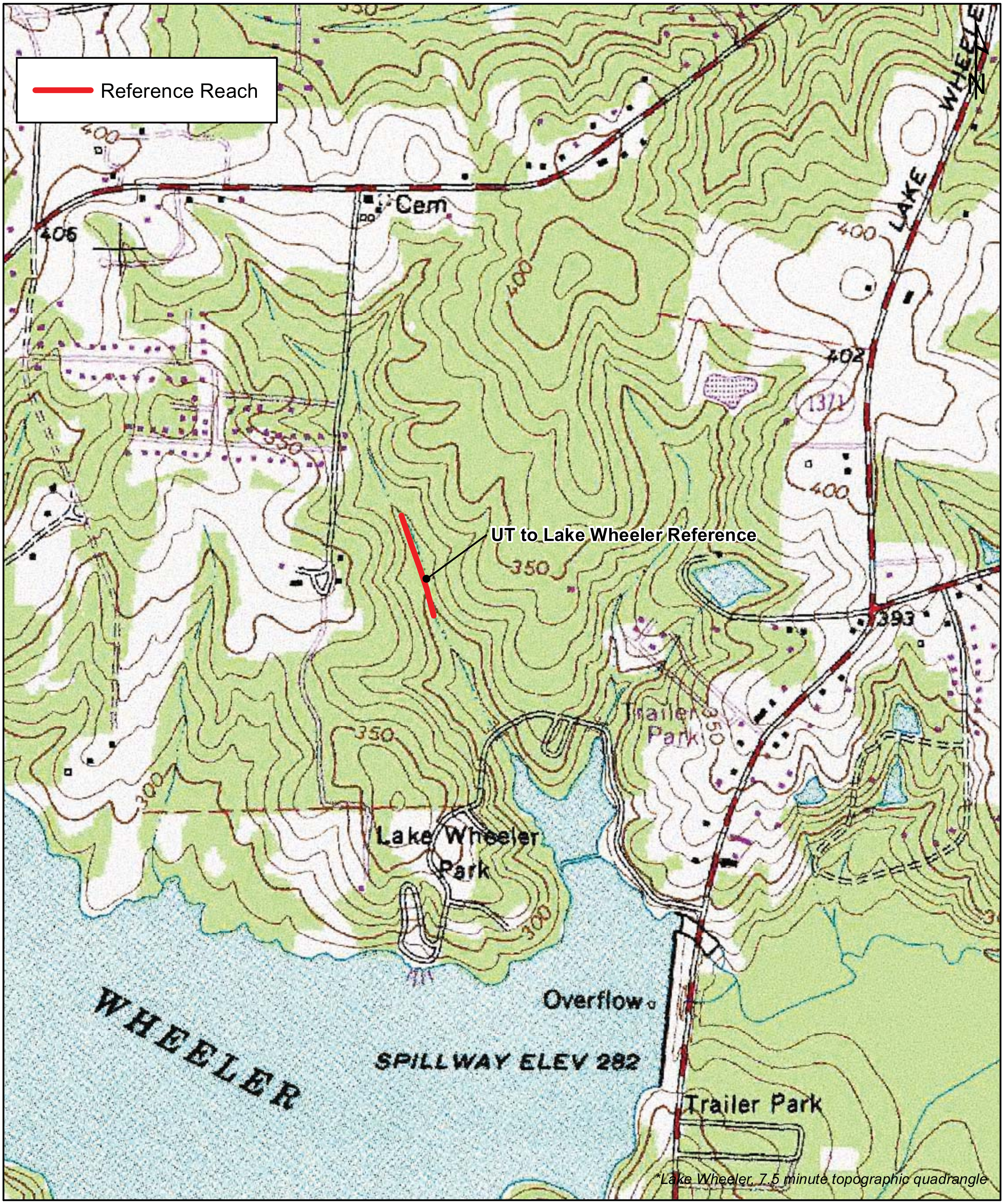
Catawba County, NC



WILDLANDS ENGINEERING

Figure 13 UT to Catawba Reference Topographic Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC



WILDLANDS ENGINEERING

Figure 14 UT to Lake Wheeler Reference
Topographic Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC

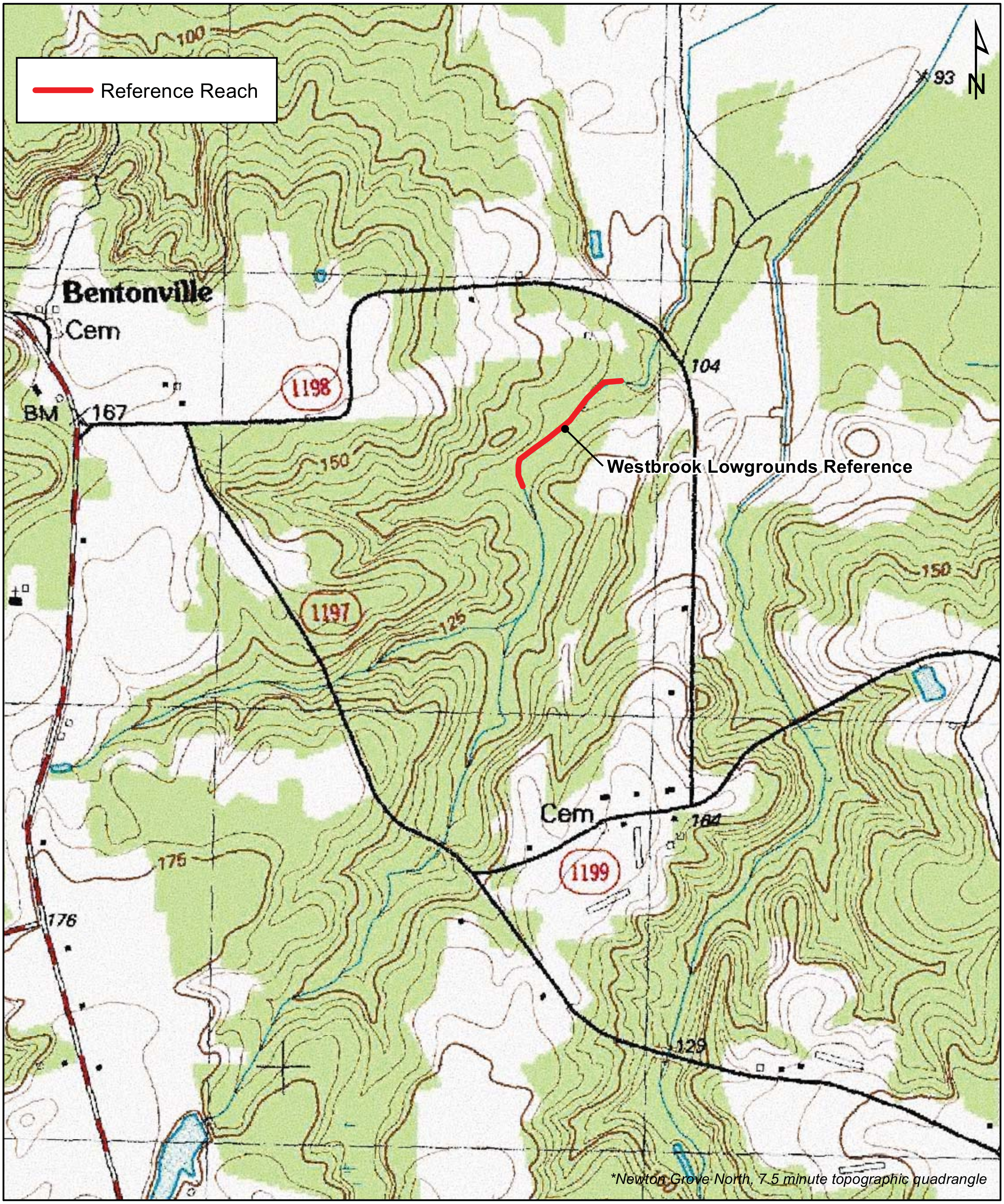


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Figure 15 Westbrook Lowgrounds Reference
Topographic Map
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC

Figure 16
Wetland Soil Boring Locations
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC

- Easement Area
- Project Streams
- Streams
- Monitoring Gauges
- Soil Borings

Hydric Soils

🟩	Cw - Chewacla loam
🟪	Wd - Wehadkee fine sandy loam

0 125 250 ft

WILDLANDS ENGINEERING

*2010 Aerial Photography

Figure 17
Stream & Wetland Design
Lyle Creek Mitigation Site
Catawba River Basin (03050101)

Catawba County, NC

Easement Area
Property Boundary
⊕ Monitoring Wells
Stream Enhancement II
Stream Restoration
▨ Wetland Creation
▨ Wetland Restoration
Streams

0 150 300 ft

*2010 Aerial Photography

WILDLANDS ENGINEERING

APPENDIX 1

Site Photographs

Photo 1-View of Perennial UT1, facing upstream near confluence with UT1a.

Photo 2-View of downstream portion of Perennial UT1, facing downstream.

Photo 3-View of Intermittent UT1a, facing downstream near confluence with UT1.

Photo 4-View of Perennial UT1b, facing upstream from existing culvert.

Photo 5- View of Intermittent UT1c, facing upstream from existing culvert.

Photo 6-View of Intermittent UT1d, facing upstream.

Photo 7-View of Wetland WL-1, west of UT1a.

Photo 8-View of Wetland WL-1, west of UT1a.

Photo 9-View of riparian Wetland WL-2, adjacent to UT1a.

Photo 10-View of Wetland WL-3, facing west.

Photo 11-View of Wetland WL-4, facing west.

Photo 12-View of Wetland WL-5, facing west.

APPENDIX 2

Wetland and Stream Documentation

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action I.D.: **SAW 2010-02102** County: **Catawba** U.S.G.S. Quad: **NC Catawba**

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Property Owner/Agent: **Matt Jenkins; Wildlands Engineering Inc.**
Address: **1430 South Mint Street,**
Suite 104 Charlotte, NC 28203
Telephone No.: **704-332-7754**

Property description:

Size (acres): 4045 LF of stream and 1.85 acres	Nearest Town: Catawba
Nearest Waterway: Lyle Creek	River Basin: Catawba
Coordinates: 35.711674 N/ -81.081496 W	Hydrologic Unit Code: 03050101

Location Description:

Indicate Which of the Following Apply:

A. Preliminary Determination

_ Based on preliminary information, there may be waters on the above described property. We strongly suggest you have this property inspected to determine the extent of Department of the Army (DA) jurisdiction. To be considered final, a jurisdictional determination must be verified by the Corps. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331).

B. Approved Determination

_ There are Navigable Waters of the United States within the above described property subject to the permit requirements of Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

X There are waters on the above described property subject to the permit requirements of Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ We strongly suggest you have the waters on your property delineated. Due to the size of your property and/or our present workload, the Corps may not be able to accomplish this wetland delineation in a timely manner. For a more timely delineation, you may wish to obtain a consultant. To be considered final, any delineation must be verified by the Corps.

_**X** The waters on your property have been delineated and the delineation has been verified by the Corps. We strongly suggest you have this delineation surveyed. Upon completion, this survey should be reviewed and verified by the Corps. Once verified, this survey will provide an accurate depiction of all areas subject to CWA jurisdiction on your property which, provided there is no change in the law or our published regulations, may be relied upon for a period not to exceed five years.

_The waters have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on ___. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are no waters of the U.S., to include wetlands, present on the above described property which are subject to the permit requirements of Section 404 of the Clean Water Act (33 USC 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

This delineation/determination has been conducted to identify the limits of COE's Clean Water Act jurisdiction for the particular site identified in this request. The delineation/determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA Program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service, prior to starting work.

Placement of dredged or fill material within waters of the US and/or wetlands without a Department of the Army permit may constitute a violation of Section 301 of the Clean Water Act (33 USC § 1311). If you have any questions regarding this determination and/or the Corps regulatory program, please contact **Tyler Crumbley** at **828-271-7980**.

C. Basis For Determination

The site contains wetlands as determined by the USACE 1987 Wetland Delineation Manual and they directly abut stream channels located on the property that exhibit indicators of ordinary high water marks. The stream channel on the property is an unnamed tributary to Lyle Creek which flows into the Catawba River which is Section 10 Navigable at the Mountain Island Lake dam on the Mecklenburg/Gaston county line in NC.

D. Remarks

E. Appeals Information (This information applies only to approved jurisdictional determinations as indicated in B. above)

Attached to this verification is an approved jurisdictional determination. If you are not in agreement with that approved jurisdictional determination, you can make an administrative appeal under 33 CFR 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and request for appeal (RFA) form. If you request to appeal this determination you must submit a completed RFA form to the following address:

District Engineer, Wilmington Regulatory Program
Attn: Tyler Crumbley, Project Manager
151 Patton Avenue, Room 208
Asheville, North Carolina 28801

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address within 60 of the issue date.

It is not necessary to submit an RFA form to the Division Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: Tyler Crumbley

Issue Date: 6 April, 2011 Expiration Date: 6 April, 2016

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete the Customer Satisfaction Survey located at our website at http://per2.nwp.usace.army.mil/survey.html to complete the survey online.

SURVEY PLATS, FIELD SKETCH, WETLAND DELINEATION FORMS, PROJECT PLANS, ETC., MUST BE ATTACHED TO THE FILE COPY OF THIS FORM, IF REQUIRED OR AVAILABLE.

CF:

NC DWQ Stream Identification Form Version 4.11

Date: 2/26/10 (revised 9/20/10)	**Project/Site:** Lyle Creek	**Latitude:** 35.712843° N
Evaluator: MLS	**County:** Catawba	**Longitude:** 81.079538° W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 33.5	**Stream Determination (~~circle one~~)** **Ephemeral Intermittent [✓ Perennial]**	**Other** SCPl - UT1 *e.g. Quad Name*:

A. Geomorphology (Subtotal = 14.5)	Absent	Weak	Moderate	Strong
1^a. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	[✓ 0]	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	[✓ 1]	2	3
4. Particle size of stream substrate	0	1	[✓ 2]	3
5. Active/relict floodplain	0	1	2	[✓ 3]
6. Depositional bars or benches	0	1	[✓ 2]	3
7. Recent alluvial deposits	0	1	[✓ 2]	3
8. Headcuts	[✓ 0]	1	2	3
9. Grade control	0	[✓ 0.5]	1	1.5
10. Natural valley	0	0.5	[✓ 1]	1.5
11. Second or greater order channel	No = 0		[✓ Yes = 3]	

^{a} artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	[✓ 3]
13. Iron oxidizing bacteria	[✓ 0]	1	2	3
14. Leaf litter	1.5	[✓ 1]	0.5	0
15. Sediment on plants or debris	0	0.5	[✓ 1]	1.5
16. Organic debris lines or piles	0	0.5	[✓ 1]	1.5
17. Soil-based evidence of high water table?	No = 0		[✓ Yes = 3]	

C. Biology (Subtotal = 10)				
18. Fibrous roots in streambed	3	2	1	[✓ 0]
19. Rooted upland plants in streambed	[✓ 3]	2	1	0
20. Macrobenthos (note diversity and abundance)	0	[✓ 1]	2	3
21. Aquatic Mollusks	[✓ 0]	1	2	3
22. Fish	0	0.5	[✓ 1]	1.5
23. Crayfish	0	[✓ 0.5]	1	1.5
24. Amphibians	0	0.5	1	[✓ 1.5]
25. Algae	0	0.5	1	[✓ 1.5]
26. Wetland plants in streambed	FACW = 0.75; OBL [✓ = 1.5] Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2/26/10 (revised 9/20/10)	**Project/Site:** Lyle Creek	**Latitude:** 35.711453° N
Evaluator: MLJ	**County:** Catawba	**Longitude:** 81.080894° W
Total Points: 33.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** SCP2 - UT1b *e.g. Quad Name*:

A. Geomorphology (Subtotal = 17)	Absent	Weak	Moderate	Strong
1ª. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	[✓ 0]	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	[✓ 1]	2	3
4. Particle size of stream substrate	0	[✓ 1]	2	3
5. Active/relict floodplain	0	1	2	[✓ 3]
6. Depositional bars or benches	0	1	2	[✓ 3]
7. Recent alluvial deposits	0	1	2	[✓ 3]
8. Headcuts	0	[✓ 1]	2	3
9. Grade control	0	0.5	[✓ 1]	1.5
10. Natural valley	0	0.5	[✓ 1]	1.5
11. Second or greater order channel	No = 0		[✓ Yes = 3]	

ª artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8)				
12. Presence of Baseflow	0	1	[✓ 2]	3
13. Iron oxidizing bacteria	[✓ 0]	1	2	3
14. Leaf litter	1.5	1	[✓ 0.5]	0
15. Sediment on plants or debris	0	0.5	1	[✓ 1.5]
16. Organic debris lines or piles	0	0.5	[✓ 1]	1.5
17. Soil-based evidence of high water table?	No = 0		[✓ Yes = 3]	

C. Biology (Subtotal = 8.5)				
18. Fibrous roots in streambed	3	2	[✓ 1]	0
19. Rooted upland plants in streambed	[✓ 3]	2	1	0
20. Macrobenthos (note diversity and abundance)	0	[✓ 1]	2	3
21. Aquatic Mollusks	[✓ 0]	1	2	3
22. Fish	[✓ 0]	0.5	1	1.5
23. Crayfish	[✓ 0]	0.5	1	1.5
24. Amphibians	0	0.5	1	[✓ 1.5]
25. Algae	0	[✓ 0.5]	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL [✓ = 1.5] Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2/26/10 (revised 9/20/10)	**Project/Site:** Lyle Creek	**Latitude:** 35.711674° N
Evaluator: MLJ	**County:** Catawba	**Longitude:** 81.081496° W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23.5	**Stream Determination (circle one)** **Ephemeral [✓ Intermittent] Perennial**	**Other** SCP3 - UT/c *e.g. Quad Name*:

A. Geomorphology (Subtotal = 9)	Absent	Weak	Moderate	Strong
1.ⓐ Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	[✓ 0]	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	[✓ 1]	2	3
4. Particle size of stream substrate	0	[✓ 1]	2	3
5. Active/relict floodplain	0	1	2	[✓ 3]
6. Depositional bars or benches	0	1	[✓ 2]	3
7. Recent alluvial deposits	0	[✓ 1]	2	3
8. Headcuts	[✓ 0]	1	2	3
9. Grade control	0	[✓ 0.5]	1	1.5
10. Natural valley	0	[✓ 0.5]	1	1.5
11. Second or greater order channel	No = [✓ 0]		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8)

12. Presence of Baseflow	0	1	[✓ 2]	3
13. Iron oxidizing bacteria	[✓ 0]	1	2	3
14. Leaf litter	1.5	[✓ 1]	0.5	0
15. Sediment on plants or debris	0	0.5	[✓ 1]	1.5
16. Organic debris lines or piles	0	0.5	[✓ 1]	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = [✓ 3]	

C. Biology (Subtotal = 6.5)

18. Fibrous roots in streambed	3	2	1	[✓ 0]
19. Rooted upland plants in streambed	[✓ 3]	2	1	0
20. Macrobenthos (note diversity and abundance)	[✓ 0]	1	2	3
21. Aquatic Mollusks	[✓ 0]	1	2	3
22. Fish	[✓ 0]	0.5	1	1.5
23. Crayfish	[✓ 0]	0.5	1	1.5
24. Amphibians	0	0.5	[✓ 1]	1.5
25. Algae	0	0.5	[✓ 1]	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = [✓ 1.5] Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2/26/10 (revised 9/20/10)	**Project/Site:** Lyle Creek	**Latitude:** 35.711583° N
Evaluator: MLI	**County:** Catawba	**Longitude:** 81.079629° W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 19.5	**Stream Determination (circle one)** **Ephemeral [✓ Intermittent] Perennial**	**Other** SCP4 - UT1a *e.g. Quad Name*:

A. Geomorphology (Subtotal = 7)	Absent	Weak	Moderate	Strong
1.[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	[✓ 0]	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	[✓ 1]	2	3
4. Particle size of stream substrate	[✓ 0]	1	2	3
5. Active/relict floodplain	0	1	2	[✓ 3]
6. Depositional bars or benches	0	[✓ 1]	2	3
7. Recent alluvial deposits	0	[✓ 1]	2	3
8. Headcuts	[✓ 0]	1	2	3
9. Grade control	0	[✓ 0.5]	1	1.5
10. Natural valley	0	[✓ 0.5]	1	1.5
11. Second or greater order channel	No = [✓ 0]		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7.5)

12. Presence of Baseflow	0	1	[✓ 2]	3
13. Iron oxidizing bacteria	[✓ 0]	1	2	3
14. Leaf litter	[✓ 1.5]	1	0.5	0
15. Sediment on plants or debris	0	[✓ 0.5]	1	1.5
16. Organic debris lines or piles	0	[✓ 0.5]	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = [✓ 3]	

C. Biology (Subtotal = 5)

18. Fibrous roots in streambed	3	2	1	[✓ 0]
19. Rooted upland plants in streambed	[✓ 3]	2	1	0
20. Macrobenthos (note diversity and abundance)	[✓ 0]	1	2	3
21. Aquatic Mollusks	[✓ 0]	1	2	3
22. Fish	[✓ 0]	0.5	1	1.5
23. Crayfish	[✓ 0]	0.5	1	1.5
24. Amphibians	[✓ 0]	0.5	1	1.5
25. Algae	0	[✓ 0.5]	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = [✓ 1.5] Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2/26/10 (revised 9/20/10)	**Project/Site:** Lyle Creek	**Latitude:** 35.712311° N
Evaluator: MLJ	**County:** Catawba	**Longitude:** 81.084864°W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 19.25	**Stream Determination (circle one)** **Ephemeral [✓ Intermittent] Perennial**	**Other** SCP5 - UT1d *e.g. Quad Name*:

A. Geomorphology (Subtotal = 8.5)	**Absent**	**Weak**	**Moderate**	**Strong**
1ⓐ Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	[✓ 0]	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	[✓ 1]	2	3
4. Particle size of stream substrate	0	[✓ 1]	2	3
5. Active/relict floodplain	0	1	2	[✓ 3]
6. Depositional bars or benches	0	[✓ 1]	2	3
7. Recent alluvial deposits	[✓ 0]	1	2	3
8. Headcuts	0	[✓ 1]	2	3
9. Grade control	0	0.5	[✓ 1]	1.5
10. Natural valley	0	[✓ 0.5]	1	1.5
11. Second or greater order channel	No = [✓ 0]		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6)

12. Presence of Baseflow	0	1	[✓ 2]	3
13. Iron oxidizing bacteria	[✓ 0]	1	2	3
14. Leaf litter	1.5	1	[✓ 0.5]	0
15. Sediment on plants or debris	0	[✓ 0.5]	1	1.5
16. Organic debris lines or piles	[✓ 0]	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = [✓ 3]	

C. Biology (Subtotal = 4.75)

18. Fibrous roots in streambed	3	2	1	[✓ 0]
19. Rooted upland plants in streambed	[✓ 3]	2	1	0
20. Macrobenthos (note diversity and abundance)	[✓ 0]	1	2	3
21. Aquatic Mollusks	[✓ 0]	1	2	3
22. Fish	[✓ 0]	0.5	1	1.5
23. Crayfish	[✓ 0]	0.5	1	1.5
24. Amphibians	[✓ 0]	0.5	1	1.5
25. Algae	0	0.5	[✓ 1]	1.5
26. Wetland plants in streambed	FACW = [✓ 0.75]; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

OFFICE USE ONLY: USACE AID#________________________ DWQ #____________________________

SCP1 – UT1 to Lyle Creek (Perennial RPW)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 2/26/10
4. Time of Evaluation: 9:00am
5. Name of Stream: UT1 to Lyle Creek
6. River Basin: Catawba 03050101
7. Approximate Drainage Area: 281 acres
8. Stream Order: Second
9. Length of Reach Evaluated: 200 lf
10. County: Catawba
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Catawba, NC travel north on N. Main Street and turn left onto 2nd Street NW. Continue to follow gravel road around to Catawba Tree Farm.
12. Site Coordinates (if known): 35.712843°N, 81.079538°W
13. Proposed Channel Work (if any): Stream Restoration
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 40°
16. Identify any special waterway classifications known: ____Section 10 ____Tidal Waters ____Essential Fisheries Habitat ____Trout Waters ____Outstanding Resource Waters ____ Nutrient Sensitive Waters ____Water Supply Watershed _____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area:_
18. Does channel appear on USGS quad map? [✓ YES] NO
19. Does channel appear on USDA Soil Survey? [✓ YES] NO
20. Estimated Watershed Land Use: ____% Residential ____% Commercial ____% Industrial 50 % Agricultural 50 % Forested ____% Cleared / Logged ____% Other (__________________)
21. Bankfull Width: 15'
22. Bank Height (from bed to top of bank): 3-4'
23. Channel slope down center of stream: X Flat (0 to 2%) ____Gentle (2 to 4%) ____Moderate (4 to 10%) ____Steep (>10%)
24. Channel Sinuosity: X___Straight ____Occasional Bends ____Frequent Meander ____Very Sinuous ____Braided Channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 37 **Comments:**

Evaluator's Signature **Date** 2/26/10

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers in order to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 05/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET
SCP1 – UT1 to Lyle Creek (Perennial RPW)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	5
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	0
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	4
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	4
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	4
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	1
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	1
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	0
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	0
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				37

* These characteristics are not assessed in coastal streams.

OFFICE USE ONLY: USACE AID#____________ DWQ #____________

SCP2 – UT1b to Lyle Creek (Perennial RPW)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 2/26/10
4. Time of Evaluation: 9:30am
5. Name of Stream: UT1b to Lyle Creek
6. River Basin: Catawba 03050101
7. Approximate Drainage Area: 78 acres
8. Stream Order: First
9. Length of Reach Evaluated: 200 lf
10. County: Catawba
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Catawba, NC travel north on N. Main Street and turn left onto 2nd Street NW. Continue to follow gravel road around to Catawba Tree Farm.
12. Site Coordinates (if known): 35.711453°N, 81.080894°W
13. Proposed Channel Work (if any): Stream Restoration
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 40°
16. Identify any special waterway classifications known: ____Section 10 ____Tidal Waters ____Essential Fisheries Habitat ____Trout Waters ____Outstanding Resource Waters ____ Nutrient Sensitive Waters ____Water Supply Watershed ____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area:_
18. Does channel appear on USGS quad map? YES [✓ NO]
19. Does channel appear on USDA Soil Survey? YES [✓ NO]
20. Estimated Watershed Land Use: ____% Residential ____% Commercial ____% Industrial 60 % Agricultural 40 % Forested ____% Cleared / Logged ____% Other (__________)
21. Bankfull Width: 16 feet
22. Bank Height (from bed to top of bank): 2-3 feet
23. Channel slope down center of stream: X Flat (0 to 2%) ____Gentle (2 to 4%) ____Moderate (4 to 10%) ____Steep (>10%)
24. Channel Sinuosity: X____Straight ____Occasional Bends ____Frequent Meander ____Very Sinuous ____Braided Channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 34 **Comments:**

Evaluator's Signature **Date** 2/26/10

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers in order to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 05/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET
SCP2 – UT1b to Lyle Creek (Perennial RPW)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	1
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	0
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	4
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	4
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	1
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	0
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	0
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				34

* These characteristics are not assessed in coastal streams.

OFFICE USE ONLY: USACE AID#________________________ DWQ #____________________________

SCP3 – UT1c to Lyle Creek (Intermittent RPW)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 2/26/10
4. Time of Evaluation: 10:00am
5. Name of Stream: UT1c to Lyle Creek
6. River Basin: Catawba 03050101
7. Approximate Drainage Area: 26 acres
8. Stream Order: First
9. Length of Reach Evaluated: 100 lf
10. County: Catawba
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Catawba, NC travel north on N. Main Street and turn left onto 2nd Street NW. Continue to follow gravel road around to Catawba Tree Farm.
12. Site Coordinates (if known): 35.711674°N, 81.081496°W
13. Proposed Channel Work (if any): Stream Restoration
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 40°
16. Identify any special waterway classifications known: ____Section 10 ____Tidal Waters ____Essential Fisheries Habitat ____Trout Waters ____Outstanding Resource Waters ____ Nutrient Sensitive Waters ____Water Supply Watershed ____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area:_
18. Does channel appear on USGS quad map? YES [✓ NO] 19. Does channel appear on USDA Soil Survey? YES [✓ NO]
20. Estimated Watershed Land Use: ____% Residential ____% Commercial ____% Industrial 90 % Agricultural 10 % Forested ____% Cleared / Logged ____% Other (__________________)
21. Bankfull Width: 22'
22. Bank Height (from bed to top of bank): 3-4'
23. Channel slope down center of stream: X Flat (0 to 2%) ____Gentle (2 to 4%) ____Moderate (4 to 10%) ____Steep (>10%)
24. Channel Sinuosity: X Straight ____Occasional Bends ____Frequent Meander ____Very Sinuous ____Braided Channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 31 **Comments:**____

Evaluator's Signature______________________________ **Date** 2/26/10

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STREAM QUALITY ASSESSMENT WORKSHEET
SCP3 – UT1c to Lyle Creek (Intermittent RPW)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	0
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	1
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	4
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	4
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	0
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	0
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	1
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	0
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				31

* These characteristics are not assessed in coastal streams.

OFFICE USE ONLY: USACE AID#________________________ DWQ #____________________________

SCP4 – UT1a to Lyle Creek (Intermittent RPW)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 2/26/10
4. Time of Evaluation: 10:30am
5. Name of Stream: UT1a to Lyle Creek
6. River Basin: Catawba 03050101
7. Approximate Drainage Area: 50 acres
8. Stream Order: First
9. Length of Reach Evaluated: 100 lf
10. County: Catawba
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Catawba, NC travel north on N. Main Street and turn left onto 2nd Street NW. Continue to follow gravel road around to Catawba Tree Farm.
12. Site Coordinates (if known): 35.711583°N, 81.079629°W
13. Proposed Channel Work (if any): Stream Restoration
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 40°
16. Identify any special waterway classifications known: ____Section 10 ____Tidal Waters ____Essential Fisheries Habitat ____Trout Waters ____Outstanding Resource Waters ____ Nutrient Sensitive Waters ____Water Supply Watershed ____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area:_
18. Does channel appear on USGS quad map? YES [✓ NO] 19. Does channel appear on USDA Soil Survey? YES [✓ NO]
20. Estimated Watershed Land Use: _____% Residential ____% Commercial ____% Industrial 60 % Agricultural 40 % Forested ____% Cleared / Logged ____% Other (___________________)
21. Bankfull Width: 9'
22. Bank Height (from bed to top of bank): 0.5-1'
23. Channel slope down center of stream: X Flat (0 to 2%) ____Gentle (2 to 4%) ____Moderate (4 to 10%) ____Steep (>10%)
24. Channel Sinuosity: X___Straight ____Occasional Bends ____Frequent Meander ____Very Sinuous ____Braided Channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 31 **Comments:**

Evaluator's Signature______________________ **Date** 2/26/10

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STREAM QUALITY ASSESSMENT WORKSHEET
SCP4 – UT1a to Lyle Creek (Intermittent RPW)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	0
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	4
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	4
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	2
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	1
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	0
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	0
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	0
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						31

* These characteristics are not assessed in coastal streams.

OFFICE USE ONLY: USACE AID#________________________ DWQ #____________________________

SCP5 – UT1d to Lyle Creek (Intermittent RPW)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering

2. Evaluator's Name: Matt Jenkins

3. Date of Evaluation: 2/26/10

4. Time of Evaluation: 11:00am

5. Name of Stream: UT1d to Lyle Creek

6. River Basin: Catawba 03050101

7. Approximate Drainage Area: 8 acres

8. Stream Order: First

9. Length of Reach Evaluated: 100 lf

10. County: Catawba

11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Catawba, NC travel north on N. Main Street and turn left onto 2nd Street NW. Continue to follow gravel road around to Catawba Tree Farm.

12. Site Coordinates (if known): 35.712311°N, 81.084864°W

13. Proposed Channel Work (if any): Stream Restoration

14. Recent Weather Conditions: rain within the past 48 hours

15. Site conditions at time of visit: sunny, 40°

16. Identify any special waterway classifications known: ____Section 10 ____Tidal Waters ____Essential Fisheries Habitat ____Trout Waters ____Outstanding Resource Waters ____ Nutrient Sensitive Waters ____Water Supply Watershed ____(I-IV)

17. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area:_

18. Does channel appear on USGS quad map? YES [✓ NO] 19. Does channel appear on USDA Soil Survey? YES [✓ NO]

20. Estimated Watershed Land Use: _____% Residential ____% Commercial ____% Industrial 50 % Agricultural

50 % Forested ____% Cleared / Logged ____% Other (__________________)

21. Bankfull Width: 12'

22. Bank Height (from bed to top of bank): 0.5-1'

23. Channel slope down center of stream: X Flat (0 to 2%) ____Gentle (2 to 4%) ____Moderate (4 to 10%) ____Steep (>10%)

24. Channel Sinuosity: X___Straight ____Occasional Bends ____Frequent Meander ____Very Sinuous ____Braided Channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 31 **Comments:**________________________________

Evaluator's Signature________________________ **Date** 2/26/10

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STREAM QUALITY ASSESSMENT WORKSHEET
SCP5 – UT1d to Lyle Creek (Intermittent RPW)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	0
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	4
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	4
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	2
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	1
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	0
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	1
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	1
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	0
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				31

* These characteristics are not assessed in coastal streams.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID: **wetland**
Transect ID: **WL-1**
Plot ID: **DP1**

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1 *Leersia oryzoides*	herb	OBL	9		
2 *Scirpus cyperinus*	herb	OBL	10		
3 *Polygonum pensylvanicum*	herb	FACW	11		
4 *Juncus effusus*	herb	FACW+	12		
5 *Cyperus strigosus*	herb	FACW	13		
6 *Typha latifolia*	herb	OBL	14		
7			15		
8			16		

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

100% of the dominant plant species are FAC or wetter.

HYDROLOGY

___ Recorded Data (Describe in remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **1-2** (in.)

Depth to Free Water in Pit: **N/A** (in.)

Depth to Saturated Soil: **<12** (in.)

Wetland Hydrology Indicators:

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

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- X Water-Stained Leaves
- ___ Local Soil Survey Data
- X FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

Indicators of wetland hydrology are present.

SOILS

Map Unit Name

(Series and Phase): **Chewacla loam (Cw)**

Drainage Class **poorly drained**

Field Observations

Taxonomy (Subgroup): **thermic Fluvaquentic Dystrudepts**

Confirm Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4	B	2.5Y 4/1	N/A	N/A	sandy silt loam
4-12	B	2.5Y 5/2	7.5YR 4/6	many distinct	clay loam

Histosol

Histic Epipedon

Sulfidic Odor

Aquic Moisture Regime

Reducing Conditions

X Gleyed or Low-Chroma Colors

Concretions

High Organic Content in Surface Layer in Sandy Soils

Organic Streaking in Sandy Soils

X Listed on Local Hydric Soils List (Inclusions)

Listed on National Hydric Soils List

Other (Explain in Remarks)

Remarks:

Indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)

Wetland Hydrology Present? [✓ Yes] No

Hydric Soils Present? [✓ Yes] No

(Circle)

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

Remarks:

Data point is representative of a jurisdictional wetland area. Jurisdictional area is a drainage feature located within a heavily maintained agricultural field.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID: **upland**
Transect ID:
Plot ID: **DP2**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Cyperus strigosus*	herb	FACW	9			
2	*Juncus effusus*	herb	FACW+	10			
3	*Setaria parviflora*	herb	FAC	11			
4	*Festuca spp.*	herb	-	12			
5				13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

All of the dominant plant species are FAC or wetter.

