EMH&T
Engineers, Surveyors, Planners, Scientists

December, 2012

Mr. Guy Pearce
Full Delivery Supervisor
Ecosystem Enhancement Program
2728 Capital Blvd., Suite 1H 103
Raleigh, North Carolina 27604

Subject: Year 4 Monitoring Report for Stream Mitigation of Davis Branch
SCO# D06054-F

Dear Guy,

On behalf of Wetlands Resource Center, EMH&T Inc. is pleased to submit the Year 4 Monitoring Report for Davis Branch (SCO# D06054-F). This report contains data from both the vegetation and stream monitoring events, which were completed in mid-September, 2012. Three hard copies and one electronic copy of the document are being provided. Questions regarding this monitoring report may be directed to Cal Miller of Wetlands Resource Center at (614) 864-7511 or me at (614) 775-4507. We appreciate your willingness to work with us on this report.

Sincerely,

EVANS, MECHWART, HAMBLETON & TILTON, INC.

Megan F. Wolf, M.En.
Environmental Scientist

Enclosure

Copies: Cal Miller, WRC

Year 4 Monitoring Report for Stream Restoration of Davis Branch and Unnamed Tributary

Union County, NC
SCO # D06054-F

Prepared for:
NCDENR – EEP
2728 Capital Blvd, Suite 1H 103
Raleigh NC 27604

Submitted: December, 2012

Prepared by:

Wetlands Resource Center
3970 Bowen Road
Canal Winchester, Ohio 43110
Project Manager: Cal Miller
P: (614) 864-7511
F: (614) 866-3691

And

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5500 New Albany Road
Columbus, Ohio 43054
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Main: (614) 775-4500

Table of Contents

List of Tables

List of Appendices

I. EXECUTIVE SUMMARY

The Davis Branch stream restoration project is located near the town of Marshville, Union County, North Carolina. Prior to restoration, active use of the land for cattle grazing and hay resulted in impaired, channelized, eroding, incised and entrenched stream channels. The project reaches include the restoration of 1,799 linear feet of the Davis Branch mainstem, enhancement of 1,229 linear feet of the mainstem, preservation of 766 linear feet of the mainstem, restoration of 459 linear feet of an unnamed tributary (UT1) and enhancement of 396 linear feet of the same tributary. Restoration of the project streams, completed during April 2009, provided the desired habitat and stability features required to improve and enhance the ecologic health of the streams for the long-term. The following report documents the Year 4 annual monitoring for this project.

Vegetative monitoring was completed on September 13, 2012, following the Carolina Vegetation Survey methodology. Stem counts completed at ten vegetation plots show an average density of 591 stems/acre in Year 4. This is a slight decrease from the Year 3 total of 741 stems/acre for the site but is a marked increase over the Year 2 average of 454 stems/ acre for the site. This density meets the success criteria of 288 stems/acre after four years of monitoring. Only one plot (plot 3) had a stem density below the minimum. To address the issue of low stem counts for planted stems observed in the fall of 2010, specific areas where targeted for supplemental planting in the spring 2011 within the riparian corridors, concentrated along UT1 and the portion of the Davis Branch downstream from the confluence with UT1. This planting effort is reflected in the 2011 increase in average stem density for planted stems across the site. Some natural mortality has occurred over the dry summer months of 2012. This is reflected in the smaller number of stems/acre observed in Year 4.

In 2011, there was a minor area of the riparian corridor along the right bank of the mainstem that was exhibiting denudation. This area is situated between stations 8+00 and 10+00. A that time, it was labeled as a vegetation problem area of low concern because there was no evidence that denudation was affecting stream stability. The lack of vegetation appeared to be attributed to a natural condition. It is situated in the understory of a secondary growth forest where there is competition for light during certain portions of the day. It was expected that shade tolerant recruits would establish along this section of stream in future years. Indeed, this is what appears to be happening in Year 4. Therefore, this area has been taken off of the Vegetation Problem Area Map in Appendix A.

Year 4 monitoring of the streams identified a few problem areas along the project reaches. The banks of a few of the outside meander bends are lacking vegetation to stabilize the slopes. These areas are considered low concern at this time. However, it should be noted that vegetation is beginning to infiltrate the bare areas in 2012; further stabilizing the banks of the project reaches.

The visual stream stability assessment revealed that the majority of stream features are functioning as designed and built on the Davis Branch mainstem and unnamed tributary. Dimensional measurements of the monumented cross-sections remain stable when compared to as-built conditions. The comparison of the As-Built, Year 1, Year 2, and Year 3 profiles to the Year 4 long-term stream monitoring profile data shows stability with minimal change from as-built conditions. The substrate of the constructed riffles remains stable, with a median particle distribution in the very coarse gravel range. The pool substrate remains stable as well, with median particle sizes ranging from silt to very coarse gravel, based on Year 4 substrate analysis. Based on the crest gage network installed on the project reaches, at least 3 bankfull events have been recorded since construction was completed. No bankfull events were recorded in Year 4.

The tables below summarize the geomorphological changes along the restoration and enhancement level 1 reaches for each stream.

Davis Branch Mainstem – Restoration Reach

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	**1,562 ft**	**1,799 ft**	**1,799 ft**	**1,799 ft**	**1,799 ft**	**1,799 ft**
Bankfull Width	**8.3 ft**	**11.3 ft**	**10.9 ft**	**12.2 ft**	**11.0 ft**	**13.8 ft**
Bankfull Max Depth	**1.8 ft**	**1.3 ft**	**1.2 ft**	**1.5**	**1.4**	**1.5**
Width/Depth Ratio	**9.1**	**19.3**	**16.2**	**13.8**	**13.1**	**18.8**
Entrenchment Ratio	**12.8**	**8.5**	**8.9**	**6.1**	**7.2**	**5.3**
Bank Height Ratio	**1.4**	**1**	**1**	**1**	**1**	**1**
Sinuosity	**1.12**	**1.29**	**1.29**	**1.29**	**1.29**	**1.29**

Davis Branch Mainstem – Enhancement Reach

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	**1,289 ft**	**1,289 ft**	**1,289 ft**	**1,289 ft**	**1,289 ft**	**1,289 ft**
Bankfull Width	**8.8 ft**	**16.7 ft**	**17.5 ft**	**19.6**	**17.8**	**18.2**
Bankfull Max Depth	**2.0 ft**	**1.3 ft**	**1.3 ft**	**1.5**	**1.4**	**1.5**
Width/Depth Ratio	**6.9**	**27**	**24.8**	**26.2**	**22.2**	**23.8**
Entrenchment Ratio	**7.2**	**3.7**	**3.5**	**3.2**	**3.7**	**3.9**
Bank Height Ratio	**1.7**	**1**	**1**	**1**	**1**	**1**
Sinuosity	**1.06**	**1.06**	**1.06**	**1.06**	**1.06**	**1.06**

Unnamed Tributary 1 – Restoration Reach

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	**334 ft**	**459 ft**	**459 ft**	**459 ft**	**459 ft**	**459 ft**
Bankfull Width	**7.8 ft**	**12.4 ft**	**11.7 ft**	**11.6**	**9.9**	**7.4**
Bankfull Max Depth	**0.9 ft**	**1.0 ft**	**0.9 ft**	**0.9**	**0.9**	**0.7**
Width/Depth Ratio	**14.4**	**29.1**	**31.6**	**26.8**	**20.2**	**20.6**
Entrenchment Ratio	**3.6**	**4.4**	**4**	**4.3**	**5.0**	**5.2**
Bank Height Ratio	**2.8**	**1**	**1**	**1**	**1**	**1**
Sinuosity	**1.09**	**1.34**	**1.34**	**1.34**	**1.34**	**1.34**

II. PROJECT BACKGROUND

A. Location and Setting

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.

The directions to the project site are as follows:

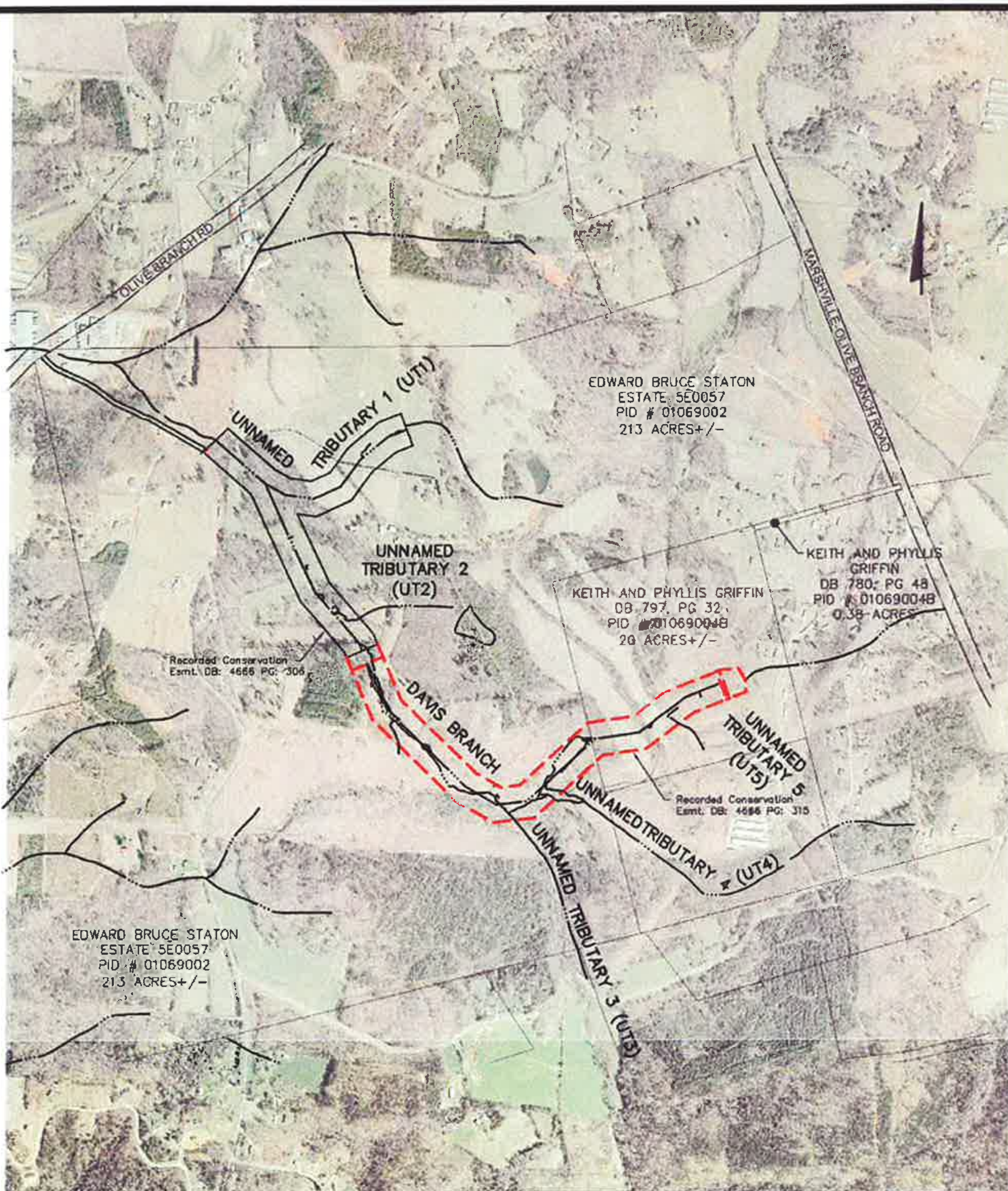
> From U.S. Route 74 in Marshville, North Carolina, turn onto North Elm Street (SR 205) and travel 5.3 miles to Olive Branch Road (SR 1006). Turn right onto Olive Branch Road and travel 3.9 miles to 9406 Olive Branch Road (Edward and Deborah Staton Residence). Turn right onto the Staton's driveway, the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

B. Project Structure, Mitigation Type, Approach and Objectives

Pre-restoration land use surrounding the project streams involved cattle pasture and hay land. Cattle had direct access to the project stream reaches for drinking water, and in areas where established riparian canopy exist, cattle frequently accessed the project corridors for shade. In doing so, the cattle had denuded and destabilized streambanks due to grazing, browsing and associated hoof shear. The unstable streambanks and denuded riparian corridors were contributing large quantities of nutrient laden sediment to the project stream reaches. Eroded sediment from the unstable streambanks was transported downstream and off site into the larger Davis Branch, Gourdvine Creek and Richardson Creek watersheds.

Runoff from agricultural land use together with cattle intrusion along the project corridors provided direct nutrient pathways into the project stream reaches. Pre-restoration, the upper reach of UT1 had sparse riparian vegetation along its stream corridor. The lower third of UT1 and the upper Davis Branch mainstem reaches had established hardwood forested riparian corridors. However, cattle intrusion had denuded herbaceous groundcover, and adversely impaired shrub, mid-story and canopy vegetation.

Prior to restoration, a number of anthropogenic factors impacted the stream channel and riparian corridor along the impaired upper mainstem restoration reach, resulting in an unstable, moderately incised and braided condition. In its pre-existing impaired state, upper Davis Branch was transitioning from E4/1 channel dimensions to a multiple thread Rosgen D4/1 stream type, albeit under incised conditions along the reach. Deep channel incision was attributed to uncontrolled cattle intrusion (herbaceous groundcover grazing, shrub vegetation browsing and hoof shear) resulting in a denuded riparian landscape and destabilized, eroding streambanks. Multiple thread channels, created by breaches that rerouted the channel around woody debris jams (avulsions) were present at locations throughout the reach. In addition to cattle intrusion, channelization and an average channel slope of 1.58 percent increased critical shear stresses acting on the streambed and banks during



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BURKE COUNTY, NORTH CAROLINA

DAVID BRANCH RESTORATION

FIGURE 1: SITE VICINITY MAP

N.C. ECOSYSTEM ENHANCEMENT PROGRAM

Date: January, 2011

Not To Scale

Ecosystem Enhancement PROGRAM

bankfull flows. Bank height ratios (BHR) calculated at impaired conditions cross-sections ranged from 1.38 to 1.41 (moderately incised).

A number of anthropogenic factors also impacted the stream channel and riparian corridor along the impaired lower mainstem Enhancement Level I (EI) reach, resulting in its pre-restoration channelized, deeply incised, eroding impaired condition. Bank height ratios calculated at impaired conditions cross-sections ranged from 1.58 to 1.86 (deeply incised). Deep channel incision resulted from steep channel gradient (2.16 percent), linear channel alignment (channel sinuosity = 1.06), mean bankfull flow velocities approaching 5.5 ft/sec, high shear velocity (u* = 0.93 ft/sec), and extremely high nearbank critical shear stress (τ_c = 1.48 lbs/ft^2). In addition to unstable channel hydraulics and morphology, uncontrolled cattle intrusion exacerbated streambank and streambed erosion. The cumulative effect of these factors resulted in nearly 5 feet high, vertical eroding streambanks on the lower Davis Branch, EI mainstem reach.

A number of anthropogenic factors impacted the stream channel and riparian corridor along the impaired UT1 reach, resulting in a channelized, entrenched and deeply incised condition. In its pre-existing impaired state, UT1 maintained E4/1b channel morphology, albeit under incised conditions. Bank height ratios calculated at impaired riffles 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), linear channel alignment (sinuosity = 1.09) high bankfull mean velocity (6.58 ft/sec), high shear velocity (u* = 0.68 ft/sec), high nearbank critical shear stress (τ_c = 0.85 lbs/ft^2) and uncontrolled cattle intrusion. The cumulative effects of these impacts resulted in nearly 4 feet high, vertical, eroding streambanks on the impaired UT1 reach.

As discussed in the Restoration Plan for Davis Branch and 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 and 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.
- Reference reach boundary conditions were superimposed 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.
- Restored connection between the bankfull channels and their floodplains, by constructing stable stream channels, protected by vegetation and jute coir fabric to prevent erosion.
- Minimized future land use impacts to project stream reaches by conveying perpetual, restrictive conservation easements 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 hay and pasture land.

The restoration of Davis Branch mainstem and UT1 met 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 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 9.1 to 18.8 on the PI/II reach and from 6.9 to 23.8 on the EI reach after three years of monitoring.
- Restored natural pattern to the PI/PII reach 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. Pattern (sinuosity = 1.06) was not modified).
- 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 vegetation including 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., deeply 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 3.34 to 6.85 after four years of monitoring.
- 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 corridors by placing livestock exclusion fencing at the edge of the perpetual, recorded conservation easement boundary.

Davis Branch 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 was 20.62 after four years of monitoring. Stable dimension and profile grade control was restored on the EII reach (profile station 0+00 to 3+96). Stable pattern, profile and dimension were restored on the PI reach (profile station 3+96 to 8+54) based on extrapolation from reference reach to restored reach boundary conditions.
- Restored stable channel pattern on the PI reach, increasing sinuosity from 1.09 to 1.34.

- 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 (deeply 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 5.22 after four years of monitoring.
- Created stable channel dimensions, substrate and grade control structures (rock sills) on the EII 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.
- Revegetated the riparian corridor with indigenous canopy, mid-story, shrub and herbaceous ground cover, preserving 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.

Information on the project structure and objectives is included in Tables I and II.

Table I. Project Structure Table
Davis Branch Stream Restoration / EEP Project No. D06054-F

Project Segment/Reach ID	Linear Footage or Acreage
Davis Branch Mainstem	3,794 ft
UT1	855 ft
TOTAL	**4,649 ft**

Table II. Project Mitigation Objectives Table
Davis Branch Stream Restoration / EEP Project No. D06054-F

Project Segment/ Reach ID	Mitigation Type	Linear Footage or Acreage	Mitigation Ratio	Mitigation Units	Comment
Davis Branch Mainstem	Preservation	766 ft	5	153 SMU's	Preserved within the conservation easement
Davis Branch Mainstem	Priority Level I/II Restoration	1,799 ft	1	1,799 SMU's	Restore dimension, pattern, and profile
Davis Branch Mainstem	Enhancement Level I	1,229 ft	1.5	819 SMU's	Restore dimension and profile
UT1	Enhancement Level II	396 ft	2.5	158 SMU's	Restore dimension and profile grade control
UT1	Priority Level I Restoration	459 ft	1	459 SMU's	Restore dimension, pattern, and profile
TOTAL		**4,649 ft**		**3,388 SMU's**	

C. Project History and Background

Project activity and reporting history are provided in Table III. The project contact information is provided in Table IV. The project background history is provided in Table V.

Table III. Project Activity and Reporting History
Davis Branch Stream Restoration / EEP Project No. D06054-F

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration plan	Apr 2007	Jul 2007	Jun 2008
Final Design - 90%[1]	--	--	--
Construction	Dec 2008	N/A	Apr 2009
Temporary S&E applied to entire project area[2]	Dec 2008	N/A	Apr 2009
Permanent plantings	Mar 2009	N/A	Apr 2009
Mitigation plan/As-built	July 2009	May 2009	June 2009
Year 1 monitoring	2009	Sept 2009 (Vegetation) Nov 2009 (Geomorphology)	Dec 2009
Year 2 monitoring	2010	Sept 2010 (Vegetation) Sep 2010 (Geomorphology)	Jan 2011
Year 3 monitoring	2011	Sept 2011 (Vegetation) Sept 2011(Geomorphology)	Dec 2011
Year 4 monitoring	2012	Sept 2012 (Vegetation) Sept 2012(Geomorphology)	Dec 2012
Year 5 monitoring	2013		

[1]Full-delivery project; 90% submittal not provided.
[2]Erosion and sediment control applied incrementally throughout the course of the project.
N/A: Data collection is not an applicable task for these project activities.

Table IV. Project Contact Table
Davis Branch Stream Restoration / EEP Project No. D06054-F

Designer	Evans, Mechwart, Hambleton & Tilton, Inc. 5500 New Albany Road, Columbus, OH 43054
Construction Contractor	South Mountain Forestry 6624 Roper Hollow, Morganton, NC 28655
Monitoring Performers	Evans, Mechwart, Hambleton & Tilton, Inc. 5500 New Albany Road, Columbus, OH 43054
Stream Monitoring POC	Jud M. Hines, EMH&T
Vegetation Monitoring POC	Megan F. Wolf, EMH&T

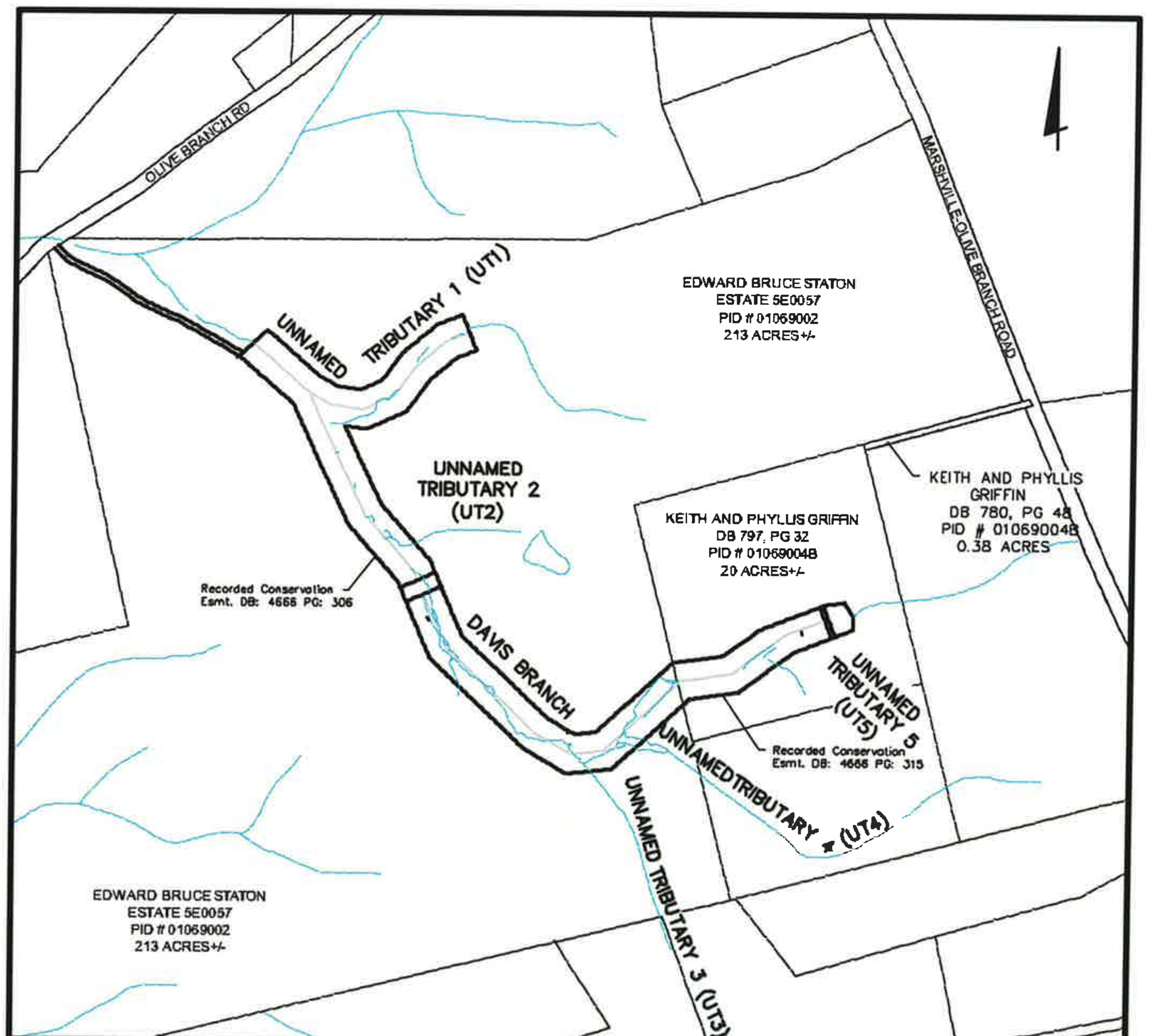
Table V. Project Background Table Davis Branch Stream Restoration / EEP Project No. D06054-F	
Project County	Union
Drainage Area	Mainstem-214.5 acres UT1-46.1 acres
Drainage Impervious Cover Estimate	0.52%
Stream Order	Mainstem - 1st, 2nd UT1 - 1st
Physiographic Region	Piedmont
Ecoregion	Carolina Slate Belt
Rosgen Classification of As-built	Mainstem restoration reach - C4/1 Mainstem E1 reach – C3/1b UT1 restoration reach - C4/1
Dominant Soil Types	Badin channery silt loam, Cid channery silt loam , Goldston-Badin complex
Reference Site ID	Davis Branch
USGS HUC for Project and Reference	03040105
NCDWQ Sub-basin for Project and Reference	3040105070080
NCDWQ Classification for Project and Reference	C*
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	Yes
Reason for 303d listing or stressor	Sediment
% of project easement fenced	100%

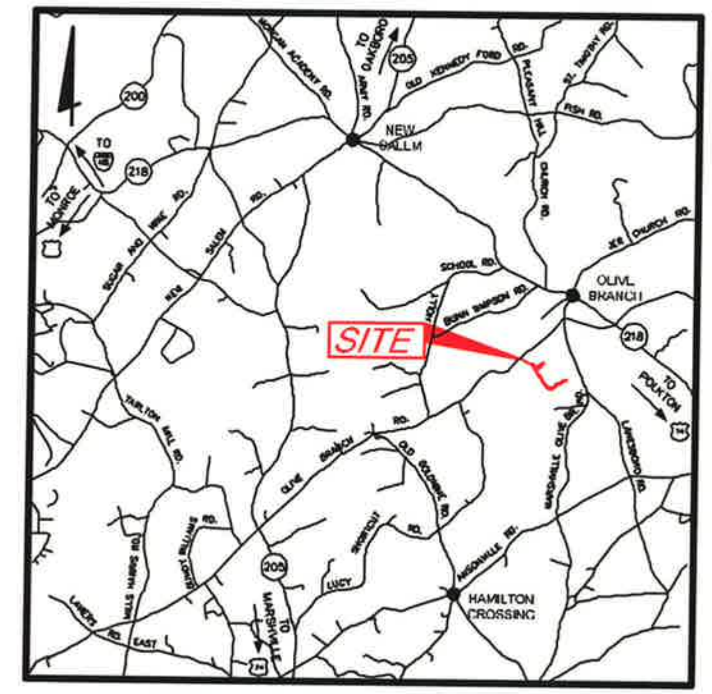
*The classification for Davis Branch was not listed within the NC DWQ Schedule of Classifications. Gourdvine Creek, the receiving water for Davis Branch, has been assigned as a Class C water.

D. Monitoring Plan View

The monitoring plan view is included as Figure 2.

