Stonebridge Mitigation Project
Moore County, North Carolina

FINAL Year 4 Monitoring Report

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1.0 SUMMARY

The Stonebridge Stream Mitigation Project site is located north of the town of Carthage in Moore County, North Carolina. It lies within hydrologic unit 03030003 in the Cape Fear River Basin. This project was identified by EBX-Neuse I, LLC (EBX) as having potential to help meet the compensatory mitigation requirements of the NC Department of Transportation (NCDOT). NCDOT contracted with EBX to perform the mitigation work under Full Delivery Project S-1. Two unnamed tributaries (UT-1 and UT-2) to Crawley Creek were restored to create a total of 6,120 stream mitigation units (SMU). All restoration is being monitored for five years to document success. Baseline data on stream morphology and vegetation were collected immediately after construction and planting were complete. This information is documented in the As-Built Report dated April 27, 2006. The As-Built survey is included as **Appendix A** of this report. Information on stream morphology and vegetation will be collected each year and compared to the baseline data and data from previous monitoring years.

This Annual Monitoring Report presents the monitoring data collected during Monitoring Year 4 at the Stonebridge Stream Restoration Site. Data collected for 2009 include: monthly crest gauge readings, monthly observations of current conditions, vegetation monitoring, cross section survey, digital images, and observations of potential problems with stream stability.

Fourteen 100-square-meter monitoring plots were used to measure survival of the planted woody vegetation. The 2009 vegetation monitoring documents a range of survival between 324 and 850 stems per acre. With an average of 526 stems per acre, the site is on track to achieve the final vegetation success criteria of 260 stems per acre after the fifth growing season. Areas surrounding vegetation plots 4 and 5 were replanted with 2-year-old trees prior to the start of the 2007 growing season to address high mortality in these plots. These areas were also replanted with 3-year-old trees during the spring of 2008 due to continued high mortality rates. In 2009 vegetation plots 4 and 5 did not exhibit high mortality compared to 2008 mortality rates.

At least two occurrences out-of-bank or bankfull events occurred between the months of February and August 2009. The stream morphology remains stable and little fluvial erosion was observed during the 2009 monitoring season.

Overall, the project is on track to achieve the stream and vegetative success criteria specified in the Mitigation Plan.

2.0 INTRODUCTION

2.1 PROJECT DESCRIPTION

The project site is located in Moore County, North Carolina, north of the town of Carthage (**Figure 1 & Figure 2**) within hydrologic unit 03030003 in the Cape Fear River Basin. The project site is accessed from the west via Glendon-Carthage Road. The 1,196-acre parcel has been used for agricultural purposes as a livestock operation. The surrounding area is rural, with a mix of farms, woodlands and home sites. Dominant soil types on this project site include Congaree, Mooshaunee, Pinkston, and Tetotum.

Two unnamed tributaries to Crawley Creek flow across the project site. The streams are referred to in this Annual Report as UT-1 and UT-2. UT-1 has a drainage area of 688 acres and UT-2 of 182 acres. Prior to implementation of the mitigation plan, the streams were in a disturbed

condition due to the impacts of unrestricted cattle access, dredging, and other anthropic channel manipulations.

UT-1 was the most degraded resource and was the focus of restoration efforts. A total of 5,556 stream mitigation units (SMU) were achieved by restoring plan form, cross section, and profile features on UT-1. This number is derived from the as-built survey of 5,676 linear feet of restored stream length minus 70 feet for a crossing reservation near the middle of the project and minus another 50 feet adjacent to the culvert at the downstream end of the project. UT-1 was restored to a Rosgen Classification of C4/E4.

UT-2 was similarly degraded and flows east-southeast from a small dam, entering UT-1 near the center of the project area. The design for this small tributary yielded an additional 564 linear feet of restored stream. The total SMUs generated from stream restoration on UT-1 and UT-2 are 6,120. The entire easement, including UT-1 and UT-2, is completely fenced in.

2.2 PROJECT PURPOSE

This project was identified by EBX-Neuse I, LLC as having potential to help meet the compensatory mitigation requirements of the NC Department of Transportation (NCDOT) as solicited through the NCDOT Full Delivery Project S-1. The objective of this project is to provide at least 5,556 stream mitigation units (SMU) to the NCDOT through the full delivery process. The mitigation units are to be accomplished through the restoration and enhancement of stream and riparian habitats as defined in the inter-agency Stream Mitigation Guidelines (USACE, 2003).

Table 1. Project Mitigation Structure and Objectives

Reach Name	Stream Mitigation Units (SMU)	Mitigation Approach
UT1	5,556	Restoration
UT2	564	Restoration
Total	**6,120**	

2.3 PROJECT HISTORY & SCHEDULE

This project was identified by EBX-Neuse I, LLC in the spring of 2003. **Table 2** outlines the project history and milestones. **Table 3** lists the project contacts.

Table 2. Project Activity and Reporting History

Month	Activity
June 2005	Mitigation Plan
December 2005	Final Design
February 2006	Construction
March 2006	Vegetation Planting
April 2006	As-built (Baseline) Report
November 2006	Year 2 Monitoring
March 2007	Supplemental Vegetation Planting
November 2007	Year 2 Monitoring
November 2008	Year 3 Monitoring
November 2009 (Scheduled)	Year 4 Monitoring
November 2010 (Scheduled)	Year 5 Monitoring

Table 3. Project Contacts

Contact	Firm Information
Project Manager Norton Webster	EBX-Neuse 1, LLC (919) 608-9688
Designer Michael Ellison	WK Dickson and Co., Inc (919) 782-0495
Monitoring Contractor Daniel Ingram	WK Dickson and Co., Inc (919) 782-0495

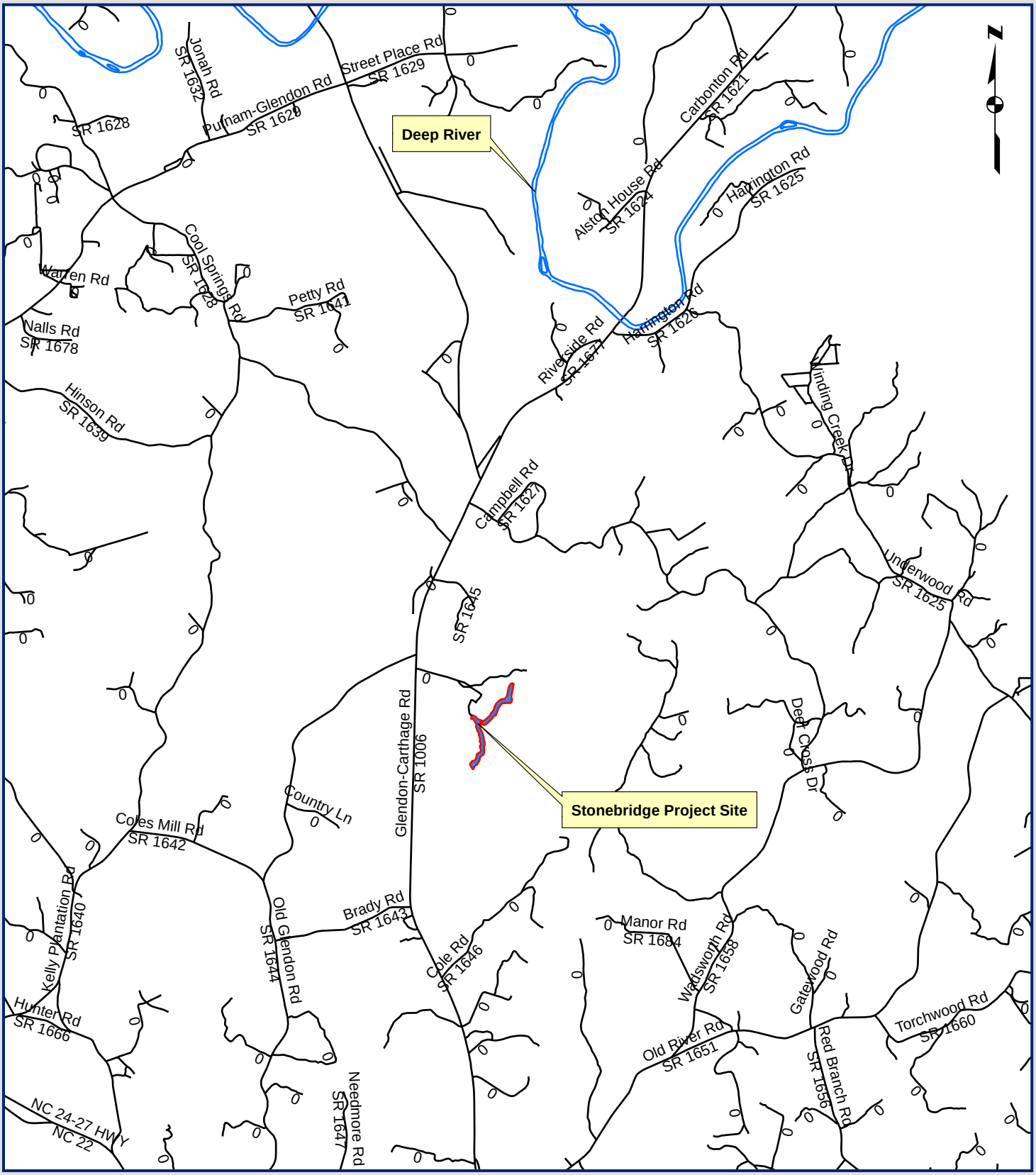
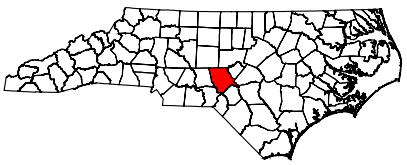


Figure 1.
Stonebridge Stream Mitigation Site
Project Location Map
Moore County, NC

1 inch equals 1 mile



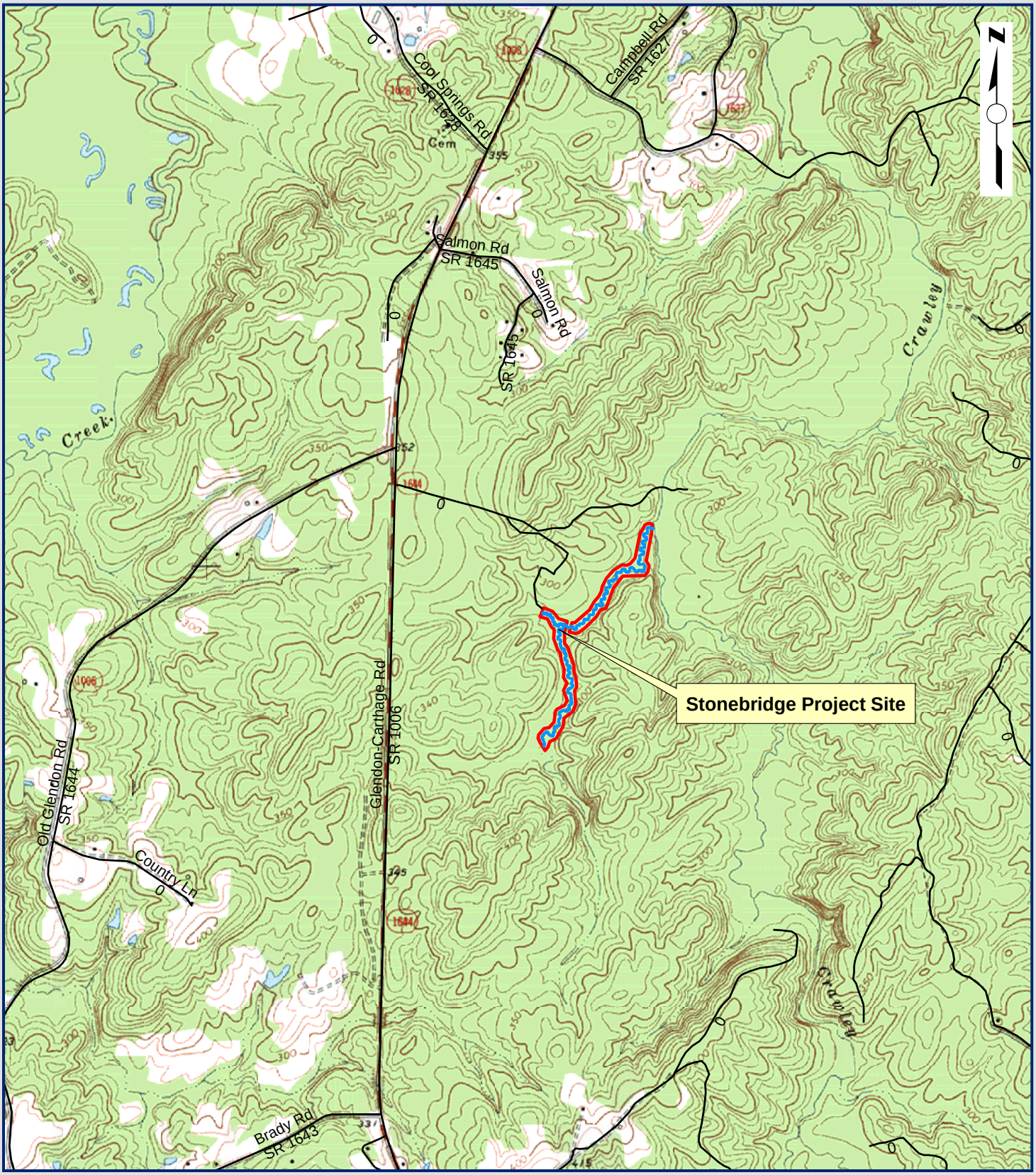
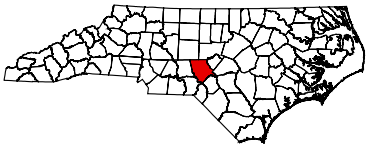


Figure 2.
Stonebridge Stream Mitigation Site
USGS Topographic Map
Moore County, NC