HYDROLOGY

___ Recorded Data (Describe in remarks):
    ___ Stream, Lake or Tide Gauge
    ___ Aerial Photographs
    ___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: **N/A** (in.)

Depth to Free Water in Pit: **N/A** (in.)

Depth to Saturated Soil: **>12** (in.)

Wetland Hydrology Indicators:

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

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

No indicators of wetland hydrology are present.

SOILS

Map Unit Name

(Series and Phase): **Chewacla loam (Cw)**

Drainage Class **poorly drained**

Field Observations

Taxonomy (Subgroup): **thermic Fluvaquentic Dystrudepts**

Confirm Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-5	B	10YR 4/3	7.5YR 4/4	few faint	clay loam
5-12	B	10YR 4/4	7.5YR 4/6	few distinct	silty clay loam

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List (Inclusions)
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

No indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)

Wetland Hydrology Present? Yes [✓ No]

Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? (Circle) Yes [✓ No]

Remarks:

Data point is representative of a non-jurisdictional upland area; mowed agricultural field.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: **wetland**
Transect ID: **WL-2**
Plot ID: **DP3**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Leersia oryzoides*	herb	OBL	9			
2	*Scirpus cyperinus*	herb	OBL	10			
3	*Polygonum pensylvanicum*	herb	FACW	11			
4	*Juncus effusus*	herb	FACW+	12			
5	*Cyperus strigosus*	herb	FACW	13			
6	*Typha latifolia*	herb	OBL	14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

100% of the dominant plant species are FAC or wetter.

HYDROLOGY

___ Recorded Data (Describe in remarks):
___ Stream, Lake or Tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: **N/A** (in.)
Depth to Free Water in Pit: **N/A** (in.)
Depth to Saturated Soil: **24"** (in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
X Saturated in Upper 12 Inches
X Water Marks
___ Drift Lines
___ Sediment Deposits (on leaves)
X Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
X Water-Stained Leaves
___ Local Soil Survey Data
X FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

Indicators of wetland hydrology are present.

SOILS

Map Unit Name
(Series and Phase): **Chewacla loam (Cw)**

Drainage Class: **poorly drained**

Field Observations
Confirm Mapped Type? Yes [✓ No]

Taxonomy (Subgroup): **thermic Fluvaquentic Dystrudepts**

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3	B	10YR 5/3	N/A	N/A	sandy silt loam
3-12	B	10YR 4/2	7.5YR 4/6	many distinct	sandy clay loam

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors

- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☒ Listed on Local Hydric Soils List (Inclusions)
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

Indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

(Circle)
Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

Data point is representative of a jurisdictional wetland area. Jurisdictional area is a drainage feature located within a heavily maintained agricultural field.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID: **upland**
Transect ID:
Plot ID: **DP4**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Cyperus strigosus*	herb	FACW	9			
2	*Juncus effusus*	herb	FACW+	10			
3	*Setaria parviflora*	herb	FAC	11			
4	*Festuca spp.*	herb	-	12			
5				13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

All of the dominant plant species are FAC or wetter.

HYDROLOGY

____ Recorded Data (Describe in remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **N/A** (in.)
Depth to Free Water in Pit: **N/A** (in.)
Depth to Saturated Soil: **>12** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- ____ Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits (on leaves)
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- Other (Explain in Remarks)

Remarks:

No indicators of wetland hydrology are present.

SOILS

Map Unit Name

(Series and Phase): **Chewacla loam (Cw)**

Drainage Class **poorly drained**

Field Observations

Taxonomy (Subgroup): **thermic Fluvaquentic Dystrudepts**

Confirm Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-7	B	10YR 5/4	N/A	N/A	silt loam
7-12	B	10YR 5/3	7.5YR 5/6	few distinct	sandy silt loam

____ Histosol
____ Histic Epipedon
____ Sulfidic Odor
____ Aquic Moisture Regime
____ Reducing Conditions
____ Gleyed or Low-Chroma Colors

____ Concretions
____ High Organic Content in Surface Layer in Sandy Soils
____ Organic Streaking in Sandy Soils
X Listed on Local Hydric Soils List (Inclusions)
____ Listed on National Hydric Soils List
____ Other (Explain in Remarks)

Remarks:

No indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

(Circle)
Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

Data point is representative of a non-jurisdictional upland area; mowed agricultural field.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID: **upland**
Transect ID:
Plot ID: **DP5**

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1 *Cyperus strigosus*	herb	FACW	9		
2 *Juncus effusus*	herb	FACW+	10		
3 *Setaria parviflora*	herb	FAC	11		
4 *Festuca spp.*	herb	-	12		
5			13		
6			14		
7			15		
8			16		

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

All of the dominant plant species are FAC or wetter.

HYDROLOGY

____ Recorded Data (Describe in remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **N/A** (in.)
Depth to Free Water in Pit: **N/A** (in.)
Depth to Saturated Soil: **>12** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- ____ Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits (on leaves)
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

Remarks:

No indicators of wetland hydrology are present.

SOILS

Map Unit Name
(Series and Phase): **Chewacla loam (Cw)**

Drainage Class **poorly drained**

Field Observations

Taxonomy (Subgroup): **thermic Fluvaquentic Dystrudepts**

Confirm Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-12	**B**	**7.5YR 4/4**	**N/A**	**N/A**	**silt loam**

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☒ Listed on Local Hydric Soils List (Inclusions)
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

No indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)

Wetland Hydrology Present? Yes [✓ No]

Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No] (Circle)

Remarks:

Data point is representative of a non-jurisdictional upland area; mowed agricultural field.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID: **upland**
Transect ID:
Plot ID: **DP6**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Cyperus strigosus*	herb	FACW	9			
2	*Juncus effusus*	herb	FACW+	10			
3	*Setaria parviflora*	herb	FAC	11			
4	*Festuca spp.*	herb	-	12			
5				13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

All of the dominant plant species are FAC or wetter.

HYDROLOGY

Recorded Data (Describe in remarks):
- Stream, Lake or Tide Gauge
- Aerial Photographs
- Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **N/A** (in.)
Depth to Free Water in Pit: **N/A** (in.)
Depth to Saturated Soil: **>12** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- Inundated
- Saturated in Upper 12 Inches
- Water Marks
- Drift Lines
- Sediment Deposits (on leaves)
- Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- Oxidized Root Channels in Upper 12 Inches
- Water-Stained Leaves
- Local Soil Survey Data
- FAC-Neutral Test
- Other (Explain in Remarks)

Remarks:

No indicators of wetland hydrology are present.

SOILS

Map Unit Name
(Series and Phase): **Chewacla loam (Cw)**

Drainage Class **poorly drained**

Field Observations

Taxonomy (Subgroup): **thermic Fluvaquentic Dystrudepts**

Confirm Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-10	B	10YR 4/3	10YR 3/4	few faint	silt loam
10-12	B	2.5Y 5/3	7.5YR 4/4	few distinct	silt loam

____ Histosol
____ Histic Epipedon
____ Sulfidic Odor
____ Aquic Moisture Regime
____ Reducing Conditions
____ Gleyed or Low-Chroma Colors

____ Concretions
____ High Organic Content in Surface Layer in Sandy Soils
____ Organic Streaking in Sandy Soils
X Listed on Local Hydric Soils List (Inclusions)
____ Listed on National Hydric Soils List
____ Other (Explain in Remarks)

Remarks:

No indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

(Circle)
Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

Data point is representative of a non-jurisdictional upland area; mowed agricultural field.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID: **wetland**
Transect ID: **WL-3**
Plot ID: **DP7**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Leersia oryzoides*	herb	OBL	9	*Salix nigra*	shrub	OBL
2	*Polygonum pensylvanicum*	herb	FACW	10			
3	*Scirpus cyperinus*	herb	OBL	11			
4	*Cyperus strigosus*	herb	FACW	12			
5	*Typha latifolia*	herb	OBL	13			
6	*Impatiens capensis*	herb	FACW	14			
7	*Cephalanthus occidentalis*	herb	OBL	15			
8	*Juncus effusus*	herb	FACW+	16			

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

100% of the dominant plant species are FAC or wetter.

HYDROLOGY

___ Recorded Data (Describe in remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **6-12** (in.)

Depth to Free Water in Pit: **N/A** (in.)

Depth to Saturated Soil: **<12** (in.)

Wetland Hydrology Indicators:

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

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- X Water-Stained Leaves
- ___ Local Soil Survey Data
- X FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

Indicators of wetland hydrology are present.

SOILS

Map Unit Name
(Series and Phase): **Wehadkee fine sandy loam (Wd)**

Drainage Class **poorly drained**

Field Observations

Taxonomy (Subgroup): **mesic Fluvaquentic Endoaquepts**

Confirm Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-6	**B**	**2.5Y 4/2**	**7.5YR 4/6**	**many distinct**	**silt loam**
6-12	**B**	**7.5YR 4/4**	**10YR 4/3**	**few faint**	**silty clay**

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors

___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
X Listed on Local Hydric Soils List (Inclusions)
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

Indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

(Circle)
Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

Data point is representative of a jurisdictional wetland area. Jurisdictional area is a drainage feature located within a heavily maintained agricultural field.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: **wetland**
Transect ID: **WL-4**
Plot ID: **DP8**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Leersia oryzoides*	herb	OBL	9			
2	*Scirpus cyperinus*	herb	OBL	10			
3	*Juncus effusus*	herb	FACW+	11			
4	*Cyperus strigosus*	herb	FACW	12			
5	*Polygonum pensylvanicum*	herb	FACW	13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

100% of the dominant plant species are FAC or wetter.

HYDROLOGY

Recorded Data (Describe in remarks):
- Stream, Lake or Tide Gauge
- Aerial Photographs
- Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **3-4** (in.)
Depth to Free Water in Pit: **N/A** (in.)
Depth to Saturated Soil: **<12** (in.)

Wetland Hydrology Indicators:

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

Secondary Indicators (2 or more required):
- Oxidized Root Channels in Upper 12 Inches
- X Water-Stained Leaves
- Local Soil Survey Data
- X FAC-Neutral Test
- Other (Explain in Remarks)

Remarks:

Indicators of wetland hydrology are present.

SOILS

Map Unit Name
(Series and Phase): **Chewacla loam (Cw)**

Drainage Class **poorly drained**

Field Observations

Taxonomy (Subgroup): **thermic Fluvaquentic Dystrudepts**

Confirm Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4	**B**	**10YR 4/2**	**7.5YR 4/4**	**many distinct**	**silty clay**
4-12	**B**	**10YR 4/1**	**7.5YR 4/6**	**few distinct**	**clay**

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- **X** Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- **X** Listed on Local Hydric Soils List (Inclusions)
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

Indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)

Wetland Hydrology Present? [✓ Yes] No

Hydric Soils Present? [✓ Yes] No

(Circle)

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

Remarks:

Data point is representative of a jurisdictional wetland area. Jurisdictional area is a drainage feature located within a heavily maintained agricultural field.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **Lyle Creek Mitigation Site**
Applicant/Owner: **Wildlands Engineering**
Investigator(s): **Matt Jenkins, PWS**
Date: **08/24/10**
County: **Catawba**
State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID: **wetland**
Transect ID: **WL-5**
Plot ID: **DP9**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Leersia oryzoides*	herb	OBL	9			
2	*Scirpus cyperinus*	herb	OBL	10			
3	*Juncus effusus*	herb	FACW+	11			
4	*Cyperus strigosus*	herb	FACW	12			
5	*Polygonum pensylvanicum*	herb	FACW	13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC

100%

Remarks:

100% of the dominant plant species are FAC or wetter.

HYDROLOGY

___ Recorded Data (Describe in remarks):
___ Stream, Lake or Tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: **2-6** (in.)
Depth to Free Water in Pit: **N/A** (in.)
Depth to Saturated Soil: **<12** (in.)

Wetland Hydrology Indicators:

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

Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
X Water-Stained Leaves
___ Local Soil Survey Data
X FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

Indicators of wetland hydrology are present.

SOILS

Map Unit Name
(Series and Phase): **Chewacla loam (Cw)**

Drainage Class **poorly drained**

Field Observations
Confirm Mapped Type? Yes [✓ No]

Taxonomy (Subgroup): **thermic Fluvaquentic Dystrudepts**

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3	B	7.5YR 4/3	N/A	N/A	silty clay
3-12	B	10YR 4/2	7.5YR 4/4	many faint	clay

Histosol
Histic Epipedon
Sulfidic Odor
Aquic Moisture Regime
Reducing Conditions
X Gleyed or Low-Chroma Colors

Concretions
High Organic Content in Surface Layer in Sandy Soils
Organic Streaking in Sandy Soils
X Listed on Local Hydric Soils List (Inclusions)
Listed on National Hydric Soils List
Other (Explain in Remarks)

Remarks:

Indicators of hydric soils are present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

(Circle)
Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

Data point is representative of a jurisdictional wetland area. Jurisdictional area is a drainage feature located within a heavily maintained agricultural field.

Approved by HQUSACE 2/92

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Lyle Creek Mitigation Site: WL-1

Date 08/24/2010

Wetland Type Bottomland Hardwood Forest

Assessor Name/Organization Matt Jenkins, PWS

Level III Ecoregion Piedmont

Nearest Named Water Body Lyle Creek

River Basin Catawba

USGS 8-Digit Catalogue Unit 03050101

○ **Yes** ● **No** **Precipitation within 48 hrs?**

Latitude/Longitude (deci-degrees) 35.712843°N, 81.079538°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)

Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ● Yes ○ No

Describe effects of stressors that are present.

Wetland located within an actively managed tree farm. Vegetation is regularly mowed, soils are driven on and occansionally compacted.

Regulatory Considerations

Select all that apply to the assessment area.

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

○ Blackwater
● Brownwater
☐ Tidal (if tidal, check one of the following boxes) ○ Lunar ○ Wind ○ Both

Is the assessment area on a coastal island? ○ Yes ● No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ○ Yes ● No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**
   Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
○ A	○ A	Not severely altered
● B	● B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**
   Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
○ A	● A	Water storage capacity and duration are not altered.
● B	○ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
○ C	○ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**
   Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
○ A	○ A	Majority of wetland with depressions able to pond water > 1 foot deep
○ B	○ B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
○ C	○ C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
● D	● D	Depressions able to pond water < 3 inches deep

○ A Evidence that maximum depth of inundation is greater than 2 feet
○ B Evidence that maximum depth of inundation is between 1 and 2 feet
● C Evidence that maximum depth of inundation is less than 1 foot

4. **Soil Texture/Structure – assessment area condition metric**
Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

○ A Sandy soil
● B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
○ C Loamy or clayey soils not exhibiting redoxymorphic features
○ D Loamy or clayey gleyed soil
○ E Histosol or histic epipedon

● A Soil ribbon < 1 inch
○ B Soil ribbon ≥ 1 inch

● A No peat or muck presence
○ B A peat or muck presence

5. **Discharge into Wetland – opportunity metric**
Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf Sub
● A ● A Little or no evidence of pollutants or discharges entering the assessment area
○ B ○ B Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
○ C ○ C Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. **Land Use – opportunity metric**
Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS 5M 2M
☐ A ☐ A ☐ A ≥ 10% impervious surfaces
☑ B ☑ B ☑ B < 10% impervious surfaces
☐ C ☐ C ☐ C Confined animal operations (or other local, concentrated source of pollutants)
☐ D ☐ D ☐ D ≥ 20% coverage of pasture
☐ E ☐ E ☐ E ≥ 20% coverage of agricultural land (regularly plowed land)
☑ F ☑ F ☑ F ≥ 20% coverage of maintained grass/herb
☐ G ☐ G ☐ G ≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H ☐ H ☐ H Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. **Wetland Acting as Vegetated Buffer – assessment area condition metric**

7a. Is assessment area within 50 feet of a tributary or other open water?
● Yes ○ No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.
○ A ≥ 50 feet
○ B From 30 to < 50 feet
○ C From 15 to < 30 feet
● D From 5 to < 15 feet
○ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
● ≤ 15-feet wide ○ > 15-feet wide ○ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
○ Yes ● No

7e. Is tributary or other open water sheltered or exposed?
● Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
○ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. **Wetland Width at the Assessment Area – wetland type/wetland complex metric**
Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT WC
○ A ○ A ≥ 100 feet
○ B ○ B From 80 to < 100 feet
○ C ○ C From 50 to < 80 feet
○ D ○ D From 40 to < 50 feet
○ E ○ E From 30 to < 40 feet
○ F ○ F From 15 to < 30 feet
○ G ○ G From 5 to < 15 feet
● H ● H < 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- ● A Evidence of short-duration inundation (< 7 consecutive days)
- ○ B Evidence of saturation, without evidence of inundation
- ○ C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- ● A Sediment deposition is not excessive, but at approximately natural levels.
- ○ B Sediment deposition is excessive, but not overwhelming the wetland.
- ○ C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
○ A	○ A	○ A	≥ 500 acres
○ B	○ B	○ B	From 100 to < 500 acres
○ C	○ C	○ C	From 50 to < 100 acres
○ D	○ D	○ D	From 25 to < 50 acres
○ E	○ E	○ E	From 10 to < 25 acres
○ F	○ F	○ F	From 5 to < 10 acres
○ G	○ G	○ G	From 1 to < 5 acres
○ H	○ H	○ H	From 0.5 to < 1 acre
● I	● I	○ I	From 0.1 to < 0.5 acre
○ J	○ J	○ J	From 0.01 to < 0.1 acre
○ K	○ K	● K	< 0.01 acre <u>or</u> assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- ○ A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- ○ B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
○ A	○ A	≥ 500 acres
○ B	○ B	From 100 to < 500 acres
○ C	○ C	From 50 to < 100 acres
○ D	○ D	From 10 to < 50 acres
○ E	○ E	< 10 acres
● F	● F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

○ Yes ○ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- ○ A No artificial edge within 150 feet in all directions
- ○ B No artificial edge within 150 feet in four (4) to seven (7) directions
- ● C An artificial edge occurs within 150 feet in more than four (4) directions <u>or</u> assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- ○ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- ○ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- ● C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- ○ A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- ○ B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- ○ C Vegetation is dominated by exotic species (>50% cover of exotics).

○

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

● Yes ○ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

- ○ A ≥ 25% coverage of vegetation
- ○ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
○ A	○ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
○ B	○ B	Canopy present, but opened more than natural gaps
● C	● C	Canopy sparse or absent
○ A	○ A	Dense mid-story/sapling layer
○ B	○ B	Moderate density mid-story/sapling layer
● C	● C	Mid-story/sapling layer sparse or absent
○ A	○ A	Dense shrub layer
○ B	○ B	Moderate density shrub layer
● C	● C	Shrub layer sparse or absent
● A	● A	Dense herb layer
○ B	○ B	Moderate density herb layer
○ C	○ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

- ○ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
- ● B Not A

19. Diameter Class Distribution – wetland type condition metric

- ○ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
- ○ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
- ● C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

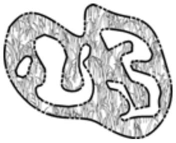
Include both natural debris and man-placed natural debris.

- ○ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
- ● B Not A

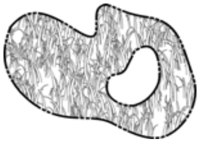
21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

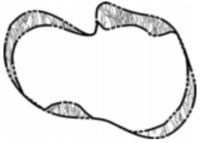
○ A



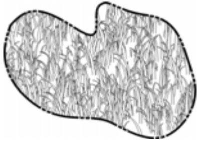
○ B



○ C



○ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

- ○ A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
- ○ B Overbank flow is severely altered in the assessment area.
- ● C Overland flow is severely altered in the assessment area.
- ○ D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Lyle Creek Mitigation Site: WL-1

Date 08/24/2010

Wetland Type Bottomland Hardwood Forest

Assessor Name/Organization Matt Jenkins, PWS

Presence of stressor affecting assessment area (Y/N)	YES
Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	YES
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**LOW**
	Sub-Surface Storage and Retention	Condition	**MEDIUM**
Water Quality	Pathogen Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Particulate Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**NO**
	Soluble Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Physical Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**NO**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**LOW**

Function Rating Summary

Function	Metrics/Notes	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**LOW**
	Condition/Opportunity	**LOW**
	Opportunity Presence? (Y/N)	**NO**
Habitat	Conditon	**LOW**

Overall Wetland Rating **LOW**

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Lyle Creek Mitigation Site: WL-2
Date 08/24/2010
Wetland Type Bottomland Hardwood Forest
Assessor Name/Organization Matt Jenkins, PWS
Level III Ecoregion Piedmont
Nearest Named Water Body Lyle Creek
River Basin Catawba
USGS 8-Digit Catalogue Unit 03050101
○ **Yes** ● **No** **Precipitation within 48 hrs?**
Latitude/Longitude (deci-degrees) 35.712843°N, 81.079538°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ● Yes ○ No

Describe effects of stressors that are present.
Wetland located within an actively managed tree farm. Vegetation is regularly mowed, soils are driven on and occansionally compacted.

Regulatory Considerations
Select all that apply to the assessment area.
☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)
○ Blackwater
● Brownwater
☐ Tidal (if tidal, check one of the following boxes) ○ Lunar ○ Wind ○ Both

Is the assessment area on a coastal island? ○ Yes ● No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ○ Yes ● No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
○ A	○ A	Not severely altered
● B	● B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
○ A	● A	Water storage capacity and duration are not altered.
● B	○ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
○ C	○ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
○ A	○ A	Majority of wetland with depressions able to pond water > 1 foot deep
○ B	○ B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
○ C	○ C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
● D	● D	Depressions able to pond water < 3 inches deep

○ A Evidence that maximum depth of inundation is greater than 2 feet
○ B Evidence that maximum depth of inundation is between 1 and 2 feet
● C Evidence that maximum depth of inundation is less than 1 foot

4. **Soil Texture/Structure – assessment area condition metric**
Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

○ A Sandy soil
● B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
○ C Loamy or clayey soils not exhibiting redoxymorphic features
○ D Loamy or clayey gleyed soil
○ E Histosol or histic epipedon

● A Soil ribbon < 1 inch
○ B Soil ribbon ≥ 1 inch

● A No peat or muck presence
○ B A peat or muck presence

5. **Discharge into Wetland – opportunity metric**
Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf Sub
● A ● A Little or no evidence of pollutants or discharges entering the assessment area
○ B ○ B Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
○ C ○ C Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. **Land Use – opportunity metric**
Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS 5M 2M
☐ A ☐ A ☐ A ≥ 10% impervious surfaces
☑ B ☑ B ☑ B < 10% impervious surfaces
☐ C ☐ C ☐ C Confined animal operations (or other local, concentrated source of pollutants)
☐ D ☐ D ☐ D ≥ 20% coverage of pasture
☐ E ☐ E ☐ E ≥ 20% coverage of agricultural land (regularly plowed land)
☑ F ☑ F ☑ F ≥ 20% coverage of maintained grass/herb
☐ G ☐ G ☐ G ≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H ☐ H ☐ H Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. **Wetland Acting as Vegetated Buffer – assessment area condition metric**

7a. Is assessment area within 50 feet of a tributary or other open water?
● Yes ○ No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.
○ A ≥ 50 feet
● B From 30 to < 50 feet
○ C From 15 to < 30 feet
○ D From 5 to < 15 feet
○ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
● ≤ 15-feet wide ○ > 15-feet wide ○ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
● Yes ○ No

7e. Is tributary or other open water sheltered or exposed?
● Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
○ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. **Wetland Width at the Assessment Area – wetland type/wetland complex metric**
Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT WC
○ A ○ A ≥ 100 feet
○ B ○ B From 80 to < 100 feet
○ C ○ C From 50 to < 80 feet
● D ● D From 40 to < 50 feet
○ E ○ E From 30 to < 40 feet
○ F ○ F From 15 to < 30 feet
○ G ○ G From 5 to < 15 feet
○ H ○ H < 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- ○ A Evidence of short-duration inundation (< 7 consecutive days)
- ● B Evidence of saturation, without evidence of inundation
- ○ C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- ● A Sediment deposition is not excessive, but at approximately natural levels.
- ○ B Sediment deposition is excessive, but not overwhelming the wetland.
- ○ C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
○ A	○ A	○ A	≥ 500 acres
○ B	○ B	○ B	From 100 to < 500 acres
○ C	○ C	○ C	From 50 to < 100 acres
○ D	○ D	○ D	From 25 to < 50 acres
○ E	○ E	○ E	From 10 to < 25 acres
○ F	○ F	○ F	From 5 to < 10 acres
○ G	○ G	○ G	From 1 to < 5 acres
○ H	○ H	○ H	From 0.5 to < 1 acre
● I	● I	○ I	From 0.1 to < 0.5 acre
○ J	○ J	○ J	From 0.01 to < 0.1 acre
○ K	○ K	● K	< 0.01 acre <u>or</u> assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- ○ A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- ○ B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
○ A	○ A	≥ 500 acres
○ B	○ B	From 100 to < 500 acres
○ C	○ C	From 50 to < 100 acres
○ D	○ D	From 10 to < 50 acres
○ E	○ E	< 10 acres
● F	● F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

○ Yes ○ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- ○ A No artificial edge within 150 feet in all directions
- ○ B No artificial edge within 150 feet in four (4) to seven (7) directions
- ● C An artificial edge occurs within 150 feet in more than four (4) directions <u>or</u> assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- ○ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- ○ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- ● C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- ○ A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- ○ B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- ○ C Vegetation is dominated by exotic species (>50% cover of exotics).

○

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

● Yes ○ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

○ A ≥ 25% coverage of vegetation
○ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
○ A	○ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
○ B	○ B	Canopy present, but opened more than natural gaps
● C	● C	Canopy sparse or absent
○ A	○ A	Dense mid-story/sapling layer
○ B	○ B	Moderate density mid-story/sapling layer
● C	● C	Mid-story/sapling layer sparse or absent
○ A	○ A	Dense shrub layer
○ B	○ B	Moderate density shrub layer
● C	● C	Shrub layer sparse or absent
● A	● A	Dense herb layer
○ B	○ B	Moderate density herb layer
○ C	○ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

○ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
● B Not A

19. Diameter Class Distribution – wetland type condition metric

○ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
○ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
● C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

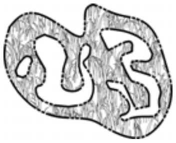
Include both natural debris and man-placed natural debris.

○ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
● B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

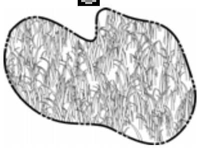
○ A



○ B

○ C

○ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

○ A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
○ B Overbank flow is severely altered in the assessment area.
● C Overland flow is severely altered in the assessment area.
○ D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name: Lyle Creek Mitigation Site: WL-2
Date: 08/24/2010
Wetland Type: Bottomland Hardwood Forest
Assessor Name/Organization: Matt Jenkins, PWS

Presence of stressor affecting assessment area (Y/N)	YES
Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	YES
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**LOW**
	Sub-Surface Storage and Retention	Condition	**MEDIUM**
Water Quality	Pathogen Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Particulate Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**NO**
	Soluble Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**NO**
	Physical Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**LOW**

Function Rating Summary

Function	Metrics/Notes	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**LOW**
	Condition/Opportunity	**LOW**
	Opportunity Presence? (Y/N)	**NO**
Habitat	Conditon	**LOW**

Overall Wetland Rating **LOW**

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Lyle Creek Mitigation Site: WL-3
Date 08/24/2010
Wetland Type Bottomland Hardwood Forest
Assessor Name/Organization Matt Jenkins, PWS
Level III Ecoregion Piedmont
Nearest Named Water Body Lyle Creek
River Basin Catawba
USGS 8-Digit Catalogue Unit 03050101
○ **Yes** ● **No** **Precipitation within 48 hrs?**
Latitude/Longitude (deci-degrees) 35.712843°N, 81.079538°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ● Yes ○ No

Describe effects of stressors that are present.
Wetland located within an actively managed tree farm. Vegetation is regularly mowed, soils are driven on and occansionally compacted.

Regulatory Considerations
Select all that apply to the assessment area.
☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)
○ Blackwater
● Brownwater
☐ Tidal (if tidal, check one of the following boxes) ○ Lunar ○ Wind ○ Both

Is the assessment area on a coastal island? ○ Yes ● No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ○ Yes ● No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
○ A	○ A	Not severely altered
● B	● B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
○ A	● A	Water storage capacity and duration are not altered.
● B	○ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
○ C	○ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
○ A	○ A	Majority of wetland with depressions able to pond water > 1 foot deep
● B	● B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
○ C	○ C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
○ D	○ D	Depressions able to pond water < 3 inches deep

○ A Evidence that maximum depth of inundation is greater than 2 feet
● B Evidence that maximum depth of inundation is between 1 and 2 feet
○ C Evidence that maximum depth of inundation is less than 1 foot

4. **Soil Texture/Structure – assessment area condition metric**
Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

○ A Sandy soil
● B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
○ C Loamy or clayey soils not exhibiting redoxymorphic features
○ D Loamy or clayey gleyed soil
○ E Histosol or histic epipedon

○ A Soil ribbon < 1 inch
● B Soil ribbon ≥ 1 inch

● A No peat or muck presence
○ B A peat or muck presence

5. **Discharge into Wetland – opportunity metric**
Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
● A	● A	Little or no evidence of pollutants or discharges entering the assessment area
○ B	○ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
○ C	○ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. **Land Use – opportunity metric**
Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	≥ 10% impervious surfaces
☑ B	☑ B	☑ B	< 10% impervious surfaces
☐ C	☐ C	☐ C	Confined animal operations (or other local, concentrated source of pollutants)
☐ D	☐ D	☐ D	≥ 20% coverage of pasture
☐ E	☐ E	☐ E	≥ 20% coverage of agricultural land (regularly plowed land)
☑ F	☑ F	☑ F	≥ 20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. **Wetland Acting as Vegetated Buffer – assessment area condition metric**

7a. Is assessment area within 50 feet of a tributary or other open water?
● Yes ○ No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.
○ A ≥ 50 feet
● B From 30 to < 50 feet
○ C From 15 to < 30 feet
○ D From 5 to < 15 feet
○ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
● ≤ 15-feet wide ○ > 15-feet wide ○ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
● Yes ○ No

7e. Is tributary or other open water sheltered or exposed?
● Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
○ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. **Wetland Width at the Assessment Area – wetland type/wetland complex metric**
Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
○ A	○ A	≥ 100 feet
○ B	○ B	From 80 to < 100 feet
○ C	○ C	From 50 to < 80 feet
○ D	○ D	From 40 to < 50 feet
○ E	○ E	From 30 to < 40 feet
○ F	○ F	From 15 to < 30 feet
● G	● G	From 5 to < 15 feet
○ H	○ H	< 5 feet

9. **Inundation Duration – assessment area condition metric**
Answer for assessment area dominant landform.
- ○ A Evidence of short-duration inundation (< 7 consecutive days)
- ○ B Evidence of saturation, without evidence of inundation
- ● C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. **Indicators of Deposition – assessment area condition metric**
Consider recent deposition only (no plant growth since deposition).
- ● A Sediment deposition is not excessive, but at approximately natural levels.
- ○ B Sediment deposition is excessive, but not overwhelming the wetland.
- ○ C Sediment deposition is excessive and is overwhelming the wetland.

11. **Wetland Size – wetland type/wetland complex condition metric**
Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select “K” for the FW column.

WT	WC	FW (if applicable)	
○ A	○ A	○ A	≥ 500 acres
○ B	○ B	○ B	From 100 to < 500 acres
○ C	○ C	○ C	From 50 to < 100 acres
○ D	○ D	○ D	From 25 to < 50 acres
○ E	○ E	○ E	From 10 to < 25 acres
○ F	○ F	○ F	From 5 to < 10 acres
○ G	○ G	○ G	From 1 to < 5 acres
○ H	○ H	○ H	From 0.5 to < 1 acre
● I	● I	○ I	From 0.1 to < 0.5 acre
○ J	○ J	○ J	From 0.01 to < 0.1 acre
○ K	○ K	● K	< 0.01 acre <u>or</u> assessment area is clear-cut

12. **Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**
- ○ A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- ○ B Pocosin is < 90% of the full extent of its natural landscape size.

13. **Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
○ A	○ A	≥ 500 acres
○ B	○ B	From 100 to < 500 acres
○ C	○ C	From 50 to < 100 acres
○ D	○ D	From 10 to < 50 acres
○ E	○ E	< 10 acres
● F	● F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.
○ Yes ○ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. **Edge Effect – wetland type condition metric**
May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.
- ○ A No artificial edge within 150 feet in all directions
- ○ B No artificial edge within 150 feet in four (4) to seven (7) directions
- ● C An artificial edge occurs within 150 feet in more than four (4) directions <u>or</u> assessment area is clear-cut

15. **Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**
- ○ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- ○ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- ● C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. **Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**
- ○ A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- ○ B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- ○ C Vegetation is dominated by exotic species (>50% cover of exotics).

○

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

◉ Yes ○ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

○ A ≥ 25% coverage of vegetation
○ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
○ A	○ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
○ B	○ B	Canopy present, but opened more than natural gaps
◉ C	◉ C	Canopy sparse or absent
○ A	○ A	Dense mid-story/sapling layer
○ B	○ B	Moderate density mid-story/sapling layer
◉ C	◉ C	Mid-story/sapling layer sparse or absent
○ A	○ A	Dense shrub layer
○ B	○ B	Moderate density shrub layer
◉ C	◉ C	Shrub layer sparse or absent
◉ A	◉ A	Dense herb layer
○ B	○ B	Moderate density herb layer
○ C	○ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

○ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
◉ B Not A

19. Diameter Class Distribution – wetland type condition metric

○ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
○ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
◉ C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

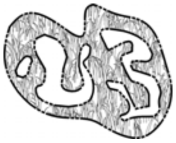
Include both natural debris and man-placed natural debris.

○ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
◉ B Not A

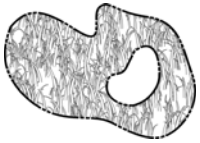
21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

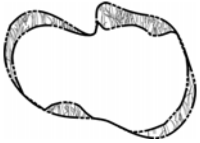
○ A



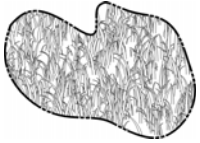
○ B



○ C



○ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

○ A Overbank and overland flow are not severely altered in the assessment area.
○ B Overbank flow is severely altered in the assessment area.
◉ C Overland flow is severely altered in the assessment area.
○ D Both overbank and overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name: Lyle Creek Mitigation Site: WL-3
Date: 08/24/2010
Wetland Type: Bottomland Hardwood Forest
Assessor Name/Organization: Matt Jenkins, PWS

Presence of stressor affecting assessment area (Y/N)	YES
Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	YES
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**LOW**
	Sub-Surface Storage and Retention	Condition	**LOW**
Water Quality	Pathogen Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**NO**
	Particulate Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**NO**
	Soluble Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Physical Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**LOW**

Function Rating Summary

Function	Metrics/Notes	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**LOW**
	Condition/Opportunity	**LOW**
	Opportunity Presence? (Y/N)	**NO**
Habitat	Conditon	**LOW**

Overall Wetland Rating **LOW**

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Lyle Creek Mitigation Site: WL-4
Date 08/24/2010
Wetland Type Bottomland Hardwood Forest
Assessor Name/Organization Matt Jenkins, PWS
Level III Ecoregion Piedmont
Nearest Named Water Body Lyle Creek
River Basin Catawba
USGS 8-Digit Catalogue Unit 03050101
○ **Yes** ● **No** **Precipitation within 48 hrs?**
Latitude/Longitude (deci-degrees) 35.712843°N, 81.079538°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ● Yes ○ No

Describe effects of stressors that are present.
Wetland located within an actively managed tree farm. Vegetation is regularly mowed, soils are driven on and occansionally compacted.

