Davis Branch and Unnamed Tributary Mitigation Plan

Union County North Carolina NC EEP Project Number: D06054-F



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Evans, Mechwart, Hambleton & Tilton, Inc.

EXECUTIVE SUMMARY

As discussed in the Restoration Plan for Davis Branch and an associated unnamed tributary (UT1), the mitigation goals and objectives for the project involved restoring stable physical and biological function of the project streams beyond pre-restoration (impaired) conditions. Impaired conditions consisted of channelized, eroding, incised and entrenched stream channels. Nutrient and sediment loading from agricultural land use and runoff, together with vegetative denuding and destabilized streambanks associated with hoof shear resulting from uncontrolled cattle access was evident. The specific mitigation goals and objectives proposed and achieved for the project are listed below.

- Stable stream channels with features inherent of ecologically diverse environments, with appropriate streambed features including appropriately spaced pool and riffle sequences, and riparian corridors planted with a diversity of indigenous vegetation.
- Superimposed reference reach boundary conditions on the impaired project reaches in the restoration design and construction of improvements.
- Constructed stream channels with the appropriate geometry and gradient to convey bankfull flows while entraining suspended sediment (wash load) and bedload materials readily available to the streams.
- Created an improved connection between the bankfull channels and their floodprone areas, with stable channel geometries, protective vegetation and jute coir fabric to prevent erosion.
- Minimized future land use impacts to project stream reaches by conveying a perpetual, restrictive conservation easement to the State of North Carolina, including stream corridor protection via livestock exclusion fencing at the surveyed and recorded conservation easement boundaries, with gates at the edge of the riparian corridor on river right and left at reserved conservation easement crossings adjacent to active pasture land.

The restoration of Davis Branch mainstem and UT1 met the project goals and objectives set forth in the restoration plan, by providing desired habitat and stability features required to enhance and provide long-term ecologic health for the project reaches. More specifically, the completed restoration project has accomplished the enhancements listed below.

Davis Branch Mainstem:

- Reversed the effects of channelization using a Priority Level I/Level II (PI/II) and Enhancement Level I (EI) restoration approaches; restoration increased the average width/depth ratio from 9.13 to 19.34 on the PI/II reach and from 6.91 to 27.02 on the EI reach.
- Restored natural pattern to the channel alignment, increasing sinuosity from 1.12 to 1.29 on the PI/II reach, while maintaining a stable relationship between the valley slope and bankfull slope (the bankfull slope was steeper than the valley slope prior to restoration and is now less than the valley slope post-restoration). Stable pattern, profile and dimension were restored based on extrapolation from reference reach

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- boundary conditions. On the mainstem EI reach, profile and dimension were restored based upon reference reach boundary conditions.
- Stabilized eroding streambanks by constructing appropriately sized channels with stable streambank slopes, built using a combination of embedded stone, grade control structures, topsoil, herbaceous seeding, mulch, natural fabrics and hearty vegetative live branch (3-foot spacings), bareroot (4-foot spacings) and 1-gallon tree (100-foot spacings) plantings.
- The average Bank Height Ratio was decreased from 1.41 to 1.00 on the PI/II reach and 1.86 to 1.00 on the EI reach, respectively (i.e., extremely incised to stable).
- Restored connection between the bankfull channel and the adjacent floodprone area by raising the bankfull channel to the elevation of the adjacent floodplain. The restored mainstem PI/II and EI reach entrenchment ratios range from 3.75 to 12.30 (stable).
- Created instream aquatic habitat features, including appropriately spaced pool and riffle sequences, and a stable transition of the mainstem reach EI thalweg to the invert of the existing channel at the bottom of the mainstem project reach.
- Revegetated the riparian corridor with indigenous canopy, mid-story, shrub and herbaceous ground cover species, and preserved existing forested riparian corridors where present.
- Protected the riparian corridor by placing livestock exclusion fencing at the edge of the perpetual, recorded conservation easement boundary.

Unnamed Tributary 1 (UT1):

- Reversed the effects of channelization through a combination of Enhancement Level II (EII) and Priority Level I (PI) restoration techniques. The average width/depth ratio of the restored UT1 project reach is 29.13. Stable dimension and grade control was restored on the EII reach (as-built profile station 0+00 to 3+96). Stable pattern, profile and dimension were restored on the PI reach (as-built profile station 3+96 to 8+54) based on extrapolation from reference reach boundary conditions.
- Restored stable channel pattern on the PI reach, increasing sinuosity from 1.09 to 1.37.
- Stabilized eroding streambanks by providing appropriately sized channels with stable streambank slopes. The average Bank Height Ratio has been reduced from 2.82 to 1.00 (extremely incised to stable).
- Improved the connection between the restored stream channel and the adjacent floodprone area by raising the bankfull channel to the elevation of the adjacent floodplain. The completed restoration increased the average entrenchment ratio from 3.63 to 4.38.
- Created stable channel dimensions, substrate and grade control structures (rock sills) on the EI reach; Created stable pattern, profile and dimension, including appropriately spaced riffle, run, pool and glide sequences, together with a stable transition of the UT1 PI reach thalweg at its confluence with the Davis Branch Mainstem.

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- Revegetated the riparian corridor with indigenous canopy, mid-story, shrub and herbaceous ground cover, preserved existing forested riparian corridors where present.
- Protected the riparian corridor by placing livestock exclusion fencing at the edge of the perpetual, recorded conservation easement boundary.

The following table summarizes pre-existing and post-restoration stream lengths, mitigation approach and identification of the reaches restored as presented throughout this Mitigation Plan. The original Restoration Plan includes mitigation specific to the Davis Branch mainstem and an unnamed tributary (UT1). The stream segments and reach identifications used in this table are shown on the As-Built Plan Sheets in Section 7.0 and on Figure 3.

Pre-Existing Conditions/Post-Construction Summary Project Number D06054-F (Davis Branch and Unnamed Tributary 1)							
Project Reach ID	Pre-existing length	Restored Length*	Restoration Level	Credit Ratio	SMUs**		
Davis Branch Mainstem	781 l.f.	766 l.f.*	Preservation	5	153		
Davis Branch Mainstem	1,562 l.f.	1,799 l.f.	Priority Level I/II Restoration	1	1,799		
Davis Branch Mainstem	1,289 l.f.	1,229 l.f.*	Enhancement Level I Restoration	1.5	819		
UT1	396 l.f.	396 l.f.	Enhancement Level II Restoration	2.5	158		
UT1	334 l.f.	459 l.f.	Priority Level I Restoration	1	459		
Totals		4,649 l.f.			3,388		

^{*}Restored Length excludes permanent conservation easement crossings.

To demonstrate the success of the project, three forms of monitoring will be performed: (1) photo documentation; (2) ecological function assessment; and (3) channel stability measurements. Demonstration of long-term success of channel features will be tested in terms of a minimum exposure to two (2) bankfull events occurring in separate monitoring years. The monitoring shall be performed each year for the 5-year monitoring period. Long-term success will be evaluated by monitoring and documenting the criteria listed below.

- 1. Channel aggradation or degradation.
- 2. Streambank erosion.
- 3. Presence of in-stream bar deposits.

^{**}Restored Length divided by SMU Credit Ratio

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- 4. Health and survival of indigenous, non-invasive vegetation (80% survival of planted species after 5 years).
- 5. Changes in as-built channel pattern, profile and dimension (should be minimal in comparison to as-built conditions, noting minor changes may represent increases in stability). Maintenance of floodplain connectivity, with respect to dimension, is a key success criteria.

The annual long-term monitoring of the constructed project reaches includes **3,547** l.f. longitudinal profile surveys (i.e., 1,799 l.f. Davis Branch mainstem restoration reach + 1,289 l.f. Davis Branch Enhancement Level I reach + 459 l.f. UT1 restoration reach = 3,547 l.f. total); nine monumented cross-sections, collection and analysis of particle distributions at each of the monumented cross-sections; and ten vegetation monitoring plots with live branches, herbaceous ground cover, shrub, mid-story and canopy plantings representative of indigenous streamside, meanders bends, floodplain and riparian zone plant communities. Two galvanized steel, USGS Type A, 4-foot crest gages have been installed on the project reaches; one crest gage is installed on the right bank at profile station 19+16 on the mainstem restoration reach, and the second is installed near the confluence of UT1 with Davis Branch mainstem on the left bank at profile station 6+59, as shown on the As-Built plan sheets in **Section 7.0**, to document bankfull and greater flows.

Stream monitoring will be in accordance with the multi-agency, North Carolina Stream Mitigation Guidelines (April 2003) applicable to Priority Level I/II Restoration projects, following the template for *Content, Format and Data Requirements for EEP Monitoring Reports, Version 1.2* (November 16, 2006). Vegetation monitoring will be conducted in accordance with *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee, M.T., Peet, RK., Roberts, S.R., Wentworth, T.R. 2006) for Levels 1 and 2 Plot Sampling. Throughout the monitoring period, remedial action will be performed based on agency review of monitoring documents, and decision making between EEP and the provider to ensure the long-term success of the Davis Branch and Unnamed Tributary Mitigation Project.

Differences Between Design and As-Built Conditions

The "As-Built" geomorphologic parameters in this report show some notable differences in comparison to design parameters for the project stream reaches. The detailed Rosgen Level III reference reach study conducted downstream from the project reaches on Davis Branch shows stable E-type channel geomorphologic relationships were indicated for both the Davis Branch mainstem and UT1. In each case the "As-built" reaches have C-type channel geomorphologic and hydraulic relationships with approximately the same cross-sectional areas proposed in the design. The detailed assessment of the "As-Built" conditions presented in this mitigation plan show the restored streams are stable, properly sized and well connected to their floodplains. Additionally, the "As-Built" project stream reaches meet the mitigation goals and objectives acknowledged as set forth in the project Restoration Plan.

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Davis Branch Mainstem Restoration Reach

The most notable differences when comparing the "As-Built" geomorphologic conditions to the proposed design conditions in the Restoration Plan are listed below.

- 1. The median bankfull width is 25 percent greater than proposed (9.0 ft to 11.3 ft)
- 2. The median bankfull mean depth is 32 percent less than proposed (0.88 ft to 0.60 ft)
- 3. The median floodprone width is 25 percent less than proposed (117 ft to 88 ft)
- 4. The median entrenchment ratio is 35 percent less than proposed (13.1 to 8.5)
- 5. The median width/depth ratio 47 percent greater than proposed (10.2 to 19.3)

Despite the differences between design and "As-Built" channel morphology, the bankfull cross-sectional area under design and "As-Built" conditions is similar (7.9 ft² vs. 7.0 ft²). The entrenchment ratio is very stable (8.5). The transition from the designed E-type channel to the "As-Built" C-type channel remains stable and functional from an ecologic enhancement perspective. Additionally, "As-Built" pattern and profile slope, from the top to the bottom of the 1,799 l.f. mainstem restoration reach, is consistent with proposed conditions in the site Restoration Plan.

UT1 Restoration Reach

The most notable differences when comparing the "As-Built" geomorphologic data to the proposed design conditions in the Restoration Plan are listed below.

- 1. The median bankfull width is 50 percent greater than proposed (6.2 ft to 12.4ft)
- 2. The median bankfull mean depth is 40 percent less than proposed (0.72 ft to 0.43 ft)
- 3. The median entrenchment ratio is 43 percent less than proposed (7.7 to 4.4)
- 4. The median width/depth ratio is 70 percent greater than proposed (8.6 to 29.1)

Despite these changes between design and "As-Built" conditions, the bankfull cross-sectional area under design and "As-Built" conditions is similar (4.5 ft² vs. 5.3 ft²). The entrenchment ratio is stable (4.4). The median floodprone width is 12 percent greater than proposed (54.1 ft vs. 47.4 ft). The transition from the designed E-type channel to the "As-Built" C-type channel remains stable and functional from an ecologic enhancement perspective. "As-Built" pattern and profile slope, from the top to the bottom of the 459 l.f. UT1 restoration reach, is consistent with proposed conditions in the site Restoration Plan.

1.0 PROJECT BACKGROUND

1.1 Project Site Location and Details

The project is located southeast of Olive Branch Road and west of Marshville-Olive Branch Road, 7.8 miles north-northeast of the town of Marshville, Union County, North Carolina. The site location and vicinity map is presented on **Figure 1**. The project is located on properties owned by Edward Bruce Staton and wife Deborah H. Staton, and Keith Bunyan Griffin and wife Phyllis Griffin. The project includes restoration activities along Davis Branch mainstem and one unnamed tributary stream, designated as UT1 throughout this document.

To travel to the site from U.S. Route 74 in Marshville, North Carolina, turn onto North Elm Street (SR 205) and travel 5.3 miles to Olive Branch Road (SR 1006). Turn right onto Olive Branch Road and travel 3.9 miles to 9406 Olive Branch Road (Edward and Deborah Staton Residence). Turn right onto the Staton's driveway, the dedicated egress/ingress access to the recorded EEP Conservation Easement Areas on the Davis Branch and Unnamed Tributary, Stream Restoration Project.

USGS Hydrologic Unit Code and NCDWQ River Basin Designations

The Davis Branch watershed is located within the USGS 14-digit HUC watershed 03040105070080. Davis Branch is a tributary to Gourdvine Creek, to Richardson Creek to the Rocky River in the Lower Yadkin-Pee Dee River Subbasin 03-07-14, as shown on **Figure 2**. The project is not located within a North Carolina Wetland Restoration Program (WRP) targeted watershed; however, it is located immediately north of Beaverdam Creek WRP Targeted Watershed 81030. The project stream reaches are mapped on North Carolina Department of Transportation, Light Detection and Ranging (LiDAR) March 2005 coverage for Union County, North Carolina as shown on **Figure 3**.

Physiography

The Davis Branch watershed is located in the Piedmont Physiographic Province of south central North Carolina in the Carolina Slate Belt Ecoregion (Draft Level III and Level IV Ecoregions of North Carolina, USEPA, USDA-NRCS & NCDENR, August 17, 2000). Valley Type VIII (Rosgen, 1996) is the most readily identified landform along the lower 2,100 l.f. mainstem reach corridor, with subtle terraces positioned laterally along the broad valley. Floodprone widths vary from 120 to 150 feet with moderate, down-valley elevation relief. Alluvial terraces and floodplains are the predominant depositional features in this fluvial geomorphologic system and produce a high sediment supply. On UT1 and the upstream east-west trending reach on the mainstem, the valley narrows and transitions to a moderately steep, gentle sloping side slopes Type II colluvial valley. As shown on **Figure 2** and **Figure 3** the first and second order Davis Branch stream reaches are headwater streams to Gourdvine Creek to Richardson Creek in the Rocky River Basin. Existing valley slopes for the project reaches range from 0.0170 ft/ft to 0.0249 ft/ft with elevations from the upstream

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watershed divide to the mouth of Davis Branch ranging from 526 feet to 390 feet (NAVD 88), with a total local elevation relief of 136 feet.

Geology

In the project vicinity, bedrock consists of heated and deformed (metamorphosed) sedimentary and volcanic rock. Bedrock is exposed at outcrops in the streambeds along the mainstem and the lower segment of UT1. Exposed bedrock is dense, crystalline on a microscopic scale (i.e., grains not visible to the naked eye), slate. The Carolina Slate Belt was the site of a series of oceanic volcanic islands about 550 – 650 million years ago (Pre-Cambrian and Cambrian Systems). Metamorphic rocks that occur in this region include metamudstone and meta-argillite (slate), thin to thick bedded, bedding planes and axial-planar cleavage common, interbedded with meta-sandstone, meta-conglomerate and meta-volcanic rock.

Four formations are recognized in the Union County, North Carolina portion of the Carolina Slate Belt section – from oldest to youngest, the Uwharrie Formation, Tillery Formation, McManus Formation and Yadkin Formation, that together comprise over 16,500 feet of the Lower Paleozoic Section in south-central North Carolina. The Uwharrie Formation represents a period of extensive volcanism with the formation of crystal lithic and devitrified tuffs, a rock formed from compacted volcanic fragments, generally smaller than four millimeters in diameter, incorporated in a micro-crystalline groundmass. The Tillery Formation consists of thin bedded, laminated argillite with some interbedded non-laminated argillite and sandstone. Thick bedded, tuffaceous argillite characterizes the McManus Formation which also contains an appreciable amount of crystal tuff and very fine-grained sandstone. The youngest unit is the is the Yadkin Graywacke which consists of thick bedded graywacke and laminated argillite. Quartz and igneous intrusions are found in all of the units. The age of the rocks studied is Early Paleozoic, probably Cambrian or Ordovician.

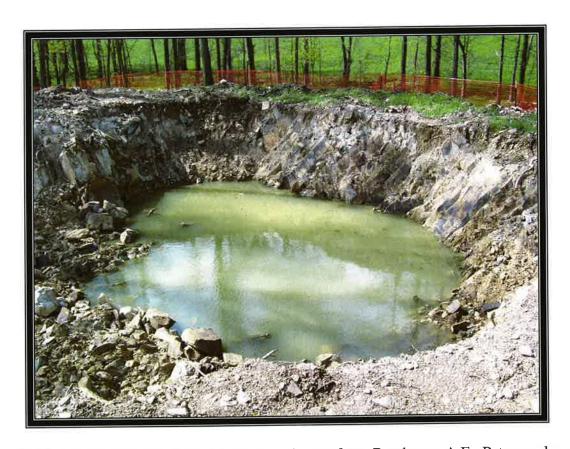


The Davis Branch mainstem and UT1 project reaches are located on the northwest limb of the northeast-southwest trending Troy Anticlinorium near the axial plane of a small unnamed syncline. The axial plane (i.e., fold crest orientation) strikes N49°E, with a regional bedding plane dip angle of 37° to the northwest. Across the fold axis to the southeast, the regional bedding plane dip angle is somewhat less steep, 29° to the southeast. The Troy Anticlinorium represents a series of local anticlines (upward folded arches) and synclines (downward folded troughs) that regionally form a large anticline. The local folds are open and predominantly asymmetric, mimicking the asymmetric geometry of the parent fold. Axial plane cleavage (rock splitting planes essentially parallel to the axial plane of the fold) is best developed where argillites (i.e., slate - metamorphosed, fine-grained mudstone and clay) are involved in the folding.

Locally, the site is underlain by the McManus Formation which comprises approximately 11,600 feet, or approximately 70 percent of the Carolina Slate Belt section in Union County, North Carolina. On the project stream reaches, large, blocky cobble deposited on the streambed is a secondary substrate, resulting from physical weathering of the highly fractured, steeply dipping, thick-bedded slate bedrock.

On site, the dominant bedding plane orientation strikes N65°E and dips 55° to the northwest. The average stream bedrock protrusion height is 0.57 feet (or 174 mm) based on Rosgen Level III field measurements. Bedrock outcrops along the restored Davis Branch mainstem restoration reach, the mainstem Enhancement Level I reach, and the UT1 restoration reach. The Davis Branch reference reach, located downstream from the mainstem project reach on the north side of Olive Branch Road, has strong bedrock control as well. Bedrock exposed in the streambeds is dense, crystalline on a microscopic scale (grains not visible to the naked

eye), moderately to steeply dipping, fractured, medium to thick bedded slate. The following photograph shows typical bedrock streambed conditions on the upper section of the mainstem Enhancement Level I reach. The following photograph shows the onsite quarry (now reclaimed, seeded and stabilized) utilized as a source for instream structure stone during construction of the project stream reaches. Note the steeply dipping bedding planes and rock cleavage in the thick bedded slate bedrock of the McManus Formation.



Detailed local geologic structure and stratigraphy are from Randazzo, A.F., <u>Petrography and Stratigraphy of the Carolina Slate Belt, Union County, North Carolina</u>, Ph.D. Thesis (University of North Carolina at Chapel Hill, 1968). The structural geologic map on the following page is published in the cited thesis.

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Soils

Mapped soil units within the project site and vicinity and taxonomic descriptions are from the USDA NRCS, Soil Survey of Union County, North Carolina (USDA - NRCS, January 1996). The soils along Davis Branch mainstem and UT1 have been derived from and developed over crystalline on a microscopic scale (grains not visible to the naked eye), dense metamorphic rock formations (i.e., meta-mudstone and meta-argillite, geologic nomenclatures synonymous with slate).

The predominant soil type mapped on the Davis Branch mainstem is the Cid channery silt loam, 1 to 5 percent slopes. This map unit consists mainly of moderately deep, moderately well drained and somewhat poorly drained, nearly level and gently sloping Cid and similar soils on flats, on ridges in the uplands, in depressions and in headwater drainageways. Typically, the surface layer is light brownish gray channery silt loam 4 inches thick. The subsurface layer is a pale yellow channery silt loam 5 inches thick. The subsoil is 18 inches thick. In the upper part, it is light olive brown silty clay that has light brownish gray mottles. In the lower part, it is mottled grayish brown and light olive brown channery silty clay. Weathered, fractured slate bedrock is encountered at a depth of about 27 inches. Hard, fractured slate bedrock is encountered at a depth of about 32 inches. Permeability is slow in the Cid soil. Average water capacity is low or moderate. The shrink-swell potential is moderate. A seasonal high water table is perched between 1.5 to 2.5 feet below ground surface from December through May. The depth to hard bedrock ranges from 20 to 40 inches. The hazard of erosion is moderate on construction sites if the ground cover is removed. This map unit is used mainly as cropland, hay, pasture or woodland. The following photograph shows the entire Cid pedon section, exposed to erosion along the east (river right) bank of Davis Branch, taken on April 15, 2008, facing upstream.



The next photograph, taken at the bottom of the mainstem reach on March 9, 2006, shows the Cid pedon section, with nutrient laden water, as evidenced by prolific algae bloom, attributed to agricultural runoff exacerbated by livestock intrusion, and hoof-shear streambank destabilization leading to streambank failure and erosion.



Included with the Cid soils on site are areas of Badin channery silt loam (map symbol - BaB), 2 to 8 percent slopes, mapped on river left along the mainstem Priority Level I/II restoration reach on the Staton property and along the mainstem preservation reach on the Griffin property.

The Badin map unit consists mainly of moderately deep, well drained undulating soils on convex upland ridges that are highly dissected by intermittent drainageways. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is brown Channery silt loam 7 inches thick. The subsoil is 21 inches thick. In the upper part, it is red silty clay. In the lower part, it is red Channery silty clay loam that has yellow and strong brown mottles. Weathered, fractured slate bedrock is encountered at a depth of about 28 inches. Hard, fractured slate bedrock is at a depth of about 41 inches. In some eroded areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown Channery silty clay loam.

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Permeability is moderate in the Badin soil. Available water capacity is low or moderate. The shrink-swell potential is moderate. The hazard of erosion is moderate in bare or unprotected areas. Flat slate fragments on the surface helps to control erosion. The depth to weathered bedrock ranges from 20 to 40 inches. The depth to hard, fractured slate bedrock is greater than 40 inches. This map unit is used mainly for cropland, pasture and woodland.

An area of Badin channery silty clay loam, 2 to 8 percent, eroded (map symbol - BdC2) is present along the lower Enhancement Level 1 mainstem reach on Davis Branch. The soil taxonomy is essentially identical to the BaB map unit described in the preceding paragraph. Some primary differences are the BdC2 map unit is poorly suited to cultivated crops because of slope constraints and the eroded surface layer. The hazard of further erosion is very severe. Weathered, fractured slate bedrock is encountered at a depth of about 29 inches. Hard, fractured slate bedrock is encountered at a depth of about 41 inches. The following photograph, taken on April 15, 2008 looking upstream on Davis Branch mainstem Enhancement Level 1 reach, shows the erodible nature of the Badin, BdC2 soil pedon on site, with streambank sloughing in the foreground and vertical, denuded streambanks upstream attributed to cattle intrusion.



Goldston-Badin complex soils (map symbols - GsB and GsC), 2 to 8 and 8 to 15 percent slopes, respectively, are the mapped units on UT-1. GsB soils are mapped along the upper third of the project reach. GsC soils are mapped to the confluence of UT-1 with Davis Branch mainstem.

The GsB component of the mapped unit consists mainly of shallow and moderately deep, well drained to excessively drained, undulating Goldston and Badin soils on ridges in the uplands. The topography is highly dissected by intermittent drainageways. The unit is about 45 percent Goldston soil and about 40 percent Badin soil. The two soils occur as areas so intricately mixed that mapping them separately at the selected scale in not practical. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer of the Goldston soil is brown very channery silt loam 5 inches thick. The subsoil is light yellow brown very channery silt loam 11 inches thick. Weathered, fractured slate bedrock is typically encountered at a depth of 27 inches. In some places

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bedrock is exposed at ground surface, resulting in narrow, scattered bands of weathered slate outcrops. In other areas, flagstones (flat slabs of slate) are in and on the surface layer.

Permeability is moderately rapid in the Goldston soil. Available water capacity is low. The hazard of erosion is moderate in bare or unprotected areas. Flat slate fragments on the surface create a "mulch effect" that helps to hold water in the soil and helps to control erosion. The depth to weathered bedrock ranges from 10 to 20 inches. The depth to hard, fractured slate bedrock ranges from 20 to 40 inches.

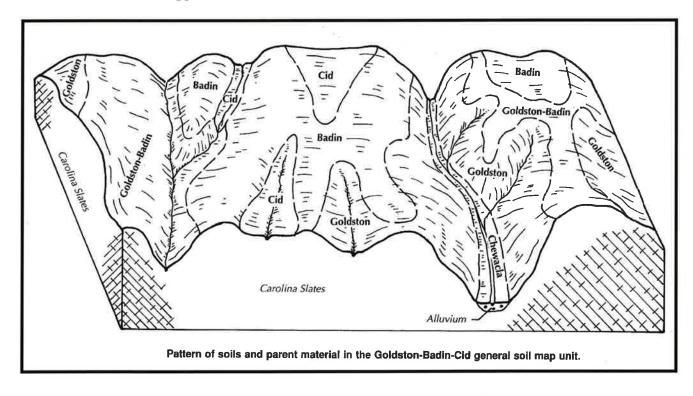
The Badin soil is well drained. Typically, the surface layer is brown channery silt loam 7 inches thick. The subsoil is 21 inches thick. In the upper part, it is red silty clay. In the lower part, it is red channery silty clay loam that has yellow and strong brown mottles. Weathered, fractured slate bedrock is encountered at a depth of about 28 inches. Hard, fractured slate bedrock is at a depth of about 41 inches. In some eroded areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown channery silty clay loam. Permeability is moderate in the Badin soil. Available water capacity is low or moderate. The shrink-swell potential is moderate. The hazard of erosion is moderate in bare or unprotected areas. Flat slate fragments on the surface helps to control erosion. The depth to weathered bedrock ranges from 20 to 40 inches. The depth to hard, fractured slate bedrock is greater than 40 inches. This map unit is used mainly for cropland, pasture and woodland.

The GsB component of Goldston-Badin complex, 8 to 15 percent slopes is mapped along the lower two-thirds of the UT-1 project reach to its confluence with Davis Branch. The GsB mapped soil unit consists mainly of shallow and moderately deep, well drained to excessively drained, undulating Goldston and Badin soils on hillside valley slopes, as opposed to the GsC (2 to 8 percent slopes) soils mapped on ridges in upland areas. The topography is highly dissected by intermittent drainageways. The unit is about 55 percent Goldston soil and about 30 percent Badin soil. The two soils occur as areas so intricately mixed that mapping them separately at the selected scale in not practical. Individual areas are irregular in shape and range from 4 to more than 25 acres in size.

The Goldston soil is well drained to excessively drained and is shallow over bedrock. Typically, the surface layer of the Goldston soil is brown very channery silt loam 5 inches thick. The subsoil is light yellow brown very channery silt loam 11 inches thick. Weathered, fractured slate bedrock is typically encountered at a depth of 16 inches. Hard, fractured slate bedrock is encountered at approximately 27 inches below ground surface In some places bedrock is exposed at ground surface, resulting in narrow, scattered bands of weathered slate outcrops. In other areas, flagstones are in and on the surface layer. Other than shallower accumulated soil thickness attributed to hill slope landform geomorphologic processes associated with steeper land surface slope, as described above, with the GsB component containing a proportionately higher composition of Goldston soil based on slope position, the GsB pedon is otherwise identical to the GsC pedon. The following photograph shows soil conditions near the mouth of UT-1, partially obscured to vegetation on April 15, 2008, characteristic of the onsite GsB soil pedon section.



The following block diagram, from the cited Soil Survey of Union County, is representative of the occurrence of mapped Goldston-Badin-Cid soils on site.



The drainage area tributary to the downstream limits of the project on Davis Branch mainstem is 0.3352 square miles or 214.5 acres. UT1 has a contribution drainage area of 0.0721 square miles (46.1 acres). The project contribution drainage areas watershed map is presented on **Figure 4**. Drainage areas for the project reaches are summarized in **Table 1**.

TABLE 1					
Drainage Areas					
Project Number D06054-F (Davis Branch and Unnamed Tributary)					
Reach	Drainage Area (Acres)				
Davis Branch Mainstem (downstream	214.5				
project limit)					
UT1 to Davis Branch*	46.1				
Total	214.5				

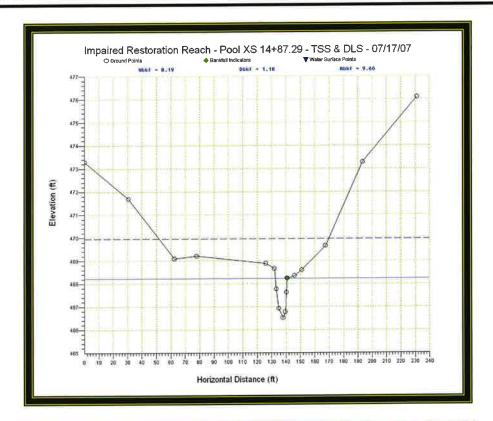
^{*}UT1 drainage areas is included in the total contribution drainage area for the Davis Branch stream restoration project. Refer to **Figure 4** for delineation of project sub-watershed drainage areas.

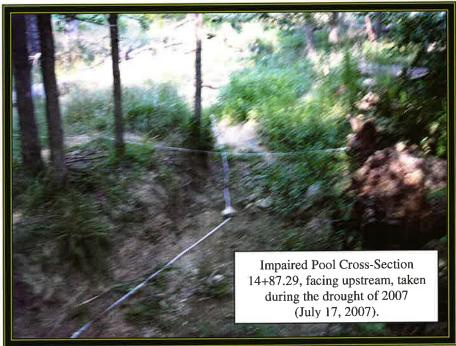
1.2 Pre-Restoration Existing Conditions

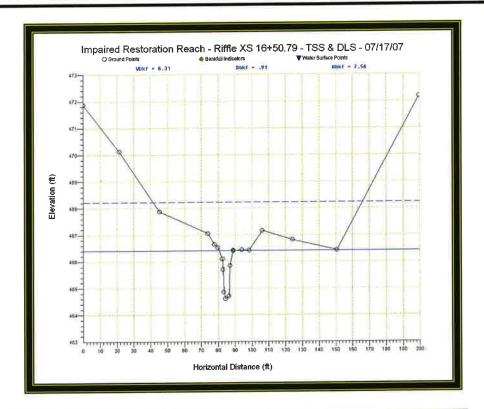
<u>Davis Branch Impaired Mainstem - Priority Level I/II Restoration Reach</u>

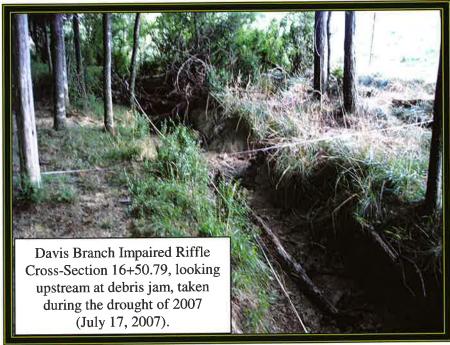
The stable, natural channel form for the Davis Branch mainstem restoration reach is Rosgen E4/1 stream type, based on a detailed Rosgen Level III quantitative and qualitative analysis of stable reference reach conditions on August 8-9, 2006. The reference reach is located downstream from the site, beginning at the outlet end of the culvert carrying Davis Branch under Olive Branch Road in a northwesterly direction to the confluence of Davis Branch with Gourdvine Creek as shown on **Figure 5**. Detailed geomorphologic surveys were conducted along representative segments of each of the impaired project reaches on July 17, 2007.

A number of anthropogenic factors impacted the stream channel and riparian corridor along the impaired upper mainstem restoration reach, resulting in its pre-restoration unstable, moderately incised and braided condition. Bank height ratios (BHR) calculated at impaired pool cross-section 14+87.29 and impaired riffle cross-section 16+50.79, located 706 feet and 870 feet downstream from the top of the mainstem preservation reach on the Griffin property, are 1.38 and 1.41, respectively (BHR = Low Bank Height/Bankfull Maximum Depth). Deep channel incision was attributed to uncontrolled cattle intrusion (herbaceous groundcover grazing, shrub vegetation browsing and streambank hoof shear) resulting in a denuded riparian landscape and destabilized, eroding streambanks. Multiple thread channels, created by breaches that rerouted the mainstem channel around woody debris jams (avulsions) were present at a number of locations throughout the reach. (Degree of Channel Incision, *River Stability Field Guide*, David L. Rosgen, Ph.D., P.H. and Hilton Lee Silvey, 2008).









In its pre-existing impaired state, upper Davis Branch was transitioning from E4/1 channel dimensions (i.e., width/depth ratio < 12; entrenchment ratio > 2.2) to a multiple thread Rosgen DA4/1 (i.e., width/depth ratio > 40; entrenchment ratio > 2.2) stream type albeit

under incised conditions along the reach. In addition to cattle intrusion, channelization (impaired conditions sinussity = 1.12), and an average channel slope of 1.58 percent increased critical shear stress acting on the streambed and banks during bankfull flows (Qbkf = 24.8 cfs with a mean velocity of 5.26 ft/sec under impaired conditions) and greater flows. The following impaired conditions cross-section 18+42.50 graphically shows the multithread, braided stream channels characteristic of Davis Branch prior to restoration.

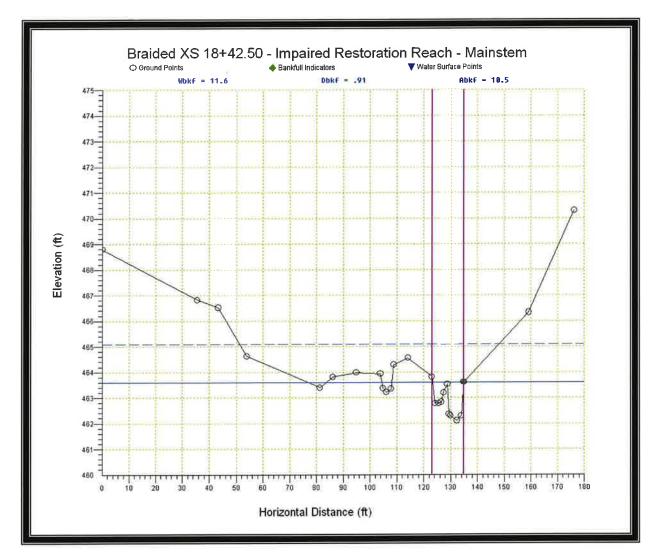
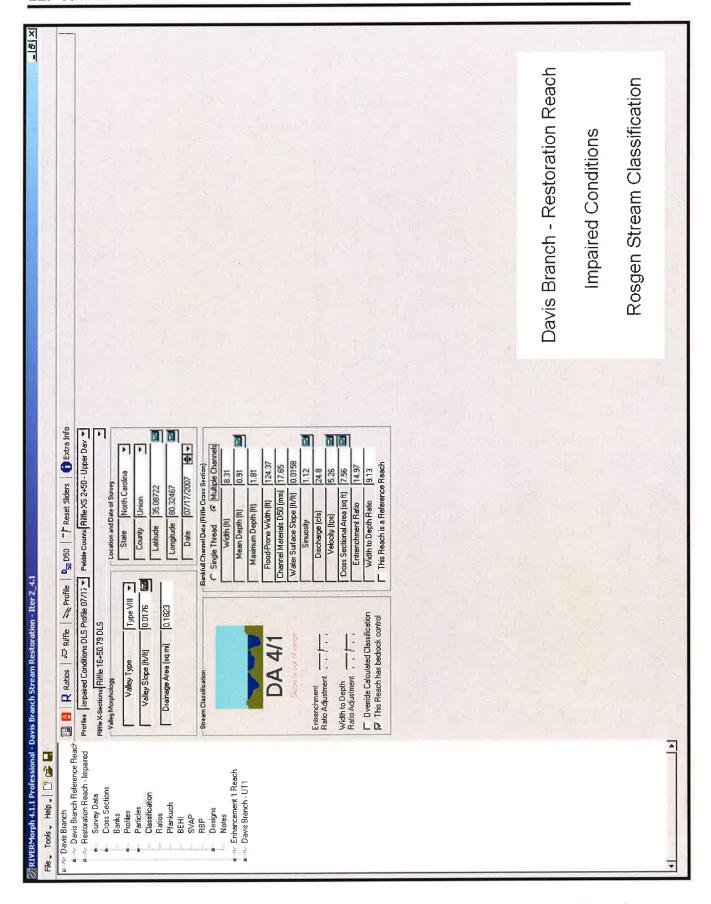


Table 2a provides baseline morphologic and hydraulic summaries for regional curve, reference reach, existing, proposed and As-Built channel dimension, pattern, profile and substrate, along with additional reach parameters for upper Davis Branch. The following screenshot from RiverMorph v. 4.1.1, shows impaired project reach Rosgen stream channel classification, dominant substrate materials readily available to the stream, geomorphologic and hydraulic conditions on the Davis Branch mainstem restoration reach. The impaired mainstem restoration reach longitudinal profile is presented following the Rosgen Classification screen capture. Supporting impaired conditions documentation is included with the information in Appendix 3 of the Davis Branch and Unnamed Tributary Restoration Plan (EMH&T, June 2008).

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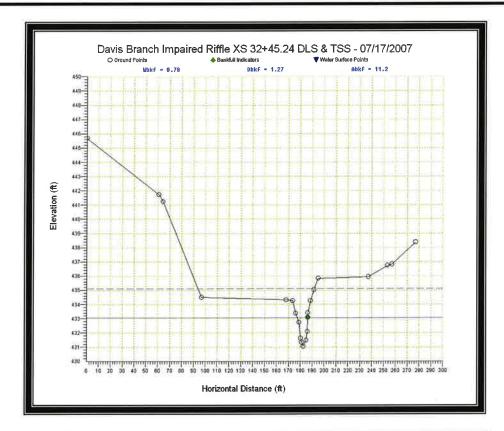
Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

Davis Branch Enhancement Level I Reach

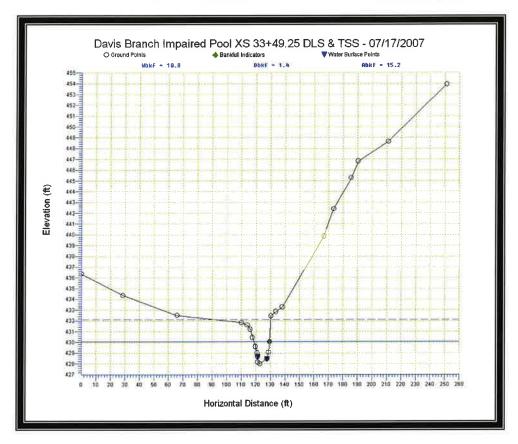
The stable, natural channel form for the Davis Branch mainstem EI reach is a Rosgen E3/1b stream type based on a detailed Rosgen Level III, quantitative analysis of stable reference reach boundary conditions on August 8-9, 2006. A detailed geomorphologic survey on the impaired project reach was conducted on July 17, 2007.

A number of anthropogenic factors impacted the stream channel and riparian corridor along the impaired lower mainstem EI reach, resulting in its pre-restoration channelized, deeply incised, and eroding, unstable streambanks. Bank height ratios calculated at impaired riffle cross-section 32+45.24 and impaired pool cross-section 33+49.25, located 85.3 and 187.5 feet downstream from the former confluence of UT1 with the mainstem, were 1.58 and 1.86, respectively. Deep channel incision resulted from steep channel gradient (2.16 percent or 0.0216 ft/ft), linear channel alignment (channel sinuosity = 1.06) mean bankfull flow velocity approaching 5.5 ft/sec, high shear velocity (u* = 0.93 ft/sec), where u* = (gdS)^{0.5} [g = gravitational acceleration = 31.74 ft/sec², d = mean depth (ft) and S = channel slope (ft/ft)], extremely high nearbank critical shear stress (τ_c = 1.48 lbs/ft²), where τ_c = γ RS [γ = specific weight of water = 62.4 lbs/ft³, R = hydraulic radius (ft) and S = channel slope (ft/ft)]. In addition to unstable channel hydraulics and morphology, uncontrolled cattle intrusion (hoof shear streambank destabilization and vegetative denuding) exacerbated bank and streambed erosion. The cumulative effect of these factors resulted in nearly 5 feet high, vertical eroding streambanks on the EI Davis Branch mainstem reach.

Priority Level I/II restoration approach was initially proposed as the preferred mitigation approach to restore stable boundary conditions on the lower mainstem reach. Based on a field meeting held on April 15, 2008 between EEP and EMH&T, during the design phase of the project, the mitigation approach was modified from full-scale restoration Enhancement Level I restoration along the final 1,289 l.f. Davis Branch mainstem reach, under which only profile and channel dimension would be restored. The design approach included sizing the channel based on reference reach boundary conditions and the construction of riffles and step-pools to dissipate energy and reduce bankfull flow velocities. EEP approved Priority Level I/II offline restoration approach for the 1,562 l.f. impaired mainstem reach located in a wooded corridor immediately upstream from the EI 1,289 l.f. mainstem reach located in an open meadow. Differential level survey cross-sections plots and impaired conditions photographs taken at the line of section that follow, were taken during the impaired conditions geomorphologic survey on August 17, 2007.







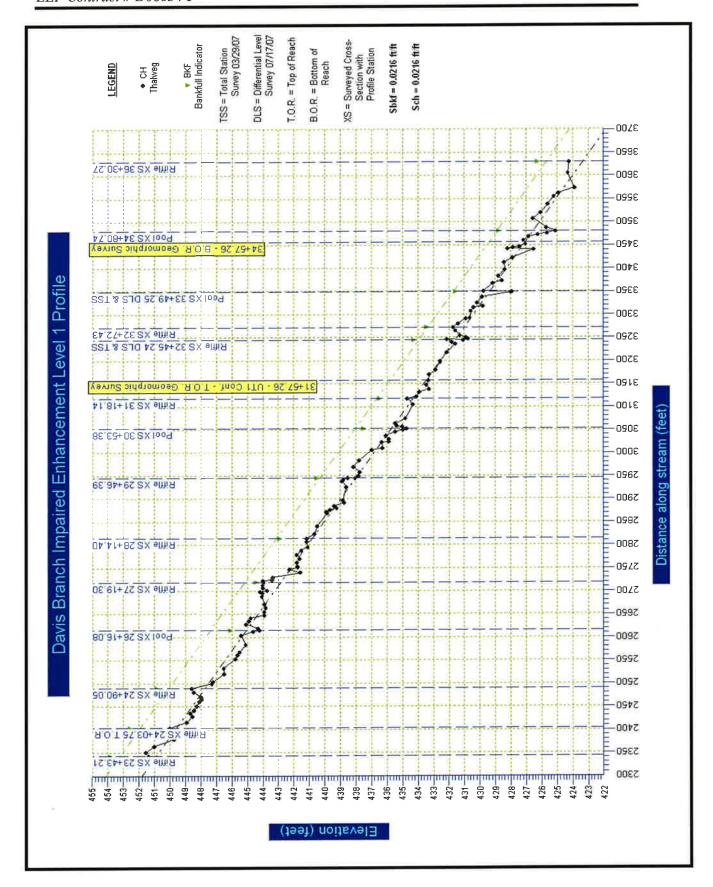


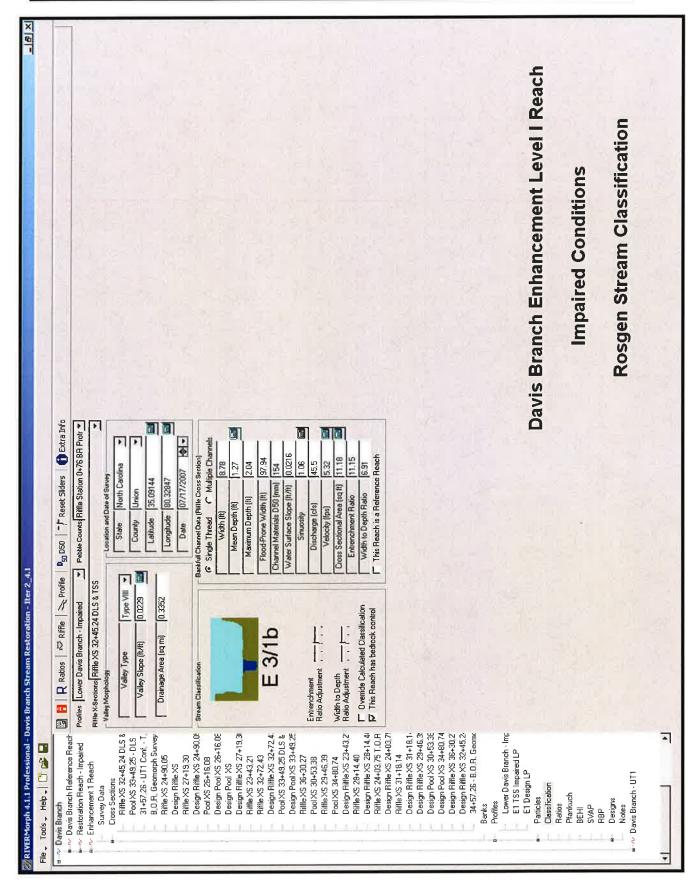
Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

With a linear channel sinuosity of 1.06, an average profile slope of 2.16 percent, verified bankfull discharge of 45.5 cubic feet per second, and mean bankfull velocity approaching 5.5 feet per second, the channel had incised (degraded) to bedrock. Without stable pattern to decrease velocity head, near-bank shear stress, or shear velocity, the impaired channel compensated by eroding its vertically and laterally confined streambanks, resulting in an over-widened, over-deepened channel with unstable width/depth relationships and high streambank erosion rates.