1 inch equals 2,000 feet



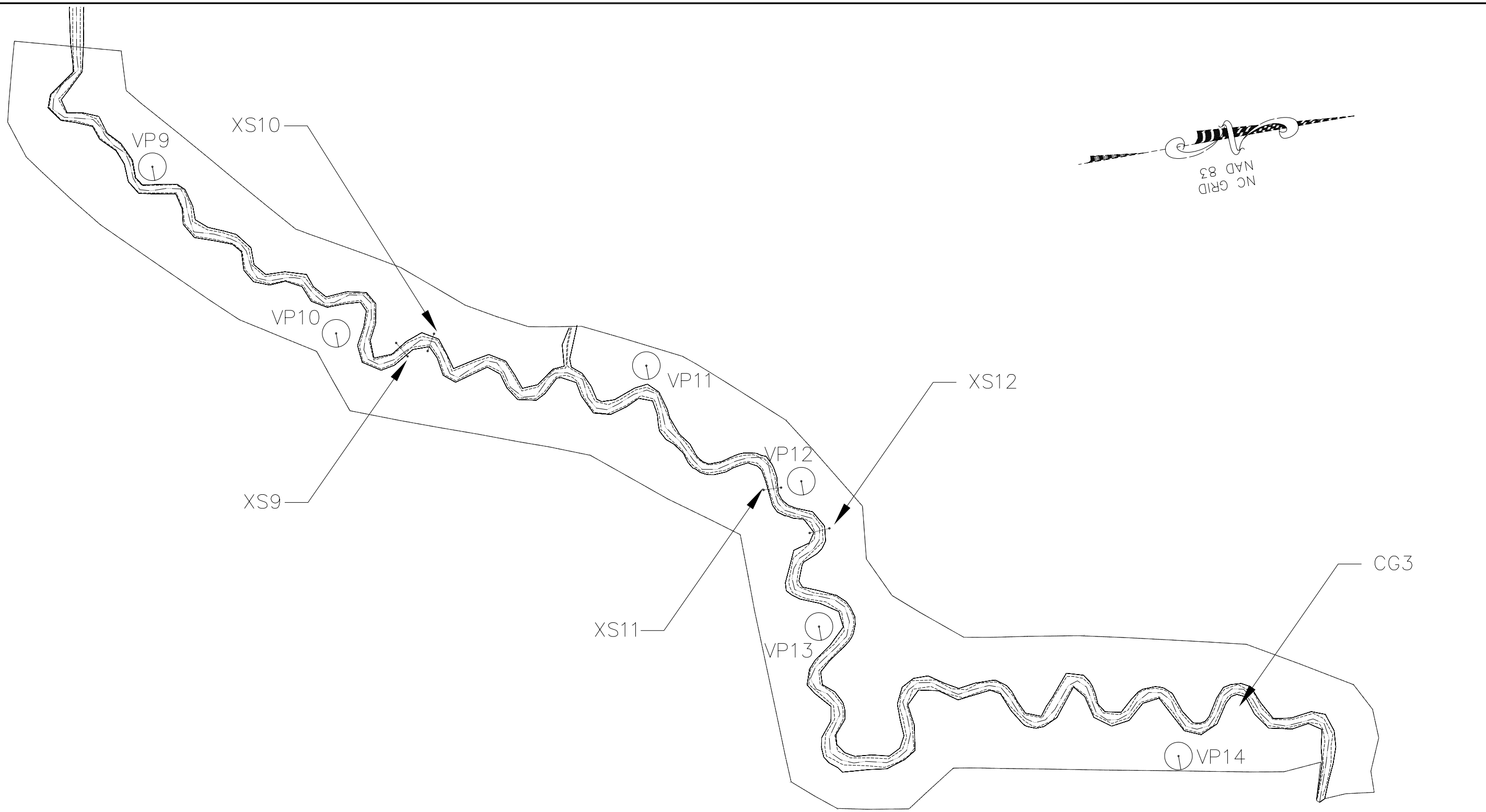
NC GRID
NAD 83

XS7
XS8
XS5
CG1
VP7
CG2
VP8
VP6
VP9
XS6
XS4
XS3
VP5
XS1
XS2
VP4
VP2
VP1
VP3

Stonebridge
Monitoring Overview

Figure 3A

60 30 0 60 120
SCALE (FT)



Stonebridge
Monitoring Overview

Figure 3B

60 30 0 60 120
SCALE (FT)

3.0 VEGETATION

3.1 VEGETATION SUCCESS CRITERIA

Specific and measurable success criteria for plant density within the riparian buffer on the site are based on the recommendations found in the WRP Technical Note and correspondence from review agencies on mitigation sites recently approved under the Neu-Con Mitigation Banking Instrument. The interim measure of vegetative success for the Stonebridge Mitigation Site—at least 320 planted stems per acre at the end of the Year 3 monitoring period—was met in 2008. The final vegetative success criteria will be the survival of 260-planted trees per acre at the end of Year 5 of the monitoring period (U.S. Army Corps of Engineers et. al. 2003).

Success of riparian vegetation will be evaluated annually through monitoring planted stem survival and photo documentation of vegetation plots. An assessment of the natural regeneration of woody stems and herbaceous cover will also be performed. Up to 20 percent of the species composition may be comprised of volunteers. Remedial action may be required should these volunteers (i.e. loblolly pine (*Pinus taeda*), red maple (*Acer rubrum)*, sweet gum (*Liquidambar styraciflua*), etc.) exceed 20 percent composition.

3.2 DESCRIPTION OF SPECIES AND VEGETATION MONITORING

All vegetation was planted in March 2006 after construction was complete. Bare root native tree and shrub species were planted to establish forested riparian buffers of at least fifty feet on both sides of the restored stream. The plants were selected to establish vertical habitat structure and a diverse mix of species **(Table 4)**. The planted area consists of two zones. The first is a wetter zone predominantly consisting of moist soil species such as green ash (*Fraxinus pennslyvanica*), ironwood (*Carpinus caroliniana*), and elderberry (*Sambucus canadensis*). The second is a drier zone predominantly consisting of more mesic species such as yellow poplar (*Liriodendron tulipifera*) and Northern red oak (*Quercus rubra*). Black locust (*Robinia pseudo-acacia*) was planted as a nurse tree in the upland zone. The initial stocking of riparian plantings across the site was approximately 758 stems per acre. In addition to the riparian plantings, black willow (*Salix nigra*) cuttings bundles were installed on the outside of bends.

Table 4. Planted Tree Species

Common Name	Scientific Name	FAC Status
Shrubs		
Elderberry	*Sambucus canadensis*	FACW-
Silky Dogwood	*Cornus amomum*	FACW+
Trees		
Black Locust	*Robiinia pseudocacia*	FACU-
Green ash	*Fraxinus pennsylvanica*	FACW
Ironwood	*Carpinus caroliniana*	FAC
Red Oak	*Quercus rubra*	FACU
Red Bud	*Cercis canadensis*	FACU
River Birch	*Betula nigra*	FACW
Sweet Bay	*Magnolia virginiana*	FACW+
Sycamore	*Platanus occidentalis*	FACW-
Tulip Tree	*Liriodendron tulipifera*	FAC

Fourteen 100-square-meter vegetation-sampling plots were established at the restoration site to monitor the success of riparian buffer vegetation. The locations of these plots were randomly distributed across the planted portions of the site. The plots cover approximately 2% of the site. The center of each plot is located with a ten-foot section of metal fence post with a white PVC cover. Each planted woody stem was located with a three-foot section of white PVC and identified with an aluminum tag. Planted woody species will be monitored twice per year for the first three years. Herbaceous plant cover will be monitored annually using the notched-boot method. The total number of each species planted is listed in **Table 5b**.

Because of high mortality and the low stems per acre documented in 2006 for Plots 4 and 5, these portions of the site were planted with approximately 600 2-year-old trees in the spring of 2007 to supplement the surviving stems per acre. This area was also supplementally planted in Spring 2008 with 3-year old trees due to mortality resulting from 2007 drought conditions. The stem counts reflect both the surviving original live stems and the supplemental stems planted.

3.3 RESULTS OF VEGETATION MONITORING

Stem counts were conducted at each monitoring plot during June 2009. All 14 vegetation-monitoring plots were evaluated for success, and the overall condition of vegetation at the site was assessed. **Tables 5a and 5b** show the number of each species of woody stems recorded for each plot, and the success rate of each plot. Early above-average mortality necessitated that some areas be replanted to maintain adequate density. The surviving planted stems per acre after the fourth year ranged from 324 to 850, with an average of 526-planted trees per acre surviving at the site. Two photos of each vegetation plot were taken at the time of the stem counts, one facing upstream and the other facing downstream (**Appendix C**).

All vegetation plots are on track to meet the final success criteria of 260 planted trees per acre after 5 years. Slight changes in survival percentage have also occurred because of the resprouting ability of some species. In a number of plots, individual stems previously recorded as dead had resprouted from the root crown. This pattern was observed in several plots with redbud in 2009, and, in previous years, with green ash and elderberry.

In 2008 livestock entered a portion of the easement and temporarily damaged the herbaceous vegetation around Plots 1 and 2. This problem was corrected, and no reduction in planted stem survival was observed between 2008 and 2009. However, the herbaceous vegetation in this area is now primarily grass species, and is relatively sparse. Plot 4 has the lowest density, but with 324 stems per acre it is still on track to meet the final success criteria of 260 stems per acre after 5 years. The higher mortality experienced in this plot over the three previous monitoring years appears to be due to locally shallow bedrock around this plot. No mortality occurred in Plot 4 between the 2008 and 2009 monitoring periods.

Table 5a. Results of Vegetation Monitoring

	Plots													
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Shrubs														
Elderberry										2				
Silky Dogwood,		2	4	1	3	7	2	3	3	1	4	3	5	2
Trees														
Black Locust		1	1	1	1	2			1			1	1	1
Green Ash	12	1		2	2	2		1		3	1		2	1
Ironwood	1	2	4	2				2	4		1			
Red Oak						3	1	1			1	1	1	1
Redbud		1					1				2			3
River Birch	1	6	2		2	3	1	2	4		1	2		
Sweet Bay		1							1			1		
Sycamore	1	1	4	2	2	1	5	1	2	5	3			1
Tulip Tree			2			3			1	1	2	3		2

Table 5b. Summary of Results

Plots	**Stems Planted**	**Additional Stems Planted**	**Total Stems Planted**	**Stems Year 4**	**Stems per Acre Year 4**
1	16	14	30	15	607
2	20	6	26	15	607
3	21		21	17	688
4	16	5	21	8	324
5	24	1	25	10	405
6	29	1	30	21	850
7	14		14	10	405
8	16		16	10	405
9	17		17	16	648
10	19	1	20	12	486
11	20		20	15	607
12	17		17	11	445
13	14		14	9	364
14	19		19	13	526
Average	**19**			**13**	**526**

Average Stems per Acre: 526

Range of Stems per Acre: 324-850
Replanted in Spring 2007 and Spring 2008

A plan view drawing of the vegetation plots is provided in **Figures 3a and 3b**. The drawing includes the appropriate information pertaining to vegetation monitoring of the project. The drawing also shows the locations of the following features:

- Vegetation monitoring plots,
- Vegetation plot photo points,
- Locations of any vegetation problem areas, and
- Symbology to represent vegetative problem types (if appropriate).

The vegetation at the site is mostly dense, with an average of 95.5 percent herbaceous cover that is variable in composition, as would be expected in a natural riparian system. Areas previously observed to have bare soil, particularly around Plot 4, now have good herbaceous cover. The locally dominant species are panic grass (*Panicum anceps*), dog fennel (*Eupatorium capillifolium*), Canadian horseweed (*Conyza canadensis*), and Canada goldenrod (*Solidago canadensis*). Other prominent species include white thoroughwort (*Eupatorium album*), devil's darning needles (*Clematis virginiana*), sawtooth blackberry (*Rubus argutus*), trumpet creeper (*Campsis radicans*), Carolina horsenettle (*Solanum carolinense*), American pokeweed (*Phytolacca americana*), Pennsylvania smartweed (*Polygonum pensylvanicum*), common rush (*Juncus effusus*), sedges (*Carex* sp.), and grape (*Vitis* sp.).

Volunteer species are also monitored throughout the five-year monitoring period. **Table 6** shows the most commonly found woody volunteer species. The volunteer stems do not compromise more than five percent of species surveyed at the site.

Table 6. Volunteer Tree Species

Common Name	Scientific Name	FAC Status
Sweetgum	*Liquidambar styraciflua*	FAC+
Red Maple	*Acer rubrum*	FAC
Persimmon	*Diospyros virginiana*	FAC
Slippery elm	*Ulmus rubra*	FAC
Ironwood	*Carpinus caroliniana*	FAC
Green Ash	*Fraxinus Pennsylvanica*	FACW
Tulip Poplar	*Liriodendron tulipifera*	FAC
Black Locust	*Robinia pseudoacacia*	UPL

3.4 VEGETATION OBSERVATIONS & CONCLUSIONS

Both herbaceous early successional vegetation and planted stems have become well established across the site. Natural recruitment of species is also beginning to develop but does not threaten to compete with the planted stems at this time. Despite the drought year in 2007 and below to normal rainfall in 2008, the vegetation at this site is generally healthy and appears to be thriving. A few areas, such as around plot 4, have experienced a slightly higher mortality than desired in the past, but the stem counts for 2009 indicate that this trend may be abating. The site is on track to meet the 5-year success criteria for the vegetation plots. No remedial actions are necessary at this time.

4.0 STREAM MONITORING

4.1 STREAM SUCCESS CRITERIA

As stated in the Mitigation Plan, success criteria for the stream restoration site include the following:

- *Bankfull Events*: Two bankfull flow events must be documented within the five-year monitoring period.
- *Cross sections*: There should be little change in as-built cross sections. Cross sections shall be classified using the Rosgen stream classification method, and all monitored cross sections should fall within the quantitative parameters defined for "E" or "C" type channels.
- *Longitudinal Profiles*: The longitudinal profiles should show that the bedform features are remaining stable, e.g. they are not aggrading or degrading. Bedforms observed should be consistent with those observed in "E" and "C" type channels.
- *Photo Reference Stations*: Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures.
- *Benthic Macroinvertebrate*: Sampling of benthic macroinvertebrates within the restored stream channel shall be conducted for the first three years of post-restoration monitoring.

Plan view drawings of the project site are provided in **Figures 4a- 4d**. The drawings include the appropriate information pertaining to monitoring of the project. These drawings show the locations of the following features (if applicable):

- Bankfull channel limits
- Centerline of channel
- Easement boundary/Fencing
- Road crossings
- Root wads
- Log vanes
- Cuttings bundles
- Channel plugs
- Log toe protection
- Riffle grade control
- Cross weir structures
- Step pool structures
- Tributaries

The drawings also show locations of monitoring activities. These include:

- Cross section survey locations,
- Crest gauge locations,
- Vegetation plots, and
- Benthic macroinvertebrate monitoring locations.

4.2 STREAM MORPHOLOGY MONITORING PLAN

Along UT-1 and UT-2 a natural channel design approach was applied to develop stable hydraulic geometry parameters. Construction began in October 2005 and was completed in February 2006. The rebuilding of the channel established stable cross-sectional geometry, increased plan form sinuosity, and restored streambed diversity to improve benthic habitat. Approximately 6,120 linear feet of stream restoration has been constructed.

4.2.1 Cross Sections

The mitigation plan for the Stonebridge Stream Mitigation Project requires twelve permanent cross sections to be monitored along the restored tributaries UT-1 and UT-2. The cross sections were established during monitoring set-up in evenly distributed pairs of one riffle and one pool per 1,000 linear feet of restored stream. Locations of cross sections are specified in **Figures 3a and 3b**. The cross section surveys and photographs are shown in **Appendix B**. Each cross section will be surveyed annually including measurements of floodplain, top of bank, bankfull, inner berm, edge of water, and thalweg. In addition, any fluvial features present will be documented.

4.2.2 Longitudinal Profile

Longitudinal profiles will be surveyed annually during the monitoring period. The cumulative length of the measured profiles will be at least 3,000 linear feet. Features measured will include thalweg, inverts of in-stream structures, water surface, bankfull, and top of low bank.

4.2.3 Hydrology

Three crest gauges were installed at the site: one on UT-1 (CG3) near the downstream end of the project and one each on UT-2 (CG2) and UT-1 (CG1) immediately above the confluence (see locations in **Figures 3a and 3b**). Crest gauges will be checked monthly to document high flows. During each visit, a determination will be made if an out-of-bank event has occurred since the prior visit. During the gauge inspections, any high water marks or debris lines will be documented and photographed.

4.2.4 Stream Photo Reference Stations

There are no designated photo reference stations on the Stonebridge Mitigation site. Photos are collected showing general conditions of the site (within the restoration easement), at all structures, cross-sections, as well as specific areas of concern along the stream corridor (**Appendix C**).

4.3 STREAM MORPHOLOGY MONITORING RESULTS

Photographs were taken throughout the monitoring season to document the evolution of the restored stream channel (**Appendix C**). Herbaceous vegetation is moderately dense along the restored stream. Pools have maintained a variety of depths and habitat qualities, depending on the location and type of scour features (logs, root wads, transplants, etc.). During the early portion of the growing season, a consistent stream flow was present during the monthly site visits.

Very few problems with stream morphology were observed during the monitoring field visits. Photos of each located structure taken in July 2009 are included in **Appendix C**. The plan view drawings in **Figures 4a-4d** show the locations of the following features:

- As-built stream centerline and bankfull limits
- In-stream structures (e.g. root wads and log vanes)
- Locations of any stream channel problem areas requiring observation

Table 7 gives a description of each stream area requiring further observation, the station where the problem occurs, and the photo number for the problem area.