Regulatory Considerations
Select all that apply to the assessment area.
☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)
○ Blackwater
● Brownwater
☐ Tidal (if tidal, check one of the following boxes) ○ Lunar ○ Wind ○ Both

Is the assessment area on a coastal island? ○ Yes ● No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ○ Yes ● No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
○ A	○ A	Not severely altered
● B	● B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
○ A	● A	Water storage capacity and duration are not altered.
● B	○ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
○ C	○ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
○ A	○ A	Majority of wetland with depressions able to pond water > 1 foot deep
○ B	○ B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
● C	● C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
○ D	○ D	Depressions able to pond water < 3 inches deep

○ A Evidence that maximum depth of inundation is greater than 2 feet
○ B Evidence that maximum depth of inundation is between 1 and 2 feet
● C Evidence that maximum depth of inundation is less than 1 foot

4. **Soil Texture/Structure – assessment area condition metric**
Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

○ A Sandy soil
● B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
○ C Loamy or clayey soils not exhibiting redoxymorphic features
○ D Loamy or clayey gleyed soil
○ E Histosol or histic epipedon

○ A Soil ribbon < 1 inch
● B Soil ribbon ≥ 1 inch

● A No peat or muck presence
○ B A peat or muck presence

5. **Discharge into Wetland – opportunity metric**
Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf Sub
● A ● A Little or no evidence of pollutants or discharges entering the assessment area
○ B ○ B Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
○ C ○ C Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. **Land Use – opportunity metric**
Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS 5M 2M
☐ A ☐ A ☐ A ≥ 10% impervious surfaces
☑ B ☑ B ☑ B < 10% impervious surfaces
☐ C ☐ C ☐ C Confined animal operations (or other local, concentrated source of pollutants)
☐ D ☐ D ☐ D ≥ 20% coverage of pasture
☐ E ☐ E ☐ E ≥ 20% coverage of agricultural land (regularly plowed land)
☑ F ☑ F ☑ F ≥ 20% coverage of maintained grass/herb
☐ G ☐ G ☐ G ≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H ☐ H ☐ H Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. **Wetland Acting as Vegetated Buffer – assessment area condition metric**
7a. Is assessment area within 50 feet of a tributary or other open water?
● Yes ○ No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.
7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.
○ A ≥ 50 feet
● B From 30 to < 50 feet
○ C From 15 to < 30 feet
○ D From 5 to < 15 feet
○ E < 5 feet or buffer bypassed by ditches
7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
● ≤ 15-feet wide ○ > 15-feet wide ○ Other open water (no tributary present)
7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
● Yes ○ No
7e. Is tributary or other open water sheltered or exposed?
● Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
○ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. **Wetland Width at the Assessment Area – wetland type/wetland complex metric**
Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT WC
○ A ○ A ≥ 100 feet
○ B ○ B From 80 to < 100 feet
○ C ○ C From 50 to < 80 feet
○ D ○ D From 40 to < 50 feet
○ E ○ E From 30 to < 40 feet
○ F ○ F From 15 to < 30 feet
○ G ○ G From 5 to < 15 feet
● H ● H < 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

● A Evidence of short-duration inundation (< 7 consecutive days)
○ B Evidence of saturation, without evidence of inundation
○ C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

● A Sediment deposition is not excessive, but at approximately natural levels.
○ B Sediment deposition is excessive, but not overwhelming the wetland.
○ C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
○ A	○ A	○ A	≥ 500 acres
○ B	○ B	○ B	From 100 to < 500 acres
○ C	○ C	○ C	From 50 to < 100 acres
○ D	○ D	○ D	From 25 to < 50 acres
○ E	○ E	○ E	From 10 to < 25 acres
○ F	○ F	○ F	From 5 to < 10 acres
○ G	○ G	○ G	From 1 to < 5 acres
○ H	○ H	○ H	From 0.5 to < 1 acre
○ I	○ I	○ I	From 0.1 to < 0.5 acre
● J	● J	○ J	From 0.01 to < 0.1 acre
○ K	○ K	● K	< 0.01 acre <u>or</u> assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

○ A Pocosin is the full extent (≥ 90%) of its natural landscape size.
○ B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
○ A	○ A	≥ 500 acres
○ B	○ B	From 100 to < 500 acres
○ C	○ C	From 50 to < 100 acres
○ D	○ D	From 10 to < 50 acres
○ E	○ E	< 10 acres
● F	● F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

○ Yes ○ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

○ A No artificial edge within 150 feet in all directions
○ B No artificial edge within 150 feet in four (4) to seven (7) directions
● C An artificial edge occurs within 150 feet in more than four (4) directions <u>or</u> assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

○ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
○ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
● C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

○ A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
○ B Vegetation diversity is low or has > 10% to 50% cover of exotics.
○ C Vegetation is dominated by exotic species (>50% cover of exotics).

○

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

● Yes ○ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

○ A ≥ 25% coverage of vegetation
○ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
○ A	○ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
○ B	○ B	Canopy present, but opened more than natural gaps
● C	● C	Canopy sparse or absent
○ A	○ A	Dense mid-story/sapling layer
○ B	○ B	Moderate density mid-story/sapling layer
● C	● C	Mid-story/sapling layer sparse or absent
○ A	○ A	Dense shrub layer
○ B	○ B	Moderate density shrub layer
● C	● C	Shrub layer sparse or absent
● A	● A	Dense herb layer
○ B	○ B	Moderate density herb layer
○ C	○ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

○ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
● B Not A

19. Diameter Class Distribution – wetland type condition metric

○ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
○ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
● C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

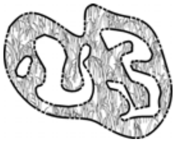
Include both natural debris and man-placed natural debris.

○ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
● B Not A

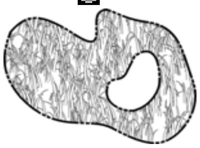
21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

○ A

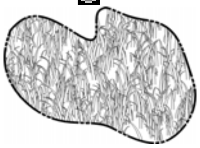


○ B



○ C

○ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

○ A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
○ B Overbank flow is severely altered in the assessment area.
● C Overland flow is severely altered in the assessment area.
○ D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name: Lyle Creek Mitigation Site: WL-4
Date: 08/24/2010
Wetland Type: Bottomland Hardwood Forest
Assessor Name/Organization: Matt Jenkins, PWS

Presence of stressor affecting assessment area (Y/N)	YES
Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	YES
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**LOW**
	Sub-Surface Storage and Retention	Condition	**LOW**
Water Quality	Pathogen Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Particulate Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**NO**
	Soluble Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Physical Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**LOW**

Function Rating Summary

Function	Metrics/Notes	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**MEDIUM**
	Condition/Opportunity	**MEDIUM**
	Opportunity Presence? (Y/N)	**NO**
Habitat	Conditon	**LOW**

Overall Wetland Rating **LOW**

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Lyle Creek Mitigation Site: WL-5

Date 08/24/2010

Wetland Type Bottomland Hardwood Forest

Assessor Name/Organization Matt Jenkins, PWS

Level III Ecoregion Piedmont

Nearest Named Water Body Lyle Creek

River Basin Catawba

USGS 8-Digit Catalogue Unit 03050101

○ **Yes** ● **No** **Precipitation within 48 hrs?**

Latitude/Longitude (deci-degrees) 35.712843°N, 81.079538°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)

Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ● Yes ○ No

Describe effects of stressors that are present.

Wetland located within an actively managed tree farm. Vegetation is regularly mowed, soils are driven on and occansionally compacted.

Regulatory Considerations

Select all that apply to the assessment area.

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

○ Blackwater
● Brownwater
☐ Tidal (if tidal, check one of the following boxes) ○ Lunar ○ Wind ○ Both

Is the assessment area on a coastal island? ○ Yes ● No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ○ Yes ● No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
○ A	○ A	Not severely altered
● B	● B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
○ A	● A	Water storage capacity and duration are not altered.
● B	○ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
○ C	○ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**

Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
○ A	○ A	Majority of wetland with depressions able to pond water > 1 foot deep
○ B	○ B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
● C	● C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
○ D	○ D	Depressions able to pond water < 3 inches deep

○ A Evidence that maximum depth of inundation is greater than 2 feet
○ B Evidence that maximum depth of inundation is between 1 and 2 feet
● C Evidence that maximum depth of inundation is less than 1 foot

4. **Soil Texture/Structure – assessment area condition metric**

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

○ A Sandy soil
● B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
○ C Loamy or clayey soils not exhibiting redoxymorphic features
○ D Loamy or clayey gleyed soil
○ E Histosol or histic epipedon

○ A Soil ribbon < 1 inch
● B Soil ribbon ≥ 1 inch

● A No peat or muck presence
○ B A peat or muck presence

5. **Discharge into Wetland – opportunity metric**

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf Sub
● A ● A Little or no evidence of pollutants or discharges entering the assessment area
○ B ○ B Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
○ C ○ C Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. **Land Use – opportunity metric**

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS 5M 2M
☐ A ☐ A ☐ A ≥ 10% impervious surfaces
☑ B ☑ B ☑ B < 10% impervious surfaces
☐ C ☐ C ☐ C Confined animal operations (or other local, concentrated source of pollutants)
☐ D ☐ D ☐ D ≥ 20% coverage of pasture
☐ E ☐ E ☐ E ≥ 20% coverage of agricultural land (regularly plowed land)
☑ F ☑ F ☑ F ≥ 20% coverage of maintained grass/herb
☐ G ☐ G ☐ G ≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H ☐ H ☐ H Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. **Wetland Acting as Vegetated Buffer – assessment area condition metric**

7a. Is assessment area within 50 feet of a tributary or other open water?
● Yes ○ No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.
○ A ≥ 50 feet
● B From 30 to < 50 feet
○ C From 15 to < 30 feet
○ D From 5 to < 15 feet
○ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
● ≤ 15-feet wide ○ > 15-feet wide ○ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
● Yes ○ No

7e. Is tributary or other open water sheltered or exposed?
● Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
○ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. **Wetland Width at the Assessment Area – wetland type/wetland complex metric**

Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT WC
○ A ○ A ≥ 100 feet
○ B ○ B From 80 to < 100 feet
○ C ○ C From 50 to < 80 feet
○ D ○ D From 40 to < 50 feet
○ E ○ E From 30 to < 40 feet
○ F ○ F From 15 to < 30 feet
○ G ○ G From 5 to < 15 feet
● H ● H < 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

● A Evidence of short-duration inundation (< 7 consecutive days)
○ B Evidence of saturation, without evidence of inundation
○ C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

● A Sediment deposition is not excessive, but at approximately natural levels.
○ B Sediment deposition is excessive, but not overwhelming the wetland.
○ C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
○ A	○ A	○ A	≥ 500 acres
○ B	○ B	○ B	From 100 to < 500 acres
○ C	○ C	○ C	From 50 to < 100 acres
○ D	○ D	○ D	From 25 to < 50 acres
○ E	○ E	○ E	From 10 to < 25 acres
○ F	○ F	○ F	From 5 to < 10 acres
○ G	○ G	○ G	From 1 to < 5 acres
○ H	○ H	○ H	From 0.5 to < 1 acre
○ I	○ I	○ I	From 0.1 to < 0.5 acre
● J	● J	○ J	From 0.01 to < 0.1 acre
○ K	○ K	● K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

○ A Pocosin is the full extent (≥ 90%) of its natural landscape size.
○ B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
○ A	○ A	≥ 500 acres
○ B	○ B	From 100 to < 500 acres
○ C	○ C	From 50 to < 100 acres
○ D	○ D	From 10 to < 50 acres
○ E	○ E	< 10 acres
● F	● F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

○ Yes ○ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

○ A No artificial edge within 150 feet in all directions
○ B No artificial edge within 150 feet in four (4) to seven (7) directions
● C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

○ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
○ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
● C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

○ A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
○ B Vegetation diversity is low or has > 10% to 50% cover of exotics.
○ C Vegetation is dominated by exotic species (>50% cover of exotics).

○

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

● Yes ○ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

○ A ≥ 25% coverage of vegetation
○ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
○ A	○ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
○ B	○ B	Canopy present, but opened more than natural gaps
● C	● C	Canopy sparse or absent
○ A	○ A	Dense mid-story/sapling layer
○ B	○ B	Moderate density mid-story/sapling layer
● C	● C	Mid-story/sapling layer sparse or absent
○ A	○ A	Dense shrub layer
○ B	○ B	Moderate density shrub layer
● C	● C	Shrub layer sparse or absent
● A	● A	Dense herb layer
○ B	○ B	Moderate density herb layer
○ C	○ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

○ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
● B Not A

19. Diameter Class Distribution – wetland type condition metric

○ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
○ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
● C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

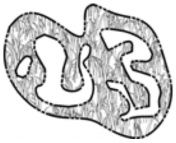
Include both natural debris and man-placed natural debris.

○ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
● B Not A

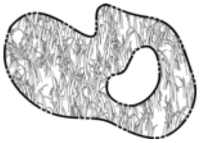
21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

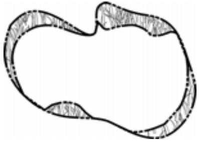
○ A



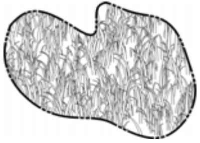
○ B



○ C



○ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

○ A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
○ B Overbank flow is severely altered in the assessment area.
● C Overland flow is severely altered in the assessment area.
○ D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name: Lyle Creek Mitigation Site: WL-5
Date: 08/24/2010
Wetland Type: Bottomland Hardwood Forest
Assessor Name/Organization: Matt Jenkins, PWS

Presence of stressor affecting assessment area (Y/N)	YES
Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	YES
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO

Sub-function Rating Summary

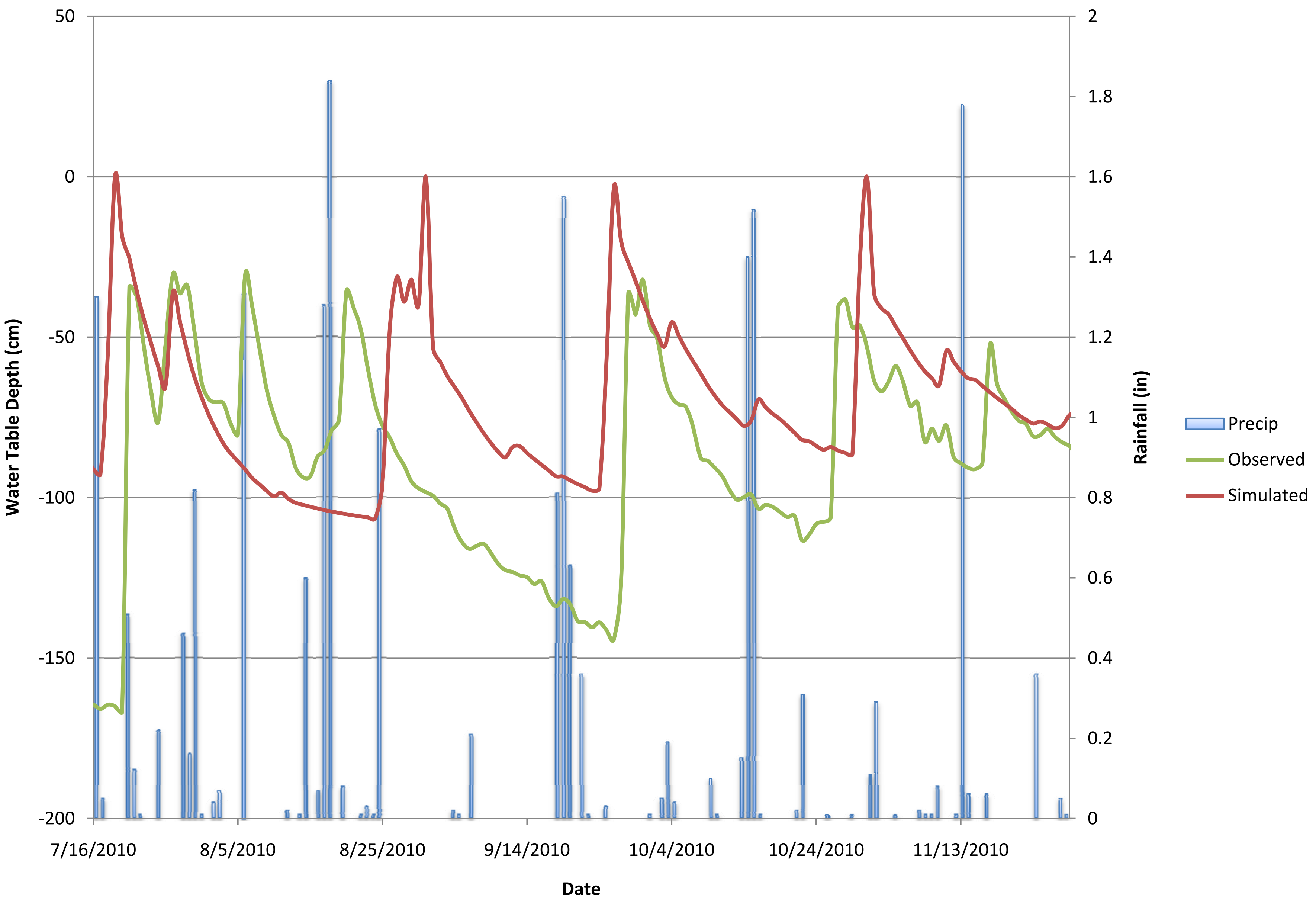
Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**LOW**
	Sub-Surface Storage and Retention	Condition	**LOW**
Water Quality	Pathogen Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Particulate Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**NO**
	Soluble Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Physical Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**NO**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**LOW**

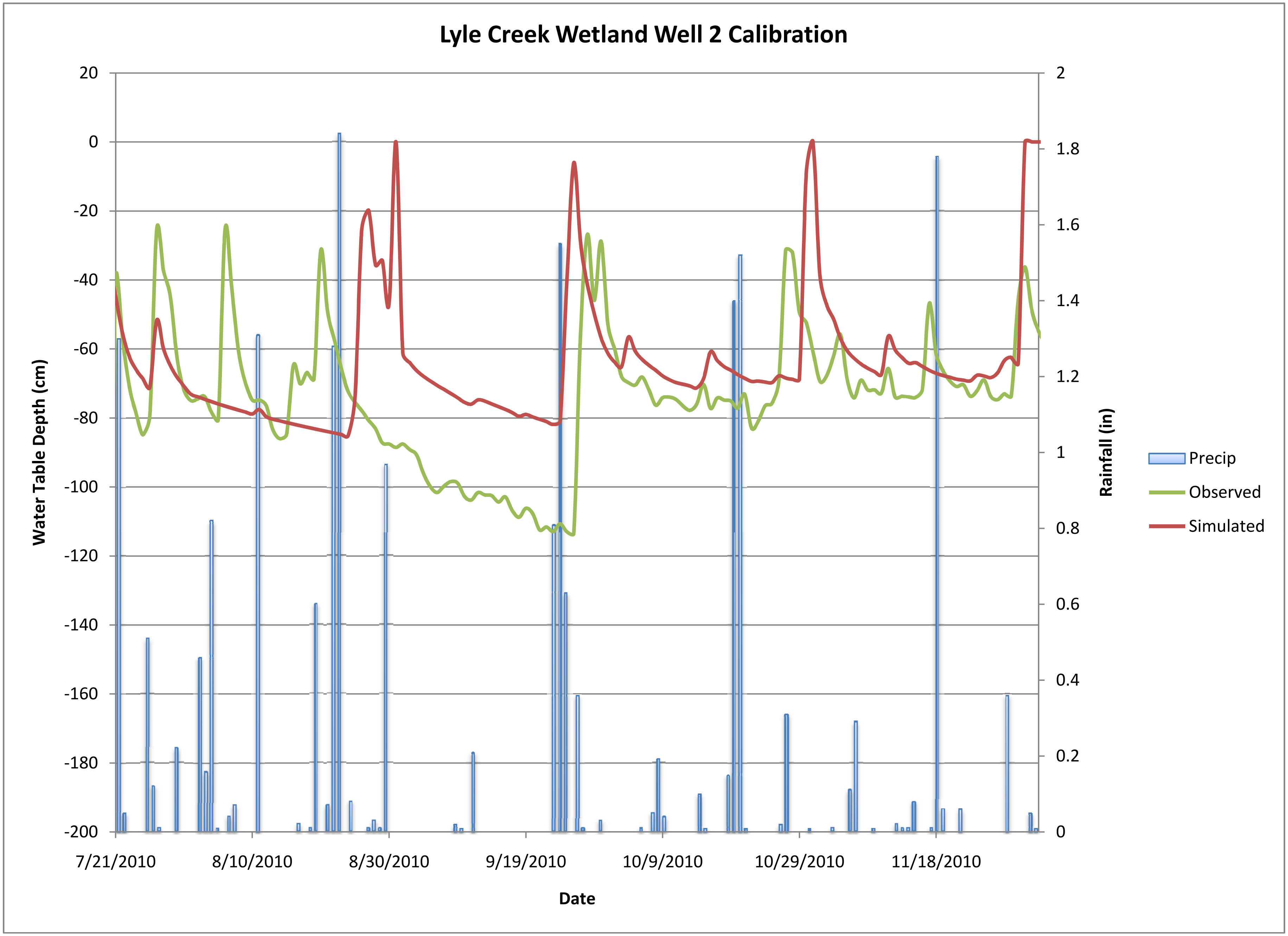
Function Rating Summary

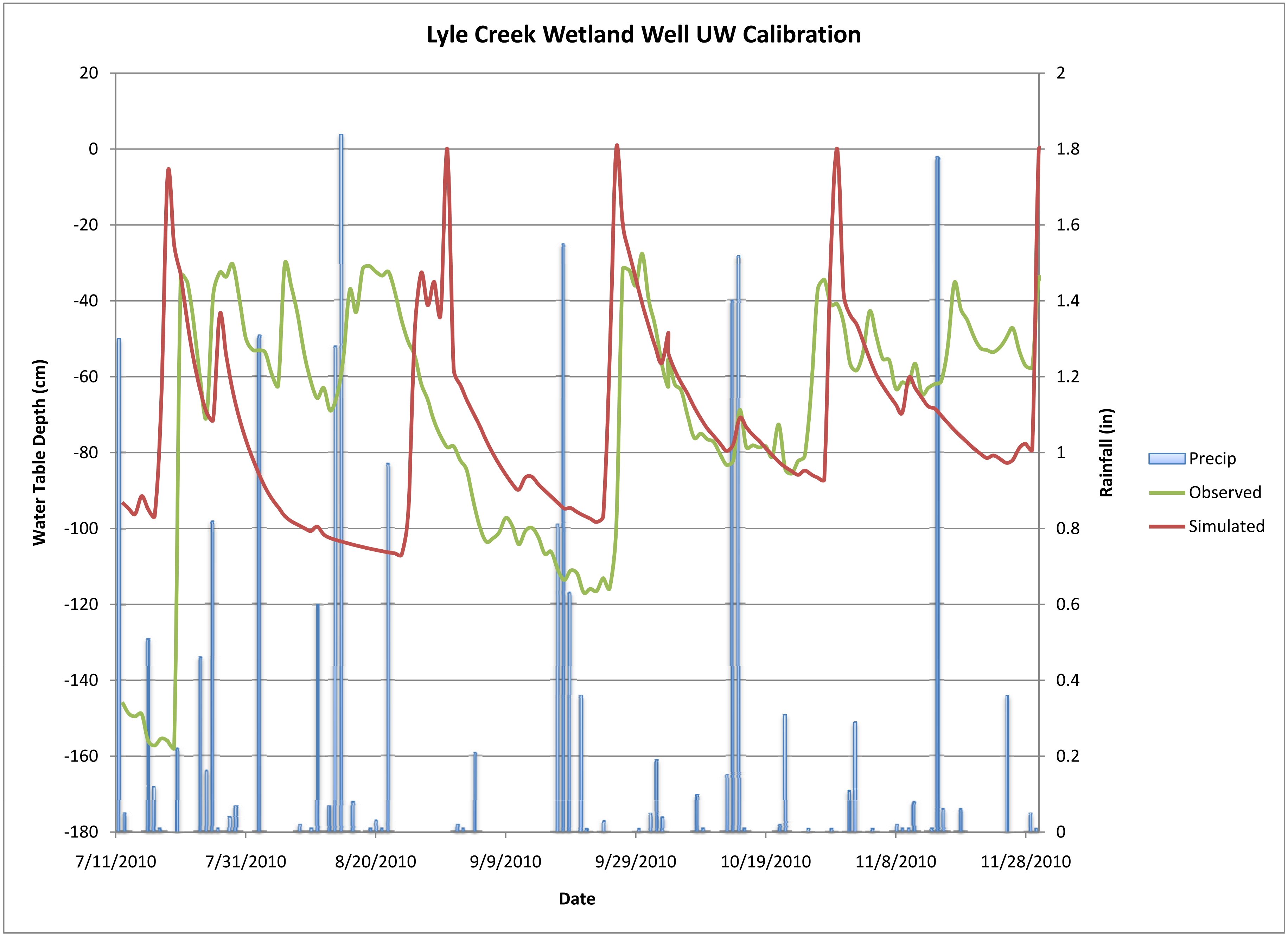
Function	Metrics/Notes	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**MEDIUM**
	Condition/Opportunity	**MEDIUM**
	Opportunity Presence? (Y/N)	**NO**
Habitat	Conditon	**LOW**

Overall Wetland Rating **LOW**

Lyle Creek Wetland Well 1 Calibration




Lyle Creek Wetland Well 2 Calibration
Water Table Depth (cm)
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
Rainfall (in)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
7/21/2010
8/10/2010
8/30/2010
9/19/2010
10/9/2010
10/29/2010
11/18/2010
Date
Precip
Observed
Simulated



Lyle Creek Wetland Well UW Calibration

Soil Profile Descriptions Wildlands Project Sites

Soils Descriptions performed by **Mike Ortosky** (NC Licensed Soil Scientist # 1075)

Garmin Property - 3/3/10

Profile #1

Depth	Color (Munsell)	Mottles	Texture	Notes
0-8	10 YR 4/2	C2D 7.5 YR 5/4	Loam	
8-18	7.5 YR 5/4	C2D 10 YR 4/2	Clay Loam	
				Free water at 14"

Profile #2

Depth	Color (Munsell)	Mottles	Texture	Notes
0-4	10 YR 4/3		Loam	
4-14	10 YR 5/2	C2D 7.5 YR 5/4	Clay Loam	
14+	10 YR 5/2	M2D 7.5 YR 5/4	Clay	Manganese
				Free water at 6"

Profile #3

Depth	Color (Munsell)	Mottles	Texture	Notes
0-10	10 YR 4/4		Clay Loam	Blocky structure – Fill material
10-36	10 YR 5/2	C2D 10 YR 4/4	Clay Loam	Blocky Structure – Fill material
				No free water to 24 "

Profile #4

Depth	Color (Munsell)	Mottles	Texture	Notes
0-6	10 YR 4/2		Loam	
6-9	10 YR 4/2	F2D 10 YR 4/6	Clay Loam	
9-16	10 Yr 5/2	C2D 7.5 YR 5/4	Clay Loam	Manganese
				Saturated in upper 6"

Profile #5

Depth	Color (Munsell)	Mottles	Texture	Notes
0-10	7.5 YR 4/3		Loam	
10-14	7.5 YR 5/1	C2F 7.5 YR 5/4	Clay Loam	

Profile #6

Depth	Color (Munsell)	Mottles	Texture	Notes
0-24	7.5 YR 4/3	C2D 10 YR 5/2	Loam	Obvious fill over hydric soil
24-32+	7.5 YR 2.5/1		SCL	Original hydric soil surface

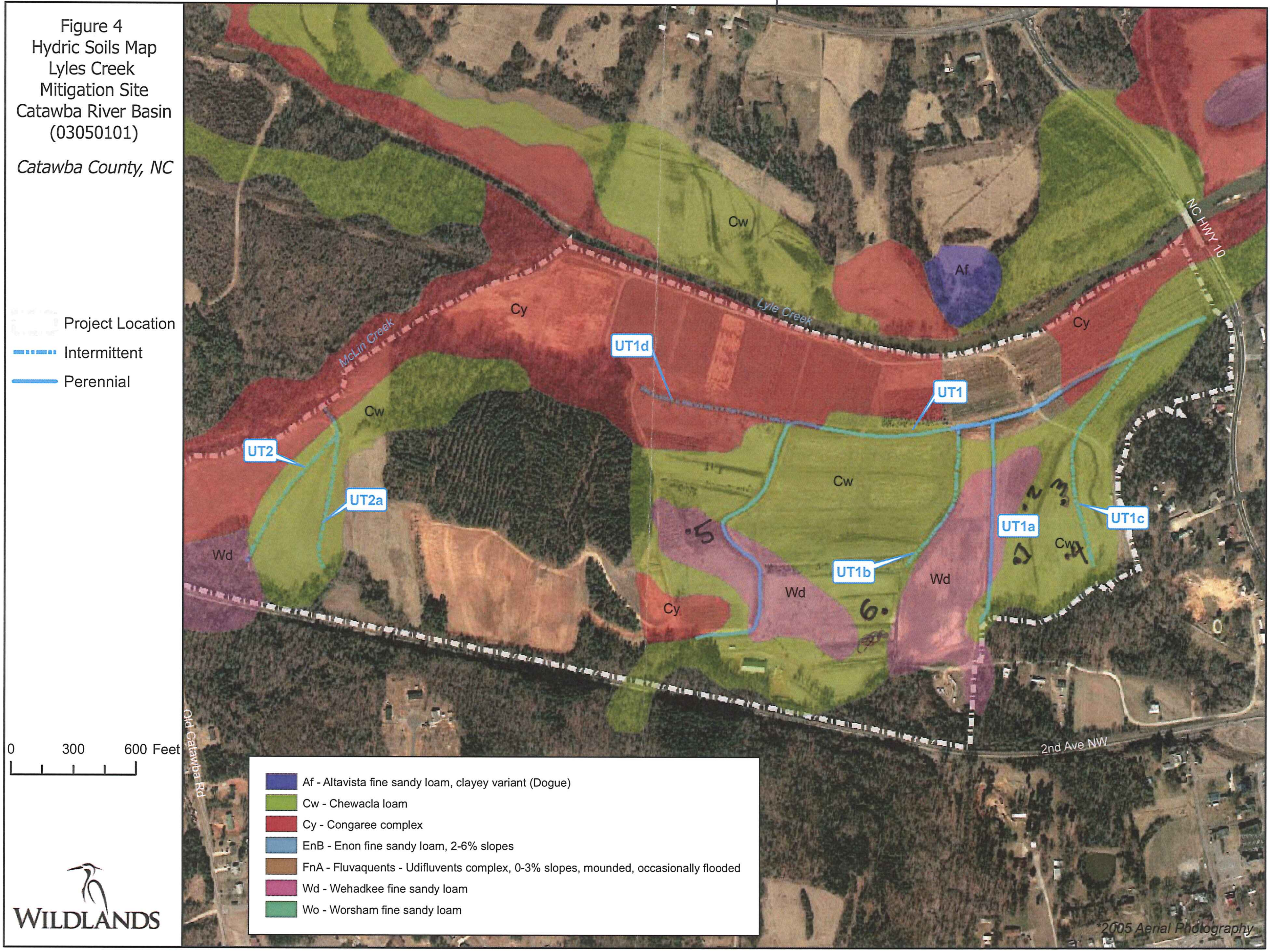
JOSEPH MICHAEL [illegible] JR.