Under reference reach boundary conditions downstream on Davis Branch, where Rosgen stream type, width/depth, pool to pool spacings, riffle lengths, riffle slopes, average profile slope, channel dimensions and pattern relationships are within normal ranges for the Carolina Slate Belt ecologic, geologic and physiographic region, the streambed and banks are inherently stable. **Table 2b** presents baseline geomorphologic and hydraulic summary data from the *North Carolina Rural Piedmont Regional Curve* dataset, stratified by Rosgen E stream type regression analysis, the Davis Branch Reference Reach, existing, proposed and As-Built channel dimension, profile and substrate, and hydraulic parameters for mainstem EI project reach.

The following longitudinal profile, analyzed using RiverMorph v. 4.1.1, shows the impaired EI mainstem project reach, with locations of impaired conditions cross-sections shown on the profile. Following the impaired conditions longitudinal profile, the impaired conditions Rosgen stream channel classification, dominant substrate materials, geomorphologic parameters and hydraulic geometries from representative impaired riffle cross-section 32+45.24, surveyed in the field on July 17, 2007 are presented. Supporting impaired conditions geomorphologic and hydraulic assessment documentation is included with the information in **Appendix 3** of the Davis Branch and Unnamed Tributary Restoration Plan (EMH&T, June 2008) incorporated herein by reference.





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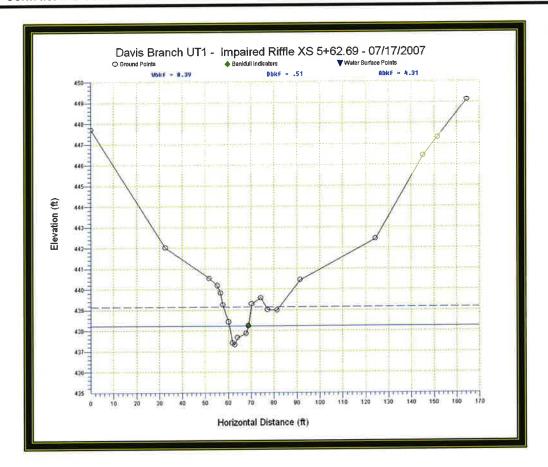
Davis Branch UT1

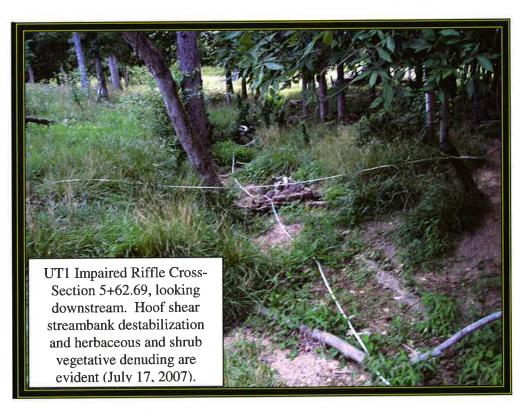
The stable, natural channel form for the Davis Branch UT1 restoration reach is a Rosgen E4/1b stream type, based on a detailed Rosgen Level III, quantitative analysis of a stable reference reach conditions on August 8-9, 2006 combined with a detailed geomorphologic survey along the final 240 linear feet of the impaired project reach, conducted on July 17, 2007.

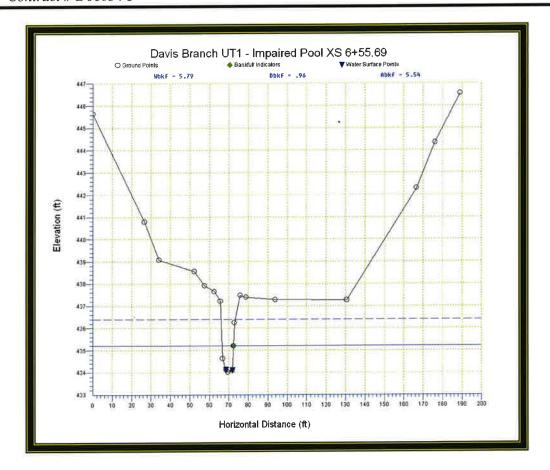
A number of anthropogenic factors impacted the stream channel and riparian corridor along the impaired UT1 reach (existing conditions profile station 0+00.00 to 7+29.60) resulting in its pre-restoration channelized, entrenched and deeply incised condition. Bank height ratios were calculated at impaired profile stations 5+62.69, 6+13.69 and 7+24.30 corresponding to representative existing conditions riffle cross-section locations. Low bank heights ranged from 1.78 to 3.45 feet, with a mean of 2.50 feet. Corresponding bank height ratios were 2.47, 3.67 and 2.32, respectively, with a mean BHR of 2.82.

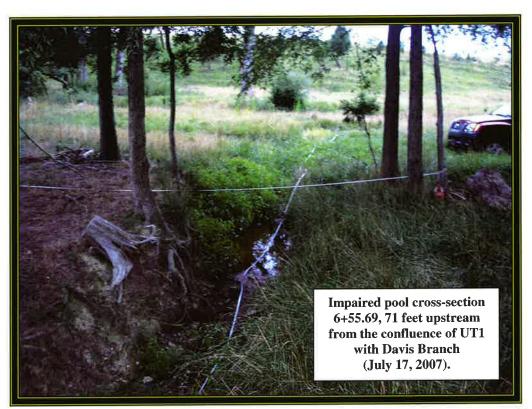
The extreme degree of channel incision leading to entrenchment was attributed to steep profile gradient (2.3 percent or 0.023 ft/ft), linear channel alignment (sinuosity = 1.09), high bankfull mean velocity (6.58 ft/sec), high shear velocity (u* = 0.68 ft/sec), high near-bank critical shear stress ($\tau_c = 0.85 \text{ lbs/ft}^2$) and uncontrolled cattle intrusion (hoof shear streambank destabilization, vegetative denuding resulting in streambank failure, erosion and degradation). The cumulative effects of these impacts resulted in nearly 4 feet high, vertical, eroding streambanks on the impaired UT1 reach. Impaired pool cross-section 6+55.69 and riffle cross-section 5+62.69, located 71 and 164 feet upstream from the pre-restoration confluence of UT1 and the Davis Branch EI mainstem reach, respectively, are presented below. Photographs at the line of section were taken during the impaired conditions geomorphologic survey on July 17, 2007 under severe drought conditions. The degree of channel incision increased from the top to the bottom of the reach as shown by the best fit trendlines through thalweg, bankfull and low bank elevation points plotted on the impaired conditions longitudinal profile, presented following the impaired conditions riffle and pool cross-section plots and photographs. A screenshot from RiverMorph v. 4.1.1, showing impaired UT1 project reach Rosgen stream type classification, valley type, dominant substrate materials, together with geomorphologic and hydraulic parameters is presented following the impaired conditions longitudinal profile.

In its pre-existing impaired state, UT1 was transitioning from E4/1b to C4/1b channel morphology, based on dimensions measured at impaired reach riffle cross-sections, albeit under incised conditions. The transition from E to C channel morphology occurs at below impaired profile station 3+16. **Table 2c** provides baseline geomorphologic and hydraulic summary data for regional curve, reference reach, impaired, proposed and As-Built channel dimensions, pattern and profile, along with addition reach parameters.

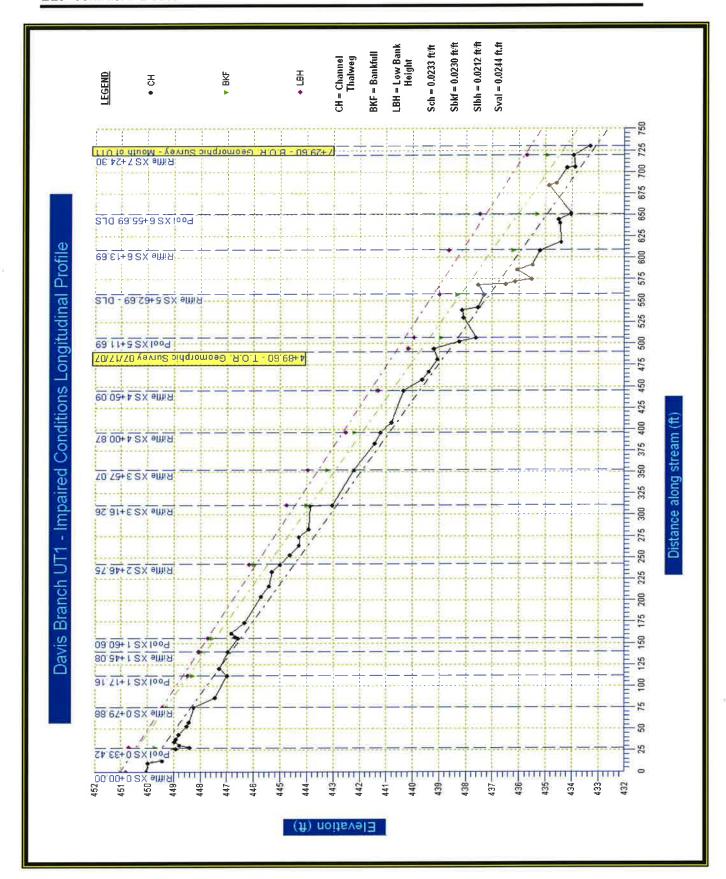


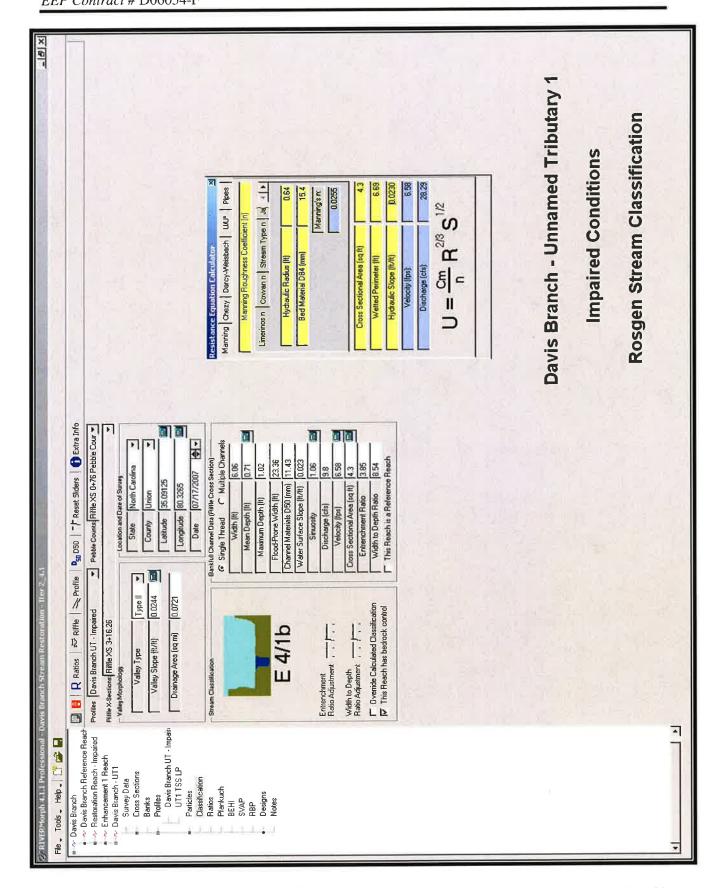






Evans, Mechwart, Hambleton & Tilton, Inc. Engineers, Surveyors, Planners, Scientists





2.0 RESTORATION SUMMARY

2.1 Mitigation Goals and Objectives

As discussed in the Restoration Plan for Davis Branch and an associated unnamed tributary (UT1), the mitigation goals and objectives for the project involved restoring stable physical and biological function of the project streams beyond pre-restoration (impaired) conditions. Impaired conditions consisted of channelized, eroding, incised and entrenched stream channels. Nutrient and sediment loading from agricultural runoff, together with vegetative denuding and destabilized streambanks associated with hoof shear resulting from uncontrolled cattle access was evident. The specific mitigation goals and objectives proposed and achieved for the project are listed below.

- Stable stream channels with features inherent of ecologically diverse environments, with appropriate streambed features including appropriately spaced pool and riffle sequences, and riparian corridors planted with a diversity of indigenous vegetation.
- Superimposed reference reach boundary conditions on the impaired project reaches in the restoration design and construction of improvements.
- Constructed stream channels with the appropriate geometry and gradient to convey bankfull flows while entraining suspended sediment (wash load) and bedload materials readily available to the streams.
- Created an improved connection between the bankfull channels and their floodprone areas, with stable channel geometries, protective vegetation and jute coir fabric to prevent erosion.
- Minimized future land use impacts to project stream reaches by conveying a perpetual, restrictive conservation easement to the State of North Carolina, including stream corridor protection via livestock exclusion fencing at the surveyed and recorded conservation easement boundaries, with gates at the edge of the riparian corridor on river right and left at reserved conservation easement crossings adjacent to active pasture land.

The restoration of Davis Branch mainstem and UT1 met the project goals and objectives set forth in the restoration plan, by providing desired habitat and stability features required to enhance and provide long-term ecologic health for the project reaches. More specifically, the completed restoration project has accomplished the enhancements listed below.

Davis Branch Mainstem:

- Reversed the effects of channelization using a Priority Level I/Level II (PI/II) and Enhancement Level I (EI) restoration approaches; restoration increased the average width/depth ratio from 9.13 to 19.34 on the PI/II reach and from 6.91 to 27.02 on the EI reach.
- Restored natural pattern to the channel alignment, increasing sinuosity from 1.12 to 1.29 on the PI/II reach, while maintaining a stable relationship between the valley slope and bankfull slope (the bankfull slope was steeper than the valley slope prior to restoration and is now less than the valley slope post-restoration). Stable pattern,

- profile and dimension were restored based on extrapolation from reference reach boundary conditions. On the mainstem EI reach, profile and dimension were restored based upon reference reach boundary conditions.
- Stabilized eroding streambanks by constructing appropriately sized channels with stable streambank slopes, built using a combination of embedded stone, grade control structures, topsoil, herbaceous seeding, mulch, natural fabrics and hearty vegetative live branch (3-foot spacings), bareroot (4-foot spacings) and 1-gallon tree (100-foot spacings) plantings.
- The average Bank Height Ratio was decreased from 1.41 to 1.00 on the PI/II reach and 1.86 to 1.00 on the EI reach, respectively (i.e., extremely incised to stable).
- Restored connection between the bankfull channel and the adjacent floodprone area by raising the bankfull channel to the elevation of the adjacent floodplain. The restored mainstem PI/II and EI reach entrenchment ratios range from 3.75 to 12.30 (stable).
- Created instream aquatic habitat features, including appropriately spaced pool and riffle sequences, and a stable transition of the mainstem reach EI thalweg to the invert of the existing channel at the bottom of the mainstem project reach.
- Revegetated the riparian corridor with indigenous canopy, mid-story, shrub and herbaceous ground cover species, and preserved existing forested riparian corridors where present.
- Protected the riparian corridor by placing livestock exclusion fencing at the edge of the perpetual, recorded conservation easement boundary.

Unnamed Tributary 1 (UT1):

- Reversed the effects of channelization through a combination of Enhancement Level II (EII) and Priority Level I (PI) restoration techniques. The average width/depth ratio of the restored UT1 project reach is 29.13. Stable dimension and grade control was restored on the EII reach (as-built profile station 0+00 to 3+96). Stable pattern, profile and dimension were restored on the PI reach (as-built profile station 3+96 to 8+54) based on extrapolation from reference reach boundary conditions.
- Restored stable channel pattern on the PI reach, increasing sinuosity from 1.09 to 1.37.
- Stabilized eroding streambanks by providing appropriately sized channels with stable streambank slopes. The average Bank Height Ratio has been reduced from 2.82 to 1.00 (extremely incised to stable).
- Improved the connection between the restored stream channel and the adjacent floodprone area by raising the bankfull channel to the elevation of the adjacent floodplain. The completed restoration increased the average entrenchment ratio from 3.63 to 4.38.
- Created stable channel dimensions, substrate and grade control structures (rock sills) on the EI reach; Created stable pattern, profile and dimension, including appropriately spaced riffle, run, pool and glide sequences, together with a stable

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- transition of the UT1 PI reach thalweg at its confluence with the Davis Branch Mainstem.
- Revegetated the riparian corridor with indigenous canopy, mid-story, shrub and herbaceous ground cover, preserved existing forested riparian corridors where present.
- Protected the riparian corridor by placing livestock exclusion fencing at the edge of the perpetual, recorded conservation easement boundary.

2.2 Restoration Approach

Engineering Field Reconnaissance

EMH&T scientists and engineers mobilized to the site on July 17, 2007 to assess the impaired project reaches. The following sections describe the results of the impaired conditions field assessment. Representative stream profiles ≥ 20 bankfull widths were surveyed using differential leveling techniques on each of the project reaches. Representative riffle and pool cross-sections were surveyed on each reach and riffle and pool streambed particle distributions were collected following standard NC EEP protocols. The following sections discuss, in detail, the results from engineering field reconnaissance, by project stream reach.

Project Mitigation Approaches

The restoration approaches for the project were implemented to return the impaired streams to a more natural condition that it is ecologically productive, aesthetically appealing, physically stable, and valuable from a conservation perspective. Project restoration goals and objectives were achieved utilizing an off-line, Priority Level I/Level II mitigation approach, restoring stable pattern, profile and dimension along the upper 1,799 linear feet (profile stations 7+81.31 to 25+79.02) on the Davis Branch mainstem and the final 459 linear feet (profile stations 3+95.76 to 8+54.91) on UT1. The mitigation approach restored connection of the vertically and laterally confined incised and entrenched stream reaches with their floodplains.

Channel profile and dimension was restored on the mainstem EI reach (profile stations 25+79.02 to 38+67.53) to stabilize existing over-widened and incised channel conditions. Dimension was restored on the upper 396 linear feet (profile stations 0+00.00 to 3+95.76) EII reach on UT1, with three grade control structures (rock sills) constructed approximately at profile stations 0+00, 2+00 and 3+00, together with placement of appropriately sized substrate material in the channel to reduce critical shear stress (0.56 lbs/ft²) in the near-bank region while maintaining bankfull flow velocity (2.74 ft/sec) and critical depth (0.95 ft) required to entrain coarse gravel (D50 particle size = 28.8 mm), based on analysis of channel hydraulics (entrainable particle size = 32.8 mm) and analysis of a particle distribution sample (n = 71) collected from the streambed at monumented riffle cross-section 8 (Riffle XS-8) at UT1 As-Built profile station 2+00.10.

Channel reinforcement materials were used in high near-bank shear stress regions (i.e., along outside meander bends). Reinforcement materials consist of a combination of rock toe channel

protection, temporary seeding and mulching, application of coconut fiber geotextile fabric, live branch plantings and revetment of streambanks and the riparian corridor.

Existing forested riparian corridors were preserved along the realigned Davis Branch mainstem and UT1 to enhance streambank stability, provide sediment and nutrient storage, and enhance terrestrial and aquatic habitat. Portions of the existing corridor that was disturbed during project-related construction was planted on April 6, 2009. Denuded areas within the limits of the project conservation easement have been fully planted to reestablish a native riparian corridor. The stream corridors are protected by livestock exclusion fencing placed at the edge of the conservation easement boundary.

2.3 Bankfull Verification

For the project stream reaches, bankfull discharge was evaluated through quantitative analysis of stable reference reach boundary conditions and comparison of predicted bankfull discharge through a stable, surveyed riffle cross-section, located 43 feet upstream from the confluence of Davis Branch with Gourdvine Creek, as shown on **Figure 4**. The contribution drainage area for the Davis Branch Reference Reach is 365.55 acres or 0.5712 square mile. Discharge versus drainage area relationships for the reference reach riffle cross-section were compared to published *Bankfull Hydraulic Geometry Relationships for North Carolina Streams (Rural Piedmont)* regional curve dataset. Through this analysis, it was determined the rural Piedmont regional curves underestimates bankfull discharge and geometric relationships for project stream reaches.

The Bankfull Hydraulic Geometry Relationships for North Carolina Streams (Rural Piedmont) power function regression equation for bankfull discharge is:

$$Q_{bkf} = 66.57 \text{ x } A_w^{0.89} \text{ } (R^2 = 0.97)$$

where Q_{bkf} = bankfull discharge (cfs) and A_w = watershed drainage area (mi²). Inputting the Davis Branch Reference Reach drainage area (0.5712 mi²) into the power function regression equation yields the following result:

$$Q_{bkf} = 66.57 \times 0.5712^{0.89} = 40.4 \text{ cfs}$$

To validate bankfull discharge for the project reaches, the *Bankfull Hydraulic Geometry Relationships for North Carolina Streams (Rural Piedmont)* dataset was stratified by E stream type using the regional curve data editor in RiverMorph® v.4.3. The resulting Log-Pearson Type III distributions and regression analysis from the stratified regional curve dataset yielded the following power function regression equations for bankfull discharge, bankfull cross-sectional area, mean depth and width is shown on the following page. The empirical relationships (predicted values) and the quantified relationships (measured values) from the Level III Davis Branch Reference Reach field study are presented in bold, where $A_w = 0.5712 \text{ mi}^2$.

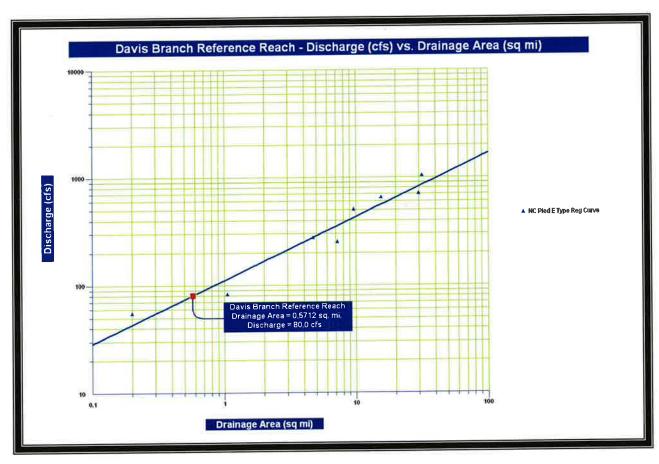
$$Q_{bkf} = 111.28 \text{ x A}_{w}^{0.5878} (R^2 = 0.94)$$
 $Q_{bkf} = 80.0 \text{ cfs}$ (predicted) 77.6 cfs (quantified)

$$A_{bkf} = 22.57 \text{ x } A_{w}^{0.6317} \text{ (R}^{2} = 0.88)$$
 $A_{bkf} = 15.85 \text{ sq ft (predicted) } 15.65 \text{ sq ft (quantified)}$

$$D_{bkf} = 1.53 \text{ x A}_{w}^{0.3206} (R^2 = 0.90)$$
 $D_{bkf} = 1.35 \text{ ft (predicted) } 1.21 \text{ ft (quantified)}$

$$W_{bkf} = 14.02 \text{ x A}_{w}^{0.3188} (R^2 = 0.94) \text{ } W_{bkf} = 11.77 \text{ ft (predicted) } 12.91 \text{ ft (quantified)}$$

The calculated discharge, using carefully delineated reference reach drainage area, quantified reference bankfull riffle geometry, profile slope, and bed roughness yielded a bankfull discharge of 77.6 cubic feet per second (cfs). The following Discharge versus Drainage Area, Rural Piedmont Regional Curve, stratified by Rosgen E stream type analysis predicts Q_{bkf} = 80.0 cfs and validates quantified bankfull discharge calculations for the Davis Branch Reference Reach.



Since the quantitatively derived bankfull discharge of 77.6 cfs, based on carefully measured field parameters, closely matches the empirical relationships between drainage area and bankfull discharge estimates from the stratified Rosgen E stream type Rural Piedmont Regional Curve dataset, the quantitatively derived bankfull discharge was carried forward into the design, proportionally adjusted for individual project reach drainage areas. Refer to Table 2a through

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Table 2c for reach specific estimates of bankfull discharge and hydraulic geometries from the stratified Rural Piedmont regional curve dataset, reference reach, pre-existing, design and as-built conditions.

Channel Morphology

Landform morphology along the Davis Branch mainstem and UT1 is Rosgen Valley Type VIII and Valley Type II, respectively. The pre-restoration Davis Branch mainstem restoration reach, mainstem EI reach and UT1 restoration reach were a deeply incised E4/1b \rightarrow D4/1b, E3/1b and E4/1b \rightarrow C4/1b Rosgen stream types, respectively. The restoration goal to reconnect project stream reaches with their adjacent floodplains and re-establish stable pattern, profile and dimension consistent with reference reach boundary conditions was achieved. The as-built Davis Branch mainstem restoration reach, mainstem EI reach and the UT1 restoration reach are Rosgen C4/1, C3/1b and C4/1 stream types, respectively, with areas of bedrock control. Summary geomorphologic and hydraulic summary data from the Bankfull Hydraulic Geometry Relationships for North Carolina Streams (Rural Piedmont) regional curves, stratified by Rosgen E stream types, Davis Branch Reference Reach, Pre-Existing, Design and As-Built conditions for the Davis Branch mainstem and UT1 stream reaches are presented in Table 2a through Table 2c.

Table 2a: Baseline Geomorphologic and Hydraulic Summary Davis Branch and Unnamed Tributary Restoration / EEP Project No. D06054-F Station/Reach: Davis Branch Priority Level I/II Restoration Reach Station 7+81 to 25+80 (1,799 linear feet)

Parameter Dimension Drainage Area (mi²) Bankfull Discharge (cfs) BF Width (ft) Floodprone Width (ft)	Regio Min	onal Curve Max	Data Mean 0.5712	Davis Bra Min	nch Refere Max	nce Reach Mean	Pre-E	xisting Co			Design		As-Built		-1 & XS-3)
Drainage Area (mi²) Bankfull Discharge (cfs) BF Width (ft)	Min	Max		Min	Max	Mean	Min	3.5							
Drainage Area (mi²) Bankfull Discharge (cfs) BF Width (ft)			0.5712				IATIII	Max	Mean	Min	Max	Median	Min	Max	Median
Bankfull Discharge (cfs) BF Width (ft)			0.5712												
BF Width (ft)						0.5712			0.1823			0.1823			0.1823
			80.0			77.6			24.8			24.8			24.8
Floodpropo Width (ft)			11.77			12.91			8.31			9.00	9.17	13.38	11.28
Produptone width (11)						50.00	52.12	165.18	106.28	63.19	238.17	117.44	63.06	112.74	87.90
BF Cross Sectional Area (ft²)			15.85			15.65			7.56			7.92	3.99	9.98	6.99
BF Mean Depth (ft)			1.35			1.21			0.91			0.88	0.44	0.75	0.60
BF Max Depth (ft)						1.61			1.81			1.20	0.87	1.62	1.25
Width/Depth Ratio			8.72			10.67			9.13			10.23	17.84	20.84	19.34
Entrenchment Ratio						3.87	6.27	19.88	12.79	7.02	26.46	13.05	4.71	12.30	8.51
Bank Height Ratio						1.00	1.38	1.41	1.40			1.00	1.00	1.00	1.00
Wetted Perimeter (ft)			14.47			13.72			9.84			9.57	9.33	13.80	11.57
Hydraulic Radius (ft)			1.10			1.14			0.77			0.83	0.43	0.72	0.58
Pattern															
Channel Beltwidth (ft)				27.80	53.00	38.00	Incised Lir	near Braide	d Channe			50.00			50.00
Radius of Curvature (ft)				16.40	45.30	29.40	Incised Lir	ear Braide	d Channe	10.65	35.00	19.70	10.65	35.00	19.70
Meander Wavelength (ft)				80.10	116.50	99.20	Incised Lir	ear Braide	d Channe	49.94	101.80	77.76	49.94	101.80	77.76
Meander Width Ratio				2.15	4.11	2.94	Incised Lir	ear Braide	d Channe			5.56			4.43
Profile															
Riffle Length (ft)				12.0	18.5	15.0	25.0	31.0	27.0	7.7	45.2	21.3	7.1	34.5	12.6
Riffle Slope (ft/ft)				0.02830	0.07990	0.05200	0.02080	0.06290	0.04499	0.02270	0.07620	0.03990	0.02806	0.07468	0.04822
Pool Length (ft)				12.0	29.1	21.2	19.5	29.8	22.9	17.1	36.8	23.9	11.5	42.6	24.5
Pool Spacing (ft)				33.4	43.7	38.6	35.3	43.7	40.0	24.9	78.1	48.5	16.8	79.8	40.3
Substrate															
D50 (mm)						69.2			17.7			17.7	33.3	36.3	34.8
D84 (mm)						140.1			28.9			28.9	52.8	61.5	57.2
Additional Reach Parameters															
Valley Length (ft)						974			1,397			1,397			1,397
Channel Length (ft)						1129			1,562			1,802			1,799
Sinuosity						1.2			1.12			1.29			1.29
Water Surface Slope (ft/ft)						0.03110			0.01579			0.01320	0.00828	0.01917	0.01304
Valley Slope (ft/ft)						0.03256			0.01760			0.01703	0.01066	0.02469	0.01679
Rosgen Classification			Е			E3/1b*		E4/1→]	DA4/1			E4/1			C4/1

Notes: *E channel morphology, large cobble substrate with bedrock control, bankfull slope greater than 0.02 ft/ft.

Reference reach dimensionless ratios used to design project stream reaches are included with the information in Appendix 4 in the approved site Restoration Plan.

Table 2b: Baseline Geomorphologic and Hydraulic Summary Davis Branch and Unnamed Tributary Restoration / EEP Project No. D06054-F Station/Reach: Davis Branch Enhancement Level I Reach Station 25+83 to 38+72 (1,289 linear feet)

	St	tation/Rea	ch: Davis	Branch Enl	hancement	Level I R	leach Stati	on 25+83	to 38+72 ((1,289 linea	ar feet)				
Parameter	Regi	onal Curve	Data Data	Davis Bran	nch Referer	nce Reach	Pre-Ex	isting Cor	ndition		Design		As-Built	(Riffle XS	-5 & XS-7)
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median
Dimension															
Drainage Area (mi ²)			0.5712			0.5712			0.3352			0.3352			0.3352
Bankfull Discharge (cfs)			80.0			77.6			45.5			45.5			45.5
BF Width (ft)			11.77			12.91			8.78			10.00	15.97	17.38	16.68
Floodprone Width (ft)						50.00	21.57	97.94	62.74	70.58	144.67	104.34	59.88	63.70	61.79
BF Cross Sectional Area (ft²)			15.85			15.65			11.18			11.52	10.30	10.38	10.34
BF Mean Depth (ft)			1.35			1.21			1.27			1.15	0.59	0.65	0.62
BF Max Depth (ft)						1.61			2.04			1.60	1.22	1.31	1.27
Width/Depth Ratio			8.72			10.67			6.91			8.70	24.57	29.46	27.02
Entrenchment Ratio						3.87	2.46	11.15	7.15	7.06	14.47	10.43	3.67	3.75	3.71
Bank Height Ratio						1.00	1.58	1.86	1.72			1.00	1.00	1.00	1.00
Wetted Perimeter (ft)			14.47			13.72			10.21			10.85	16.19	17.57	16.88
Hydraulic Radius (ft)			1.10			1.14			1.10			1.06	0.59	0.64	0.62
Pattern															
Channel Beltwidth (ft)				27.80	53.00	38.00	Incised	Linear Ch	nannel	Lir	ear Chanr	nel	Restor	ed Linear	Channel
Radius of Curvature (ft)				16.40	45.30	29.40	Incised	Linear Ch	nannel	Lir	ear Chanr	nel	Restor	tored Linear Channel	
Meander Wavelength (ft)				80.10	116.50	99.20	Incised	Linear Ch	nannel	Lir	ear Chanr	nel	Restor	ed Linear	Channel
Meander Width Ratio				2.15	4.11	2.94	Incised	Linear Ch	nannel	Lin	ear Chanr	nel	Restor	ed Linear	Channel
Profile															
Riffle Length (ft)				12.0	18.5	15.0	57.9	85.3	67.1	24.0	57.0	45.0	18.7	109.9	62.3
Riffle Slope (ft/ft)				0.0283	0.0799	0.0520	0.0264	0.0518	0.0393	0.0098	0.0549	0.0504	0.0316	0.1217	0.0591
Pool Length (ft)				12.0	29.1	21.2	29.5	48.8	39.2	6.0	40.0	22.5	9.5	50.1	29.5
Pool Spacing (ft)				33.4	43.7	38.6	92.2	103.0	97.6	40.0	88.0	68.5	28.3	109.1	63.4
Substrate															
D50 (mm)						69.2			154.0			154.0	63.1	97.1	80.1
D84 (mm)						140.1			207.4			207.4	179.3	216.5	197.9
Additional Reach Parameters															
Valley Length (ft)						974			1213			1213			1213
Channel Length (ft)						1129			1289			1289			1289
Sinuosity						1.2			1.06			1.06			1.06
Water Surface Slope (ft/ft)						0.03110			0.02160			0.02160			0.02122
Valley Slope (ft/ft)						0.03256			0.02290			0.02290			0.02290
Rosgen Classification			Е			E3/1b*			E3/1b			E3/1b			C3/1b

Notes: *E channel morphology, large cobble substrate with bedrock control, bankfull slope greater than 0.02 ft/ft.

Reference reach dimensionless ratios used to design project stream reaches are included with the information in **Appendix 4** in the approved site Restoration Plan.

Table 2c: Baseline Geomorphologic and Hydraulic Summary Davis Branch and Unnamed Tributary Restoration / EEP Project No. D06054-F Station/Reach: Davis Branch UT1 Restoration Reach Station 3+96 to 8+54 (459 linear feet)

Parameter	Regi	onal Cu	ırve Data	Davis	Branch R Reach	eference	Pre-Ex	kisting Cor	ndition**		Design		As-Built (Riffle XS-8 & XS-9)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median
Dimension**														THE T	
Drainage Area (mi ²)			0.5712			0.5712			0.0721			0.0721			0.0721
Bankfull Discharge (cfs)			80.0			77.6			9.8			9.8			9.8
BF Width (ft)			11.77			12.91	6.85	8.39	7.82			6.20	12.18	12.58	12.38
Floodprone Width (ft)						50.00	7.17	78.27	28.42	32.37	105.76	47.40	50.49	57.74	54.12
BF Cross Sectional Area (ft²)			15.85			15.65	4.27	4.31	4.30			4.45	5.14	5.45	5.30
BF Mean Depth (ft)			1.35			1.21	0.51	0.63	0.55			0.72	0.42	0.43	0.43
BF Max Depth (ft)						1.61	0.77	0.92	0.88			1.00	0.95	1.02	0.99
Width/Depth Ratio			8.72			10.67	10.87	16.45	14.37			8.61	29.00	29.26	29.13
Entrenchment Ratio						3.87	0.92	10.01	3.63	5.22	17.06	7.65	4.01	4.74	4.38
Bank Height Ratio						1.00	2.32	3.67	2.82			1.00	1.00	1.00	1.00
Wetted Perimeter (ft)			14.47			13.72	7.28	8.74	8.15			6.73	12.38	12.74	12.56
Hydraulic Radius (ft)			1.10			1.14	0.49	0.59	0.53			0.66	0.42	0.43	0.43
Pattern															
Channel Beltwidth (ft)				27.80	53.00	38.00	Incise	ed Linear (Channel			50.00	50.00	50.00	50.00
Radius of Curvature (ft)				16.40	45.30	29.40	Incise	ed Linear C	Channel	11.10	18.00	12.60	11.10	18.00	12.60
Meander Wavelength (ft)				80.10	116.50	99.20	Incise	ed Linear C	Channel	50.53	58.82	52.60	50.53	58.82	52.60
Meander Width Ratio				2.15	4.11	2.94	Incise	ed Linear C	Channel			8.06	3.97	4.11	4.04
Profile															
Riffle Length (ft)				12.0	18.5	15.0	1.1	305.7	30.6	9.0	23.0	17.1	8.7	45.0	17.0
Riffle Slope (ft/ft)				0.0283	0.0799	0.0520	0.0372	0.1001	0.0586	0.0278	0.0486	0.0314	0.0372	0.0682	0.0496
Pool Length (ft)				12.0	29.1	21.2	7.2	31.9	19.2	12.8	22.8	18.7	11.9	28.4	17.2
Pool Spacing (ft)				33.4	43.7	38.6	15.6	324.8	76.9	24.6	41.5	34.7	12.8	50.3	28.7
Substrate															
D50 (mm)						69.2			11.4			11.4	28.8	38.5	34.8
D84 (mm)						140.1			15.4			15.4	62.0	91.0	57.2
Additional Reach Parameters							,								
Valley Length (ft)						974			670			343			343
Channel Length (ft)						1129			730			450			459
Sinuosity						1.2			1.09			1.31			1.34
Water Surface Slope (ft/ft)						0.03110			0.02300			0.02010			0.02021
Valley Slope (ft/ft)						0.03256			0.02506			0.02637			0.02704
Rosgen Classification			E			E3/1b*		E4/1b-	→ C 4/1b			E4/1b			C4/1b

Notes: *E channel morphology, large cobble substrate with bedrock control, bankfull slope greater than 0.02 ft/ft.

**Pre-Existing Conditions includes both the UT1 EII and PI project reaches. The "As-Built" Dimension data includes Riffle XS-8 on the EII reach.

Table 2c: Baseline Geomorphologic and Hydraulic Summary Davis Branch and Unnamed Tributary Restoration / EEP Project No. D06054-F Station/Reach: Davis Branch UT1 Restoration Reach Station 3+96 to 8+54 (459 linear feet)

Parameter Station/Reach: Davis Branch UT1 Restoration Reach Station 3+96 to 8+54 (459 linear feet) Regional Curve Data Davis Branch Reference Reach Pre-Existing Condition** Design As-Built (Riffle XS-8)															
Parameter		onal Curve						sting Conc	lition**		Design		As-Built	(Riffle XS	-8 & XS-9)
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median
Dimension**															
Drainage Area (mi ²)			0.5712			0.5712			0.0721			0.0721			0.072
Bankfull Discharge (cfs)			80.0			77.6			9.8			9.8			9.8
BF Width (ft)			11.77			12.91	6.85	8.39	7.82			6.20	12.18	12.58	12.38
Floodprone Width (ft)						50.00	7.17	78.27	28.42	32.37	105.76	47.40	50.49	57.74	54.12
BF Cross Sectional Area (ft²)			15.85			15.65	4.27	4.31	4.30			4.45	5.14	5.45	5.30
BF Mean Depth (ft)			1.35			1.21	0.51	0.63	0.55			0.72	0.42	0.43	0.43
BF Max Depth (ft)						1.61	0.77	0.92	0.88			1.00	0.95	1.02	0.99
Width/Depth Ratio			8.72			10.67	10.87	16.45	14.37			8.61	29.00	29.26	29.13
Entrenchment Ratio						3.87	0.92	10.01	3.63	5.22	17.06	7.65	4.01	4.74	4.38
Bank Height Ratio						1.00	2.32	3.67	2.82			1.00	1.00	1.00	1.00
Wetted Perimeter (ft)			14.47			13.72	7.28	8.74	8.15			6.73	12.38	12.74	12.56
Hydraulic Radius (ft)			1.10			1.14	0.49	0.59	0.53			0.66	0.42	0.43	0.43
Pattern															
Channel Beltwidth (ft)				27.80	53.00	38.00	Incised	l Linear Cl	nannel			50.00	50.00	50.00	50.00
Radius of Curvature (ft)				16.40	45.30	29.40	Incised	l Linear Ch	nannel	11.10	18.00	12.60	11.10	18.00	12.60
Meander Wavelength (ft)				80.10	116.50	99.20	Incised	l Linear Ch	nannel	50.53	58.82	52.60	50.53	58.82	52.60
Meander Width Ratio				2.15	4.11	2.94	Incised	l Linear Ch	nannel			8.06	3.97	4.11	4.04
Profile															
Riffle Length (ft)				12.0	18.5	15.0	1.1	305.7	30.6	9.0	23.0	17.1	8.7	45.0	17.0
Riffle Slope (ft/ft)				0.0283	0.0799	0.0520	0.0372	0.1001	0.0586	0.0278	0.0486	0.0314	0.0372	0.0682	0.0496
Pool Length (ft)				12.0	29.1	21.2	7.2	31.9	19.2	12.8	22.8	18.7	11.9	28.4	17.2
Pool Spacing (ft)				33.4	43.7	38.6	15.6	324.8	76.9	24.6	41.5	34.7	12.8	50.3	28.7
Substrate															
D50 (mm)						69.2			11.4			11.4	28.8	38.5	34.8
D84 (mm)						140.1			15.4			15.4	62.0	91.0	57.2
Additional Reach Parameters															1
Valley Length (ft)						974			670			343			343
Channel Length (ft)						1129			730			450			459
Sinuosity						1.2			1.09			1.31			1.34
Water Surface Slope (ft/ft)						0.03110			0.02300			0.02010			0.02021
Valley Slope (ft/ft)						0.03256			0.02506			0.02637			0.02704
Rosgen Classification			Е			E3/1b*		E4/1b→	C4/1b			E4/1b			C4/1b

Notes: *E channel morphology, large cobble substrate with bedrock control, bankfull slope greater than 0.02 ft/ft.

Reference reach dimensionless ratios used to design project stream reaches are included with the information in **Appendix 4** in the approved site Restoration Plan.

^{**}Pre-Existing Conditions includes both the UT1 EII and PI project reaches. The "As-Built" Dimension data includes Riffle XS-8 on the EII reach.

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2.4 As-Built Channel Stability Assessment

Davis Branch Mainstem PI/II Reach

Prior to restoration, the stream's high degree of channel incision (BHR range 1.38 - 1.41), low sinuosity (K = 1.12), denuded and destabilized streambanks, relatively steep average profile slope (0.0158 ft/ft) had resulted in a deeply incised, unstable channel with a high sediment supply. The incised vertical to undercut streambanks, accelerated streambank erosion. Utilizing the near bank stress bank erosion hazard index (BEHI) algorithm in RiverMorph® v.4.1.1, it is estimated 31 cubic yards per year (or 40 tons per year) of sediment was being eroded from the unstable, vertical to undercut streambanks along the upper mainstem impaired reach. Post restoration bank erosion rates are presented in **Table 3a**. Individual BEHI study streambank input data, assumptions and output data are presented in **Appendix D**.

Davis Branch EI Reach

Prior to restoration, the stream's high degree of channel incision (BHR range 1.58 - 1.86), low sinuosity (K = 1.06), denuded and destabilized streambanks, relatively steep average profile slope (0.0216 ft/ft) had resulted in a deeply incised, unstable channel with a high sediment supply. The incised vertical to undercut streambanks, accelerated streambank erosion. Utilizing the near bank stress bank erosion hazard index (BEHI) algorithm in RiverMorph® v.4.1.1, it is estimated 46 cubic yards per year (or 56 tons per year) of sediment was being eroded from the unstable, vertical to undercut streambanks along the lower mainstem impaired reach. Post restoration bank erosion rates are presented in **Table 3a**. Individual BEHI study streambank input data, assumptions and output data are presented in **Appendix D**.

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Table 3a: Davis Branch Mainstem "As-Built" Predicted Bank Erosion Rates

	anch Mainstem Reach entification Summary							
Bank	Name							
1	XS7 Riffle EI BEHI							
2	XS6 Pool EI BEHI							
3	XS5 Riffle EI BEHI							
4	XS1 Riffle PI/II BEHI							
5	XS2 Pool PI/II BEHI							
6	XS3 Riffle PI/II BEHI	1						
7	XS4 Pool PI/II BEHI	İ						
Davis	Branch Mainstem EI & P			icted Annual l	Bank Erosion	Rates		
	ВЕНІ	ВЕНІ	NBS					
Bank	Numeric	Adjective	Adjective	Length	Loss	Loss		
	Rating	Rating	Rating	ft	cu yds/yr	tons/yr		
1	18.1	Low	Very Low	451	0.37	0.48		
2	27.1	Moderate	Very Low	387	2.05	2.67		
3	16.7	Low	Very Low	451	0.35	0.45		
4	15.2	Low	Very Low	450	0.25	0.33		
5	19.7	Low	Very Low	449	0.6	0.78		
6	18.4	Low	Very Low	450	0.46	0.6		
7	20.3	Moderate	Very Low	450	1.57	2.04		
Totals		3,088 5.65 7.35						
			otal Loss per fo					

Note: PI/II estimated total sediment loss per foot of reach = 0.0021 tons/yr/ft = 0.03 ft bank loss/year. EI predicted total sediment loss per foot of reach = 0.0029 tons/yr/ft = 0.04 ft bank loss/year.

