Year 3 Monitoring Report for Stream Restoration of Silver Creek and Unnamed Tributaries

Burke County, NC
SCO # D05016-01

Prepared for:
NCDENR – EEP
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Raleigh NC 27604

Ecosystem Enhancement PROGRAM

Submitted: December 2009

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

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I. EXECUTIVE SUMMARY

The Silver Creek stream restoration project is located near Morganton in Burke County, North Carolina. Prior to restoration, channelization and cattle intrusion resulted in vegetative denuding and bank destabilization due to hoof shear. The vertical to undercut unstable streambanks were contributing large volumes of suspended sediment and bedload material to the larger Silver Creek watershed. The project reach includes the restoration of 2,905 linear feet of the Silver Creek mainstem and 1,552 linear feet of an unnamed tributary (UTA); also included is 166 linear feet of preservation along UTB, UTC and UTD. Restoration of the project streams, completed during April 2007, re-established geomorphologic features consistent with natural stream channel characteristics. Elements of the restoration included stable channel pattern, profile and dimension consistent with reference reach conditions quantified within the Silver Creek watershed, upstream from the project on Brindle Creek. In-stream structures were constructed to provide grade control, streambank stabilization and aquatic habitat features. Restoration reconnected project stream channels to functional floodplains with extensive riparian plantings The following report documents the Year 3 Annual Monitoring for this project.

Vegetative monitoring was completed in September 2009 following the Carolina Vegetation Survey methodology. Stem counts completed at ten (10) vegetation plots show an average density of 328 stems per acre for the site. This density meets the success criteria of 320 stems/acre after three years of monitoring. Four individual plots had stem densities below the minimum, with the largest deficit occurring along UTA, where recent has cattle intrusion caused woody damage and mortality. In addition to the planted woody species, a substantial number of recruit stems have been found in all plots. The recruit stems result in nearly a 75% increase in the total stem density across the site, and bring nearly all plots into compliance with the Year 3 minimum criteria.

Monitoring of the streams identified a few problem areas along the project reaches. A few vegetative problem areas of low concern were noted in the project area, included scattered populations of problematic species and sparse vegetative cover. The problematic species will be proactively managed by herbicide treatment. Minor areas of aggradation were noted on the mainstem; these areas are considered low concern at this time. A few minor areas of bank scour were noted on UTA, including a few small areas of minor streambank erosion. Any of these areas deemed to require maintenance to improve stability will be stabilized using vegetative means. The most substantial problem occurred along UTA due to accidental cattle access into both the channel and riparian corridor. The cattle access occurred as a result of a fallen tree limb knocking over a section of the constructed fence row. The cattle intrusion resulted in damage to planted and native woody species and trampling of the herbaceous understory. These areas were reseeded in the fall of 2009. Tree and shrub species appropriate for partial shade conditions will be planted to replace those woody species damaged by the cattle. The disturbance to the stream channel was limited to a reach approximately 400 feet long. Minor repairs to the bed and bank of the channel were already made to address the disturbance.

The visual stream stability assessment revealed that the majority of stream features are functioning as designed and built on the Silver Creek mainstem. A number of features along UTA were not found to be performing as intended during the visual assessment. The majority of these features were associated with the cattle intrusion. There was also a noticeable decrease in the number and depth of pools along UTA due to aggradation of fine sediment. It is expected that these shallow pools will cyclically flush and aggrade during corresponding wet and dry seasons.

Dimensional measurements of the monumented cross-sections remain stable when compared to as-built conditions. The comparison of the yearly long-term stream monitoring profile data show stability with minimal changes from as-built conditions. The substrate of the constructed riffles remains stable, although there has been a shift to particle distributions with a smaller median particle size. Based on the crest gage network installed on the project reaches, one bankfull event has occurred since construction was completed.

In addition to the monitoring protocol required by EEP, additional monitoring of tributaries UTB and UTC has been required by the NC DWQ under the Section 401 permit issued for the project on May 25, 2007. Vegetation monitoring found that the average stem density for the combined tributaries exceeds the minimum criteria of 320 stems per acre. Stream monitoring found no stability problems along these tributaries.

The following tables summarize the geomorphological changes along the restoration reaches for each stream. The values in the tables are the median values for each parameter.

Silver Creek Mainstem

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3
Length	**3,040 ft**	**2,905 ft**	**2,905 ft**	**2,905 ft**	**2,905 ft**
Bankfull Width	**60.9 ft**	**58.0 ft**	**57.5 ft**	**63.9 ft**	**55.0 ft**
Bankfull Mean Depth	**4.0 ft**	**1.6 ft**	**1.6 ft**	**1.4 ft**	**1.6 ft**
Bankfull Max Depth	**7.0 ft**	**3.3 ft**	**3.2 ft**	**3.4 ft**	**3.7 ft**
Width/Depth Ratio	**25.8**	**38.8**	**36.2**	**45.3**	**34.8**
Entrenchment Ratio	**1.3**	**1.7**	**1.7**	**1.8**	**1.9**
Bank Height Ratio	**4.0**	**1.0**	**1.0**	**1.0**	**1.0**
Sinuosity	**1.46**	**1.40**	**1.40**	**1.40**	**1.40**

Unnamed Tributary A

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3
Length	**1,508 ft**	**1,552 ft**	**1,552 ft**	**1,552 ft**	**1,552 ft**
Bankfull Width	**13.7 ft**	**7.5 ft**	**7.1 ft**	**6.9 ft**	**8.5 ft**
Bankfull Mean Depth	**0.3 ft**	**0.5 ft**	**0.5 ft**	**0.5 ft**	**0.6 ft**
Bankfull Max Depth	**0.9 ft**	**0.9 ft**	**0.8 ft**	**1.0 ft**	**1.0 ft**
Width/Depth Ratio	**52.8**	**15.9**	**14.0**	**14.7**	**14.6**
Entrenchment Ratio	**0.9**	**1.9**	**1.7**	**2.1**	**1.6**
Bank Height Ratio	**1.9**	**1.0**	**1.0**	**1.0**	**1.0**
Sinuosity	**1.06**	**1.09**	**1.09**	**1.09**	**1.09**

II. PROJECT BACKGROUND

A. Location and Setting

The project is located approximately 3,000 feet east of Dysartsville Road and approximately 2,500 feet south of Patton Road, west of the City of Morganton, in Burke County, North Carolina, as shown on Figure 1. The stream channels included in this project are the Silver Creek mainstem and four unnamed tributary streams designated UTA, UTB, UTC and UTD.

The directions to the project site are as follows:

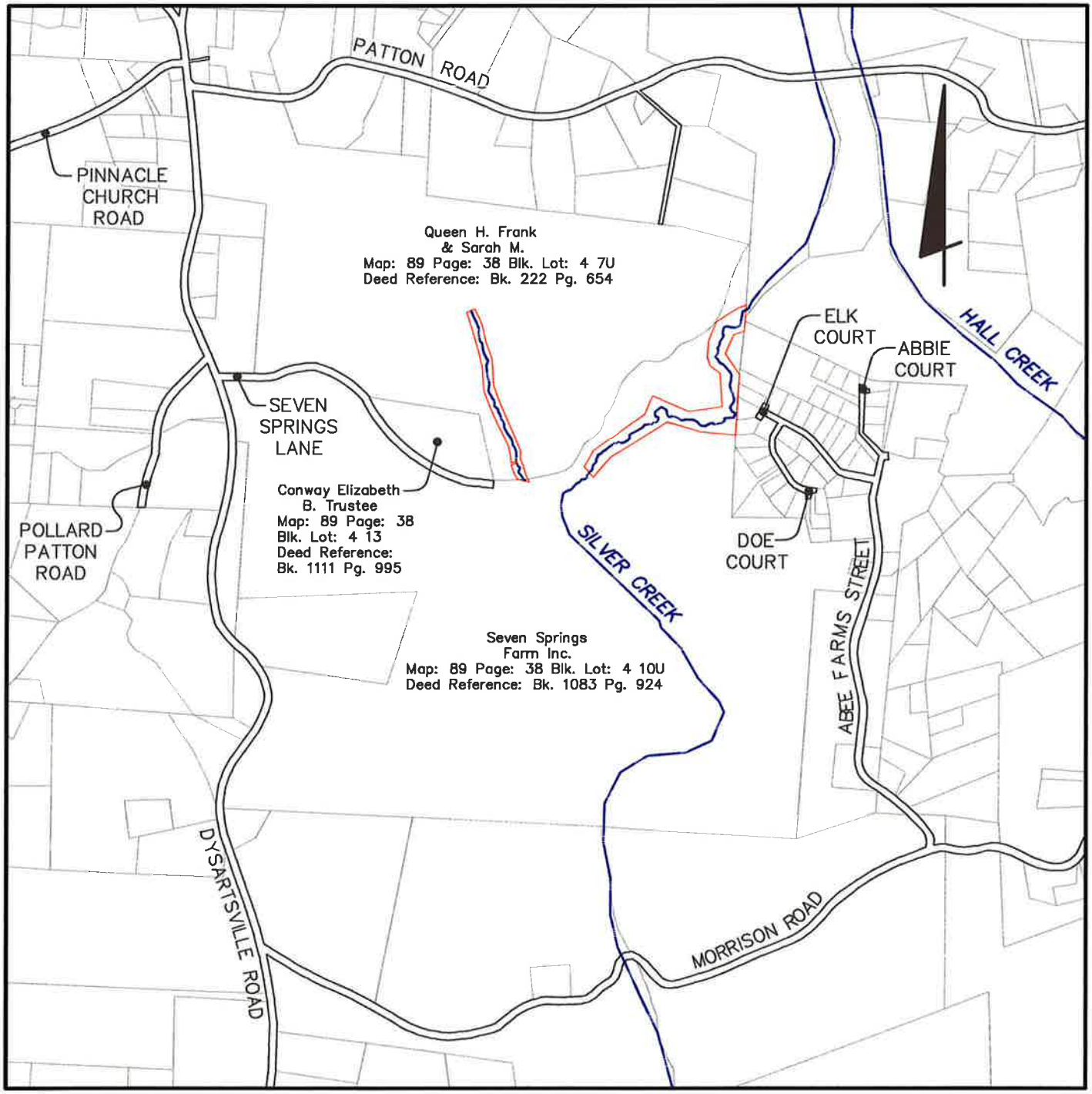
> From I-40, exit at Exit 94 and travel south along Dysartsville Road and turn left (east) onto Seven Springs Lane. The project spans properties owned separately by Mr. and Mrs. Frank Queen and Mr. (deceased) and Mrs. Richard Conway (Seven Springs Farms, Inc.).

B. Project Structure, Mitigation Type, Approach and Objectives

The primary, pre-existing land use within the immediate project site was agricultural. Based on photographic interpretation, the site had been historically utilized for agricultural row crop production and hayland. It is likely the project site had been farmed since early colonial times. The site was degraded by past land management practices including mechanical land clearing, straightening and dredging the stream channels. Silver Creek was one of the first streams in North Carolina to be mined for precious metals and gem stones. The project site was most recently utilized to produce hay for livestock feed. The pre-existing riparian corridor along Silver Creek, including UTB, UTC and UTD, varied from wide to denuded within the project area. The wide portion consisted of a mature forested corridor, while narrow and denuded areas were the result of a recent pine beetle infestation. Active pasture is located to the east and west of UTA. A wooded corridor is present along the UTA reach and has been maintained. Typical species observed along the streams and adjacent forested areas include *Pinus taeda* (loblolly pine), *Platanus occidentalis* (sycamore) and *Ilex opaca* (American holly).

Prior to restoration, agricultural land use and channel incision had altered the Silver Creek mainstem throughout the project reach, resulting in an unstable Rosgen F4 stream type. The incised nature of the channel was attributed to channelization and cattle intrusion, which resulted in vegetative denuding and bank destabilization due to hoof shear. The Silver Creek channel's unstable width to depth ratio, entrenchment ratio, relatively flat average profile slope and poorly defined active streambed resulted in a deeply incised channel disconnected from its floodplain. Mid-channel, lateral, and transverse sand and gravel bar deposits were observed at locations throughout the reach, demonstrating the stream lacked stable pattern, profile and dimension to entrain its bedload. The locations of these depositional features in the near bank region deflected flows from the center of the channel toward the incised vertical to undercut streambanks, accelerating streambank erosion. It is estimated that approximately 5,570 cubic yards per year (or 6,980 tons per year) of sediment was being eroded from the unstable streambanks along the impaired mainstem reach into the Silver Creek watershed prior to restoration.

The UTA channel was a classic Type I valley confined, A1-A2 stream type transitioning to a Type II colluvial valley, B4 stream type in the lower third of the impaired reach. The upper two-thirds of the reach exhibited some bedrock control, in-stream boulders together with flood placed woody debris from leaning or fallen trees along the unstable, steep to undercut streambanks. The



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BURKE COUNTY, NORTH CAROLINA

SILVER CREEK RESTORATION

FIGURE 1: SITE VICINITY MAP

N.C. ECOSYSTEM ENHANCEMENT PROGRAM

Date: December, 2008

Not To Scale

Ecosystem Enhancement PROGRAM

impaired riparian vegetative communities were exacerbating streambank erosion rates and down-slope movement of colluvium. Cattle intrusion had adversely impacted the entire tributary as evidenced by vegetative denuding and bank failure attributed to hoof shear. Agricultural land use (pastureland) adjacent to the stream corridor and uncontrolled cattle access to the stream for watering and shade resulted in unstable, steep to undercut streambanks, and accelerated severe to extreme streambank erosion. The unstable streambanks were contributing large volumes of suspended sediment and bedload material to the larger Silver Creek watershed. It was estimated 290 cubic yards per year (or 375 tons per year) of sediment was being eroded from the unstable streambanks along UTA prior to restoration.

The mitigation goals and objectives for the project streams were met by restoring physical and biological functions of the project reaches beyond pre-existing conditions. Pre-restoration conditions consisted of impaired, channelized, eroding and entrenched stream channels. The project restoration goal was to restore channel dimension, pattern, and profile to stable and self-maintaining conditions utilizing natural channel design methods and techniques. The mitigation goals and objectives were met by providing the attributes described below.

- Stable stream channels with features inherent of a diverse aquatic and riparian ecosystem.
- Integrated a Priority Level II restoration approach by creating a floodprone area connected to the bankfull elevation, or by raising the streambed elevations, reconnecting the bankfull elevation to the existing floodplain elevation.
- Improved and created bedform and physical aquatic habitat features (riffles, runs, pools and glides).
- Minimization of existing land use impacts on the stream.
- Long-term protection of the stream corridors via a perpetual conservation easement conveyed to the State of North Carolina.

Restoration of the project streams re-established geomorphologic features consistent with reference reach conditions. Results achieved are listed below.

- Bankfull channels constructed with the appropriate geometries to convey bankfull flows and transport suspended sediment and bedload materials available to the streams.
- Stable channel pattern, profile and dimension consistent with natural streams in the region.
- Grade control and bank stabilization in-stream structures, such as cross vanes, J-hook vanes, rock vanes, dual-winged jetties, constructed riffles, step pools, root wad revetment, rock-toe channel protection or native revetment, that enhance environmental attributes of the stream channels while creating stable and functional aquatic habitat.
- Reconnection of project stream channels to functional floodplains.
- Extensive indigenous riparian plantings and exotic vegetation control that establishes a native forested plan community within the newly constructed and protected stream corridor.

Restoration of the streams has met the objective of the project along both the Silver Creek mainstem and UTA, providing the desired habitat and stability features required to improve and enhance the ecologic health of the streams for the long-term. Specifically, the completed restoration project has accomplished the following items, considering both the pre-existing impaired condition and the channel conditions as verified as part of the Year 3 monitoring.

Silver Creek Mainstem:

- Reversed the effects of channel incision and entrenchment using a Priority Level II restoration approach. The restoration has increased the width/depth ratio from 5.36 (most impaired reach) to 34.82 (median value) after construction completion and three years of monitoring.
- Restored natural stream pattern, profile and dimension throughout the 2,959 l.f. mainstem reach, decreasing channel sinuosity from 1.46 to 1.40, while creating a stable relationship between valley, channel, water surface and bankfull slopes.
- Stabilized eroding streambanks by providing an appropriately sized channel with stable streambank slopes using a combination of embedded stone, natural fabrics and aggressive native streamside and riparian revetment. The average Bank Height Ratio has been decreased from 3.98 (deeply incised) to 1.00 (stable) in Year 3.
- Provided a re-connection between the restored stream bankfull elevation and floodprone area (Priority Level II restoration). The completed restoration changed the average entrenchment ratio from 1.3 to 1.9, and restored the pre-existing unstable, incised and entrenched F4 stream channel to a stable B4c stream type (Rosgen, 1994).
- Created instream aquatic habitat features including deep pools, rootwad streamside fish cover and streambank stabilization, constructed riffles, rock cross vanes, J-Hook rock vanes, log vane – J-Hook – root wad combination structures with deep pools and native streamside revetment to enhance outer meander bend stability, shade the pools, provide fish cover and lower water temperature.
- Revegetated the streambanks and riparian corridor with indigenous canopy and mid-story trees, shrubs and herbaceous ground cover.
- Preserved the riparian corridor within a fenced, perpetual conservation easement conveyed to the State of North Carolina.

Unnamed Tributary A (UTA):

- Reversed the effects of channelization utilizing Priority Level II natural channel design restoration techniques. The average width/depth ratio of the restored stream channel has been adjusted to a stable median value of 14.6.
- Restored natural stream pattern, profile and dimension throughout the 1,552 l.f. stream reach providing a more stable relationship between the Rosgen Type II Valley (Rosgen, 1994) slope and bankfull channel slopes.
- Stabilized vertical to undercut, eroding streambanks by constructing an appropriately sized channel with stable streambank slopes. The average Bank Height Ratio was decreased from 1.91 (deeply incised) to 1.00 (stable).
- Raised the streambed elevation by constructing appropriately spaced step-pools and riffle sequences, decreasing near-bank shear stress from 1.68 to 1.30 lb/sq ft.
- Restoration increased the average entrenchment ratio from 0.91 to 1.59, restoring the unstable, incised and entrenched A4 stream type to a stable B4a stream type (Rosgen, 1994).
- Created instream aquatic habitat features including step-pools, log sills, streambank slope stabilization, constructed riffles, rock sills and rock toe channel protection.
- Revegetated stabilized streambanks and the riparian corridor with indigenous canopy, mid-story, shrubs and herbaceous plant species, where deficient.
- Preserved the riparian corridor within a fenced, perpetual conservation easement conveyed to the State of North Carolina.

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

Table I. Project Structure Table Silver Creek Stream Restoration / EEP Project No. D05016-01	
Project Segment/Reach ID	**Linear Footage or Acreage**
Silver Creek Mainstem	2,905 ft
Unnamed Tributary A (UTA)	1,552 ft
Unnamed Tributary B (UTB)	66 ft
Unnamed Tributary C (UTC)	48 ft
Unnamed Tributary D (UTD)	52 ft
TOTAL	4,623 ft

Table II. Project Mitigation Objectives Table Silver Creek Stream Restoration / EEP Project No. D05016-01					
Project Segment/ Reach ID	**Mitigation Type**	**Linear Footage or Acreage**	**Mitigation Ratio**	**Mitigation Units**	**Comment**
Silver Creek Mainstem	Priority 2 Restoration	2,905 ft	1.0	2,905 ft	Restore dimension, pattern, and profile
UTA	Priority 2 Restoration	1,552 ft	1.0	1,552 ft	Restore dimension, pattern, and profile
UTB	Preservation	66 ft	5.0	13 ft	Preserved within the conservation easement
UTC	Preservation	48 ft	5.0	10 ft	Preserved within the conservation easement
UTD	Preservation	52 ft	5.0	10 ft	Preserved within the conservation easement
TOTAL		4,623 ft		4,490 ft	

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 Silver Creek Stream Restoration / EEP Project No. D05016-01			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration plan	Aug 2005	Feb 2006	May 2006
Final Design - 90%[1]	--	--	--
Construction	Feb 2006	N/A	Apr 2007
Temporary S&E applied to entire project area[2]	Feb 2006	N/A	Apr 2007
Permanent plantings	Apr 2006	N/A	Apr 2007
Mitigation plan/As-built	Jun 2006	May 2007	Sep 2007
Year 1 monitoring	2007	Sep 2007 (vegetation) Nov 2007 (geomorphology)	Jan 2008
Year 2 monitoring	2008	Sep 2008 (vegetation) Dec 2008 (geomorphology)	Dec 2008
Year 3 monitoring	2009	Sep 2009 (vegetation) Nov 2009 (geomorphology)	Dec 2009
Year 4 monitoring	2010		
Year 5 monitoring	2011		

[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 Silver Creek Stream Restoration / EEP Project No. D05016-01	
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	Warren E. Knotts, PG, EMH&T
Vegetation Monitoring POC	Holly M. Blunck, Botanist, EMH&T

Table V. Project Background Table Silver Creek Stream Restoration / EEP Project No. D05016-01	
Project County	Burke
Drainage Area[1]	Mainstem-8.26 sq mi UTA-0.075 sq mi
Drainage Impervious Cover Estimate	5.5%
Stream Order[1]	Mainstem-3rd UTA-1st
Physiographic Region	Blue Ridge Mountains/Southern Inner Piedmont
Ecoregion	Eastern Blue Ridge Foothills
Rosgen Classification of As-built[1]	Mainstem-B4c UTA-B4a
Dominant Soil Types	Colvard sandy loam, Rhodhiss sandy loam
Reference Site ID	Brindle Creek
USGS HUC for Project and Reference	03050101
NCDWQ Sub-basin for Project and Reference	03050101050050
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?	No
Reason for 303d listing or stressor	N/A
% of project easement fenced	100%

[1]Data for UTB, UTC, and UTD are not reported as they are Preservation reaches.

In addition to the monitoring required by EEP protocol, monitoring has been required by the NC DWQ under the Section 401 permit issued for the project on May 25, 2007. The 401 permit conditions require monitoring data collection related to bank stability and success of vegetative plantings installed along UTB and UTC, which were inadvertently impacted during restoration construction along Silver Creek. The additional monitoring data is summarized under the appropriate sections of this report.

D. Monitoring Plan View

The monitoring plan view is included as Figure 2.