4.3.1 Cross Sections

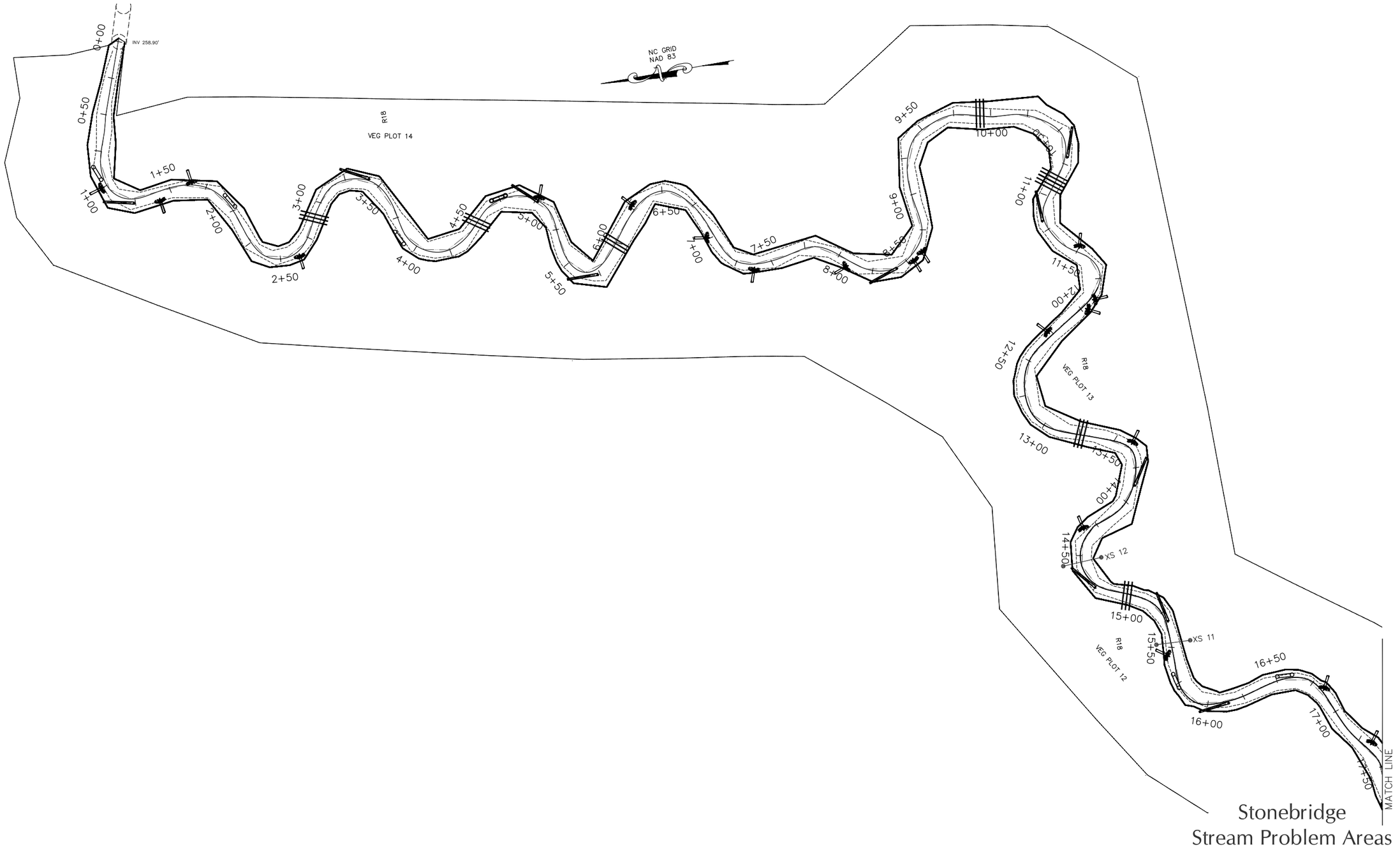
The cross sections were surveyed during the Year 4 monitoring activities in July 2009. The As-Built cross-section surveys are shown with the Year 1, Year 2, Year 3, and Year 4 monitoring cross section surveys in **Appendix B**. The Year 4 cross sections do not differ significantly from the As-Built, Year 1, Year 2, and Year 3 cross sections.

4.3.2 Longitudinal Profile

A longitudinal profile survey was conducted during the Year 4 monitoring activities in July 2009. The previous profile and cross sections indicate that there has been very little adjustment to the stream profile or dimension since construction. Using the surveyed dimensions of the cross sections, morphological parameters were calculated for each reach and are included in **Tables 10a and 10b** below.

Table 7. Stream Areas Requiring Observation

Feature	STA	Description	Photo Number
Mid Channel Bar	Throughout UT1	Sediment in channel allowing vegetation to root in the channel, no action recommended	SPA 1
Damaged Fence	UT1 48+00	Fallen trees and debris have damaged fence, repair is needed in order to prevent cattle from entering easement	SPA2
Right Bank Erosion	UT1 47+50 to 47+80	Minor erosion on right bank, will continue to monitor	SPA3
Left Bank Erosion	UT1 44+60 to 45+10	Minor erosion on left bank, will continue to monitor	SPA4
Right Bank Erosion	UT1 40+10 to 40+50	Minor erosion on right bank, will continue to monitor	SPA5
Log Grade Control	UT2 2+50	Water flowing under and around log grade control causing erosion, repair is recommended to prevent headcut and additional structure failures	SPA6
Log Vane	UT1 29+50	Water flowing under and around log vane causing erosion, repair is recommended to prevent headcut and additional structure failures	SPA7
Root Wad	UT1 29+30	Erosion behind root wad, will continue to monitor	SPA8
Log Vane	UT1 29+20	Erosion along arm of log vane, will continue to monitor	SPA9
Mid Channel Bar	UT1 24+00	Sediment in channel allowing vegetation to root in the channel, no action recommended	SPA10



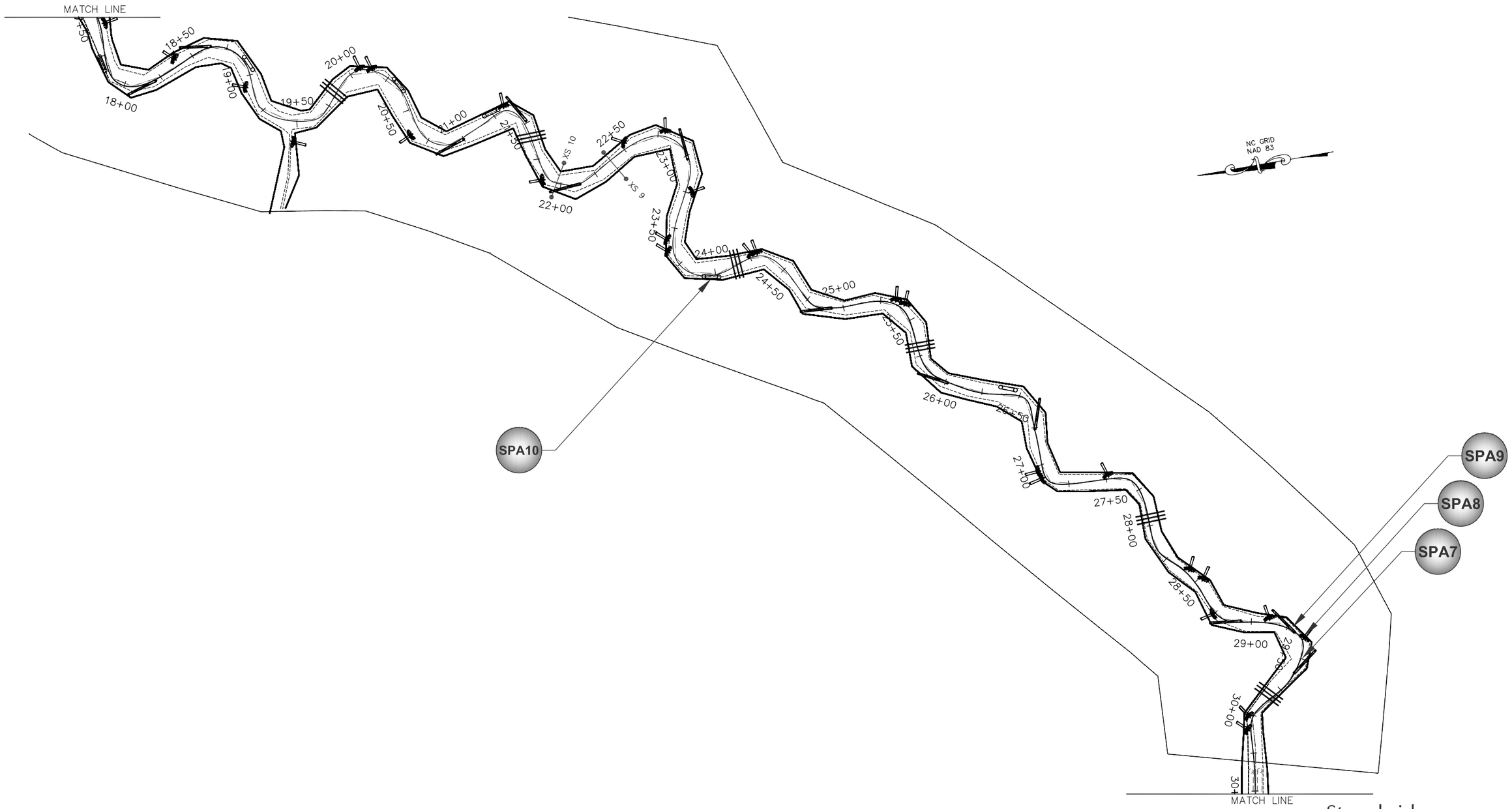
NOTE:
HEAVY VEGETATION IN CHANNEL THROUGHOUT REACH UT1

SPA1

Stonebridge
Stream Problem Areas

Figure 4A

30 15 0 30 60
SCALE (FT)



NOTE:
HEAVY VEGETATION IN CHANNEL
THROUGHOUT REACH UT1

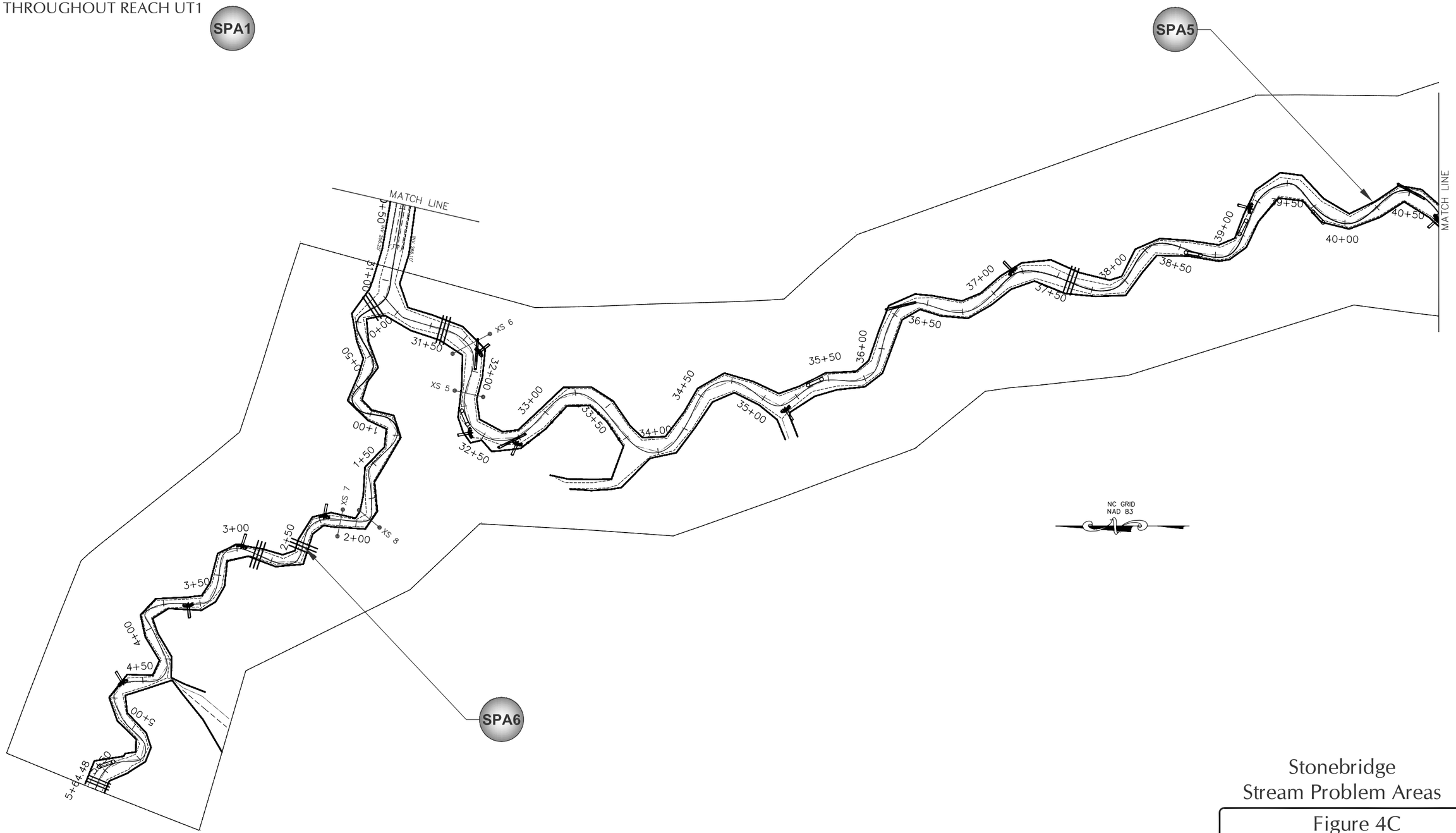
SPA1

Stonebridge
Stream Problem Areas

Figure 4B

30 15 0 30 60
SCALE (FT)