UT1 Restoration Reach

Prior to restoration, the stream's extreme degree of channel incision along the final 300 linear feet (BHR range 2.32 – 3.67), low sinuosity (K = 1.09), denuded and destabilized streambanks, steep profile slope (0.0230 ft/ft) resulted in a deeply incised, unstable channel with a high sediment supply. The incised vertical to undercut denuded streambanks, accelerate erosion rates. Utilizing the near bank stress bank erosion hazard index (BEHI) algorithm in RiverMorph® v.4.1.1, it is estimated 11 cubic yards per year (or 14 tons per year) of sediment was being eroded from the unstable, vertical to undercut streambanks along the final 300 linear feet of the UT1 impaired reach. Post restoration bank erosion rates are presented in **Table 3c** through **Table 3e**. Individual BEHI study streambank input assumptions and output data are presented in **Appendix D**.

Table 3b: Davis Branch UT1 Reach "As-Built" Predicted Bank Erosion Rates

Bank	Davis Branch UT1 Identification Summary					
Bank	Name					
1	XS8 Riffle EII Reach BEHI	1				
2	XS9 Riffle P1 Reach BEHI	1				
	ВЕНІ	BEHI	NBS		al Bank Erosion	
	BEHI Numeric	BEHI Adjective	NBS Adjective	Length	Loss	Loss
Bank	ВЕНІ	BEHI	NBS			
	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr
	BEHI Numeric Rating 15.6	BEHI Adjective Rating Low	NBS Adjective Rating Very Low	Length ft 396	Loss cu yds/yr 0.37	Loss tons/yr 0.48

Note: Estimated total sediment loss per foot of reach = $0.0008 \frac{1}{1000} = 0.02 \frac{1}{1000} = 0.02 \frac{1}{1000} = 0.0008 \frac{1}{$

Channel Stability Summary

Summing the predicted annual streambank erosion rates for each of the project reaches under impaired conditions, it was estimated the impaired streambanks had the potential to contribute approximately 88 cubic yards (or 114 tons) of nutrient laden sediment off site into the larger Davis Branch, Gourdvine Creek and Richardson Creek catchments on an annual basis. Post-restoration predicted annual streambank erosion rate estimates for the restored project reaches is 7.6 cubic yards (or 9.9 tons) – an estimated net 91.4 percent reduction from pre-restoration conditions.

Table 3c: Davis Branch & UT1 "As-Built" Predicted Bank Erosion Rates (Project Summary)

	Branch Project Summary Identification Summary					
Bank	Name					
1	XS7 Riffle MS EI BEHI					
2	XS6 Pool MS EI BEHI					
3	XS5 Riffle MS EI BEHI					
4	XS1 Riffle MS PI/II BEHI					
5	XS2 Pool MS PI/II BEHI					
6	XS3 Riffle MS PI/II BEHI					
7	XS4 Pool MS PI/II BEHI					
8	XS8 Riffle UT1 EII BEHI					
9	XS9 Riffle UT1 PI BEHI					
	Davis Branch & UT1 Project St	ummary: Pro	edicted Annu	al Bank Er	osion Rates	3
	BEHI	BEHI	NBS			
Bank	Numeric	Adjective	Adjective	Length	Loss	Loss
	Rating	Rating	Rating	ft	cu yds/yr	tons/yr
1	18.1	Low	Very Low	451	0.37	0.48
2	27.1	Moderate	Very Low	387	2.05	2.67
3	16.7	Low	Very Low	451	0.35	0.45
4	15.2	Low	Very Low	450	0.25	0.33
5	19.7	Low	Very Low	449	0.6	0.78
6	18.4	Low	Very Low	450	0.46	0.6
7	20.3	Moderate	Very Low	450	1.57	2.04
8	15.6	Low	Very Low	396	0.37	0.48
9	16	Low	Very Low	459	1.57	2.04
			3,943	7.59	0.07	
Totals				3,943	7.39	9.87

Note: Estimated total sediment loss per foot of reach = 0.0024 tons/yr/ft ≥ 0.03 ft bank loss/year.

The consequence of channelization, cattle intrusion, confinement (lateral containment), incision (vertical containment) major floods, changes in sediment regime, and loss of riparian vegetation are attributed causes and effects for impaired conditions along the project reaches prior to restoration. The effects of these anthropogenic changes were accelerated streambank erosion, channel incision, land loss, aquatic habitat loss, lowering of the water table, land productivity reduction and in-stream and downstream sedimentation and nutrient loading.

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As the revegetated riparian corridors canopy, mid-story, shrub, herbaceous and streamside vegetation matures, intuitively, annual streambank erosion rates should decrease as root mass and density along the restored stream reaches become more pervasive over time.

Reference Reach Data Collection

For Davis Branch, bankfull discharge was determined through a quantitative assessment and analysis of reference reach boundary conditions and comparison of predicted bankfull discharge through a stable riffle cross-section located on the Davis Branch mainstem, 43 feet upstream from its confluence with Gourdvine Creek. The reference reach is located along the same geologic structural feature, the Troy Anticlinorium (northwest limb near the axial plane of an unnamed, northeast-southwest trending syncline), in the same geologic setting, the McManus Formation (see Geologic Map of the Carolina Slate Belt, Union County, North Carolina presented on page 9 in **Section 1.0**), is mapped on the same soil series (Chewacla silt loam, Goldston soils and Cid channery silt loam), and is located in the same local watershed as the Davis Branch and Unnamed Tributary restored stream reaches. The reference reach is shown at watershed scale on **Figure 4**.

A complete Rosgen Level III watershed assessment and analysis of the reference reach conditions was conducted during August 8 and 9, 2006. Due to extremely thick riparian vegetation during August 2006, it was possible to collect profile and cross-section data only along a relatively short length of the stable reach. Approximately 118 linear feet of profile, capturing three pool and four riffle sequences, with one representative riffle and pool cross-section, were surveyed in the field. Geologic structural controls and lithology, fluvial geomorphologic processes, depositional materials, climatic influence, riparian vegetation, deposition pattern, debris occurrence, meander pattern, channel stability rating, sediment supply, streambed stability and width/depth ratio state were evaluated following Rosgen Level III stream assessment protocols. Visibility was limited in the field to dense vegetative cover along the Davis Branch Reference Reach; therefore, Union County orthoimagery (February 2004) was used to verify stream pattern.

A total of 1,129 linear feet of the reach was assessed for each Level III stream state and condition parameter consistent with a Rosgen Level III methodologies. The assessment included GPS data spatial analysis to evaluate channel pattern upstream from the surveyed reach, beyond the point where additional differential level surveying was impracticable and channel pattern could not be discerned using either standard field measurement techniques or recent aerial imagery.

Calculated bankfull discharge for the surveyed reference reach riffle cross-section, was computed using hydraulic radius, wetted perimeter, channel slope and a relative roughness (u/u*) method based on the average protrusion height of the steeply dipping bedrock (Rosgen, 1998). Additionally, a particle distribution was collected from the large angular cobble deposited along the reference reach riffle bed.

Reference reach survey data, analysis, classification and geomorphologic summary reports for the Davis Branch Reference Reach are presented in Appendix 3, Davis Branch and Unnamed

Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

Tributary Restoration Plan, NC EEP Project Number: D06054-F (EMH&T, January 16, 2008). The Davis Branch Reference Reach morphologic and hydraulic data are summarized in **Table 2**.

Reference Reach Classification

The reference reach is a Rosgen Valley Type VIII, E3/1b stream type (i.e., E channel morphology, large cobble substrate with strong bedrock control, profile gradient greater than 2 percent). The reference reach is located within a healthy, deciduous hardwood forested riparian corridor. The D84 particle size from the stable riffle particle distribution is 140.1 mm and is consistent with the observed bed thickness and axial splitting planes and observed joint sets in the folded and deformed slate bedrock.

Reference Reach Discharge

See Section 3.5 for a comprehensive analysis and of bankfull discharge for the Davis Branch Reference Reach and the Davis Branch and UT1 project reaches. Regional curve, reference reach, pre-existing, design and as-built bankfull discharge are presented in tabular format in **Table 2**.

Channel Morphology

Stream channel morphology data for the Davis Branch reference reach, the Davis Branch mainstem and UT1 is presented in tabular format on **Table 2**. The Davis Branch reference reach is a Rosgen Valley Type VIII, E3/1b stream type.

Channel Stability Assessment

Reference reach channel stability was analyzed using the vertical velocity near-bank stress method algorithm in RiverMorph® v.4.1.1 and reach streambank observations and channel morphology from reference reach Pool Cross-Section 1+83, located on Davis Branch 117 feet upstream from its confluence with Gourdvine Creek. The predicted annual erosion rate estimate was calculated for the entire 1,129 linear feet of stream evaluated as part of the Rosgen Level III reference reach study. Based on reference reach conditions, the predicted sediment loss is 3.23 cubic yards or 4.2 tons per year. This equates to 0.0043 tons/year per foot of reach, or two one hundredths of a foot (0.02 ft) streambank erosion on an annual basis. The near-bank adjective rating (0.35) is very low for the reference reach, indicating extremely stable channel conditions.

Vegetation

The Davis Branch reference reach flows through a deciduous hardwood forest area, which provides a wide riparian corridor. The canopy layer is dominated by native tree species including *Plantanus occidentalis* (American sycamore), *Carya* species (hickory), and *Acer negundo* (boxelder). The shrub/ sapling and herbaceous understory is extremely thick and provides

significant protection against bank erosion. Species such as *Rosa multiflora* (multiflora rose), *Alnus serrulata* (hazel alder), *Bignonia capreolata* (crossvine), *Viola* sp. (violet), and *Convolvulus species* (bindweed) are present within the understory. This healthy, robust vegetation and associated root mass along the reference reach riparian corridor, extending overbank into the channel, is extremely stable and resistant to streambank erosion.

2.5 Restoration Summary

A summary of the restored stream lengths, restoration approach and associated SMU credits are presented in Table 4 below.

				~	
	Table 4: Pre-Ex	isting Condition	s/Post-Construction	Summary Tributage 1	
Į F	Project Number D	06054-F (Davis)	Branch and Unnamed		
Project	Pre-existing	Restored	Restoration Level	Credit Ratio	SMUs**
Reach ID	length	Length*			
Davis Branch	781 l.f.	766 l.f.*	Preservation	5	153
Mainstem			T Teser vation		
Davis Branch	1,562 l.f.	1,799 l.f.	Priority Level I/II	1	1,799
Mainstem			Restoration		
Davis Branch	1,289 l.f.	1,229 l.f.*	Enhancement	1.5	819
Mainstem			Level I		
			Restoration		
UT1	396 l.f.	396 l.f.	Enhancement	2.5	158
			Level II		
			Restoration		
UT1	334 l.f.	459 l.f.	Priority Level I	1	459
			Restoration		
Totals		4,649 l.f.			3,388

^{*}Restored lengths exclude permanent conservation easement crossings.

<u>Differences Between Design and As-Built Conditions</u>

The "As-Built" geomorphologic parameters in this report show some notable differences in comparison to design parameters for the project stream reaches. The detailed Rosgen Level III reference reach study conducted downstream from the project reaches on Davis Branch shows stable E-type channel geomorphologic relationships were indicated for both the Davis Branch mainstem and UT1. In each case the "As-built" reaches have C-type channel geomorphologic and hydraulic relationships with approximately the same cross-sectional areas proposed in the design. The detailed assessment of the "As-Built" conditions presented in this mitigation plan show the restored streams are stable, properly sized and well connected to their floodplains. Additionally, the "As-Built" project stream reaches meet the mitigation goals and objectives acknowledged as set forth in the project Restoration Plan.

^{**}Restored Length divided by SMU Credit Ratio

Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

Davis Branch Mainstem Restoration Reach

The most notable differences when comparing the "As-Built" geomorphologic conditions to the proposed design conditions in the Restoration Plan are listed below.

- 1. The median bankfull width is 25 percent greater than proposed (9.0 ft to 11.3 ft)
- 2. The median bankfull mean depth is 32 percent less than proposed (0.88 ft to 0.60 ft)
- 3. The median floodprone width is 25 percent less than proposed (117 ft to 88 ft)
- 4. The median entrenchment ratio is 35 percent less than proposed (13.1 to 8.5)
- 5. The median width/depth ratio 47 percent greater than proposed (10.2 to 19.3)

Despite the differences between design and "As-Built" channel morphology, the bankfull cross-sectional area under design and "As-Built" conditions is similar (7.9 ft² vs. 7.0 ft²). The entrenchment ratio is very stable (8.5). The transition from the designed E-type channel to the "As-Built" C-type channel remains stable and functional from an ecologic enhancement perspective. Additionally, "As-Built" pattern and profile slope, from the top to the bottom of the 1,799 l.f. mainstem restoration reach, is consistent with proposed conditions in the site Restoration Plan.

UT1 Restoration Reach

The most notable differences when comparing the "As-Built" geomorphologic data to the proposed design conditions in the Restoration Plan are listed below.

- 1. The median bankfull width is 50 percent greater than proposed (6.2 ft to 12.4ft)
- 2. The median bankfull mean depth is 40 percent less than proposed (0.72 ft to 0.43 ft)
- 3. The median entrenchment ratio is 43 percent less than proposed (7.7 to 4.4)
- 4. The median width/depth ratio is 70 percent greater than proposed (8.6 to 29.1)

Despite these changes between design and "As-Built" conditions, the bankfull cross-sectional area under design and "As-Built" conditions is similar (4.5 ft² vs. 5.3 ft²). The entrenchment ratio is stable (4.4). The median floodprone width is 12 percent greater than proposed (54.1 ft vs. 47.4 ft). The transition from the designed E-type channel to the "As-Built" C-type channel remains stable and functional from an ecologic enhancement perspective. "As-Built" pattern and profile slope, from the top to the bottom of the 459 l.f. UT1 restoration reach, is consistent with proposed conditions in the site Restoration Plan.

Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

3.0 MONITORING PLAN

To demonstrate the success of the project, three forms of monitoring will be performed: (1) photo documentation; (2) ecological function assessment; and (3) channel stability measurements. Long-term success criteria will be evaluated by monitoring and documenting the following:

- Channel aggradation or degradation,
- streambank erosion,
- effectiveness of erosion control measures,
- presence of instream bar deposits,
- health and survival of indigenous, non-invasive vegetation, and
- changes in as-built channel pattern, profile and dimension.

Parameters included in the annual stream monitoring to ensure the success of the restoration activities will include stream channel surveys along longitudinal profiles and monumented cross sections, pebble counts across representative riffle and pool cross-sections, photographs, and vegetation surveys.

The restoration site will be monitored for five consecutive years or until the required success criteria have been met as determined by North Carolina Division of Water Quality (DWQ) and the Wilmington District of the U.S. Army Corps of Engineers (USACE). Channel stability monitoring field surveys, including measurements and photographs, will be performed during June 2009. Planting was completed on April 6, 2009. The planted vegetation will first be monitored during the growing season, in September-October 2009. Monitoring will be conducted in accordance with the multi-agency, North Carolina Stream Mitigation Guidelines (April 2003) applicable to Restoration and Enhancement Level I projects and the template *Content, Format and Data Requirements for EEP Monitoring Reports, Version 1.2* (11/16/06). Vegetation monitoring will be conducting in accordance with *CVS-EEP Protocol for Recording Vegetation, Version 4.2* (Lee, M.T., Peet, RK., Roberts, S.R., Wentworth, T.R. 2008) for Levels 1 and 2 Plot Sampling.

Monitoring reports and discussions of remedial actions will take place with EEP. EEP will review the monitoring documents and make them available to the agencies after the review period. Decision making regarding remediation will be between EEP and WRC and its agents or representatives. Agency interaction will take place through permit requests for maintenance should they become necessary. Agency interaction will take place at the end of the monitoring period.

3.1 Stream Channel Monitoring

Stream channel stability will be physically monitored at eight permanent, monumented cross-sections annually. This includes seven cross-sections (4 riffles, 3 pools) on Davis Branch mainstem, and two cross-sections (2 riffles) on UT1. Stream stability and pattern will also be

Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

evaluated, with annual longitudinal profiles surveyed along the entire length of each restored reach during the five year monitoring period.

Photographs will be taken upstream, downstream and across channel at each monumented cross-section at the time of survey. The monumented cross-section locations and longitudinal profiles were surveyed immediately following construction as part of the "As-Built" survey and are shown on the As-Built Plan sheets in **Section 7.0**. The As-Built Plan sheets include the dimension, pattern, and profiles of the constructed stream channels. The As-Built condition (Year 0) will be utilized as baseline to compare future monitoring surveys and subsequently to determine channel stability and transition. Year 0 "As-Built" Long-Term Monitoring Profiles are included in **Appendix B**. Year 0 "As-Built" Long-Term Monitoring Cross-Section summary templates and particle distribution summary templates are included in **Appendix C**.

Yearly monitoring will also include pebble counts to evaluate streambed particle distributions. Pebble count data will be collected at each of the nine monumented cross-sections. The number of particles in standard size classes will be reported each year to assess sediment transport capacity and competency, streambed particle sorting and depositional trends, and channel stability over time. Annual inspection of in-stream structures, which for this project includes rock sills, step-pools and constructed riffles, will also occur to verify proper function and stability. Stream channel visual assessment surveys will be completed annually for five consecutive years, beginning in September 2009 (Year 1), greater than six months post-construction completion. Annual stream profile and cross-section surveys will be compared to the as-built conditions stream corridor survey (Year 0, December 2008).

A minimum of two bankfull flow events will be documented during the five year monitoring period, occurring separate monitoring years. Bankfull flow events will be documented utilizing two galvanized steel 4-feet, USGS Type A crest-stage stream gages installed on the project reaches; one crest-gage set at bankfull stage near the confluence of Davis Branch and UT1, and one crest-gage set at bankfull stage on the right bank at Davis Branch mainstem profile station 19+18. Photo-documentation after bankfull flows will be presented in the monitoring reports. The locations of the crest-stage stream gages are shown on the As-Built Plan Sheets in **Section 7.0**. In the event two bankfull events do not occur during the five-year monitoring period, consultations with the U.S. Army Corps of Engineers, the Division of Water Quality and the resource agencies will be coordinated to determine if further monitoring is necessary to demonstrate success criteria have been achieved.

3.2 Planted Woody Vegetation Monitoring

Woody vegetation planted along the streams on April 6, 2009 will be monitored for five consecutive years. Per the required plots calculation from EEP, a total of ten (10) ten by ten meter square plots (eight along Davis Branch mainstem, and two along UT1) have been permanently established. Corner markers were permanently installed and one corner surveyed for future reference. The species, density of living stems, and the cause of mortality, if identifiable, will be recorded for all planted woody species within each plot. Vegetation will be

Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

sampled annually and reported each year along with the data collected during the physical monitoring of the project stream reaches. The focus of the vegetative monitoring will be a stem count of planted individuals in the tree and shrub stratum. Data on height and diameter will also be recorded according to the *CVS-EEP* protocol. Percent cover of the plot will be documented via photographic documentation at each vegetative plot. Vegetative problem areas along the project area will be identified, mapped, and documented via photographs. Vegetation monitoring will occur between the months of September and October.

3.3 Performance Standards

The performance standards for the restoration project are those mandated in the multi-agency *Stream Mitigation Guidelines* (USACE Wilmington District, et al., April 2003). Performance goals for the site are:

- Minimal or negligible development of instream bar deposits.
- Minimal or negligible change in channel pattern, profile and dimension in comparison to As-Built conditions. Adjustments may occur and some may be indicative of increasing stability, such as moderate reductions in width/depth ratios as a result of slight channel narrowing and natural substrate sorting and shaping of bedform and features
- Maintenance of floodplain connectivity (only reductions or very small increases will be considered acceptable).
- Target density of 320 stems per acre after 3 years and 260 stems per acre after 5 years for planted woody vegetation (represents 80% survival after 5 years).

Subsequent monitoring reports will address the attainment of performance goals. If goals are not being attained, then the monitoring reports will document any remedial actions taken during the monitoring period and the success of those actions.

Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

4.0 MAINTENANCE AND CONTINGENCY PLANS

Adaptive management is a systematic process for developing knowledge and continually improving project development by learning from previous projects and their performance outcomes (River Institute, 2004). This project is large in scope and entails many new applications of natural stream channel design methodologies, making an adaptive management approach essential to the success of the project. Rather than following the conventional approach to construction projects where a plan is developed and closely constructed in a rigid and structured format, we will employ a adaptive management strategy in the truest sense. Essentially, we have initiated the initial restoration of the Davis Branch Mainstem and UT1 in the context of the data, methodologies and technology currently available. As the project is monitored, we will collect data to verify the streams are evolving in the direction of increased stability and biological diversity. As the data are collected and evaluated, the knowledge gained will be directly integrated into the management and maintenance of the project throughout the monitoring period.

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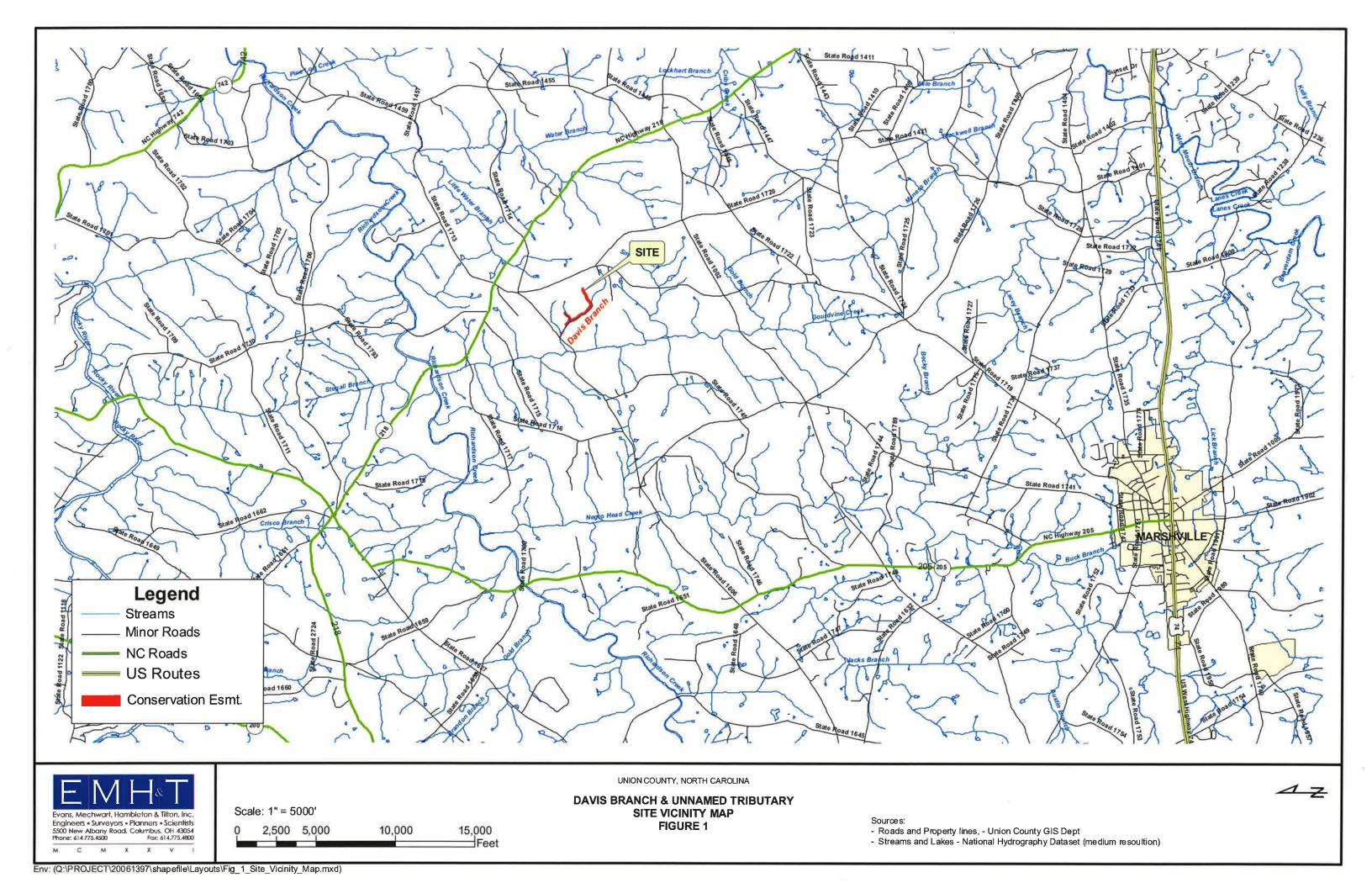
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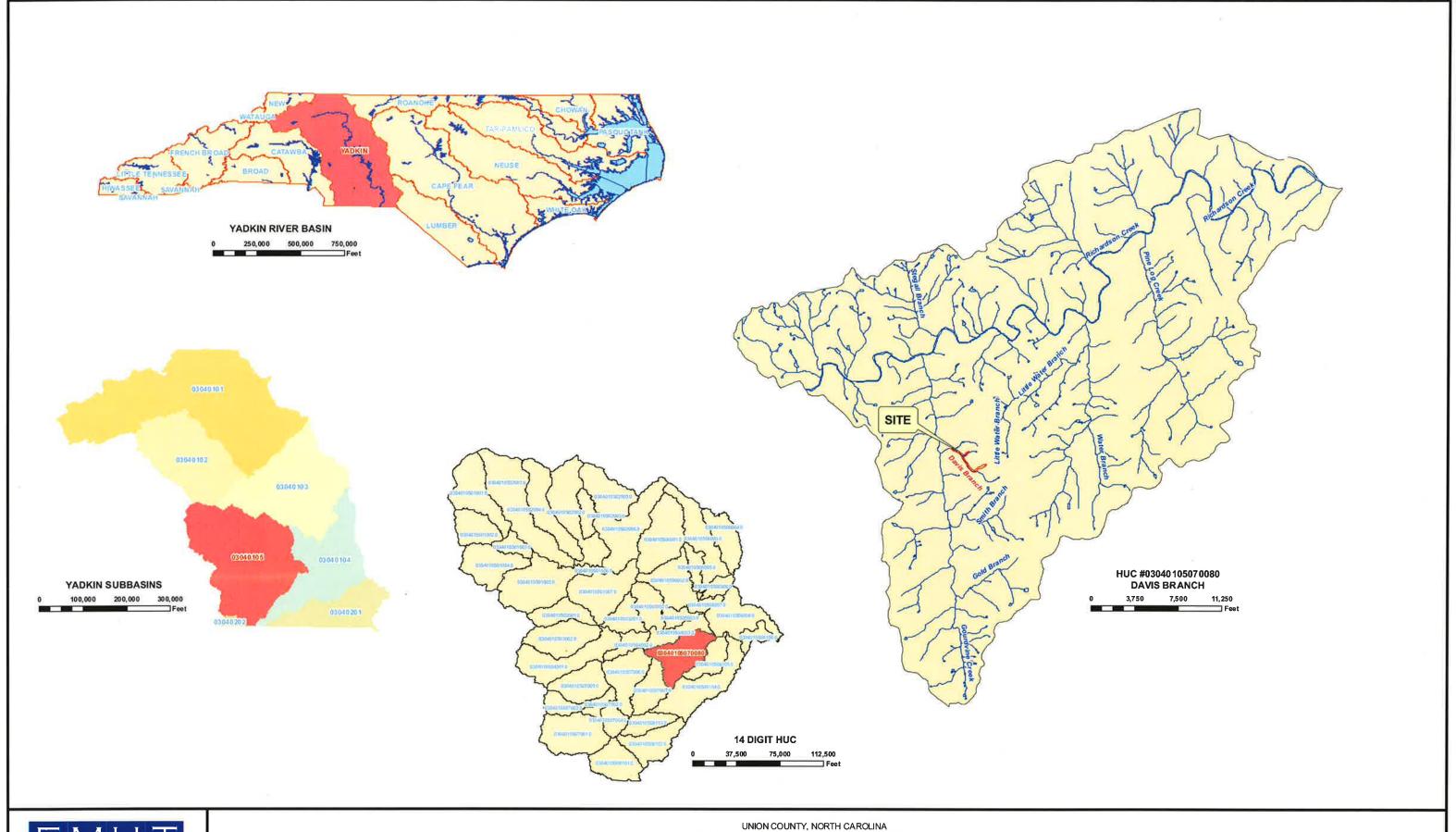
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Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

6.0 FIGURES



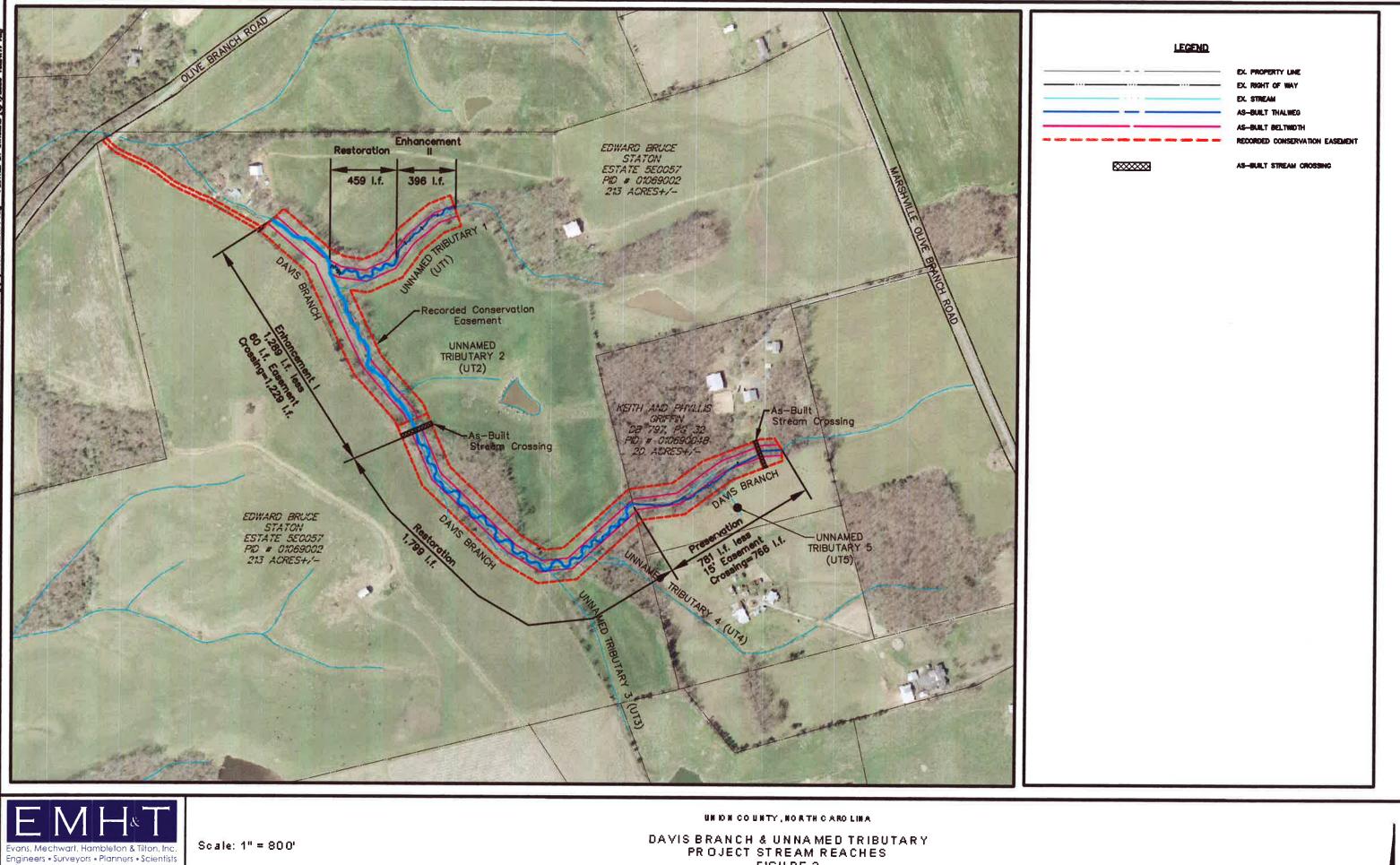




DAVIS BRANCH & UNNAMED TRIBUTARY TARGETED LOCAL WATERSHED SUBBASIN MAP FIGURE 2

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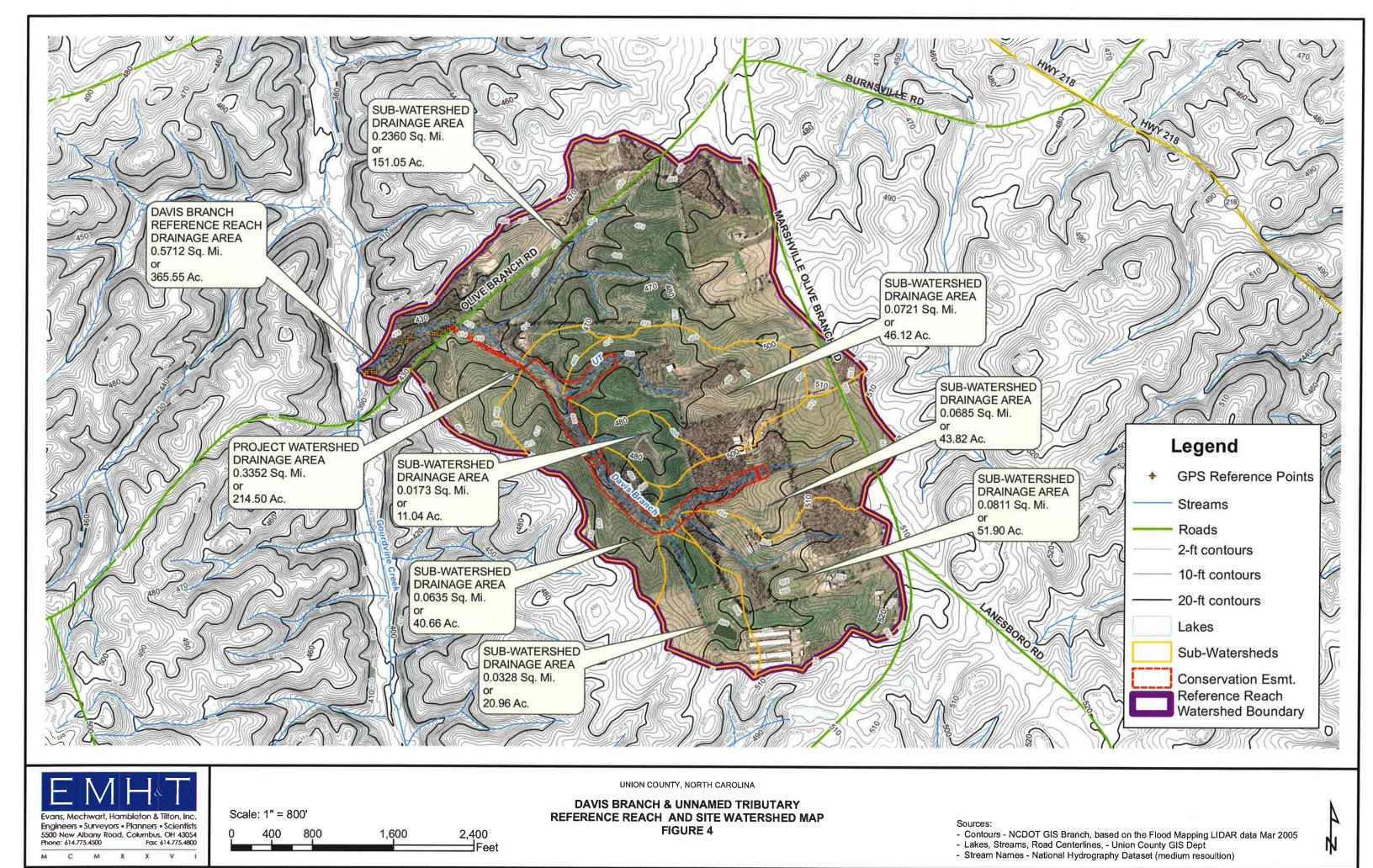
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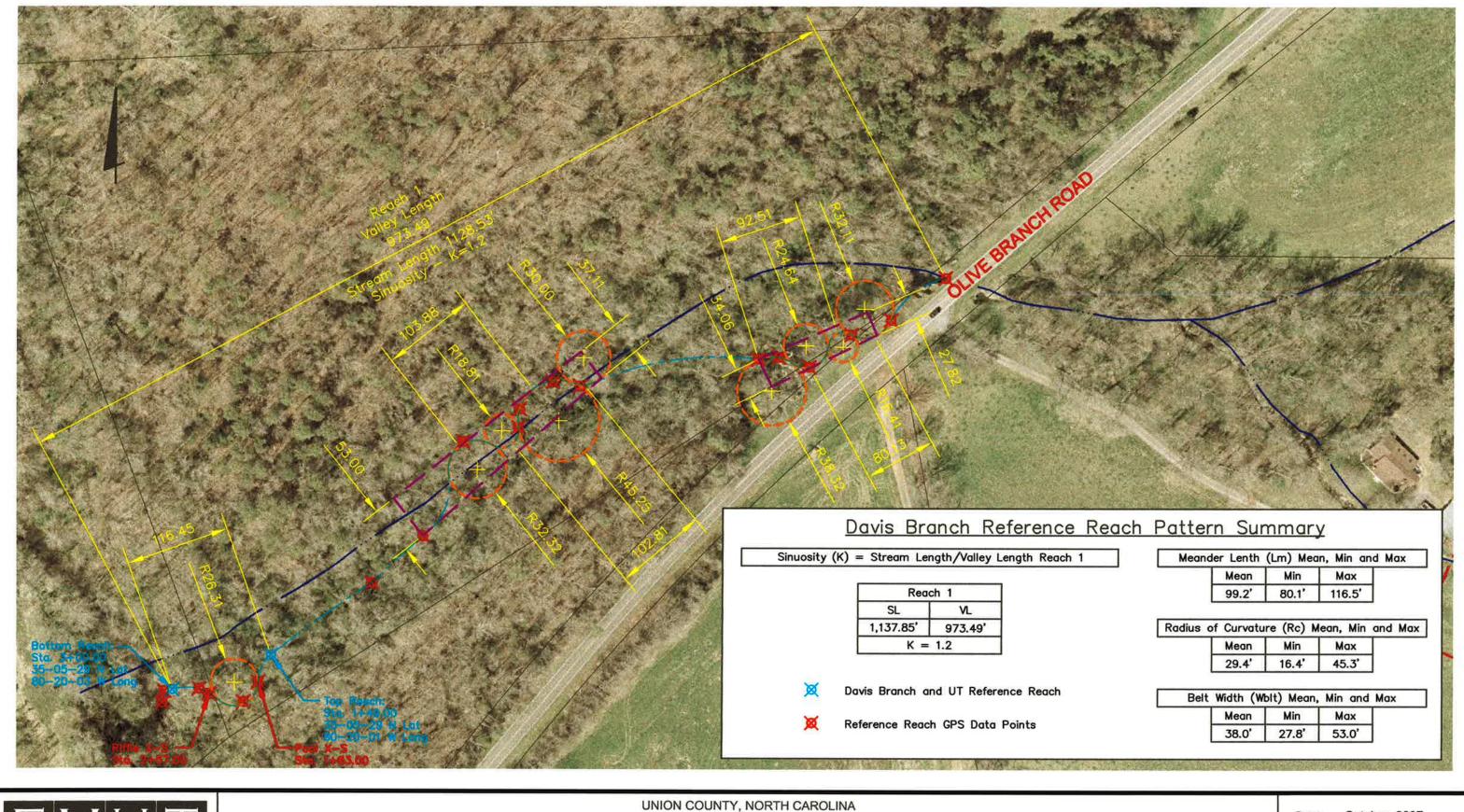
5500 New Albany Road, Columbus, OH 43054 Phone: 614.775.4500 Fax: 614.775.4800

400 800 1,600

2,400 ⊟Feet FIGURE 3



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Engineers • Surveyors • Planners • Scientists 5500 New Albany Road, Columbus, OH 43054 Phone: 614.775.4500 Fax: 614.775.4800

DAVIS BRANCH & UNNAMED TRIBUTARY RESTORATION

REFERENCE REACH PATTERN SUMMARY MAP FIGURE 5

Date: October, 2007

Scale: 1" = 100'

Job No: 2006-1397

Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

7.0 AS-BUILT PLAN SHEETS

UNION COUNTY, NORTH CAROLINA STREAM AS-BUILT PLAN **FOR**

DAVIS BRANCH AND UNNAMED TRIBUTARY NC EEP PROJECT NO. D06054-F

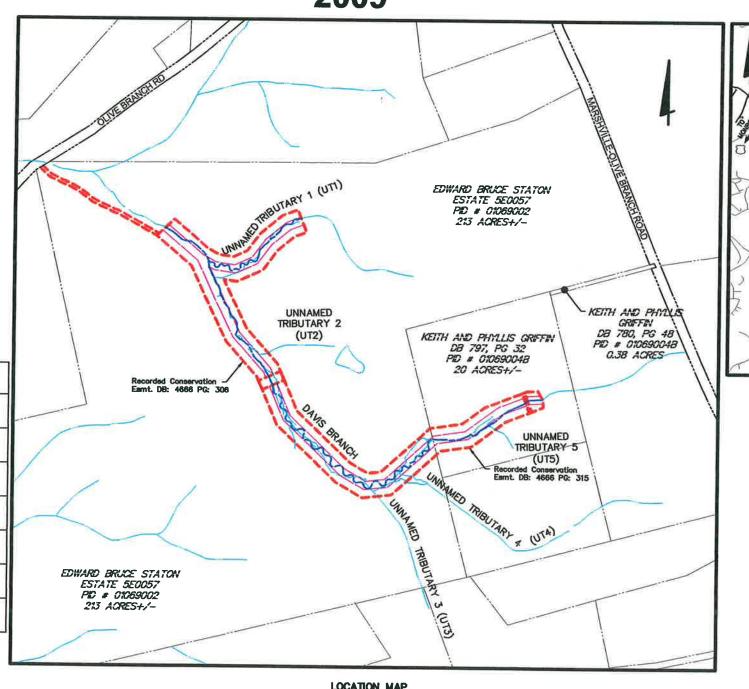
2009

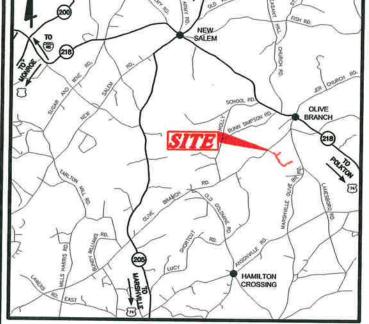
INDEX OF SHEETS

Title Sheet		
Plan and Profile	_	Davis Branch
Plan and Profile	_	Unnamed Tributary 1 (UT1)
		10-11

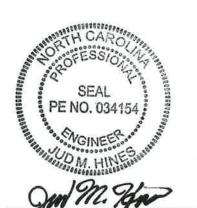
Project N	Pre-Existin Number D06054	g Conditions, ⊢F (Davis B	/Post-Construction ranch & Unnamed	Summary Tributaries Rest	oration)
Tributary Reach ID	Pre-existing Length	Restored Length *	Restoration Level	Credit Ratio	SMUs**
Davis Branch	781 ft.	766 ft.	Preservation	5.0	153
Davis Branch	1,289 ft.	1,229 ft.	Enhancement I	1.5	819
Davis Branch	1,562 ft.	1,799 ft.	Restoration	1.0	1,799
Unnamed Tributary 1	396 ft.	396 ft.	Enhancement II	2.5	158
Unnamed Tributary 1	334 ft.	459 ft.	Restoration	1.0	459
Totals					3,388

Does	not	include	portion	of	channel	outside	the	conservation	easement.



