Open Springs Mitigation Project
Randolph County, North Carolina

FINAL Year 5 Monitoring Report

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Table of Contents

1.0 SUMMARY 1
2.0 INTRODUCTION 2
2.1 Project Description 2
2.2 Project Purpose 2
2.3 Project History & Schedule 6
3.0 VEGETATION 6
3.1 Vegetation Success Criteria 6
3.2 Description of Species and Vegetation Monitoring 6
3.3 Results of Vegetation Monitoring 8
3.4 Vegetation Observations & Conclusions 10
4.0 STREAM MONITORING 10
4.1 Stream Success Criteria 10
4.2 Stream Morphology Monitoring Plan 10
4.2.1 Cross Sections 11
4.2.2 Longitudinal Profile 11
4.2.3 Hydrology 11
4.3 Stream Morphology Monitoring Results 11
4.3.1 Cross Sections 15
4.3.2 Longitudinal Profile 15
4.3.3 Hydrology 15
4.4 Stream Conclusion 17
5.0 CONCLUSIONS AND RECOMMENDATIONS 17

List of Figures

Figure 1. Vicinity Map 3
Figure 2. USGS Map 4
Figure 3. Site Overview 5
Figure 4. Stream Problem Areas 12
Figure 5. 2009 Precipitation for Open Springs 16

List of Tables

Table 1. Project Mitigation Structure and Objectives 2
Table 2. Project Activity and Reporting History 6
Table 3. Project Contacts 6
Table 4. Planted Tree Species 7
Table 5. Results of Vegetation Monitoring – Year 5 8
Table 6. Summary of Results – Year 5 9
Table 7. Volunteer Tree Species 10
Table 8a. Summary of Morphologic Monitoring Parameters – UT1 14
Table 8b. Summary of Morphologic Monitoring Parameters – UT4 14
Table 9. Stream Areas Requiring Observation 14
Table 10. Crest Gauge Data 15
Table 11. Randolph County and On-site Rainfall Data 16
Table 12. Summary of Stream Crest Gauge Data 2005-2009 17
Table 13a. Summary of Morphologic Monitoring Parameters 2005-2009 for UT1 17
Table 13b. Summary of Morphologic Monitoring Parameters 2005-2009 for UT4 18
Table 14. Summary of Vegetative Monitoring Data 2005-2009 18

APPENDICES

Appendix A As-Built Survey
Appendix B 2008 Profile and Cross Section Data
Appendix C 2008 Site Photos

1.0 SUMMARY

This Annual Report details the monitoring data collected during the 2009 growing season on the Open Springs Mitigation Site. Construction of the site, including planting of trees, was completed in April 2005. The 2009 data represent results from Year 5 of morphologic and vegetation monitoring.

The Open Springs Stream Mitigation Project site is located in Randolph County, North Carolina, northeast of Ramseur within hydrologic unit 03030003 in the Cape Fear River Basin. The NC Department of Transportation (NCDOT) contracted with EBX Neuse I, LLC (EBX) to perform mitigation work at the site under Full Delivery Project S-1. A total of 4,835 stream mitigation units (SMU) were generated from this project through restoration and enhancement of stream and riparian habitats.

The project has been monitored for five years to determine the success of the restoration and enhancement efforts. 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 July 25, 2005 (**Appendix A**). Information on stream morphology and vegetation was collected each year and compared to the baseline data and data from previous monitoring years in order to determine whether the site is meeting success criteria.

Monitoring of the vegetation plots in 2009 recorded an average of 570 planted stems per acre at the site. All of the plots exceeded the five year success criteria of 260 stems per acre.

The stream morphology is stable with the site experiencing multiple bankfull events in 2009. Very little fluvial erosion was observed, and many of the riffle features are collecting small gravel, as expected. The longitudinal profile and all monitored cross-sections show very little adjustment of stream dimension.

Habitat has been improved significantly throughout the project. Vegetation is successful across the site, and provides riparian habitat, water quality benefits, and cover for the stream system. Based on the results of the vegetative and morphological monitoring over years one through five, it was concluded that the site has achieved the vegetative and stream success criteria specified in the Mitigation Plan.

2.0 INTRODUCTION

2.1 PROJECT DESCRIPTION

The project site is located in Randolph County, North Carolina, northeast of the town of Ramseur (**Figure 1** & **Figure 2**) within hydrologic unit 03030003 in the Cape Fear River Basin. The project site is bound to the north and east by Ferguson Road and Low Bridge Road, respectively.

2.2 PROJECT PURPOSE

The objective of this project is to provide at least 4,520 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).

Four unnamed tributaries to the Deep River flow across the project site. The streams are referred to in this report as UT-1, UT-2, UT-3, and UT-4. Prior to implementation of the mitigation plan, the streams were disturbed 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 3,202 mitigation units were achieved by restoring plan form, cross section, and profile features on UT-1. In addition, a small tributary enters UT-1 near station 14+50, referred to herein as UT-4. The bed of this tributary was raised to maintain a stable confluence with UT-1. An existing slope discontinuity approximately 175 feet upstream of the confluence was deemed the natural location to tie in grades. The sinuosity designed for this small tributary yielded an additional 307 linear feet of stream. Therefore, a total of 3,509 SMU were generated from stream restoration on UT-1 and UT-4.

UT-2 is the master stream and, although it has been locally disturbed by cattle, it was in relatively good physical condition. Enhancements to UT-2 include cattle exclusion, localized bank stabilization and debris removal, riparian buffer planting, and control of invasive/exotic vegetation. UT-2 has a total length of 2,397 feet on the subject property. An existing farm crossing was maintained, and 53 feet are being held near the east property line to accommodate a future crossing, leaving 2,329 linear feet for stream enhancement. Using the 2.5:1 ratio for Level II stream enhancement (USACE, 2003), 931 SMU were generated from UT-2. UT-3 flows through a regenerated pine plantation and is also in good physical condition. However, the riparian habitat along UT-3 is in poor condition and enhancement efforts included riparian buffer planting to increase diversity and control invasive/exotic vegetation. At the 2.5:1 enhancement ratio, 395 linear feet of UT-3 were enhanced to deliver the total 4,835 SMU.

Table 1. Project Mitigation Structure and Objectives

Reach Name	Stream Mitigation Units (SMU)	Restoration Approach
UT -1	3,202	Restoration
UT-2	931	Enhancement
UT-3	395	Enhancement
UT-4	307	Restoration
Total	**4,835**	

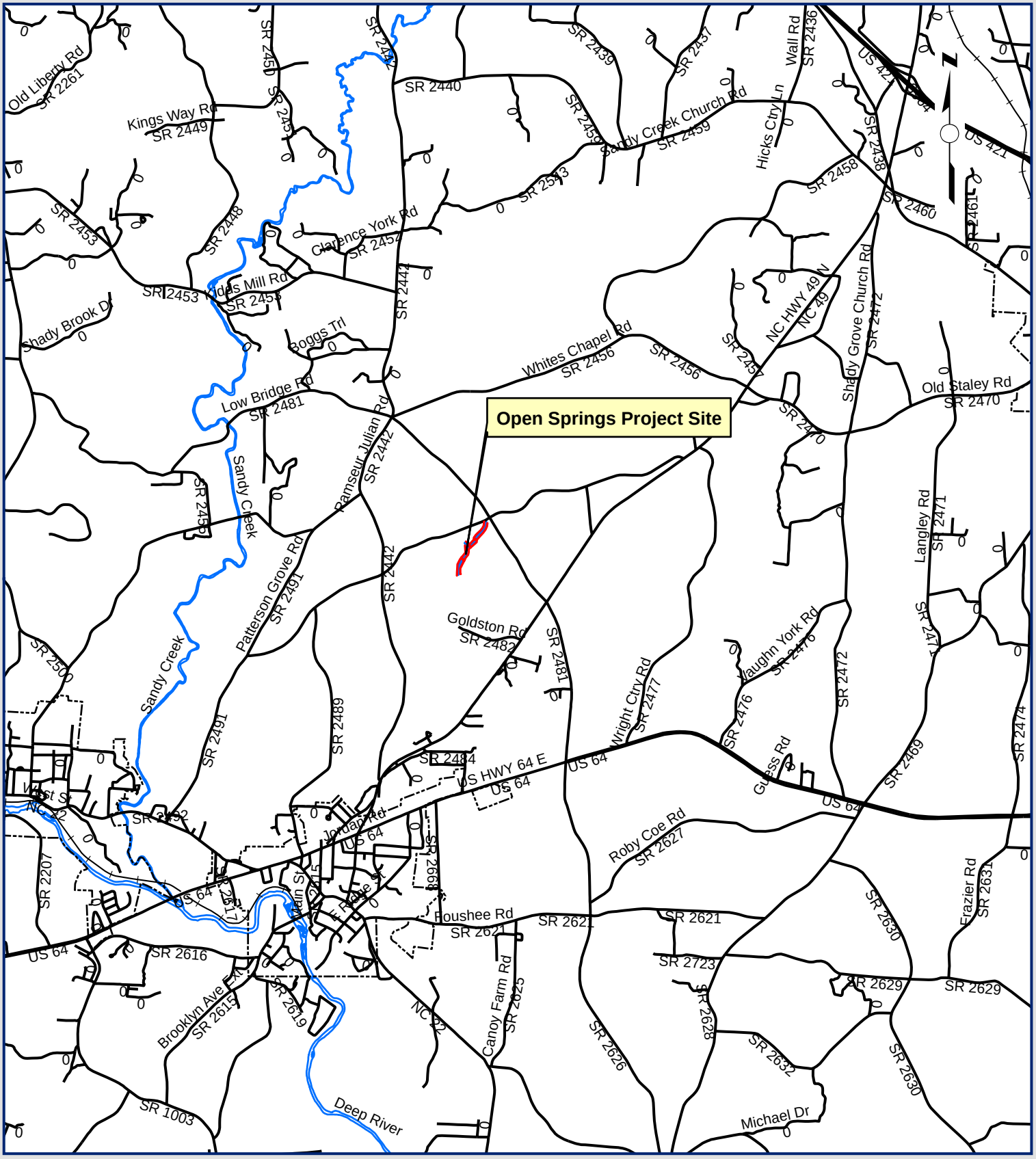
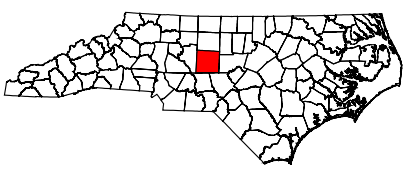