1075

Soil Core Location Map

Figure 4
Hydric Soils Map
Lyles Creek
Mitigation Site
Catawba River Basin
(03050101)

Catawba County, NC



Lyle Creek Soil Borings

01

Depth	Color	Mottles	Texture	Notes
0-12	7.5YR 4/6		silt loam	
12-20	7.5YR 5/4	7.5YR 4/6	silt loam	
20-24	10YR 4/3	7.5YR 4/6	clay loam	

02

Depth	Color	Mottles	Texture	Notes
0-12	7.5YR 4/6		silt loam	
12-20	7.5YR 5/4	7.5YR 4/6	silt loam	
20-24	10YR 4/3	5YR 4/4	clay loam	

03

Depth	Color	Mottles	Texture	Notes
0-18	5YR 4/6		silt loam	
18-24	7.5YR 4/3	5YR 4/6	silt loam	

04

Depth	Color	Mottles	Texture	Notes
0-18	5YR 4/6		silt loam	
18-24	7.5YR 4/4	5YR 4/6	silt loam	concretions, saturation

05

Depth	Color	Mottles	Texture	Notes
0-24	5YR 4/6		silt loam	

06

Depth	Color	Mottles	Texture	Notes
0-3	5YR 4/6		silt loam	
3-20	7.5YR 4/4	5YR 4/6	silt loam	
20-24	10YR 4/3	5YR 4/6	silt loam	

07

Depth	Color	Mottles	Texture	Notes
0-12	7.5YR 4/6		silt loam	
12-20	10YR 4/3	5YR 4/6	silt loam	
20-24	7.5YR 4/3	5YR 4/6	clay loam	

08

Depth	Color	Mottles	Texture	Notes
0-16	5YR 4/6		silt loam	
16-24	7.5YR 4/3	5YR 4/6	clay loam	groundwater at 20-24"

09

Depth	Color	Mottles	Texture	Notes
0-12	7.5YR 4/4		silt loam	
12-24	10YR 4/3	7.5YR 4/6	clay loam	groundwater at 22-24"

10

Depth	Color	Mottles	Texture	Notes
0-16	7.5YR 4/6		silt loam	
16-24	10YR 4/3	7.5YR 4/4	clay loam	

11

Depth	Color	Mottles	Texture	Notes
0-6	7.5YR 4/6		silt loam	
6-20	7.5YR 4/4	5YR 4/6	silty clay loam	
20-24	7.5YR 4/3	5YR 4/6	clay loam	groundwater

12

Depth	Color	Mottles	Texture	Notes
0-16	7.5YR 4/6		silt loam	
16-24	10YR 5/3	7.5YR 4/6	clay loam	

13

Depth	Color	Mottles	Texture	Notes
0-18	7.5YR 4/4		silt loam	
18-24	10YR 4/3	7.5YR 4/6	clay loam	

14

Depth	Color	Mottles	Texture	Notes
0-14	7.5YR 4/6		silt loam	
14-20	5YR 4/6	7.5YR 4/3	silt loam	
20-24	7.5YR 4/2	7.5YR 4/6	silt loam	

15

Depth	Color	Mottles	Texture	Notes
0-12	7.5YR 4/3	7.5YR 4/4	silt loam	
12-20	7.5YR 4/2	7.5YR 4/6	silt loam	concretions
20-24	7.5YR 4/1	7.5YR 4/6	silt loam	concretions

16

Depth	Color	Mottles	Texture	Notes
0-14	7.5YR 4/3		silt loam	
14-24	10YR 5/2	7.5YR 4/6	silty clay loam	

17

Depth	Color	Mottles	Texture	Notes
0-14	7.5 YR 4/4		silt loam	
14-24	7.5YR 4/2	7.5YR 4/4	silty clay loam	

18

Depth	Color	Mottles	Texture	Notes
0-5	7.5YR 4/3		silty clay loam	
5-10	2.5Y 4/2	5YR 4/6	clay loam	
10-24	10YR 4/1	5YR 4/6	clay loam	oxidized root channels

19

Depth	Color	Mottles	Texture	Notes
0-6	7.5YR 4/3	10YR 4/3	silt loam	
8-24	2.5Y 4/2	7.5YR 4/6	silty clay loam	

20

Depth	Color	Mottles	Texture	Notes
0-18	10YR 4/4		silt loam	
18-24	7.5YR 4/6		loamy sand	groundwater at 22"-24"

21

Depth	Color	Mottles	Texture	Notes
0-6	10YR 4/3(2)	7.5YR 4/6	silt loam	
6-20	7.5YR 4/3	7.5YR 4/6	clay loam	
20-24	7.5YR 4/2	7.5YR 4/4	clay loam	

22

Depth	Color	Mottles	Texture	Notes
0-5	7.5YR 4/3		silt loam	
5-24	5YR 4/2	5YR 4/4	silt loam	

23

Depth	Color	Mottles	Texture	Notes
0-2	10YR 4/2	7.5YR 4/6	silt loam	oxidized root channels
2-10	10YR 5/3	7.5YR 4/6	silt loam	oxidized root channels
10-24	7.5YR 4/3	5YR 4/6	silt loam	concretions

24

Depth	Color	Mottles	Texture	Notes
0-8	7.5YR 4/3		clay loam	
8-22	7.5YR 4/2	5YR 4/6	clay loam	
22-24	10YR 4/2	7.5YR 4/6	loamy clay	

25

Depth	Color	Mottles	Texture	Notes
0-12	7.5YR 4/6		sandy silt loam	
12-24	7.5YR 4/4	5YR 4/6	silt loam	

26

Depth	Color	Mottles	Texture	Notes
0-6	5YR 4/6		silt loam	
6-18	7.5YR 4/2	7.5YR 4/6	clay loam	
18-24	7.5YR 4/2	5YR 4/6	clay loam	concretions

27

Depth	Color	Mottles	Texture	Notes
0-8	10YR 4/3	7.5YR 4/6	silt loam	
8-20	10YR 4/3	5YR 4/6	silt loam	
20-24	2.5Y 5/3	7.5YR 4/6	clay loam	

28

Depth	Color	Mottles	Texture	Notes
0-10	7.5YR 3/3		silt loam	
10-24	10YR 5/3	7.5YR 5/6	silty clay loam	

29

Depth	Color	Mottles	Texture	Notes
0-3	10YR 4/2	5YR 4/6	silt loam	
3-8	10YR 4/3	7.5YR 5/6	sandy silt loam	
8-20				coarse sand/gravel layer
20-24	10YR 5/3	7.5YR 5/6	sandy silt loam	

30

Depth	Color	Mottles	Texture	Notes
0-6	10YR 4/3	7.5YR 4/6	silt loam	
6-12	7.5YR 4/6		silt loam	
12-18	10YR 5/3	7.5YR 4/6	sandy silt loam	
18-24	7.5YR 4/4	7.5YR 5/6	sandy clay loam	

31

Depth	Color	Mottles	Texture	Notes
0-10	10YR 5/4	7.5YR 4/6	sandy silt loam	
10-14	10YR 5/3	7.5YR 4/6	silty clay loam	oxidized root channels
14-24	10YR 4/3	7.5YR 4/6	loamy sand	

32

Depth	Color	Mottles	Texture	Notes
0-3	10YR 3/2		silt loam	
3-10	10YR 4/2	7.5YR 4/4	silt loam	
10-16	10YR 4/2	7.5YR 4/6	silty clay loam	
16-24	2.5Y 5/2	10YR 4/4	silty clay loam	

33

Depth	Color	Mottles	Texture	Notes
0-12	7.5YR 4/4		silt loam	
12-20	7.5YR 4/2	5YR 4/6	silt loam	
20-24	10YR 5/3	7.5YR 4/6	clay loam	

34

Depth	Color	Mottles	Texture	Notes
0-12	5YR 4/4		silt loam	
12-20	7.5YR 4/2	7.5YR 4/6	sandy silt loam	
20-24	2.5Y 4/2	7.5YR 4/4	sandy clay loam	

35

Depth	Color	Mottles	Texture	Notes
0-16	7.5YR 3/4		silt loam	
16-18	7.5YR 4/2	7.5YR 4/6	silty clay loam	
18-24	7.5YR 4/6		sand	

36

Depth	Color	Mottles	Texture	Notes
0-4	7.5YR 4/4		silt loam	
4-12	10YR 4/3	7.5YR 4/6	silt loam	
12-24	2.5Y 4/2	7.5YR 4/6	clay silt loam	

37

Depth	Color	Mottles	Texture	Notes
0-6	7.5YR 4/4		silt loam	
6-14	7.5YR 4/3	5YR 4/4	silt loam	
14-24	2.5Y 5/2	7.5YR 4/6	clay loam	

38

Depth	Color	Mottles	Texture	Notes
0-20	7.5YR 4/6		silt	
20-24	7.5YR 5/6		sand	

39

Depth	Color	Mottles	Texture	Notes
0-6	7.5YR 4/3	7.5YR 3/4	silt loam	
6-12	10YR 4/1	7.5YR 4/6	silt clay loam	
12-24	2.5Y 4/2	7.5YR 4/6	sandy clay loam	

40

Depth	Color	Mottles	Texture	Notes
0-3	7.5YR 4/4		silt loam	
3-8	10YR 4/2	7.5YR 4/6	clay silt loam	
8-14	10YR 4/3	7.5YR 4/4	clay loam	
14-22	7.5YR 5/6		sand	
22-24	10YR 5/2	10YR 5/8	clay sand	

41

Depth	Color	Mottles	Texture	Notes
0-14	10YR 4/4	7.5YR 4/6	silt loam	
14-20	10YR 4/2	7.5YR 4/6	silt loam	
20-24	2.5Y 4/2	7.5YR 4/6	silty clay loam	

42

Depth	Color	Mottles	Texture	Notes
0-8	7.5YR 4/3		clay loam	
8-22	7.5YR 4/2	5YR 4/6	clay loam	
22-24	10YR 4/2	7.5YR 4/6	loamy clay	

43

Depth	Color	Mottles	Texture	Notes
0-7	7.5YR 4/3		sandy silt loam	
7-24	7.5YR 4/3(2)	5YR 4/6	silt loam	groundwater at 12"

44

Depth	Color	Mottles	Texture	Notes
0-3	7.5YR 4/4		clay loam	
3-8	10YR 4/3	7.5YR 4/4	clay loam	
8-24	10YR 4/2	7.5YR 4/4	clay loam	

45

Depth	Color	Mottles	Texture	Notes
0-6	10YR 4/3		silt loam	
6-24	10YR 4/2	5YR 4/4	clay loam	

46

Depth	Color	Mottles	Texture	Notes
0-12	7.5YR 4/3		sandy silt loam	
12-16	10YR 4/2	7.5YR 4/6	sandy silt loam	

47

Depth	Color	Mottles	Texture	Notes
0-6	10YR 3/3		clay loam	
6-12	2.5Y 4/2	5YR 4/4	clay loam	

48

Depth	Color	Mottles	Texture	Notes
0-7	10YR 4/3		sandy clay loam	
7-12	10YR 4/2	7.5YR 4/6	clay loam	

49

Depth	Color	Mottles	Texture	Notes
0-7	10YR 4/3		sandy clay loam	
7-12	10YR 4/2	7.5YR 4/6	clay loam	

50

Depth	Color	Mottles	Texture	Notes
0-4	10YR 4/3			
4-12	2.5Y 4/2	7.5YR 4/6	clay loam	

51

Depth	Color	Mottles	Texture	Notes
0-4	2.5Y 4/2			
4-12	10YR 4/2	7.5YR 4/6	clay loam	

52

Depth	Color	Mottles	Texture	Notes
0-2	10YR 4/2		silty clay loam	
2-12	10YR 4/2	7.5YR 4/6	clay loam	

53

Depth	Color	Mottles	Texture	Notes
0-3	2.5Y 3/3		silt loam	
3-8	10YR 4/3		silt loam	
8-14	2.5Y 5/2	7.5YR 4/6	clay loam	

54

Depth	Color	Mottles	Texture	Notes
0-4	10YR 4/2		silt loam	
4-12	10YR 5/2	10YR 4/6	clay loam	

55

Depth	Color	Mottles	Texture	Notes
0-5	10YR 4/2	10YR 4/6	clay loam	
5-12	10YR 5/1	7.5YR 4/4	clay loam	oxidized roots

56

Depth	Color	Mottles	Texture	Notes
0-6	10YR 4/2	7.5YR 4/6	clay loam	oxidized roots

57

Depth	Color	Mottles	Texture	Notes
0-3	10YR 4/4		clay loam	
3-12	2.5Y 4/1	10YR 4/6	clay loam	oxidized roots

58

Depth	Color	Mottles	Texture	Notes
0-4	10YR 4/2	7.5YR 4/4	silt loam	
4-12	10YR 4/1	7.5YR 4/6	clay loam	oxidized roots

59

Depth	Color	Mottles	Texture	Notes
0-3	10YR 4/3		silt loam	
3-12	10YR 4/2	5YR 4/4	clay loam	

60

Depth	Color	Mottles	Texture	Notes
0-4	7.5YR 4/4		silt loam	
4-12	10YR 4/2	5YR 3/6	silty clay loam	

APPENDIX 3

Agency Communication and Approved Categorical Exclusion

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information

Project Name:	Lyle Creek Mitigation Site
County Name:	Catawba County
EEP Number:	003241
Project Sponsor:	Wildlands Engineering, Inc.
Project Contact Name:	Andrea M. Spangler
Project Contact Address:	1430 S. Mint Street, Suite 104, Charlotte, NC 28203
Project Contact E-mail:	aspangler@wildlandsinc.com
EEP Project Manager:	Guy Pearce

Project Description

The Lyle Creek Mitigation Site is a stream and wetland mitigation project located in Catawba County, NC. The project is located on Lyle Creek and its tributaries immediately west of NC Highway 10. The project will provide stream and wetland mitigation units to NCEEP in the Catawba River Basin (03050103). The mitigation project involves a combination of stream restoration and enhancement and wetland creation and restoration.

For Official Use Only

Reviewed By: Guy C Pearce

9/13/2010

Date

Guy C Pearce

EEP Project Manager

Conditional Approved By:

Date

For Division Administrator FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

9-10-10

Date

For Division Administrator FHWA

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☑ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☑ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☑ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☑ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☑ No ☐ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☑ No ☐ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☑ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☑ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☑ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☑ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☑ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Does the project require the acquisition of real estate?	☑ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☑ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☑ Yes ☐ No ☐ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☑ Yes ☐ No
2. Is the site of religious importance to American Indians?	☐ Yes ☑ No ☐ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☑ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☑ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☑ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☑ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☑ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☐ Yes ☑ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
4. Is the project "likely to adversely affect" the species and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☑ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☑ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☑ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☑ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☑ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☑ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☑ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☑ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☑ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☑ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☑ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☑ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☑ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☑ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☑ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☑ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☑ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☑ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☑ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☑ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☑ N/A

July 12, 2010

Renee Gledhill-Earley
State Historic Preservation Office
4617 Mail Service Center
Raleigh, NC 27699-4617

Subject: EEP Wetland and Stream mitigation project in Catawba County.
Lyle Creek Mitigation Project

Dear Ms. Gledhill-Earley,

The Ecosystem Enhancement Program (EEP) requests review and comment on any possible issues that might emerge with respect to archaeological or cultural resources associated with a potential wetland and stream restoration project on the attached site (a USGS site map using the Catawba, NC 7.5 Minute Topographic Quadrangle is enclosed). The figure shows the parcel boundary and areas of potential ground disturbance.

The Lyle Creek Mitigation site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel and wetland impacts. Several sections of channel have been identified as significantly degraded.

No architectural structures or archeological artifacts have been observed or noted during preliminary surveys of the site for restoration purposes. The majority of the site has historically been disturbed due to agricultural purposes such as tilling. Enclosed are current photos of the site.

In addition, Wildlands contracted New South Associates to perform an "in-office" historical and archaeological screening of the Lyles Creek site. Maps from 1886, 1902, and 1938 showed no buildings on the site. Their findings indicate that there are no previously recorded archaeological sites in the tract, and that the area in general has a low potential for archaeological sites. More importantly, the North Carolina Office of State Archaeology (OSA) reviewed the entire area when it was being considered for development for sewer facilities. The OSA review (CH09-2771) recommended clearance without survey, based on the fact that the likelihood of encountering archaeological sites in these areas is extremely low. New South Associates' professional opinion is that more detailed surveys would not be required.

We ask that you review this site based on the attached information to determine the presence of any historic properties.

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Andrea M. Spangler
Senior Environmental Planner

cc:
Donnie Brew
EEP Project Manager
1652 Mail Service Center
Raleigh, NC 27699

North Carolina Department of Cultural Resources
State Historic Preservation Office
Peter B. Sandbeck, Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

August 11, 2010

Andrea Spangler
Wildlands Engineering, Inc.
1430 South Mint Street, #104
Charlotte, NC 28203

Re: Lyle Creek Mitigation Proejct, Catawba County, ER 10-1315

Dear Ms. Spangler:

Thank you for your letter of July 12, 2010, concerning the above project.

We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Peter Sandbeck

Location: 109 East Jones Street, Raleigh NC 27601 **Mailing Address:** 4617 Mail Service Center, Raleigh NC 27699-4617 **Telephone/Fax:** (919) 807-6570/807-6599

July 12, 2010

Tyler Howe
Tribal Historic Preservation Specialist
Eastern Band of Cherokee Indians
Tribal Historic Preservation Office
P.O. Box 455
Cherokee, NC 28719

Subject: EEP Wetland and Stream mitigation project in Catawba County.
Lyle Creek Mitigation Project

Dear Mr. Howe,

The Ecosystem Enhancement Program (EEP) requests review and comment on any possible issues that might emerge with respect to archaeological or religious resources associated with a potential wetland and stream restoration project on the attached site (a USGS site map using the Catawba, NC 7.5 Minute Topographic Quadrangle is enclosed). The figure shows the parcel boundary and areas of potential ground disturbance.

A similar letter has been sent to the North Carolina State Preservation Office for compliance with Section 106 of the Historic Preservation Act.

The Lyle Creek Mitigation site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel and wetland impacts. Several sections of channel have been identified as significantly degraded. No architectural structures or archeological artifacts have been observed or noted during preliminary surveys of the site for restoration purposes. The majority of the site has historically been disturbed due to agricultural purposes such as tilling. Enclosed are current photos of the site.

In addition, Wildlands contracted New South Associates to perform an “in-office” historical and archaeological screening of the Lyles Creek site. Maps from 1886, 1902, and 1938 showed no buildings on the site. Their findings indicate that there are no previously recorded archaeological sites in the tract, and that the area in general has a low potential for archaeological sites. More importantly, the North Carolina Office of State Archaeology (OSA) reviewed the entire area when it was being considered for development for sewer facilities. The OSA review (CH09-2771) recommended clearance without survey, based on the fact that the likelihood of encountering archaeological sites in these areas is extremely low. New South Associates’ professional opinion is that more detailed surveys would not be required.

We ask that you review this site based on the attached information to determine if you know of any existing resources that we need to know about. In addition, please let us know the level your future involvement with this project needs to be (if any).

We thank you in advance for your timely response and cooperation. Please feel free to contact the below referenced EEP Project Manager with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Andrea M. Spangler
Senior Environmental Planner

cc:
Donnie Brew
EEP Project Manager
1652 Mail Service Center
Raleigh, NC 27699

WILDLANDS

July 12, 2010

Marella Buncick
US Fish and Wildlife Service
Asheville Field Office
160 Zillicoa Street
Asheville, NC 28801

Subject: **Lyle Creek Mitigation Site**
Catawba County, North Carolina

Dear Ms. Buncick,

The Lyle Creek Mitigation Site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel and wetland impacts. Several sections of channel throughout the site have been identified as significantly degraded as a result of current agricultural activities. Additionally, several on-site areas have been identified for wetland creation and restoration.

We have already obtained an updated species list for Catawba County from your web site (http://nc-es.fws.gov/es/countyfr.html). The threatened or endangered species for this county are: the bald eagle (*Haliaeetus leucocephalus*) (BGPA) and the dwarf-flowered heartleaf (*Ptilimnium nodosum*). We are requesting that you please provide any known information for each species in the county. The USFWS will be contacted if suitable habitat for any listed species is found or if we determine that the project may affect one or more federally listed species or designated critical habitat.

Please provide comments on any possible issues that might emerge with respect to endangered species, migratory birds or other trust resources from the construction of a stream and wetland restoration project on the subject property. A USGS map (Figure 1) showing the approximate property lines and areas of potential ground disturbance is enclosed. Figure 1 was prepared from the Catawba, NC 7.5-Minute Topographic Quadrangle.

If we have not heard from you in 30 days we will assume that our species list and site determination are correct, that you do not have any comments regarding associated laws, and that you do not have any information relevant to this project at the current time.

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Matt L. Jenkins, PWS
Environmental Scientist

Attachment:
Figure 1. USGS Topographic Map

WILDLANDS

July 12, 2010

Shannon Deaton
North Carolina Wildlife Resource Commission
Division of Inland Fisheries
1721 Mail Service Center
Raleigh, NC 27699

Subject: **Lyle Creek Mitigation Site**
Catawba County, North Carolina

Dear Mr. Deaton,

The purpose of this letter is to request review and comment on any possible issues that might emerge with respect to fish and wildlife issues associated with a potential stream and wetland restoration project on the attached site. A USGS map (Figure 1) showing the approximate property lines and areas of potential ground disturbance is enclosed. Figure 1 was prepared from the Catawba, NC 7.5-Minute Topographic Quadrangle.

The Lyle Creek Mitigation Site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel and wetland impacts. Several sections of channel throughout the site have been identified as significantly degraded as a result of current agricultural activities. Additionally, several on-site areas have been identified for wetland creation and restoration.

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Matt L. Jenkins, PWS
Environmental Scientist

Attachment:
Figure 1. USGS Topographic Map

North Carolina Wildlife Resources Commission
Gordon Myers, Executive Director

July 19, 2010

Mr. Matt L. Jenkins, PWS
Wildlands Engineering, Inc.
1430 South Mint Street, Suite 104
Charlotte, North Carolina 28203

RE: Lyle Creek Mitigation Site, Catawba County

Dear Mr. Jenkins:

This correspondence is in response to your letter of July 12, 2010 requesting wildlife site determinations. Biologists with the North Carolina Wildlife Resources Commission (NCWRC) are familiar with habitat values in the area. The NCWRC is authorized to comment and make recommendations which relate to the impacts of this project on fish and wildlife pursuant to pursuant to the Clean Water Act of 1977, North Carolina Environmental Policy Act, US National Environmental Policy Act, Endangered Species Act (16 U. S. C. 1531-1543; 87 Stat 884), and Fish and Wildlife Coordination Act (48 Stat. 401, as amended.

The proposed project is proposed to restore an unspecified amount of stream. Based on our review, the project area has warm water fisheries. Lyle Creek Wetland, Significant Natural Heritage Area # 607 is located to the northeast. The Santee chub, *Cyprinella zanema* (NCSR) is known from the area.

Based on our review of your letter and the map provided, we find no reason to object to the restoration project providing Clean Water Act permits and certifications are obtained prior to beginning any restoration work. These comments should not be construed as pre-approval of mitigation credits.

Thank you for the opportunity to comment on this project during its early planning stages. If you have any questions regarding these comments, please contact me at 336-769-9453.

Sincerely,

Ron Linville
Regional Coordinator
Habitat Conservation Program

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

MEETING MINUTES

MEETING:	Preliminary Site Review and Field Walk Lyle Creek Stream and Wetland Restoration Site Catawba County, NC Catawba 03050103 EEP Full-Delivery Contract 003241 Wildlands Project No. 005-02123
DATE:	August 18, 2010
PREPARED BY:	Emily Reinicker, PE, CFM
ATTENDEES:	Guy Pearce, NC EEP Tim Baumgartner, NC EEP Todd Tugwell, USACE Steve Kichefski, USACE Alan Johnson, NC DWQ John Hutton, Wildlands Engineering Emily Reinicker, Wildlands Engineering

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The following items were discussed during the site walk:

1. USACE and DWQ did not receive pdf file containing figures for the technical proposal. Wildlands to forward to EEP for distribution.
2. Proposed stream and wetland concept design was discussed (Figure 6 from proposal). Wildlands discussed history of manipulation of the landscape at this site; aerial photos back to 1938 show site in current ditched configuration. Stream layout was selected to follow fall of the valley and dendritic pattern collection of smaller tributaries for stable confluence to Lyle Creek. USACE and DWQ agreed with overall approach on stream alignments and credit ratios.
3. Guy Pearce highlighted more stringent signage requirements for conservation easement required with this round of full-delivery RFPs.
4. USACE noted it is Important to provide 50-foot wide buffers as proposed.
5. USACE noted that easement road crossings and overhead electric crossings should be excluded from the conservation easement. For overhead electric utility with no dedicated easement, a reasonable width that will be maintained should be used for the easement break. 30 feet is typical for distribution lines.
6. Wildlands clarified that no fencing is proposed at the easement edge for this site since it is a tree farm and not an active livestock farm. Easement boundary will be clearly delineated with signage and markers.
7. USACE requires verified jurisdictional determination.
8. USACE repeated that wetland creation is not the preferred method of producing wetland credit at this time but does not prohibit this approach. USACE requests that a vigor measurement be incorporated into success criteria for wetland creation and restoration areas. Failure to meet vigor criteria could result in credit

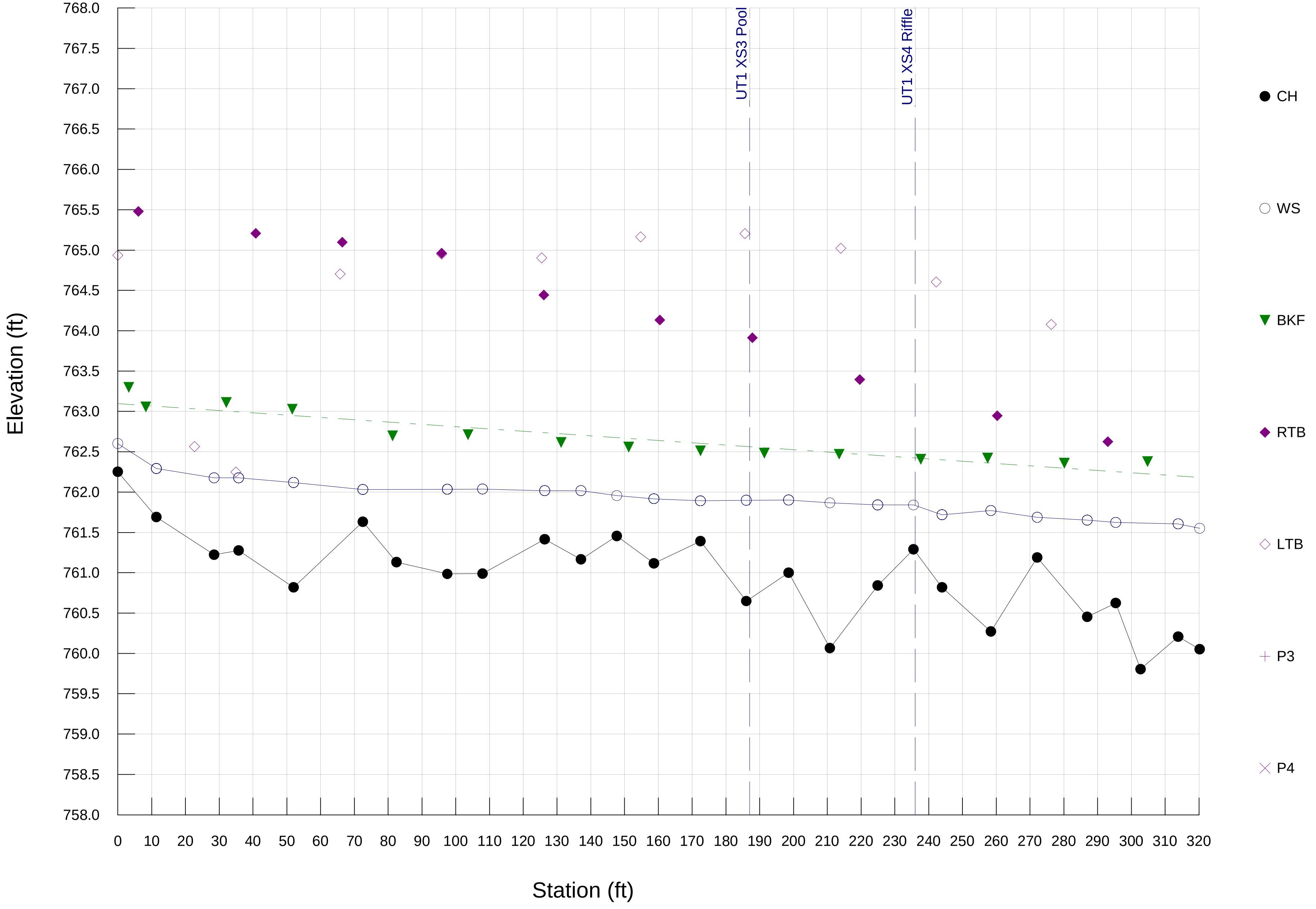
reduction. No hydraulic barriers (e.g. bentonite) should be used in wetland creation or restoration. No deep disking resulting in 18” or greater height furrows should be used.

9. USACE noted concern in long-term management of kudzu at upstream end of UT1a adjacent to wetland RW1 and property line. USACE will require treatment of kudzu within and immediately adjacent to easement. Suggested maintaining existing site road and excluding road from easement on eastern boundary of RW1 to help with long-term management of kudzu and serve as physical barrier.
10. Soil characteristics of RW1 and wetland restoration classification supported by USACE.
11. Soil characteristics of RW2 and wetland restoration classification not supported by USACE. USACE will view this area as wetland creation unless additional evidence supporting historic wetland conditions can be collected. Additional soil borings will be conducted. Groundwater hydrology will be compared to reference conditions. Jurisdictional determination will be submitted for USACE-verification.
12. DWQ agrees with stream classification of channels, but is concerned about design channel width and hydrology. Stream classification forms will be submitted to DWQ for verification.

APPENDIX 4

Existing Conditions Data

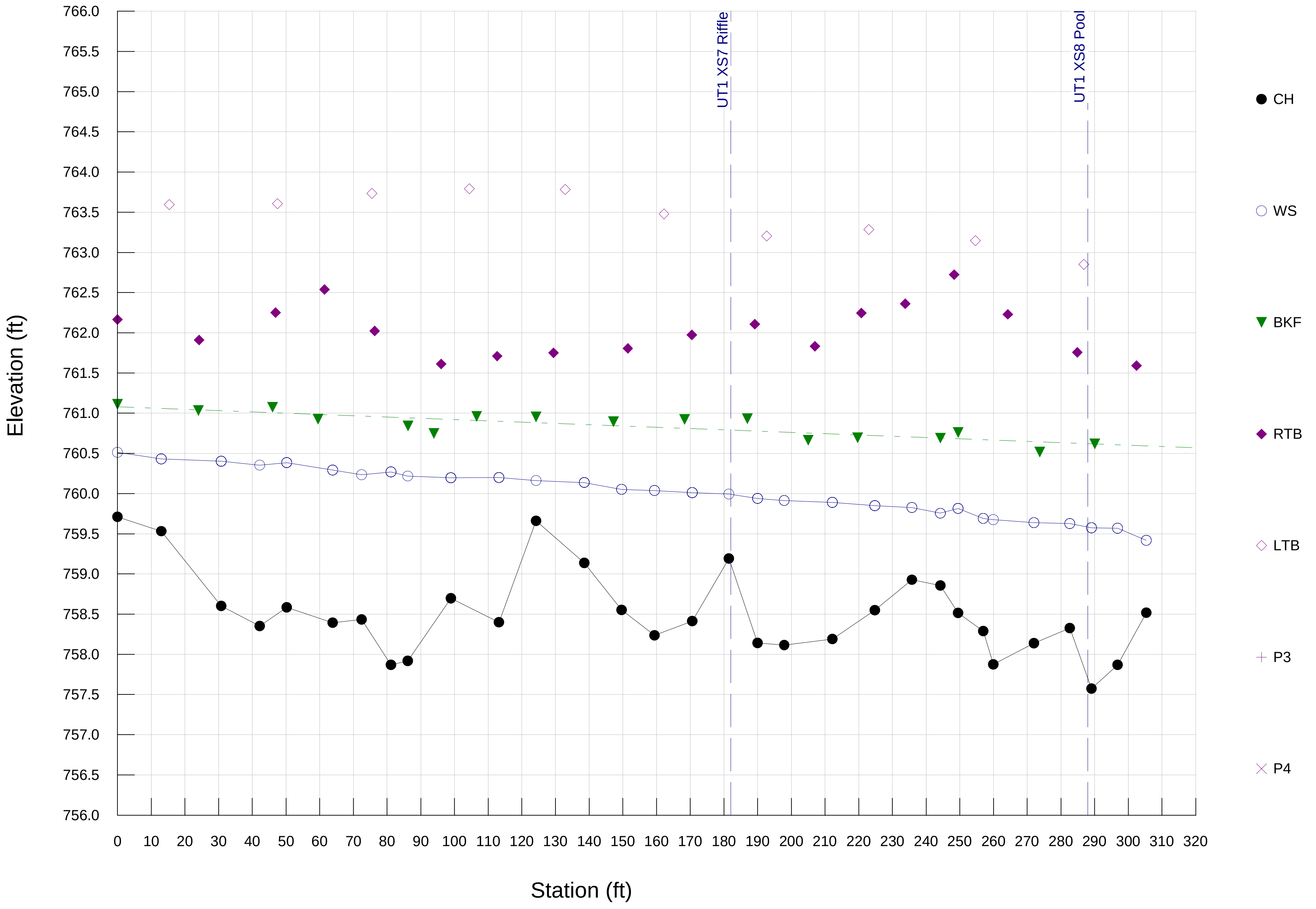
UT1 to Lyle Creek, Reach 1 Profile



```
                                 UT1 Reach 1 Profile
                      RIVERMORPH PROFILE SUMMARY

----------------------------------------------------------------------

River Name:   UT1 to Lyle Creek
Reach Name:   Reach 1
Profile Name: UT1 Reach 1 Profile
Survey Date:  08/17/10

----------------------------------------------------------------------

Survey Data


DIST       CH         WS         BKF        RTB        LTB
----------------------------------------------------------------------
0          762.251    762.601
0                                                      764.936
3.211                            763.3
6.08                                        765.479
8.272                            763.057
11.434     761.691    762.291
22.695                                                 762.565
28.505     761.225    762.175
32.088                           763.111
34.918                                                 762.248
35.797     761.276    762.176
40.808                                      765.206
51.651                           763.028
52.06      760.819    762.119
65.779                                                 764.704
66.405                                      765.098
72.515     761.632    762.032
81.342                           762.698
82.504     761.132
95.831                                                 764.949
95.843                                      764.96
97.539     760.985    762.035
103.642                          762.711
107.972    760.988    762.038
125.477                                                764.904
126.066                                     764.442
126.336    761.416    762.016
131.201                          762.616
137.124    761.167    762.017
147.66     761.456    761.956
151.191                          762.558
154.721                                                765.164
158.668    761.117    761.917
160.444                                     764.133
172.434                          762.513
172.434    761.391    761.891
185.636                                                765.205
186.009    760.649    761.899
187.84                                      763.914
191.359                          762.482
198.578    761        761.9
210.773    760.067    761.867
213.533                          762.47
213.998                                                765.022
219.627                                     763.395
224.919    760.841    761.841
235.512    761.289    761.839
```

```
                                UT1 Reach 1 Profile
237.672                          762.408
242.209                                                764.605
243.967    760.819    761.719
257.429                          762.422
258.399    760.272    761.772
260.317                                     762.947
272.158    761.188    761.688
276.278                                                764.077
280.129                          762.358
286.931    760.453    761.653
293.055                                     762.626
295.388    760.624    761.624
302.737    759.805
304.79                           762.379
313.884    760.207    761.607
320.233    760.05     761.55

Cross Section Locations

Cross Section Name            Type      Profile Station
----------------------------------------------------------------------
UT1 XS1 Pool                  Riffle    0
UT1 XS2 Riffle                Riffle    0
UT1 XS3 Pool                  Pool      186.67
UT1 XS4 Riffle                Riffle    235.512


Measurements from Graph

Bankfull Slope:     0.00288

Variable       Min            Avg            Max
----------------------------------------------------------------------
S riffle       0.00324        0.01383        0.02625
S pool         0.0005         0.00162        0.00346
S run          0.00096        0.00254        0.00352
S glide        0              0.0017         0.00471
P - P          50.43          69.31          100.24
P length       28.51          48.95          59.83
Dmax riffle    1              1.12           1.22
Dmax pool      1.76           2.16           2.56
Dmax run       1.46           1.61           1.75
Dmax glide     1.42           1.53           1.6
Low Bank Ht    1.7            2.44           3.07
Length and depth measurements in feet, slopes in ft/ft.
```

