DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

January 24, 2012

Regulatory Division

Re: NCIRT Review and USACE Approval of the Hogan Creek Mitigation Plan (SAW-2011-02268)

Mr. Michael Ellison
North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Dear Mr. Ellison:

The purpose of this letter is to provide the North Carolina Ecosystem Enhancement Program (NCEEP) with all comments generated by the North Carolina Interagency Review Team (NCIRT) during the 30-day comment period for the Hogan Creek Mitigation Plan, which closed on January 6, 2012. These comments are attached for your review.

Based on our review of these comments, we have determined that no major concerns have been identified with the Draft Mitigation Plan. However, several minor issues were identified, as shown below, that must be addressed in the Final Mitigation Plan.

1. The performance standards must be changed to reflect a minimum requirement of 260 live, planted stems per acre.

2. Some buffers along the stream appear to have buffers of less than 30', particularly in the vicinity of Miller Gap Road. Be sure that there is enough forested buffer to meet the minimum standard of 30' forested. The project will be subject to credit adjustments per current non-standard buffer width guidelines at the time of closeout.

3. Proposed riffles should be constructed utilizing local material salvaged from the abandoned stream reaches. Confirmation was provided by Julie Cahill with NCEEP that local material from abandoned reaches will be utilized in the constructed riffles.

4. The mitigation plan should be updated to include monitoring of the steep slope along UT 2 that is proposed to have exotics (Kudzu) removed due to the potential that the eroding slope may impact the preservation reach. Julie Cahill verified that this issue will be addressed in the Final Mitigation Plan.

The Final Mitigation Plan is to be submitted with the Preconstruction Notification (PCN) Application for Nationwide permit approval of the project along with a copy of this letter. Issues identified above must be addressed in the Final Mitigation Plan. If it is determined that the project does not require a Department of the Army permit, you must still provide a copy of the Final Mitigation Plan, along with a copy of this letter, to the appropriate USACE field office at least 30 days in advance of beginning construction of the project. Please note that this approval does not preclude the inclusion of permit conditions in the permit authorization for the project, particularly if issues mentioned above are not satisfactorily addressed. Additionally, this letter provides initial approval for the Mitigation Plan, but this does not guarantee that the project will generate the requested amount of mitigation credit. As you are aware, unforeseen issues may arise during construction or monitoring of the project that may require maintenance or reconstruction that may lead to reduced credit.

Thank you for your prompt attention to this matter, and if you have any questions regarding this letter, the mitigation plan review process, or the requirements of the Mitigation Rule, please call me at 919-846-2564.

Sincerely,

Todd Tugwell
Special Projects Manager

Enclosures

Electronic Copies Furnished:

NCIRT Distribution List
CESAW-RG/McLendon
CESAW-RG-R/Matthews
Jeff Jurek, NCEEP
Julie Cahill, NCEEP

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

CESAW-RG/Tugwell January 9, 2012

MEMORANDUM FOR RECORD

SUBJECT: NCIRT Comments During 30-day Mitigation Plan Review

Purpose: The comments and responses listed below were posted to the NCEEP Mitigation Plan Review Portal during the 30-day comment period in accordance with Section 332.8(g) of the 2008 Mitigation Rule.

NCEEP Project Name: Hogan Creek Mitigation Project, Surry County, NC

USACE AID#: SAW-2011-02268

30-Day Comment Deadline: January 6, 2012

1. Travis Wilson, NCWRC, December 22, 2011: Significant portions of this project show the use of constructed riffles, if possible utilize local material salvaged from the abandoned stream reaches. My observation of the use of angular quarried material is: larger stone tends to form aquatic barriers at normal and low flow periods, and smaller quarried stone quickly becomes imbedded. Both resulting in sub-optimal habitat conditions.

   NCEEP Response: This is addressing Travis Wilson comment on 12/22/11 - Local material from abandoned stream reaches will be utilized.

2. Sue Homewood, NCDWQ, January 4, 2012: DWQ is concerned about a section of UT2 where kudzu treatment is to take place. The slope is steep and there is a concern that during the treatment process and while new vegetation is being established that the steep slope my cause the stream to degrade. We request this area be specifically monitored during the treatment and vegetation re-establishment period.

   NCEEP Response: This is addressing Sue Homewood comment from 1/4/12 - This will be addressed in the Final Mit. Plan.

MITIGATION PLAN – FINAL

Hogan Creek Stream Mitigation Project
Surry County, North Carolina
EEP Project No. 94708

Upper Yadkin River Basin
Cataloging Unit 03040101

Prepared for:

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

February 2012

MITIGATION PLAN – FINAL

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Prepared for:

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

Prepared by:

Confluence Engineering, PC
16 Broad Street
Asheville, NC 28801
828.255.5530

February 2012

EXECUTIVE SUMMARY

The NCDENR Ecosystem Enhancement Program (EEP) provides off-site compensatory wetland and stream mitigation to private sector, state government agencies, municipalities, schools, military bases and other applicants through its In Lieu Fee Programs. EEP is proposing the Hogan Creek Stream Mitigation Project (project) to help fulfill stream mitigation requirements accepted by this program for the Upper Yadkin River Basin (CU 03040101). Through this project, EEP proposes to restore and enhance approximately 4,109 linear feet (LF) of Hogan Creek and three unnamed tributaries (UTs), provide livestock fencing and alternative water sources to keep livestock out of the streams, remove invasive plant species across the project, establish native riparian buffers, and preserve approximately 5,673 LF of relatively un-impacted forested streams. Based on preliminary estimates from the design proposed in this Mitigation Plan, the Hogan Creek Stream Mitigation Project will net 4,994 stream mitigation credits through a combination of restoration, enhancement I and II, and preservation.

This Mitigation Plan describes specific project goals and objectives as they relate to EEP's programmatic goals (watershed planning-based mitigation), provides baseline data on the existing conditions of Hogan Creek and its UTs at the project site, and describes the methodologies that were used develop the preliminary design. The Mitigation Plan also outlines the performance standards and monitoring protocol that will be used to evaluate the project’s success, and it details long term management strategies for protecting and maintaining the restoration site in perpetuity.

This Mitigation Plan has been written in conformance with the requirements of the following:

- 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).
- EEP In-Lieu Fee Instrument signed and dated July 28, 2010

These documents govern EEP operations and procedures for the delivery of compensatory mitigation.

TABLE OF CONTENTS

1.0 RESTORATION PROJECT GOALS AND OBJECTIVES

The EEP 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 EEP planning and restoration project funds.

The 2009 Upper Yadkin RBRB Restoration Priorities (www.nceep.net/services/restplans/Upper_Yadkin_RBRP_2009.pdf) identified the Candiff Creek/Hogan Creek 14-digit HUC 03040101110060 as a TLW due to water quality and habitat impacts from past and present agricultural practices. Agriculture is the primary land use in the watershed (41% agriculture land cover) and the RBRP identified non-forested buffers and livestock operations as major stressors to water quality. There are 26 permitted animal operations and 25% of the watershed has non-forested riparian buffers. The site assessment phase of the project identified other stressors as well, including bank erosion, sediment deposition, disconnection of the streams and floodplains, and exotic plant species. The project was identified as an opportunity to improve water quality and aquatic and terrestrial habitats within the TLW. In addition to being within an EEP TLW, the upper Hogan Creek subwatershed has been identified as a priority area for stream restoration and agricultural BMPs as part of EEP's initial Ararat River Local Watershed Planning (LWP) effort (EcoEngineering, 2008).

The project goals address stressors identified in the TLW and LWP priority subwatershed, and include the following:

- Improve water quality in Hogan Creek and the UTs through reductions in sediment and nutrient inputs from local sources;
- Create conditions for dynamic equilibrium of water and sediment movement between the supply reaches and project reaches;
- Promote floodwater attenuation and secondary functions associated with more frequent and extensive floodwater contact times;
- Improve in-stream habitat by increasing the diversity of bedform features;
- Enhance and protect native riparian vegetation communities; and
- Reduce fecal, nutrient, and sediment loads to project streams by promoting and implementing livestock best management practices.

The project goals will be addressed through the following project objectives:

- Restoration of the dimension, pattern, profile of approximately 2,493 LF (proposed) of Hogan Creek and two UTs;
- Restoration of the dimension and profile (Enhancement I) of approximately 1,200 LF of Hogan Creek;
- Limited channel work coupled with livestock exclusion and/or invasive species control (Enhancement II) on approximately 416 LF along two UT;
- Livestock exclusion fencing and alternative water source installations;
- Invasive plant species control measures across the entire project wherever necessary; and
- Preservation of approximately 5,673 LF relatively un-impacted forested streams in permanent conservation easement.

2.0 SITE SELECTION

2.1 Directions to Site

The Hogan Creek project site (Figure 1) is located southeast of Level Cross in Surry County, North Carolina. The site is accessed from I-77 north out of Statesville. Turn east off I-77 at exit 85 (NC 268 Bypass) and travel approximately 3 miles to the intersection with NC 268. Turn east and travel approximately 12 miles to a south turn onto Miller Gap Road (SR2088). The site is located approximately 2 miles south of NC 268 on Miller Gap Road, which bisects the project site at the bridge over Hogan Creek. The project site is bordered to the north by Trajan Trail, to the south by Anderson Road, and to the west by Siloam Road. Latitude and longitude for the site are 36.321609 N and 80.602389 W, respectively.

2.2 Historical Conditions and Future Land Use Trends

Reference is made in the following discussions to project reaches and design stationing as shown on the attached preliminary plans (Appendix D). The project site falls within two parcels owned by Marion Chilton and Marion H. Chilton, Jr. encompassing a total of 179 acres. The Chiltons currently operate a cattle farm on the two parcels. The majority of the cattle operations take place on a 25-acre field with barns on the northeast side of Miller Gap Road and on a 13-acre field on the opposite side of the road. The site also includes seven 1 to 3-acre fields scattered around the parcels that are accessed by farm paths. The total cleared area measures approximately 56 acres (about one-third of the total land area).

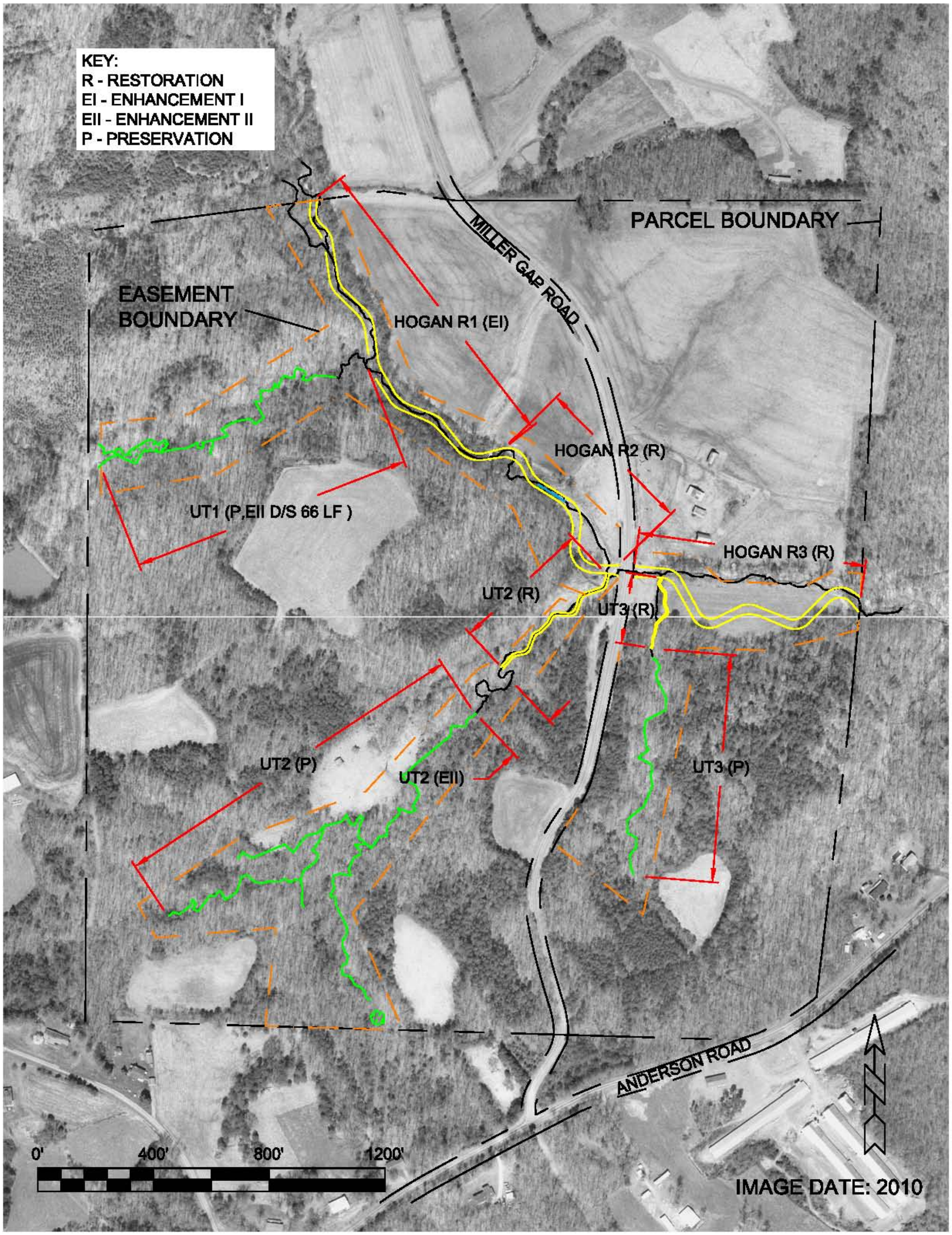
Based on a review of an aerial photograph of the project site from 1966 (Figure 6), the left floodplain of Hogan Creek upstream of Miller Gap Road and both floodplains downstream of the road have been maintained as field or pasture for over 50 years. A row of mature trees, generally one stem wide, has been present along the left bank of Hogan Creek upstream of the road and on both banks downstream of the road during this period. Aerial photographs from 1966 through 2010 (Figures 4 through 6) indicate that land use practices and the extent of cleared land at the project site have remained consistent over the past five decades.

Based on the series of aerial photographs, the right bank of Hogan Creek between the upstream project limits and the confluence with UT2 has been forested over this same time period, as has the UT1 valley and the upstream 90 percent of the UT3 valley. The age of the trees (estimated at roughly 50 years for a 12-inch diameter oak, growth factor of 4) in these upland areas supports this conclusion.

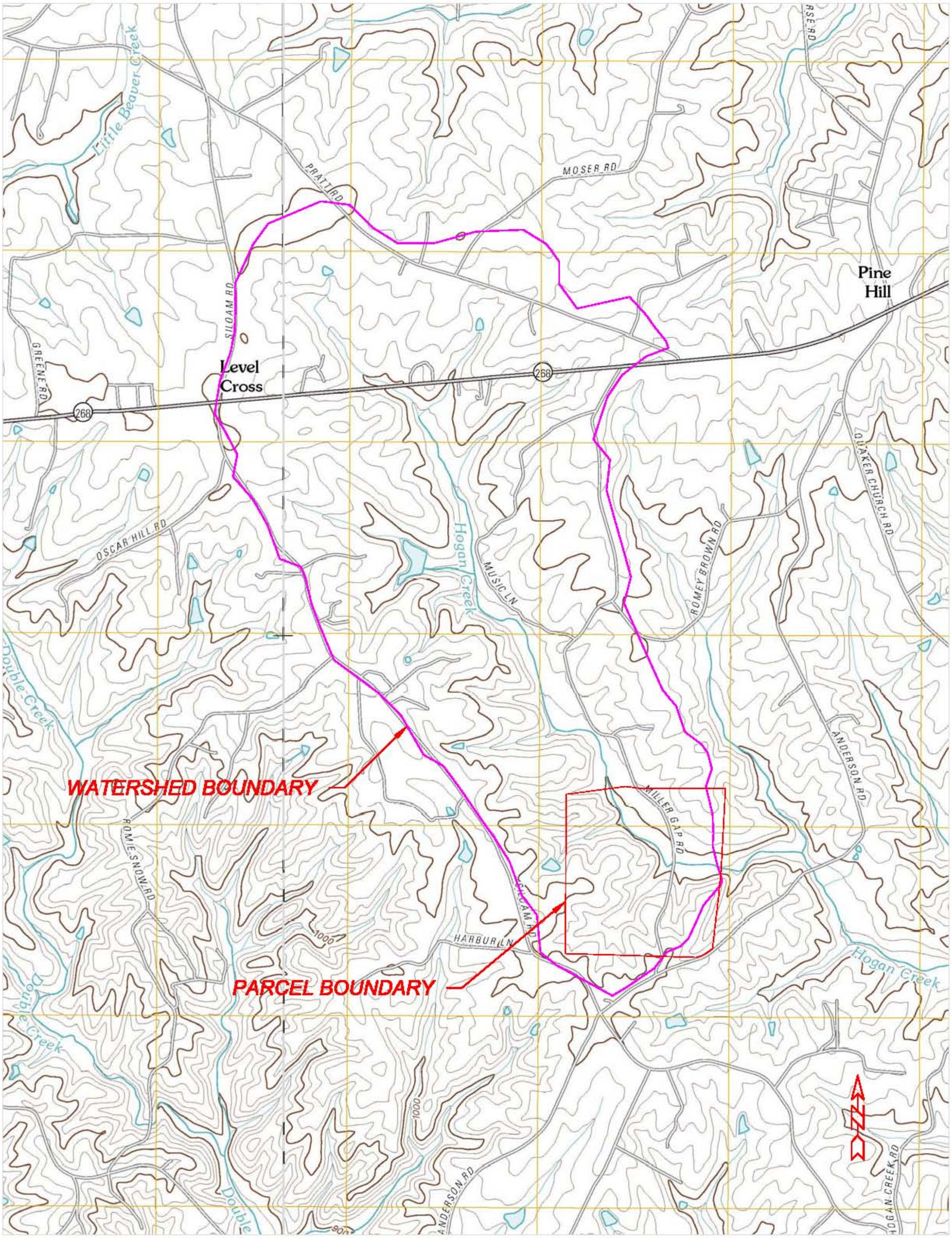
The existing Hogan Creek crossing at Miller Gap Road is a triple 7-foot by 9.5-foot CMP arch culvert with concrete headwalls. Based on the relatively large size and good condition of the crossing, it appears to have been constructed within the past twenty years. The alignment of Miller Gap Road has not changed since at least 1966.

Invasive plant species, particularly kudzu, are a significant problem at the site. Hogan Creek between Stations 20+00 and 30+00 and UT2 between Stations 10+00 and 15+50 are the reaches most severely impacted; kudzu is the dominant ground cover and has infested most of the canopy trees in these areas. A recent infestation of kudzu was noted encroaching into the wooded upstream reach of UT3.

In October 2006, Surry County issued ***Land Use Plan 2015*** which describes growth, land use changes and future development policies through 2015. The Hogan Creek site is located in a rural land use area and this land use classification extends four miles or more in all directions from the site, inclusive of the Hogan Creek project catchment (Figure 2). According to the 2015 plan, the best use of land within the Hogan Creek watershed will be agriculture, low density residential, forestry and other similar practices. Technical Memorandum Task 2, Upper Yadkin Basin Local Watershed Plan (EcoEngineering, 2008) identified the Hogan Creek sub-watershed as a high priority for stream restoration because of its low population density and agricultural land uses. Current and projected future land use for this watershed supports an investment in restoration at this site.

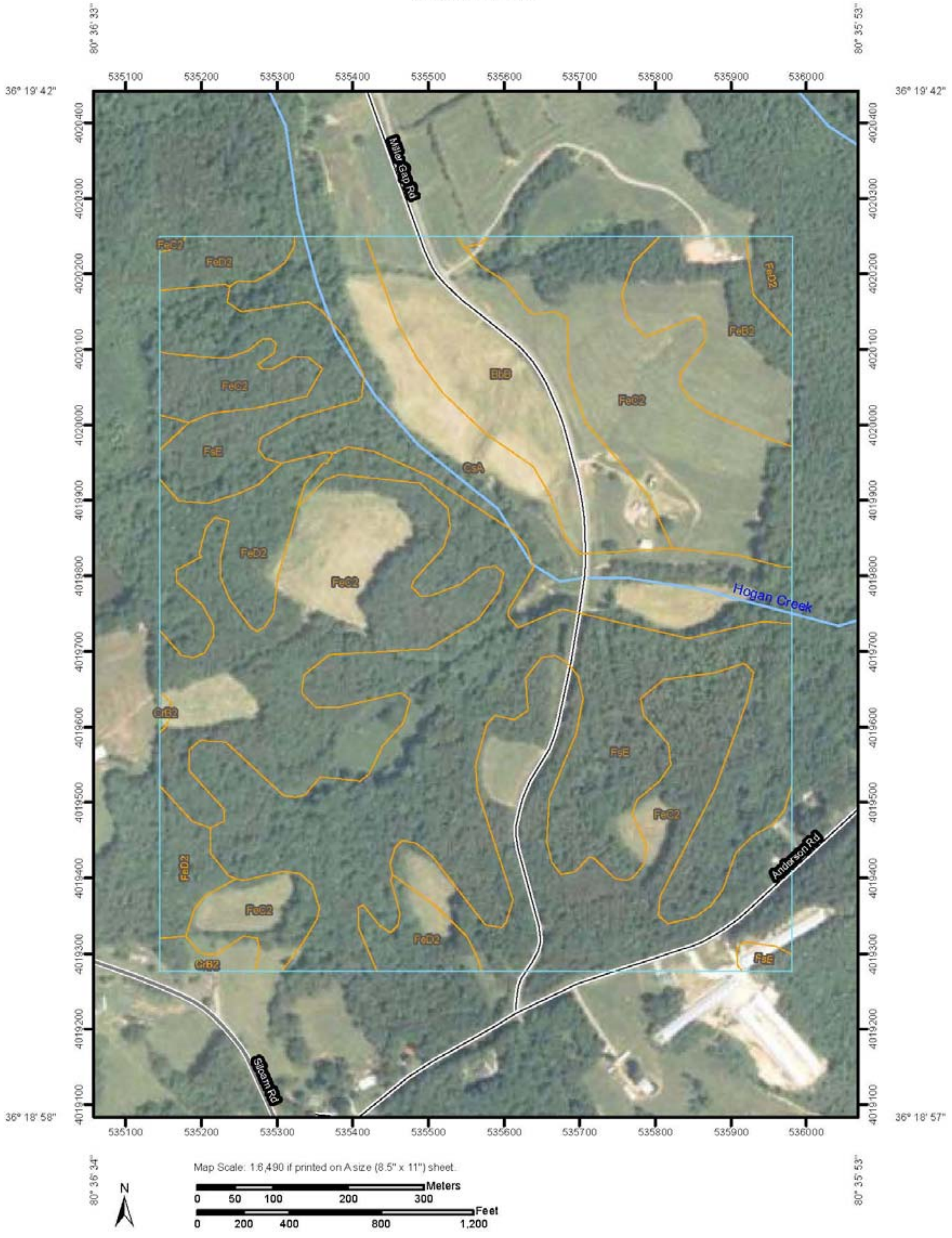


As Shown	**Hogan Creek Restoration** **Surry County, NC**	**Figure 1: Site Vicinity Map**



Scale: 1" = 2,000'	**Hogan Creek Restoration** **Surry County, NC**	**Figure 2: Watershed Map**

Soil Map—Surry County, North Carolina
(Hogan Creek Site)

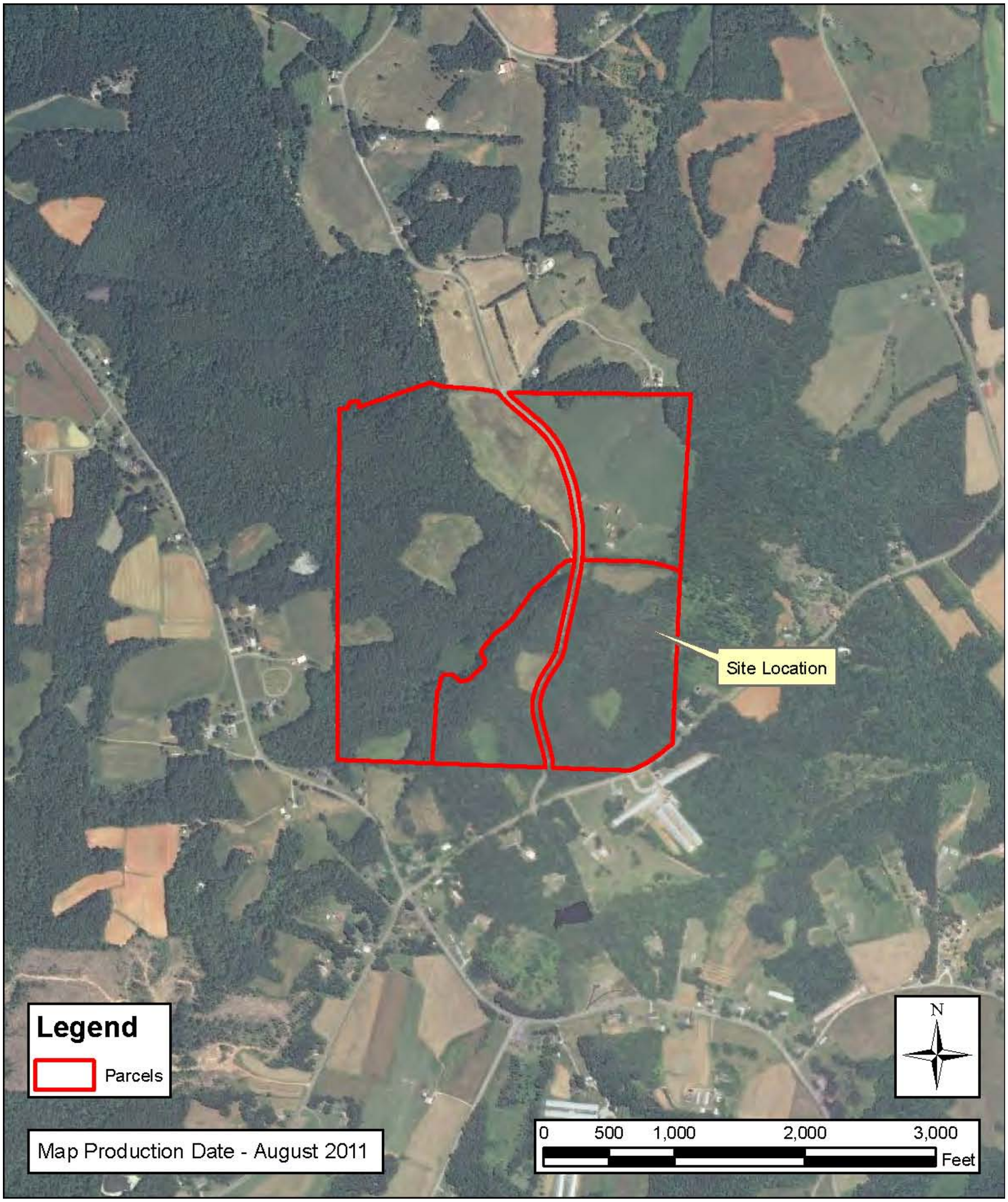


USDA Natural Resources Conservation Service

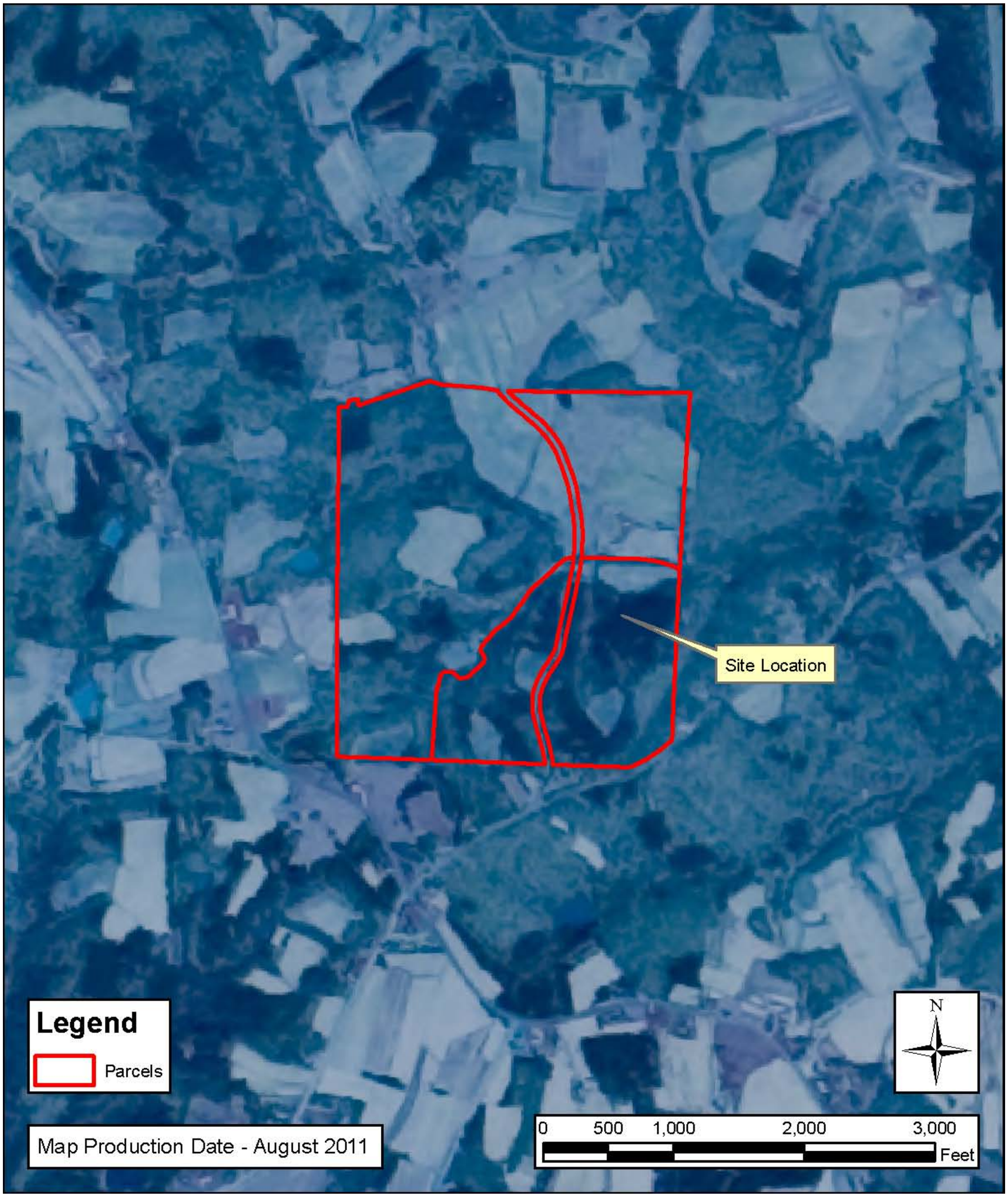
Web Soil Survey
National Cooperative Soil Survey

9/16/2011
Page 1 of 3

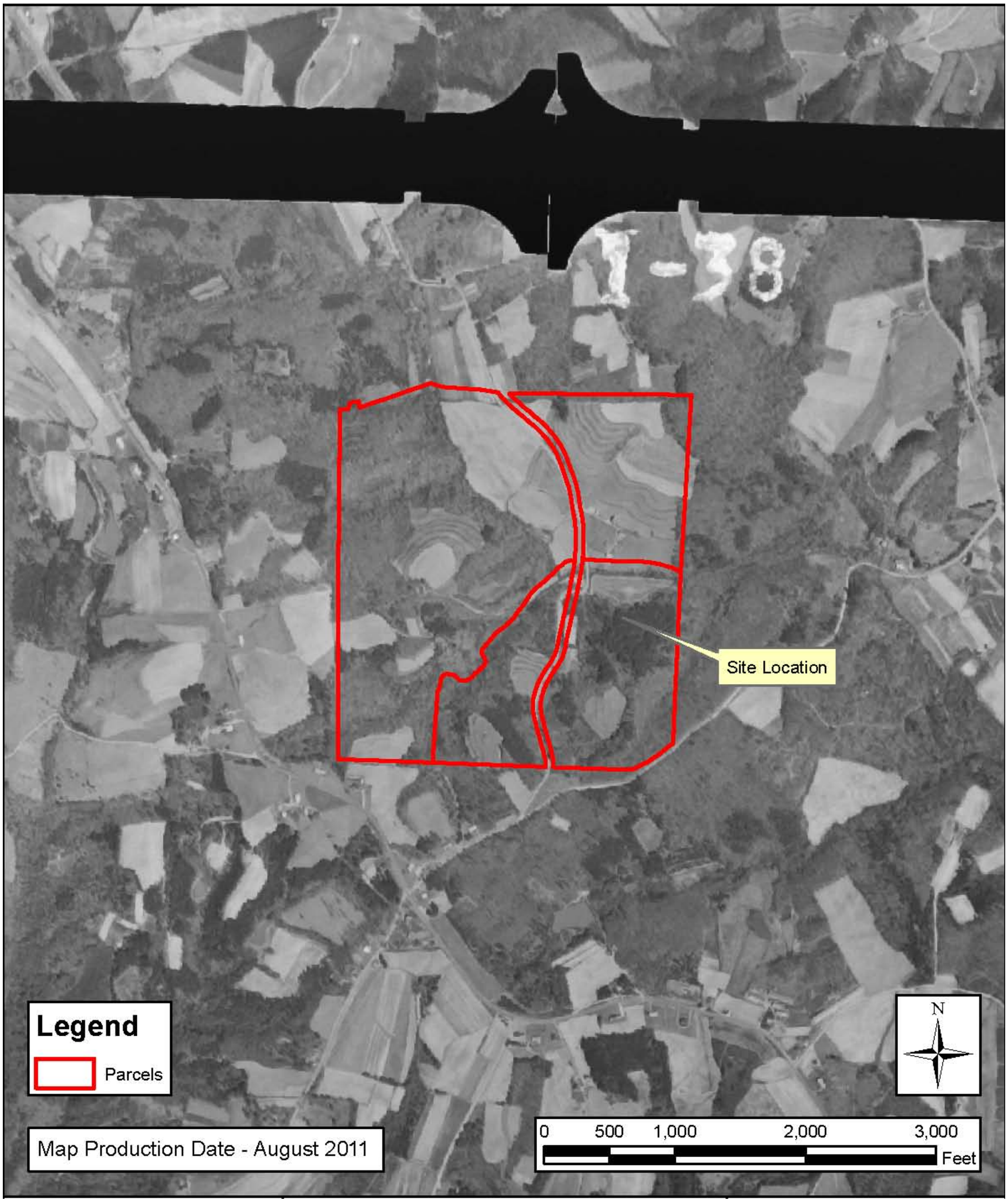
Scale: As Shown	**Hogan Creek Restoration Surry County, NC**	**Figure 3: Soils Map**



Scale: As Shown	**Hogan Creek Restoration Surry County, NC**	**Figure 4: Current Conditions (2010 Aerial)**



Scale: As Shown	**Hogan Creek Restoration Surry County, NC**	**Figure 5: Historical Conditions (1982 Aerial)**



Scale: As Shown	**Hogan Creek Restoration** **Surry County, NC**	**Figure 6: Historical Conditions** **(1966 Aerial)**

2.3 Site Modifications, Stressors and Ecological Services

Throughout the project area site modifications have diminished the ecological services provided by riparian buffers and adjacent floodplains. Farming operations over the past several decades have deforested riparian buffers, a water quality and habitat stressor identified for this TLW. The creeks and adjacent floodplain areas have also been impacted by levee construction. A prominent levee, measuring up to 3 feet above the adjacent floodplain, exists along the left bank of Hogan Creek Reach 1 and on the right bank in Reach 2. Another levee, aligned perpendicular to Hogan Creek near Station 21+20, is present on the left floodplain; the landowners indicted that this perpendicular levee was constructed several decades ago to provide flood relief to the downstream reach.

Three-foot high levees are present on both banks of UT3 between a culvert on a farm road at Station 10+20 and the confluence with Hogan Creek. In addition to restricting floodplain access on UT3, the levees constitute a significant pinch point in the Hogan Creek floodplain. Judging from the low sinuosity of this downstream reach relative to the sinuosity of the less disturbed upstream reach, the alignment of UT3 appears to have been straightened when the levees were constructed.

Widespread bank erosion, identified as a major stressor in this TLW, is visible throughout Hogan Creek and within the impacted reaches of the UTs. A clear-span bridge is present on a farm road over UT2 near station 14+00 and erosion on the left bank of UT2 threatens the stability of this road near station 10+50.

A well supplies water to cattle adjacent to Hogan Creek Reach 2 and livestock fencing is present along the left bank of Hogan Creek between the upstream property line and station 16+50, along both banks within Reach 2 and on UT2 upstream of Station 12+50. However, cattle have direct access to Hogan Creek Reach 1 and the downstream end of UT2, exacerbating bank erosion and allowing direct nutrient and fecal inputs to the stream. Table 1 provides a summary of stressors and ecological services needing enhancement in this project area.

Table 1. Stressors and Proposed Ecological Service Enhancements

Stressor	**Ecological Services Needing Enhancement**
Levees disconnecting streams from floodplains	Flood attenuation, fine sediment storage, maintenance of stable channel bed and banks
Bank erosion and mid-channel sediment deposition	Equilibrium sediment transport, maintenance of in-stream riffle and pool habitats
Buffer deforestation	Filtration of runoff, thermal regulation, input of organic matter
Invasive, exotic vegetation	Riparian buffer habitat, species diversity
Direct livestock access to streams	Protection of water quality from nutrient inputs.

2.4 Evolutionary Trends

Reach 1 of Hogan Creek generally flows through the low point of its valley, and judging by valley topography, it does not appear that the channel position within the valley was altered significantly during the levee construction activities. It does appear that the bankfull channel alignment and cross sectional dimensions were modified enough to create bank stability and sediment transport problems. In Reach 2 of Hogan Creek, the topography indicates that the low point of the valley is 60 to 80 feet south of the current channel alignment; it appears that the channel was shifted north at some time prior to 1966. This conclusion is supported by data from three hand auger borings in the low area of the right floodplain, which encountered gravel indicative of the one-time creek bed at depths of 3 to 4 feet below existing grade.

Hogan Creek appears to be near the midpoint of a trend from a C-type steam to an F-type stream, as evidenced by the following (refer to project site photographs, section 2.5):

- Bank erosion;
- Leaning and fallen trees;
- Channel cross sectional areas up to twice the estimated bankfull areas;
- Bank heights up to twice the bankfull depth; and
- Mid-channel sediment bars.

Bedrock is visible in the channel bed throughout much of Hogan Creek and the tributaries. Exposed rocks appear to be gneisses and schists. The Soil Survey of Surry County indicates most of the rock in the area strikes northeast-southwest and dips northwest. This attitude of the rock is not apparent from surface observations of the stream pattern or topography; the shape and alignment Hogan Creek and tributary valleys appear to have been governed by rocky hillsides, which are evident in the topography.

Soils on the Hogan Creek floodplain are mapped as the Colvard series, described in the soil survey as a fine sandy loam originating from recent alluvium with a depth to bedrock generally more than 5 feet. Soils in the tributary valleys are mapped as the Fairview series, described as a clayey loam and the product of in-situ weathering; the depth to bedrock in the Fairview series is indicated to be more than 5 feet. The soil survey provides general information about soils but it cannot describe reach-scale historic alluvial deposits, isolated bedrock outcrops and other geologic influences.

The aforementioned bedrock has prevented channel down-cutting; incised channel conditions are the result of the levees, which have restricted floodplain access and confined flows greater than bankfull to within the channel. The confinement of these large flows has lead to bank erosion, which in turn has lead to channel widening, mid-channel sediment deposition and loss of near-bank vegetation. Left unchecked, this process of widening and mid-channel deposition will likely continue as leaning trees fall and expose erodible soils. The evolutionary trend suggests that the stream will migrate laterally and breach the levees until the system eventually reaches equilibrium with its water and sediment supply. Evidence of this process at work can be found in a short meander bend between Stations 21+00 and 24+00. Observations of recent bank slumping and review of aerial photographs (1982 and 2010) indicate that the channel has eroded roughly 10 feet into the left bank. This response of lateral migration is evident in an area that is devoid of mature trees and their stabilizing root masses. Similar meander bends would likely be evident elsewhere, if not for some remaining mature trees on the banks. Appendix C includes an inventory drawing showing areas of significant bank erosion, tree falls, debris jams, and mid-channel and lateral bars. Judging by the fresh conditions of the wood, most of the tree falls shown on the inventory appear to have occurred within the last year or two. In the 14 months since the initial site visit, new tree falls have been observed in both reaches of Hogan Creek and bars have shifted in size and shape; these are both indications that the stream is not close to reaching a state of dynamic equilibrium.

UT1, UT2 and UT3 are similar to each other in terms of valley and channel slope. Each of these tributaries has formed a sinuous pattern within a confined valley. The belt widths of these streams appear to be governed by bedrock at the valley walls. Observations of bank soil profiles in Hogan Creek reveal a buried topsoil layer is present about 2 feet below existing grade, indicating that the Hogan Creek valley was subjected to significant aggradation, likely from surface erosion following initial land disturbances in the 19th century. Under this scenario, the tributaries were also subjected to this aggradation process and observations of fine-grained soils in the tributary banks generally support this idea. The highly sinuous tributary patterns may be a response to large volumes of deposited sediment filling the valleys. The forest in the upstream reaches of these tributaries appears to have recovered significantly since initial disturbance and the streams are generally stable, aided by deep rooted vegetation and frequent bedrock outcrops at the valley walls.

Over the downstream 100 LF of UT1, the stream makes a tight meander bend through a highly incised reach (bank heights at least twice the bankfull maximum depth) as the tributary reaches its confluence with Hogan Creek. Observations of active bank erosion indicate that this downstream reach is likely to avulse without intervention.

Upstream of station 6+50 on UT2, the stream is highly sinuous and generally stable, with isolated bank erosion at the outside of some meander bends. Between stations 6+50 and 11+00, the valley is confined topographically and by the aforementioned farm road, which was constructed on the left hill slope. Bank erosion near Station 10+50 has caused the partial collapse of the road and a 40-foot length of fencing along the road is currently suspended in air. Between Stations 11+00 and the confluence with Hogan Creek, the UT2 channel is incised with bank heights of twice the bankfull maximum depth, and the buffer is dominated by kudzu. The reach of UT2 downstream of Station 10+00 lacks the appropriate geomorphic characteristics and buffer vegetation to heal itself without first causing widespread bank erosion.

Instability within the UT3 system begins upstream of an 18-inch culvert on a farm road near station 10+20; the banks immediately upstream of the culvert are unstable, apparently due to culvert effects on flow. Downstream of the culvert, bank heights are up to 4 feet higher than the estimated bankfull maximum depth due to the aforementioned levees. This high level of incision has resulted in a very low frequency of floodplain access and flows reaching levee elevations are producing bed shear stress more than twice that estimated for bankfull. The downstream reach of UT3 will not regain floodplain access and heal to a stable dimension, pattern and profile without the removal of the levees and restoration of the appropriate geomorphic characteristics.

2.5 Project Site Photographs

 Hogan Creek, looking downstream from station 12+50; bank erosion and mid-channel bar deposition; March 8, 2011	 Agricultural field and levee looking downstream along left bank of Hogan Creek from station 14+00; March 8, 2011
 Hogan Creek, looking downstream from station 16+00; leaning trees, bank erosion; mid-channel bar; September 12, 2011	 Hogan Creek, looking downstream at station 22+50; lateral migration, mid-channel bar deposition; October 18, 2010
 Hogan Creek, looking downstream from station 27+25; buffer deforestation and kudzu infestation; March 8, 2011	 Hogan Creek, looking downstream from station 33+75; narrow buffers; levee on right bank; March 8, 2011

 Hogan Creek looking downstream from station 35+00; bank erosion and mid-channel deposition; April 8, 2011	 UT1 looking downstream from station10+00; bank erosion at confluence with Hogan Creek; March 8, 2011
 UT1 looking upstream from station10+00 at downstream end of preservation reach; April 8, 2011	 UT2, looking downstream from station 12+50; buffer deforestation and kudzu infestation; March 8, 2011
 UT2, looking downstream from station 10+50; bank erosion threatening farm road on left; April 8, 2011	 UT3, looking downstream from station 11+00. Straightened channel with levees on both banks; March 8, 2011

3.0 SITE PROTECTION INSTRUMENT

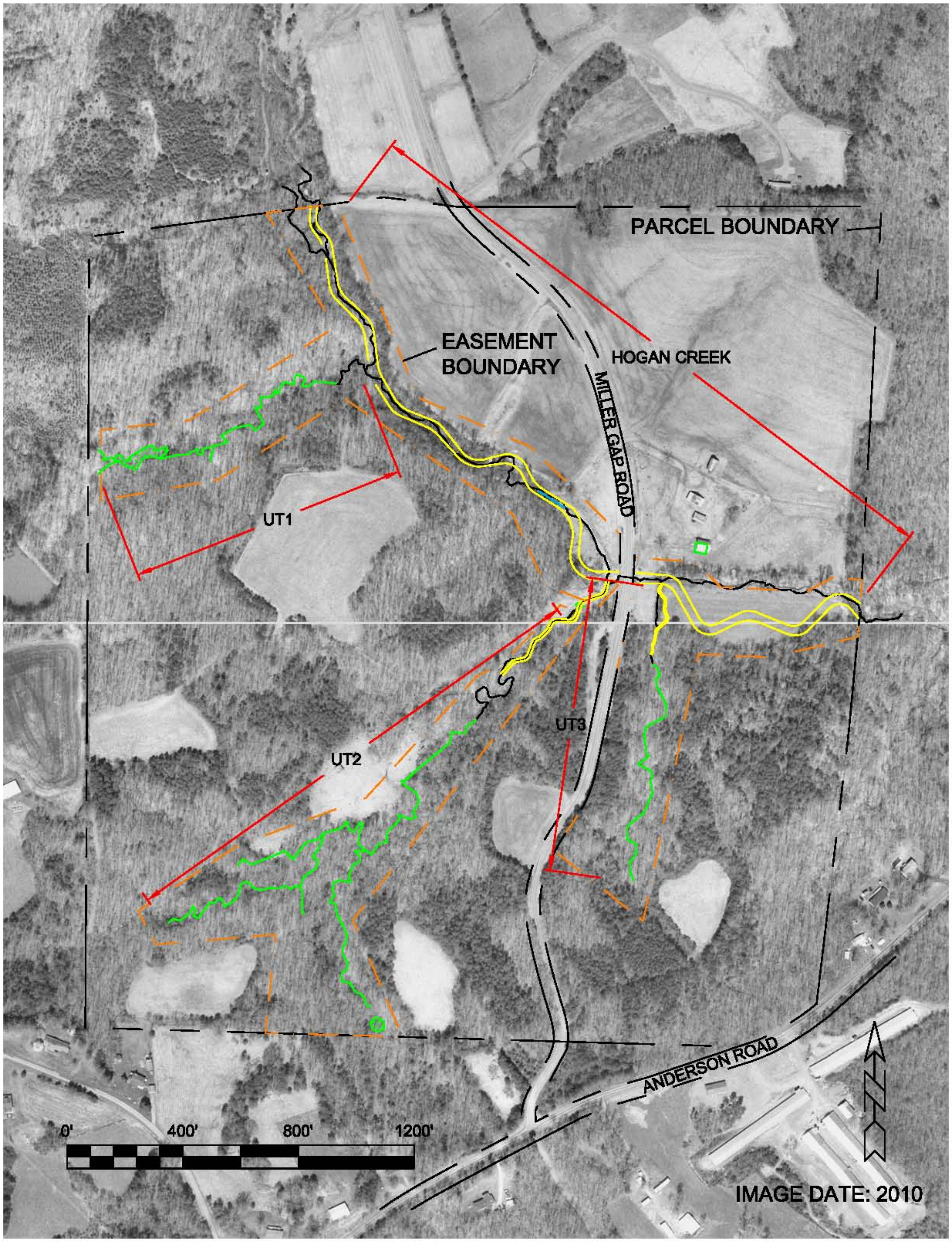
The land required for the construction, management, and stewardship of this mitigation project includes portions of the following parcels. A copy of the land protection instrument(s) will be included in Appendix A upon completion of the documents.

Table 2: Summary of Project Land Parcels and Site Protection Instruments

Parcel ID	Landowner	PIN	County	Site Protection Instrument	Deed Book and Page Number	Acreage protected
Parcel A	Chilton, Marion	5924-00-80-2896	Surry	Conservation Easement	TBD	**17.4 ac**
Parcel B	Chilton, Marion H. Jr.	5923-00-79-9259	Surry	Conservation Easement	TBD	**13.5 ac**

All site protection instruments require 60-day advance notification to the Corps and the State prior to any action to void, amend, or modify the document. No such action shall take place unless approved by the State.

Figure 7 shows the current parcel boundaries and the proposed conservation easement boundaries.