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
DAVIS BRANCH AND UNNAMED TRIBUTARY
NC EEP PROJECT NO. D06054-F
2012





VICINITY MAP
Not To Scale

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
DAVIS BRANCH
AND UNNAMED TRIBUTARY
STREAM RESTORATION PROJECT
PLAN

Ecosystem Enhancement PROGRAM

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Date: December, 2012
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Sheet 1/6

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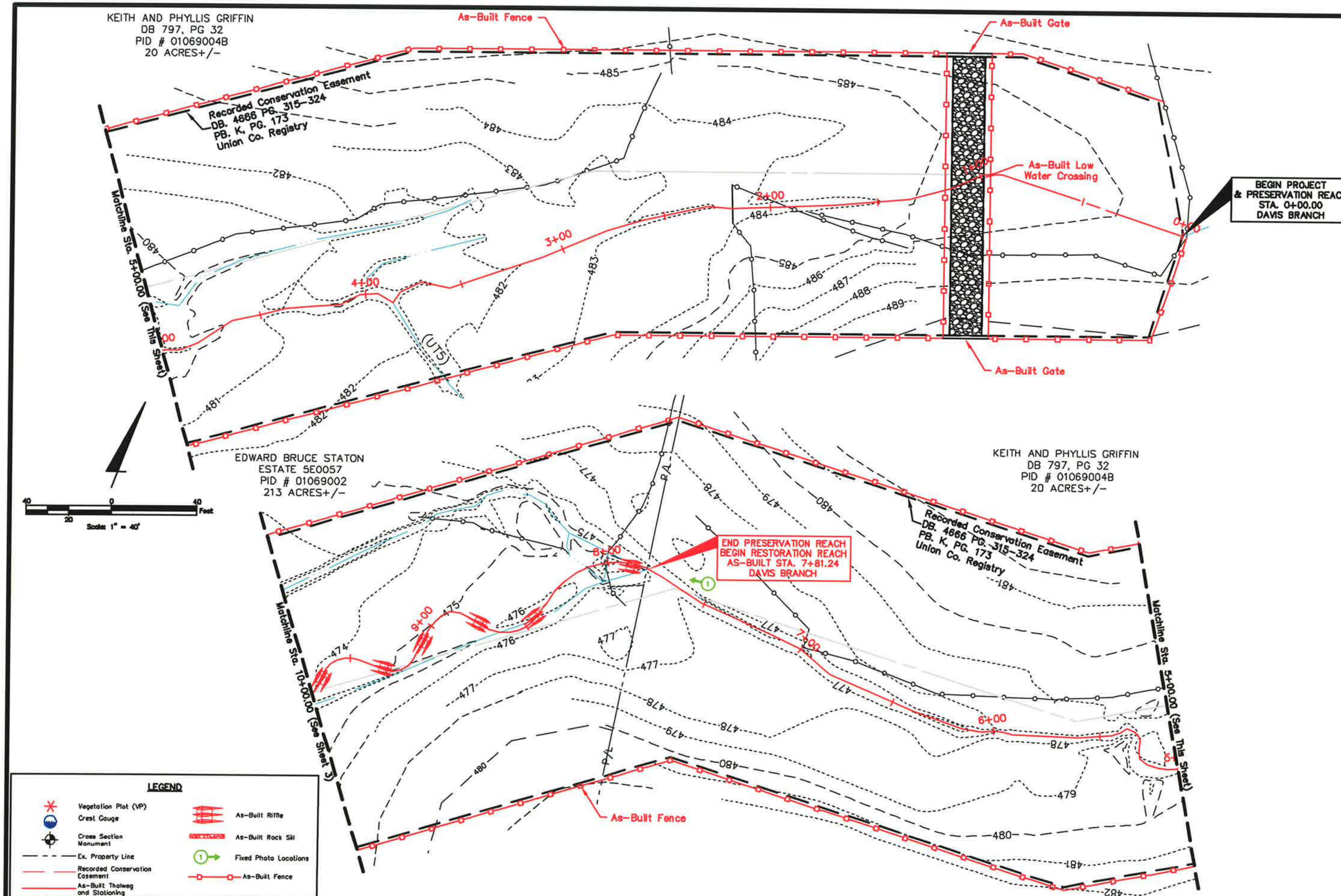

KEITH AND PHYLLIS GRIFFIN
DB 797, PG 32
PID # 01069004B
20 ACRES+/-
As-Built Fence
As-Built Gate
Recorded Conservation Easement
DB. 4666 PG. 315-324
PB. K, PG. 173
Union Co. Registry
As-Built Low Water Crossing
BEGIN PROJECT & PRESERVATION REACH STA. 0+00.00 DAVIS BRANCH
Matchline Sta. 5+00.00 (See This Sheet)
(UT5)
EDWARD BRUCE STATON
ESTATE 5E0057
PID # 01069002
213 ACRES+/-
END PRESERVATION REACH
BEGIN RESTORATION REACH
AS-BUILT STA. 7+81.24
DAVIS BRANCH
Matchline Sta. 10+00.00 (See Sheet 3)
Scale: 1" = 40'
LEGEND
Vegetation Plot (VP)
Crest Gauge
Cross Section Monument
Ex. Property Line
Recorded Conservation Easement
As-Built Thalweg and Stationing
As-Built Riffle
As-Built Rock Sill
Fixed Photo Locations
As-Built Fence

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
DAVIS BRANCH
AND UNNAMED TRIBUTARY
DAVIS BRANCH
PLAN

December, 2012 | Hor: 1" = 40' Vert: 1" = 5' | 2009-0326 | 2/6

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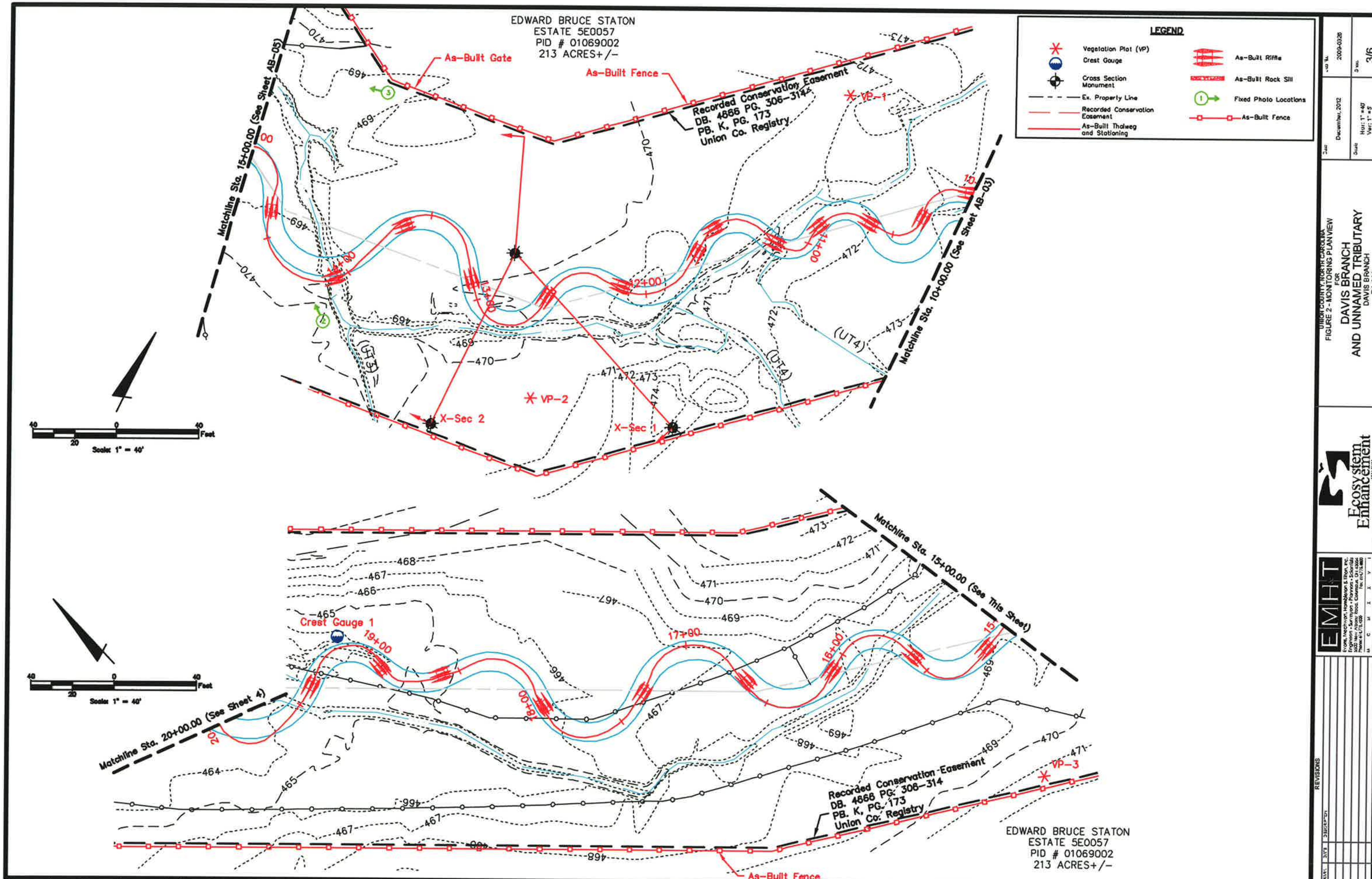

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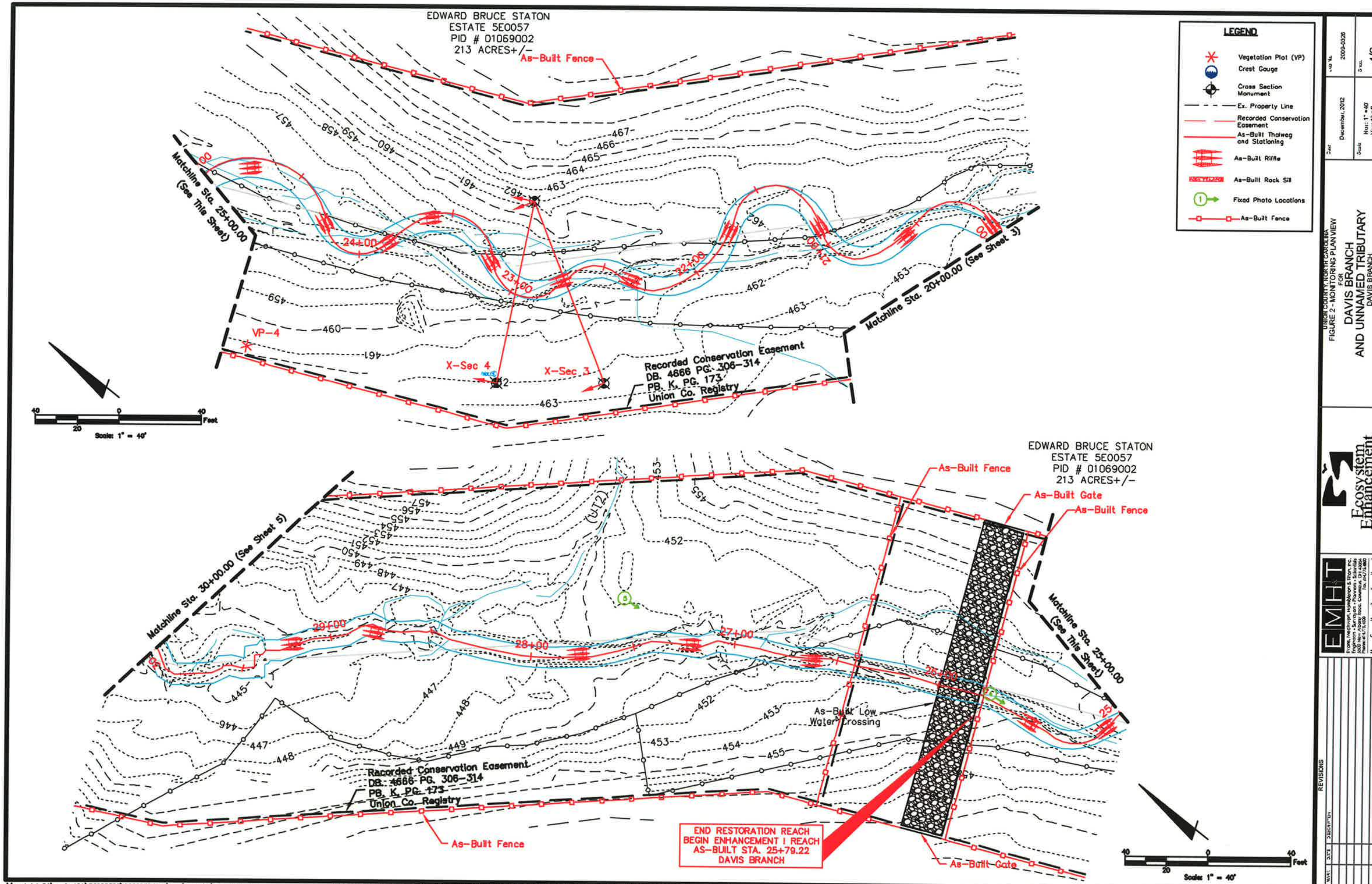
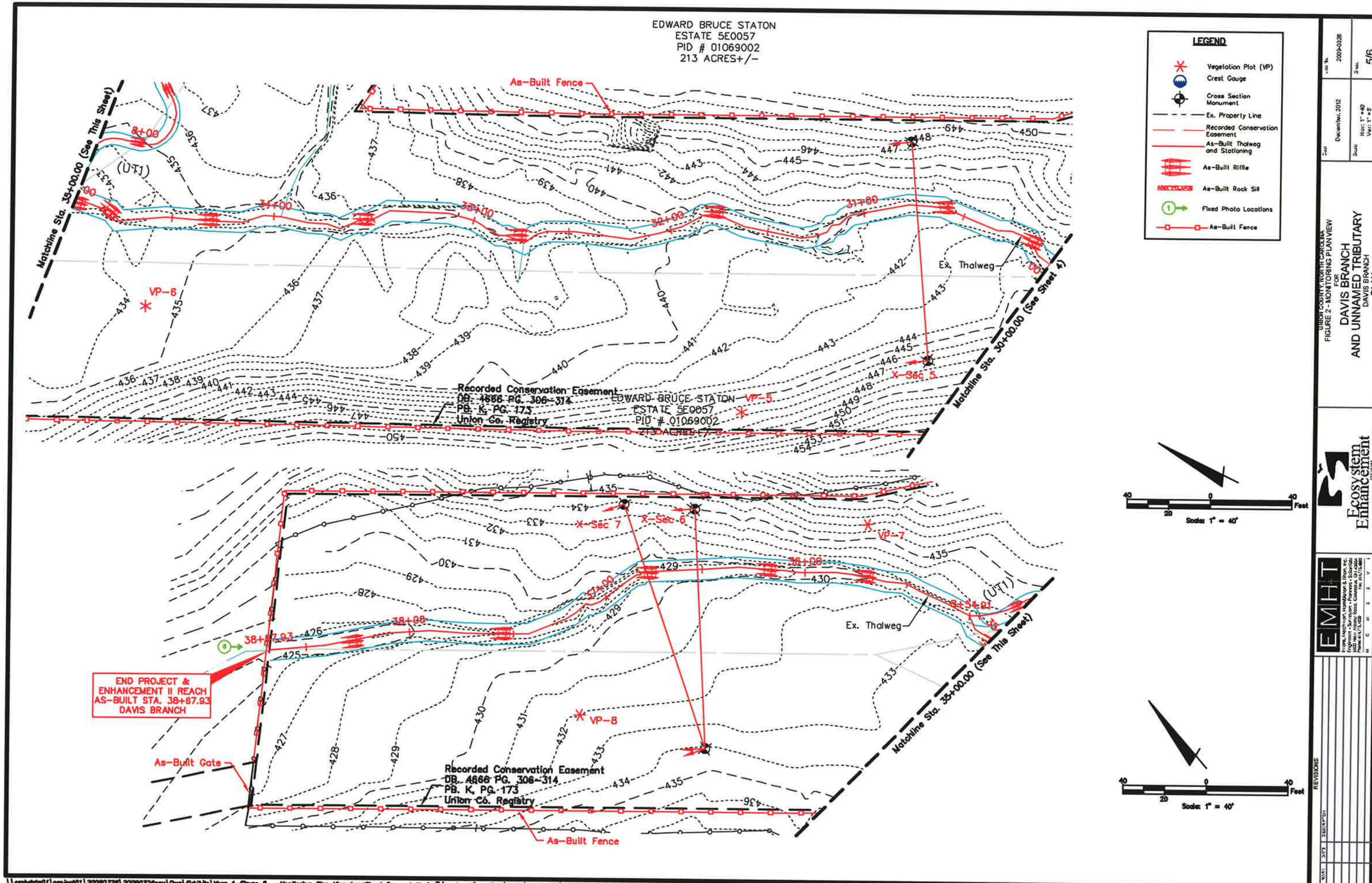
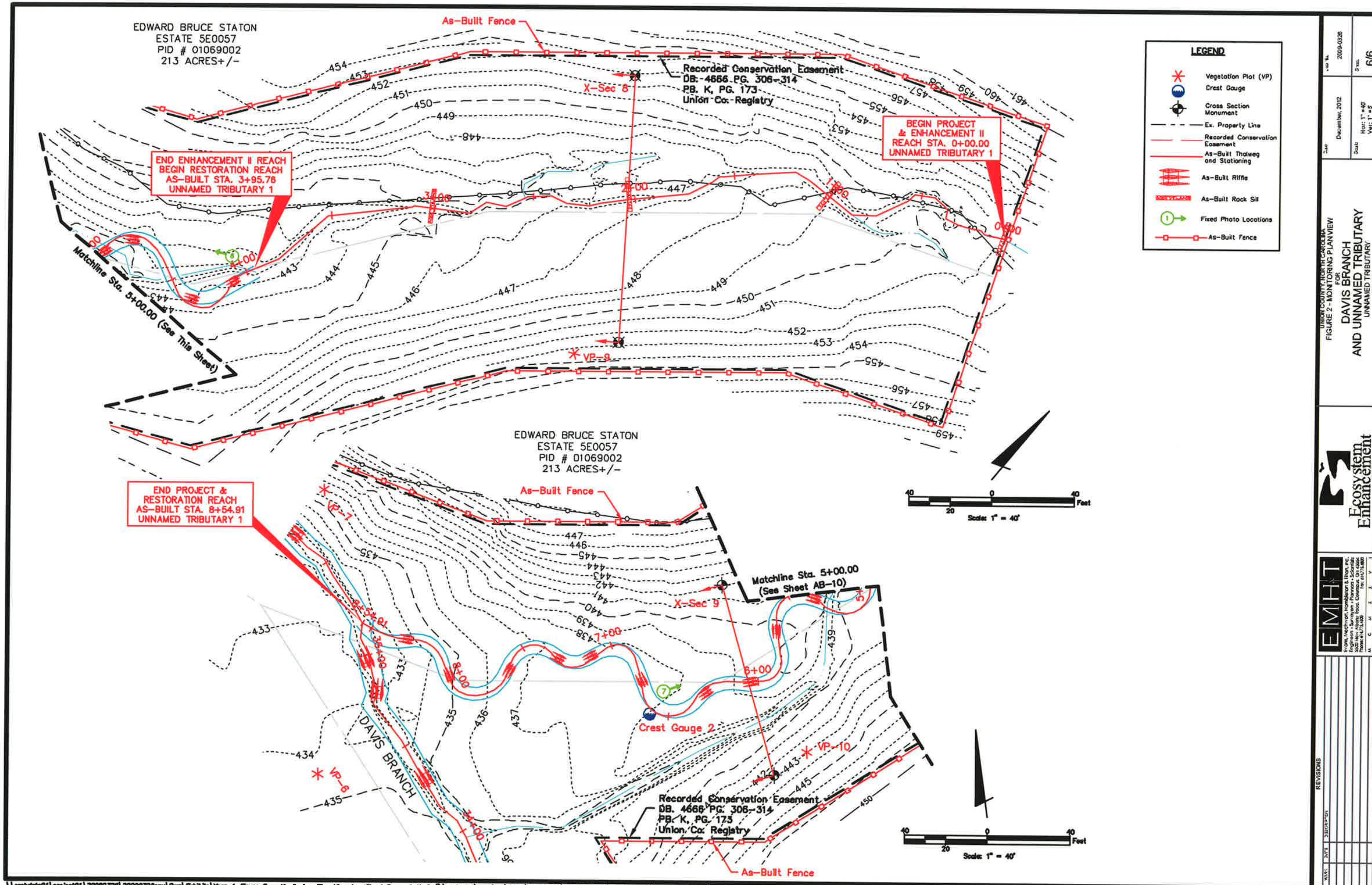


EDWARD BRUCE STATON
ESTATE 5E0057
PID # 01069002
213 ACRES+/-
As-Built Fence
Matchline Sta. 25+00.00 (See This Sheet)
Matchline Sta. 20+00.00 (See Sheet 3)
24+00
23+00
22+00
21+00
VP-4
X-Sec 4
X-Sec 3
Recorded Conservation Easement
DB. 4666 PG. 306-314
PB. K. PG. 173
Union Co. Registry
Scale: 1" = 40'
Feet
LEGEND
Vegetation Plot (VP)
Crest Gauge
Cross Section Monument
Ex. Property Line
Recorded Conservation Easement
As-Built Thalweg and Stationing
As-Built Riffle
As-Built Rock Sill
Fixed Photo Locations
As-Built Fence
As-Built Gate
Matchline Sta. 30+00.00 (See Sheet 5)
29+00
28+00
27+00
26+00
25
(UT2)
As-Built Low Water Crossing
END RESTORATION REACH
BEGIN ENHANCEMENT I REACH
AS-BUILT STA. 25+79.22
DAVIS BRANCH
As-Built Gate
UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
DAVIS BRANCH
AND UNNAMED TRIBUTARY
DAVIS BRANCH
PLAN
December, 2012
2009-0326
Hor: 1" = 40'
Ver: 1" = 5'
4/6
Ecosystem Enhancement
EMHT
REVISIONS


EDWARD BRUCE STATON
ESTATE 5E0057
PID # 01069002
213 ACRES+/-
As-Built Fence
Matchline Sta. 35+00.00 (See This Sheet)
Matchline Sta. 30+00.00 (See Sheet 4)
(UT1)
VP-6
VP-5
VP-7
VP-8
X-Sec 5
X-Sec 6
X-Sec 7
Ex. Thalweg
Recorded Conservation Easement
DB. 4666 PG. 306-314
PB. K, PG. 173
Union Co. Registry
EDWARD BRUCE STATON
ESTATE 5E0057
PID # 01069002
213 ACRES+/-
END PROJECT & ENHANCEMENT II REACH AS-BUILT STA. 38+67.93 DAVIS BRANCH
38+67.93
As-Built Gate
LEGEND
Vegetation Plot (VP)
Crest Gauge
Cross Section Monument
Ex. Property Line
Recorded Conservation Easement
As-Built Thalweg and Stationing
As-Built Riffle
As-Built Rock Sill
Fixed Photo Locations
As-Built Fence
Scale: 1" = 40'
Feet
UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
DAVIS BRANCH
AND UNNAMED TRIBUTARY
DAVIS BRANCH
PLAN
December, 2012
Hor: 1" = 40'
Ver: 1" = 5'
2009-0328
5/6
Ecosystem Enhancement
EMHT
REVISIONS



EDWARD BRUCE STATON
ESTATE 5E0057
PID # 01069002
213 ACRES+/-
As-Built Fence
Recorded Conservation Easement
DB. 4666 PG. 306-314
PB. K, PG. 173
Union Co. Registry
X-Sec 8
BEGIN PROJECT & ENHANCEMENT II REACH STA. 0+00.00 UNNAMED TRIBUTARY 1
END ENHANCEMENT II REACH BEGIN RESTORATION REACH AS-BUILT STA. 3+95.76 UNNAMED TRIBUTARY 1
Matchline Sta. 5+00.00 (See This Sheet)
VP-9
END PROJECT & RESTORATION REACH AS-BUILT STA. 8+54.91 UNNAMED TRIBUTARY 1
Matchline Sta. 5+00.00 (See Sheet AB-10)
X-Sec 9
VP-7
VP-8
VP-10
Crest Gauge 2
DAVIS BRANCH
LEGEND
Vegetation Plot (VP)
Crest Gauge
Cross Section Monument
Ex. Property Line
Recorded Conservation Easement
As-Built Thalweg and Stationing
As-Built Riffle
As-Built Rock Sill
Fixed Photo Locations
As-Built Fence
Scale: 1" = 40'
Feet
UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLANVIEW
FOR
DAVIS BRANCH
AND UNNAMED TRIBUTARY
UNNAMED TRIBUTARY
PLAN
December, 2012
2009-0326
Hor: 1" =40
Ver: 1" =5
6/6
Ecosystem Enhancement
EMHT
REVISIONS

\\emhdata01\project01\20090326\20090326env\Dwg\Exhibits\Year 4-Figure 2 - Monitoring Plan View.dwg<Sheet 6> - 1 Xref: [\\emharc1\archives\2008\20081387\20081387env\dwg\X-Refs\81387xbs(update).dwg] - No Images - SavedBy: JCRAMER [12/18/2012 10:58:58 AM] - PlottedBy: JCRAMER [12/18/2012 11:00:03 AM]

III. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

1. Soil Data

Soil information was obtained from the NRCS Soil Survey of Union County, North Carolina (USDA NRCS, January, 1996). 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, while the subsurface layer is a pale yellow channery silt loam 5 inches thick. The subsoil is 18 inches thick. 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. The depth to hard bedrock ranges from 20 to 40 inches.

Included with the Cid soils on site are areas of Badin channery silt loam (BaB), 2 to 8 percent slopes, mapped on river left along the mainstem Priority Level I/II restoration reach and along the mainstem preservation reach. The Badin map unit consists mainly of moderately deep, well drained undulating soils on convex upland ridges that are highly dissected by intermittent drainageways. Typically, the surface layer is brown Channery silt loam 7 inches thick. The subsoil is 21 inches thick. 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. An area of Badin Channery silty clay loam, 2 to 8 percent, eroded (BdC2) is present along the lower Enhancement Level I mainstem reach on Davis Branch. The soil taxonomy is essentially identical to the BaB map unit.

Goldston-Badin complex soils (map symbols - GsB and GsC), 2 to 8 and 8 to 15 percent slopes, respectively, are the mapped units on UT1. GsB soils are mapped along the upper third of the project reach. GsC soils are mapped to the confluence of UT1 with Davis Branch mainstem. The GsB mapped soil unit consists mainly of shallow and moderately deep, well drained to excessively drained, undulating Goldston and Badin soils on ridges in upland areas, as opposed to the GsC (2 to 8 percent slopes) soils mapped on side slopes. The topography is highly dissected by intermittent drainageways. The GsB unit is about 45 percent Goldston soil and about 40 percent Badin soil, while the GsC unit is about 55 percent Goldston soil and about 30 percent Badin soil.