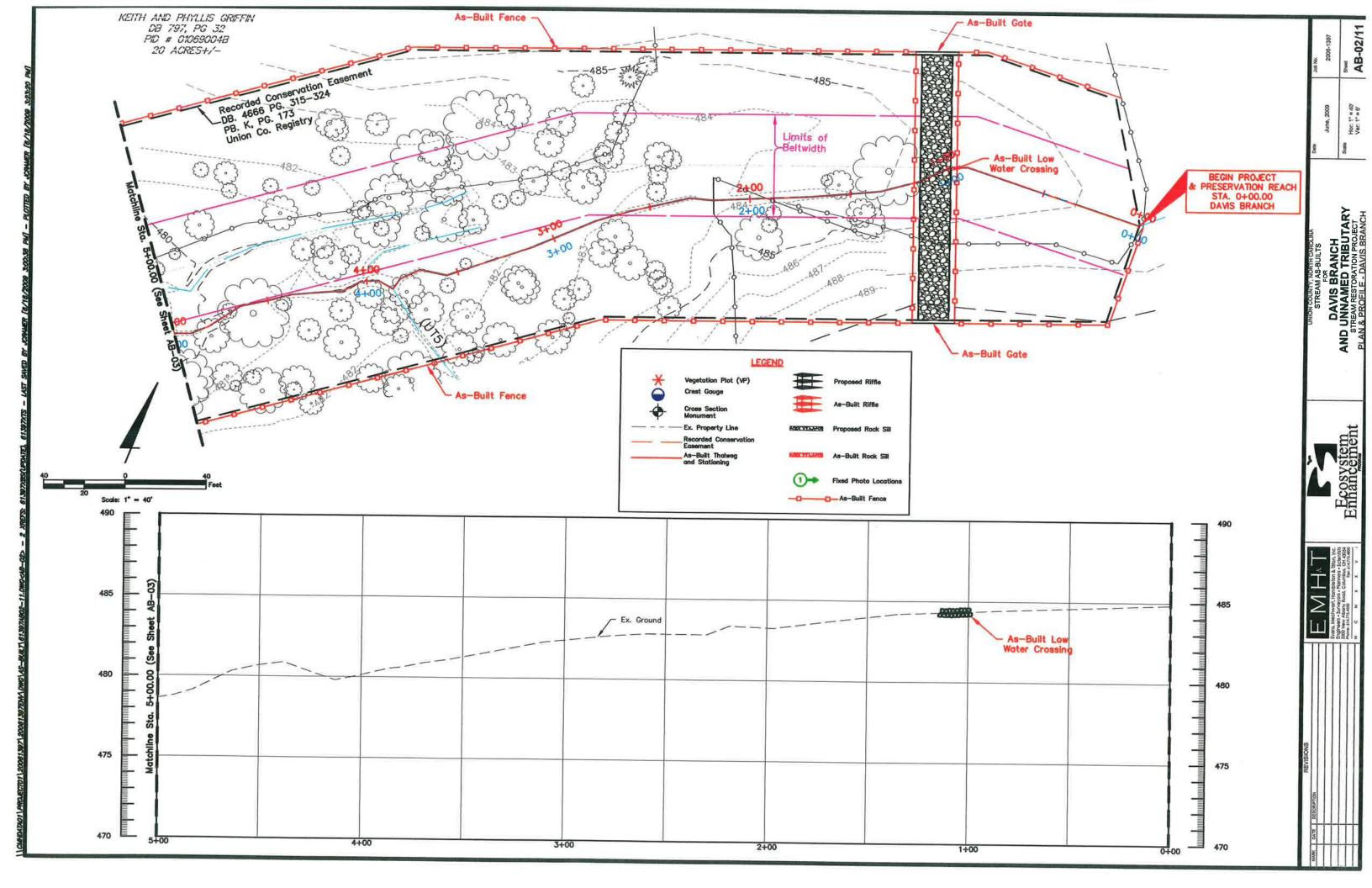


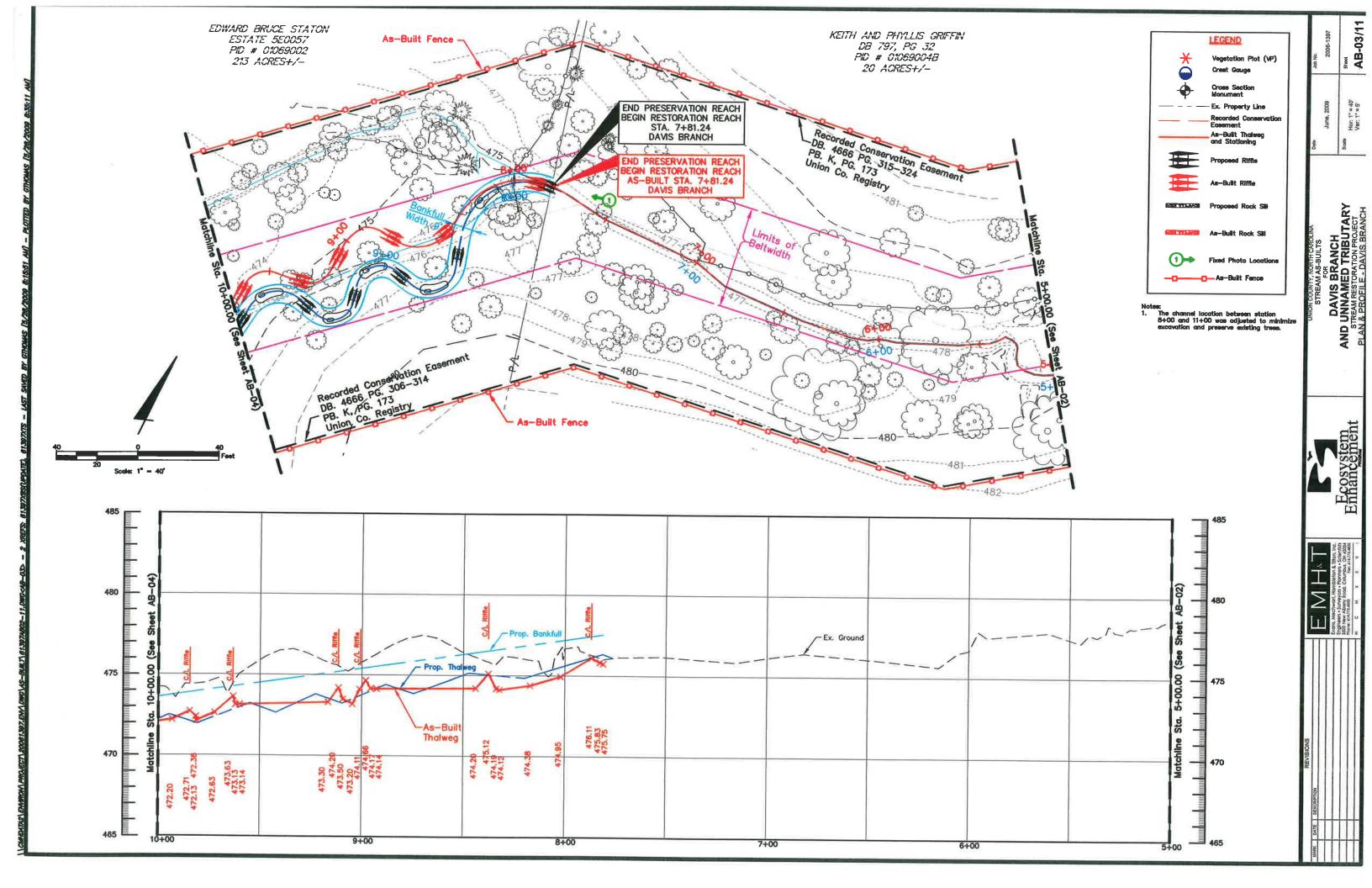


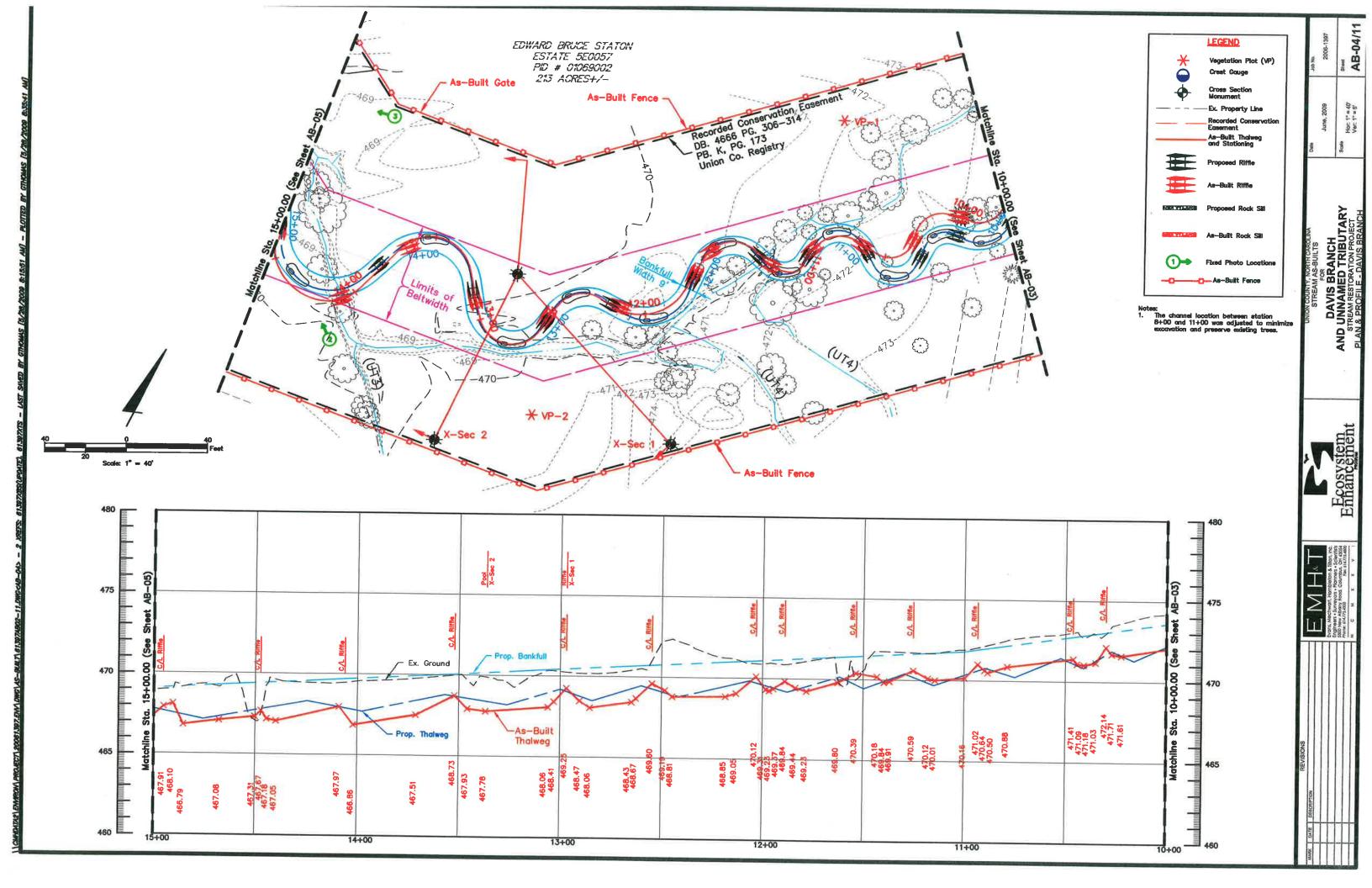


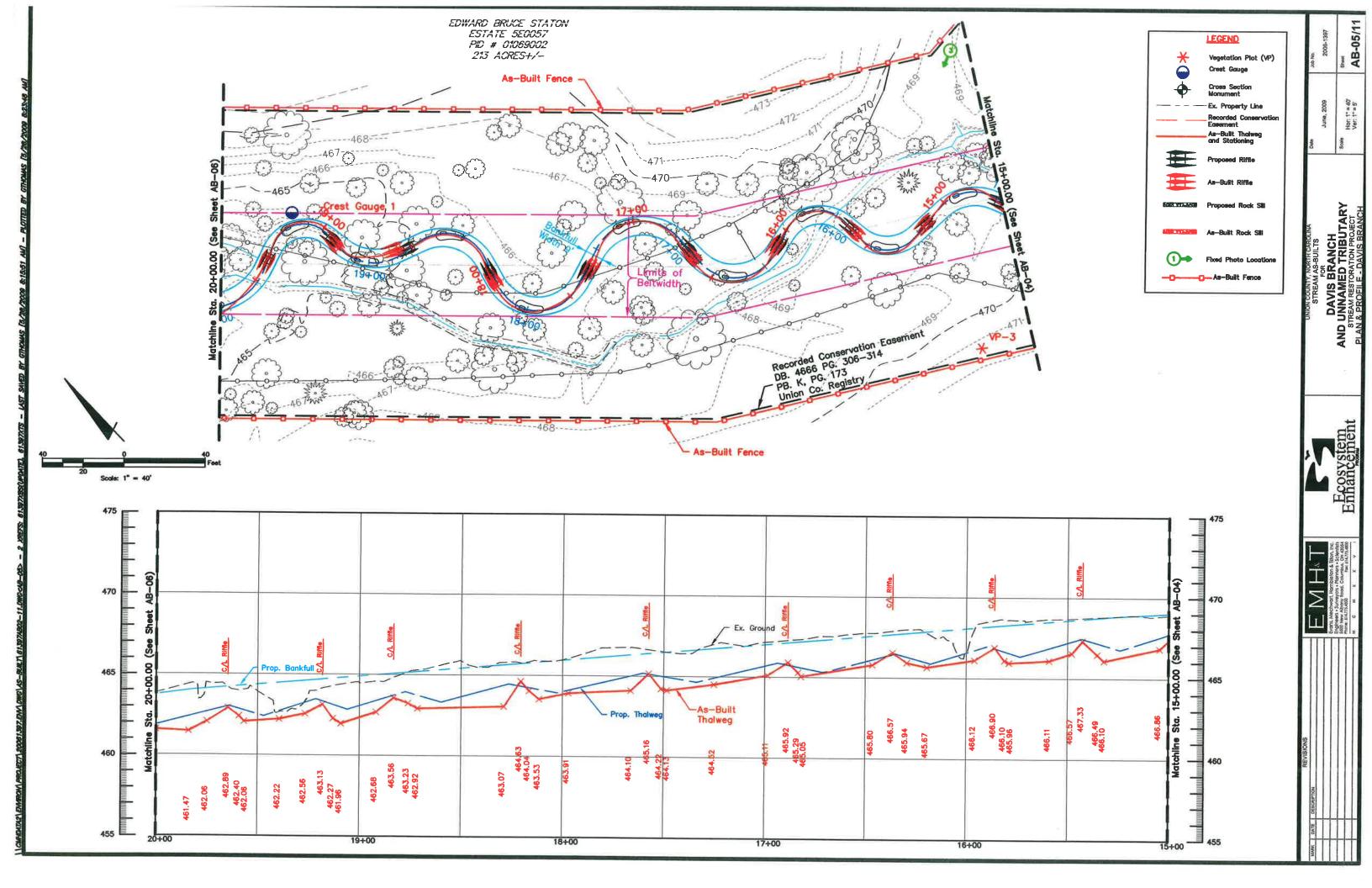
LOCATION MAP

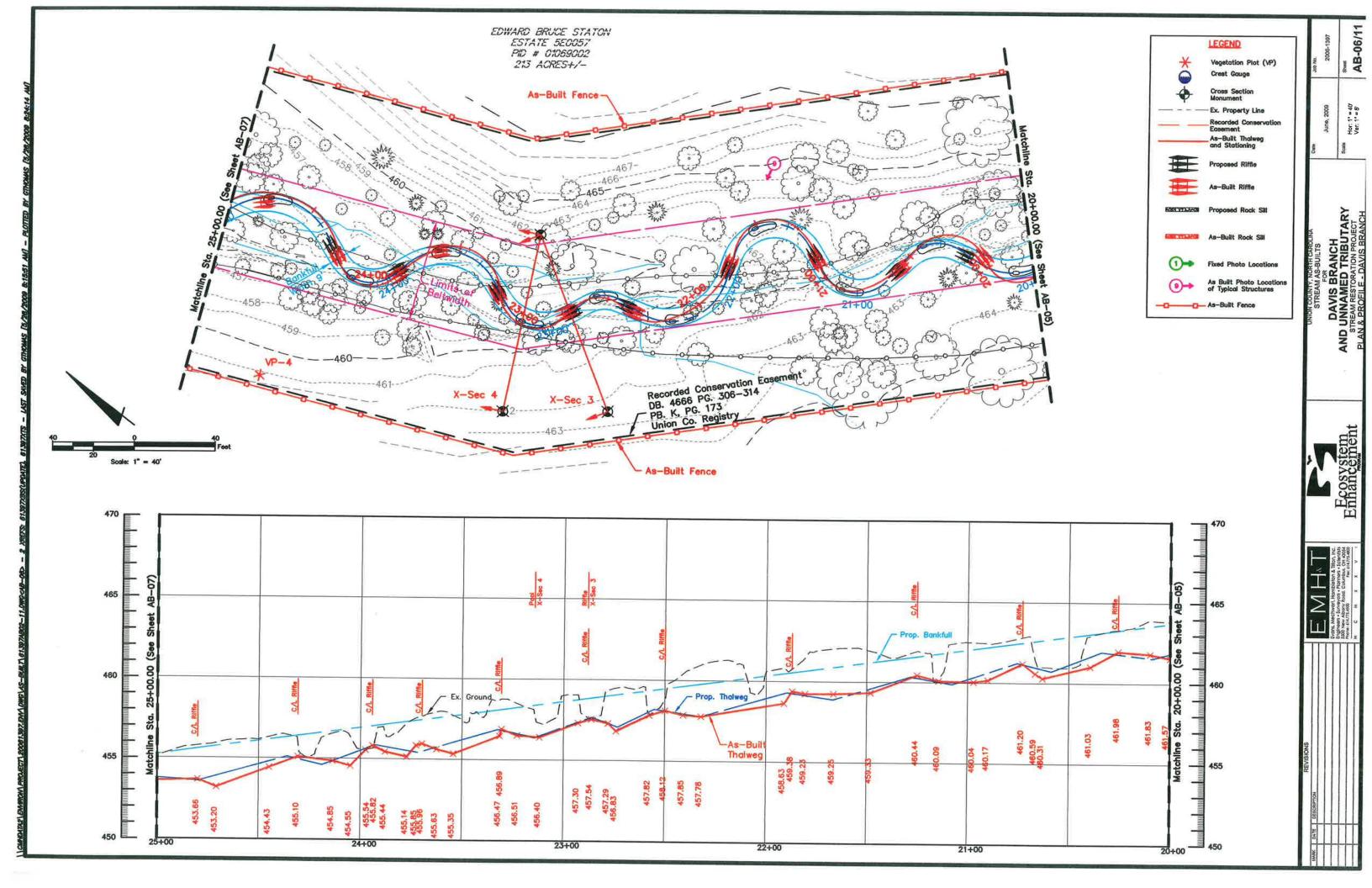
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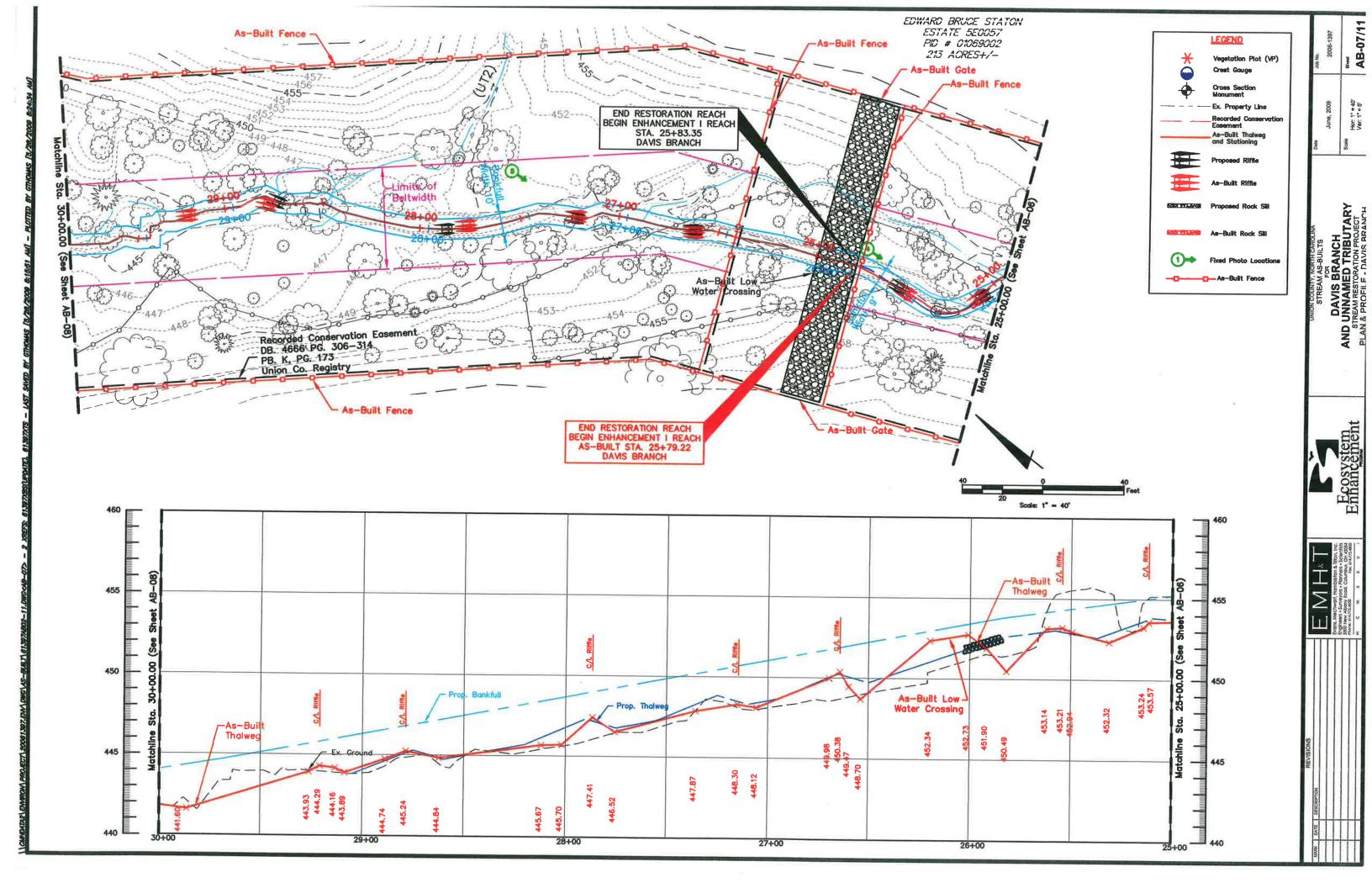


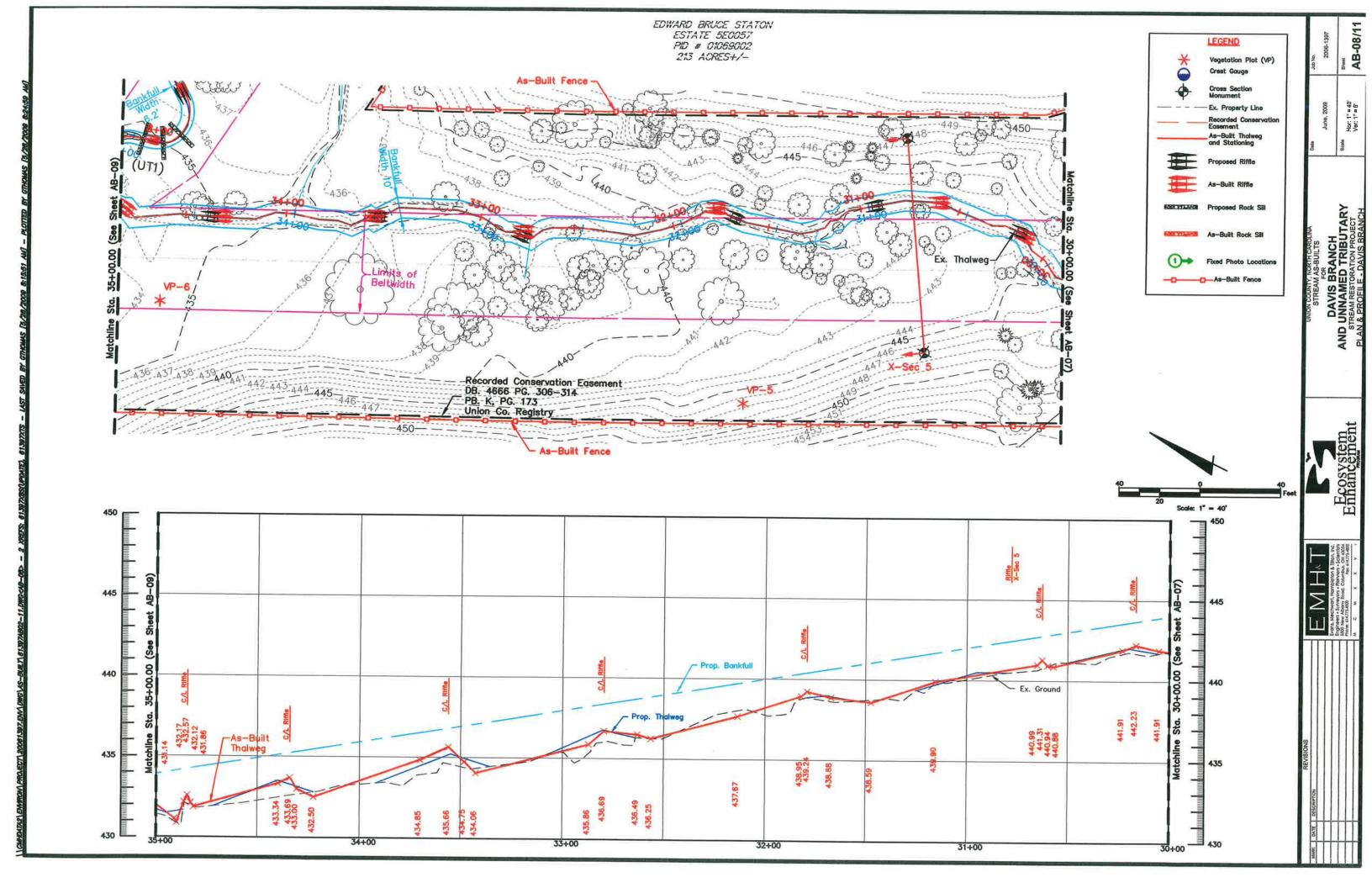


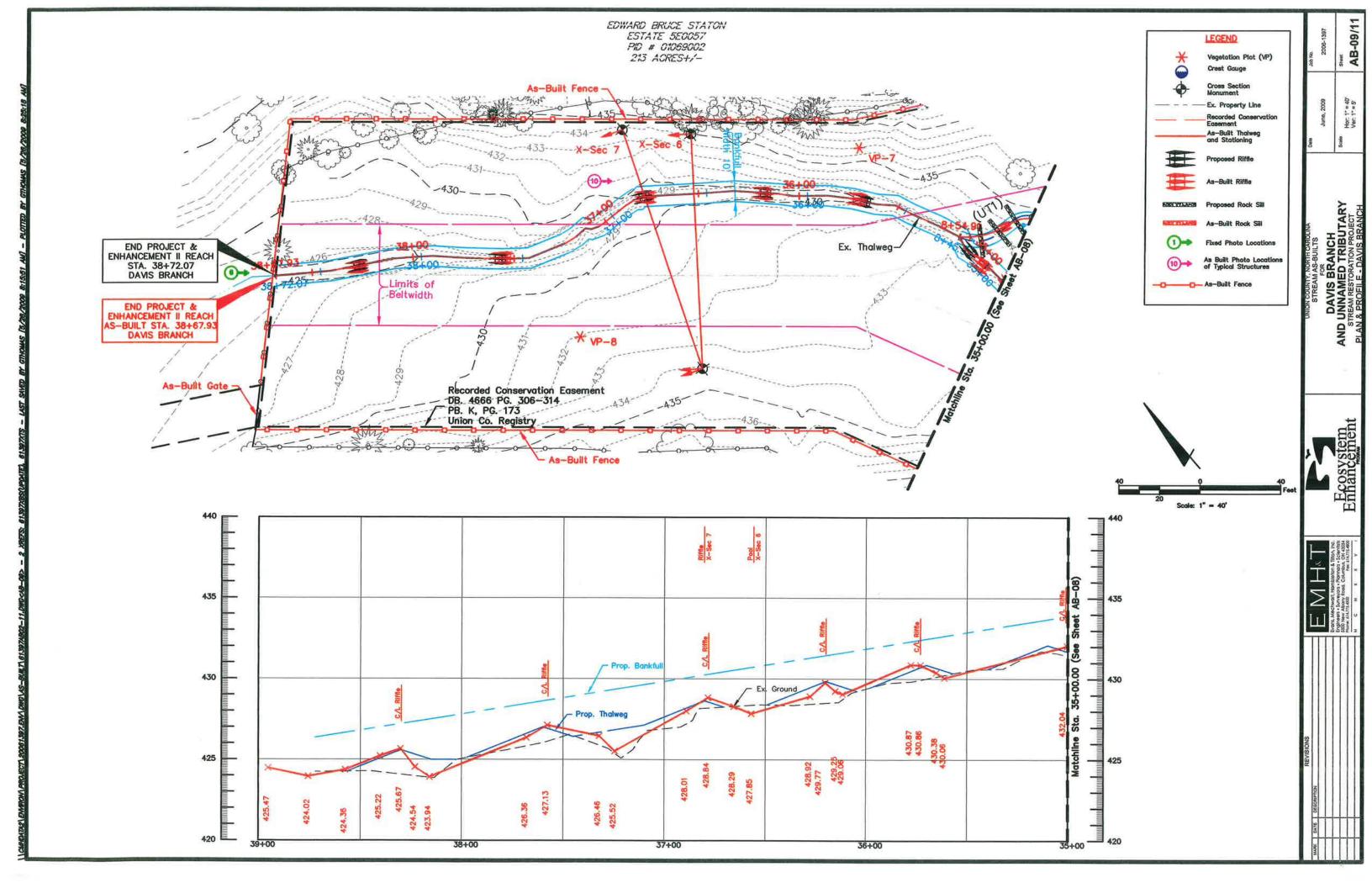


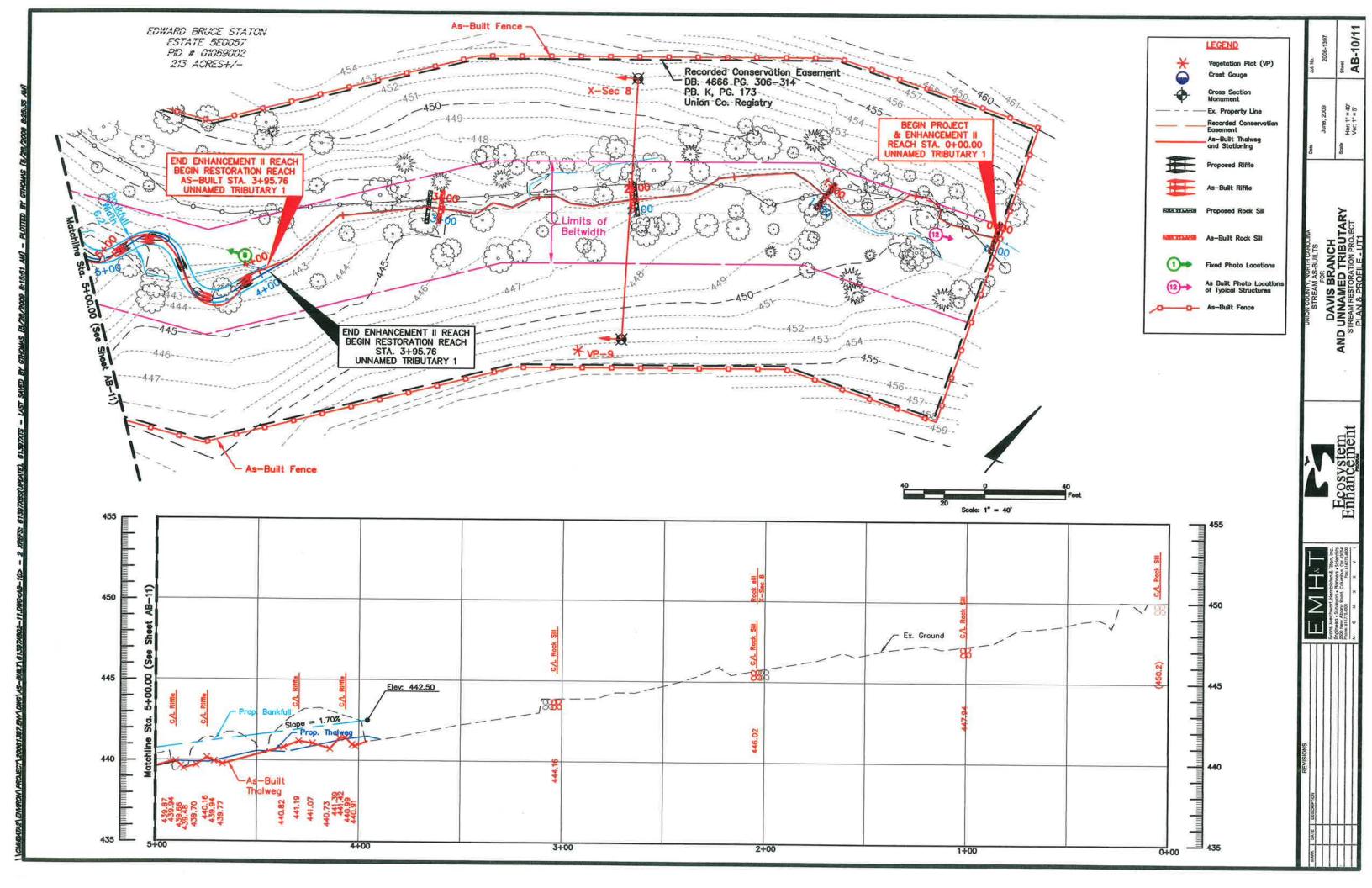


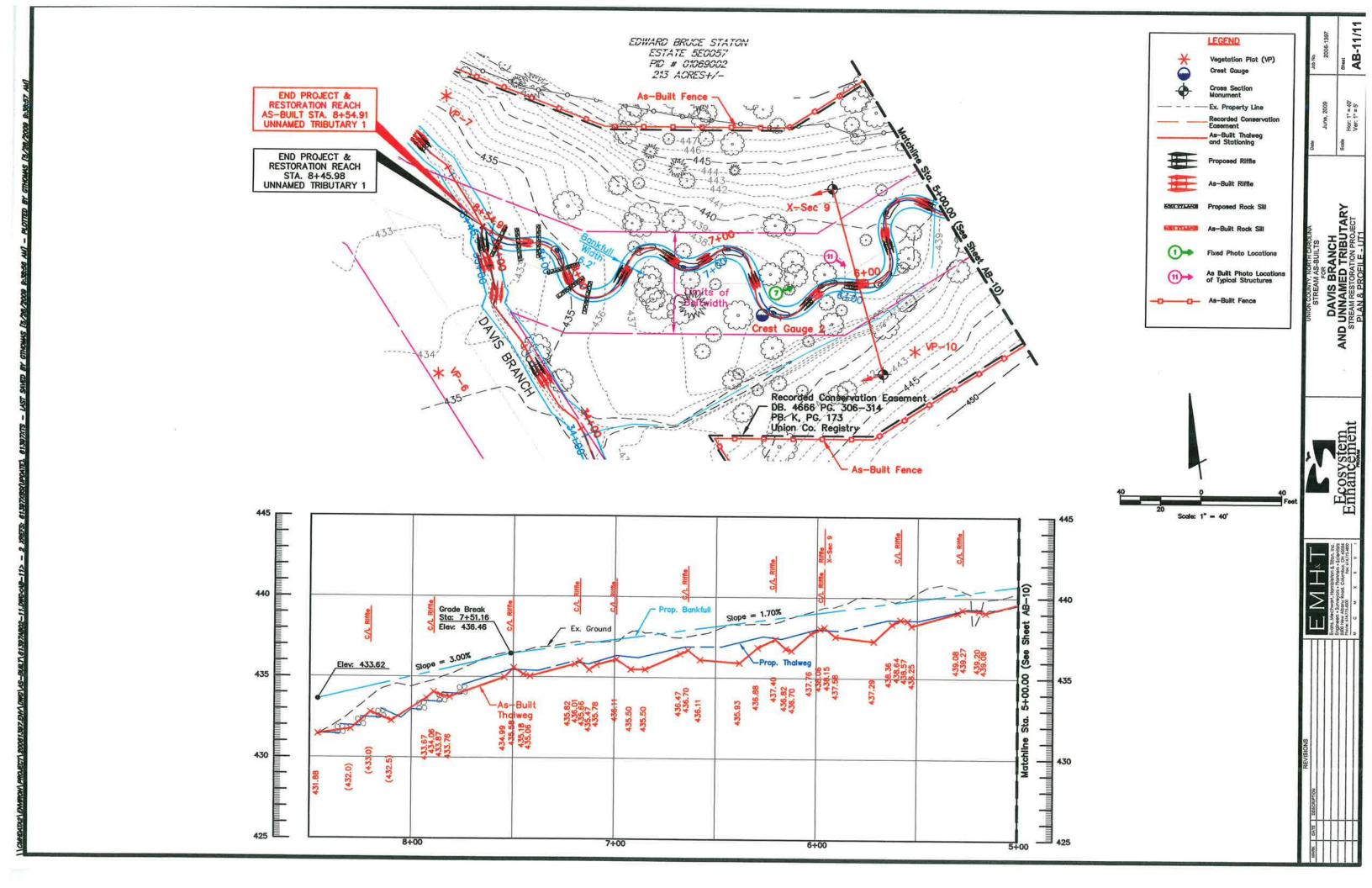












Appendix A

Davis Branch Mainstem and Unnamed Tributary 1

Fixed Station As-Built Photographic Documentation



Photograph 1
Fixed Station 1. Overview of Davis Branch, looking downstream at Sta. 7+80



Photograph 3
Fixed Station 3. Overview of Davis Branch, looking downstream near Sta. 15+50



Photograph 2
Fixed Station 2. Overview of Davis Branch, looking downstream near Sta. 14+75



Photograph 4
Fixed Station 4. Overview of Davis Branch, looking upstream near Sta. 25+75



Photograph 5
Fixed Station 5. Overview of Davis Branch, looking upstream near Sta. 27+25



Photograph 6
Fixed Station 6. Overview of Davis Branch, looking upstream near Sta. 38+75



Photograph 7
Fixed Station 7. Overview of UT1, looking upstream near Sta. 6+50



Photograph 8
Fixed Station 8. Overview of UT1,
looking downstream near Sta. 4+50



Photograph 9
Example Structure. Riffle near Sta. 22+00
on Davis Branch, looking downstream.



Photograph 10
Example Structure. Riffle near Sta. 36+75
on Davis Branch, looking upstream.



Photograph 11
Example Structure. Riffle near Station 6+00 on UT1, looking upstream.



Photograph 12
Example Structure. Rock Sill near Station 0+00 on UT1, looking upstream.



Vegetation Plot No. 1 10m x 10 m. Davis Branch Mainstem Station 11+00, looking downstream.



Vegetation Plot No. 2 10m x 10 m. Davis Branch Mainstem Station 13+00, looking downstream.



Vegetation Plot No. 3 10m x 10 m. Davis Branch Mainstem Station 15+50, looking downstream.



Vegetation Plot No. 4
10m x 10 m. Davis Branch Mainstem
Station 24+50, looking downstream.



Vegetation Plot No. 5 10m x 10 m. Davis Branch Mainstem Station 31+50, looking downstream.



Vegetation Plot No. 6 10m x 10 m. Davis Branch Mainstem Station 34+50, looking downstream.



Vegetation Plot No. 7 10m x 10 m. Davis Branch Mainstem Station 35+50, looking downstream.



Vegetation Plot No. 8 10m x 10 m. Davis Branch Mainstem Station 37+50, looking downstream.



Vegetation Plot No. 9 10 m x 10 m. UT1 Station 2+00, looking downstream.



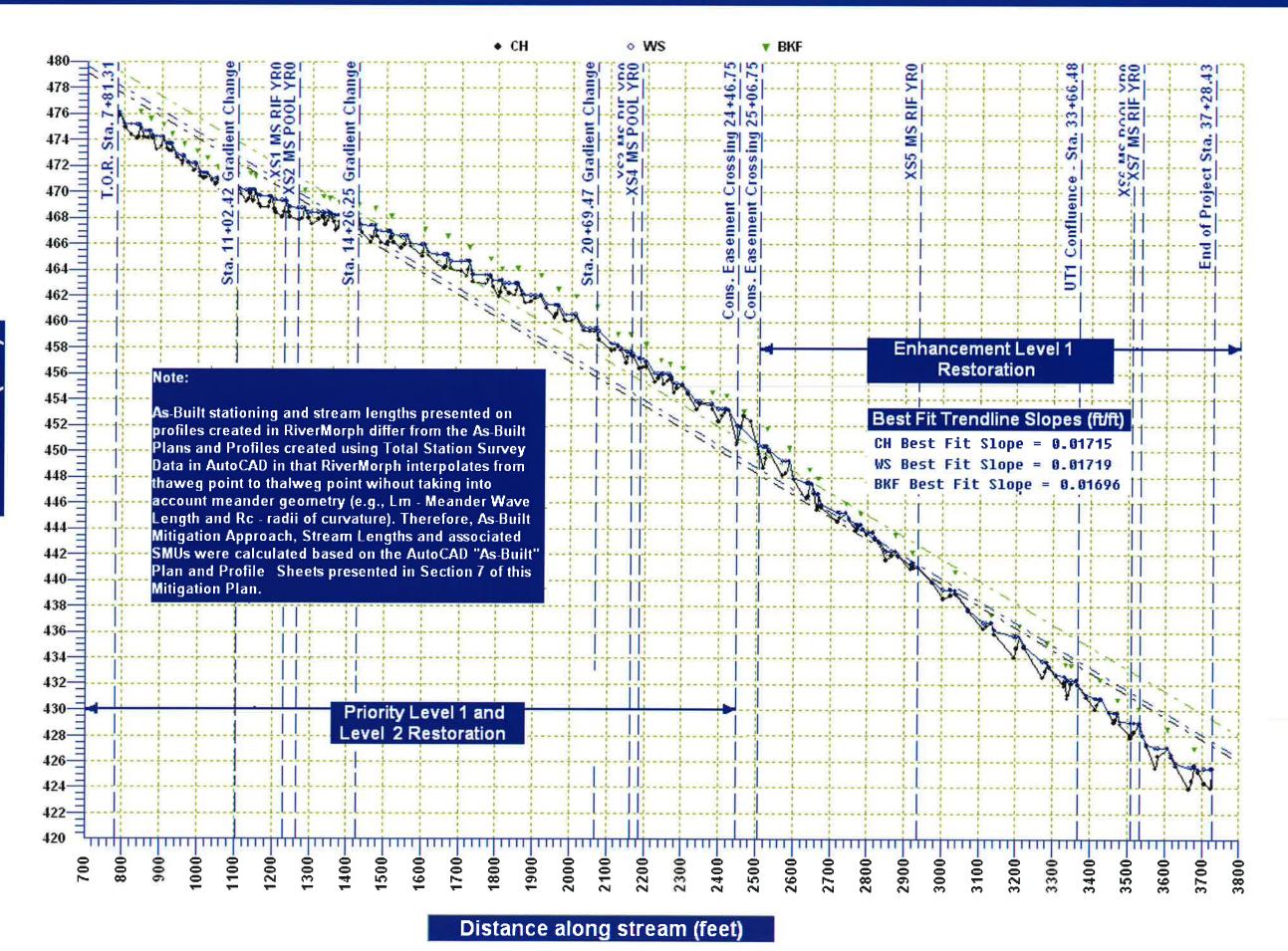
Vegetation Plot No. 10 10 m x 10 m. UT1 Station 6+00, looking downstream.