Scale: As Shown	**Hogan Creek Restoration Surry County, NC**	**Figure 7: Site Protection Instrument Boundaries**

4.0 BASELINE INFORMATION

Table 3: Project Baseline Information

Project Name	Hogan Creek Restoration
County	Surry
Project Area (acres)	40 (conservation and temporary construction easements)
Project Coordinates (latitude and longitude)	36.321609 N, 80.602389 W

Project Watershed Summary Information

Physiographic Province	Piedmont
River Basin	Yadkin
USGS Hydrologic Unit 8-digit	03040101
USGS Hydrologic Unit 14-digit	03040101110060
DWQ Sub-basin	Pee Dee River Subbasin 03-07-02
Project Drainage Area (acres)	1,514 ac (2.37 mi^2)
Project Drainage Area Percentage of Impervious Area	0.4%
CGIA Land Use Classification	Managed Herbaceous Cover, Broadleaf Deciduous Forest Land

Reach Summary Information

Parameters	**Reach 1 Hogan Creek**	**Reach 2 Hogan Creek**	**Main Stem UT1**	**Main Stem UT2**	**UT3**
Existing length of reach (LF)	2,128	876	1,395	2,983	1,223
Valley classification (Rosgen)	VIII	VIII	VI	VI	VI
Drainage area (acres)	1,479	1,514	60	81	18
NCDWQ stream identification score	40	37	31	31.5	32.5
NCDWQ Water Quality Classification	C	C	C	C	C
Morphological Description (Rosgen stream type)	C4	C4	E4b	E4b	G4
Evolutionary trend	C-F	C-F	Eb-G	Eb-G	Eb-G
Underlying mapped soils	CsA	CsA	CsA, FsE	FsE	FsE
Drainage class	well drained	well drained	well drained	well drained	well drained
Soil Hydric status	not hydric	not hydric	not hydric	not hydric	not hydric
Slope	0.007	0.005	0.031	0.021	0.030
FEMA classification	AE	AE	Not in SFHA	Not in SFHA	Not in SFHA
Native vegetation community	Felsic Mesic Forest	Felsic Mesic Forest	Felsic Mesic Forest	Felsic Mesic Forest	Felsic Mesic Forest
Percent composition of exotic invasive vegetation	40	10	<10	40	20

Wetland Summary Information

Parameters	**Wetland 1**	**Wetland 2**	**Wetland 3**	**Wetland 4**
Size of Wetland (acres)	0.09	0.02	0.13	0.1
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	riparian non-riverine	riparian non-riverine	riparian non-riverine	riparian non-riverine
Mapped Soil Series	CsA	CsA and FsE	CsA and FsE	CsA and FsE
Drainage class	well drained	well drained	well drained	well drained
Soil Hydric Status	not hydric	not hydric	not hydric	not hydric
Source of Hydrology	Creek (oxbow)	Toe seep	Toe seep	Impoundment
Hydrologic Impairment	none	none	none	none
Native vegetation community	Dist. Small Stream/ Narrow FP Forest	Dist. Small Stream/ Narrow FP Forest	Dist. Small Stream/ Narrow FP Forest	herbaceous
Percent composition of exotic invasive vegetation	80	<10	<10	<10

Regulatory Considerations

Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States – Section 404	Y	N	
Waters of the United States – Section 401	Y	N	
Endangered Species Act	Y	Y	CE Approved 9/30/11
Historic Preservation Act	N	N/A	
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	N	N/A	
FEMA Floodplain Compliance	Y	N	CLOMR in progress
Essential Fisheries Habitat	N	N/A	

5.0 DETERMINATION OF CREDITS

Mitigation credits presented in these tables are projections based upon site design. Upon completion of site construction the project components and credits data will be revised to be consistent with the as-built condition.

Table 4: Projected Mitigation Credits

Hogan Creek Stream Mitigation
Surry County, North Carolina
EEP Project No. 94708

Stream Mitigation Credits

Type	Restoration	Enhancement I	Enhancement II	Preservation
Total	**2,493**	**1,200**	**166**	**1,135**

Project Components

Project Component -or- Reach ID	Proposed Stationing/Location	Existing (Thalweg) LF	Approach	Restoration -or- Restoration Equivalent	Proposed LF	Mitigation Ratio
Hogan Reach 1	STA 1000-2200	1,331	P2	EI	1,200	1:1
Hogan Reach 1	STA 2200-2884	797	P2	R	684	1:1
Hogan Reach 2	STA 2935-3897	876	P2	R	962	1:1
UT1, 1A, 1B	Upstream of STA 1000	1,485	Preservation	P	1,485	5:1
UT1	STA 1000-1066	66	P3	EII	66	2.5:1
UT2, 2A, 2B, 2C	Upstream of STA 650	3,225	Preservation	P	3,225	5:1
UT2	STA 650-1000	370	P3	EII	350	2.5:1
UT2	STA 1000-1555	633	P2	R	555	1:1
UT3	Upstream of STA 940	963	Preservation	P	963	5:1
UT3	STA 940-1232	260	P2	R	292	1:1

Component Summary

Restoration Level	Proposed Stream Length (LF)
Restoration	2,493
Enhancement I	1,200
Enhancement II	416
Preservation	5,673

6.0 CREDIT RELEASE SCHEDULE

All credit releases will be based on the total credit generated as reported by the as-built survey of the mitigation site. Under no circumstances shall any mitigation project be debited until the necessary US Department of the Army (DA) authorization has been received for its construction or the District Engineer (DE) has otherwise provided written approval for the project in the case where no DA authorization is required for construction of the mitigation project. The DE, in consultation with the Interagency Review Team (IRT), will determine if performance standards have been satisfied sufficiently to meet the requirements of the release schedules below. In cases where some performance standards have not been met, credits may still be released depending on the specifics of the case. Monitoring may be required to restart or be extended, depending on the extent to which the site fails to meet the specified performance standard. The release of project credits will be subject to the criteria described as follows:

Table 5: Stream Credits Release Schedule

Monitoring Year	Credit Release Activity	Interim Release	Total Released
0	Initial Allocation – see requirements above	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50% (65%*)
3	Third year monitoring report demonstrates performance standards are being met	10%	60% (75%*)
4	Fourth year monitoring report demonstrates performance standards are being met	10%	70% (85%*)
5	Fifth year monitoring report demonstrates performance standards are being met and project has received closeout approval	15%	100%

6.1 Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the EEP without prior written approval of the DE upon satisfactory completion of the following activities:

a. Approval of the final Mitigation Plan

b. Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property

c. Completion of project construction (the initial physical and biological improvements to the mitigation site) pursuant to the mitigation plan; per the EEP Instrument, construction means that a mitigation site has been constructed in its entirety, to include planting, and an as-built report has been produced. As-built reports must be sealed by an engineer prior to project closeout, if appropriate but not prior to the initial allocation of released credits.

d. Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

6.2 Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the IRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 15% of a site's total stream credits shall be released after two bankfull events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than two bankfull events occur during the monitoring period, release of these reserve credits shall be at the discretion of the IRT. As projects approach milestones associated with credit release, the EEP will submit a request for credit release to the DE along with documentation substantiating achievement of criteria required for release to occur. This documentation will be included with the annual monitoring reports.

7.0 MITIGATION WORK PLAN

7.1 Target Streams

The Hogan Creek site affords the opportunity to address the major stressors described in the RBRP (EEP, 2009) and the Local Watershed Plan Technical Memorandum (EcoEngineering, 2008) for the Hogan Creek watershed. The project's conceptual design phase focused on developing objectives that would enhance the ecological services threatened by these stressors. (The proposed conservation easement boundaries will encompass the four wetlands at the site, but no work is proposed and no wetland mitigation credit is being sought.) Table 6 below summarizes the links between each design objective proposed for this project and the ecological service improvements that can be achieved on a reach-by-reach basis. Specific site constraints and design measures for each reach, along with the target Rosgen stream types, are presented in Table 7.

Table 6: Design Objectives and Ecological Services

Design Objective	Enhanced Ecological Services	Project Reach				
		Hogan Reach 1	Hogan Reach 2	UT1	UT2	UT3
Remove levees; restore stream to floodplain interaction.	a. Flood attenuation b. Fine sediment storage	✓	✓			✓
Create new channel dimension, pattern and profile	a. Maintenance of stable channel bed and banks. b. Equilibrium sediment transport c. Maintenance of in-stream riffle and pool habitats	✓	✓		✓	✓
Use in-stream structures and bank grading to promote stability, riffle and pool formation and sediment transport continuity for on-line reaches.	a. Maintenance of stable channel bed and banks. b. Equilibrium sediment transport c. Maintenance of in-stream riffle and pool habitats	✓	✓	✓	✓	✓
Establish 50-foot wide riparian buffers with diverse group of native species.	a. Filtration of runoff b. Thermal regulation c. Input of organic matter	✓	✓		✓	✓
Eradicate invasive exotic vegetation and seed source; replant buffer areas with native vegetation.	a. Riparian buffer habitat b. Robust species diversity	✓	✓		✓	✓
Install additional livestock fencing and ford crossings to restrict livestock access to streams; provide alternative water source.	a. Protection of water quality from nutrient and pathogen inputs. b. Protection of banks from livestock trampling	✓			✓	

Table 7. Target Streams, Constraints and Reach-Specific Measures

Reach	Target Stream Type (Slope)	Constraints	Reach-Specific Measures
Hogan R1	C4 (0.007)	Farming operations on left bank; bedrock in profile; culverts at downstream end	Levee removal; in-stream structures; bank grading; bankfull benches; new off-line channel segments; riparian buffers; invasive species removal; livestock fencing; ford crossing

Table 7. Target Streams, Constraints and Reach-Specific Measures

Hogan R2	C4 (0.006)	Farming operations on left bank; culverts at upstream end	Levee removal; new off-line channel; in-stream structures; bank grading; bankfull benches; riparian buffers; invasive species removal
UT1	B4 (0.031)	Mature forest; confluence with Hogan Creek	Bank sloping and minor re-alignment at downstream end
UT2	B4 (0.022)	Farm road and new bridge crossing; right-of-way; mature forest	New off-line channel; in-stream structures; bank grading; bankfull benches; riparian buffers; invasive species removal; livestock fencing
UT3	B4 (0.025)	Mature forest upstream; confluence with Hogan Creek	New off-line channel; in-stream structures; bank grading; bankfull benches; riparian buffers; invasive species removal

7.2 Target Plant Communities

The target plant community is a more robust and diverse version of the existing Felsic Mesic Forest plant community identified in the upland and relatively undisturbed reaches of the three UTs. In upland areas where stream and floodplain grading are not proposed but where invasive exotic plants have encroached, buffer restoration design will include the following:

- Eradication of invasive exotic species;
- Preservation of desirable existing species; and
- Supplemental planting with selected native trees and shrubs to encourage a more diverse version of the target community.

Most of the areas proposed for stream and floodplain grading are currently pasture or hay field. The target plant community for these areas will be the same as the upland areas, but species within this community will be selected for their adaptation to streambank and floodplain conditions. Appendix C includes a table with several candidate species for buffer planting.

7.3 Design Methodology and Data Analyses

The design methodology incorporated form-based and analytical approaches, using a combination of statistical relationships and analyses to arrive at a design discharge for each reach. Other primary design criteria, such as cross section dimensions, pattern and profile, are all linked to the design discharge and to each other. The following sections summarize each phase of the methodology; supporting calculations and data are included in Appendix C.

7.3.1 Design Discharge

In order to estimate a range of design discharge for each reach, we evaluated regional regression equations, analyzed field bankfull indicators using hydraulic models, and considered sediment transport competence using critical discharge for initiation of bed material mobility.

In addition to evaluating discharge at various surveyed riffle cross sections on the project reaches, we also evaluated the predicted discharge for the Mill Creek reference reach as a check of the analysis methodology. As indicated in the table, there is considerable spread in the predicted design discharge values. The USGS 2-year estimate typically provides an upper bound on the bankfull discharge while the critical discharge estimates typically provide a lower bound. (The nearest USGS stream gauging station is not particularly helpful for our analyses; it is located on the Mitchell River with a drainage area nearly 40 times larger than the project reach.) The critical discharge estimates based on competence for the bar sample D_{100} appear to over-predict bankfull discharge for Hogan Creek and under-predict bankfull discharge for the two tributaries and the reference reach. The field indicators and the critical discharge based on pavement D_{84} appear to be reasonable predictions, judging by their close agreement to each other and the regional curve. Selected design discharge values are indicated Table 8 below. We did not perform hydraulic or sediment transport analyses for UT1 since the bank sloping work proposed is minor and will not significantly affect channel dimension, pattern or profile.

Table 8: Design Discharge Estimates (cfs)

Design Reach	NC Rural Piedmont Regional Curve	USGS 2-year	Hydraulic Model using Field Indicators	Critical Discharge (Pavement D_{84})	Critical Discharge (Bar D_{100})	Selected Design Value
Hogan Reach 1	163	211	201-308	111-163	215-290	170
Hogan Reach 2	166	215	220	142	356	180
UT 2	20	22	25	8	3	20
UT3	7	7	28	3	1	7
Mill Creek R.R.	284	385	191-196	173-270	77-87	N/A

7.3.2 Sediment Transport

Table 8 above summarizes sediment transport *competence* analyses; supporting data are included in Appendix C. Our analyses indicate the design streams (in terms of cross section and profile) will transport the size of the large bed materials sampled at the site. We also evaluated sediment transport *capacity* and *continuity* between the supply and design reaches, using unit stream power as the indicator parameter. We compared stream power over a range of stages up to and above the bankfull stage to check if continuity was achieved. Hydraulic models (HEC-RAS and RIVERMorph) of the existing and design conditions were used to support the sediment transport analyses by providing hydraulic parameters such as hydraulic radius, slope, shear stress, and power. Graphical output of these analyses is included in Appendix C.

Given the presence of mid-channel sediment deposition and abundant bedrock in the bed, aggradation is more of a concern that degradation for Hogan Creek. Bars were observed to contain a mixture of coarse gravel (bed material) and fine to medium sand. The sand fraction is likely the product of bank erosion in upstream reaches rather than watershed supply and overland flow given the presence of the levee adjacent to agricultural fields, which tends to trap sediment and confine stream flows. A primary design objective is to create somewhat greater stream power than currently exists in order to minimize the potential for future aggradation from the upstream supply reach. Analyses indicate that the Hogan Creek design reaches have slightly greater unit stream power than the supply reach for stages up to 1.2 to 1.3 times the bankfull stage (about 2.5 times the bankfull discharge). At UT2, unit stream power comparisons show similar values in the supply and design reaches up 2.3 times the bankfull stage (about 5 times the bankfull discharge). At UT3, the supply reach has consistently greater unit stream power than the design reach, but aggradation is not of great concern for UT3 (or UT1 or UT2) because sediment supply is relatively low with the forested headwaters, which will remain forested in conservation easement.

7.3.3 Cross Section

Design discharge and sediment transport analyses inform the design of cross section dimensions and shapes; cross section dimensions and shapes along with slope govern hydraulic parameters that are relevant to design. Past experience also informs the cross section design. For example, project monitoring over the past several years has indicated that a newly constructed E or C-type channel with a width-depth ratio less than about 10 can lead to stability problems. We evaluated reference cross sections as indications of bankfull area and general shape, but the design bank slopes are also governed by geotechnical stability needs during the monitoring period in areas where little or no deep-rooted vegetation will be present for the first few growing seasons. Ratios of pool-to-riffle depth and top width are based in part on reference reach data and in part on past experience.

The design cross sections also account for sediment storage within the channel on point bars and/or in lateral bars upstream of vane structures. This stored sediment is available for transport during large flow events, which promotes long-term stability and sediment transport equilibrium; if sediment is not available for transport within the channel, hungry water conditions can lead to bed and bank scour.

7.3.4 Plan and Profile

Plan geometry design is based on multiple factors, chiefly the selected design slope and lateral constraints such as easement boundaries and topography. At a particular plan feature such as a meander bend, geometry is based on a range of dimensionless ratios that have proven to be effective in meeting design objectives while promoting stability. The prime example for plan geometry is radius of curvature ratio; well-vegetated and/or bedrock-influenced reference reaches (Mill Creek and upstream reaches of the UTs) suggest a radius of curvature ratio of 1.0 or less would be desirable, but experience indicates that a ratio less than about 1.8 places undue stresses on newly constructed banks that lack deep rooted vegetation. We note that the geomorphic characteristics of the Mill Creek reference reach are affected by bedrock on the banks and in the bed.

We considered reference reaches when developing plan geometry. Our search for a Hogan Creek reference reach included upstream reaches of Hogan itself and several other streams in relatively undisturbed watersheds, primarily in Surry County. We identified a reach of Mill Creek with a stable meander bend in a valley and with bed materials similar to Hogan Creek. For the UTs, we were able to locate stable reference cross sections and/or reaches in upland areas at the project site. Reference cross section/reach data for each project stream are summarized in Appendix C.

As with reference cross sections, reference plan form is useful as a general guide for parameters such as belt width, radius of curvature and pool-pool spacing. However, as with low width-depth ratios in reference cross sections, tight radii and pool spacing in reference reaches often cannot be assigned to a design reach without risk of stability problems in the time while vegetation is becoming established. The selected pattern and profile take into account aquatic habitat needs, stability throughout the monitoring period and space constraints. With pattern being directly linked to profile, we considered profile constraints such as existing bedrock outcrops and the culverts on Miller Gap Road, as well as sediment transport equilibrium, when assigning profile grades. We also referenced data from three hand auger borings on the right floodplain of Hogan Creek Reach 2; as mentioned previously, these borings encountered coarse grained sediments indicative of a former creek bed at depths close to the Reach 2 design thalweg.

The target stream type for Hogan Creek is a moderately sinuous, moderate width-depth ratio C4, which is appropriate for the relatively flat and wide alluvial valley through which it will flow. Reach 1 will be constructed largely within the existing channel, with modest pattern shifts at station 22+00 where existing pattern is unstable and near station 27+00 where the new channel will connect to an abandoned oxbow (wetland 1). The levee on the left bank will be removed, as will a portion of the perpendicular levee near 21+20. In-stream structures will be incorporated in Reach 1 to promote sediment transport equilibrium, riffle and pool formation, and enhanced bank stability. Bedrock is not anticipated to affect construction significantly because the profile will generally follow the existing thalweg.

Reach 2 will be constructed mainly off-line to position the channel in the low point of the valley and provide much improved floodplain access on both banks. The short reach immediately downstream of Miller Gap Road will be left relatively straight, with a pool constructed in order to dissipate energy. We considered enhancing Reach 2 in its existing channel but determined that the result would be sub-optimal in terms of natural riffle and pool formation and floodplain access. In-line enhancement would also require as much if not more earthwork/hauling, significant structure/bioengineering, and considerably more streamflow control during construction than an off-line approach. In the proposed off-line scenario, excess cut material not used to backfill the abandoned channel can be spoiled on-site in upland areas.

The target stream type for each of the UTs is a B4, with a moderate width-depth ratio and moderate sinuosity which is suited to the somewhat steeper and more confined tributary valleys. Bankfull benches, cut on 10:1 slopes, will be provided on both banks. The off-line channel segments promote formation of riffle and pool sequences while also affording the ability during construction to maintain clean flow separate in the original channel.

7.3.5 In-Stream Structures

In-stream structure types and locations were selected based on design stability, habitat enhancement and sediment transport objectives within each reach. Table 9 below provides a summary of specific objectives for the proposed structures. Data and analyses supporting the sizing of stone for in-stream structures are provided in Appendix C.

Table 9. In-Stream Structures

Structure	Objectives
Geolifts	a. Bank stability at channel plugs b. Quickly establish deep rooted bank vegetation
Rock Vane or Log Vane	a. Direct flow toward center of channel b. Promote sediment storage upstream and pool formation downstream
Cross Vane / Parabolic Vane	a. Center flow b. Mitigate over-wide conditions and lessen potential for mid-channel bar formation c. Promote sediment storage upstream and pool formation downstream
Constructed Riffle or Step Structure	a. Set grade in profile b. Provide roughness in bed c. Initiate riffle habitat and sediment transport equilibrium
Root Wad Cluster	a. Enhance bank stability b. Provide bank roughness c. Establish near-bank cover and pool habitat

8.0 MAINTENANCE PLAN

EEP shall monitor the site on a regular basis and shall conduct a physical inspection of the site a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include the following:

Table 10. Maintenance Provisions

Component/Feature	Maintenance through project close-out
Stream	Routine channel maintenance and repair activities may include securing of loose coir matting and supplemental installations of live stakes and other target vegetation along the channel. Areas where stormwater and floodplain flows intercept the channel may also require maintenance to prevent bank failures and head-cutting.
Vegetation	Vegetation shall be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Exotic invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, tree-blazing, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.
Ford Crossing	By landowner, as allowed by Conservation Easement.
Road Crossing	By landowner, as allowed by Conservation Easement.

9.0 PERFORMANCE STANDARDS

In accordance with the provisions in CFR Title 33, "*performance standards that will be used to assess whether the project is achieving its objectives… and should relate to the objectives … so that the project can be objectively evaluated to determine if it is developing into the desired resource type, providing the expected functions, and attaining any other applicable metrics".*

Table 11 below lists proposed success criteria for each proposed ecological service enhancement. While some success criteria are quantitative (e.g. bank height ratio) and others are qualitative (e.g. observations of fine sediment deposition on the floodplain), each is measurable. Year to year comparisons for the various parameters will allow adaptive management to be implemented early on in the monitoring period if necessary in order to reduce the risk of widespread problems.

Table 11. Performance Standards

Proposed Ecological Service Enhancements	Metrics/Success Criteria
Flood attenuation	a. Evidence of at least two out-of-bank flows (wrack lines, crest gage data) by year 5 b. BHR < 1.2 each year
Fine sediment storage	a. Evidence of fine sediment on floodplain at least twice by year 5
Maintenance of stable channel bed and banks	a. Annual changes in riffle cross sectional area generally modest (e.g. <20%) and exhibit a stabilizing trend. b. Annual width-depth ratio changes generally modest (e.g. <20%) and exhibit a stabilizing trend
Equilibrium sediment transport	a. No trends in widespread development of robust (e.g. comprised of coarse material and/or vegetated actively diverting flow) mid-channel bar features b. Majority of riffle pebble counts indicate maintenance or coarsening of substrate distributions
Maintenance of in-stream riffle and pool habitats	a. Overall number and distributions of riffle and pool features are generally maintained b. Pool depths may vary from year to year, but the majority maintain depths sufficient to be observed as distinct features in the profile c. Majority of riffle pebble counts indicate maintenance or coarsening of substrate distributions
Filtration of runoff	a. Evidence of floating debris or fine sediment on buffer vegetation at least twice by year 5
Thermal regulation	a. Measured water temperature reduction at locations of new buffer establishment and at selected dates at years 3 and 5;
Riparian buffer habitat density and diversity	a. Density of 320 live, planted stems/ac at year 3; 260 live, planted stems/acre at year 5 b. Four dominant species at year 5 shall be native c. <20% non-native species at year 5, based on measurements of aerial extent
Protection of water quality from nutrient and pathogen inputs	a. Observations of intact livestock fencing and absence of evidence of livestock access to streams, each year
Protection of banks from livestock trampling	a. Observations of intact livestock fencing and absence of evidence of livestock impacts, each year
Re-vegetation of areas treated for non-native species	a. Bare soil areas shall comprise no more than 10 percent of the total treated area, based on measurements of aerial extent

10.0 MONITORING REQUIREMENTS

Annual monitoring data will be reported using the EEP monitoring template. The monitoring report shall provide a project data chronology that will facilitate an understanding of project status and trends, population of EEP databases for analysis, research purposes, and assist in decision making regarding project close-out.

Table 12. Monitoring Requirements

Required Parameter	Quantity	Frequency	Notes
Pattern	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	Pattern/profile survey will extend for at least 20 bankfull widths per reach.
Dimension	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	A minimum of one representative riffle and pool cross section will be surveyed per reach.
Profile	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	Pattern/profile survey will extend for at least 20 bankfull widths per reach.
Substrate	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	Sampling will include reach-wide pebble counts and zigzag pebble counts
Surface Water Hydrology	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	A crest gauge and/or pressure transducer will be installed on site; the device will be inspected on a quarterly/semi-annual basis to document the occurrence of bankfull events on the project
Vegetation	Quantity and location of vegetation plots will be determined in consultation with EEP	annual	Vegetation will be monitored using the Carolina Vegetation Survey (CVS) protocols
Exotic and nuisance vegetation		annual	Locations of exotic and nuisance vegetation will be mapped.
Project boundary		semi-annual	Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped
Photographs		annual	Reference photographs will be made at selected overviews and near-stream locations.

11.0 LONG-TERM MANAGEMENT PLAN

Upon approval for close-out by the Interagency Review Team (IRT) the site will be transferred to the NCDENR Division of Natural Resource Planning and Conservation's Stewardship Program or other IRT-approved stewardship entity. This party shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

The NCDENR Division of Natural Resource Planning and Conservation's Stewardship Program currently houses EEP stewardship endowments within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by North Carolina General Statute GS 113A-232(d) (3). Interest gained by the endowment fund may be used only for the purpose of stewardship, monitoring, stewardship administration, and land transaction costs, if applicable. The NCDENR Stewardship Program intends to manage the account as a non-wasting endowment. Only interest generated from the endowment funds will be used to steward the compensatory mitigation sites. Interest funds not used for those purposes will be re-invested in the Endowment Account to offset losses due to inflation.

12.0 ADAPTIVE MANAGEMENT PLAN

Upon completion of site construction EEP will implement the post-construction monitoring protocols previously defined in this document. Project maintenance will be performed as described previously in this document. If, during the course of annual monitoring it is determined the site's ability to achieve site performance standards are jeopardized, EEP will notify the USACE of the need to develop a Plan of Corrective Action. The Plan of Corrective Action may be prepared using in-house technical staff or may require engineering and consulting services. Once the Corrective Action Plan is prepared and finalized EEP will:

1. Notify the USACE as required by the Nationwide 27 permit general conditions.
2. Revise performance standards, maintenance requirements, and monitoring requirements as necessary and/or required by the USACE.
3. Obtain other permits as necessary.
4. Implement the Corrective Action Plan.
5. Provide the USACE a Record Drawing of Corrective Actions. This document shall depict the extent and nature of the work performed.

13.0 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 North Carolina Department of Environment and Natural Resources has provided the U.S. Army Corps of Engineers Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by EEP. This commitment provides financial assurance for all mitigation projects implemented by the program.

14.0 DEFINITIONS

Belt width – amplitude of a stream meander bend, measured from outside top of bank to top of bank

D_x – with respect to sediment grain size distribution, the grain mean diameter which is larger than x% of the sample distribution

Morphological description – the stream type; stream type is determined by quantifying channel entrenchment, dimension, pattern, profile, and boundary materials; as described in Rosgen, D. (1996), *Applied River Morphology, 2nd edition*

Native vegetation community – a distinct and reoccurring assemblage of populations of plants, animals, bacteria and fungi naturally associated with each other and their population; as described in Schafale, M.P. and Weakley, A. S. (1990), *Classification of the Natural Communities of North Carolina, Third Approximation*

Project Area - includes all protected lands associated with the mitigation project

Priority Levels of Restoration – 1: convert incised stream to new stream at original floodplain elevation; 2: establish new stream and floodplain at existing stream elevation; 3: convert incised stream to new stream type without establishing an active floodplain but providing flood-prone area; 4: stabilize incised stream in place.

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APPENDIX A

SITE PROTECTION INSTRUMENTS

APPENDIX B

BASELINE INFORMATION

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Hogan Cr- Wetland #1 City/County: Surry Sampling Date: 3.21.11
Applicant/Owner: EEP State: NC Sampling Point: WL #1
Investigator(s): R. Newton, C. Riddle Section, Township, Range: ____
Landform (hillslope, terrace, etc.): toe of slope Local relief (concave, convex, none): concave Slope (%): 0-2
Subregion (LRR or MLRA): MLRA 136 Lat: 36.322698 Long: 80.602681 Datum: NAD83
Soil Map Unit Name: CSA- Colvard & Suches NWI classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ____
Hydric Soil Present? Yes X No ____
Wetland Hydrology Present? Yes X No ____

Is the Sampled Area within a Wetland? **Yes** ____ **No** ____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

X Surface Water (A1)
___ High Water Table (A2)
X Saturation (A3)
X Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
X Water-Stained Leaves (B9)
___ Aquatic Fauna (B13)

___ True Aquatic Plants (B14)
X Hydrogen Sulfide Odor (C1)
X Oxidized Rhizospheres on Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
X Drainage Patterns (B10)
X Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ Microtopographic Relief (D4)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes X No ____ Depth (inches): 0-8
Water Table Present? Yes X No ____ Depth (inches): 0-2
Saturation Present? (includes capillary fringe) Yes X No ____ Depth (inches): 0

Wetland Hydrology Present? Yes X **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

majority of area is ponded.

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WL#1

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1. Salix nigra	10	Y	OBL
2. Liriodendron tulipifera	10	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	20		

Sapling/Shrub Stratum (Plot size: ______)			
1. Hamamelis virginiana	5	N	FACU
2. Betula nigra	10	Y	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	15		

Herb Stratum (Plot size: ______)			
1. Impatiens capensis	30	Y	FACW
2. Juncus effusus	10	N	FACW
3. Carex spp	10	N	FACW
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
= Total Cover	50		

Woody Vine Stratum (Plot size: ______)			
1. Rosa multiflora	5	N	UPL
2. Pueraria spp.	10	Y	NS
3.			
4.			
5.			
6.			
= Total Cover	15		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 80 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ______

Remarks: (Include photo numbers here or on a separate sheet.)

No plots were used to evaluate vegetation.
A meandering survey of the entire wetland area was conducted.

SOIL

Sampling Point: WL#1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features				Texture	Remarks
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-6	10YR4/1	99	10YR3/3	1	RM	PL	loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- _X_ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes _X_ No ____

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Hogan Cr- Wetland #2 City/County: Surry Sampling Date: 3.21.11

Applicant/Owner: EEP State: NC Sampling Point: WL#2

Investigator(s): R. Newton, C Riddle Section, Township, Range: ______

Landform (hillslope, terrace, etc.): toe of slope Local relief (concave, convex, none): concave Slope (%): 0-2

Subregion (LRR or MLRA): MLRA 136 Lat: 36.324129 Long: -80.604857 Datum: NAD83

Soil Map Unit Name: CSA - Colvard & Suches NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes _X_ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes _X_ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes _X_ No ___

Hydric Soil Present? Yes _X_ No ___

Wetland Hydrology Present? Yes _X_ No ___

Is the Sampled Area within a Wetland? Yes ___ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- _X_ Surface Water (A1)
- ___ High Water Table (A2)
- _X_ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- _X_ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- _X_ Hydrogen Sulfide Odor (C1)
- _X_ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- _X_ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _X_ No ___ Depth (inches): 0-1

Water Table Present? Yes ___ No _X_ Depth (inches): >12

Saturation Present? (includes capillary fringe) Yes _X_ No ___ Depth (inches): 0

Wetland Hydrology Present? Yes _X_ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WL#2

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1. Liriodendron tulipifera	30	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	30 = Total Cover		

Sapling/Shrub Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1. Hamamelis virginiana	5	Y	FACU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	5 = Total Cover		

Herb Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1. Impatiens capensis	1	Y	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	1 = Total Cover		

Woody Vine Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
	______ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ______

Remarks: (Include photo numbers here or on a separate sheet.)

No plots were used to evaluate vegetation.
A meandering survey of the entire wetland area was conducted.

SOIL

Sampling Point: WL#2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-5	10YR2/1	99	10YR4/6	1	RM	PL	loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ 2 cm Muck (A10) (**LRR N**)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1) (**LRR N, MLRA 147, 148**)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7)
___ Polyvalue Below Surface (S8) (**MLRA 147, 148**)
___ Thin Dark Surface (S9) (**MLRA 147, 148**)
___ Loamy Gleyed Matrix (F2)
X Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Iron-Manganese Masses (F12) (**LRR N, MLRA 136**)
___ Umbric Surface (F13) (**MLRA 136, 122**)
___ Piedmont Floodplain Soils (F19) (**MLRA 148**)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) (**MLRA 147**)
___ Coast Prairie Redox (A16) (**MLRA 147, 148**)
___ Piedmont Floodplain Soils (F19) (**MLRA 136, 147**)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X No ___

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Hogan Cr. - Wetland #3 City/County: Surry Sampling Date: 3.21.11

Applicant/Owner: EEP State: NC Sampling Point: WL#3

Investigator(s): R. Newton C. Riddle Section, Township, Range: ______

Landform (hillslope, terrace, etc.): depressional surface Local relief (concave, convex, none): Concave Slope (%): 0-2

Subregion (LRR or MLRA): MLRA 136 Lat: 36.323723 Long: -80.608172 Datum: NAD83

Soil Map Unit Name: FSE - Fairview - Scott Knob Complex NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ___

Hydric Soil Present? Yes X No ___

Wetland Hydrology Present? Yes X No ___

Is the Sampled Area within a Wetland? Yes X No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

X Surface Water (A1)
X High Water Table (A2)
X Saturation (A3)
X Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
X Water-Stained Leaves (B9)
___ Aquatic Fauna (B13)

___ True Aquatic Plants (B14)
___ Hydrogen Sulfide Odor (C1)
X Oxidized Rhizospheres on Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ Microtopographic Relief (D4)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes X No ___ Depth (inches): 0-1

Water Table Present? Yes X No ___ Depth (inches): 0-2

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): 0

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WL#3

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1. Liriodendron tulipifera	5	Y	FAC
2. Acer rubrum	10	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
	15	= Total Cover	

Sapling/Shrub Stratum (Plot size: ____)			
1. Hamamelis virginiana	50	Y	FACU
2. Ligustrum sinense	2	N	FAC
3. Sambucus canadensis	2	N	FACW-
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	52	= Total Cover	

Herb Stratum (Plot size: ____)			
1. Impatiens capensis	5	Y	FACW
2. Polystichum acrostichoides	5	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	10	= Total Cover	

Woody Vine Stratum (Plot size: ____)			
1. Lonicera japonica	5	Y	FAC
2.			
3.			
4.			
5.			
6.			
	5	= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 83% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ____

Remarks: (Include photo numbers here or on a separate sheet.)

No plots were used to evaluate vegetation. A meandering survey of the entire wetland area was conducted.

SOIL

Sampling Point: WL#3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR4/1	90	10YR3/6	10	RM	PL	loam	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10) **(LRR N)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7)
- ☐ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ☐ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ☐ Umbric Surface (F13) **(MLRA 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10) **(MLRA 147)**
- ☐ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X No ___

Remarks:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: ~~33~~ 34 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 21)	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 = 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 = ~~6~~ 7)				
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: caddisflies (multiple kinds)

* Main stem, downstream of road crossing near confluence with UT3.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site- Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 36.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 22.5)	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 = 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 = 8)				
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: caddisflies (multiple kinds)

* Main stem, middle of reach, upstream of kudzu.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 37.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 24)	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 = 6.5)				
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 = 7)				
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: Caddisflies (multiple kinds)

* Main stem, upstream end of reach, near property line.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 295 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *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 = 5.5)				
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 = 7)				
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: caddisflies (multiple kinds) - case builders

* UT1

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 19 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral [✓ Intermittent] Perennial**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 11.5)	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 = 2.5)				
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: UT1a

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 31 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 19)	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 = 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 = 7)				
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: caddisflies (multiple kinds)

* UT1b

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site- Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 29.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 16)

	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 = 5.5)

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 = 8)

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: Caddisflies (multiple kinds) - case builders
* UT2, downstream reach near bridge

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 31.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 19.5)	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 = 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 = 6)				
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: many frogs

* UT2, upstream of confluences with other streams.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 31 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 17.5)	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 = 5.5)				
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 = 8)				
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: caddisflies, mayflies, snails

* UT2a

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 28.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral [✓ Intermittent] Perennial**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 17)	**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 = 6.5)

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: UT26

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 22.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral [✓ Intermittent] Perennial**	**Other** Siloam Quad *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 = 2.5)				
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 = 5.5)				
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: UT2C.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 31.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name:*

A. Geomorphology (Subtotal = 20)	**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 = 4)

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 = 7.5)

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: caddis flies

* downstream reach of UT3

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 30 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent [✓ Perennial]**	**Other** Siloam Quad *e.g. Quad Name***:**

A. Geomorphology (Subtotal = 19.5)	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 = 4.5)				
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 = 6)				
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: caddisflies

* upstream reach of UT3

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 03.21.2011	**Project/Site:** EEP Site - Hogan Creek	**Latitude:**
Evaluator: Rebekah Newton	**County:** Surry	**Longitude:**
Total Points: 25 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral [✓ Intermittent] Perennial**	**Other** Siloam Quad *e.g. Quad Name*:

A. Geomorphology (Subtotal = 13)	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 = 7)				
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: * UT4, approximately half way between confluence & property line.

Sketch:

Appendix A

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:	Hogan Creek Mitigation Project
County Name:	Surry
EEP Number:	94708
Project Sponsor:	Ecosystem Enhancement Program
Project Contact Name:	Julie Cahill
Project Contact Address:	5 Ravenscroft Drive, Asheville, NC 28801
Project Contact E-mail:	julie.cahill@ncdenr.gov
EEP Project Manager:	Julie Cahill

Project Description

For Official Use Only

Reviewed By:

Date | **EEP Project Manager**

Conditional Approved By:

Date | **For Division Administrator FHWA**

☐ **Check this box if there are outstanding issues**

Final Approval By:

9-30-11

Date | **For Division Administrator FHWA**

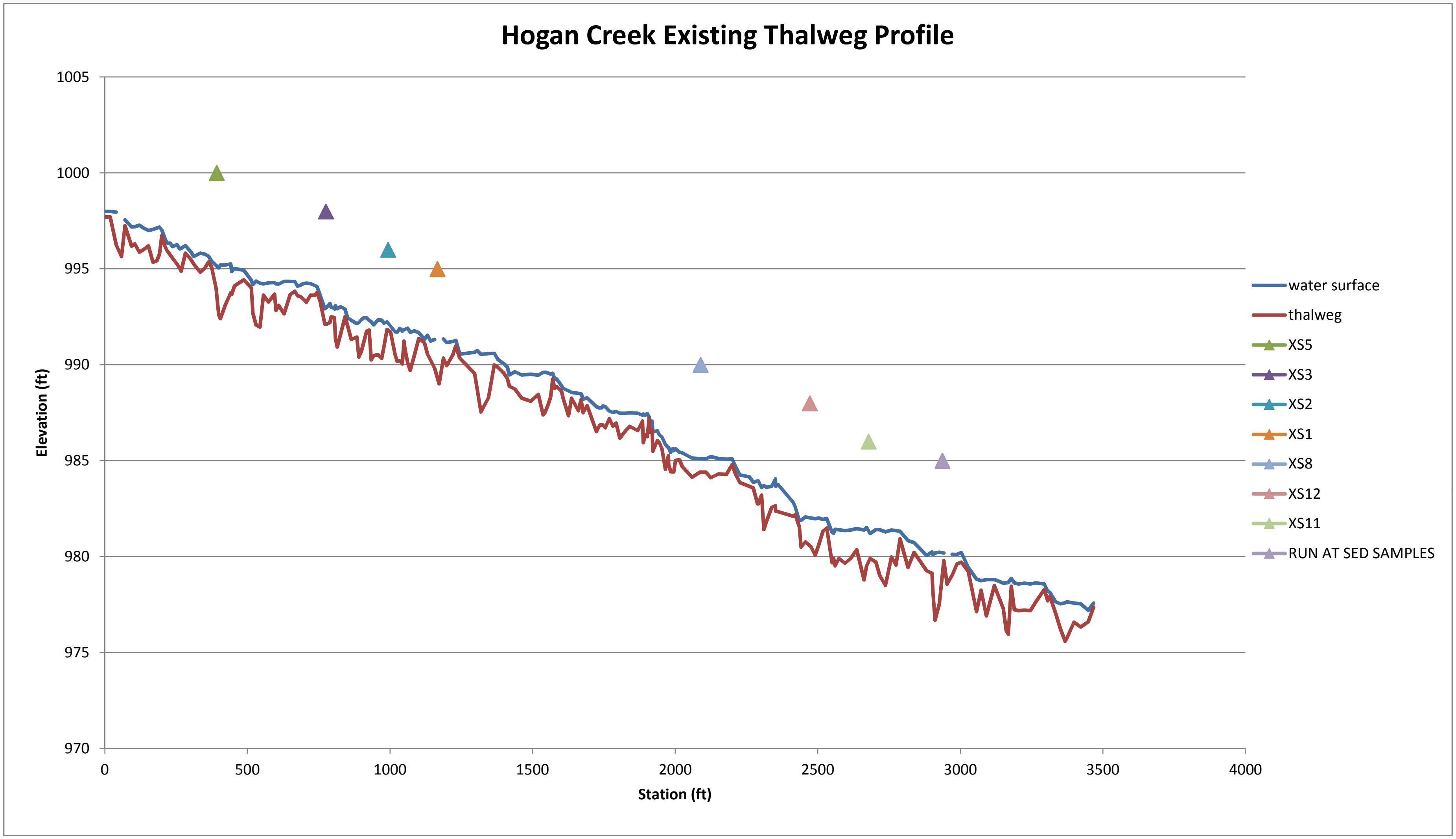
APPENDIX C

MITIGATION WORK PLAN DATA AND ANALYSIS

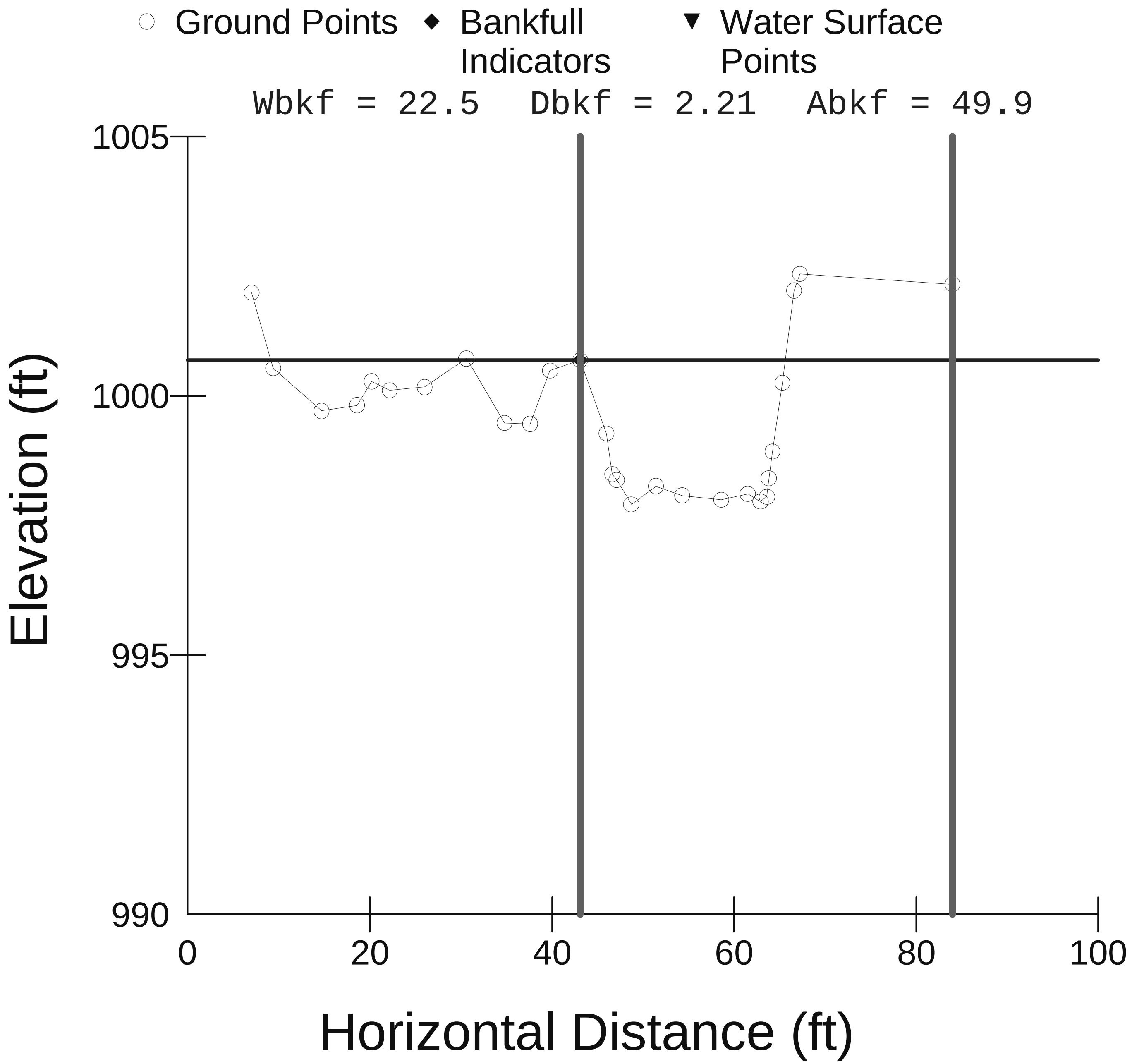
Existing Conditions Data

Existing, Design and Reference Morphology Parameters

Parameter	Existing Stream			Design Stream			Reference Stream		
	Min	Median	Max	Min	Median	Max	Min	Median	Max
Stream name	Hogan Creek			Hogan Creek			Mill Branch		
Stream type	C4			C4			C4		
Drainage area, DA (sq mi)	2.37			2.37			5		
Mean riffle depth, d_{bkf} (ft)	2.1	1.9	2.0	1.8	1.9	2.0	1.9	2.0	2.2
Riffle width, W_{bkf} (ft)	21.5	25.7	29.7	22.5	23.3	24.0	27.2	30.4	33.6
Width-to-depth ratio, $[W_{bkf}/d_{bkf}]$	10.3	13.6	14.9	12.5	12.3	12.1	14.5	15.0	15.6
Riffle cross-section area, A_{bkf} (sq ft)	45.1	48.6	59.3	40.6	44.1	47.6	50.8	61.6	72.4
Max riffle depth, d_{mbkf} (ft)	2.5	2.7	3.2	2.5	2.6	2.8	2.4	2.5	2.7
Max riffle depth ratio, $[d_{mbkf}/d_{bkf}]$	1.2	1.4	1.6	1.4	1.4	1.4	1.3	1.4	1.4
Mean pool depth, d_{bkfp} (ft)	2.2	2.5	2.9	2.6	2.6	2.6	2.3	2.4	2.6
Mean pool depth ratio, $[d_{bkfp}/d_{bkf}]$	1.0	1.3	3.0	1.4	1.4	3.0	1.2	1.3	1.4
Pool width, W_{bkfp} (ft)	28.1	31.4	34.8	34.0	35.0	36.0	20.1	22.3	24.4
Pool width ratio, $[W_{bkfp}/W_{bkf}]$	1.3	1.2	1.2	1.5	1.5	1.5	0.7	0.8	0.9
Pool cross-section area, A_{bkfp} (sq ft)	61.4	80.6	99.8	92.0	92.0	92.0	51.5	53.4	55.4
Pool area ratio, $[A_{bkfp}/A_{bkf}]$	1.4	1.7	1.7	2.3	2.1	1.9	1.0	1.1	1.1
Max pool depth, d_{mbkfp} (ft)	4.0	4.3	4.7	4.0	4.0	4.0	3.4	3.5	3.5
Max pool depth ratio, $[d_{mbkfp}/d_{bkf}]$	1.9	2.3	2.3	2.2	2.1	2.0	1.8	1.8	1.9
Low bank height, LBH (ft)	3.14	3.4	4.6	2.5	2.7	2.8	2.4	2.5	2.56
Low bank height ratio, $[LBH/d_{mbkf}]$	1.3	1.3	1.4	1.0	1.0	1.0	1.0	1.0	1.1
Width flood-prone area, W_{fpa} (ft)	178	220	246	100	150	200	72.1	72.3	72.5
Entrenchment ratio, ER $[W_{fpa}/W_{bkf}]$	8.3	8.6	8.3	4.4	6.5	8.3	2.7	2.7	2.7
Meander length, L_m (ft)	133	297	479	133	311	325	81	81	81
Meander length ratio $[L_m/W_{bkf}]$	6.2	11.6	16.1	5.9	13.4	13.5	3.0	3.0	3.0
Radius of curvature, Rc (ft)	20	29	52	67	73	101	19.6	22.7	25.8
Radius of curvature ratio $[Rc/W_{bkf}]$	0.9	1.1	1.8	3.0	3.1	4.2	0.7	0.8	0.9
Belt width, W_{blt} (ft)	44	65	117	48	88	126	86	86	86
Meander width ratio $[W_{blt}/W_{bkf}]$	2.0	2.5	3.9	2.1	3.8	5.3	3.2	3.2	3.2
Valley length, VL (ft)	2525			2525			4730		
Stream centerline length, SL (ft)	2762			2897			327		
Valley Elevation Change, VE (ft)	18			18			60		
Stream Elevation Change, SE (ft)	17.56			17.96			3.29		
Valley slope, VS (ft/ft)	0.0071			0.0071			0.0127		
Average water surface slope, S (ft/ft)	0.0064			0.0062			0.0101		
Sinuosity, k = VS/S	1.12			1.15			1.26		
Riffle slope, S_{rif} (ft/ft)	0.0100	0.0240	0.0550	0.0067	0.0100	0.0132	0.0194	0.0201	0.0207
Riffle slope ratio, $[S_{rif}/S]$	1.6	3.8	8.7	1.1	1.6	2.1	1.9	2.0	2.1
Pool slope, S_p (ft/ft)	0.0000	0.0010	0.0070	0.0010	0.0012	0.0013	0.0003	0.0013	0.0022
Pool slope ratio, $[S_p/S]$	0.0	0.2	1.1	0.2	0.2	0.2	0.0	0.2	0.3
D_{50} riffle (mm)	30			30			40		
D_{50} bar (mm)	28			28			20		
D_{100} bar (mm)	116			116			94		