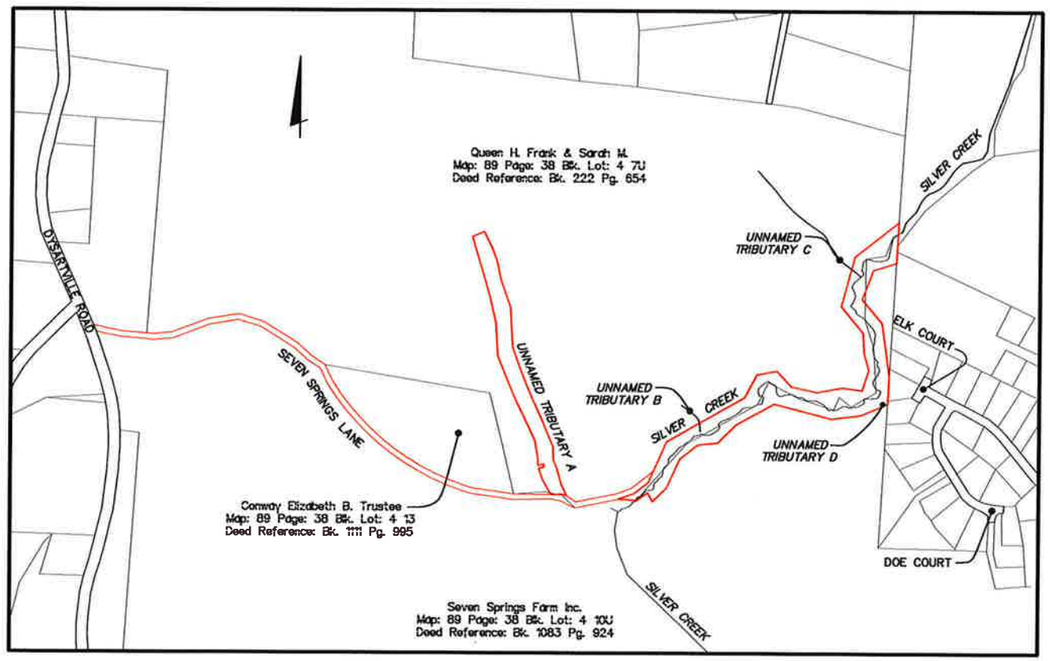
BURKE COUNTY, NORTH CAROLINA

FIGURE 2 - MONITORING PLAN VIEW

FOR

SILVER CREEK AND UNNAMED TRIBUTARY

2007



LOCATION MAP
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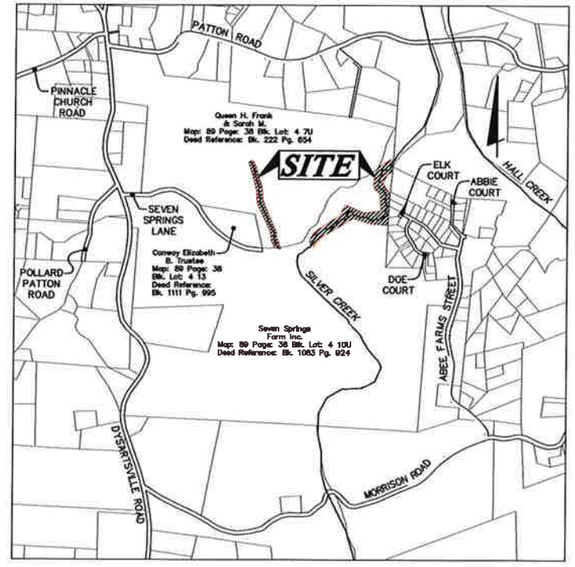

VICINITY MAP
Not To Scale

Job No 2007-1898
Sheet 1/6
Date January, 2008
Scale As Noted

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
SILVER CREEK AND UNNAMED TRIBUTARY
SILVER CREEK

Ecosystem Enhancement Program

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers / Surveyors / Planners / Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800

EEP Ingress/Egress Easement along Seven Springs Lane

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

EX. SOIL ROAD (DO NOT DISTURB)

VP-2

Recorded Conservation Easement
NC EEP Project No. D05016-1
Plat Bk. 31, Pg. 249

X-Sec. 1
Riffle

X-Sec. 2
Pool

Prop. Thalweg

Ex. Thalweg

Limits of Beltwidth

Matchline Sta. 5+00.00 (See This Sheet)

BEGIN AS-BUILT
STA. 0+00.00

Bankfull Width(30')

Stream Bank Reinforcement

BEGIN STREAM WORK
STA. 0+00.00

Ex. Low Water Crossing

VP-1

Recorded Conservation Easement
NC EEP Project No. D04006-5
Plat Bk. 27, Pgs. 119-120

Seven Springs Farm Inc.
Map: 89 Page: 38 Blk. Lot: 4 10U
Deed Reference: Bk. 1083 Pg. 924

Unnamed Tributary B (UT-B)

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

Recorded Conservation Easement
NC EEP Project No. D05016-1
Plat Bk. 31, Pg. 249

Limits of Beltwidth

Matchline Sta. 5+00.00 (See This Sheet)

Prop. Thalweg

Ex. Thalweg

Bankfull Width (30')

Constructed Point Bar (Typ.)

Matchline Sta. 10+00.00 (See Sheet 03)

Prop. Bank Fill (Typ.)

VP-3

Recorded Conservation Easement
NC EEP Project No. D05016-1
Plat Bk. 31, Pg. 249

Seven Springs Farm Inc.
Map: 89 Page: 38 Blk. Lot: 4 10U
Deed Reference: Bk. 1083 Pg. 924

LEGEND

- Vegetation Plot (VP)
- Crest Gauge
- Cross Section Monument
- P\L Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Channel
- As-Built Structure
- As-Built Bank Stabilization
- As-Built Root Wad
- As-Built Riffle
- Photo Direction and Location

Job No. 2007-1898
Sheet 2/6
Date January, 2008
Scale Hor: 1" = 40'
Ver: 1" = 4'

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
SILVER CREEK AND UNNAMED TRIBUTARY
SILVER CREEK
PLAN & PROFILE

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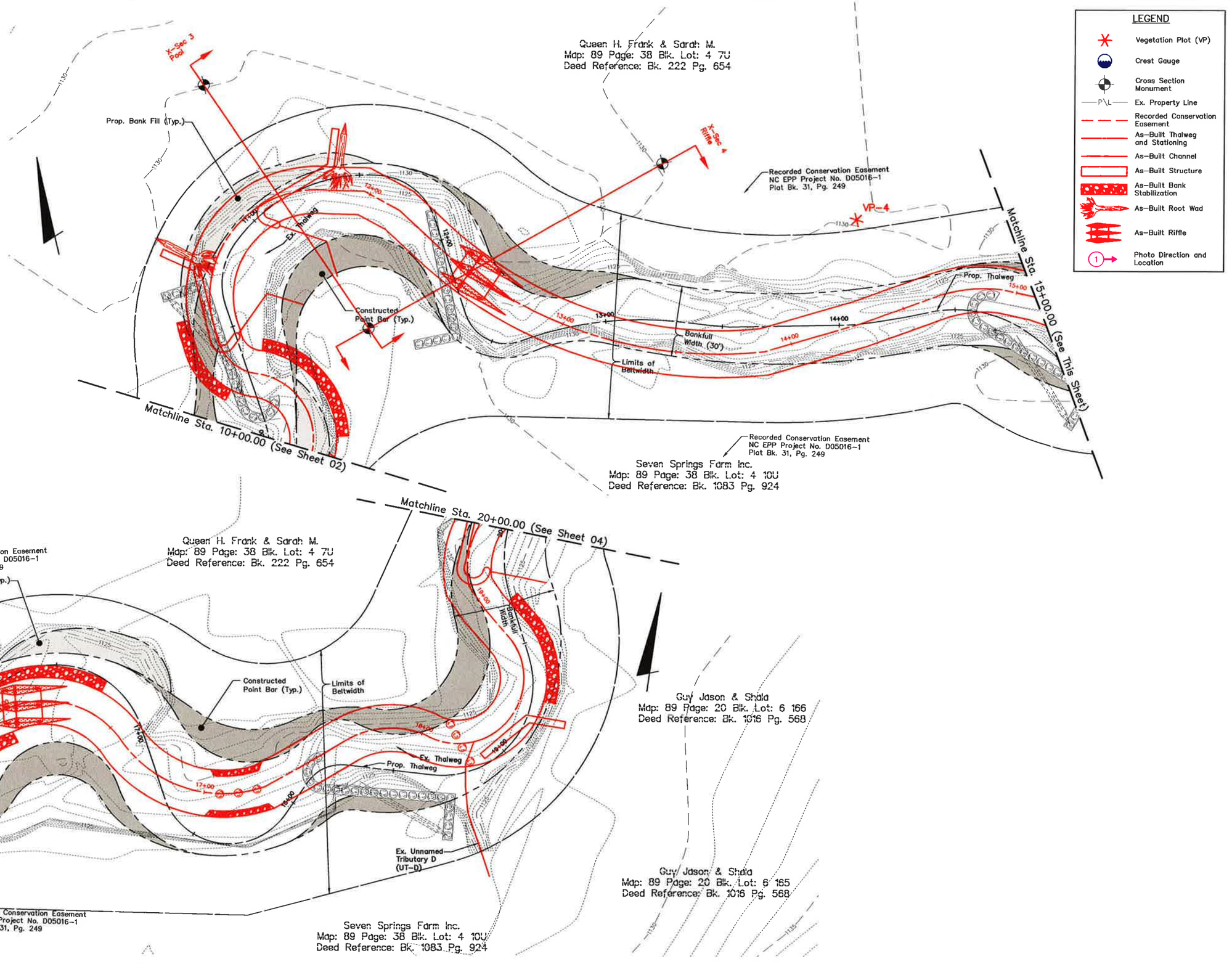

Job No 2007-1898 | Sheet 3/6

Date January, 2007

Scale Hor. 1" = 40' Ver. 1" = 4'

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR

SILVER CREEK AND UNNAMED TRIBUTARY

SILVER CREEK

PLAN & PROFILE

Ecosystem Enhancement Program

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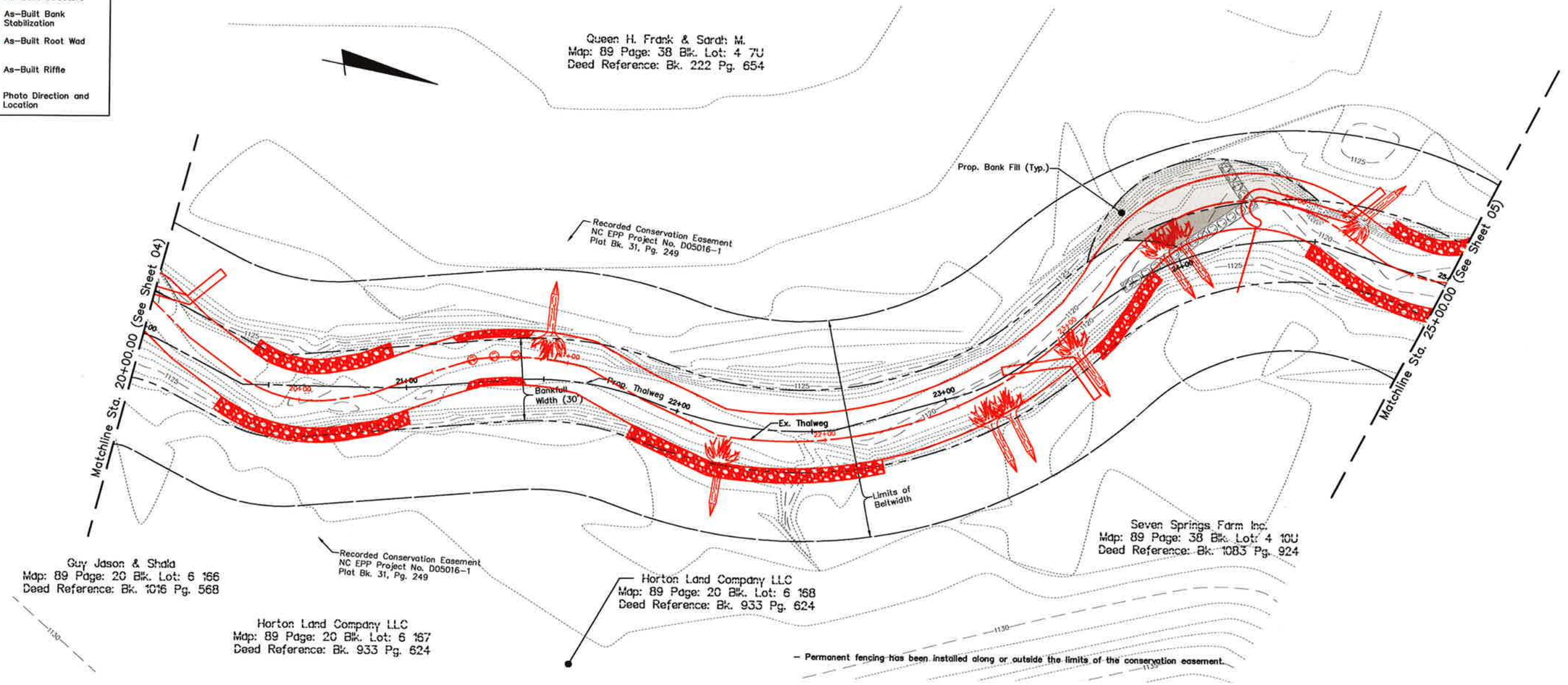
www.emht.com

LEGEND

- Vegetation Plot (VP)
- Crest Gauge
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Channel
- As-Built Structure
- As-Built Bank Stabilization
- As-Built Root Wad
- As-Built Riffle
- Photo Direction and Location



BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR

SILVER CREEK AND UNNAMED TRIBUTARY

SILVER CREEK

PLAN & PROFILE

Job No.	Sheet
2007-1898	4/6

Date	Scale
January, 2008	Hor: 1" = 40' Ver: 1" = 4'

REVISIONS

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800

Ecosystem Enhancement Program

LEGEND

- Vegetation Plot (VP)
- Crest Gauge
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
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- As-Built Structure
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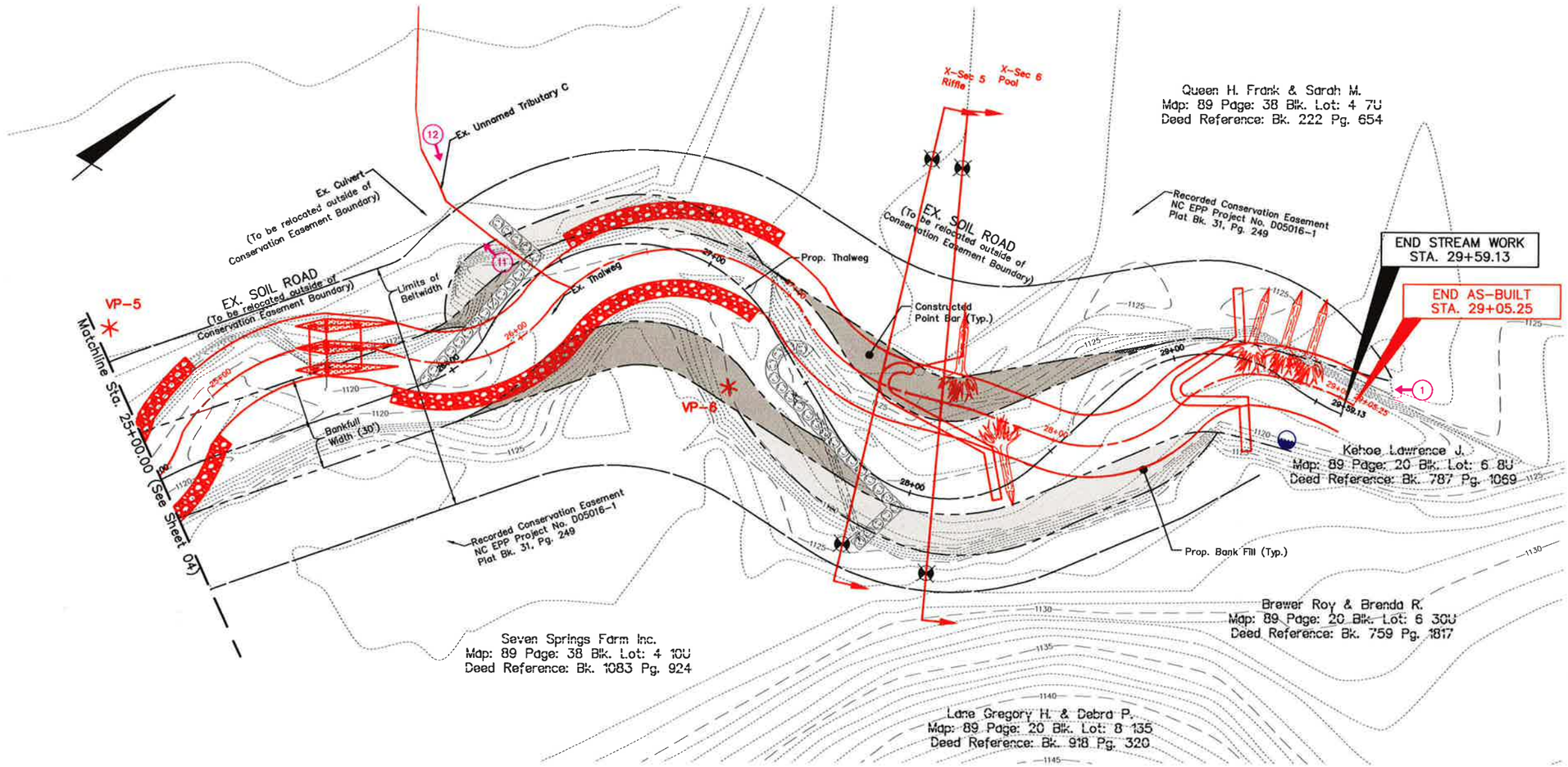
- As-Built Riffle
- Photo Direction and Location



Job No. 2007-1898
Sheet 5/6
Date January, 2008
Scale Hor: 1" = 40' Ver: 1" = 4'

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
SILVER CREEK AND UNNAMED TRIBUTARY
SILVER CREEK
PLAN & PROFILE

Ecosystem Enhancement Program

EMH&T
Environmental, Hazardous Materials & Water Resources
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, Ohio 43054
Phone: 614.775.4500 Fax: 614.775.4800

BEGIN AS-BUILT
STA. 0+00.00

BEGIN STREAM WORK
STA. 0+00.00

Regrade Channel Banks & Reinforce w/Heavy Fabric and Live Branch Plantings

Recorded Conservation Easement
NC EPP Project No. D05016-1
Plat Bk. 31, Pg. 249

VP-1

Unnamed Tributary To Silver Creek

Ex. Log Vane
(Do Not Disturb)

Ex. Thalweg

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

Recorded Conservation Easement
NC EPP Project No. D05016-1
Plat Bk. 31, Pg. 249

X-Sec 1
Riffle

VP-2

Matchline Sta. 5+00.00 (See This Sheet)

Permanent fencing has been installed along or outside the limits of the conservation easement.

Matchline Sta. 5+00.00 (See This Sheet)

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

Ex. Log Vane
(Do Not Disturb)

Recorded Conservation Easement
NC EPP Project No. D05016-1
Plat Bk. 31, Pg. 249

Step Pools

Unnamed Tributary To Silver Creek

X-Sec 2
Pool

Ex. Log Vane
(Do Not Disturb)

Ex. Overhead Electric

Proposed Bankfull
Width (8')

Ex. Thalweg

Prop. Thalweg

Build Bankfull Channel
w/Log Vanes

Recorded Conservation Easement
NC EPP Project No. D05016-1
Plat Bk. 31, Pg. 249

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

Matchline Sta. 10+00.00 (See This Sheet)

Matchline Sta. 10+00.00 (See This Sheet)

VP-3

Unnamed Tributary To Silver Creek

Reinforce Bank
w/Heavy Fabric
and Live Branch
Plantings

Ex. Thalweg

Recorded Conservation Easement
NC EPP Project No. D05016-1
Plat Bk. 31, Pg. 249

X-Sec 4
Riffle

X-Sec 3
Pool

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

Regrade Channel Banks
and Reinforce Bank
w/Heavy Frabric and Live
Branch Plantings

Reinforce Bank
w/Heavy Fabric
and Live Branch
Plantings

Proposed Bankfull
Width (8')

Excavate Floodprone
Bench

Recorded Conservation Easement
NC EPP Project No. D05016-1
Plat Bk. 31, Pg. 249

VP-4

Prop. Thalweg

Bank
Reinforcement
w/Point Bar

Riffle

Prop. Thalweg

Ex. Culvert

END AS-BUILT
STA. 15+66.60

Seven Springs Farm Inc.
Map: 89 Page: 38 Blk. Lot: 4 10U
Deed Reference: Bk. 1083 Pg. 924

END STREAM WORK
STA. 15+32.71

EX. SOIL ROAD

Recorded Conservation Easement
NC EEP Project NO. D04006-5
Plat Bk. 27, Pgs. 119-120

EEP Ingress/Egress Easement
along Seven Springs Lane

LEGEND

- Vegetation Plot (VP)
- Crest Gauge
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Channel
- As-Built Structure
- As-Built Bank Stabilization
- As-Built Root Wad
- As-Built Riffle
- Photo Direction and Location

Job No. 2007-1898
Sheet 6/6
Date January, 2008
Scale Hor. 1" = 40'
Ver. 1" = 4'

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
UNNAMED TRIBUTARY TO SILVER CREEK
UT-A
PLAN & PROFILE

Ecosystem Enhancement Program

EMHT
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists
5020 Weddington Road, Concord, NC 28027
Phone: 704.795.6000 Fax: 317.913.4800

III. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

1. Soil Data

Soil information was obtained from the NRCS Soil Survey of Burke County, North Carolina (USDA NRCS, January 3, 2006). The soils along the mainstem of Silver Creek include the Colvard Series consisting of loamy sediments ranging from 40 to 60 inches or more in thickness over deposits of sandy, loamy gravelly to cobbly sediments. Rock fragments range from 0 to 15 percent to a depth of 40 inches, and from 0 to 80 percent below 40 inches. Flakes of mica range from a few to common.

The Rhodhiss Series is present along UTA and is residuum from the underlying felsic crystalline bedrock. The Rhodhiss sandy to sandy-clay loam is found on 25 to 40 percent hillside slopes with a depth to bedrock greater than 60 inches. The depth to the top of the argillaceous (clayey) horizon ranges from 2 to 20 inches. The depth to the base of the argillaceous horizon is 20 to 60 inches or more. The pedon contains 0 to 20 percent mica flakes throughout, with mica content ranging up to 35 percent below a depth of 40 inches when the C horizon is present.

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

Table VI. Preliminary Soil Data
Silver Creek Stream Restoration / EEP Project No. D05016-01

Series	Max. Depth (in.)	% Clay on Surface	K[1]	T[2]	% Organic Matter
Colvard sandy loam (CvA)	60+	8-18	0.24	5	1-2
Rhodhiss sandy loam (RhD)	60+	5-20	0.24	5	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

Vegetative Problem Areas are defined as areas either lacking vegetation or containing populations of exotic vegetation. Each problem area identified during each year of monitoring is summarized in Table VII. Photographs of the vegetative problem areas are shown in Appendix A.