Data on the soils series found within and near the project site is summarized in Table VI.

Table VI. Preliminary Soil Data Davis Branch Stream Restoration / EEP Project No. D06054-F					
Series	**Max. Depth (in.)**	**% Clay on Surface**	**K[1]**	**T[2]**	**% Organic Matter**
Badin channery silt loam, 2 to 8 percent slopes (BaB)	41	12-27	0.24	2	0.5-2
Badin channery silty clay loam, 8 to 15 percent slopes, eroded (BdC2)	41	27-40	0.24	2	0.5-2
Cid channery silt loam, 1 to 5 percent slopes (CmB)	32	12-27	0.32	2	0.5-2
Goldston-Badin complex, 2 to 8 percent slopes (GsB)	27	5-15	0.05	1	0.5-2
Goldston-Badin complex, 8 to 15 percent slopes (GsC)	27	5-15	0.05	1	0.5-2

[1]Erosion Factor K indicates the susceptibility of a soil to sheet and rill erosion, ranging from 0.05 to 0.69.
[2]Erosion Factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity, measured in tons per acre per year.

2. Vegetative Problem Areas

Table VII. Vegetative Problem Areas Davis Branch Stream Restoration / EEP Project No. D06054-F			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
Bare Banks	8+00 – 10+00; Mainstem	Unknown: could be shade competition or poor, rocky soil **(Resolved)**	NA

Vegetative Problem Areas are defined as areas either lacking vegetation or containing populations of exotic vegetation. There is an area of the riparian corridor along the right bank of the mainstem that was exhibiting significant denudation in 2011. This area is situated between stations 8+00 and 10+00. In Year 3, it was labeled as a vegetation problem area of low concern because there was no evidence that the denudation was currently affecting stream stability. At the time, the lack of vegetation in this area appeared to be an exacerbation of a natural condition. It is situated in the understory of a secondary growth forest where there is competition for light during certain portions of the day. It was expected that shade tolerant recruits would establish along this section of stream in future years. Indeed, this is what appears to be happening in Year 4. Therefore, this area has been taken off of the Vegetation Problem Area Map in Appendix A. There were no problem areas identified along UT1 in monitoring Year 4 to report in Table VII.

There were several areas along both the mainstem and UT1 where the herbaceous vegetation was sparse underneath the canopy of the large trees preserved during stream restoration. It is likely that the herbaceous vegetation was patchy in the riparian woodlands prior to construction for stream restoration. The condition as it exists in Year 4 is an artifact of the previously sparse vegetative community. The sparse vegetation issue has improved from Year 2 monitoring to Year 4 monitoring, as native vegetation continues to spread across the project site. Because of the previously mentioned

reasons, all of these locations of sparse vegetation are not considered problem areas at this time. A trajectory toward an increase in stabilizing vegetation cover between monitoring Years 2 and 4 is depicted in the Year 4 fixed station photos (Appendix B). There is only one vegetation plot where the density of planted woody stems is not high enough to meet the required stem counts. Densities of planted woody species are discussed in the Stem Counts section of this report.

3. Vegetation Problem Area Plan View

No vegetation problem areas of concern were noted for the project reaches in Year 4. The Vegetation Problem Area Map is included in Appendix A.

4. Stem Counts

A summary of the stem count data for each species arranged by plot is shown in Table VIII. Table VIIIa provides the survival information for planted species, while Table VIIIb provides the total stem count for the plots, including all planted and recruit stems. This data was compiled from the information collected on each plot using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0*. Additional data tables generated using the CVS-EEP format are included in Appendix A. All vegetation plots are labeled as VP on Figure 2.

5. Vegetation Problem Areas Photos

Since no vegetation problem areas were noted in Year 4 photographs are not included in Appendix A.

Table VIII. Stem counts for each species arranged by plot - planted stems. Davis Branch Stream Restoration / EEP Project No. D06054-F																
	Plots										Year 0	Year 1	Year 2	Year 3	Year 4	Survival
Species	1	2	3	4	5	6	7	8	9	10	Totals	Totals	Totals	Totals	Totals	%
Shrubs																
Alnus serrulata	1			1							6	6	5	5	2	40
Aronia arbutifolia	3	1					1		1		4	4	5	4	6	150
Cephalanthus occidentalis		10	2	7						1	14	14	17	7	20	286
Cornus amomum				2		4	6	11	10	4	5	0	13	28	37	132
Sambucus canadensis				2		3		2			0	2	2	7	7	100
Trees																
Acer saccharinum									8		0	0	0	0	8	NA
Celtis occidentalis							7		1	2	0	0	0	0	10	NA
Fraxinus pennsylvanica	2	2	4		1	2	2		1		12	12	14	15	14	93
Liriodendron tulipifera									1	3	3	3	3	3	4	133
Nyssa sylvatica					2						2	2	2	2	2	100
Platanus occidentalis	3		1	2	5	4		1	1	1	21	21	17	15	18	120
Prunus serotina				2					4	2	0	0	0	0	8	NA
Quercus bicolor	3	5			3	1		1		1	18	22	22	17	14	82
Quercus coccincea								4	8		0	0	0	20	12	NA
Quercus marilandica		1									0	0	0	0	1	NA
Quercus rubra									1		0	0	0	0	1	NA
Year 4 Totals	12	19	7	16	11	14	9	19	27	12	94	101	112	146	146	130
Live Stem Density	486	770	284	648	446	567	365	770	1094	486						
Average Live Stem Density	591															

Table VIII. Stem counts for each species arranged by plot - all stems. Davis Branch Stream Restoration / EEP Project No. D06054-F										
	Plots									
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Shrubs										
Alnus serrulata	3			1						1
Aronia arbutifolia	3	1					1		1	
Celtis occidentalis							7		1	2
Cephalanthus occidentalis		10	2	7						1
Cornus amomum				2		4	6	11	10	5
Salix exigua				1						
Sambucus canadensis				1		2		1		
Trees										
Acer saccharinum									8	
Diospyros virginiana	6									
Fraxinus pennsylvanica	2	2	4		1	3	2		1	
Liquidambar styraciflua	1									
Liriodendron tulipifera									1	3
Nyssa sylvatica					2					
Platanus occidentalis	3		1	2	5	4		1	1	1
Prunus serotina				2					4	2
Quercus bicolor	3	5			3	1		3		1
Quercus coccinea								4	10	
Quercus merilandica		1								
Quercus rubra									1	
Rhus typhina					1					
Ulmus rubra				1		1				
Year 4 Totals	21	19	7	17	12	15	16	20	38	16
Live Stem Density	851	770	284	689	486	608	648	810	1539	648
Average Live Stem Density	733									

The average stem density of planted species for the site far exceeds the minimum criteria of 288 stems per acre after four years. One plot (plot 3) has a stem density below the minimum. A substantial number of recruit stems have been found across the site, increasing the total stem density by approximately 24%. The number of recruit stems for the individual plots was large enough to bring all plots, except plot 3, into compliance with the four year minimum criteria.

To address the issue of low Year 2 stem counts for planted individuals, specific areas were targeted during the Spring of 2011 and 2012 for supplemental planting within the Davis Branch and Unnamed Tributary riparian corridors, which included the deficient sample plots and surrounding areas within the buffer. The majority of these plantings were concentrated along UT1 and the portion of the Davis Branch EI mainstem reach downstream from the confluence with UT1. Deficient portions of the riparian corridors were supplemented with additional native tree and shrub plantings. These

supplemental plantings followed the specifications of the project Restoration Plan and Mitigation Plan documents.

Large (3 gallon potted material) and small (bare-root) woody stock was utilized in performing the remedial plantings. The larger saplings have a more developed root system and will thus be better able to compete with the existing vegetation. Bare root individuals were placed along UT1 and the downstream end of Davis Branch mainstem where shade and vegetation competition is relatively nonexistent. A table describing the species and approximated quantities of vegetation installed in the spring of 2011 is included in Appendix A.

5. Vegetation Plot Photos

Vegetation plot photos are provided in Appendix A.

B. Stream Assessment

1. Hydrologic Criteria

Two crest-stage stream gages were installed on the project reaches, one each on the Davis Branch Mainstem and UT1. The locations of the crest-stage stream gages are shown on the monitoring plan view (Figure 2). No bankfull event was recorded during the fourth year of monitoring, as presented in Table IX. This brings the total number of bankfull events to three a piece, for each project reach.

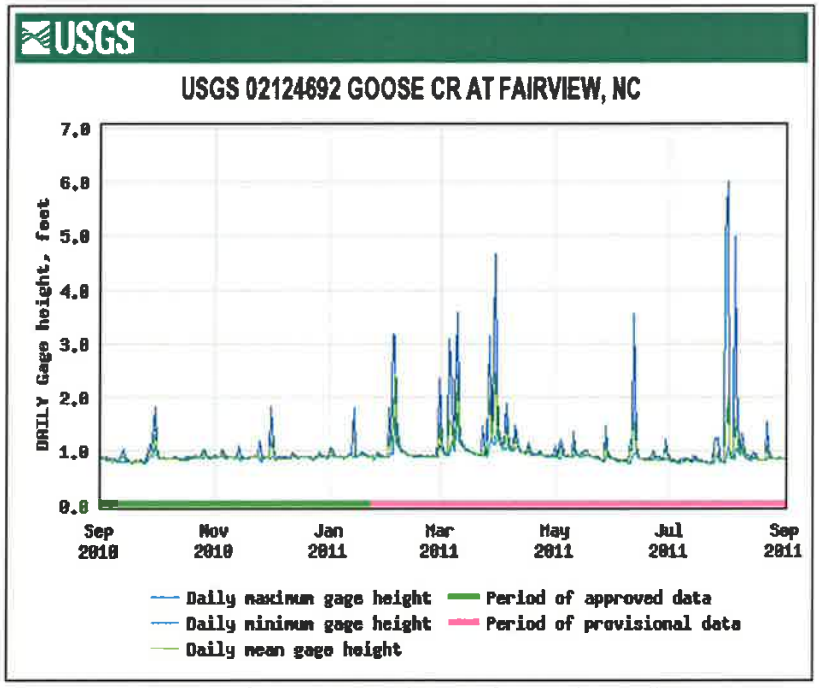
Table IX. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Photo #
9/20/2009	7/28/2009*	Mainstem & UT1 Crest Gage Data	BF1,4
9/20/2010	7/12/2010*	Mainstem & UT1 Crest Gage Data	BF2,5
9/14/2011	08/01/2011*	Mainstem & UT1 Crest Gage Data	BF3,6
9/13/2012	NA	Mainstem & UT1 Crest Gage Data	NA

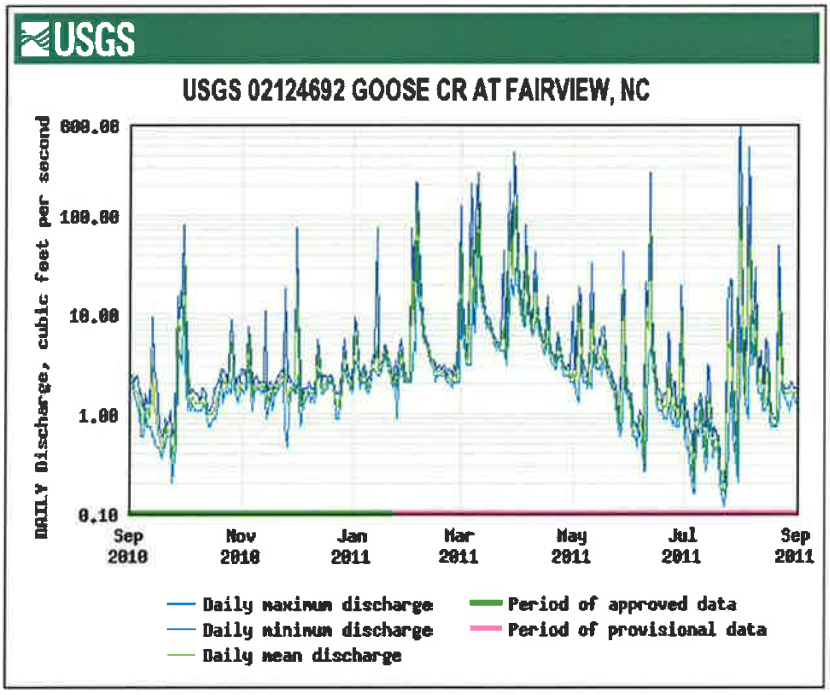
*Date is approximate; based on a review of recorded rainfall data

On September 14, 2011, the crest gage on UT1 was observed and indicated a bankfull event at a level of 6 and 5/8 inches above the bottom of the crest gage. The crest gage on the Davis Branch mainstem reach also documented the bankfull event, with a height of 6 and 3/8 inches above the bottom of the crest gage. These crest gages are set at or above the bankfull elevation of each stream channel. Photographs of the crest gages are shown in Appendix B.

The most likely date for the bankfull event was after the precipitation event that occurred on August 1, 2011. On this date, maximum daily gage height recorded at USGS Gage 02124692 Goose Creek at Fairview, NC, was 6.01 feet. Maximum discharge for this day at the same station was 759 ft^3/s. Since this is the largest precipitation event of significance since the crest gages were read in 2010, it is likely to be the bankfull event recorded by both crest gages. This particular gage lies approximately 15 miles west of the project site. The discharge and gage height recorded at the Fairview station for Year 3 monitoring are shown on the hydrographs below.



USGS Surface-Water Daily Data for North Carolina
http://waterdata.usgs.gov/nc/nwis/dv?



USGS Surface-Water Daily Data for North Carolina
http://waterdata.usgs.gov/nc/nwis/dv?

2. Stream Problem Areas

A summary of the areas of concern identified during the visual assessment of the stream for Year 4 is included in Table X.

Table X. Stream Problem Areas
Davis Branch Stream Restoration / EEP Project No. D06054-F

Feature Issue	Station Numbers	Suspected Cause	Photo Number
Erosion/Bare Banks	8+00-10+00; Mainstem	Bare banks - concern for future stability if vegetation does not develop **(RESOLVED)**	SPA 1
	18+00-19+00, 21+00-22+00, and 23+50; Mainstem	Bank erosion (along meander bends) - concern for future stability if vegetation does not develop **(RESOLVED)**	SPA 2 & SPA 3

Stream problem areas in Year 3 were isolated to a few meander bends along the Davis Branch mainstem. In these places, the right and left banks of the meander bends have little established vegetation to stabilize the slopes. In Year 4, these areas have become increasingly covered with stabilizing vegetation. These areas were considered of low concern in Year 3, as the bends were not in a state of extreme erosion. Additionally, vegetation continues to infiltrate many of the bare areas. This is resulting in an increased root density which provides better stabilization for the stream banks. At this time, remedial maintenance is not warranted. These areas are noted on the Stream Problem Area Map in Appendix B in order that they be watched to catch any erosion problems that may occur before vegetation becomes fully established along these slopes. Actively monitoring these areas will allow developing problems to be caught early and managed without the need for mechanical intervention. If erosion problems arise, the outside meander bends could be stabilized using vegetative methods such as seeding and live stakes, or with a natural fiber (coconut) geotextile. It is expected that streamside vegetation will continue to increase in density over the next year; thus allowing these stream problem areas to be de-listed from Table X and taken off the Stream Problem Area Map in Year 5.

The bare bank issues noted along UT1 in Year 2 have been lessened in Years 3 and 4 due to the colonization of native grasses and herbaceous vegetation. Evidence of the increase in streamside vegetation can be seen in the Fixed Station Photos in Appendix B. It is expected that this native vegetation will continue to fill in bare areas along UT1 in the years to come.

3. Stream Problem Areas Plan View

The locations of problem areas are shown on the stream problem area plan view included in Appendix B. Each problem area is color coded with yellow for areas of low concern (areas to be monitored) or red for high concern (areas where maintenance is warranted).

4. Stream Problem Areas Photos

Photographs of the stream problem areas are included in Appendix B.

5. Fixed Station Photos

Photographs were taken at each established photograph station on September13, 2012. These photographs are provided in Appendix B.

6. Stability Assessment Table

The visual stream assessment was performed to determine the percentage of stream features that remain in a state of stability after the fourth year of monitoring. The visual assessment for each reach is summarized in Table XIa through Table XIc. This summary was compiled from the more comprehensive Table B1, included in Appendix B. Only those structures included in the as-built survey were assessed during monitoring and reported in the tables.

Table XIa. Categorical Stream Feature Visual Stability Assessment
Davis Branch & UT1 Stream Restoration / EEP Project No. D06054-F
Segment/Reach: Mainstem Restoration Reach

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles[1]	100%	99%	98%	98%	99%	
B. Pools[2]	100%	99%	99%	98%	98%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	99%	98%	97%	98%	
E. Bed General	100%	100%	100%	100%	100%	
F. Vanes / J Hooks etc.[3]	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders[3]	N/A	N/A	N/A	N/A	N/A	

Table XIb. Categorical Stream Feature Visual Stability Assessment
Davis Branch & UT1 Stream Restoration / EEP Project No. D06054-F
Segment/Reach: Mainstem EI Reach

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles[1]	100%	100%	99%	99%	98%	
B. Pools[2]	100%	100%	100%	100%	100%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	96%	93%	98.5%	99%	
E. Bed General	100%	100%	100%	100%	100%	
F. Vanes / J Hooks etc.[3]	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders[3]	N/A	N/A	N/A	N/A	N/A	

Table XIc. Categorical Stream Feature Visual Stability Assessment Davis Branch & UT1 Stream Restoration / EEP Project No. D06054-F Segment/Reach: Unnamed Tributary 1						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles[1]	100%	97%	97%	97%	99%	
B. Pools[2]	100%	98%	98%	98%	98%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	96%	92%	96%	98%	
E. Bed General	100%	100%	100%	100%	100%	
F. Vanes / J Hooks etc.[3]	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders[3]	N/A	N/A	N/A	N/A	N/A	

[1]Riffles are assessed using the longitudinal profile. A riffle is determined to be stable based on a comparison of location and elevation with respect to the as-built profile.
[2]Pools are assessed using the longitudinal profile. A pool is determined to be stable based on a comparison of location and elevation with respect to the as-built profile and a consideration of appropriate depth.
[3]Those features not included in the stream restoration were labeled N/A. This includes structures such as rootwads and boulders.

The visual stream stability assessment revealed in-stream structures are functioning as designed and built on the Davis Branch mainstem and UT1. Rock-toe channel protection, constructed riffles and pools are functioning as designed and built. There are a few meanders along the project reaches that have minor erosion along the outer bends. In addition, there are a few meanders with bare banks, that, although not severely eroding, are in danger of doing so due to the lack of vegetation that would provide stabilization. In these areas, vegetation density has increased since 2010, especially along UT1 (see Fixed Station Photos in Appendix B). Due to increased density of streamside vegetation, meander erosion along the enhancement reach of the Davis Branch mainstem has also decreased markedly from Year 2 to Year 4.

In 2012, less meander scour and erosion was noted along the restoration reach of the mainstem than was observed in 2011. This is due in large part to a generalized increase in the density of herbaceous vegetation along channel banks since 2010. All areas of scour and erosion will again be closely monitored in Year 5 in order to assess trends in stability. If necessary, recommendations will then be given as to the appropriate bank stabilization practices needed.

In addition to the meander category, there were a few pools and riffles that did not match the as-built condition as presented in the graphs of the longitudinal profile (see Appendix B). It is assumed that the rock substrate is shifting over time, evolving into that which better matches a stable channel morphology. The pool and riffle features are all still present and functional. Additionally, a few pools on the mainstem restoration reach and UT1 exhibited minor aggradation in Year 4. These pools remain functional.

7. Quantitative Measures

Graphic interpretations of cross-sections, profiles and substrate particle distributions are presented in Appendix B. A summary of the baseline morphology for the site is included in Tables XII and XIII for comparison with the monitoring data shown in the tables in the appendix.

The stream pattern data provided for Year 4 is the same as the data provided from the As-Built survey, as pattern has not changed based on the Year 4 stream surveys and visual field assessment.

Bedform features continue to evolve along the restored reaches as shown on the long-term longitudinal profiles. Dimensional measurements of the monumented cross-sections remain stable when compared to as-built conditions. Riffle lengths, slopes and pool to pool spacings are representative of reference conditions. A few parameter measurements have changed when comparing the Year 1-4 and As-built profile data. As in previous years, the longitudinal profile survey in Year 4 continues to detect micro-features that were not identified during the as-built survey. Pool and riffle features are developing in the restored and enhanced reaches as the stream distributes its bedload and redistributes the constructed substrate during high flow events. The comparison of the As-Built and Year 4 long-term stream monitoring profile graphs show stability with minimal change from as-built conditions, with the exception of the aforementioned microfeatures.

The constructed riffles of Davis Branch mainstem remain stable, with a median particle distribution in the very coarse gravel range. The pool substrate remains stable as well, with median particle sizes ranging from silt to very course gravel based on Year 4 substrate analysis. Median particle distributions for the pools of the mainstem have fallen since 2011 (Year 3). This is a sign that, since construction, enough time has passed to allow smaller particles to settle naturally into the channel and enough flow events have occurred to sort the developing substrate. This is a sign of increasing substrate stability for the Davis Branch mainstem. The substrate is therefore stable in Year 4 and remedial maintenance work is not warranted.

A shift in particle distribution along the enhancement reach of Davis Branch resulted in a classification change from C3/1 (as-built) to C4/1 (Years 1-4). The Year 4 classification for this reach continues to be a C4/1. The as-built data was collected immediately after construction, at which time the substrate was composed almost entirely of the large material placed into the channel during construction, as well as the in situ bedrock. The subsequent monitoring results show that smaller particles have naturally settled into the larger material and caused a change in stream classification. This shift in particle distribution shows a trend toward stability and does not require any maintenance work.

The reach composite for UT1 is the same as the riffle composite for this stream, as both monumented cross sections are riffles. In Year 4, the D_{50} is 35.79 mm. This represents the second consecutive year where the D_{50} falls within the very coarse gravel range.

IV. METHODOLOGY

Year 4 vegetation monitoring was conducted in September 2012 using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee, M.T., Peet, RK., Roberts, S.R., Wentworth, T.R. 2006). Year 4 stream monitoring was conducted in September 2012 in order to provide adequate time between the Year 3 and Year 4 monitoring surveys. Subsequent stream monitoring will occur in the fall of Year 5 in order to provide a full year between surveys. Vegetation monitoring will be conducted in the fall of 2013, providing a full year between vegetative surveys.

Table XIIa: Baseline Geomorphic and Hydraulic Summary
Davis Branch and Unnamed Tributary Restoration / EEP Project No. D06054-F
Station/Reach: Mainstem Restoration Reach Station 7+81 to 25+80 (1,799 linear feet)

Parameter	Regional Curve Data			Davis Branch Reference Reach			Pre-Existing Condition			Design			As-Built (Riffle XS-1 & XS-3)			Year 1 (Riffle XS-1 & XS-3)			Year 2 (Riffle XS-1 & XS-3)			Year 3 (Riffle XS-1 & XS-3)			Year 4 (Riffle XS-1 & XS-3)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median
Dimension																											
Drainage Area (mi^2)			0.5712			0.5712			0.1823			0.1823			0.1823			0.1823			0.1823			0.1823			0.1823
Bankfull Discharge (cfs)			80.0			77.6			24.8			24.8			24.8			24.8			24.8			24.8			24.8
BF Width (ft)			11.77			12.91			8.31			9.00	9.17	13.38	11.28	8.76	13.05	10.91	9.63	14.94	12.29	7.90	14.07	10.99	10.87	16.62	13.75
Floodprone Width (ft)						50.00	52.12	165.18	106.28	63.19	238.17	117.44	63.06	112.74	87.90	60.32	114.50	87.41	69.72	71.45	70.59	66.77	76.45	71.61	61.90	74.40	68.15
BF Cross Sectional Area (ft^2)			15.85			15.65			7.56			7.92	3.99	9.98	6.99	4.22	12.01	8.12	6.48	16.87	11.68	4.81	14.97	9.89	6.05	15.06	10.56
BF Mean Depth (ft)			1.35			1.21			0.91			0.88	0.44	0.75	0.60	0.48	0.92	0.70	0.67	1.13	0.90	0.61	1.06	0.84	0.56	0.91	0.74
BF Max Depth (ft)						1.61			1.81			1.20	0.87	1.62	1.25	0.87	1.57	1.22	1.10	1.92	1.51	1.00	1.73	1.37	1.23	1.81	1.52
Width/Depth Ratio			8.72			10.67			9.13			10.23	17.84	20.84	19.34	14.18	18.25	16.22	13.22	14.37	13.80	12.95	13.27	13.11	18.26	19.41	18.84
Entrenchment Ratio						3.87	6.27	19.88	12.79	7.02	26.46	13.05	4.71	12.30	8.51	4.62	13.07	8.85	4.67	7.42	6.05	4.75	9.67	7.21	3.72	6.85	5.29
Bank Height Ratio						1.00	1.38	1.41	1.40			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	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	8.94	13.55	11.25	10.06	15.60	12.83	8.21	14.79	11.50	11.22	17.34	14.28
Hydraulic Radius (ft)			1.10			1.14			0.77			0.83	0.43	0.72	0.58	0.47	0.89	0.68	0.64	1.08	0.86	0.59	1.01	0.80	0.54	0.87	0.71
Pattern																											
Channel Beltwidth (ft)				27.80	53.00	38.00	Incised Linear Braided Channe					50.00			50.00			50.00			50.00			50.00			50.00
Radius of Curvature (ft)				16.40	45.30	29.40	Incised Linear Braided Channe			10.65	35.00	19.70	10.65	35.00	19.70	10.65	35.00	19.70	10.65	35.00	19.70	10.65	35.00	19.70	10.65	35.00	19.70
Meander Wavelength (ft)				80.10	116.50	99.20	Incised Linear Braided Channe			49.94	101.80	77.76	49.94	101.80	77.76	49.94	101.80	77.76	49.94	101.80	77.76	49.94	101.80	77.76	49.94	101.80	77.76
Meander Width Ratio				2.15	4.11	2.94	Incised Linear Braided Channe					5.56			4.43			4.59			4.07			4.55			3.64
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	6.0	25.6	12.5	5.4	28.8	12.2	7.6	37.4	14.1	7.6	29.3	14.9
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	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	0.0192	0.0887	0.0447	No Flow	No Flow	No Flow
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	10.5	44.0	22.3	10.0	51.3	26.7	10.2	65.8	30.8	12.9	65.2	31.7
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	14.0	78.6	34.1	12.3	81.3	37.6	12.1	103.3	44.8	13.4	80.1	46.4
Substrate																											
D50 (mm)						69.2			17.7			17.7	33.3	36.3	34.8	28.0	32.7	30.4	41.8	66.6	53.1	35.5	61.8	48.6	32.0	44.0	38.0
D84 (mm)						140.1			28.9			28.9	52.8	61.5	57.2	53.7	68.0	60.9	85.4	Rock	146.2	66.6	Bedrock	192.2	66.6	Bedrock	66.6
Additional Reach Parameters																											
Valley Length (ft)						974			1,397			1,397			1,397			1,397			1,397			1,397			1,397
Channel Length (ft)						1129			1,562			1,802			1,799			1,799			1,799			1,799			1,799
Sinuosity						1.2			1.12			1.29			1.29			1.29			1.29			1.29			1.29
Water Surface Slope (ft/ft)						0.03110			0.01579			0.01320	0.00828	0.01917	0.01304	0.01243	0.01782	0.01248	0.00812	0.01758	0.01232	0.01179	0.01732	0.01244	0.00895	0.01986	0.01397
Valley Slope (ft/ft)						0.03256			0.01760			0.01703	0.01066	0.02469	0.01679	0.01601	0.02295	0.01607	0.01046	0.02264	0.01587	0.01518	0.02230	0.01602	0.01153	0.02557	0.01799
Rosgen Classification			E			E3/1b*		E4/1→DA4/1				E4/1			C4/1			C4/1			C4/1			C4/1			C4/1

Notes: *E channel morphology, large cobble substrate with bedrock control, bankfull slope greater than 0.02 ft/ft.
The water surface slope in years 1, 2 and 4 represent the "channel slope" since the channel was dry.