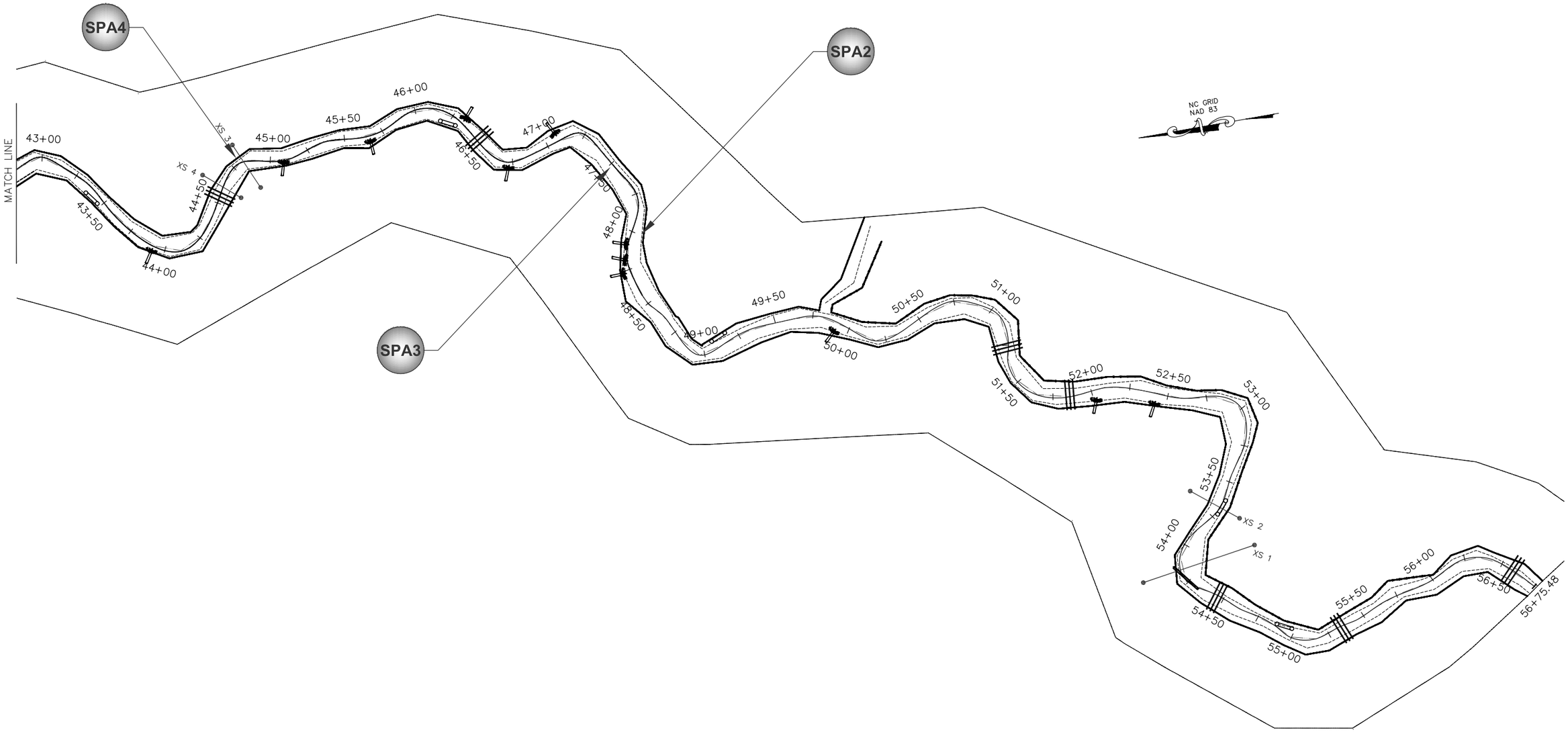
NOTE:
HEAVY VEGETATION IN CHANNEL
THROUGHOUT REACH UT1



Stonebridge
Stream Problem Areas

Figure 4C

30 15 0 30 60
SCALE (FT)



NOTE:
HEAVY VEGETATION IN CHANNEL THROUGHOUT REACH UT1

Stonebridge
Stream Problem Areas

Figure 4D

4.3.3 Hydrology

The crest gauges were read on monthly sites visits from February through August 2009. Crest gauges 1 and 2 recorded at least two out-of-bank or bankfull events occurred during this period, crest gauge 3 recorded one out-of-bank event. Crest gauge data are included in **Table 8**. Weather data were collected from a nearby weather station—Carthage Water Treatment Plant and the Moore County Airport. The data are summarized in **Table 9** and **Figure 5,** and indicate that conditions were normal early in the year and became drier in July. Data collected from the on-site gauge in February is a composite sample for December 2008 through February 2009.

Table 8. Crest Gauge Data

Month Recorded	Crest Gauge 1	Crest Gauge 2	Crest Gauge 3
January	---	---	---
February	0.43	0.30	0.00
March	3.05	2.80	3.70
April	0.00	0.00	0.00
May	0.00	0.00	0.00
June	0.00	0.00	0.00
July	0.00	0.00	0.00
August	0.00	0.00	0.00
September	---	---	---
October	---	---	---
November	---	---	---
December	---	---	---

Table 9. Summary Precipitation Data

Month	Average	Normal Limits		Carthage Precipitation	On-Site Precipitation
		30 Percent	70 Percent		
January	4.51	3.44	5.43	2.09	---
February	3.54	2.39	4.24	1.33	---
March	4.65	3.52	5.64	5.36	4.67
April	3.08	1.93	4.17	1.20	2.72
May	4.06	2.65	4.86	2.80	4.60
June	4.18	2.36	5.16	1.50	2.58
July	5.37	3.06	6.7	1.62	2.05
August	4.65	3.22	5.57	3.60	5.17
September	4.45	3.23	6.24	---	---
October	3.54	1.86	4.73	---	---
November	3.47	2.2	4.52	---	---
December	3.38	2.28	4.04	---	---
Annual		**32.14**	**61.30**		
Total	**48.88**			**19.50**	**21.79**

Figure 5. 2009 Precipitation Data for Stonebridge

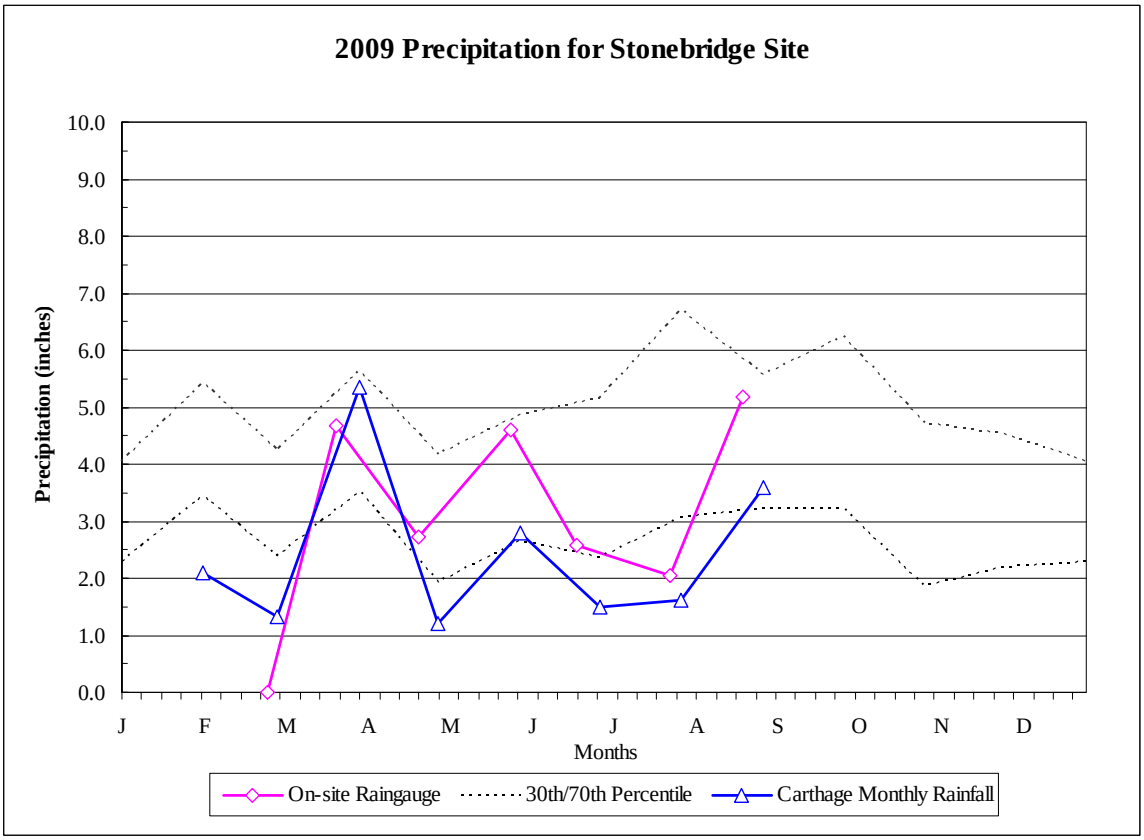


Table 10a. Summary of Morphologic Monitoring Parameters for UT1

Parameter	As-Built	Year 4
Avg. Bankfull Xsec Area, Abkf (sq ft)	31.0	29.9
Avg. Bankfull Width, Wbkf (ft)	15.6	15.1
Avg. Bankfull W/D	8.1	7.9
Avg. Bankfull Mean Depth, Dbkf (ft)	2.0	2.0
Avg. Bankfull Max Depth, Dmax (ft)	2.9	3.12

Table 10b. Summary of Morphologic Monitoring Parameters for UT2

Parameter	As-Built	Year 4
Avg. Bankfull Xsec Area, Abkf (sq ft)	10.1	10.6
Avg. Bankfull Width, Wbkf (ft)	7.2	8.3
Avg. Bankfull W/D	5.1	6.5
Avg. Bankfull Mean Depth, Dbkf (ft)	1.4	1.3
Avg. Bankfull Max Depth, Dmax (ft)	1.7	2.0

4.4 STREAM CONCLUSIONS

Overall, the restored stream channel has remained stable and is providing the intended habitat and hydrologic functions. Water is flowing around a log grade control structure and a log vane, causing erosion (**Table 7**, SPA6 and SPA7). It is recommended that these structures be repaired to prevent further erosion and headcuts. All monitored cross sections for 2009 show very little adjustment in stream dimension. Several bankfull events were recorded during the 2009 monitoring season, exceeding the requirement of two bankfull events within five years.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Observations of conditions at the Stonebridge Mitigation Site and data collected during Year 4 monitoring indicate that the project is currently successful and on track to achieve the vegetative and stream success criteria specified in the Mitigation Plan.

The stream morphology is stable, and little fluvial erosion was observed. Sedimentation that has occurred in the stream channel is minor and does not need to be addressed at this time. The fences along the crossing near station 48+00 should be repaired to prevent bank damage from cattle entering the channel. The vegetation is surviving well.

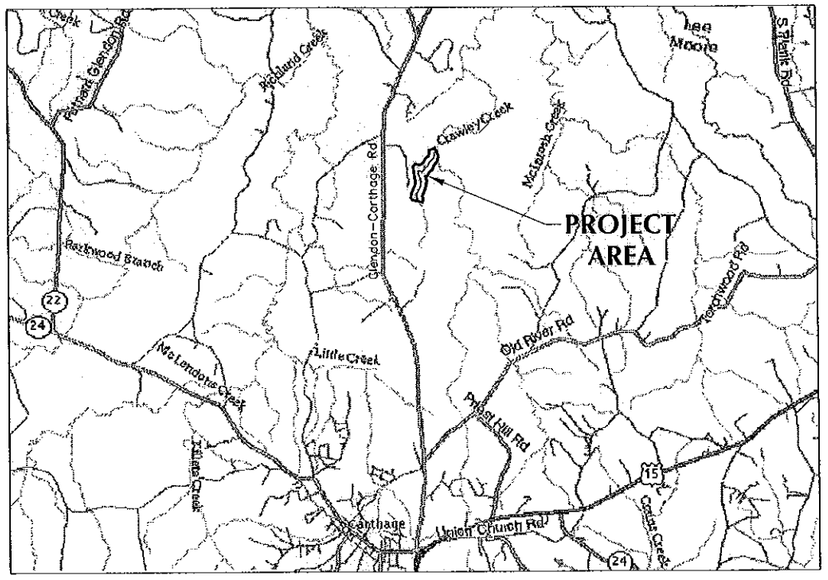
Overall, the project is performing as designed. Habitat has been improved significantly through this project. Fluvial erosion has been greatly reduced so that the project site no longer contributes excessive amounts of sediment to the receiving stream. Based on 2009 observations, site vegetation is expected to succeed and provide riparian habitat, water quality benefits, and cover for the stream system.

APPENDIX A

As-Built Survey

STONEBRIDGE STREAM AS-BUILT PLANS

APRIL 2006



VICINITY MAP
NTS

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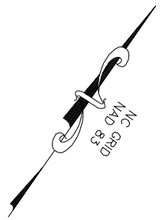
OWINGS MILLS, MARYLAND 21117-4860

WK DICKSON
community infrastructure consultants
3101 JOHN HUMPHRIES WYND
RALEIGH, NC 27612
(919) 782-0495

EBX



I, MARK W. YARBROUGH, HEREBY CERTIFY THAT THE TOPOGRAPHIC AND PLANIMETRIC AS-BUILT INFORMATION SHOWN ON THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL FIELD SURVEY PERFORMED UNDER MY SUPERVISION; THAT THE ORIGINAL FIELD DATA WAS OBTAINED BETWEEN MARCH 7, 2006 AND APRIL 20, 2006; THAT THE MAPPING ERROR AS REPRESENTED BY CONTOUR LINES PLOTTED HEREON, IF APPLICABLE, DOES NOT EXCEED 1/2 OF THE CONTOUR INTERVAL OVER 90% OF THE SURVEY AREA; THAT THE HORIZONTAL DATUM IS BASED ON NAD 83 AND THE VERTICAL DATUM IS BASED ON NGVD 88 DATUM; THAT THE HORIZONTAL AND VERTICAL DATUM WERE OBTAINED FROM 2 HOUR STATIC GPS SESSIONS USING L1/L2 GPS RECEIVERS AND THE POST PROCESSING WAS OBTAINED THROUGH NOAA OPUS (ONLINE POSITIONING USER SERVICE). WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 25TH DAY OF APRIL, 2006 A.D.

MARK W. YARBROUGH L-3396 DATE

100 0 50 100 200
1 inch = 100ft.

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER	ME
DRAWN BY	TRS
APPROVED BY	ME
FILE NAME	as-built.dwg
DRAWING SCALE	1" = 100'
PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

W.K. DICKSON
community infrastructure consultants

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(919) 782-0495

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Georgia
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CONSTRUCTION	
RECORD DWG.	

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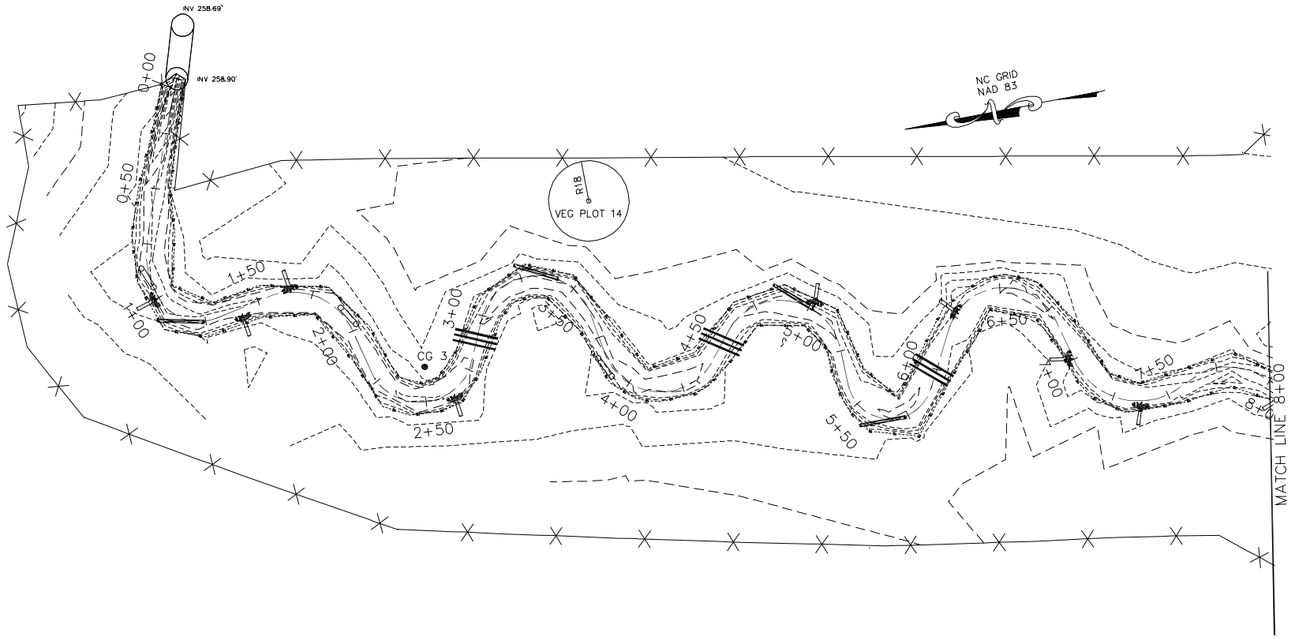
CARTHAGE, NORTH CAROLINA

STONEBRIDGE AS-BUILT PLANS
STREAM MITIGATION AS-BUILT SURVEY



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

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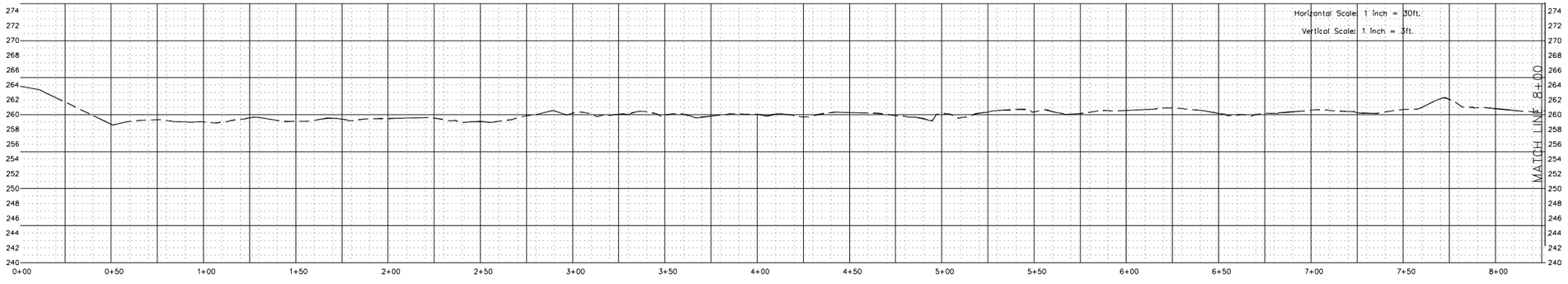
1 inch = 30ft.