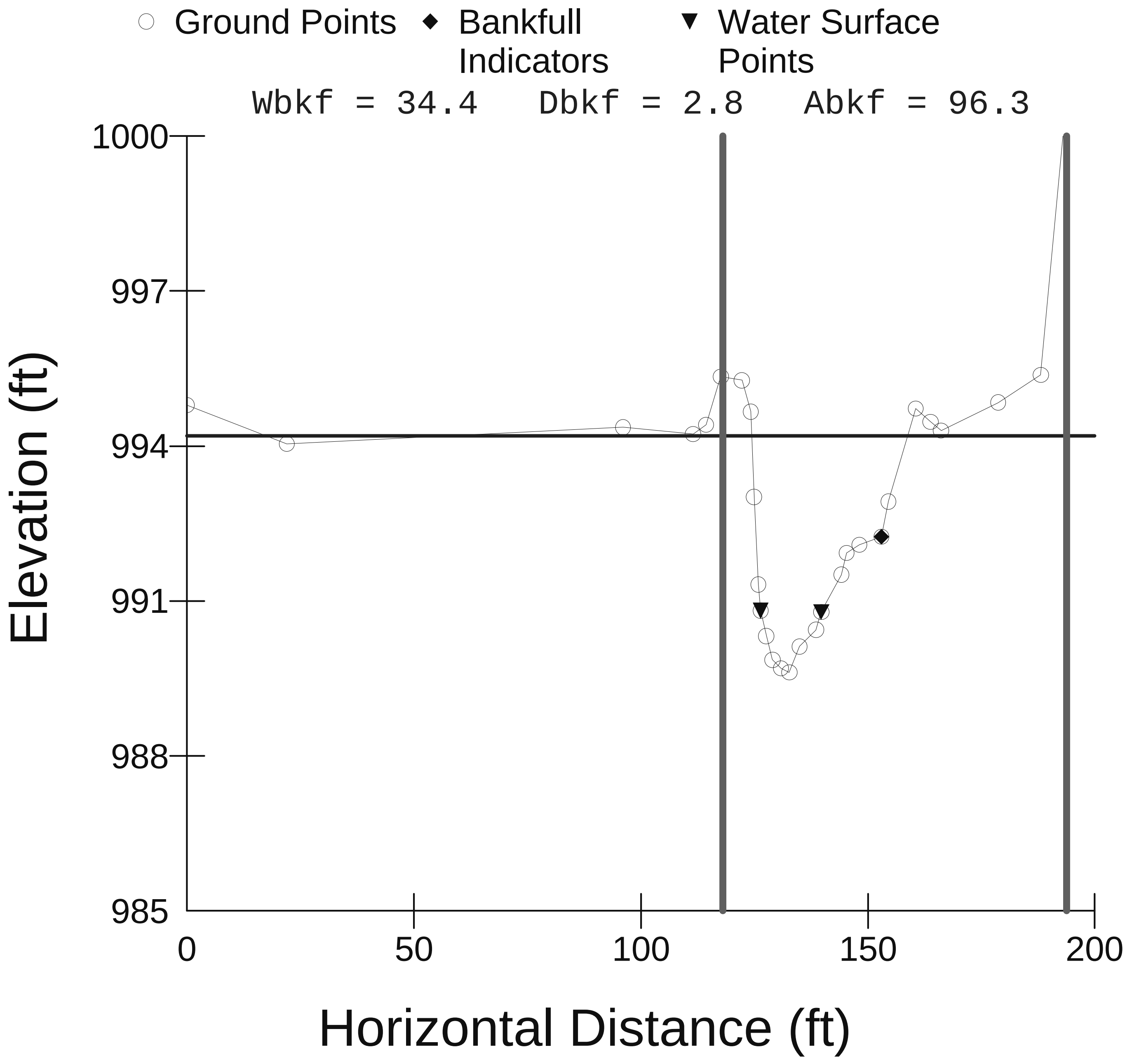

Hogan Creek Existing Thalweg Profile
Elevation (ft)
1005
1000
995
990
985
980
975
970
Station (ft)
0
500
1000
1500
2000
2500
3000
3500
4000
water surface
thalweg
XS5
XS3
XS2
XS1
XS8
XS12
XS11
RUN AT SED SAMPLES

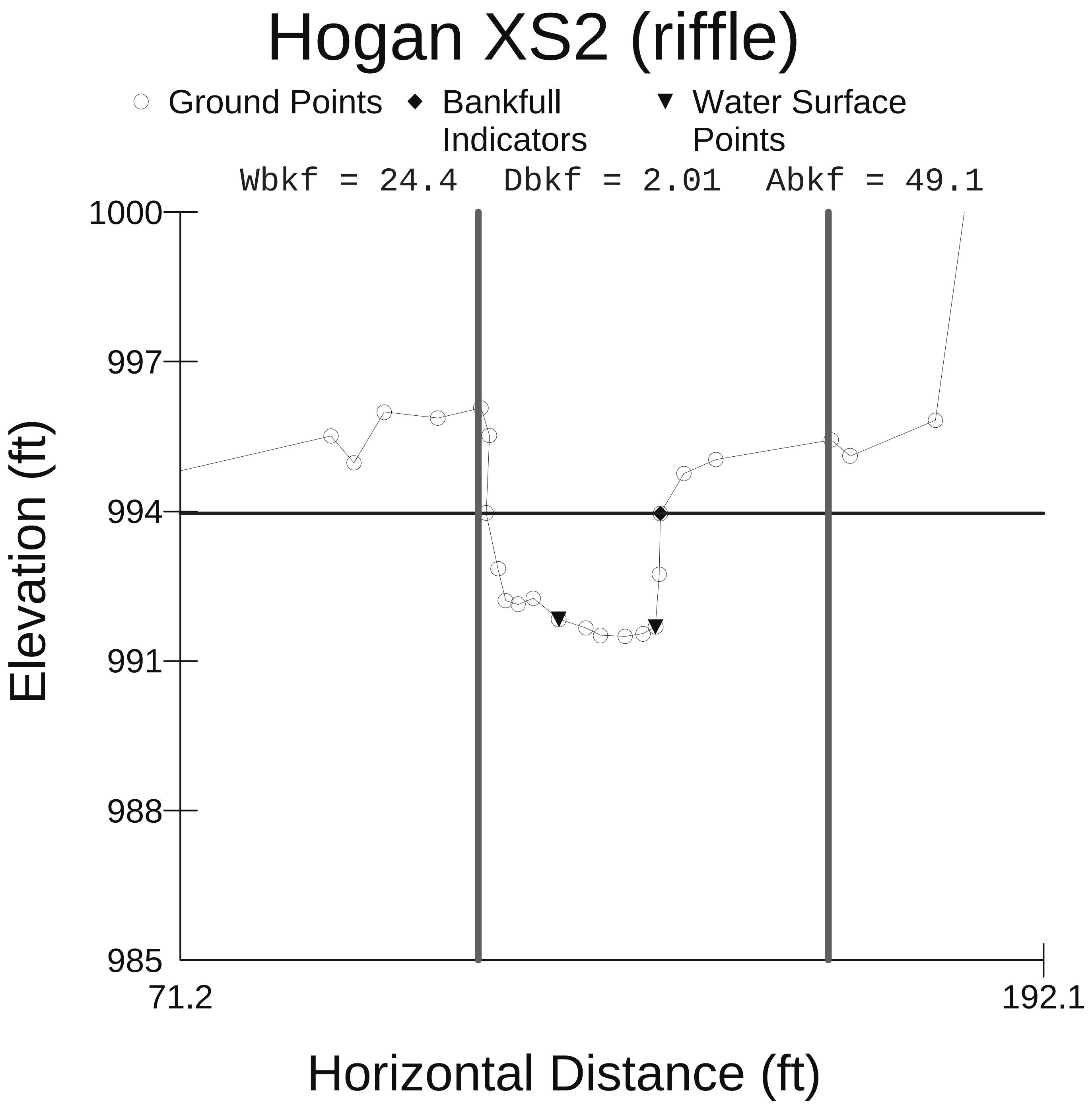
Hogan Supply Riffle

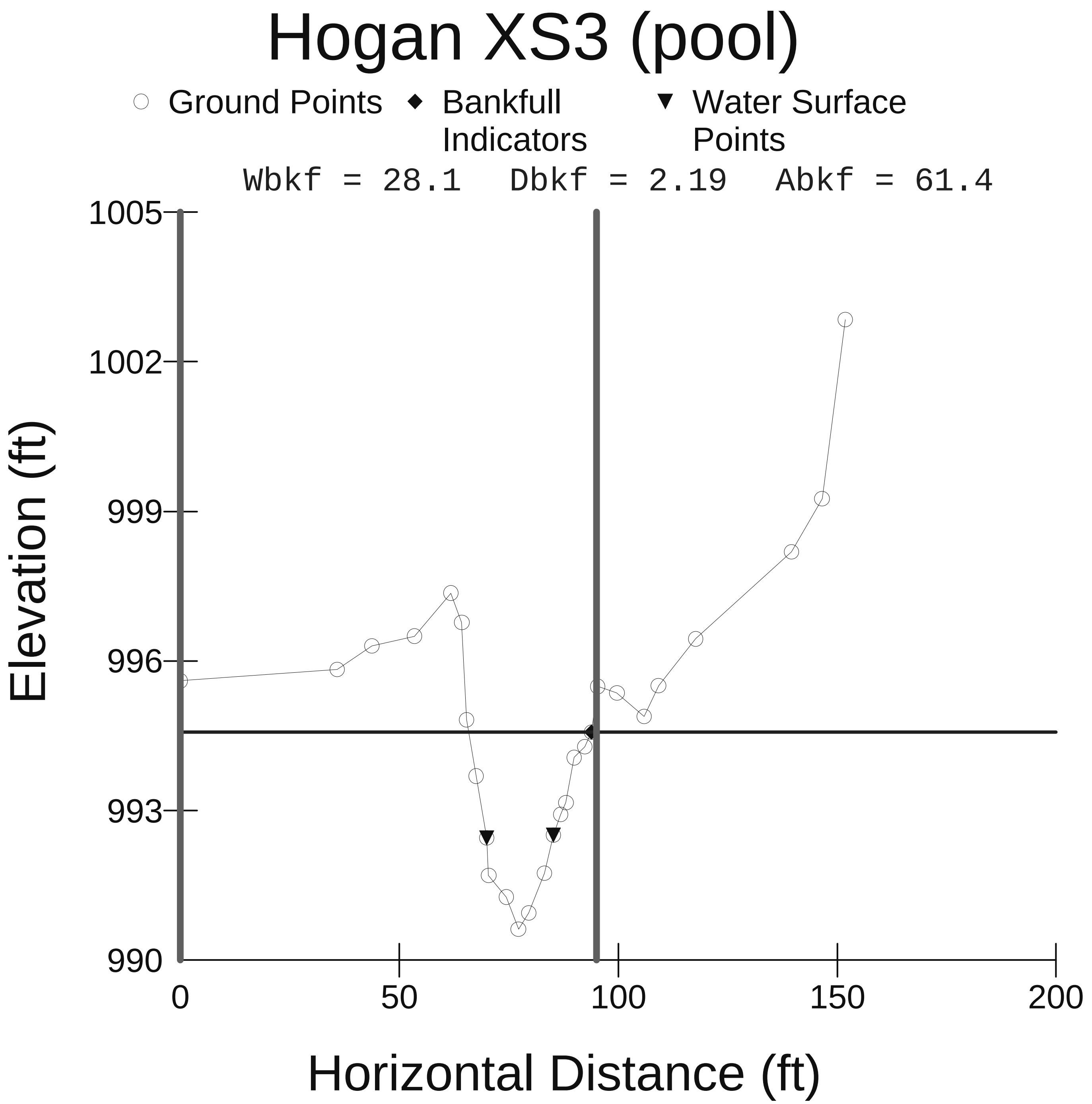


Wbkf = 22.5 Dbkf = 2.21 Abkf = 49.9

Hogan XS1 (pool)



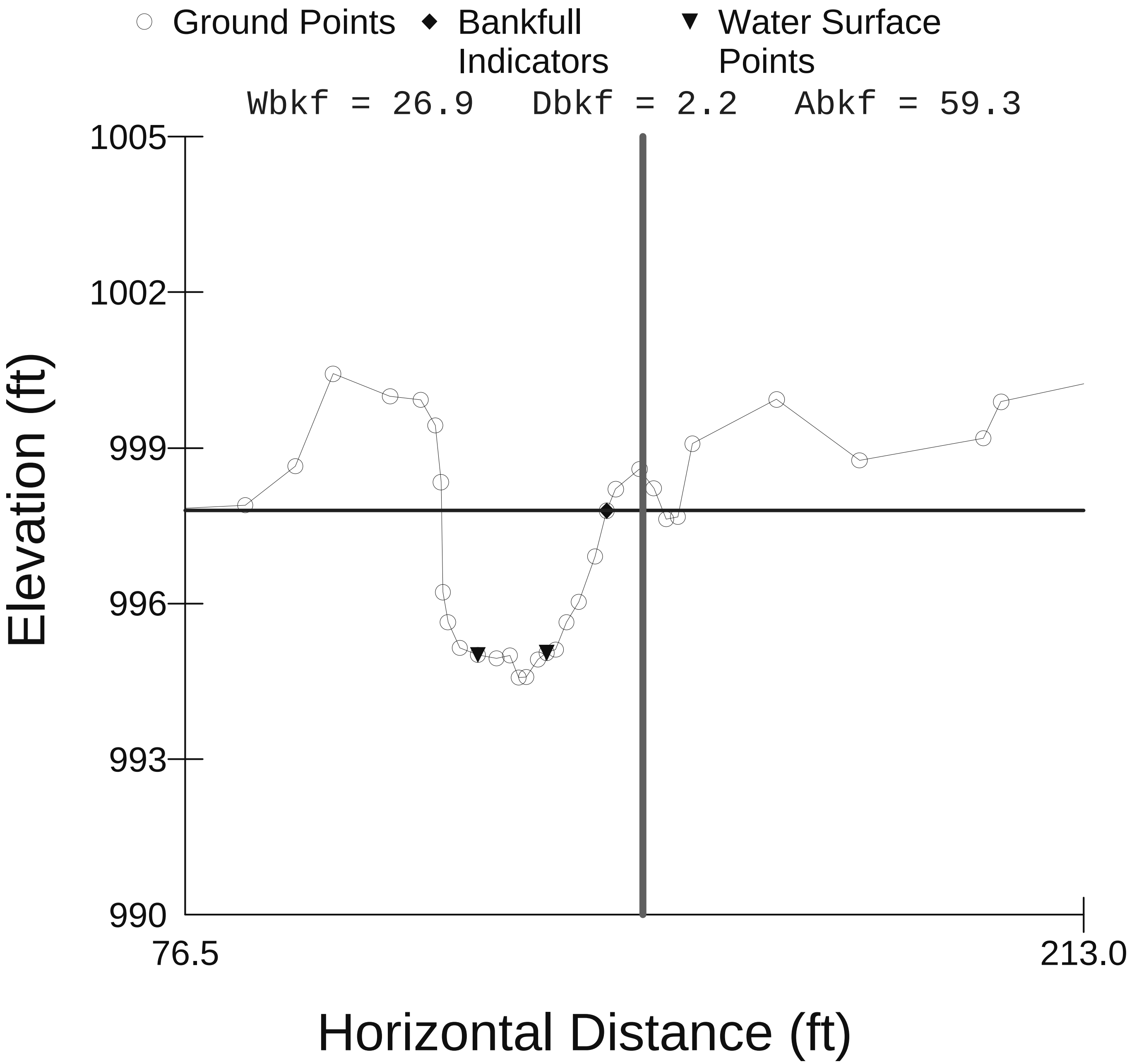

Hogan XS2 (riffle)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 24.4 Dbkf = 2.01 Abkf = 49.1
1000
997
994
991
988
985
71.2
192.1
Elevation (ft)
Horizontal Distance (ft)

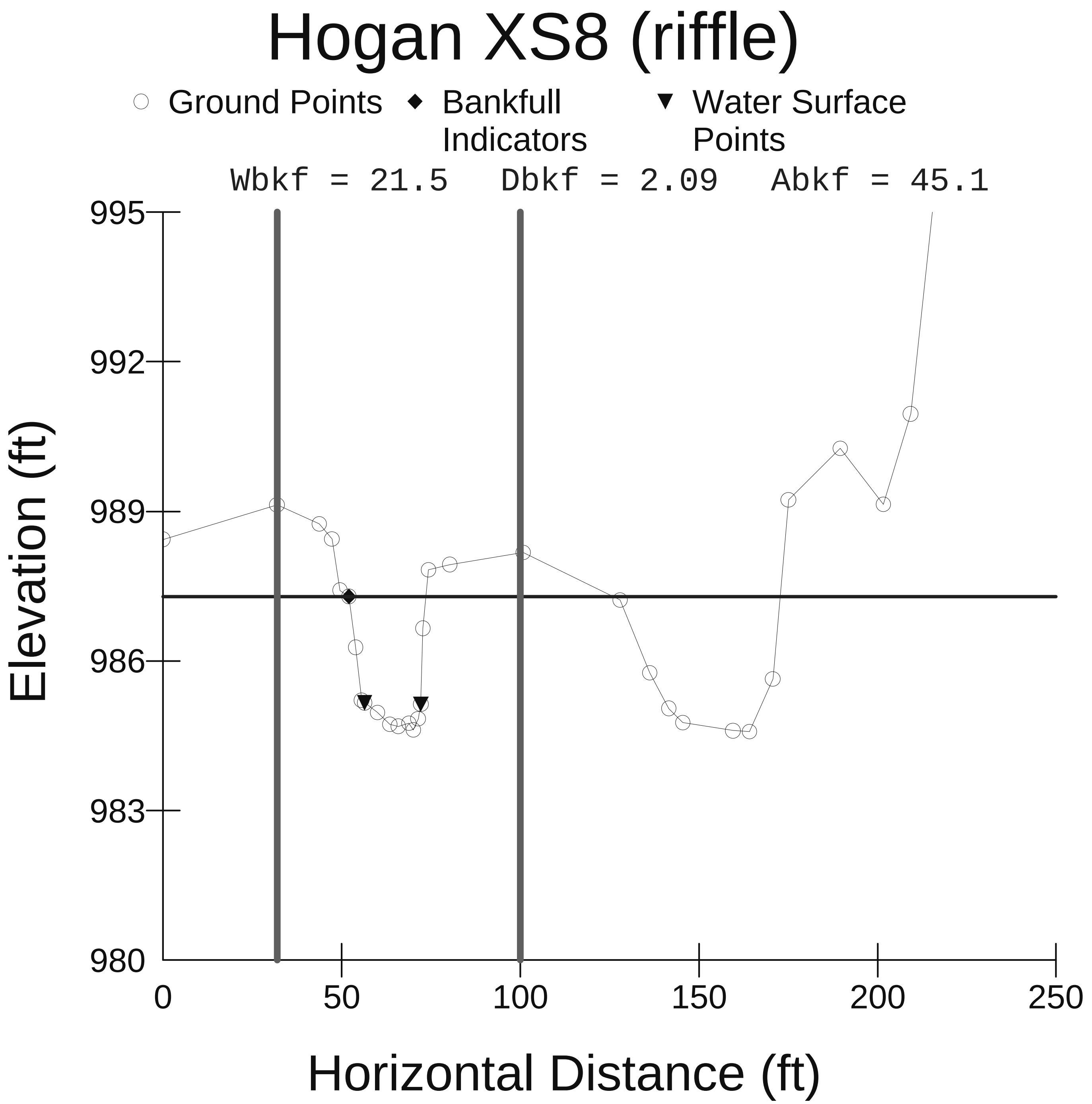


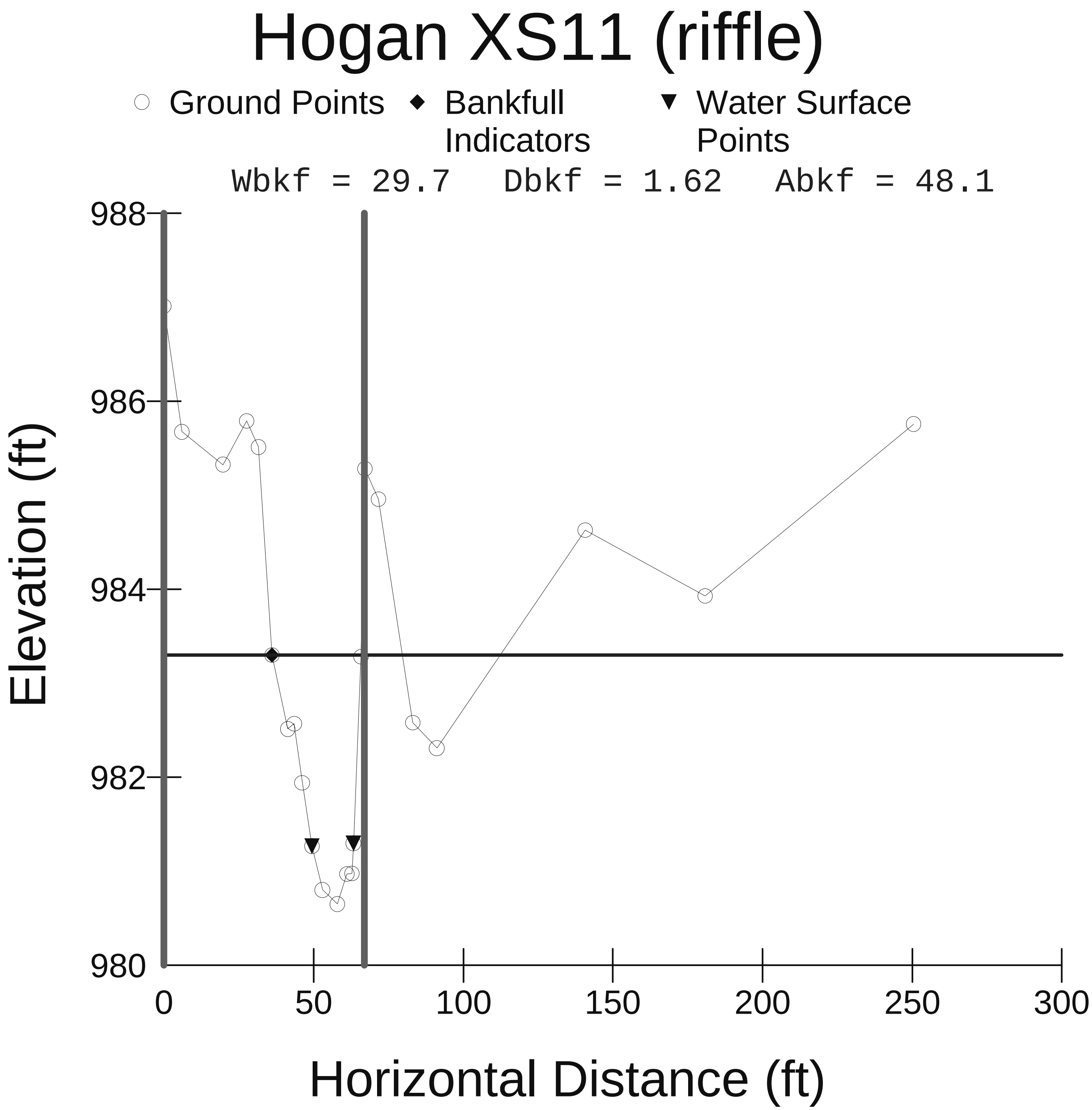
Hogan XS3 (pool)

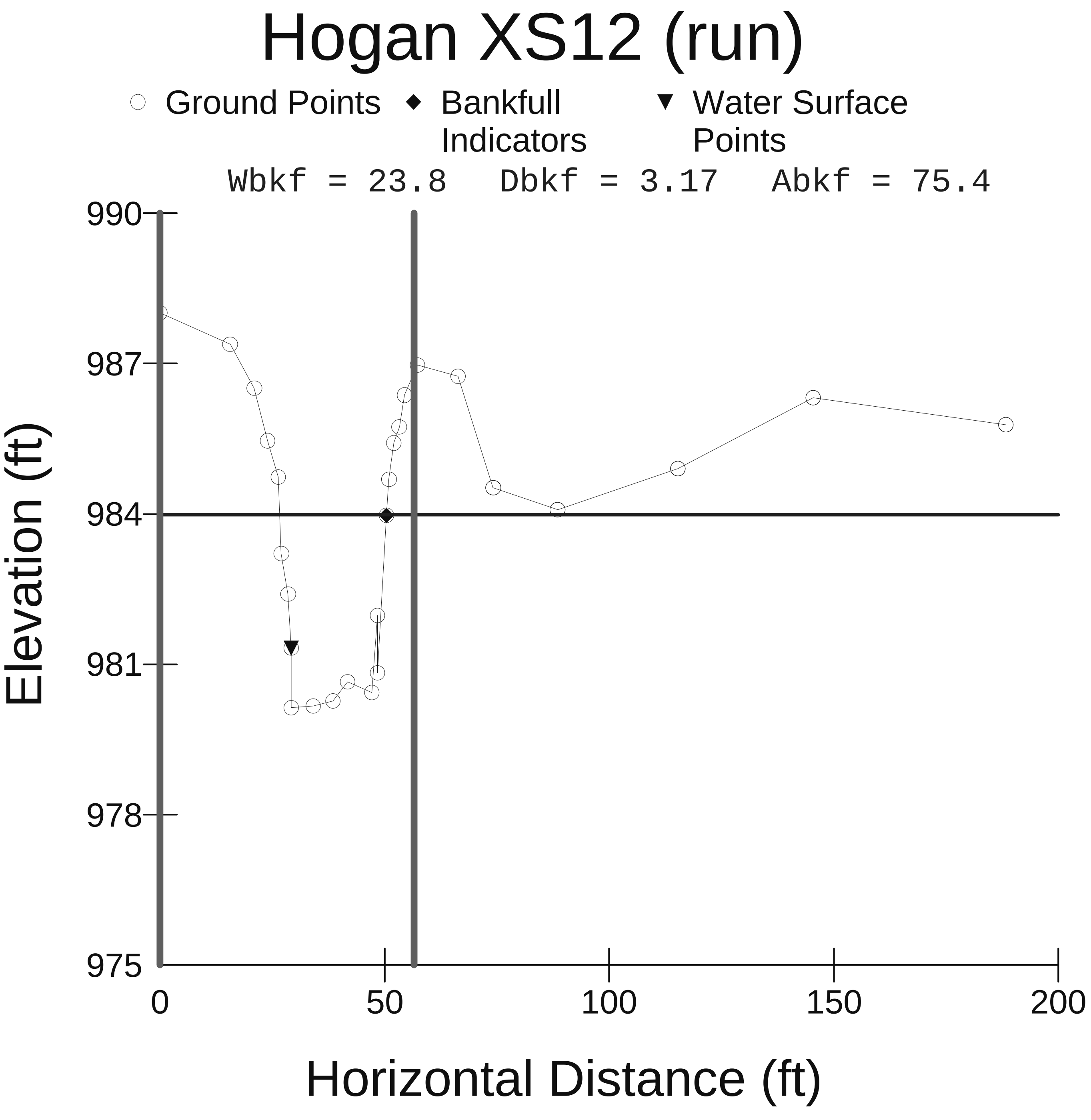
Wbkf = 28.1 Dbkf = 2.19 Abkf = 61.4

Hogan XS5 (riffle)

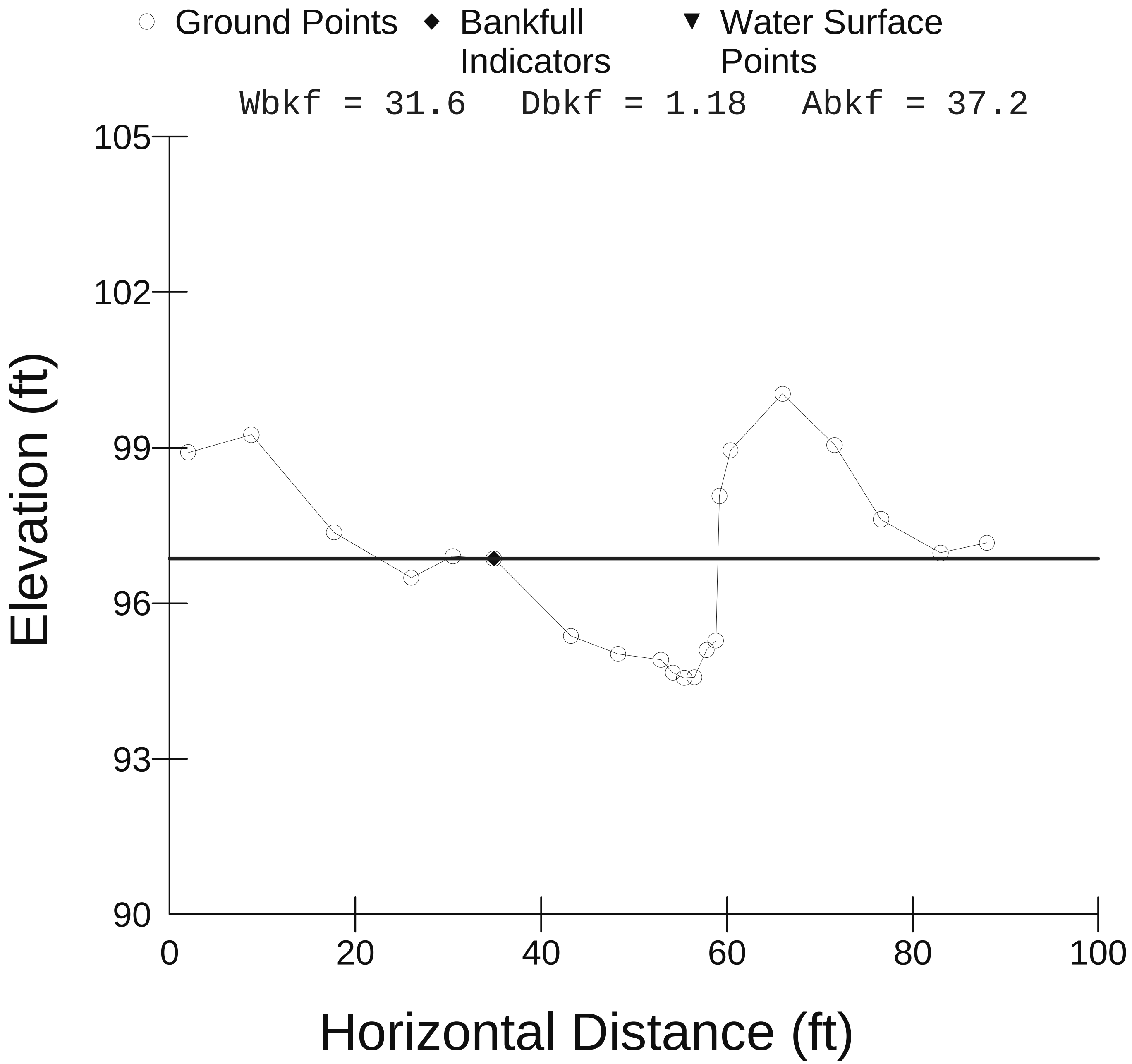



Hogan XS8 (riffle)
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 21.5
Dbkf = 2.09
Abkf = 45.1
Elevation (ft)
995
992
989
986
983
980
0
50
100
150
200
250
Horizontal Distance (ft)


Hogan XS11 (riffle)
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 29.7
Dbkf = 1.62
Abkf = 48.1
Elevation (ft)
988
986
984
982
980
Horizontal Distance (ft)
0
50
100
150
200
250
300


Hogan XS12 (run)
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 23.8   Dbkf = 3.17   Abkf = 75.4
Elevation (ft)
990
987
984
981
978
975
0
50
100
150
200
Horizontal Distance (ft)

Hogan Run at Sed. Samples



```
                RIVERMORPH PARTICLE SUMMARY

---------------------------------------------------------------------

River Name:        Hogan Creek
Reach Name:         Reach 1
Sample Name:        Hogan Reach 1 Bar
Survey Date:       03/08/2011

---------------------------------------------------------------------

SIEVE (mm)              NET WT
---------------------------------------------------------------------
31.5                     4485.2
16                      2587.3
8                      1532.2
4                      967.3
2                      785.1
PAN                        1229

D16 (mm)                4.39
D35 (mm)                16.59
D50 (mm)                28.44
D84 (mm)                86.68
D95 (mm)                106.84
D100 (mm)                116
Silt/Clay (%)           0
Sand (%)               9.33
Gravel (%)              69.63
Cobble (%)              21.04
Boulder (%)             0
Bedrock (%)              0

Total Weight = 13178.8000.

Largest Surface Particles:
        Size(mm)    Weight
Particle 1:     116     950.9
Particle 2:     111     641.8
```

```
                RIVERMORPH PARTICLE SUMMARY

------------------------------------------------------------------

River Name:        Hogan Creek
Reach Name:        Reach 1
Sample Name:       Hogan Reach 1 pebble, 200' d/s of UT1
Survey Date:       03/08/2011

------------------------------------------------------------------

Size (mm)            TOT #     ITEM %    CUM %
------------------------------------------------------------------
0 - 0.062             0        0.00      0.00
0.062 - 0.125         0        0.00      0.00
0.125 - 0.25          0        0.00      0.00
0.25 - 0.50           2        1.92      1.92
0.50 - 1.0            0        0.00      1.92
1.0 - 2.0             1        0.96      2.88
2.0 - 4.0             1        0.96      3.85
4.0 - 5.7             1        0.96      4.81
5.7 - 8.0             3        2.88      7.69
8.0 - 11.3            4        3.85      11.54
11.3 - 16.0           12       11.54     23.08
16.0 - 22.6           13       12.50     35.58
22.6 - 32.0           19       18.27     53.85
32 - 45               18       17.31     71.15
45 - 64               11       10.58     81.73
64 - 90               4        3.85      85.58
90 - 128              11       10.58     96.15
128 - 180             3        2.88      99.04
180 - 256             1        0.96      100.00
256 - 362             0        0.00      100.00
362 - 512             0        0.00      100.00
512 - 1024            0        0.00      100.00
1024 - 2048           0        0.00      100.00
Bedrock               0        0.00      100.00

D16 (mm)              13.12
D35 (mm)              22.29
D50 (mm)              30.02
D84 (mm)              79.33
D95 (mm)              123.87
D100 (mm)             255.99
Silt/Clay (%)         0
Sand (%)              2.88
Gravel (%)            78.85
Cobble (%)            18.27
Boulder (%)           0
Bedrock (%)           0

Total Particles = 104.
```

```
               RIVERMORPH PARTICLE SUMMARY

-------------------------------------------------------------------

River Name:        Hogan Creek
Reach Name:        Reach 2
Sample Name:       Bar sample by zigzag 2
Survey Date:       04/08/2011

-------------------------------------------------------------------

SIEVE (mm)             NET WT
-------------------------------------------------------------------
31.5                   2592.3
16                     2350.6
8                     1500.3
4                     1031
2                     968.1
PAN                     1303.3

D16 (mm)              2.94
D35 (mm)              10.93
D50 (mm)              20.61
D84 (mm)              89.3
D95 (mm)              122.78
D100 (mm)              138
Silt/Clay (%)          0
Sand (%)              11.85
Gravel (%)            69.96
Cobble (%)            18.2
Boulder (%)            0
Bedrock (%)            0

Total Weight = 11002.9000.

Largest Surface Particles:
          Size(mm)    Weight
Particle 1:     138     676.5
Particle 2:     122     580.8
```

```
                RIVERMORPH PARTICLE SUMMARY

---------------------------------------------------------------------

River Name:        Hogan Creek
Reach Name:        Reach 2
Sample Name:       Zigzag at Riffle
Survey Date:       04/08/2011

---------------------------------------------------------------------

Size (mm)              TOT #    ITEM %    CUM %
---------------------------------------------------------------------
0 - 0.062              0        0.00      0.00
0.062 - 0.125            0        0.00      0.00
0.125 - 0.25                    0.00      0.00
0.25 - 0.50             0        0.00      0.00
0.50 - 1.0             0        0.00      0.00
1.0 - 2.0              1        0.99      0.99
2.0 - 4.0              0        0.00      0.99
4.0 - 5.7              2        1.98      2.97
5.7 - 8.0              1        0.99      3.96
8.0 - 11.3             7        6.93      10.89
11.3 - 16.0             11       10.89     21.78
16.0 - 22.6             15       14.85     36.63
22.6 - 32.0             17       16.83     53.47
32 - 45                13       12.87     66.34
45 - 64                13       12.87     79.21
64 - 90                10       9.90      89.11
90 - 128               9        8.91      98.02
128 - 180               2        1.98      100.00
180 - 256               0        0.00      100.00
256 - 362               0        0.00      100.00
362 - 512               0        0.00      100.00
512 - 1024               0        0.00      100.00
1024 - 2048              0        0.00      100.00
Bedrock                 0        0.00      100.00

D16 (mm)                13.51
D35 (mm)                21.88
D50 (mm)                30.06
D84 (mm)                76.58
D95 (mm)                115.12
D100 (mm)                180
Silt/Clay (%)          0
Sand (%)               0.99
Gravel (%)              78.22
Cobble (%)              20.79
Boulder (%)             0
Bedrock (%)              0

Total Particles = 101.
```

```
                RIVERMORPH PARTICLE SUMMARY

--------------------------------------------------------------------

River Name:        Hogan Creek
Reach Name:        Supply Reach
Sample Name:       Bar sample by zigzag supply riff
Survey Date:       04/08/2011

--------------------------------------------------------------------

SIEVE (mm)              NET WT
--------------------------------------------------------------------
31.5                  1302.6
16                    2581.1
8                     1698.8
4                     1064.9
2                     869
PAN                   1491

D16 (mm)              2.39
D35 (mm)              8.96
D50 (mm)              16.37
D84 (mm)              68.67
D95 (mm)              110.83
D100 (mm)             130
Silt/Clay (%)         0
Sand (%)              14.38
Gravel (%)            72.77
Cobble (%)            12.85
Boulder (%)           0
Bedrock (%)           0

Total Weight = 10369.4000.

Largest Surface Particles:
          Size(mm)    Weight
Particle 1:    130      1012
Particle 2:     90       350
```

```
                RIVERMORPH PARTICLE SUMMARY

-------------------------------------------------------------------

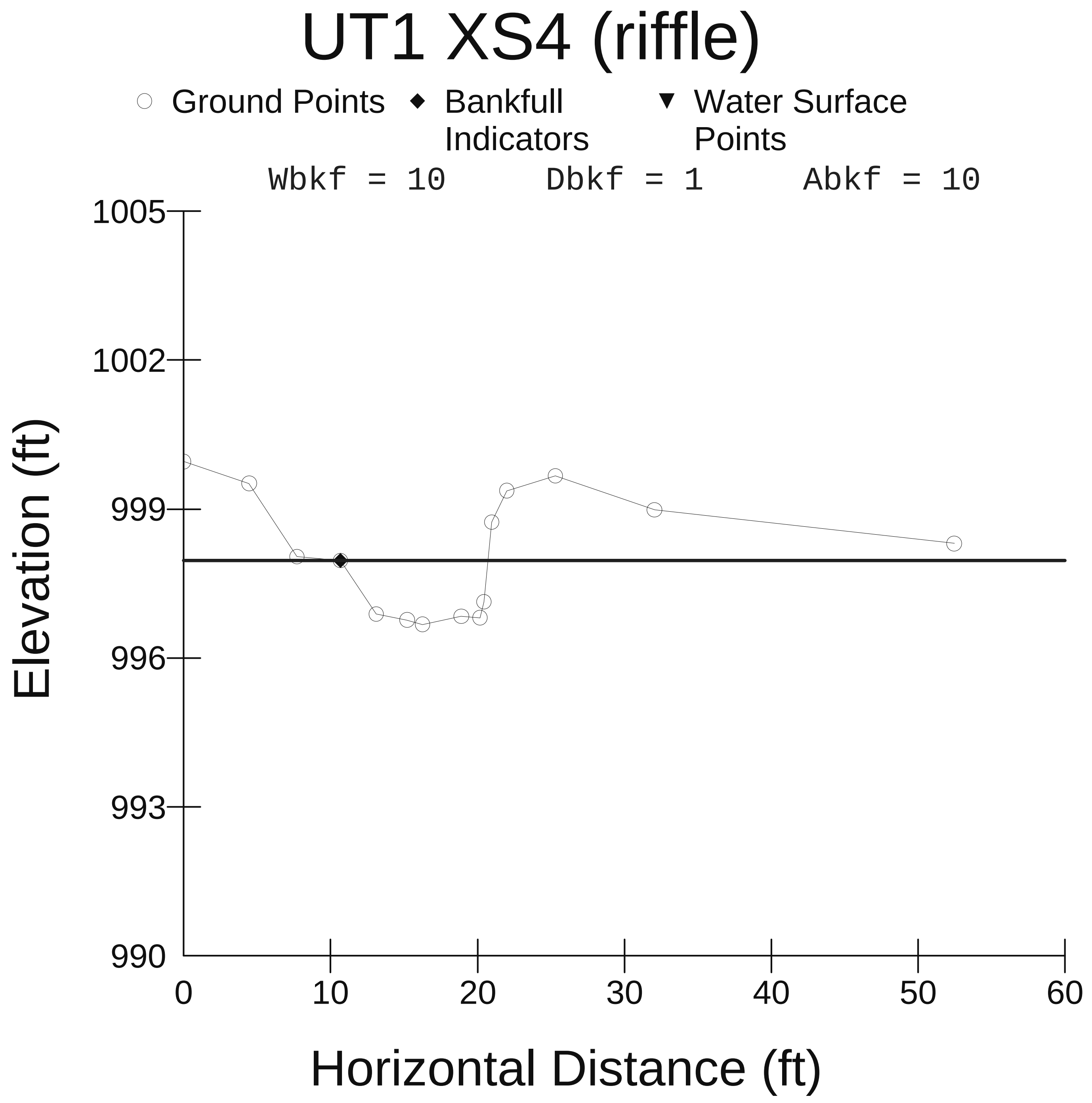
River Name:        Hogan Creek
Reach Name:         Supply Reach
Sample Name:        Zigzag at supply riffle
Survey Date:       04/08/2011

-------------------------------------------------------------------

Size (mm)              TOT #     ITEM %    CUM %
-------------------------------------------------------------------
0 - 0.062             0        0.00      0.00
0.062 - 0.125           0        0.00      0.00
0.125 - 0.25           1        0.97      0.97
0.25 - 0.50           0        0.00      0.97
0.50 - 1.0           0        0.00      0.97
1.0 - 2.0            0        0.00      0.97
2.0 - 4.0            0        0.00      0.97
4.0 - 5.7            3        2.91      3.88
5.7 - 8.0            3        2.91      6.80
8.0 - 11.3            4        3.88      10.68
11.3 - 16.0            12        11.65     22.33
16.0 - 22.6            14        13.59     35.92
22.6 - 32.0            16        15.53     51.46
32 - 45              14        13.59     65.05
45 - 64              19        18.45     83.50
64 - 90              9        8.74      92.23
90 - 128              6        5.83      98.06
128 - 180             2        1.94      100.00
180 - 256             0        0.00      100.00
256 - 362             0        0.00      100.00
362 - 512             0        0.00      100.00
512 - 1024             0        0.00      100.00
1024 - 2048             0        0.00      100.00
Bedrock              0        0.00      100.00

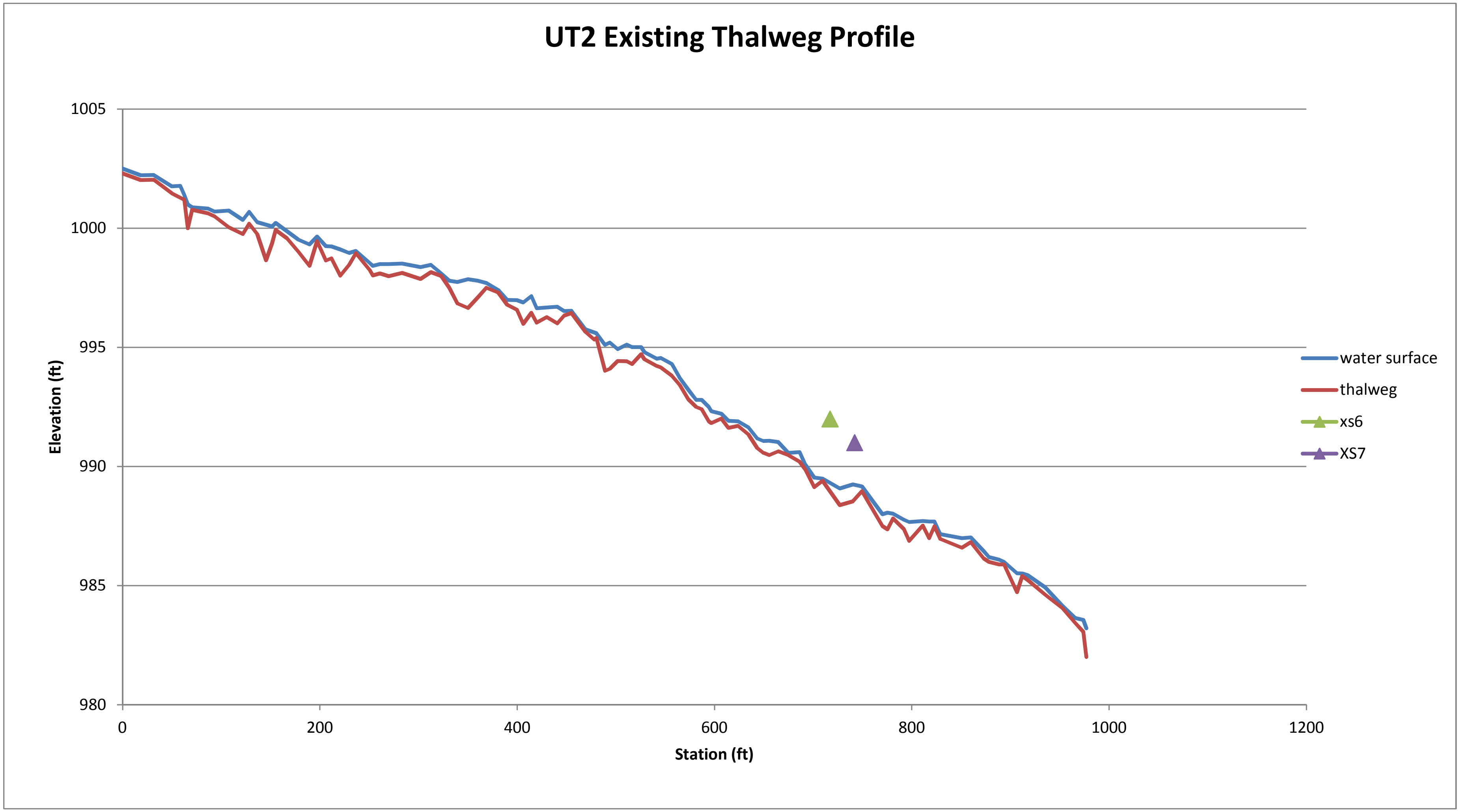
D16 (mm)               13.45
D35 (mm)               22.15
D50 (mm)               31.12
D84 (mm)               65.49
D95 (mm)               108.05
D100 (mm)               180
Silt/Clay (%)           0
Sand (%)              0.97
Gravel (%)             82.53
Cobble (%)             16.5
Boulder (%)             0
Bedrock (%)              0

Total Particles = 103.
```

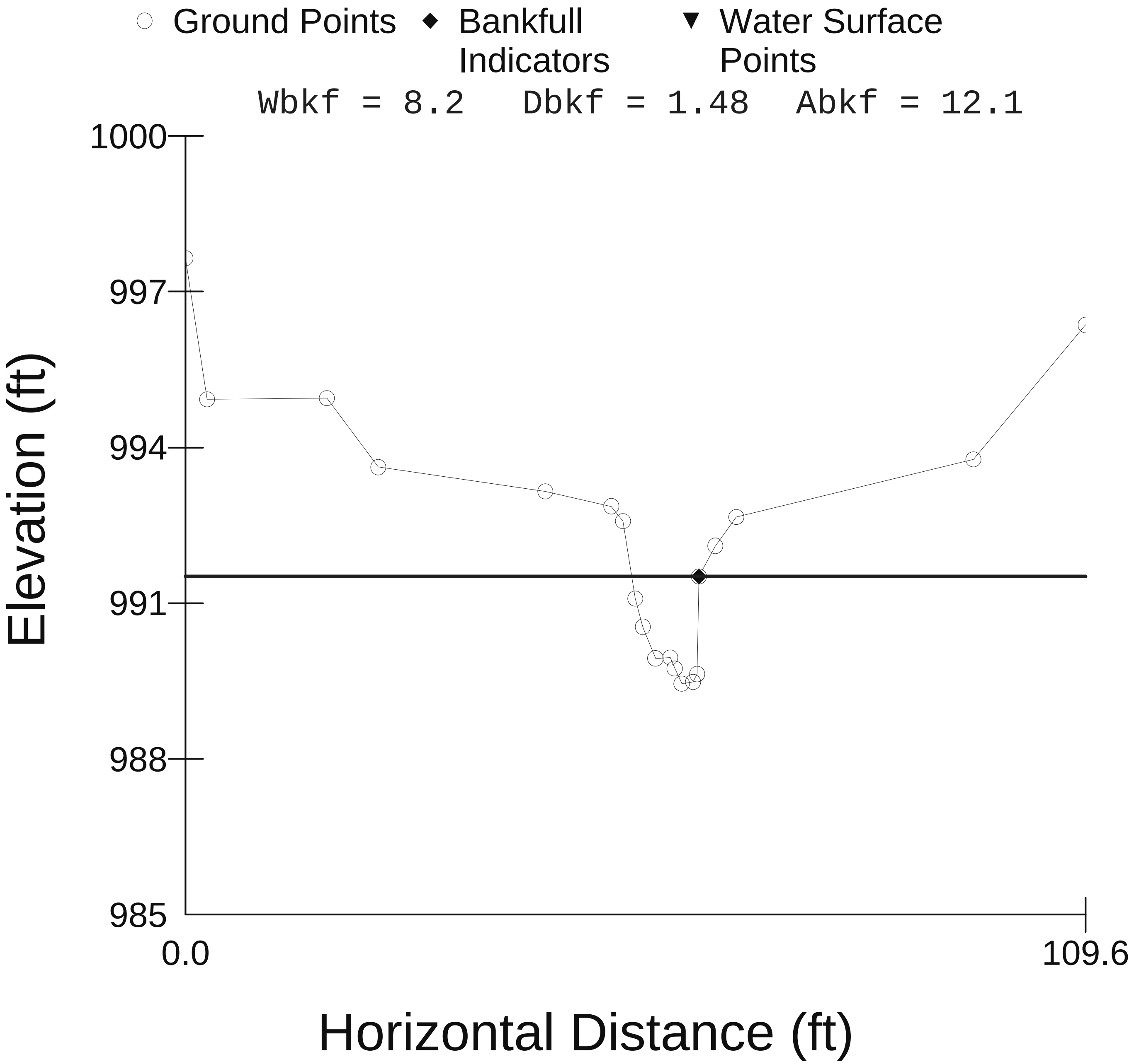

UT1 XS4 (riffle)
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 10
Dbkf = 1
Abkf = 10
Elevation (ft)
1005
1002
999
996
993
990
0
10
20
30
40
50
60
Horizontal Distance (ft)