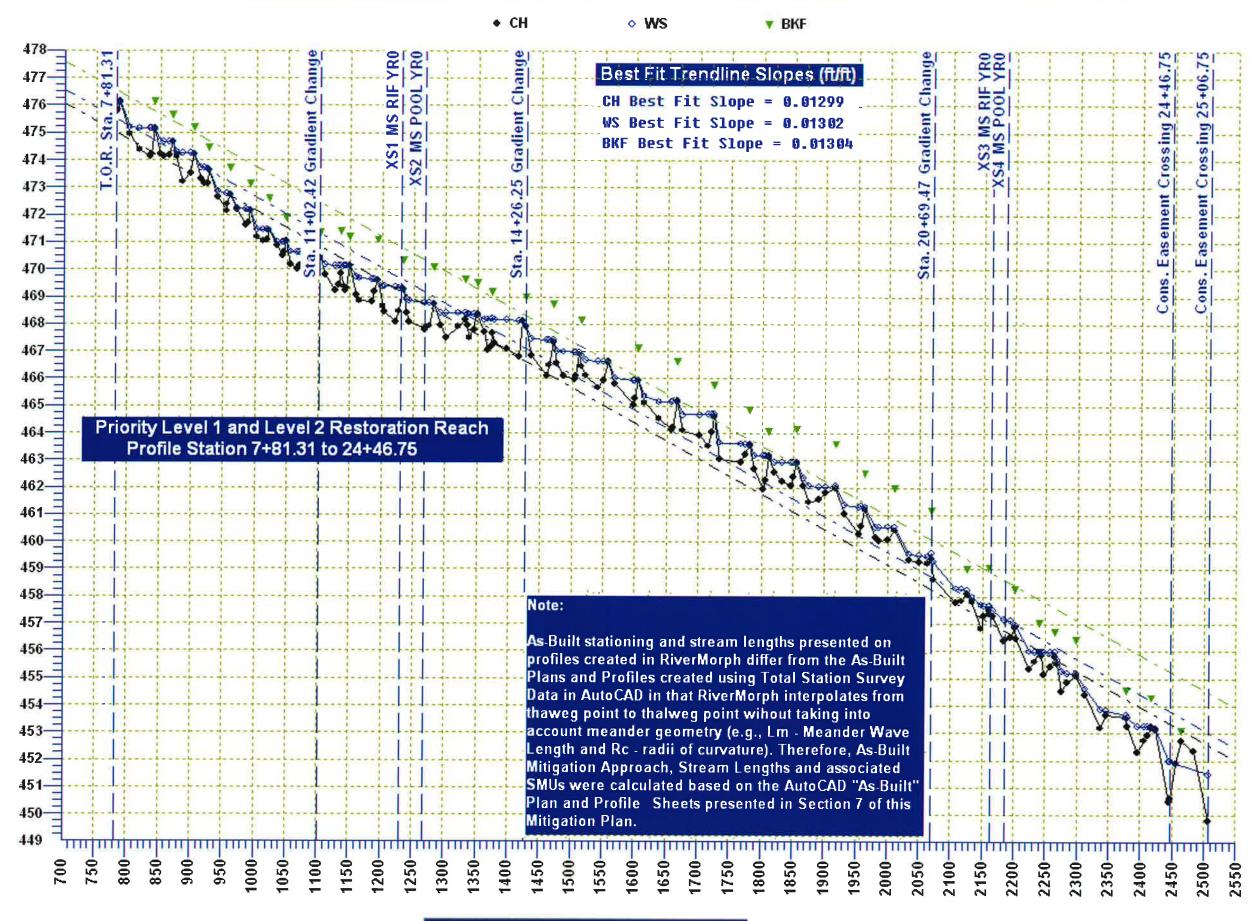
ECOSYSTEM ENHANCEMENT PROGRAM

Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

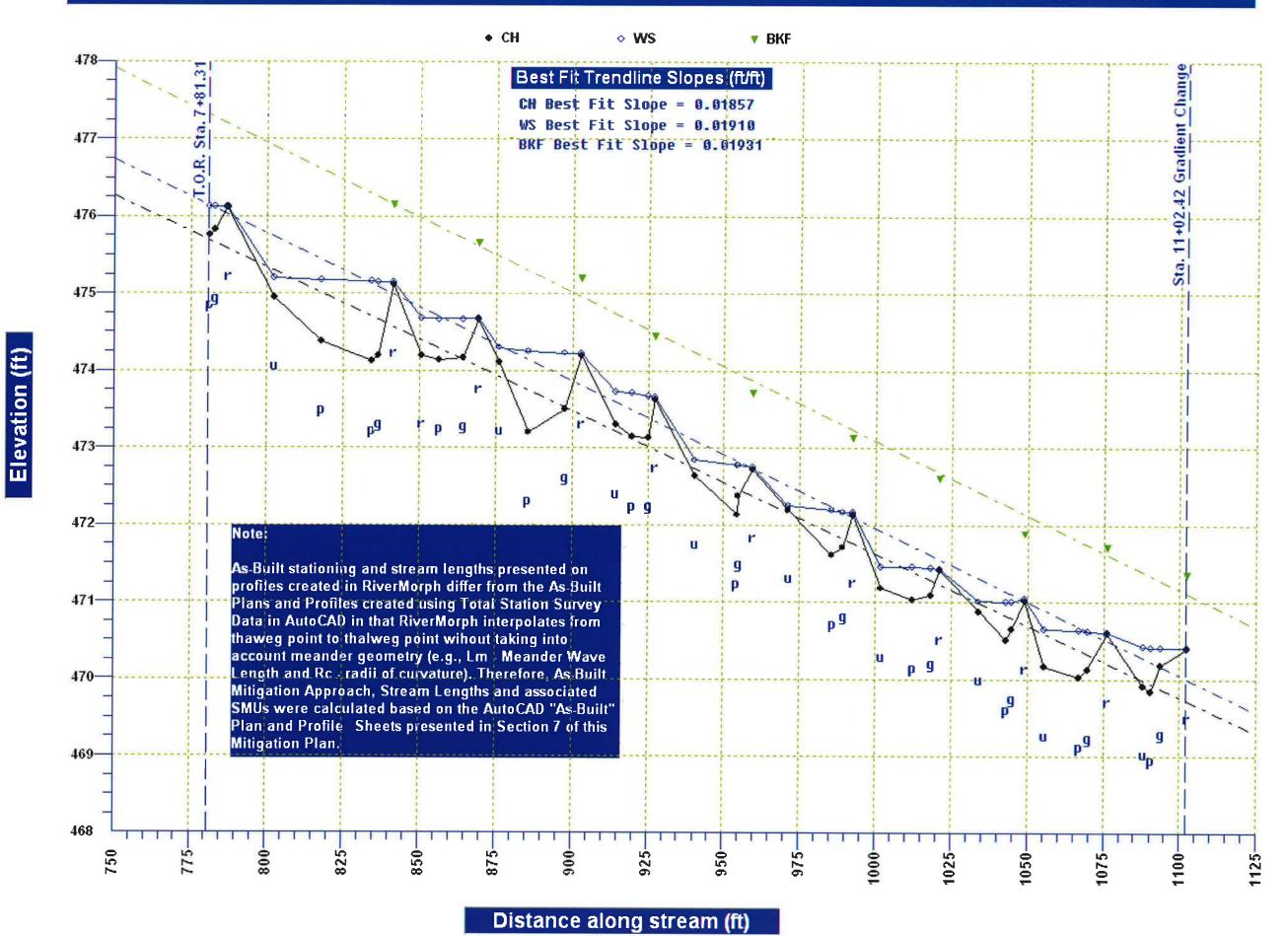
Appendix B

As-Built Long-Term Monitoring Profiles

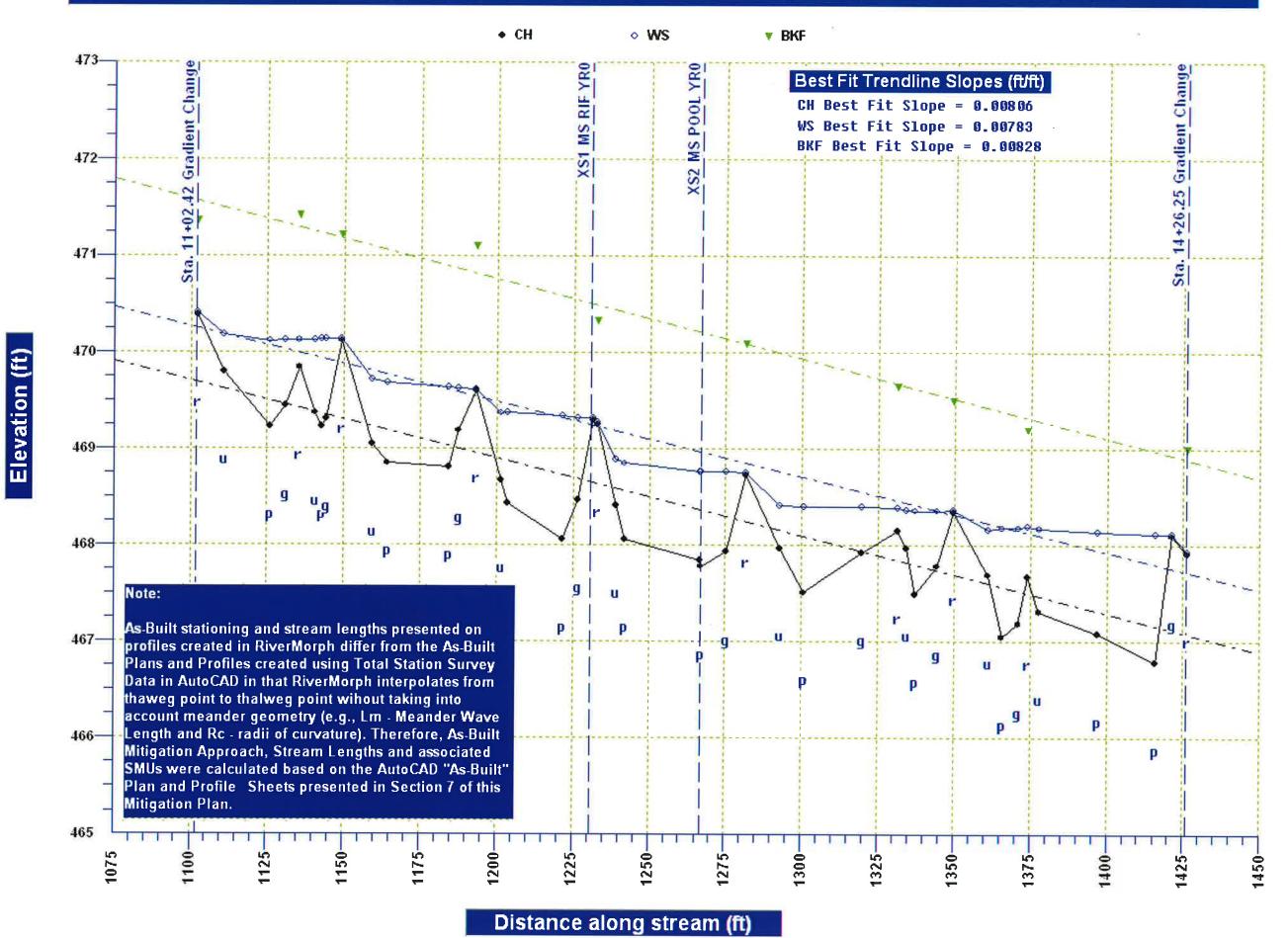




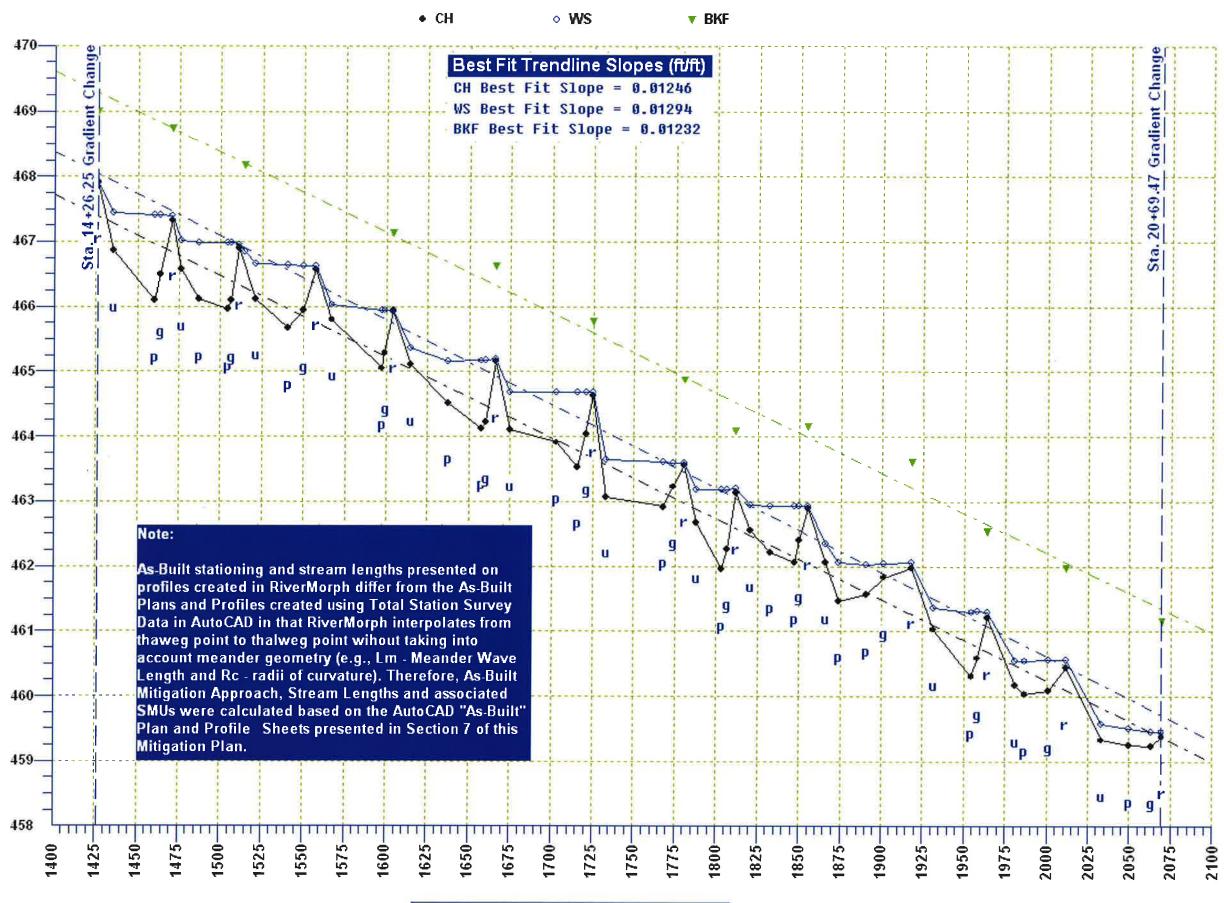
Davis Branch Mainstem "As-Built" Profile - Station 7+81 to 11+02 - 5/5/2009



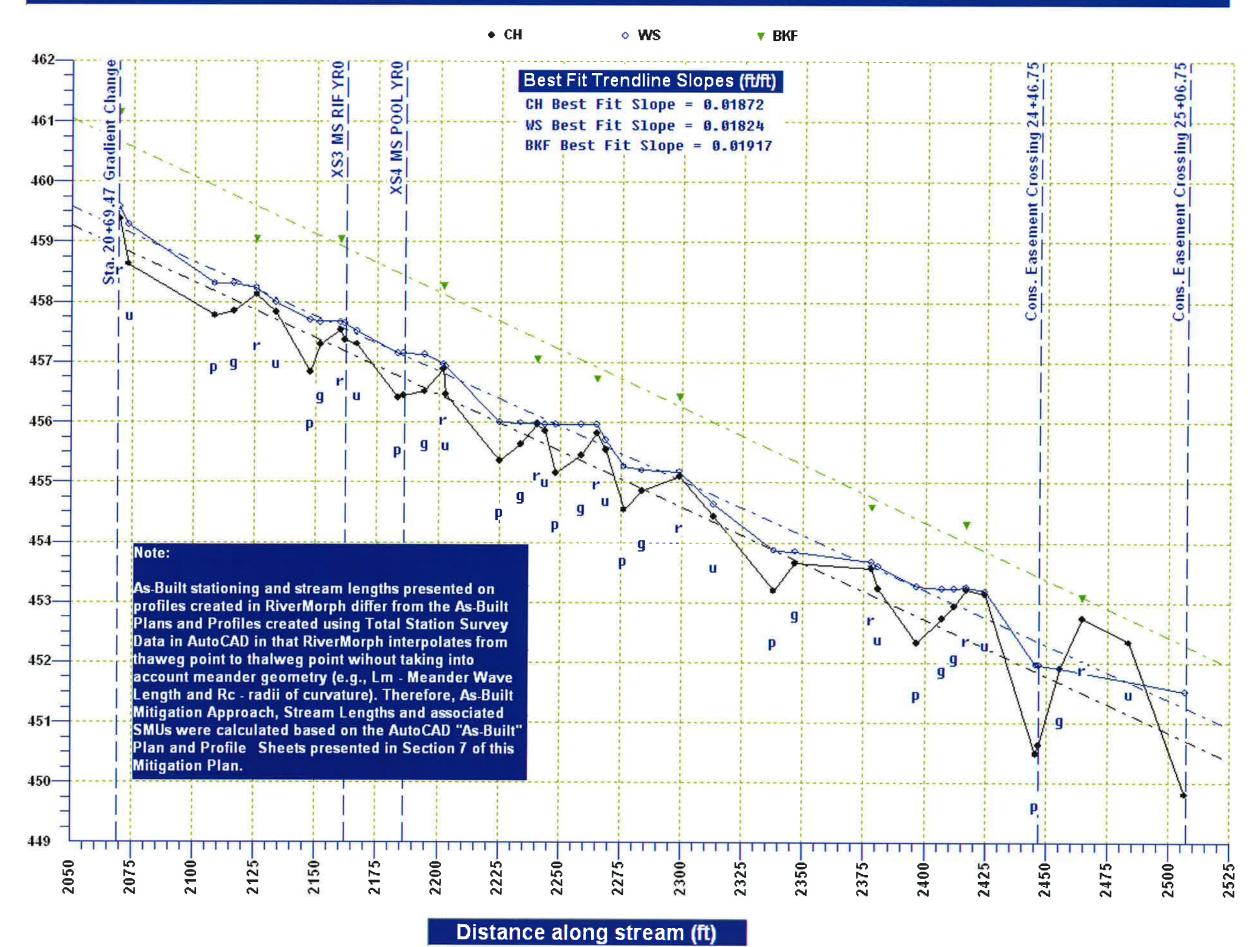
Davis Branch Mainstem "As-Built" Profile - Station 11+02 - 14+26 - 5/5/2009



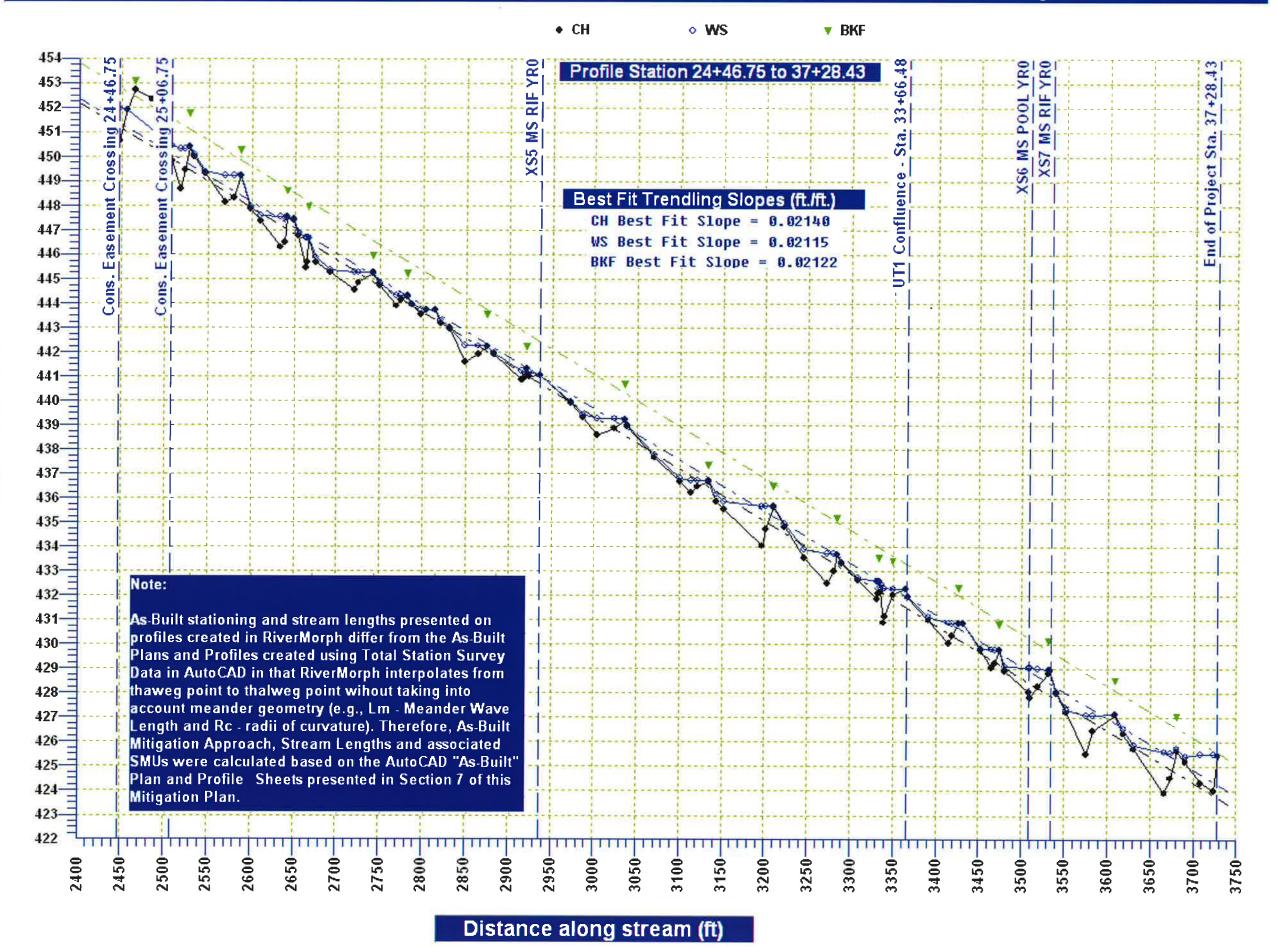
Davis Branch Mainstem "As-Built" Profile - Station 14+26 - 20+69 - 5/5/2009



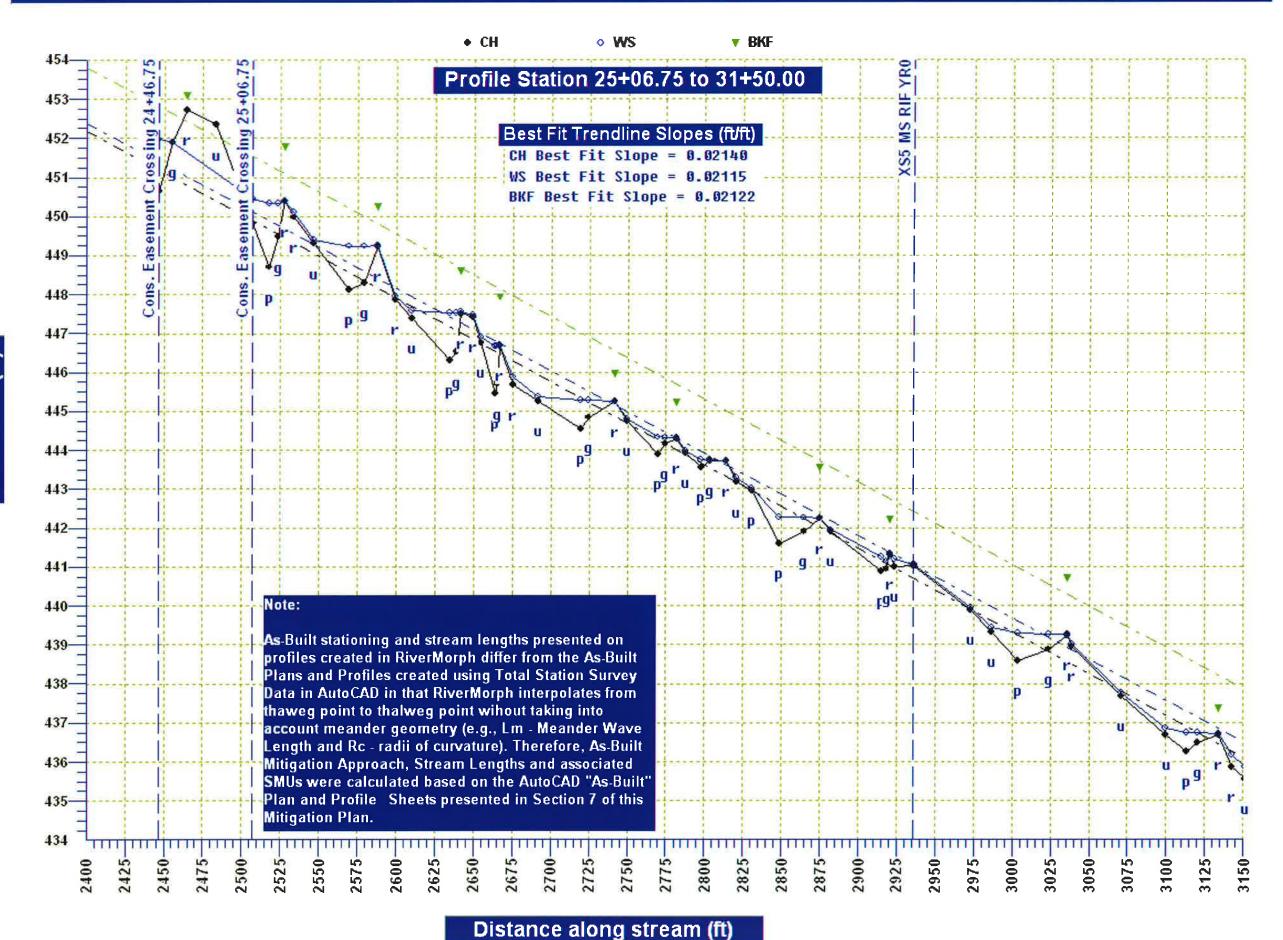
Davis Branch Mainstem "As-Built" Profile - Station 20+69 - 25+07 - 5/5/2009



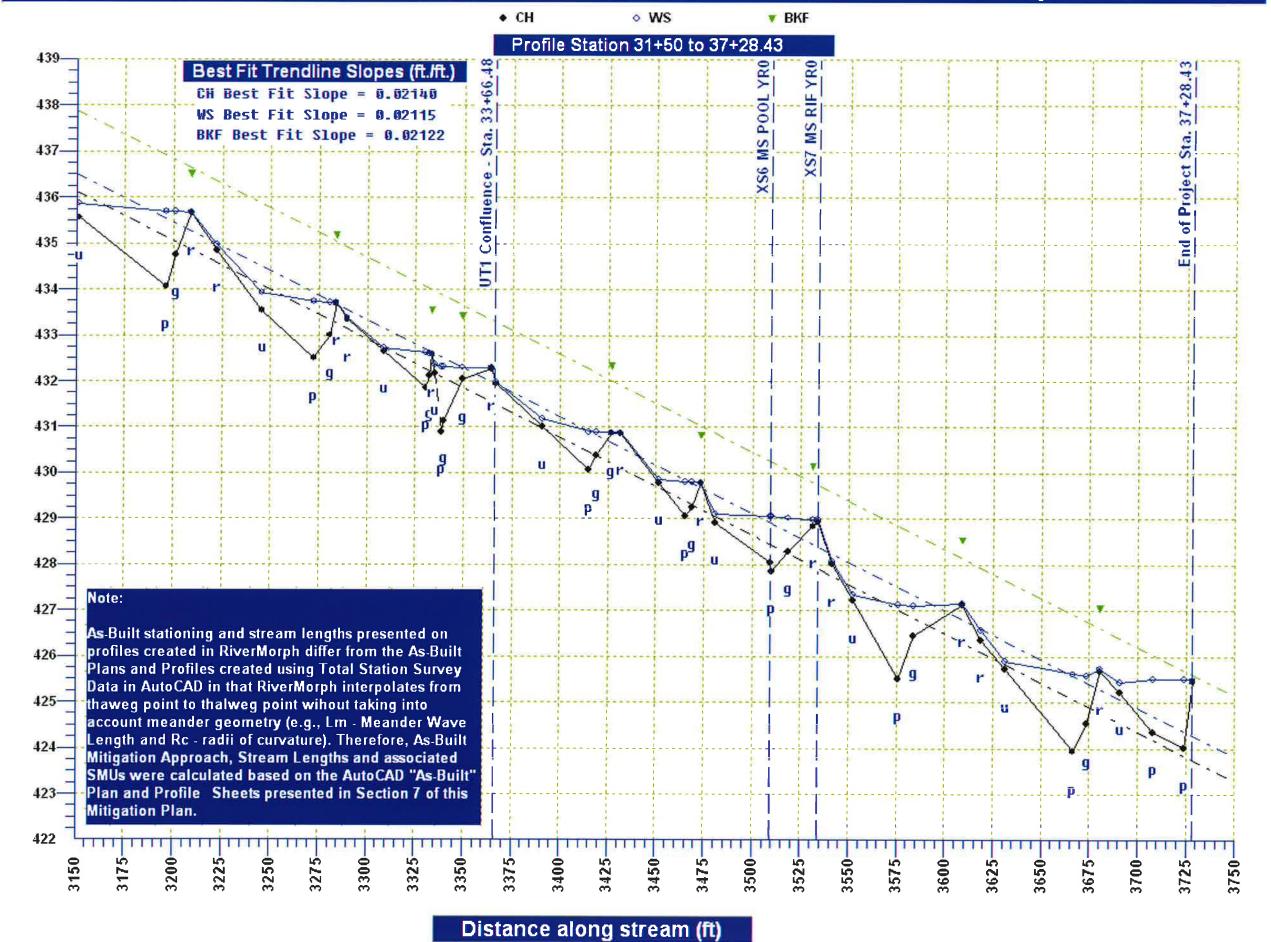




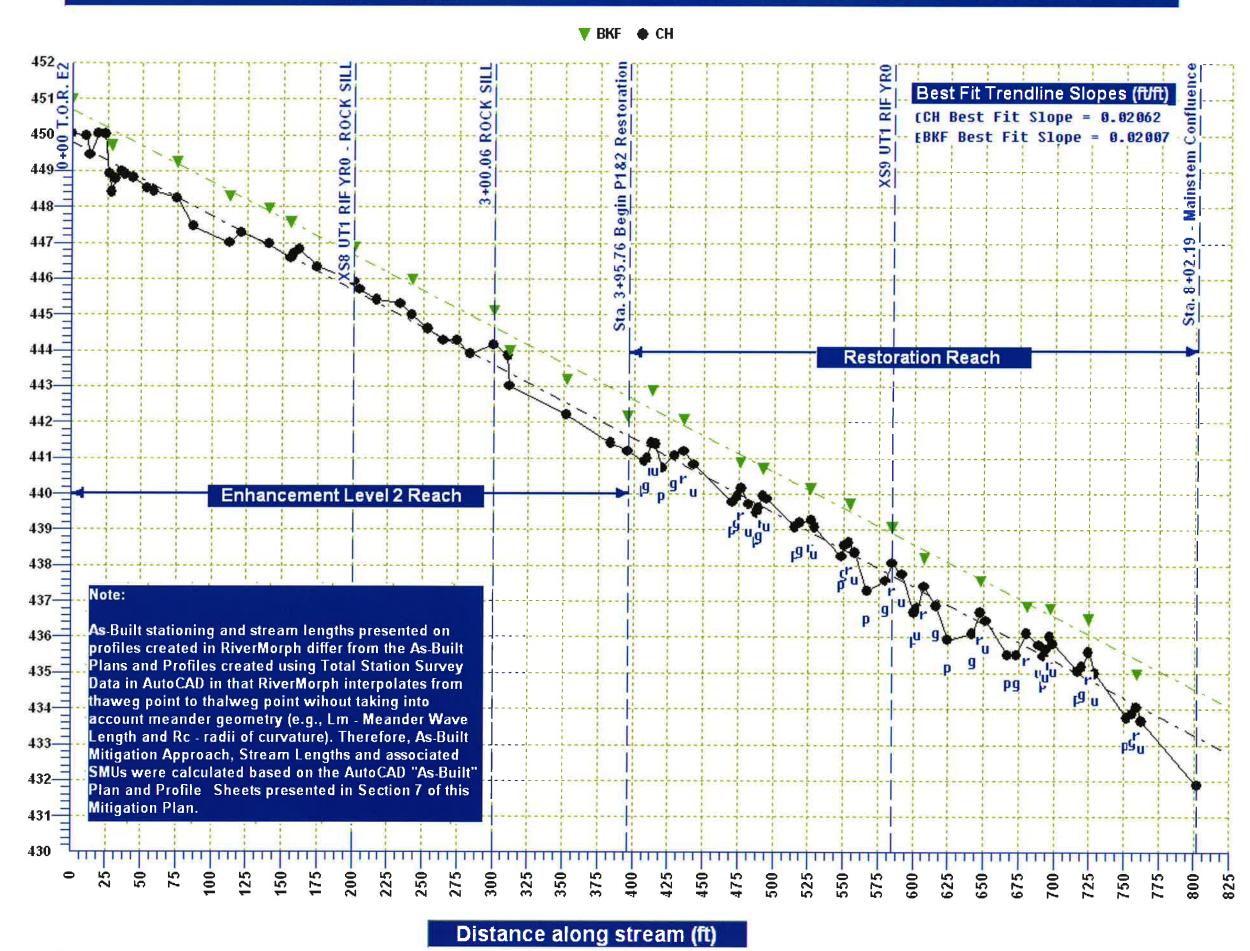




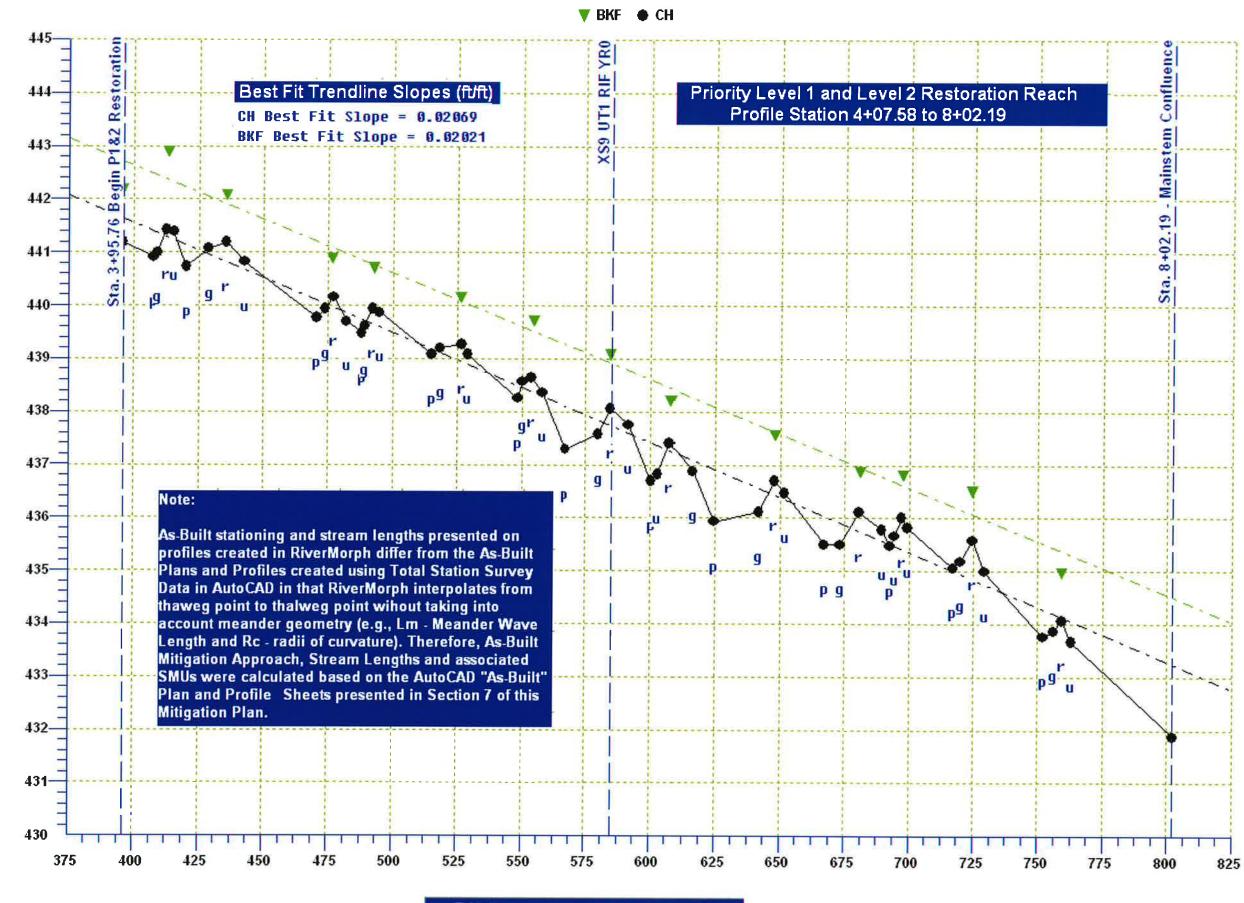
Davis Branch Mainstem - Enhancement Level 1 Reach "As-Built" - May 5, 2009



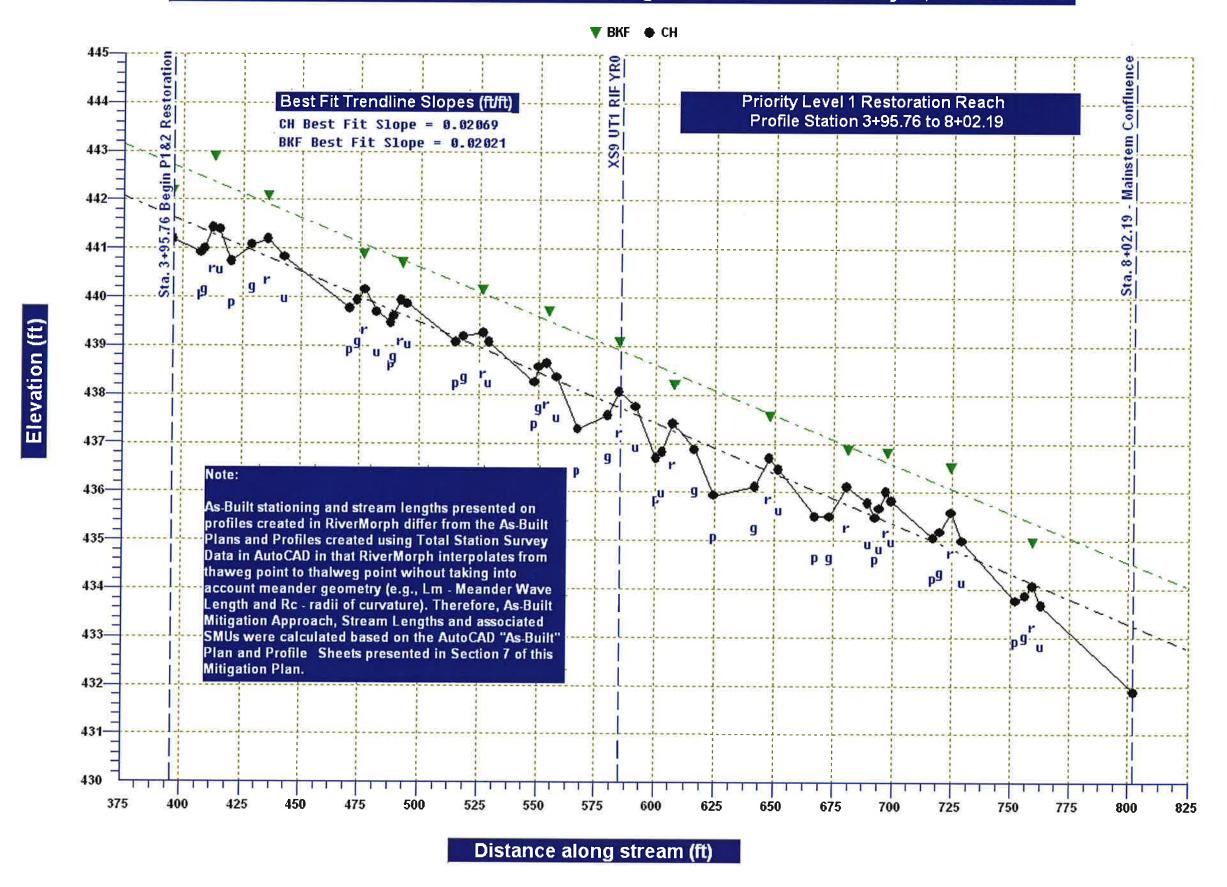
UT1 - "As-Built" Enhancement Level 2 & Restoration Profile - 5/5/2009



Davis Branch UT1 - As-Built Longitudinal Profile - May 5, 2009



Davis Branch UT1 - As-Built Longitudinal Profile - May 5, 2009



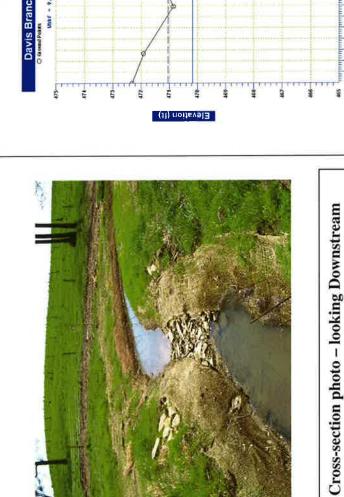
ECOSYSTEM ENHANCEMENT PROGRAM

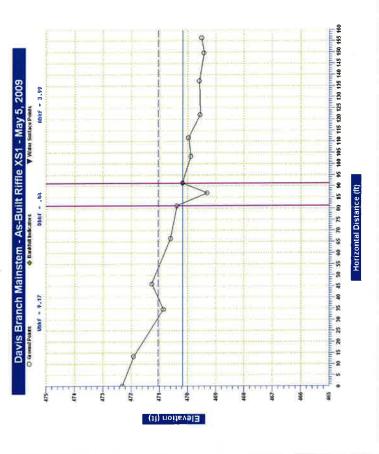
Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

Appendix C

As-Built Long-Term Monitoring Cross-Section Summary Templates and Substrate Particle Distribution Summary Templates

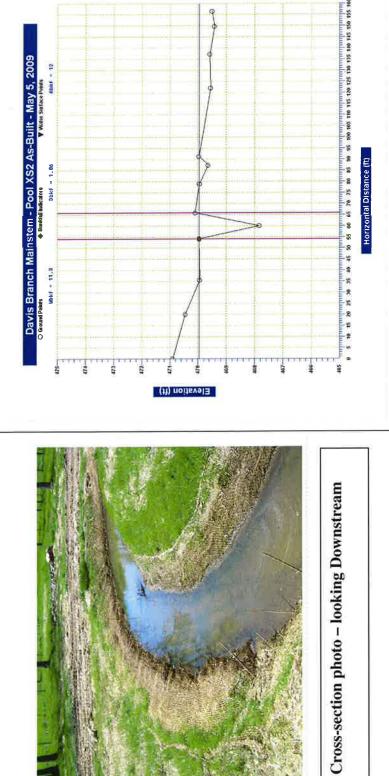
Davis Branch D06054-F 0-YEAR Riffle PROJECT Cross-Section Davis Branch CROSS SECTION: **FEATURE**: 5/5/09 REACH TASK DATE 3.99 ft² 9.17 ft 0.44 ft 0.87 ft 20.84 12.3 C4 All dimensions in feet. Entrenchment Ratio Width/Depth Ratio Maximum Depth Summary Data Bankfull Width Bankfull Area Classification Mean Depth







Davis Branch D06054-F 0-YEAR Pool PROJECT **Cross-Section** Davis Branch CROSS SECTION: FEATURE: 2/5/09 REACH DATE TASK 11.97 ft² 11.34 ft 1.06 ft 2.11 ft 10.7 13.8 E5 All dimensions in feet. Mean Depth Maximum Depth Width/Depth Ratio Entrenchment Ratio Summary Data Bankfull Width Bankfull Area Classification



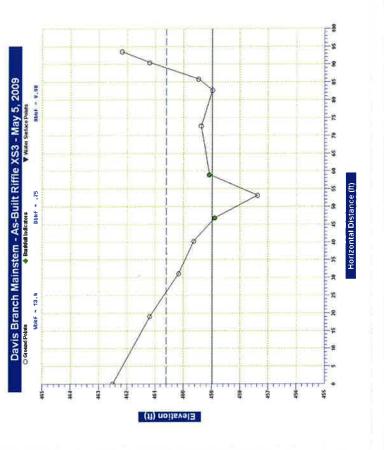




Cummony Doto			PROJECT	PROJECT Davis Branch	
Summary Data All dimensions in feet				D06054-F	
				0-YEAR	
Bankfull Area	9.98 ft^2	TASK	Cross-Section		
Bankfull Width	13.38 ft	REACH	Davis Branch		
Mean Depth	0.75 ft	DATE	5/5/09		
Maximum Depth	1.62 ft				
Width/Depth Ratio	17.84	,		9	
Entrenchment Ratio	4.71	V	SECTION:	m	
Classification	C4	Ecosystem	FEATURE	Riffle	
		Emhancement			









Davis Branch D06054-F 0-YEAR Pool **PROJECT Cross-Section** Davis Branch CROSS SECTION: FEATURE: 5/5/09 REACH DATE TASK 18.64 ft² 21.38 ft 0.87 ft 2.24 ft 24.57 3.15 C4 All dimensions in feet.