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APPROVED BY	ME
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PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

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CONSTRUCTION	
RECORD DWG.	

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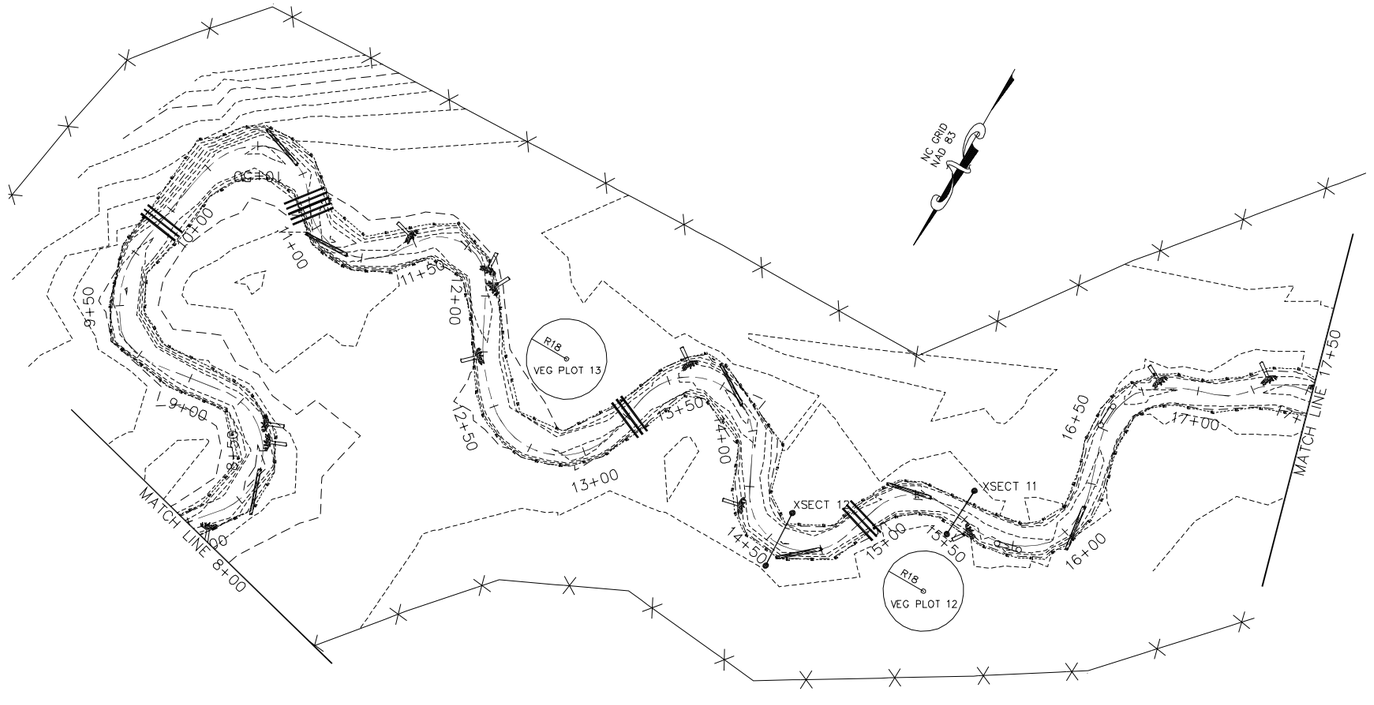
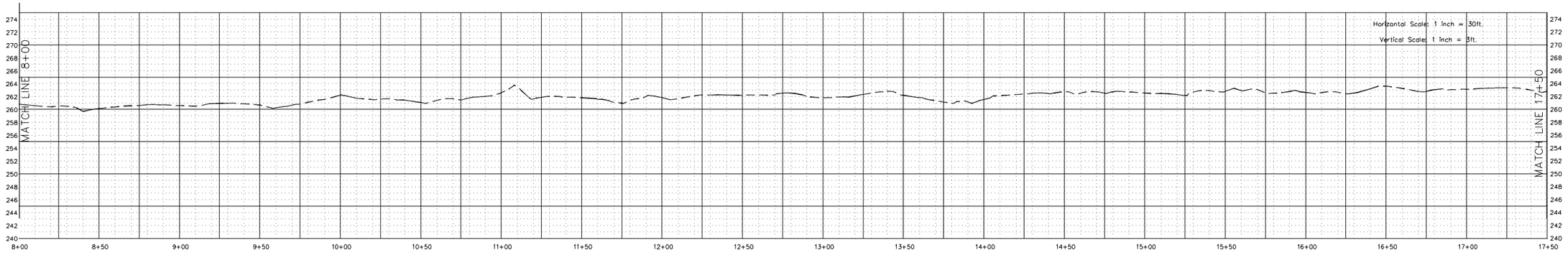
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 0+00 TO STA. 8+00



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
1 inch = 30ft.



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PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

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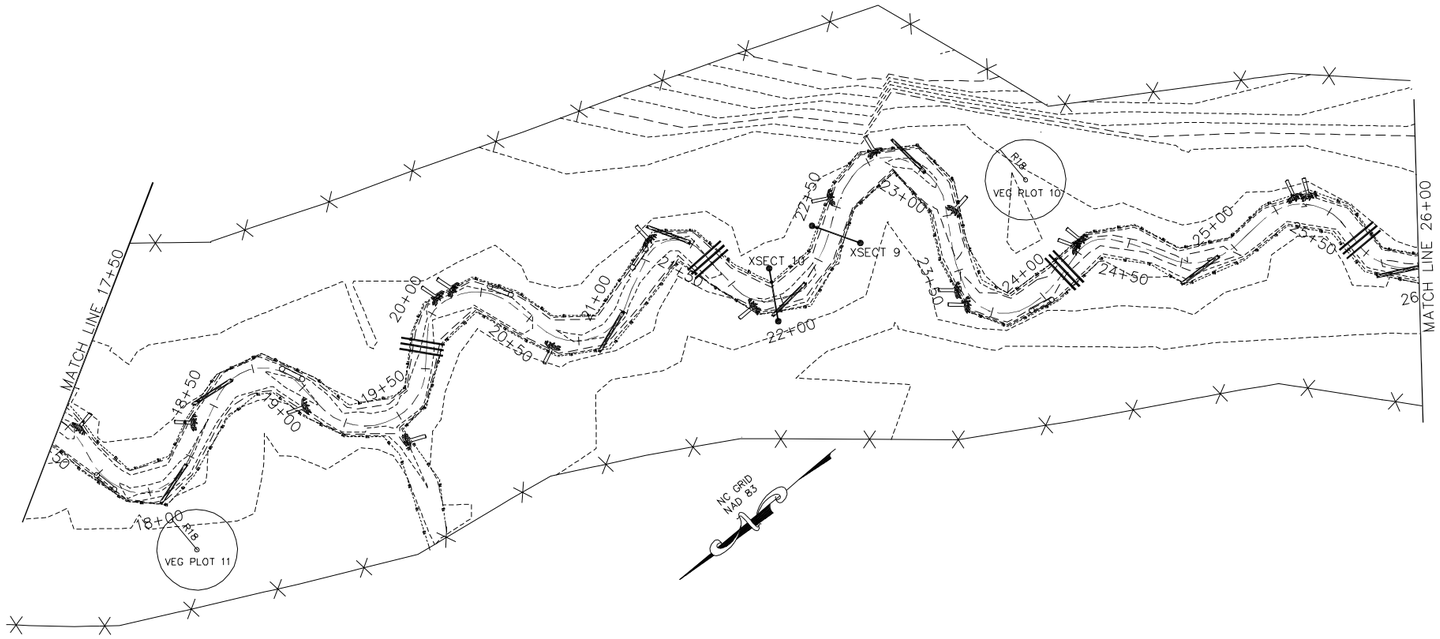
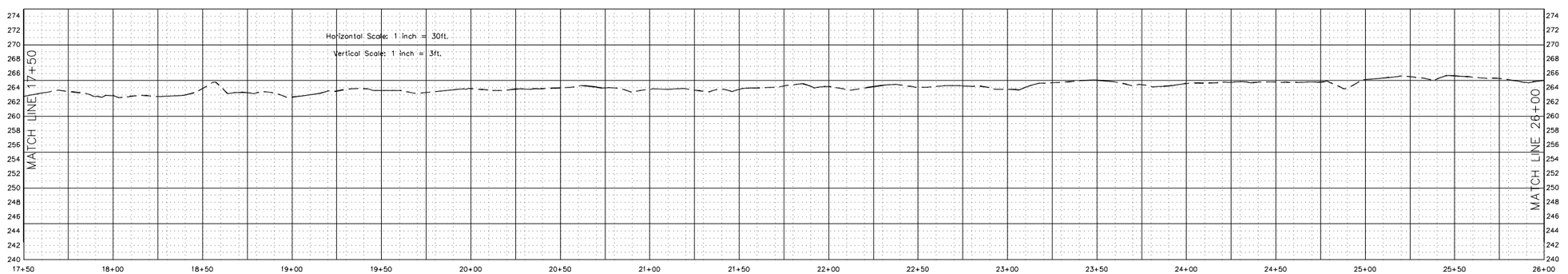
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 8+00 TO 17+50



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
1 inch = 30ft.



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FILE NAME	as-built.dwg
DRAWING SCALE	1" = 30'
PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
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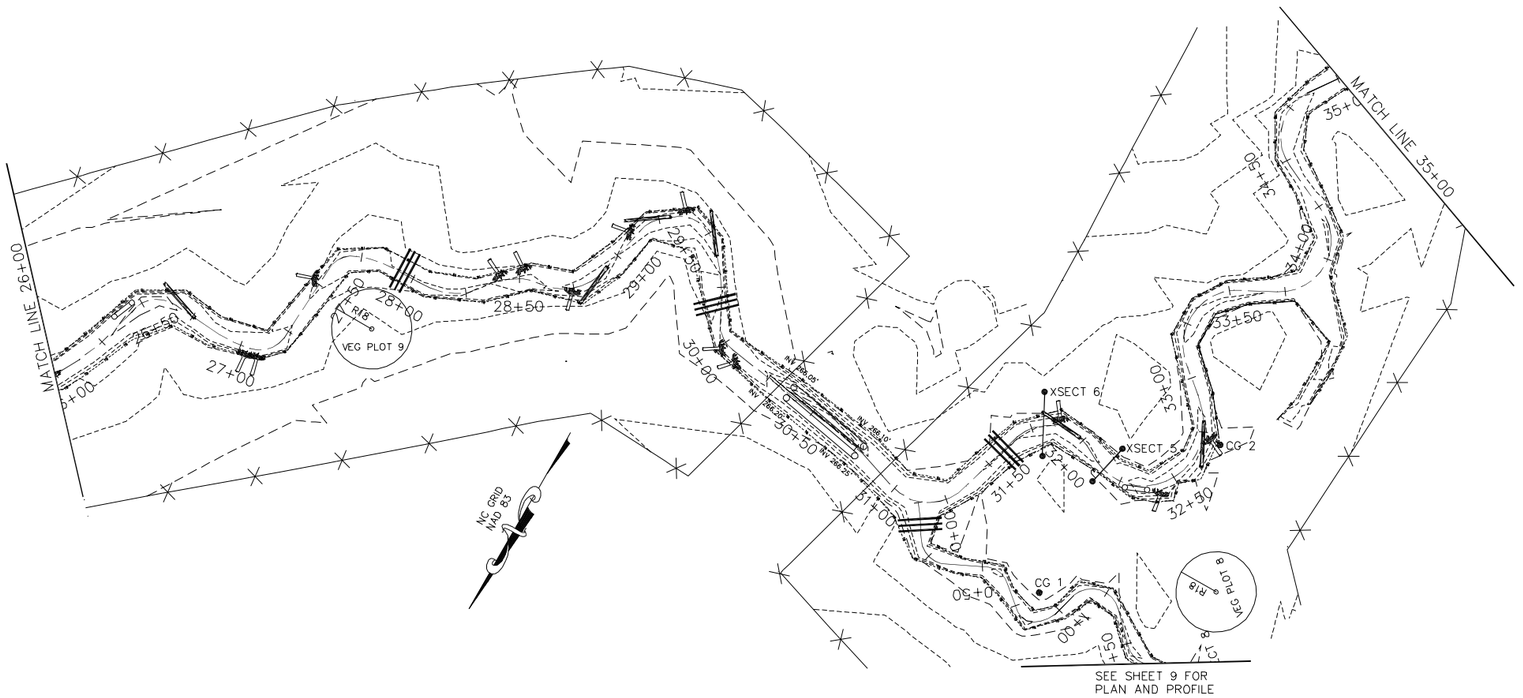
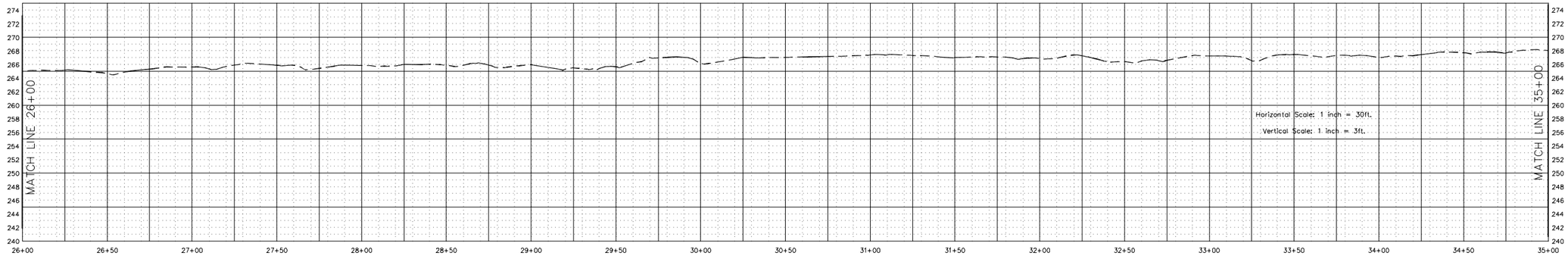
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 17+50 TO 26+00



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
1 inch = 30ft.