Table VII. Vegetative Problem Areas Silver Creek Stream Restoration / EEP Project No. D05016-1			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
Invasive Population	8+00 Mainstem / left bank	Sericea lespedeza: encroachment from pasture	No photo
	14+50 Mainstem/ right bank	Sericea lespedeza: encroachment from pasture	
	27+50 Mainstem/ right bank	Sericea lespedeza: encroachment from pasture	
Bare Floodplain	Mainstem: See VPA Plan View	Sparse vegetation along riparian corridor; likely due to poor soil, plus previous cattle intrusion	VPA 1,2
	UTA: See VPA Plan View	Sparse vegetation along riparian corridor, some areas completely denuded; due to cattle intrusion	

There are a few areas with a population of sericea lespedeza along the Silver Creek mainstem. This species is a common component of pasture mixes, and as this project is adjacent to pasture lands, it likely spread into the project area from the surrounding landscape. Because this species is limited to isolated patches of small plants, it does not appear to be impacting the survival of woody stems and is therefore considered a problem of low concern at this time. However, proactive management in the form of herbicide treatments will be conducted throughout the spring of 2010 to limit the impact of this species on the vegetative success of the project.

Several areas along the Silver Creek Mainstem were noted to have low overall herbaceous cover along the riparian corridor on the right bank. These areas are patchy and scattered throughout the corridor, with none of the areas showing banks that are completely bare. The soil along this project is a mix of sand and gravel, and as such, provides very dry conditions in which seed must germinate and grow. In addition to the poor soil conditions, evidence of previous cattle intrusion was also noticed along the areas of sparse vegetation. Early in the year, cattle had accessed a restoration project upstream of this site, and subsequently moved down the stream corridor into the fenced riparian easement. Fencing has been placed across the stream to prevent cattle access from the offsite project. Now that the cattle have been excluded, it is expected the permanent ground cover growing in the corridor will spread to fill the bare areas.

Cattle had unintentional access to UTA through the early part of September 2009 due to a fallen tree across the protective fencing. The cattle intrusion into the riparian corridor resulted in several areas of bare ground and sparse vegetation. These areas were reseeded in the fall of 2009 using a seed mix appropriate for shady, partial canopied woodland areas. Cattle damage to planted woody species and stream stability are discussed under subsequent sections of this report.

3. Vegetation Problem Area Plan View

The location of each vegetation problem area is shown on the vegetative problem area plan view included in Appendix A. Each problem area is color coded with yellow for areas of low concern (areas to be watched) or red for high concern (areas where maintenance is warranted).

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.

Table VIIIa. Stem counts for each species arranged by plot - planted stems. Silver Creek Stream Restoration / EEP Project No. D05016-1

	Plots										Year 0	Year 1	Year 2	Year 3	Survival
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Totals**	**Totals**	**Totals**	**Totals**	**%**
Shrubs															
Alnus serrulata	3			1	1	1		1	2		5	5	7	9	100
Aronia arbutifolia								1						1	100
Aronia melanocarpa			3			1		2	1		8	8	4	7	88
Cornus amomum	2	2	5	2	4	4	1	2	2		31	25	20	24	77
Trees															
Acer rubrum							2				2	2	2	2	100
Acer saccharum	1				6	1					18	18	13	8	44
Fraxinus pennsylvanica						1	1	2	2	4	15	15	9	10	67
Liriodendron tulipifera					1	2					4	4	4	3	75
Platanus occidentalis	2	4								2	16	11	8	8	50
Quercus michauxii	1	3									3	3	3	4	133
Quercus palustris	1										0	0	1	1	100
Salix nigra			3								5	5	3	3	100
Sambucus canadensis						1					0	0	0	1	100
Year 1 Totals	10	9	11	3	12	11	4	8	7	6	107	96	74	81	76
Live Stem Density	405	365	446	122	486	446	162	324	284	243					
Average Live Stem Density	328														

Table VIIIb. Stem counts for each species arranged by plot - all stems. Silver Creek Stream Restoration / EEP Project No. D05016-1										
	Plots									
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Shrubs										
Alnus serrulata	3		7	1	7	1		1	2	
Aronia arbutifolia								1		
Aronia melanocarpa			3			1		2	1	
Cornus amomum	2	2	5	2	4	4	1	2	2	
Lindera benzoin						4				
Trees										
Acer rubrum	4				1	6	3			
Acer saccharum	1				9	1		1		
Fraxinus pennsylvanica		1	1	1	1	1	1	2	3	4
Juglans nigra										1
Liriodendron tulipifera	1				1	4				
Lonicera sp.									2	3
Morus sp.									1	
Pinus sp.	2				1					
Platanus occidentalis	3	4								2
Quercus michauxii	1	3								
Quercus palustris	1									
Quercus sp.			1							
Rhus sp.				1						
Salix nigra			3	5						
Sambucus canadensis						1				
Year 1 Totals	18	10	20	10	24	23	5	9	11	10
Live Stem Density	729	405	810	405	972	932	203	365	446	405
Average Live Stem Density	567									

The average stem density for the site falls meets the minimum criteria of 320 stems per acre after three years. However, four of the ten vegetation plots fall below this threshold number. The largest deficit occurred along the Unnamed Tributary, where cattle intrusion had killed several trees and severely damaged others. In previous years, seedling mortality had been an issue along the entire length of the unnamed tributary. While the woody plantings were focused on areas of open canopy in the existing tree cover, the presence of large trees and the well-developed existing vegetative cover shades the smaller seedlings and provides substantial competition for resources. Plot 4 along the mainstem also exhibited poor survivability; however, the cause of the high seedling mortality is unknown. The dry sandy soil could partially explain the mortality in Plot 4, although it is unknown why the soil has affected this plot along the mainstem in much greater proportion than the five other plots along the same stream.

In addition to the planted woody species, a substantial number of recruit stems have been found in all plots. The recruit stems result in nearly a 75% increase in the total stem density across the site, and bring nearly all plots into compliance with the Year 3 minimum criteria.

Remedial plantings were conducted in late April, 2009 to supplement the number of trees along the streams. The following species were planted across the project site:

Scientific name	Common Name
Aronia arbutifolia	Red chokeberry
Alnus incana	Speckled alder
Ilex verticillata	Winterberry
Cornus amomum	Silky dogwood
Platanus occidentalis	Sycamore
Liriodendron tulipifera	Tulip poplar
Quercus bicolor	Swamp white oak
Quercus velutina	Black oak

These additional trees brought the average live stem density to 328 stems per acre in Year 3, an increase over the average live stem density of 300 stems per acre in Year 2. However, the cattle damaged large areas of woody vegetation, creating open patches where seedlings and smaller saplings had been trampled or broken off a few feet above the ground. The damage resulted in a lower stem count for several plots than would have been found prior to the cattle intrusion.

To address the issue of low plant stem counts on those plots affected by cattle intrusion, specific areas will be targeted for replanting within the Silver Creek and Unnamed Tributary riparian corridors, which will include the deficient sample plots and surrounding areas within the buffer. All deficient portions of the riparian corridors will be supplemented with additional native tree and shrub plantings. These supplemental plantings will follow the specifications of the project proposed in the project Restoration Plan and Mitigation Plan documents. Consideration will be given to using larger woody stock, such as three-gallon potted material versus bare root specimen in performing the remedial plantings. These larger saplings should have a more developed root system and thus be better able to compete with the existing vegetation. Species more suitable for full or partial shade will also be included in the species mix to provide better survivability under the existing canopy. Supplemental replanting will occur during spring 2010. The subsequent Year 4 (2010) monitoring report will contain specific documentation of this remedial planting effort including the specific locations of replanting, and the quantity and species of tree and shrub material installed.

Section 401 Permit Monitoring

In addition to the vegetative monitoring plots on the Silver Creek Mainstem and UTA, one vegetation monitoring plot each has been placed on UTB and UTC, as required by the NC DWQ under the Section 401 permit. Monitoring for these plots includes simple stem counts by species, and does not follow the full methodology of the *CVS-EEP Protocol for Recording Vegetation, Version 4.0.* A summary of the stem count data for these plots is shown in Table VIIIc.

Table VIIIc. Stem counts for the additional plots on UTB and UTC					
Species	Plots		Year 1 Totals	Year 2 Totals	Year 3 Totals
	UTB	UTC			
Shrubs					
Aronia melanocarpa		1	0	1	1
Cephalanthus occidentalis	1	2	0	2	3
Cornus amomum	7	1	2	6	8
Trees					
Acer saccharum	1	5	7	8	6
Fraxinus pennsylvanica	0	0	6	1	0
Liriodendron tulipifera	3	1	2	4	4
Platanus occidentalis	1	0	0	1	1
Quercus alba	1	3	2	3	4
Year 1 Totals	14	13	19	26	27
Live Stem Density	567	527			
Average Live Stem Density	547				

The average stem density for these tributaries well exceeds the minimum criteria of 320 stems per acre after three years. The few supplemental plantings added to the site successfully contributed to the large stem count total, and no further plantings are anticipated for these tributaries.

5. Vegetation Plot Photos

Vegetation plot photos, including photos for the additional plots on UTB and UTC, are provided in Appendix A.

B. Stream Assessment

1. Hydrologic Criteria

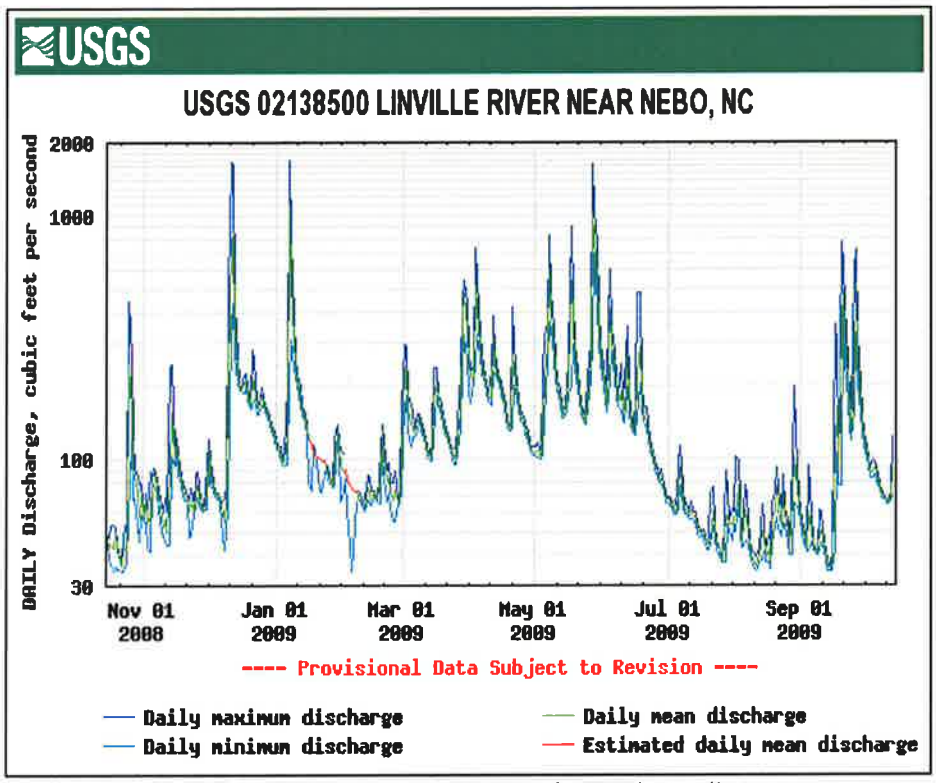
Two crest-stage stream gages were installed on the project reaches, one each for the Silver Creek Mainstem and UTA. The locations of the crest-stage stream gages are shown on the monitoring plan view (Figure 2). No bankfull events were documented for this site during the first or second years of monitoring. Bankfull events were recorded during Year 3, as documented in Table IX.

Table IX. Verification of Bankfull Events			
Date of Data Collection	Date of Occurrence	Method	Photo #
9/21/09	1/6/09-1/8/09*	Crest gage on UTA	BF 1
9/21/09	1/6/09-1/8/09*	Crest gage on Mainstem	BF 2

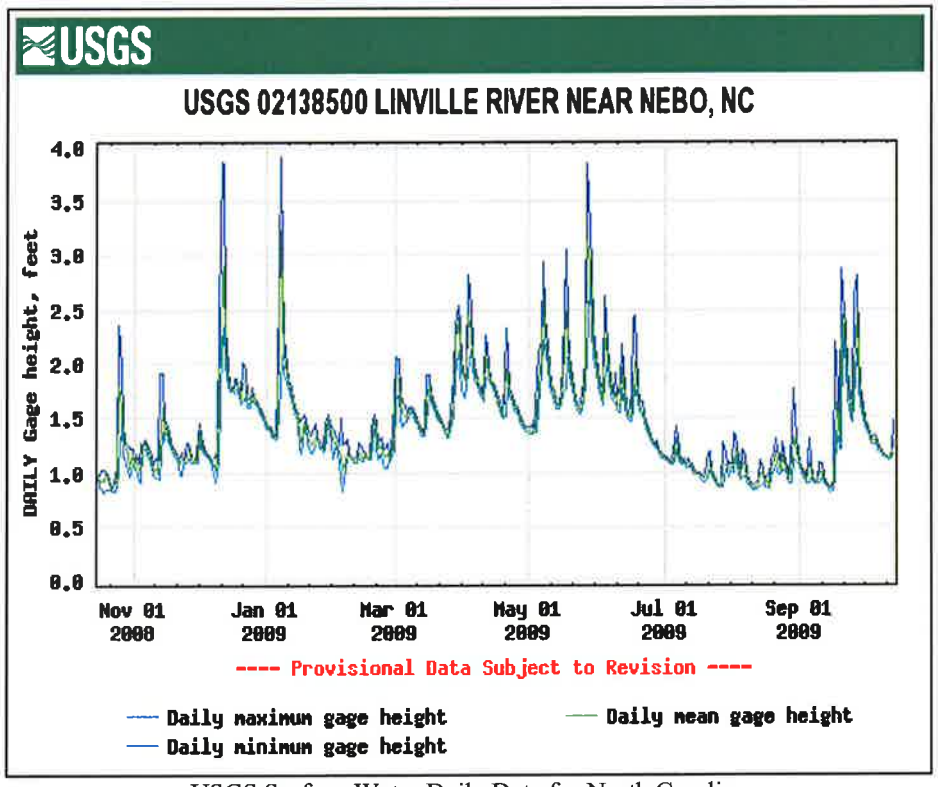
*Date is approximate; based on a review of recorded rainfall data

In September 2009, the crest gage on the unnamed tributary registered a bankfull event at a level of 1.5" above the bottom of the crest gage. The crest gage on the mainstem of Silver Creek also documented a bankfull event, at a height of 5.75" 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 rain events that occurred on January 6 and January 7, 2009. On these dates, rainfall as recorded in Rutherford, NC totaled 1.91 inches, with 1.03" on January 6 and 0.88" on January 7. As this was the largest precipitation event of significance since the completion of the Year 2 monitoring documentation, this is likely the bankfull event recorded by both crest gages. This corresponds to a high discharge event on January 8, as recorded at USGS Gage 02138500 at Nebo, NC, which lies approximately 15 miles west of Morganton and 5 miles east of Marion, NC. Other large precipitation events occurred on December 10-11, 2008, with a total precipitation of 1.73" over the two days, and May 24-26, 2009, with a total precipitation of 1.32" over the three day period. The discharge and gage height recorded at the Nebo station 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 Years 1 through 3 is included in Tables Xa through Xc.

Table Xa. Stream Problem Areas – Year 1
Silver Creek Stream Restoration / EEP Project No. D05016-1

Feature Issue	Station Numbers	Suspected Cause	Photo Number
Stressed/failing structure	5+75 UTA	Natural log sill - concern for long-term stability	SPA 1
Other	11+00 - 13+00 UTA	Nearly vertical banks - need to be stabilized with matting and vegetation	SPA 2

Table Xb. Stream Problem Areas – Year 2 Silver Creek Stream Restoration / EEP Project No. D05016-1			
Feature Issue	**Station Numbers**	**Suspected Cause**	**Photo Number**
Stressed/failing structure	5+75 UTA	Natural log sill – removed due to concern for long-term stability; channel stabilized	SPA 1
Bank scour	2+50 UTA	Bank scour/ sloughing on left bank	SPA 2
	3+55 UTA	Bank scour/ sloughing on right bank	
	5+60 UTA	Bank scour/ sloughing on left bank	
	10+50 UTA	Bank scour/ sloughing	
Other	11+00 - 13+00 UTA	Nearly vertical banks – have been reshaped, still in need of matting and revetment	SPA 3

Table Xc. Stream Problem Areas – Year 3 Silver Creek Stream Restoration / EEP Project No. D05016-1			
Feature Issue	**Station Numbers**	**Suspected Cause**	**Photo Number**
Aggradation	12+20 Mainstem	Mid-channel bar downstream of J-hook	SPA 1
	19+50 Mainstem	Mid-channel bar downstream of J-hook	
Bank scour	0+25 UTA	Bank scour/ sloughing on right bank	SPA 2,3
	2+40 – 2+60 UTA	Bank scour/ sloughing by log vane along left bank	
	3+55 UTA	Bank scour/ sloughing on right bank	
	5+60 UTA	Bank scour/ sloughing on left bank	
	8+50 UTA	Vertical bank along the right bank	
	10+50 UTA	Bank scour/ sloughing	
Other	11+00 - 13+00 UTA	Nearly vertical banks – have been reshaped, damaged by cattle intrusion	SPA 4,5
	Throughout UTA; most extensive from 11+00 to downstream project terminus	Cattle intrusion into stream channel and along stream banks	

Two small areas of aggradation were noted along the Silver Creek Mainstem. The mid-channel bars that have formed downstream of J-hook features are small and are not posing a threat to stream stability. These features are noted as problem areas of low concern in order that they be watched in future years of monitoring.

On UTA, a natural log sill was preserved during construction. The long-term stability of this feature was a noted concern during the EEP scheduled site visit upon completion of restoration. This structure has been removed, and the channel has been stabilized with appropriately size rock quarried on site. This feature has been removed from the problem area table in Year 3 due to the continued stability of the stabilized channel.

Areas of bank scour noted on UTA include a few small areas of minor streambank erosion. Because these areas are small, the use of mechanical means to regrade the banks is not warranted. The areas noted are located in short, narrow channel reaches surrounded by existing forested cover. Any areas deemed to require maintenance to improve stability will be stabilized using vegetative means by seeding with a mix appropriate for partial shade conditions. Erosion matting will be placed on any exposed ground to protect the slopes until the seed established appropriate cover. Live stakes may be installed to enhance stability in areas of nearly vertical banks.

An additional area of concern exists along UTA concerning the steep slopes of the stream banks, also noted by EEP during the construction completion site visit. These banks had been regraded to stable slope conditions; however, this is one of the areas impacted by the cattle intrusion. These slopes will be reseeded with a mix of grass and forb seeds appropriate for steep slope and partially shaded conditions. Erosion matting will be placed on any exposed ground to protect the slopes until the seed established appropriate cover. Live stakes may be added where necessary to enhance stability.

In the late summer of 2009, a tree fell across the protective easement fencing and provided an avenue for cattle access into both the channel and riparian corridor along UTA. The cattle damage along the riparian corridor resulted in mortality to planted woody stems, damage to native woody species, and trampling of the herbaceous understory vegetation. Seeding has been placed on areas of bare ground exposed by the cattle. Tree and shrub species appropriate for partial shade conditions will be planted in the spring of 2010 to replace those woody species damaged by the cattle. The cattle also accessed the stream channel itself, causing hoof shear along the downstream portion of the restored channel. Minor repairs of the bed and bank of the channel were made to address the disturbance. One riffle has been rebuilt to restore the designed grade.

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 September 17, 2009. These photographs are provided in Appendix B. Photographs of UTB and UTC are also provided, as required by the NC DWQ under the Section 401 permit.

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 third year of monitoring. The visual assessment for each reach is summarized in Table XIa and Table XIb. 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
Silver Creek Stream Restoration / EEP Project No. D05016-01
Segment/Reach: Mainstem

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles[1]	100%	100%	100%	100%		
B. Pools[2]	100%	100%	100%	100%		
C. Thalweg	100%	100%	100%	100%		
D. Meanders	100%	100%	100%	100%		
E. Bed General	100%	100%	100%	99%		
F. Vanes / J Hooks etc.[3]	100%	100%	100%	100%		
G. Wads and Boulders[4]	N/A	N/A	N/A	N/A		

Table XIa. Categorical Stream Feature Visual Stability Assessment
Silver Creek Stream Restoration / EEP Project No. D05016-01
Segment/Reach: Tributary A

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles[1]	100%	100%	100%	96%		
B. Pools[2]	100%	66%	100%	51%		
C. Thalweg	100%	100%	100%	100%		
D. Meanders	100%	100%	100%	79%		
E. Bed General	100%	100%	100%	99%		
F. Vanes / J Hooks etc.[3]	100%	98%	100%	98%		
G. Wads and Boulders[4]	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]Physical structures such as vanes, J-hooks, and root wads are assessed using the as-built plan sheets to define the location of such features. A structure is considered stable if the feature remains functional in the same location as shown in the as-built plan.
[4]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 that the majority of in-stream structures are functioning as designed and built on the Silver Creek mainstem. A few bars have formed along the mainstem; all meanders and pools are performing as intended.

A number of features along UTA were not found to be performing as intended during the visual assessment. The majority of these features were associated with the cattle intrusion, particularly along the downstream portion of the restored channel. In this area, one riffle was damaged, as well as several outer meander bends, all of which was caused by hoof shear and trampling. A few additional meanders were noted as having steep, eroding banks along the upstream reach of UTA.

The majority of instream structures were functioning as designed on UTA. One exception to this involves a log vane near station 2+50, behind which there is a minor amount of bank scour and channel downcutting.

There was a noticeable decrease in the number and depth of pools along UTA. The pools were designed to be shallow, but due to this design, sediment tends to collect and essentially fill these pools during extended low-flow periods. It is expected that these shallow pools will cyclically flush and aggrade during corresponding wet and dry seasons.

Section 401 Permit Monitoring

Monitoring is required by the NC DWQ under the Section 401 permit to ensure that stability is achieved along the restored portions of Unnamed Tributaries B and C. These streams were visually assessed for stability at the same time that the visual stream stability assessment was performed for the Silver Creek Mainstem and UTA. Both UTB and UTC appeared to be stable during this assessment. Photographic documentation of the stability of the preserved portions of Tributaries B and C is included with the Fixed Station Photographs in Appendix B.

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 Table XII for comparison with the monitoring data shown in the tables in the appendix.