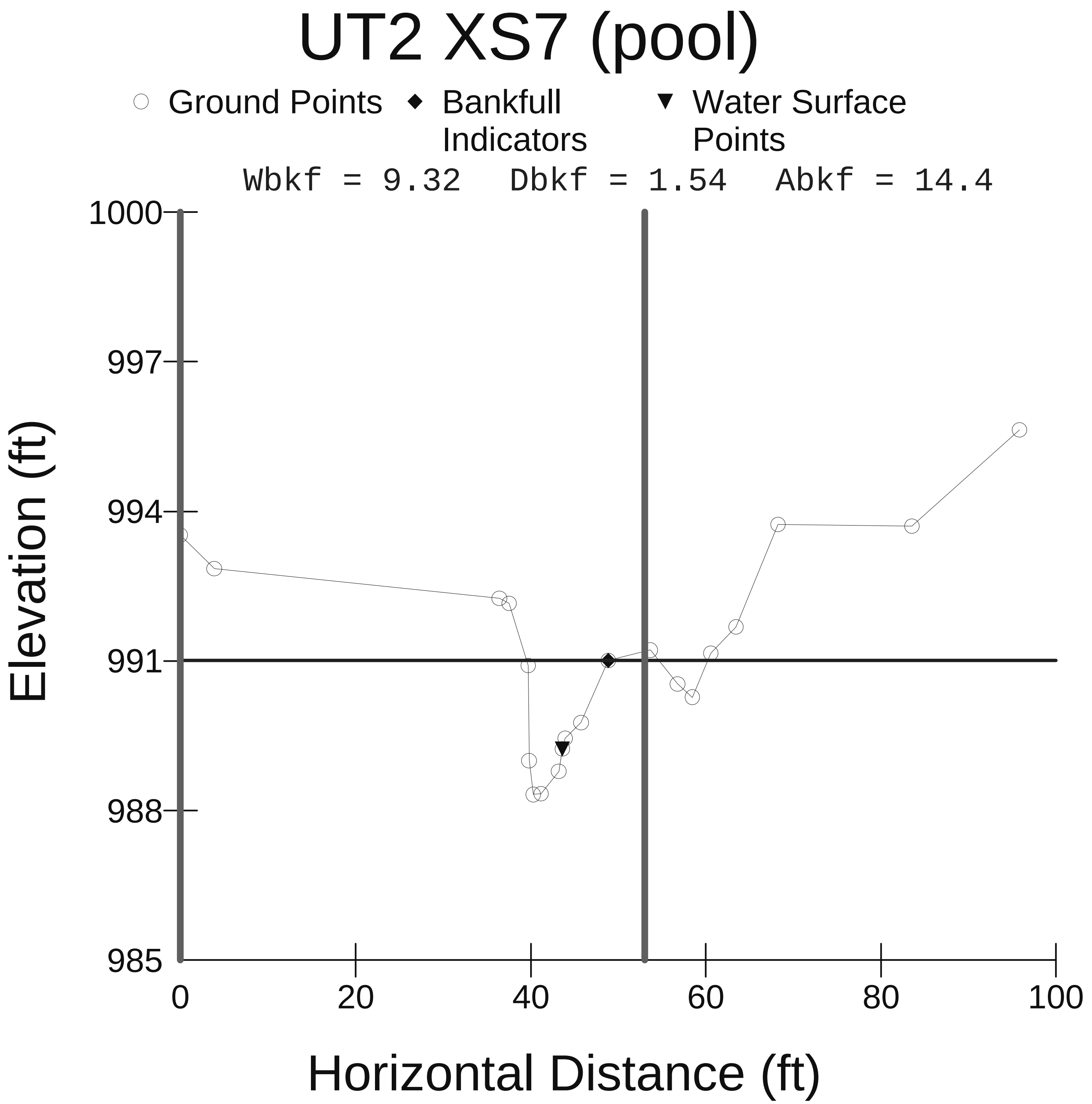
Existing, Design and Reference Morphology Parameters

Parameter	Existing Stream			Design Stream			Reference Stream		
	Min	Median	Max	Min	Median	Max	Min	Median	Max
Stream name	Hogan Creek UT2			Hogan Creek UT2			UT2 Upstream		
Stream type	E4b			B4			E4b		
Drainage area, DA (sq mi)	0.13			0.13			0.12		
Mean riffle depth, d_{bkf} (ft)	1.5			0.7			0.9		
Riffle width, W_{bkf} (ft)	8.2			9.0			7.1		
Width-to-depth ratio, $[W_{bkf}/d_{bkf}]$	5.6			12.5			7.6		
Riffle cross-section area, A_{bkf} (sq ft)	12.1			6.5			6.6		
Max riffle depth, d_{mbkf} (ft)	2.1			1.0			1.2		
Max riffle depth ratio, $[d_{mbkf}/d_{bkf}]$	1.4			1.4			1.3		
Mean pool depth, d_{bkfp} (ft)	1.5			1.1			1.1		
Mean pool depth ratio, $[d_{bkfp}/d_{bkf}]$	1.0			1.5			1.2		
Pool width, W_{bkfp} (ft)	9.3			12.0			6.8		
Pool width ratio, $[W_{bkfp}/W_{bkf}]$	1.1			1.3			1.0		
Pool cross-section area, A_{bkfp} (sq ft)	14.4			12.8			7.3		
Pool area ratio, $[A_{bkfp}/A_{bkf}]$	1.2			2.0			1.1		
Max pool depth, d_{mbkfp} (ft)	2.7			1.6			1.5		
Max pool depth ratio, $[d_{mbkfp}/d_{bkf}]$	1.8			2.2			1.6		
Low bank height, LBH (ft)	3.2			1.0			1.2		
Low bank height ratio, $[LBH/d_{mbkf}]$	1.6			1.0			1.0		
Width flood-prone area, W_{fpa} (ft)	66.0			30.0			15.0		
Entrenchment ratio, ER $[W_{fpa}/W_{bkf}]$	8.0			3.3			2.1		
Meander length, L_m (ft)	128	159	190	73	103	130	53	58.5	64
Meander length ratio $[L_m/W_{bkf}]$	15.6	19.4	23.2	8.1	11.4	14.4	7.5	8.2	9.0
Radius of curvature, Rc (ft)	16	18.5	21	22	27	30	7	16	25
Radius of curvature ratio $[Rc/W_{bkf}]$	2.0	2.3	2.6	2.4	3.0	3.3	1.0	2.3	3.5
Belt width, W_{blt} (ft)	28	42	56	17	26	49	62	67.5	73
Meander width ratio $[W_{blt}/W_{bkf}]$	3.4	5.1	6.8	1.9	2.9	5.5	8.7	9.5	10.3
Valley length, VL (ft)	641			641			1350		
Stream length, SL (ft)	568			555			1980		
Valley Elevation Change, VE (ft)	20			20			48		
Stream Elevation Change, SE (ft)	13.33			12.35			52		
Valley slope, VS (ft/ft)	0.0312			0.0312			0.0356		
Average water surface slope, S (ft/ft)	0.0235			0.0223			0.0263		
Sinuosity, k = VS/S	1.33			1.40			1.47		
Riffle slope, S_{rif} (ft/ft)	0.0303	0.0326	0.0561	0.0267	0.0323	0.0378	0.0227	0.0334	0.0363
Riffle slope ratio, $[S_{rif}/S]$	1.3	1.4	2.4	1.2	1.5	1.7	0.9	1.3	1.4
Pool slope, S_p (ft/ft)	-0.0036	0.0028	0.0069	0.0030	0.0045	0.0060	0.0008	0.0027	0.0118
Pool slope ratio, $[S_p/S]$	-0.2	0.1	0.3	0.1	0.2	0.3	0.0	0.1	0.5
D_{50} riffle (mm)	21			21			40		
D_{50} bar (mm)	8			8			20		
D_{100} bar (mm)	84			84			94		

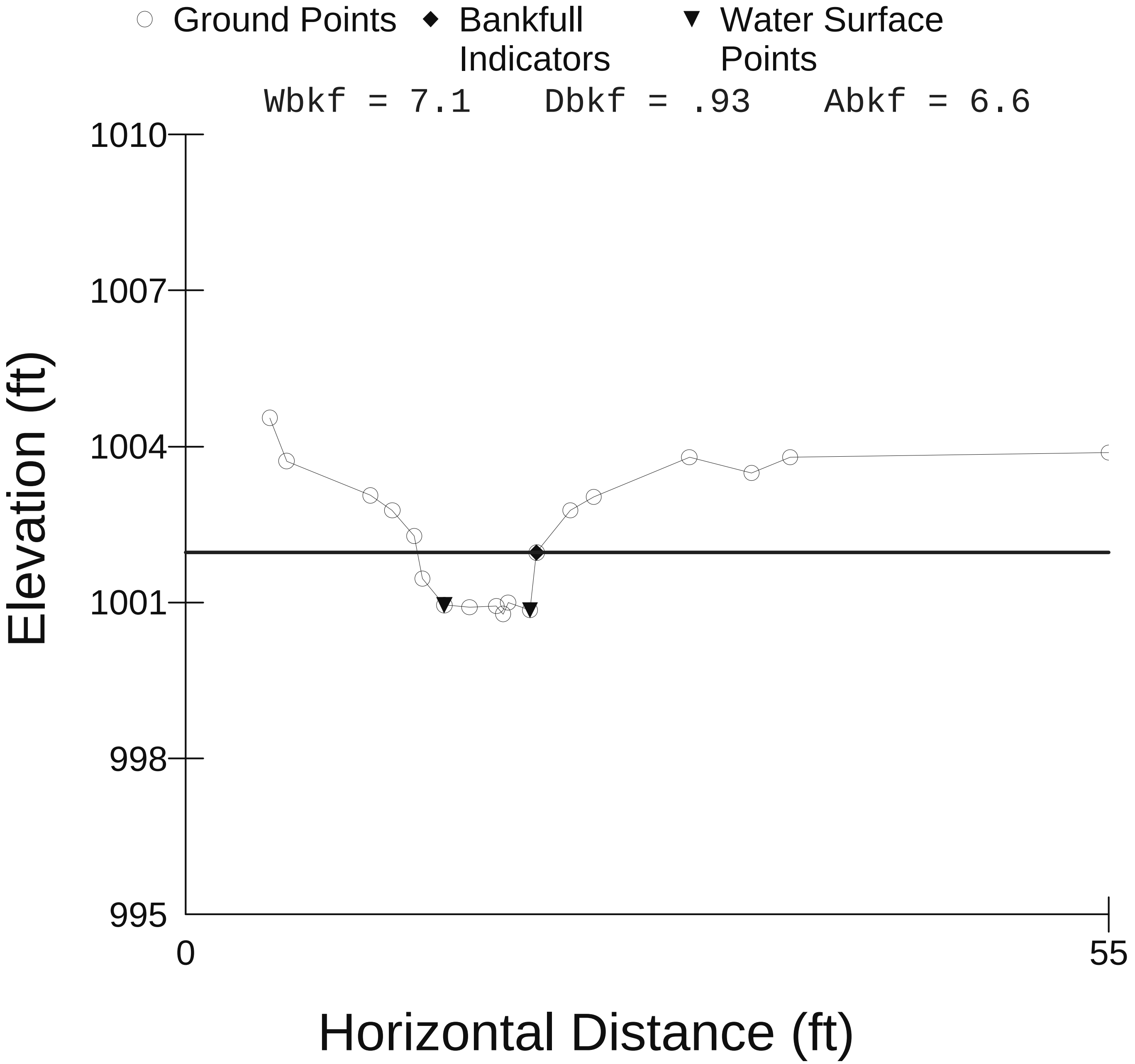

UT2 Existing Thalweg Profile
Elevation (ft)
1005
1000
995
990
985
980
0
200
400
600
800
1000
1200
Station (ft)
water surface
thalweg
xs6
XS7

UT2 XS6 (riffle)

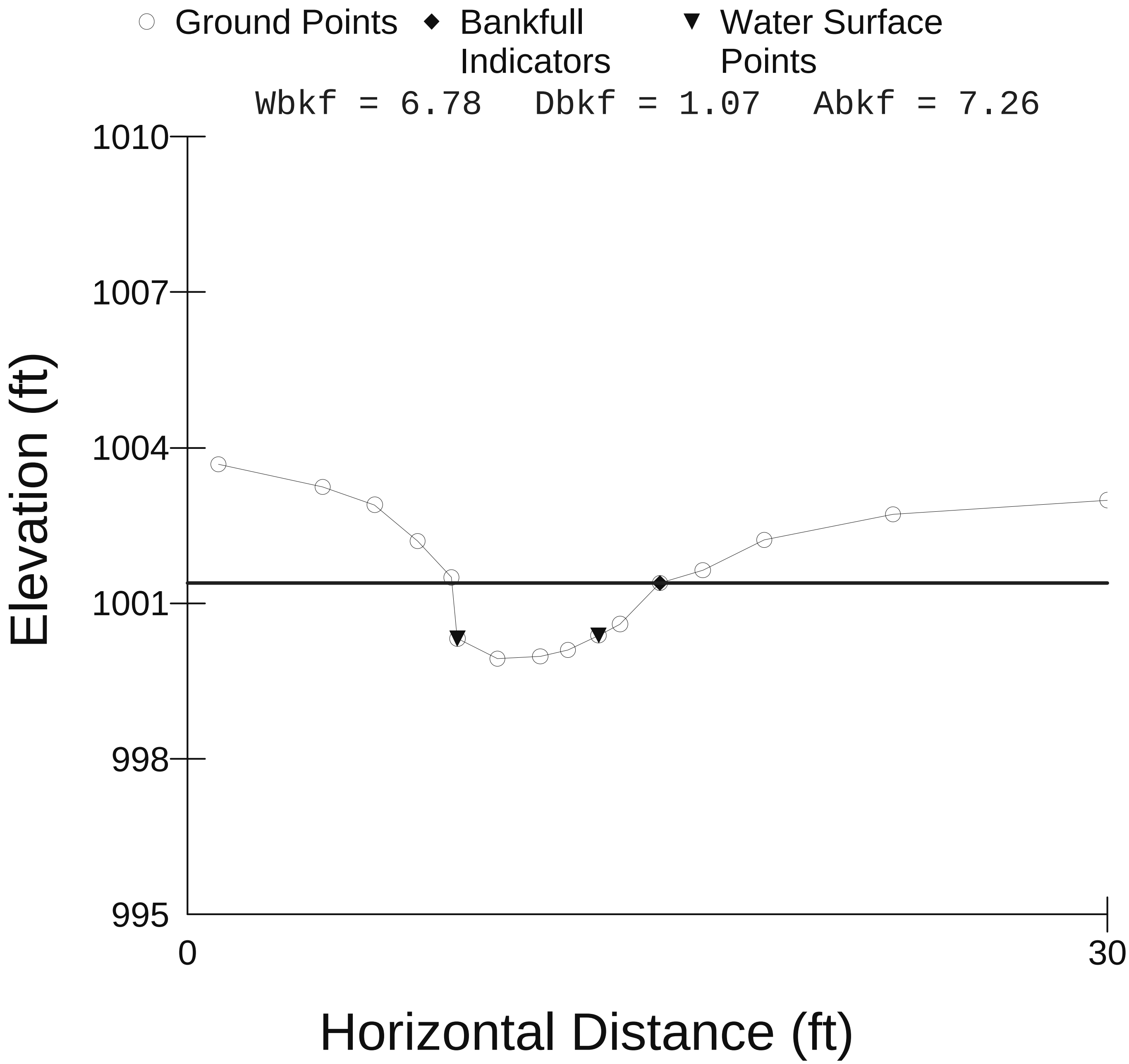



UT2 XS7 (pool)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 9.32 Dbkf = 1.54 Abkf = 14.4
1000
997
994
991
988
985
0
20
40
60
80
100
Elevation (ft)
Horizontal Distance (ft)

UT2 reference riffle



UT2 reference pool



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            RIVERMORPH PARTICLE SUMMARY

--------------------------------------------------------------

River Name:       Hogan Creek
Reach Name:       UT2
Sample Name:      zigzag near ref riffle
Survey Date:      09/12/2011

--------------------------------------------------------------

Size (mm)           TOT #    ITEM %    CUM %
--------------------------------------------------------------
0 - 0.062             0       0.00      0.00
0.062 - 0.125         0       0.00      0.00
0.125 - 0.25          0       0.00      0.00
0.25 - 0.50           3       2.86      2.86
0.50 - 1.0            4       3.81      6.67
1.0 - 2.0             2       1.90      8.57
2.0 - 4.0             6       5.71      14.29
4.0 - 5.7             4       3.81      18.10
5.7 - 8.0             6       5.71      23.81
8.0 - 11.3            8       7.62      31.43
11.3 - 16.0           14      13.33     44.76
16.0 - 22.6           7       6.67      51.43
22.6 - 32.0           6       5.71      57.14
32 - 45               8       7.62      64.76
45 - 64               11      10.48     75.24
64 - 90               8       7.62      82.86
90 - 128              7       6.67      89.52
128 - 180             5       4.76      94.29
180 - 256             2       1.90      96.19
256 - 362             1       0.95      97.14
362 - 512             0       0.00      97.14
512 - 1024            1       0.95      98.10
1024 - 2048           0       0.00      98.10
Bedrock               2       1.90      100.00

D16 (mm)              4.76
D35 (mm)              12.56
D50 (mm)              21.19
D84 (mm)              96.5
D95 (mm)              208.4
D100 (mm)             Bedrock
Silt/Clay (%)         0
Sand (%)              8.57
Gravel (%)            66.67
Cobble (%)            20.95
Boulder (%)           1.91
Bedrock (%)           1.9

Total Particles = 105.
```

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                    RIVERMORPH PARTICLE SUMMARY

----------------------------------------------------------------------

River Name:        Hogan Creek
Reach Name:        UT2
Sample Name:       Bar sample us reach
Survey Date:       09/15/2011

----------------------------------------------------------------------

SIEVE (mm)             NET WT
----------------------------------------------------------------------
16                    508.6
8                     509.1
4                     420.8
2                     467.2
PAN                   477.1

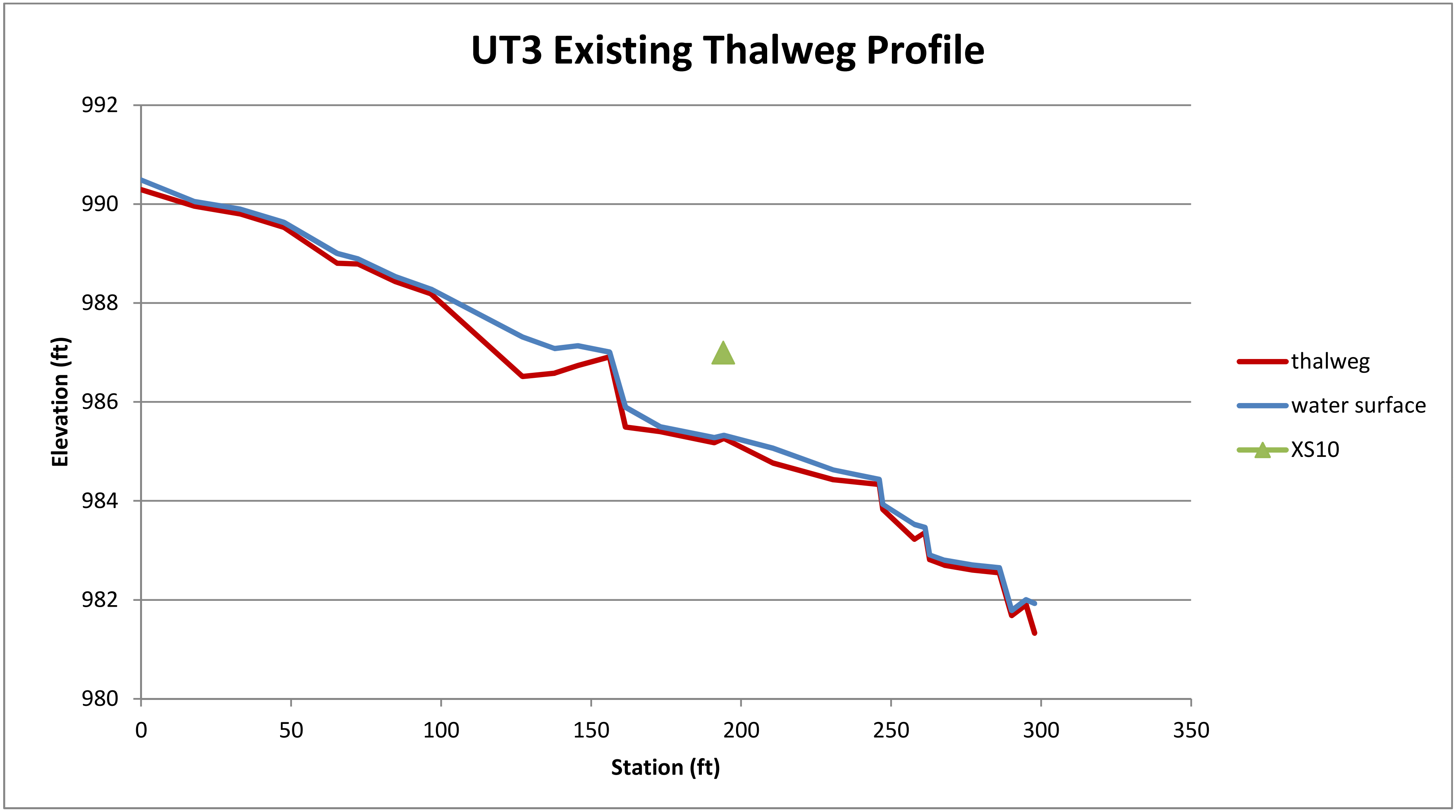
D16 (mm)               0
D35 (mm)               4.23
D50 (mm)               8.29
D84 (mm)               50.29
D95 (mm)               73.46
D100 (mm)              84
Silt/Clay (%)          0
Sand (%)               17.24
Gravel (%)             77.47
Cobble (%)             5.29
Boulder (%)            0
Bedrock (%)            0

Total Weight = 2767.2000.

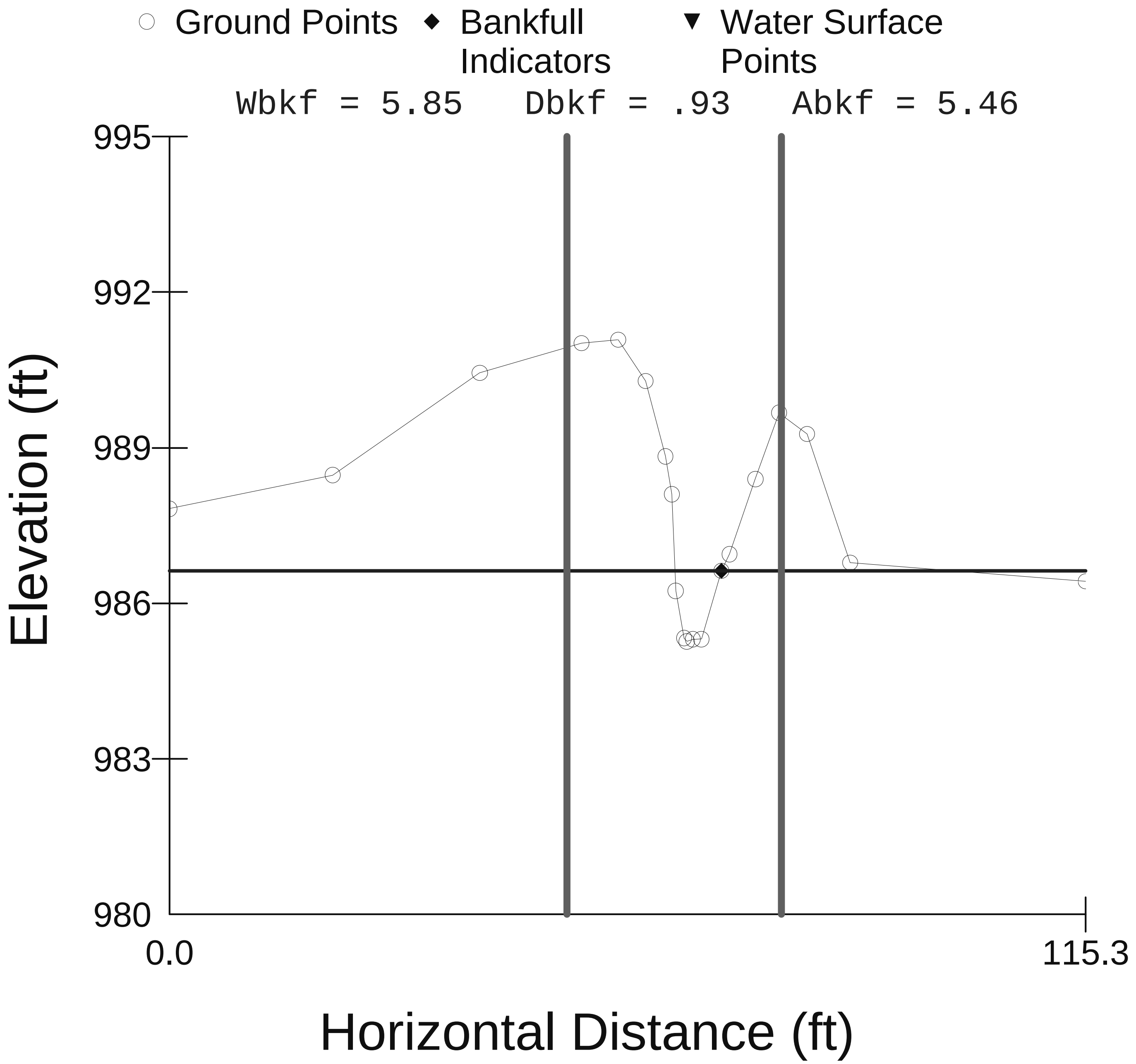
Largest Surface Particles:
         Size(mm)    Weight
Particle 1:    84     146.1
Particle 2:    80     238.3
```

Existing, Design and Reference Morphology Parameters

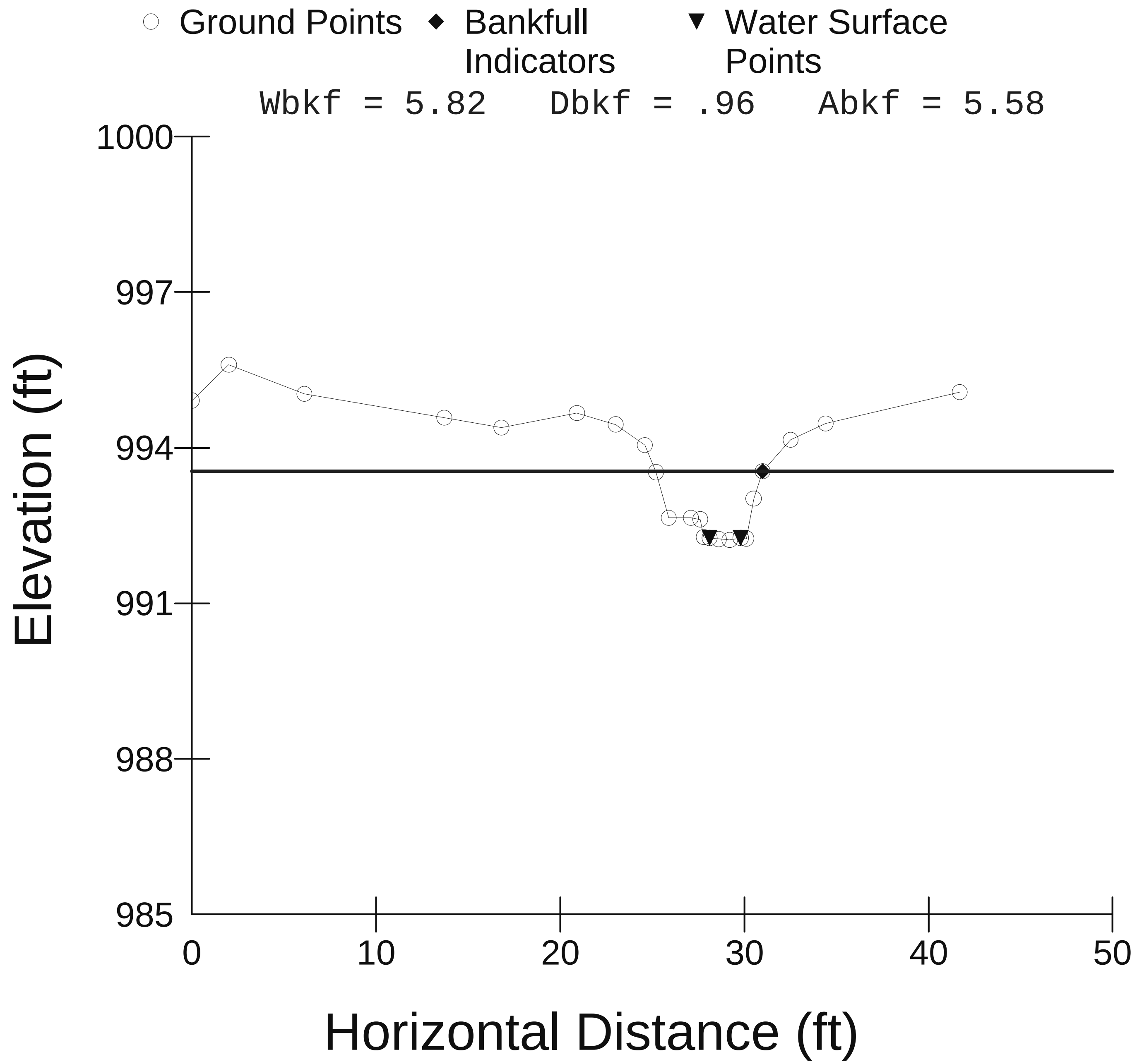
Parameter	Existing Stream			Design Stream			Reference Stream		
	Min	Median	Max	Min	Median	Max	Min	Median	Max
Stream name	UT3			UT3			Upstream UT3		
Stream type	G4			B4			E4b		
Drainage area, DA (sq mi)	0.03			0.03			0.02		
Mean riffle depth, d_{bkf} (ft)	0.9			0.4			1.0		
Riffle width, W_{bkf} (ft)	5.9			5.0			5.8		
Width-to-depth ratio, $[W_{bkf}/d_{bkf}]$	6.3			12.5			6.1		
Riffle cross-section area, A_{bkf} (sq ft)	5.5			2.0			5.6		
Max riffle depth, d_{mbkf} (ft)	1.4			0.5			1.3		
Max riffle depth ratio, $[d_{mbkf}/d_{bkf}]$	1.5			1.3			1.4		
Mean pool depth, d_{bkfp} (ft)	1.0			0.7			1.0		
Mean pool depth ratio, $[d_{bkfp}/d_{bkf}]$	1.0			1.7			1.0		
Pool width, W_{bkfp} (ft)	7.0			8.0			7.0		
Pool width ratio, $[W_{bkfp}/W_{bkf}]$	1.2			1.6			1.2		
Pool cross-section area, A_{bkfp} (sq ft)	6.8			5.5			6.8		
Pool area ratio, $[A_{bkfp}/A_{bkf}]$	1.2			2.8			1.2		
Max pool depth, d_{mbkfp} (ft)	1.6			1.0			1.6		
Max pool depth ratio, $[d_{mbkfp}/d_{bkf}]$	1.7			2.5			1.6		
Low bank height, LBH (ft)	4.4			0.5			1.9		
Low bank height ratio, $[LBH/d_{mbkf}]$	3.2			1.0			1.5		
Width flood-prone area, W_{fpa} (ft)	12.0			20.0			31.0		
Entrenchment ratio, ER $[W_{fpa}/W_{bkf}]$	2.1			4.0			5.3		
Meander length, L_m (ft)	75.0			64	70	76	78.0	128.5	179.0
Meander length ratio $[L_m/W_{bkf}]$	12.8			12.8	14.0	15.2	15.6	25.7	35.8
Radius of curvature, Rc (ft)	11.0			16	17	29	14.0	21.0	28.0
Radius of curvature ratio $[Rc/W_{bkf}]$	1.9			3.2	3.4	5.7	2.8	4.2	5.6
Belt width, W_{blt} (ft)	26.0			22	25	27	47.0	55.5	64.0
Meander width ratio $[W_{blt}/W_{bkf}]$	4.4			4.4	5.0	5.4	9.4	11.1	12.8
Valley length, VL (ft)	290			290			697		
Stream length, SL (ft)	298			292			925		
Valley Elevation Change, VE (ft)	9			9			40		
Stream Elevation Change, SE (ft)	9			7.76			41		
Valley slope, VS (ft/ft)	0.0310			0.0310			0.0574		
Average water surface slope, S (ft/ft)	0.0302			0.0266			0.0443		
Sinuosity, k = VS/S	1.03			1.17			1.29		
Riffle slope, S_{rif} (ft/ft)	0.0247	0.1447	0.3831	0.0254	0.0317	0.0381	0.0247	0.1181	0.2115
Riffle slope ratio, $[S_{rif}/S]$	0.8	4.8	12.7	1.0	1.2	1.4	0.6	2.7	4.8
Pool slope, S_p (ft/ft)	0.0038	0.0098	0.0126	0.0013	0.0013	0.0013	0.0038	0.0060	0.0082
Pool slope ratio, $[S_p/S]$	0.1	0.3	0.4	0.0	0.0	0.0	0.1	0.2	0.3
D_{50} riffle (mm)	14			14			14		
D_{50} bar (mm)	2			2			2		
D_{100} bar (mm)	65			65			65		


UT3 Existing Thalweg Profile
Elevation (ft)
992
990
988
986
984
982
980
Station (ft)
0
50
100
150
200
250
300
350
thalweg
water surface
XS10

UT3 XS10 (riffle)

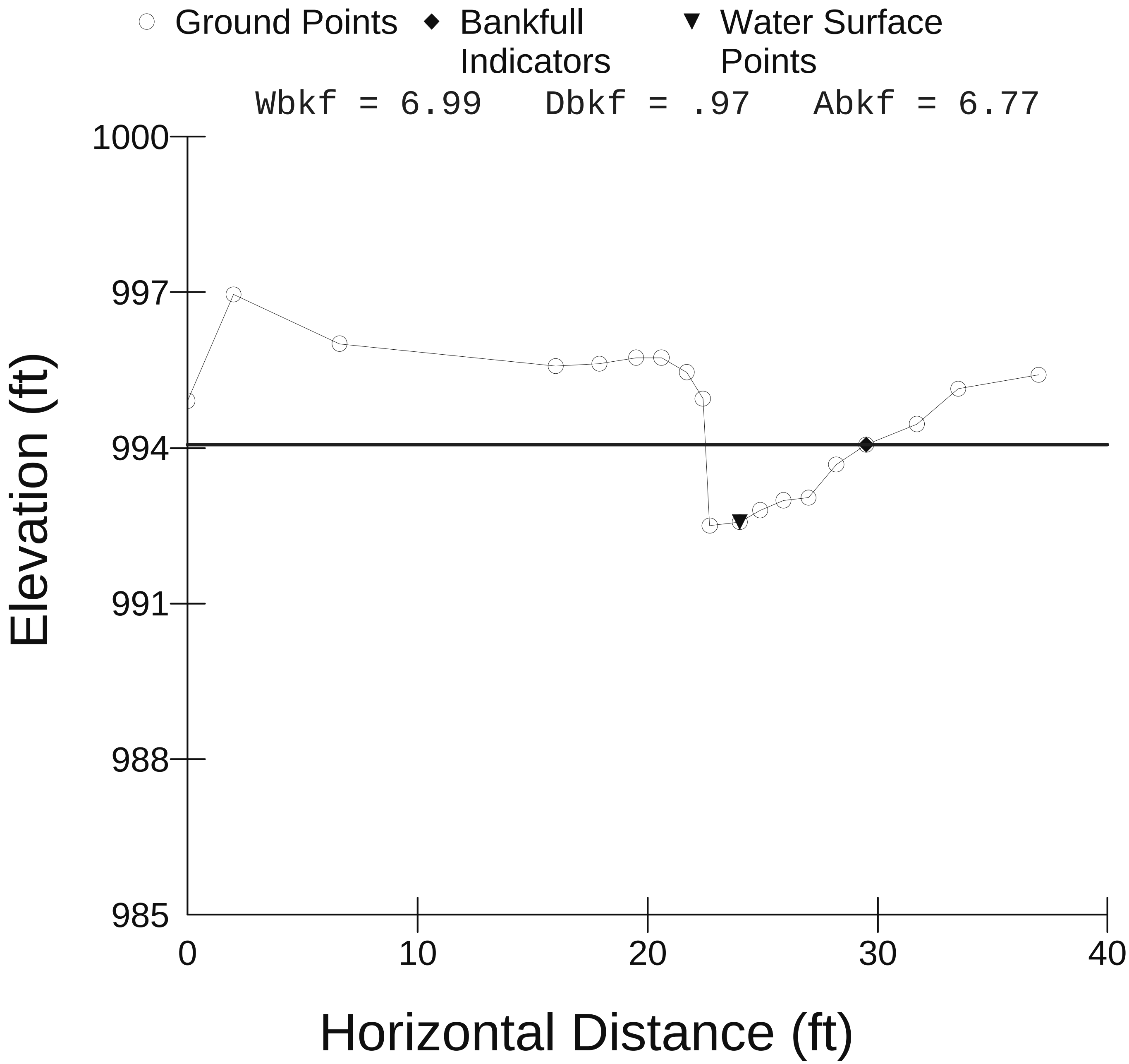


UT3 reference riffle



`Wbkf = 5.82   Dbkf = .96   Abkf = 5.58`

UT3 reference pool



```
              RIVERMORPH PARTICLE SUMMARY

-----------------------------------------------------------------

River Name:       Hogan Creek
Reach Name:        UT3
Sample Name:        zigzag thru ref riffle
Survey Date:      09/12/2011

-----------------------------------------------------------------

Size (mm)              TOT #    ITEM %    CUM %
-----------------------------------------------------------------
0 - 0.062            0       0.00      0.00
0.062 - 0.125          0       0.00      0.00
0.125 - 0.25          4       3.92      3.92
0.25 - 0.50          6       5.88      9.80
0.50 - 1.0           5       4.90      14.71
1.0 - 2.0           1       0.98      15.69
2.0 - 4.0           2       1.96      17.65
4.0 - 5.7           8       7.84      25.49
5.7 - 8.0           9       8.82      34.31
8.0 - 11.3           10       9.80      44.12
11.3 - 16.0           11       10.78      54.90
16.0 - 22.6           15       14.71      69.61
22.6 - 32.0           8       7.84      77.45
32 - 45             3       2.94      80.39
45 - 64             10       9.80      90.20
64 - 90             6       5.88      96.08
90 - 128             2       1.96      98.04
128 - 180            1       0.98      99.02
180 - 256            1       0.98      100.00
256 - 362            0       0.00      100.00
362 - 512            0       0.00      100.00
512 - 1024            0       0.00      100.00
1024 - 2048            0       0.00      100.00
Bedrock              0       0.00      100.00

D16 (mm)             2.32
D35 (mm)             8.23
D50 (mm)             13.86
D84 (mm)             51.99
D95 (mm)             85.22
D100 (mm)             255.99
Silt/Clay (%)          0
Sand (%)            15.69
Gravel (%)           74.51
Cobble (%)           9.8
Boulder (%)           0
Bedrock (%)            0

Total Particles = 102.
```

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                 RIVERMORPH PARTICLE SUMMARY

---------------------------------------------------------------------

River Name:        Hogan Creek
Reach Name:        UT3
Sample Name:       Bar sample us reach
Survey Date:       09/12/2011

---------------------------------------------------------------------

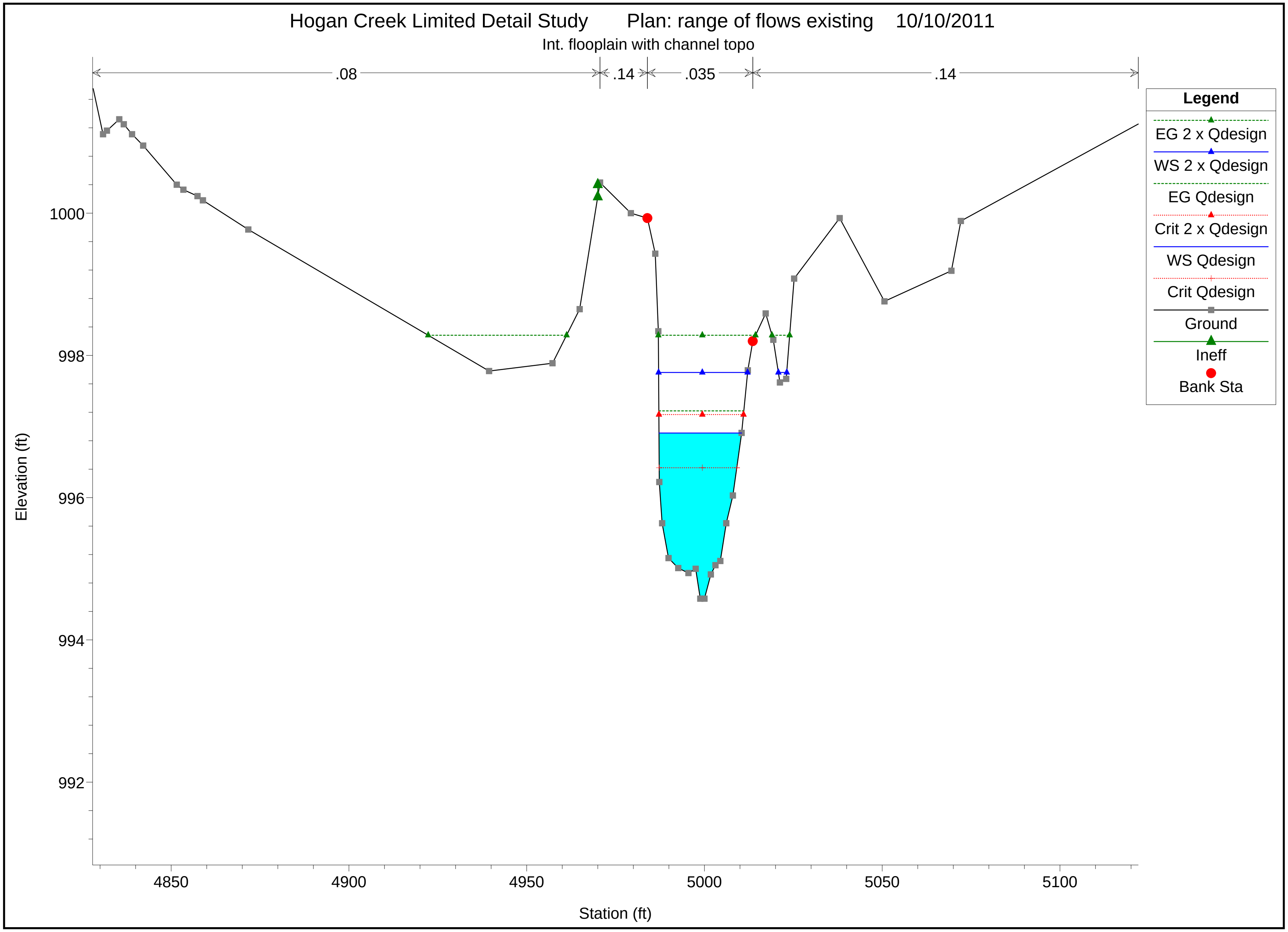
SIEVE (mm)              NET WT
---------------------------------------------------------------------
16                 150.1
8                  258.3
4                  280
2                  346.1
PAN                   1346.1

D16 (mm)              0
D35 (mm)              0
D50 (mm)              0
D84 (mm)              13.94
D95 (mm)              46.74
D100 (mm)             65
Silt/Clay (%)        0
Sand (%)             52.25
Gravel (%)           47.6
Cobble (%)            0.15
Boulder (%)           0
Bedrock (%)           0

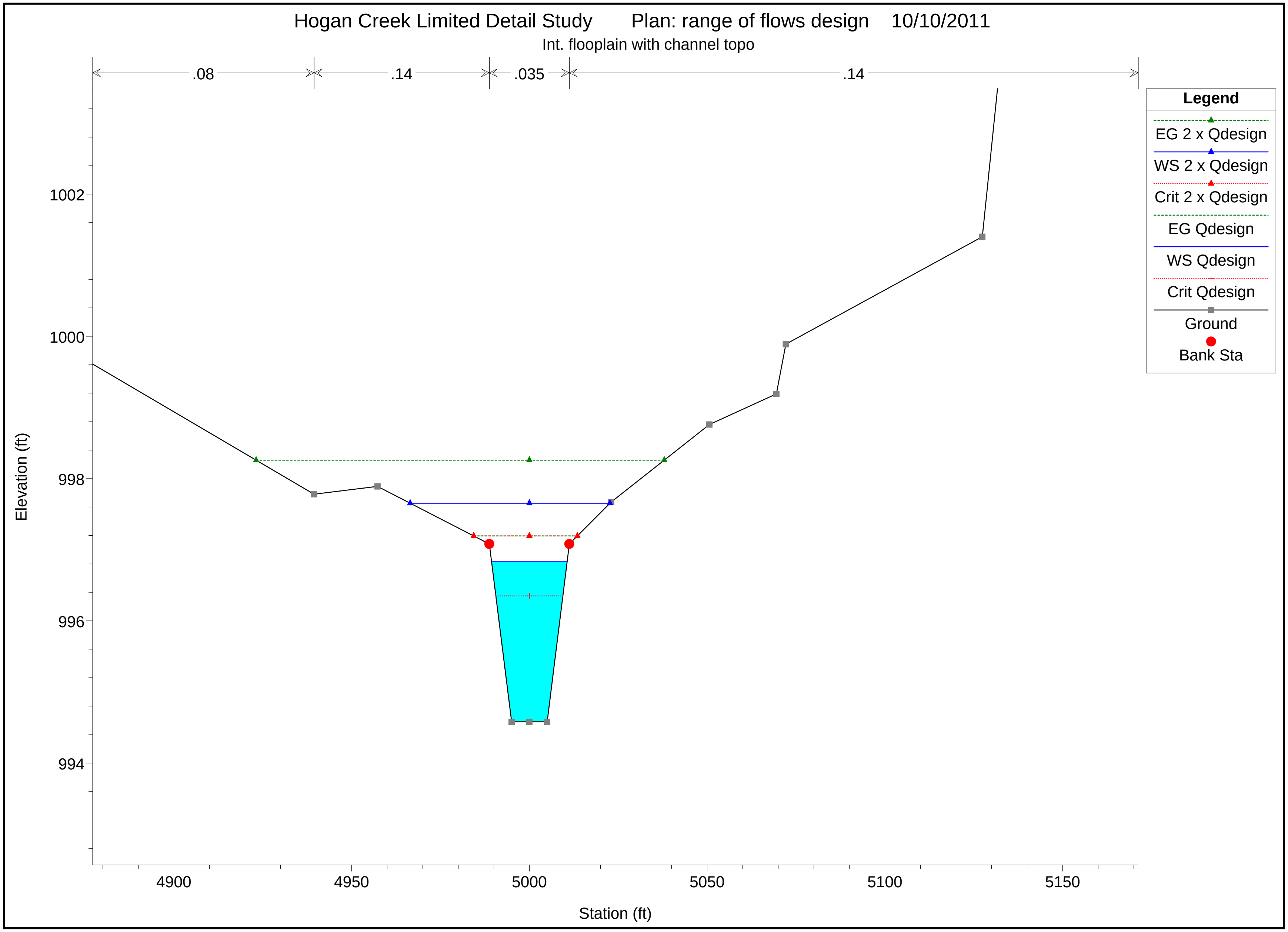
Total Weight = 2576.2000.