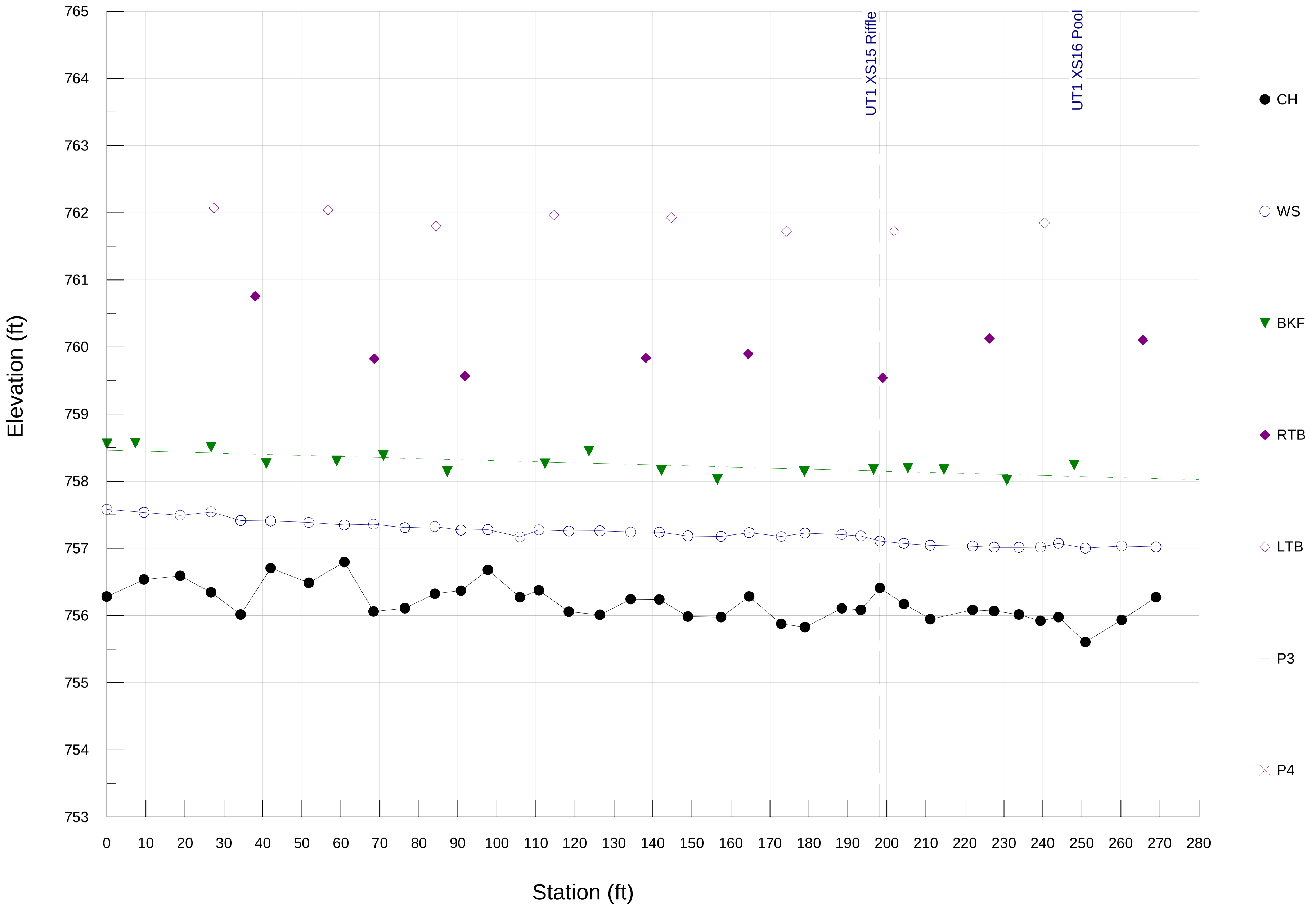
UT1 to Lyle Creek, Reach 2 Profile



```
                                 UT1 Reach 2 Profile
                      RIVERMORPH PROFILE SUMMARY

----------------------------------------------------------------------

River Name:   UT1 to Lyle Creek
Reach Name:   Reach 2
Profile Name: UT1 Reach 2 Profile
Survey Date:  08/11/10

----------------------------------------------------------------------

Survey Data


DIST       CH         WS         BKF        RTB        LTB
----------------------------------------------------------------------
0          759.711    760.511
0                                761.111
0                                           762.166
13.023     759.532    760.432
15.36                                                  763.594
24.02                            761.032
24.22                                       761.909
30.768     758.602    760.402
42.184     758.352    760.352
45.982                           761.075
46.909                                      762.251
47.497                                                 763.606
50.246     758.584    760.384
59.482                           760.925
61.416                                      762.539
63.852     758.392    760.292
72.473     758.434    760.234
75.489                                                 763.734
76.357                                      762.024
81.203     757.87     760.27
86.147     757.918    760.218
86.235                           760.841
93.904                           760.748
96.031                                      761.612
98.94      758.697    760.197
104.406                                                763.793
106.607                          760.96
112.696                                     761.709
113.19     758.4      760.2
124.252    759.661    760.161
124.252                          760.956
129.413                                     761.75
132.872                                                763.782
138.552    759.137    760.137
147.172                          760.893
149.652    758.552    760.052
151.458                                     761.807
159.367    758.236    760.036
162.186                                                763.479
168.29                           760.922
170.431                                     761.973
170.592    758.412    760.012
181.442    759.193    759.993
186.954                          760.932
189.158                                     762.107
189.985    758.14     759.94
192.666                                                763.205
```

```
197.9      758.114    759.914
204.985                          760.664
207.001                                     761.833
212.209    758.19     759.89
219.681                          760.694
220.792                                     762.246
223                                                    763.284
224.762    758.55     759.85
233.816                                     762.361
235.784    758.927    759.827
244.236                          760.69
244.236    758.855    759.755
248.349                                     762.723
249.467                          760.76
249.467    758.514    759.814
254.625                                                763.147
256.95     758.289    759.689
259.97     757.876    759.676
264.259                                     762.23
272.014    758.137    759.637
273.72                           760.517
282.67     758.327    759.627
284.885                                     761.757
286.778                                                762.851
289.114    757.573    759.573
290.059                          760.619
296.832    757.868    759.568
302.466                                     761.592
305.353    758.518    759.418

Cross Section Locations

Cross Section Name            Type      Profile Station
----------------------------------------------------------------------
UT1 XS7 Riffle                Riffle    182.23
UT1 XS8 Pool                  Pool      287.72


Measurements from Graph

Bankfull Slope:     0.00163

Variable       Min            Avg            Max
----------------------------------------------------------------------
S riffle       0.00333        0.00462        0.00595
S pool         0.00204        0.00244        0.0028
S run          0.00294        0.0058         0.01142
S glide        0.001          0.00286        0.00525
P - P          48.87          75.7           114.65
P length       39.16          58.19          98.05
Dmax riffle    1.28           1.64           2.05
Dmax pool      2.6            2.84           3.03
Dmax run       1.79           2.06           2.21
Dmax glide     2.07           2.19           2.27
Low Bank Ht    2.1            2.78           3.47
Length and depth measurements in feet, slopes in ft/ft.
```

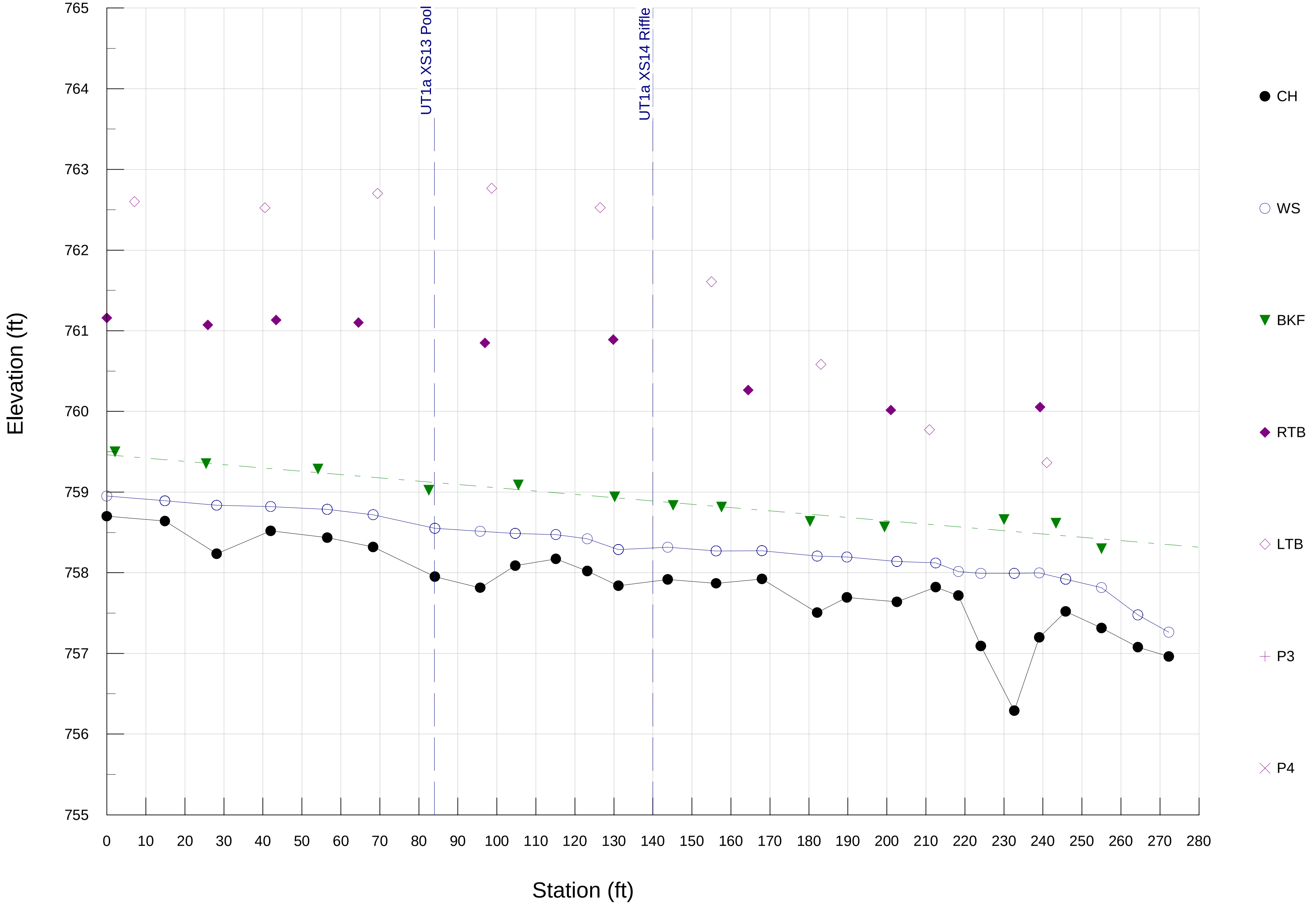
UT1 to Lyle Creek, Reach 3 Profile



```
                                 UT1 Reach 3 Profile
                      RIVERMORPH PROFILE SUMMARY

----------------------------------------------------------------------

River Name:   UT1 to Lyle Creek
Reach Name:   Reach 3
Profile Name: UT1 Reach 3 Profile
Survey Date:  08/12/10

----------------------------------------------------------------------

Survey Data


DIST       CH         WS         BKF        RTB        LTB
----------------------------------------------------------------------
0          756.282    757.582
0.06                             758.557
7.323                            758.567
9.503      756.534    757.534
18.801     756.592    757.492
26.73      756.343    757.543
26.73                            758.509
27.44                                                  762.073
34.36      756.015    757.415
38.05                                       760.755
40.891                           758.266
42.035     756.706    757.406
51.803     756.487    757.387
56.688                                                 762.042
58.92                            758.302
60.912     756.797    757.347
68.412     756.06     757.36
68.594                                      759.826
70.899                           758.384
76.446     756.108    757.308
84.118     756.323    757.323
84.398                                                 761.803
87.281                           758.144
90.815     756.37     757.27
91.811                                      759.567
97.7       756.679    757.279
105.936    756.271    757.171
110.789    756.375    757.275
112.314                          758.26
114.636                                                761.963
118.465    756.056    757.256
123.6                            758.449
126.404    756.01     757.26
134.359    756.242    757.242
138.184                                     759.837
141.662    756.239    757.239
142.218                          758.159
144.691                                                761.928
148.984    755.984    757.184
156.497                          758.026
157.47     755.977    757.177
164.453                                     759.899
164.673    756.283    757.233
172.916    755.876    757.176
174.287                                                761.726
178.821                          758.142
179.006    755.826    757.226
```

```
188.456    756.106    757.206
193.328    756.084    757.184
196.587                          758.176
198.215    756.409    757.109
198.881                                     759.539
201.819                                                761.723
204.36     756.172    757.072
205.376                          758.194
211.142    755.946    757.046
214.594                          758.174
221.964    756.083    757.033
226.295                                     760.126
227.49     756.066    757.016
230.737                          758.014
233.866    756.014    757.014
239.377    755.919    757.019
240.409                                                761.847
243.963    755.975    757.075
248.01                           758.24
250.861    755.603    757.003
260.175    755.935    757.035
265.613                                     760.104
269.011    756.272    757.022

Cross Section Locations

Cross Section Name            Type      Profile Station
----------------------------------------------------------------------
UT1 XS15 Riffle               Riffle    198.07
UT1 XS16 Pool                 Pool      251.25


Measurements from Graph

Bankfull Slope:     0.00152

Variable       Min            Avg            Max
----------------------------------------------------------------------
S riffle       0.00295        0.00636        0.01051
S pool         0.00027        0.00253        0.0051
S run          0.00122        0.00552        0.01661
S glide        0.00071        0.00221        0.00538
P - P          40.7           47.35          55.89
P length       22.52          41.95          65.39
Dmax riffle    1.54           1.73           1.96
Dmax pool      2.22           2.4            2.62
Dmax run       1.87           2.01           2.22
Dmax glide     1.81           1.98           2.25
Low Bank Ht    2.97           3.44           4.24
Length and depth measurements in feet, slopes in ft/ft.
```

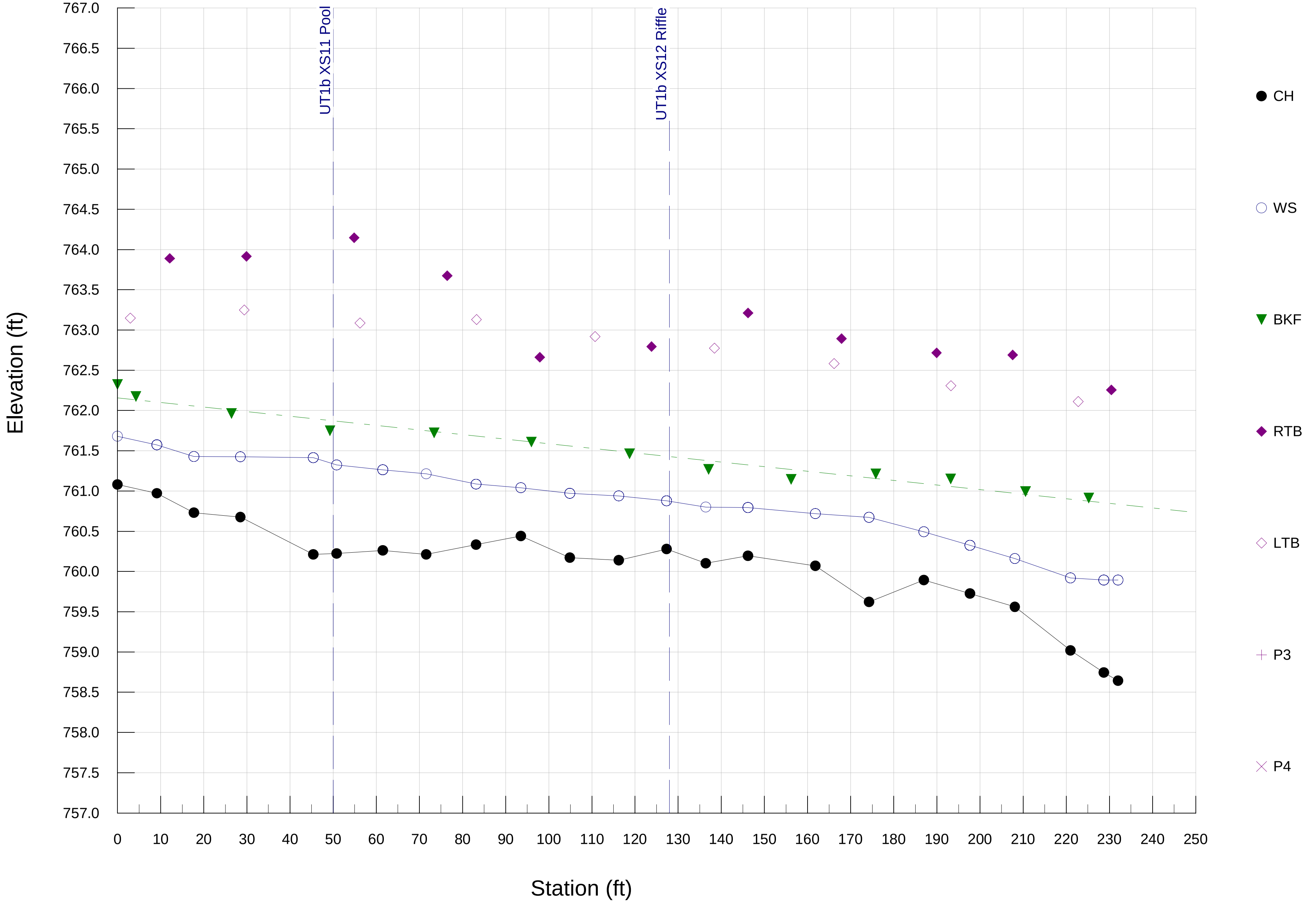
UT1a to Lyle Creek Profile



```
                                    UT1a Profile
                      RIVERMORPH PROFILE SUMMARY

----------------------------------------------------------------------

River Name:   UT1a to Lyle Creek
Reach Name:   Reach 1
Profile Name: UT1a Profile
Survey Date:  08/12/10

----------------------------------------------------------------------

Survey Data


DIST       CH         WS         BKF        RTB        LTB
----------------------------------------------------------------------
0          758.7      758.95
0                                           761.158
2.076                            759.499
7.09                                                   762.601
14.887     758.641    758.891
25.439                           759.353
25.906                                      761.071
28.138     758.236    758.836
40.521                                                 762.524
42.008     758.52     758.82
43.365                                      761.134
54.149                           759.286
56.538     758.436    758.786
64.525                                      761.1
68.28      758.32     758.72
69.394                                                 762.701
82.56                            759.022
84.096     757.952    758.552
95.71      757.814    758.514
96.918                                      760.85
98.658                                                 762.765
104.711    758.088    758.488
105.498                          759.088
115.125    758.172    758.472
123.188    758.02     758.42
126.493                                                762.526
129.821                                     760.89
130.211                          758.941
131.153    757.838    758.288
143.784    757.917    758.317
145.162                          758.836
155.032                                                761.609
156.244    757.869    758.269
157.612                          758.813
164.42                                      760.264
167.985    757.922    758.272
180.291                          758.639
182.135    757.506    758.206
183.077                                                760.582
189.745    757.695    758.195
199.388                          758.569
201.008                                     760.017
202.542    757.64     758.14
210.916                                                759.773
212.542    757.821    758.121
218.323    757.716    758.016
224.071    757.092    757.992
```

```
                                    UT1a Profile
230.044                          758.66
232.662    756.291    757.991
239.056    757.198    757.998
239.253                                     760.054
240.983                                                759.363
243.32                           758.614
245.836    757.521    757.921
255.037    757.316    757.816
255.037                          758.298
264.345    757.077    757.477
272.287    756.962    757.262

Cross Section Locations

Cross Section Name            Type      Profile Station
----------------------------------------------------------------------
UT1a XS13 Pool                Riffle    83.79
UT1a XS14 Riffle              Riffle    140.27


Measurements from Graph

Bankfull Slope:     0.00415

Variable       Min            Avg            Max
----------------------------------------------------------------------
S riffle       0.00353        0.01278        0.03241
S pool         0.00082        0.00251        0.00371
S run          0.00389        0.00663        0.0146
S glide        0.00134        0.00235        0.00497
P - P          34.73          51.15          67.56
P length       24.69          31.54          38.53
Dmax riffle    0.8            0.88           1.04
Dmax pool      1.12           1.17           1.26
Dmax run       0.94           1.06           1.22
Dmax glide     0.87           1.03           1.32
Low Bank Ht    1.86           2.32           2.69
Length and depth measurements in feet, slopes in ft/ft.
```

UT1b to Lyle Creek Profile



UT1b Profile
RIVERMORPH PROFILE SUMMARY

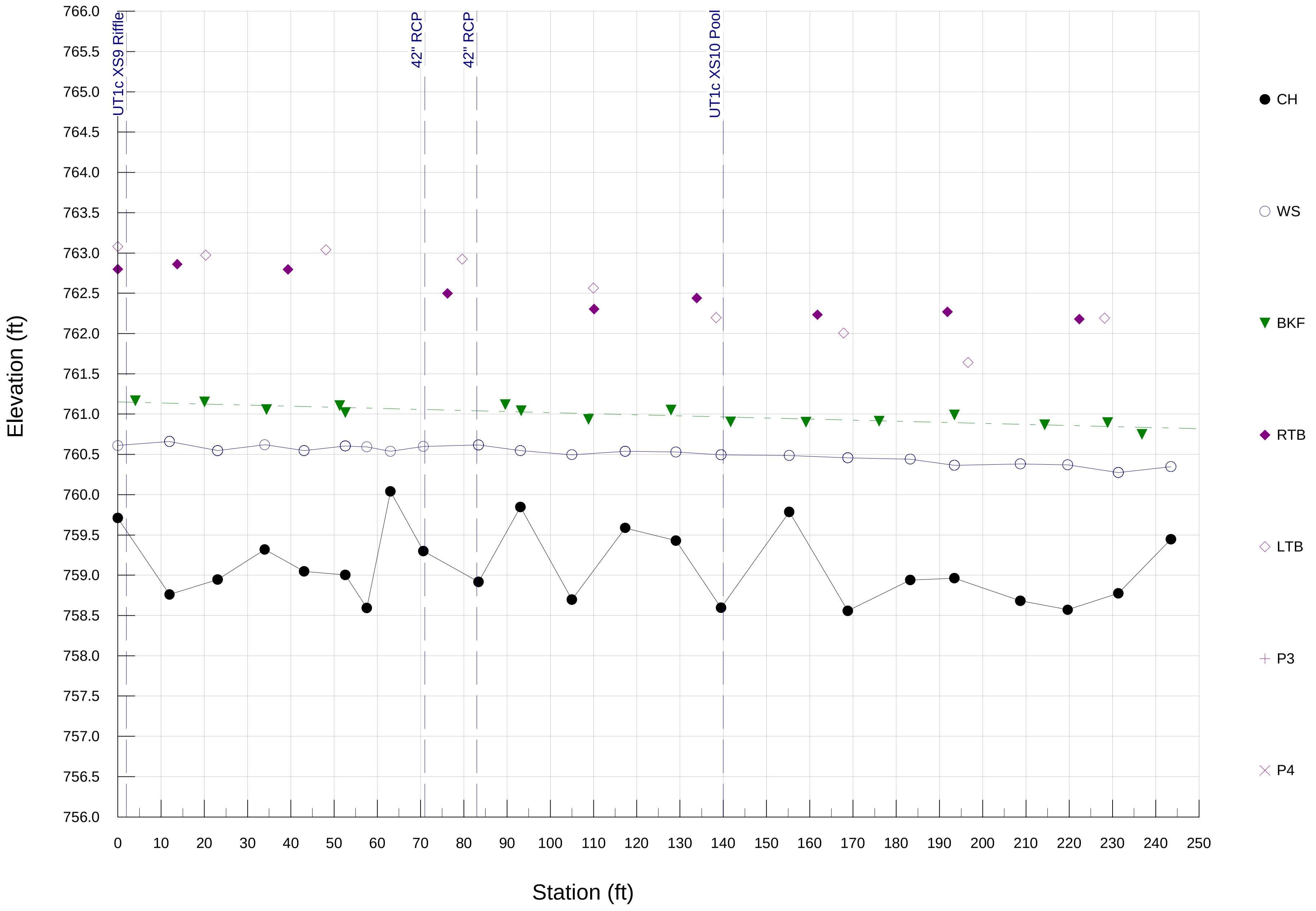
River Name: UT1b to Lyle Creek
Reach Name: Reach 1
Profile Name: UT1b Profile
Survey Date: 08/11/10

Survey Data

DIST	CH	WS	BKF	RTB	LTB
0	761.081	761.681			
0			762.324		
2.97					763.148
4.241			762.176		
9.12	760.972	761.572			
12.12				763.89	
17.713	760.729	761.429			
26.412			761.963		
28.513	760.674	761.424			
29.377					763.248
29.913				763.914	
45.424	760.213	761.413			
49.275			761.749		
50.834	760.223	761.323			
54.888				764.145	
56.232					763.086
61.543	760.262	761.262			
71.563	760.213	761.213			
73.423			761.723		
76.464				763.674	
83.159	760.335	761.085			
83.233					763.13
93.528	760.44	761.039			
95.967			761.609		
97.891				762.66	
104.888	760.171	760.971			
110.737					762.919
116.261	760.14	760.94			
118.724			761.464		
123.84				762.795	
127.317	760.279	760.879			
136.409	760.101	760.801			
137.074			761.27		
138.429					762.774
146.187				763.21	
146.194	760.194	760.794			
156.218			761.144		
161.817	760.069	760.719			
166.163					762.584
167.885				762.893	
174.262	759.622	760.672			
175.811			761.215		
186.974	759.894	760.494			
189.918				762.716	
193.207			761.15		
193.23					762.309
197.664	759.725	760.325			

```
                                    UT1b Profile
207.564                                     762.69
208.087    759.56     760.16
210.557                          760.995
220.999    759.02     759.92
222.752                                                762.111
225.224                          760.912
228.702    758.745    759.895
230.425                                     762.255
231.997    758.644    759.894

Cross Section Locations

Cross Section Name            Type      Profile Station
----------------------------------------------------------------------
UT1b XS11 Pool                Pool      49.73
UT1b XS12 Riffle              Riffle    127.5


Measurements from Graph

Bankfull Slope:     0.00581

Variable       Min            Avg            Max
----------------------------------------------------------------------
S riffle       0.00563        0.01245        0.01648
S pool         0.0013         0.0032         0.00416
S run          0.00216        0.00819        0.0193
S glide        0              0.00729        0.01243
P - P          28.39          51.21          86.88
P length       14.68          30.28          56.53
Dmax riffle    1.13           1.19           1.29
Dmax pool      1.19           1.45           1.6
Dmax run       1.13           1.32           1.47
Dmax glide     1.19           1.31           1.39
Low Bank Ht    2.05           2.36           2.62
Length and depth measurements in feet, slopes in ft/ft.
```

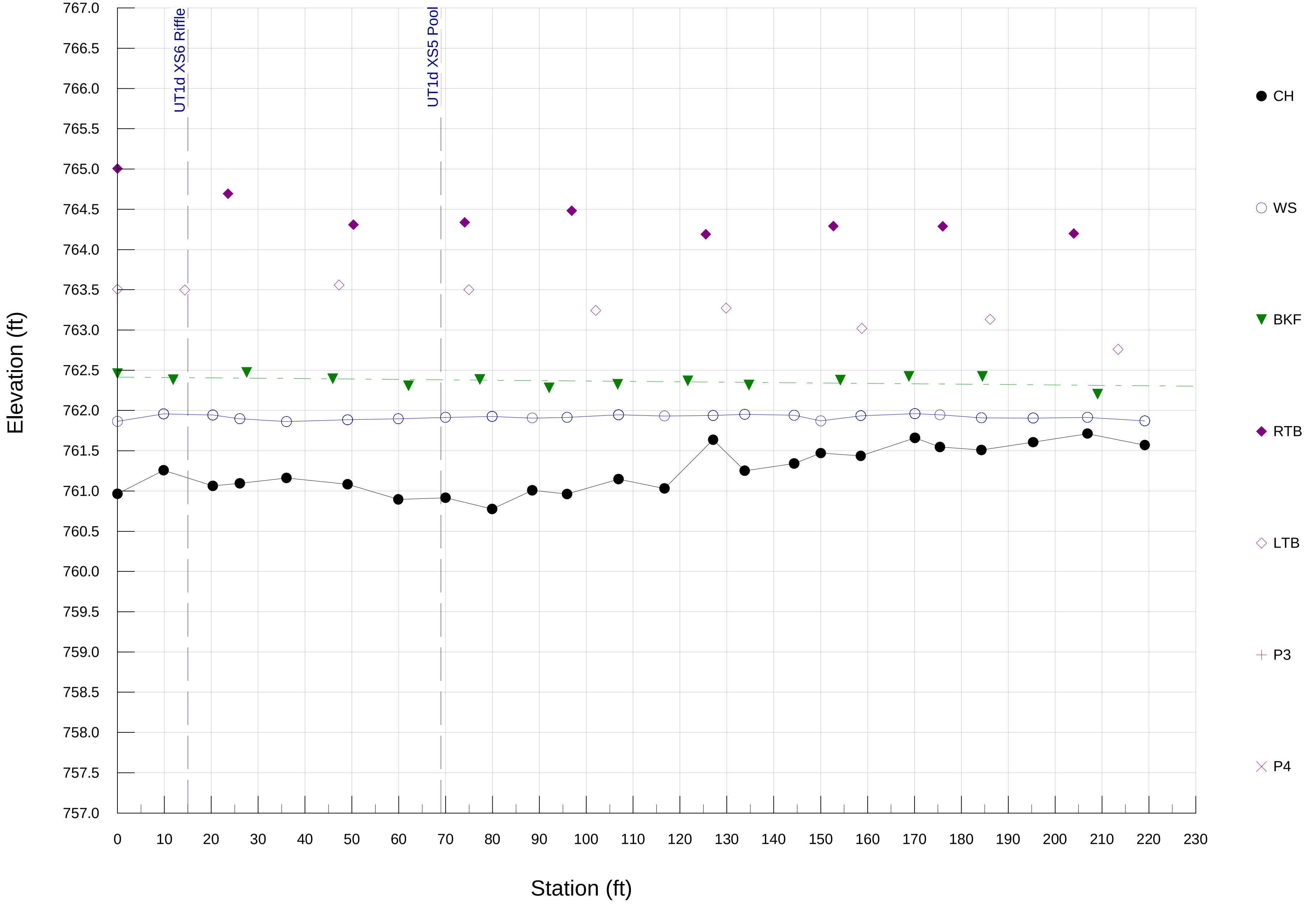
UT1c to Lyle Creek Profile



```
                                    UT1c Profile
                      RIVERMORPH PROFILE SUMMARY

----------------------------------------------------------------------

River Name:   UT1c to Lyle Creek
Reach Name:   Reach 1
Profile Name: UT1c Profile
Survey Date:  08/11/10

----------------------------------------------------------------------

Survey Data


DIST       CH         WS         BKF        RTB        LTB
----------------------------------------------------------------------
0          759.709    760.609
0                                           762.8
0                                                      763.08
4.057                            761.167
11.964     758.76     760.66
13.749                                      762.861
20.028                           761.151
20.316                                                 762.973
23.06      758.947    760.547
33.974     759.32     760.62
34.373                           761.057
39.369                                      762.795
43.098     759.047    760.547
48.115                                                 763.039
51.281                           761.106
52.589                           761.019
52.589     759.005    760.605
57.593     758.593    760.593
63.052     760.039    760.539
70.682     759.299    760.599
76.217                                      762.498
79.615                                                 762.923
83.433     758.917    760.617
89.601                           761.116
93.109     759.847    760.547
93.241                           761.042
104.985    758.696    760.496
108.849                          760.935
109.985                                                762.565
110.151                                     762.304
117.313    759.587    760.537
127.911                          761.05
129.038    759.429    760.529
133.861                                     762.439
138.336                                                762.198
139.496    758.595    760.495
141.713                          760.903
155.258    759.785    760.485
159.147                          760.901
161.759                                     762.233
167.834                                                762.005
168.804    758.558    760.458
176.064                          760.912
183.219    758.941    760.441
191.855                                     762.269
193.466                          760.99
193.466    758.963    760.363
```

```
                                    UT1c Profile
196.586                                                761.64
208.72     758.683    760.383
214.332                          760.868
219.658    758.571    760.371
222.353                                     762.18
228.174                                                762.191
228.862                          760.894
231.35     758.774    760.274
236.803                          760.75
243.51     759.447    760.347

Cross Section Locations

Cross Section Name            Type      Profile Station
----------------------------------------------------------------------
UT1c XS9 Riffle               Riffle    2
UT1c XS10 Pool                Pool      140.28
42" RCP                       Riffle    70.682
42" RCP                       Riffle    83.433


Measurements from Graph

Bankfull Slope:     0.00128

Variable       Min            Avg            Max
----------------------------------------------------------------------
S riffle       0              0              0
S pool         0              0.00131        0.00235
S run          0.00179        0.00428        0.0084
S glide        0.00053        0.00311        0.00691
P - P          29.86          41.36          49.68
P length       21.29          31.03          50.41
Dmax riffle    0              0              0
Dmax pool      2.27           2.38           2.54
Dmax run       1.64           1.79           1.99
Dmax glide     1.5            1.63           1.72
Low Bank Ht    2.36           2.7            3.05
Length and depth measurements in feet, slopes in ft/ft.
```