Entrenchment Ratio

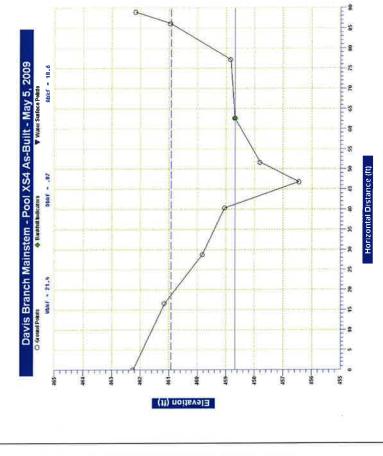
Classification

Width/Depth Ratio Maximum Depth

Bankfull Width Bankfull Area

Mean Depth

Summary Data

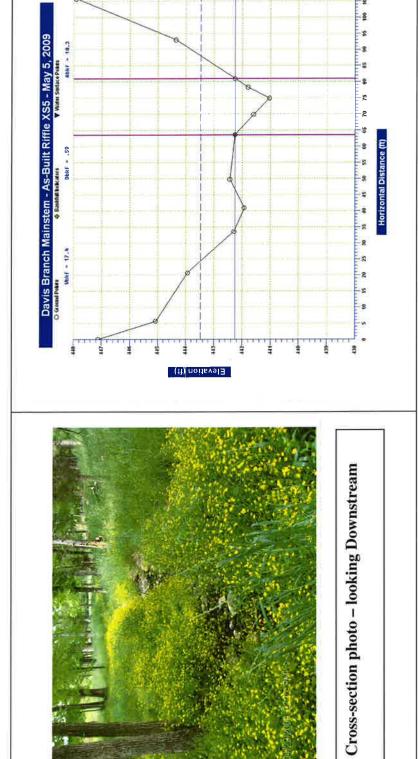








Cummont Doto			PROJECT	PROJECT Davis Branch
Summary Data All dimensions in feet				D06054-F
				0-YEAR
Bankfull Area	10.3 ft^2	TASK	Cross-Section	
Bankfull Width	17.38 ft	REACH	Davis Branch	
Mean Depth	0.59 ft	DATE	5/2/08	
Maximum Depth	1.22 ft			
Width/Depth Ratio	29.46	,		
Entrenchment Ratio	3.67	V	SECTION:	2
Classification	C4b/1	Froevetern	EE ATI IDE.	9,910
		Emhancement		

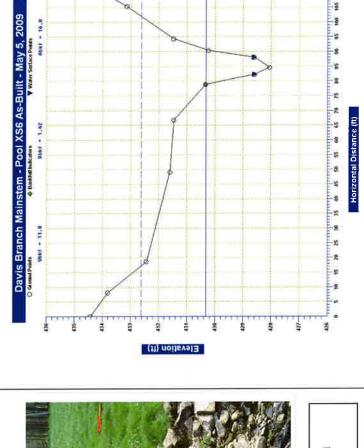




PROJECT CROSS SECTION: Cross-Section Davis Branch FEATURE: 2/5/09 REACH TASK DATE 16.75 ft² 11.81 ft 1.42 ft 2.28 ft 8.32 7.16 E4b/1 All dimensions in feet. Entrenchment Ratio Width/Depth Ratio Maximum Depth Summary Data Bankfull Width Bankfull Area Classification Mean Depth

Pool

Davis Branch D06054-F 0-YEAR





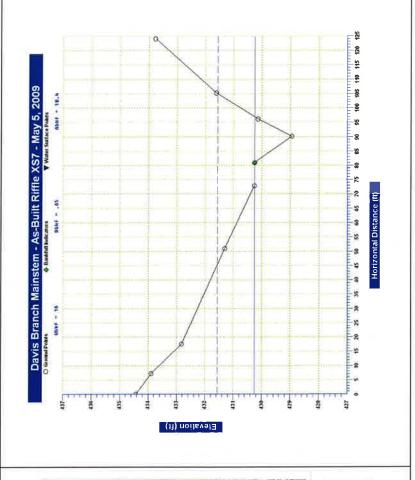




CROSS SECTION: Cross-Section Davis Branch FEATURE: 2/5/09 REACH TASK DATE 10.38 ft² 15.97 ft 0.65 ft 1.31 ft 24.57 3.75 All dimensions in feet. Entrenchment Ratio Width/Depth Ratio Maximum Depth Summary Data Bankfull Width Bankfull Area Classification Mean Depth

Davis Branch D06054-F 0-YEAR

PROJECT





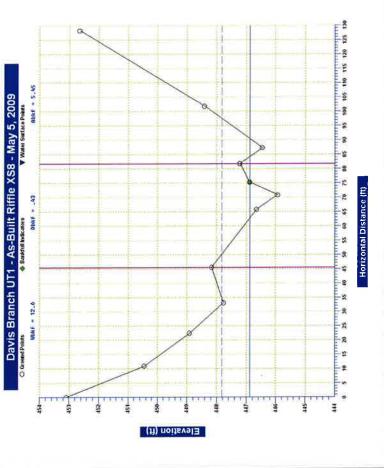


Cross-section photo - looking Upstream

Cummony Doto			PROJECT	PROJECT Davis Branch
Summary Data All dimensions in feet				D06054-F
				0-YEAR
Bankfull Area	5.45 ft ²	TASK	Cross-Section	
Bankfull Width	12.58 ft	REACH	Unnamed Trib. 1	
Mean Depth	0.43 ft	DATE	2/2/09	
Maximum Depth	0.95 ft			
Width/Depth Ratio	29.26	1		į
Entrenchment Ratio	4.01	V	CHOSS SECTION:	20
Classification	C4b	Fcosystem	FEATURE:	Riffle
		Hanancement		

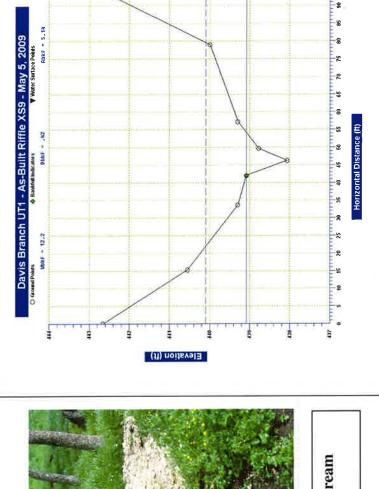


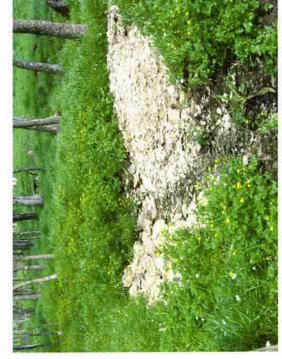






Davis Branch D06054-F 0-YEAR Riffle PROJECT CROSS SECTION: Unnamed Trib. 1 Cross-Section **FEATURE**: 2/5/09 REACH DATE TASK 5.14 ft² 12.18 ft 0.42 ft 1.02 ft 29.0 4.74 C4b All dimensions in feet. Entrenchment Ratio Maximum Depth Width/Depth Ratio Summary Data Bankfull Area Bankfull Width Classification Mean Depth



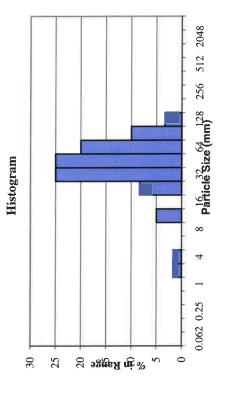


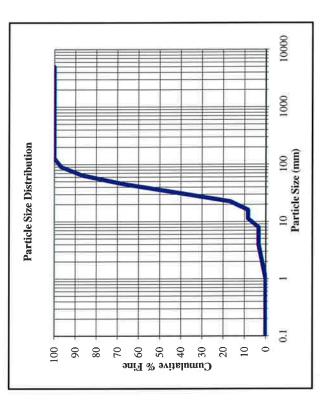




Particle Distribution - Riffle XS-1: Sta. 12+31.44 (D50 = 36.3 mm; D84 = 61.5 mm)	Riffle XS-1: Sta. 12-	+31.44 (D	50 = 36.3 mm;	D84 = 61.5 mm
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	0	0	0
Coarse Sand	0.5-1.0	0	0	0
Very Coarse Sand	1.0-2.0	1	2	2
Very Fine Gravel	2.0-4.0	1	2	3
Fine Gravel	4.0-5.7	0	0	3
Fine Gravel	5.7-8.0	0	0	3
Medium Gravel	8.0-11.3	3	5	8
Medium Gravel	11.3-16.0	0	0	8
Coarse Gravel	16.0-22.6	5	8	17
Coarse Gravel	22.6-32	15	25	42
Very Coarse Gravel	32-45	15	25	<i>L</i> 9
Very Coarse Gravel	45-64	12	20	87
Small Cobble	64-90	9	10	26
Small Cobble	90-128	2	3	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	>2048	0	0	100
Totals	s	09	100	100

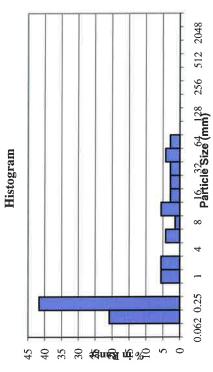
Branch &	Davis Branch & Unnamed Tributary - EEP Project No. D06054-F	- EEP Project No.	D06054-F
Reach	Mainstem	X Sec	1
Date	04/08/2009	Sta No.	12+31.44

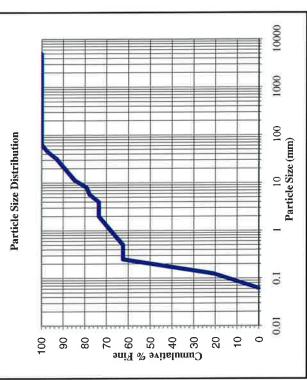




Pebble Count - P	Pebble Count - Pool XS-2: Sta. 12+66.55 (D50 = 0.21 mm; D84	.55 (D50 = 0).21 mm; D84	= 10.9 mm)	
Material	Particle Size (mm)	Count	% in Range	% Cumulative	
Silt/Clay	<0.062	0	0	0	
Very Fine Sand	0.062-0.125	15	21	21	
Fine Sand	0.125-0.25	30	42	63	
Medium Sand	0.25-0.5	0	0	63	
Coarse Sand	0.5-1.0	4	9	89	
Very Coarse Sand	1.0-2.0	4	9	74	
Very Fine Gravel	2.0-4.0	0	0	74	
Fine Gravel	4.0-5.7	3	4	78	
Fine Gravel	5.7-8.0	1	1	62	
Medium Gravel	8.0-11.3	4	9	85	
Medium Gravel	11.3-16.0	2	3	88	
Coarse Gravel	16.0-22.6	2	3	06	L
Coarse Gravel	22.6-32	2	3	93	
Very Coarse Gravel	32-45	3	4	16	
Very Coarse Gravel	45-64	2	3	100	
Small Cobble	64-90	0	0	100	
Small Cobble	90-128	0	0	100	
Large Cobble	128-180	0	$\bar{0}$	100	
Large Cobble	180-256	0	0	100	
Small Boulder	256-362	0	0	100	
Small Boulder	362-512	0	0	100	
Medium Boulder	512-1024	0	0	100	
Large Boulder	1024-2048	0	0	100	
Bedrock	>2048	0	0	100	
Totals	als	72	100	100	

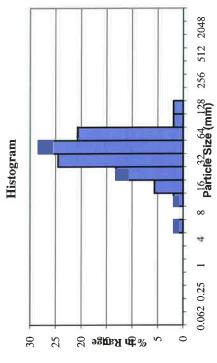
Davis Branch &	Davis Branch & Unnamed Tributary - EEP Project No. D06054-F	- EEP Project No.	. D06054-F
Reach	Mainstem	X Sec	2
Date	04/08/2009	Sta No.	12+66.55

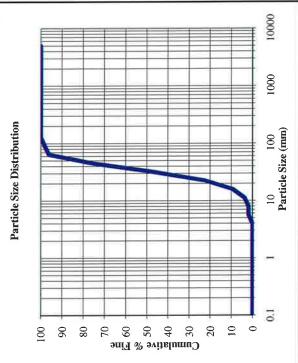




Particle Distribution -	Particle Distribution - Riffle XS-3; Sta. 21+61.52 (D50	51.52 (D50	= 33.3 mm; D	33.3 mm; D84 = 52.8 mm)	Davi
Material	Particle Size (mm)	Count	% in Range	% Cumulative	
Silt/Clay	<0.062	0	0	0	
Very Fine Sand	0.062-0.125	0	0	0	
Fine Sand	0.125-0.25	0	0	0	30
Medium Sand	0.25-0.5	0	0	0	8
Coarse Sand	0.5-1.0	0	0	0	C7 S
Very Coarse Sand	1.0-2.0	0	0	0	ge 20
Very Fine Gravel	2.0-4.0	0	0	0	Rank
Fine Gravel	4.0-5.7	1	2	2	₽ %
Fine Gravel	5.7-8.0	0	0	2	5
Medium Gravel	8.0-11.3	1	2	4	0
Medium Gravel	11.3-16.0	3	9	6	
Coarse Gravel	16.0-22.6	7	13	23	L
Coarse Gravel	22.6-32	13	25	47	
Very Coarse Gravel	32-45	15	28	75	
Very Coarse Gravel	45-64	11	21	96	
Small Cobble	64-90	1	2	86	
Small Cobble	90-128	1	2	100	ət
Large Cobble	128-180	0	0	100	ıi∄ %
Large Cobble	180-256	0	0	100	eviti
Small Boulder	256-362	0	0	100	3[nwi
Small Boulder	362-512	0	0	100	r)
Medium Boulder	512-1024	0	0	100	
Large Boulder	1024-2048	0	0	100	
Bedrock	>2048	0	0	100	
Totals	als	53	100	100	

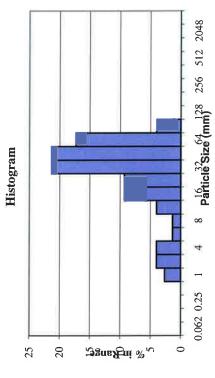
Davis Branch	Davis Branch & Unnamed Tributary - EEP Project No. D06054-F	- EEP Project No.	. D06054-F
Reach	Mainstem	X Sec	3
Date	04/08/2009	Sta No.	21+61.52

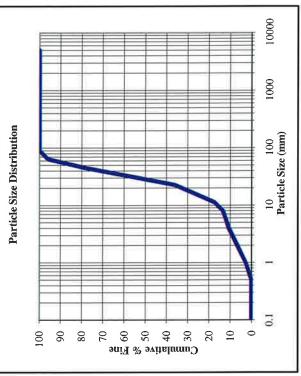




Particle Distribution - Pool XS-4: Sta. 21+85.85 (D50 = 28.8 mm; D84 = 50.8 mm)	- Pool XS-4: Sta. 21+	85.85 (D50	= 28.8 mm; D	84 = 50.8 mm
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	0	0	0
Coarse Sand	0.5-1.0	2	3	3
Very Coarse Sand	1.0-2.0	3	4	7
Very Fine Gravel	2.0-4.0	3	4	11
Fine Gravel	4.0-5.7	1	1	12
Fine Gravel	5.7-8.0	1	1	13
Medium Gravel	8.0-11.3	3	4	17
Medium Gravel	11.3-16.0	7	6	27
Coarse Gravel	16.0-22.6	7	6	36
Coarse Gravel	22.6-32	16	21	57
Very Coarse Gravel	32-45	16	21	62
Very Coarse Gravel	45-64	13	17	96
Small Cobble	64-90	3	4	001
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	>2048	0	0	100
Totals	als	75	100	100

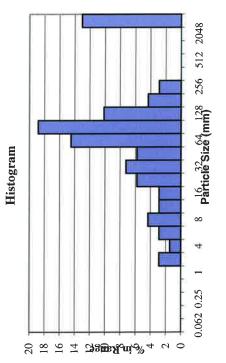
Davis Branch	Davis Branch & Unnamed Tributary - EEP Project No. D06054-F	- EEP Project No.	. D06054-F
Reach	Mainstem	X Sec	4
Date	04/08/2009	Sta No.	21+85.85

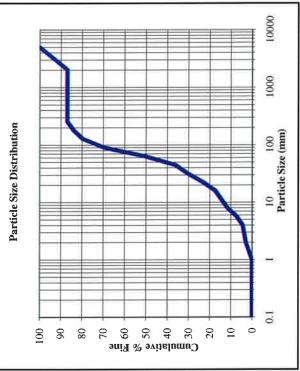




Particle Distribution	Particle Distribution - Riffle XS-5: Sta. $29+36.09$ ($\overline{D50} = 63.1$ mm; $\overline{D84} = 179.3$ mm)	86.09 (D50	= 63.1 mm; D8	4 = 179.3 mm)	Davis
Material	Particle Size (mm)	Count	% in Range	% Cumulative	Ä
Silt/Clay	<0.062	0	0	0	
Very Fine Sand	0.062-0.125	0	0	0	
Fine Sand	0.125-0.25	0	0	0	ć
Medium Sand	0.25-0.5	0	0	0	07 81
Coarse Sand	0.5-1.0	0	0	0	16
Very Coarse Sand	1.0-2.0	2	3	3	4 3)
Very Fine Gravel	2.0-4.0	1	1	4	र् <mark>ध</mark> ार
Fine Gravel	4.0-5.7	2	3	7	oni.e%
Fine Gravel	5.7-8.0	3	4	12	4 0
Medium Gravel	8.0-11.3	2	3	14	0 7
Medium Gravel	11.3-16.0	2	3	17	
Coarse Gravel	16.0-22.6	4	9	23	Į
Coarse Gravel	22.6-32	5	7	30	
Very Coarse Gravel	32-45	4	9	36	
Very Coarse Gravel	45-64	10	14	51	
Small Cobble	64-90	13	19	70	
Small Cobble	90-128	7	10	80	
Large Cobble	128-180	3	4	84	
Large Cobble	180-256	2	3	87	
Small Boulder	256-362	0	0	87	
Small Boulder	362-512	0	0	87	
Medium Boulder	512-1024	0	0	87	
Large Boulder	1024-2048	0	0	87	
Bedrock	>2048	6	13	100	
Tot	Totals	69	100	100	

Davis Branch	Davis Branch & Unnamed Tributary - EEP Project No. D06054-F	- EEP Project No.	D06054-F
Reach	Mainstem	X Sec	5
Date	04/08/2009	Sta No.	29+36.09



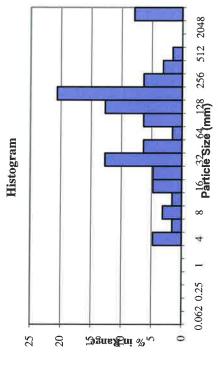


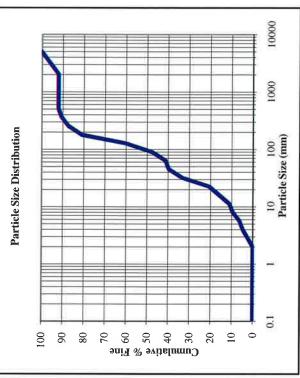
Particle Distribution	Particle Distribution - Pool XS-6: Sta. 35+09.15 (D50	09.15 (D50	= 40.1 mm; D	= 40.1 mm; D84 = 89.7 mm)	Davis Bra
Material	Particle Size (mm)	Count	% in Range	% Cumulative	Reack
Silt/Clay	<0.062	0	0	0	Date
Very Fine Sand	0.062-0.125	0	0	0	
Fine Sand	0.125-0.25	0	0	0	
Medium Sand	0.25-0.5	0	0	0	20 18 18
Coarse Sand	0.5-1.0	0	0	0	16
Very Coarse Sand	1.0-2.0	3	5	5	4 5
Very Fine Gravel	2.0-4.0	3	5	10)8 0 2)
Fine Gravel	4.0-5.7	3	5	14	Lui, é
Fine Gravel	5.7-8.0	1	2	16	% 4
Medium Gravel	8.0-11.3	3	5	21	7 0
Medium Gravel	11.3-16.0	3	5	25	0.062
Coarse Gravel	16.0-22.6	5	8	33	
Coarse Gravel	22.6-32	3	5	38	
Very Coarse Gravel	32-45	12	19	57	100
Very Coarse Gravel	45-64	10	16	73	06
Small Cobble	64-90	7	111	84	08
Small Cobble	90-128	2	3	87	0, 0,
Large Cobble	128-180	2	3	06	oni¶ o
Large Cobble	180-256	0	0	06	% 9vi ℃ 0
Small Boulder	256-362	0	0	06	telun 4
Small Boulder	362-512	0	0	06	Ст
Medium Boulder	512-1024	0	0	06	20
Large Boulder	1024-2048	0	0	06	01
Bedrock	>2048	9	10	100	0.0
Totals	als	63	100	100	

o. D06054-F	9	35+09.15			256 512 2048		00001
- EEP Project No. D06054-F	X Sec	Sta No.	yram		16 32 5 6 mm) 28 2	istribution	0001
Unnamed Tributary	Mainstem	04/08/2009	Histogram		1 4 8 Particl	Particle Size Distribution	100
Davis Branch &	Reach	Date		5 ≈ 7 4 3%±%.M ily	0.062 0.25		Cumulative % Fine

Material Particle Size (mm) Count % in Range % Cumul Silt/Clay <0.062 0 0 0 Very Fine Sand 0.062-0.125 0 0 0 Fine Sand 0.125-0.25 0 0 0		1000	- C		
					Reach
Silt/Clay Very Fine Sand Fine Sand	Particle Size (mm)	Count	% in Range	% Cumulative	Date
Very Fine Sand Fine Sand	<0.062	0	0	0	
Fine Sand	0.062-0.125	0	0	0	
	0.125-0.25	0	0	0	25
Medium Sand	0.25-0.5	0	0	0	20
Coarse Sand	0.5-1.0	0	0	0	
Very Coarse Sand	1.0-2.0	0	0	0	nng&
Very Fine Gravel	2.0-4.0	3	5	5	s E ni
Fine Gravel	4.0-5.7	1	2	9	96
Fine Gravel	5.7-8.0	2	3	01)
Medium Gravel	8.0-11.3	1	2	11	0 6500
Medium Gravel	11.3-16.0	3	5	16	0.002 0.23
Coarse Gravel	16.0-22.6	3	5	21	
Coarse Gravel	22.6-32	%	13	33	
Very Coarse Gravel	32-45	4	9	40	100
Very Coarse Gravel	45-64	1	2	41	06
Small Cobble	64-90	4	9	48	- 08
Small Cobble	90-128	œ	13	09	9 Jo
Large Cobble	128-180	13	21	81	ni¶ %
Large Cobble	180-256	4	9	87	Vive %
Small Boulder	256-362	2	3	06	elum 04
Small Boulder	362-512	1	2	92	30 Cm
Medium Boulder	512-1024	0	0	92	20
Large Boulder	1024-2048	0	0	92	10
Bedrock	>2048	5	8	100	0.1
Totals		63	100	100	

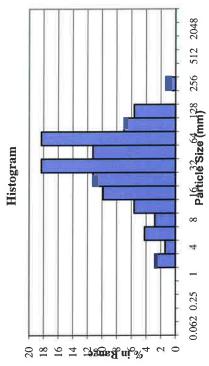
Davis Branch	Davis Branch & Unnamed Tributary - EEP Project No. D06054-F	- EEP Project No.	. D06054-F
Reach	Mainstem	X Sec	7
Date	04/08/2009	Sta No.	35+33.67

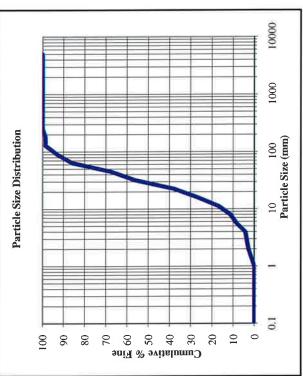




Particle Distribu	Particle Distribution - Riffle XS-8: Sta. $2+00.10 \text{ (D50} = 28.8 \text{ mm; D84} = 62.0 \text{ mm})$	2+00.10 (D50	= 28.8 mm; D84	= 62.0 mm)	Davis Branc
Material	Particle Size (mm)	Count	% in Range	% Cumulative	Reach
Silt/Clay	<0.062	0	0	0	Date
Very Fine Sand	0.062-0.125	0	0	0	j.
Fine Sand	0.125-0.25	0	0	0	00
Medium Sand	0.25-0.5	0	0	0	18
Coarse Sand	0.5-1.0	0	0	0	16
Very Coarse Sand	1.0-2.0	2	3	3	. 3s
Very Fine Gravel	2.0-4.0	1	1	4	Ran
Fine Gravel	4.0-5.7	3	4	8	uj.%
Fine Gravel	5.7-8.0	2	3	111	4 6
Medium Gravel	8.0-11.3	4	9	17	0
Medium Gravel	11.3-16.0	7	10	27	0.062 0.
Coarse Gravel	16.0-22.6	8	11	38	
Coarse Gravel	22.6-32	13	18	56	
Very Coarse Gravel	32-45	8	11	89	<u> </u>
Very Coarse Gravel	45-64	13	18	98	8 8
Small Cobble	64-90	2	7	93	08
Small Cobble	90-128	4	9	66	- 0 <i>L</i> "
Large Cobble	128-180	0	0	66	Fine 6
Large Cobble	180-256	1	1	100	% 9vi
Small Boulder	256-362	0	0	100	tislun 6
Small Boulder	362-512	0	0	100	Cun ⊗ ⊗
Medium Boulder	512-1024	0	0	100	20
Large Boulder	1024-2048	0	0	100	10
Bedrock	>2048	0	0	100	0.1
Totals	als	71	100	100	

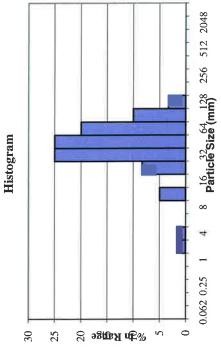
Davis Branch	Davis Branch & Unnamed Tributary - EEP Project No. D06054-F	- EEP Project No.	. D06054-F
Reach	UT-1	X Sec	8
Date	04/08/2009	Sta No.	2+00.10

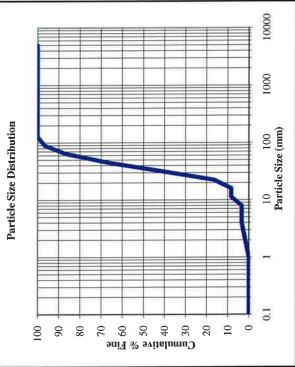




Particle Distrib	Particle Distribution - Riffle XS-9; Sta. 5+84.56 (D50 = 38.5 mm; D84 = 91.0 mm)	. 5+84.56 (D	50 = 38.5 mm; D	84 = 91.0 mm)	Davis Branch	Davis Branch & Unnamed Tributa
Material	Particle Size (mm)	Count	% in Range	% Cumulative	Reach	UT-1
Silt/Clay	<0.062	0	0	0	Date	04/08/2009
Very Fine Sand	0.062-0.125	0	0	0		
Fine Sand	0.125-0.25	0	0	0	30	His
Medium Sand	0.25-0.5	0	0	0	OC :	
Coarse Sand	0.5-1.0	0	0	0	25	
Very Coarse Sand	1.0-2.0	1	2	2	£ 50	
Very Fine Gravel	2.0-4.0	3	5	9	इक्तस्थ	
Fine Gravel	4.0-5.7	0	0	9	uP%	
Fine Gravel	5.7-8.0	7	11	18	% ·~	
Medium Gravel	8.0-11.3	9	10	27		
Medium Gravel	11.3-16.0	4	9	34	0.062 0.25	1 4 8 16
Coarse Gravel	16.0-22.6	2	3	37		-
Coarse Gravel	22.6-32	5	8	45		Particle Size
Very Coarse Gravel	32-45	9	10	55	001	
Very Coarse Gravel	45-64	13	21	92	06	
Small Cobble	64-90	5	8	84	08	
Small Cobble	90-128	3	5	68	6 70	
Large Cobble	128-180	7	11	100	ni'I &	
Large Cobble	180-256	0	0	100	S svil	
Small Boulder	256-362	0	0	100		
Small Boulder	362-512	0	0	100		
Medium Boulder	512-1024	0	0	100	707	
Large Boulder	1024-2048	0	0	100		
Bedrock	>2048	0	0	100	0.1	1 10
Tot	Totals	62	100	100		Partic

Davis Branch &	Davis Branch & Unnamed Tributary - EEP Project No. D06054-F	- EEP Project No.	D06054-F	
Reach	UT-1	X Sec	6	
Date	04/08/2009	Sta No.	5+84.56	





ECOSYSTEM ENHANCEMENT PROGRAM Mitigation Plan – Davis Branch and Unnamed Tributary EEP Contract # D06054-F

Appendix D

Supporting Documentation

Worksheet 5-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream:	Davis Branch Mainstem Restoration Reach - "As-Built"		
Basin:	Yadkin - PeeDee River Drainage Area: 116.67 acres	0.1823	mi ²
Location:	Eddie Staton Property, 7.8 mi. NNE from Marshville, NC		
Twp.&Rge:	; Sec.&Qtr.: ;		
Cross-Sect	tion Monuments (Lat./Long.): 35.08722 Lat / 80.32286 Long	Date	: 05/05/09
Observers:	M. Hebert, PE, J. Hines, PE & W. Knotts, PG	Valley Type	: VIII
	Bankfull WIDTH (W _{bkf})		7
	WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	13.38	ft
	Bankfull DEPTH (d _{bkf})	/	1
	Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a		
	riffle section ($d_{bkf} = A / W_{bkf}$).	0.75	_ft
	Bankfull X-Section AREA (Abkf)		7
	AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	9.98	ft ²
	Width/Depth Ratio (W _{bkf} / d _{bkf})		7
	Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	17.84	ft/ft
	Maximum DEPTH (d _{mbkf}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	1.62	ft
	WIDTH of Flood-Prone Area (W _{fpa})		1
	Twice maximum DEPTH, or $(2 \times d_{mbxl})$ = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	63.06	ft
	Entrenchment Ratio (ER)		1
	The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa}/W_{bkf}) (riffle section).	4.71	ft/ft
	Channel Materials (Particle Size Index) D ₅₀		1
	The D ₅₀ particle size index represents the mean diameter of channel materials, as		
	sampled from the channel surface, between the bankfull stage and Thalweg elevations.	22.2	
	MINISTER STATE OF THE STATE OF	33.3]mm
	Water Surface SLOPE (S)		1
	Channel slope = "rise over run" for a reach approximately 20–30 bankfull channel widths in length, with the "riffle-to-riffle" water surface slope representing the gradient at bankfull stage.	Validado Nacional (18)	nanite:
		0.01304]ft/ft
	Channel SINUOSITY (k) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL / VL); or estimated from a ratio of valley slope divided by channel slope (VS / S).		
ļ	orialine stype (VO / O).	1.29	1
	Stream Type C 4/1 (See Figure 2-	14)	

Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2005).

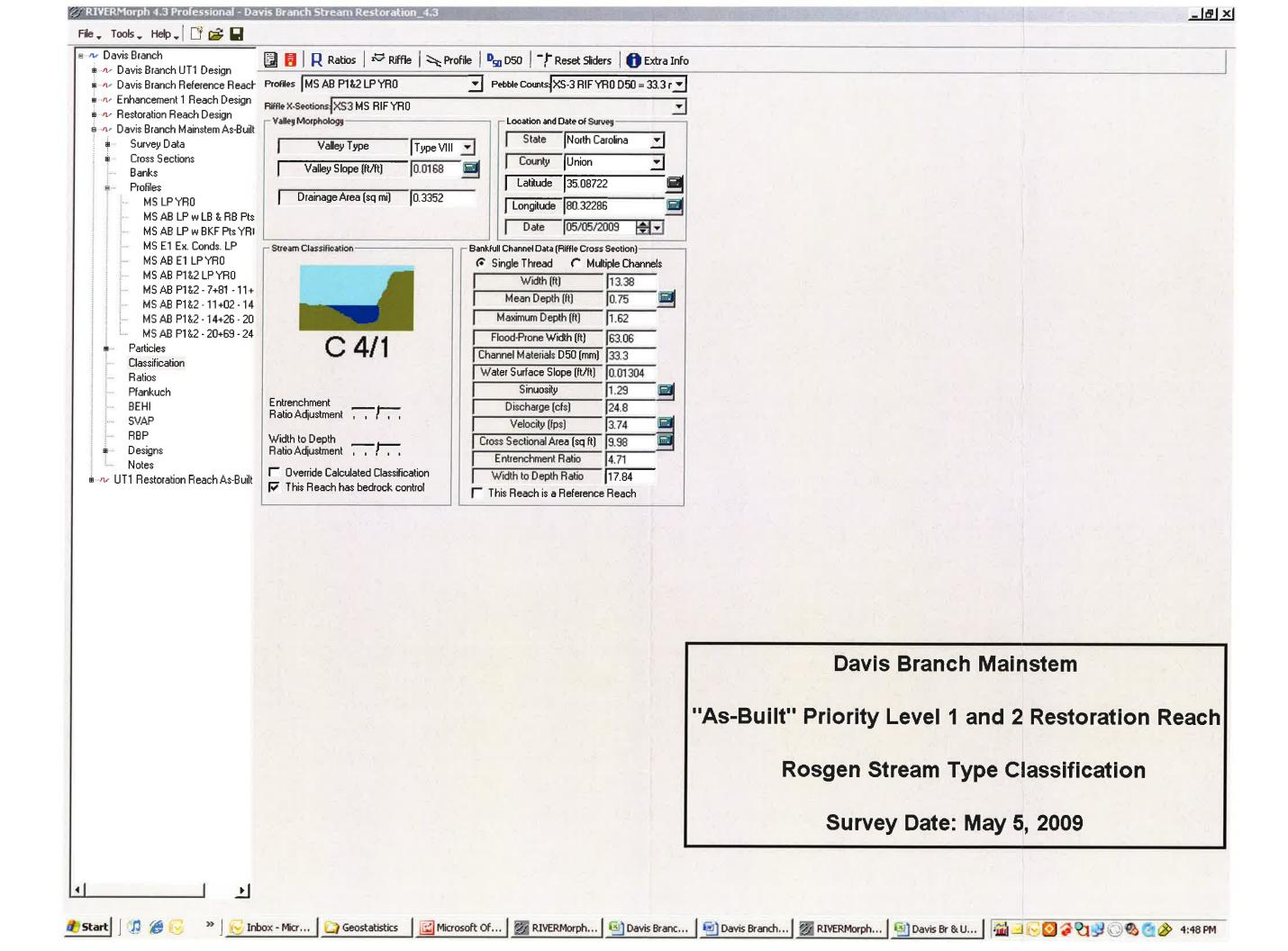
_	eam: Davis Branch Mainst									perty, 7.8 n				
Ob	servers: M. Hebert, PE, J. Hin	es, PE &	W. Knot	ts, PG	Date	- 1000 a 20	5/5/2009	Garage and	alley Typ	e: VIII	Strea	m Type:	C 4/1	200
_	[1001		To.		_	ummary [In.	Diffic Assoc	(A)			12
	Mean Riffle Depth (d _{bkt})		0.6	ft	Riffle Wid	CONTRACTOR OF	_	11.28	_	Riffle Area			0	ft ²
Channel Dimension	Mean Pool Depth (dektp)	m ž lo	0.97	ft	Pool Widt			16.36	ft W _{bkfp}	Pool Area (19	ft ²
ime	Mean Pool Depth/Mean Riffle Dep	μm	1.62	d _{bidp} / d _{bid}	Poor wide	IVAIIIIE	widai		W _{bkf}	1,500,1100,1		<u> </u>		bkf
elD	Max Riffle Depth (d _{maxil})		1.25	ft	Max Pool	Depth (d _{maxp})	2	.22 ft		Depth/Mean F	_	_	2.0
Jann	Max Pool Depth/Mean Riffle Dept	th		3.70	Point Bar	Slope		0.1	ft/ft	Inner Berm	Width (W _b)	1	0	ft
ਹ	Inner Berm Depth (d _b)		0	ft	Inner Bern	n Width	Depth Ration	0	0	W _{ib} /d _{ib} In	ner Berm Are	a (A _b)	0	ft ²
ل	Streamflow: Estimated Mean Velo	ocity at Ba	ankfull Stag	je (u _{bkl})				3.74	ft/s	Estimation	Method	Man	ning's	_
	Streamflow: Estimated Discharge	at Bankfu	ull Stage (C	Q _{bkf})				24.8	cfs	Drainage A	rea	0.3	352	mi ²
	Geometry		Mean	Min	Max			Dimens	ionless C	Seometry Rat	ios	Mean	Min	Max
Pattern	Meander Wavelength (L _m)		77.76	49.94	101.80	ft	Meander	Length R	atio (L _m /W	/ _{bkf})		6.89	4.43	9.0
Pat	Radius of Curvature (R _c)		19.70	10.65	35.00	ft	Radius of	Curvatur	e/Riffle W	ridth (R _c /W _{bkf})		1.75	0.94	3.1
Channel	Belt Width (W _{bk})		50.00	50.00	50.00	ft	Meander	Width Ra	tio (W _{bb} /V	V _{bkf})		4.43	4.43	4.4
Shar	Individual Pool Length		24.47	11.47	42.63	ft	Pool Leng	th/Riffle	Width			2.17	1.02	3.7
	Pool to Pool Spacing		40.33	16.80	79.78	ft	Pool to Po	ool Spaci	ng/Riffle V	Vidth		3.58	1.49	7.0
	Riffle Length		12.55	7.05	34.47	ft	Riffle Len	gth/Riffle	Width			1.11	0.63	3.0
	Valley Slope (VS)	0.01	1600	ft/ft	I								_	
		16.65	1000	iivit	Average v	Vater S	urface Slope	e (S)	0.0	01304 ft/ft	Sinuosity	(VS/S)		1.29
	Stream Length (SL)	100.000	799	ft	Valley Len			e (S)		01304 ft/ft 1397 ft	Sinuosity	*1 (2-c) (-2)		100000
	Stream Length (SL) Low Bank Height (LBH)	100.000	0.92		Valley Len)	start 0	.92 ft	1397 ft Bank-H	100000000000000000000000000000000000000	(SL/VL)	start	
le	Low Bank Height	17 start	799 0.92	ft ft	Valley Len	igth (VL) e	start 0	92 ft 63 ft	1397 ft Bank-H	Sinuosity eight Ratio (B	(SL/VL)		1.2
Profile	Low Bank Height (LBH)	17 start	0.92 1.63	ft ft	Valley Len	igth (VL) e	start 0 end 1	.92 ft .63 ft	1397 ft Bank-H (LBH/N	Sinuosity eight Ratio (B Max Riffle Dep	(SL/VL) HR) oth)	end Min	1.2 1 1 Max
	Low Bank Height (LBH) Facet Slopes	17 start	0.92 1.63 Mean	ft ft Min	Valley Len	ngth (VL lax Riffl Depth	e Riffle Slop	start 0 end 1	.92 ft .63 ft onless Sk	Bank-H (LBH/N	Sinuosity eight Ratio (B Max Riffle Dep (S _{rif} / S)	(SL/VL) HR) oth)	end Min	1.2 1 1 Max
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rt})	17 start	0.92 1.63 Mean	ft ft Min	Valley Len	igth (VL lax Riffl Depth	Riffle Slop	start 0 1 1 Dimensione/Average	92 ft 63 ft onless Sid ge Water S	Bank-H (LBH/N Ope Ratios Surface Slope	Sinuosity eight Ratio (B Max Riffle Dep (S _{rif} / S) S _{run} / S)	(SL/VL) HR) oth)	Min 2.152	1.21 1 1 Mar 5.72
Channel Profile	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rth}) Run Stope (S _{rtn})	17 start	0.92 1.63 Mean 0.0482	ft ft ft Min 0.0281	Max 0.0747	agth (VL lax Riffi Depth ft/ft	Riffle Slope Run Slope Poel Slop	start 0 1 1 Dimension of Average e/Average	.92 ft .63 ft penless Slo ge Water S e Water S	Bank-H (LBH/N ope Ratios Surface Slope (Sinusity eight Ratio (B Aax Riffle Dep (S rif / S) S run / S) (S p / S)	(SL/VL) HR) oth) Mean 3.698	Min 2.152	1.29 1 1 Max 5.72
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rin}) Run Slope (S _{run}) Pool Slope (S _p)	17 start	0.92 1.63 Mean 0.0482	ft ft ft Min 0.0281	Max 0.0747	gth (VL lax Riffi Depth ft/ft ft/ft ft/ft	Riffle Slope Run Slope Pool Slop Glide Slop	start 0 end 1. Dimensione/Average e/Average e/Average pe/Average	92 ft ft ft somes Sign Water Sign	Bank-H (LBH/N ope Ratios Surface Slope Gurface Slope Surface Slope Surface Slope	Sinuosity eight Ratio (B flax Riffle Dep (S _{rif} / S) S _{run} / S) (S _p / S) (S _g / S)	(SL/VL) HR) oth) Mean 3.698 0.163	end Min 2.152 0.000	1.29 1 1 1 5.72 0.40
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rit}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint ^a Max Riffle Depth (d _{maxri})	17 start	0.92 1.63 Mean 0.0482	ft ft ft Min 0.0281	Max 0.0747	agth (VL lax Riffil Depth ft/ft ft/ft ft/ft	Riffle Slope Run Slope Pool Slop Glide Slop	start 0 1 Dimension	92 ft	Bank-H (LBH/N DOPE Ratios Surface Slope (Surface Slope (Surface Slope (Surface Slope (Depth (d _{max})	Sinuosity Sinuosity Sinuosity Sinuosity Sinuo (Bit Aatio (Bit	(SL/VL) HR) oth) Mean 3.698 0.163	end Min 2.152 0.000	1.29 1 1 1 5.72 0.40
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rtn}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint ^a	17 start	0.92 1.63 Mean 0.0482 0.0021	ft ft ft Min 0.0281 0.0000	Max 0.0747 0.0052 Max	gth (VL lax Riffi Depth ft/ft ft/ft ft/ft	Riffle Slop Run Slope Pool Slop Glide Slop Max Riffle Max Run I	start 0 end 1. Dimension e/Average e/Average e/Average pe/Average Dimension Depth/Me	92 ft	Bank-H (LBH/N Depe Ratios Surface Slope Gurface Slope Surface Slope Surface Slope Depth (d _{maxru} Depth (d _{maxru}	Sinuosity eight Ratio (B flax Riffle Dep (S _{rit} / S) S _{run} / S) (S _p / S) (S _g / S) / d _{bkf})	(SL/VL) HR) oth) Mean 3.698 0.163	90000000000000000000000000000000000000	1.29 1 1 1 5.72 0.40
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rit}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint ^a Max Riffle Depth (d _{maxri})	17 start	0.92 1.63 Mean 0.0482 0.0021	ft ft ft Min 0.0281 0.0000	Max 0.0747 0.0052 Max	agth (VL lax Riffil Depth ft/ft ft/ft ft/ft	Riffle Slop Run Slope Pool Slop Glide Slop Max Riffle Max Run I	start 0 end 1. Dimension e/Average e/Average e/Average pe/Average Dimension Depth/Me	92 ft	Bank-H (LBH/N DOPE Ratios Surface Slope (Surface Slope (Surface Slope (Surface Slope (Depth (d _{max})	Sinuosity eight Ratio (B flax Riffle Dep (S _{rit} / S) S _{run} / S) (S _p / S) (S _g / S) / d _{bkf})	(SL/VL) HR) oth) Mean 3.698 0.163	end Min 2.152 0.000	1.29 1 1 Max 5.72
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rit}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxru}) Max Run Depth (d _{maxru})	17 start	0.92 1.63 Mean 0.0482 0.0021 Mean 1.25	ft ft ft ft ft 0.0281 0.0000 Min 0.92	Max 0.0747 0.0052 Max 1.63	agth (VL lax Riffli Depth ft/ft ft/ft ft/ft ft ft	Riffle Slop Run Slope Pool Slop Glide Slop Max Riffle Max Run I Max Pool	start 0 end 1 Dimension Dimension Dimension Dimension Dimension Dimension Dimension Depth/Me	92 ft	Bank-H (LBH/N Depe Ratios Surface Slope Gurface Slope Surface Slope Surface Slope Depth (d _{maxru} Depth (d _{maxru}	Sinuosity eight Patio (B Aax Riffle Dep (Srif / S) Srun / S) (Sp / S) (Sg / S) (dbkf) dbkf)	(SL/VL) HR) oth) Mean 3.698 0.163 Mean 2.08	90000000000000000000000000000000000000	1.2 1 1 Maa 5.72 0.40 Maa
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rin}) Run Slope (S _p) Glide Slope (S _p) Glide Slope (S _p) Feature Midpoint ^a Max Riffle Depth (d _{maxel}) Max Run Depth (d _{maxel}) Max Pool Depth (d _{maxep})	start end	0.92 1.63 Mean 0.0482 0.0021 Mean 1.25	ft ft ft ft Min 0.0281 0.0000 Min 0.92	Max 0.0747 0.0052 Max 1.63	egth (VL	Riffle Slop Run Slope Pool Slop Glide Slop Max Riffle Max Run I Max Pool	start 0 end 1 Dimension e/Average e/Average e/Average Dimension Depth/Me Depth/Me Depth/Me	92 ft ft ft some some some some some some some some	Bank-H (LBH/N pope Ratios Surface Slope Gurface Slope Surface Slope Surface Slope Depth (d _{maxri} Depth (d _{maxri} Depth (d _{maxri}	Sinuosity eight Patio (B Aax Riffle Dep (Srif / S) Srun / S) (Sp / S) (Sg / S) (dbkf) dbkf)	(SL/VL) HR) oth) Mean 3.698 0.163 Mean 2.08 3.7	90000000000000000000000000000000000000	1.25 1 1 1 1 Max 5.72 0.40 Max 2.77
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rin}) Run Slope (S _p) Glide Slope (S _p) Glide Slope (S _p) Feature Midpoint ^a Max Riffle Depth (d _{maxel}) Max Run Depth (d _{maxel}) Max Pool Depth (d _{maxep})	start end	0.92 1.63 Mean 0.0482 0.0021 Mean 1.25	ft f	Max 0.0747 0.0052 Max 1.63	egth (VL	Riffle Slope Run Slope Pool Slop Glide Slop Max Riffle Max Run I Max Pool Max Glide Bar	start 0 end 1 Dimension e/Average e/Average e/Average Dimension Depth/Me Depth/Me Depth/Me	92 ft	Bank-H (LBH/N Depe Ratios Surface Slope Urface Slope Surface Slope Depth Ratios Depth (d _{maxr}) Depth (d _{maxr}) Depth (d _{maxr})	Sinuosity eight Patio (B Aax Riffle Dep (Srif / S) Srum / S) (Sp / S) (Sp / S) (Sg / S) / dbkl) / dbkl) / dbkl)	(SL/VL) HR) oth) Mean 3.698 0.163 Mean 2.08	90000000000000000000000000000000000000	1.22 1 1 1 Max 5.72 0.40 Max 2.77
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rit}) Run Slope (S _{rit}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint ^a Max Riffle Depth (d _{maxrl}) Max Run Depth (d _{maxrl}) Max Pool Depth (d _{maxrl}) Max Glide Depth (d _{maxg})	start end	0.92 1.63 Mean 0.0482 0.0021 Mean 1.25	ft ft ft ft Min 0.0281 0.0000 Min 0.92	Max 0.0747 0.0052 Max 1.63 3.11	egth (VL	Riffle Slope Run Slope Pool Slop Glide Slop Max Riffle Max Run I Max Pool Max Glide Bar	start 0 end 1 Dimension Dimension Dimension Dimension Dimension Dimension Depth/Me Depth/Me Depth/Me	92 ft tonless Side Water Side Wat	Bank-H (LBH/N Deperment of the control of the cont	Sinuosity eight Patio (B Aax Riffle Dep (Srif / S) Srum / S) (Sp / S) (Sp / S) (Sg / S) / dbkl) / dbkl) / dbkl)	Mean 3.698 0.163 Mean 2.08 3.7	end Min 2.152 0.000 Min 1.53 2.9	1.22 1 1 1 Ma: 5.72 0.40 Ma: 2.77
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rit}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxen}) Max Run Depth (d _{maxen}) Max Pool Depth (d _{maxen}) Max Glide Depth (d _{maxen}) Max Glide Depth (d _{maxen})	start end	0.92 1.63 Mean 0.0482 0.0021 Mean 1.25	Min 0.0281 0.0000 Min 0.92 1.74	Max 0.0747 0.0052 Max 1.63 3.11	egth (VL	Riffle Slope Run Slope Pool Slop Glide Slop Max Riffle Max Run I Max Pool Max Glide Bar	start 0 end 1 Dimension De/Average De/Average De/Average De/Average De/Average De/Average De/Average De/Average De/Average Depth/Me Depth/Me Depth/Me	92 ft 63 ft conless Siege Water Siege Wate	Bank-H (LBH/N Depe Ratios Surface Slope (Gurface Slope Surface Slope Depth (dmax)	Sinuosity eight Patio (B Aax Riffle Dep (Srif / S) Srum / S) (Sp / S) (Sp / S) (Sg / S) / dbkl) / dbkl) / dbkl)	(SL/VL) HR) oth) Mean 3.698 0.163 Mean 2.08 3.7	0.000 Min 1.53 2.9	1.2 1 1 1 Maa 5.72 0.40 Ma 2.7
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rth}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrd}) Max Run Depth (d _{maxrd}) Max Pool Depth (d _{maxrd}) Max Glide Depth (d _{maxrd}) Max Glide Depth (d _{maxrd}) % Silt/Clay % Sand	start end	0.92 1.63 Mean 0.0482 0.0021 Mean 1.25	Min 0.0281 0.0000 Min 0.92 1.74	Max 0.0747 0.0052 Max 1.63 3.11 fftec 0 .67	egth (VL	Riffle Slope Run Slope Pool Slop Glide Slop Max Riffle Max Run I Max Pool Max Glide Bar	start 0 end 1 Dimensione/Average e/Average e/Average Dimensione Depth/Me Depth/Me Depth/Me Depth/Me Depth/Me	92 ft ft ft some some some some some some some some	Bank-H (LBH/N pope Ratios Surface Slope urface Slope Surface Slope Surface Slope Depth (d _{maxi}	Sinuosity eight Patio (B Aax Riffle Dep (Srif / S) Srum / S) (Sp / S) (Sp / S) (Sg / S) / dbkl) / dbkl) / dbkl)	(SL/VL) HR) oth) Mean 3.698 0.163 Mean 2.08 3.7 Protru	0.000 Min 1.53 2.9	1.2 1 1 1 Max 5.72 0.40 Max 2.7 5.11
Channel Materials Channel Profile	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rit}) Run Slope (S _p) Glide Slope (S _p) Glide Slope (S _p) Feature Midpoint a Max Riffle Depth (d _{maxra}) Max Run Depth (d _{maxru}) Max Pool Depth (d _{maxru}) Max Glide Depth (d _{maxq}) Max Glide Depth (d _{maxq}) % Silt/Clay % Sand % Gravel	Start end Rea	0.92 1.63 Mean 0.0482 0.0021 Mean 1.25 2.22	Min 0.0281 0.0000 Min 0.92 1.74 Ri	Max 0.0747 0.0052 Max 1.63 3.11 Max 67 85	egth (VL	Riffle Slope Run Slope Pool Slop Glide Slop Max Riffle Max Run I Max Pool Max Glide Bar	start 0 end 1 Dimension De/Average De/Average De/Average De/Average De/Average De/Average De/Average De/Average De/Average Depth/Me Depth/Me Depth/Me Depth/Me Depth/Me Depth/Me	92 ft	Bank-H (LBH/N pope Ratios Surface Slope urface Slope Surface Slope Depth Ratios Depth (d _{maxr}	Sinuosity eight Patio (B Aax Riffle Dep (Srif / S) Srum / S) (Sp / S) (Sp / S) (Sg / S) / dbkl) / dbkl) / dbkl)	(SL/VL) HR) oth) Mean 3.698 0.163 Mean 2.08 3.7	Min 1.53 2.9 2.9	1.2 1 1 1 1 5.72 0.40 Maa 2.77 5.11 inm mm

Min, max, mean depths are ave. mid-point values except pools: taken at deepest part of pool.