Largest Surface Particles:
          Size(mm)    Weight
Particle 1:      65    116.7
Particle 2:      64     78.9
```

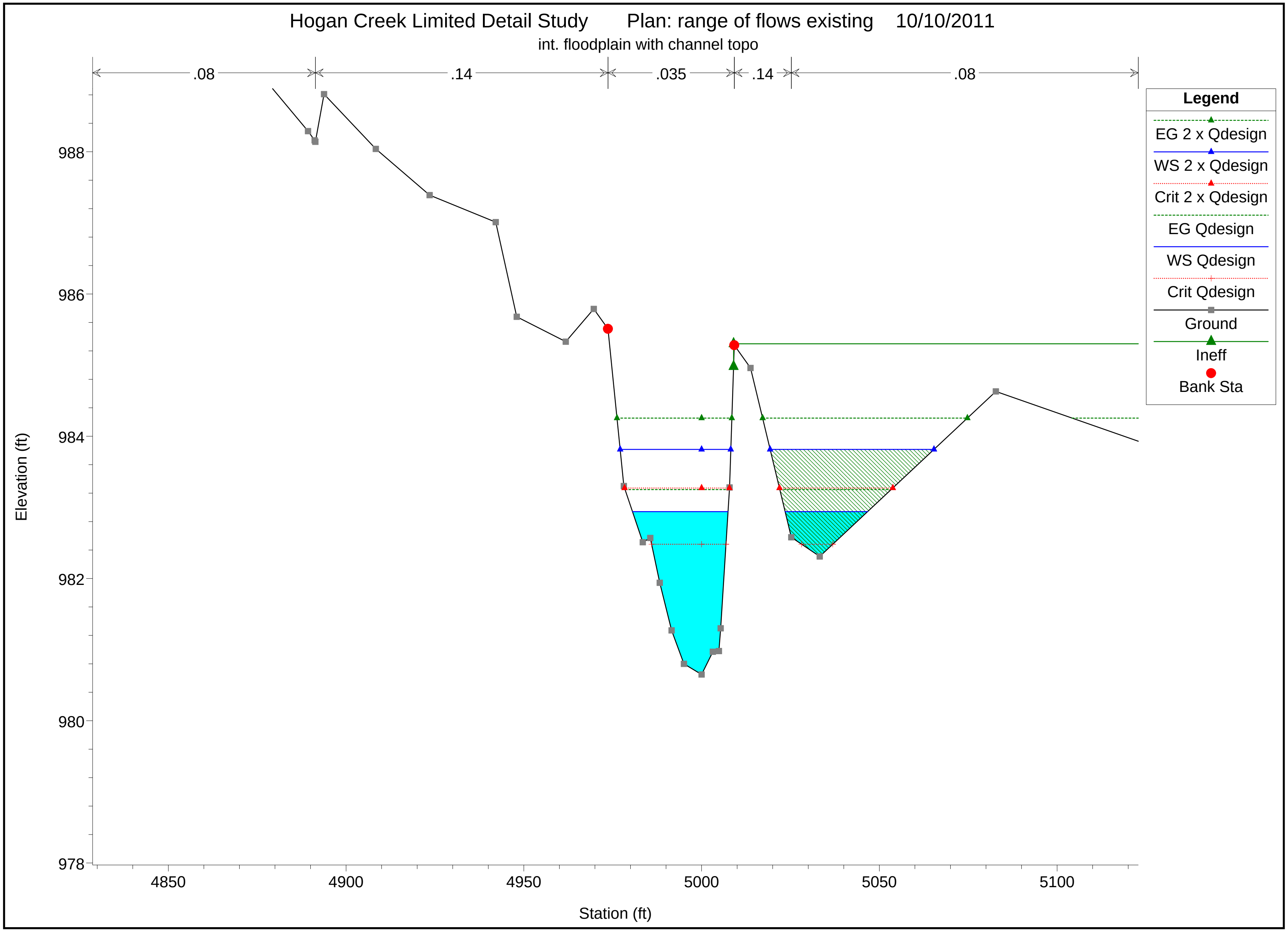
Hydraulic Analyses – Flood Attenuation



1 in Horiz. = 40 ft 1 in Vert. = 2 ft



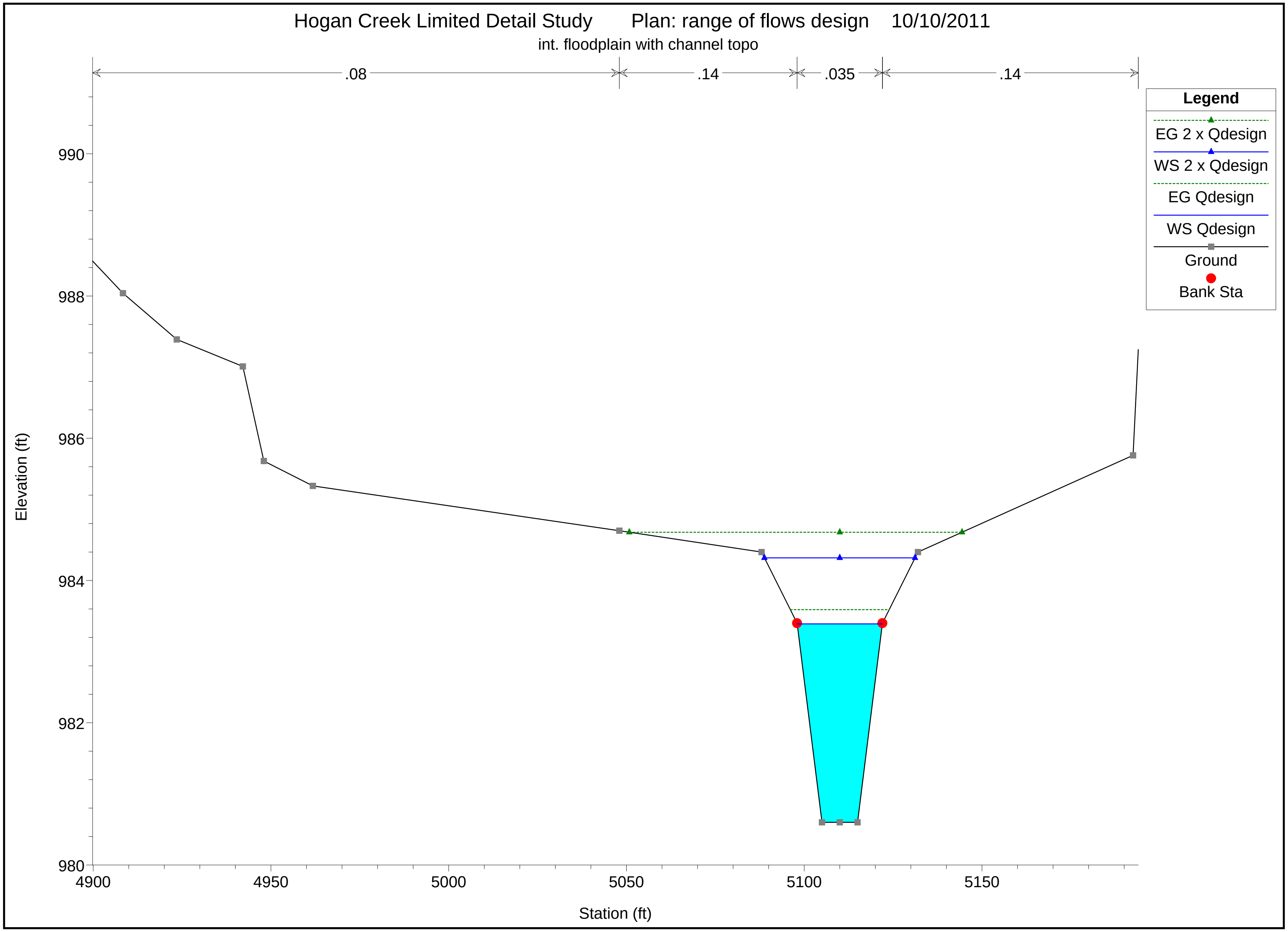
1 in Horiz. = 40 ft 1 in Vert. = 2 ft



Hogan Creek Limited Detail Study Plan: range of flows existing 10/10/2011

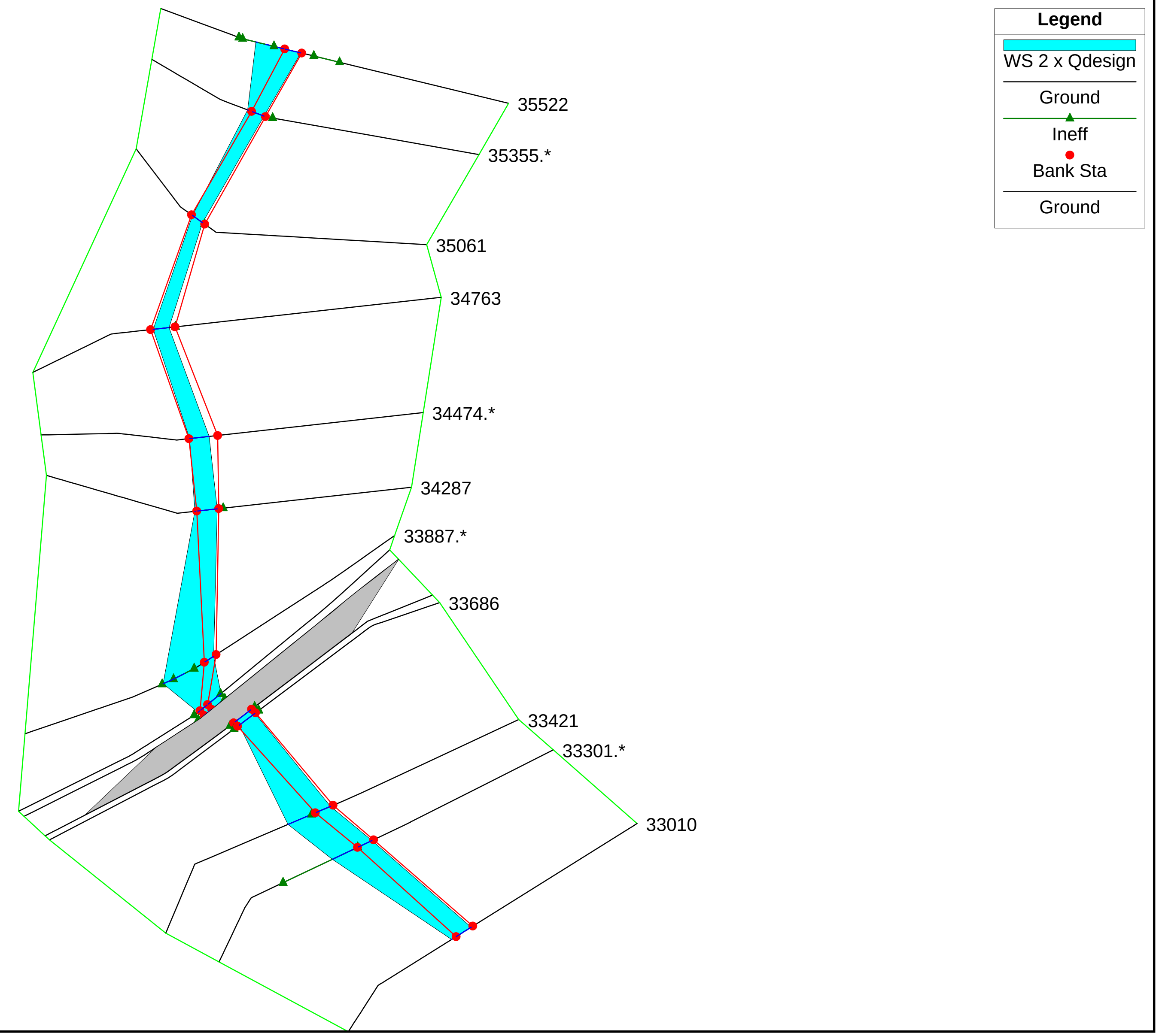
int. floodplain with channel topo

1 in Horiz. = 40 ft 1 in Vert. = 2 ft

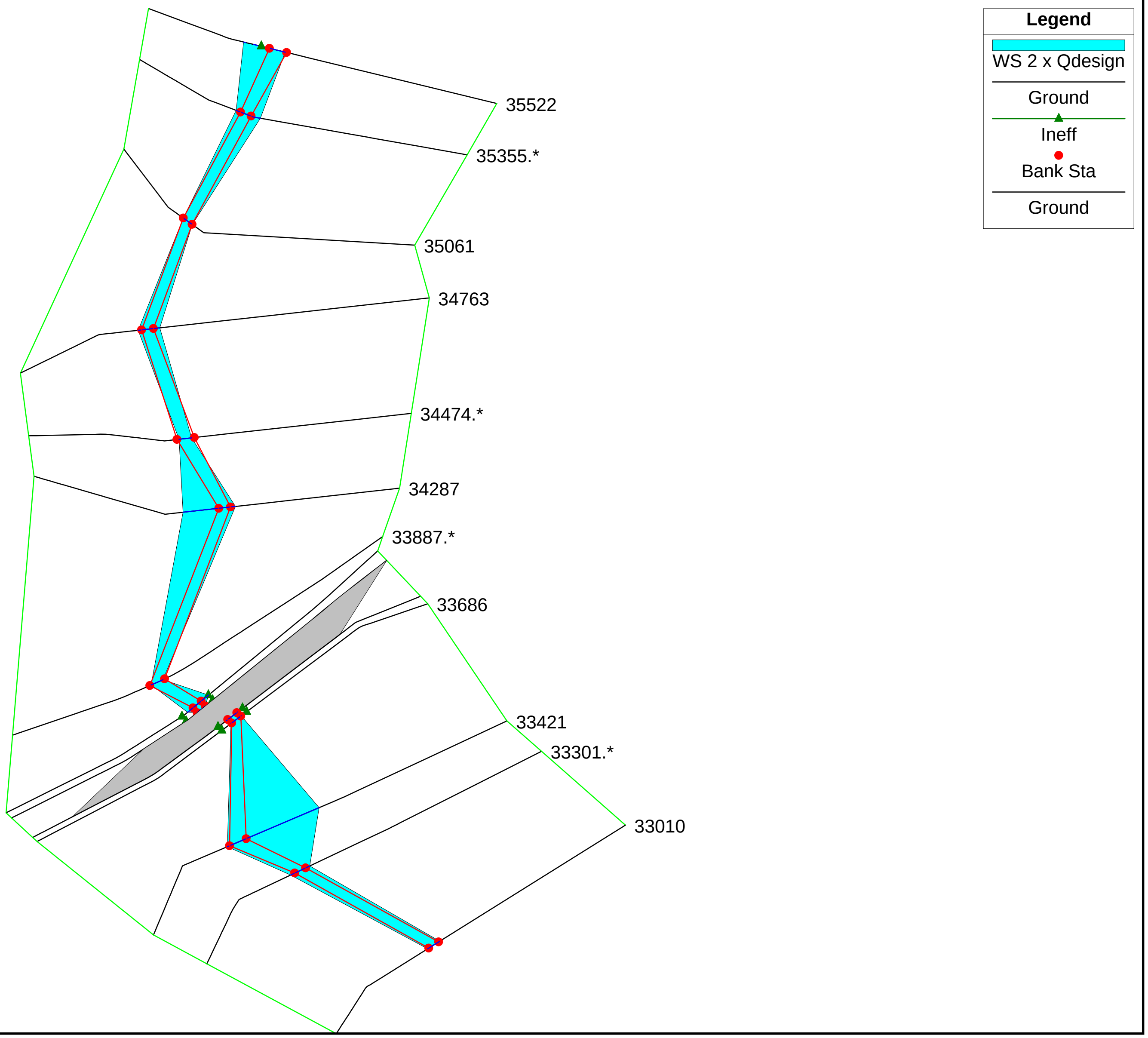


1 in Horiz. = 40 ft 1 in Vert. = 2 ft

Hagan Creek Limited Detail Study Plan: range of flows existing 10/5/2011



Hagan Creek Limited Detail Study Plan: range of flows design 10/5/2011



Section Design and Sediment Transport Analyses

Hogan Creek Reach 1 Typical Section Design

RIFFLE SECTION

Right Bank Slope, x:1	2.5
Left Bank Slope, x:1	2.5
Max Depth (ft)	2.5
Bottom Width (ft)	10
Area	40.625
Bankfull Width (ft)	22.5
Bankfull Depth (ft)	1.81
W/D ratio	12.46
Ave Width (ft) =	

Regional Curve Estimate Hogan Creek to Miller Gap bridge

DA (sq. mi.)	2.31
NC Mountains (area)	38.18659
NC Mountains (discharge)	190.1585
NC rural Piedmont (area)	37.86852
NC rural Piedmont (discharge)	162.6993
USGS 2 year discharge	
NC Hydro Area 1	211
SW Appalachian (area)	58.4128
SW Appalachian (discharge)	281.117

Discharge Calculation overall reach

$Q = 1.49/n\ R^{2/3}\ s^{1/2}\ A$

WP (ft)	23.46
R (ft)	1.73
design slope	0.0073
Channel n	0.035
Q (cfs)	214
Ω (power)	4.36

FROM CAD, design tw slope = 0.006959

existing eg slope from RAS = 0.007881
design eg slope from RAS = 0.007348

γRs = 0.7939221 psf
grain diam, Shields = 120 mm (CO data)

bar sample 1
d_{84} = 79 mm
d_{100} = 256 mm <---- questionable, more like 130 mm

ON-LINE POOL

Right Bank Slope, x:1	3.5
Left Bank Slope, x:1	2.5
Max Depth (ft)	4
Bottom Width (ft)	10
Area	88
Bankfull Width (ft)	34
pt bar tob o/s	19
outside bank tob o/s	15

width ratio = 1.51
depth ratio = 2.22

OFF-LINE POOL

Right Bank Slope, x:1	4
Left Bank Slope, x:1	2.5
Max Depth (ft)	4
Bottom Width (ft)	10
Area	92
Bankfull Width (ft)	36
pt bar tob o/s	21
outside bank tob o/s	15

width ratio = 1.60
depth ratio = 2.22

Andrews (1984) and Andrews and Nankervis (1995)

$\tau_{ci}* = 0.0834(d_i/d'_{50})^{-0.872}$	applies if di/d'50 ranges from 3 to 7
$\tau_{ci}* = 0.0384(d_i/d'_{50})^{-0.887}$	if di/d'50 is 1.3 to 3.0

$d_i = d_{50}$ of riffle pavement (from zigzag), mm

$d'_{50} = d_{50}$ of sub-pavement (bar sample), mm

$d = \tau_{ci}*((\rho_{sand}-\rho_{h20})/\rho_{h20)}*D_i)/s$

d = mean bankfull depth of water (ft) needed to move largest particle

ρ_{sand} =	2.65 g/cc	specific gravity of sand
ρ_{h20} =	1.00 g/cc	specific gravity of water
Di =	largest particle found in bar or subpavement sample (ft)	
s =	average (bankfull) water surface slope	

For Reach 1 sample location

d_i	30	mm			
d'_{50}	28	mm			
$d_{i/d'50}$	1.071429			out of range	
τ_{ci}* =	0.036121				
Di	116	mm	=	0.380577	ft
s	0.0071	ft/ft			
d =	3.19	ft			

For Hogan supply reach samples

d_i	31	mm				
d'_{50}	16	mm				
$d_{i/d'50}$	1.9375					
τ_{ci}* =	0.021357					
Di	130	mm	=	0.426509	ft	
s	0.0071	ft/ft				from RAS model of Qbkf for reach 1
d =	2.12	ft				

from stage report in RM w/ d_{bkf} = d, q_{ci} ~	215	cfs	XS2
	290	cfs	XS5
	237	cfs	XS8

Bathurst et al (1987)

$q_{cD50} = (0.15g^{0.5}D_{50}^{1.5})/(s^{1.12})$ D in ft
$q_{ci} = q_{cD50}(D_i/D_{50})^b$
$b = 1.5(D_{84}/D_{16})^{-1}$

Hogan Reach 1 Pebble Count

D_{50} =	0.03	m	0.0984	ft
D_{84} =	0.079	m	0.25912	ft
D_{16} =	0.013	m	0.04264	ft
s =	0.007881			
q_{cD50} =	5.961453	cfs		
b =	0.246835			
q_{ci} =	7.570906	cfs/ft		

Section	Active Channel Width (ft)	q_{ci} (cfs) =
Supply	17.2	130
XS2	21.5	163
XS5	14.6	111
XS8	15.7	119

Check discharge for initiation of Phase 2 transport using **Bathurst (2007)** equations:

$q_{c2} = 0.0513\ g^{0.5}\ D_{50}^{1.5}\ S^{-1.2}$ units of cms; D (m) of the surface material from pebble count

$q_{c2} = 0.0133\ g^{0.5}\ D_{84}^{1.5}\ S^{-1.23}$ g = 9.81 m/s^2

From Hogan Supply Reach:

D_{50} = 0.031 m
D_{84} = 0.065 m
S = 0.0079

Bottom Width (active channel) = 17.2 ft

qc2, D_{50} = 0.292 $m^3/s/m$ 0.089 cms/ft = 3.145 cfs/ft 54 cfs
qc2, D_{84} = 0.266 $m^3/s/m$ 0.081 cms/ft = 2.862 cfs/ft 49 cfs

From Hogan XS 2

D_{50} = 0.03 m
D_{84} = 0.079 m
S = 0.0079
Bottom Width (active channel) = 21.5 ft

qc2, D_{50} = 0.278279517 $m^3/s/m$ 0.0848413 cms/ft = 2.993842 cfs/ft 64 cfs
qc2, D_{84} = 0.356488447 $m^3/s/m$ 0.1086855 cms/ft = 3.835245 cfs/ft 82 cfs

From Hogan XS 5

D_{50} = 0.03 m
D_{84} = 0.079 m
S = 0.0079
Bottom Width (active channel) = 14.6 ft

qc2, D_{50} = 0.278279517 $m^3/s/m$ 0.0848413 cms/ft = 2.993842 cfs/ft 44 cfs
qc2, D_{84} = 0.356488447 $m^3/s/m$ 0.1086855 cms/ft = 3.835245 cfs/ft 56 cfs

From Hogan XS 8

D_{50} = 0.03 m
D_{84} = 0.079 m
S = 0.0079
Bottom Width (active channel) = 15.7 ft

qc2, D_{50} = 0.278279517 $m^3/s/m$ 0.0848413 cms/ft = 2.993842 cfs/ft 47 cfs
qc2, D_{84} = 0.356488447 $m^3/s/m$ 0.1086855 cms/ft = 3.835245 cfs/ft 60 cfs

Hogan Creek Reach 2 Typical Section Design

RIFFLE SECTION

Right Bank Slope, x:1	2.5
Left Bank Slope, x:1	2.5
Max Depth (ft)	2.8
Bottom Width (ft)	10
Area	47.6
Bankfull Width (ft)	24
Bankfull Depth (ft)	1.98
W/D ratio	12.10
Ave Width (ft) =	

Discharge Calculation overall reach

$Q = 1.49/n\ R^{2/3}\ s^{1/2}\ A$

WP (ft)	25.08
R (ft)	1.90
design slope	0.0061
Channel n	0.035
Q (cfs)	244
Ω (power)	4

Regional Curve Estimate Hogan Creek to downstream end

DA (sq. mi.)	2.37
NC Mountains (area)	38.85829
NC Mountains (discharge)	193.9007
NC rural Piedmont (area)	38.53462
NC rural Piedmont (discharge)	165.7311
USGS 2 year discharge	
NC Hydro Area 1	215
SW Appalachian (area)	59.47228
SW Appalachian (discharge)	286.5757

Qbkf slope from design model = 0.00615

$\gamma Rs =$ 0.7283777 psf

grain diam, Shields = 110 mm (CO data)

bar sample 2

$d_{84} =$ 89 mm

$d_{100} =$ 138 mm

POOL SECTION

Right Bank Slope, x:1	4
Left Bank Slope, x:1	2.5
Max Depth (ft)	4
Bottom Width (ft)	10
Area	92
Bankfull Width (ft)	36
pt bar tob o/s	21
outside bank tob o/s	15

width ratio = 1.50

depth ratio = 2.02

Andrews (1984) and Andrews and Nankervis (1995)

$\tau_{ci}* = 0.0834(d_i/d'_{50})^{-0.872}$ applies if di/d'50 ranges from 3 to 7

$\tau_{ci}* = 0.0384(d_i/d'_{50})^{-0.887}$ if di/d'50 is 1.3 to 3.0

$d_i = d_{50}$ of riffle pavement (from zigzag), mm

$d'_{50} = d_{50}$ of sub-pavement (bar sample), mm

$d = \tau_{ci}*((\rho_{sand}-\rho_{h20})/\rho_{h20)}*D_i)/s$

d = mean bankfull depth of water (ft) needed to move largest particle

$\rho_{sand =}$	2.65 g/cc	specific gravity of sand
$\rho_{h20 =}$	1.00 g/cc	specific gravity of water
Di =	largest particle found in bar or subpavement sample (ft)	
s =	average (bankfull) water surface slope	

For Hogan Reach 2 sample location

d_i	31	mm					
d'_{50}	21	mm					
$d_{i/d}'_{50}$	1.47619						
$\tau_{ci}* =$	0.027183						
Di	138	mm	=	0.452756	ft		
s	0.0063	ft/ft				from RAS model of Qbkf for reach 2	
d =	3.22	ft		mean bankfull depth			

from stage report in RM w/ $d_{bkf} = d$, q_{ci} ~ 356 cfs XS11

Bathurst et al (1987)

$q_{cD50} = (0.15g^{0.5}D_{50}^{1.5})/(s^{1.12})$ D in ft

$q_{ci} = q_{cD50}(D_i/D_{50})^b$

$b = 1.5(D_{84}/D_{16})^{-1}$

Hogan Reach 2 Pebble Count

D_{50} =	0.03	m	0.0984	ft
D_{84} =	0.077	m	0.25256	ft
D_{16} =	0.014	m	0.04592	ft
s =	0.0061			
q_{cD50} =	7.942229	cfs		
b =	0.272727			
q_{ci} =	10.27043	cfs/ft		

Section	Active Channel Width (ft)	q_{ci} (cfs) =
XS11	13.8	142

Check discharge for initiation of Phase 2 transport using **Bathurst (2007)** equations:

$q_{c2} = 0.0513\ g^{0.5}\ D_{50}^{1.5}\ S^{-1.2}$ units of cms; D (m) of the surface material from pebble count

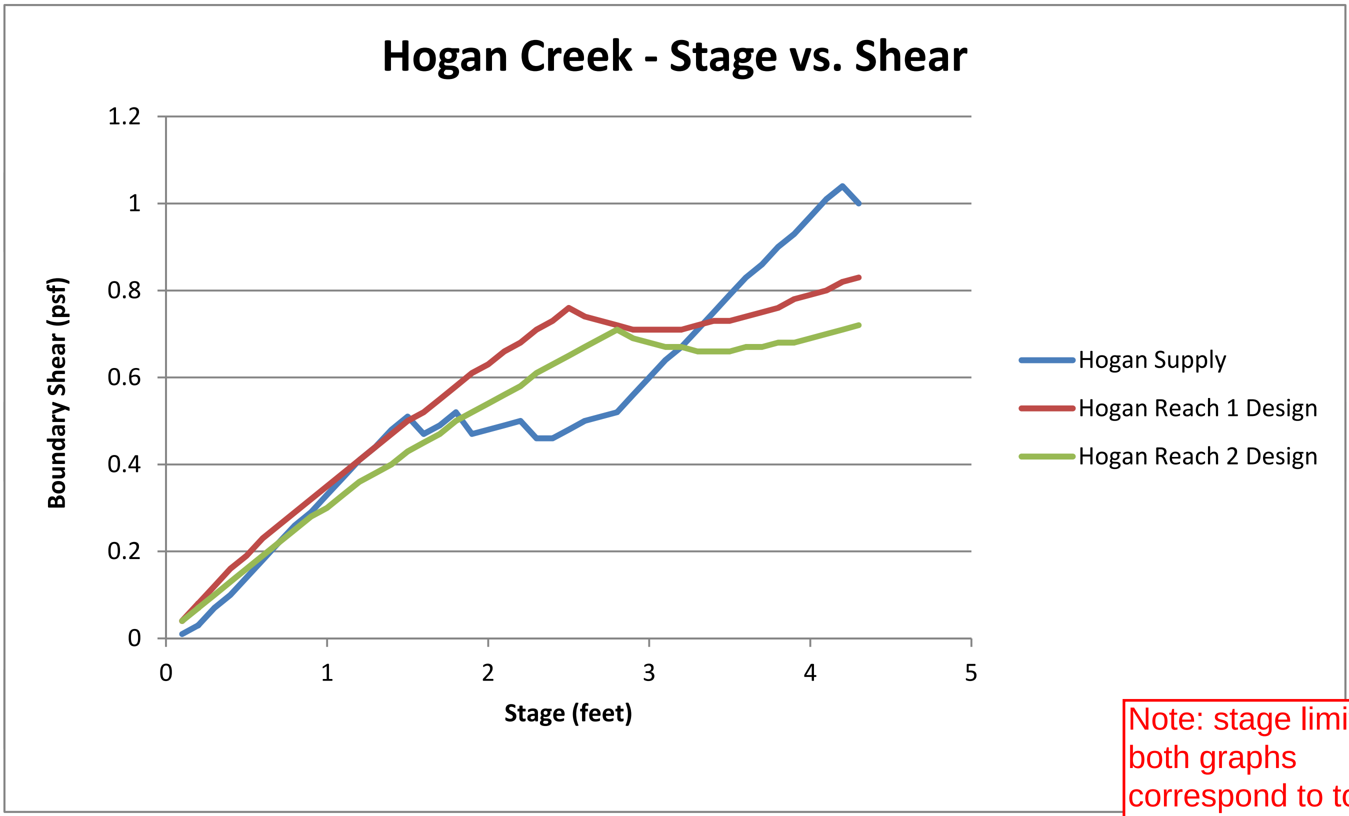
$q_{c2} = 0.0133\ g^{0.5}\ D_{84}^{1.5}\ S^{-1.23}$ g = 9.81 m/s^2

From Hogan Reach 2 (XS11):

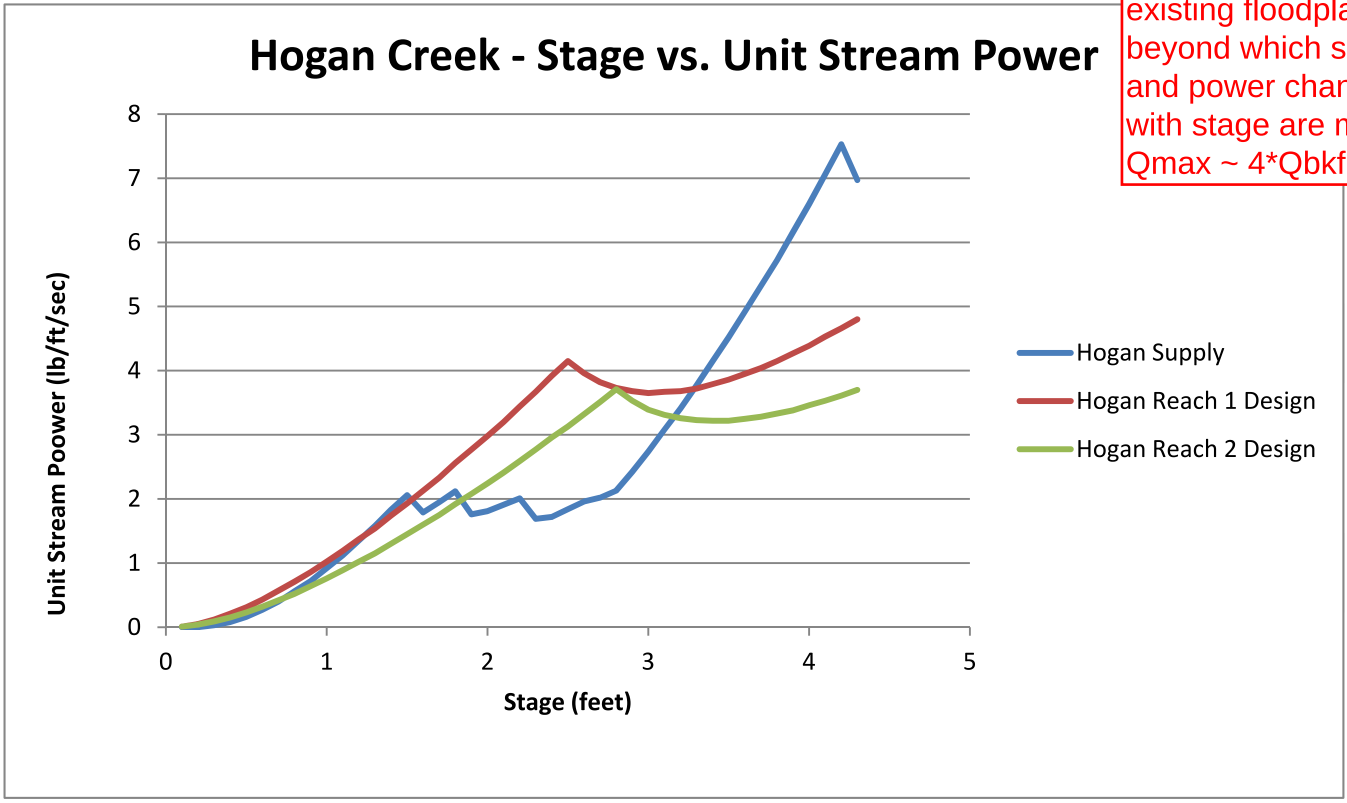
D_{50} = 0.03 m
D_{84} = 0.077 m
S = 0.0079

Bottom Width (active channel) = 13.8 ft

qc2, D_{50} =	0.278	$m^3/s/m$	0.085	cms/ft =	2.994	cfs/ft	41	cfs
qc2, D_{84} =	0.343	$m^3/s/m$	0.105	cms/ft =	3.691	cfs/ft	51	cfs



Note: stage limits on both graphs correspond to top of terrace slope at existing floodplain, beyond which shear and power changes with stage are minor; Qmax ~ 4*Qbkf



UT2 TYPICAL SECTION DESIGN

RIFFLE SECTION

Right Bank Slope, x:1	2.5
Left Bank Slope, x:1	2.5
Max Depth (ft)	1
Bottom Width (ft)	4
Area	6.5
Bankfull Width (ft)	9
Bankfull Depth (ft)	0.72
W/D ratio	12.46

Regional Curve Estimates

DA (sq. mi.)	0.126199
NC Mountains (area)	5.288994
NC Mountains (discharge)	20.87245
NC rural Piedmont (area)	5.244939
NC rural Piedmont (discharge)	20.06068
USGS 2 year discharge	
NC Hydro Area 1	22
SW Appalachian (area)	7.611258
SW Appalachian (discharge)	31.76657

Discharge Calculation overall reach

$Q = 1.49/n\ R^{2/3}\ s^{1/2}\ A$

WP (ft)	9.39
R (ft)	0.69
design slope	0.0223
Channel n	0.04
Q (cfs)	28

FROM CAD, design slope = 0.022252

γRs = 0.961682 psf

grain diam, Shields = 140 mm (CO data)

bar sample 1

d_{84} = 30 mm

d_{100} = 84 mm

POOL SECTION

Right Bank Slope, x:1	3
Left Bank Slope, x:1	2
Max Depth (ft)	1.6
Bottom Width (ft)	4
Area	12.8
Bankfull Width (ft)	12
pt bar tob o/s	6.8
outside bank tob o/s	5.2

width ratio = 1.33

depth ratio = 2.22

Andrews (1984) and Andrews and Nankervis (1995)

$\tau_{ci}* = 0.0834(d_i/d'_{50})^{-0.872}$ applies if di/d'50 ranges from 3 to 7

$\tau_{ci}* = 0.0384(d_i/d'_{50})^{-0.887}$ if di/d'50 is 1.3 to 3.0