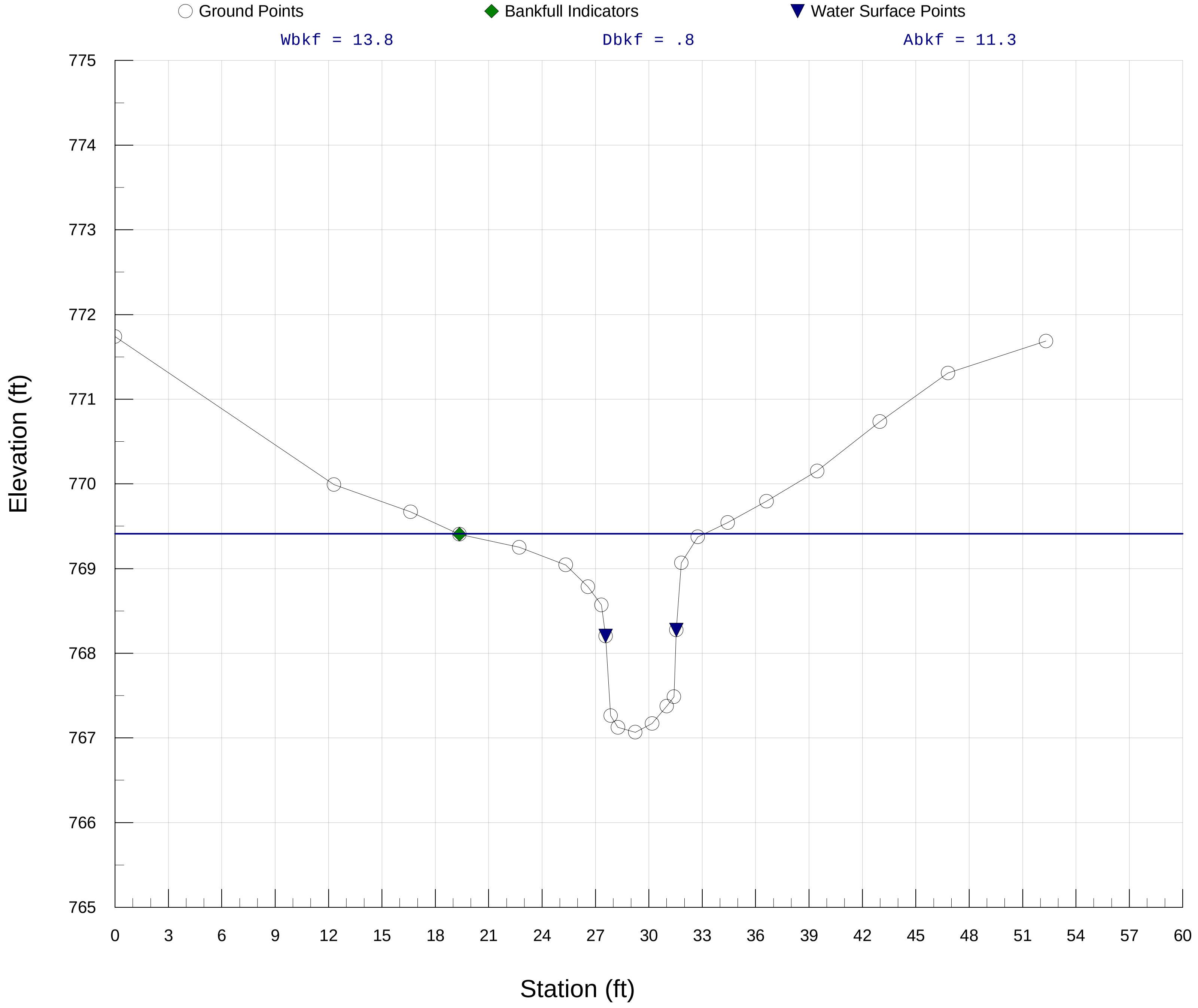
UT1d to Lyle Creek Profile



```
                                    UT1d Profile
                      RIVERMORPH PROFILE SUMMARY

----------------------------------------------------------------------

River Name:   UT1d to Lyle Creek
Reach Name:   Reach 1
Profile Name: UT1d Profile
Survey Date:  08/10/10

----------------------------------------------------------------------

Survey Data


DIST       CH         WS         BKF        RTB        LTB
----------------------------------------------------------------------
0          760.966    761.866
0                                762.458
0                                           765.007
0                                                      763.507
9.845      761.258    761.958
11.896                           762.384
14.343                                                 763.497
20.351     761.062    761.942
23.576                                      764.694
26.109     761.096    761.896
27.555                           762.474
36.07      761.162    761.862
45.894                           762.394
47.272                                                 763.559
49.082     761.084    761.884
50.319                                      764.309
59.911     760.896    761.896
62.086                           762.308
69.996     760.915    761.915
74.056                                      764.336
74.94                                                  763.501
77.313                           762.387
79.91      760.776    761.926
88.47      761.007    761.907
92.088                           762.283
95.921     760.963    761.913
96.889                                      764.483
102.04                                                 763.242
106.679                          762.325
106.901    761.147    761.947
116.673    761.031    761.931
121.65                           762.368
125.5                                       764.191
127.065    761.637    761.937
129.836                                                763.271
133.811    761.251    761.951
134.715                          762.316
144.358    761.341    761.941
150.047    761.47     761.87
152.73                                      764.292
154.192                          762.377
158.558    761.436    761.936
158.769                                                763.021
168.833                          762.424
170.112    761.66     761.96
175.46     761.546    761.946
176.024                                     764.288
```

```
                                    UT1d Profile
184.312    761.508    761.908
184.48                           762.423
186.123                                                 763.134
195.349    761.606    761.906
204.009                                      764.199
206.953    761.713    761.913
209.052                          762.203
213.436                                                 762.759
219.146    761.57     761.87

Cross Section Locations

Cross Section Name            Type      Profile Station
----------------------------------------------------------------------
UT1d XS5 Pool                 Pool      68.99
UT1d XS6 Riffle               Riffle    15.46


Measurements from Graph

Bankfull Slope:     0.00067

Variable       Min            Avg            Max
----------------------------------------------------------------------
S riffle       0.0023         0.00401        0.00676
S pool         0.00025        0.0011         0.00194
S run          0              0              0
S glide        0              0              0
P - P          104.69         104.69         104.69
P length       20.71          36.7           56.06
Dmax riffle    0.57           0.92           1.28
Dmax pool      0.94           1.3            1.66
Dmax run       0              0              0
Dmax glide     0              0              0
Low Bank Ht    1.19           1.62           2.23
Length and depth measurements in feet, slopes in ft/ft.
```

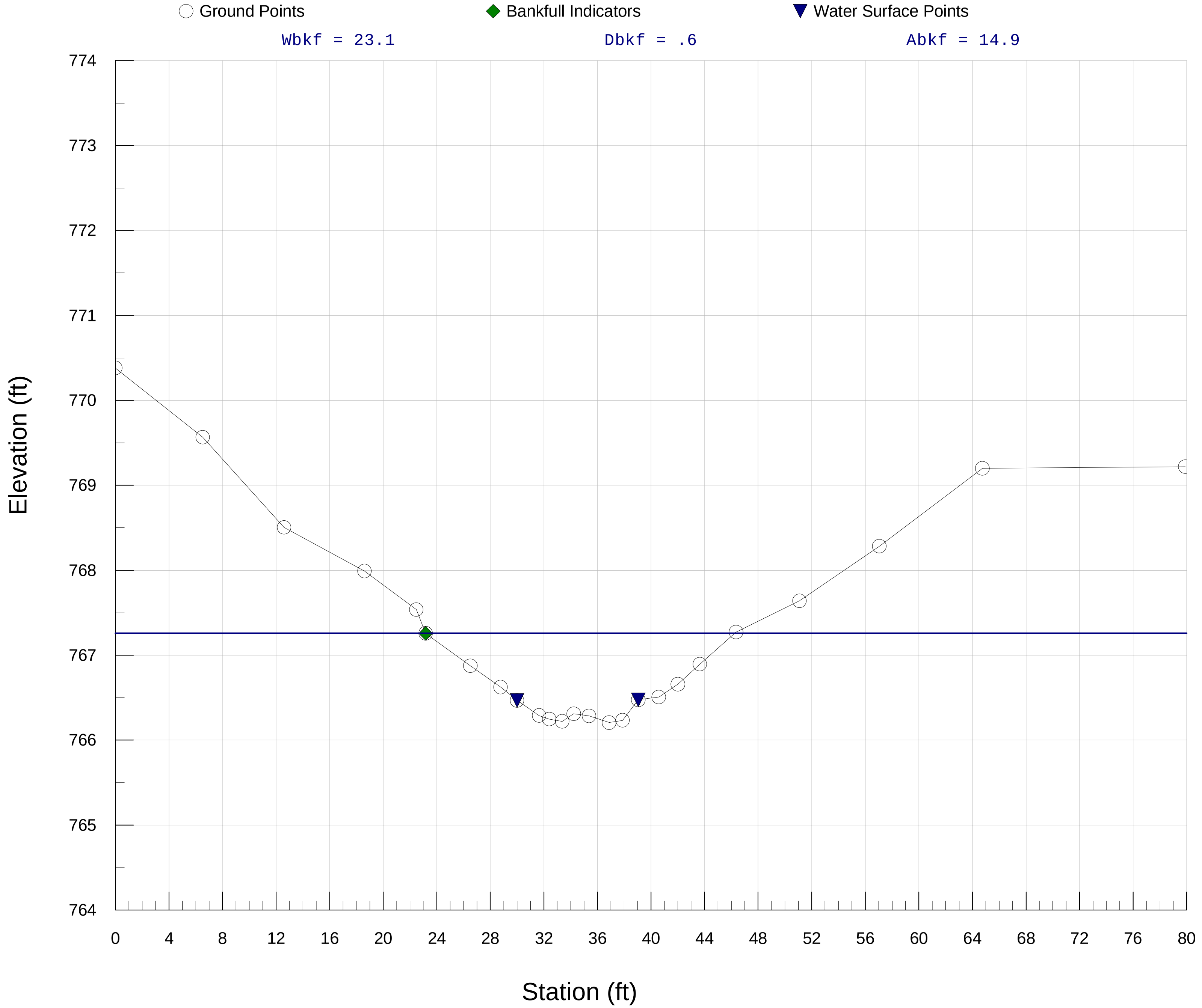
UT1 to Lyle Creek, XS1 Pool



```
                                    UT1 XS1 Pool
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1 to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1 XS1 Pool
Survey Date:        08/17/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              771.739349     POOL
12.3           0              769.990635
16.61          0              769.670061
19.36          0              769.405533     BKF
22.72          0              769.250393
25.33          0              769.04403
26.57          0              768.78508
27.33          0              768.570202
27.57          0              768.204149     LEW
27.85          0              767.262892
28.26          0              767.124968
29.24          0              767.067501
30.18          0              767.170092
31.01          0              767.374833
31.41          0              767.486232
31.54          0              768.274844     REW
31.83          0              769.068253
32.75          0              769.374356
34.43          0              769.543266
36.61          0              769.795269
39.46          0              770.152772
42.98          0              770.735563
46.81          0              771.308524
52.32          0              771.685949


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  771.75     771.75     771.75
Bankfull Elevation (ft)    769.41     769.41     769.41
Floodprone Width (ft)      52.32      -----      -----
Bankfull Width (ft)        13.79      6.9        6.89
Entrenchment Ratio         3.79       -----      -----
Mean Depth (ft)            0.82       0.2        1.45
Maximum Depth (ft)         2.34       0.55       2.34
Width/Depth Ratio          16.78      34.85      4.76
Bankfull Area (sq ft)      11.34      1.36       9.97
Wetted Perimeter (ft)      16.1       7.48       9.72
Hydraulic Radius (ft)      0.7        0.18       1.03
Begin BKF Station          19.31      19.31      26.21
End BKF Station            33.1       26.21      33.1

----------------------------------------------------------------------
```

```
                                    UT1 XS1 Pool
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

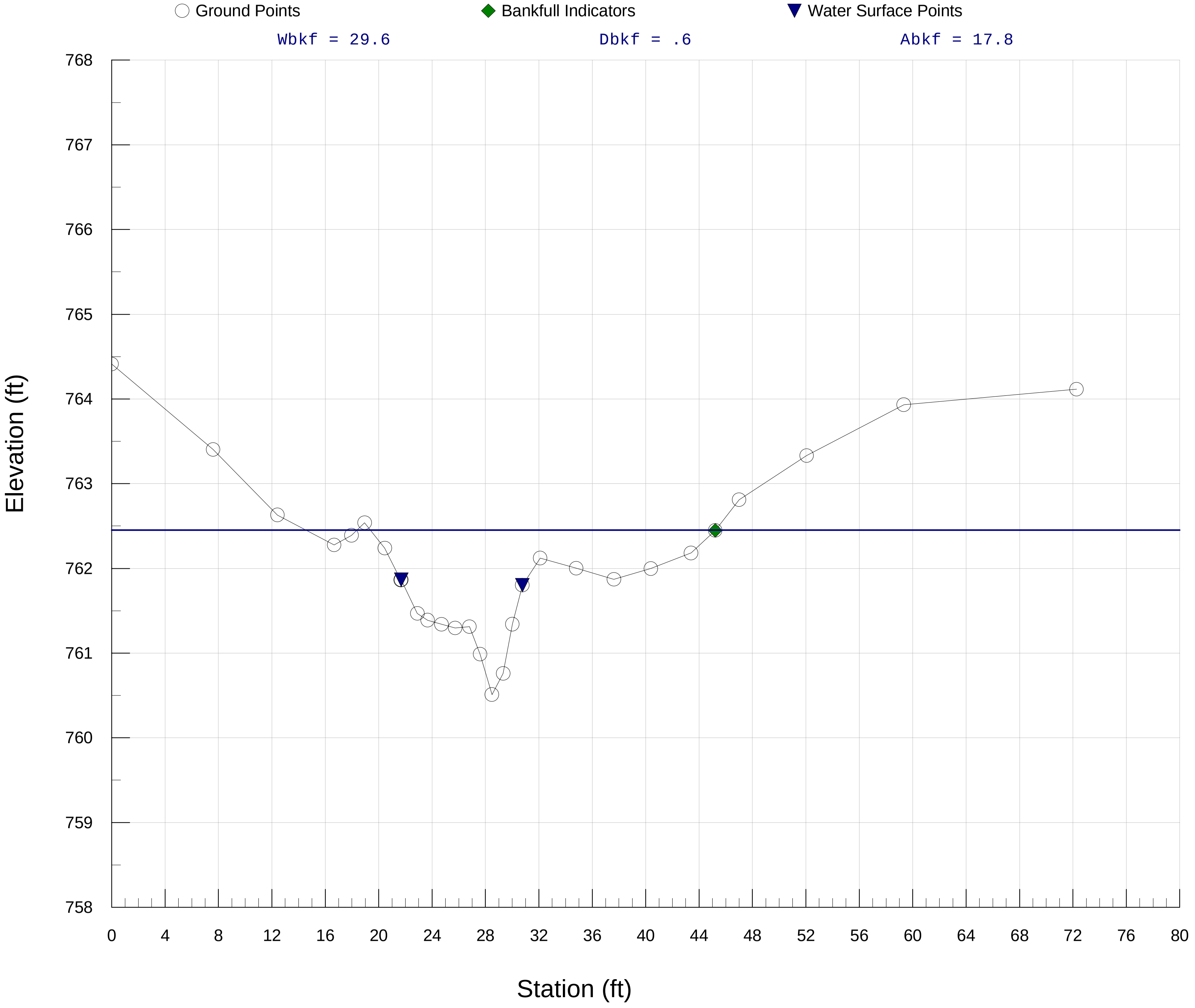
UT1 to Lyle Creek, XS2 Riffle



```
                                UT1 XS2 Riffle
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1 to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1 XS2 Riffle
Survey Date:        08/10/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              770.381827     RIFFLE
6.52           0              769.565872
12.59          0              768.504082
18.61          0              767.990376
22.48          0              767.537198
23.17          0              767.257124     BKF
26.51          0              766.875777
28.76          0              766.62434
29.99          0              766.467875     LEW
31.64          0              766.289663
32.4           0              766.247974
33.37          0              766.220741
34.23          0              766.31068
35.37          0              766.285402
36.87          0              766.205778
37.87          0              766.233127
39.05          0              766.474133     REW
40.58          0              766.506112
42.01          0              766.658435
43.65          0              766.894614
46.35          0              767.271817
51.09          0              767.639262
57.05          0              768.283495
64.75          0              769.199306
79.9           0              769.219954


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  768.31     768.31     768.31
Bankfull Elevation (ft)    767.26     767.26     767.26
Floodprone Width (ft)      42.49      -----      -----
Bankfull Width (ft)        23.1       11.55      11.56
Entrenchment Ratio         1.84       -----      -----
Mean Depth (ft)            0.64       0.62       0.67
Maximum Depth (ft)         1.05       1.04       1.05
Width/Depth Ratio          35.88      18.55      17.37
Bankfull Area (sq ft)      14.88      7.19       7.69
Wetted Perimeter (ft)      23.24      12.57      12.59
Hydraulic Radius (ft)      0.64       0.57       0.61
Begin BKF Station          23.16      23.16      34.71
End BKF Station            46.27      34.71      46.27
```

```
                                   UT1 XS2 Riffle
----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

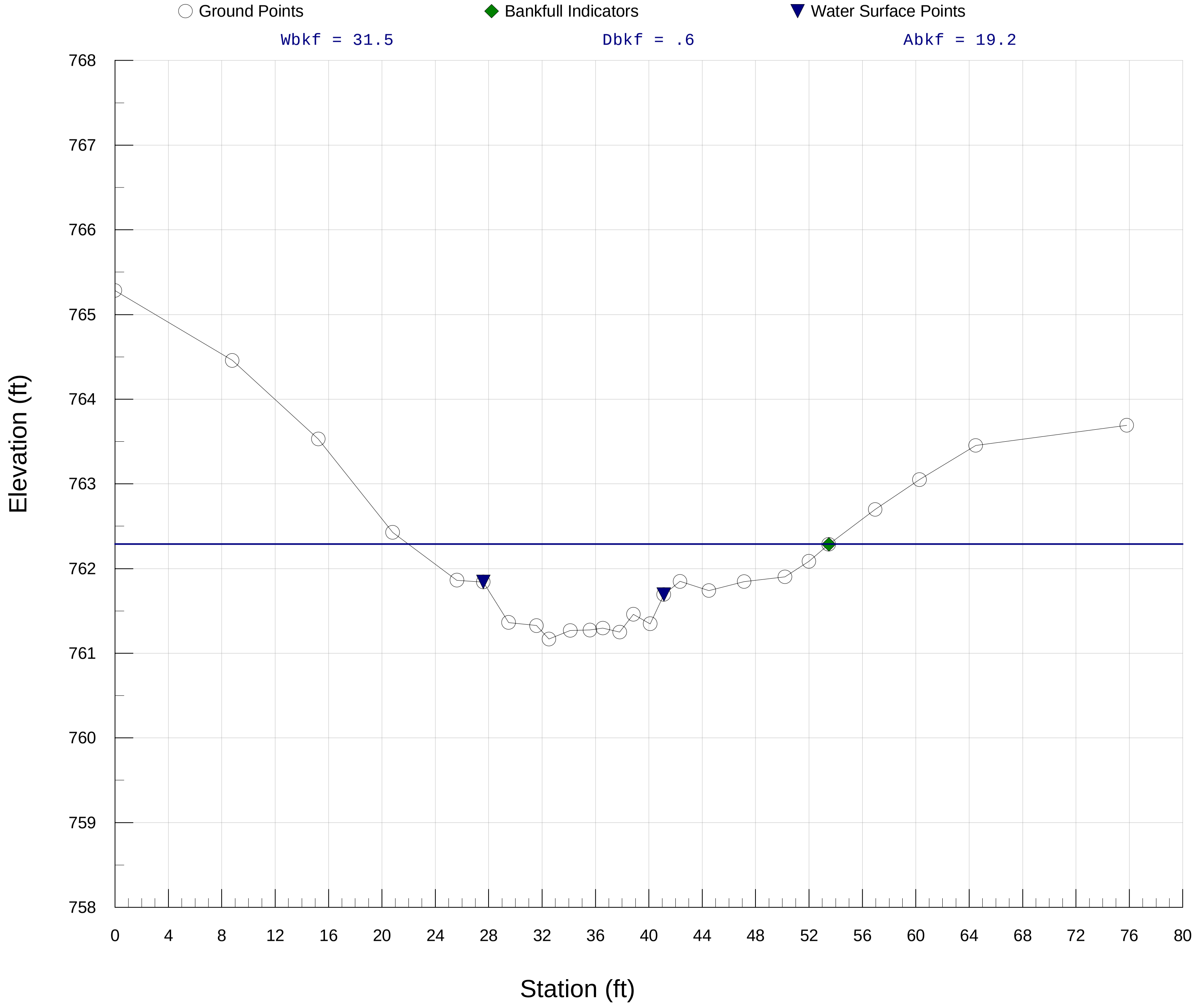
UT1 to Lyle Creek, XS3 Pool



```
                                    UT1 XS3 Pool
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1 to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1 XS3 Pool
Survey Date:        08/10/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              764.41119
7.59           0              763.403523
12.42          0              762.630854
16.66          0              762.275888
17.96          0              762.390057
18.95          0              762.539523
20.46          0              762.238358
21.65          0              761.863626
21.69          0              761.86628      LEW
22.9           0              761.468962
23.67          0              761.388438
24.71          0              761.339414
25.73          0              761.296071
26.8           0              761.312571
27.59          0              760.986898
28.48          0              760.510697
29.33          0              760.759187
30.01          0              761.341822
30.76          0              761.801259     REW
32.1           0              762.121753
34.8           0              762.002229
37.62          0              761.871579
40.39          0              761.997589
43.4           0              762.181369
45.21          0              762.448132     BKF
47             0              762.809935
52.06          0              763.331631
59.33          0              763.932428
72.27          0              764.11589


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  764.39     764.39     764.39
Bankfull Elevation (ft)    762.45     762.45     762.45
Floodprone Width (ft)      72.11      -----      -----
Bankfull Width (ft)        29.6       14.8       15.84
Entrenchment Ratio         2.44       -----      -----
Mean Depth (ft)            0.6        0.75       0.47
Maximum Depth (ft)         1.94       1.94       1.65
Width/Depth Ratio          49.21      18.26      33.75
Bankfull Area (sq ft)      17.8       10.37      7.43
Wetted Perimeter (ft)      30.4       15.81      17.89
```

```
Hydraulic Radius (ft)      0.59       0.66       0.42
Begin BKF Station          14.58      14.58      29.38
End BKF Station            45.22      29.38      45.22

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

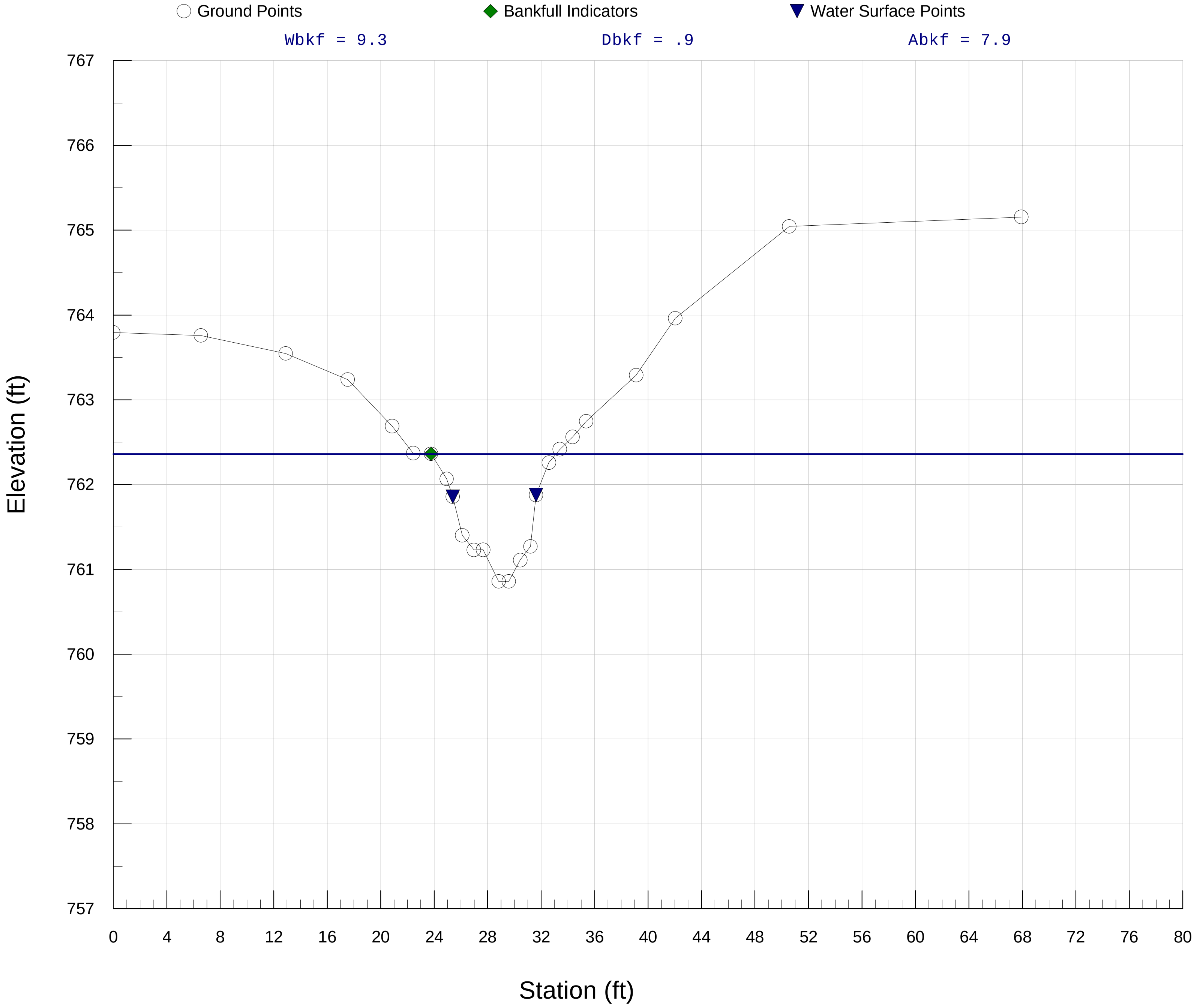
UT1 to Lyle Creek, XS4 Riffle



```
                                UT1 XS4 Riffle
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:          UT1 to Lyle Creek
Reach Name:          Reach 1
Cross Section Name: UT1 XS4 Riffle
Survey Date:         08/10/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                  0 ft
Backsight Rod Reading:         0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              765.281933     RIFFLE
8.78           0              764.457458
15.23          0              763.52937
20.8           0              762.427712
25.62          0              761.862907
27.59          0              761.840798     LEW
29.49          0              761.363077
31.58          0              761.326118
32.52          0              761.166973
34.11          0              761.268244
35.59          0              761.27353
36.55          0              761.295823
37.82          0              761.249842
38.84          0              761.459757
40.1           0              761.347813
41.12          0              761.693025     REW
42.34          0              761.847613
44.5           0              761.739427
47.14          0              761.845706
50.2           0              761.902
52             0              762.085233
53.48          0              762.285235     BKF
56.96          0              762.697764
60.28          0              763.049183
64.49          0              763.453981
75.81          0              763.691701


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  763.41     763.41     763.41
Bankfull Elevation (ft)    762.29     762.29     762.29
Floodprone Width (ft)      48.25      -----      -----
Bankfull Width (ft)        31.54      15.77      15.77
Entrenchment Ratio         1.53       -----      -----
Mean Depth (ft)            0.61       0.72       0.5
Maximum Depth (ft)         1.12       1.12       1.04
Width/Depth Ratio          51.79      22.02      31.44
Bankfull Area (sq ft)      19.21      11.3       7.91
Wetted Perimeter (ft)      31.77      16.91      16.93
Hydraulic Radius (ft)      0.6        0.67       0.47
Begin BKF Station          21.98      21.98      37.75
End BKF Station            53.52      37.75      53.52
```

```
                                   UT1 XS4 Riffle

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

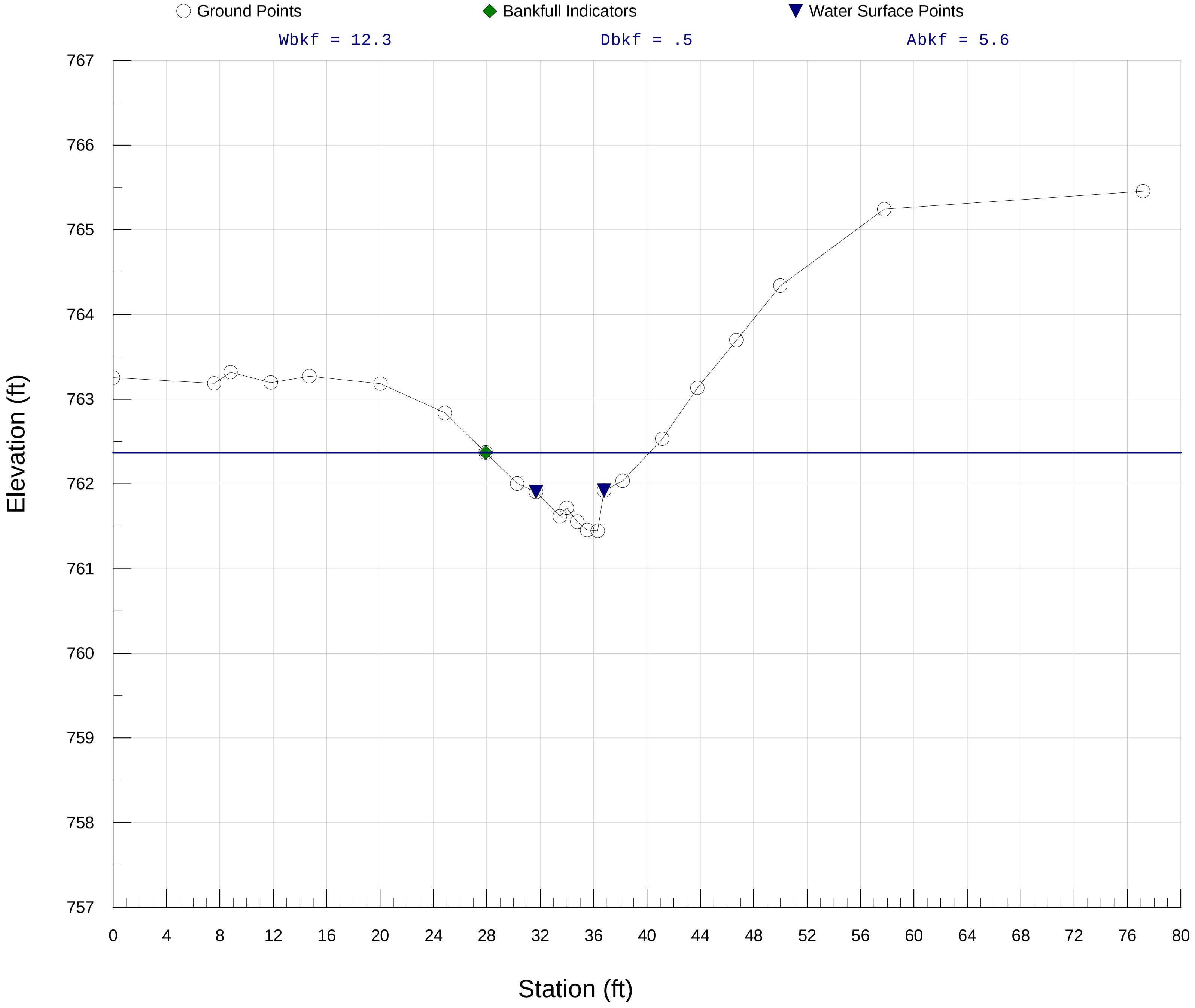
UT1d to Lyle Creek, XS5 Pool



```
                                    UT1d XS5 Pool
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1d to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1d XS5 Pool
Survey Date:        08/10/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              763.793677     POOL
6.54           0              763.758919
12.89          0              763.545863
17.54          0              763.237972
20.86          0              762.688604
22.44          0              762.370131
23.77          0              762.363662     BKF
24.94          0              762.065763
25.39          0              761.857994     LEW
26.1           0              761.401465
26.97          0              761.230406
27.66          0              761.231362
28.82          0              760.858921
29.58          0              760.858614
30.44          0              761.109722
31.2           0              761.269939
31.62          0              761.878138     REW
32.58          0              762.258454
33.4           0              762.417398
34.36          0              762.561495     -
35.37          0              762.747606
39.11          0              763.289574
42.03          0              763.961072
50.56          0              765.044549
67.92          0              765.154673


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  763.86     763.86     763.86
Bankfull Elevation (ft)    762.36     762.36     762.36
Floodprone Width (ft)      41.6       -----      -----
Bankfull Width (ft)        9.32       4.14       5.18
Entrenchment Ratio         4.46       -----      -----
Mean Depth (ft)            0.85       0.69       0.98
Maximum Depth (ft)         1.5        1.21       1.5
Width/Depth Ratio          10.95      5.98       5.29
Bankfull Area (sq ft)      7.93       2.86       5.07
Wetted Perimeter (ft)      10.07      5.59       6.89
Hydraulic Radius (ft)      0.79       0.51       0.74
Begin BKF Station          23.78      23.78      27.92
End BKF Station            33.1       27.92      33.1
```

```
                                   UT1d XS5 Pool
----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

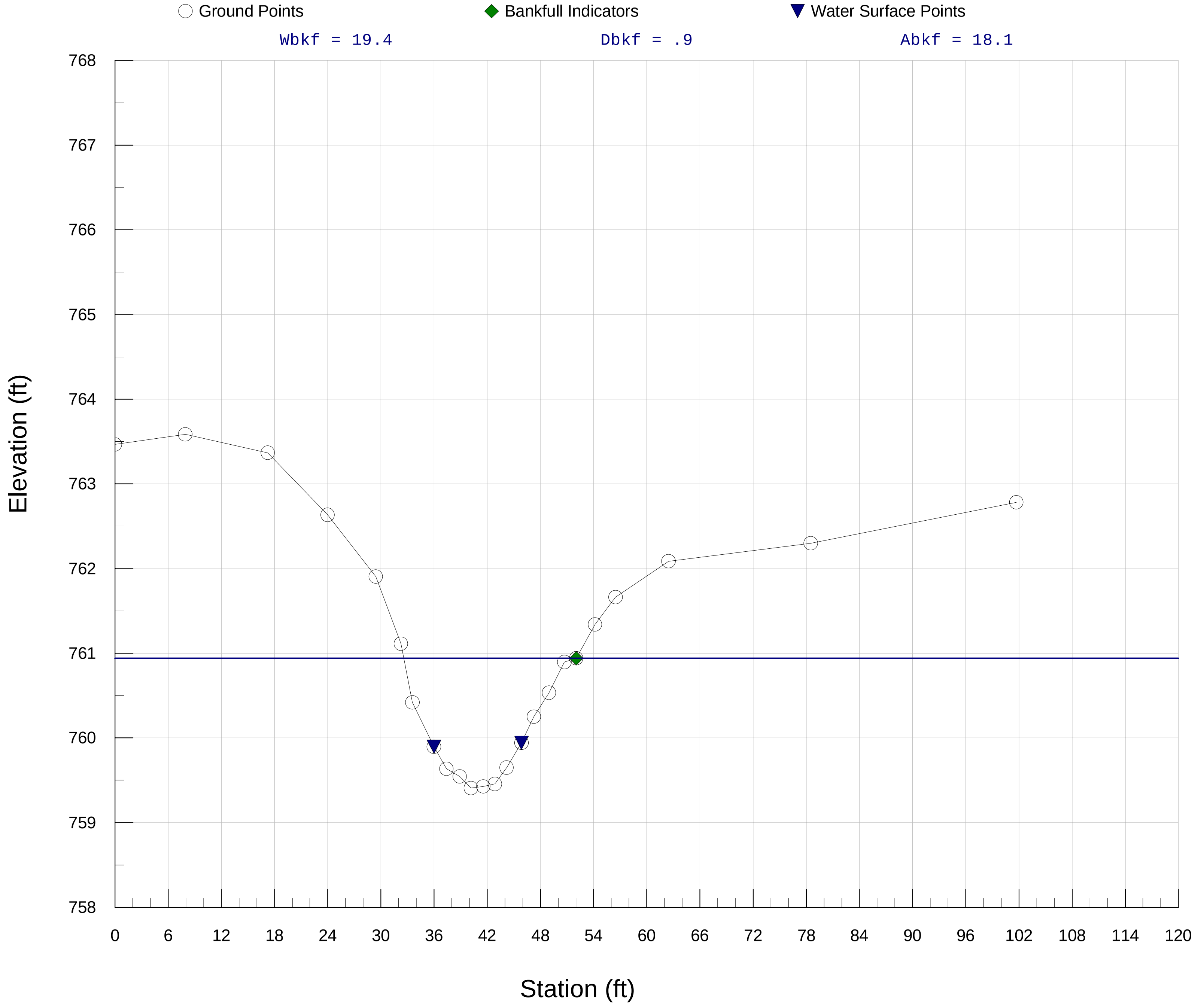
UT1d to Lyle Creek, XS6 Riffle



```
                                  UT1d XS6 Riffle
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1d to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1d XS6 Riffle
Survey Date:        08/10/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              763.254412     RIFFLE
7.58           0              763.186695
8.81           0              763.317859
11.81          0              763.196009
14.71          0              763.270891
20.04          0              763.184657
24.87          0              762.836376
27.91          0              762.37043      BKF
30.27          0              762.002778
31.69          0              761.904636     LEW
33.48          0              761.617305
33.99          0              761.716289
34.78          0              761.553079
35.51          0              761.454143
36.31          0              761.445487
36.79          0              761.920506     REW
38.18          0              762.035638
41.14          0              762.530778     -
43.78          0              763.134009
46.7           0              763.697251
49.99          0              764.340283
57.77          0              765.24308
77.18          0              765.455879