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

Parameter	Regional Curve Data			Davis Branch Reference Reach			Pre-Existing Condition			Design			As-Built (Riffle XS-5 & XS-7)			Year 1 (Riffle XS-5 & XS-7)			Year 2 (Riffle XS-5 & XS-7)			Year 3 (Riffle XS-5 & XS-7)			Year 4 (Riffle XS-5 & XS-7)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median
Dimension																											
Drainage Area (mi^2)			0.5712			0.5712			0.3352			0.3352			0.3352			0.3352			0.3352			0.3352			0.3352
Bankfull Discharge (cfs)			80.0			77.6			45.5			45.5			45.5			45.5			45.5			45.5			45.5
BF Width (ft)			11.77			12.91			8.78			10.00	15.97	17.38	16.68	16.56	18.43	17.50	17.44	21.71	19.58	17.56	18.00	17.78	14.78	21.51	18.15
Floodprone Width (ft)						50.00	21.57	97.94	62.74	70.58	144.67	104.34	59.88	63.70	61.79	59.77	63.23	61.50	54.36	69.38	61.87	62.58	69.09	65.84	64.44	71.73	68.09
BF Cross Sectional Area (ft^2)			15.85			15.65			11.18			11.52	10.30	10.38	10.34	11.35	13.76	12.56	14.56	15.02	14.79	13.92	14.51	14.22	12.77	15.22	14.00
BF Mean Depth (ft)			1.35			1.21			1.27			1.15	0.59	0.65	0.62	0.62	0.83	0.73	0.69	0.83	0.76	0.79	0.81	0.80	0.71	0.86	0.79
BF Max Depth (ft)						1.61			2.04			1.60	1.22	1.31	1.27	1.25	1.33	1.29	1.35	1.64	1.50	1.35	1.52	1.44	1.50	1.51	1.51
Width/Depth Ratio			8.72			10.67			6.91			8.70	24.57	29.46	27.02	19.95	29.73	24.84	21.01	31.46	26.24	22.22	22.23	22.23	17.19	30.30	23.75
Entrenchment Ratio						3.87	2.46	11.15	7.15	7.06	14.47	10.43	3.67	3.75	3.71	3.43	3.61	3.52	2.50	3.98	3.24	3.48	3.93	3.71	3.34	4.36	3.85
Bank Height Ratio						1.00	1.58	1.86	1.72			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	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	16.85	18.79	17.82	17.93	22.01	19.97	17.97	18.35	18.16	15.16	21.84	18.50
Hydraulic Radius (ft)			1.10			1.14			1.10			1.06	0.59	0.64	0.62	0.60	0.82	0.71	0.68	0.81	0.75	0.77	0.79	0.78	0.70	0.84	0.77
Pattern																											
Channel Beltwidth (ft)				27.80	53.00	38.00	Incised Linear Channel			Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel		
Radius of Curvature (ft)				16.40	45.30	29.40	Incised Linear Channel			Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel		
Meander Wavelength (ft)				80.10	116.50	99.20	Incised Linear Channel			Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel		
Meander Width Ratio				2.15	4.11	2.94	Incised Linear Channel			Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored Linear Channel			Restored 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	8.4	50.7	19.1	8.1	59.5	21.3	4.3	49.9	19.4	8.3	68.8	23.6
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	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	0.0155	0.1799	0.0634	No Flow	No Flow	No Flow
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	8.4	39.2	20.4	8.0	57.9	26.2	9.8	51.2	29.2	9.4800	62.8200	34.8900
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	12.5	79.0	35.6	18.6	96.9	55.1	19.9	92.3	47.7	27.3	96.0	62.8
Substrate																											
D50 (mm)						69.2			154.0			154.0	63.1	97.1	80.1	22.6	59.3	41.0	45.0	47.7	46.9	22.6	56.4	39.5	48.8	60.2	54.5
D84 (mm)						140.1			207.4			207.4	179.3	216.5	197.9	87.8	146.2	117.0	97.3	148.8	119.9	100.6	114.3	103.7	110.9	372.1	241.5
Additional Reach Parameters																											
Valley Length (ft)						974			1213			1213			1213			1213			1213			1213			1213
Channel Length (ft)						1129			1289			1289			1289			1289			1289			1289			1289
Sinuosity						1.2			1.06			1.06			1.06			1.06			1.06			1.06			1.06
Water Surface Slope (ft/ft)						0.03110			0.02160			0.02160			0.02122			0.02124			0.02121			0.02087			0.02144
Valley Slope (ft/ft)						0.03256			0.02290			0.02290			0.02290			0.02290			0.02290			0.02290			0.02290
Rosgen Classification			E			E3/1b*			E3/1b			E3/1b			C3/1b			C4/1b			C4/1b			C4/1b			C4/1b

Notes: *E channel morphology, large cobble substrate with bedrock control, bankfull slope greater than 0.02 ft/ft.
The water surface slope in years 1, 2 and 4 represent the "channel slope" since the channel was dry.

Table XIIc: Baseline Geomorphic 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	Regional Curve Data			Davis Branch Reference Reach			Pre-Existing Condition			Design			As-Built (Riffle XS-8 & XS-9)			Year 1 (Riffle XS-8 & XS-9)			Year 2 (Riffle XS-8 & XS-9)			Year 3 (Riffle XS-8 & XS-9)			Year 4 (Riffle XS-8 & XS-9)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median
Dimension**																											
Drainage Area (mi^2)			0.5712			0.5712			0.0721			0.0721			0.0721			0.0721			0.0721			0.0721			0.0721
Bankfull Discharge (cfs)			80.0			77.6			9.8			9.8			9.8			9.8			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	11.57	11.88	11.73	11.27	11.92	11.60	8.79	10.93	9.86	6.33	8.37	7.35
Floodprone Width (ft)						50.00	7.17	78.27	28.42	32.37	105.76	47.40	50.49	57.74	54.12	37.21	56.82	47.02	44.22	55.60	49.91	45.30	52.62	48.96	35.32	40.57	37.95
BF Cross Sectional Area (ft^2)			15.85			15.65	4.27	4.31	4.30			4.45	5.14	5.45	5.30	3.69	5.18	4.44	4.32	5.93	5.13	4.65	4.81	4.73	2.17	3.11	2.64
BF Mean Depth (ft)			1.35			1.21	0.51	0.63	0.55			0.72	0.42	0.43	0.43	0.32	0.44	0.38	0.38	0.50	0.44	0.46	0.53	0.50	0.34	0.37	0.36
BF Max Depth (ft)						1.61	0.77	0.92	0.88			1.00	0.95	1.02	0.99	0.70	0.99	0.85	0.71	1.05	0.88	0.81	0.95	0.88	0.67	0.76	0.72
Width/Depth Ratio			8.72			10.67	10.87	16.45	14.37			8.61	29.00	29.26	29.13	27.00	36.16	31.58	23.84	29.66	26.75	16.58	23.76	20.17	18.62	22.62	20.62
Entrenchment Ratio						3.87	0.92	10.01	3.63	5.22	17.06	7.65	4.01	4.74	4.38	3.22	4.78	4.00	3.92	4.66	4.29	4.81	5.15	4.98	4.85	5.58	5.22
Bank Height Ratio						1.00	2.32	3.67	2.82			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	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	11.70	12.08	11.89	11.41	12.13	11.77	9.00	11.14	10.07	6.59	8.53	7.56
Hydraulic Radius (ft)			1.10			1.14	0.49	0.59	0.53			0.66	0.42	0.43	0.43	0.32	0.42	0.37	0.38	0.49	0.44	0.45	0.52	0.49	0.33	0.36	0.35
Pattern																											
Channel Beltwidth (ft)				27.80	53.00	38.00	Incised Linear Channel					50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Radius of Curvature (ft)				16.40	45.30	29.40	Incised Linear Channel			11.10	18.00	12.60	11.10	18.00	12.60	11.10	18.00	12.60	11.10	18.00	12.60	11.10	18.00	12.60	11.10	18.00	12.60
Meander Wavelength (ft)				80.10	116.50	99.20	Incised Linear Channel			50.53	58.82	52.60	50.53	58.82	52.60	50.53	58.82	52.60	50.53	58.82	52.60	50.53	58.82	52.60	50.53	58.82	52.60
Meander Width Ratio				2.15	4.11	2.94	Incised Linear Channel					8.06	3.97	4.11	4.04	4.21	4.32	4.26	4.19	4.44	4.31	4.57	5.69	5.07	5.97	7.90	6.80
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	8.3	46.6	14.8	8.5	33.1	18.8	7.7	40.0	16.6	7.4	37.8	18.4
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	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	0.0154	0.0676	0.0382	No Flow	No Flow	No Flow
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	7.1	27.8	14.7	6.2	30.6	16.9	8.5	29.2	17.6	9.5	32.5	19.6
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	10.5	38.2	22.1	13.2	58.2	28.9	13.6	40.0	28.2	14.0	57.5	29.2
Substrate																											
D50 (mm)						69.2			11.4			11.4	28.8	38.5	34.8	33.5	46.5	40.0	45.0	48.2	46.9	37.6	45.0	41.3	34.8	37.2	36.0
D84 (mm)						140.1			15.4			15.4	62.0	91.0	57.2	82.2	93.1	87.6	93.8	123.4	110.3	107.7	124.2	118.7	80.6	85.1	82.9
Additional Reach Parameters																											
Valley Length (ft)						974			670			343			343			343			343			343			343
Channel Length (ft)						1129			730			450			459			459			459			459			459
Sinuosity						1.2			1.09			1.31			1.34			1.34			1.34			1.34			1.34
Water Surface Slope (ft/ft)						0.03110			0.02300			0.02010			0.02021			0.02055			0.02055			0.01932			0.02003
Valley Slope (ft/ft)						0.03256			0.02506			0.02637			0.02704			0.02704			0.02704			0.02704			0.02704
Rosgen Classification			E			E3/1b*		E4/1b→C4/1b				E4/1b			C4/1b			C4/1b			C4/1b			C4/1b			C4/1b

Notes: *E channel morphology, large cobble substrate with bedrock control, bankfull slope greater than 0.02 ft/ft.
The water surface slope in years 1, 2 and 4 represent the "channel slope" since the channel was dry.

Table XIII: Baseline Geomorphic and Hydraulic Summary - All Cross Sections
Davis Branch and Unnamed Tributaries Stream Restoration / EEP Project No. D06054-F
Reach: Davis Branch Mainstem - Restoration

Parameter	Cross Section (Riffle 1)					Cross Section (Pool 2)					Cross Section (Riffle 3)					Cross Section (Pool 4)				
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**
BF Width (ft)	9.17	8.76	9.63	7.90	10.87	11.34	11.09	11.91	12.52	12.20	13.38	13.05	14.94	14.07	16.62	21.38	21.92	16.67	19.37	15.41
Floodprone Width (ft)	112.74	114.50	71.45	76.45	74.40	156.53	150.00	91.32	91.34	80.59	63.06	60.32	69.72	66.77	61.90	67.34	71.38	58.73	61.93	62.01
BF Cross Sectional Area (ft^2)	3.99	4.22	6.48	4.81	6.05	11.97	11.49	13.26	10.84	12.94	9.98	12.01	16.87	14.97	15.06	18.64	20.97	15.37	18.71	15.65
BF Mean Depth (ft)	0.44	0.48	0.67	0.61	0.56	1.06	1.04	1.11	0.87	1.06	0.75	0.92	1.13	1.06	0.91	0.87	0.96	0.92	0.97	1.02
BF Max Depth (ft)	0.87	0.87	1.10	1.00	1.23	2.11	2.00	2.15	2.17	2.06	1.62	1.57	1.92	1.73	1.81	2.24	2.32	1.83	1.94	1.88
Width/Depth Ratio	20.84	18.25	14.37	12.95	19.41	10.70	10.66	10.73	14.39	11.51	17.84	14.18	13.22	13.27	18.26	24.57	22.83	18.12	19.97	15.11
Entrenchment Ratio	12.30	13.07	7.42	9.67	6.85	13.80	13.53	7.67	7.30	6.61	4.71	4.62	4.67	4.75	3.72	3.15	3.26	3.52	3.20	4.02
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	9.33	8.94	10.06	8.21	11.22	12.10	11.79	12.74	13.36	12.95	13.80	13.55	15.60	14.79	17.34	22.03	22.69	17.21	20.03	16.04
Hydraulic Radius (ft)	0.43	0.47	0.64	0.59	0.54	0.99	0.97	1.04	0.81	1.00	0.72	0.89	1.08	1.01	0.87	0.85	0.92	0.89	0.93	0.98
Substrate																				
D50 (mm)	36.33	27.97	41.75	35.47	32.00	0.21	0.06	20.40	8.47	0.05	33.30	32.65	66.60	61.81	44.00	28.77	26.13	59.25	46.68	43.14
D84 (mm)	61.46	68.01	85.37	66.61	66.61	10.87	14.21	76.71	21.81	10.54	52.81	53.74	Bedrock	Bedrock	Bedrock	50.84	55.45	113.89	81.16	78.30

Table XIII: Baseline Geomorphic and Hydraulic Summary - All Cross Sections
Davis Branch and Unnamed Tributaries Stream Restoration / EEP Project No. D06054-F
Reach: Davis Branch Mainstem - Enhancement Level I

Parameter	Cross Section (Riffle 5)					Cross Section (Pool 6)					Cross Section (Riffle 7)				
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**
BF Width (ft)	17.38	18.43	17.44	17.56	21.51	11.81	12.61	12.69	10.94	14.70	15.97	16.56	21.71	18.00	14.78
Floodprone Width (ft)	63.70	63.23	69.38	69.09	71.73	84.56	79.85	74.40	65.11	89.27	59.88	59.77	54.36	62.58	64.44
BF Cross Sectional Area (ft²)	10.30	11.35	14.56	13.92	15.22	16.75	18.35	16.73	11.92	19.99	10.38	13.76	15.02	14.51	12.77
BF Mean Depth (ft)	0.59	0.62	0.83	0.79	0.71	1.42	1.46	1.32	1.09	1.36	0.65	0.83	0.69	0.81	0.86
BF Max Depth (ft)	1.22	1.25	1.64	1.52	1.50	2.28	2.33	2.27	1.85	2.39	1.31	1.33	1.35	1.35	1.51
Width/Depth Ratio	29.46	29.73	21.01	22.23	30.30	8.32	8.64	9.61	10.04	10.81	24.57	19.95	31.46	22.22	17.19
Entrenchment Ratio	3.67	3.43	3.98	3.93	3.34	7.16	6.33	5.86	5.95	6.07	3.75	3.61	2.50	3.48	4.36
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	17.57	18.79	17.93	17.97	21.84	12.87	13.64	13.75	11.67	15.69	16.19	16.85	22.01	18.35	15.16
Hydraulic Radius (ft)	0.59	0.60	0.81	0.77	0.70	1.30	1.34	1.22	1.02	1.27	0.64	0.82	0.68	0.79	0.84
Substrate															
D50 (mm)	63.06	16.00	45.00	56.40	48.80	40.13	42.84	45.00	16.94	0.05	97.12	59.25	47.72	22.60	60.20
D84 (mm)	179.28	86.10	97.27	100.63	110.90	89.70	80.16	82.80	103.66	34.61	216.50	146.19	148.80	114.32	372.05

Table XIII: Baseline Geomorphic and Hydraulic Summary - All Cross Sections
Davis Branch and Unnamed Tributaries Stream Restoration / EEP Project No. D06054-F
Reach: UT1

Parameter	Cross Section (Riffle 8)					Cross Section (Riffle 9)				
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**
BF Width (ft)	12.58	11.57	11.27	8.79	8.37	12.18	11.88	11.92	10.93	6.33
Floodprone Width (ft)	50.49	37.21	44.22	45.30	40.57	57.74	56.82	55.60	52.62	35.32
BF Cross Sectional Area (ft^2)	5.45	3.69	4.32	4.65	3.11	5.14	5.18	5.93	4.81	2.17
BF Mean Depth (ft)	0.43	0.32	0.38	0.53	0.37	0.42	0.44	0.50	0.46	0.34
BF Max Depth (ft)	0.95	0.70	0.71	0.81	0.67	1.02	0.99	1.05	0.95	0.76
Width/Depth Ratio	29.26	36.16	29.66	16.58	22.62	29.00	27.00	23.84	23.76	18.62
Entrenchment Ratio	4.01	3.22	3.92	5.15	4.85	4.74	4.78	4.66	4.81	5.58
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	12.74	11.70	11.41	9.00	8.53	12.38	12.08	12.13	11.14	6.59
Hydraulic Radius (ft)	0.43	0.32	0.38	0.52	0.36	0.42	0.43	0.49	0.45	0.33
Substrate										
D50 (mm)	28.75	46.46	45.00	37.57	37.20	38.50	33.45	48.16	45.00	34.79
D84 (mm)	62.01	82.20	93.82	107.71	80.64	91.02	93.05	123.44	124.20	85.13

APPENDIX A

Vegetation Raw Data

1. Vegetation Monitoring Plot Photos
2. Vegetation Data Tables
3. Vegetation Problem Area Plan View
4. Vegetation Installed During 2011 & 2012 Remedial Planting

Vegetation Plot 1
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 2
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 3
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 4
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 5
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 6
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 7
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 8 - note that flagging tape signifies the location of a bare root planting
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 9 – note that flagging tape signifies the location of a bare root planting
Monitoring Year 4
(EMH&T, 9/13/12)

Vegetation Plot 10
Monitoring Year 4
(EMH&T, 9/13/12)

Table 1. Vegetation Metadata	
Report Prepared By	Megan Wolf
Date Prepared	12/10/2012 12:07
database name	cvs-eep-entrytool-v2.2.6.mdb
database location	Q:\ENVIRONMENTAL\Monitoring\EEP Vegetation Database
computer name	HX1N941
file size	51777536
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj. planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj. total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	D06054F
project Name	Davis Branch
Description	Stream restoration of Davis Branch mainstem and unnamed tributary.
River Basin	
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	10

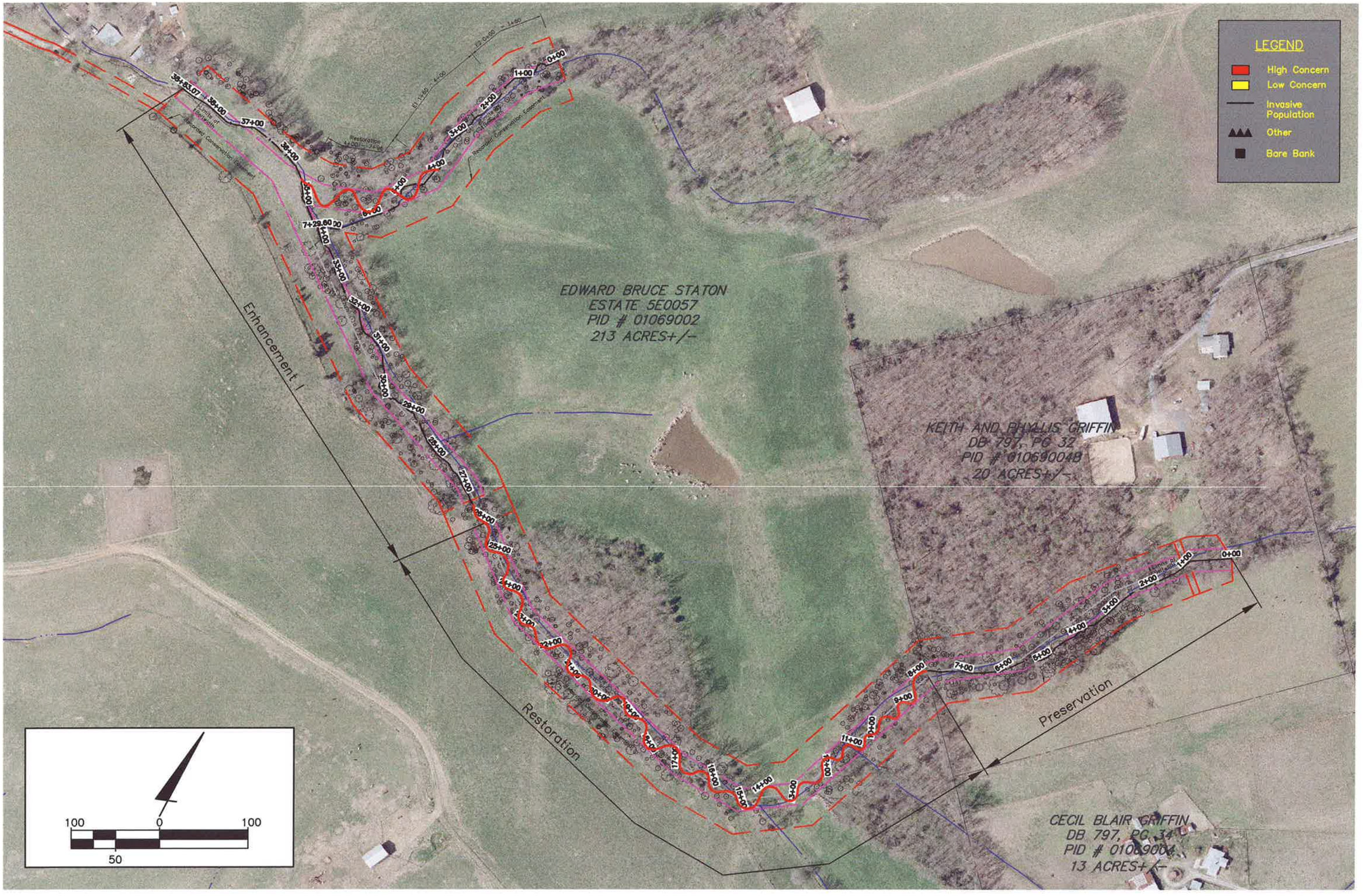
Table 2. Vegetation Vigor by Species								
	Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
	Acer saccharinum	5	3					
	Alnus serrulata	2				2	1	
	Aronia arbutifolia	5					1	1
	Celtis occidentalis	10						
	Cephalanthus occidentalis	10	2	2				6
	Cornus amomum	18	15	4		1	4	
	Fraxinus pennsylvanica	10	3			1	2	1
	Nyssa sylvatica		2					
	Quercus bicolor	8	3			2	2	3
	Quercus coccinea	6	6			2	6	
	Sambucus canadensis	4						
	Ulmus rubra	1				1		
	Cercis canadensis						1	
	Quercus marilandica		1					
	Quercus rubra	1						
	Liriodendron tulipifera	2	1	1				
	Platanus occidentalis	15	3				3	
	Prunus serotina	5	3					
TOT:	**18**	**102**	**42**	**7**		**9**	**20**	**11**

Table 3. Vegetation Damage by Species				
	Species	All Damage Categories	(no damage)	(other damage)
	Acer saccharinum	9	9	
	Alnus serrulata	5	5	
	Aronia arbutifolia	7	7	
	Celtis occidentalis	11	11	
	Cephalanthus occidentalis	20	17	3
	Cercis canadensis	1	1	
	Cornus amomum	42	37	5
	Fraxinus pennsylvanica	17	16	1
	Liriodendron tulipifera	4	2	2
	Nyssa sylvatica	2	2	
	Platanus occidentalis	21	21	
	Prunus serotina	8	6	2
	Quercus bicolor	18	17	1
	Quercus coccinea	21	17	4
	Quercus marilandica	1	1	
	Quercus rubra	2	2	
	Sambucus canadensis	5	5	
	Ulmus rubra	2	2	
TOT:	**18**	**196**	**178**	**18**

Table 4. Vegetation Damage by Plot				
	plot	All Damage Categories	(no damage)	(other damage)
	D06054F-01-0001 (year 4)	15	14	1
	D06054F-01-0002 (year 4)	19	19	
	D06054F-01-0003 (year 4)	7	7	
	D06054F-01-0004 (year 4)	17	13	4
	D06054F-01-0005 (year 4)	11	11	
	D06054F-01-0006 (year 4)	18	18	
	D06054F-01-0007 (year 4)	19	19	
	D06054F-01-0008 (year 4)	24	21	3
	D06054F-01-0009 (year 4)	48	40	8
	D06054F-01-0010 (year 4)	18	16	2
TOT:	**10**	**196**	**178**	**18**

Table 5. Stem Count by Plot and Species - Planted Stems														
	Species	Total Planted Stems	# plots	avg# stems	plot D06054F-01-0001 (year 4)	plot D06054F-01-0002 (year 4)	plot D06054F-01-0003 (year 4)	plot D06054F-01-0004 (year 4)	plot D06054F-01-0005 (year 4)	plot D06054F-01-0006 (year 4)	plot D06054F-01-0007 (year 4)	plot D06054F-01-0008 (year 4)	plot D06054F-01-0009 (year 4)	plot D06054F-01-0010 (year 4)
	Acer saccharinum	8	1	8									8	
	Alnus serrulata	2	2	1	1			1						
	Aronia arbutifolia	6	4	1.5	3	1					1		1	
	Celtis occidentalis	10	3	3.33							7		1	2
	Cephalanthus occidentalis	20	4	5		10	2	7						1
	Cornus amomum	37	6	6.17				2		4	6	11	10	4
	Fraxinus pennsylvanica	14	7	2	2	2	4		1	2	2		1	
	Liriodendron tulipifera	4	2	2									1	3
	Nyssa sylvatica	2	1	2					2					
	Platanus occidentalis	18	8	2.25	3		1	2	5	4		1	1	1
	Prunus serotina	8	3	2.67				2					4	2
	Quercus bicolor	14	6	2.33	3	5			3	1		1		1
	Quercus coccinea	12	2	6								4	8	
	Quercus marilandica	1	1	1		1								
	Quercus rubra	1	1	1									1	
	Sambucus canadensis	4	3	1.33				1		2		1		
	Ulmus rubra	1	1	1						1				
TOT:	**17**	**162**	**17**		**12**	**19**	**7**	**15**	**11**	**14**	**16**	**18**	**36**	**14**