Figure 1.
Open Springs Stream Mititgation Site
Project Location Map
Randolph County, NC

1 inch equals 5,280 feet



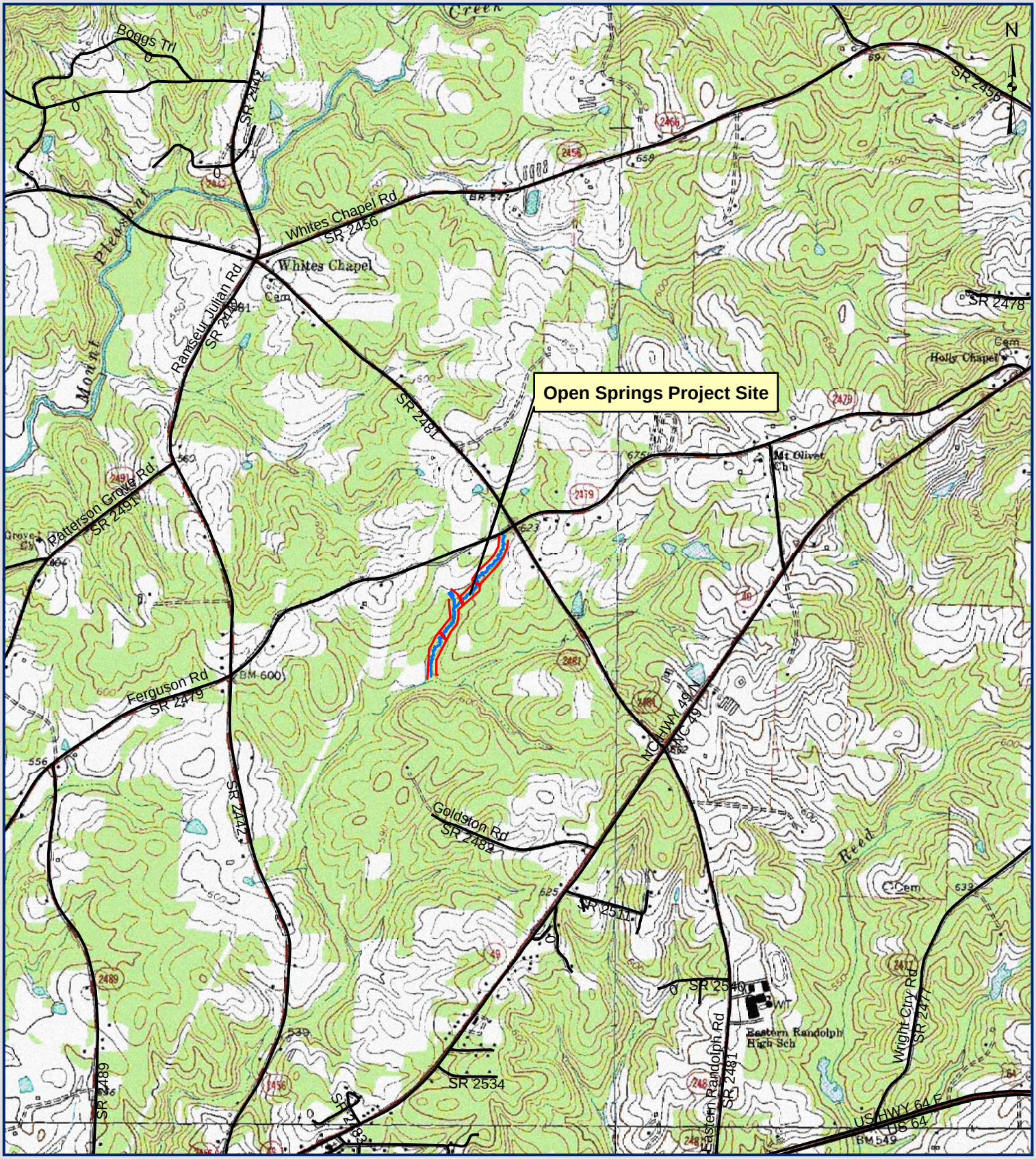
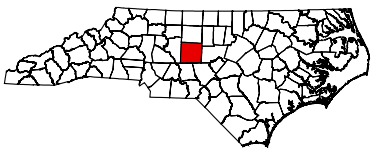
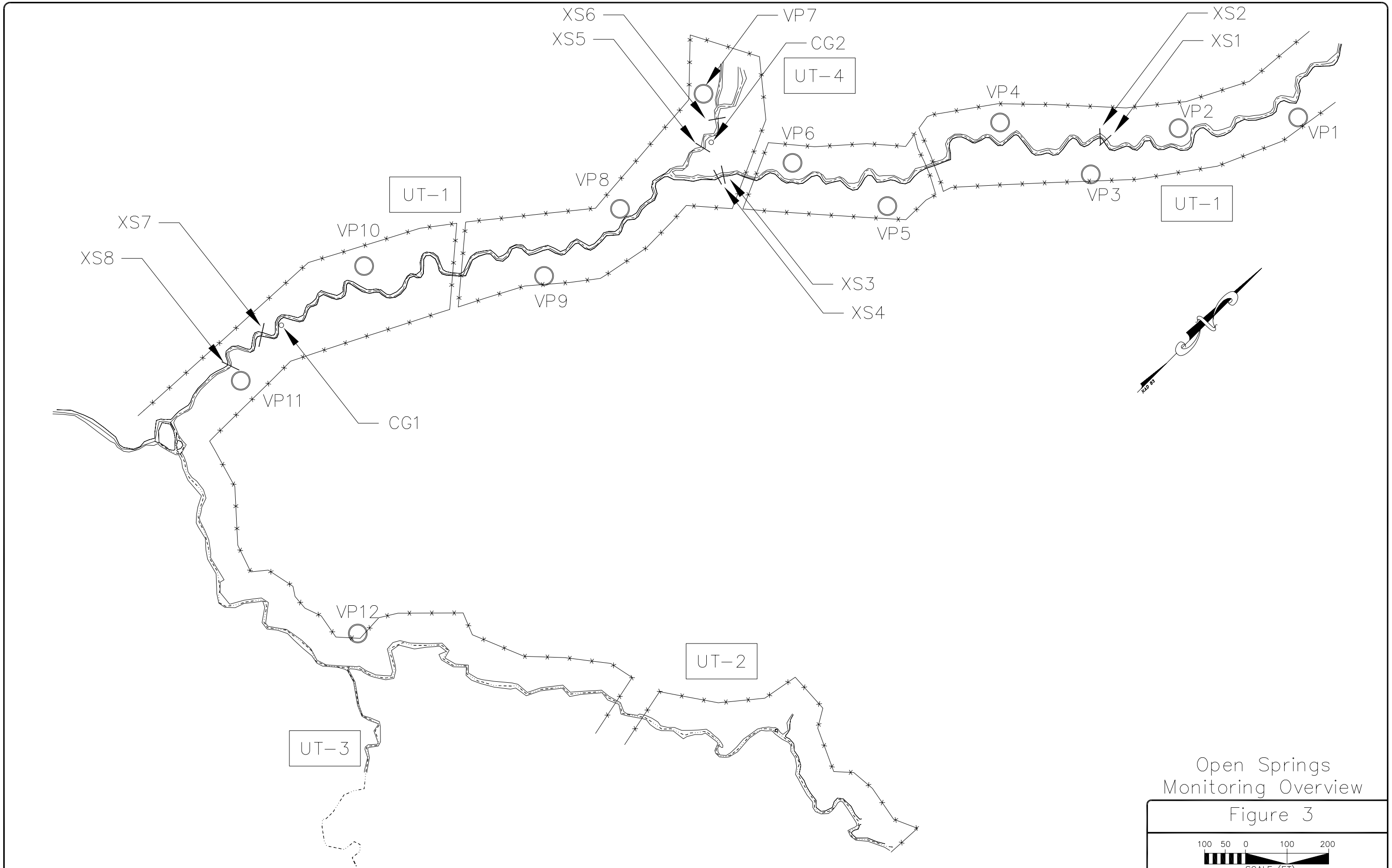


Figure 2.
Open Springs Stream Mititgation Site
USGS Topographic Map
Randolph County, NC

1 inch equals 2,000 feet




XS6
XS5
VP7
CG2
UT–4
XS2
XS1
VP4
VP2
VP1
VP6
VP8
UT–1
VP3
UT–1
XS7
VP10
XS8
VP5
XS3
VP9
XS4
VP11
CG1
VP12
UT–2
UT–3
NAD 83
Open Springs
Monitoring Overview
Figure 3
100 50 0 100 200
SCALE (FT)

2.3 PROJECT HISTORY & SCHEDULE

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) as solicited through the NCDOT's Full Delivery Project S-1. This project was identified by EBX in the spring of 2003. **Table 2** outlines the project history and milestones.

Table 2. Project Activity and Reporting History

Month	Activity
Mitigation Plan	April-04
Final Design	November-04
Construction	April-05
Vegetation Planting	April-05
As-built (Baseline) Report	July-05
Year 1 Monitoring	November-05
Year 2 Monitoring	November-06
Year 3 Monitoring	November-07
Year 4 Monitoring	November-08
Year 5 Monitoring	November-09

Table 3. Project Contacts

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

3.0 VEGETATION

3.1 VEGETATION SUCCESS CRITERIA

The interim measure of vegetative success for the Open Springs Mitigation Site was survival of at least 320 planted stems per acre at the end of the year three monitoring period. The final vegetative success criteria is the survival of 260 planted trees per acre at the end of year five of the monitoring period (U.S. Army Corps of Engineers et. al. 2003). Success of riparian vegetation will be evaluated annually through monitoring of 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 site species composition may be comprised of volunteers. Remedial action may be required should these volunteers (i.e. loblolly pine, red maple, sweet gum, etc.) present a problem and exceed 20 percent composition.

3.2 DESCRIPTION OF SPECIES AND VEGETATION MONITORING

All vegetation was planted in April 2005 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 multiple strata 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*) and silky dogwood (*Cornus amomum*). The second is a drier zone predominantly consisting of mesic species such as yellow poplar (*Liriodendron tulipifera*) and slippery elm (*Ulmus rubra*). The plots were planted at an average density of 693 stems per acre.