The stream pattern data provided for Year 1, Year 2 and Year 3 is the same as the data provided from the As-Built survey, as pattern has not changed based on the Year 3 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, riffle slopes and pool to pool spacings are stable. The comparison of the As-Built, Year 2 and Year 3 long-term stream monitoring profile data show stability with minimal change from as-built conditions. The longitudinal profiles contained in Appendix B reflect a software anomaly resulting in a shift in the locations of profile features in the various years. RiverMorph uses the shortest straight line distance between the consecutive survey points to create the stationing for the profile. The Year 3 survey represents a larger number of collected survey points which has resulted in a higher cumulative length of stream profile, particularly affected by the number of points collected around each meander bend. The lengthening of the stream profile in Year 3 also affects the locations of each pool and riffle with respect to the profiles of the previous years. In fact, the pool and riffle features remain in the same locations shown on the as-built mitigation plan, with only slight adjustments. As such, we have evaluated stability from the standpoint of comparing features between the different yearly profiles with the understanding of the 'shift' in these features between the profiles.

Table XII. Baseline Geomorphic and Hydraulic Summary

Silver Creek Stream Restoration / EEP Project No. D05016-01

Station/Reach: Mainstem {Long-Term Monitoring Profile Station 0+00 to 20+71.94 (2071.94 linear feet)}

Parameter	Reference Reach			Pre-Existing Condition			Design			As-Built			Year 1 Sta. 0+00 - 18+71			Year 2 Sta. 0+00 - 20+72			Year 3 Sta. 0+00 - 20+72		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Drainage Area (mi^2)			1.16			8.26			8.26			8.26			8.26			8.26			8.26
BF Width (ft)			24.02	29.22	122.47	60.86			30.00	46.18	69.81	58.00	46.14	68.80	57.47	43.86	68.44	63.90	43.85	61.08	55.01
Floodprone Width (ft)			232.00	37.00	84.00	60.00	54.0	145.0	99.5	82.81	114.45	98.63	82.93	114.25	98.59	81.98	114.11	101.89	73.96	126.00	105.03
BF Cross Sectional Area (ft^2)			30.77	139.70	230.44	176.46			90.00	83.59	103.55	93.57	83.97	100.15	92.06	73.69	95.39	89.90	82.72	91.44	86.88
BF Mean Depth (ft)			1.28	1.88	5.45	3.95			1.59	1.29	1.81	1.55	1.46	1.82	1.64	1.39	1.68	1.41	1.50	1.89	1.58
BF Max Depth (ft)			1.72	6.57	7.62	7.04			3.00	2.80	3.75	3.28	2.81	3.48	3.15	3.08	4.15	3.35	3.54	4.21	3.73
Width/Depth (ft)			18.77	5.36	65.14	25.78			18.87	25.51	52.16	38.84	25.35	47.12	36.24	26.11	49.24	45.32	23.20	40.72	34.82
Entrenchment Ratio			9.66	0.69	1.91	1.29	1.80	4.83	3.32	1.59	1.79	1.69	1.66	1.80	1.73	1.60	1.87	1.79	1.69	2.06	1.91
Bank Height Ratio			1.00	3.89	4.07	3.98			1.00	1.00	1.02	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wetted Perimeter (ft)			26.58	35.78	152.95	75.32			33.18	46.98	70.20	58.59	46.96	69.18	58.07	44.62	69.80	59.58	44.85	61.64	56.03
Hydraulic Radius (ft)			1.16	1.51	4.28	3.23			2.71	1.27	1.78	1.53	1.45	1.79	1.62	1.37	1.65	1.47	1.48	1.84	1.55
Pattern																					
*Channel Beltwidth (ft)	44.17	46.50	45.22	37	84	60	54.0	145.0	93.9	82.81	181.94	109.79	82.93	114.25	102.73	82.93	114.25	102.73	82.93	114.25	102.73
*Radius of Curvature (ft)	12.97	24.44	17.67				45.0	75.0	60.0	46.07	185.40	68.70	46.07	185.40	68.70	46.07	185.40	68.70	46.07	185.40	68.70
*Meander Wavelength (ft)	88.23	115.70	104.80				60.0	191.8	125.9	73.79	191.70	124.86	73.79	191.70	124.86	73.79	191.70	124.86	73.79	191.70	124.86
*Meander Width Ratio	1.84	1.94	1.88	0.61	1.38	0.99	1.80	4.83	3.13	1.79	2.61	1.89	1.66	1.80	1.79	1.57	1.89	1.61	1.87	1.89	1.87
Profile																					
Riffle Length (ft)	19.0	31.0	25.7	6.5	10.5	12.5			32.9	9.4	47.7	28.4	7.3	47.3	27.8	7.5	68.6	29.6	5.1	49.8	20.7
Riffle Slope (ft/ft)	0.0125	0.0362	0.0211	0.0045	0.0096	0.0069			0.0056	0.0039	0.1787	0.0242	0.0084	0.0318	0.0165	0.0080	0.0218	0.0131	0.0031	0.0242	0.0085
Pool Length (ft)	11.0	31.6	17.4	20.1	36.1	26.3			65.7	17.1	56.9	35.7	28.1	70.7	51.3	17.8	89.9	47.4	23.7	86.3	54.5
Pool Spacing (ft)	67.6	77.5	71.4	101.1	149.0	129.1			131.4	36.4	388.3	145.5	61.5	257.3	161.2	49.1	245.9	114.9	38.8	217.9	89.4
Substrate																					
d50 (mm)			38.5	12.9	38.5	26.6	12.9	38.5	25.7	15.5	26.9	21.2	7.7	16.5	12.1	9.8	21.4	18.9	6.0	16.7	7.4
d84 (mm)			60.2	20.6	60.2	52.3	20.6	60.2	40.4	21.2	30.4	25.8	10.9	21.3	16.1	15.3	29.8	27.6	11.4	38.4	25.4
Additional Reach Parameters																					
Valley Length (ft)			294.00			2077			2077			2077			2077			2077			2077
Channel Length (ft)			353.00			3040			2959			2905			2905			2905			2905
Sinuosity			1.2			1.46			1.43			1.40			1.40			1.40			1.40
Water Surface Slope (ft/ft)			0.0106	0.0022	0.0030	0.0026			0.0025			0.0026			0.0028			0.0027			0.0029
BF Slope (ft/ft)			0.0115			**			0.0026			0.0027			0.0028			0.0027			0.0028
Rosgen Classification			C4			F4	B4c	C4	C4			B4c			B4c			B4c			B4c
*Habitat Index																					
*Macrobenthos																					

Notes: * Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria

**Insufficient field indicators to estimate bankfull slope under impaired F4 channel conditions.

Blank fields = Historic project documentation necessary to provide these data were unavailable at the time of this report submission.

Where no min/max values are provided, only one value was measured or computed and is presented as the median value.

Table XII. Baseline Geomorphic and Hydraulic Summary

Silver Creek Stream Restoration / EEP Project No. D05016-01

Station/Reach: Tributary A {Long-Term Monitoring Profile Station 0+00 to 10+49.79 (1049.79 feet)}

Parameter	Reference Reach			Pre-Existing Condition			Design			As-Built			Year 1 Sta 0+00 - 10+43			Year 2 Sta 0+00 - 10+50			Year 3 Sta 0+00 - 10+50		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Drainage Area (mi^2)			1.16			0.08			0.08			0.08			0.08			0.08			0.08
BF Width (ft)			24.02			13.72			8.00	6.81	8.11	7.46	6.78	7.32	7.05	6.62	7.20	6.91	7.51	9.42	8.47
Floodprone Width (ft)			232.00	10.00	15.00	12.50	10.00	15.00	12.50	13.28	14.57	13.93	10.45	13.35	11.90	12.15	17.83	14.71	11.93	14.83	13.38
BF Cross Sectional Area (ft^2)			30.77			3.54			3.50	3.51	3.59	3.55	3.52	3.57	3.55	3.29	4.08	3.69	4.10	5.78	4.94
BF Mean Depth (ft)			1.28			0.26			0.50	0.43	0.53	0.48	0.48	0.53	0.51	0.50	0.57	0.54	0.55	0.61	0.58
BF Max Depth (ft)			1.72			0.90			1.00	0.81	1.01	0.91	0.63	1.01	0.82	1.00	1.02	1.01	0.98	0.99	0.99
Width/Depth (ft)			18.77			52.77			16.00	12.85	18.86	15.86	12.79	15.25	14.02	12.63	17.13	14.71	13.65	15.44	14.55
Entrenchment Ratio			9.66			0.91			1.56	1.80	1.95	1.88	1.43	1.97	1.70	1.84	2.48	2.13	1.58	1.59	1.59
Bank Height Ratio			1.00			1.91			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)			26.58			13.97			9.00	6.97	8.28	7.63	7.08	7.56	7.32	6.97	7.50	7.24	7.80	9.68	8.74
Hydraulic Radius (ft)			1.16			0.25			0.39	0.42	0.50	0.46	0.47	0.50	0.49	0.47	0.54	0.51	0.53	0.60	0.57
Pattern																					
*Channel Beltwidth (ft)	44.17	46.50	45.22							10.80	14.57	12.95	10.80	14.57	12.95	10.80	14.57	12.95	10.80	14.57	12.95
*Radius of Curvature (ft)	12.97	24.44	17.67							9.32	124.90	23.59	9.32	124.90	23.59	9.32	124.90	23.59	9.32	124.90	23.59
*Meander Wavelength (ft)	88.23	115.70	104.80							58.82	106.30	73.72	58.82	106.30	73.72	58.82	106.30	73.72	58.82	106.30	73.72
*Meander Width Ratio	1.84	1.94	1.88							1.45	1.95	1.74	1.59	1.99	1.84	1.63	2.02	1.87	1.44	1.55	1.53
Profile																					
Riffle Length (ft)	19.0	31.0	25.7							1.34	47.90	15.30	2.35	49.50	12.84	1.85	48.70	14.07	4.08	40.46	17.28
Riffle Slope (ft/ft)	0.0125	0.0362	0.0211							0.0344	0.6094	0.1389	0.0401	0.4593	0.1278	0.0373	0.5344	0.1334	No flow	No flow	No flow
Pool Length (ft)	11.0	31.6	17.4							6.07	22.79	12.43	6.59	24.21	13.81	6.30	23.50	13.10	5.27	18.25	11.77
Pool Spacing (ft)	67.6	77.5	71.4							10.19	143.20	55.63	10.92	150.25	38.78	10.60	146.70	47.20	15.92	149.41	63.19
Substrate																					
d50 (mm)			38.5							6.9	15.8	11.4	2.4	8.2	5.3	2.4	11.8	7.1	0.4	1.9	1.2
d84 (mm)			60.2							20.2	42.4	31.3	9.2	14.3	11.8	1.6	17.9	10.7	18.7	23.4	10.7
Additional Reach Parameters																					
Valley Length (ft)			294.00			1426			1426			1426			1426			1426			1426
Channel Length (ft)			353.00			1508			1533			1552			1552			1552			1552
Sinuosity			1.2			1.06			1.07			1.09			1.09			1.09			1.09
Water Surface Slope (ft/ft)			0.0106	0.0350	0.0500	0.0425	0.0350	0.0500	0.0425			0.0427			0.0385			0.0386			No flow
BF Slope (ft/ft)			0.0115			**	0.0375	0.0535	0.0455			0.0469			0.0367			0.0386			0.0389
Rosgen Classification			C4			A→B	A1/A2 → B4a					B4a			B4			B4			B5
*Habitat Index																					
*Macrobenthos																					

Notes: * Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria

**Insufficient field indicators to estimate bankfull slope under altered A → B channel conditions.

Blank fields = Historic project documentation necessary to provide these data were unavailable at the time of this report submission.

Where no min/max values provided, only one value was measured or computed and is presented as the mean value.

The constructed riffles remain stable, although there has been a shift in the particle distributions. The substrate in the mainstem of Silver Creek has shifted very slightly, from a median distribution in Year 2 ranging from medium to coarse gravel, to a median distribution in Year 3 ranging from fine to coarse gravel. The shift in particle distribution along UTA resulted in a classification change from B4 to B5 according to the Year 3 data. The profile graphs for both streams show that aggradation is occurring in various locations along both streams, particularly in the upstream reaches. This is most noticeable in pool locations along the profile graphs, where maximum depths have visibly decreased from Year 2. It is assumed that fine particulates are settling during low flows, both in the pools, and to a smaller extent, in riffle features. The shift in particle distributions is considered as a natural byproduct of the flow regime, rather than an indication of instability. Remedial maintenance work is not suggested at this time.

IV. METHODOLOGY

Year 1 vegetation monitoring was conducted in September 2007 using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee, M.T., Peet, RK., Roberts, S.R., Wentworth, T.R. 2006). Year 3 vegetation monitoring was conducted in September 2009 using the same protocol as used in Years 1 and 2. Year 1 stream monitoring was conducted in November 2007 to provide adequate time between the as-built survey (completed in May 2007) and the Year 1 monitoring survey. Stream monitoring for Year 2 occurred in the fall of 2008, providing a full year between the Year 1 and Year 2 surveys. Year 3 monitoring occurred in the fall of 2008 to provide a full year between surveys. Subsequent stream monitoring will occur in the fall of Years 4 and 5 to continue to provide adequate time between surveys. Vegetation monitoring will continue to be conducted in the fall of each subsequent year of monitoring, providing a full year between vegetative surveys.

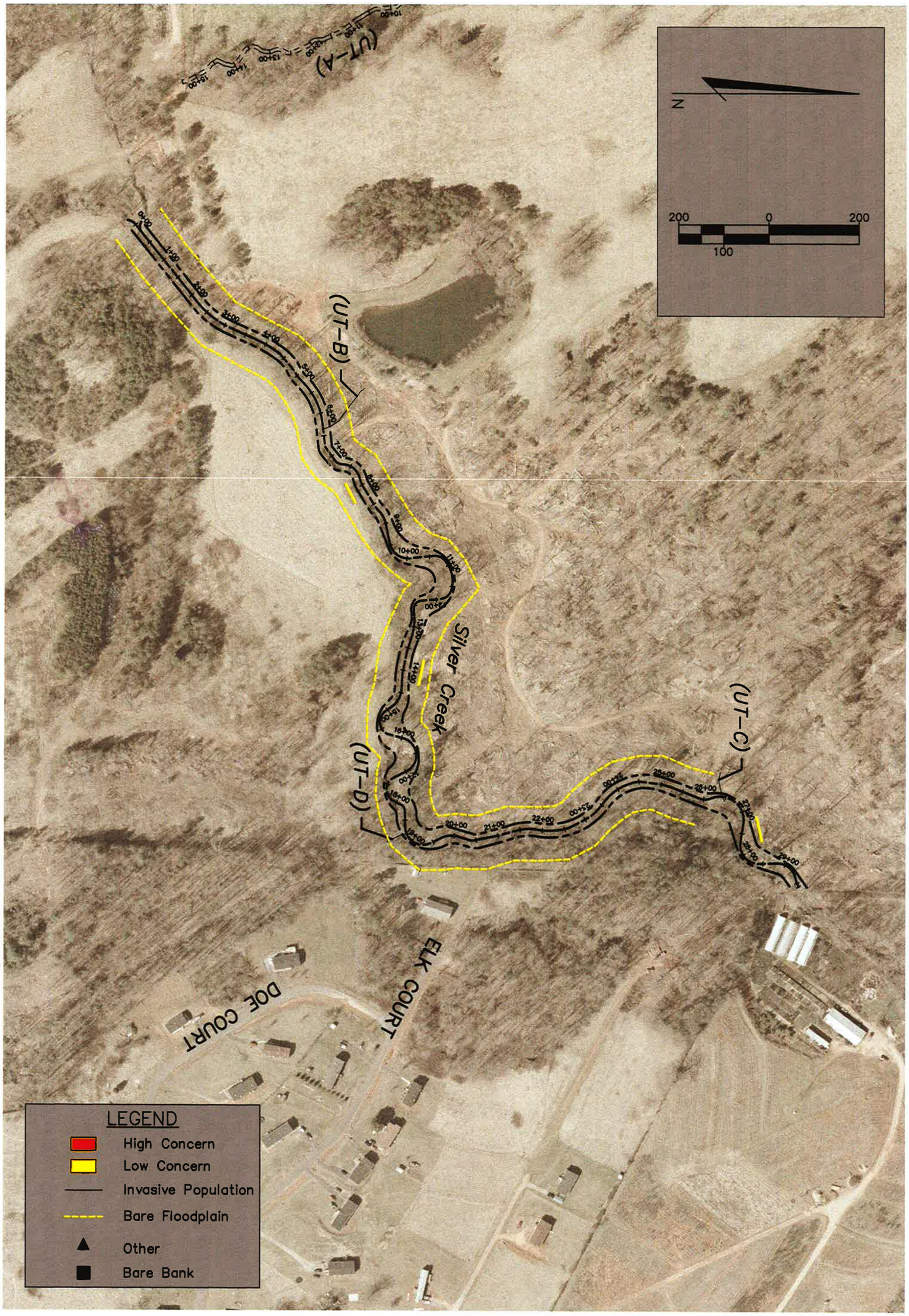
APPENDIX A

Vegetation Raw Data

1. Vegetation Problem Area Photos
2. Vegetation Problem Area Plan View
3. Vegetation Monitoring Plot Photos
4. Vegetation Data Tables

VPA 1
View of sparse vegetation in the floodplain along the mainstem.
(EMH&T, Inc. 9/17/09)

VPA 2
Overview of the sparse vegetation and bare banks along UT1 in an area of cow damage.
(EMH&T, Inc. 9/17/09)



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BURKE COUNTY, NORTH CAROLINA

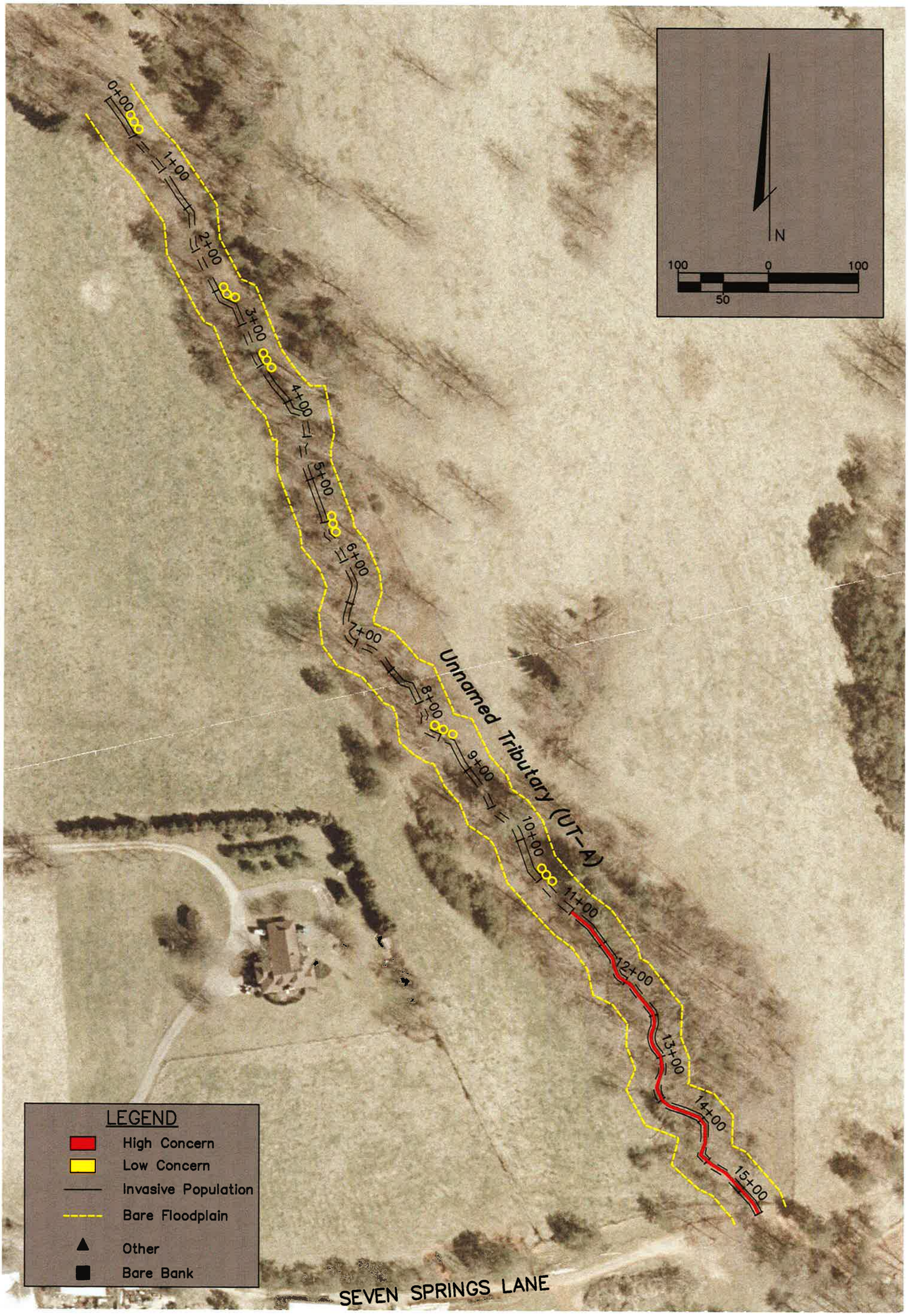
SILVER CREEK AND UNNAMED TRIBUTARY

MONITORING

APPENDIX A-1

VEGETATION PROBLEM AREA PLAN VIEW

Date:	December, 2008
Scale:	1" = 200'
Job No:	2007-1898
Sheet:	2/2



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M C M X X V I

BURKE COUNTY, NORTH CAROLINA

SILVER CREEK AND UNNAMED TRIBUTARY

MONITORING

APPENDIX A-2

VEGETATION PROBLEM AREA PLAN VIEW

Date:	December, 2008
Scale:	1" = 200'
Job No:	2007-1898
Sheet:	1/2

Vegetation Plot 1 on Mainstem
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot 2 on Mainstem
Monitoring Year 3
Photo blurred due to rainstorm.
(EMH&T, Inc. 9/17/09)

Vegetation Plot 3 on Mainstem
Monitoring Year 3
Photo blurred due to rainstorm.
(EMH&T, Inc. 9/17/09)

Vegetation Plot 4 on Mainstem
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot 5 on Mainstem
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot 6 on Mainstem
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot 1 on Tributary A
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot 2 on Tributary A
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot 3 on Tributary A
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot 4 on Tributary A
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot on Tributary B
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Vegetation Plot on Tributary C
Monitoring Year 3
(EMH&T, Inc. 9/17/09)

Table 1. Vegetation Metadata	
Report Prepared By	Holly Blunck
Date Prepared	10/5/2009 14:17
database name	cvs-eep-entrytool-v2.2.6.mdb
database location	Q:\ENVIRONMENTAL\Monitoring\EEP Vegetation Database
computer name	26WYM41
file size	61800448
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	D0501601
project Name	Silver Creek
Description	Restoration of Silver Creek Mainstem and Unnamed Tributary A.
River Basin	
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	0