Table 6. Stem Count by Plot and Species - All Stems														
	Species	Total Stems	# plots	avg# stems	D06054F-01-0001 (year 4)	D06054F-01-0002 (year 4)	D06054F-01-0003 (year 4)	D06054F-01-0004 (year 4)	D06054F-01-0005 (year 4)	D06054F-01-0006 (year 4)	D06054F-01-0007 (year 4)	D06054F-01-0008 (year 4)	D06054F-01-0009 (year 4)	D06054F-01-0010 (year 4)
	Acer saccharinum	8	1	8									8	
	Alnus serrulata	4	3	1.33	2			1						1
	Aronia arbutifolia	6	4	1.5	3	1					1		1	
	Celtis occidentalis	10	3	3.33							7		1	2
	Cephalanthus occidentalis	20	4	5		10	2	7						1
	Cornus amomum	38	6	6.33				2		4	6	11	10	5
	Fraxinus pennsylvanica	15	7	2.14	2	2	4		1	3	2		1	
	Nyssa sylvatica	2	1	2					2					
	Quercus bicolor	16	6	2.67	3	5			3	1		3		1
	Quercus coccinea	14	2	7								4	10	
	Sambucus canadensis	4	3	1.33				1		2		1		
	Ulmus rubra	2	2	1				1		1				
	Quercus marilandica	1	1	1		1								
	Quercus rubra	1	1	1									1	
	Liriodendron tulipifera	4	2	2									1	3
	Platanus occidentalis	18	8	2.25	3		1	2	5	4		1	1	1
	Prunus serotina	8	3	2.67				2					4	2
TOT:	**17**	**171**	**17**		**13**	**19**	**7**	**16**	**11**	**15**	**16**	**20**	**38**	**16**



Job No. 2009-0326
Sheet 1 — 1
Date December, 2012
Scale 1" = 200'

UNION COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
DAVIS BRANCH
AND UNNAMED TRIBUTARY
APPENDIX A
VEGETATION PROBLEM AREAS

Ecosystem Enhancement Program

EMH&T
Environmental Management & Planning, Inc.
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800

Table 7. Vegetation Installed during 2011 Remedial Planting			
Species (scientific name)	Species (common name)	Quantity (approximate)	Material size
Cehphalanthus occidentalis	Buttonbush	300	bare root & 3-gallon
Cornus amomum	Silky dogwood	500	bare root & 3-gallon
Quercus coccinea	Scarlet oak	300	bare root
Sambucus canadensis	Elderberry	400	bare root & 3-gallon
Ulmus americana	American elm	200	bare root

Table 8. Vegetation Installed during 2012 Remedial Planting			
Species (scientific name)	Species (common name)	Quantity (approximate)	Material size
Cehphalanthus occidentalis	Buttonbush	100	bare root & 3-gallon
Cornus amomum	Silky dogwood	200	bare root & 3-gallon
Prunus serotina	Black cherry	150	3 gallon
Quercus marilandica	Blackjack oak	300	bare root & 3-gallon
Quercus rubra	Red oak	100	bare root & 3-gallon

APPENDIX B

Geomorphologic Raw Data

1. Fixed Station Photos
2. Table B1. Qualitative Visual Stability Assessment
3. Cross Section Plots
4. Longitudinal Plots
5. Pebble Count Plots
6. Bankfull Event Photos
7. Stream Problem Areas Photos
8. Stream Problem Areas Plan View

Fixed Station 1
Overview of Davis Branch, looking downstream at Station 7+80.
(EMH&T, 9/13/12)

Fixed Station 2
Overview of Davis Branch, looking downstream near Station 14+75.
(EMH&T, 9/13/12)

Fixed Station 3
Overview of Davis Branch, looking downstream near Station 15+50.
(EMH&T, 9/13/12)

Fixed Station 4
Overview of Davis Branch, looking upstream near Station 25+75.
(Top Photo – Year 1: Sept-2009, Bottom Photo – Year 4: 9/13/12).
(EMH&T)

Fixed Station 5
Overview of Davis Branch, looking upstream near Station 27+25.
(Top Photo – Year 1: Sept-2009, Bottom Photo – Year 4: 9/13/12).
(EMH&T)

Fixed Station 6
Overview of Davis Branch, looking upstream near Station 38+75.
(Top Photo – Year 1: Sept-2009, Bottom Photo – Year 4: 9/13/12).
(EMH&T)

Fixed Station 7
Overview of UT1, looking upstream near Station 6+50.
(Top Photo – Year 1: Sept-2009, Bottom Photo – Year 4: 9/13/12).
(EMH&T)

Fixed Station 8
Overview of UT1, looking downstream near Station 4+50.
(Top Photo – Year 1: Sept-2009, Bottom Photo – Year 4: 9/13/12).
(EMH&T)

Table B1. Visual Morphological Stability Assessment
Davis Branch Stream Restoration / EEP Project No. D06054-F
Segment/Reach: Mainstem enhancement

Feature Category	Metric (per As-built and reference baselines	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	18	18	0	100	
	2. Armor stable (e.g. no displacement)?	17	18	1,0	94	
	3. Facet grade appears stable?	18	18	0	100	
	4. Minimal evidence of embedding/fining?	18	18	0	100	
	5. Length appropriate?	18	18	0	100	**99%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	19	19	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	19	19	0	100	
	3. Length appropriate?	19	19	0	100	**100%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	18	18	0	100	
	2. Downstream of meander (glide/inflection) centering?	18	18	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	17	18	1,0	94	
	2. Of those eroding, # w/concomitant point bar formation?	18	18	0	100	
	3. Apparent Rc within spec?	18	18	0	100	
	4. Sufficient floodplain access and relief?	18	18	0	100	**99%**
E. Bed General	1. Geveral channel bed aggradation areas (bar formation)	N/A	N/A	0/0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/0 feet	100	**100%**
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	**N/A**
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	
	2. Footing stable?	N/A	0	N/A	N/A	**N/A**

Table B1. Visual Morphological Stability Assessment
Davis Branch Stream Restoration / EEP Project No. D06054-F
Segment/Reach: Mainstem restoration

Feature Category	Metric (per As-built and reference baselines	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	41	41	0	100	
	2. Armor stable (e.g. no displacement)?	37	41	4,0	90	
	3. Facet grade appears stable?	41	41	0	100	
	4. Minimal evidence of embedding/fining?	41	41	0	100	
	5. Length appropriate?	41	41	0	100	**98%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	40	40	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	37	40	3,0	92.5	
	3. Length appropriate?	40	40	0	100	**98%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	36	36	0	100	
	2. Downstream of meander (glide/inflection) centering?	36	36	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	33	36	3,0	92	
	2. Of those eroding, # w/concomitant point bar formation?	36	36	0	100	
	3. Apparent Rc within spec?	36	36	0	100	
	4. Sufficient floodplain access and relief?	36	36	0	100	**98%**
E. Bed General	1. Geveral channel bed aggradation areas (bar formation)	N/A	N/A	0/0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/0 feet	100	**100%**
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	**N/A**
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	
	2. Footing stable?	N/A	0	N/A	N/A	**N/A**

Table B1. Visual Morphological Stability Assessment
Davis Branch Stream Restoration / EEP Project No. D06054-F
Segment/Reach: UT1 restoration

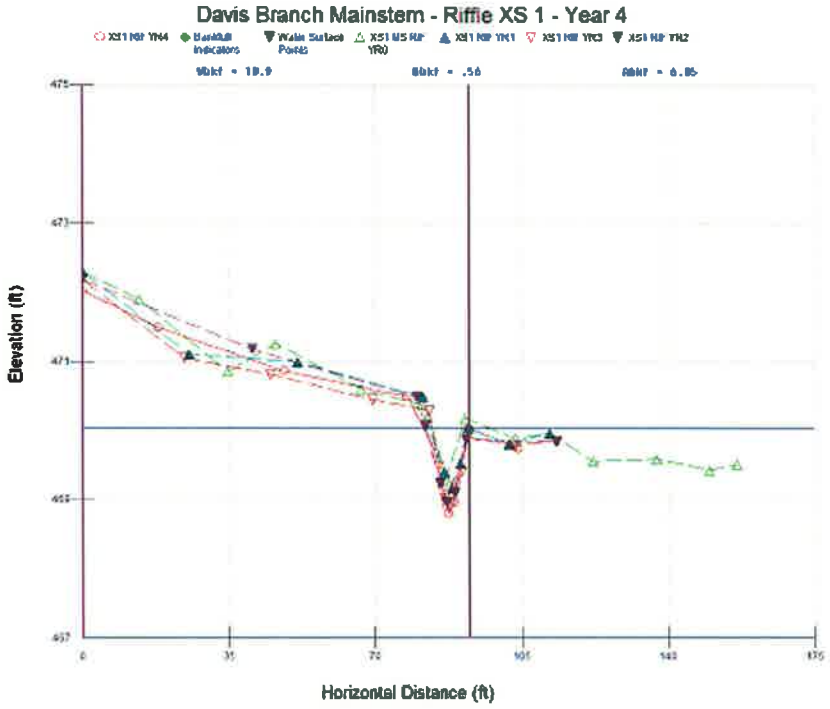
Feature Category	Metric (per As-built and reference baselines	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	14	14	0	100	
	2. Armor stable (e.g. no displacement)?	13	14	1,0	93	
	3. Facet grade appears stable?	14	14	0	100	
	4. Minimal evidence of embedding/fining?	14	14	0	100	
	5. Length appropriate?	14	14	0	100	**99%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	14	14	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	13	14	1,0	93	
	3. Length appropriate?	14	14	0	100	**98%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	12	12	0	100	
	2. Downstream of meander (glide/inflection) centering?	12	12	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	11	12	1,0	92	
	2. Of those eroding, # w/concomitant point bar formation?	12	12	0	100	
	3. Apparent Rc within spec?	12	12	0	100	
	4. Sufficient floodplain access and relief?	12	12	0	100	**98%**
E. Bed General	1. Geveral channel bed aggradation areas (bar formation)	N/A	N/A	0/0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/0 feet	100	**100%**
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	**N/A**
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	
	2. Footing stable?	N/A	0	N/A	N/A	**N/A**

Summary Data
All dimensions in feet.

Bankfull Area	6.05 ft^2
Bankfull Width	10.87 ft
Mean Depth	.56 ft
Maximum Depth	1.23 ft
Width/Depth Ratio	19.41
Entrenchment Ratio	6.85
Classification	C

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Davis Branch
DATE	09/13/2012
CROSS SECTION:	1
FEATURE:	Riffle

Cross-section photo – looking across channel from right bank to left bank

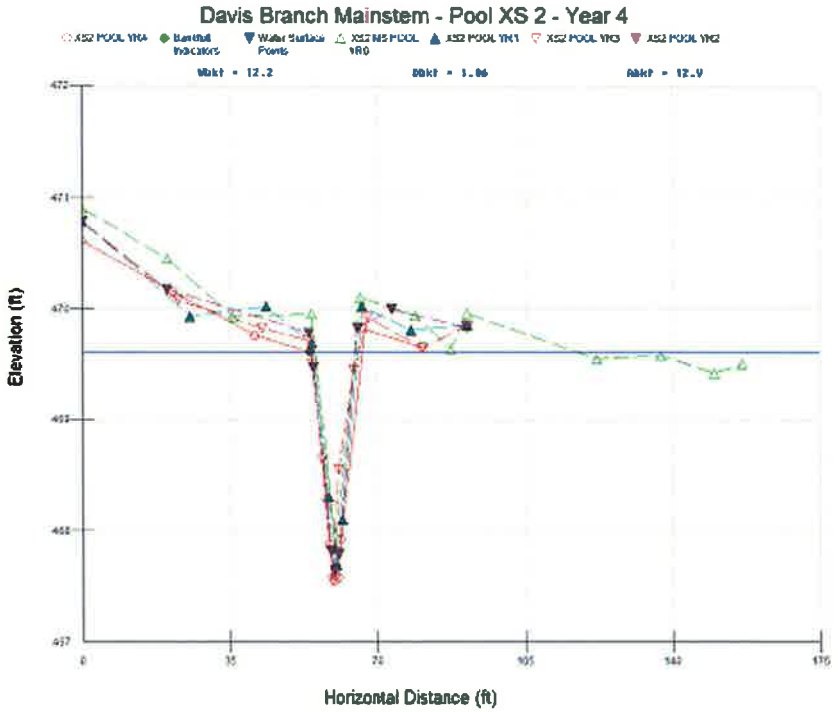


Summary Data
All dimensions in feet.

Bankfull Area	12.94 ft^2
Bankfull Width	12.20 ft
Mean Depth	1.06 ft
Maximum Depth	2.06 ft
Width/Depth Ratio	11.51
Entrenchment Ratio	6.61

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Davis Branch
DATE	09/13/2012
CROSS SECTION:	2
FEATURE:	Pool

Cross-section photo – looking across channel from right bank to left bank

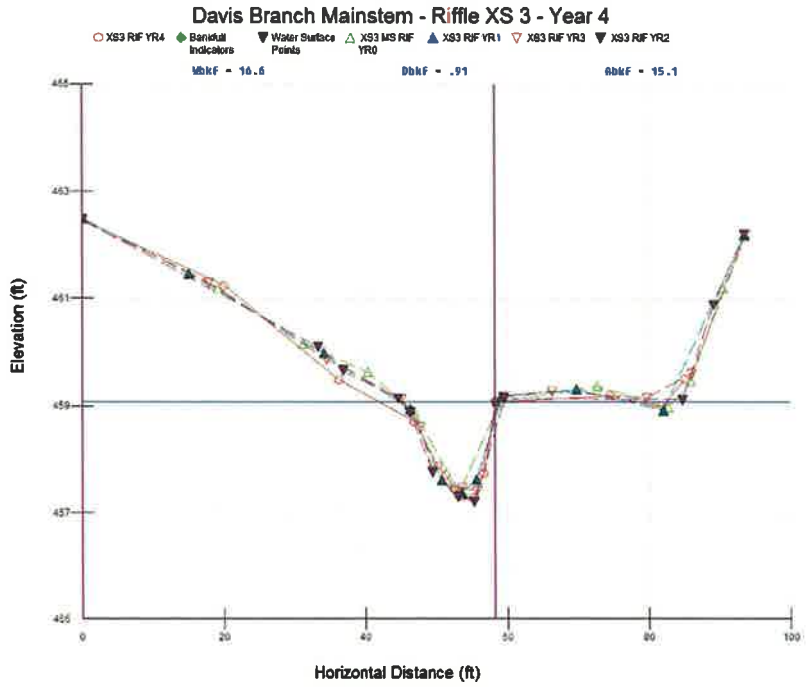


Summary Data
All dimensions in feet.

Bankfull Area	15.06 ft^2
Bankfull Width	16.62 ft
Mean Depth	0.91 ft
Maximum Depth	1.81 ft
Width/Depth Ratio	18.26
Entrenchment Ratio	3.72
Classification	C

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Davis Branch
DATE	09/13/2012
CROSS SECTION:	3
FEATURE:	Riffle

Cross-section photo – looking right bank to left bank

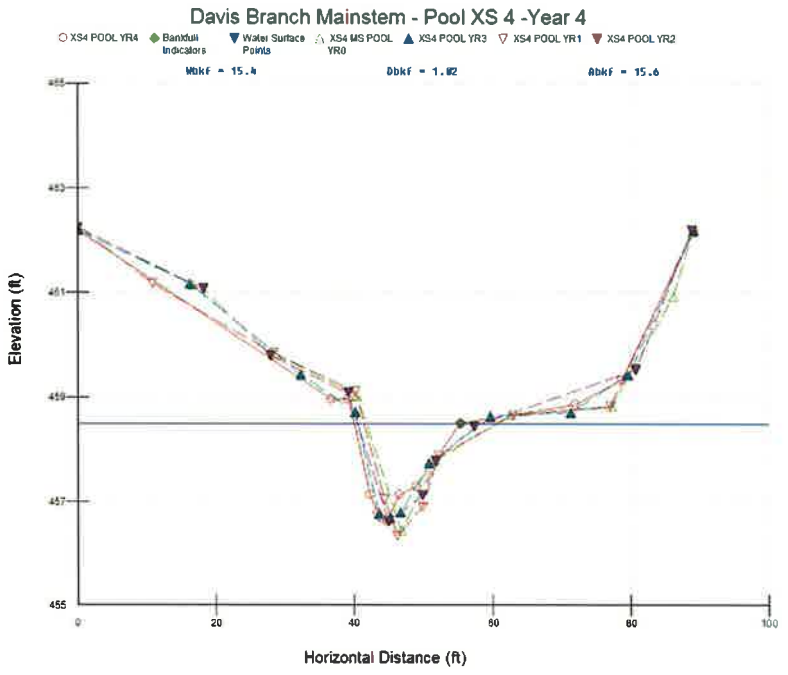


Summary Data
All dimensions in feet.

Bankfull Area	15.65 ft^2
Bankfull Width	15.41 ft
Mean Depth	1.02 ft
Maximum Depth	1.88 ft
Width/Depth Ratio	15.11
Entrenchment Ratio	4.02

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Davis Branch
DATE	09/13/2012
CROSS SECTION:	4
FEATURE:	Pool

Cross-section photo – looking upstream

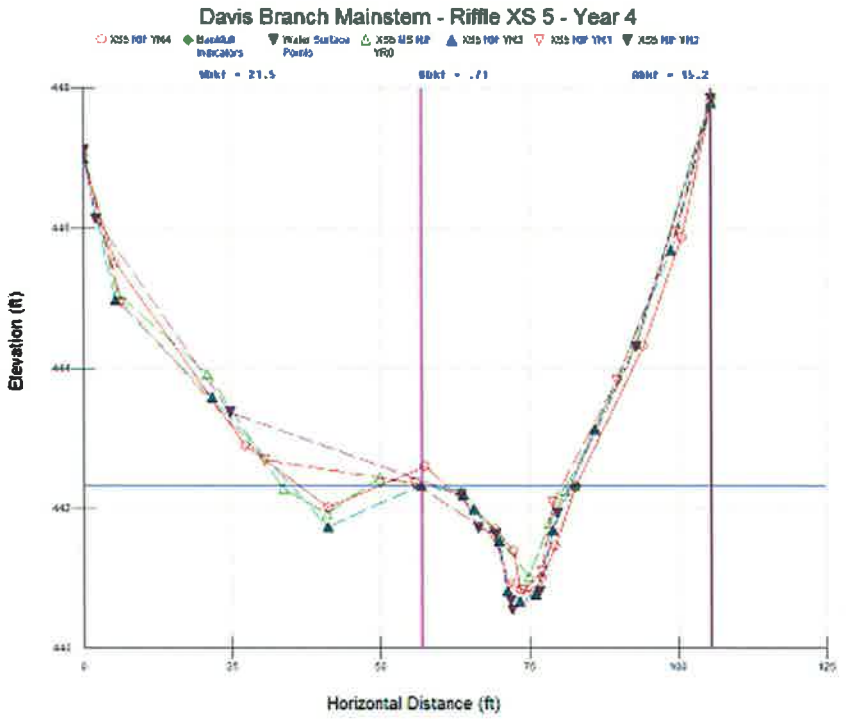


Summary Data
All dimensions in feet.

Bankfull Area	15.22 ft^2
Bankfull Width	21.51 ft
Mean Depth	0.71 ft
Maximum Depth	1.50 ft
Width/Depth Ratio	30.30
Entrenchment Ratio	3.34
Classification	C

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Davis Branch
DATE	09/13/2012
CROSS SECTION:	5
FEATURE:	Riffle

Cross-section photo – looking right bank to left bank

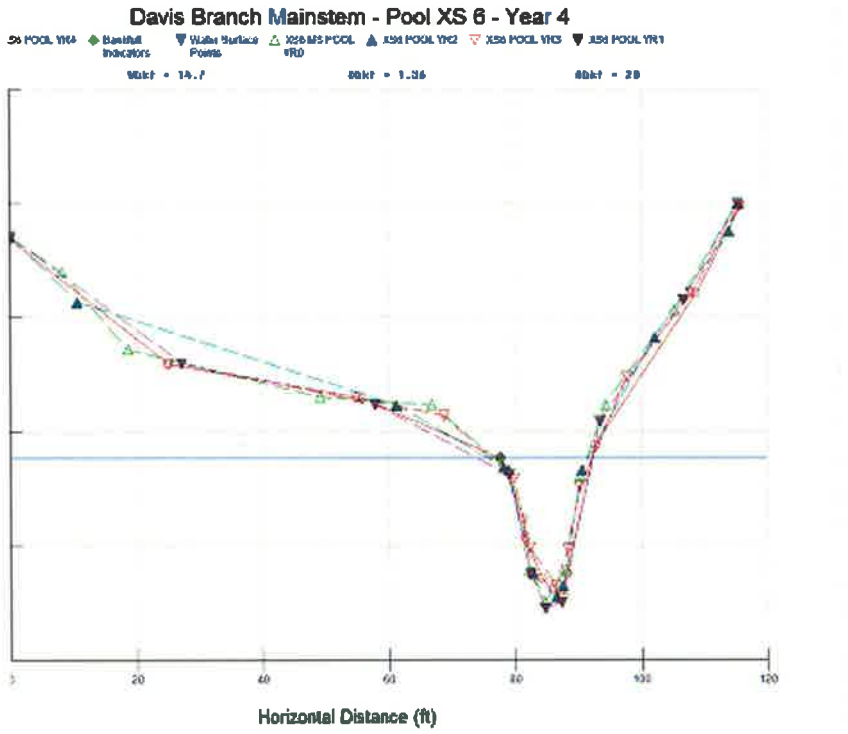


Summary Data
All dimensions in feet.

Bankfull Area	19.99 ft^2
Bankfull Width	14.70 ft
Mean Depth	1.36 ft
Maximum Depth	2.39 ft
Width/Depth Ratio	10.81
Entrenchment Ratio	6.07

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Davis Branch
DATE	09/13/2012
CROSS SECTION:	6
FEATURE:	Pool

Cross-section photo – looking left bank to right bank

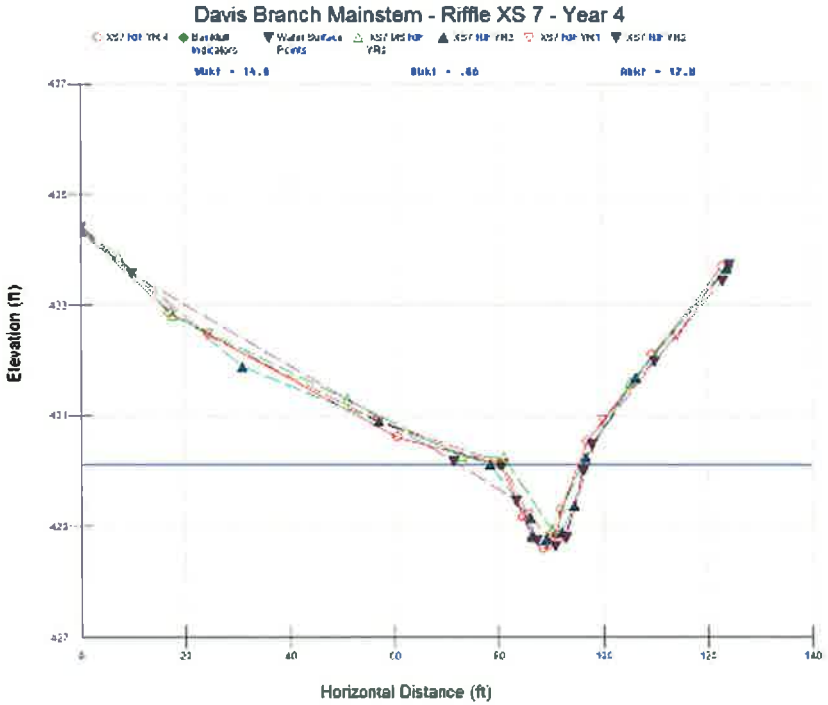


Summary Data
All dimensions in feet.

Bankfull Area	12.77 ft^2
Bankfull Width	14.78 ft
Mean Depth	0.86 ft
Maximum Depth	1.51 ft
Width/Depth Ratio	17.19
Entrenchment Ratio	4.36
Classification	C

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Davis Branch
DATE	09/13/2012
CROSS SECTION:	7
FEATURE:	Riffle

Cross-section photo – looking across channel from left bank to right bank

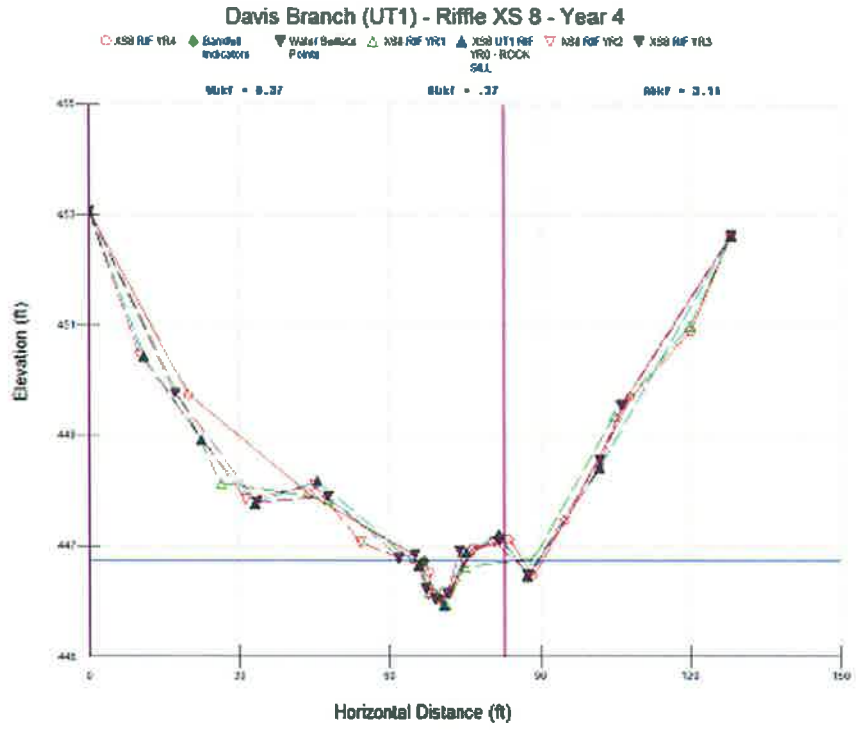


Summary Data
All dimensions in feet.