Table 4. Planted Tree Species

Common Name	Scientific Name	FAC Status
Shrubs		
Elderberry	*Sambucus canadensis*	FACW-
Paw Paw	*Asimina triloba*	FAC
Silky Dogwood	*Cornus amomum*	FACW+
Tag alder	*Alnus serrulata*	FACW+
Trees		
Black Gum	*Nyssa sylvatica*	FAC
Black Locust	*Robiinia pseudocacia*	FACU-
Green ash	*Fraxinus pennsylvanica*	FACW
Ironwood	*Carpinus caroliniana*	FAC
Red Oak	*Quercus rubra*	FACU
River Birch	*Betula nigra*	FACW
Slippery Elm	*Ulmus rubra*	FAC
Sycamore	*Platanus occidentalis*	FACW-
Tulip Poplar	*Liriodendron tulipifera*	FAC
Black Gum	*Nyssa sylvatica*	FAC

To monitor the success of riparian buffer vegetation, twelve plots were established on the Open Springs Mitigation Site. The plots cover approximately 2 percent of the site and are 1/40th of an acre in size. The locations of these plots were randomly distributed across the planted portions of the site. The center of each plot is marked with a ten-foot section of metal fence post with a white PVC cover. Within each established plot, the planted woody stems were identified with a numbered aluminum tag, and marked with a three-foot section of white PVC pipe. The initial and total numbers of trees planted in each plot are listed in **Table 6**. **Table 5** shows the number of trees in each plot by species. Planted woody species will be monitored twice per year for the first three years. Herbaceous plant cover was monitored during the 2009 annual monitoring visit using the notched-boot method.

In the years immediately following construction, abnormally dry to drought conditions caused higher than normal mortality in some areas and slowed overall growth of both planted trees and herbaceous vegetation. To compensate for the mortality observed in 2006, portions of the site were replanted in March 2007 with 2-year-old trees, and the site was treated with herbicide to control fescue. Approximately 1,600 trees were replanted around vegetation plots VP 1, VP 2, VP 4, VP 7, VP 9, and VP 12. Tree species planted include those shown in **Table 4**, except for slippery elm, tag alder, and black gum. Eastern redbud was an additional species planted. Due to low stem counts, a replanting around plotsVP9 and VP10 was conducted in spring 2008 with 3-year old stems.

3.3 RESULTS OF VEGETATION MONITORING

Stem counts were conducted at each monitoring plot during July 2009. All 12 vegetation monitoring plots were evaluated for success, and the overall condition of vegetation at the site was assessed. **Table 5** and **Table 6** show the number of each species of woody plants recorded for each plot and the success rate of each plot. The range of surviving planted stems after the fifth year range from 324 to 810 stems per acre, with an average of 570 planted trees per acre. Plots 9 and 10 were identified as problem areas in 2007 due to low stem counts. In 2009, plots 9 and 10 had 445 and 324 stems per acre, respectively. All of the plots met the five year success criteria of 260 stems per acre. In previous years, plots 6 and 9 had high numbers of black willow, which appeared to be affecting the survival of the planted trees. In 2009, black willow was no longer a dominant species in either of these plots, and it was noted that the planted trees in plot 9 appear to be healthier than in previous years.

Changes in survival have also occurred because of re-sprouting of some species. In previous years, elderberry, iron wood, green ash, sycamore, and red oak in several plots resprouted from the root crown of stems that were previously recorded as dead. Resprouts were observed in plots 2, 3, and 7 in 2009. 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**).

Table 5. Results of Vegetation Monitoring – Year 5

	Plots											
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Shrubs												
Elderberry			1									
Paw Paw		3		1		6						
Silky Dogwood			1		3			2			1	
Trees												
Black Locust			4									1
Blackgum		1				1	1					
Green Ash	10	1	2	14	2	6	9	8	3	4	1	3
Iron Wood		2	4		5		2	5	1	1	12	4
Red Oak		1	2						7	3		1
River Birch	2	1		5	1	1	4	1				
Sycamore	1	2			3	3	1					2
Tulip Poplar		1										

Table 6. Summary of Results – Year 5

Plots	Initial Stems Planted	Additional Stems Planted	Total Stems Planted	Stems Year 5	Stems per Acre Year 5
1	18	3	21	13	526
2	18	1	19	12	486
3	21		21	14	567
4	21		21	20	810
5	17		17	15	607
6	21		21	17	688
7	19	2	21	17	688
8	16		16	16	648
9	21	16	37	11	445
10	10	7	17	8	324
11	15		15	14	567
12	26	4	30	11	445
Average	**19**			**14**	**570**

Average Stems per Acre: 570
Range of Stems per Acre: 324-810

A plan view drawing of the vegetation plots is provided in **Figures 3**. 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 herbaceous vegetation at the site is variable in composition, as would be expected in a natural riparian system. Areas previously observed to have bare soil have filled in with herbaceous cover. Except for a few small linear areas found just above top of bank in the section between vegetation plots VP3 and VP4 herbaceous coverage is nearly 100 percent. These areas have filled in with herbaceous vegetation and no remedial action is recommended at this time.

The locally dominant herbaceous species are dog fennel (*Eupatorium capillifolium*), Canadian horseweed (*Conyza canadensis*), panic grass (*Panicum anceps*), Carolina horsenettle (*Solanum carolinense*), and annual ragweed (*Ambrosia artemisiifolia*). The herbaceous vegetation across the site is becoming diverse, and some of the other species found include: American pokeweed (*Phytolacca americana*), blackberry (*Rubus argutus*), Canada goldenrod (*Solidago canadensis*), common boneset (*Eupatorium perfoliatum*), foxtail (*Setaria* sp.), New York ironweed (*Vernonia noveboracensis*), Pennsylvania smartweed (*Polygonum pensylvanicum*), shallow sedge (*Carex lurida*), and strawcolored flatsedge (*Cyperus strigosus*).

The most commonly found woody volunteer species were identified and monitored throughout the five-year monitoring period (**Table 7).** Volunteer species were less visible, most likely because of decreased germination, vigor, and survival due to the 2007 drought. The herbaceous cover also obscures the smaller volunteer individuals. Natural recruitment across most of the site

is limited, mostly due to limited seed sources. The volunteer woody vegetation is less than 5 percent and does not present a problem.

Table 7. Volunteer Tree Species

Common Name	Scientific Name	FAC Status
Black Willow	*Salix nigra*	OBL
Persimmon	*Diospyros virginiana*	FAC
Red Maple	*Acer rubrum*	FAC
Slippery Elm	*Ulmus rubra*	FAC
Sweetgum	*Liquidambar styraciflua*	FAC+
Winged Elm	*Ulmus alata*	FACU+

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, the vegetation at this site is healthy and thriving. The area around plot VP10 has experienced a slightly higher mortality than desired, but the stem counts have remained steady since 2008. No volunteer tree species threaten the success of the planted trees. Each of the vegetation plots and the site as a whole meets the year five vegetative success criteria.

4.0 STREAM MONITORING

4.1 STREAM SUCCESS CRITERIA

As stated in the Mitigation Plan, the stream restoration success criteria for the 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.
- *Photos*: 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 and Fish Sampling*: Sampling of benthic macroinvertebrates and fish within the restored stream channel shall be conducted for the first three years of post-restoration monitoring.

4.2 STREAM MORPHOLOGY MONITORING PLAN

Along UT-1 and UT-4 a natural channel design approach was applied to develop stable hydraulic geometry parameters. Construction began in February 2005 and was completed in April 2005. The rebuilding of the channel established stable cross-sectional geometry, increased plan form

sinuosity, and restored riffle-pool sequences and other streambed diversity to improve benthic habitat. Approximately 3,510 linear feet of stream restoration has been constructed.

4.2.1 Cross Sections

The mitigation plan for the Open Springs project requires eight permanent cross sections to be monitored along the restored tributaries UT-1 and UT-4. The cross sections were established after construction 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 **Figure 3a**. 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

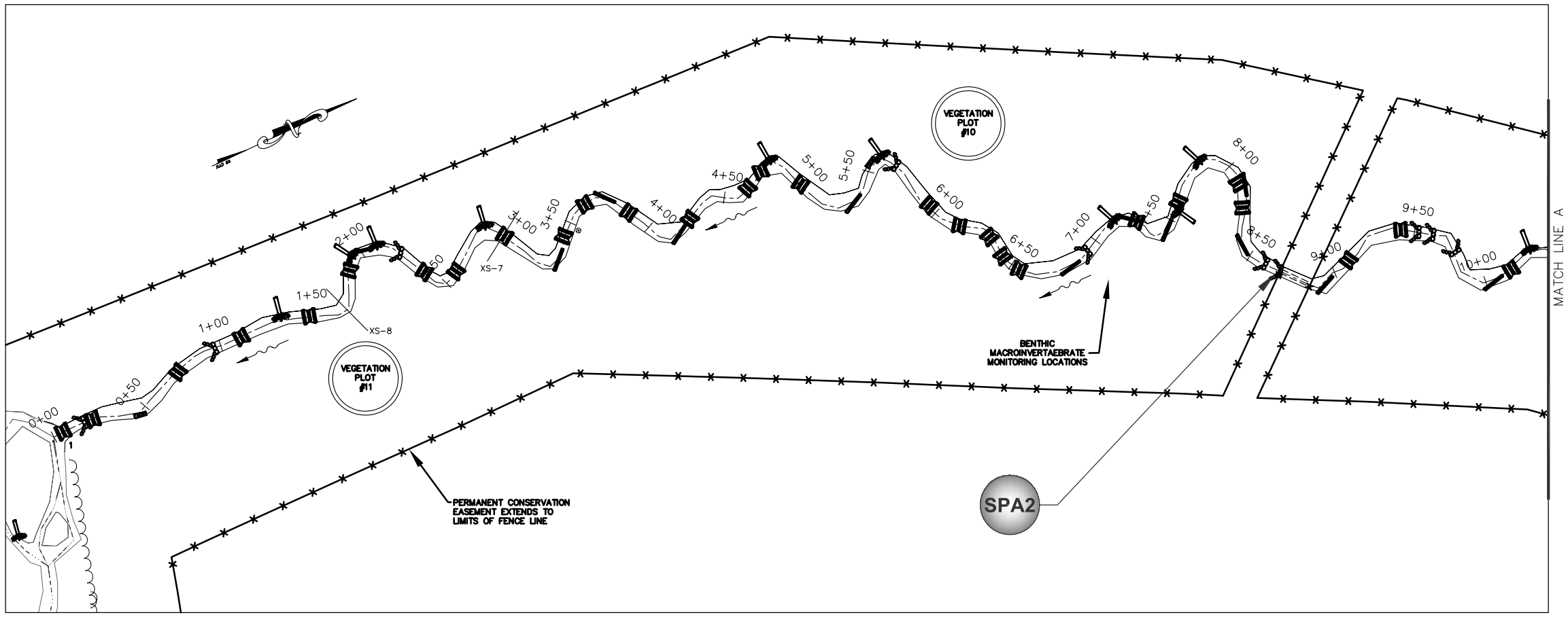
Longitudinal profiles will be surveyed in all five years of the monitoring period. UT-4 will be surveyed for its entire length. Profiles along UT-1 will be measured at three representative sections, each comprising approximately 900 linear feet. The cumulative length of the measured profiles will be 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