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  763.29     763.29     763.29
Bankfull Elevation (ft)    762.37     762.37     762.37
Floodprone Width (ft)      43.82      -----      -----
Bankfull Width (ft)        12.27      6.09       6.18
Entrenchment Ratio         3.57       -----      -----
Mean Depth (ft)            0.46       0.41       0.51
Maximum Depth (ft)         0.92       0.75       0.92
Width/Depth Ratio          26.72      14.95      12.11
Bankfull Area (sq ft)      5.63       2.48       3.15
Wetted Perimeter (ft)      12.58      6.81       7.09
Hydraulic Radius (ft)      0.45       0.36       0.44
Begin BKF Station          27.91      27.91      34
End BKF Station            40.18      34         40.18

----------------------------------------------------------------------
Entrainment Calculations
```

```
                                  UT1d XS6 Riffle
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

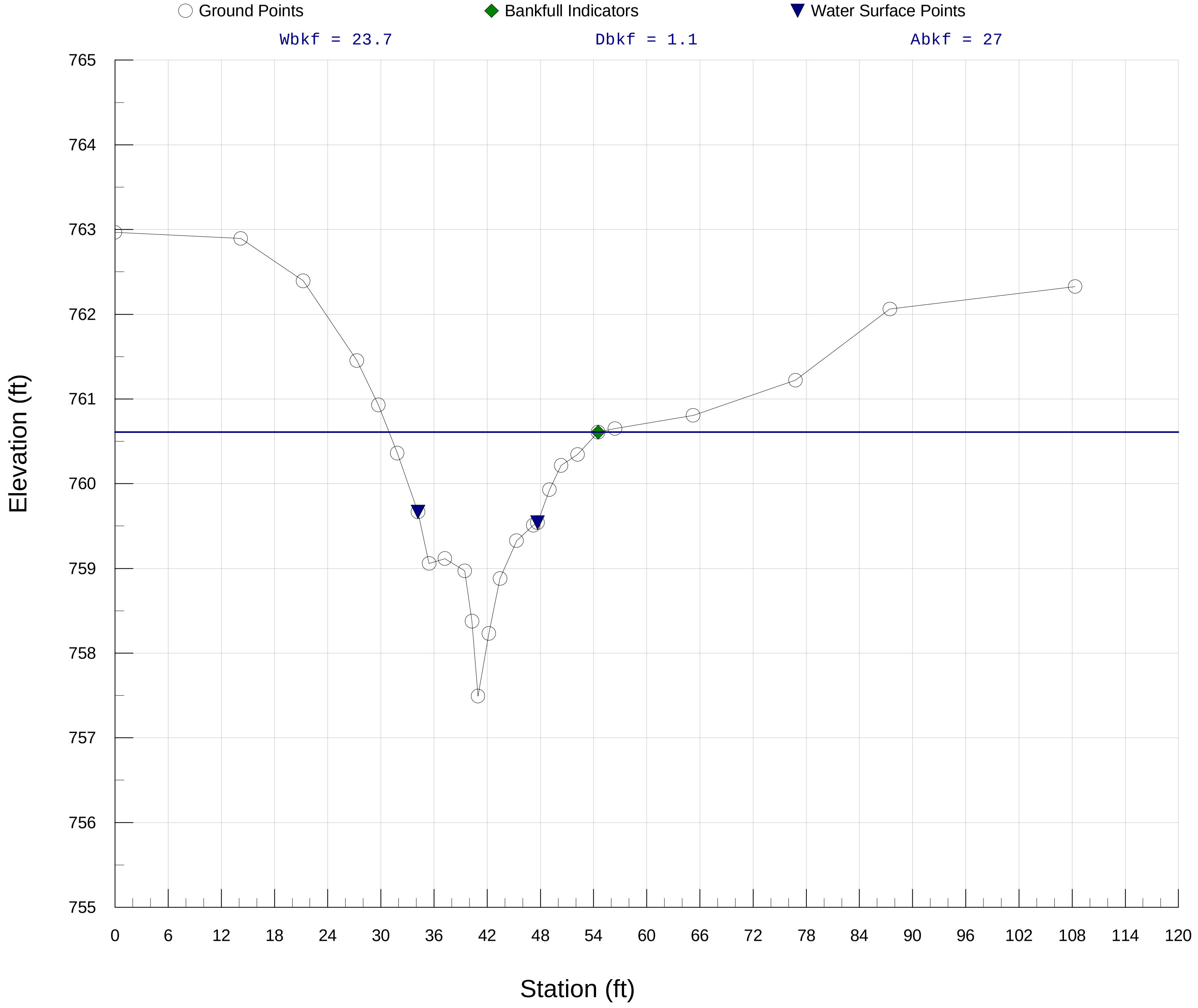
UT1 to Lyle Creek, XS7 Riffle



```
                                   UT1 XS7 Riffle
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1 to Lyle Creek
Reach Name:         Reach 2
Cross Section Name: UT1 XS7 Riffle
Survey Date:        08/10/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              763.466105     RIFFLE
7.93           0              763.584323
17.24          0              763.367387
23.99          0              762.634651
29.42          0              761.904257
32.27          0              761.111748
33.56          0              760.419317
35.99          0              759.8956       LEW
37.41          0              759.636261
38.89          0              759.544402
40.17          0              759.407558
41.56          0              759.426681
42.87          0              759.456635
44.19          0              759.64964
45.87          0              759.941759     REW
47.27          0              760.250732
48.96          0              760.532887
50.71          0              760.895942
52.05          0              760.941053     BKF
54.17          0              761.339887
56.48          0              761.66242
62.46          0              762.085705
78.5           0              762.297652
101.7          0              762.7819


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  762.47     762.47     762.47
Bankfull Elevation (ft)    760.94     760.94     760.94
Floodprone Width (ft)      61.68      -----      -----
Bankfull Width (ft)        19.43      9.71       9.72
Entrenchment Ratio         3.17       -----      -----
Mean Depth (ft)            0.93       1.12       0.73
Maximum Depth (ft)         1.53       1.53       1.5
Width/Depth Ratio          20.9       8.63       13.24
Bankfull Area (sq ft)      18.06      10.92      7.13
Wetted Perimeter (ft)      19.78      11.43      11.35
Hydraulic Radius (ft)      0.91       0.96       0.63
Begin BKF Station          32.59      32.59      42.3
End BKF Station            52.02      42.3       52.02

----------------------------------------------------------------------
```

```
                                   UT1 XS7 Riffle
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

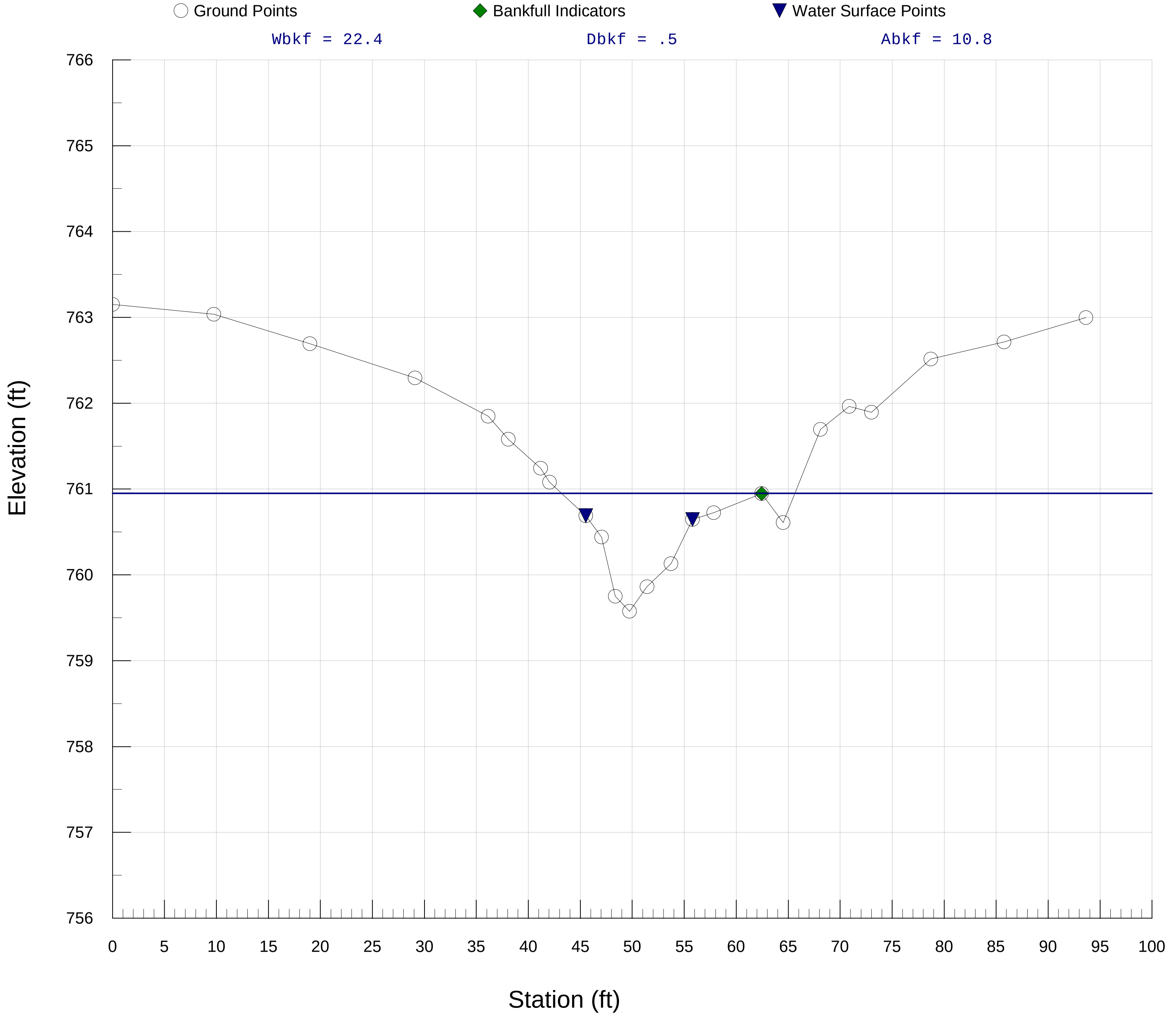
UT1 to Lyle Creek, XS8 Pool



```
                                    UT1 XS8 Pool
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1 to Lyle Creek
Reach Name:         Reach 2
Cross Section Name: UT1 XS8 Pool
Survey Date:        08/10/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              762.967046     POOL
14.18          0              762.893779
21.23          0              762.393734
27.29          0              761.452401
29.72          0              760.929344
31.85          0              760.361909
34.19          0              759.666289     LEW
35.44          0              759.057355
37.23          0              759.11516
39.47          0              758.971093
40.28          0              758.37656
40.96          0              757.492404
42.18          0              758.232543
43.45          0              758.880601
45.31          0              759.326491
47.2           0              759.509128
47.67          0              759.540185     REW
49.03          0              759.928488
50.34          0              760.215079
52.19          0              760.343635
54.51          0              760.608306     BKF
56.42          0              760.650021     -
65.24          0              760.806991
76.78          0              761.221766
87.43          0              762.060391
108.34         0              762.326657


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  763.73     763.73     763.73
Bankfull Elevation (ft)    760.61     760.61     760.61
Floodprone Width (ft)      108.34     -----      -----
Bankfull Width (ft)        23.67      12.67      11
Entrenchment Ratio         4.58       -----      -----
Mean Depth (ft)            1.14       1.49       0.74
Maximum Depth (ft)         3.12       3.12       1.7
Width/Depth Ratio          20.72      8.5        14.85
Bankfull Area (sq ft)      27.04      18.89      8.14
Wetted Perimeter (ft)      25.11      15.64      12.86
Hydraulic Radius (ft)      1.08       1.21       0.63
Begin BKF Station          30.92      30.92      43.59
End BKF Station            54.59      43.59      54.59
```

```
                                    UT1 XS8 Pool

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

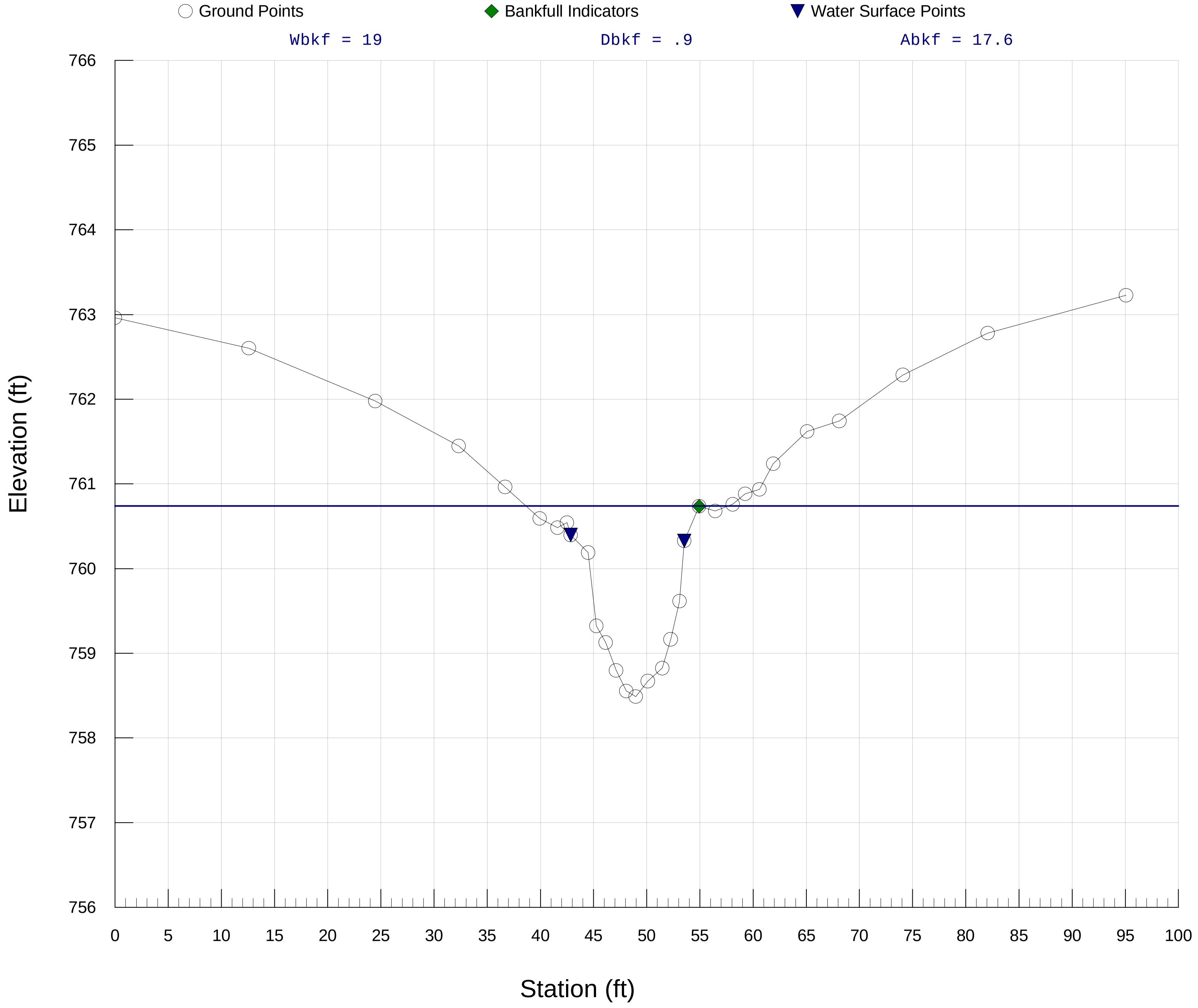
UT1c to Lyle Creek, XS9 Riffle



```
                                  UT1c XS9 Riffle
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1c to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1c XS9 Riffle
Survey Date:        08/11/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              763.150941     RIFFLE
9.75           0              763.037262
19             0              762.691408
29.12          0              762.294607
36.14          0              761.846997
38.07          0              761.58096
41.18          0              761.242806
42.05          0              761.080842
45.53          0              760.689171     LEW
47.05          0              760.44183
48.37          0              759.749445
49.73          0              759.576338
51.42          0              759.861096
53.72          0              760.131015
55.8           0              760.645777     REW
57.84          0              760.723277
62.44          0              760.948066     BKF
64.52          0              760.609132     -
68.1           0              761.694838
70.86          0              761.964076
73.01          0              761.893685
78.72          0              762.514473
85.77          0              762.714011
93.64          0              762.996269


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  762.32     762.32     762.32
Bankfull Elevation (ft)    760.95     760.95     760.95
Floodprone Width (ft)      48.59      -----      -----
Bankfull Width (ft)        22.43      7.63       14.8
Entrenchment Ratio         2.17       -----      -----
Mean Depth (ft)            0.48       0.68       0.38
Maximum Depth (ft)         1.37       1.37       1.19
Width/Depth Ratio          46.49      11.22      38.85
Bankfull Area (sq ft)      10.82      5.19       5.64
Wetted Perimeter (ft)      22.83      9.05       16.16
Hydraulic Radius (ft)      0.47       0.57       0.35
Begin BKF Station          43.21      43.21      50.84
End BKF Station            65.64      50.84      65.64

----------------------------------------------------------------------
```

```
                                   UT1c XS9 Riffle
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

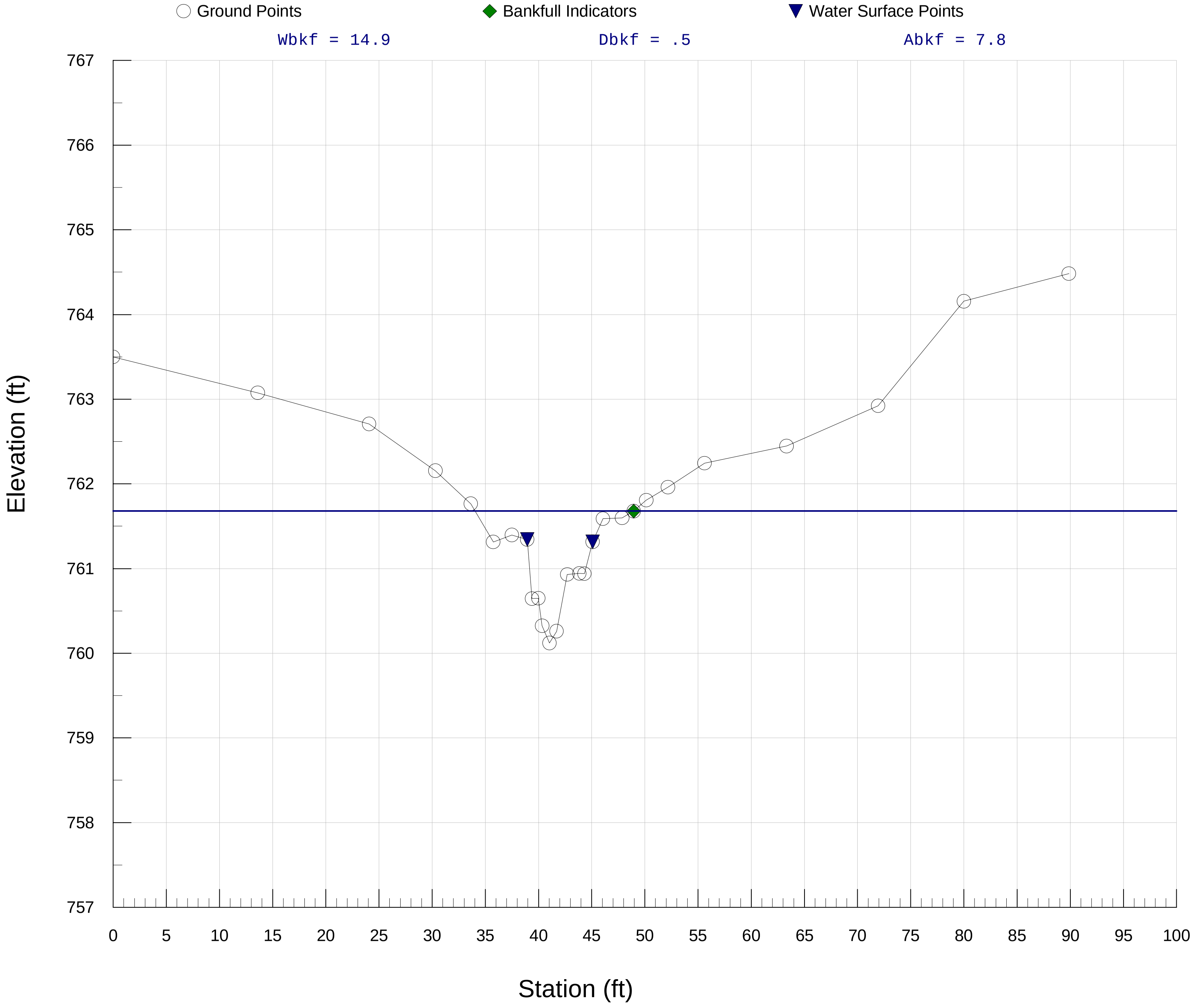
UT1c to Lyle Creek, XS10 Pool



```
                                   UT1c XS10 Pool
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1c to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1c XS10 Pool
Survey Date:        08/11/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              762.961476     POOL
12.58          0              762.602484
24.47          0              761.977936
32.32          0              761.446756
36.68          0              760.963701
39.94          0              760.592089
41.6           0              760.481955
42.5           0              760.542171
42.85          0              760.39649      LEW
44.49          0              760.187693
45.26          0              759.322475
46.14          0              759.126959
47.12          0              758.797376
48.08          0              758.553425
48.96          0              758.488438
50.11          0              758.670718
51.46          0              758.823914
52.25          0              759.163831
53.08          0              759.614624
53.53          0              760.326089     REW
54.93          0              760.735769     BKF
56.44          0              760.679716
58.09          0              760.759499
59.25          0              760.881444
60.6           0              760.934583     -
61.89          0              761.238361
65.08          0              761.618995
68.11          0              761.742272
74.08          0              762.284861
82.06          0              762.780549
95.07          0              763.227129


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  762.99     762.99     762.99
Bankfull Elevation (ft)    760.74     760.74     760.74
Floodprone Width (ft)      88.21      -----      -----
Bankfull Width (ft)        19.04      10.09      8.96
Entrenchment Ratio         4.63       -----      -----
Mean Depth (ft)            0.93       0.86       1
Maximum Depth (ft)         2.25       2.23       2.25
Width/Depth Ratio          20.56      11.67      9
```

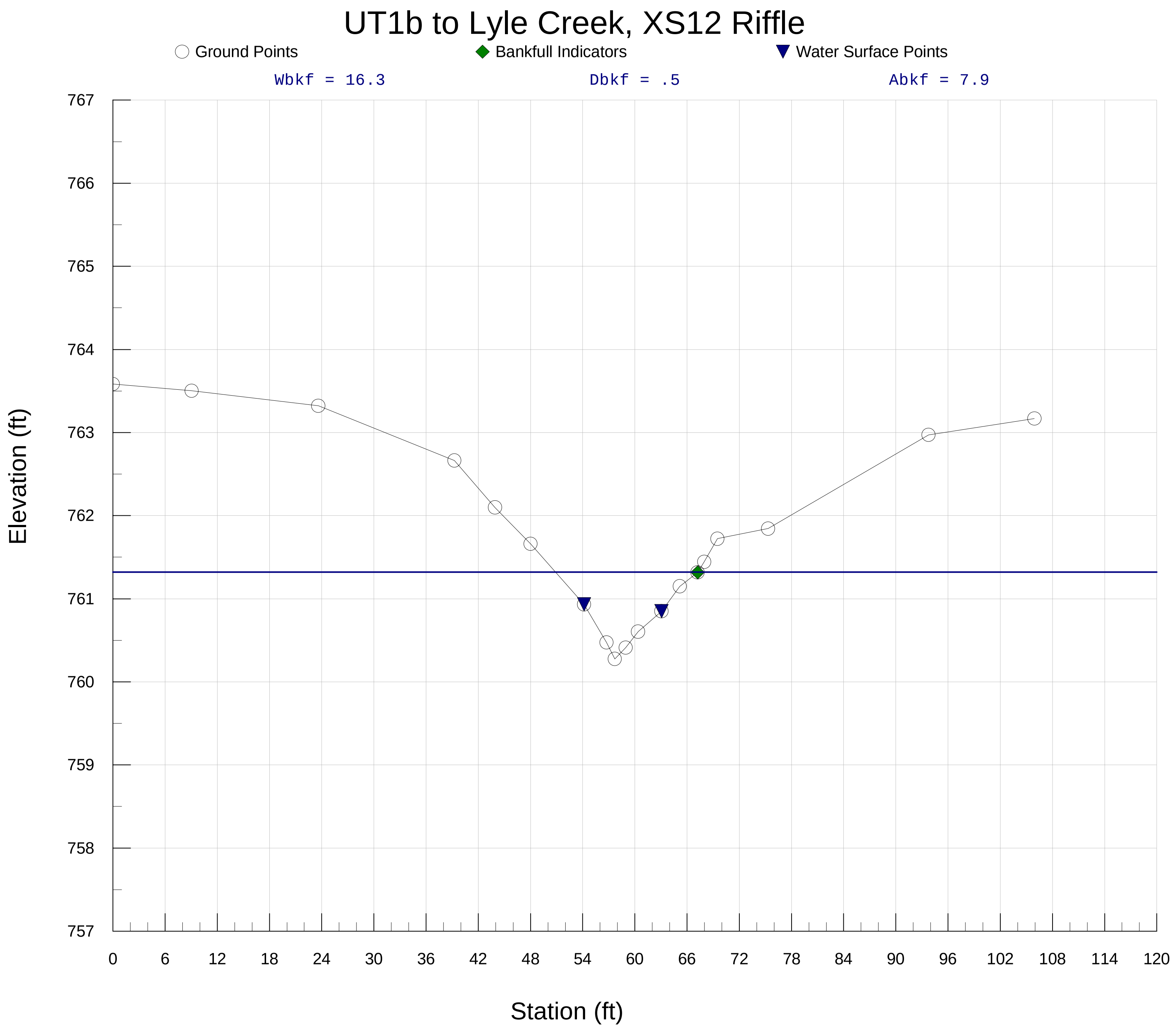
```
                                   UT1c XS10 Pool
Bankfull Area (sq ft)      17.64      8.72       8.92
Wetted Perimeter (ft)      20.26      12.87      11.85
Hydraulic Radius (ft)      0.87       0.68       0.75
Begin BKF Station          38.64      38.64      48.73
End BKF Station            57.69      48.73      57.69

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

UT1b to Lyle Creek, XS11 Pool



```
                                   UT1b XS11 Pool
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1b to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1b XS11 Pool
Survey Date:        08/11/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              763.499897     POOL
13.6           0              763.074431
24.07          0              762.707318
30.31          0              762.154806
33.64          0              761.764472
35.74          0              761.314732
37.49          0              761.396295
38.94          0              761.343291     LEW
39.39          0              760.644668
39.98          0              760.649073
40.34          0              760.324475
41.03          0              760.120247
41.7           0              760.25995
42.71          0              760.929608
43.85          0              760.942088
44.31          0              760.939253
45.09          0              761.314927     REW
46.06          0              761.588827
47.86          0              761.597751
48.95          0              761.678269     BKF
50.13          0              761.807036     -
52.17          0              761.961015
55.61          0              762.243762
63.33          0              762.445761
71.93          0              762.921856
80             0              764.156387
89.87          0              764.482209


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  763.24     763.24     763.24
Bankfull Elevation (ft)    761.68     761.68     761.68
Floodprone Width (ft)      65.69      -----      -----
Bankfull Width (ft)        14.93      7.68       7.26
Entrenchment Ratio         4.4        -----      -----
Mean Depth (ft)            0.52       0.61       0.43
Maximum Depth (ft)         1.56       1.56       1.41
Width/Depth Ratio          28.51      12.55      16.85
Bankfull Area (sq ft)      7.82       4.7        3.12
Wetted Perimeter (ft)      15.85      9.68       9
Hydraulic Radius (ft)      0.49       0.48       0.35
Begin BKF Station          34.03      34.03      41.71
```

```
End BKF Station             48.97      41.71      48.97

-----------------------------------------------------------------------
Entrainment Calculations
-----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```



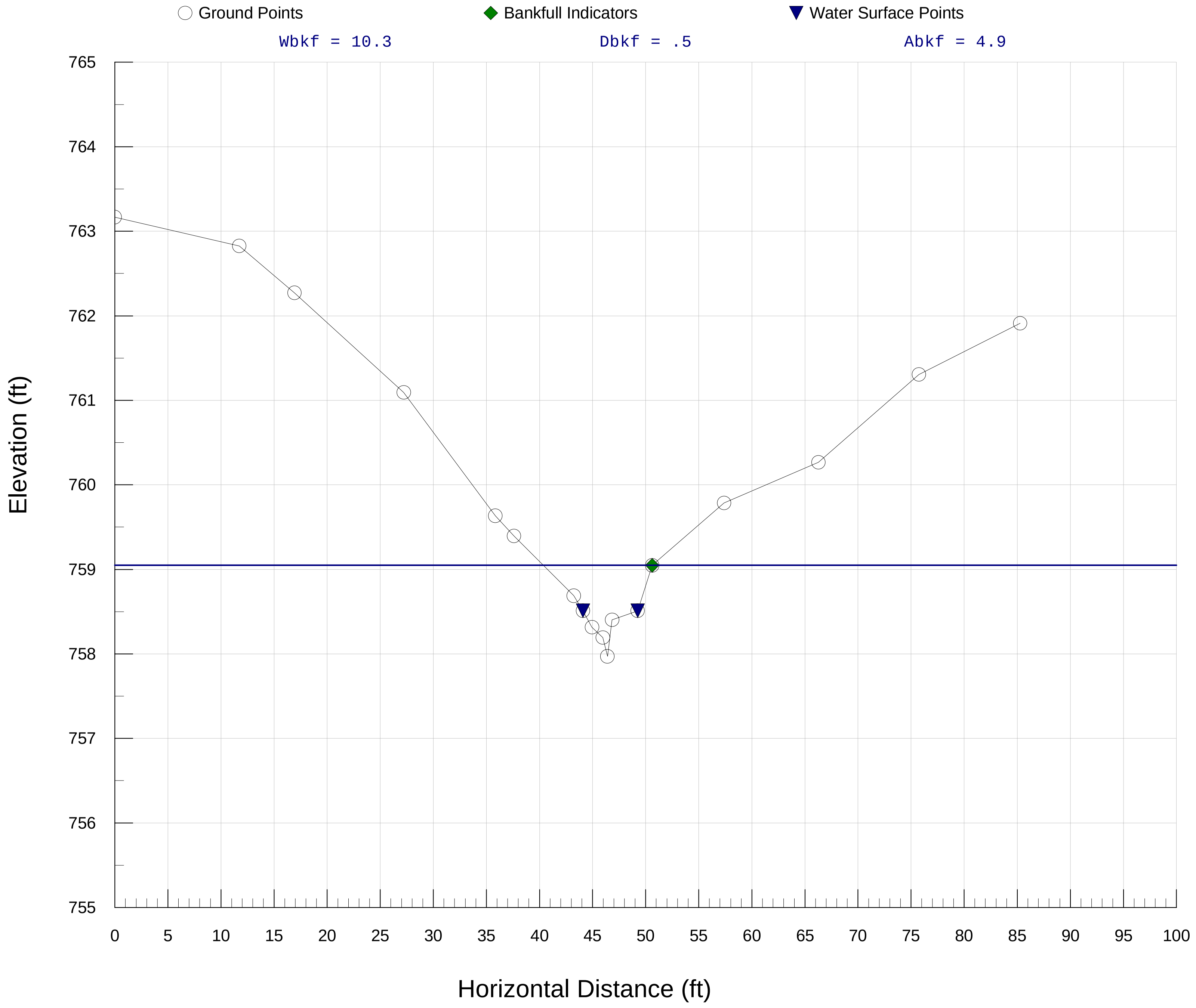
UT1b to Lyle Creek, XS12 Riffle

```
                                  UT1b XS12 Riffle
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1b to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1b XS12 Riffle
Survey Date:        08/11/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              763.58398      RIFFLE
9.04           0              763.502365
23.62          0              763.320611
39.26          0              762.663737
43.93          0              762.098646
48.01          0              761.660498
54.17          0              760.931325     LEW
56.74          0              760.473903
57.69          0              760.275966
58.94          0              760.412122
60.37          0              760.604092
63.06          0              760.850413     REW
65.16          0              761.149472
67.21          0              761.316365     BKF
67.97          0              761.44363      -
69.49          0              761.721612
75.32          0              761.843286
93.76          0              762.970814
105.93         0              763.168604


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  762.36     762.36     762.36
Bankfull Elevation (ft)    761.32     761.32     761.32
Floodprone Width (ft)      42.1       -----      -----
Bankfull Width (ft)        16.35      8.02       8.32
Entrenchment Ratio         2.58       -----      -----
Mean Depth (ft)            0.49       0.54       0.44
Maximum Depth (ft)         1.04       1.04       0.91
Width/Depth Ratio          33.61      14.92      19.05
Bankfull Area (sq ft)      7.95       4.32       3.63
Wetted Perimeter (ft)      16.49      9.03       9.28
Hydraulic Radius (ft)      0.48       0.48       0.39
Begin BKF Station          50.89      50.89      58.91
End BKF Station            67.23      58.91      67.23