^b Composite sample of riffles and pools within the designated reach.

^d Active bed of a riffle.

d Height of roughness feature above bed.



Abkf = 9.98

Wbkf = 13.4

463

464

462

461

(ff) noitsvel3

C Ground Points

100

90

80

25

455

456

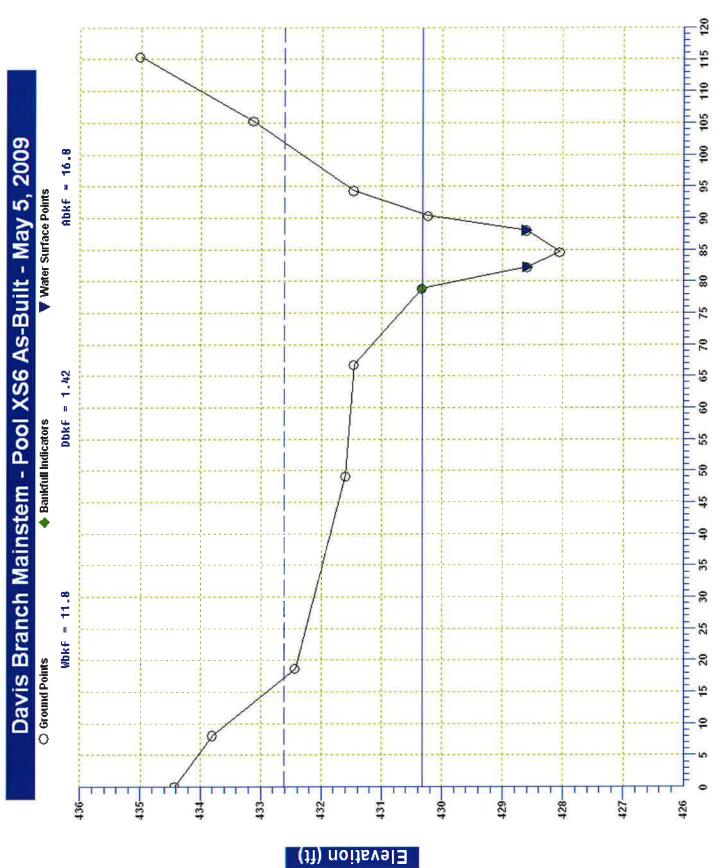
457

Elevation (ft)

448

438

105



Horizontal Distance (ff)

XS1 RIF YRO.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Davis Branch
Reach Name: Davis Branch Mainstem As-Built
Cross Section Name: XS1 MS RIF YR0

Survey Date: 05/05/2009

Cross Section Data Entry

BM Elevation: 0 ft Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	472.3	left mon 1
13.45	0	471.9	FP
34.68		470.85	FP
46.13	0	471.26	FP
66.56		470.6	FP
81.21	0	470.37	LB
86.94		469.3	TWO.00 r
91.45	0	470.17	BKF RB
103.51	0	469.88	FP
111.75		469.96	right mon 2
122.12	0	469.55	FP
137.21		469.58	FP
149.82	0	469.42	FP
156.53		469.5	FP

Cross Sectional Geometry

Floodprone Elevation (ft) Bankfull Elevation (ft) Floodprone Width (ft)	Channel 471.04 470.17 112.74	Left 471.04 470.17	Right 471.04 470.17
Bankfull Width (ft) Entrenchment Ratio	9.17 12.3	4.59	4.58
Mean Depth (ft)	0.44	0.43	0.44
Maximum Depth (ft) Width/Depth Ratio	0.87 20.84	0.86 10.67	0.87 10.41
Bankfull Area (sq ft) Wetted Perimeter (ft)	3.99 9.33	1.97 5.53	2.02 5.52
Hydraulic Radius (ft)	0.43 Page 1	0.36	0.37

Begin BKF Station End BKF Station	(S1 RIF YRO) 82.28 91.45		86.87 91.45
Entrainment Calculations			
Entrainment Formula: Rosge	en Modified	Shields Cur	ve
Slope Shear Stress (lb/sq ft) Movable Particle (mm)	Channel 0.00828 0.22 50.3	Left Side 0	Right Side O

XS2 POOL YR0.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Davis Branch
Reach Name: Davis Branch Mainstem As-Built
Cross Section Name: XS2 MS POOL YR0

Survey Date: 05/05/2009

Cross Section Data Entry

BM Elevation: 0 ft Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
1APE 0 20.05 35.62 54.17 60.06 65.9 78.97	0 0 0 0 0 0 0	470.9 470.45 469.93 469.95 467.84 470.1 469.94	left mon 1 FP FP BKF LB TW0.00 p RB FP
87.38 91.34 122.12 137.21 149.82 156.53	0 0 0 0 0	469.64 469.96 469.55 469.58 469.42 469.5	FP right mon 2 FP FP FP FP

Cross Sectional Geometry

Channel Left Right
472.06 472.06 472.06
469.95 469.95 469.95
156.53 ---- --11.34 5.67 5.67
13.8 ----Floodprone Elevation (ft)
Bankfull Elevation (ft) Floodprone Width (ft) Bankfull Width (ft) Entrenchment Ratio 13.8 ----- 1.09

Mean Depth (ft) 1.06 1.02 1.09

Maximum Depth (ft) 2.11 2.03 2.11

Width/Depth Ratio 10.7 5.56 5.2

Bankfull Area (sq ft) 11.97 5.76 6.21

Wetted Perimeter (ft) 12.1 8.05 8.11

Hydraulic Radius (ft) 0.99 0.71 0.77

Begin BKF Station 54.17 59.84

End BKF Station	65.51		65.51
Entrainment Calculations			
Entrainment Formula: Rosg	en Modified	Shields Cur	ve
Slope Shear Stress (lb/sq ft) Movable Particle (mm)	Channel 0.00828 0.51 92.8	Left Side O	Right Side O

XS3 RIF YRO.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built Cross Section Name: XS3 MS RIF YR0 Survey Date: 05/05/2009 Cross Section Data Entry 0 ft BM Elevation: Backsight Rod Reading: 0 ft ELEV NOTE FS le: FP left mon 1 462.49 462.49 461.18 460.16 459.63 458.89 457.37 459.08 459.37 19.15 31.16 0 0 FP BKF LB TW0.00 r BKF RB FP 40.24 0 0 46.8 53.15 0 58.97 0 72.67 0 CL FP CH 0 82.7 459.46 FP 461.19 FP 462.17 right mon 2 85.86 0 90.47 93.54 Cross Sectional Geometry Floodprone Elevation (ft) 460.61 460.61 460.61

Bankfull Elevation (ft) 458.99 458.99

Floodprone Width (ft) 63.06 ----
Bankfull Width (ft) 13.38 6.98 29.94

Entrenchment Ratio 4.71 ----
Mean Depth (ft) 0.75 0.73 0.76

Maximum Depth (ft) 1.62 1.56 1.62

Width/Depth Ratio 17.84 9.56 39.39

Bankfull Area (sq ft) 9.98 5.09 4.89

Wetted Perimeter (ft) 13.8 8.71 8.2

Hydraulic Radius (ft) 0.72 0.58

Begin BKF Station 45.91 52.89

End BKF Station 82.83 52.89

Page 1

XS3 RIF YR0.txt

Entrainment Calculations				
	· 			
Entrainment Formula: Rosg	en Modified	l Shields Cur	ve	
Slope Shear Stress (lb/sq ft) Movable Particle (mm)	Channel 0.01917 0.86 136.2	Left Side O	Right Side O	

XS4 POOL YR0.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Reach Name: Cross Section Name Survey Date:	: XS4 MS PC	anch Mains	stem As-Bu	ilt
 Cross Section Data	Entry			
BM Elevation: Backsight Rod Read	ling:	0 ft 0 ft		
TAPE FS		ELEV	NO:	TE
0 0 16.6 0 28.75 0 40.36 0 46.81 0 51.68 0 62.63 0 77.21 0 86.13 0		462.25 461.15 459.82 459.04 456.44 457.8 458.68 458.83 460.94 462.17	FP FP LB TW RB BK FP FP	0.00 p F
Cross Sectional Ge	ometry			
Floodprone Elevation Bankfull Elevation Floodprone Width (Bankfull Width (ft) Entrenchment Ratio Mean Depth (ft) Maximum Depth (ft) Width/Depth Ratio Bankfull Area (sq Wetted Perimeter (Hydraulic Radius (Begin BKF Station End BKF Station	on (ft) 46 (ft) 45 (ft) 67 (ft) 21 (ft) 18 (ft) 22 (ft) 0.	nannel 50.92 58.68 7.34 1.38 .15 .87 .24 4.57 8.64 2.03 .85	Left 460.92 458.68 10.69 1.31 2.24 8.16 14.05 12.17 1.15 41.25 51.94	Right 460.92 458.68 10.69 0.43 0.86 24.86 4.59 11.58 0.4 51.94 62.63

XS4 POOL YR0.txt

Entrainment	Calculations
half-may-she-ye-she-the-	

Entrainment Formula: Rosgen Modified Shields Curve

Slope Shear Stress (lb/sq ft) Movable Particle (mm)	Channel 0.01917 1.02 153.9	0	Right Side 0
---	-------------------------------------	---	-----------------

XS5 RIF YRO.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Davis Branch
Reach Name: Davis Branch Mainstem As-Built Cross Section Name: XS5 MS RIF YR0 Survey Date: 05/05/2009 _____ Cross Section Data Entry 0 ft BM Elevation: BM Elevation: 0 ft Backsight Rod Reading: 0 ft ELEV NOTE FS left mon 1 447.11 0 5.72 20.8 445.06 0 0 443.92 FP 442.28 441.92 442.43 442.25 FP 33.64 0 CL 0 40.92 FP 0 49.82 BKF LB 0 63.64 441.59 69.91 0 SB TW0.00 r 441.03 74.95 0 0 441.79 SB 78.38 81.02 442.25 0 RB 444.34 FP 447.91 right mon 2 93.02 0 105.71 Cross Sectional Geometry

End BKF Station

XS5 RIF YR0.txt
81.02

73.69

81.02

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

Channel Left Side Right Side
0.02122
0
Shear Stress (lb/sq ft)
Movable Particle (mm)

126.8

XS6 POOL YR0.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built Cross Section Name: XS6 MS POOL YR0 Survey Date: 05/05/2009				
Cross Section Data Entry				=:=::
BM Elevation: Backsight Rod Reading:	0 ft 0 ft			
TAPE FS	ELEV	NC	OTE	
0 0 8.14 0 18.69 0 49.18 0 66.82 0 78.86 0 82.21 0 84.61 0 88.02 0 90.35 0 94.33 0 105.28 0 115.44 0	434.42 433.79 432.43 431.6 431.46 430.33 428.58 428.05 428.6 430.23 431.47 433.13 435.01	FF FF FF BK LE TW RE FF FF	F LB W O.59 p	
Cross Sectional Geometry				
Floodprone Elevation (ft) Bankfull Elevation (ft) Floodprone Width (ft) Bankfull Width (ft) Entrenchment Ratio Mean Depth (ft) Maximum Depth (ft) Width/Depth Ratio Bankfull Area (sq ft) Wetted Perimeter (ft) Hydraulic Radius (ft) Begin BKF Station	Channel 432.61 430.33 84.56 11.81 7.16 1.42 2.28 8.32 16.75 12.87 1.3 78.86 Page 1	Left 432.61 430.33 5.84 1.37 2.28 4.26 7.97 8.59 0.93 78.86	Right 432.61 430.33 5.97 1.47 2.27 4.06 8.78 8.81 1 84.7	

End BKF Station	S6 POOL YR0 90.67	.txt 84.7	90.67
Entrainment Calculations			
Entrainment Formula: Rosgen Modified Shields Curve			
Slope Shear Stress (lb/sq ft) Movable Particle (mm)	Channel 0.02122 1.72 226.7	Left Side O	Right Side O

XS7 RIF YR0.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built Cross Section Name: XS7 MS RIF YR0 Survey Date: 05/05/2009				
 Cross Section Data Entry				
BM Elevation: Backsight Rod Reading:	0 ft 0 ft			
TAPE FS	ELEV	N	IOTE	
0 0 7.3 0 17.55 0 51.03 0 72.96 0 80.98 0 90.13 0 96.21 0 105.25 0	434.42 433.88 432.82 431.29 430.25 430.25 428.94 430.13 431.6 433.75	F F F B T R	eft mon 1 P P P P P P B B B B B B B B B B B B B	
Cross Sectional Geometry				
Floodprone Elevation (ft) Bankfull Elevation (ft) Floodprone Width (ft) Bankfull Width (ft) Entrenchment Ratio Mean Depth (ft) Maximum Depth (ft) Width/Depth Ratio Bankfull Area (sq ft) Wetted Perimeter (ft) Hydraulic Radius (ft) Begin BKF Station End BKF Station	Channel 431.56 430.25 59.88 15.97 3.75 0.65 1.31 24.57 10.38 16.19 0.64 80.98 96.95	Left 431.56 430.25 7.98 0.57 1.14 14 4.56 9.2 0.5 80.98 88.96	Right 431.56 430.25 7.99 0.73 1.31 10.95 5.83 9.27 0.63 88.96 96.95	

XS7 RIF YRO.txt

Entrainment Formula: Rosgen Modified Shields Curve

Channel Left Side Right Side 0.02122 0 0 0

Slope Shear Stress (lb/sq ft) Movable Particle (mm)

XS8 RIF YRO.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Davis Branch
Reach Name: UT1 Restoration Reach As-Built
Cross Section Name: XS8 UT1 RIF YR0 - ROCK SILL Survey Date: 05/05/2009 Cross Section Data Entry BM Elevation: 0 ft Backsight Rod Reading: 0 ft ELEV NOTE FS 0 453.09 left mon 1 10.96 22.47 450.44 0 448.9 0 448.9 447.76 448.16 446.65 445.93 446.88 447.21 FP 33.14 0 FP 45.58 0 FP LB TWO.00 rs 65.8 0 0 70.84 75.3 0 BKF RB FP 81.82 0 446.45 87.37 0 FP 101.9 0 448.4 FP 448.4 FF 452.64 right mon 2 128.24 Cross Sectional Geometry

XS8 RIF YRO.txt

 Entrainment Calculations				
Entrainment Formula: Rosgen Modified Shields Curve				
Slope Shear Stress (lb/sq ft) Movable Particle (mm)	Channel 0.0207 0.56 98.6	Left Side O	Right Side O	

XS9 RIF YRO.txt RIVERMORPH CROSS SECTION SUMMARY

River Name: Davis Reach Name: UT1 Re Cross Section Name: XS9 UT Survey Date: 05/05/	estoration R r1 RIF YRO /2009		
Cross Section Data Entry			
BM Elevation: Backsight Rod Reading:	0 ft 0 ft		
TAPE FS	ELEV		NOTE
0 0 15.31 0 33.7 0 42.02 0 46.26 0 49.69 0 57.25 0 79 0 94.72 0	442.65 440.55 439.29 439.08 438.06 438.77 439.29 439.99 442.78		left mon 1 FP FP BKF LB TW0.00 r RB FP FP right mon 2
Cross Sectional Geometry			
Floodprone Elevation (ft) Bankfull Elevation (ft) Floodprone Width (ft) Bankfull Width (ft) Entrenchment Ratio Mean Depth (ft) Maximum Depth (ft) Width/Depth Ratio Bankfull Area (sq ft) Wetted Perimeter (ft) Hydraulic Radius (ft) Begin BKF Station End BKF Station	Channel 440.1 439.08 57.74 12.18 4.74 0.42 1.02 29 5.14 12.38 0.42 42.02 54.2	Left 440.1 439.08 4.48 0.54 1.02 8.3 2.4 5.58 0.43 42.02 46.5	Right 440.1 439.08 7.7 0.36 0.97 21.39 2.74 8.75 0.31 46.5 54.2

Page 1

XS9 RIF YRO.txt

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0.02021	0	0
	0 53		

Shear Stress (lb/sq ft) 0.53 Movable Particle (mm) 95.3

Worksheet 5-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream:	Davis Branch Mainstem - Enhancement Level 1 Reach "As	-Built"	
Basin:	Yadkin - PeeDee R. Drainage Area: 214.53 acres	0.3352	mi ²
Location:	Eddie Staton Property, 7.8 mi. NNE from Marshville, NC		
Twp.&Rge:	Sec.&Qtr.:;		
Cross-Sect	tion Monuments (Lat./Long.): 35.08931 Lat / 80.32697 Long	Date	: 05/05/0
Observers:	M. Hebert, PE, J. Hines, PE & W. Knotts, PG	Valley Type	: VIII
	Bankfull WIDTH (W _{bkf})		7
	WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	15.97	ft
	Bankfull DEPTH (d _{bkf})		7
	Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a		
	riffle section ($d_{bkf} = A / W_{bkf}$).	0.65	ft
	Bankfull X-Section AREA (A _{bkf})		1
	AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle		
	section.	10.38	ft ²
	Width/Depth Ratio (W _{bkf} / d _{bkf})		1
	Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	24.57	_ft/ft
	Maximum DEPTH (d _{mbkf})		1
	Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.		
	Schildin Stage and Thairing Clevations, in a time Section.	1.31	_ft
	WIDTH of Flood-Prone Area (W _{fpa})		
	Twice maximum DEPTH, or $(2 \times d_{mbkf})$ = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	59.88	ft
		00.00],,,
	Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W _{fpa} / W _{bkf})		
	(riffle section).	3.75	ft/ft
	Channel Materials (Particle Size Index) D ₅₀		1
	The D_{50} particle size index represents the mean diameter of channel materials, as		
	sampled from the channel surface, between the bankfull stage and Thalweg elevations.		
1	oisvations.	63.1	mm
3	Water Surface SLOPE (S)		1
	Channel slope = "rise over run" for a reach approximately 20–30 bankfull channel widths in length, with the "riffle-to-riffle" water surface slope representing the gradient		
	at bankfull stage.	0.02122	ft/ft
1	Charmal CIMILOCITY (IA)		1
	Channel SINUOSITY (k) Sinuosity is an index of channel pattern, determined from a ratio of stream length		
	divided by valley length (SL / VL); or estimated from a ratio of valley slope divided by		
	channel slope (VS / S).	1.06	J
Ì	Stream C 4/1h (See Figure 2)]
	Stream C 4/1b (See Figure 2-	14)	
	77		J

Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2005).

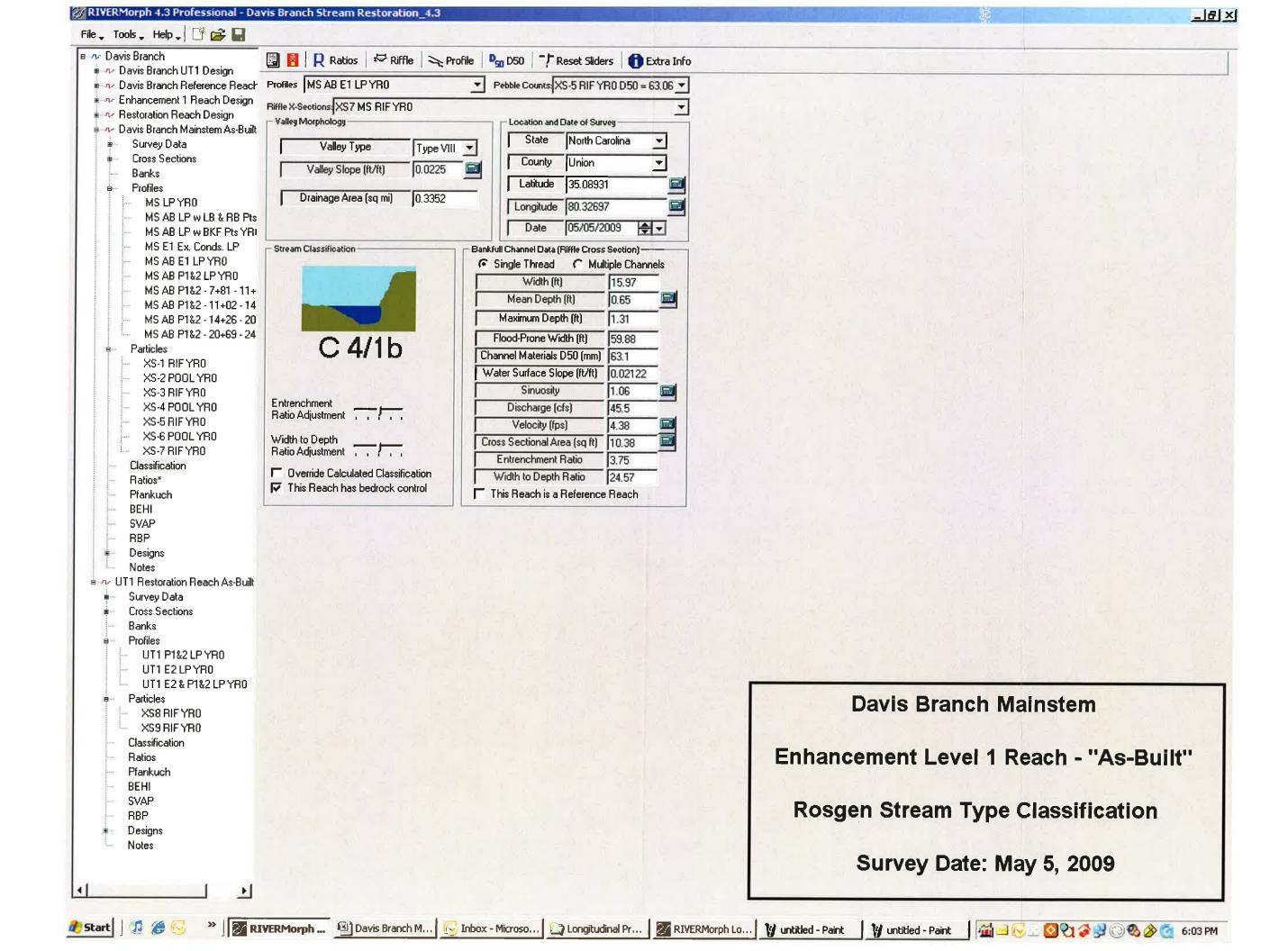
	servers: M. Hebert, PE, J. Hine	s, PE &	W. Kno	tts, PG	Date	: 5/5/2	2009		Valle	y Type:	VIII	Stream	т Туре	: C 4/	1b
					River Re	ach S	ummary	Data					J.		
	Mean Riffle Depth (d _{bkf})		0.62	ft	Riffle Wid	th (W _b	kd)	16	.68	ft	Riffle Area (A	A _{bld})	1	0.3	ft ²
uc	Mean Pool Depth (d _{bkfp})		1.42	ft Pool Width (V			(qt	11	.81	ft	Pool Area (A	чыбр)	16	.75	ft ²
Dimension	Mean Pool Depth/Mean Riffle Dep	oth	2.29	d _{bldp} / d _{bld}	Pool Widt	h/Riffle	Width		0.71	W _{bkfp} / W _{bkf}	Pool Area / F	Riffle Area	1	.62	A _{bkf}
Ö	Max Riffle Depth (d _{maxrif})		1.56	ft	Max Pool	Depth	(d _{maxp})		2.65	ft	Max Riffle De	epth/Mean R	liffle De	pth	2.5
Channel	Max Pool Depth/Mean Riffle Dept	h		4.27	Point Bar	Slope		0	.1	ft/ft	Inner Berm V	Width (W _{ib})		0	ft
ဌ	Inner Berm Depth (d _{ib})		0	ft	Inner Berr	n Widt	th/Depth F	atio		0	W _{tb} /d _{ib} Inne	er Berm Area	a (A _{ib})	0	ft ²
	Streamflow: Estimated Mean Velo	city at Ba	ankfull Sta	age (u _{bkf})				3.	74	ft/s	Estimation M	lethod	Mai	nning's	s Eq
	Streamflow: Estimated Discharge	at Bankf	ull Stage	(Q _{bkf})				24	4.8	cfs	Drainage Are	a	0.3	352	mi ²
	Geometry	= 10 11	Mean	Min	Max		, U	Dim	ensionl	ess Ge	ometry Ratio	os	Mean	Min	Ma
ern	Meander Wavelength (L _m)					ft	Meande		h Ratio						
Pattern	Radius of Curvature (R _c)					ft	Radius	of Curv	ature/Ri	ffle Wic	th (R _c /W _{bkf})				
	Belt Width (W _{bit})		50	50	50	ft	Meande	r Width	Ratio (W _{bb} /W _b	at)		3.00	3.00	3.0
Channel	Individual Pool Length		29.52	9.5	50.09	ft	Pool Le	ngth/Rif	h/Riffle Width				1.77	0.57	3.0
٥	Pool to Pool Spacing		63.42	28.32	109.07	ft	Pool to	to Pool Spacing/Riffle Width					3.80	1.70	6.5
	Riffle Length		62.32	18.72	109.88	ft	Riffle Le	ngth/Ri	ffle Wid	th			3.74	1.12	6.5
	Valley Slope (VS)	0.016	80	ft/ft	Average V	Vater S	Surface SI	ope (S)		0.02	2122 ft/ft	Sinuosity (VS/S)		1.0
	Stream Length (SL)	1289	9	ft	Valley Len	gth (V	L)			12	13 ft	Sinuosity (SL/VL)		1.0
	Low Bank Height	1289	9	ft ft	М	ax Riff	le	start	1.4	_	Bank-Hei	ight Ratio (B	HR)	start	
	HILLSON AW-CHARACTURES	start	1.4	ft ft	м		le	end	1.87	ft ft	Bank-Hei (LBH/Ma		HR) th)	end	1
ofile	Low Bank Height (LBH)	start end	1.4 1.87 Mean	ft ft Min	Max	ax Riff Depth	le	end	1.87	ft ft ss Slop	Bank-Hei (LBH/Ma	ight Ratio (Blax Riffle Dep	HR) th)	end Min	1 Ma
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd})	start end	1.4	ft ft	м	ax Riff Depth	Riffle Si	Dimer ope/Ave	1.87 nsionles erage W	ft ft ss Slop ater Su	Bank-Hei (LBH/Ma be Ratios urface Slope (S	ight Ratio (Blax Riffle Dep	HR) th)	end	1 Ma
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run})	start end 0	1.4 1.87 Mean 0.05911	ft ft Min 0.03157	Max 0.12167	ax Riff Depth ft/ft ft/ft	Riffle Sl	Dimer ope/Ave	1.87 nsionles erage W rage Wa	ft ft ss Slop ater Su	Bank-Hei (LBH/Ma pe Ratios urface Slope (S	ight Ratio (Blax Riffle Dep S _{rif} / S)	HR) th) Mean 2.79	Min 1.49	1 1 Ma
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p)	start end 0	1.4 1.87 Mean	ft ft Min	Max 0.12167	ax Riff Depth ft/ft ft/ft	Riffle Si Run Slo	Dimer ope/Ave pe/Ave	1.87 erage W rage Wa	ft ft ss Slop ater Su ater Sur	Bank-Hei (LBH/Ma be Ratios urface Slope (S face Slope (S	ight Ratio (Blax Riffle Dep	HR) th)	end Min	1 1 Ma
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g)	start end 0	1.4 1.87 Mean 0.05911	ft ft Min 0.03157	Max 0.12167 0.00721	ax Riff Depth ft/ft ft/ft	Riffle Si Run Slo	end Dimer ope/Ave pe/Ave pe/Ave ope/Ave	1.87 erage Warage Warag	ft ft ss Slop ater Su ater Su ater Su	Bank-Hei (LBH/Ma be Ratios urface Slope (S face Slope (S rface Slope (S urface Slope (S	ight Ratio (Blax Riffle Dep	HR) th) Mean 2.79 0.13	Min 1.49	1 Ma 5.7
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p) Gilde Slope (S _g) Feature Midpoint ^a	start end 0	1.4 1.87 Mean 0.05911	ft Min 0.03157 0.00041	Max 0.12167 0.00721	ax Riff Depth ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Slo Glide SI	Dimer ppe/Ave ppe/Ave ppe/Ave ppe/Ave ppe/Ave	1.87 nsionleserage Warage Wara	ft ft ss Slop ater Su ater Sur ater Sur ater Sur	Bank-Hei (LBH/Ma be Ratios urface Slope (S face Slope (S rface Slope (S urface Slope (S	ight Ratio (Blax Riffle Dep	HR) th) Mean 2.79 0.13	9 0.02 Min	1 1 1 Ma 5.7
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxet})	start end 0	1.4 1.87 Mean 0.05911	ft ft Min 0.03157	Max 0.12167 0.00721	ax Riff Depth ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Slo Glide SI Max Riff	pe/Ave pe/Ave pe/Ave pe/Ave pe/Ave pe/Ave pe/Ave	1.87 nsionles rage Wa rage Wa rage Wa rage Wa rage Wa rage Wa rage W	ft ft ss Slop ater Su ater Su ater Su ater Su ater Su ater Su	Bank-Hei (LBH/Ma be Ratios urface Slope (S face Slope (S urface Slope (S urface Slope (S urface Slope (S	ght Ratio (B ax Riffle Dep S _{rift} / S) S _{run} / S) S _p / S) S _g / S)	HR) th) Mean 2.79 0.13	Min 1.49	1 1 1 Ma 5.7
Channel Profile	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun})	start end 0	1.4 1.87 Mean 0.05911 0.00278 Mean 1.56	ft Min 0.03157 0.00041 Min 1.4	Max 0.12167 0.00721 Max 1.87	ax Riff Depth ft/ft ft/ft ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Sic Glide SI Max Riffl Max Ru	pe/Ave ppe/Ave ppe/Ave ppe/Ave ppe/Ave ppe/Ave ppe/Ave ppe/Ave	1.87 nsionles erage Wa rage Wa rage Wa rage Wa erage W nsionles h/Mean F	ft ft ss Slop fater Su ater Su	Bank-Hei (LBH/Ma De Ratios urface Slope (S frace Slope (S urface Slope (S	ight Ratio (Biax Riffle Dep S_{rif} / S) S_{run} / S) S_p / S) S_g / S) S_g / S) S_g / S)	Mean 2.79 0.13 Mean 2.52	Min 1.49 0.02 Min 2.26	1 1 1 1 1 5.7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _p) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint ^a Max Riffle Depth (d _{maxrd}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun})	start end 0	1.4 1.87 Mean 0.05911	ft Min 0.03157 0.00041	Max 0.12167 0.00721 Max 1.87	ax Riff Depth ft/ft ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Sid Glide SI Max Riffl Max Ru Max Pool	pe/Ave ppe/Ave	1.87 nsionles erage Wa rage Wa rage Wa erage W h/Mean h/Mean I	ft ft ss Slop ater Su	Bank-Hei (LBH/Ma De Ratios urface Slope (S rface Slope (S urface Slope	ight Ratio (Blax Riffle Dep S _{rif} / S) S _{run} / S) S _p / S) S _g / S) d _{bkl}) d _{bkl})	Mean 2.79 0.13 Mean 2.52	9 0.02 Min	1 1 1 1 5.7 5.7 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun})	start end 0	1.4 1.87 Mean 0.05911 0.00278 Mean 1.56	ft Min 0.03157 0.00041 Min 1.4	Max 0.12167 0.00721 Max 1.87	ax Riff Depth ft/ft ft/ft ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Sid Glide SI Max Riffl Max Ru Max Pool	pe/Ave ppe/Ave	1.87 nsionles erage Wa rage Wa rage Wa erage W h/Mean h/Mean I	ft ft ss Slop ater Su	Bank-Hei (LBH/Ma De Ratios urface Slope (S frace Slope (S urface Slope (S	ight Ratio (Blax Riffle Dep S _{rif} / S) S _{run} / S) S _p / S) S _g / S) d _{bkl}) d _{bkl})	Mean 2.79 0.13 Mean 2.52	Min 1.49 0.02 Min 2.26	1 1 1 1 5.7 5.7 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint ⁸ Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxg})	start end 0	1.4 1.87 Mean 0.05911 0.00278 Mean 1.56	ft Min 0.03157 0.00041 Min 1.4 2.08	Max 0.12167 0.00721 Max 1.87 3.33	ax Riff Depth ft/ft ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Sid Glide SI Max Riffl Max Ru Max Pool	end Dimer ppe/Aver pe/Aver ppe/Aver ppe/Aver Dimer ple Depth popth de Depth	1.87 nsionles erage Wa rage Wa	ft ft ss Slop ater Su	Bank-Hei (LBH/Ma De Ratios Jurface Slope (S Jurface Slope (S J	ight Ratio (Blax Riffle Dep S _{rif} / S) S _{run} / S) S _p / S) S _g / S) d _{bkl}) d _{bkl})	Mean 2.52 4.27 Protra	Min 1.49 0.02 Min 2.26 3.35	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p) Gilde Slope (S _g) Feature Midpoint Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxry})	start end 0	1.4 1.87 Mean 0.05911 0.00278 Mean 1.56	Min 0.03157 0.00041 Min 1.4 2.08	Max 0.12167 0.00721 Max 1.87 3.33	ax Riff Depth ft/ft ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Slo Glide SI Max Riffl Max Ru Max Pool Max Glide	pe/Ave	1.87 nsionles erage Wa rage Wa rage Wa erage W nsionles h/Mean I h/Mean I h/Mean Rea 13.	ft ft ft ss Slop ater Su ater	Bank-Hei (LBH/Ma De Ratios De R	ght Ratio (Blax Riffle Dep	Mean 2.52 4.27	Min 1.49 0.02 Min 2.26 3.35	1 1 1 Ma 5.7 1 0.3 Ma 3.0 5.3 1 Ma mm
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _p) Glide Slope (S _p) Glide Slope (S _g) Feature Midpoint ⁸ Max Riffle Depth (d _{maxrt}) Max Run Depth (d _{maxru}) Max Pool Depth (d _{maxru}) Max Glide Depth (d _{maxg}) % Silt/Clay % Sand	start end 0 0 0 Provided in the start of the	1.4 1.87 Mean 0.05911 0.00278 Mean 1.56	Min 0.03157 0.00041 Min 1.4 2.08	Max 0.12167 0.00721 Max 1.87 3.33	ax Riff Depth ft/ft ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Slo Glide SI Max Riffl Max Ru Max Pool Max Glide	pe/Ave	1.87 nsionles erage Wa rage Wa rage Wa rage Wa sionles h/Mean I h/Mean I h/Mean I 13.	ft ft ft ss Slop ater Su ater	Bank-Hei (LBH/Ma Pe Ratios urface Slope (S urface Slop	ght Ratio (Blax Riffle Dep	Mean 2.79 0.13 Mean 2.52 4.27	Min 1.49 0.02 Min 2.26 3.35	0.:: M: 3.0 5.:: mm
Channel	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _p) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxrun}) % Silt/Clay % Sand % Gravel	Reacl 0 2.9 47.83	1.4 1.87 Mean 0.05911 0.00278 Mean 1.56 2.65	Min 0.03157 0.00041 Min 1.4 2.08	Max 0.12167 0.00721 Max 1.87 3.33	ax Riff Depth ft/ft ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Slo Glide SI Max Riffl Max Ru Max Pool Max Glide	pe/Ave pe	1.87 nsionles erage Wa rage Wa rage Wa sionles h/Mean F h/Mean I h/Mean 13. 42.	ft ft ft ss Slopp ater Su ater	Bank-Hei (LBH/Ma De Ratios De R	ght Ratio (Blax Riffle Dep	Mean 2.52 4.27	Min 1.49 0.02 Min 2.26 3.35 3.35	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	Low Bank Height (LBH) Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _p) Glide Slope (S _p) Glide Slope (S _g) Feature Midpoint ⁸ Max Riffle Depth (d _{maxrt}) Max Run Depth (d _{maxru}) Max Pool Depth (d _{maxru}) Max Glide Depth (d _{maxg}) % Silt/Clay % Sand	start end 0 0 0 Provided in the start of the	1.4 1.87 Mean 0.05911 0.00278 Mean 1.56 2.65	Min 0.03157 0.00041 Min 1.4 2.08 Bif 41 46	Max 0.12167 0.00721 Max 1.87 3.33	ax Riff Depth ft/ft ft/ft ft/ft ft/ft	Riffle SI Run Slo Pool Slo Glide SI Max Riffl Max Ru Max Pool Max Glide	pe/Ave	1.87 nsionles erage Wa rage Wa rage Wa rage Wa sionles h/Mean I h/Mean I h/Mean I 13.	ft ft ft ss Slop dater Su date	Bank-Hei (LBH/Ma Pe Ratios urface Slope (S urface Slop	ght Ratio (Blax Riffle Dep	Mean 2.79 0.13 Mean 2.52 4.27	Min 1.49 0.02 Min 2.26 3.35	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

^a Min, max, mean depths are ave, mid-point values except pools: taken at deepest part of pool,

^b Composite sample of riffles and pools within the designated reach.

[°] Active bed of a riffle.

^d Height of roughness feature above bed



Worksheet 5-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream:	Davis Branch, UT1 Restoration Reach "As-Built"		
Basin:	Yadkin - Pee Dee River Drainage Area: 46.144 acres	0.0721	mi ²
Location:	Eddie Staton Property, 7.8 Miles N-NE of Marshville, Union	Co., NC	
Twp.&Rge:	; Sec.&Qtr.: ;		
Cross-Sect	tion Monuments (Lat./Long.): 35.09175 Lat / 80.32553 Long	Date	: 05/05/0
Observers:	M. Hebert, PE, J. Hines, PE, W. Knotts, PG	Valley Type	e: 11
	Bankfull WIDTH (W _{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	12.18	ft
	Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section (d_{bkf} = A / W_{bkf}).	0.42	ft
	Bankfull X-Section AREA (A _{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	5.14	ft²
	Width/Depth Ratio (W _{bkf} / d _{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	29	ft/ft
	Maximum DEPTH (d _{mbkf}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	1.02	ft
	WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d _{mbkl}) = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	57.74] ft
	Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa}/W_{bkl}) (riffle section).	4.74	ft/ft
	Channel Materials (Particle Size Index) D ₅₀ The D ₅₀ particle size index represents the mean diameter of channel materials, as sampled from the channel surface, between the bankfull stage and Thalweg elevations.	38.5	mm
	Water Surface SLOPE (S) Channel slope = "rise over run" for a reach approximately 20–30 bankfull channel widths in length, with the "riffle-to-riffle" water surface slope representing the gradient at bankfull stage.	0.02021	ft/ft
	Channel SINUOSITY (k) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL / VL); or estimated from a ratio of valley slope divided by channel slope (VS / S).	1.37	
	Stream Type C 4/1b (See Figure 2-	14)	

Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2005).