Bankfull Area	3.11 ft^2
Bankfull Width	8.37 ft
Mean Depth	0.37 ft
Maximum Depth	0.67 ft
Width/Depth Ratio	22.62
Entrenchment Ratio	4.85
Classification	C

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Unnamed Trib. 1
DATE	09/13/2012
CROSS SECTION:	8
FEATURE:	Riffle

Cross-section photo – looking right bank to left bank

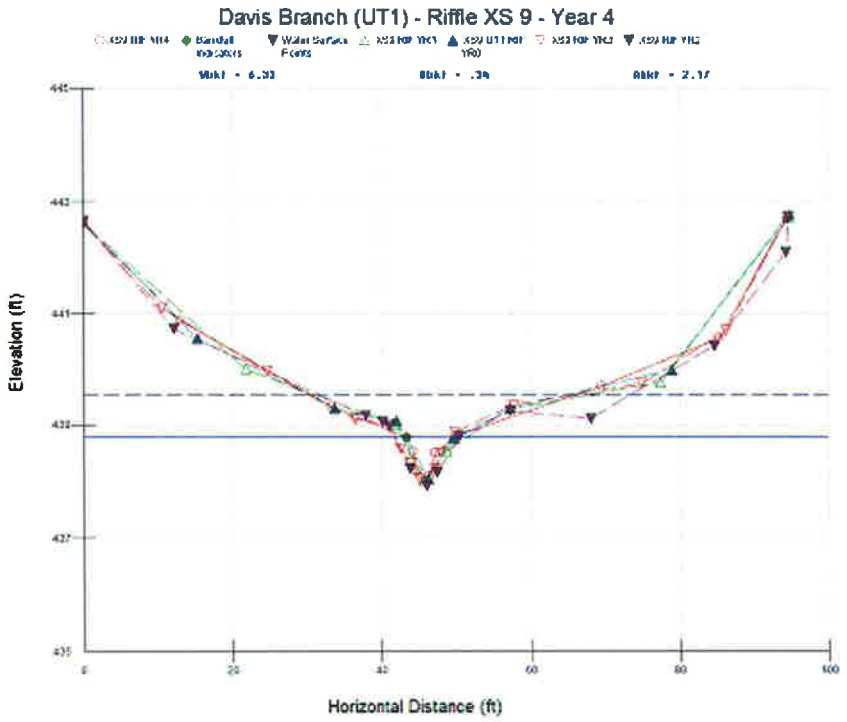


Summary Data
All dimensions in feet.

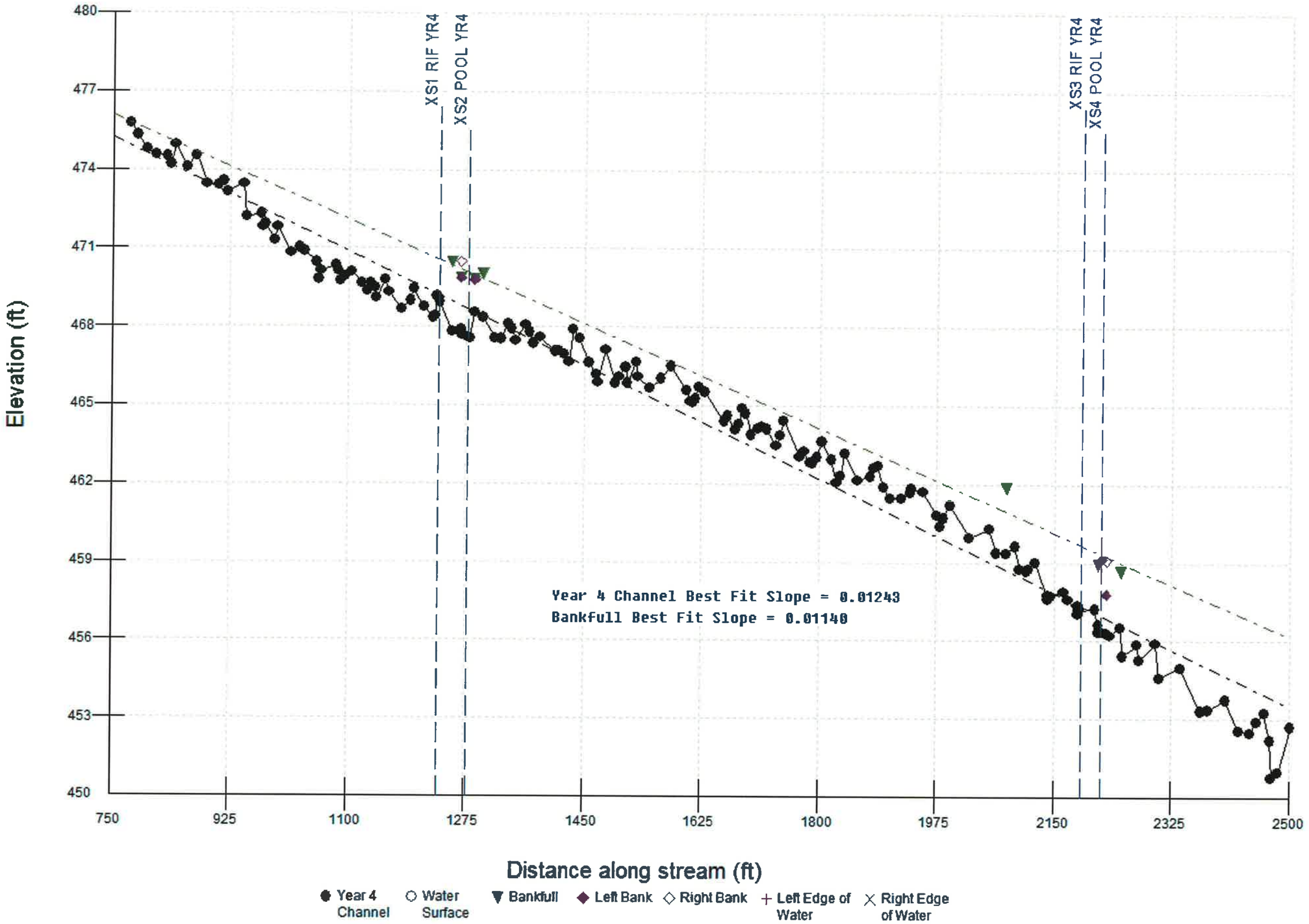
Bankfull Area	2.17 ft^2
Bankfull Width	6.33 ft
Mean Depth	0.34 ft
Maximum Depth	0.76 ft
Width/Depth Ratio	18.62
Entrenchment Ratio	5.58
Classification	C

PROJECT	Davis Branch
	D06054-F
	4-YEAR
TASK	Cross-Section
REACH	Unnamed Trib. 1
DATE	09/13/2012
CROSS SECTION:	9
FEATURE:	Riffle

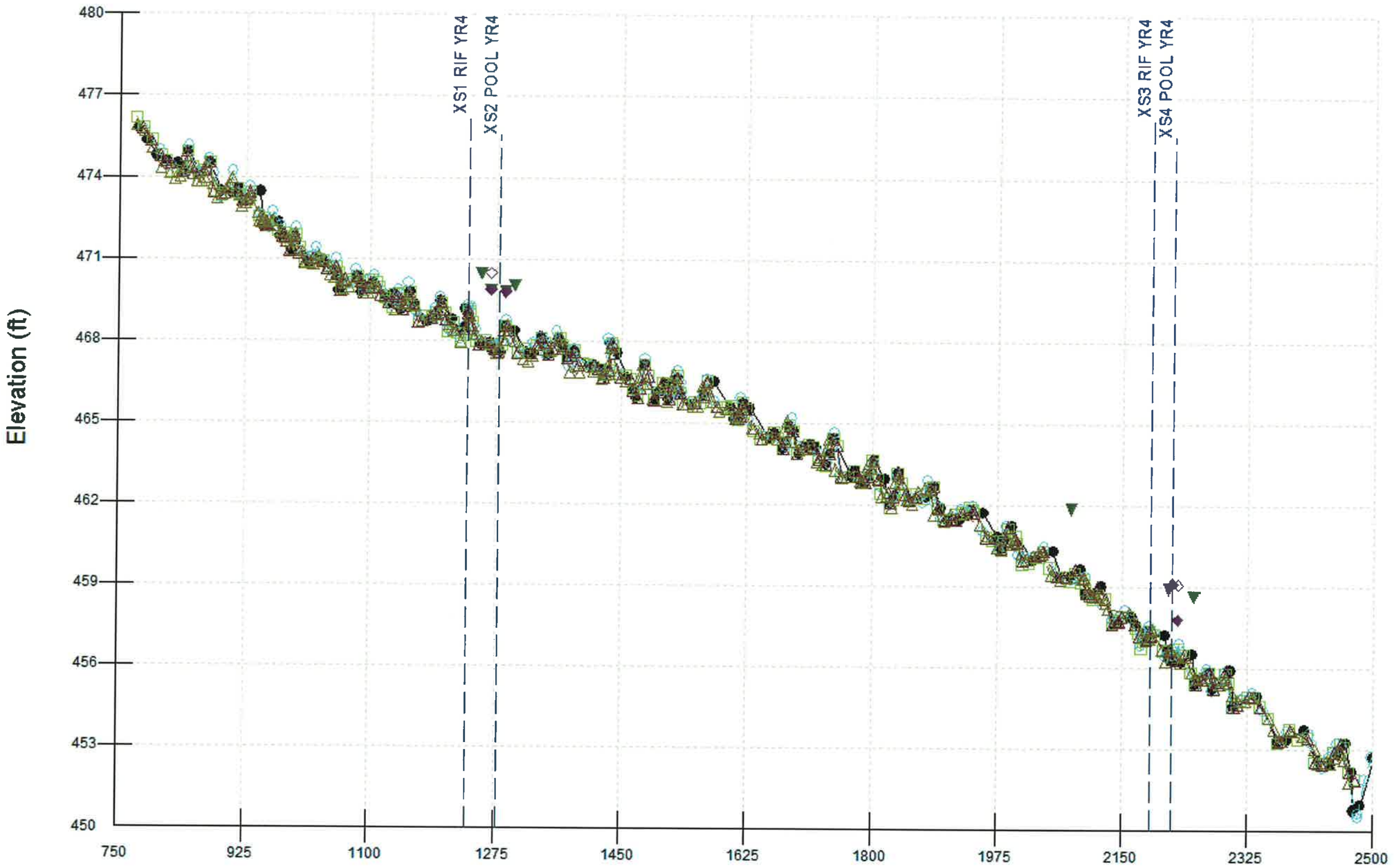
Cross-section photo – looking across the channel from right bank to left bank



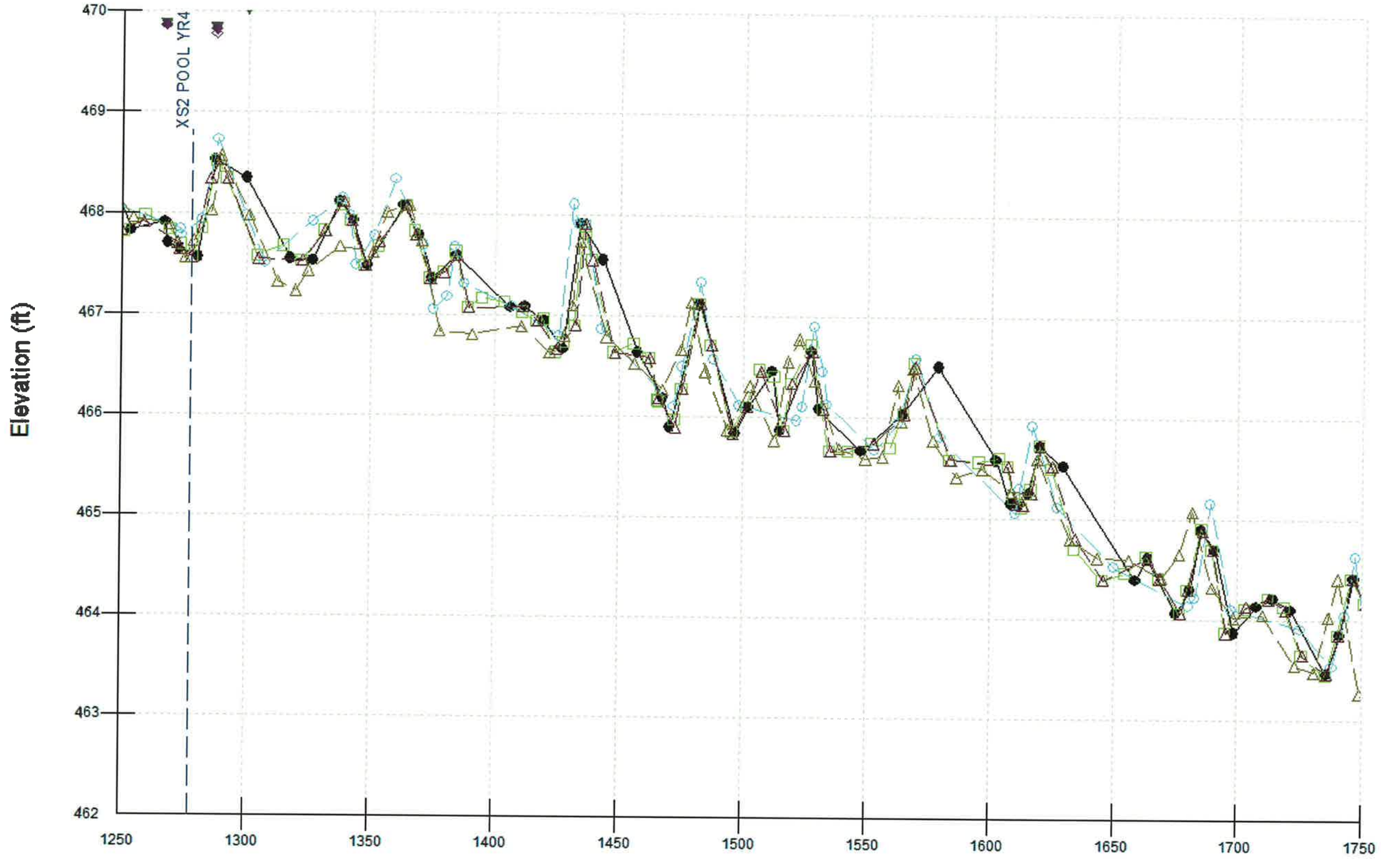
Davis Branch Mainstem - Restoration Profile - Year 4 - 13 Sep 2012



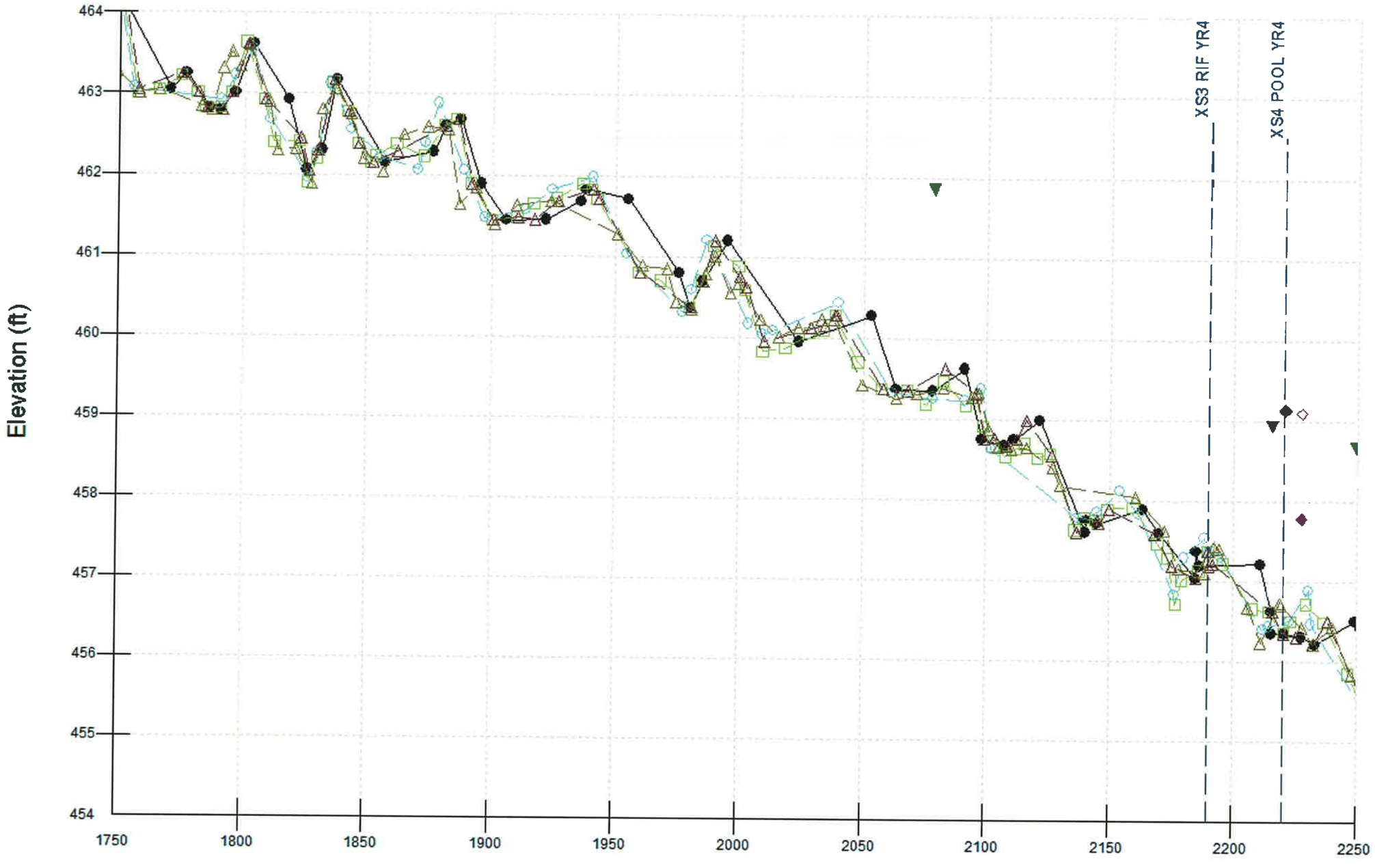
Davis Branch Mainstem - Restoration Profile - Year 4 - 13 Sep 2012



Davis Branch Mainstem - Restoration Profile - Year 4 - 13 Sep 2012



Davis Branch Mainstem - Restoration Profile - Year 4 - 13 Sep 2012



Distance along stream (ft)

Year 4 Channel | Water Surface | Bankfull | Left Bank | Right Bank | Left Edge of Water | Right Edge of Water | Year 1 Channel | Year 0 Channel | Year 2 Channel | Year 3 Channel

Davis Branch Mainstem - Restoration Profile - Year 4 - 13 Sep 2012

XS4 POOL YR4

Elevation (ft)

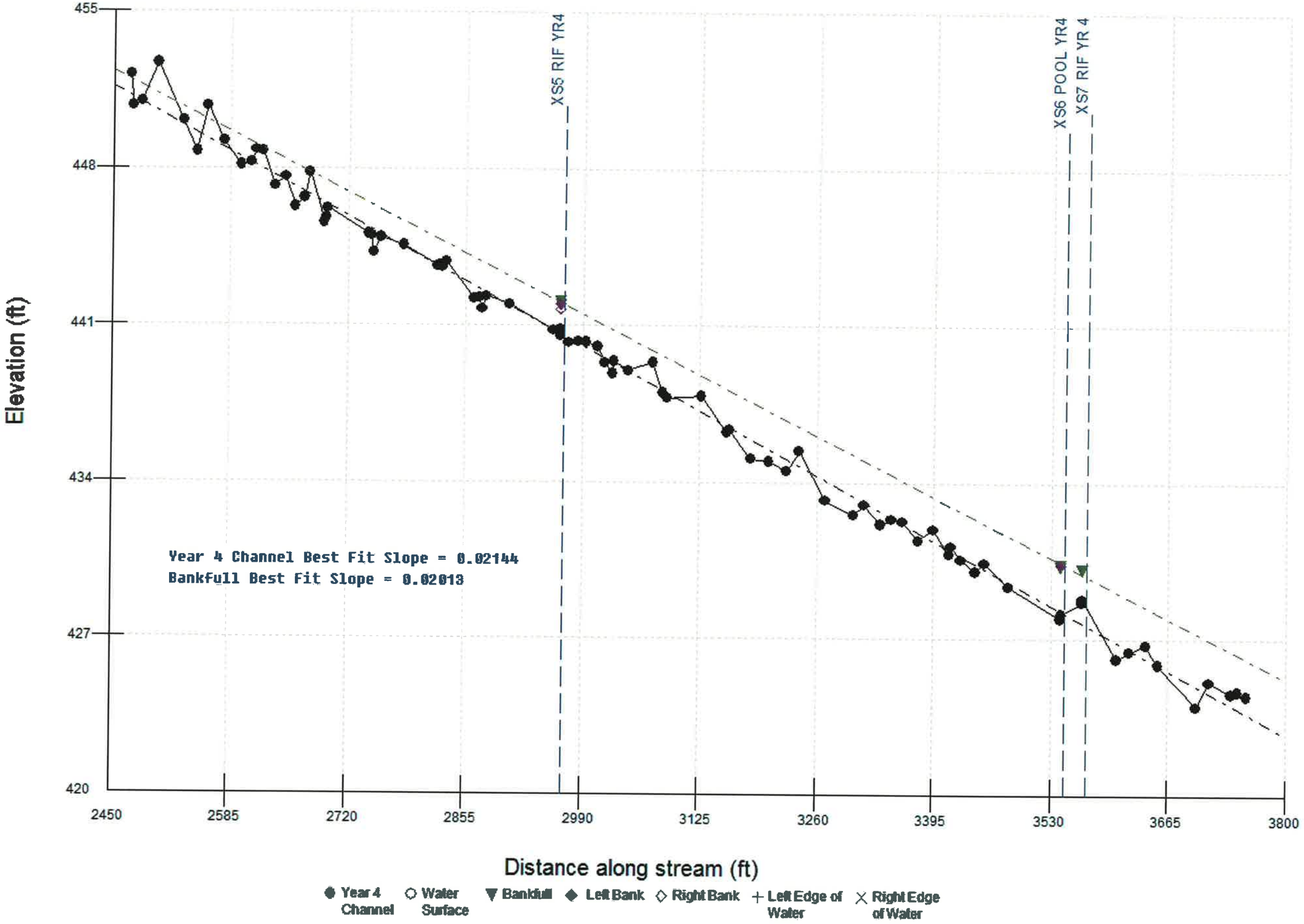
457
456
455
454
453
452
451
450
449

2250 2275 2300 2325 2350 2375 2400 2425 2450 2475 2500

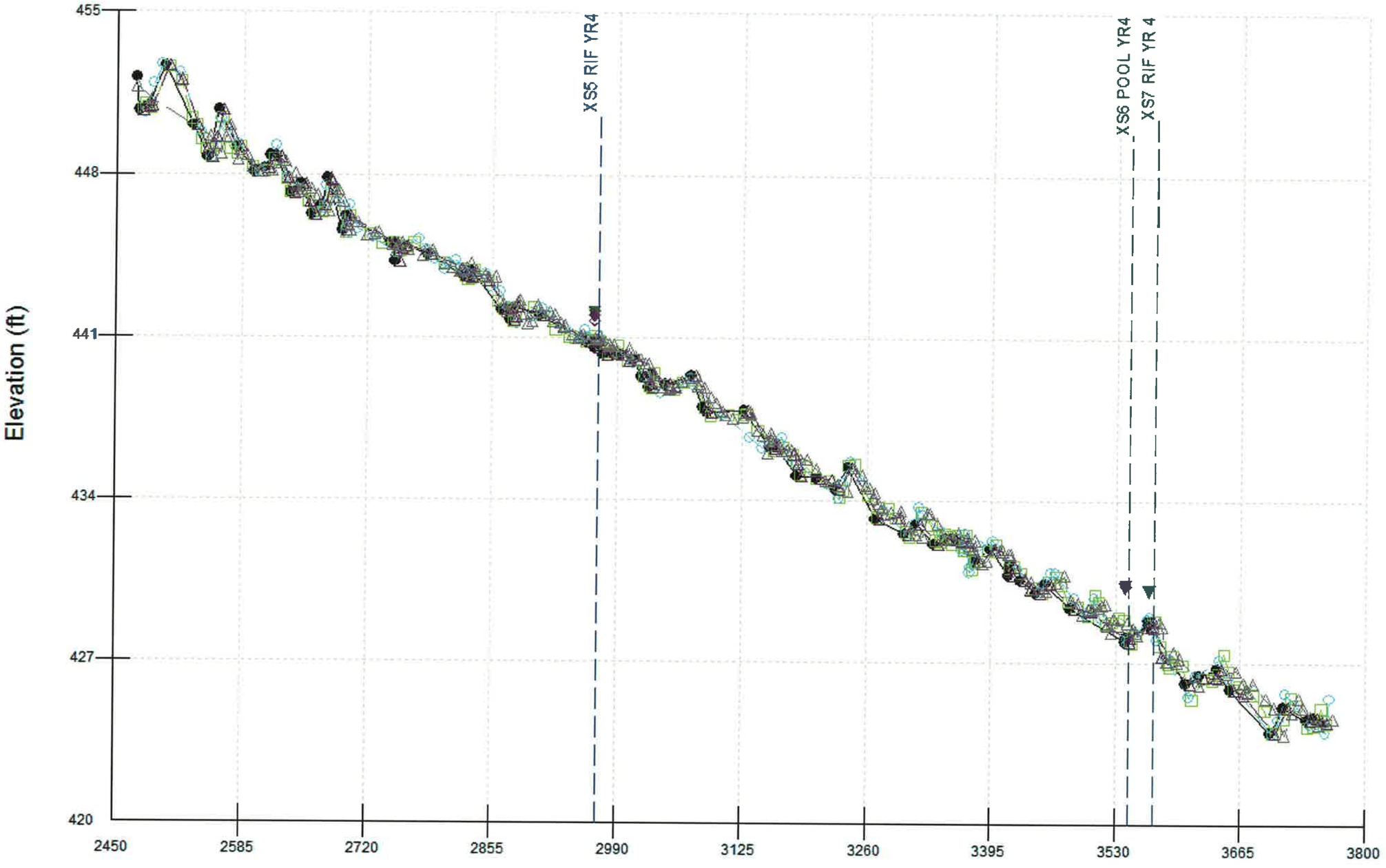
Distance along stream (ft)

Year 4 Channel | Water Surface | Bankfull | Left Bank | Right Bank | Left Edge of Water | Right Edge of Water | Year 1 Channel | Year 0 Channel | Year 2 Channel | Year 3 Channel