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve
```

UT1b XS12 Riffle

	Channel	Left Side	Right Side
Slope			
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

UT1a XS13 Pool

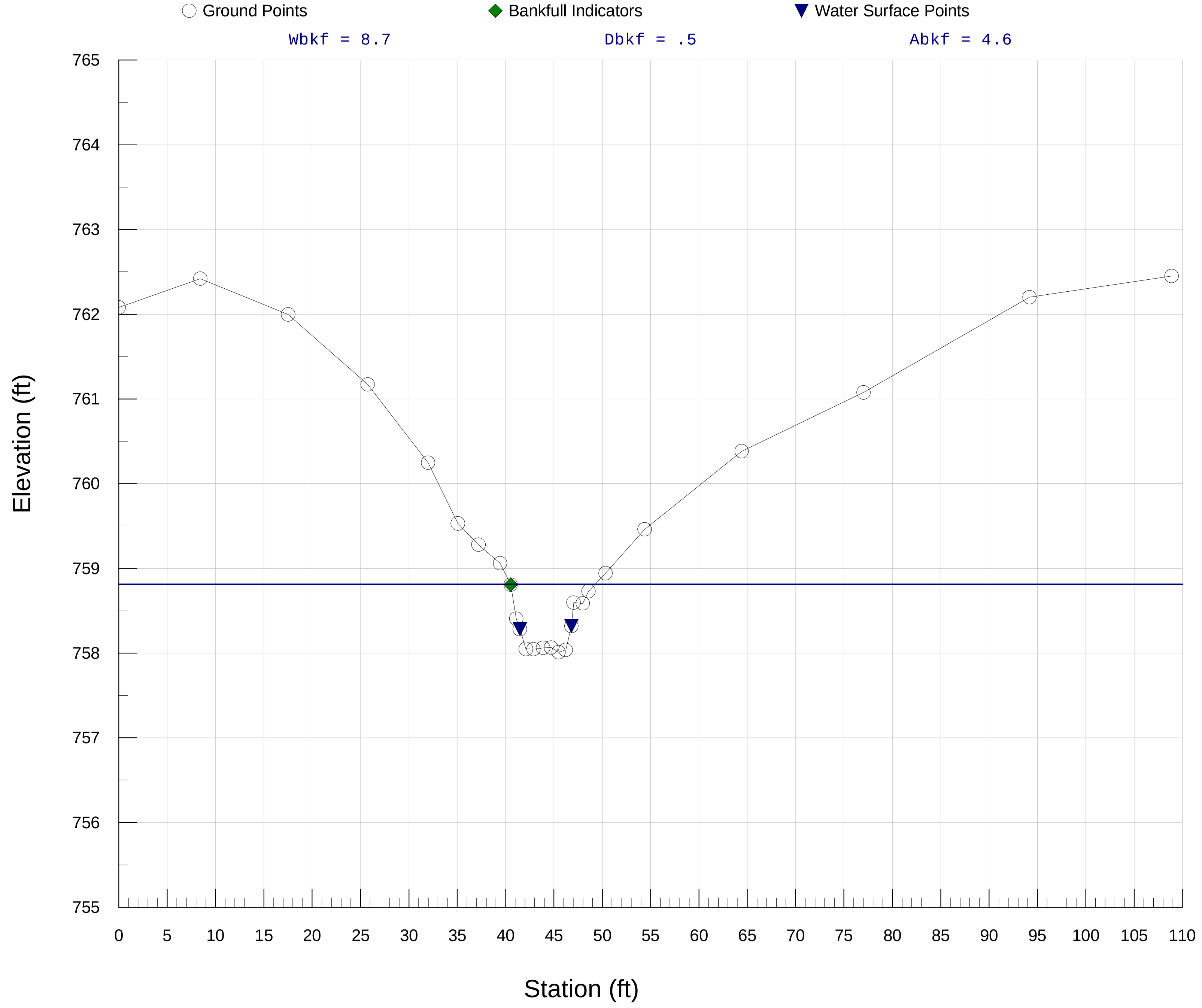


```
                                UT1a XS13 Pool
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1a to Lyle Creek
Reach Name:         Reach 1
Cross Section Name: UT1a XS13 Pool
Survey Date:        08/18/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              763.167198     POOL
11.72          0              762.826193
16.93          0              762.271584
27.22          0              761.093835
35.84          0              759.633586
37.6           0              759.39568
43.23          0              758.688217
44.09          0              758.5102       LEW
44.95          0              758.314502
45.97          0              758.192637
46.4           0              757.970715
46.84          0              758.40323
49.25          0              758.51016      REW
50.62          0              759.047701     BKF
57.39          0              759.785955
66.28          0              760.266501
75.74          0              761.305066
85.27          0              761.911026


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  760.13     760.13     760.13
Bankfull Elevation (ft)    759.05     759.05     759.05
Floodprone Width (ft)      30.83      -----      -----
Bankfull Width (ft)        10.29      5.15       5.14
Entrenchment Ratio         3          -----      -----
Mean Depth (ft)            0.47       0.37       0.58
Maximum Depth (ft)         1.08       0.8        1.08
Width/Depth Ratio          21.76      14.11      8.84
Bankfull Area (sq ft)      4.87       1.88       2.99
Wetted Perimeter (ft)      10.7       6.02       6.28
Hydraulic Radius (ft)      0.46       0.31       0.48
Begin BKF Station          40.35      40.35      45.5
End BKF Station            50.64      45.5       50.64

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
```

UT1a XS13 Pool

Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)

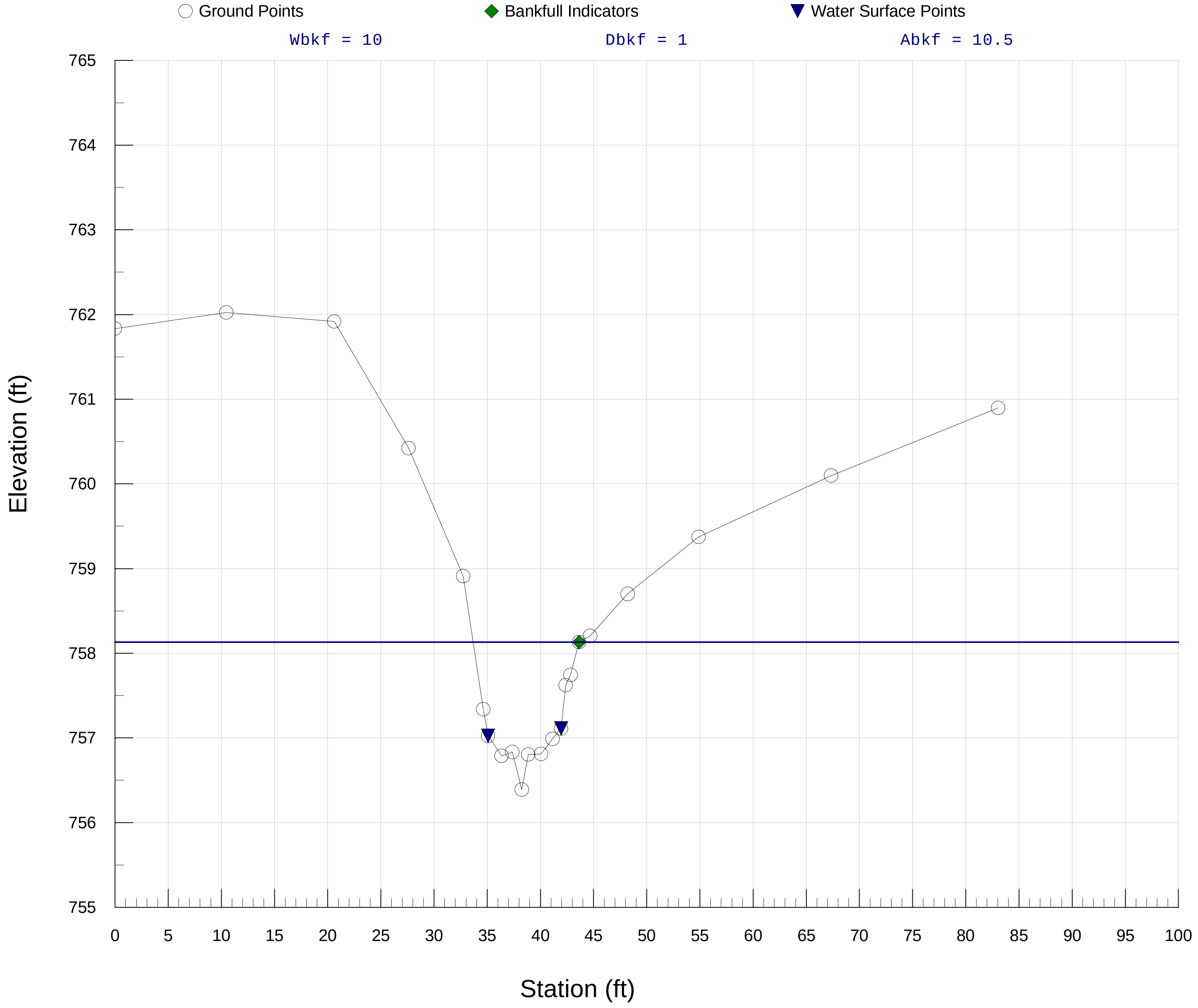
UT1a to Lyle Creek, XS14 Riffle



```
                              UT1a XS14 Riflle
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:          UT1a to Lyle Creek
Reach Name:          Reach 1
Cross Section Name: UT1a XS14 Riffle
Survey Date:         08/12/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                  0 ft
Backsight Rod Reading:         0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              762.080984     RIFFLE
8.43           0              762.420423
17.51          0              761.997335
25.74          0              761.171303
31.99          0              760.247327
35.07          0              759.530629
37.2           0              759.280332
39.43          0              759.06134
40.53          0              758.808486     BKF
41.11          0              758.406469
41.48          0              758.282934     LEW
42.1           0              758.048357
42.88          0              758.046827
43.89          0              758.062484
44.71          0              758.064683
45.49          0              758.010496
46.22          0              758.036767
46.81          0              758.318902     REW
47.04          0              758.596236
47.98          0              758.585993
48.59          0              758.729447     -
50.34          0              758.943686
54.38          0              759.460731
64.42          0              760.383022
77.01          0              761.076669
94.19          0              762.200969
108.88         0              762.451398


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  759.61     759.61     759.61
Bankfull Elevation (ft)    758.81     758.81     758.81
Floodprone Width (ft)      21.27      -----      -----
Bankfull Width (ft)        8.72       4.1        4.63
Entrenchment Ratio         2.44       -----      -----
Mean Depth (ft)            0.53       0.63       0.44
Maximum Depth (ft)         0.8        0.76       0.8
Width/Depth Ratio          16.5       6.48       10.59
Bankfull Area (sq ft)      4.61       2.59       2.02
Wetted Perimeter (ft)      9.13       5.03       5.59
Hydraulic Radius (ft)      0.51       0.52       0.36
Begin BKF Station          40.52      40.52      44.62
```

```
End BKF Station            49.25      44.62      49.25

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

UT1 to Lyle Creek, XS15 Riffle



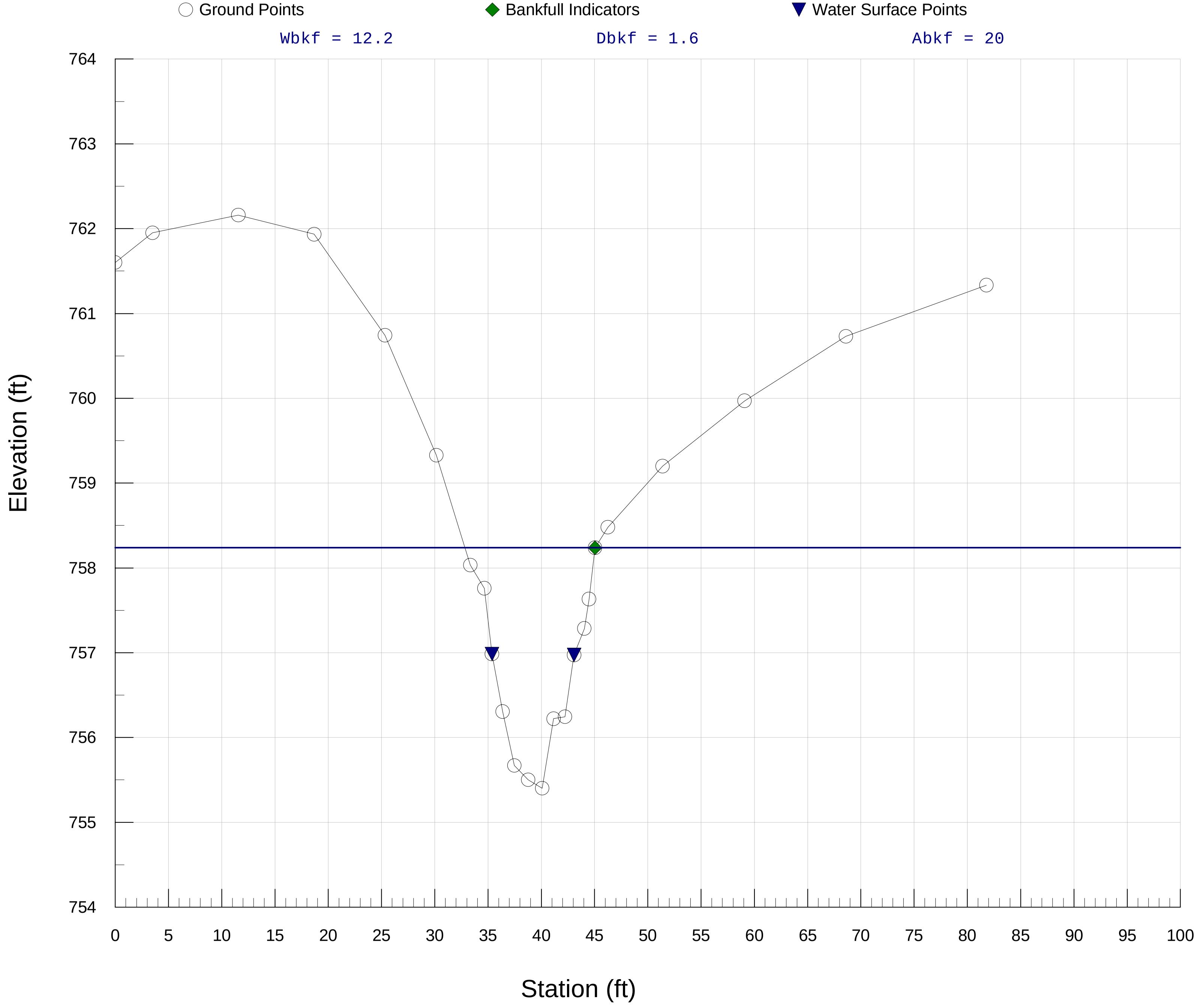
```
                                  UT1 XS15 Riffle
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1 to Lyle Creek
Reach Name:         Reach 3
Cross Section Name: UT1 XS15 Riffle
Survey Date:        08/12/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              761.832578     RIFFLE
10.46          0              762.0229
20.61          0              761.917253
27.61          0              760.421653
32.74          0              758.911002
34.62          0              757.337334
35.08          0              757.024591     LEW
36.35          0              756.788456
37.36          0              756.833313
38.25          0              756.38963
38.87          0              756.805103
40.06          0              756.810517
41.14          0              756.988238
41.95          0              757.112321     REW
42.37          0              757.622645
42.83          0              757.744676
43.65          0              758.1303       BKF
44.68          0              758.204765
48.21          0              758.700976     -
54.87          0              759.373511
67.34          0              760.098087
83.03          0              760.895883


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  759.87     759.87     759.87
Bankfull Elevation (ft)    758.13     758.13     758.13
Floodprone Width (ft)      33.94      -----      -----
Bankfull Width (ft)        9.98       4.99       4.99
Entrenchment Ratio         3.4        -----      -----
Mean Depth (ft)            1.05       1.14       0.95
Maximum Depth (ft)         1.74       1.74       1.47
Width/Depth Ratio          9.51       4.36       5.24
Bankfull Area (sq ft)      10.46      5.71       4.75
Wetted Perimeter (ft)      10.98      7.05       6.86
Hydraulic Radius (ft)      0.95       0.81       0.69
Begin BKF Station          33.67      33.67      38.66
End BKF Station            43.65      38.66      43.65

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------
```

UT1 XS15 Riffle

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope			
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

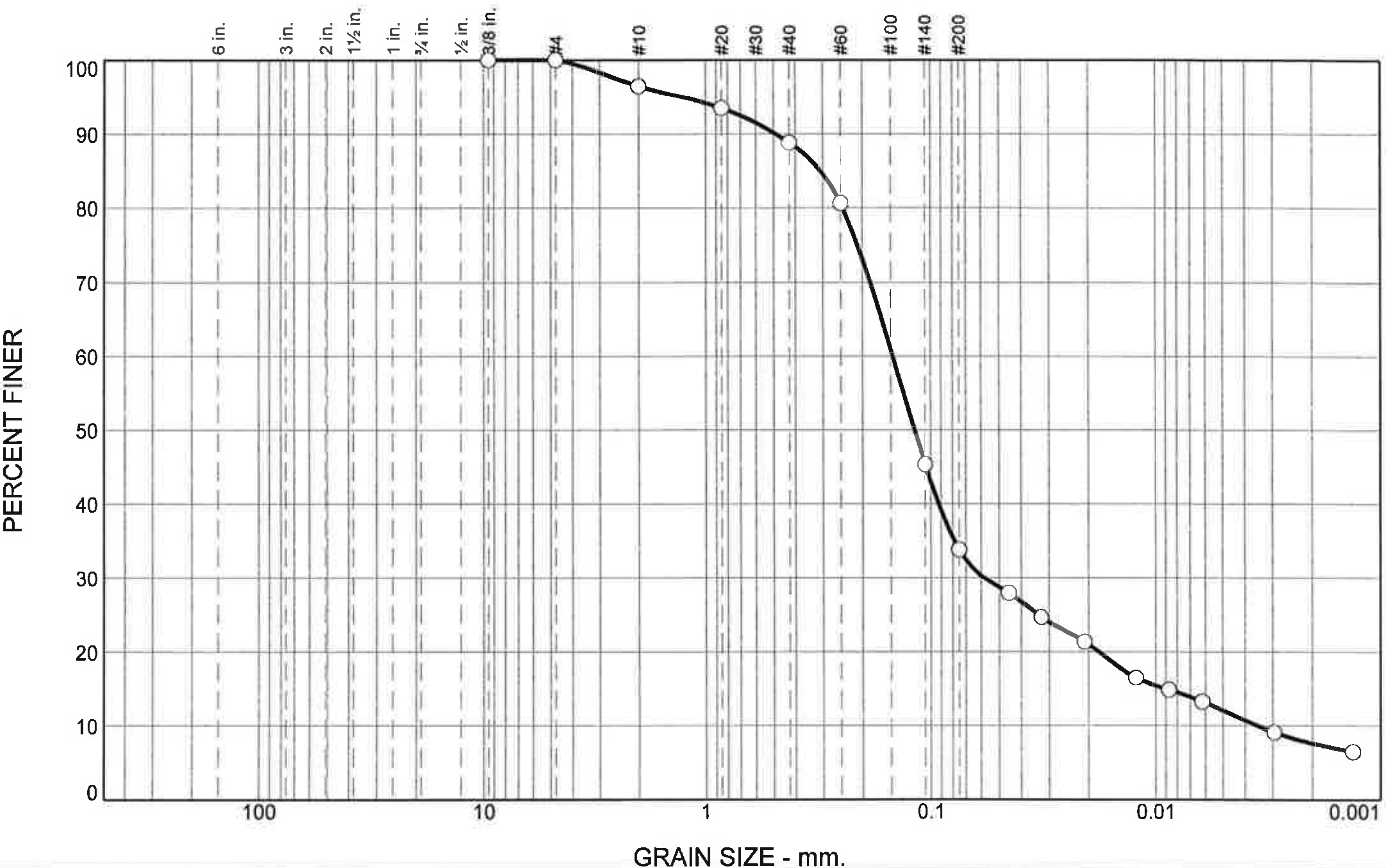
UT1 to Lyle Creek, XS16 Pool



```
                                   UT1 XS16 Pool
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         UT1 to Lyle Creek
Reach Name:         Reach 3
Cross Section Name: UT1 XS16 Pool
Survey Date:        08/12/10

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 0 ft
Backsight Rod Reading:        0 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              0              761.600473     POOL
3.51           0              761.950311
11.56          0              762.160242
18.68          0              761.933739
25.33          0              760.742997
30.15          0              759.329138
33.34          0              758.033157
34.66          0              757.759541
35.37          0              756.983816     LEW
36.38          0              756.304854
37.47          0              755.670922
38.77          0              755.501535
40.08          0              755.400863
41.15          0              756.221398
42.23          0              756.244437
43.08          0              756.973731     REW
44.04          0              757.285337
44.48          0              757.631818
45.04          0              758.237169     BKF
46.25          0              758.480212
51.39          0              759.199652
59.08          0              759.969562
68.6           0              760.730077
81.79          0              761.333863


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  761.08     761.08     761.08
Bankfull Elevation (ft)    758.24     758.24     758.24
Floodprone Width (ft)      52.77      -----      -----
Bankfull Width (ft)        12.22      6.11       6.11
Entrenchment Ratio         4.32       -----      -----
Mean Depth (ft)            1.64       1.49       1.79
Maximum Depth (ft)         2.84       2.75       2.84
Width/Depth Ratio          7.46       4.1        3.42
Bankfull Area (sq ft)      20.03      9.11       10.92
Wetted Perimeter (ft)      14.01      9.66       9.85
Hydraulic Radius (ft)      1.43       0.94       1.11
Begin BKF Station          32.83      32.83      38.94
End BKF Station            45.05      38.94      45.05

----------------------------------------------------------------------
```

```
                                   UT1 XS16 Pool
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	3.5	7.7	55.0	21.8	12.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	100.0		
#10	96.5		
#20	93.5		
#40	88.8		
#60	80.6		
#140	45.4		
#200	33.8		

* (no specification provided)

Material Description

Brown Clayey Silty Sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4883 D_{85}= 0.3066 D_{60}= 0.1473
D_{50}= 0.1181 D_{30}= 0.0585 D_{15}= 0.0091
D_{10}= 0.0035 C_u= 41.63 C_c= 6.57

Classification

USCS= AASHTO=

Remarks

Dry weight of soil: 234.93g

Location: XS-2 Bulk SAmple, UT-1 07-15-2011

Date: 07-28-2011

Summit Engineering

Ft. Mill, South Carolina

Client: Wildlands Engineering
Project: Lyle Creek
Project No: SL-262-11 **Figure**

Tested By: Mimi Hourani

GRAIN SIZE DISTRIBUTION TEST DATA

7/28/2011

Client: Wildlands Engineering
Project: Lyle Creek
Project Number: SL-262-11
Location: XS-2 Bulk SAmple, UT-1 07-15-2011
Material Description: Brown Clayey Silty Sand
Date: 07-28-2011
Testing Remarks: Dry weight of soil: 234.93g
Tested by: Mimi Hourani

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
234.93	0.00	0.00	0.375	0.00	100.0
			#4	0.00	100.0
			#10	8.34	96.5
57.84	0.00	0.00	#20	1.77	93.5
			#40	4.57	88.8
			#60	9.50	80.6
			#140	30.63	45.4
			#200	37.57	33.8

Hydrometer Test Data

Hydrometer test uses material passing#10
Percent passing #10 based upon complete sample =96.5
Weight of hydrometer sample =57.84
Table of composite correction values:

Temp., deg. C:	27.6	25.9	21.8	20.5
Comp. corr.:	-4.0	-4.5	-5.5	-6.0

Meniscus correction only =1.0
Specific gravity of solids =2.70
Hydrometer type =152H
Hydrometer effective depth equation: L =16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	23.6	22.0	16.9	0.0129	23.0	12.5	0.0455	27.9
2.00	23.6	20.0	14.9	0.0129	21.0	12.9	0.0326	24.6
5.00	23.7	18.0	13.0	0.0129	19.0	13.2	0.0209	21.4
15.00	23.7	15.0	10.0	0.0129	16.0	13.7	0.0123	16.4
30.00	23.8	14.0	9.0	0.0128	15.0	13.8	0.0087	14.8
60.00	23.9	13.0	8.0	0.0128	14.0	14.0	0.0062	13.2
270.00	23.9	10.5	5.5	0.0128	11.5	14.4	0.0030	9.1
1440.00	21.6	9.5	3.9	0.0132	10.5	14.6	0.0013	6.5

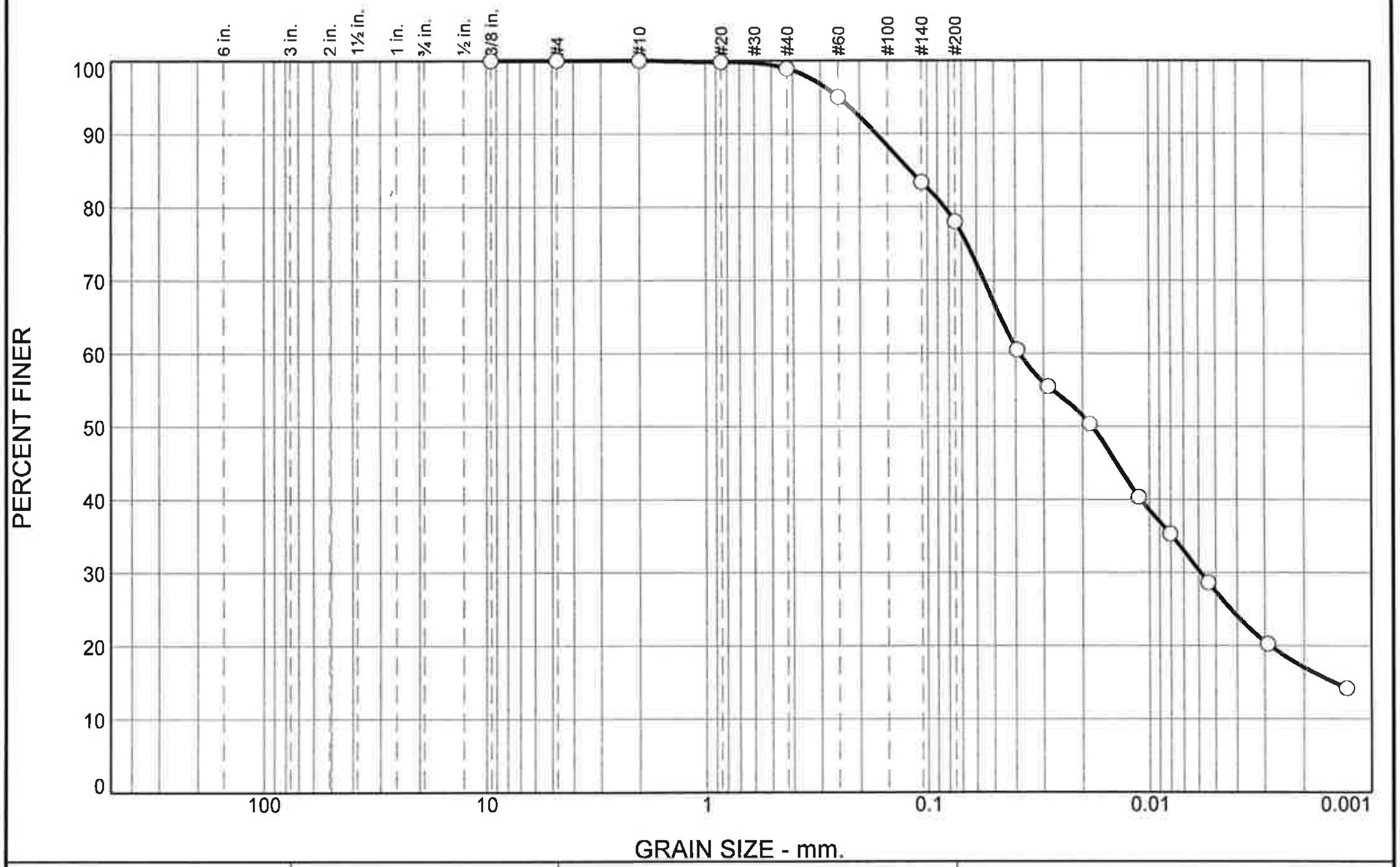
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	3.5	7.7	55.0	66.2	21.8	12.0	33.8

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0035	0.0091	0.0180	0.0585	0.1181	0.1473	0.2446	0.3066	0.4883	1.2880

Fineness Modulus	C_u	C_c
0.71	41.63	6.57

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.1	20.9	50.7	27.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	100.0		
#10	100.0		
#20	99.8		
#40	98.9		
#60	95.0		
#140	83.4		
#200	78.0		

* (no specification provided)

Material Description

Brown Sandy Clayey Silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1688 D_{85}= 0.1193 D_{60}= 0.0385

D_{50}= 0.0181 D_{30}= 0.0059 D_{15}= 0.0015

D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Dry weight of soil: 672.12g

Location: XS-15, Riffle, 07-15-2011

Date: 07-28-2011

Summit Engineering

Ft. Mill, South Carolina

Client: Wildlands Engineering

Project: Lyle Creek

Project No: SL-262-11 **Figure**

Tested By: Mimi Hourani

GRAIN SIZE DISTRIBUTION TEST DATA

7/28/2011

Client: Wildlands Engineering
Project: Lyle Creek
Project Number: SL-262-11
Location: XS-15, Riffle, 07-15-2011
Material Description: Brown Sandy Clayey Silt
Date: 07-28-2011
Testing Remarks: Dry weight of soil: 672.12g
Tested by: Mimi Hourani

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
672.12	0.00	0.00	0.375	0.00	100.0
			#4	0.00	100.0
			#10	0.00	100.0
58.76	0.00	0.00	#20	0.13	99.8
			#40	0.66	98.9
			#60	2.93	95.0
			#140	9.77	83.4
			#200	12.94	78.0

Hydrometer Test Data

Hydrometer test uses material passing#10
Percent passing #10 based upon complete sample =100.0
Weight of hydrometer sample =58.76
Table of composite correction values:

Temp., deg. C:	27.6	25.9	21.8	20.5
Comp. corr.:	-4.0	-4.5	-5.5	-6.0

Meniscus correction only =1.0
Specific gravity of solids =2.70
Hydrometer type =152H
Hydrometer effective depth equation: L =16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	23.7	41.0	36.0	0.0129	42.0	9.4	0.0394	60.5
2.00	23.7	38.0	33.0	0.0129	39.0	9.9	0.0286	55.5
5.00	23.7	35.0	30.0	0.0129	36.0	10.4	0.0185	50.4
15.00	23.7	29.0	24.0	0.0129	30.0	11.4	0.0112	40.3
30.00	23.8	26.0	21.0	0.0128	27.0	11.9	0.0081	35.3
70.00	23.9	22.0	17.0	0.0128	23.0	12.5	0.0054	28.6
260.00	23.9	17.0	12.0	0.0128	18.0	13.3	0.0029	20.2
1440.00	21.6	14.0	8.4	0.0132	15.0	13.8	0.0013	14.2

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	1.1	20.9	22.0	50.7	27.3	78.0

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0015	0.0028	0.0059	0.0181	0.0385	0.0835	0.1193	0.1688	0.2497

Fineness Modulus
0.15

APPENDIX 5

Historical Aerial Photographs

Lyle Creek
109 3rd Ave NW
Catawba, NC 28609

Inquiry Number: 2827697.4
July 28, 2010

The EDR Aerial Photo Decade Package

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

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Please contact EDR at 1-800-352-0050
with any questions or comments.

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Date EDR Searched Historical Sources:

Aerial Photography July 28, 2010

Target Property:

109 3rd Ave NW
Catawba, NC 28609

Year	*Scale*	*Details*	*Source*
1961	Aerial Photograph. Scale: 1"=1000'	Panel #: 35081-F1, Catawba, NC;/Flight Date: August 29, 1961	EDR
1983	Aerial Photograph. Scale: 1"=1000'	Panel #: 35081-F1, Catawba, NC;/Flight Date: March 03, 1983	EDR
1993	Aerial Photograph. Scale: 1"=750'	Panel #: 35081-F1, Catawba, NC;/Flight Date: January 30, 1993	EDR
1998	Aerial Photograph. Scale: 1"=750'	Panel #: 35081-F1, Catawba, NC;/Flight Date: March 13, 1998	EDR
2006	Aerial Photograph. Scale: 1"=604'	Panel #: 35081-F1, Catawba, NC;/Flight Date: January 01, 2006	EDR

INQUIRY #: 2827697.4

YEAR: 1961

= 1000'

INQUIRY #: 2827697.4

YEAR: 1983

= 1000'

INQUIRY #: 2827697.4

YEAR: 1993

= 750'

INQUIRY #: 2827697.4

YEAR: 1998

= 750'

N

EDR Environmental Data Resources Inc

INQUIRY #: 2827697.4

YEAR: 2006

= 604'


3BB 27 P
④
3C 50 P
+A4 L
3BB 11 L
3B11 L
BB 15 X
B 15 X
3BB F
+A6 L
+A1 P
47B 15 P
+A39
⑥
+A3 L
⑦
⑨
3BB 11 L F
3-16D 11 P L
2B25 L
3B21 L
2B 21
+A60 L
2-18D-11
2BB21 L
F
+A63 L
④
+A P
⑧
37-16D 11 L
37B 11 L
3BB 11 L
+A2 L
+A3 L
3BB 86
2 BB 21 L
2B86 L
3 B 21 L
4B 15 L
X
4 BB 15 L
4B15 L
L
+A1 L
3B64 L
+A1 P
⑩ L
+A1 P
+A2 L
4C15 L
3B11 L
3BB 86 L
+ B 87 L
⑪
B 104

1938 Aerial

1938 Aerial
Streams drawn in by WEI, 2011

APPENDIX 6

FEMA Floodplain Checklist

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Lyle Creek Mitigation Site
Name of stream or feature:	Unnamed tributaries (UTs) in floodplain of Lyle Creek
County:	Catawba
Name of river basin:	Catawba
Is project urban or rural?	rural
Name of Jurisdictional municipality/county:	Town of Catawba ETJ
DFIRM panel number for entire site:	Community: Town of Catawba Community No. 370052 FIRM Panel: 3782, 3781 Map Number: 3710378200K, 3710378100K Effective Date: March 18, 2008
Consultant name:	Wildlands Engineering, Inc. Emily Reinicker, PE, CFM
Phone number:	704-332-7754
Address:	1430 S. Mint Street, Suite 104 Charlotte, NC 28203

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500'.
Please see attached Figure 7 FEMA Flood Map and Figure 13 Proposed Stream Restoration Design from the Restoration Plan report.

Summarize stream reaches or wetland areas according to their restoration priority.
No work is proposed on Lyle Creek, the FEMA-mapped stream; however, grading is taking place on tributary channels and wetlands that are located within the mapped floodplain of Lyle Creek.

The construction on four unnamed tributaries (UTs) to Lyle Creek will be comprised of Rosgen Priority 1 restoration of dimension, pattern, and profile. A stable cross-section will be designed to flood onto the surrounding topography at flows greater than the 1.5-year bankfull event. A meandering pattern will be restored, and the channel profile elevation will be raised approximately 6" to 12" to connect the channel to the surrounding floodplain topography. Low profile in-stream habitat structures comprised of logs and rocks will be used to help stabilize the channel. Native vegetation will be planted within the conservation easement boundary to establish a riparian buffer. This vegetation will replace tree farm fields of 1-inch to 6-inch caliper nursery stock and fescue. Wetland work will include grading and planting.

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

YES- Grading will take place in the Lyle Creek SFHA.

If project is located in a SFHA, check how it was determined:

☒ Redelineation

☐ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☑ AE Zone

- ☒ Floodway
- ☐ Non-Encroachment

☐ A Zone

- ☐ Local Setbacks Required
- ☐ No Local Setbacks Required

If local setbacks are required, list how many feet: n/a

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

☐ Yes ☒ No

Land Acquisition (Check)

☐ State owned (fee simple)

☐ Conservation easment (Design Bid Build)

☒ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

● Yes ○ No

Name of Local Floodplain Administrator: Mr. John Kinley
Phone Number: 828-485-4238
John Kinley
Planner
Western Piedmont Council of Governments
PO Box 9026
Hickory, NC 28603
828-485-4238
828-322-5991 fax

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☐ No Action

☒ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision (CLOMR)

☐ Other Requirements

List other requirements:

Comments:
Earthwork calculations and grading plan to be submitted showing no net fill in Lyle Creek floodplain.

Name: Emily G. Reinicker, PE, CFM Signature:

Title: Senior Water Resources Engineer Date: 5/25/2011