Two crest gauges were installed at the site; one on UT-1 near the downstream end of the project and one on UT-4 near the UT-1 confluence (see locations in **Figure 3a**). Crest gauges will be checked at least quarterly. During each visit, a determination of whether an out-of-bank event has occurred since the prior visit will be made. During the gauge inspections, any high water marks or debris lines will be documented and photographed.

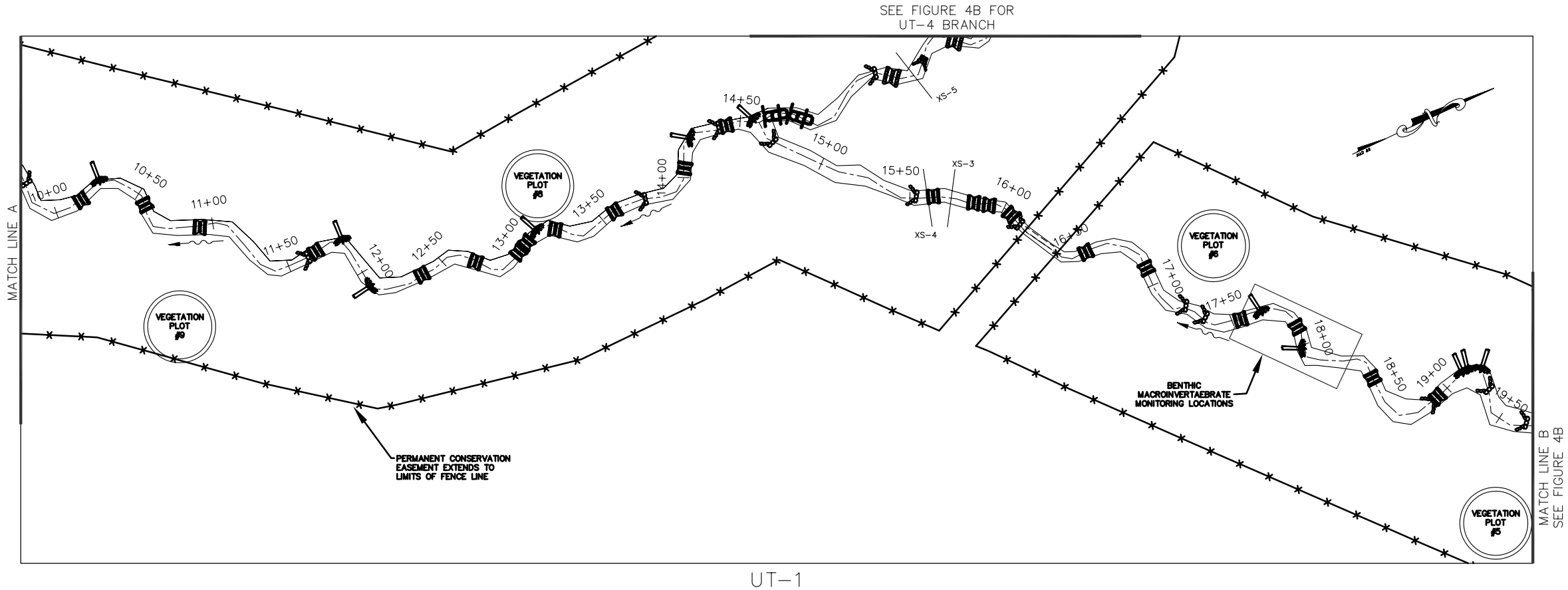
4.3 STREAM MORPHOLOGY MONITORING RESULTS

Photographs were taken throughout the monitoring season to document the evolution of the restored stream channel (see **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.). Throughout the monitoring season, both reaches had a steady flow. Few problems with stream morphology were observed during the monitoring field visit. Throughout the project, many riffle structures were covered with vegetation. Many of the riffle features are collecting small gravel, as expected. Some minor siltation was observed, especially in the pool features, along UT-1. A summary of morphologic



NOTE:
HEAVY VEGETATION IN CHANNEL THROUGHOUT REACH UT1

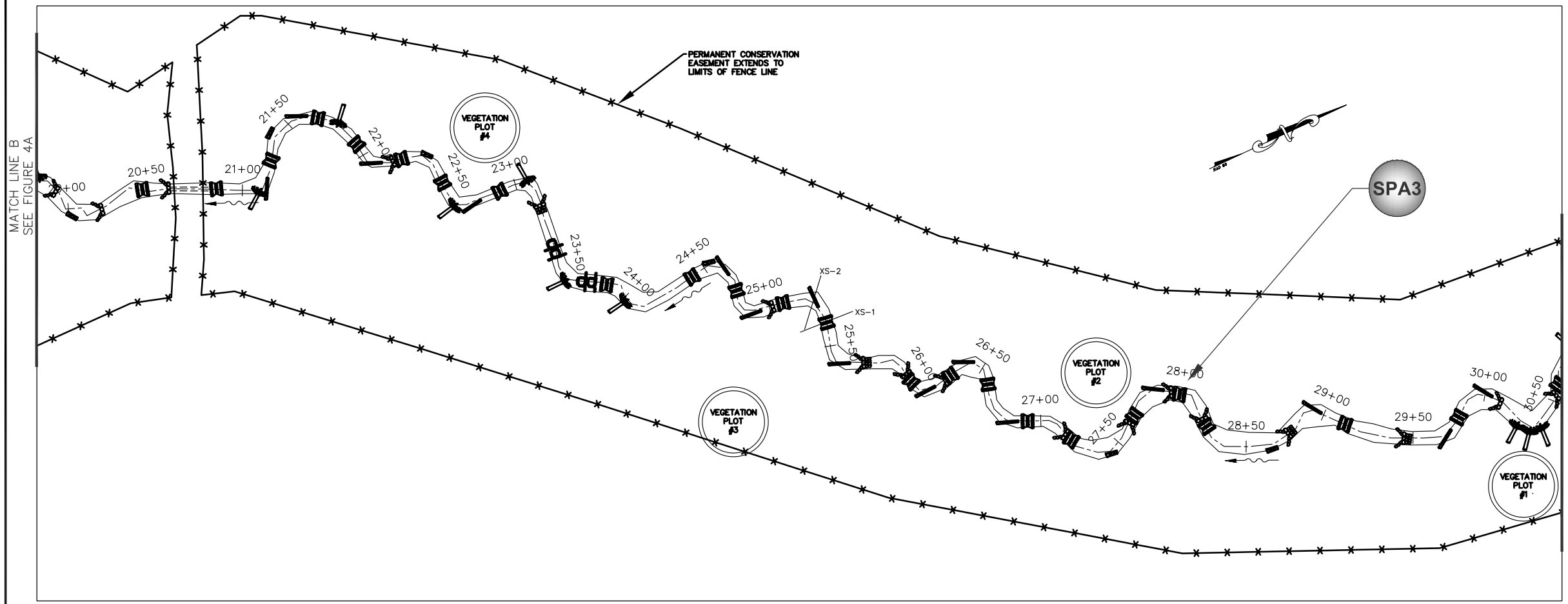
SPA1



Open Springs
Stream Problem Areas

Figure 4A

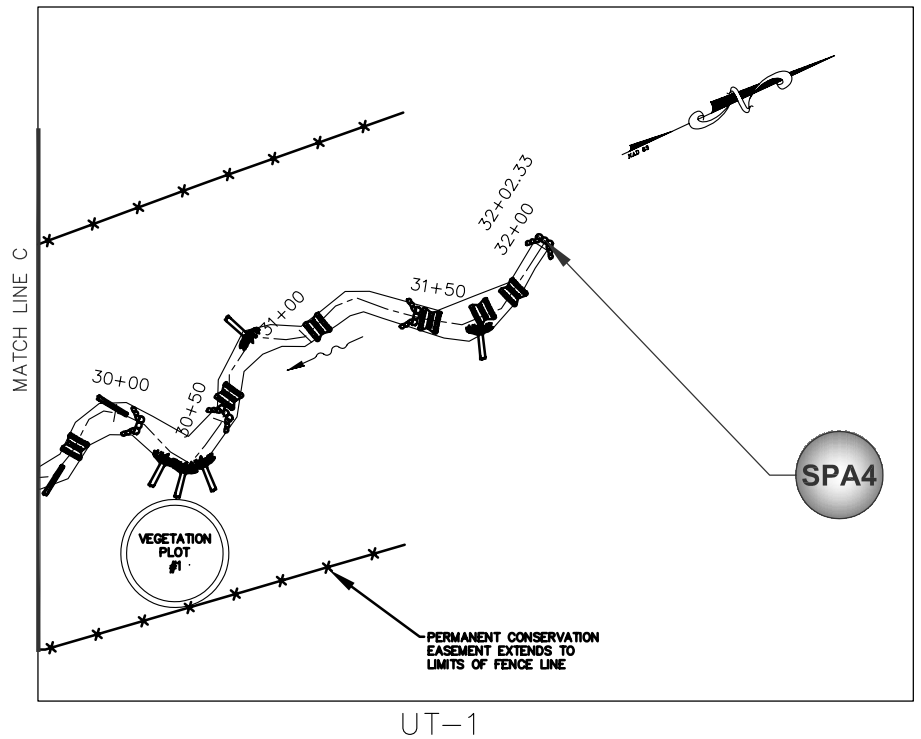
30 15 0 30 60
SCALE (FT)