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DRAWN BY	TRS
APPROVED BY	ME
FILE NAME	as-built.dwg
DRAWING SCALE	1" = 30'
PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

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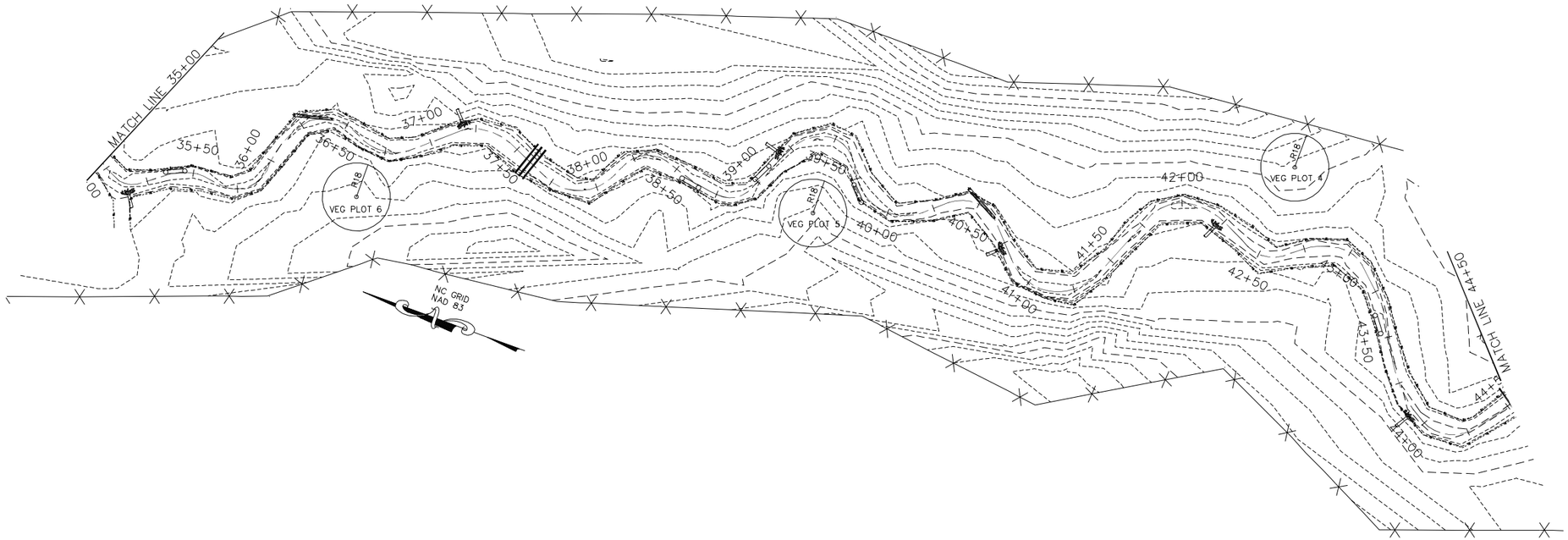
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 26+00 TO 35+00



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- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
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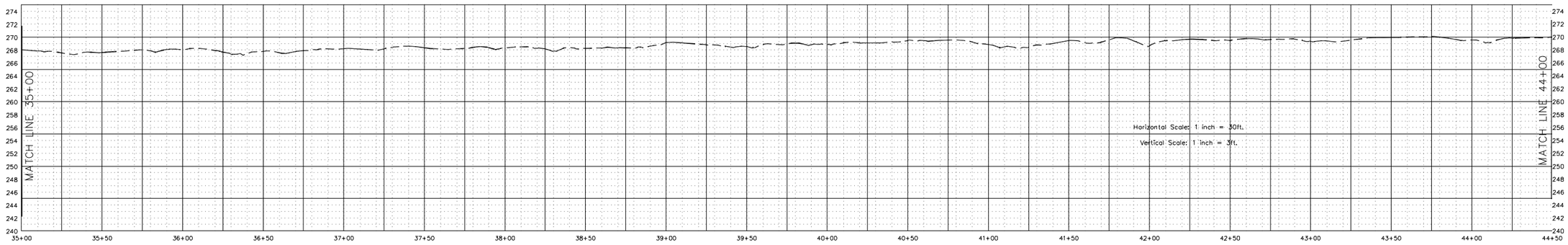

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APPROVED BY	ME
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DRAWING SCALE	1" = 30'
PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

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CONSTRUCTION	
RECORD DWG.	

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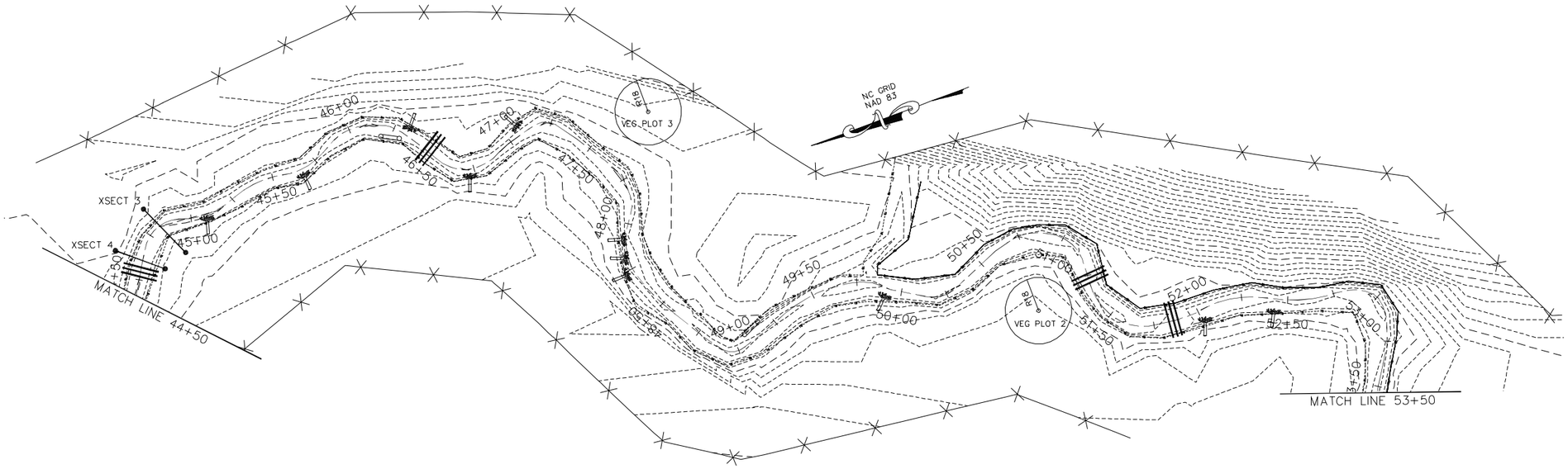
UT-1 STA. 35+00 TO 44+00



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
1 inch = 30ft.

Horizontal Scale: 1 inch = 30ft.
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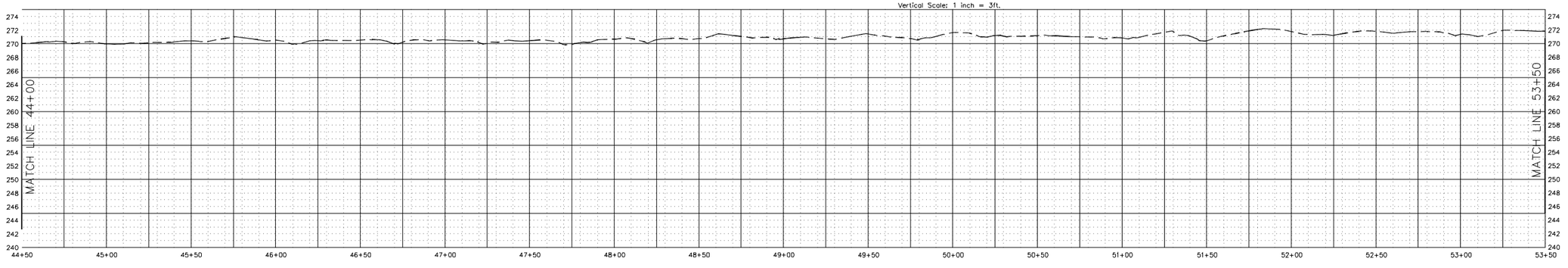

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FILE NAME	as-built.dwg
DRAWING SCALE	1" = 30'
PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

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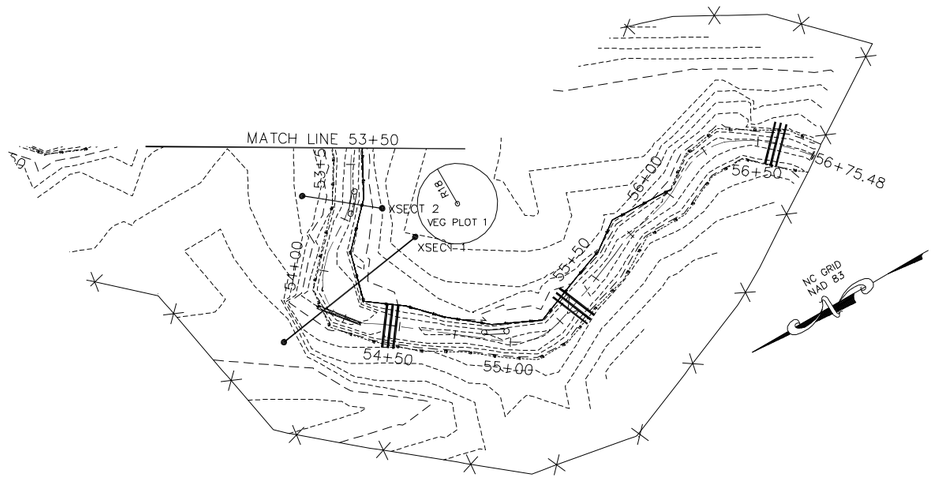
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 44+00 TO 53+50



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

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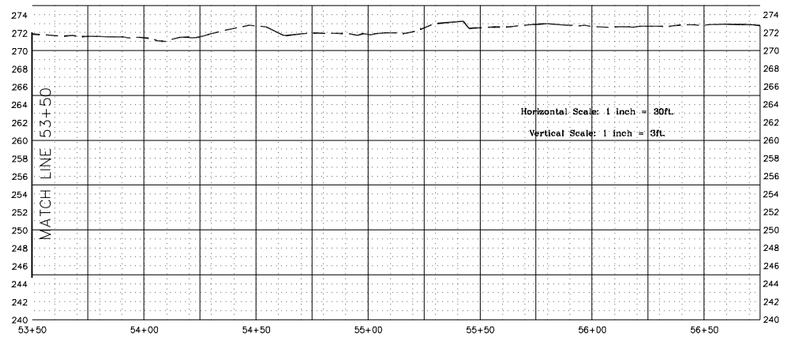
1 inch = 30ft.



REV. NO.	DESCRIPTION	DATE
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APPROVED BY	ME
FILE NAME	as-built.dwg
DRAWING SCALE	1" = 30'
PROJECT DATE	03/30/2004
PROJECT NUMBER	
PLOT DATE	10/4/07

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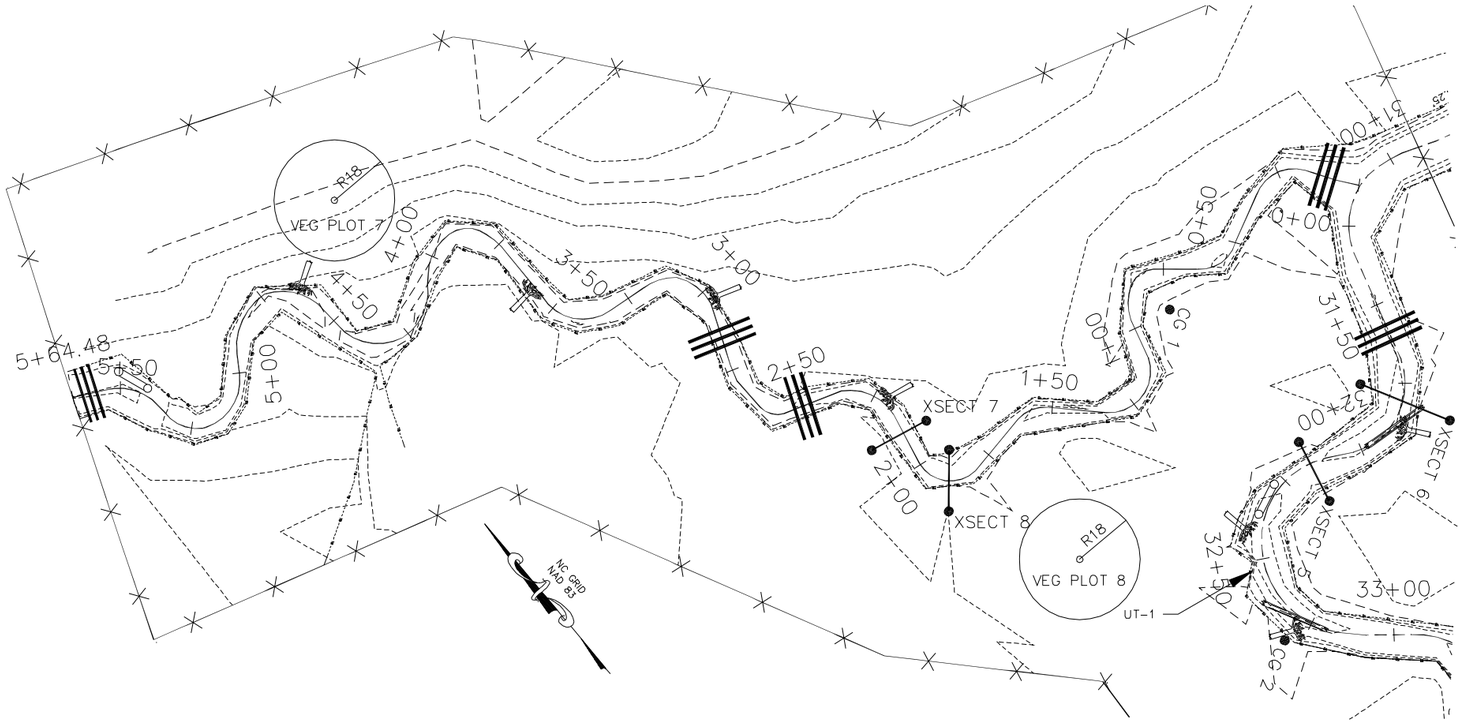
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 53+50 TO 56+75

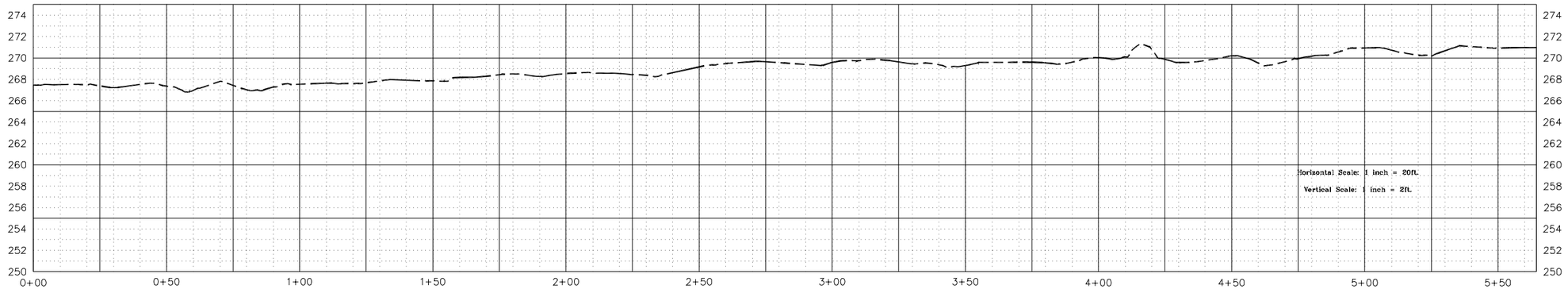


LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASEMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

20 0 10 20 40

1 inch = 20ft.