$d_i = d_{50}$ of riffle pavement (from zigzag), mm

$d'_{50} = d_{50}$ of sub-pavement (bar sample), mm

$d = \tau_{ci}*((\rho_{sand}-\rho_{h20})/\rho_{h20)}*D_i)/s$

d = mean bankfull depth of water (ft) needed to move largest particle

$\rho_{sand =}$ 2.65 g/cc specific gravity of sand

$\rho_{h20 =}$ 1.00 g/cc specific gravity of water

Di = largest particle found in bar or subpavement sample (ft)

s = average (bankfull) water surface slope

Using UT2 sediment data from reference reach:

d_i	21	mm
d'_{50}	8	mm
$d_{i/d'50}$	2.625	
$\tau_{ci}* =$	0.016314	

Di	84	mm	=	0.275591	ft
s	0.022252	ft/ft			
d =	0.33	ft			

from stage report in RM w/ d_{bkf} = d, q_{ci} ~	2.6	cfs	xs6
	3.0	cfs	ref riffle

Bathurst et al (1987)

$q_{cD50} = (0.15g^{0.5}D_{50}{}^{1.5})/(s^{1.12})$ D in ft

$q_{ci} = q_{cD50}(D_i/D_{50})^b$

$b = 1.5(D_{84}/D_{16})^{-1}$

UT2 Reference Riffle

D_{50} =	0.021	m	0.06888	ft
D_{84} =	0.097	m	0.31816	ft
D_{16} =	0.005	m	0.0164	ft
s =	0.022252			
q_{cD50} =	1.091688	cfs		
b =	0.07732			
q_{ci} =	1.2288	cfs/ft		

channel width (assumed bottom width) = 6.4 ft

q_{ci} = 7.9 cfs

Check discharge for initiation of Phase 2 transport using **Bathurst (2007)** equations:

$q_{c2} = 0.0513\ g^{0.5}\ D_{50}^{1.5}\ S^{-1.2}$ units of cms; D (m) of the surface material from pebble count

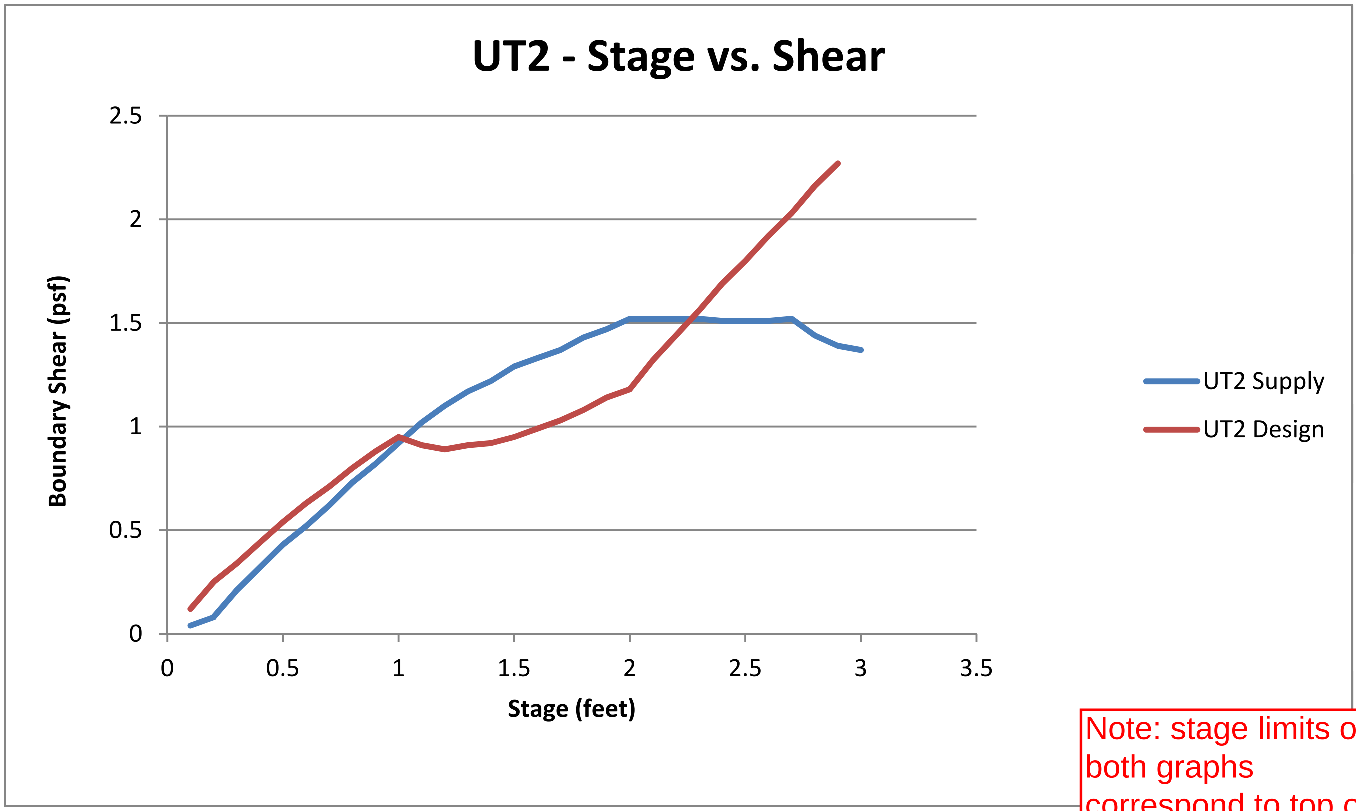
$q_{c2} = 0.0133\ g^{0.5}\ D_{84}^{1.5}\ S^{-1.23}$ g = 9.81 m/s^2

From UT2 reference reach:

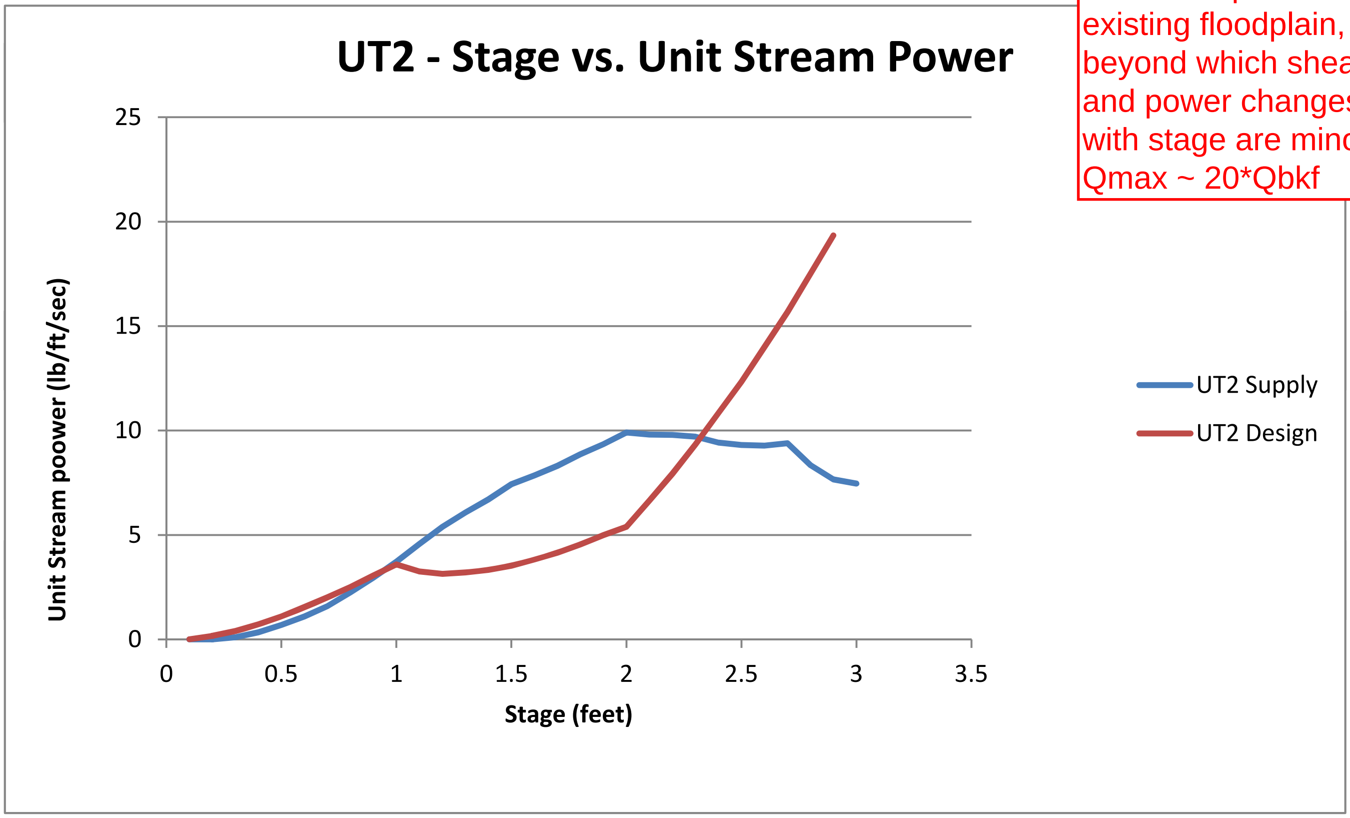
D_{50} = 0.021 m
D_{84} = 0.097 m
S = 0.0223

Bottom Width (active channel) = 6.4 ft

qc2, D_{50} = 0.047 $m^3/s/m$ 0.014 cms/ft = 0.506 cfs/ft 3.2 cfs
qc2, D_{84} = 0.136 $m^3/s/m$ 0.041 cms/ft = 1.460 cfs/ft 9.3 cfs



Note: stage limits on both graphs correspond to top of terrace slope at existing floodplain, beyond which shear and power changes with stage are minor; Qmax ~ 20*Qbkf



UT3 TYPICAL SECTION DESIGN

RIFFLE SECTION

Right Bank Slope, x:1	2
Left Bank Slope, x:1	2
Max Depth (ft)	0.5
Bottom Width (ft)	3
Area	2.0
Bankfull Width (ft)	5
Bankfull Depth (ft)	0.40
W/D ratio	12.50
Ave Width (ft) =	

Discharge Calculation overall reach

$Q = 1.49/n\ R^{2/3}\ s^{1/2}\ A$

WP (ft)	5.24
R (ft)	0.38
design slope	0.0254
Channel n	0.045
Q (cfs)	6
Ω (power)	9

γRs = 0.605 psf

grain diam, Shields = 100 mm (CO data)

POOL SECTION

Right Bank Slope, x:1	3
Left Bank Slope, x:1	2
Max Depth (ft)	1
Bottom Width (ft)	3
Area	5.5
Bankfull Width (ft)	8
pt bar tob o/s	4.5
outside bank tob o/s	3.5

width ratio = 1.60

depth ratio = 2.50

Regional Curve Estimate UT3

DA (sq. mi.)	0.027515
NC Mountains (area)	1.877441
NC Mountains (discharge)	6.559159
NC rural Piedmont (area)	1.861803
NC rural Piedmont (discharge)	6.700075
USGS 2 year discharge	
NC Hydro Area 1	7
SW Appalachian (area)	2.616728
SW Appalachian (discharge)	10.13584

FROM CAD, design slope = 0.02538

UT3 bar sample 1

d_{84} = 14 mm

d_{100} = 65 mm

Andrews (1984) and Andrews and Nankervis (1995)

$\tau_{ci}* = 0.0834(d_i/d'_{50})^{-0.872}$ applies if di/d'50 ranges from 3 to 7
$\tau_{ci}* = 0.0384(d_i/d'_{50})^{-0.887}$ if di/d'50 is 1.3 to 3.0

$d_i = d_{50}$ of riffle pavement (from zigzag), mm
$d'_{50} = d_{50}$ of sub-pavement (bar sample), mm

$d = \tau_{ci}*((\rho_{sand}-\rho_{h20})/\rho_{h20)}*D_i)/s$

d = mean bankfull depth of water (ft) needed to move largest particle
$\rho_{sand} =$ 2.65 g/cc specific gravity of sand
$\rho_{h20} =$ 1.00 g/cc specific gravity of water
Di = largest particle found in bar or subpavement sample (ft)
s = average (bankfull) water surface slope

For UT3 sample location

d_i	14	mm			
d'_{50}	6	mm			
$d_{i/d}'_{50}$	2.333333				
$\tau_{ci}* =$	0.018111				
Di	52	mm	=	0.170604	ft
s	0.023292	ft/ft			
d =	0.22	ft			

from stage report in RM w/ $d_{bkf} = d$, q_{ci} ~ 1.11 cfs

Bathurst et al (1987)

$q_{cD50} = (0.15g^{0.5}D_{50}^{1.5})/(s^{1.12})$ D in ft
$q_{ci} = q_{cD50}(D_i/D_{50})^b$
$b = 1.5(D_{84}/D_{16})^{-1}$

UT3 Reference Riffle

D_{50} =	0.014	m	0.04592	ft		
D_{84} =	0.052	m	0.17056	ft		
D_{16} =	0.002	m	0.00656	ft		
s =	0.023292				Existing REW above culvert	0.023292
q_{cD50} =	0.564614	cfs				
b =	0.057692					
q_{ci} =	0.609017	cfs/ft				

channel width (assumed bottom width) = 4.4 ft

q_{ci} = 2.7 cfs

Check discharge for initiation of Phase 2 transport using **Bathurst (2007)** equations:

$q_{c2} = 0.0513\ g^{0.5}\ D_{50}^{\ 1.5}\ S^{-1.2}$ units of cms; D (m) of the surface material from pebble count

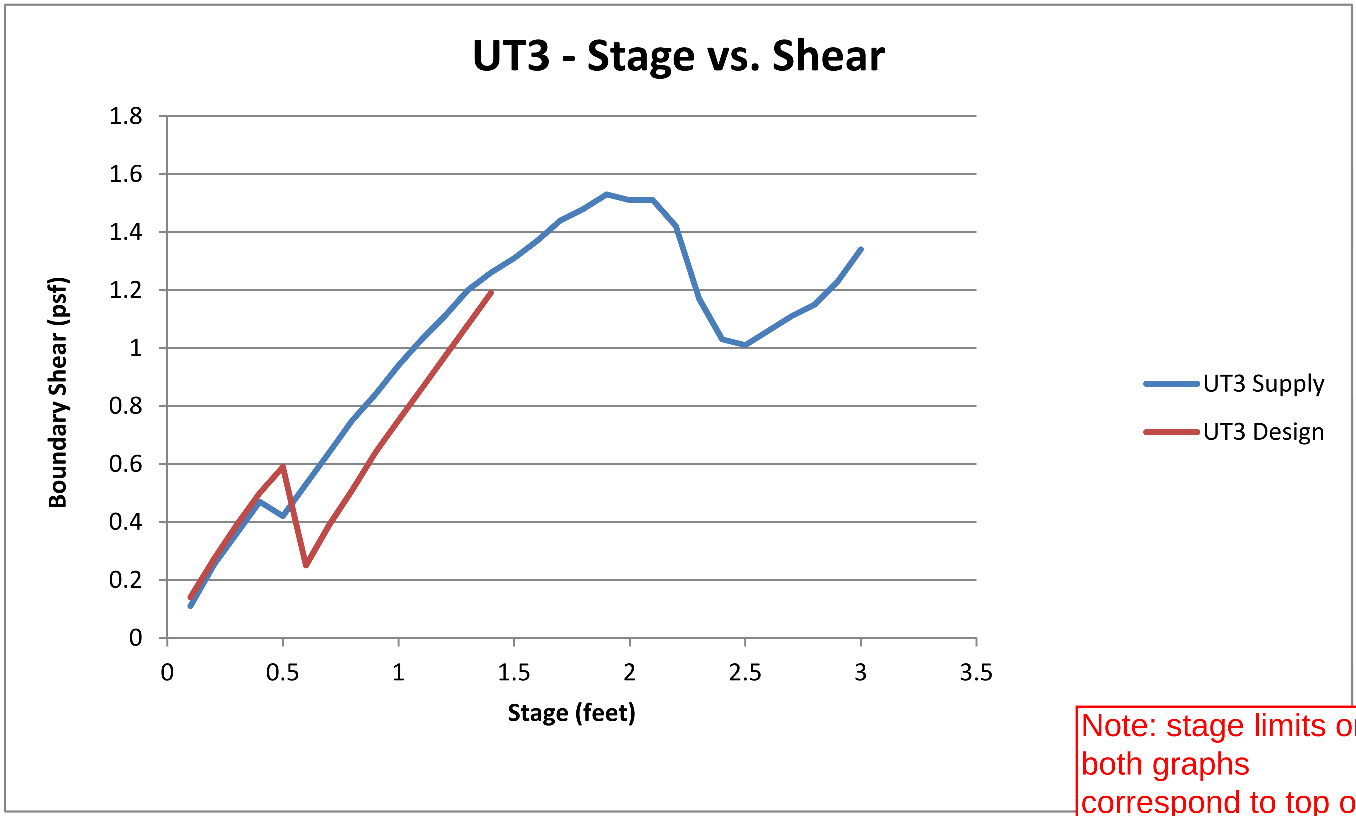
$q_{c2} = 0.0133\ g^{0.5}\ D_{84}^{\ 1.5}\ S^{-1.23}$ g = 9.81 m/s^2

From UT3 reference reach:

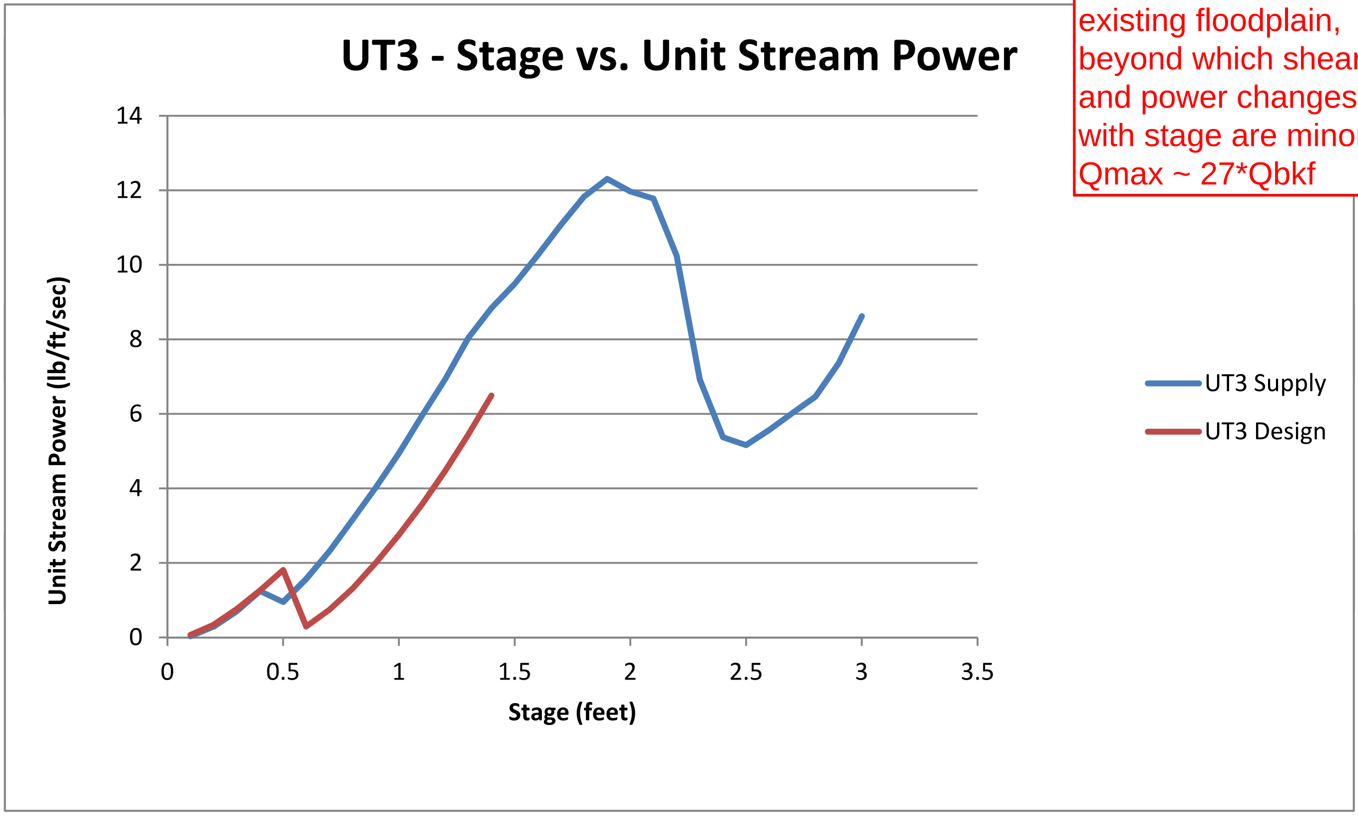
D_{50} = 0.014 m
D_{84} = 0.052 m
S = 0.0233

Bottom Width (active channel) = 4.4 ft

qc2, D_{50} =	0.024 $m^3/s/m$	0.007 cms/ft =	0.261 cfs/ft	1.1 cfs
qc2, D_{84} =	0.050 $m^3/s/m$	0.015 cms/ft =	0.542 cfs/ft	2.4 cfs



Note: stage limits on both graphs correspond to top of terrace slope at existing floodplain, beyond which shear and power changes with stage are minor; Qmax ~ 27*Qbkf



Hand Auger Boring Summary
Hogan Creek Restoration
4/20/2011

HA-1	right floodplain Hogan Reach 2
0-0.3'	Topsoil
0.3' - 4.0'	Tan silty sand, moist to wet
4.0' - 4.7'	Gray silty sand, gw at 4.05'
4.7'	Refusal on gravel

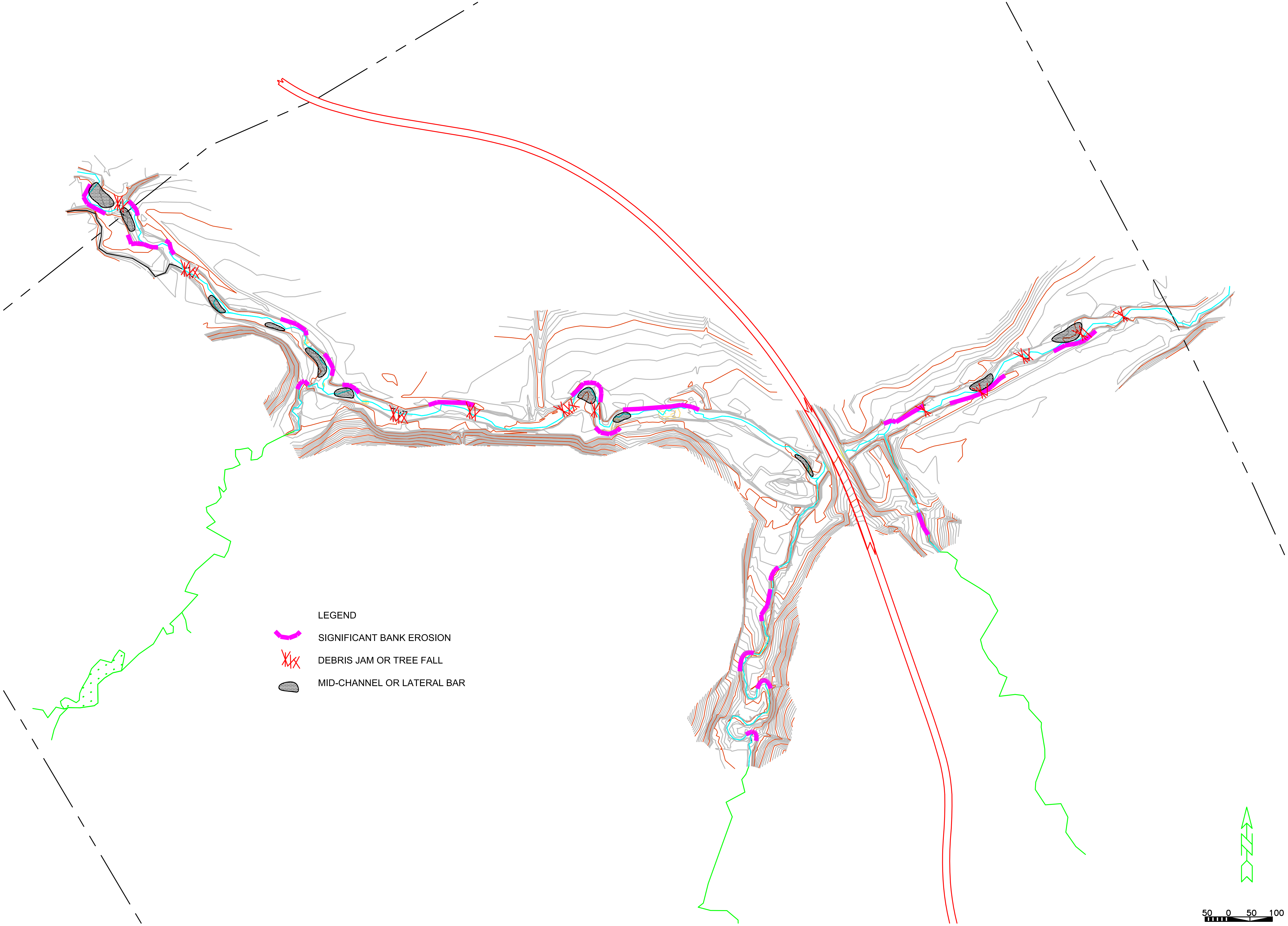
N: 940065.91
E: 1528232.14
Z: 984.68

HA-2	right floodplain Hogan Reach 2
0-0.4'	Topsoil
0.4' - 2.0'	Tan and gray clayey sand, moist
2.0' - 3.9'	Mottled gray and tan sandy clay, wood debris and gw at 2.5'
3.9'	Refusal on gravel

N: 940071.48
E: 1528334.01
Z: 983.68

HA-3	right floodplain Hogan Reach 2
0-0.3'	Topsoil
0.4' - 2.2'	Red-brown silty sand, moist
2.2' - 3.0'	Red-brown and gray silt sandy, moist
3.0' - 3.7'	Red-brown and gray coarse sand and gravel, wet
3.7'	Refusal on gravel

N: 940050.98
E: 1528450.15
Z: 983.87



A			
B			
C			
DESCRIPTION	DATE	APP.	

REVISIONS

PRELIMINARY PLANS

SEAL 2220

ANDREW DAVID BICK

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Asheville, North Carolina 28801
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HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: DEC. 2011
SCALE: 1" = 100'

EXISTING CONDITIONS INVENTORY

SHEET 1 OF 1

APPENDIX D

PRELIMINARY PLANS

EEP PROJECT NO. 94708

PRELIMINARY PLANS

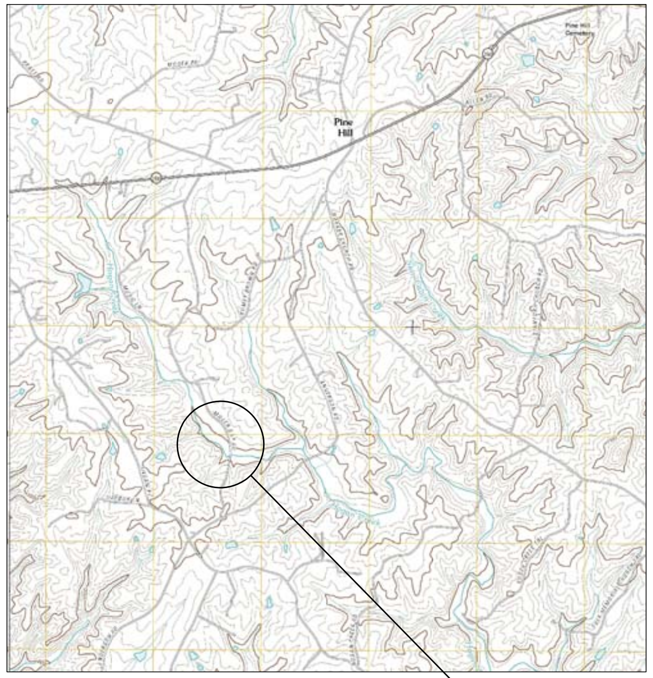
HOGAN CREEK MITIGATION PROJECT

STREAM NAMES: HOGAN CREEK AND THREE UNNAMED TRIBUTARIES
LOCATION: SURRY COUNTY, NORTH CAROLINA

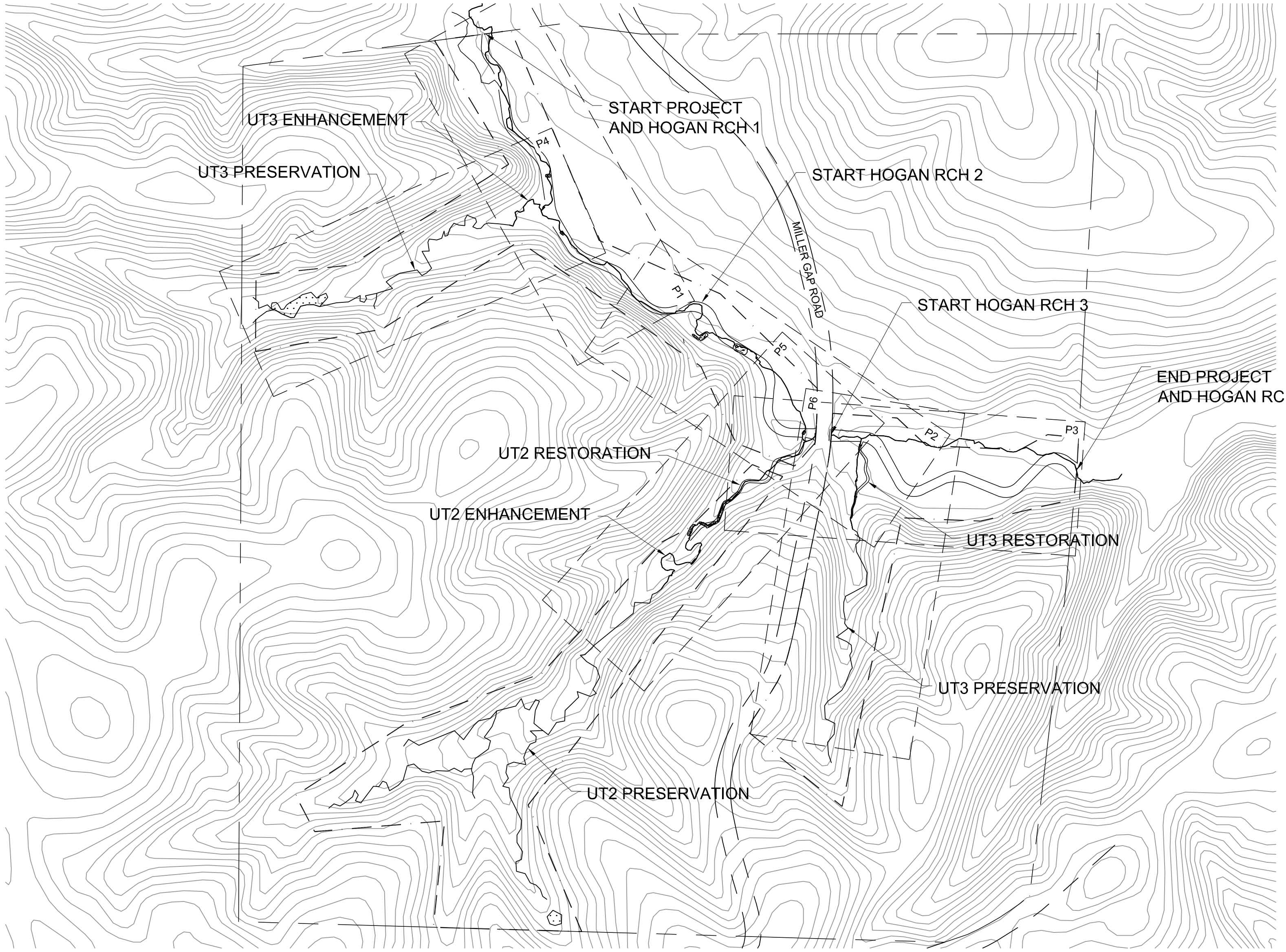
EEP PROJECT NUMBER	SHEET	TOTAL
94708	T1	21

SYM	REVISIONS	DATE	APPROVED
A	PRELIMINARY	10/11	
B			
C			
D			
E			

PRELIMINARY PLANS
NOT FOR CONSTRUCTION



VICINITY MAP
NOT TO SCALE



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INDEX OF SHEETS

T1: TITLE
T2: NOTES AND SYMBOLS
P1-P6: STREAM PLAN AND PROFILE
P7: EASEMENT BOUNDARY MARKING PLAN
P8: CONSTRUCTION ACCESS PLAN
PP1-PP3: PLANTING PLAN AND DETAILS
TS1-TS2: TYPICAL SECTIONS
D1-D6: DETAILS

GRAPHIC SCALES

40 20 0 40 80
PLAN (EXCEPT AS NOTED)

40 20 0 40 80
PROFILE (HORZ.)

4 2 0 4 8
PROFILE (VERT.)

Prepared By:

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PROJECTED START DATE:

COMPLETION DATE:

DESIGN

APPROVAL

PROJECT ENGINEER

SIGNATURE

Prepared for:

Ecosystem Enhancement PROGRAM

CONSTRUCTION SEQUENCE OF EVENTS

Phase 1: Mobilization and General Site Preparation

1. Mobilize equipment and materials to the site. Locate limits of disturbance.
2. Establish construction entrances/exits and staging areas as shown on the plans. Access to the site will be via existing state road and farm paths. Existing stream crossings on UT2 and UT3 shall be used during construction. Install additional temporary stream crossings on Hogan Creek as needed to access work areas.
3. Establish construction haul routes using existing farm paths to the extent feasible. Minimize disturbance beyond immediate haul routes and grading limits. Stabilize haul route surfaces with stone and filter fabric as necessary.
4. Hardwood trees 12 inches dbh and larger that require removal per the plans shall be salvaged for on-site use as in-stream structures. Attention shall be paid to the specified trunk lengths of log and root wad structures shown on the plans.
5. The stems and root masses of exotic invasive species (multi flora rose, Chinese privet, etc.) generated during grading operations shall be burned on site or disposed in approved off site locations.
6. Any stockpiled materials not used for backfill within 30 days of excavation shall be stabilized with temporary seed and straw mulch

Phase 2: Off -Line Channel Construction

1. Perform sod mat cutting within grading limits and stockpile separate from backfill soil for later use on stream banks and planting areas. Limit stripping to those areas that will be graded within 3 days to minimize softening and degradation of subgrade soils under construction traffic.
2. When excavating new off-line channel, leave plugs of existing bank material in place at upstream and downstream ends Base flow shall be maintained in the existing channel until new channel is fully stabilized with sod mats, seeding and structures. riffles
3. Complete in-stream structure installation and bank stabilization on the new channel. Transplant sod mats. Seed and mat banks where sod mat transplanting is not feasible. Stockpile excavated soils between new channel and existing channel for later backfilling. Silt fence shall be installed on the creek side of all stockpiles.