Table 2. Vegetation Vigor by Species								
	Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
	Acer saccharum		3	3	2	3	7	
	Alnus serrulata	7		2			1	
	Aronia arbutifolia		1					
	Aronia melanocarpa		1	6			1	
	Cornus amomum	4	9	8	3		10	
	Fraxinus pennsylvanica	1	3	1	5	2	3	
	Quercus michauxii	3	1				1	
	Quercus palustris	1						
	Salix nigra	3					2	
	Sambucus canadensis	1						
	Liriodendron tulipifera	1	1	1		1	1	
	Platanus occidentalis	4	1	2	1		9	
	Acer rubrum			2				
TOT:	**13**	**25**	**20**	**25**	**11**	**6**	**35**	

Table 3. Vegetation Damage by Species									
	Species	All Damage Categories	(no damage)	Human Trampled	Insects	Livestock	Site Too Dry	Unknown	Vine Strangulation
	Acer rubrum	2				2			
	Acer saccharum	18	18						
	Alnus serrulata	10	7		1			2	
	Aronia arbutifolia	1	1						
	Aronia melanocarpa	8	8						
	Cornus amomum	34	27		1	3		2	1
	Fraxinus pennsylvanica	15	9	1		4		1	
	Liriodendron tulipifera	5	5						
	Platanus occidentalis	17	15			1	1		
	Quercus michauxii	5	5						
	Quercus palustris	1	1						
	Salix nigra	5	5						
	Sambucus canadensis	1	1						
TOT:	**13**	**122**	**102**	**1**	**2**	**10**	**1**	**5**	**1**

Table 4. Vegetation Damage by Plot									
	plot	All Damage Categories	(no damage)	Human Trampled	Insects	Livestock	Site Too Dry	Unknown	Vine Strangulation
	D0501601-01-0001 (year 3)	14	11				1	2	
	D0501601-01-0002 (year 3)	12	12						
	D0501601-01-0003 (year 3)	12	9			2		1	
	D0501601-01-0004 (year 3)	12	12						
	D0501601-01-0005 (year 3)	19	19						
	D0501601-01-0006 (year 3)	12	11					1	
	D0501601-01-0007 (year 3)	5	1			4			
	D0501601-01-0008 (year 3)	9	8		1				
	D0501601-01-0009 (year 3)	12	8	1	1			1	1
	D0501601-01-0010 (year 3)	15	11			4			
TOT:	**10**	**122**	**102**	**1**	**2**	**10**	**1**	**5**	**1**

Table 5. Stem Count by Plot and Species - Planted Stems														
	Species	Total Planted Stems	# plots	avg# stems	plot D0501601-01-0001 (year 3)	plot D0501601-01-0002 (year 3)	plot D0501601-01-0003 (year 3)	plot D0501601-01-0004 (year 3)	plot D0501601-01-0005 (year 3)	plot D0501601-01-0006 (year 3)	plot D0501601-01-0007 (year 3)	plot D0501601-01-0008 (year 3)	plot D0501601-01-0009 (year 3)	plot D0501601-01-0010 (year 3)
	Acer rubrum	2	1	2							2			
	Acer saccharum	8	3	2.67	1				6	1				
	Alnus serrulata	9	6	1.5	3			1	1	1		1	2	
	Aronia arbutifolia	1	1	1								1		
	Aronia melanocarpa	7	4	1.75			3			1		2	1	
	Cornus amomum	24	9	2.67	2	2	5	2	4	4	1	2	2	
	Fraxinus pennsylvanica	10	5	2						1	1	2	2	4
	Liriodendron tulipifera	3	2	1.5					1	2				
	Platanus occidentalis	8	3	2.67	2	4								2
	Quercus michauxii	4	2	2	1	3								
	Quercus palustris	1	1	1	1									
	Salix nigra	3	1	3			3							
	Sambucus canadensis	1	1	1						1				
TOT:	**13**	**81**	**13**		**10**	**9**	**11**	**3**	**12**	**11**	**4**	**8**	**7**	**6**

Table 6. Stem Count by Plot and Species - All Stems														
	Species	Total Stems	# plots	avg# stems	D0501601-01-0001 (year 3)	D0501601-01-0002 (year 3)	D0501601-01-0003 (year 3)	D0501601-01-0004 (year 3)	D0501601-01-0005 (year 3)	D0501601-01-0006 (year 3)	D0501601-01-0007 (year 3)	D0501601-01-0008 (year 3)	D0501601-01-0009 (year 3)	D0501601-01-0010 (year 3)
	Acer saccharum	12	4	3	1				9	1		1		
	Alnus serrulata	22	7	3.14	3		7	1	7	1		1	2	
	Aronia arbutifolia	1	1	1								1		
	Aronia melanocarpa	7	4	1.75			3			1		2	1	
	Cornus amomum	24	9	2.67	2	2	5	2	4	4	1	2	2	
	Fraxinus pennsylvanica	15	9	1.67		1	1	1	1	1	1	2	3	4
	Juglans nigra	1	1	1										1
	Quercus michauxii	4	2	2	1	3								
	Quercus palustris	1	1	1	1									
	Salix nigra	8	2	4			3	5						
	Sambucus canadensis	1	1	1						1				
	Rhus	1	1	1				1						
	Lonicera	5	2	2.5									2	3
	Quercus	1	1	1			1							
	Lindera benzoin	4	1	4						4				
	Liriodendron tulipifera	6	3	2	1				1	4				
	Morus	1	1	1									1	
	Pinus	3	2	1.5	2				1					
	Platanus occidentalis	9	3	3	3	4								2
	Acer rubrum	14	4	3.5	4				1	6	3			
TOT:	**20**	**140**	**20**		**18**	**10**	**20**	**10**	**24**	**23**	**5**	**9**	**11**	**10**

APPENDIX B

Geomorphologic Raw Data

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

EMH&T
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BURKE COUNTY, NORTH CAROLINA

SILVER CREEK AND UNNAMED TRIBUTARY

MONITORING

APPENDIX B-1

STREAM PROBLEM AREA PLAN VIEW

Date:	December, 2008
Scale:	1" = 200'
Job No:	2007-1898
Sheet:	1/2

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BURKE COUNTY, NORTH CAROLINA

SILVER CREEK AND UNNAMED TRIBUTARY

MONITORING

APPENDIX B-2

STREAM PROBLEM AREA PLAN VIEW

Date:	December, 2008
Scale:	1" = 200'
Job No:	2007-1898
Sheet:	2/2

SPA 1
Area of aggradation (mid-channel bar) near station 19+50 on Silver Creek.
(EMH&T, Inc. 9/16/09)

SPA 2
Bank scour along Unnamed Tributary A near station 2+60.
(EMH&T, Inc. 9/17/09)

SPA 3
Vertical bank along Unnamed Tributary A near station 8+50.
(EMH&T, Inc. 9/17/09)

SPA 4
Cattle damage along vertical banks along Unnamed Tributary A near station 11+50.
(EMH&T, Inc. 9/17/09)

SPA 5
Cattle intrusion into channel of Unnamed Tributary A near station 13+00.
(EMH&T, Inc. 9/17/09)

Table B1. Visual Morphological Stability Assessment
Silver Creek Stream Restoration / EEP Project No. D05016-1
Segment/Reach: Mainstem

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?	25	25	0	100	
	2. Armor stable (e.g. no displacement)?	25	25	0	100	
	3. Facet grade appears stable?	25	25	0	100	
	4. Minimal evidence of embedding/fining?	25	25	0	100	
	5. Length appropriate?	25	25	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	24	24	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	24	24	0	100	
	3. Length appropriate?	24	24	0	100	**100%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	25	25	0	100	
	2. Downstream of meander (glide/inflection) centering?	25	25	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	25	25	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	25	25	0	100	
	3. Apparent Rc within spec?	25	25	0	100	
	4. Sufficient floodplain access and relief?	25	25	0	100	**100%**
E. Bed General	1. Geveral channel bed aggradation areas (bar formation)	N/A	N/A	1/ 10 feet	99	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/ 0 feet	100	**99%**
F. Vanes	1. Free of back or arm scour?	15	15	0	100	
	2. Height appropriate?	15	15	0	100	
	3. Angle and geometry appear appropriate?	15	15	0	100	
	4. Free of piping or other structural failures?	15	15	0	100	**100%**
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
Silver Creek Stream Restoration / EEP Project No. D05016-1
Segment/Reach: Tributary A

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?	24	25	1	96	
	2. Armor stable (e.g. no displacement)?	24	25	1	96	
	3. Facet grade appears stable?	24	25	1	96	
	4. Minimal evidence of embedding/fining?	24	25	1	96	
	5. Length appropriate?	24	25	1	96	**96%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	8	15	7	53	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	7	15	8	47	
	3. Length appropriate?	8	15	7	53	**51%**
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?	8	12	4	67	
	2. Of those eroding, # w/concomitant point bar formation?	12	12	0	100	
	3. Apparent Rc within spec?	10	12	2	83	
	4. Sufficient floodplain access and relief?	8	12	4	67	**79%**
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	1/ 5 feet	99	**99%**
F. Vanes	1. Free of back or arm scour?	16	17	1	94	
	2. Height appropriate?	17	17	0	100	
	3. Angle and geometry appear appropriate?	17	17	0	100	
	4. Free of piping or other structural failures?	17	17	0	100	**98%**
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

Fixed Station 1
Overview of the Silver Creek Mainstem, facing downstream from the downstream project terminus.
(EMH&T, Inc. 9/16/09)

Fixed Station 2
Overview of the Silver Creek Mainstem near Riffle #3, facing downstream.
(EMH&T, Inc. 9/16/09)

Fixed Station 3
Overview of the Silver Creek Mainstem at Riffle #1, facing downstream.
(EMH&T, Inc. 9/16/09)

Fixed Station 4
Overview of the Silver Creek Mainstem at Riffle #1, facing upstream.
(EMH&T, Inc. 9/16/09)

Fixed Station 5
Overview of the Silver Creek Mainstem, facing downstream near station 2+60.
(EMH&T, Inc. 9/16/09)

Fixed Station 6
Overview of UT-A, facing upstream near station 0+50.
(EMH&T, Inc. 9/17/09)

Fixed Station 7
Overview of UT-A, facing upstream near station 8+00.
(EMH&T, Inc. 9/17/09)

Fixed Station 8
Overview of UT-A, facing upstream near station 11+00.
(EMH&T, Inc. 9/17/09)

Fixed Station 9
Overview of UT-B, facing upstream from the confluence of UT-B with Silver Creek.
(EMH&T, Inc. 9/17/09)

Fixed Station 10
Overview of UT-B, facing downstream towards the confluence of UT-B with Silver Creek.
(EMH&T, Inc. 9/17/09)

Fixed Station 11
Overview of UT-C, facing upstream from the confluence of UT-C with Silver Creek.
(EMH&T, Inc. 9/17/09)

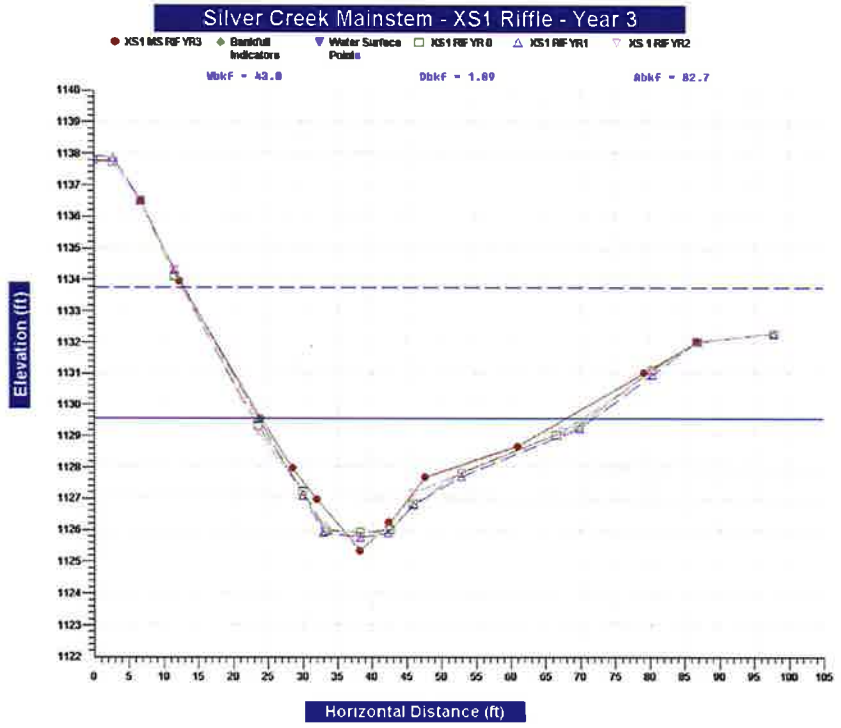
Fixed Station 12
Overview of UT-C, facing downstream towards the confluence of UT-C with Silver Creek.
(EMH&T, Inc. 9/17/09)

Summary Data

Bankfull Area (sq ft)	82.72
Bankfull Width (ft)	43.85
Mean Depth (ft)	1.89
Maximum Depth (ft)	4.21
Width/Depth Ratio	23.2
Entrenchment Ratio	1.69
Classification	B4c

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	11/12/2009
CROSS SECTION:	1
FEATURE:	Riffle at Cross Vane # 1

Riffle Cross-Section 1, looking downstream

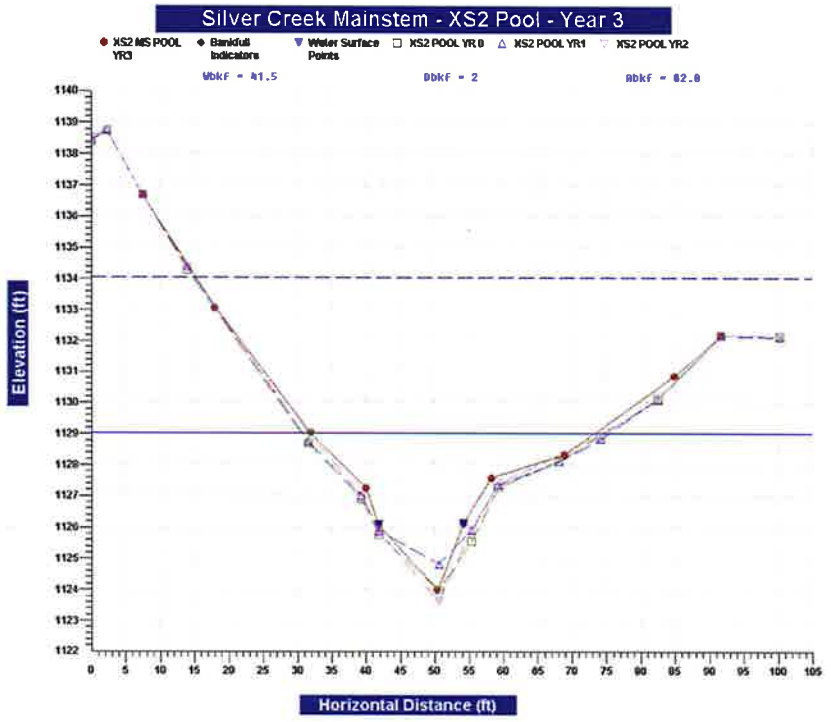


Summary Data

Bankfull Area (sq ft)	82.81
Bankfull Width (ft)	41.46
Mean Depth (ft)	2.0
Maximum Depth (ft)	5.03
Width/Depth Ratio	20.73
Entrenchment Ratio	1.85

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	11/12/2009
CROSS SECTION:	2
FEATURE:	Pool at Cross Vane # 1

Pool Cross-Section 2, looking upstream

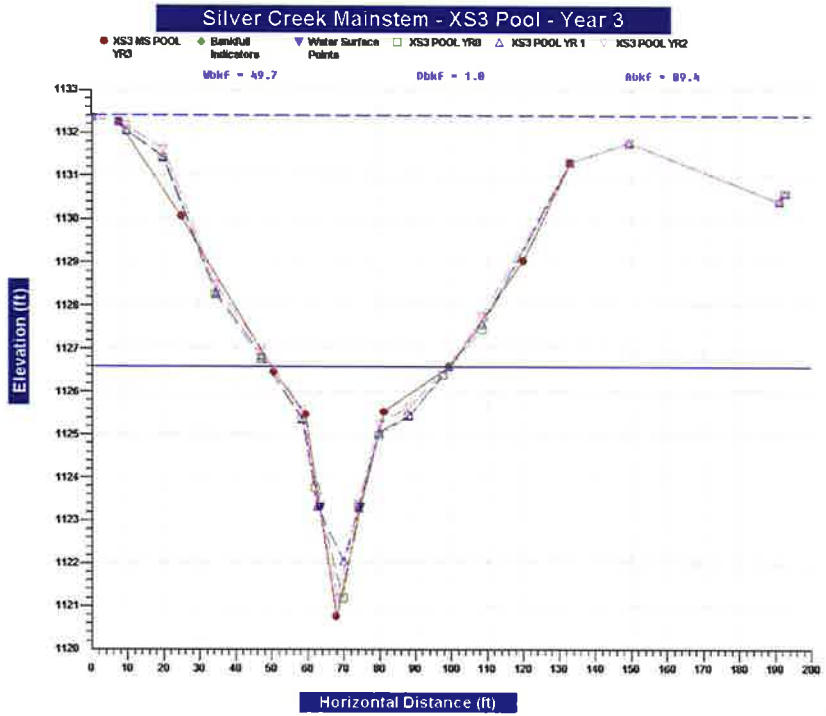


Summary Data

Bankfull Area (sq ft)	89.42
Bankfull Width (ft)	49.67
Mean Depth (ft)	1.8
Maximum Depth (ft)	5.83
Width/Depth Ratio	27.59
Entrenchment Ratio	2.53

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	11/12/09
CROSS SECTION:	3
FEATURE:	Pool at J-Hook # 4

Pool Cross-Section 3, looking downstream

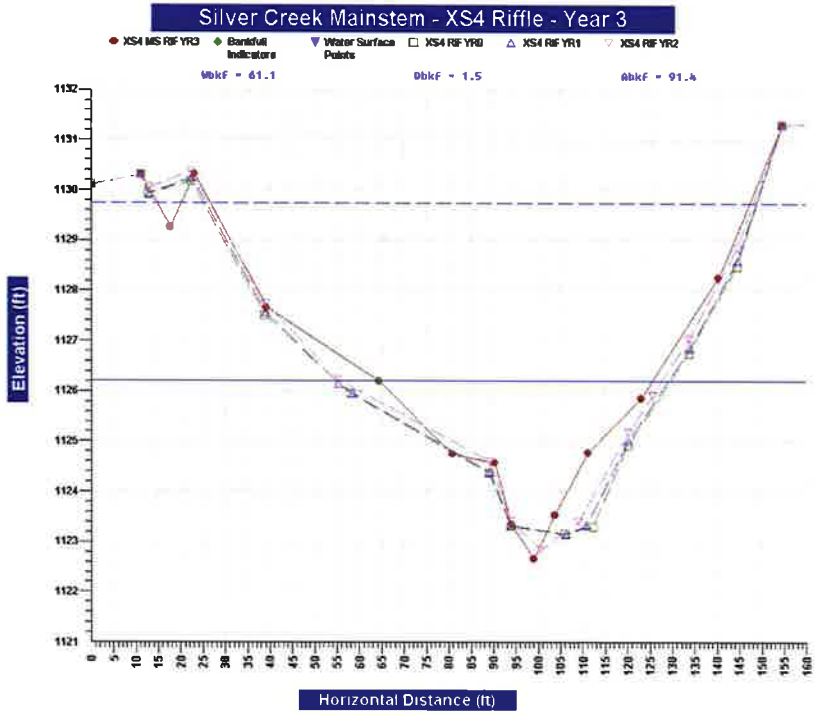


Summary Data

Bankfull Area (sq ft)	91.44
Bankfull Width (ft)	61.08
Mean Depth (ft)	1.5
Maximum Depth (ft)	3.54
Width/Depth Ratio	40.72
Entrenchment Ratio	2.06
Classification	B4c

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	11/12/2009
CROSS SECTION:	4
FEATURE:	Riffle

Riffle Cross-Section 4, looking downstream

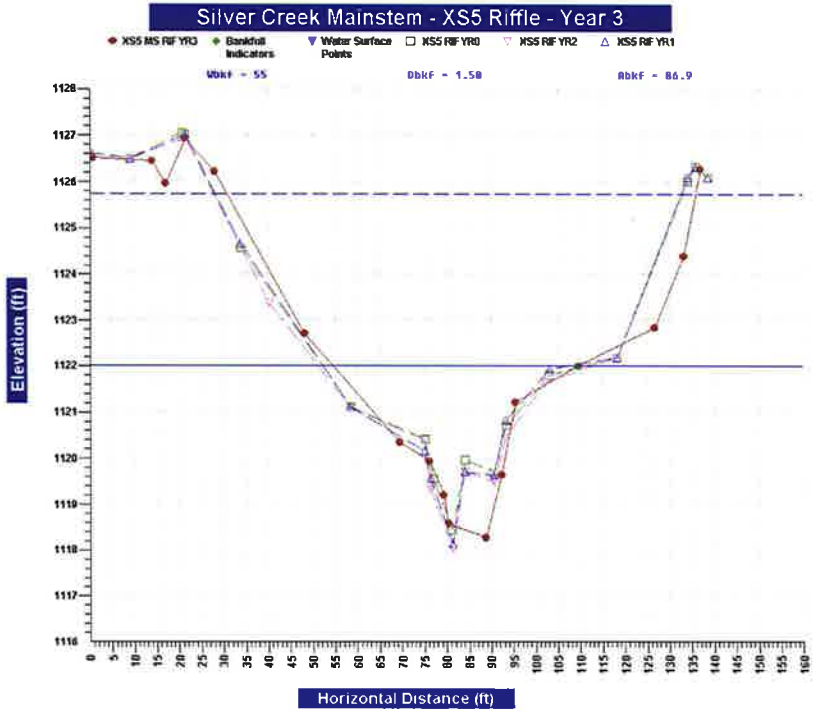


Summary Data

Bankfull Area (sq ft)	86.88
Bankfull Width (ft)	55.01
Mean Depth (ft)	1.58
Maximum Depth (ft)	3.73
Width/Depth Ratio	34.82
Entrenchment Ratio	1.91
Classification	B4c

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	11/12/2009
CROSS SECTION:	5
FEATURE:	Riffle at J-Hook # 8