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REVISIONS

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APPROVED BY: ME
FILE NAME: as-built.dwg
DRAWING SCALE: 1" = 20'
PROJECT DATE: 03/30/2004
PROJECT NUMBER: 3024600RA
PLOT DATE: 10/4/07

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RECORD DWG.	

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STONEBRIDGE STREAM MITIGATION PROJECT
CARTHAGE, NORTH CAROLINA

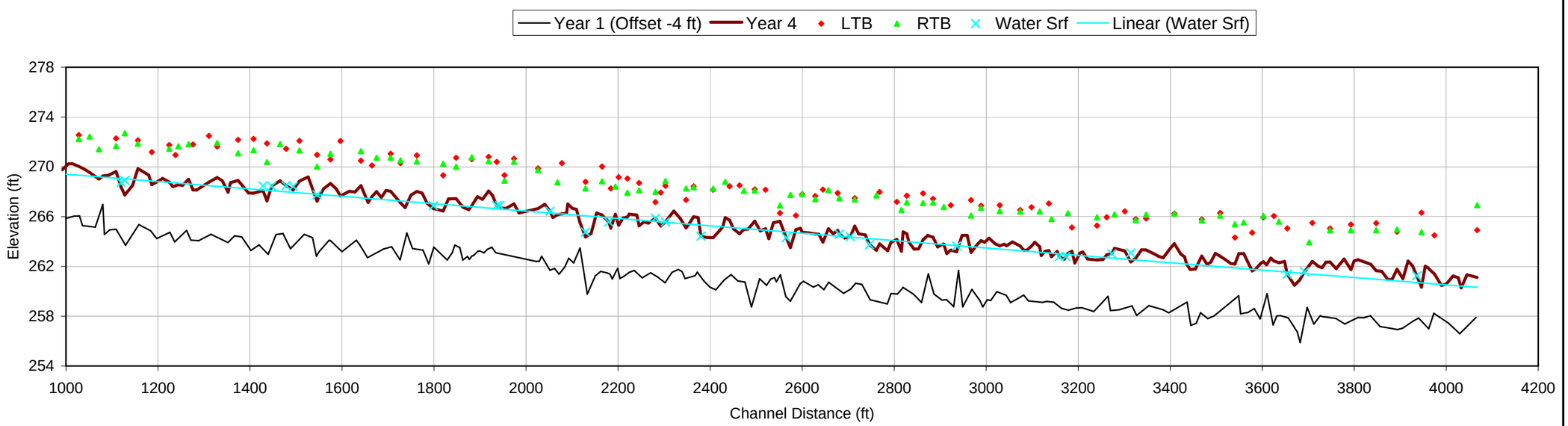
STONEBRIDGE AS-BUILT PLANS

UT-2 STA. 0+00 TO 5+64

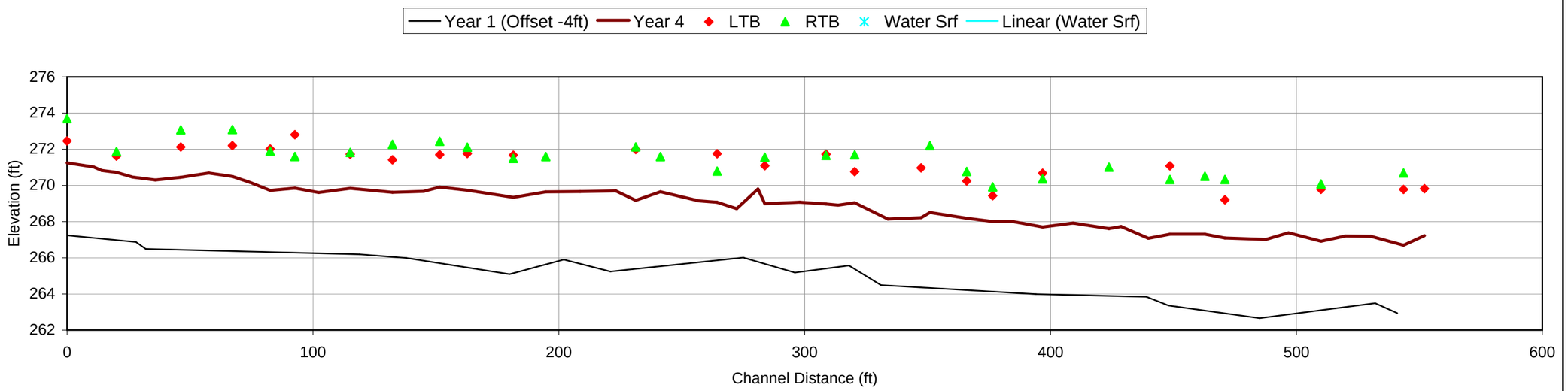
APPENDIX B

2009 Profile and Cross Section Data

Stonebridge
UT-1 Station 10+00 - 41+00

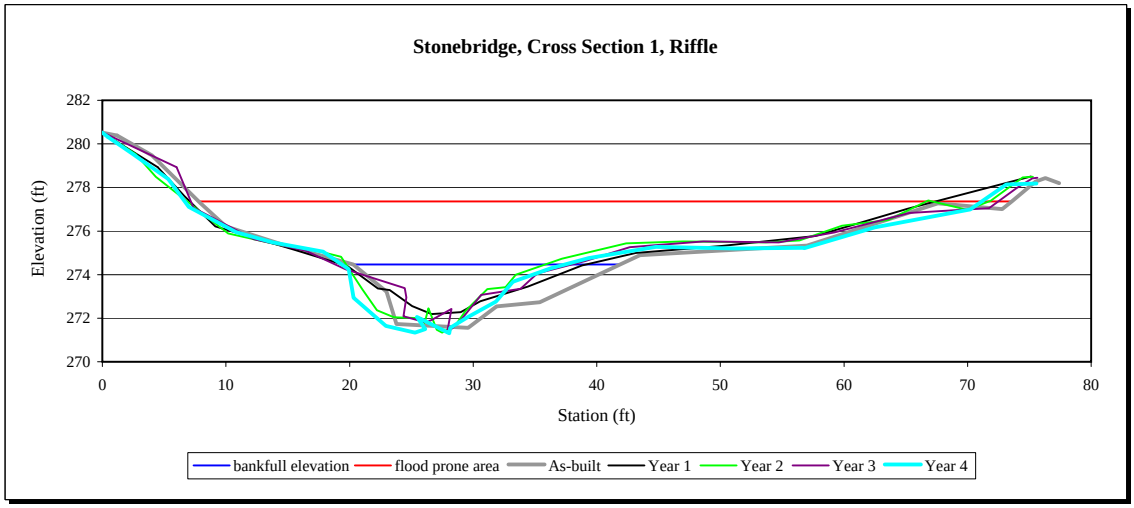


Stonebridge
UT-2 Station 0+00 - 5+64



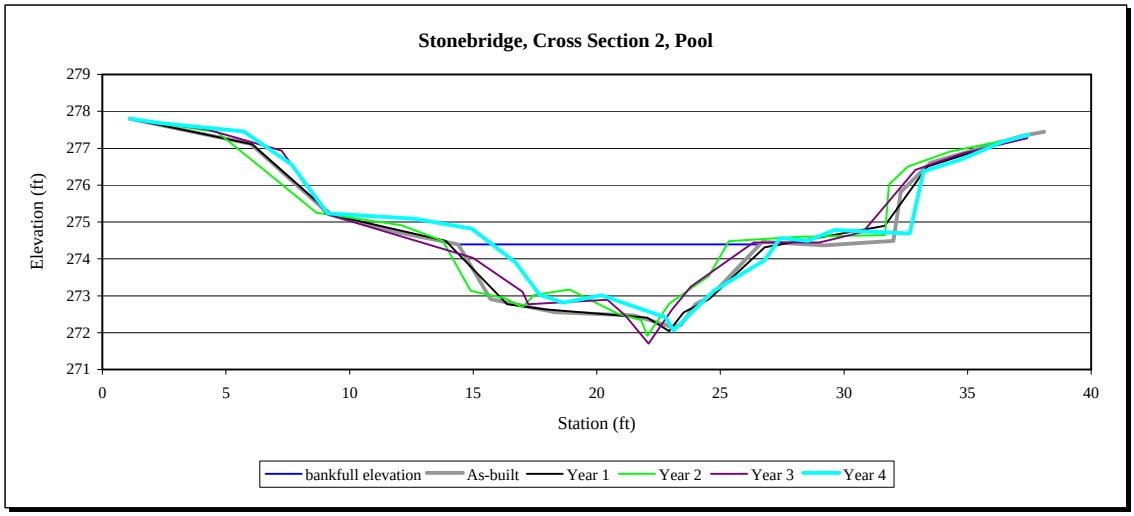
Left Bank

Right Bank

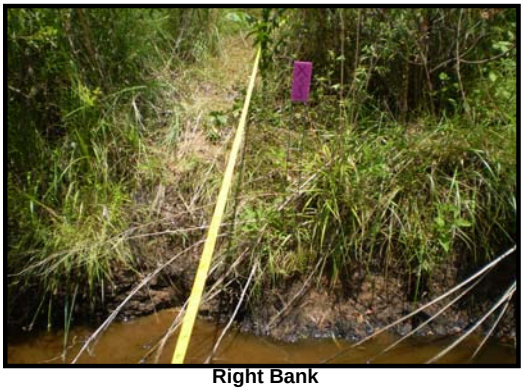


Left Bank

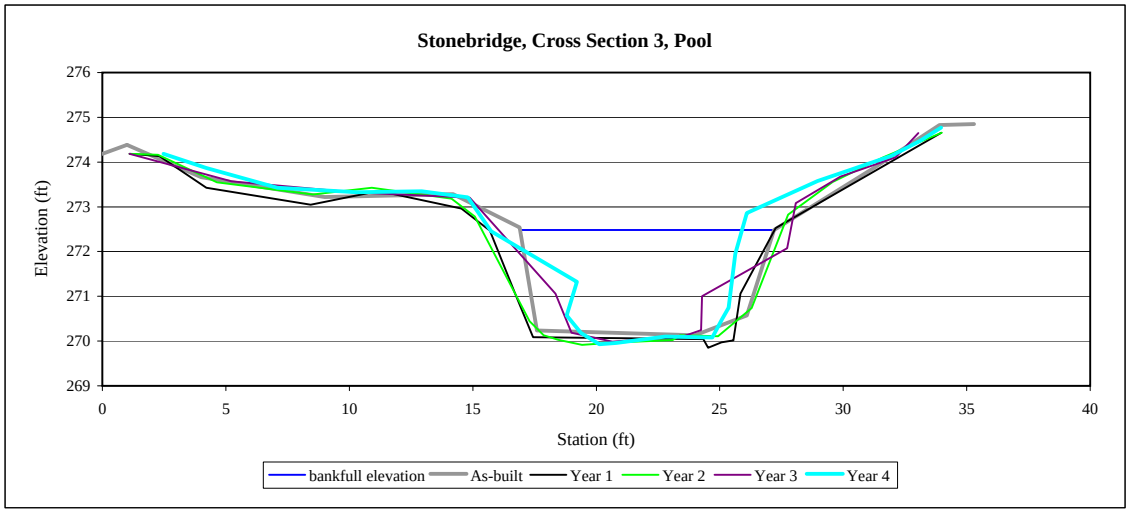
Right Bank



Left Bank

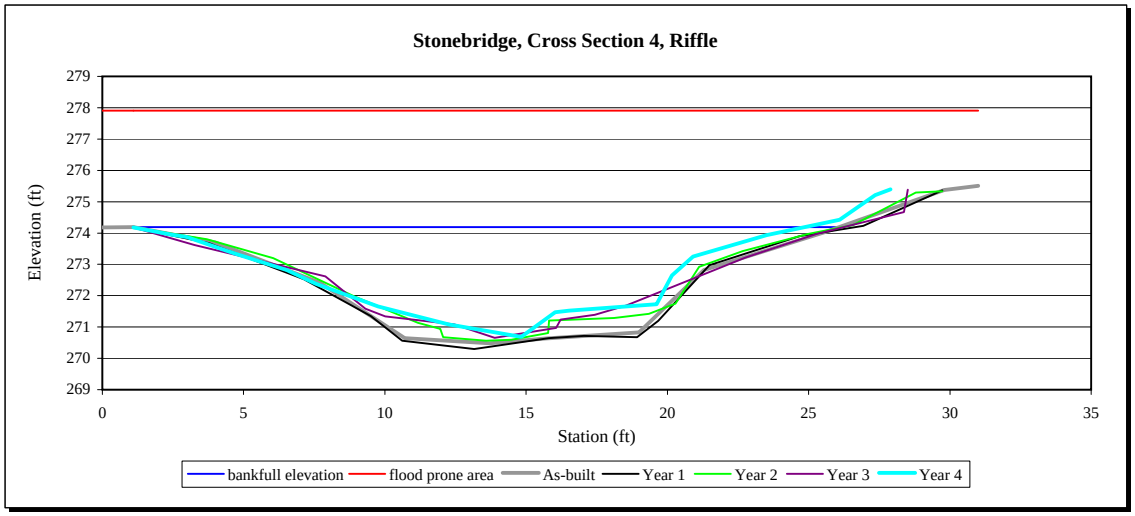


Right Bank



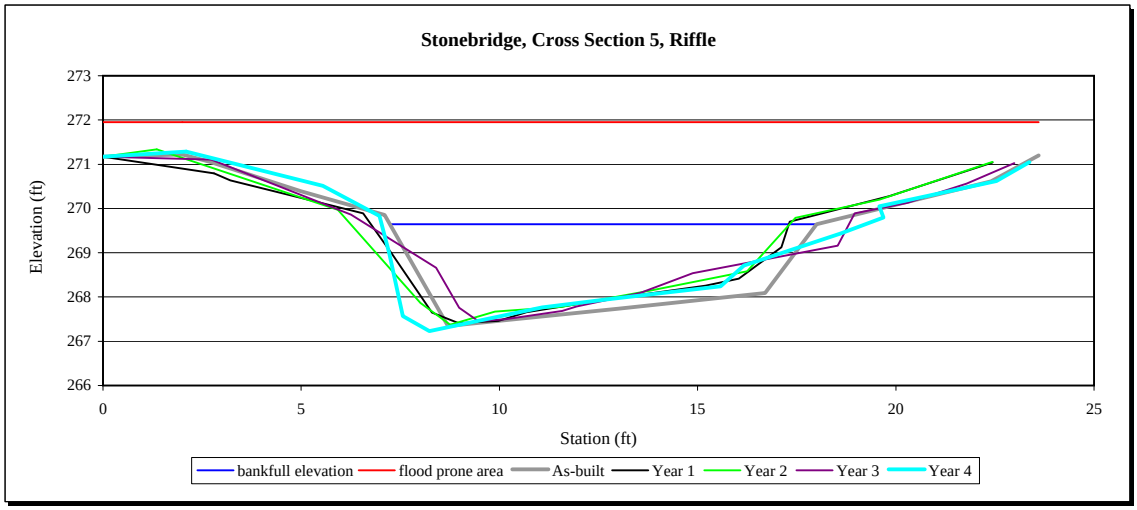
Left Bank

Right Bank



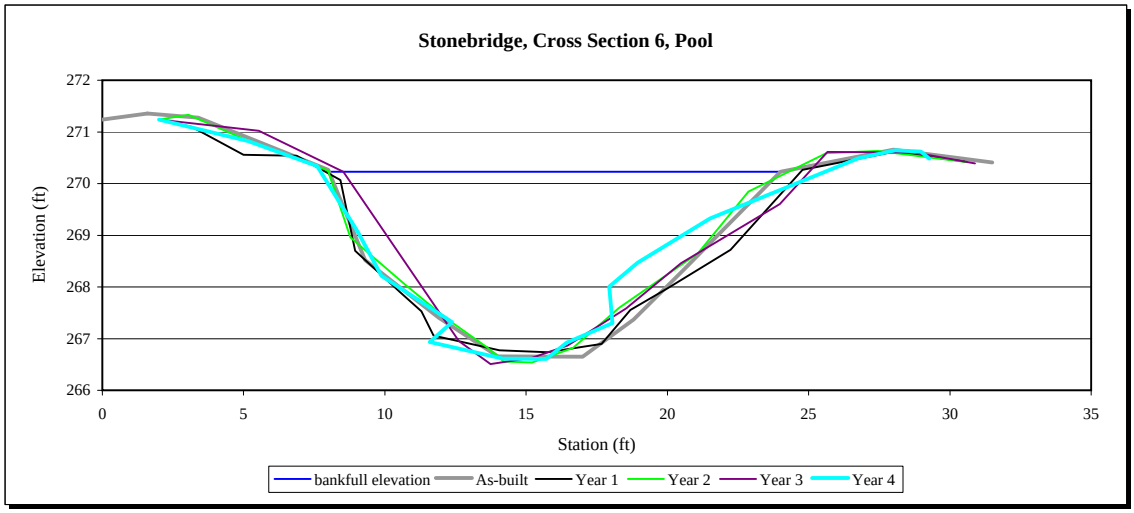
Left Bank

Right Bank



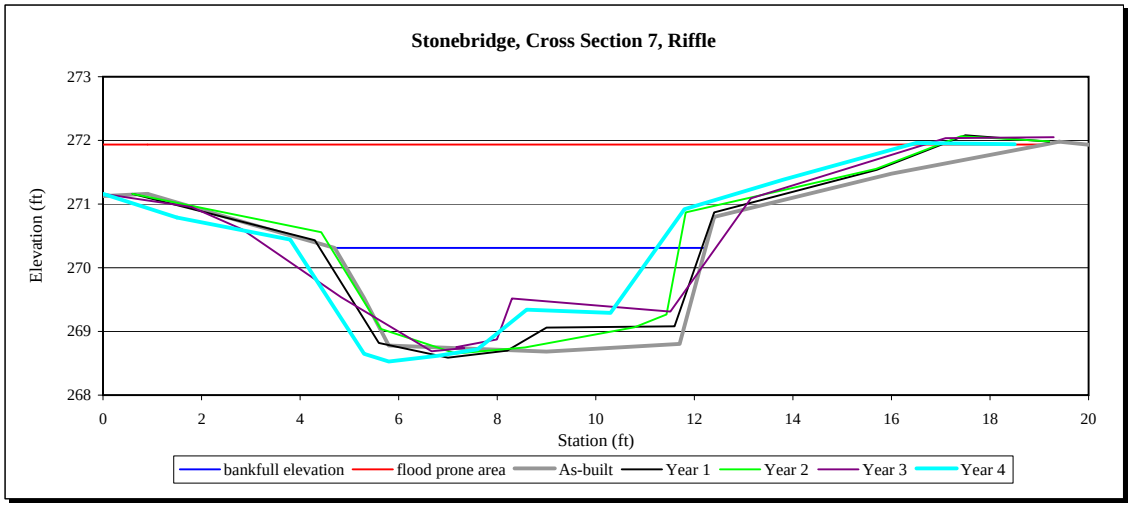
Left Bank

Right Bank



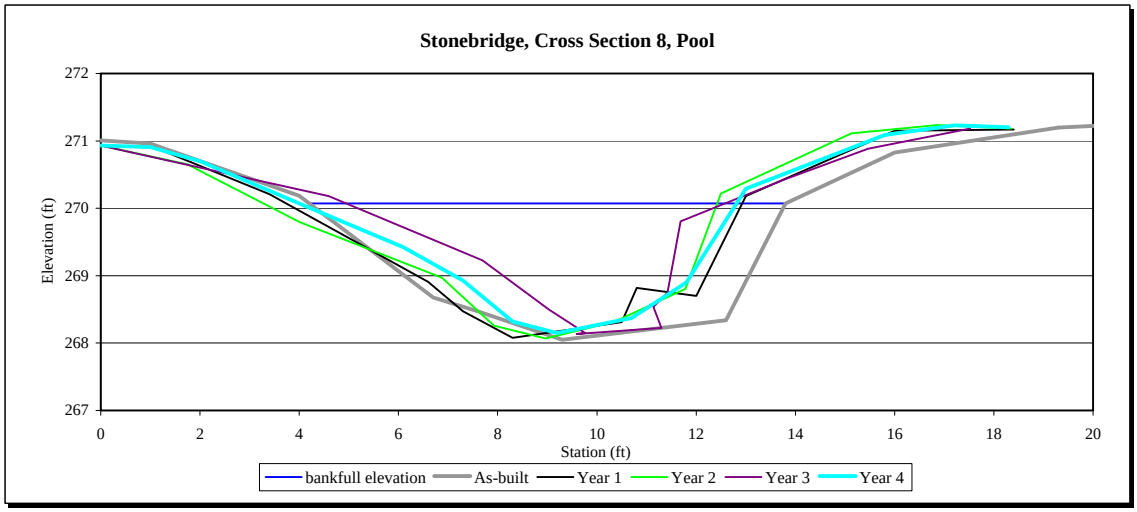
Left Bank

Right Bank



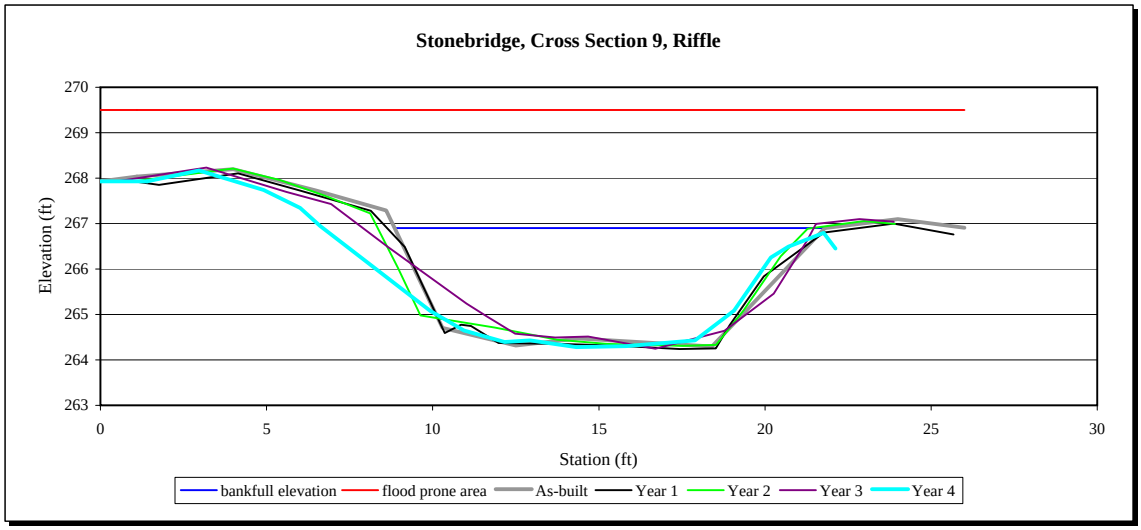
Left Bank

Right Bank



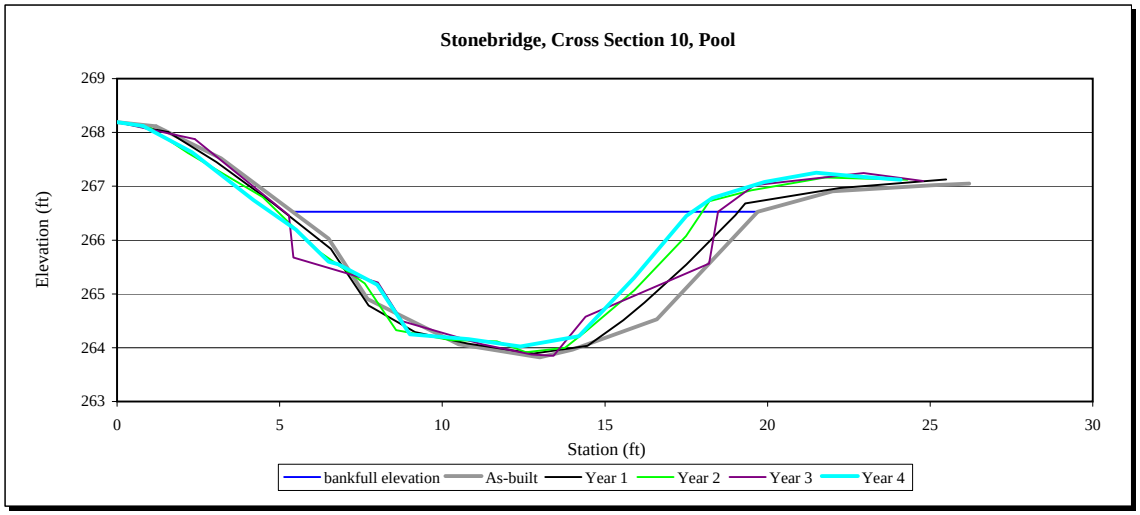
Left Bank

Right Bank



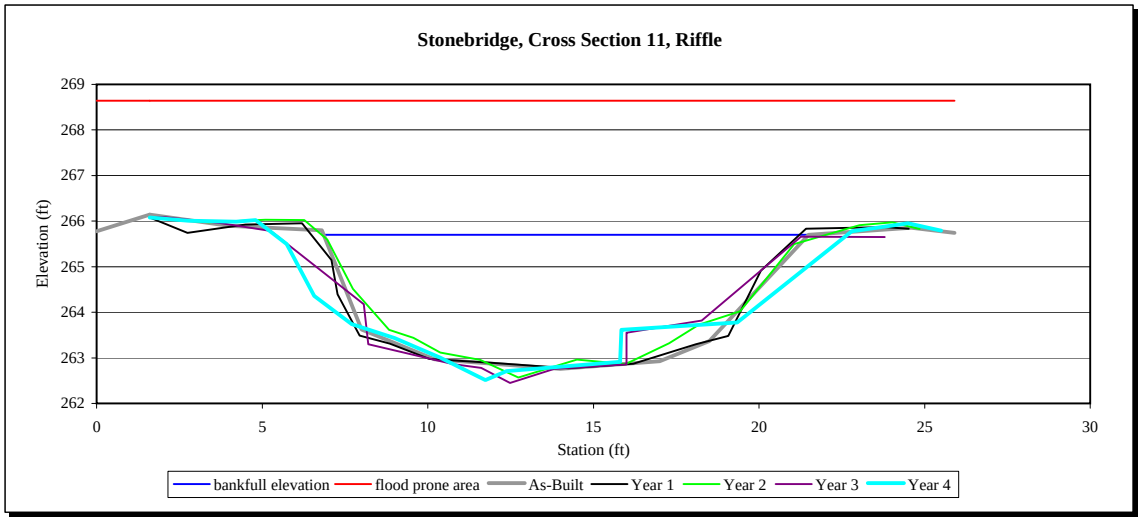
Left Bank

Right Bank



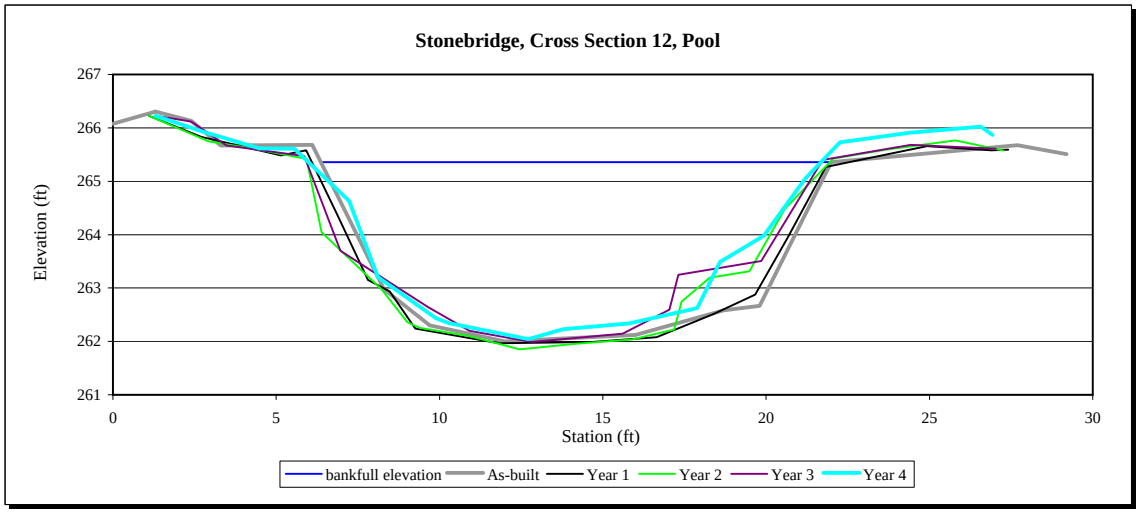
Left Bank

Right Bank



Left Bank