4. Working from the top of the existing stream banks, excavate gravel and cobble bar sediment and stockpile separately for use in constructed riffles and other structures
5. Once the new channel is stabilized, complete tie-ins from existing to new channel, taking precautions to limit introduction of soil to live stream. Diverting water into the new channel shall proceed according to the following steps
    a. Remove plug at downstream end of new off-line channel
    b. Setup pump- around operation above upstream tie-in.
    c. Grade online stream channel to proper dimensions and profile and tie -in to new offline channel.
    d. Backfill abandoned channel upstream to downstream, using stockpiled soil, compacted in lifts not to exceed 12 inches in thickness. Stabilize with straw mulch, temporary and permanent seed.

Phase 3: On-Line Channel Construction

1. Base flow shall be diverted per the plans using a single diversion setup if feasible. Install temporary sand bag coffer dams upstream and downstream of work area. Install pump, suction and discharge lines, and divert flow around tie-in area. Install dewatering pump as necessary and discharge through silt bag.
2. Perform earthwork, in-stream structure installation, geo-lifts,seeding, mulching and matting per the plans. Salvage gravel and cobble sediment for use in constructed riffles and other structures.
2. Permanently dispose of excavated material in approved upland or off- site area. Silt fence shall be installed on the creek side of all temporary stockpiles.
3. Temporarily dismantle flow diversion prior to flood event that exceeds capacity of diversion, ensuring that work areas are fully stabilized.
4. Once restored channel is fully stabilized, dismantle pumps, discharge lines and coffer dams and return flow to restored channel.

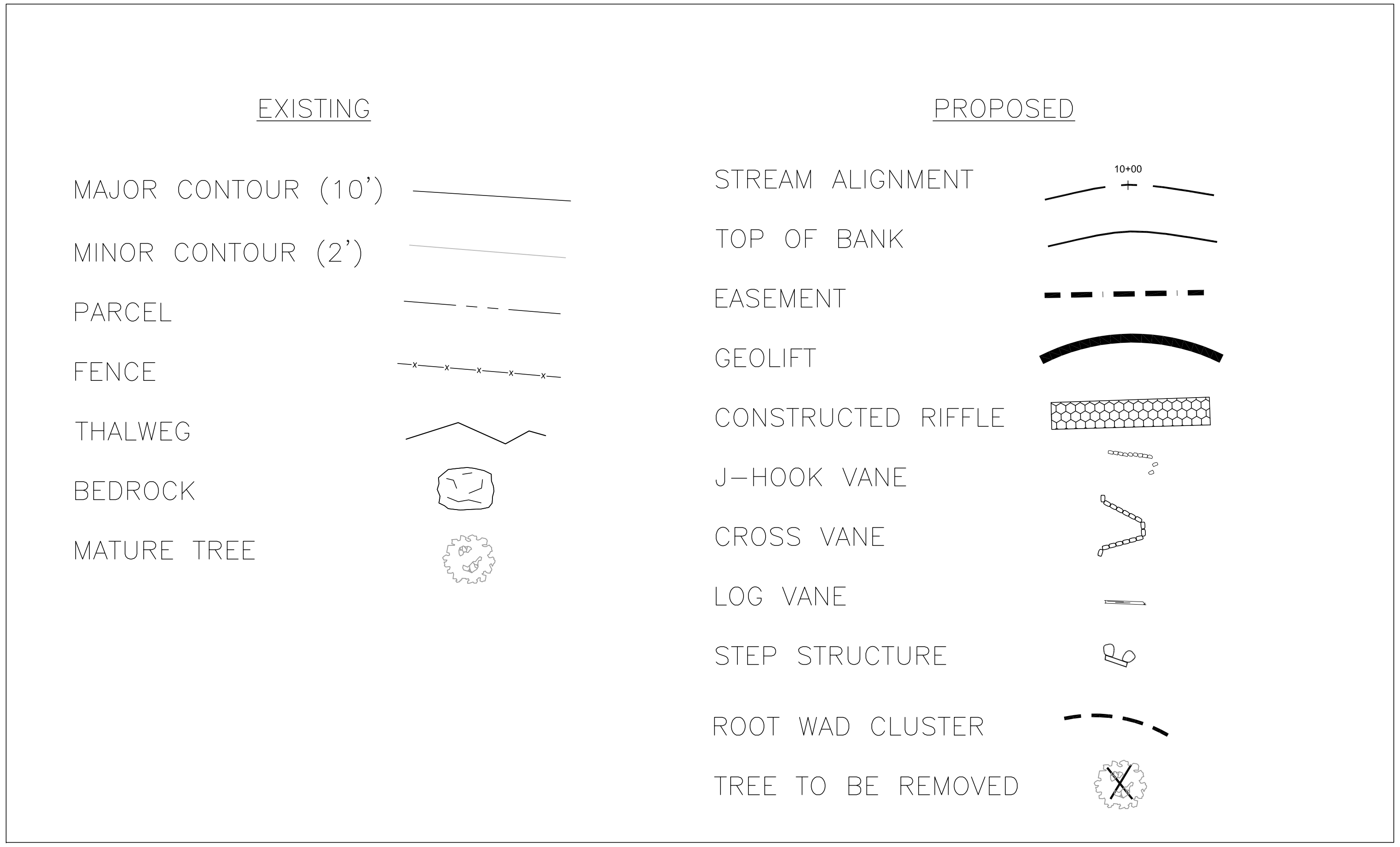
Phase 4: Demobilization

1. Upon completion of stream and floodplain grading operations, silt fences shall be removed, construction entrances/exits shall be removed, and the construction haul routes shall be graded, seeded and mulched as needed to restore them to their pre-project conditions.
2. Upon demobilization of equipment and materials, the staging areas shall be restored to their pre project conditions.

Phase 4a: Planting

1. Site planting, including live stakes and bare root trees and shrubs shall be completed after grading and in-stream structure operations are complete and during the dormant season (November to April).

LEGEND



	DESCRIPTION	DATE	APP.
A			
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REVISIONS

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PRELIMINARY PLANS

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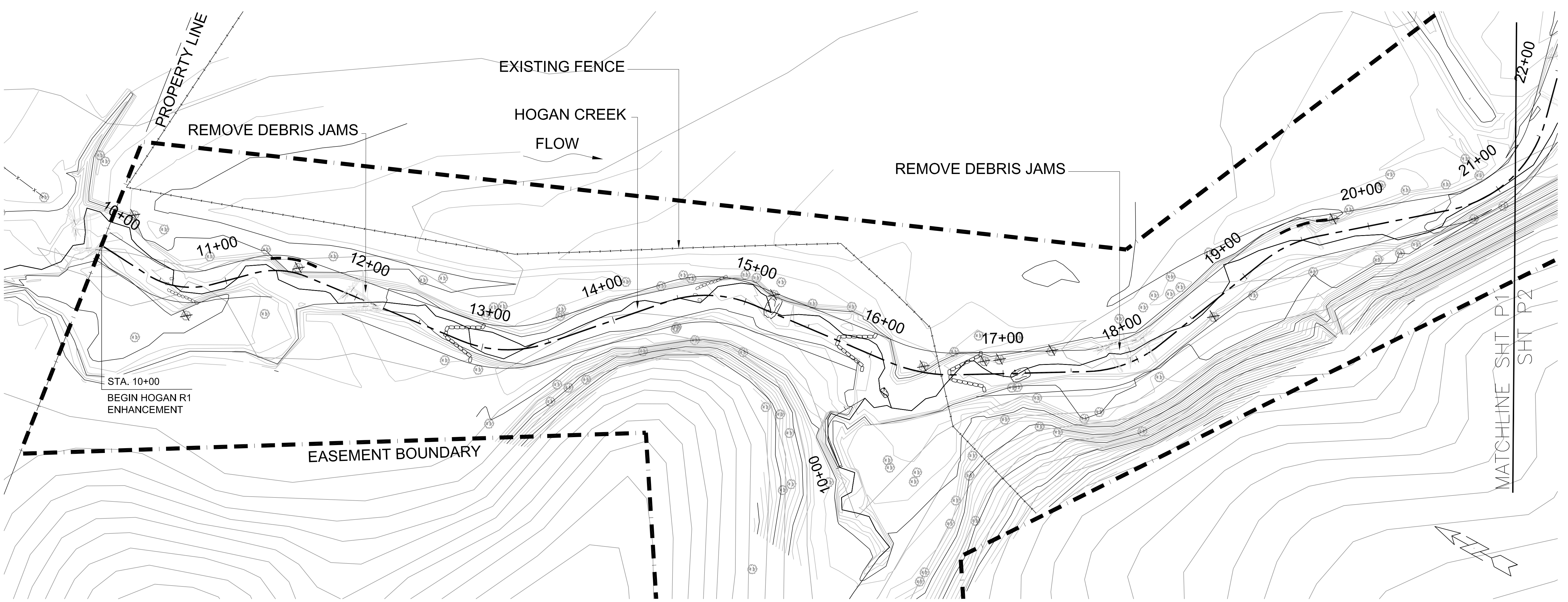
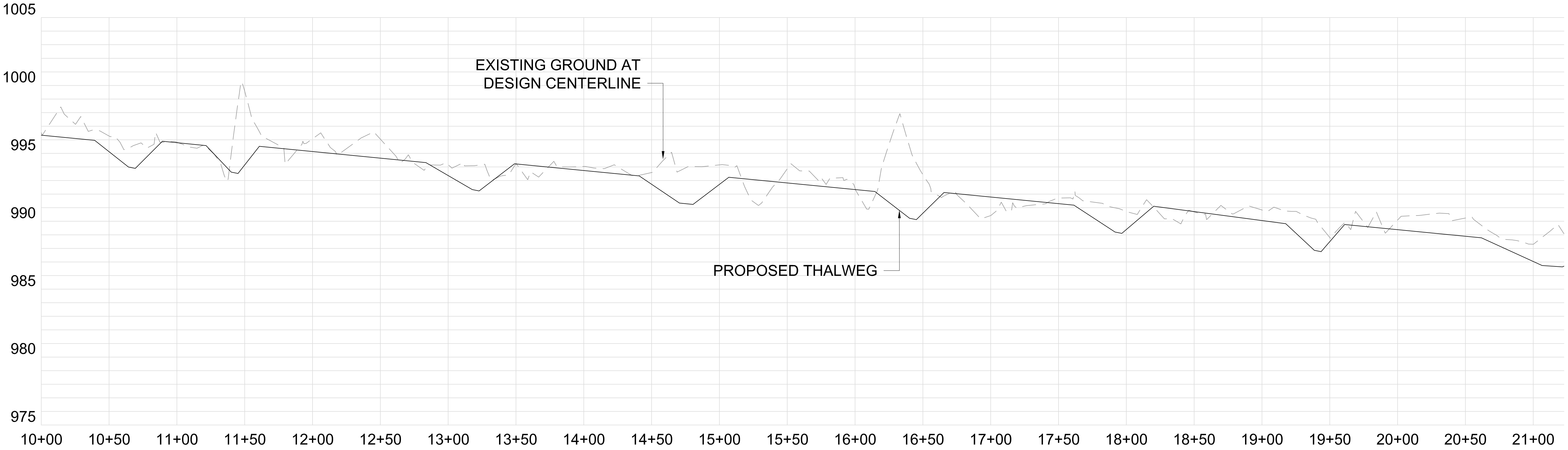
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: OCT. 2011
SCALE: NTS

NOTES AND SYMBOLS

SHEET T2 OF 21





HOGAN CREEK PROFILE 1:80

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	DESCRIPTION	DATE	APP.
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SEAL
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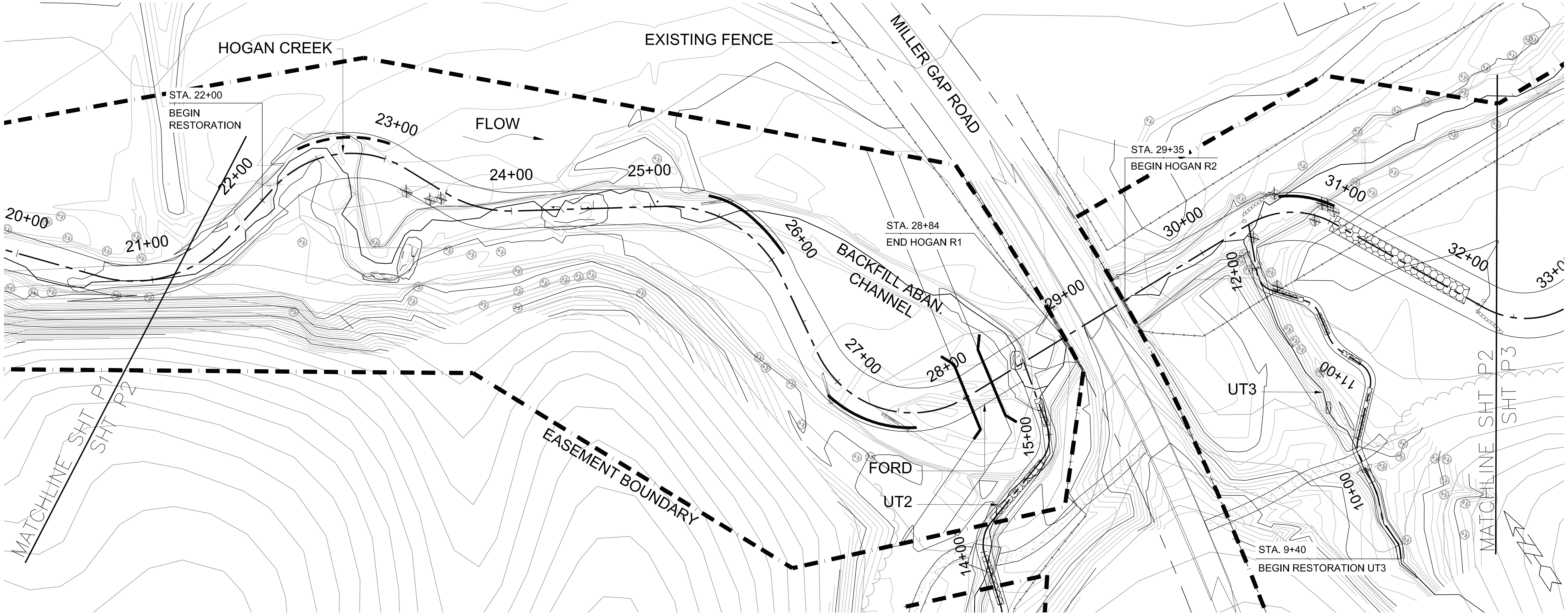
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

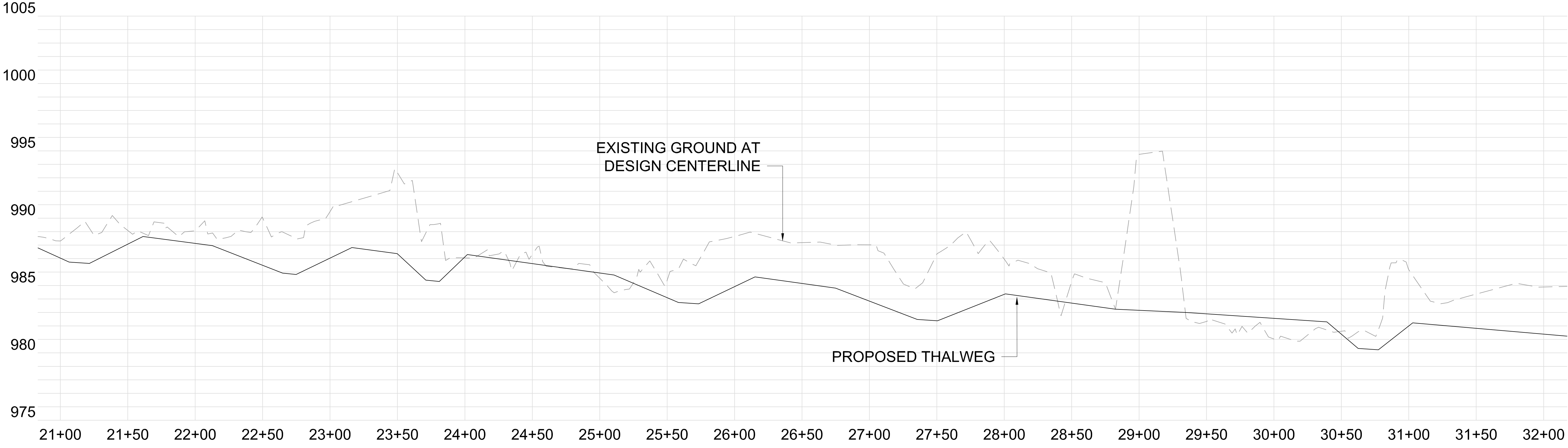
STA. 10+00 TO 21+00

DATE: OCT. 2011
SCALE: 1" = 80'

HOGAN CREEK
PLAN & PROFILE

SHEET P1 OF 21





HOGAN CREEK PROFILE 1:80

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	DESCRIPTION	DATE	APP.

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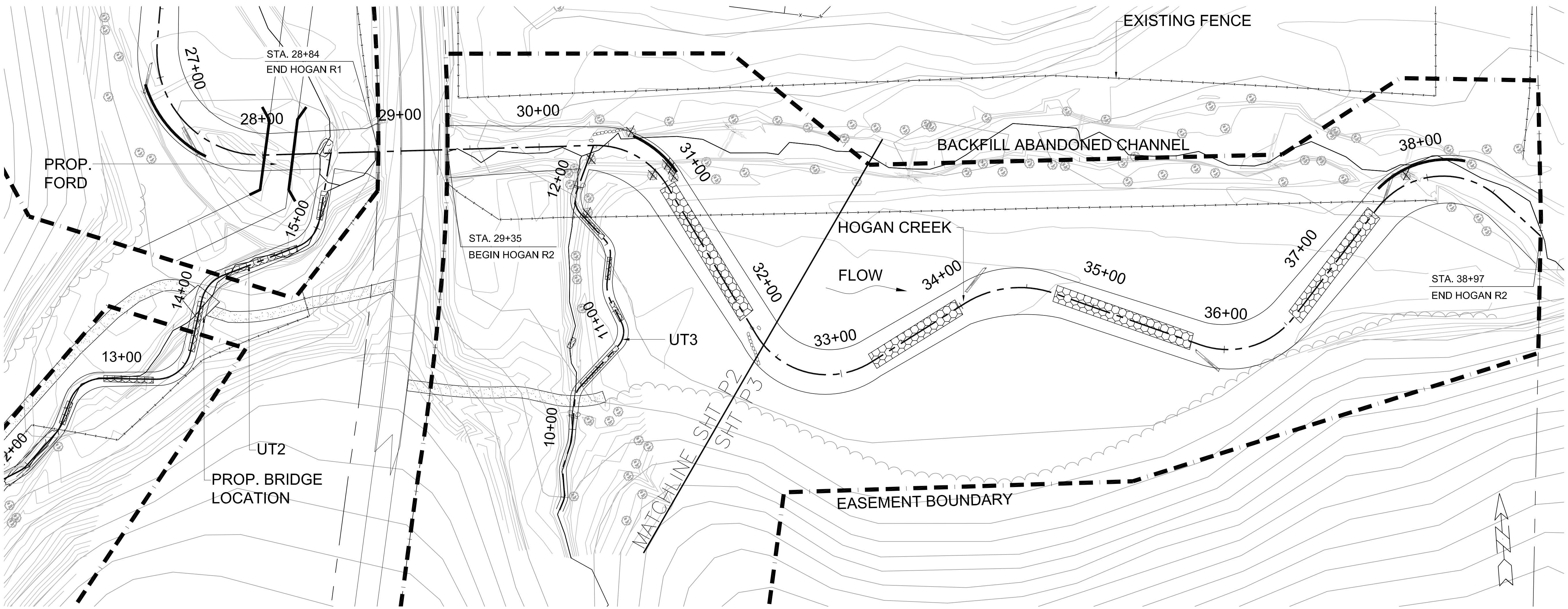
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

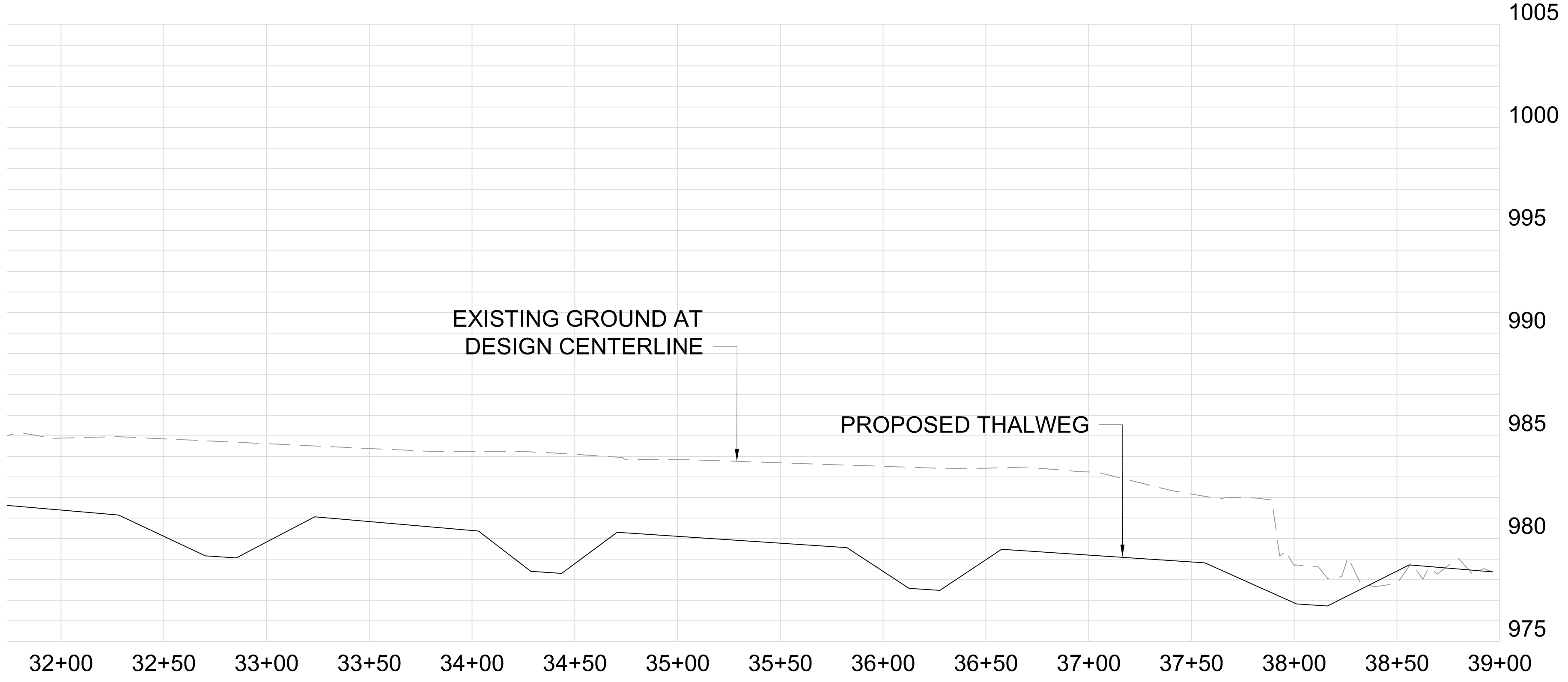
STA. 21+00 TO 32+00

DATE: OCT. 2011
SCALE: 1" = 80'

HOGAN CREEK
PLAN & PROFILE

SHEET P2 OF 21





HOGAN CREEK PROFILE 1:80

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DESCRIPTION DATE APP.

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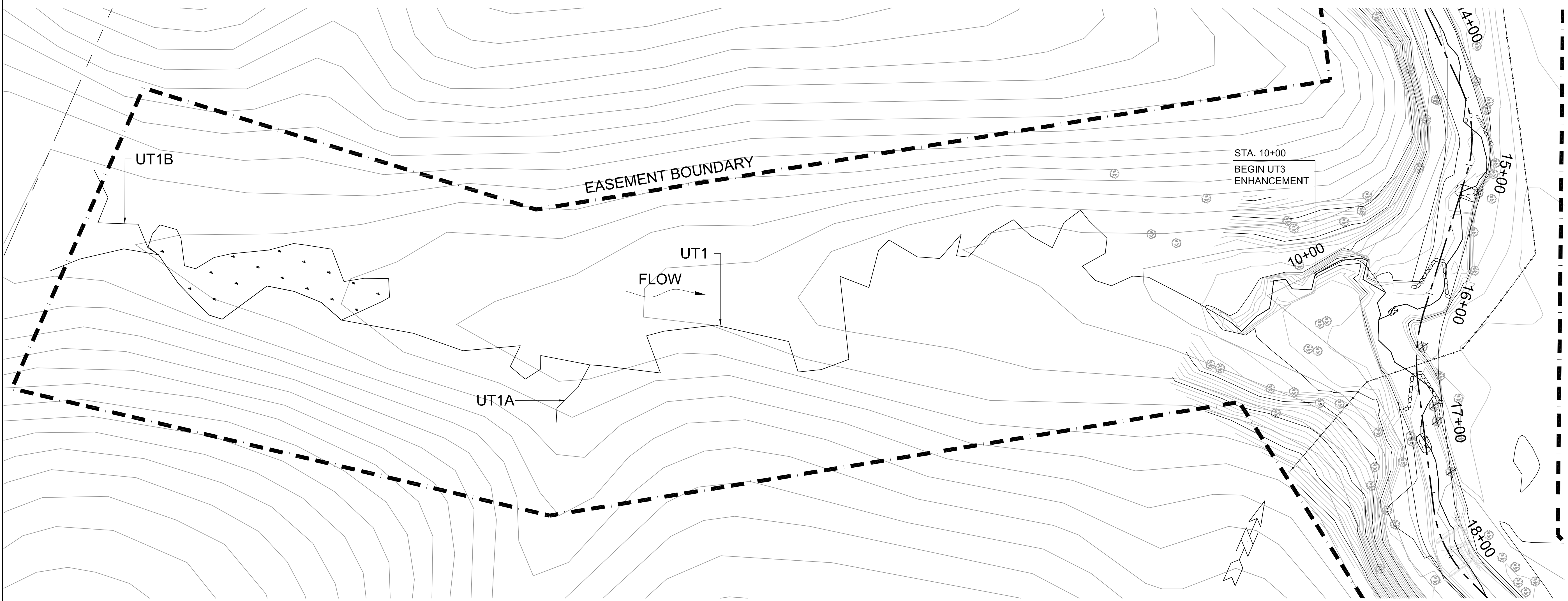
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

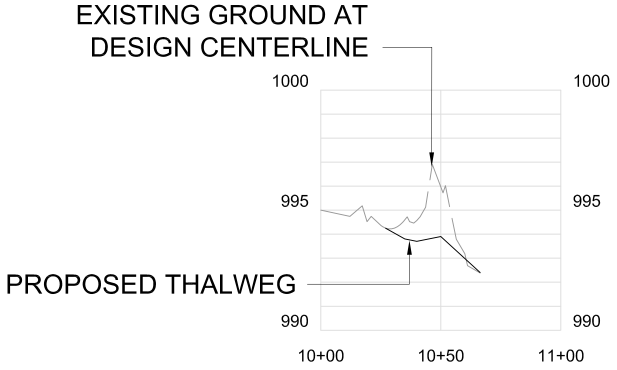
STA. 32+00 TO 38+97

DATE: OCT. 2011
SCALE: 1" = 80'

HOGAN CREEK
PLAN & PROFILE

SHEET P3 OF 21





UT1 PROFILE 1:80

	DESCRIPTION	DATE	APP.
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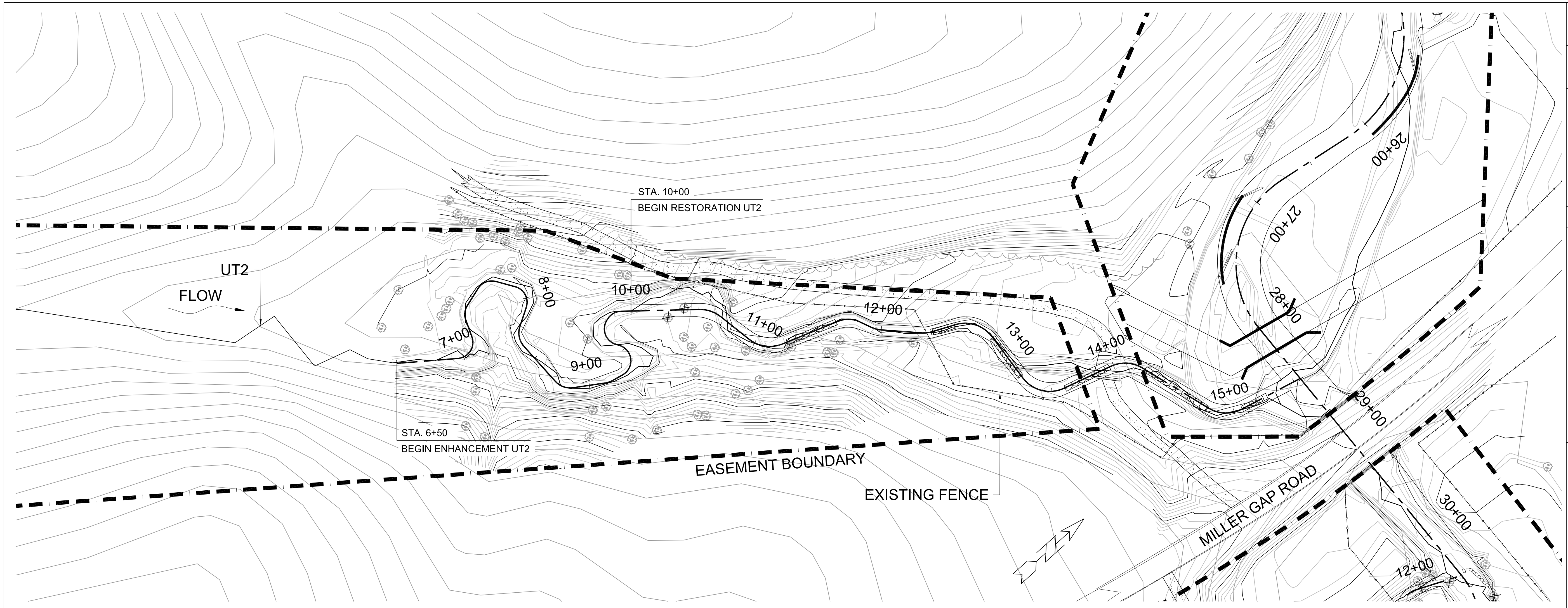
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

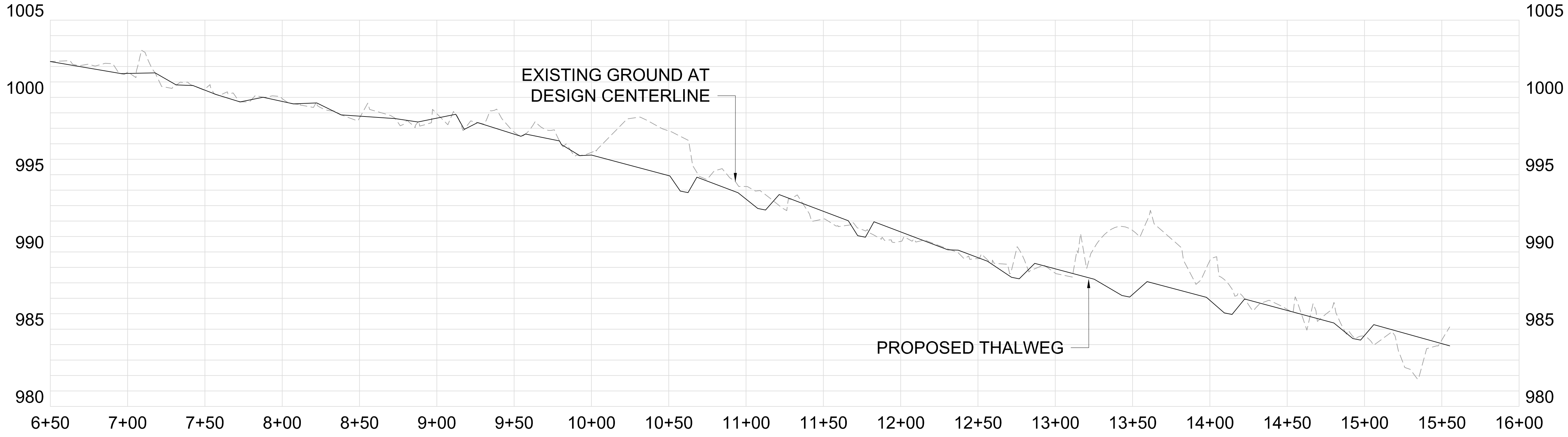
STA. 10+00 TO 10+60

DATE: OCT. 2011
SCALE: 1" = 80'

UT1 PLAN &
PROFILE

SHEET P4 OF 21





UT2 PROFILE 1:80

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	DESCRIPTION	DATE	APP.
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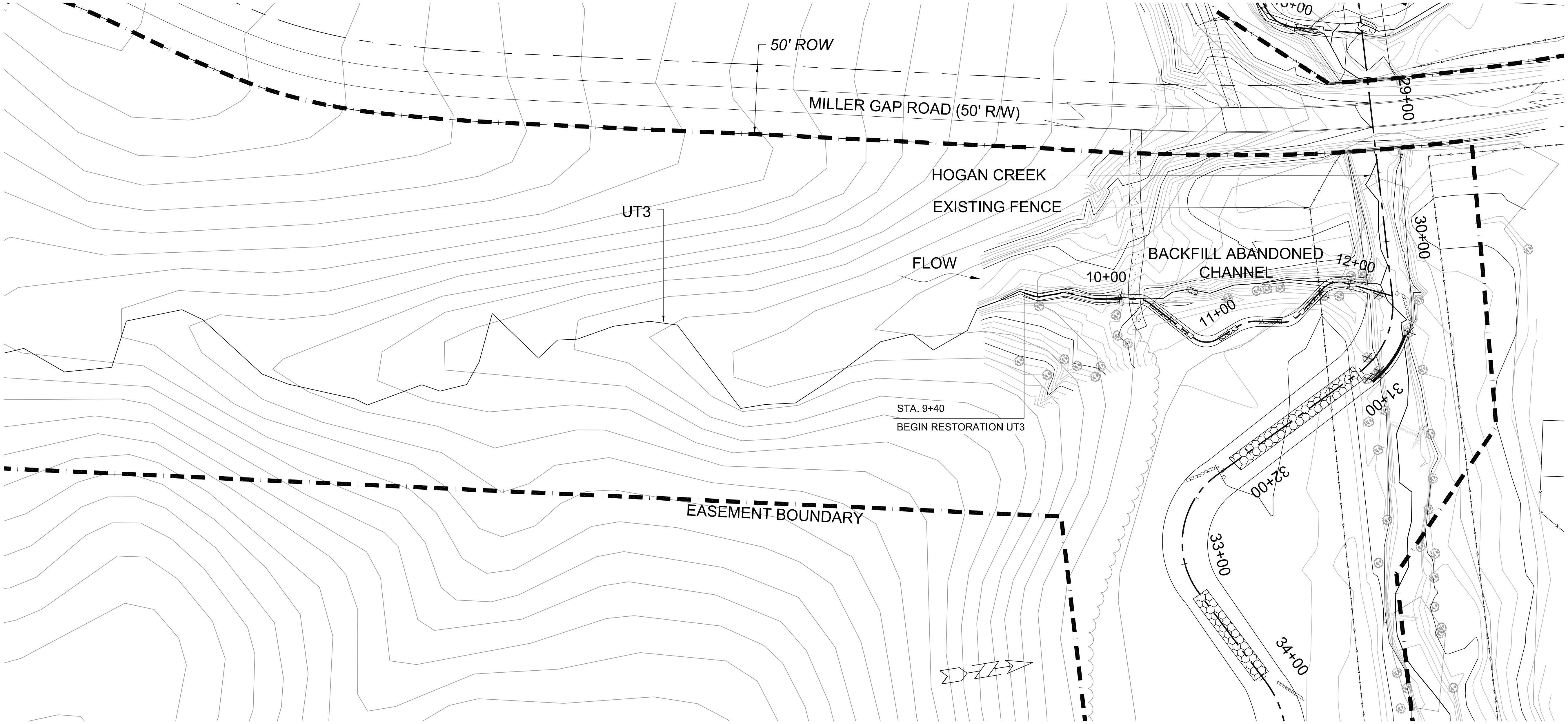
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

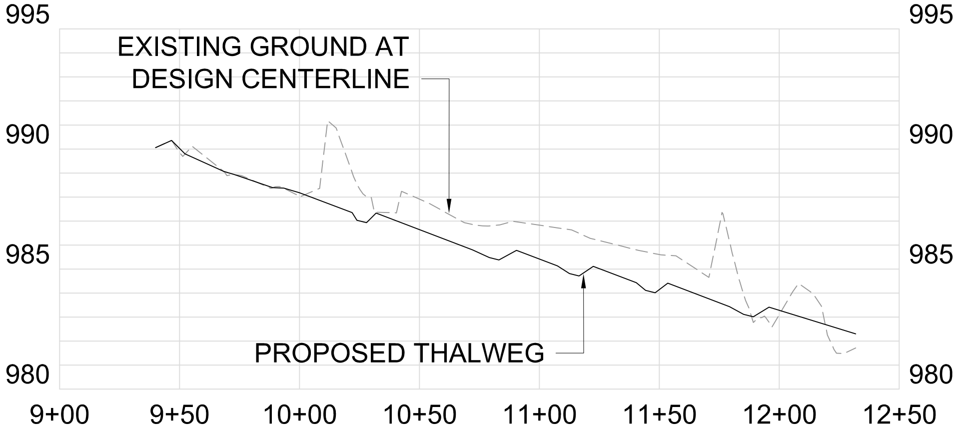
STA. 10+00 TO 15+55

DATE: OCT. 2011
SCALE: 1" = 80'

UT2 PLAN &
PROFILE

SHEET P5 OF 21





UT3 PROFILE 1:80

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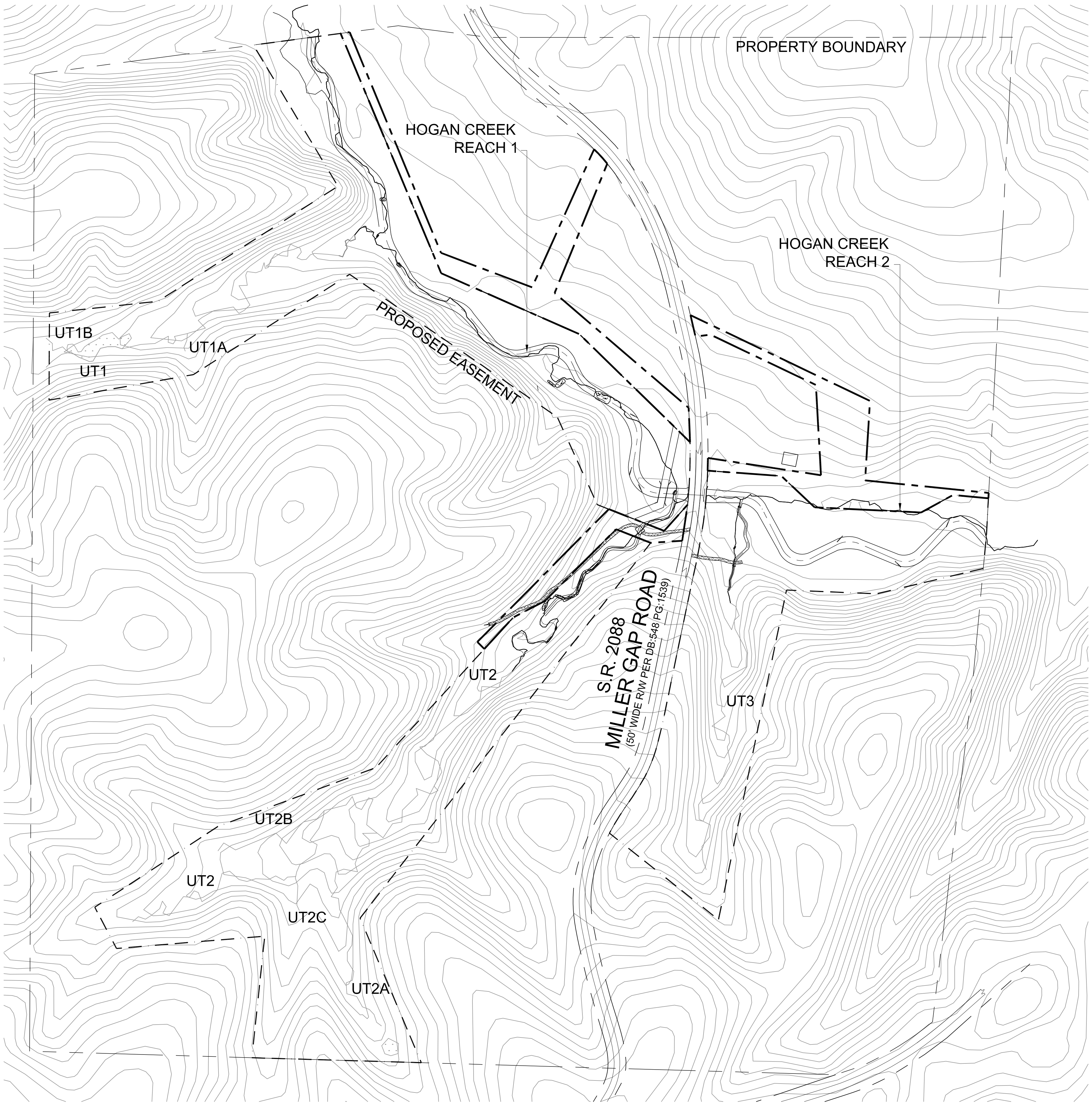
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

STA. 9+40 TO 12+32

DATE: OCT. 2011
SCALE: 1" = 80'

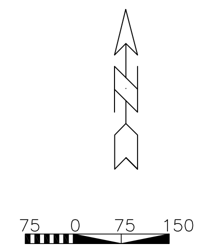
UT3 PLAN & PROFILE

SHEET P6 OF 21



LEGEND

- – – – - – – TOTAL EASEMENT BOUNDARY (36.35 ACRES)
- **— · —** TEMPORARY CONSTRUCTION EASEMENT (4.76 ACRES)



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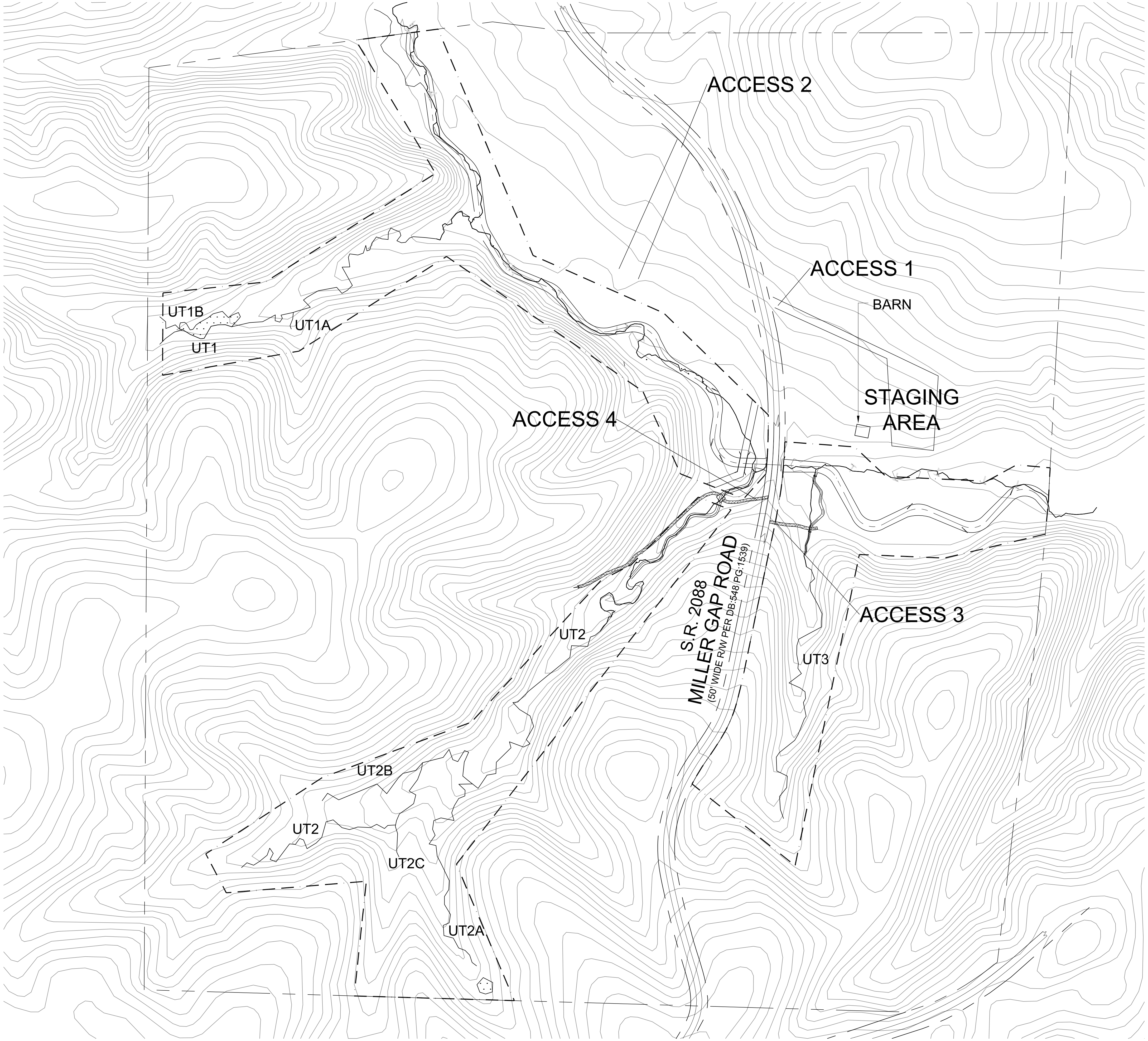
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: OCT. 2011
SCALE: 1" = 300'

EASEMENT BOUNDARY MARKING PLAN

SHEET P7 OF 21



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HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: OCT. 2011
SCALE: 1" = 300'

CONSTRUCTION ACCESS PLAN

SHEET P8 OF 21

INVASIVE SPECIES CONTROL NOTES:

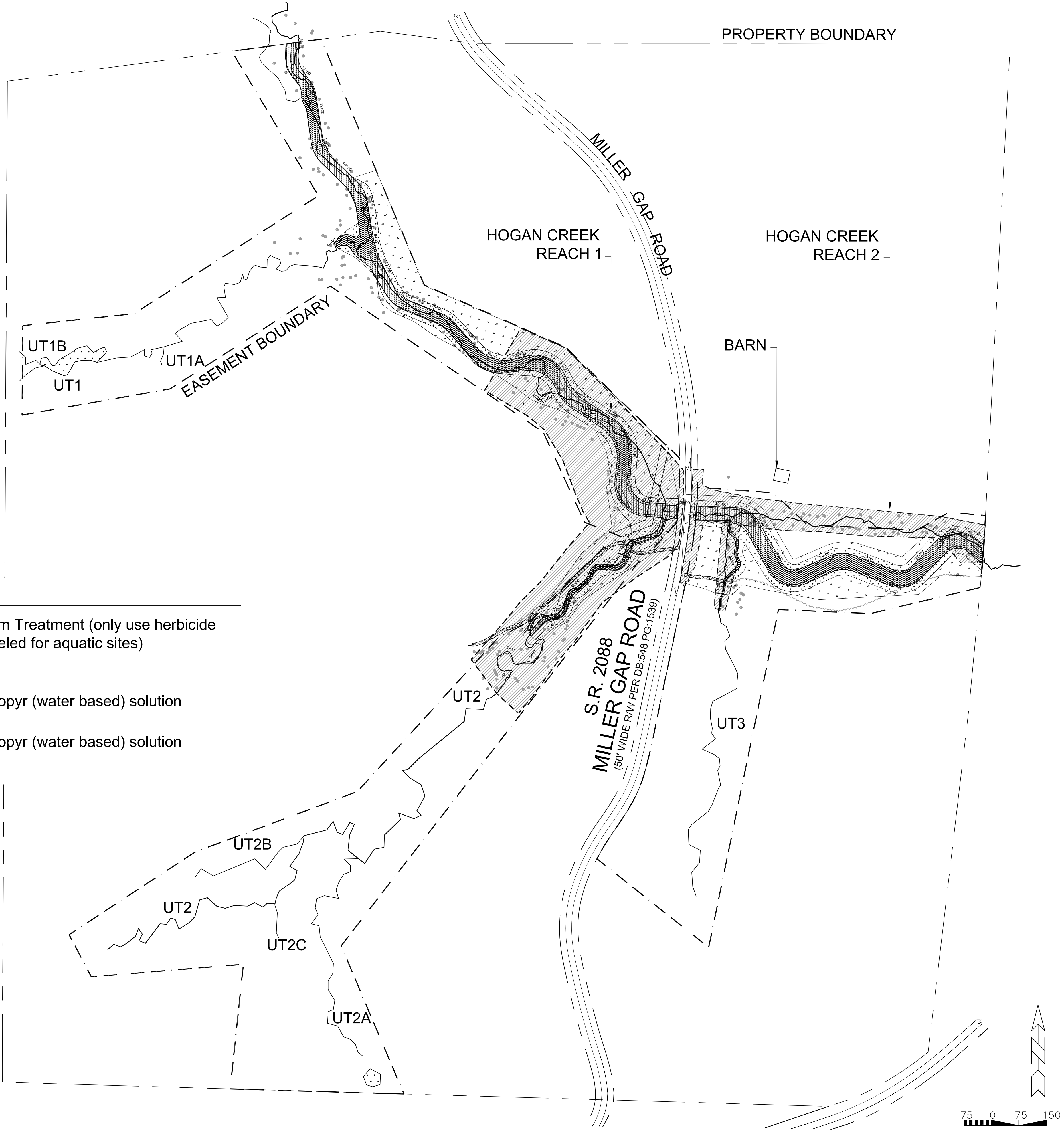
1. Invasive exotic species at the site include, but are not limited to Kudzu (*Pueraria montana)* and Chinese Privet (*Ligustrum sinense*). Invasive exotic species other than those listed above may be encountered on the site and shall be removed from within the work limits, using the herbicide solutions described herein or variations as appropriate.
2. Areas of herbicide treatment will be marked by the owner prior to application. Foliar spray shall be used in areas where spraying will not harm vegetation to be protected. Herbicide treatment shall be performed with as little disturbance to the surrounding native vegetation as possible. In areas where invasive exotic species are in close proximity to vegetation to be preserved, the invasive exotic plants shall be cut near the stem base and the cut surface treated with an approved herbicide.
3. Herbicide use in aquatic and riparian areas requires careful handling and application. The contractor shall employ qualified and licensed personnel to perform herbicide applications so as to prevent release or runoff to surface water in accordance with applicable laws and regulations.
4. Cut plant material shall be hauled off site and disposed in an approved location.

Target Species	Foliar Spray (only use herbicide labeled for aquatic sites)	Basal Cut/Stem Treatment (only use herbicide labeled for aquatic sites)
Vines		
Kudzu Pueraria montana	2 to 3% glyphosate/0.5% surfactant*	50% triclopyr (water based) solution
Chinese Privet Ligustrum sinense	2% glyphosate/0.5% surfactant*	50% triclopyr (water based) solution

LEGEND

See sheet PP2 for planting schedule

PLANTING ZONE 1 (117,651 SF) UPPER STREAM BANK	▩
PLANTING ZONE 2 (90,538 SF) FLOOD PLAIN	░
PLANTING ZONE 3 (165,545 SF) FLOOD PLAIN & TERRACE	⁘
INVASIVE SPECIES CONTROL AREA	▨



	DESCRIPTION	DATE	APP.
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REVISIONS

PRELIMINARY PLANS

SEAL 22209

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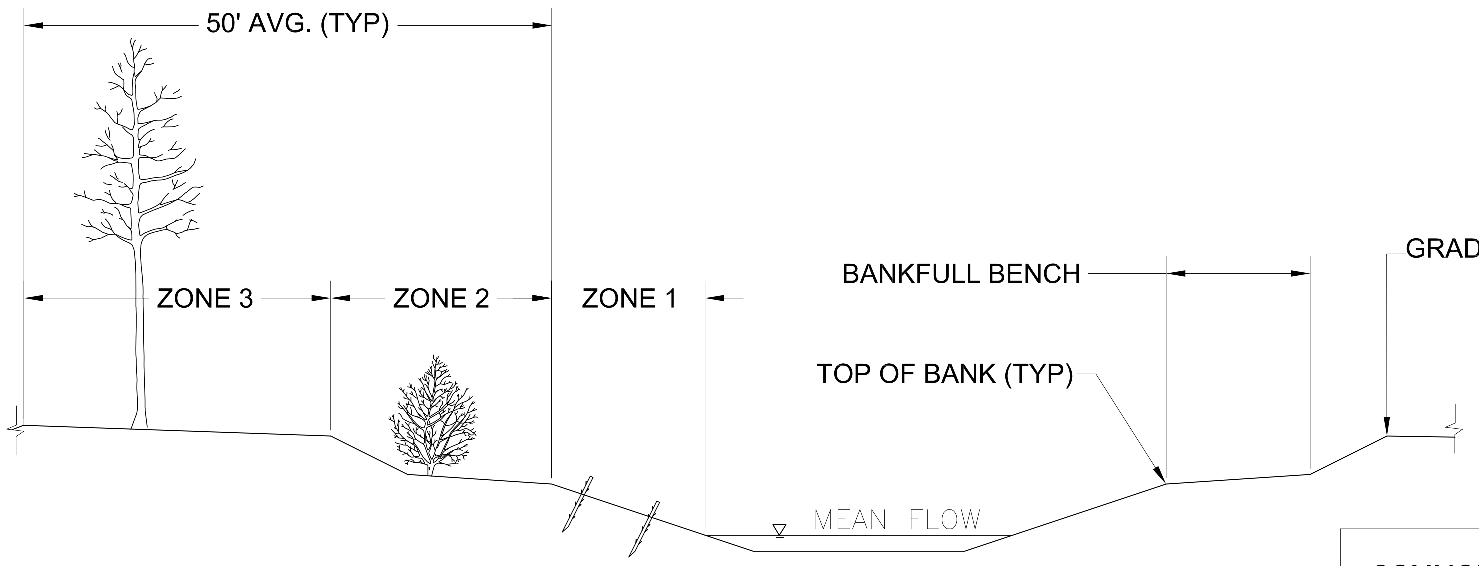
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: OCT. 2011
SCALE: 1" = 300'

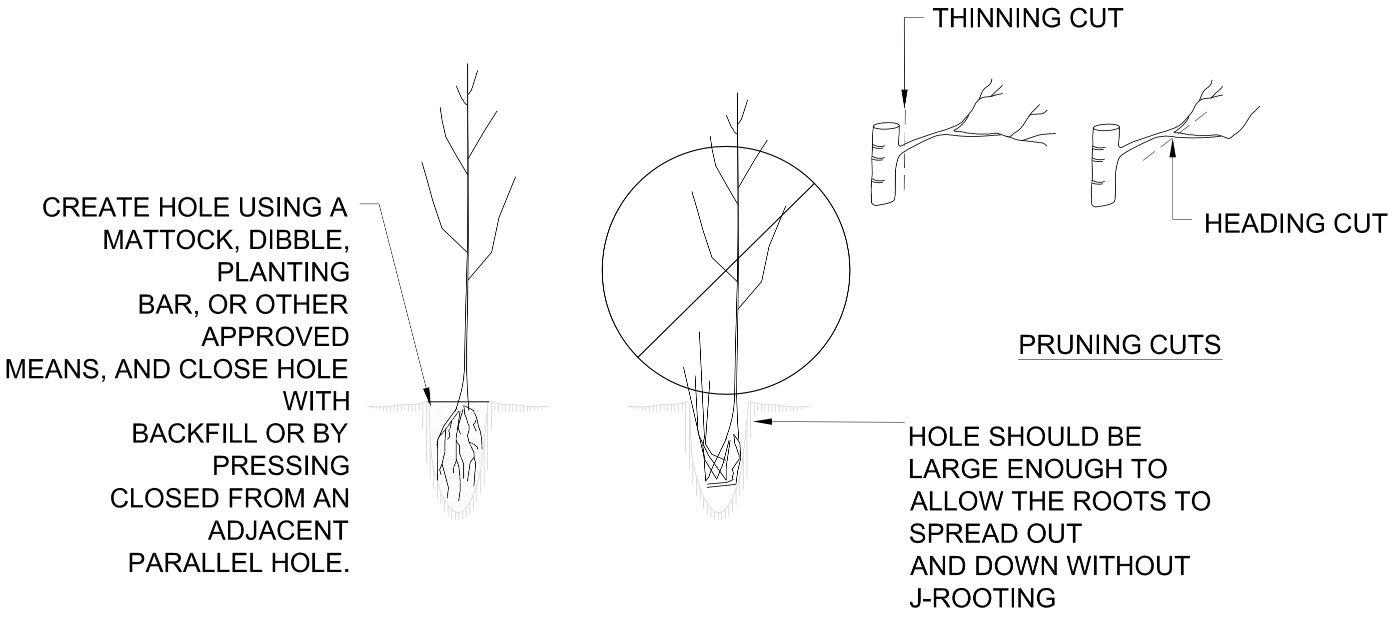
PLANTING PLAN

SHEET PP1 OF 21



1 PP2 PLANTING ZONES

NTS



PRUNING CUTS

BARE ROOT TREE PLANTING

2 PP2 BARE ROOT PLANTING

NTS

GENERAL NOTES:

1. KEEP ROOTS MOIST WHILE DISTRIBUTING OR WAITING TO PLANT BY MEANS OF WET CANVAS, BURLAP, OR STRAW.
2. HEEL-IN PLANTS IN MOIST SOIL OR SAWDUST IF NOT PROMPTLY PLANTED UPON ARRIVAL TO PROJECT SITE.
3. PRUNE ANY BROKEN LIMBS AND TREAT TORN BARK WITH TREE WOUND DRESSING.
4. KEEP EXCAVATED SOIL FROM ENTERING STREAM.

RIPARIAN BUFFER WOODY PLANTING BY ZONE

COMMON NAME	SCIENTIFIC NAME	STRATUM	INDICATOR STATUS	SPACING (FEET)	PLANT MATERIAL SIZE
ZONE 1 - UPPER STREAM BANK					
Elderberry	Sambucus canadensis	Sub-Canopy	FACW-	4	Live Stake
Silky Dogwood	Cornus amomum	Sub-Canopy	FACW+	4	Live Stake
Silky Willow	Salix sericea	Tall Shrub	OBL	4	Live Stake
Black Willow	Salix nigra	Tall Shrub	OBL	4	Live Stake
ZONE 2 - FLOODPLAIN					
Black Walnut	Juglans nigra	Canopy	FACU	12	Bare-root
Tulip Poplar	Liriodendron tulipifera	Canopy	FAC	12	Bare-root
Sycamore	Platanus occidentalis	Canopy	FACW-	12	Bare-root
Eastern Redbud	Cercis candaensis	Sub-Canopy	FACU	12	Bare-root
Silky Dogwood	Cornus amomum	Sub-Canopy	FACW+	12	Bare-root
Hophornbeam	Ostrya virginiana	Sub-Canopy	FACU-	12	Bare-root
Pawpaw	Asimina triloba	Sub-Canopy	FAC	12	Bare-root
American Beautyberry	Callicarpa americana	Tall Shrub	FACU-	12	Bare-root
ZONE 3 - TERRACE					
White Oak	Quercus alba	Canopy	FACU	12-18	Bare-root
Swamp Chestnut Oak	Quercus michauxii	Canopy	FACW+	12-18	Bare-root
Blackgum	Nyssa sylvatica Marsh.	Canopy	OBL	12-18	Bare-root
Winged Elm	Ulmus alata	Sub-Canopy	FACU+	12-18	Bare-root