Riffle Cross-Section 5, looking downstream

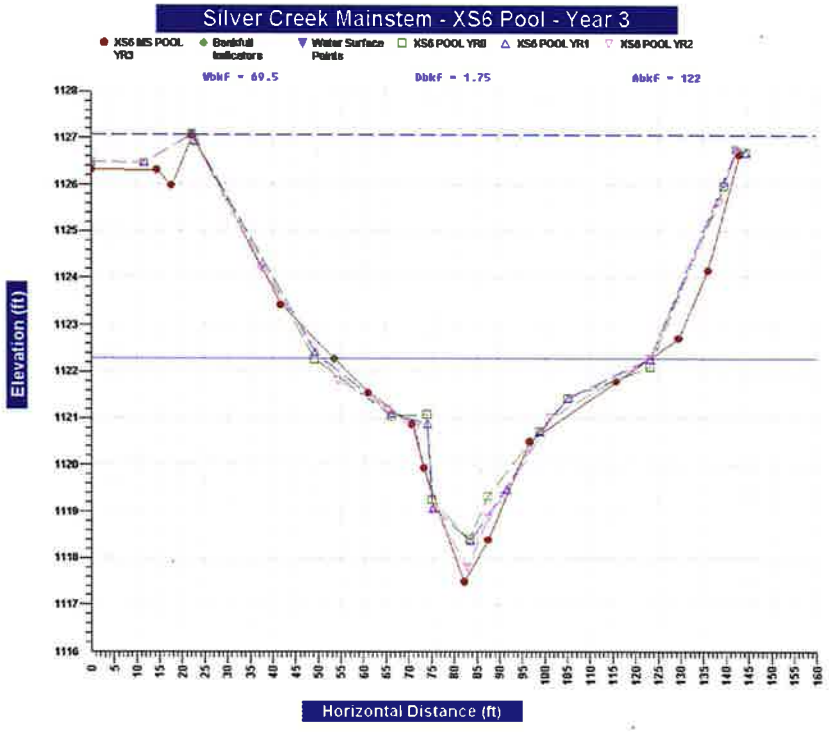


Summary Data

Bankfull Area (sq ft)	121.99
Bankfull Width (ft)	69.54
Mean Depth (ft)	1.75
Maximum Depth (ft)	4.8
Width/Depth Ratio	39.74
Entrenchment Ratio	2.05

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	11/12/2009
CROSS SECTION:	6
FEATURE:	Pool at J-Hook # 8

Pool Cross-Section 6, looking downstream

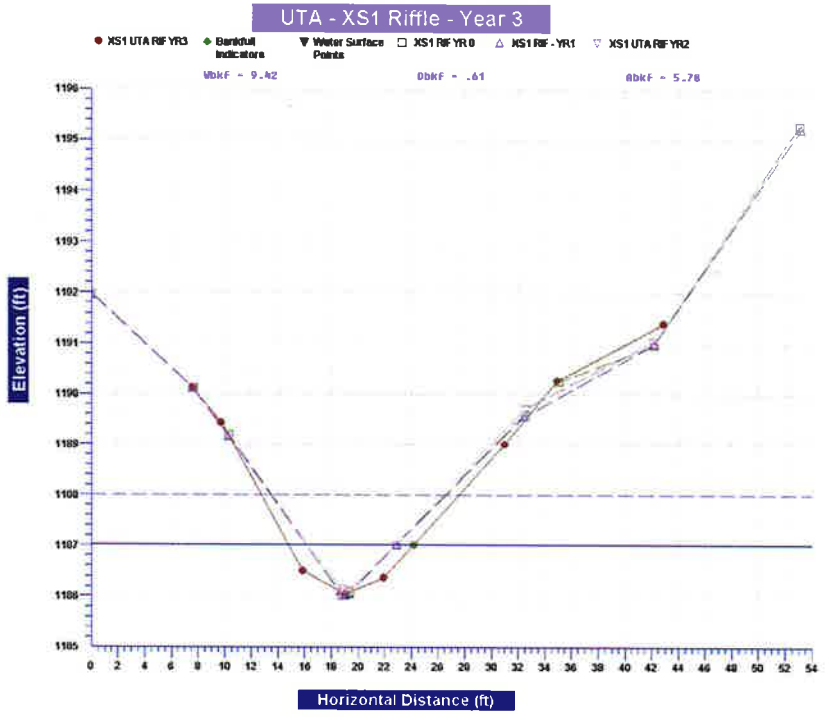


Summary Data

Bankfull Area (sq ft)	5.78
Bankfull Width (ft)	9.42
Mean Depth (ft)	0.61
Maximum Depth (ft)	0.98
Width/Depth Ratio	15.44
Entrenchment Ratio	1.58
Classification	B4

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	UT-A
DATE	11/12/2009
CROSS SECTION:	1
FEATURE:	Riffle

UTA Cross-Section 1, looking upstream

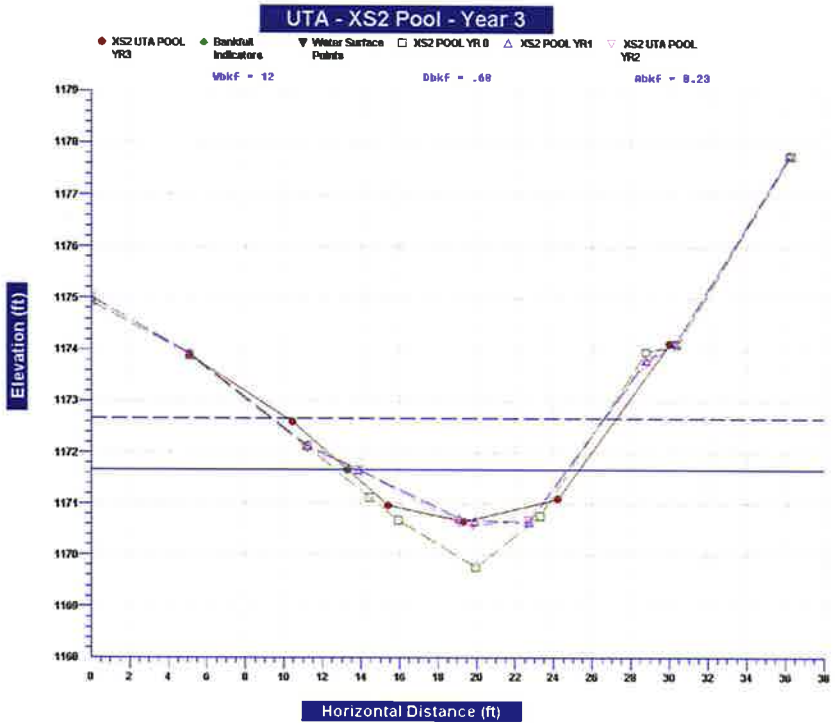


Summary Data

Bankfull Area (sq ft)	8.23
Bankfull Width (ft)	12.02
Mean Depth (ft)	0.68
Maximum Depth (ft)	1.01
Width/Depth Ratio	17.68
Entrenchment Ratio	1.43

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	UT-A
DATE	11/12/2009
CROSS SECTION:	2
FEATURE:	Pool

UTA Pool Cross-Section 2, looking upstream

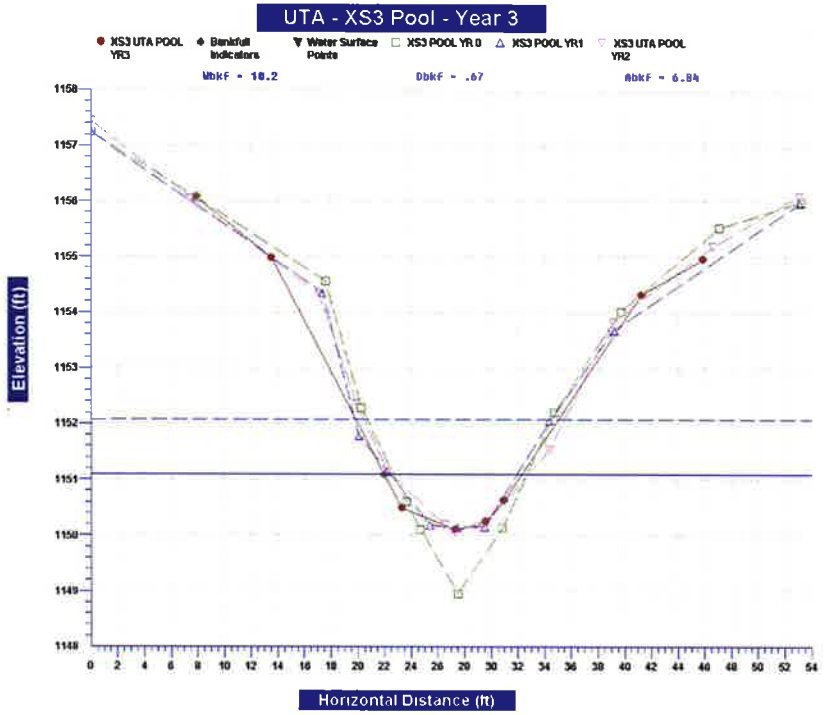


Summary Data

Bankfull Area (sq ft)	6.84
Bankfull Width (ft)	10.25
Mean Depth (ft)	0.67
Maximum Depth (ft)	0.99
Width/Depth Ratio	15.3
Entrenchment Ratio	1.48

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	UT-A
DATE	11/12/2009
CROSS SECTION:	3
FEATURE:	Pool

UTA Pool Cross-Section 3, looking from right to left across channel

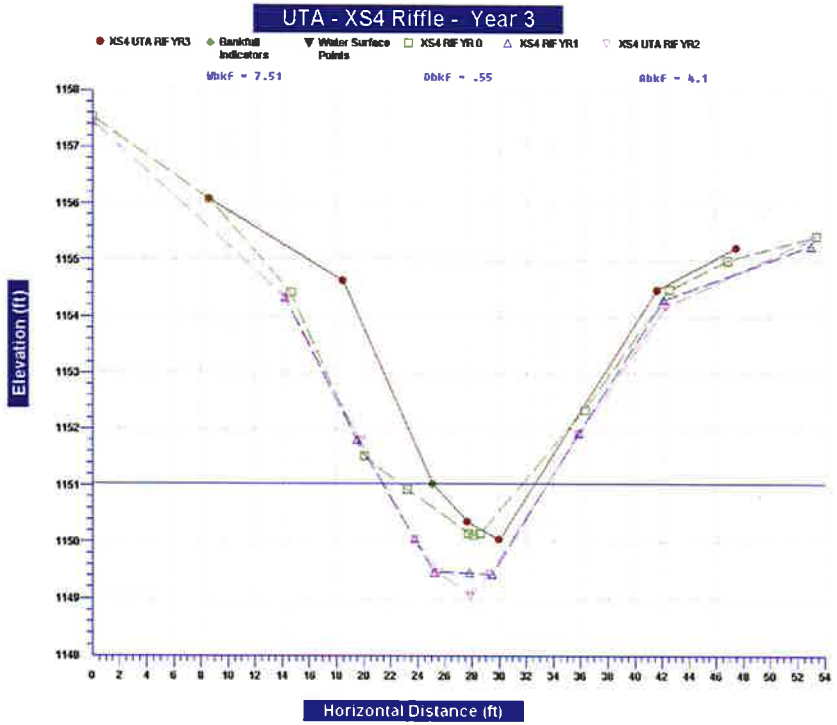


Summary Data

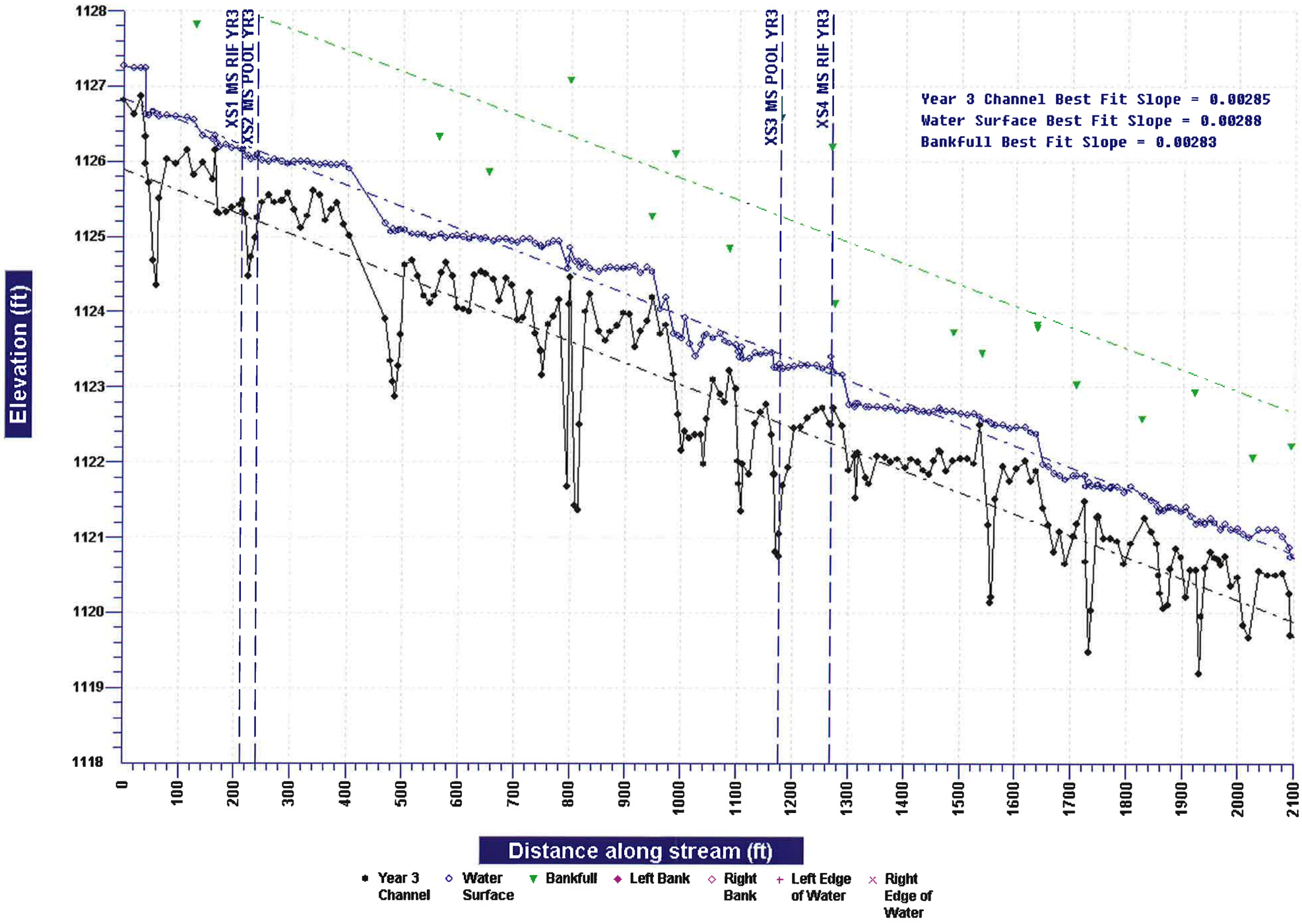
Bankfull Area (sq ft)	4.1
Bankfull Width (ft)	7.51
Mean Depth (ft)	0.55
Maximum Depth (ft)	0.99
Width/Depth Ratio	13.65
Entrenchment Ratio	1.59
Classification	B4

PROJECT	Silver Creek
	D05016-1
	3-YEAR
TASK	Cross-Section
REACH	UT-A
DATE	11/12/2009
CROSS SECTION:	4
FEATURE:	Riffle

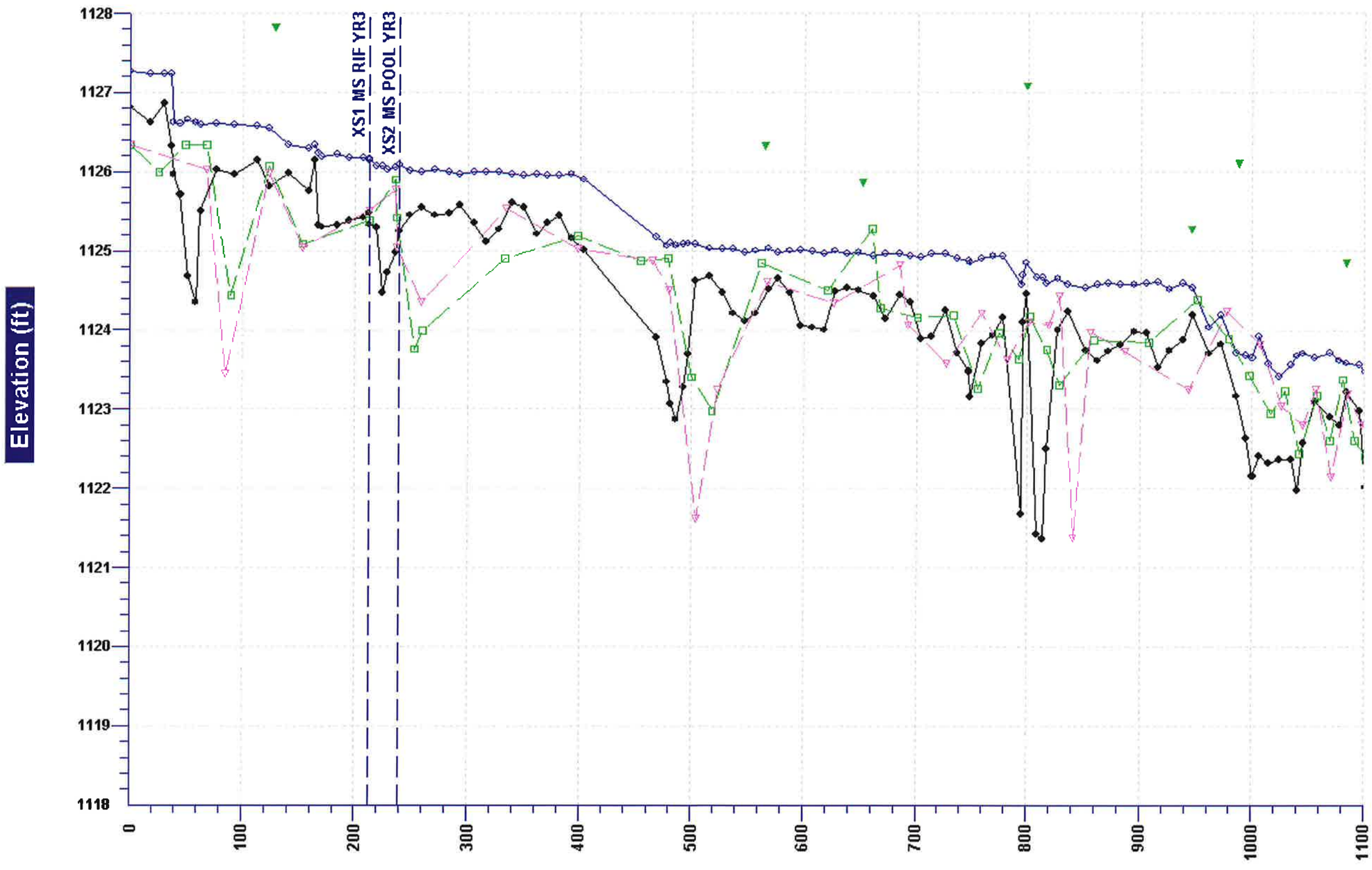
UTA Riffle Cross-Section 4, looking right to left across channel