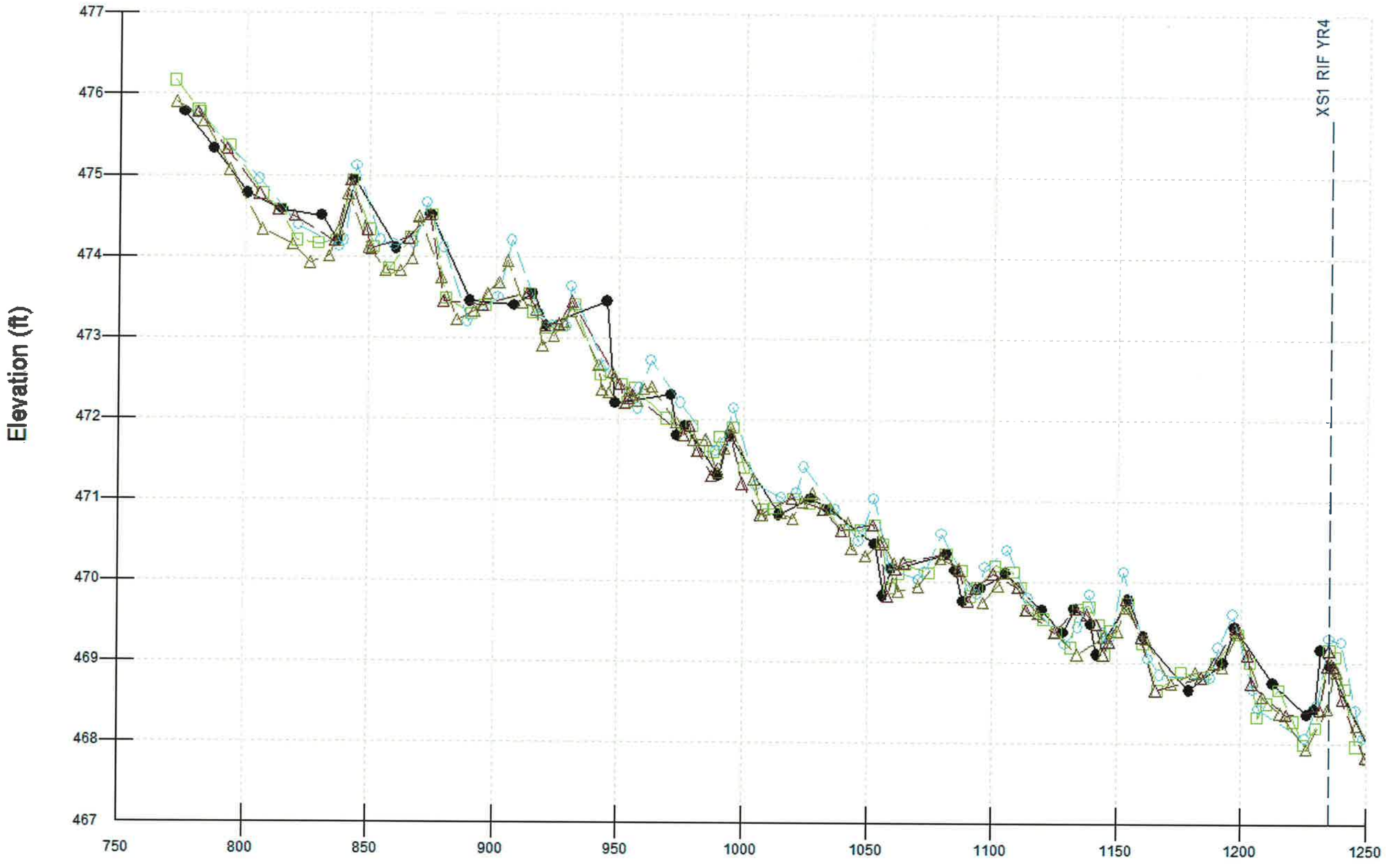
Davis Branch Mainstem - Enhancement Level 1 Profile - Year 4 - 13 Sep 2012



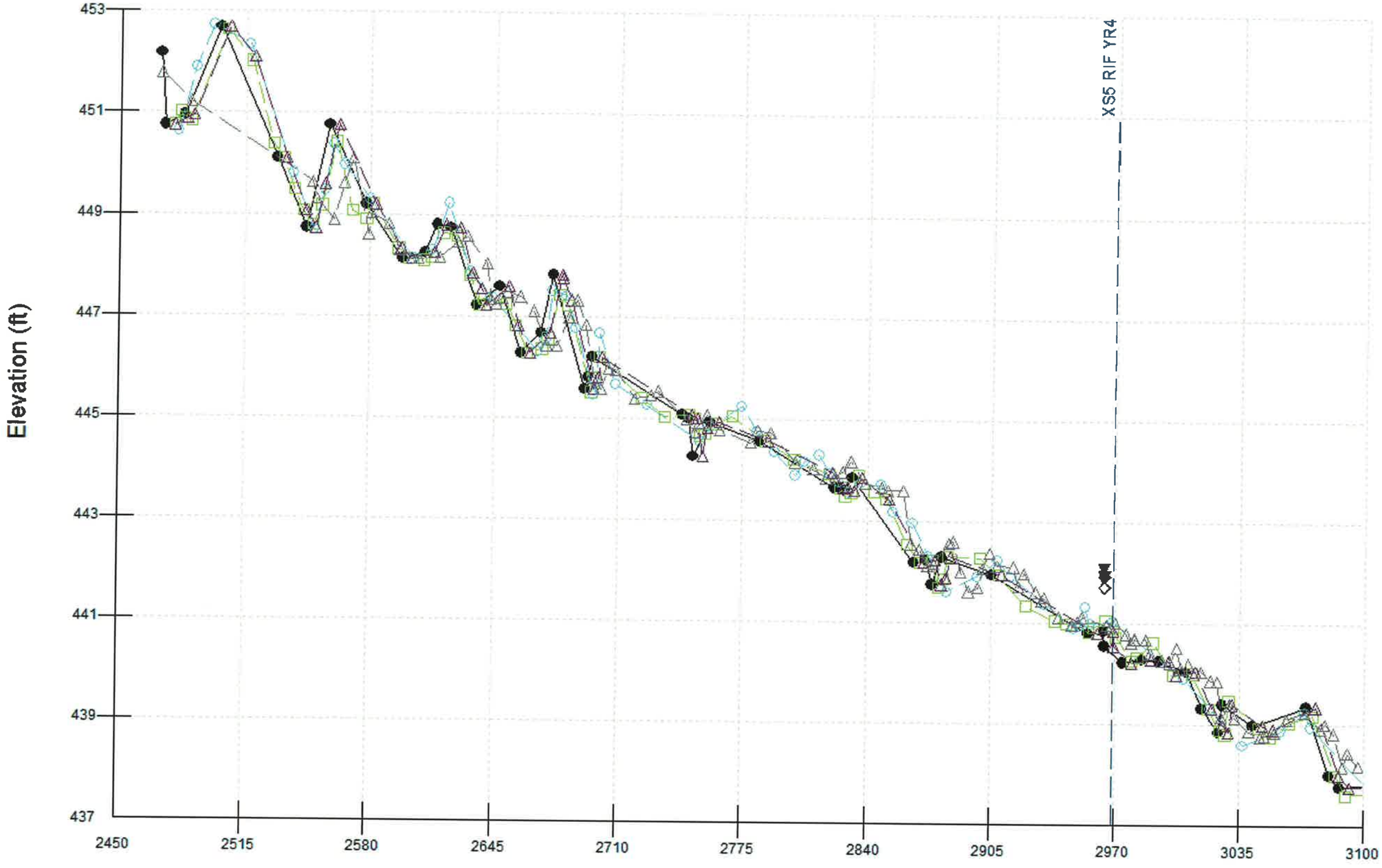
Davis Branch Mainstem - Enhancement Level 1 Profile - Year 4 - 13 Sep 2012



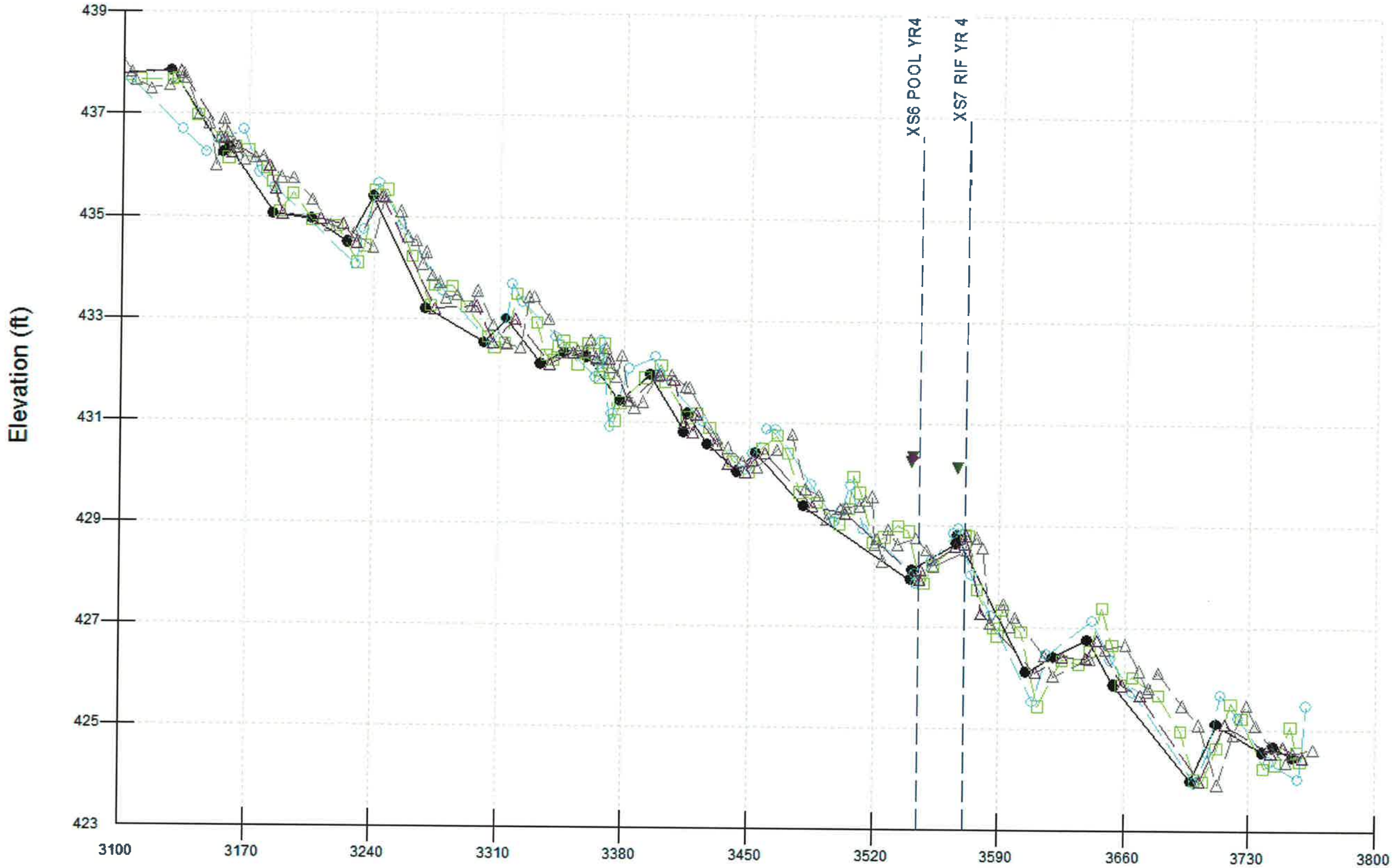
Davis Branch Mainstem - Restoration Profile - Year 4 - 13 Sep 2012



Davis Branch Mainstem - Enhancement Level 1 Profile - Year 4 - 13 Sep 2012

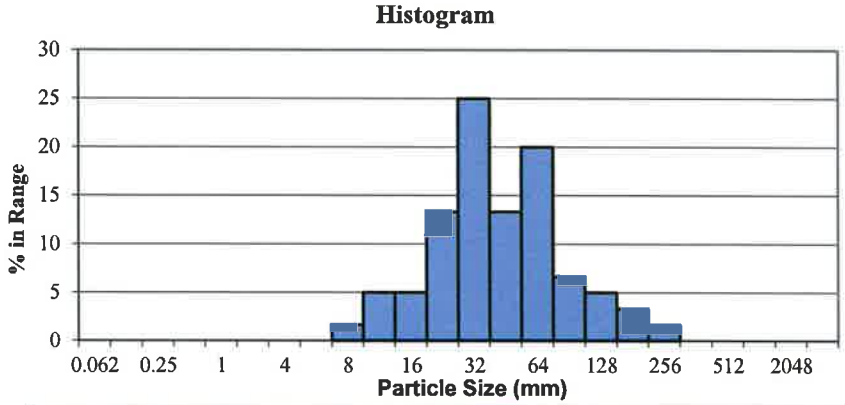


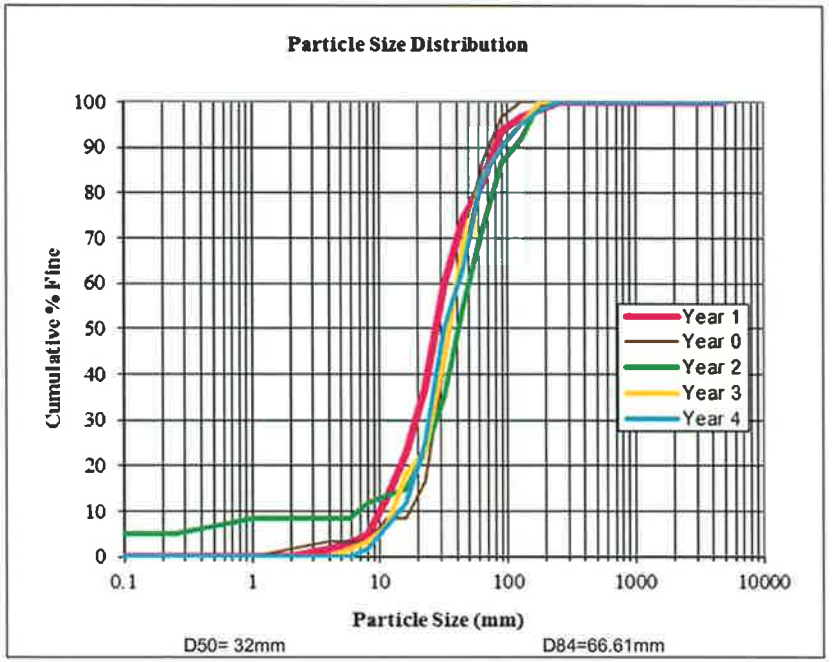
Davis Branch Mainstem - Enhancement Level 1 Profile - Year 4 - 13 Sep 2012



Pebble Count - Riffle				
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	0	0	0
Very Fine Gravel	2.0-4.0	0	0	0
Fine Gravel	4.0-5.7	0	0	0
Fine Gravel	5.7-8.0	1	2	2
Medium Gravel	8.0-11.3	3	5	7
Medium Gravel	11.3-16.0	3	5	12
Coarse Gravel	16.0-22.6	8	13	25
Coarse Gravel	22.6-32	15	25	50
Very Coarse Gravel	32-45	8	13	63
Very Coarse Gravel	45-64	12	20	83
Small Cobble	64-90	4	7	90
Small Cobble	90-128	3	5	95
Large Cobble	128-180	2	3	98
Large Cobble	180-256	1	2	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		60	100	

Davis Branch Restoration EEP Project No. D06054-F			
Reach	Mainstem	**X Sec**	1
Date	5/27/2012	**Sta No.**	12+31.44

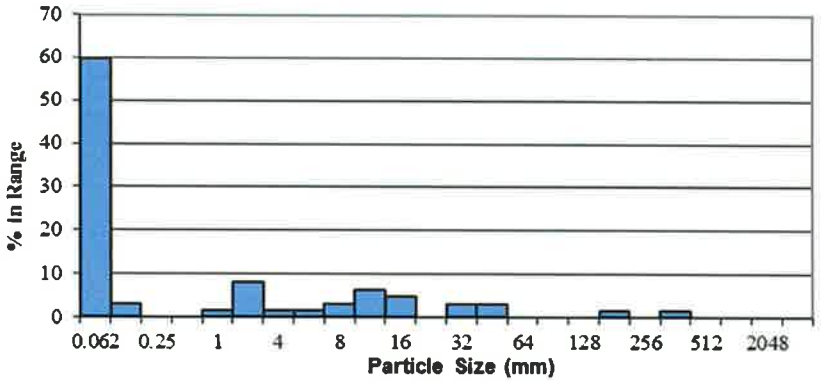


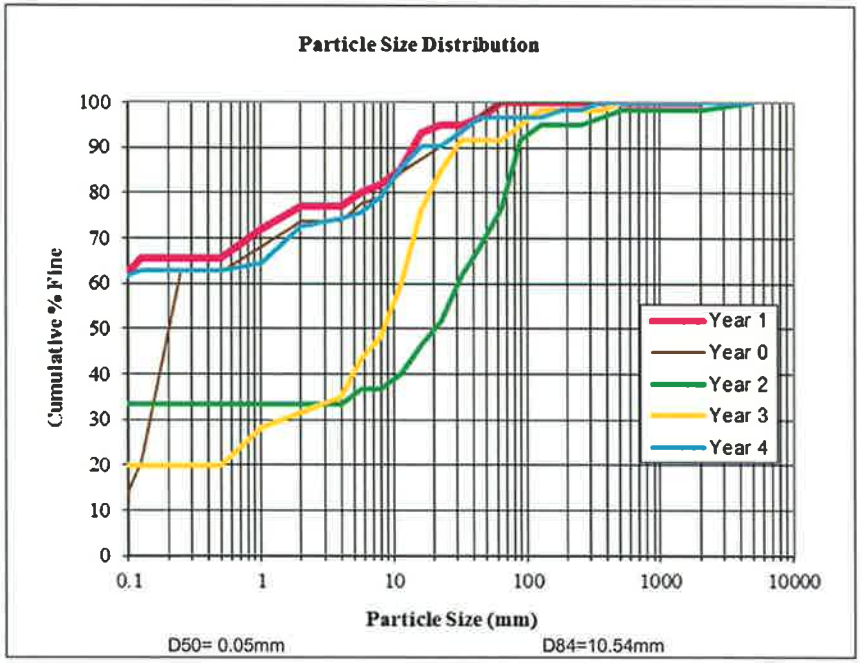


Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	37	60	60
Very Fine Sand	0.062-0.125	2	3	63
Fine Sand	0.125-0.25	0	0	63
Medium Sand	0.25-0.5	0	0	63
Coarse Sand	0.5-1.0	1	2	65
Very Coarse Sand	1.0-2.0	5	8	73
Very Fine Gravel	2.0-4.0	1	2	74
Fine Gravel	4.0-5.7	1	2	76
Fine Gravel	5.7-8.0	2	3	79
Medium Gravel	8.0-11.3	4	6	85
Medium Gravel	11.3-16.0	3	5	90
Coarse Gravel	16.0-22.6	0	0	90
Coarse Gravel	22.6-32	2	3	94
Very Coarse Gravel	32-45	2	3	97
Very Coarse Gravel	45-64	0	0	97
Small Cobble	64-90	0	0	97
Small Cobble	90-128	0	0	97
Large Cobble	128-180	1	2	98
Large Cobble	180-256	0	0	98
Small Boulder	256-362	1	2	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		62	100	

Davis Branch Restoration EEP Project No. D06054-F			
Reach	Mainstem	**X Sec**	2
Date	5/27/2012	**Sta No.**	12+66.55

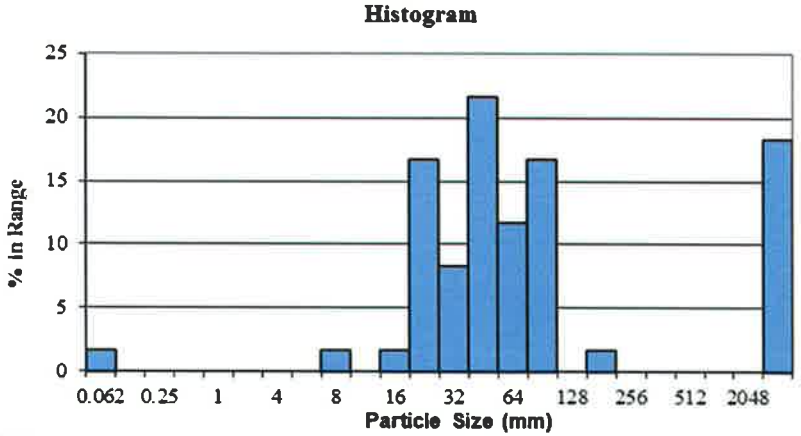
Histogram

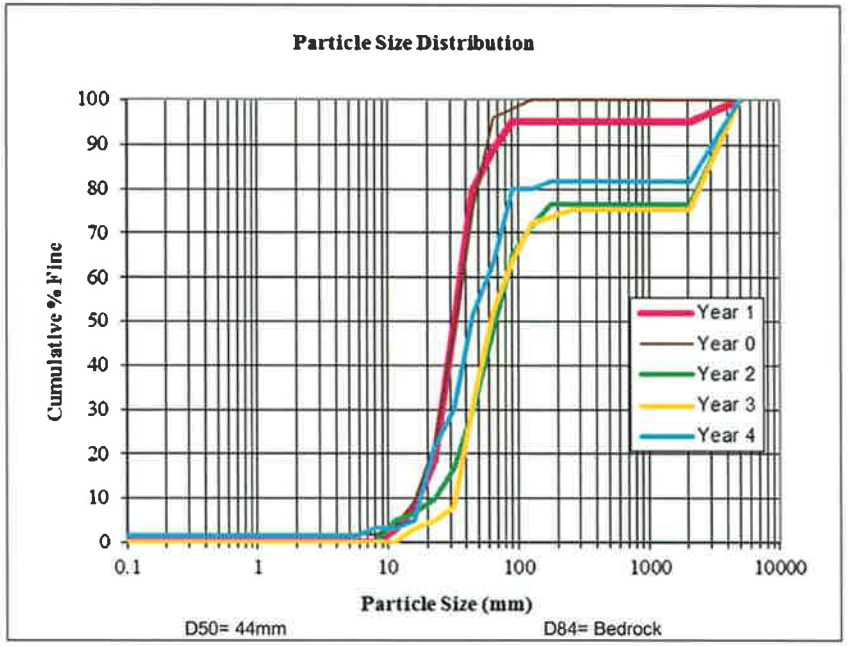




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	1	2	2
Very Fine Sand	0.062-0.125	0	0	2
Fine Sand	0.125-0.25	0	0	2
Medium Sand	0.25-0.5	0	0	2
Coarse Sand	0.5-1.0	0	0	2
Very Coarse Sand	1.0-2.0	0	0	2
Very Fine Gravel	2.0-4.0	0	0	2
Fine Gravel	4.0-5.7	0	0	2
Fine Gravel	5.7-8.0	1	2	3
Medium Gravel	8.0-11.3	0	0	3
Medium Gravel	11.3-16.0	1	2	5
Coarse Gravel	16.0-22.6	10	17	22
Coarse Gravel	22.6-32	5	8	30
Very Coarse Gravel	32-45	13	22	52
Very Coarse Gravel	45-64	7	12	63
Small Cobble	64-90	10	17	80
Small Cobble	90-128	0	0	80
Large Cobble	128-180	1	2	82
Large Cobble	180-256	0	0	82
Small Boulder	256-362	0	0	82
Small Boulder	362-512	0	0	82
Medium Boulder	512-1024	0	0	82
Large Boulder	1024-2048	0	0	82
Bedrock	<2048	11	18	100
Totals		60	100	

Davis Branch Restoration EEP Project No. D06054-F			
Reach	Mainstem	**X Sec**	3
Date	5/27/2012	**Sta No.**	21+61.52

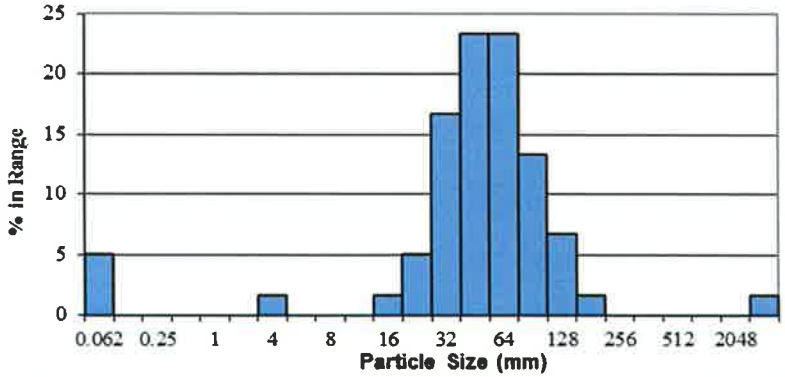


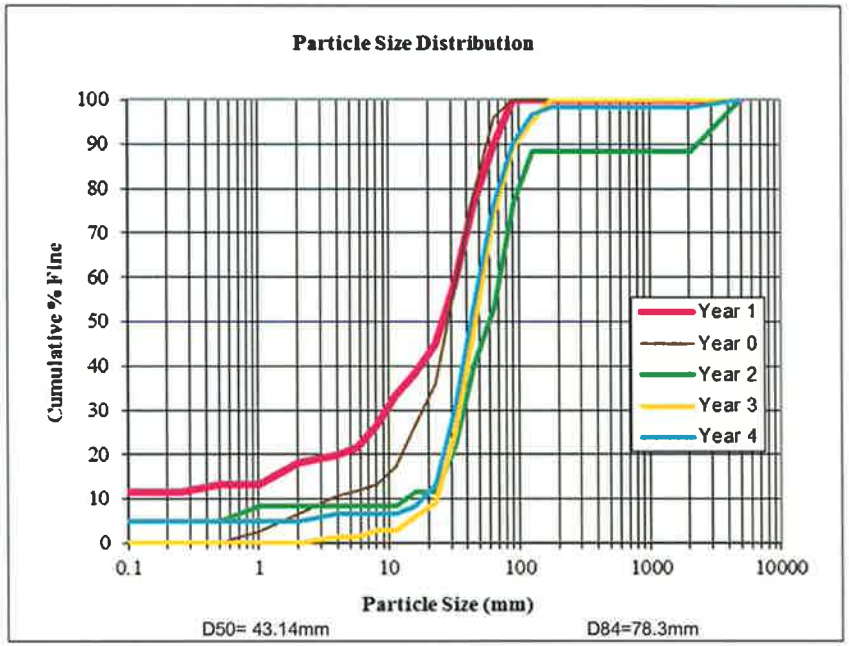


Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	3	5	5
Very Fine Sand	0.062-0.125	0	0	5
Fine Sand	0.125-0.25	0	0	5
Medium Sand	0.25-0.5	0	0	5
Coarse Sand	0.5-1.0	0	0	5
Very Coarse Sand	1.0-2.0	0	0	5
Very Fine Gravel	2.0-4.0	1	2	7
Fine Gravel	4.0-5.7	0	0	7
Fine Gravel	5.7-8.0	0	0	7
Medium Gravel	8.0-11.3	0	0	7
Medium Gravel	11.3-16.0	1	2	8
Coarse Gravel	16.0-22.6	3	5	13
Coarse Gravel	22.6-32	10	17	30
Very Coarse Gravel	32-45	14	23	53
Very Coarse Gravel	45-64	14	23	77
Small Cobble	64-90	8	13	90
Small Cobble	90-128	4	7	97
Large Cobble	128-180	1	2	98
Large Cobble	180-256	0	0	98
Small Boulder	256-362	0	0	98
Small Boulder	362-512	0	0	98
Medium Boulder	512-1024	0	0	98
Large Boulder	1024-2048	0	0	98
Bedrock	<2048	1	2	100
Totals		60	100	