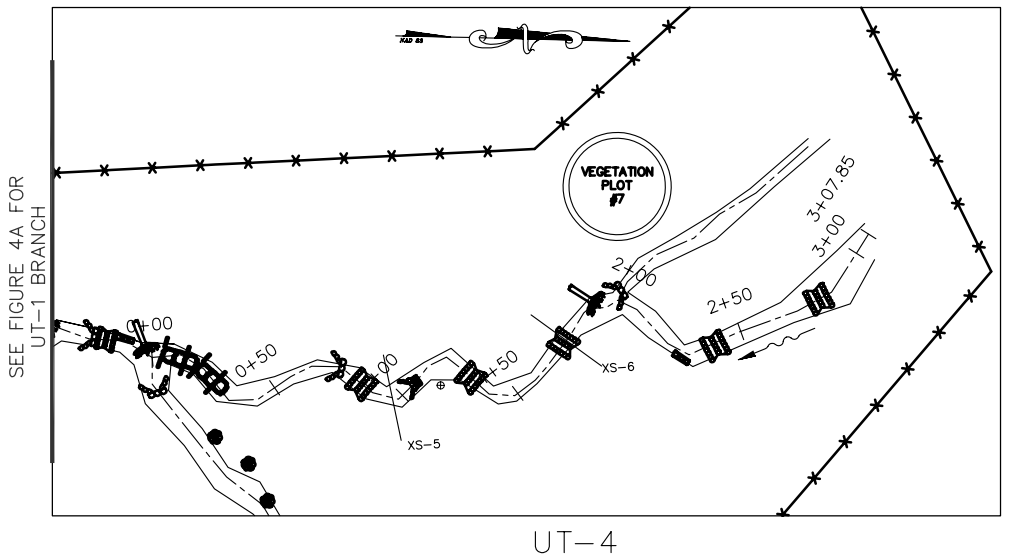
UT-1

NOTE:
HEAVY VEGETATION IN CHANNEL THROUGHOUT REACH UT4

SPA5



UT-1



UT-4

Open Springs
Stream Problem Areas

Figure 4B

30 15 0 30 60
SCALE (FT)

monitoring parameters is provided in **Tables 8a and 8b**. **Table 9** lists stream areas requiring further observation, as well as the station and description of the noted areas. Photographs of each area requiring observation can be found in **Appendix C**. A plan view drawing of the stream problem areas is provided in **Figure 4**. The drawings show the locations of the following features:

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

Table 8a. Summary of Morphologic Monitoring Parameters – UT1

Parameter	As-Built	Year 5
Bankfull Cross Section Area, Abkf (sq ft)	7.9	7.9
Avg. Bankfull Width, Wbkf (ft)	10.0	9.1
Bankfull W/D	13.6	12.0
Bankfull Mean Depth, Dbkf (ft)	0.8	0.8
Bankfull Max Depth, Dmax (ft)	1.4	1.4

Table 8b. Summary of Morphologic Monitoring Parameters – UT4

Parameter	As-Built	Year 5
Bankfull Cross Section Area, Abkf (sq ft)	5.7	5.6
Avg. Bankfull Width, Wbkf (ft)	9.8	7.8
Bankfull W/D	17.2	11.1
Bankfull Mean Depth, Dbkf (ft)	0.6	0.7
Bankfull Max Depth, Dmax (ft)	1.1	1.2

Table 9. Stream Areas Requiring Observation

Feature Issue	STA	Suspected Cause/Suggestion	Photo Number
Vegetation in channel	UT1 Throughout Channel	Siltation, no action is required	SPA1
Cross Weir	UT1 8+65	Rocks have been displaced and minor erosion has occurred; vegetation has stabilized banks, no action is required	SPA2
Riffle Grade Control/Cross Weir	UT1 28+00	Header rock has been displaced; banks and upstream grade control are stable, no action is required	SPA3
Cross Weir	UT1 32+02	Rock has been displaced; banks are stable, no action is required	SPA4
Vegetation in channel	UT4 Throughout Channel	Siltation, no action is required	SPA5

4.3.1 Cross Sections

The cross sections were surveyed during Year 5 monitoring activities in July 2009. Year 5 monitoring cross sections are shown with baseline cross sections, and Year 1, Year 2, Year 3, and Year 4 monitoring cross sections in **Appendix B**. There was very little difference between the Year 5 monitoring cross sections and the As-built, Year 1, Year 2, Year 3, and Year 4 monitoring cross sections.

4.3.2 Longitudinal Profile

The baseline longitudinal profiles were derived from the As-Built survey data. Profiles were resurveyed during Year 5 monitoring activities in July 2009. The Year 5 monitoring profile is shown with the baseline profile in **Appendix B**. Very little difference between the baseline profile and the monitoring Year 5 profile was observed.

4.3.3 Hydrology

During each visit to the site, the crest gauges were read. This was done February-August of 2009. At least three out-of-bank or bankfull events occurred during this period on UT-1, and five on UT-2. Crest gauge data are included in **Table 10**. Weather data were collected from a nearby weather station - Asheboro 2 W (310286). These data are summarized in **Table 11** and **Figure 5**, and indicate that a rainfall deficit is accumulating throughout the year.

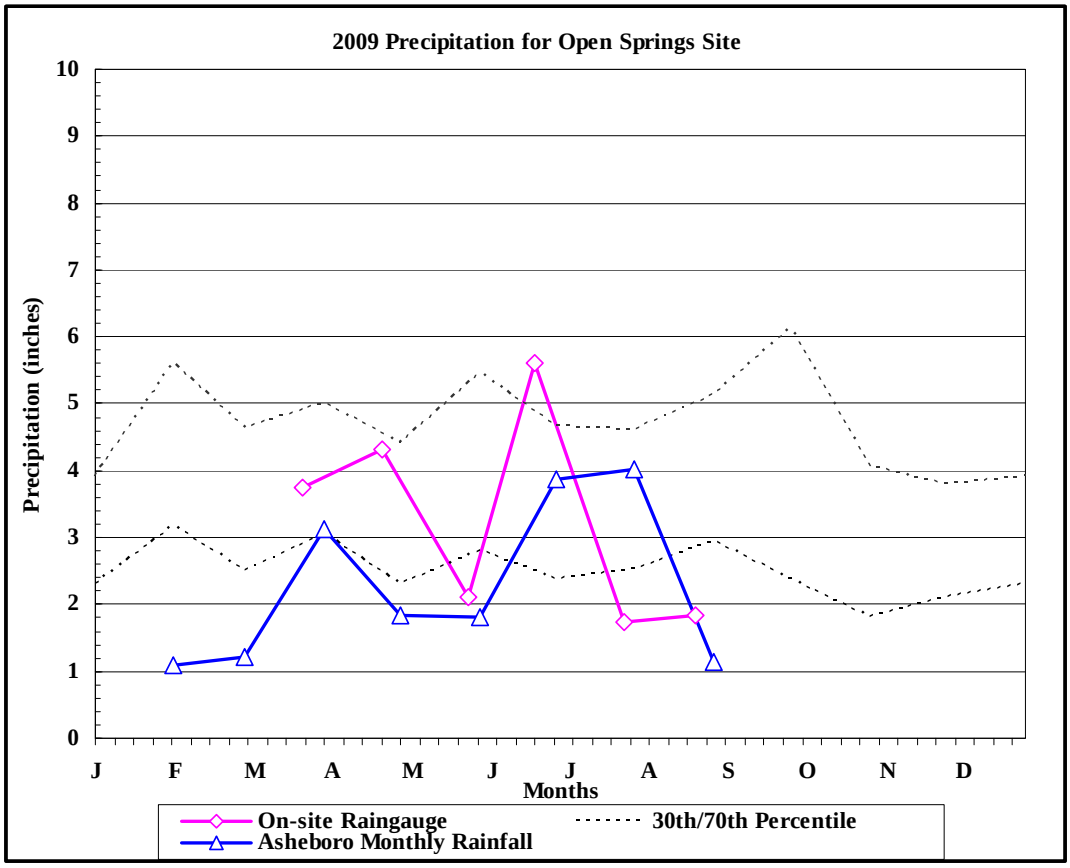
Table 10. Crest Gauge Data

Month Recorded	Crest Gauge - UT1	Crest Gauge - UT2
January	---	---
February	1.45	0.50
March	0.60	1.60
April	1.00	1.60
May	0.00	0.00
June	0.00	1.60
July	0.00	0.00
August	0.00	0.90
September	---	---
October	---	---
November	---	---
December	---	---

Table 11. Randolph County and On-site Rainfall Data

Month	Average	Normal Limits		Asheboro Precipitation	On-Site Precipitation
		30 Percent	70 Percent		
January	4.44	3.17	5.6	1.09	---
February	3.71	2.51	4.63	1.21	---
March	4.27	3.06	5.01	3.13	3.75
April	3.49	2.31	4.42	1.84	4.32
May	4.25	2.8	5.46	1.82	2.10
June	3.97	2.39	4.67	3.87	5.60
July	4.12	2.52	4.61	4.02	1.73
August	4.26	2.95	5.14	1.14	1.83
September	4.31	2.39	6.13	---	---
October	3.59	1.82	4.07	---	---
November	3.16	2.11	3.8	---	---
December	3.26	2.32	3.93	---	---
Annual	---	**42.62**	**50.34**	---	---
Total	**46.82**	---	---	**18.12**	**19.33**

Figure 5. 2009 Precipitation for Open Springs



4.4 STREAM CONCLUSION

The stream morphology is stable, with the site experiencing multiple bankfull events in 2009. Little fluvial erosion was observed, and many of the riffle features are collecting small gravel, as expected. All potential problem areas are minor, and no repairs are recommended. It appears that the site is moving toward stability.