Right Bank



APPENDIX C

2009 Site Photos

Stream Problem Area Photos

SPA 1 – Typical vegetation in channel throughout UT1.

SPA 2 – Damaged fence, UT1 Sta. 48+00.

SPA 3 – Minor right bank erosion, UT1 Sta. 47+50 to 47+80.

SPA 4 – Minor left bank erosion, UT1 Sta. 44+60 to 45+10.

SPA 5 – Minor right bank erosion, UT1 Sta. 40+10 to 40+50.

SPA 6 – Log grade control erosion, UT2, Sta. 2+50.

SPA 7 – Log vane erosion, UT1, Sta. 29+50.

SPA 8 – Erosion behind root wad, UT1 Sta. 29+30.

SPA 9 – Erosion behind log vane arm, UT1 Sta. 29+20.

SPA 10 – Mid-channel bar, vegetation in channel, UT1 Sta. 24+00.

Vegetation Plot Photos

Vegetation Plot #1 - upstream

Vegetation Plot #1 – downstream

Vegetation Plot #2 – upstream

Vegetation Plot #2 – downstream

Vegetation Plot #3 – upstream

Vegetation Plot #3 – downstream

Vegetation Plot #4 – upstream

Vegetation Plot #4 – downstream

Vegetation Plot #5 – upstream

Vegetation Plot #5 – downstream

Vegetation Plot #6 – upstream

Vegetation Plot #6 – downstream

Vegetation Plot #7 – upstream

Vegetation Plot #7 – downstream

Vegetation Plot #8 – upstream

Vegetation Plot #8 – downstream

Vegetation Plot #9 – upstream

Vegetation Plot #9 – downstream

Vegetation Plot #10 – upstream

Vegetation Plot #10 – downstream

Vegetation Plot #11 – upstream

Vegetation Plot #11 – downstream

Vegetation Plot #12 – upstream

Vegetation Plot #12 – downstream

Vegetation Plot #13 –upstream

Vegetation Plot #13 –downstream

Vegetation Plot #14 –upstream

Vegetation Plot #14 –downstream