Davis Branch Restoration EEP Project No. D06054-F			
Reach	Mainstem	**X Sec**	4
Date	5/27/2012	**Sta No.**	21+85.85

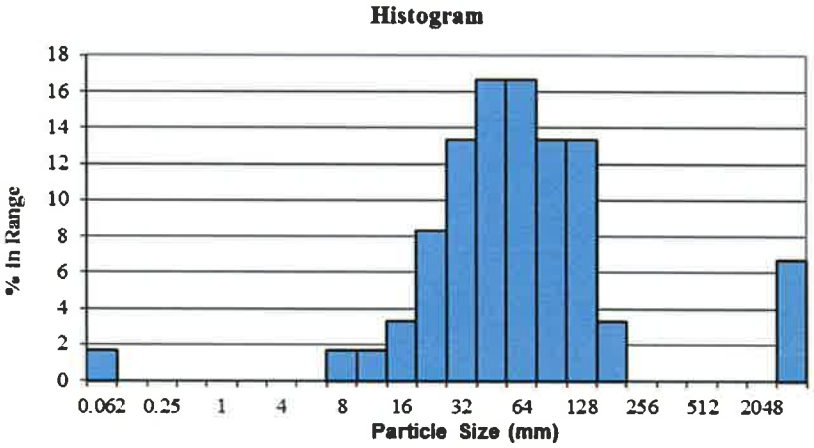
Histogram

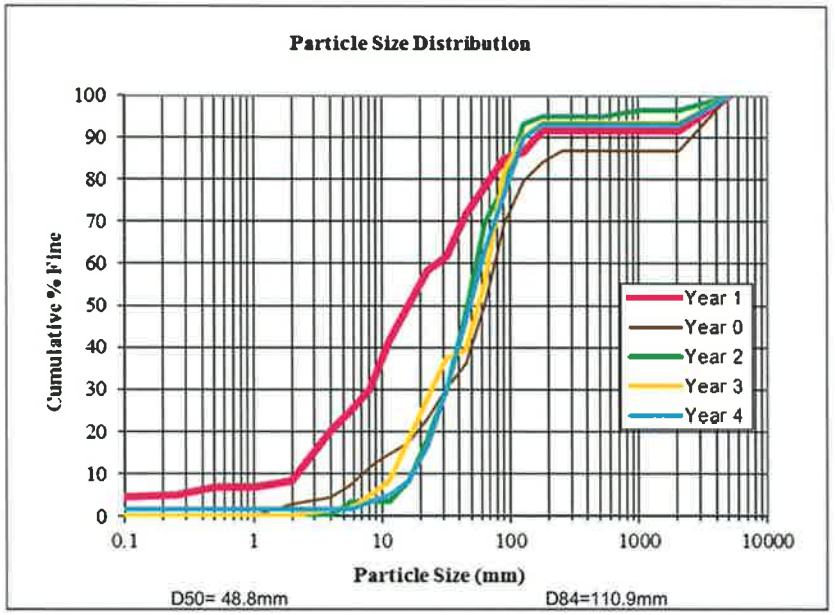




Pebble Count - Pool				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	1	2	2
Very Fine Sand	0.062-0.125	0	0	2
Fine Sand	0.125-0.25	0	0	2
Medium Sand	0.25-0.5	0	0	2
Coarse Sand	0.5-1.0	0	0	2
Very Coarse Sand	1.0-2.0	0	0	2
Very Fine Gravel	2.0-4.0	0	0	2
Fine Gravel	4.0-5.7	0	0	2
Fine Gravel	5.7-8.0	1	2	3
Medium Gravel	8.0-11.3	1	2	5
Medium Gravel	11.3-16.0	2	3	8
Coarse Gravel	16.0-22.6	5	8	17
Coarse Gravel	22.6-32	8	13	30
Very Coarse Gravel	32-45	10	17	47
Very Coarse Gravel	45-64	10	17	63
Small Cobble	64-90	8	13	77
Small Cobble	90-128	8	13	90
Large Cobble	128-180	2	3	93
Large Cobble	180-256	0	0	93
Small Boulder	256-362	0	0	93
Small Boulder	362-512	0	0	93
Medium Boulder	512-1024	0	0	93
Large Boulder	1024-2048	0	0	93
Bedrock	<2048	4	7	100
Totals		60	100	

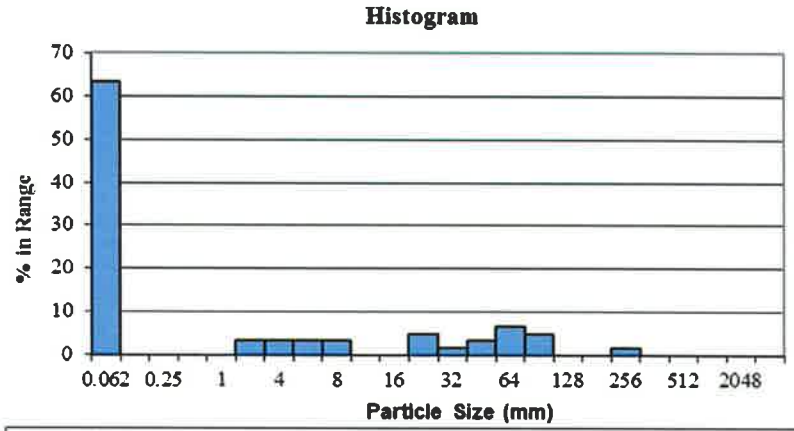
Davis Branch Restoration EEP Project No. D06054-F			
Reach	Mainstem	X Sec	5
Date	5/27/2012	Sta No.	29+36.09

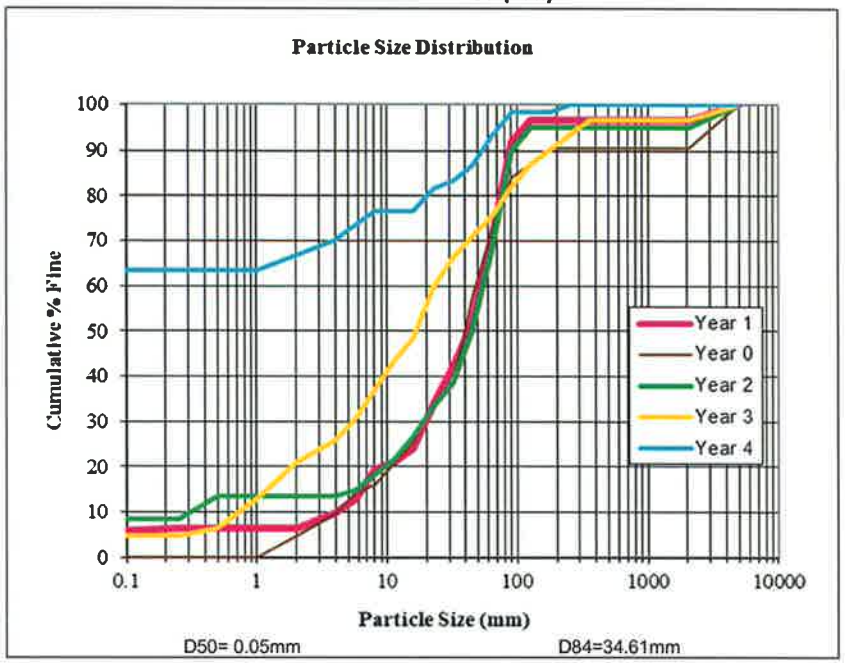




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	38	63	63
Very Fine Sand	0.062-0.125	0	0	63
Fine Sand	0.125-0.25	0	0	63
Medium Sand	0.25-0.5	0	0	63
Coarse Sand	0.5-1.0	0	0	63
Very Coarse Sand	1.0-2.0	2	3	67
Very Fine Gravel	2.0-4.0	2	3	70
Fine Gravel	4.0-5.7	2	3	73
Fine Gravel	5.7-8.0	2	3	77
Medium Gravel	8.0-11.3	0	0	77
Medium Gravel	11.3-16.0	0	0	77
Coarse Gravel	16.0-22.6	3	5	82
Coarse Gravel	22.6-32	1	2	83
Very Coarse Gravel	32-45	2	3	87
Very Coarse Gravel	45-64	4	7	93
Small Cobble	64-90	3	5	98
Small Cobble	90-128	0	0	98
Large Cobble	128-180	0	0	98
Large Cobble	180-256	1	2	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		60	100	

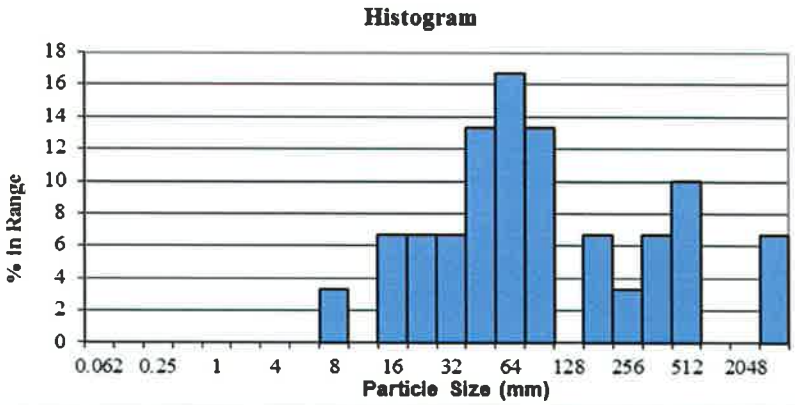
Davis Branch Restoration EEP Project No. D06054-F			
Reach	Mainstem	**X Sec**	6
Date	5/27/2012	**Sta No.**	35+09.15

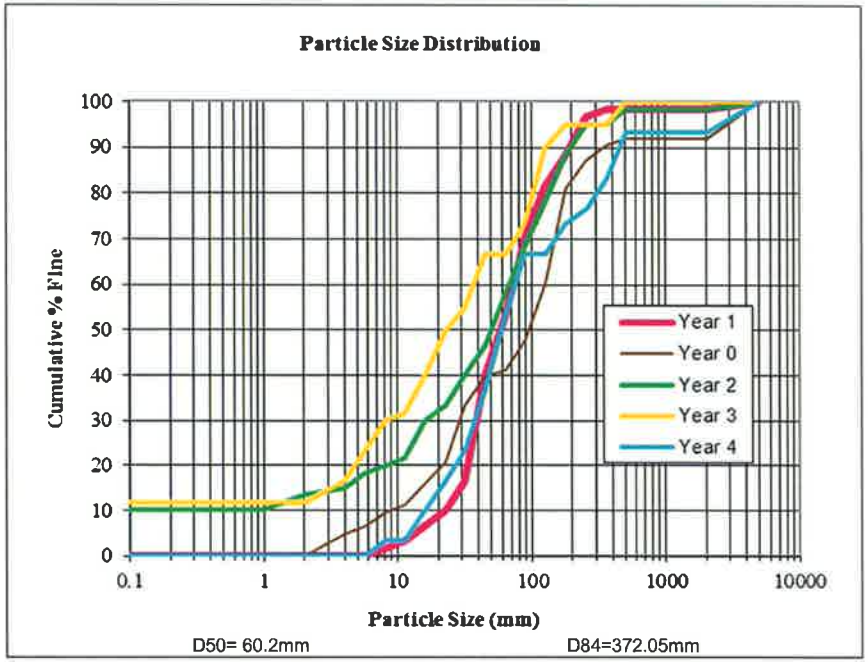




Pebble Count - Pool				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	0	0	0
Coarse Sand	0.5-1.0	0	0	0
Very Coarse Sand	1.0-2.0	0	0	0
Very Fine Gravel	2.0-4.0	0	0	0
Fine Gravel	4.0-5.7	0	0	0
Fine Gravel	5.7-8.0	2	3	3
Medium Gravel	8.0-11.3	0	0	3
Medium Gravel	11.3-16.0	4	7	10
Coarse Gravel	16.0-22.6	4	7	17
Coarse Gravel	22.6-32	4	7	23
Very Coarse Gravel	32-45	8	13	37
Very Coarse Gravel	45-64	10	17	53
Small Cobble	64-90	8	13	67
Small Cobble	90-128	0	0	67
Large Cobble	128-180	4	7	73
Large Cobble	180-256	2	3	77
Small Boulder	256-362	4	7	83
Small Boulder	362-512	6	10	93
Medium Boulder	512-1024	0	0	93
Large Boulder	1024-2048	0	0	93
Bedrock	<2048	4	7	100
Totals		60	100	

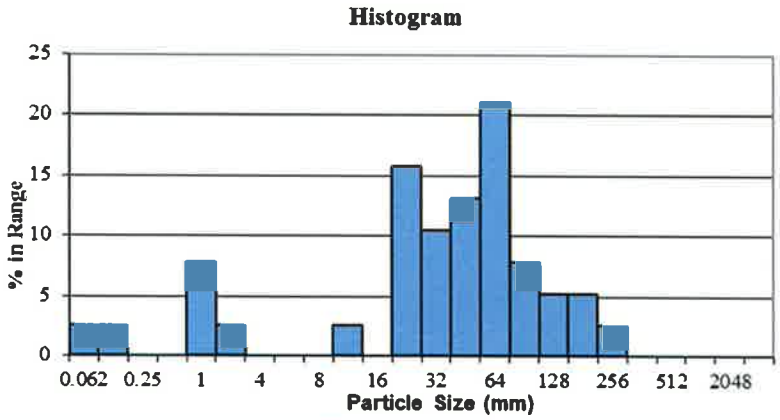
Davis Branch Restoration EEP Project No. D06054-F			
Reach	Mainstem	X Sec	7
Date	5/27/2012	Sta No.	35+33.67

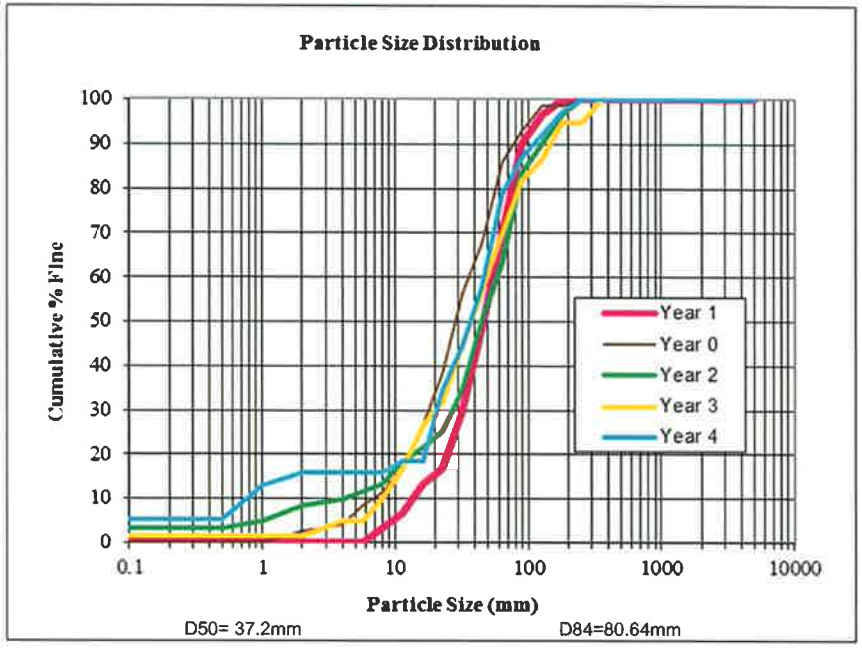




Pebble Count - Riffle				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	2	3	3
Very Fine Sand	0.062-0.125	2	3	5
Fine Sand	0.125-0.25	0	0	5
Medium Sand	0.25-0.5	0	0	5
Coarse Sand	0.5-1.0	6	8	13
Very Coarse Sand	1.0-2.0	2	3	16
Very Fine Gravel	2.0-4.0	0	0	16
Fine Gravel	4.0-5.7	0	0	16
Fine Gravel	5.7-8.0	0	0	16
Medium Gravel	8.0-11.3	2	3	18
Medium Gravel	11.3-16.0	0	0	18
Coarse Gravel	16.0-22.6	12	16	34
Coarse Gravel	22.6-32	8	11	45
Very Coarse Gravel	32-45	10	13	58
Very Coarse Gravel	45-64	16	21	79
Small Cobble	64-90	6	8	87
Small Cobble	90-128	4	5	92
Large Cobble	128-180	4	5	97
Large Cobble	180-256	2	3	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		76	100	

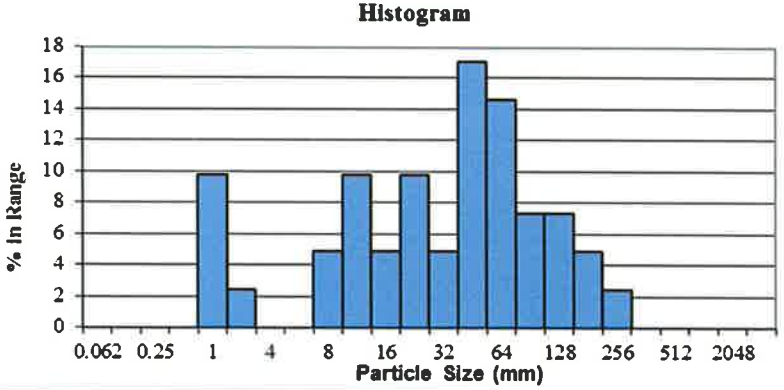
Davis Branch Restoration EEP Project No. D06054-F			
Reach	UT1	X Sec	8
Date	5/27/2012	Sta No.	2+00.10

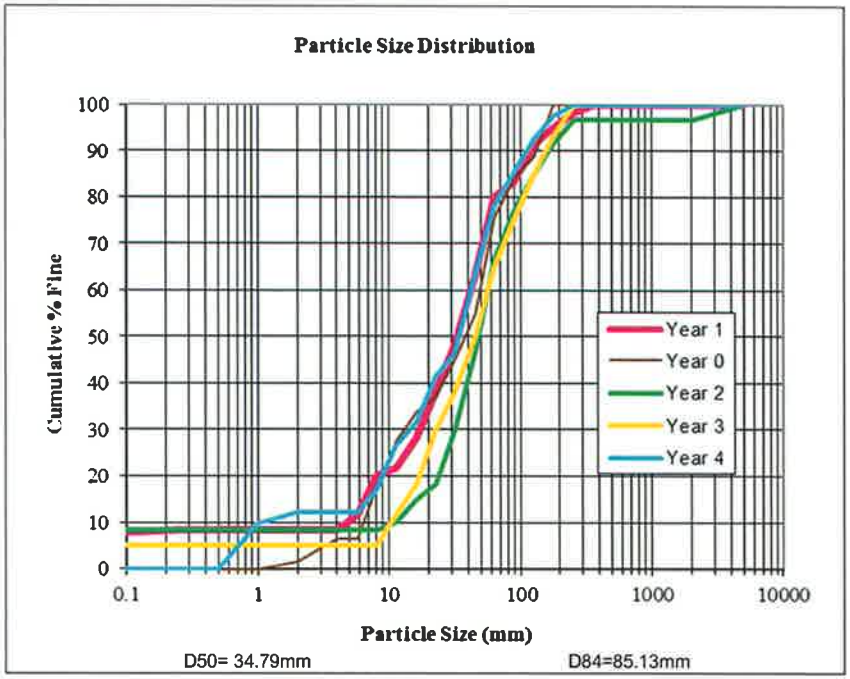




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	0	0	0
Coarse Sand	0.5-1.0	8	10	10
Very Coarse Sand	1.0-2.0	2	2	12
Very Fine Gravel	2.0-4.0	0	0	12
Fine Gravel	4.0-5.7	0	0	12
Fine Gravel	5.7-8.0	4	5	17
Medium Gravel	8.0-11.3	8	10	27
Medium Gravel	11.3-16.0	4	5	32
Coarse Gravel	16.0-22.6	8	10	41
Coarse Gravel	22.6-32	4	5	46
Very Coarse Gravel	32-45	14	17	63
Very Coarse Gravel	45-64	12	15	78
Small Cobble	64-90	6	7	85
Small Cobble	90-128	6	7	93
Large Cobble	128-180	4	5	98
Large Cobble	180-256	2	2	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		82	100	

Davis Branch Restoration EEP Project No. D06054-F			
Reach	UT1	**X Sec**	9
Date	5/27/2012	**Sta No.**	5+84.56





BF 1
Crest Gage on the mainstem of Davis Branch (Year 1).
(EMH&T, 9/20/09)

BF 2
Crest Gage on the mainstem of Davis Branch (Year 2).
(EMH&T, 9/20/10)

BF 3
Crest Gage on the mainstem of Davis Branch (Year 3).
(EMH&T, 9/14/11)

BF 2
Crest Gage 4 on UT1 of Davis Branch (Year 1).
(EMH&T, 9/20/09)

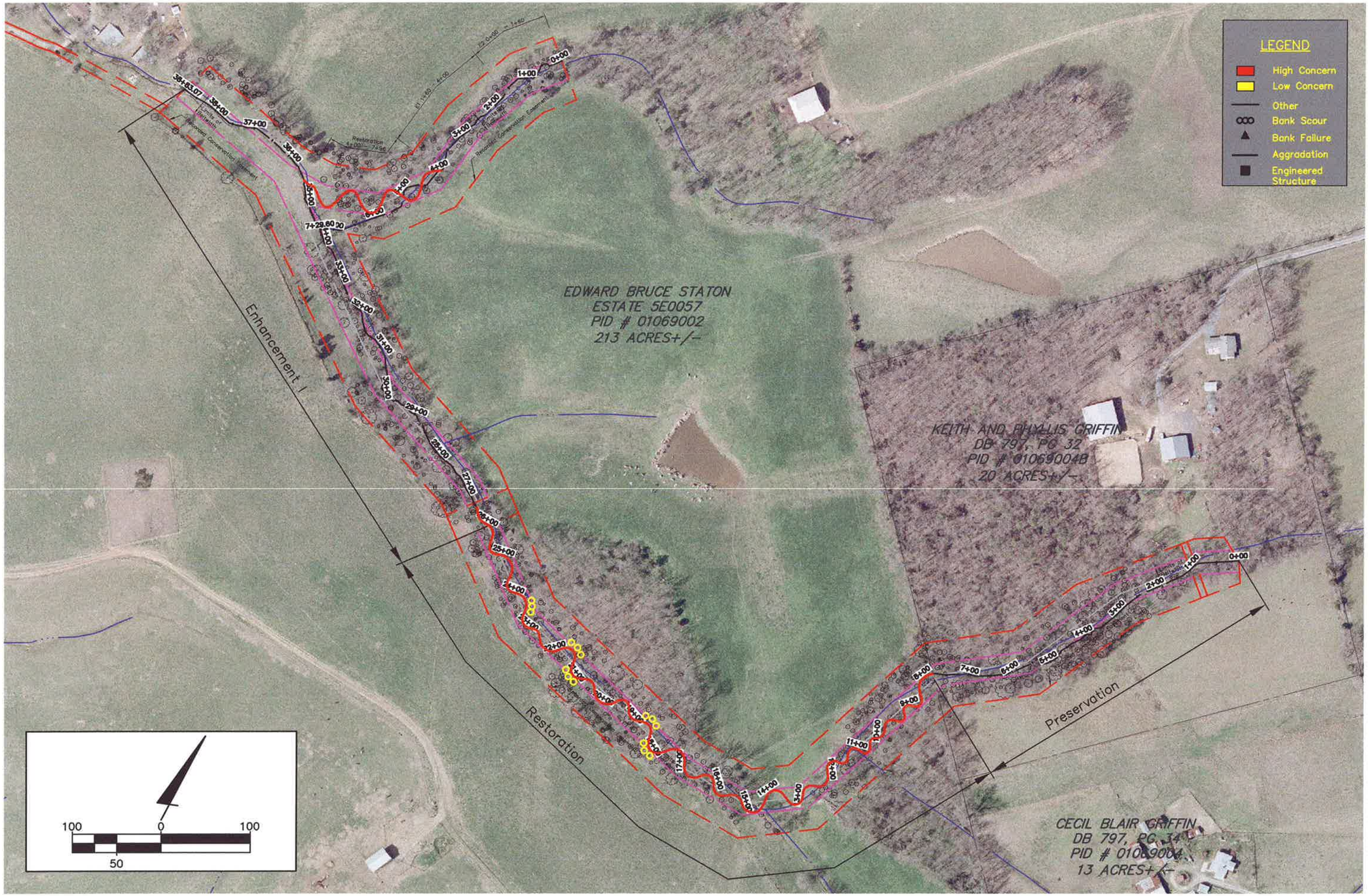
BF 5
Crest Gage 4 on UT1 of Davis Branch (Year 2).
(EMH&T, 9/20/10)

BF 6
Crest Gage 4 on UT1 of Davis Branch (Year 3).
(EMH&T, 9/14/11)

SPA 1
Bare banks along stream channel bend on Davis Branch near station 8+25. ISSUE RESOLVED - Vegetation density has increased since 2011.
(Top Photo – Year 3: 9/14/11, Bottom Photo – Year 4: 9/13/12).
(EMH&T)

SPA 2
Scour and erosion along the left and right banks at station 21+50 on Davis Branch. ISSUE RESOLVED - Vegetation density has increased since 2011.
(Top Photo – Year 3: 9/14/11, Bottom Photo – Year 4: 9/13/12).
(EMH&T)

SPA 3
Scour and erosion along the right bank at station 23+50 on Davis Branch. ISSUE RESOLVED - Vegetation density has increased since 2011.
(Top Photo – Year 3: 9/14/11, Bottom Photo – Year 4: 9/13/12).
(EMH&T)



UNION COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
DAVIS BRANCH
AND UNNAMED TRIBUTARY
APPENDIX B
STREAM PROBLEM AREAS

Job No.	Sheet
2009-0326	1 — 1
Date: December, 2012	Scale: 1" = 200'

Ecosystem Enhancement Program

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