The Open Springs site has recorded many bankfull events over the five year monitoring period. The restored stream channel has remained stable and is providing the intended habitat and hydrologic functions. In-stream structures are stable and functioning as designed. Monitored cross-sections have exhibited little adjustment in stream dimension. There are no stream problem areas requiring repair. All erosion areas are moving toward stability or are normal in a dynamic stream channel. Therefore, it can reasonably be concluded that the site has achieved the success criteria for streams as specified in the Mitigation Plan for the site.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The stream, hydrologic, and vegetation monitoring data for all five monitoring years at the site are summarized in **Tables 12-14**. Based on this data and the other data and comments provided above in Sections 3 and 4, it can be concluded that the site has achieved the stream, hydrologic, and vegetative success criteria specified in the Mitigation Plan.

Table 12. Summary of Stream Crest Gauge Data 2005-2009

	2005	2006	2007	2008	2009
Number of Bankfull Events	5	6	6	8	5†
Maximum Height Above Bankfull (feet)	1.40	2.45	2.30	2.40	1.6

† January – August

Table 13a. Summary of Morphologic Monitoring Parameters 2005-2009 for UT1

Parameter	As-Built	Year 1	Year 2	Year 3	Year 4	Year 5
Bankfull Cross Section Area, Abkf (sq ft)	7.9	8.6	7.9	8.1	7.5	7.9
Avg. Bankfull Width, Wbkf (ft)	10.0	13.4	11.7	9.3	8.9	9.1
Bankfull W/D	13.6	25.6	20.1	11.9	12.2	12.0
Bankfull Mean Depth, Dbkf (ft)	0.8	0.7	0.7	0.8	0.8	0.8
Bankfull Max Depth, Dmax (ft)	1.4	1.5	1.4	1.4	1.5	1.4

Table 13b. Summary of Morphologic Monitoring Parameters 2005-2009 for UT4

Parameter	As-Built	Year 1	Year 2	Year 3	Year 4	Year 5
Bankfull Cross Section Area, Abkf (sq ft)	5.7	6.0	5.2	4.5	5.5	5.6
Avg. Bankfull Width, Wbkf (ft)	9.8	13.3	7.7	7.9	9.9	7.8
Bankfull W/D	17.2	31.6	11.4	14.0	17.7	11.1
Bankfull Mean Depth, Dbkf (ft)	0.6	0.5	0.7	0.5	0.6	0.7
Bankfull Max Depth, Dmax (ft)	1.1	1.1	1.1	1.1	1.3	1.2

Table 14. Summary of Vegetative Monitoring Data 2005-2009

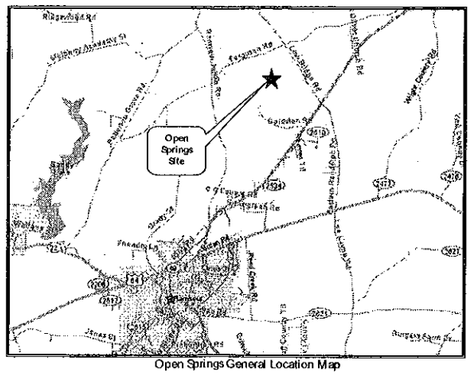
Plot	Planted Stems Per Acre					
	Base	**2005**	**2006**	**2007**	**2008**	**2009**
1	729	729	486	607	567	526
2	688	688	486	526	445	486*
3	729	729	364	526	526	567*
4	810	810	648	810	810	810
5	688	688	607	607	607	607
6	850	850	729	729	688	688
7	769	769	324	607	688	688*
8	648	648	648	648	648	648
9	769	769	162	202	486	445
10	405	405	283	283	324	324
11	567	567	567	607	567	567
12	769	769	162	405	486	445
Average	**702**	**702**	**455**	**547**	**570**	**567**
* Resprouts observed in 2009.						

APPENDIX A

As-Built Survey

OPEN SPRINGS STREAM
AS-BUILT PLANS

July 07, 2005



Open Springs General Location Map

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ENVIRONMENTAL RIGHTS

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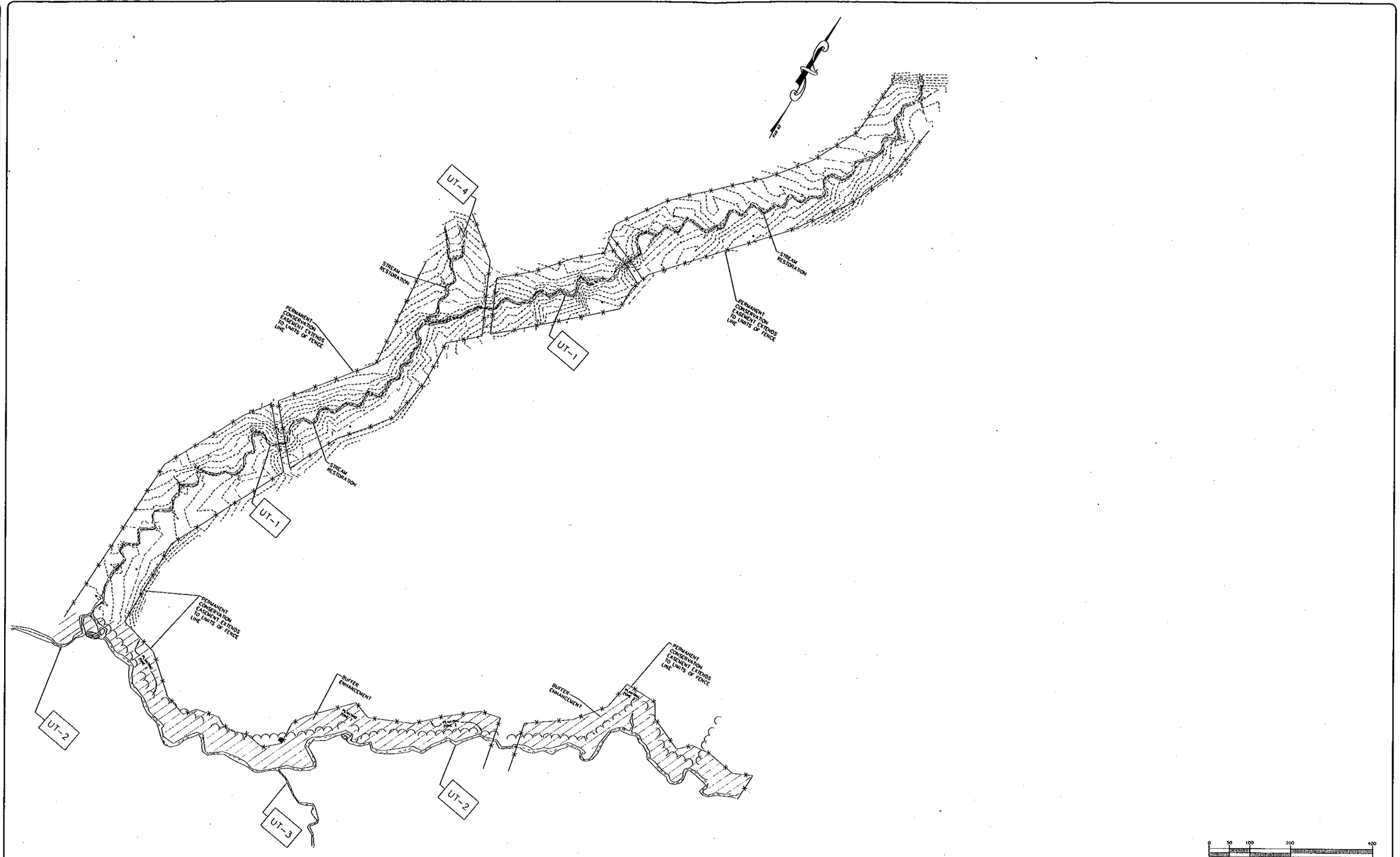

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APPROVED BY: JMK	PROJECT NUMBER: 30440.00.RA
FILE NAME: design-layout	PLOT DATE: 07/26/05

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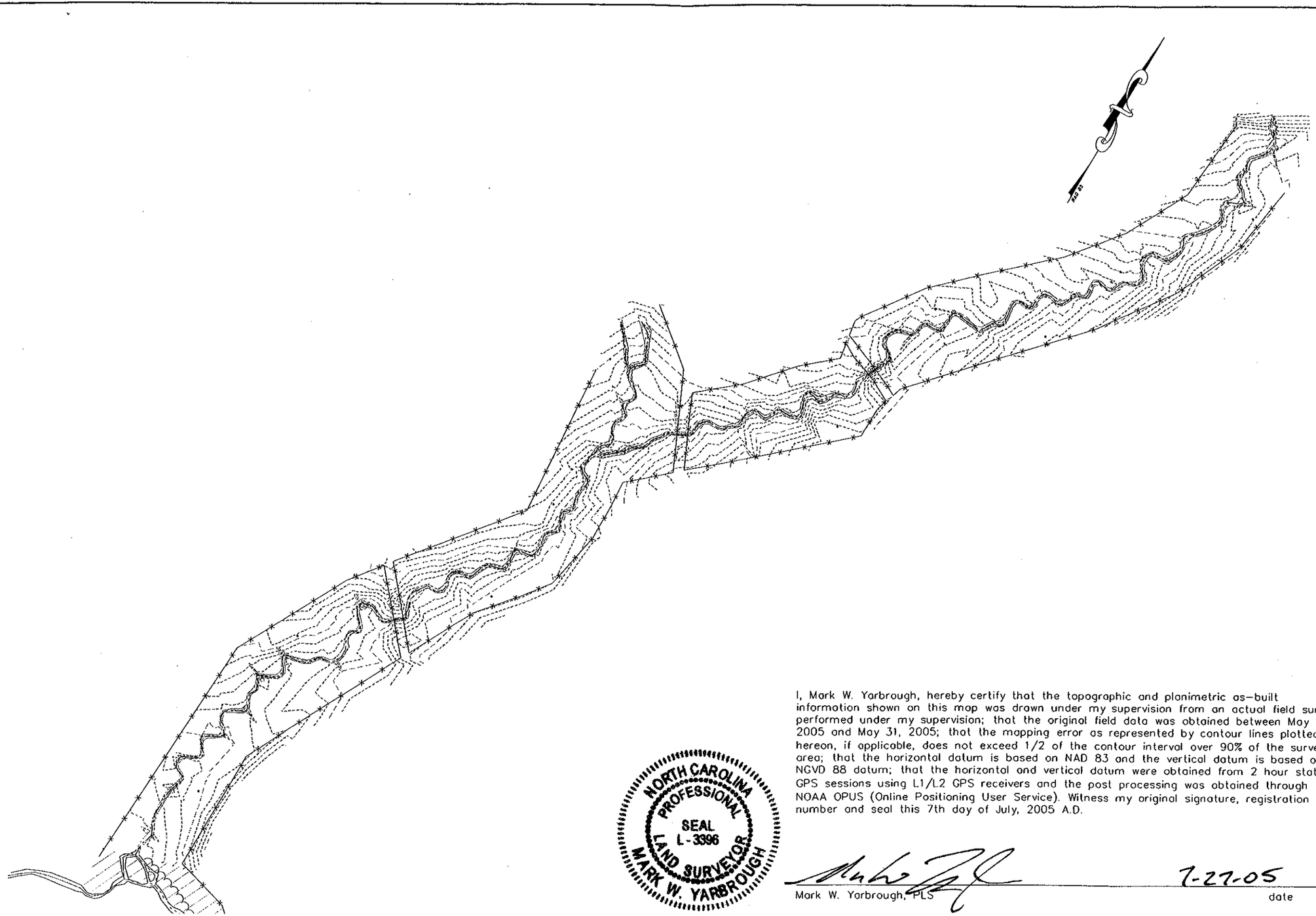
OPEN SPRINGS ASBUILT PLANS
PROJECT SITE

1/6



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 May 18, 2005 and May 31, 2005; 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 7th day of July, 2005 A.D.