Persimmon	*Diosypros virginana*	Sub-Canopy	FAC	12-18	Bare-root
Witchhazel	Hamamelis virginiana	Sub-Canopy	FACU	12-18	Bare-root
Ironwood	Carpinus caroliniana	Sub-Canopy	FAC	12-18	Bare-root
Black Haw	Viburnum prunifolium	Tall Shrub	FACU	12-18	Bare-root

	DESCRIPTION	DATE	APP.
A			
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PRELIMINARY PLANS

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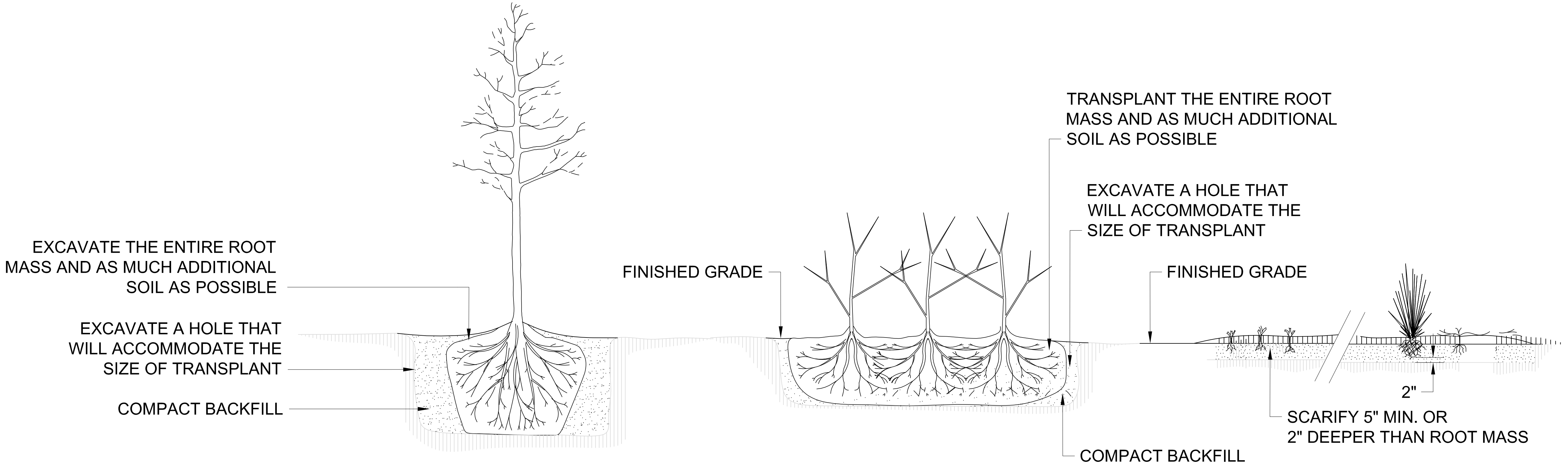
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: OCT. 2011
SCALE: NTS

PLANTING DETAILS

SHEET PP2 OF 21



SINGLE TRANSPLANT

TRANSPLANT CLUSTER

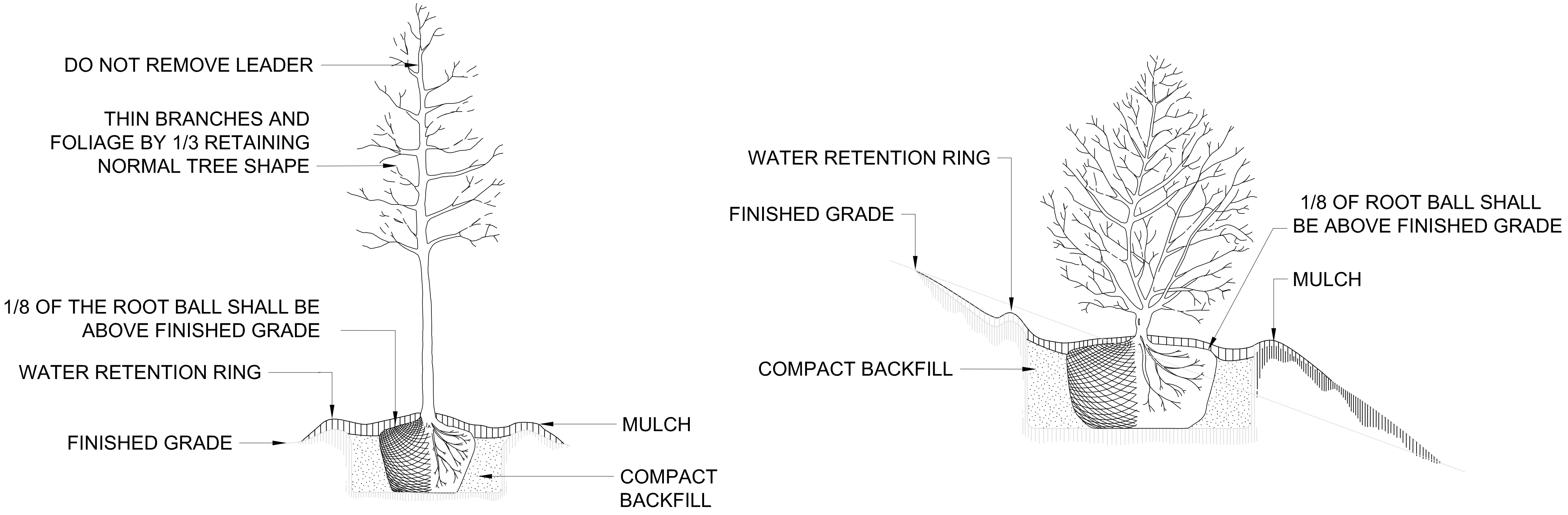
SOD MAT TRANSPLANT

TRANSPLANT NOTE:
EXCAVATE TRANSPLANTS USING A FRONT END LOADER , TRACKHOE OR SOD CUTTER, DEPENDING ON PLANT MATERIAL AND ROOT DEPTH.

1 | PP3
TRANSPLANTS
NTS

CONTAINER PLANTING NOTES:

1. EXCAVATE THE HOLE 8 -12 INCHES LARGER THAN THE DIAMETER OF THE POT AND THE SAME DEPTH AS THE POT.
2. IF THE PLANT IS ROOTBOUND, MAKE VERTICAL CUTS WITH A KNIFE OR SPADE JUST DEEP ENOUGH TO CUT THE NET OF ROOTS. MAKE A CRISS-CROSS CUT ACROSS THE BOTTOM OF THE BALL.
3. PLACE THE PLANT IN THE HOLE.
4. FILL HALF OF THE HOLE WITH SOIL (SAME SOIL REMOVED FROM HOLE).
5. WATER THE SOIL TO REMOVE AIR POCKETS AND FILL THE REST OF THE HOLE WITH THE REMAINING SOIL.



CONTAINER PLANTING
GROUND LEVEL

CONTAINER PLANTING
SLOPING GROUND

2 | PP3
CONTAINER PLANTING
NTS

	DESCRIPTION	DATE	APP.
A			
B			
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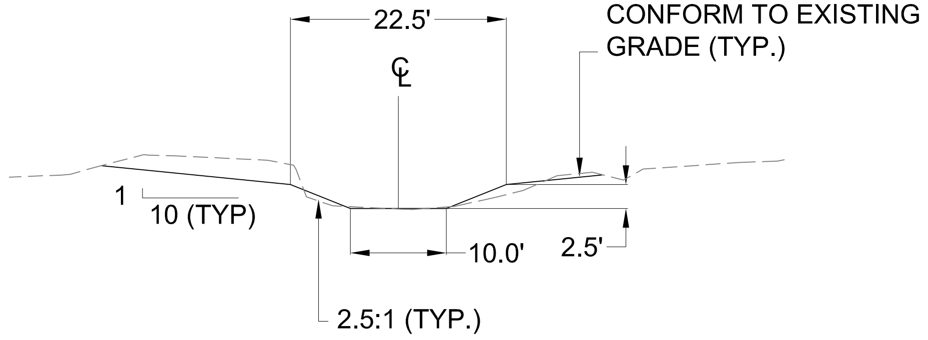
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: OCT. 2011
SCALE: NTS

PLANTING DETAILS

SHEET PP3 OF 21



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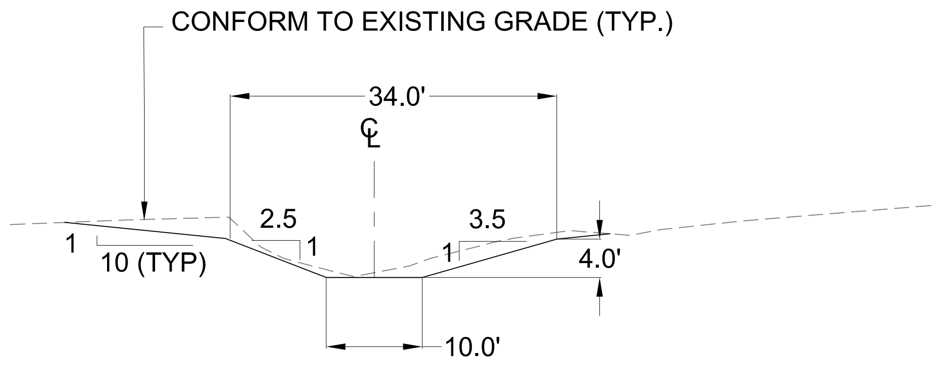
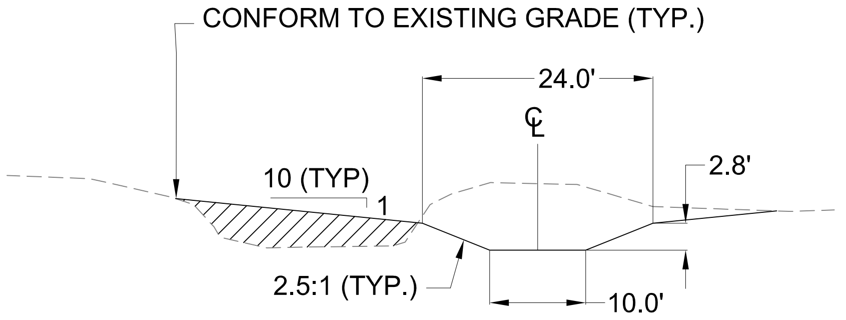
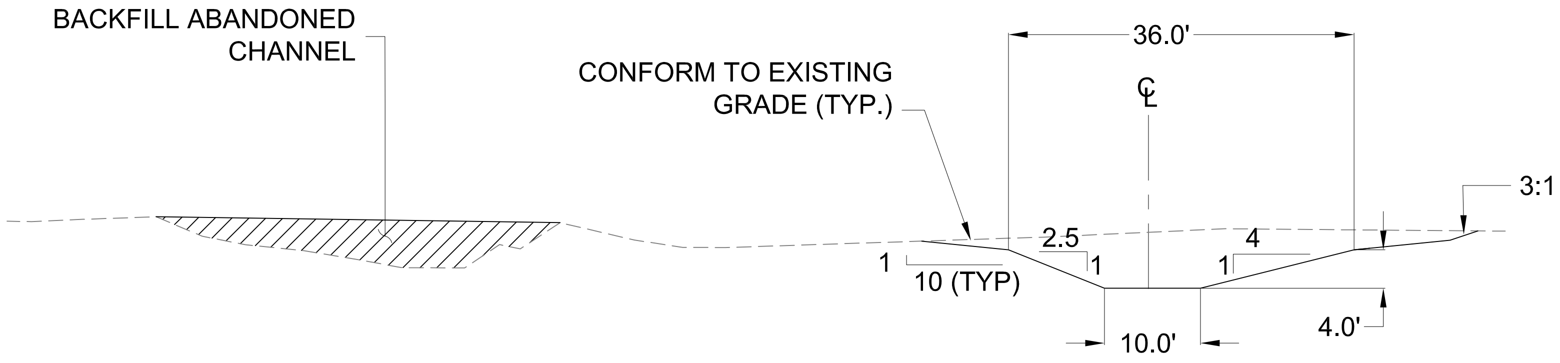
TS1
TYPICAL RIFFLE SECTION
HOGAN CREEK REACH 1



2
TS1
TYPICAL POOL SECTION
HOGAN CREEK REACH 1



3
TS1
TYPICAL RIFFLE SECTION
HOGAN CREEK REACH 2



4
TS1
TYPICAL POOL SECTION
HOGAN CREEK REACH 2

LEGEND	
EXISTING	╌╌╌
PROPOSED	───

NOTES:

1. BANKS OF ON-LINE REACHES SHALL BE ROUGHENED PERPENDICULAR TO SLOPE, COVERED WITH 2" LAYER OF TOPSOIL, SEEDED, MULCHED AND MATTED WITH 780 G/SM COIR FIBER MATTING.
2. BANKS OF OFF-LINE REACHES SHALL BE ROUGHENED PERPENDICULAR TO SLOPE AND COVERED WITH SOD MATS. APPLY SEED AND MATTING IF SOD MAT QUANTITY UNSUFFICIENT.
3. TERRACE SLOPES TO BE ROUGHENED PERPENDICULAR TO SLOPE, SEEDED AND MULCHED.

	DESCRIPTION	DATE	APP.
A			
B			
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22203
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PRELIMINARY PLANS

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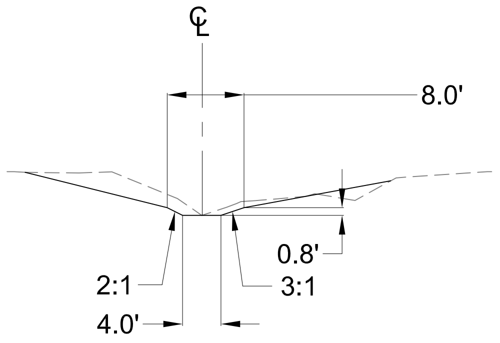
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

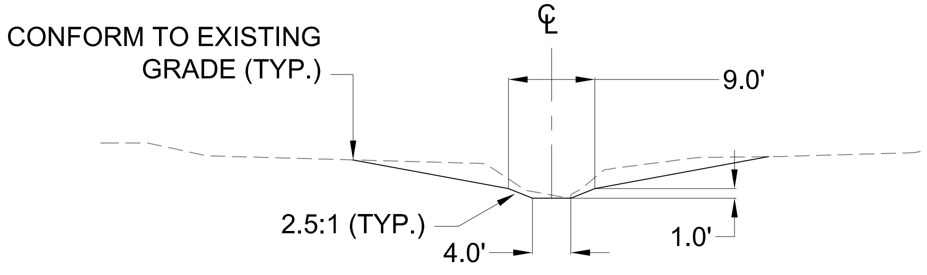
DATE: OCT. 2011
SCALE: 1" = 20'

TYPICAL
SECTIONS

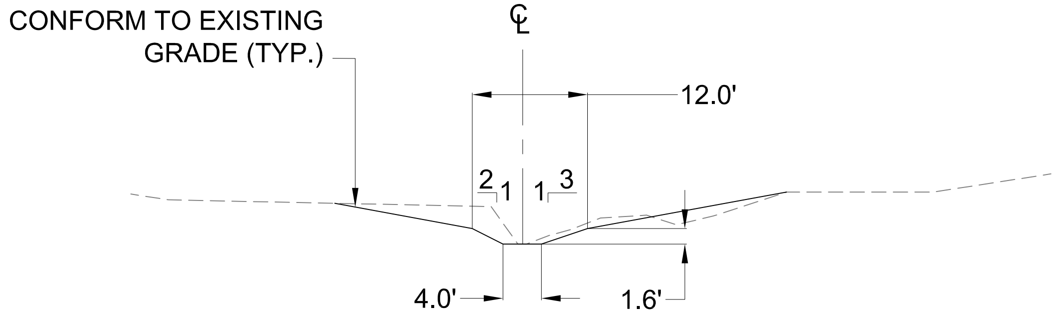
SHEET TS1 OF 21



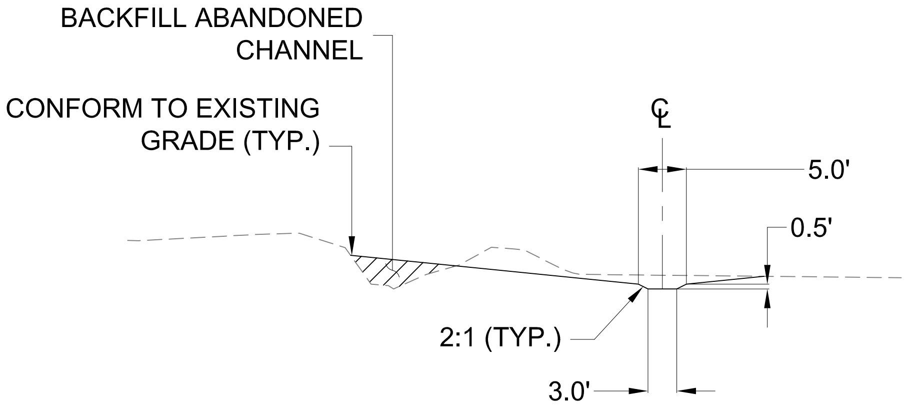
1 TYPICAL SECTION
TS2 UT 1



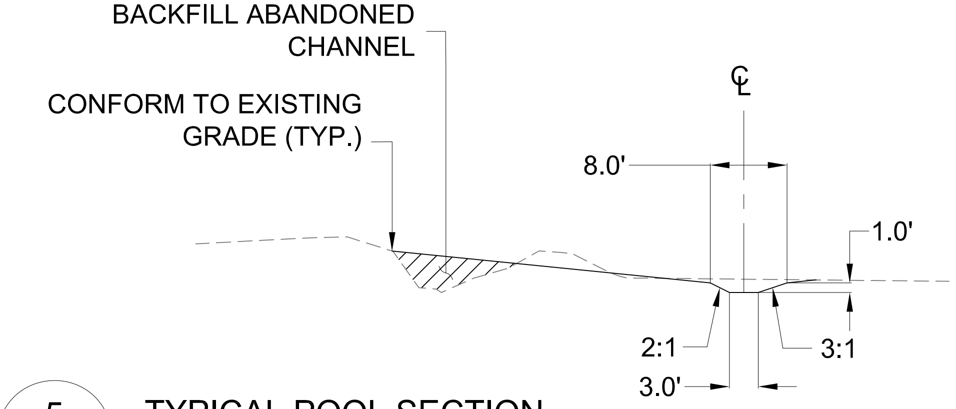
2 TYPICAL RIFFLE SECTION
TS2 UT 2



3 TYPICAL POOL SECTION
TS2 UT 2



4 TYPICAL RIFFLE SECTION
TS2 UT 3



5 TYPICAL POOL SECTION
TS2 UT 3

LEGEND

EXISTING	- - - -
PROPOSED	———

NOTES:
1. BANKS OF ON-LINE REACHES SHALL BE ROUGHENED PERPENDICULAR TO SLOPE, COVERED WITH 2" LAYER OF TOPSOIL, SEEDED, MULCHED AND MATTED WITH 780 G/SM COIR FIBER MATTING.
2. BANKS OF OFF-LINE REACHES SHALL BE ROUGHENED PERPENDICULAR TO SLOPE AND COVERED WITH SOD MATS. APPLY SEED AND MATTING IF SOD MAT QUANTITY UNSUFFICIENT.
3. TERRACE SLOPES TO BE ROUGHENED PERPENDICULAR TO SLOPE, SEEDED AND MULCHED.

	DESCRIPTION	DATE	APP.
A			
B			
C			

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HOGAN CREEK MITIGATION
SURRY COUNTY, NC

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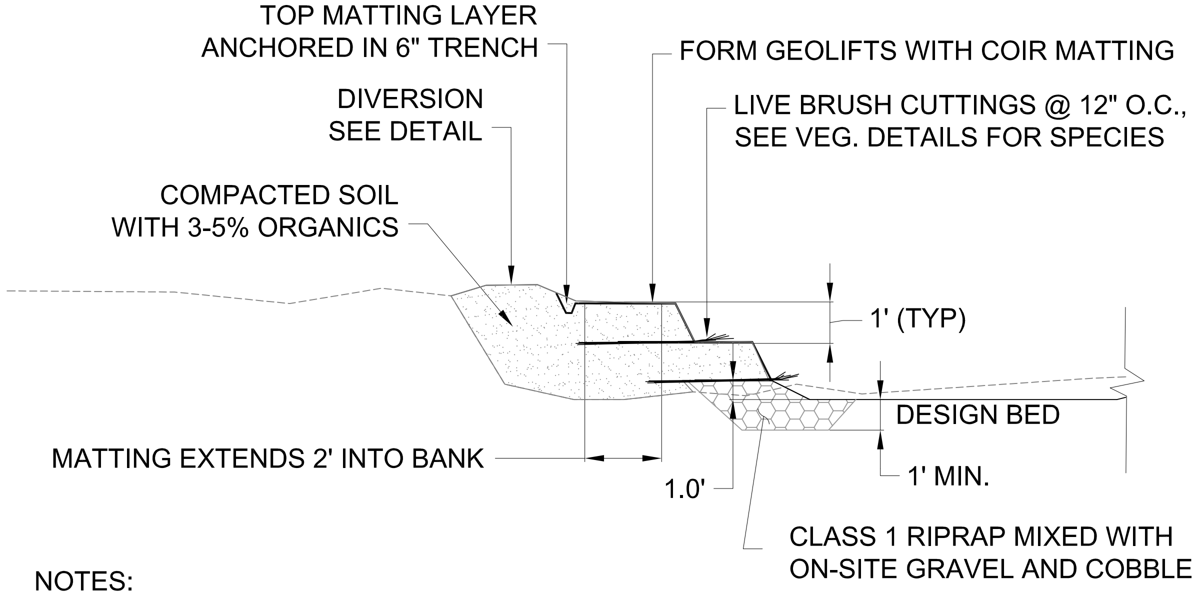
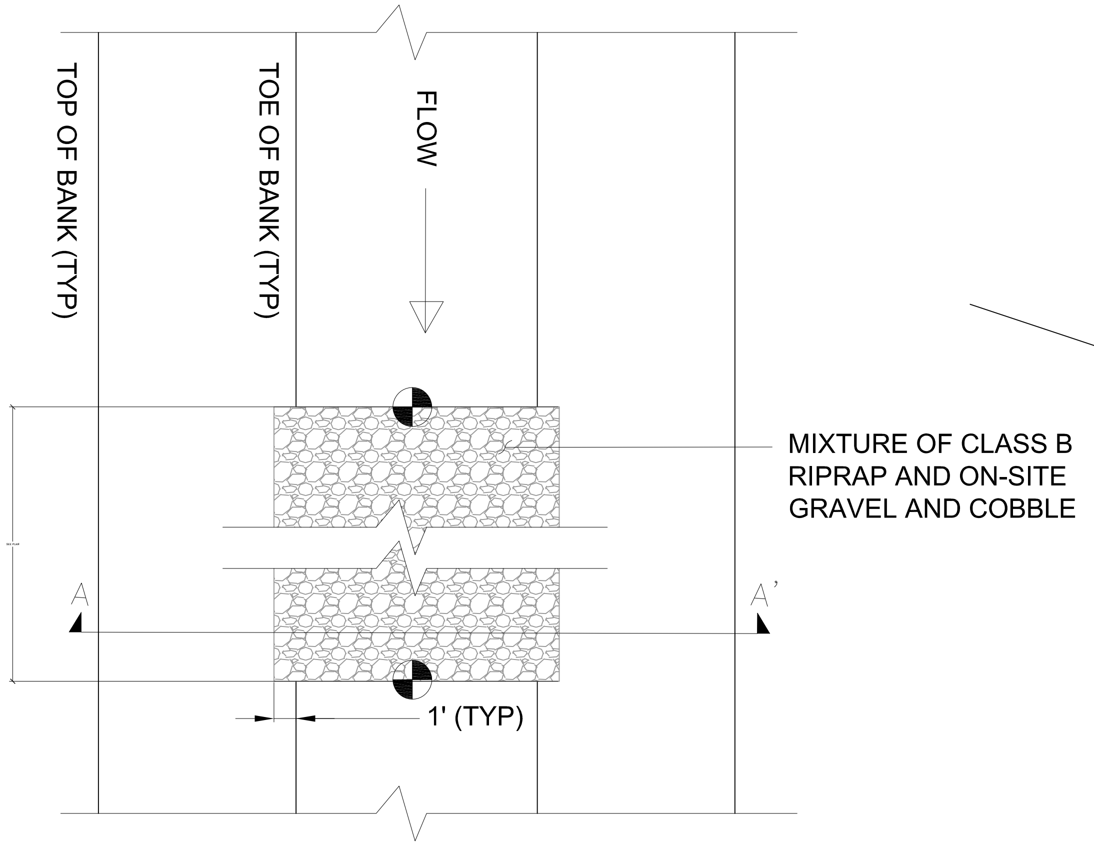
TYPICAL SECTIONS

SHEET TS2 OF 21



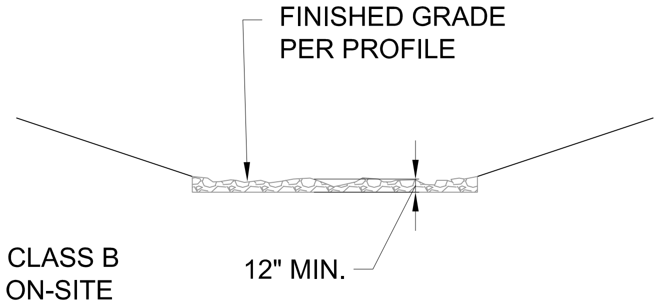
NOTES:
1. GEOLIFTS TO BE INSTALLED WITH PLYWOOD FORMS AND STEEL BRACES, OR APPROVED ALTERNATE METHOD.
2. COIR MATTING SHALL BE 980 GRAMS/SQ. METER.

1 D1 GEOLIFT DETAIL
NTS



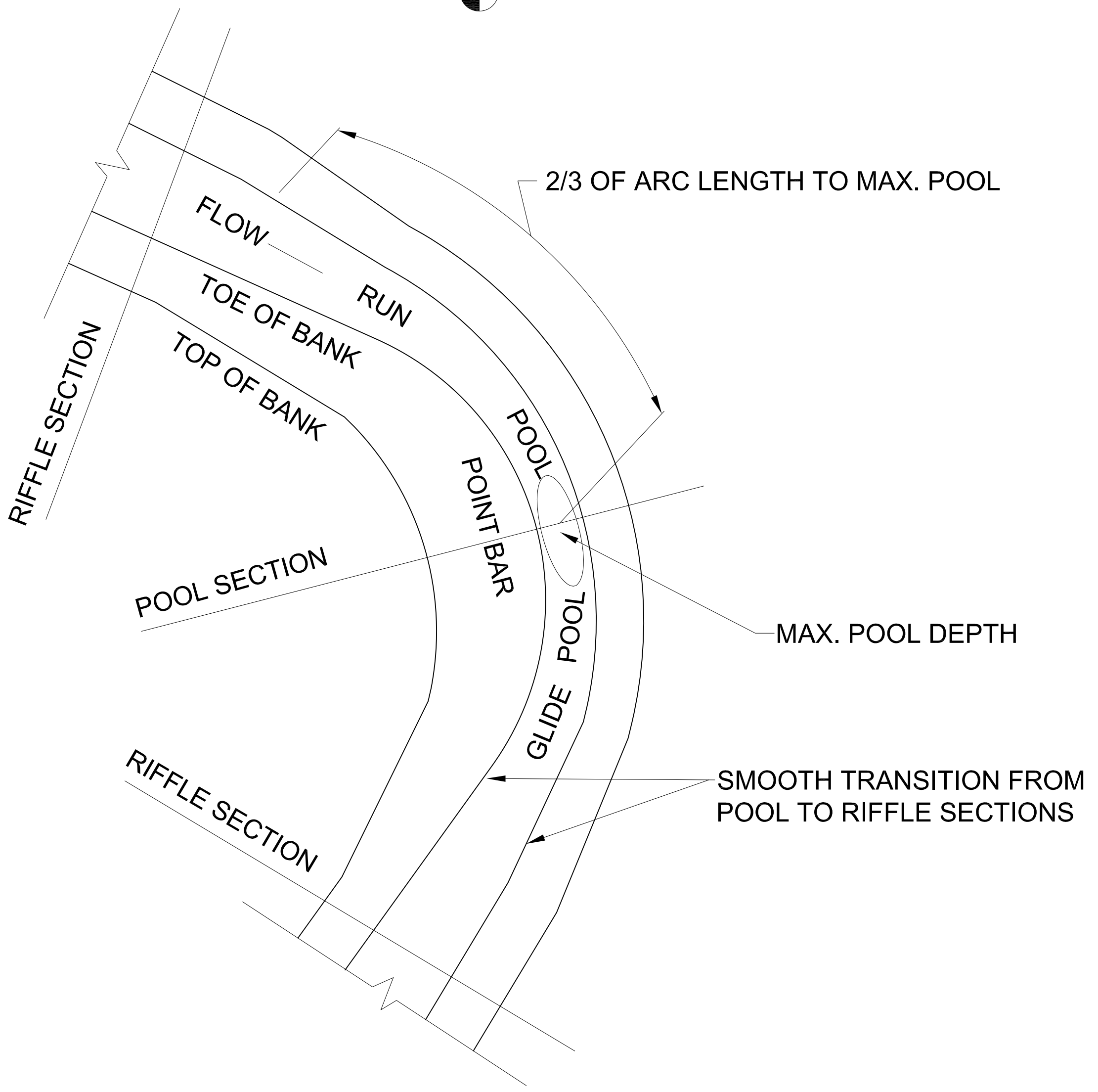
PLAN

2 D1 CONSTRUCTED RIFFLE
NTS



SECTION A-A'

ELEVATION POINT IN STRUCTURE TABLE



3 D1 RIFFLE-POOL TRANSITIONS
NTS

Hogan Creek Structure Table

Station	Structure	Elevation (ft)
10+59	J-Hook	994.40
12+71	Cross Vane	994.40
14+65	J-Hook	991.70
15+74	Cross Vane	992.60
16+61	Cross Vane	991.70
26+90	Log Vane	984.20
27+40	Log Vane	982.50
30+40	J-Hook	982.30
31+03	Const. Riffle	982.20
32+13		981.30
33+24	Const. Riffle	981.10
33+98		980.40
34+09	Log Vane	979.90
34+71	Const. Riffle	980.30
35+76		979.60
35+81	Log Vane	979.60
36+58	Const. Riffle	979.50
37+53		978.50
37+63	Log Vane	978.40

UT2 Structure Table

Station	Structure	Elevation (ft)
11+25	Const. Riffle	993.60
11+65		992.10
12+38	Const. Riffle	990.10
12+55		989.40
12+87	Const. Riffle	989.20
13+23		988.30
13+60	Const. Riffle	988.10
13+97		987.10
14+25	Const. Riffle	986.90
14+80		985.40
15+06	Const. Riffle	985.30
15+27		984.70

UT3 Structure Table

Station	Structure	Elevation (ft)
10+09	Step	987.80
10+33	Const. Riffle	987.30
10+71		985.80
10+91	Const. Riffle	985.70
11+07		985.20
11+24	Const. Riffle	985.10
11+40		984.50
11+55	Const. Riffle	988.10
11+79		984.40
11+99	Step	983.30

REVISIONS

	DESCRIPTION	DATE	APP.
A			
B			
C			

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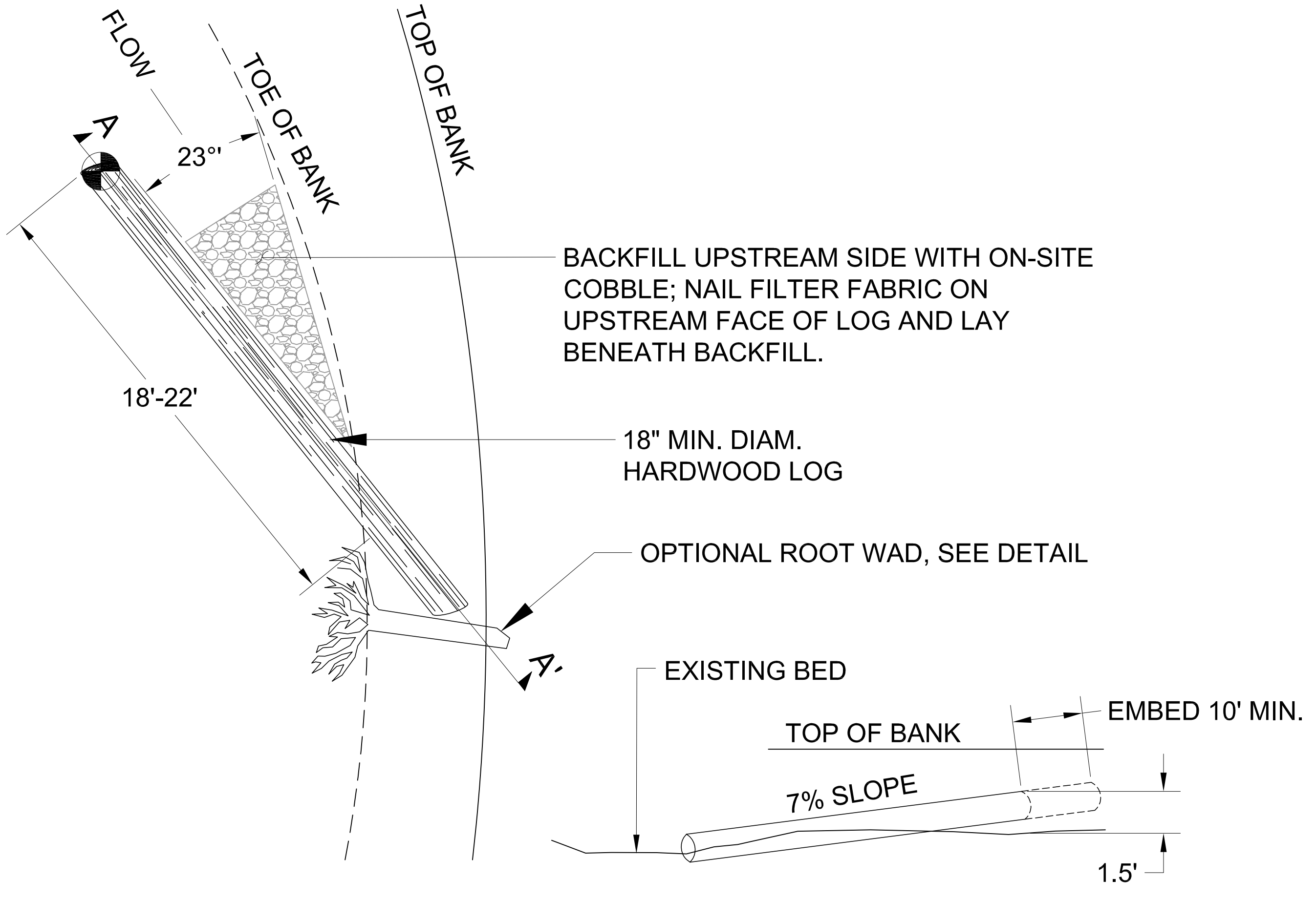
HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: OCT. 2011
SCALE: NTS

STRUCTURE
DETAILS

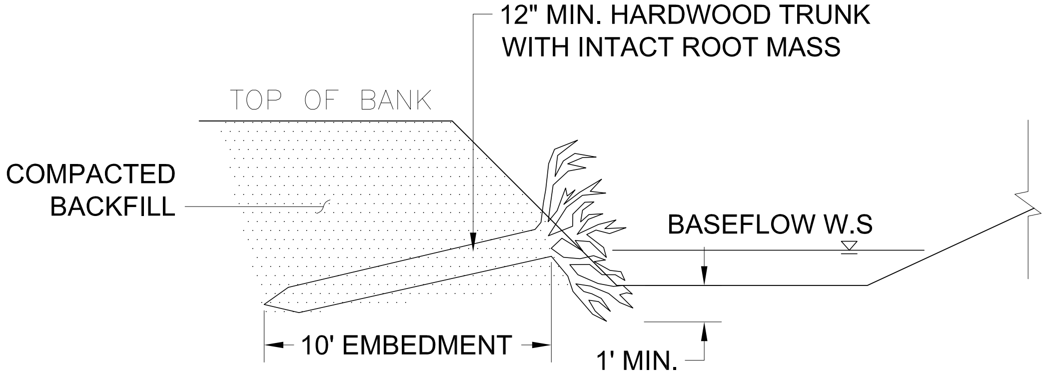
SHEET D1 OF 21



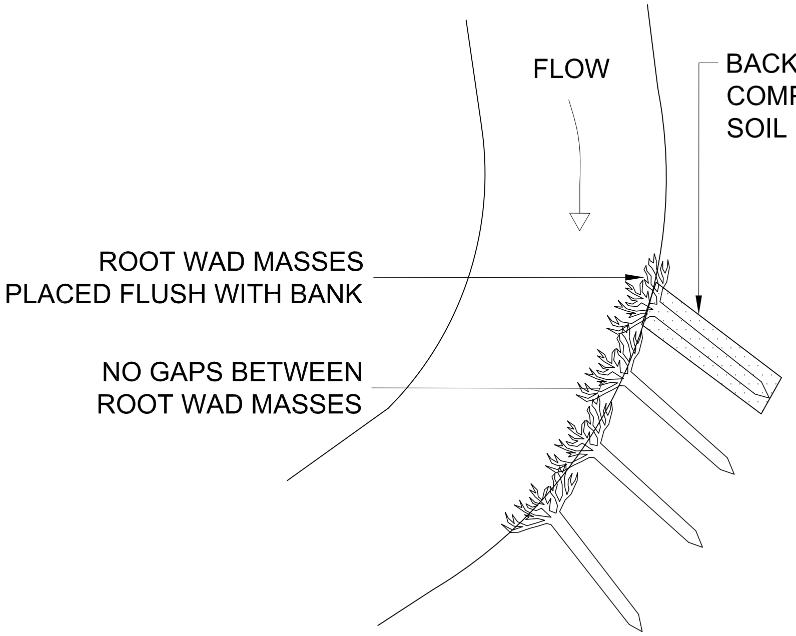
PLAN (AT HEAD OF POOL)

PROFILE A-A'

1 | D2 LOG VANE
NTS



SECTION

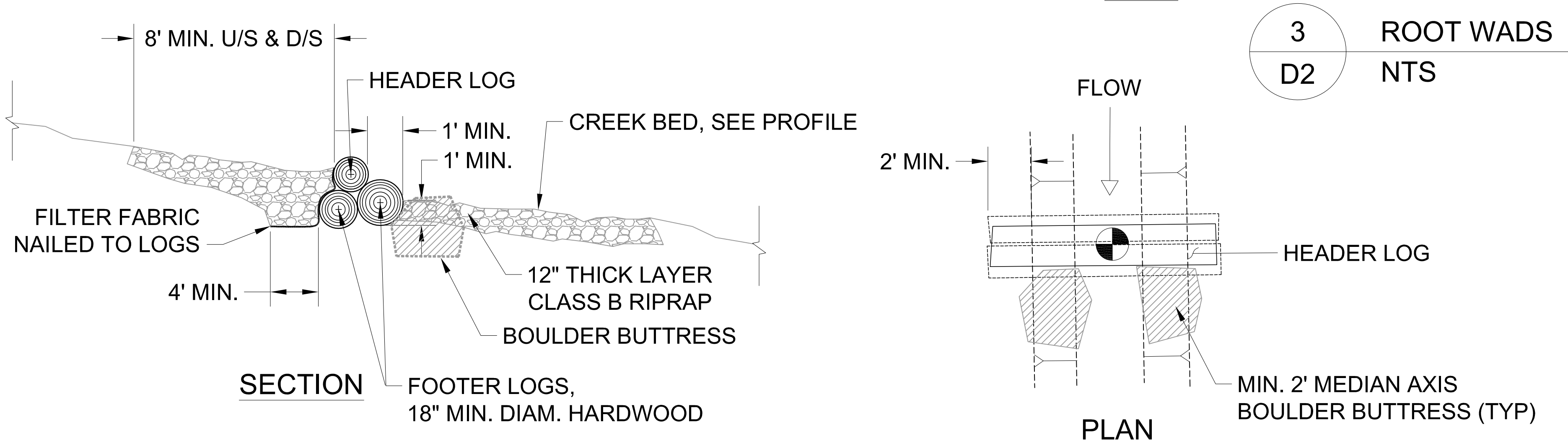


PLAN

ROOT WAD INSTALLATION NOTES:

1. DRIVEN ROOT WADS
   ATTEMPT TO PUSH SHARPENED TRUNK INTO BANK WITHOUT DAMAGE TO ROOT MASS.
2. TRENCHED ROOT WADS
   IF THE ROOTWAD CANNOT BE DRIVEN INTO THE BANK, EXCAVATE NARROW TRENCH, PLACE ROOT WAD AND TRUNK, AND BACKFILL WITH COMPACTED ON-SITE SOIL.

3 | D2 ROOT WADS
NTS



SECTION

PLAN

(RIPRAP NOT SHOWN FOR CLARITY)

STEP STRUCTURE NOTES:

1. TRENCH LOGS MINIMUM 2' INTO BANK ON BOTH SIDES AND BACKFILL WITH COMPACTED ON-SITE SOIL. MINIMIZE DISTURBANCE TO BANKS BEYOND STRUCTURE LIMITS.
2. BOULDERS (MIN. 1.5'X2'X3') MAY BE SUBSTITUTED FOR LOGS IN STEP STRUCTURE.

2 | D2 STEP STRUCTURE
NTS

◐ ELEVATION POINT IN STRUCTURE TABLE

A	B	C			DESCRIPTION	DATE	APP.

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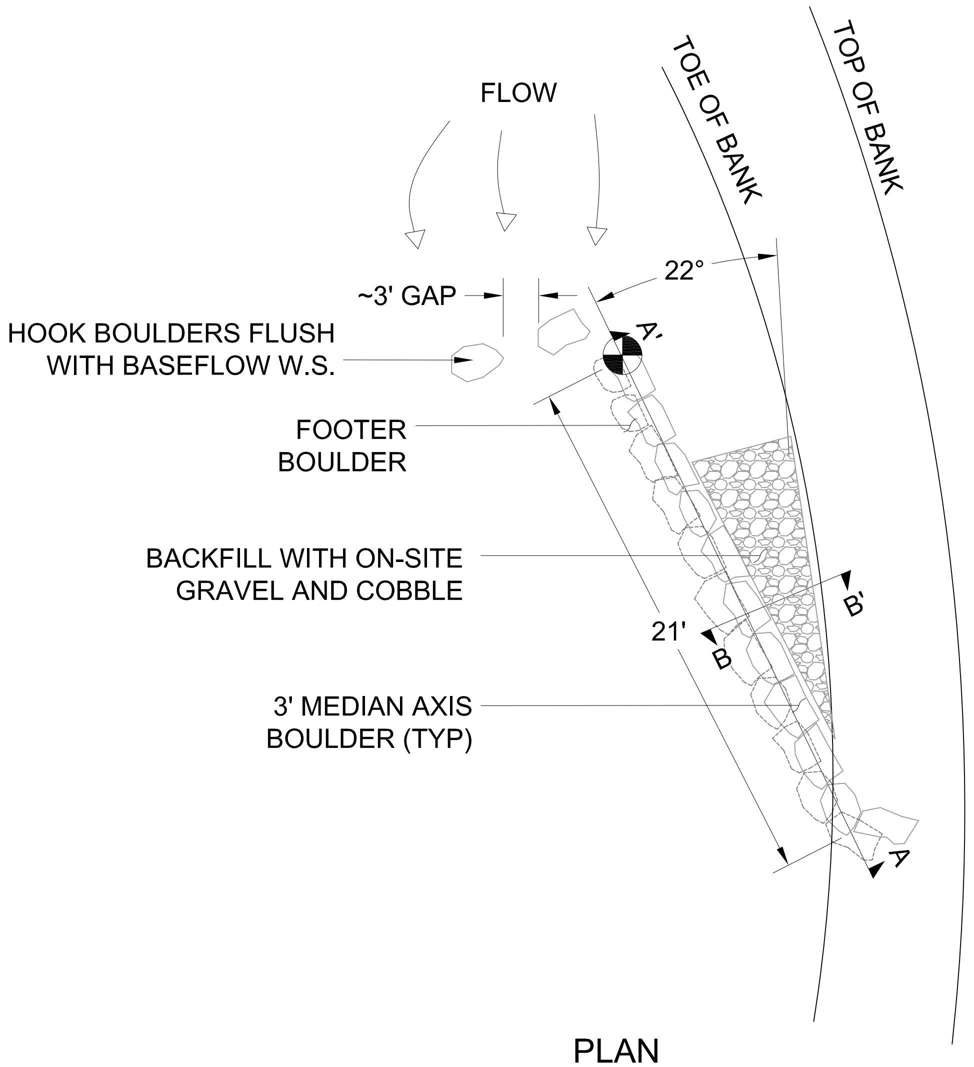
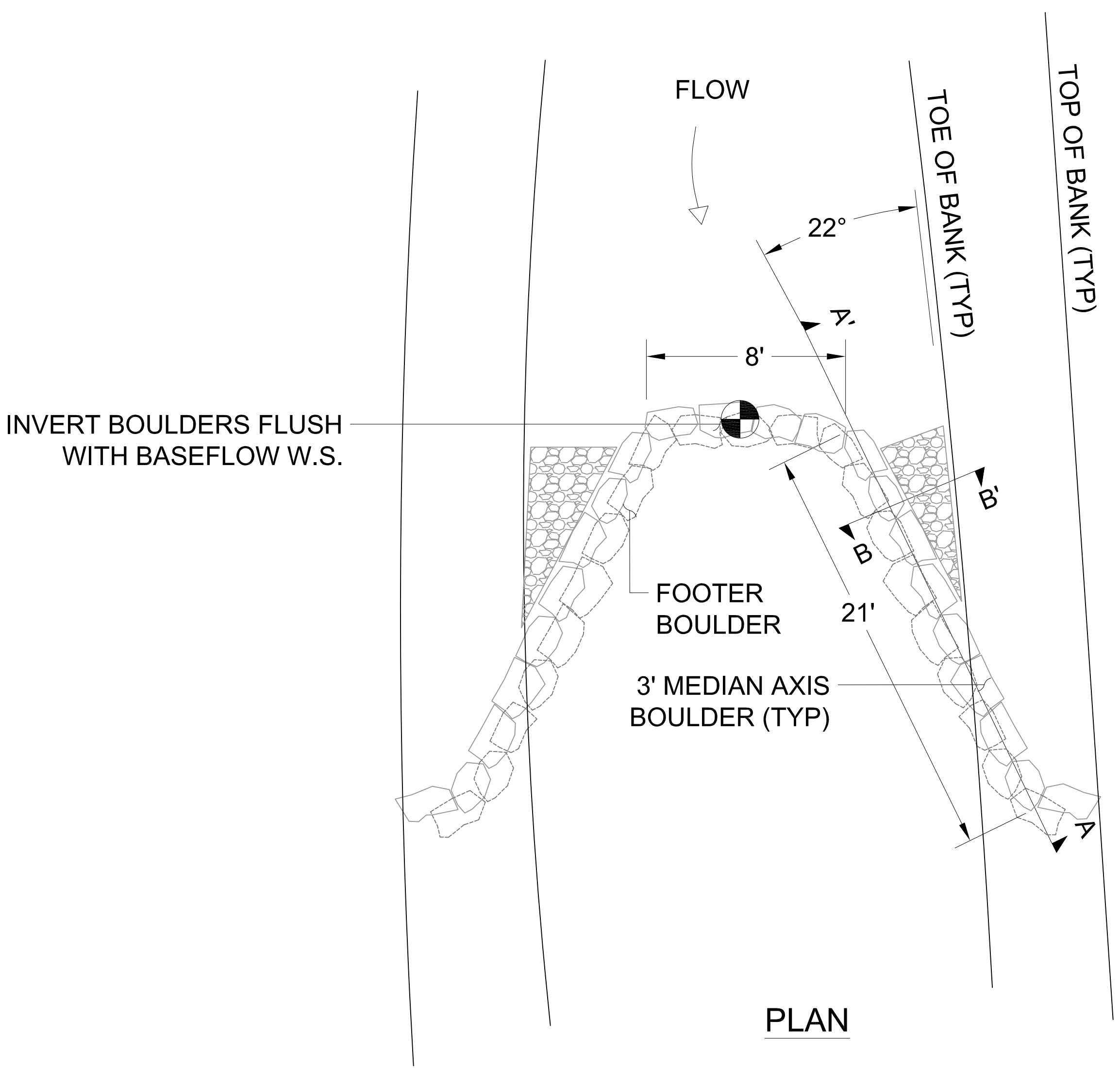
STRUCTURE DETAILS

SHEET D2 OF 21



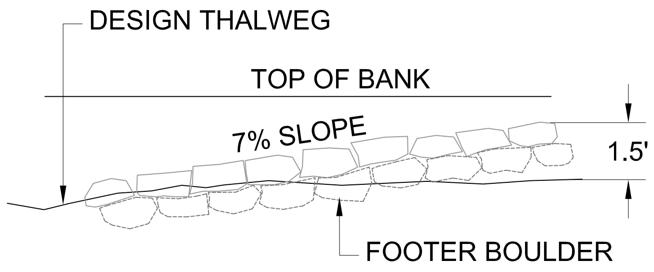
PLAN



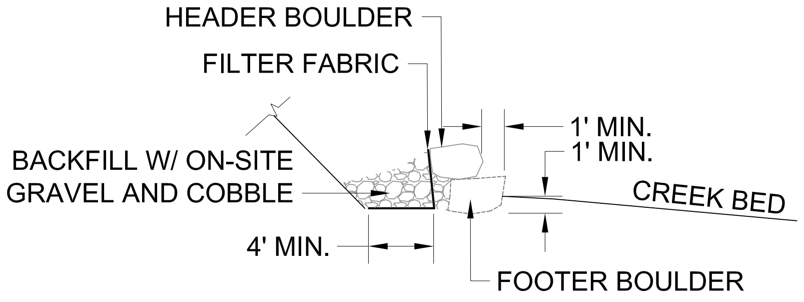
PLAN

1
D3
BOULDER J-HOOK VANE
NTS

2
D3
BOULDER CROSS VANE
NTS



PROFILE A-A'



SECTION B-B'

● ELEVATION POINT IN STRUCTURE TABLE

	DESCRIPTION	DATE	APP.
A			
B			
C			

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SURRY COUNTY, NC

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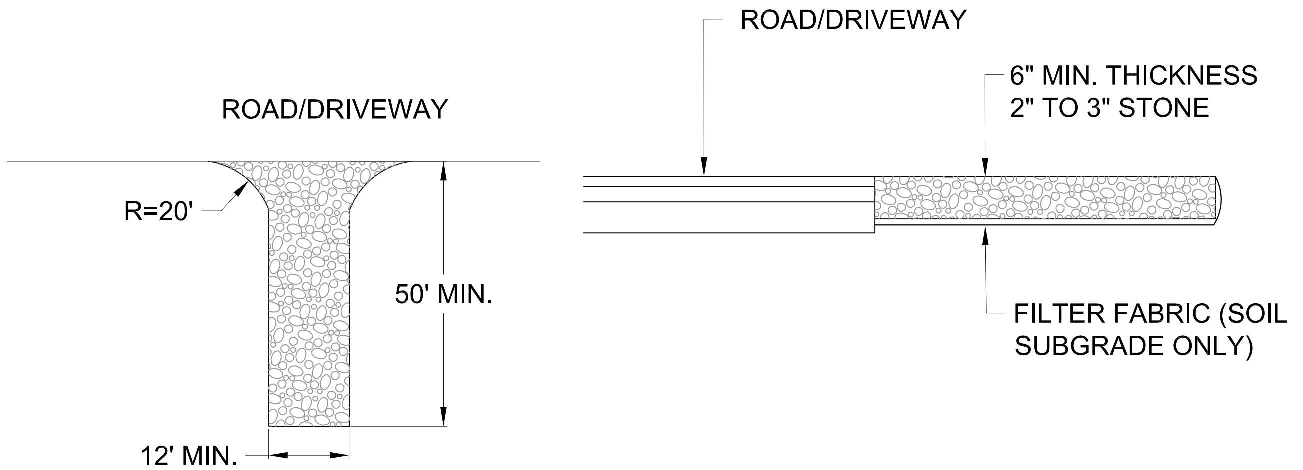
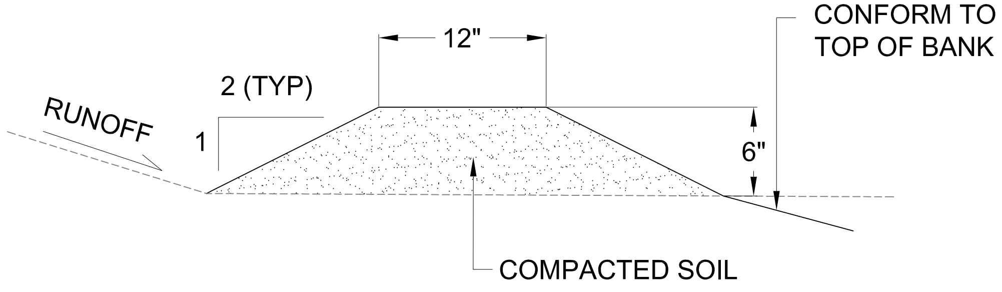
STRUCTURE DETAILS

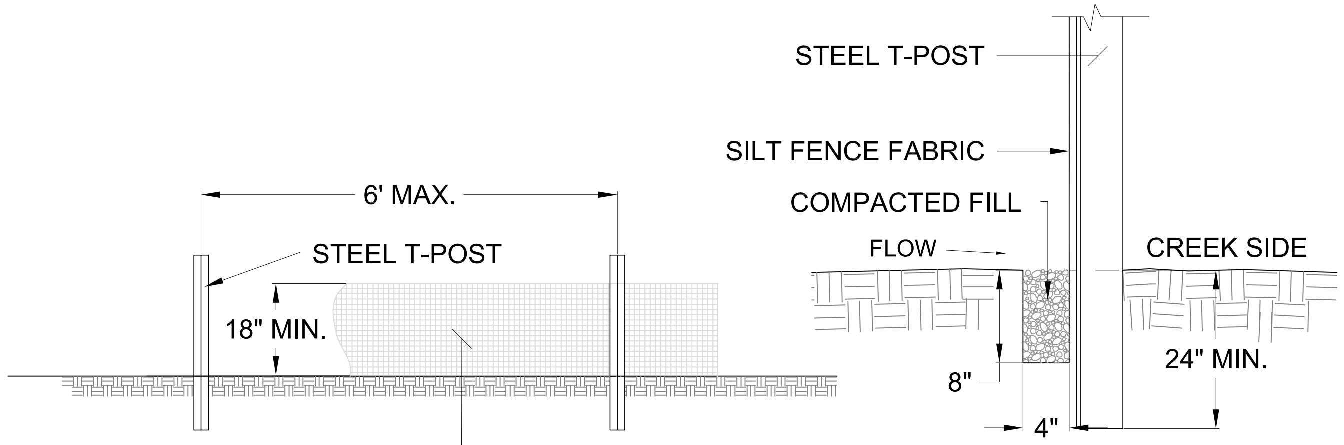
SHEET D3 OF 21



1 CONSTRUCTION ENTRANCE/EXIT
D4 NTS



3 DIVERSION BERM
D4 NTS

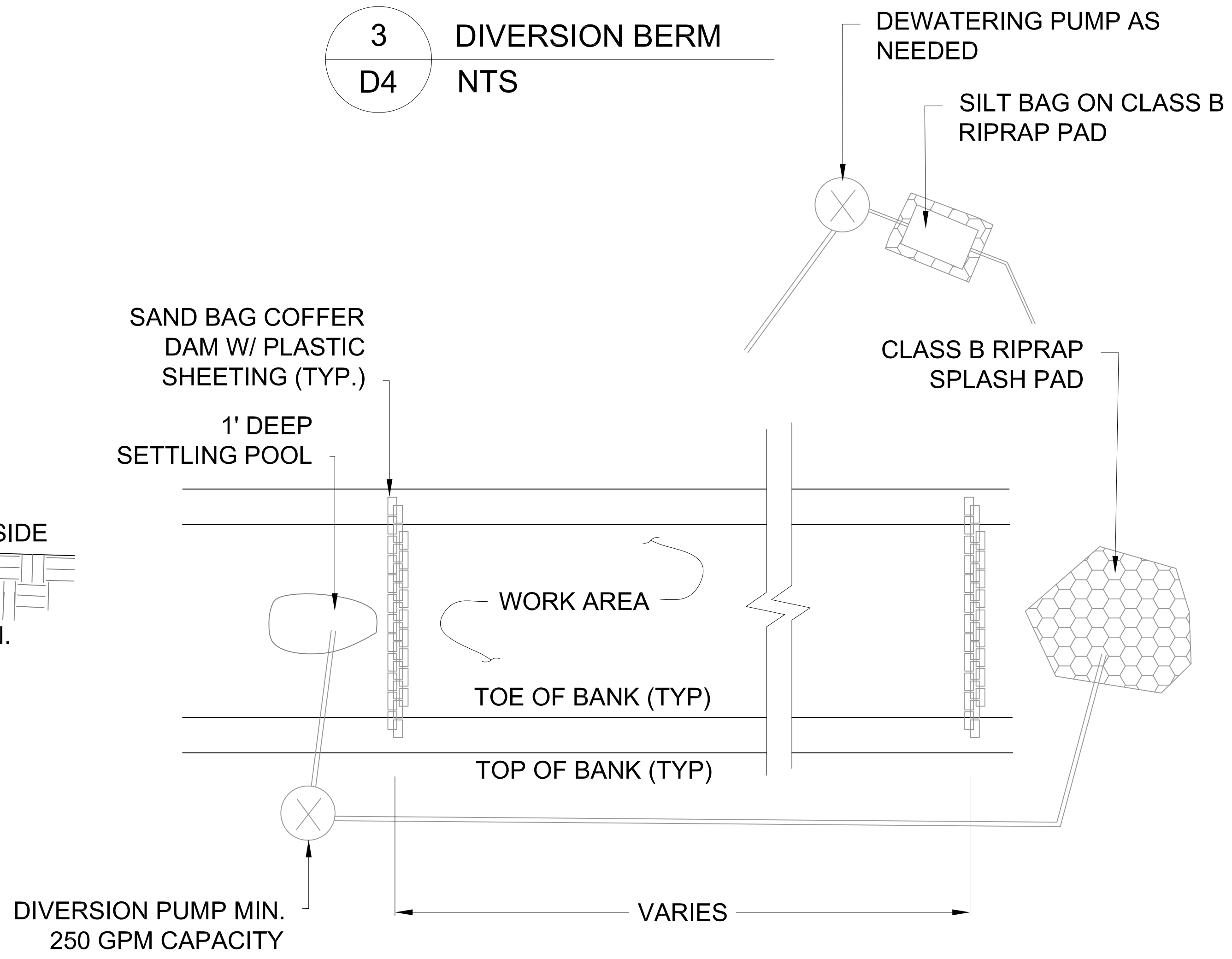


PROFILE

SECTION

NOTES:
1. SEDIMENT FENCE SHALL BE PLACED ON STREAM SIDE OF ALL STOCKPILES.
2. SEDIMENT FENCE SHALL BE REMOVED UPON COMPLETION OF EARTHWORK.

2 SILT FENCE
D4 NTS



4 FLOW DIVERSION
D4 NTS

			DESCRIPTION	DATE	APP.
A					
B					
C					

REVISIONS

PRELIMINARY

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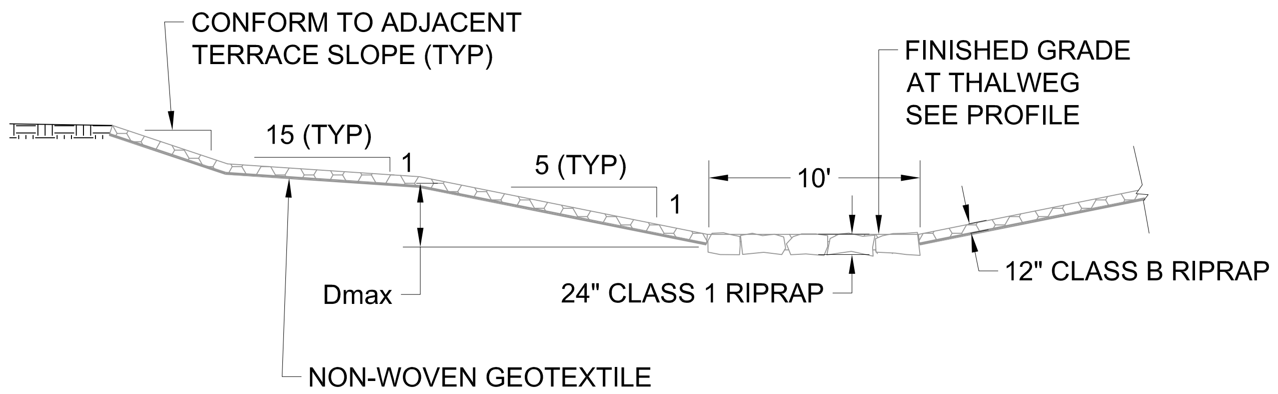
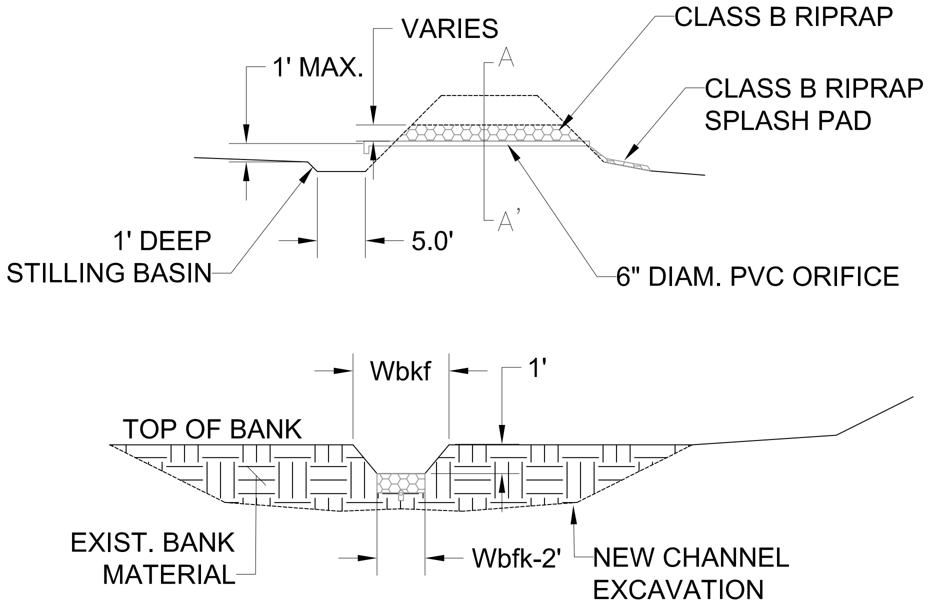
E&S
DETAILS

SHEET D4 OF 21

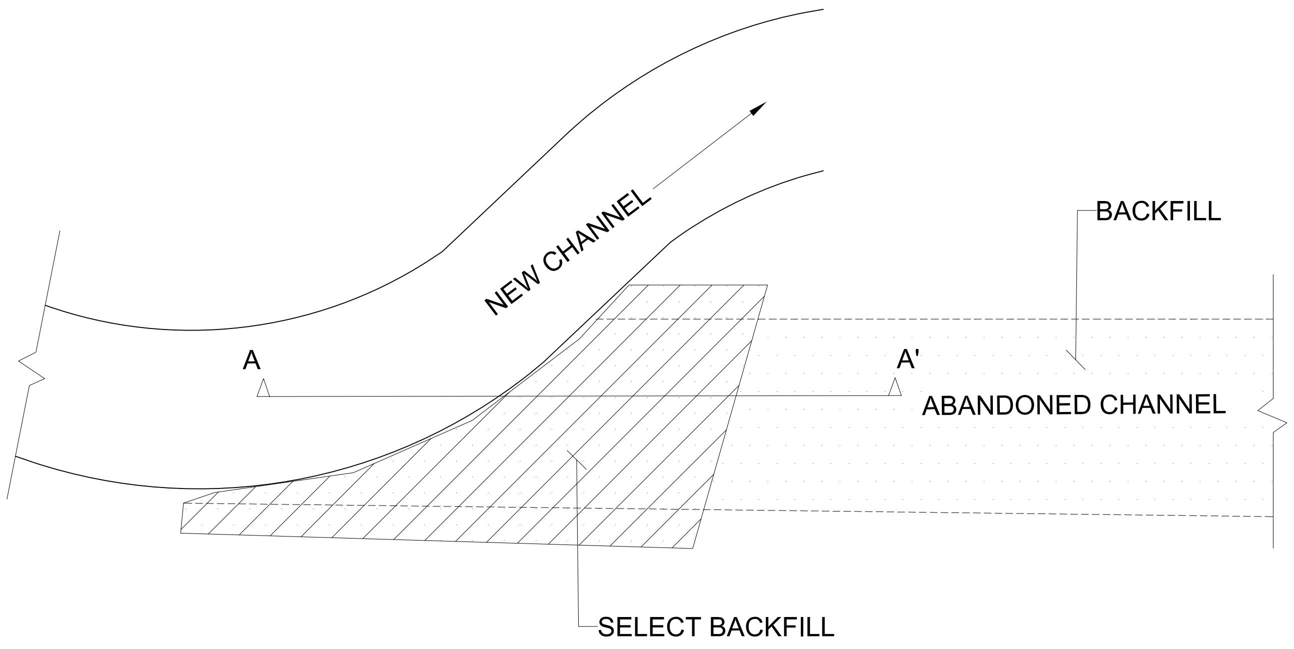


1
D5
FORD CROSSING
NTS

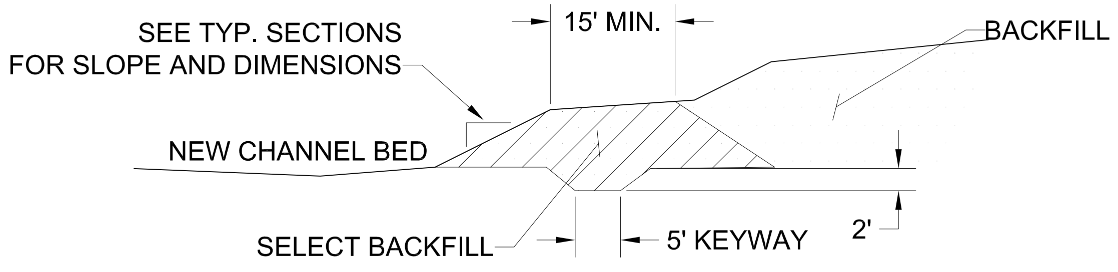


SECTION A-A'

2
D5
DRAWDOWN STRUCTURE
NTS

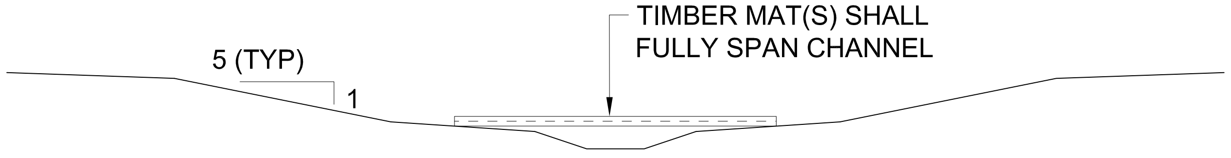


PLAN VIEW



SECTION A-A'

3
D5
CHANNEL PLUG
NTS



SECTION

4
D5
TEMPORARY STREAM CROSSING
NTS

A			
B			
C			
	DESCRIPTION	DATE	APP.

REVISIONS

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HOGAN CREEK MITIGATION
SURRY COUNTY, NC

DATE: OCT. 2011
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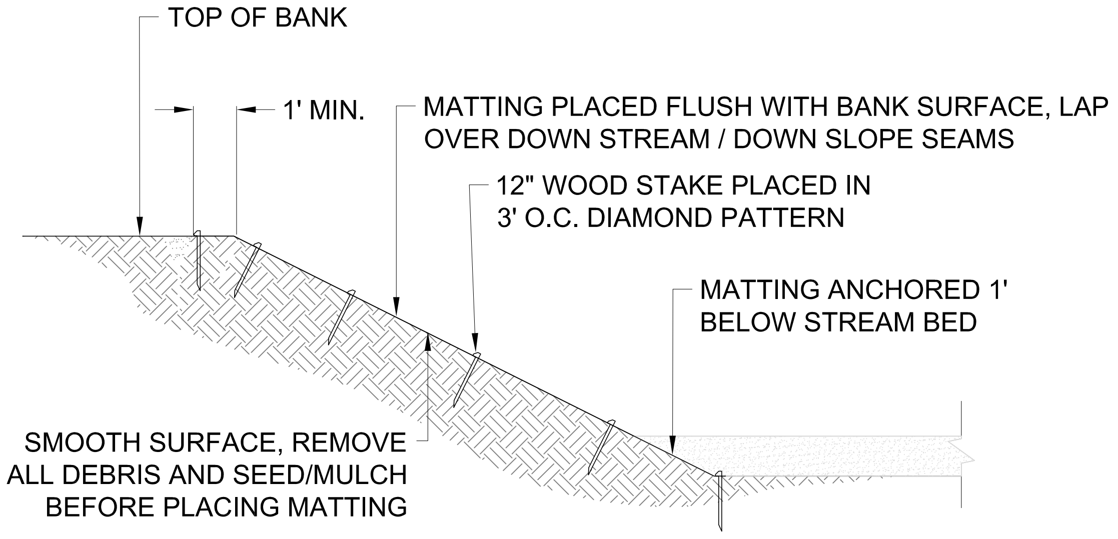
E&S
DETAILS

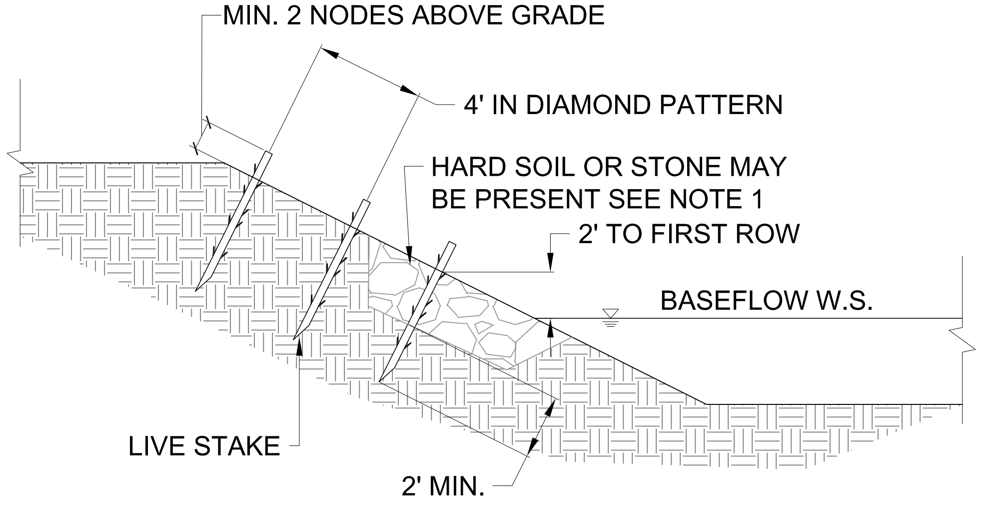
SHEET D5 OF 21



SECTION

NOTE:
1. MATTING SHALL BE COIR FIBER, 780 GRAMS/SQ. METER WITH NOMINAL 0.50 INCH OPENING SIZE.

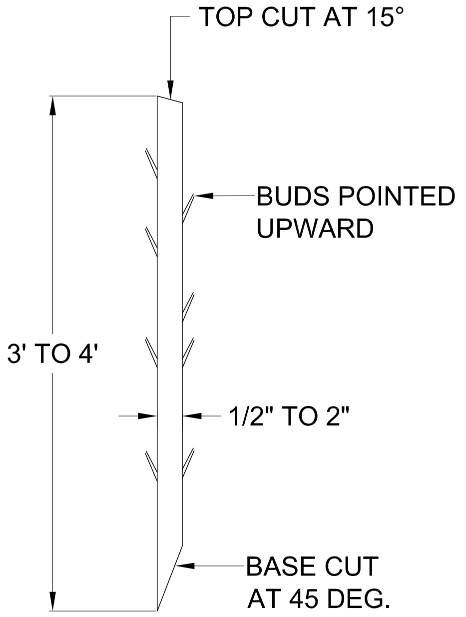
1/D6 EROSION CONTROL MATTING
NTS



SECTION

NOTES:
1. FORM PILOT HOLE THROUGH HARD SOIL OR STONE TO PREVENT DAMAGE TO STAKE.
2. LIVE STAKE MIX TO INCLUDE AT LEAST TWO OF THE FOLLOWING SPECIES: SILKY DOGWOOD, SILKY WILLOW, ELDERBERRY, BUTTONBUSH.

2/D6 LIVE STAKING
NTS



LIVE STAKE DETAIL

PERMANENT SEED MIX *
* APPLIED AT 0.5 LB/1,000 SF TO ALL DISTURBED AREAS

Common Name	Scientific Name	Percentage
Switchgrass	Panicum virgatum	30
Virginia Wild Rye	Elymus virginicus	30
Deer Tongue	Panicum clandestinum	15
Golden Tickseed	Coreopsis tinctoria	5
Showy Tickseed	Bidens aristosa	5
Ironweed	Vernonia gigantea	5
Fox Sedge	Carex vulpinoidea	10
TOTAL		100

TEMPORARY SEED MIX
(APPLIED WITH PERMANENT MIX)

Application Dates	Common Name	Rate (lb/1,000 sf)
August 15 to May 1	Rye Grain	1.0
May 1 to August 15	Browntop Millet	0.3

	DESCRIPTION	DATE	APP.
A			
B			
C			

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MATTING, LIVE STAKES AND SEEDING DETAILS

SHEET D6 OF 21