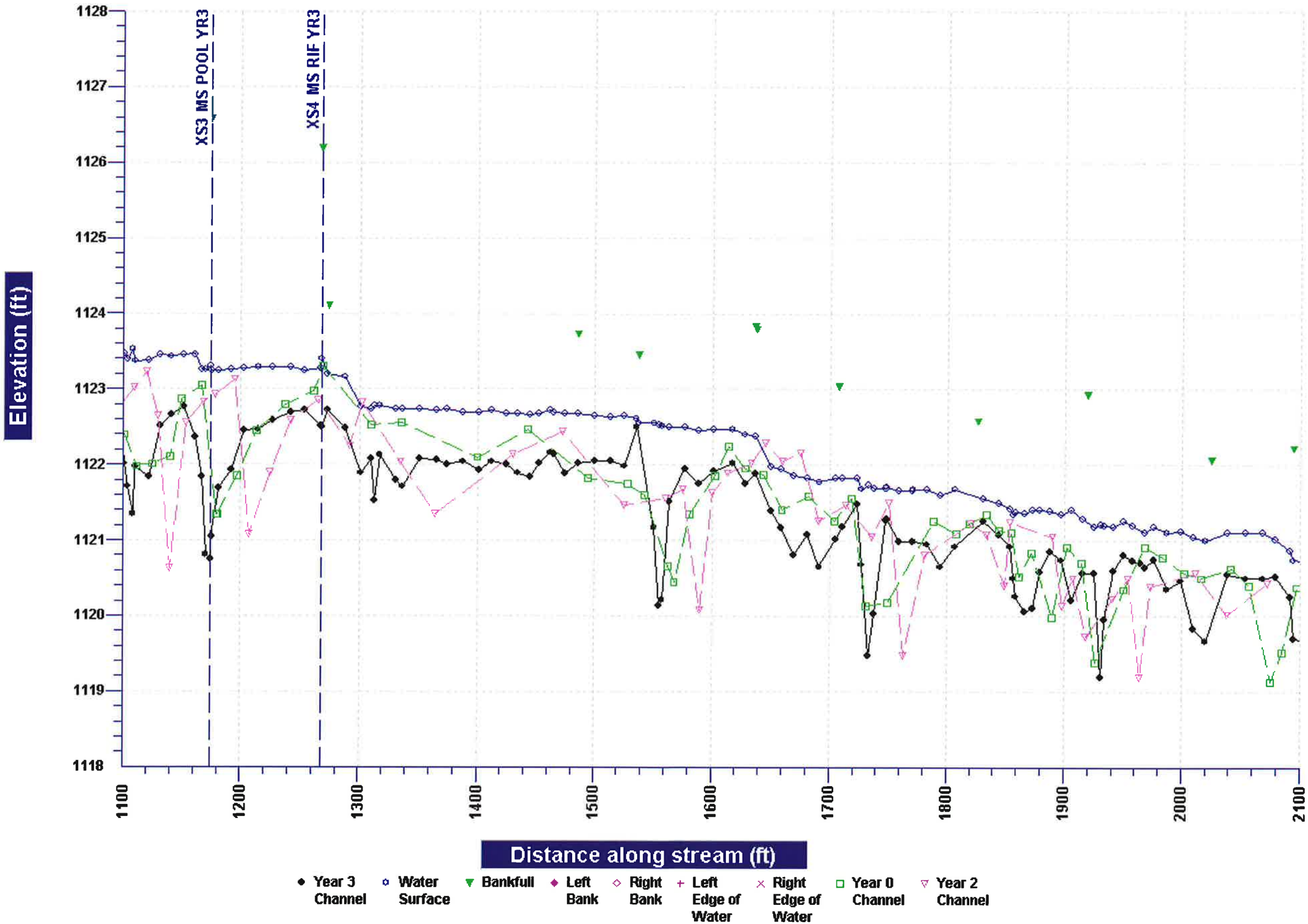
Silver Creek Mainstem Profile - Year 3



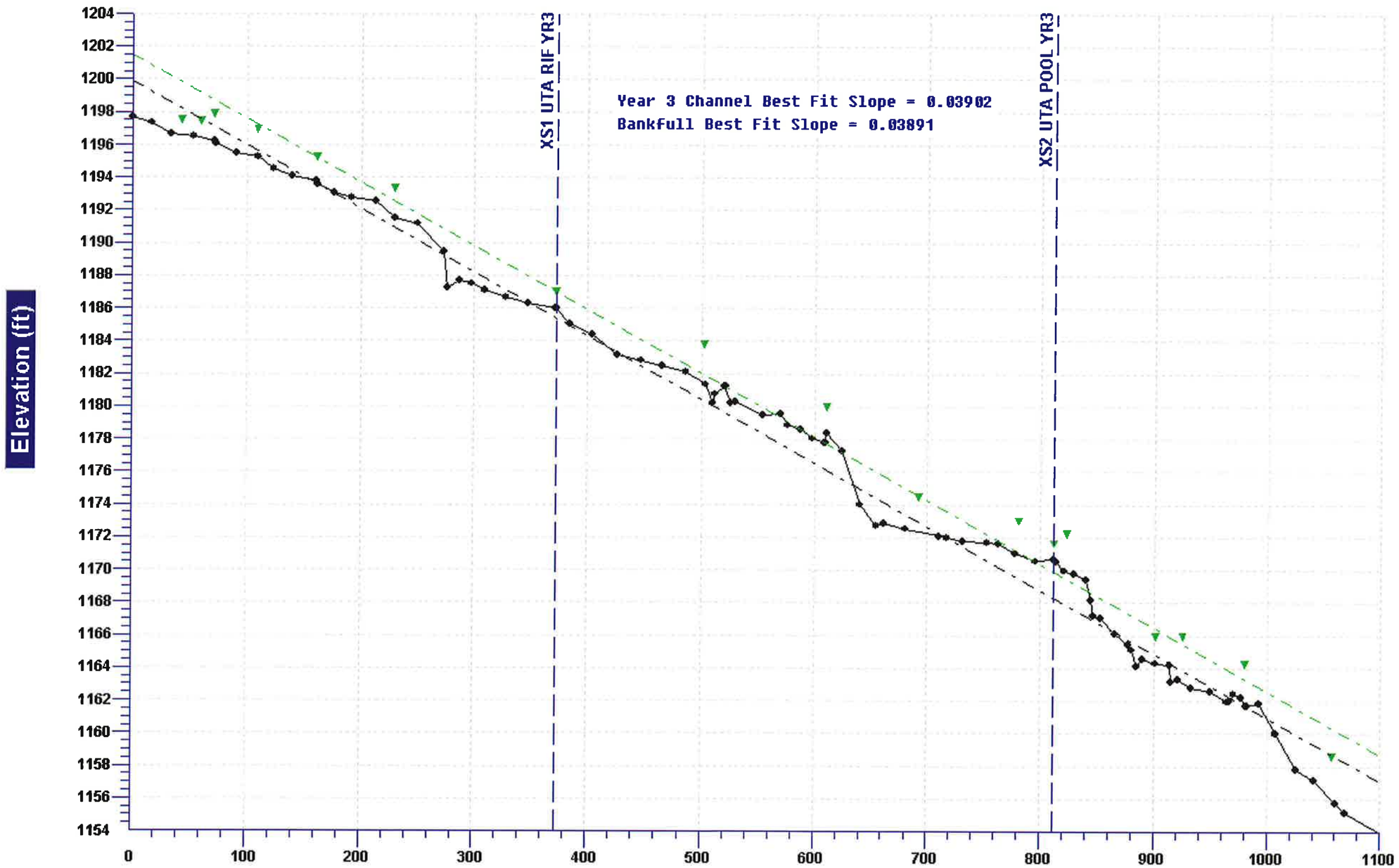
Silver Creek Mainstem Profile - Year 3



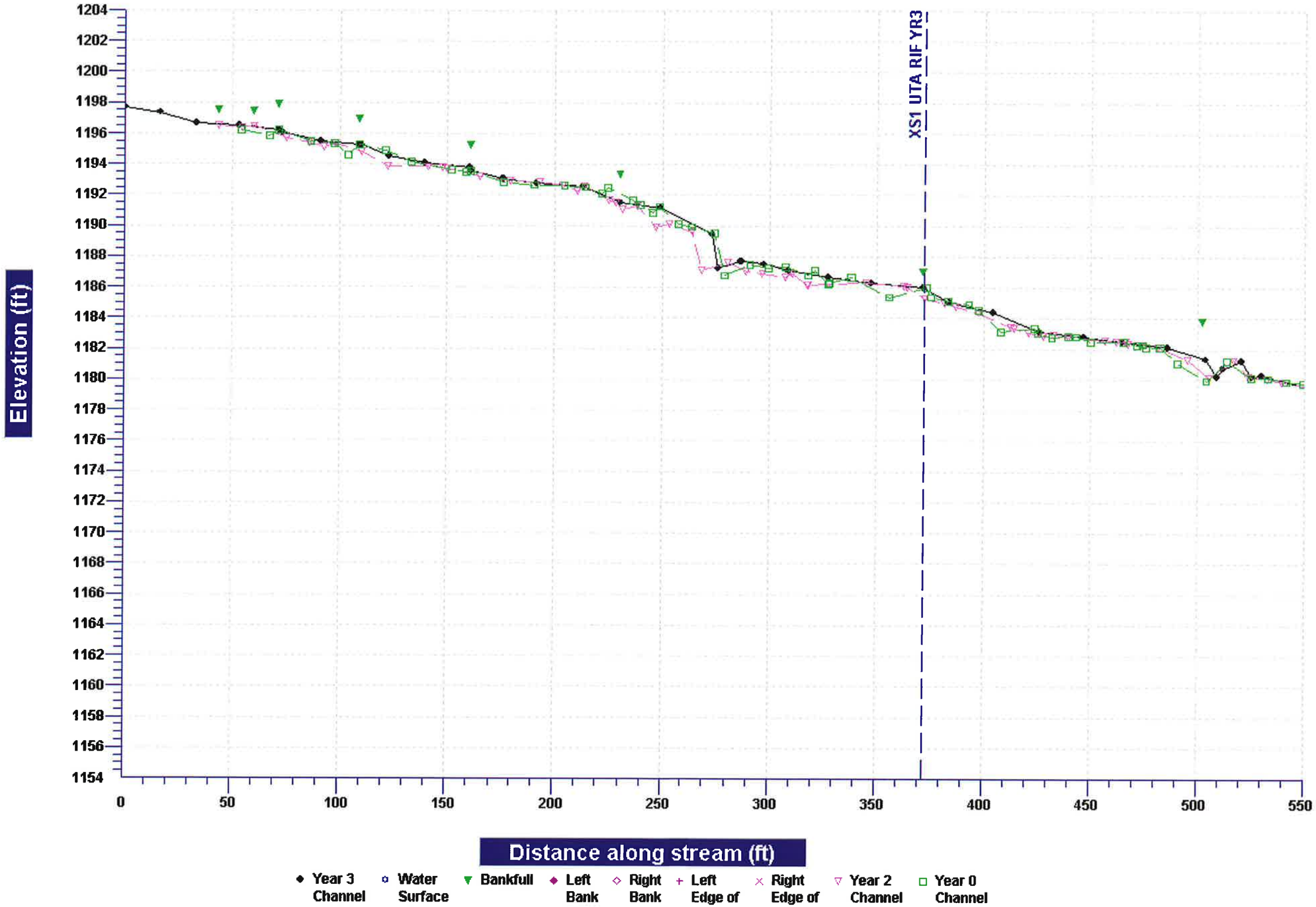
Silver Creek Mainstem Profile - Year 3



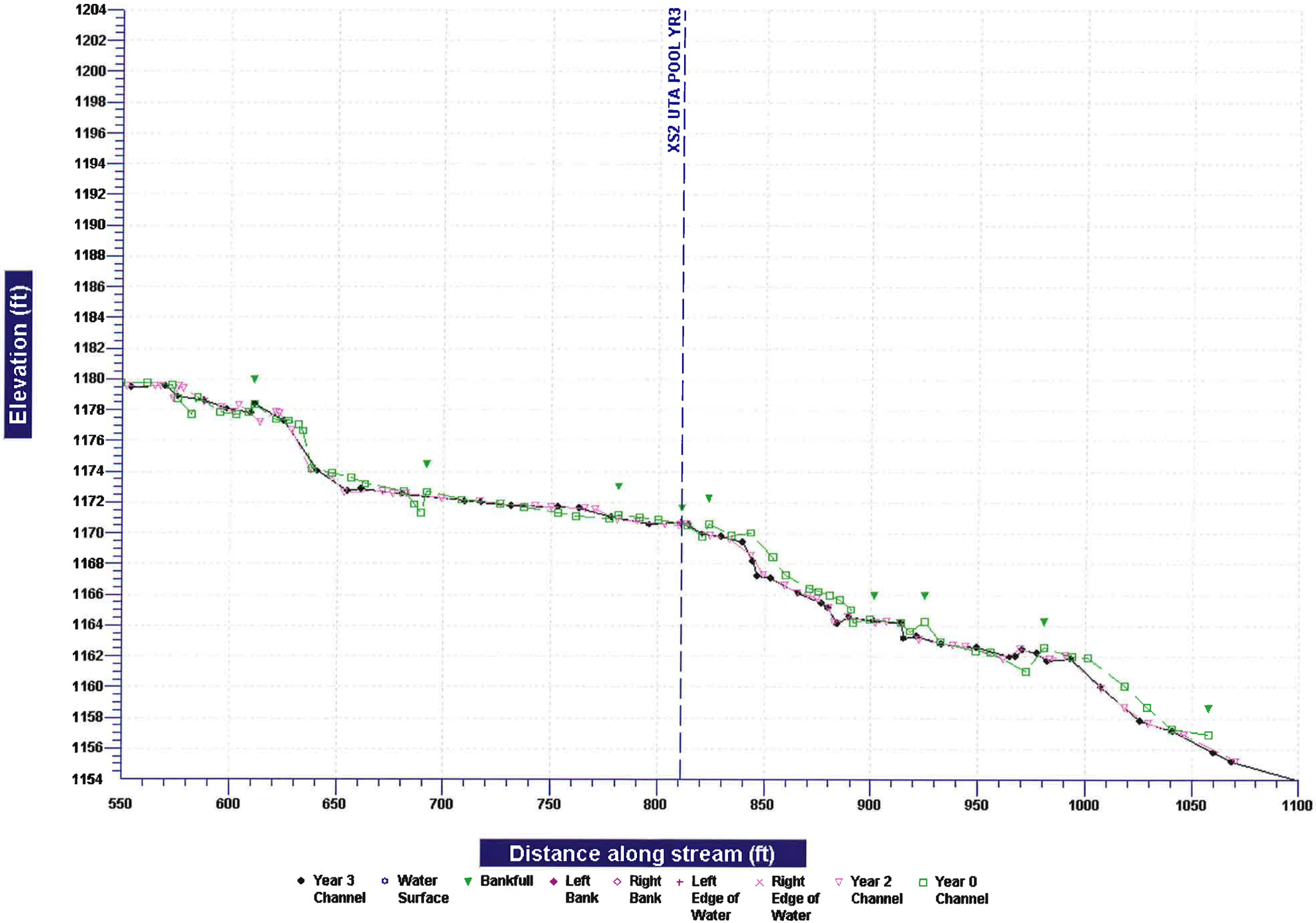
Silver Creek Unnamed Tributary A - Year 3 Profile



Silver Creek Unnamed Tributary A - Year 3 Profile

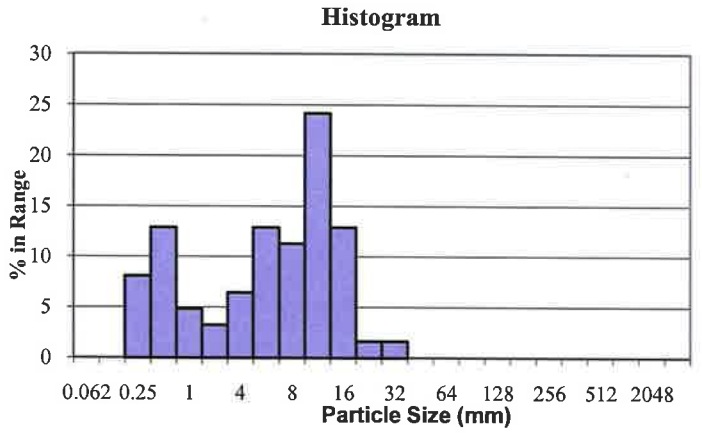


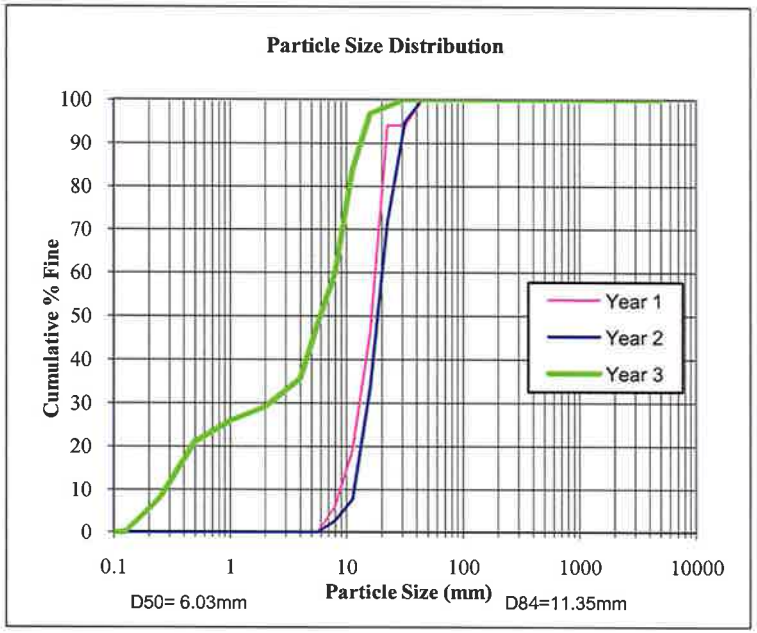
Silver Creek Unnamed Tributary A - Year 3 Profile



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	5	8	8
Medium Sand	0.25-0.5	8	13	21
Coarse Sand	0.5-1.0	3	5	26
Very Coarse Sand	1.0-2.0	2	3	29
Very Fine Gravel	2.0-4.0	4	6	35
Fine Gravel	4.0-5.7	8	13	48
Fine Gravel	5.7-8.0	7	11	60
Medium Gravel	8.0-11.3	15	24	84
Medium Gravel	11.3-16.0	8	13	97
Coarse Gravel	16.0-22.6	1	2	98
Coarse Gravel	22.6-32	1	2	100
Very Coarse Gravel	32-45	0	0	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	100
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		62	100	

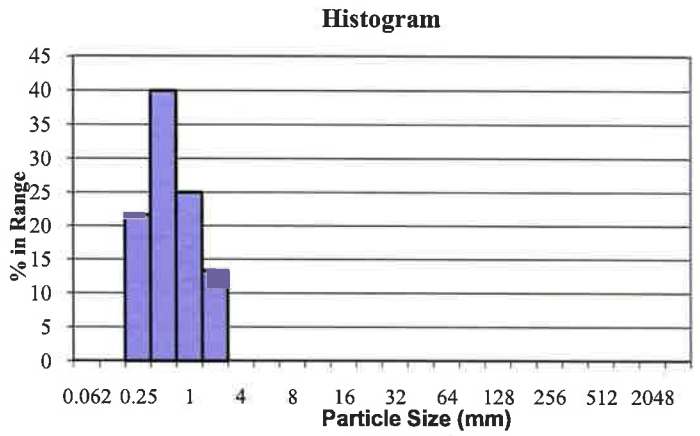
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	1
Date	9/17/09	**Sta No.**	2+05

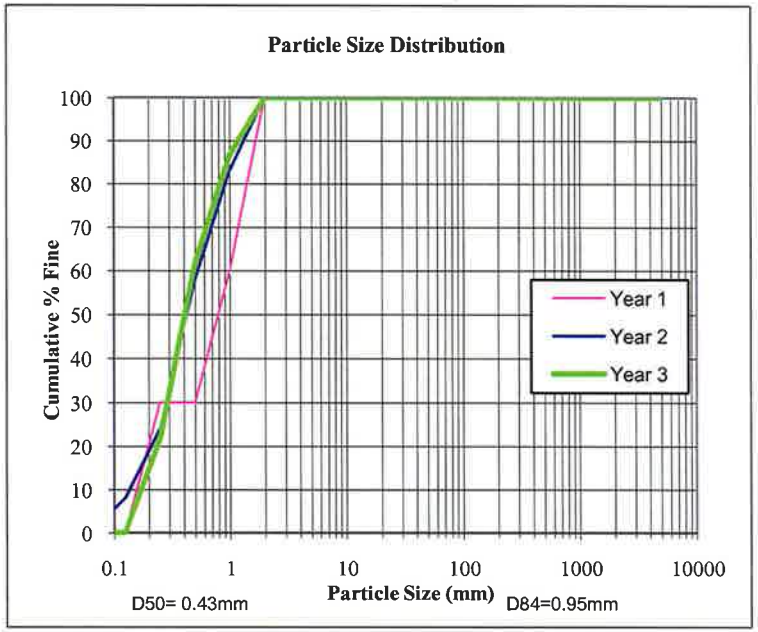




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	13	22	22
Medium Sand	0.25-0.5	24	40	62
Coarse Sand	0.5-1.0	15	25	87
Very Coarse Sand	1.0-2.0	8	13	100
Very Fine Gravel	2.0-4.0	0	0	100
Fine Gravel	4.0-5.7	0	0	100
Fine Gravel	5.7-8.0	0	0	100
Medium Gravel	8.0-11.3	0	0	100
Medium Gravel	11.3-16.0	0	0	100
Coarse Gravel	16.0-22.6	0	0	100
Coarse Gravel	22.6-32	0	0	100
Very Coarse Gravel	32-45	0	0	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	100
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

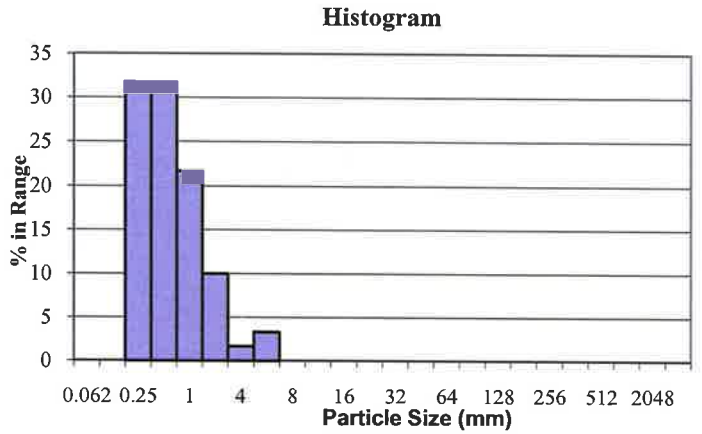
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	2
Date	9/17/09	**Sta No.**	2+30

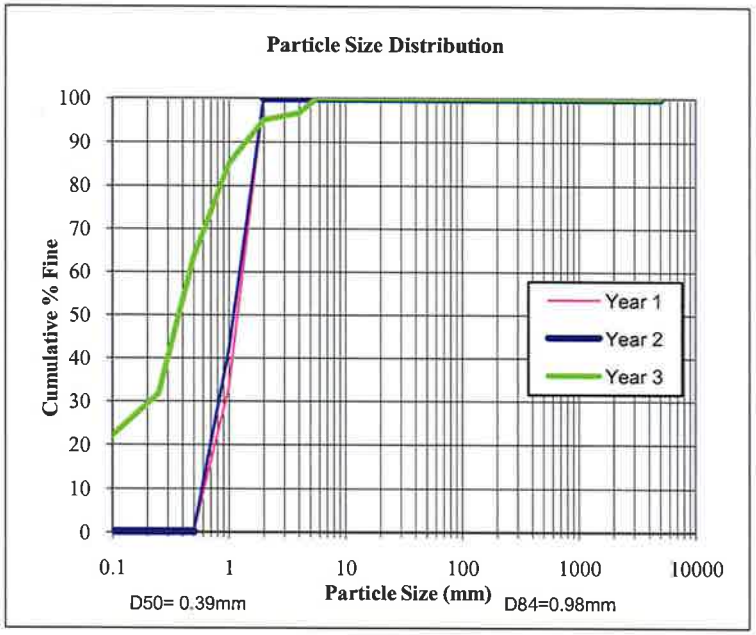




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	19	32	32
Medium Sand	0.25-0.5	19	32	63
Coarse Sand	0.5-1.0	13	22	85
Very Coarse Sand	1.0-2.0	6	10	95
Very Fine Gravel	2.0-4.0	1	2	97
Fine Gravel	4.0-5.7	2	3	100
Fine Gravel	5.7-8.0	0	0	100
Medium Gravel	8.0-11.3	0	0	100
Medium Gravel	11.3-16.0	0	0	100
Coarse Gravel	16.0-22.6	0	0	100
Coarse Gravel	22.6-32	0	0	100
Very Coarse Gravel	32-45	0	0	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	100
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

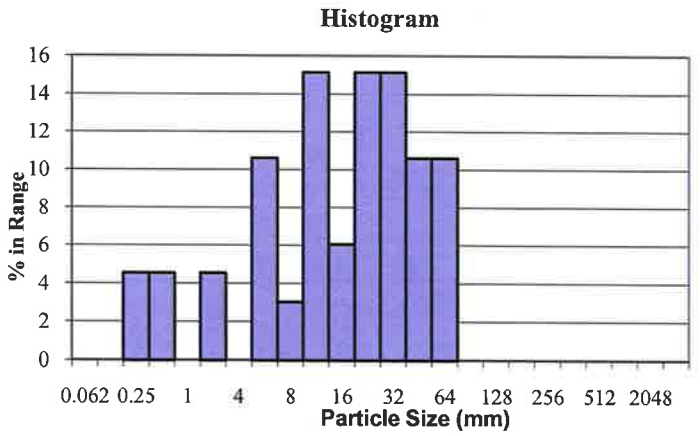
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	3
Date	9/17/09	**Sta No.**	11+18