NORTH CAROLINA PROFESSIONAL SEAL L-3396 LAND SURVEYOR MARK W. YARBROUGH

Mark W. Yarbrough, PLS — 7-27-05 date

0 40 80 160 320
SCALE

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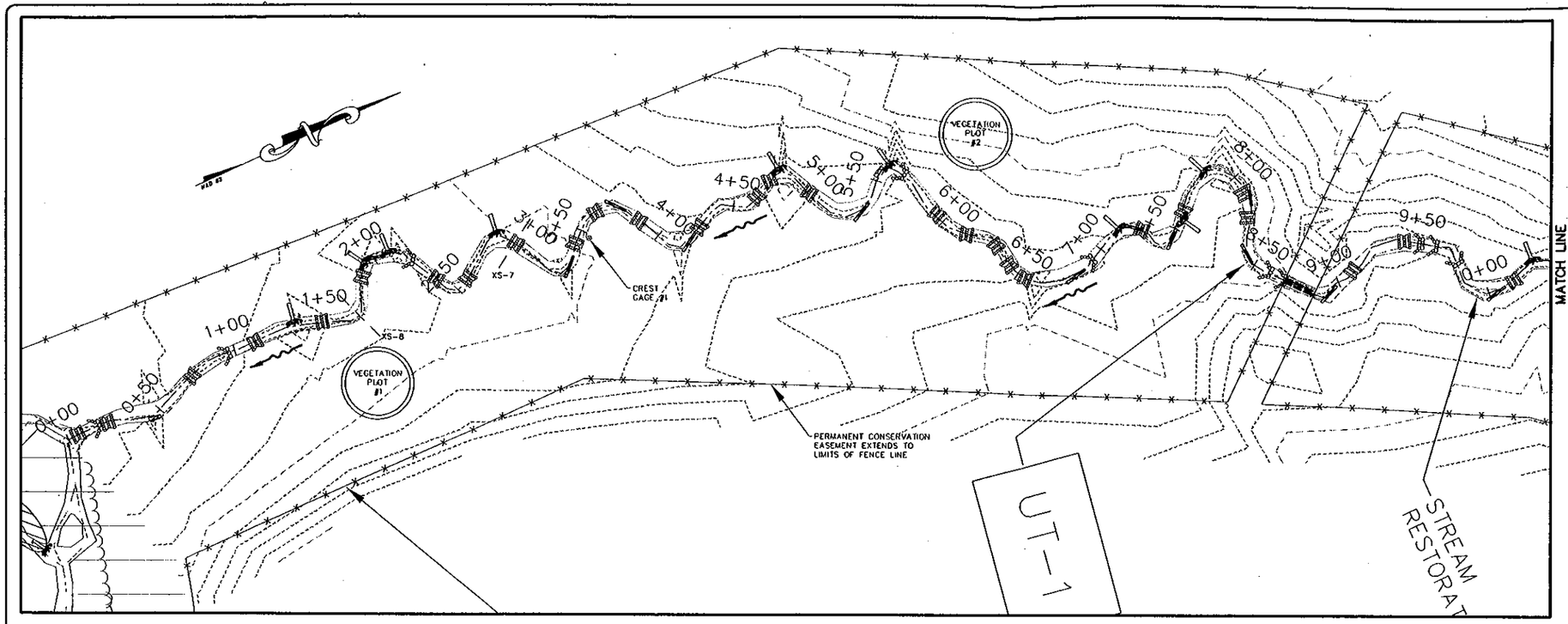
OPEN SPRINGS ASBUILT PLANS
STREAM MITIGATION AS-BUILT SURVEY

2/6



UT-1

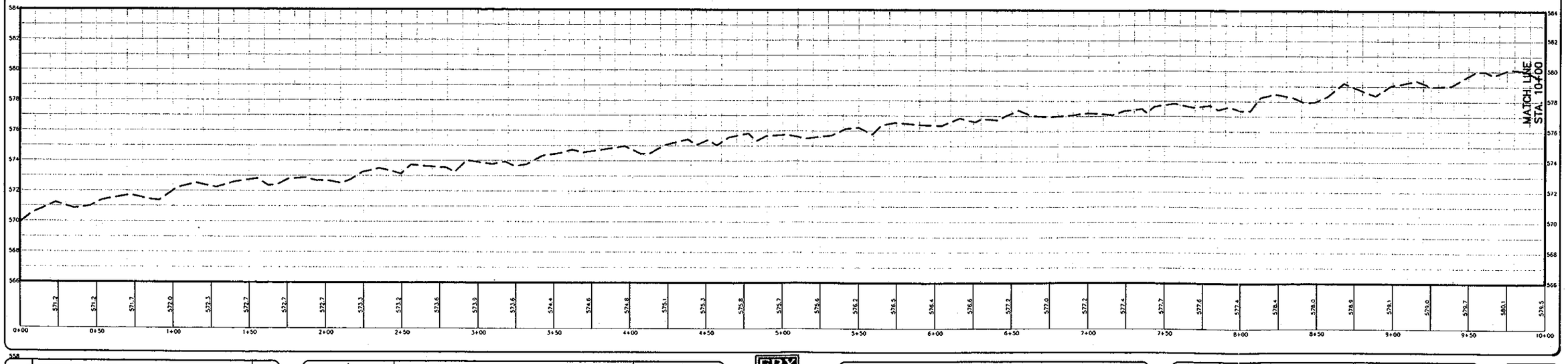
LEGEND

EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
- LOG TOE PROTECTION
- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR

0 15 30 60 120
HORZ SCALE

0 3 6 12
VERT SCALE



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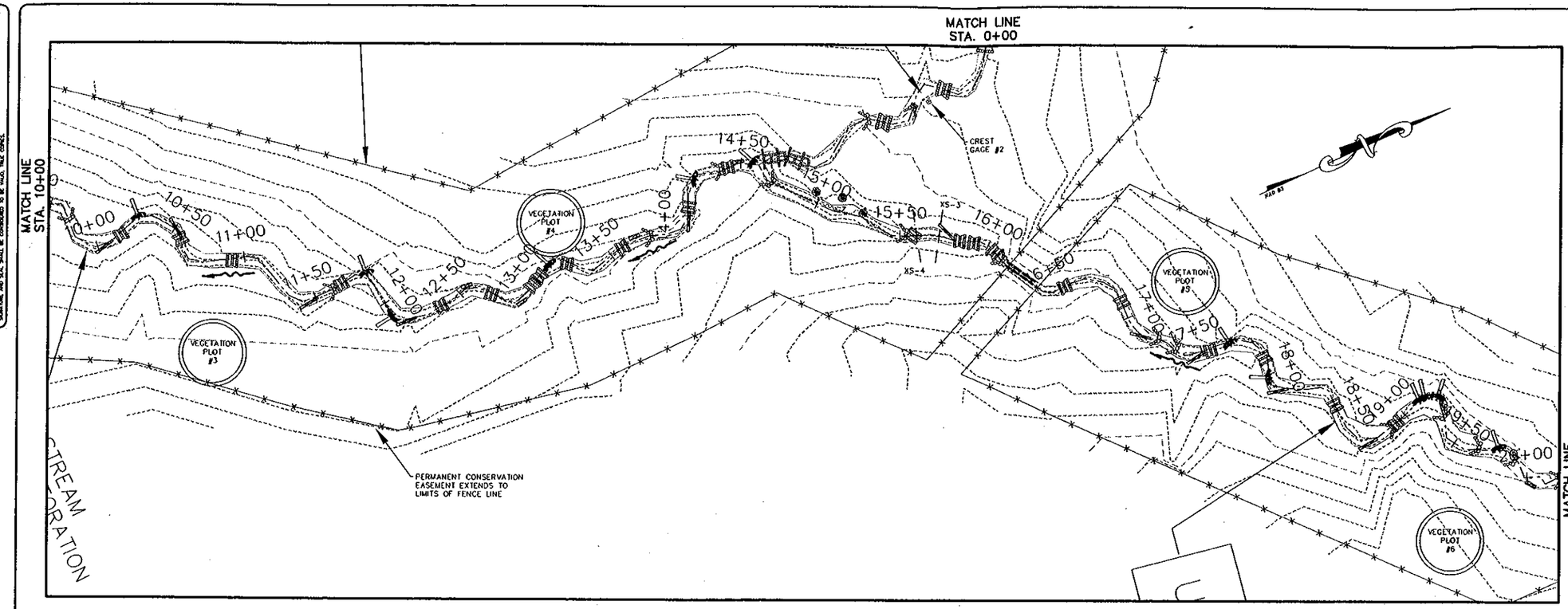
OPEN SPRINGS ASBUILT PLANS
UT-1 STA. 0+00 TO STA. 10+00

3/6



UT-1

LEGEND

EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL

- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
- LOG TOE PROTECTION
- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR