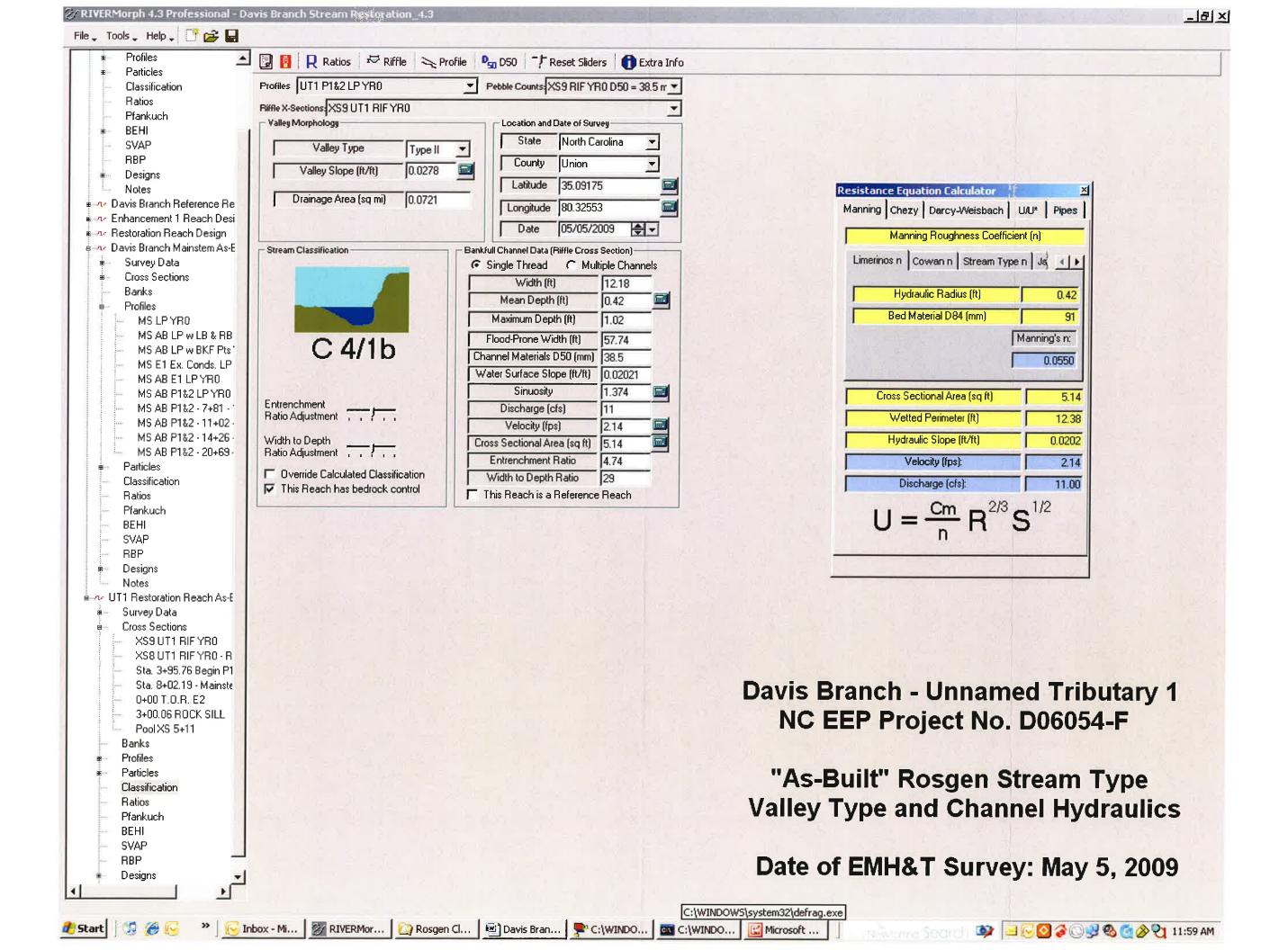
	tream: Davis Branch UT-1 Rest	oration Re	ach "As-B	uilt"		Lo	ocation:	7.8 Mi	les N-	NE of Mars	hville, Unio	n Co.,	NC	
0	bservers: M. Hebert PE, J. Hines,	PE, W, Kno	tts, PG	Date	e: 5/5/ 2	2009		Valle	у Туре:	II	Strea	m Type	: C 4/	1b
				River R	each !	Summary	Data							
	Mean Riffle Depth (d _{bkl})	0.43	ft	Riffle Widt	h (W _{bkl})	12	.38	ft	Riffle Area (A _{bkt})	5	.14	ft ²
ion	Mean Pool Depth (d _{bktp})	0.79	ft	Pool Width	ı (W _{bkfp})			ft	Pool Area (A	(_{bkfp})	5	.51	ft ²
Channel Dimension	Mean Pool Depth/Mean Riffle Depth 1.83721 dbktp/dbkd Pool Width/Riffle Width 0.57 Wbktp/					Pool Area / I	Riffle Area	1	.04	A _{bktp}				
el D	Max Riffle Depth (d _{maxvit})	0.99	ft	Max Pool	Depth (d _{maxp})		1.78	ft	Max Riffle D	epth/Mean Ri	iffle Dep	oth	2.3
ann	Max Pool Depth/Mean Riffle Depth		4.14	Point Bar	Slope		0	.1	ft/ft	Inner Berm \	Width (W _b)		0	ft
ΰ	Inner Berm Depth (d _b)	0	ft	Inner Bern	Width	/Depth Rat	io		0	W _b /d _b Inn	er Berm Area	a (A _b)	0	ft ²
	Streamflow: Estimated Mean Velocity	at Bankfull S	Stage (u _{bkl})				2.	14	ft/s	Estimation N	lethod	Mai	nning'	s Eq.
	Streamflow: Estimated Discharge at E	ankfull Stag	e (Q _{bkt})				. 11	.0	cfs	Drainage Are	эа	0.0	721	mi²
	Geometry	Mean	Min	Max			Dime	ensionk	ess Ge	ometry Ratio	os	Mean	Min	Ma
Pattern	Meander Wavelength (L _m)	52.60	50.53	58.82	ft	Meander	Length	n Ratio (L _m /W _{bkf})		4.25	4.08	4.7
		12.00	11.10	18.00	ft	Radius	f Curva	ture/Rif	le Widt	h (R _c /W _{bkf})		0.97	0.90	1.4
Channel	Belt Width (W _{bit})	50.00	50.00	50.00	ft	Meander	Width	Ratio (V	V _{bit} /W _{bkt})		4.04	4.04	4.0
cha	Individual Pool Length	17.19	11.86	28.40	ft	Pool Len	gth/Riff	le Width	Width				0.96	2.2
	Pool to Pool Spacing	28.68	12.82	50.32	ft	Pool to F	ool Spa	acing/Rit	ffle Wid	th		2.32	1.04	4.0
	Riffle Length	16.95	8.72	42.99	ft	Riffle Ler	gth/Rif	fle Width	1			1.37	0.70	3.4
	Valley Slope (VS) 0.	02704	ft/ft	Average W	ater Su	ırface Slop	e (S)		0.02	021 ft/ft	Sinuosity (VS/S)		1.3
	Stream Length (SL)	459	ft	Valley Leng	gth (VL))			33	MARINE III SON	Sinuosity (5	AV 20 11 2		1.3
	Low Bank Height sta (LBH) er		ft ft		ax Riffle	ė		0.88	-	Bank-He	ight Ratio (BI	HR)	start	1
	and 1.00 to LED WHAT TIME BOT							(h)						
e	Facet Slopes	Mean	Min	Max				sionles			ах ніпіе Бері	TO SAN TO LO	Min	Ma
rofile	Facet Slopes Riffle Slope (S _{rd})	Mean 0.04959	Min 0.03718	Max 0.06820	ft/ft	Riffle Slo	Dimen		s Slop	e Ratios face Slope (S		Mean 2.45	Min 1.84	
nel Profile	Facet Slopes Riffle Slope (S _{rit}) Run Slope (S _{run})	MARKET WARRANT VI	Market Company of the	Charles Control of	ft/ft	1	Dimen oe/Ave	rage Wa	s Slop iter Sur	e Ratios	S _{rit} / S)	Mean	Min	
hannel Profile	Facet Slopes Riffle Slope (S _{rd}) Run Slope (S _{run}) Pool Slope (S _p)	MARKET WARRANT VI	0.03718	Charles Control of	-	Run Slop	Dimen De/Aver e/Avera	rage Wa age Wat	s Slop iter Sur er Surf	e Ratios face Slope (S	S _{rif} / S)	Mean	Min	3.3
Channel Profile	Facet Slopes Riffle Slope (S _{rtt}) Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g)	0.04959	0.03718	0.06820	ft/ft	Run Slop	Dimen De/Avera e/Avera	rage Wat age Wat age Wat	s Slop iter Sur er Surfi	e Ratios face Slope (Sace Slope (S	S _{rft} / S) _{run} / S) _p / S)	Mean 2.45	Min 1.84	3.3
Channel Profile	Pool Slope (S _p)	0.04959	0.03718	0.06820	ft/ft ft/ft	Run Slop Pool Slop Glide Slo	Dimen De/Avera e/Avera pe/Avera	rage Wat age Wat age Wat rage Wa	s Slop ter Surf ter Surf ter Surf	e Ratios face Slope (S ace Slope (S ace Slope (S	S _{rft} / S) _{run} / S) _p / S)	Mean 2.45	Min 1.84	0.2
Channel Profile	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g)	0.04959	0.03718	0.06820	ft/ft ft/ft	Run Slop Pool Slop Glide Slo	Dimen De/Avera De/Avera De/Avera Dimen	rage Wat age Wat age Wat rage Wa	s Slop ter Surf ter Surf ter Surf ter Sur	e Ratios face Slope (S ace Slope (S ace Slope (S	S _{eff} / S) run / S) p / S) S _g / S)	Mean 2.45 0.13	Min 1.84 0.08	0.2 Ma
Channel Profile	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint ^a	0.04959 0.00267 Mean	0.03718 0.00170 Min	0.06820 0.00475 Max	ft/ft ft/ft ft/ft	Run Slop Pool Slop Glide Slo Max Riffle	Dimen pe/Avera pe/Avera pe/Avera pe/Avera pe/Avera pe/Avera pe/Avera	rage Wat age Wat age Wat rage Wat sionles /Mean F	s Slope ter Surfater	e Ratios face Slope (S ace Slope (S face Slope (S face Slope (S	S _{rif} / S) yun / S) p / S) Sg / S) bkl)	Mean 2.45 0.13 Mean	Min 1.84 0.08 Min	0.2 Ma
Channel Profile	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun})	0.04959 0.00267 Mean	0.03718 0.00170 Min	0.06820 0.00475 Max	ft/ft ft/ft ft/ft	Run Slop Pool Slop Glide Slop Max Riffle Max Run	Dimen pe/Avera pe/Avera pe/Avera Dimen pepth/	rage Watage Pierrage Pi	s Slop ter Surfater S	e Ratios face Slope (S ace Slope (S ace Slope (S face Slope (S face Slope (S pth (d _{maxif} / d	S _{cit} / S) S _{cit} / S) p / S) S _g / S) bki)	Mean 2.45 0.13 Mean	Min 1.84 0.08 Min	0.2 Ma 2.3
Channel Profile	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun})	0.04959 0.00267 Mean 0.99	0.03718 0.00170 Min 0.95	0.06820 0.00475 Max 1.02	ft/ft ft/ft ft/ft ft	Pool Slop Glide Slo Max Riffle Max Run Max Pool	Dimen pe/Avera pe/Avera pe/Avera pe/Avera Dimen pepth/	rage Watage Watage Watage Watage Watage Watage Watage Watage Watage Page 1	s Slope ter Surfater	e Ratios face Slope (S ace Slope (S ace Slope (S face Slope (S face Slope (S face Slope (S th Ratios th (d _{maxri} / d th (d _{maxrin} / c	S _{rit} / S) p / S) p / S) S _g / S) bid)	0.13 Mean 2.3	Min 1.84 0.08 Min 2.21	0.2 Ma 2.3
Channel	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxrun})	0.04959 0.00267 Mean 0.99	0.03718 0.00170 Min 0.95	0.06820 0.00475 Max 1.02	ft/ft ft/ft ft ft ft ft	Pool Slop Glide Slo Max Riffle Max Run Max Pool	Dimen pe/Avera pe/Avera pe/Avera pe/Avera Dimen pepth/	rage Watage Watage Watage Watage Watage Watage Watage Mean Film Mean Rimean Rim	ter Surfater	e Ratios face Slope (S ace Slope (S ace Slope (S face Slope (S face Slope (S pth (d _{maxcit} / d pth (d _{maxy} / d pth (d _{maxy} / d	S _{rit} / S) p / S) p / S) S _g / S) bid)	Mean 2.45 0.13 Mean 2.3 4.14	Min 1.84 0.08 Min 2.21	0.2 Ma 2.3
Channel	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxrun})	0.04959 0.00267 Mean 0.99	0.03718 0.00170 Min 0.95	0.06820 0.00475 Max 1.02	ft/ft ft/ft ft ft ft ft	Run Slop Pool Slop Glide Slo Max Riffle Max Run Max Pool Max Glide	Dimen pe/Avera pe/Avera pe/Avera pe/Avera Dimen pepth/	rage Watage Watage Watage Watage Watage Watage Watage Watage Watage Page 1	ter Surfater	e Ratios face Slope (S ace Slope (S ace Slope (S face Slop	S _{rit} / S) p / S) S _g / S) S _g / S) bid) bid)	0.13 Mean 2.3	Min 1.84 0.08 Min 2.21 2.98	0.2 Ma 2.3
Channel	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxrun})	0.04959 0.00267 Mean 0.99	0.03718 0.00170 Min 0.95	0.06820 0.00475 Max 1.02 2.56	ft/ft ft/ft ft ft ft ft	Run Slop Pool Slop Glide Slo Max Riffle Max Run Max Pool Max Glide	Dimen pe/Avera pe/Avera pe/Avera pe/Avera Dimen Depth/I Depth/I	rage Watage Watage Watage Watage Watage Watage Watage Watage Watage Page 1	ter Surfater	e Ratios face Slope (S ace Slope (S face Slope (S face Slope (S face Slope (S the Ratios the (d _{maxit} / d the (d _{maxy} / d the (d the (d _{maxy} / d the (d the (d _{maxy} / d the (d the	S _{rit} / S) p / S) S _g / S) S _g / S) bid) bid)	Mean 2.45 0.13 Mean 2.3 4.14	Min 1.84 0.08 Min 2.21 2.98	0.2 Ma 2.3
Channel	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxrun})	0.04959 0.00267 Mean 0.99 1.78	0.03718 0.00170 Min 0.95 1.28	0.06820 0.00475 Max 1.02 2.56	ft/ft ft/ft ft ft ft ft	Run Slop Pool Slop Glide Slo Max Riffle Max Run Max Pool Max Glide	Dimensor Dimensor Depth/Depth/Depth/Depth/Depth/Depth/Depth/Depth	rage Watage Watage Watage Watage Watage Watage Watage Watage Mean Rimean	s Slopeter Surfacer S	e Ratios face Slope (S ace Slope (S ace Slope (S face Slop	S _{rit} / S) p / S) S _g / S) S _g / S) bid) bid)	Mean 2.45 0.13 Mean 2.3 4.14	Min 1.84 0.08 Min 2.21 2.98	3.3 0.2 Ma 2.3 5.9
Channel	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxrun})	0.04959 0.00267 Mean 0.99 1.78	0.03718 0.00170 Min 0.95 1.28	0.06820 0.00475 Max 1.02 2.56	ft/ft ft/ft ft ft ft ft	Run Slop Pool Slop Glide Slo Max Riffle Max Run Max Pool Max Glide	Dimensor Depth/Dep	rage Watage Watage Watage Watage Watage Watage Watage Watage Watage Mean Film Mean Rimean Film Mean Film M	s Sloppitter Surface S	e Ratios face Slope (S ace Slope (S ace Slope (S ace Slope (S face Slope (S face Slope (S face Slope (S opth (d _{maxrun} / d opth (d _{maxry} / d	S _{rit} / S) p / S) S _g / S) S _g / S) bid) bid)	0.13 Mean 2.45 Mean 2.3 Mean 2.3	Min 1.84 0.08 Min 2.21	3.3 0.2 Ma 2.3 5.9
Channel Materials Channel Profile	Run Slope (S _{run}) Pool Slope (S _p) Glide Slope (S _g) Feature Midpoint a Max Riffle Depth (d _{maxrun}) Max Run Depth (d _{maxrun}) Max Pool Depth (d _{maxrun}) Max Glide Depth (d _{maxrun})	0.04959 0.00267 Mean 0.99 1.78 0.61	0.03718 0.00170 Min 0.95 1.28 Rif	0.06820 0.00475 Max 1.02 2.56 ffle ^c 0 82	ft/ft ft/ft ft ft ft ft	Run Slop Pool Slop Glide Slo Max Riffle Max Run Max Pool Max Glide	Dimen De/Average/Avera	rage Watage Wata	s Sloppinter Surface S	e Ratios face Slope (S ace Slope (S ace Slope (S face Slope (S face Slope (S face Slope (S pth (d _{maxri} / d pth (d _{maxy} / d	S _{rit} / S) p / S) S _g / S) S _g / S) bid) bid)	Mean 2.45 0.13 Mean 2.3 4.14 Protru 00 00	Min 1.84 0.08 Min 2.21	mm mm

^a Min, max, mean depths are ave. mid-point values except pools: taken at deepest part of pool.

^b Composite sample of riffles and pools within the designated reach.

Active bed of a riffle.

^d Height of roughness feature above bed



Davis Branch Mainstem Enhancement I and Restoration Reach Table 3a: "As-Built" Predicted Annual Bank Erosion Rates

Davis Branch Enhancement I Reach Bank Identification Summary							
Bank	Name						
1	XS7 Riffle MS BEHI						
2	XS6 Pool MS BEHI						
3	XS5 Riffle MS BEHI						

Davis Br	anch Mainstem Enhan	cement Level	l Reach: Predi	cted Annual	Bank Erosion	Rates
Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr
1	18,1	Low	Very Low	451	0.37	0.48
2	27,1	Moderate	Very Low	387	2.05	2.67
3	16.7	Low	Very Low	451	0.41	0.53
Totals				1,289	2.83	3.68
Total Reach	Length = 1,289 l.f.	To	tal Loss per fo	ot of Reach =	0.0029 tons/y	r

	Davis Branch Restoration Reach Bank Identification Summary							
Bank	Name							
1	XS1 Riffle MS BEHI							
2	XS2 Pool MS BEHI							
3	XS3 Riffle MS BEHI							
4	XS4 Pool MS BEHI							

Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr
1	15.2	Low	Very Low	450	0.25	0.33
2	19.7	Low	Very Low	449	0.6	0.78
3	18.4	Low	Very Low	450	0.46	0.6
4	20.3	Moderate	Very Low	450	1.57	2.04
Totals				1,799	2.88	3.75
Total Reach	Length = 1,799 l.f.	To	tal Loss per fo	ot of Reach =	0.0021 tons/y	r

	Davis Branch Mainstem Reach Bank Identification Summary								
Bank	Name								
1	XS7 Riffle EI BEHI								
2	XS6 Pool EI BEHI								
3	XS5 Riffle EI BEHI								
4	XS1 Riffle PI/II BEHI								
5	XS2 Pool PI/II BEHI								
6	XS3 Riffle PI/II BEHI								
7	XS4 Pool PI/II BEHI								

BEHI	BEHI	NBS				
			Length	Loss	Loss	
Rating	Rating	Rating	ft	cu yds/yr	tons/yr	
18.1	Low	Very Low	451	0.37	0.48	
27.1	Moderate	Very Low	387	2.05	2.67	
16.7	Low	Very Low	451	0.35	0.45	
15.2	Low	Very Low	450	0.25	0.33	
19.7	Low	Very Low	449	0.6	0.78	
18.4	Low	Very Low	450	0.46	0.6	
20.3	Moderate	Very Low	450	1.57	2.04	
			3,088	5.65	7.35	
	18.1 27.1 16.7 15.2 19.7 18.4	Numeric Rating Adjective Rating 18.1 Low 27.1 Moderate 16.7 Low 15.2 Low 19.7 Low 18.4 Low	Numeric Rating Adjective Rating Adjective Rating 18.1 Low Very Low 27.1 Moderate Very Low 16.7 Low Very Low 15.2 Low Very Low 19.7 Low Very Low 18.4 Low Very Low	Numeric Rating Adjective Rating Length ft 18.1 Low Very Low 451 27.1 Moderate Very Low 387 16.7 Low Very Low 451 15.2 Low Very Low 450 19.7 Low Very Low 449 18.4 Low Very Low 450 20.3 Moderate Very Low 450	Numeric Rating Adjective Rating Length ft cu yds/yr 18.1 Low Very Low 451 0.37 27.1 Moderate Very Low 387 2.05 16.7 Low Very Low 451 0.35 15.2 Low Very Low 450 0.25 19.7 Low Very Low 449 0.6 18.4 Low Very Low 450 0.46 20.3 Moderate Very Low 450 1.57	

Davis Branch Restoration Reach Table 3b: "As-Built" Predicted Annual Bank Erosion Rates

UT1 Enhancement Level II Reach						
Bank	Bank Identification Summary					
Bank	Bank Name					
1	1 XS8 Riffle EII Reach BEHI					

Davis Branch Mainstem Enhancement Level 1 Reach: Predicted Annual Bank Erosion Rates							
Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr	
- 1	15.6	Low	Very Low	396	0.24	0.31	
Totals		396 0.24 0.31					
Total :	Reach Length = 396 l.f.	Total Loss per foot of Reach = 0.0008 tons/yr					

UT1 Restoration Reach							
Bank	Bank Identification Summary						
Bank	Bank Name						
2	2 XS9 Riffle P1 Reach BEHI						

Davis Branch UT1 Priority Level I Restoration Reach: Predicted Annual Bank Erosion Rates							
Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr	
2	16.0	Low	Very Low	459	0.29	0.38	
Totals	459 0.29					0.38	
Total	each Length = 459 l.f. Total Loss per foot of Reach = 0.0008 tons/yr				r		

Davis Branch UT1 Bank Identification Summary						
Bank	Name					
1	XS8 Riffle EII Reach BEHI					
2	2 XS9 Riffle P1 Reach BEHI					

Davis Branch UT1 Enhancement II & Restoration Reaches: Predicted Annual Bank Erosion Rates							
Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr	
1	15.6	Low	Very Low	396	0.37	0.48	
2	16.0	Low	Very Low	459	1.57	2.04	
Totals				855	0.53	0.69	
Total	Reach Length = 855 l.f.	Total Loss per foot of Reach = 0.0008 tons/yr					

Davis Branch and UT1 Project Summary Table 3c: "As-Built" Predicted Annual Bank Erosion Rates

	Davis Branch Project Summary Bank Identification Summary						
Bank	Name						
1	XS7 Riffle MS EI BEHI						
2	XS6 Pool MS EI BEHI						
3	XS5 Riffle MS EI BEHI						
4	XS1 Riffle MS PI/II BEHI						
5	XS2 Pool MS PI/II BEHI						
6	XS3 Riffle MS PI/II BEHI						
7	XS4 Pool MS PI/II BEHI						
8	XS8 Riffle UT1 EII BEHI						
9	XS9 Riffle UT1 PI BEHI						

Dav	Davis Branch & UT1 Project Summary: Predicted Annual Bank Erosion Rates								
Bank	BEHI Numeric	BEHI Adjective	NBS Adjective	Length	Loss	Loss			
Dank	Rating	Rating	Rating	ft	cu yds/yr	tons/yr			
1	18.1	Low	Very Low	451	0.37	0.48			
2	27.1	Moderate	Very Low	387	2.05	2.67			
3	16.7	Low	Very Low	451	0.35	0.45			
4	15.2	Low	Very Low	450	0.25	0.33			
5	19.7	Low	Very Low	449	0.6	0.78			
6	18.4	Low	Very Low	450	0.46	0.6			
7	20.3	Moderate	Very Low	450	1.57	2.04			
8	15.6	Low	Very Low	396	0.37	0.48			
9	16	Low	Very Low	459	1.57	2.04			
Totals				3,943	7.59	9.87			
Total Reach Length = 3,943 l.f. Total Loss per foot of Reach = 0.0025 tons/yr					ns/yr				

MS P1&2 + E1 Reach BEHI Summary.txt RIVERMORPH BEHI SUMMARY REPORT

	me: Davis Branch me: Davis Branch Mainstem As-Built
Table 1.	Bank Identification Summary
Bank 1 2 3 4 5 6	Name XS7 Riffle MS BEHI XS6 Pool MS BEHI XS5 Riffle MS BEHI XS1 Riffle MS BEHI XS2 Pool MS BEHI XS3 Riffle MS BEHI XS4 Pool MS BEHI
 Table 2.	Predicted Annual Bank Erosion Rates
Nur	HI BEHI NBS meric Adjective Length Loss Loss ting Rating Rating ft cu vds/vr tons/vr

Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr
1 2 3 4 5 6 7	18.1 27.1 16.7 15.2 19.7 18.4 20.3	Low Moderate Low Low Low Low Moderate	Very Low Very Low Very Low Very Low Very Low Very Low	451 387 451 450 449 450 450	0.37 2.05 0.35 0.25 0.6 0.46 1.57	0.48 2.67 0.45 0.33 0.78 0.6 2.04
Totals	S			3088	5.65	7.35

Total Reach Ln: 3088 Total Loss (tons/yr) per ft of Reach: 0.0024

XS1 Riffle MS BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built BEHI Name: XS1 Riffle MS BEHI Survey Date: 05/05/2009 -----Bankfull Height: 0.87 ft Bank Height: 0.87 ft Root Depth: 0.5 ft Root Density: 25 % Bank Angle: 10.9 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Velocity at Bed: 3.5 fps Velocity at Surface: 3.74 fps Depth: 0.87 ft Hydraulic Radius: 0.43 ft Bankfull Slope: 0.01304 Shear Stress: 0.35 1b/sq/ft NB Shear Stress: 0.15 lb/sq/ft Shear Ratio: 0.42 BEHI Numerical Rating: 15.2 BEHI Adjective Rating: Low NBS Numerical Rating: 0.42 NBS Adjective Rating: Very Low Total Bank Length: 450 ft Estimated Sediment Loss: 0.25 Cu Yds per Year Estimated Sediment Loss: 0.33 Tons per Year

XS2 Pool MS BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built BEHI Name: XS2 Pool MS BEHI Survey Date: 05/05/2009 ______ Bankfull Height: 2.11 ft Bank Height: 2.11 ft Root Depth: 0.5 ft Root Density: 25 % Bank Angle: 19.7 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Velocity at Surface: 3.74 fps Velocity at Bed: 2.5 fps Hydraulic Radius: 0.99 ft Depth: 2.11 ft Bankfull Slope: 0.01304 Shear Stress: 0.81 1b/sq/ft NB Shear Stress: 0.67 lb/sq/ft Shear Ratio: 0.83 BEHI Numerical Rating: 19.7 BEHI Adjective Rating: Low NBS Numerical Rating: 0.83 NBS Adjective Rating: Very Low Total Bank Length: 449 ft Estimated Sediment Loss: 0.6 Cu Yds per Year Estimated Sediment Loss: 0.78 Tons per Year

XS3 Riffle MS BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built BEHI Name: XS3 Riffle MS BEHI Survey Date: 05/05/2009 _____ Bankfull Height: 1.62 ft Bank Height: 1.62 ft Root Depth: 0.5 ft Root Density: 25 % Bank Angle: 15.6 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Velocity at Bed: 3.5 fps Velocity at Surface: 3.74 fps Depth: 1.62 ft Hydraulic Radius: 0.72 ft Bankfull Slope: 0.01304 Shear Stress: 0.59 lb/sq/ft NB Shear Stress: 0.04 lb/sq/ft Shear Ratio: 0.07 BEHI Numerical Rating: 18.4 BEHI Adjective Rating: Low NBS Numerical Rating: 0.07 NBS Adjective Rating: Very Low Total Bank Length: 450 ft Estimated Sediment Loss: 0.46 Cu Yds per Year Estimated Sediment Loss: 0.6 Tons per Year

XS4 Pool MS BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built BEHI Name: XS4 Pool MS BEHI Survey Date: 05/05/2009 Bankfull Height: 2.24 ft Bank Height: 2.24 ft Root Depth: 0.5 ft Root Density: 25 % Bank Angle: 24.7 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Velocity at Bed: 2.5 fps Velocity at Surface: 3.74 fps Depth: 2.24 ft Bankfull Slope: 0.01304 Hydraulic Radius: 0.85 ft Shear Stress: 0.69 lb/sq/ft NB Shear Stress: 0.59 lb/sq/ft Shear Ratio: 0.86 BEHI Numerical Rating: 20.3 BEHI Adjective Rating: Moderate NBS Numerical Rating: 0.86 NBS Adjective Rating: Very Low Total Bank Length: 450 ft Estimated Sediment Loss: 1.57 Cu Yds per Year Estimated Sediment Loss: 2.04 Tons per Year

El Reach Erosion Rate Summary.txt RIVERMORPH BEHI SUMMARY REPORT

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River Name: Davis Branch

Reach Name: Davis Branch Mainstem As-Built

Table 1. Bank Identification Summary

Bank Name XS7 Riffle MS BEHI 1

XS6 Pool MS BEHI XS5 Riffle MS BEHI 3

Table 2. Predicted Annual Bank Erosion Rates

Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjec Ratir		Length ft	Loss cu yds/yr	Loss tons/yr
1 2 3	18.1 27.1 16.7	Low Moderate Low	Very Very Very	Low	451 387 451	0.37 2.05 0.41	0.48 2.67 0.53
Totals	5				1289	2.83	3.68

Total Reach Ln: 1289 Total Loss (tons/yr) per ft of Reach:

0.0029

XS5 BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built BEHI Name: XS5 Riffle MS BEHI Survey Date: 05/05/2009 -----Bankfull Height: 1.22 ft Bank Height: 1.22 ft Root Depth: 0.5 ft Root Density: 25 %
Bank Angle: 6.2 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Velocity at Surface: 4.38 fps
Depth: 1.22 ft Velocity at Bed: 4.1 fps Hydraulic Radius: 0.59 ft Bankfull Slope: 0.02122 Shear Stress: 0.78 lb/sq/ft NB Shear Stress: 0.10 lb/sq/ft Shear Ratio: 0.13 BEHI Numerical Rating: 16.7 BEHI Adjective Rating: Low NBS Numerical Rating: 0.13 NBS Adjective Rating: Very Low Total Bank Length: 451 ft Estimated Sediment Loss: 0.35 Cu Yds per Year Estimated Sediment Loss: 0.45 Tons per Year

XS6 BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built BEHI Name: XS6 Pool MS BEHI Survey Date: 05/05/2009 _____ Bankfull Height: 2.28 ft Bank Height: 3.41 ft Root Depth: 0.5 ft Root Density: 25 % Bank Angle: 21.6 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Velocity at Surface: 4.38 fps Velocity at Bed: 4.1 fps Depth: 2.28 ft Bankfull Slope: 0.02122 Hydraulic Radius: 1.3 ft Shear Stress: 1.72 1b/sq/ft NB Shear Stress: 0.03 lb/sq/ft Shear Ratio: 0.02 BEHI Numerical Rating: 27.1 BEHI Adjective Rating: Moderate NBS Numerical Rating: 0.02 NBS Adjective Rating: Very Low Total Bank Length: 387 ft Estimated Sediment Loss: 2.05 Cu Yds per Year Estimated Sediment Loss: 2.67 Tons per Year

XS-7 BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: Davis Branch Mainstem As-Built BEHI Name: XS7 Riffle MS BEHI Survey Date: 06/18/2009 ______ Bankfull Height: 1.31 ft Bank Height: 1.31 ft Root Depth: 0.5 ft Root Density: 25 % Bank Angle: 26.6 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Velocity at Surface: 4.38 fps Velocity at Bed: 4.1 fps Hydraulic Radius: 0.64 ft Depth: 1.31 ft Bankfull Slope: 0.02122 Shear Stress: 0.85 1b/sq/ft NB Shear Stress: 0.09 lb/sq/ft Shear Ratio: 0.10 BEHI Numerical Rating: 18.1 BEHI Adjective Rating: Low NBS Numerical Rating: 0.10 NBS Adjective Rating: Very Low Total Bank Length: 451 ft Estimated Sediment Loss: 0.37 Cu Yds per Year Estimated Sediment Loss: 0.48 Tons per Year

EII Reach BEHI Summary Report.txt RIVERMORPH BEHI SUMMARY REPORT

River Name: Davis Branch Reach Name: UT1 Restoration Reach As-Built												
Table 1. Bank Identification Summary												
Bank 1	Bank Name 1 XS-8 UT1 EII Reach BEHI											
Table	2. Pre	dicted Ann	ual Bank Erd	sion Rates								
Bank	Numeric	BEHI Adjective Rating	NBS Adjective Rating	Length ft cu	Loss yds/yr t	Loss tons/yr						
1	15.6	Low	Very Low	396	0.24	0.31						
Total	S			396	0.24	0.31						
Total 0.000	Total Reach Ln: 396 Total Loss (tons/yr) per ft of Reach: 0.0008											

XS8 BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: UT1 Restoration Reach As-Built BEHI Name: XS-8 UT1 EII Reach BEHI Survey Date: 05/05/2009 ______ Bankfull Height: 0.95 ft Bank Height: 0.95 ft Root Depth: 0.5 ft Root Density: 25 % Bank Angle: 12 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Depth: 0.95 ft Hydraulic Radius: 0.43 ft Bankfull Slope: 0.0207 Shear Stress: 0.56 lb/sq/ft NB Shear Stress: 0.11 lb/sq/ft Shear Ratio: 0.20 BEHI Numerical Rating: 15.6 BEHI Adjective Rating: Low NBS Numerical Rating: 0.20 NBS Adjective Rating: Very Low Total Bank Length: 396 ft Estimated Sediment Loss: 0.24 Cu Yds per Year Estimated Sediment Loss: 0.31 Tons per Year

UT1 EII & PI Reach BEHI SUMMARY.txt RIVERMORPH BEHI SUMMARY REPORT

River Reach	Name: Da	avis Brancl	h tion Reach <i>A</i>	As-Built								
Table 1. Bank Identification Summary												
Bank	Name	e 9 uz1 ezt :	Dooch DEUT									
<u>1</u> 2	XS9	8 UT1 EII UT1 PI Rea	ach BEHI									
Tab1e	2. Pre	dicted Ann	ual Bank Ero	osion Rates	i							
Bank	Numeric	BEHI Adjective Rating	NBS Adjective Rating	Length ft cu	Loss yds/yr to	ss Loss yr tons/yr						
1 2	15.6 Low 16 Low		Very Low Very Low	396 459	0.24 0.29	0.31 0.38						
Totals 855 0.53 0.69												
Total 0.0008	Total Reach Ln: 855 Total Loss (tons/yr) per ft of Reach: 0.0008											

XS9 UT1 PI BEHI Summary Report.txt RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Davis Branch Reach Name: UT1 Restoration Reach As-Built BEHI Name: XS9 UT1 PI Reach BEHI Survey Date: 05/05/2009 _____ Bankfull Height: 1.02 ft Bank Height: 1.02 ft Root Depth: 0.5 ft Root Density: 25 % Bank Angle: 13.5 Degrees Surface Protection: 95 % Bank Material Adjustment: Silt/Clay 0 Bank Stratification Adjustment: None 0 Erosion Loss Curve: Colorado NBS Method #7: Vertical Velocity Near-Bank Shear Stress Method Velocity at Surface: 2.14 fps Velocity at Bed: 2 fps Depth: 1.02 ft Hydraulic Radius: 0.42 ft Shear Stress: 0.53 Bankfull Slope: 0.02021 1b/sq/ft Shear Ratio: 0.07 NB Shear Stress: 0.04 lb/sq/ft BEHI Numerical Rating: 16.0 BEHI Adjective Rating: Low NBS Numerical Rating: 0.07 NBS Adjective Rating: Very Low Total Bank Length: 459 ft Estimated Sediment Loss: 0.29 Cu Yds per Year Estimated Sediment Loss: 0.38 Tons per Year

Davis Branch Restoration Reach Profile, Dimension, Hydaulics and Entraiment Geostatistics

Davis Branch	R	Restoration Rea	ich		Enhancement Level 1 Reach			Davis Branch	Restoration Reach				Enhancement Lev	vel 1 Reach	
Parameter	AB Rif XS1	AB Rif XS3	Median	Parameter	AB Rif XS5	AB Rif XS7	Median	Parameter	Min	Max	Median	Parameter	Min	Max	Median
Wfpa (ft)	112.74	63.06	87.90	Wfpa (ft)	63.7	59.88	61.79	Wfpa (ft)	63.06	112.74	87.90	Wfpa (ft)	59.88	63.7	61.79
Wbkf (ft)	9.17	13.38	11.28	Wbkf (ft)	17.38	15.97	16.68	Wbkf (ft)	9.17	13.38	11.28	Wbkf (ft)	15.97	17.38	16.68
ER	12.3	4.71	8.51	ER	3.67	3.75	3.71	ER	4.71	12.3	8.51	ER	3,67	3.75	3.71
d (ft)	0.44	0.75	0.60	d (ft)	0.59	0.65	0.62	d (ft)	0.44	0.75	0.60	d (ft)	0.59	0.65	0.62
Dmax (ft)	0.87	1.62	1.25	Dmax (ft)	1.22	1.31	1.27	Dmax (ft)	0.87	1.62	1.25	Dmax (ft)	1.22	1.31	1.27
W/D	20.84	17.84	19.34	W/D	29.46	24.57	27.02	W/D	17.84	20.84	19.34	W/D	24.57	29.46	27.02
Abkf (sq ft)	3.99	9.98	6.99	Abkf (sq ft)	10.3	10.38	10.34	Abkf (sq ft)	3.99	9.98	6.99	Abkf (sq ft)	10.3	10.38	10.34
WP (ft)	9.33	13.8	11.57	WP (ft)	17.57	16.19	16.88	WP (ft)	9.33	13.8	11.57	WP (ft)	16.19	17.57	16.88
R (ft)	0.43	0.72	0.58	R (ft)	0.59	0.64	0.62	R (ft)	0.43	0.72	0.58	R (ft)	0.59	0.64	0.62
Sbkf (ft/ft)	0.00828	0.01917	0.01304	Sbkf (ft)	0.02122	0.02122	0.02122	Sbkf (ft/ft)	0.00828	0.01917	0.01304	Sbkf (ft)	0.02122	0.02122	0.02122
Tc (lb/ft ²)	0.22	0.86	0.54	Tc (lb/ft ²)	0.78	0.85	0.82	Tc (lb/ft ²)	0.22	0.86	0.54	Tc (lb/ft ²)	0.78	0.85	0.82
Ent Part (mm)	50.3	136.2	93.3	Ent Part (mm)	126.8	134.6	130.7	Ent Part (mm)	50.3	136.2	93.3	Ent Part (mm)	126.8	134.6	130.7
Riffle D50 (mm)	36.3	33.3	34.8	Riffle D50 (mm)	63.1	97.12	80.1	Riffle D50 (mm)	33.3	36.3	34.8	Riffle D50 (mm)	63.1	97.12	80.1
Riffle D84 (mm)	61.5	52.8	57.2	Riffle D84 (mm)	179.3	216.5	197.9	Riffle D84 (mm)	52.8	61.5	57.2	Riffle D84 (mm)	179.3	216.5	197.9

					DAVIS	BRANCH MAINSTE	M - RESTORAT	ION REACH						
Statistic	Wfpa	Wbkf	ER	d	Dmax	W/D	Abkf	WP	R	Sbkf	Tc (lb/ft2)	Ent Part (mm)*	Riffle D50 (mm)	Riffle D84 (mm)
Mean	99.92	11.28	8.51	0.60	1.25	18.49	6.99	11.57	0.58	0.01277	0.54	93.3	34.8	57.2
Std Error	21.96	2.10	3.80	0.16	0.38	2.94	3.00	2.24	0.15	0.00545	0.32	43.0	1.5	4.4
Median	90.04	11.28	8.51	0.60	1.25	19.34	6.99	11.57	0.58	0.01304	0.54	93.3	34.8	57.2
Mode	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Std Dev	43.93	2.98	5.37	0.22	0.53	5.88	4.24	3.16	0.21	0.00542	0.45	60.7	2.1	6.2
Variance	1929.72	8.86	28.80	0.05	0.28	34.53	17.94	9.99	0.04	0.00003	0,20	3689.4	4.5	37.8
Kurtosis	-1.62	#N/A	#N/A	#N/A	#N/A	0.69	#N/A	#N/A	#N/A	-3.41	#N/A	#N/A	#N/A	#N/A
Skewness	0.78	#N/A	#N/A	#N/A	#N/A	-0.77	#N/A	#N/A	#N/A	-0.46	#N/A	#N/A	#N/A	#N/A
Range	93.47	4.21	7.59	0.31	0.75	13.87	5.99	4.47	0.29	0.01103	0.64	85.9	3.0	8.7
Minimum	63.06	9.17	4.71	0.44	0.87	10.70	3.99	9.33	0.43	0.00828	0.22	50.3	33.3	52.8
Maximum	156.53	13.38	12.30	0.75	1.62	24.57	9.98	13.80	0.72	0.01931	0.86	136.2	36.3	61.5
Sum	399.67	22.55	17.01	1.19	2.49	73.95	13.97	23.13	1.15	0.05908	1.08	186.5	69.6	114.3
Count	4	2	2	2	2	4	2	2	2	4	2	2	2	2

MS Restoration Reach Median Sbkf 0.01304

	DAVIS BRANCH MAINSTEM - ENHANCEMENT LEVEL 1 REACH													
Statistic	Wfpa	Wbkf	ER	d	Dmax	W/D	Abkf	WP	R	Sbkf	Tc (lb/ft2)	Ent Part (mm)*	Riffle D50 (mm)	Riffle D84 (mm)
Mean	61.79	16.68	3.71	0.62	1.27	27.02	10.34	16.88	0.62	0.02122	0.82	130.7	80.1	197.9
Std Error	1.91	0.70	0.04	0.03	0.04	2.45	0.04	0.69	0.03	0.00	0.04	3.9	17.0	18.6
Median	61.79	16.68	3.71	0.62	1.27	27.02	10.34	16.88	0.62	0.02122	0.82	130.7	80.1	197.9
Mode	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.02122	#N/A	#N/A	#N/A	#N/A
Std Dev	2.70	1.00	0.06	0.04	0.06	3.46	0.06	0.98	0.04	0.00	0.05	5.5	24.1	26.3
Variance	7.30	0.99	0.00	0.00	0.00	11.96	0.00	0.95	0.00	0.00	0.00	30.4	578.7	691.9
Kurtosis	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Skewness	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Range	3.82	1.41	0.08	0.06	0.09	4.89	0.08	1.38	0.05	0.00	0.07	7.8	34.0	37.2
Minimum	59.88	15.97	3.67	0.59	1.22	24.57	10.30	16.19	0.59	0.02122	0.78	126.8	63.1	179.3
Maximum	63.70	17.38	3.75	0.65	1.31	29.46	10.38	17.57	0.64	0.02122	0.85	134.6	97.1	216.5
Sum	123.58	33.35	7.42	1.24	2.53	54.03	20.68	33.76	1.23	0.06366	1.63	261.4	160.2	395.8
Count	2	2	2	2	2	2	2	2	2	3	2	2	2	2

MS Enhancement 1 Reach Median Sbkf 0.02122

Davis Branch UT-1	Enh Level 2 & Restoration								
Parameter	AB Rif XS8	AB Rif XS9	Median						
Wfpa (ft)	50.49	57.74	57.74						
Wbkf (ft)	12.58	12.18	12.18						
ER	4.01	4.74	4.74						
d (ft)	0.43	0.42	0.42						
Dmax (ft)	0.95	1.02	1.02						
W/D	29.26	29	29						
Abkf (sq ft)	5.45	5.14	5.14						
WP (ft)	12.74	12.38	12.38						
R (ft)	0.43	0.42	0.42						
Sbkf (ft/ft)	0.02070	0.02021	0.02021						
Tc (lb/ft²)	0.56	0.53	0.55						
Ent Part (mm)	98.6	95.3	95.3						
Riffle D50 (mm)	28.8	38.5	38.5						
Riffle D84 (mm)	62.0	91.0	91.0						

Parameter	Min	Max	Median
Wfpa (ft)	50.49	57.74	54.12
Wbkf (ft)	12.18	12.58	12.38
ER	4.01	4.74	4.38
d (ft)	0.42	0.43	0.43
Dmax (ft)	0.95	1.02	0.99
W/D	29.00	29.26	29.13
Abkf (sq ft)	5.14	5.45	5.30
WP (ft)	12.38	12.74	12.56
R (ft)	0.42	0.43	0.43
Sbkf (ft/ft)	0.02007	0.02070	0.02021
Tc (lb/ft ²)	0.53	0.56	0.55
Ent Part (mm)	95.3	98.6	97.0
Riffle D50 (mm)	28.8	38.5	34.8
Riffle D84 (mm)	62.0	91.0	57.2

	DAVIS BRANCH UNNAMED TRIBUTARY 1 - COMBINED ENHANCEMENT LEVEL 2 & RESTORATION REACHES													
Statistic	Wfpa	Wbkf	ER	d	Dmax	W/D	Abkf	WP	R	Sbkf	Tc (lb/ft2)	Ent Part (mm)*	Riffle D50 (mm)	Riffle D84 (mm)
Mean	54.12	12.38	4.38	0.43	0.99	29.13	5.30	12.56	0.43	0.02033	0.55	97.0	34.8	57.2
Std Error	3.63	0.20	0.36	0.01	0.03	0.13	0.15	0.18	0.01	0.00019	0.02	1.7	1.5	4.4
Median	54.12	12.38	4.38	0.43	0.99	29.13	5.30	12.56	0.43	0.02021	0.55	97.0	34.8	57.2
Mode	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Std Dev	5.13	0.28	0.52	0.01	0.05	0.18	0.22	0.25	0.01	0.00033	0.02	2.3	2.1	6.2
Variance	26.28	0.08	0.27	0.00	0.00	0.03	0.05	0.06	0.00	0.00000	0.00	5.4	4.5	37.8
Kurtosis	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Skewness	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	1.39	#N/A	#N/A	#N/A	#N/A
Range	7.25	0.40	0.73	0.01	0.07	0.26	0.31	0.36	0.01	0.00063	0.03	3.3	3.0	8.7
Minimum	50.49	12.18	4.01	0.42	0.95	29.00	5.14	12.38	0.42	0.02007	0.53	95.3	33.3	52.8
Maximum	57.74	12.58	4.74	0.43	1.02	29.26	5.45	12.74	0.43	0.02070	0.56	98.6	36.3	61.5
Sum	108.23	24.76	8.75	0.85	1.97	58.26	10.59	25.12	0.85	0.06098	1.09	193.9	69.6	114.3
Count	2	2	2	2	2	2	2	2	2	3	2	2	2	2

UT-1 Restoration Reach Median Sbkf 0.02021