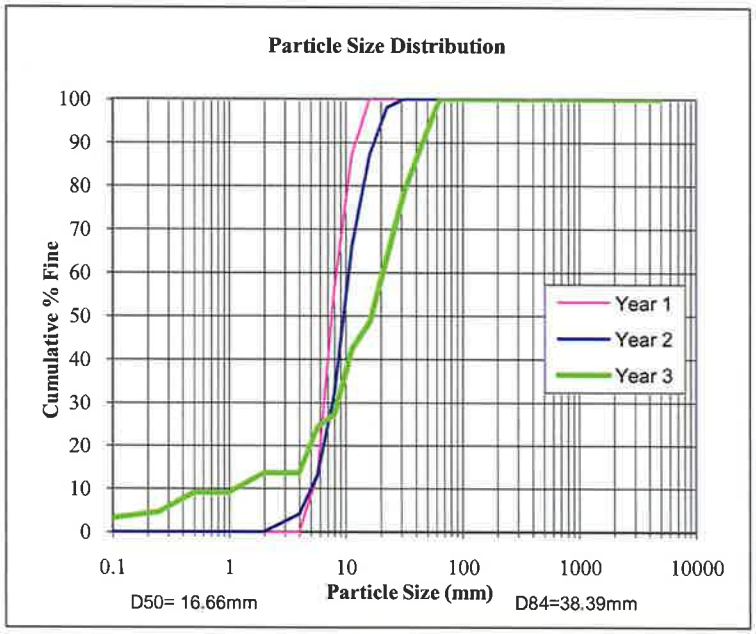




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	3	5	5
Medium Sand	0.25-0.5	3	5	9
Coarse Sand	0.5-1.0	0	0	9
Very Coarse Sand	1.0-2.0	3	5	14
Very Fine Gravel	2.0-4.0	0	0	14
Fine Gravel	4.0-5.7	7	11	24
Fine Gravel	5.7-8.0	2	3	27
Medium Gravel	8.0-11.3	10	15	42
Medium Gravel	11.3-16.0	4	6	48
Coarse Gravel	16.0-22.6	10	15	64
Coarse Gravel	22.6-32	10	15	79
Very Coarse Gravel	32-45	7	11	89
Very Coarse Gravel	45-64	7	11	100
Small Cobble	64-90	0	0	100
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		66	100	

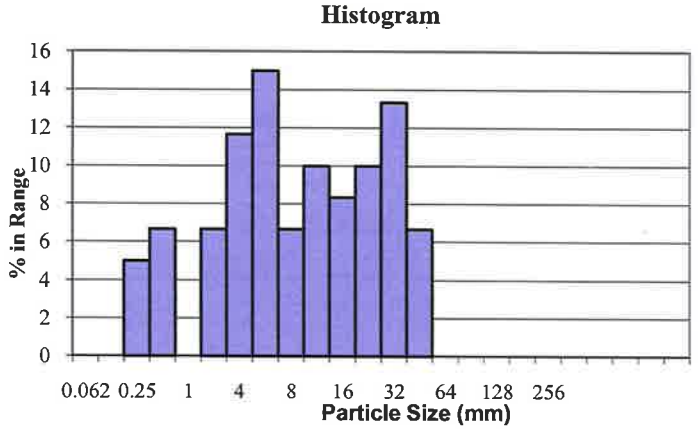
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	4
Date	9/17/09	**Sta No.**	12+25

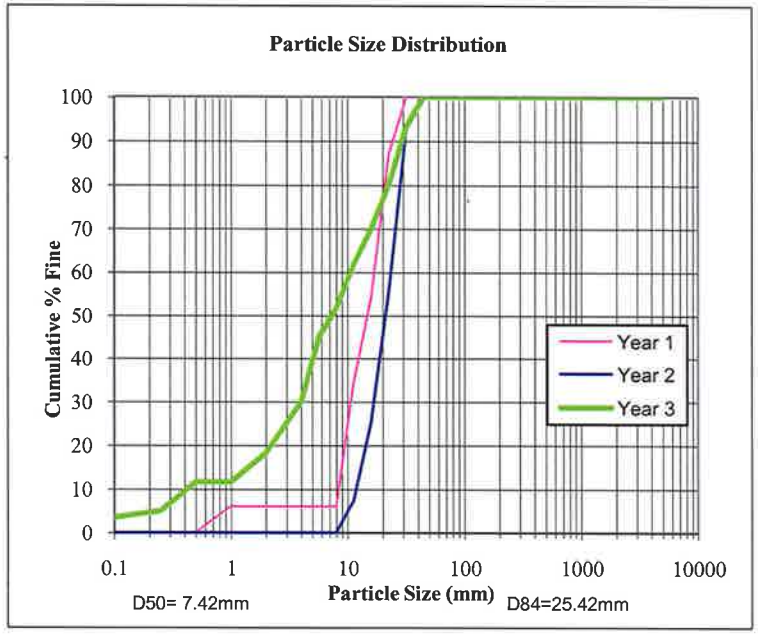




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	3	5	5
Medium Sand	0.25-0.5	4	7	12
Coarse Sand	0.5-1.0	0	0	12
Very Coarse Sand	1.0-2.0	4	7	18
Very Fine Gravel	2.0-4.0	7	12	30
Fine Gravel	4.0-5.7	9	15	45
Fine Gravel	5.7-8.0	4	7	52
Medium Gravel	8.0-11.3	6	10	62
Medium Gravel	11.3-16.0	5	8	70
Coarse Gravel	16.0-22.6	6	10	80
Coarse Gravel	22.6-32	8	13	93
Very Coarse Gravel	32-45	4	7	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	100
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

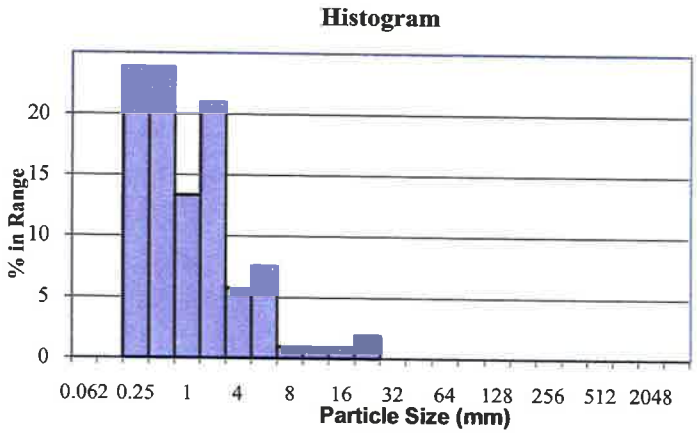
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	5
Date	9/17/09	**Sta No.**	27+62

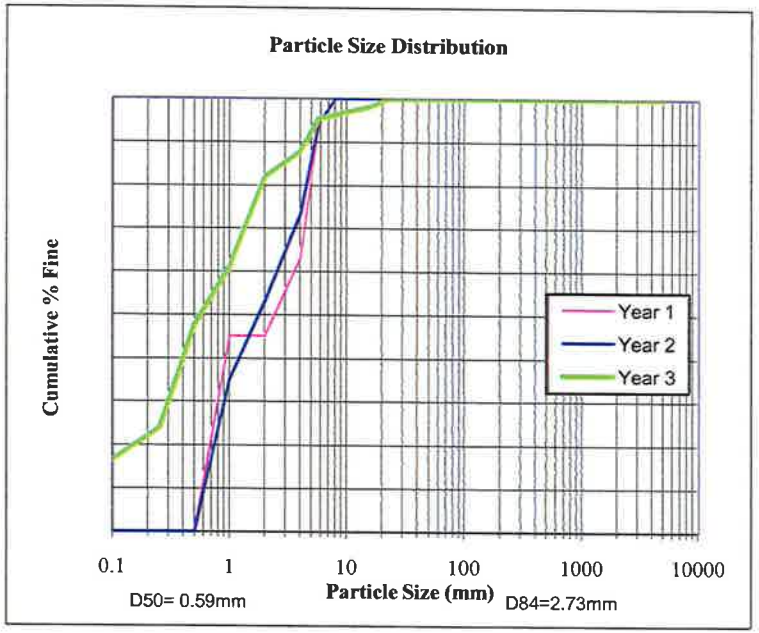




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	25	24	24
Medium Sand	0.25-0.5	25	24	48
Coarse Sand	0.5-1.0	14	13	61
Very Coarse Sand	1.0-2.0	22	21	82
Very Fine Gravel	2.0-4.0	6	6	88
Fine Gravel	4.0-5.7	8	8	95
Fine Gravel	5.7-8.0	1	1	96
Medium Gravel	8.0-11.3	1	1	97
Medium Gravel	11.3-16.0	1	1	98
Coarse Gravel	16.0-22.6	2	2	100
Coarse Gravel	22.6-32	0	0	100
Very Coarse Gravel	32-45	0	0	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	100
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		105	100	

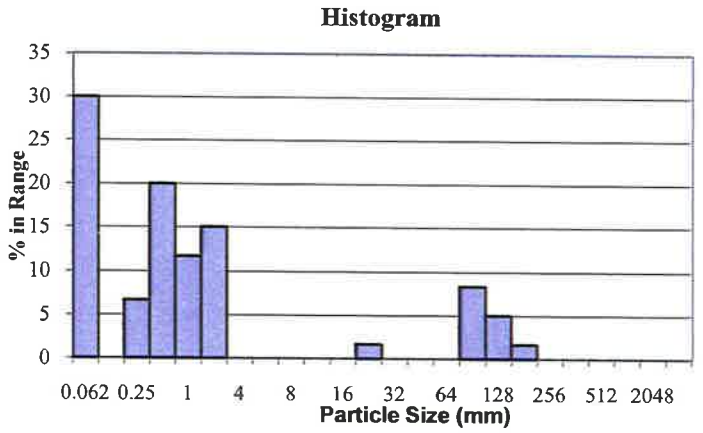
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	6
Date	9/17/09	**Sta No.**	27+75

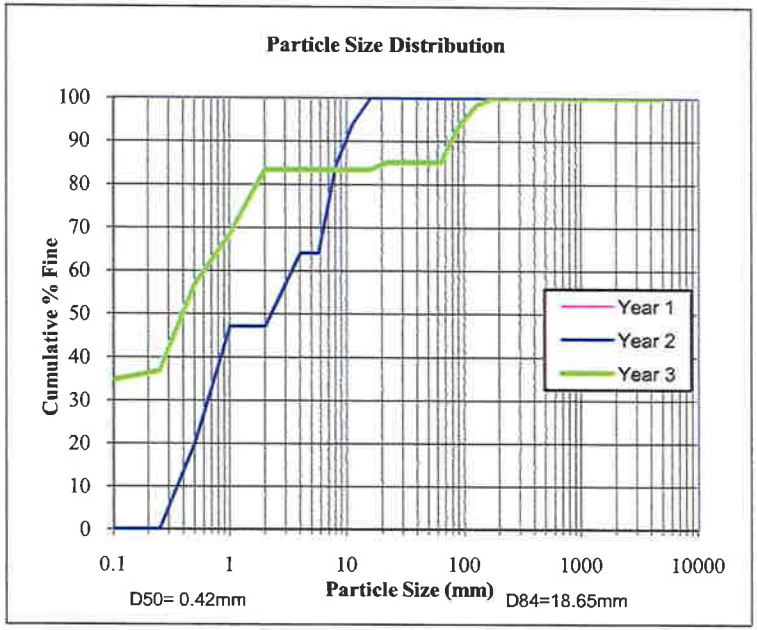




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	18	30	30
Very Fine Sand	0.062-0.125	0	0	30
Fine Sand	0.125-0.25	4	7	37
Medium Sand	0.25-0.5	12	20	57
Coarse Sand	0.5-1.0	7	12	68
Very Coarse Sand	1.0-2.0	9	15	83
Very Fine Gravel	2.0-4.0	0	0	83
Fine Gravel	4.0-5.7	0	0	83
Fine Gravel	5.7-8.0	0	0	83
Medium Gravel	8.0-11.3	0	0	83
Medium Gravel	11.3-16.0	0	0	83
Coarse Gravel	16.0-22.6	1	2	85
Coarse Gravel	22.6-32	0	0	85
Very Coarse Gravel	32-45	0	0	85
Very Coarse Gravel	45-64	0	0	85
Small Cobble	64-90	5	8	93
Small Cobble	90-128	3	5	98
Large Cobble	128-180	1	2	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

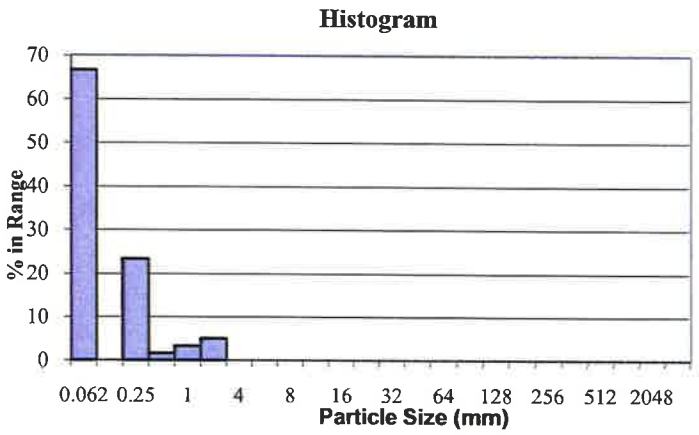
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	UTA	**X Sec**	DS of 1
Date	9/17/09	**Sta No.**	3+45

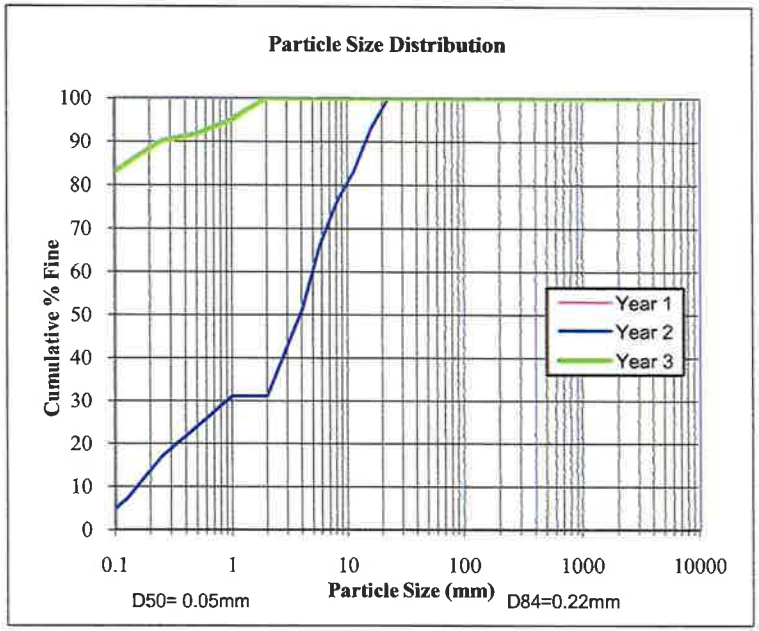




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	40	67	67
Very Fine Sand	0.062-0.125	0	0	67
Fine Sand	0.125-0.25	14	23	90
Medium Sand	0.25-0.5	1	2	92
Coarse Sand	0.5-1.0	2	3	95
Very Coarse Sand	1.0-2.0	3	5	100
Very Fine Gravel	2.0-4.0	0	0	100
Fine Gravel	4.0-5.7	0	0	100
Fine Gravel	5.7-8.0	0	0	100
Medium Gravel	8.0-11.3	0	0	100
Medium Gravel	11.3-16.0	0	0	100
Coarse Gravel	16.0-22.6	0	0	100
Coarse Gravel	22.6-32	0	0	100
Very Coarse Gravel	32-45	0	0	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	100
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

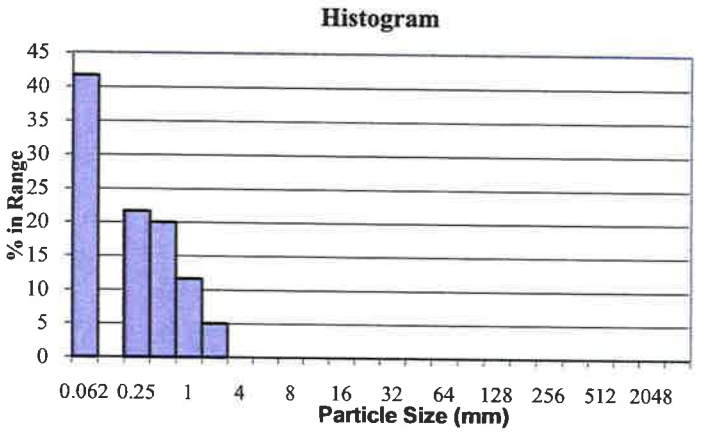
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	UTA	**X Sec**	2
Date	9/17/09	**Sta No.**	7+80

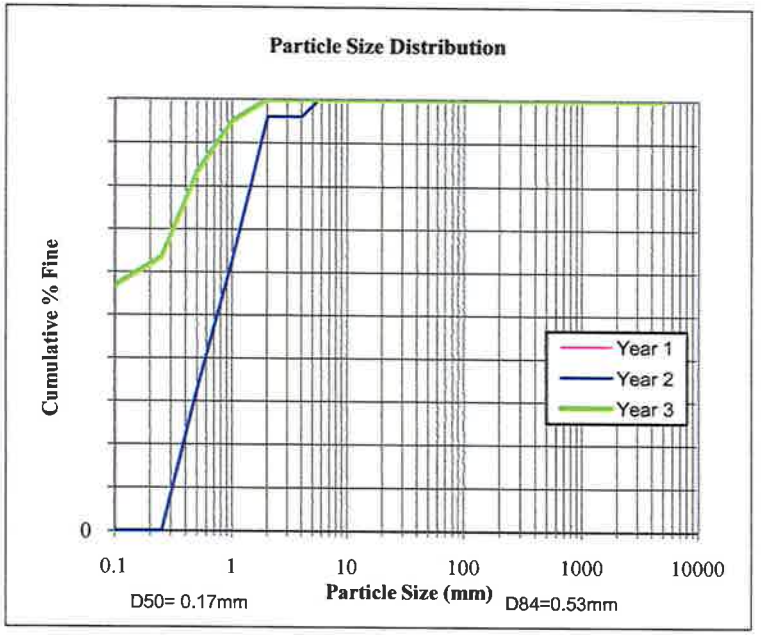




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	25	42	42
Very Fine Sand	0.062-0.125	0	0	42
Fine Sand	0.125-0.25	13	22	63
Medium Sand	0.25-0.5	12	20	83
Coarse Sand	0.5-1.0	7	12	95
Very Coarse Sand	1.0-2.0	3	5	100
Very Fine Gravel	2.0-4.0	0	0	100
Fine Gravel	4.0-5.7	0	0	100
Fine Gravel	5.7-8.0	0	0	100
Medium Gravel	8.0-11.3	0	0	100
Medium Gravel	11.3-16.0	0	0	100
Coarse Gravel	16.0-22.6	0	0	100
Coarse Gravel	22.6-32	0	0	100
Very Coarse Gravel	32-45	0	0	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	100
Small Cobble	90-128	0	0	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

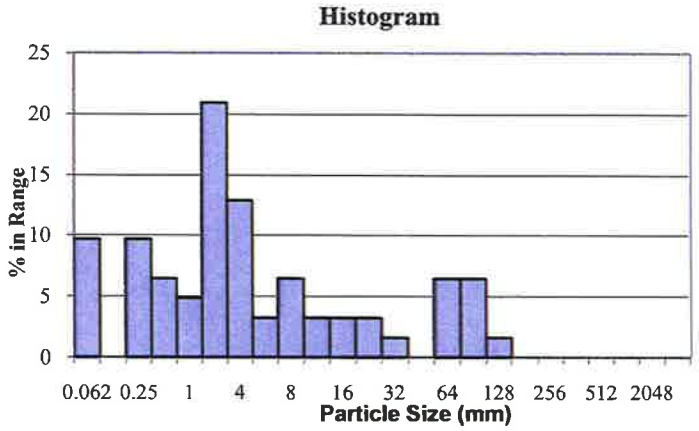
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	UTA	**X Sec**	3
Date	9/17/09	**Sta No.**	11+80

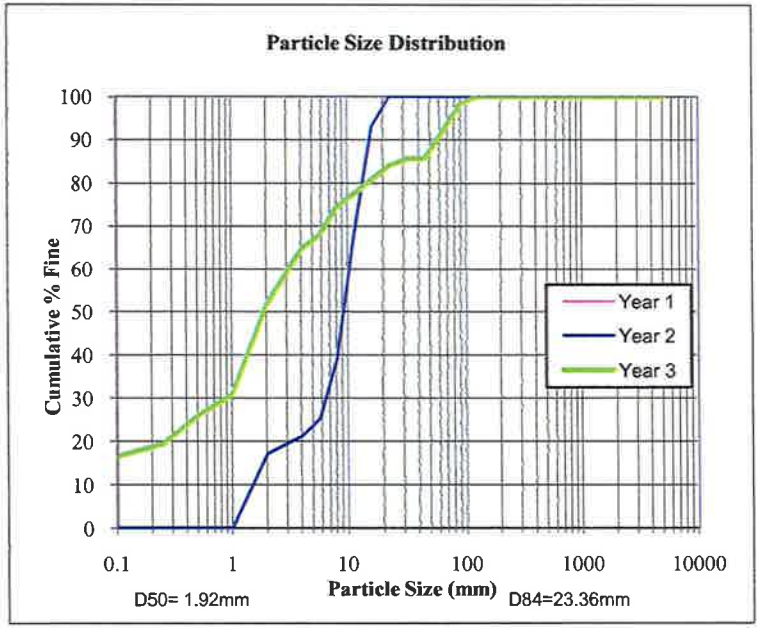




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	6	10	10
Very Fine Sand	0.062-0.125	0	0	10
Fine Sand	0.125-0.25	6	10	19
Medium Sand	0.25-0.5	4	6	26
Coarse Sand	0.5-1.0	3	5	31
Very Coarse Sand	1.0-2.0	13	21	52
Very Fine Gravel	2.0-4.0	8	13	65
Fine Gravel	4.0-5.7	2	3	68
Fine Gravel	5.7-8.0	4	6	74
Medium Gravel	8.0-11.3	2	3	77
Medium Gravel	11.3-16.0	2	3	81
Coarse Gravel	16.0-22.6	2	3	84
Coarse Gravel	22.6-32	1	2	85
Very Coarse Gravel	32-45	0	0	85
Very Coarse Gravel	45-64	4	6	92
Small Cobble	64-90	4	6	98
Small Cobble	90-128	1	2	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		62	100	

Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	UTA	**X Sec**	DS of 4
Date	9/17/09	**Sta No.**	12+00





BF 1
Crest Gage on Silver Creek UT.
(EMH&T, Inc. 9/21/09)

BF 2
Crest Gage on Silver Creek Mainstem.
(EMH&T, Inc. 9/21/09)