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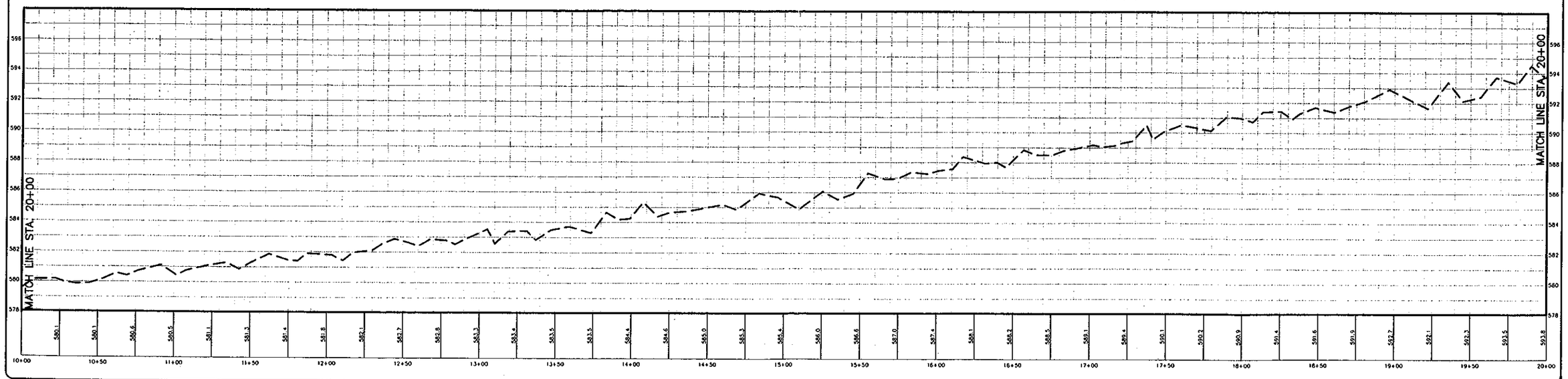
VERT SCALE: 0 3 6 12



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PLOT DATE	07/28/05

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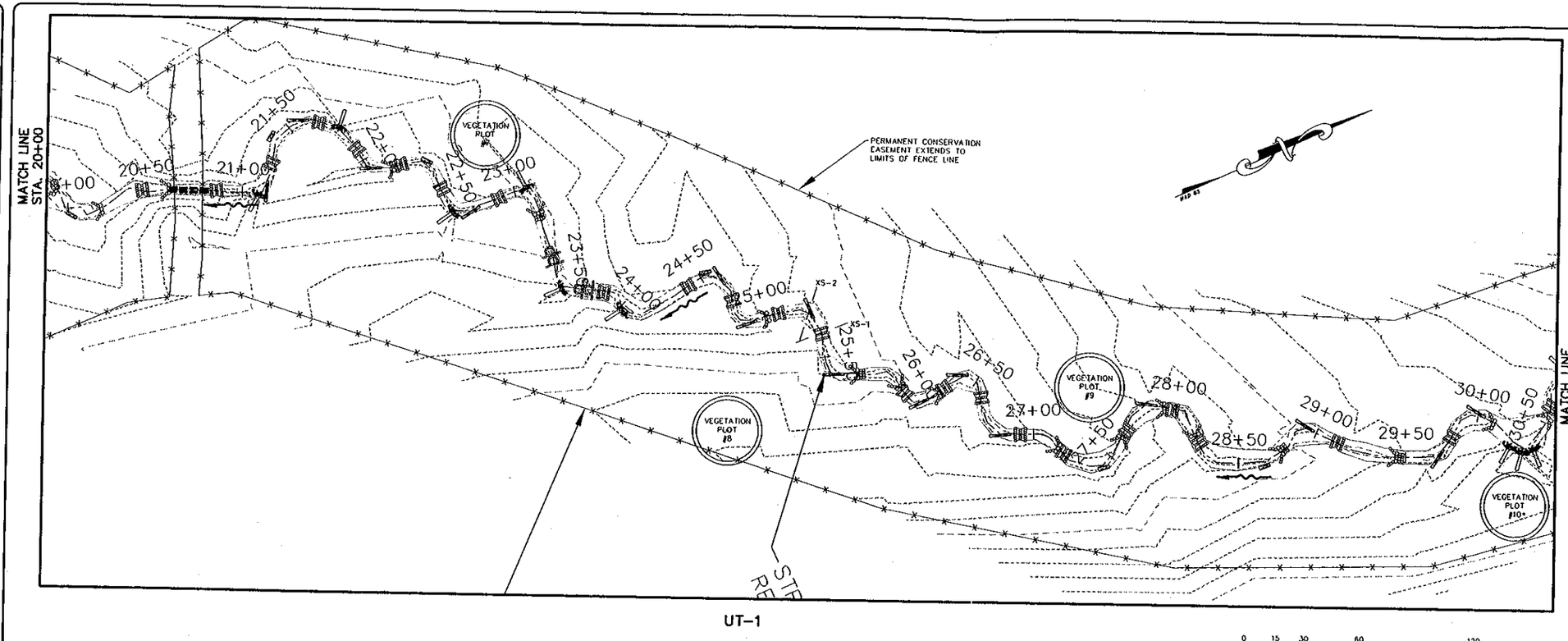
OPEN SPRINGS ASBUILT PLANS

UT-1 STA. 10+00 TO STA. 20+00



UT-1

LEGEND

EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
- LOG TOE PROTECTION
- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR

HORZ SCALE: 0, 15, 30, 60, 120

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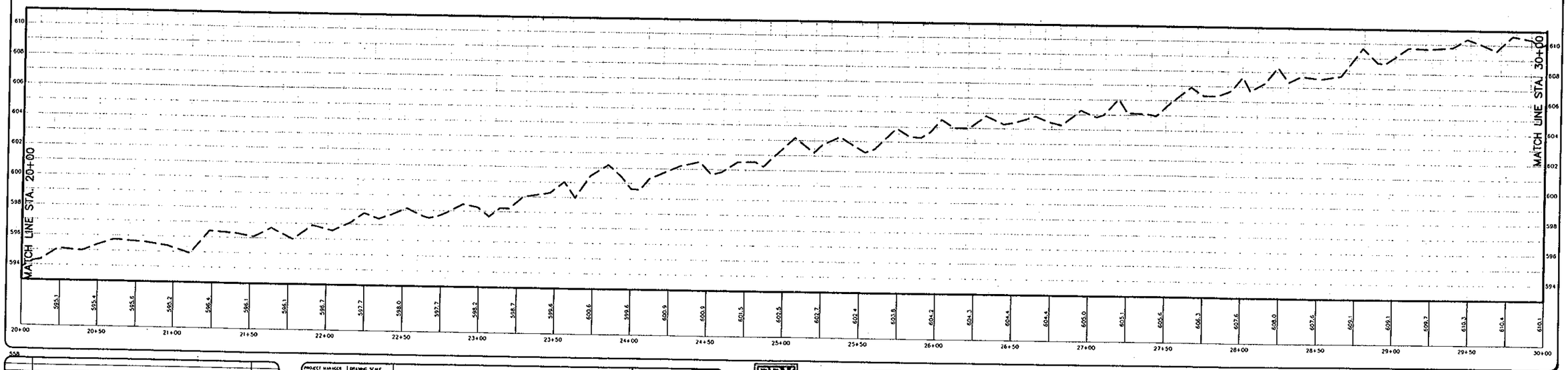

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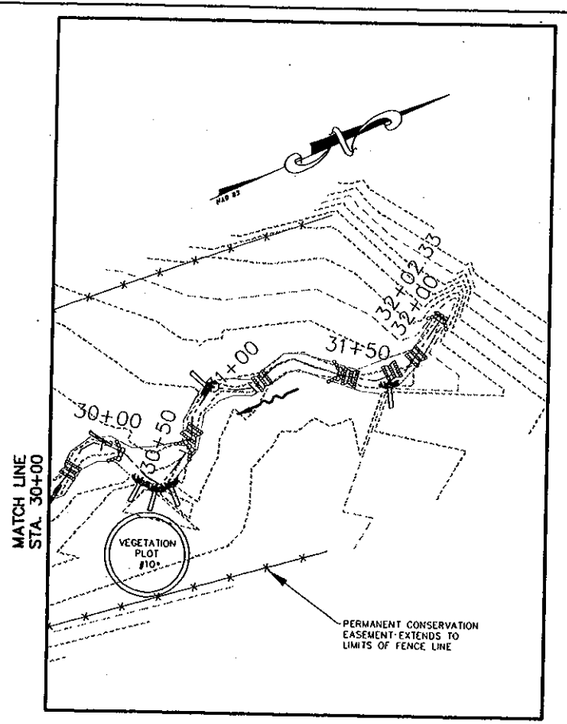
OPEN SPRINGS ASBUILT PLANS
UT-1 STA. 20+00 TO STA. 30+00



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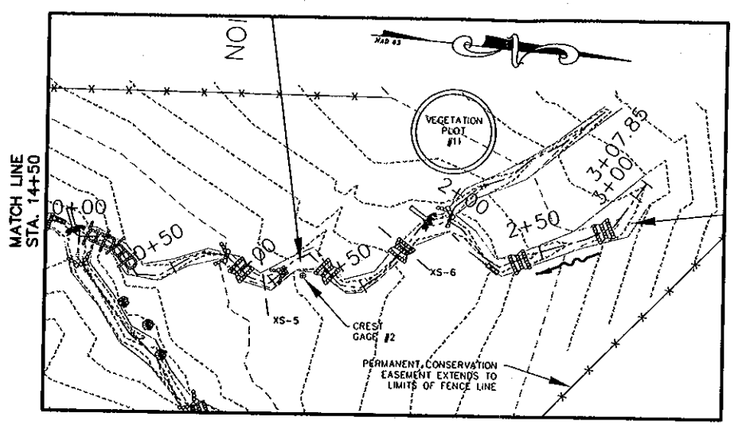

UT-4

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- MINOR CONTOUR
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- LIMITS OF BANKFULL CHANNEL

- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
- LOG TOE PROTECTION
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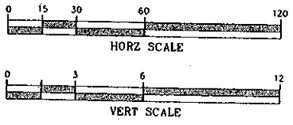
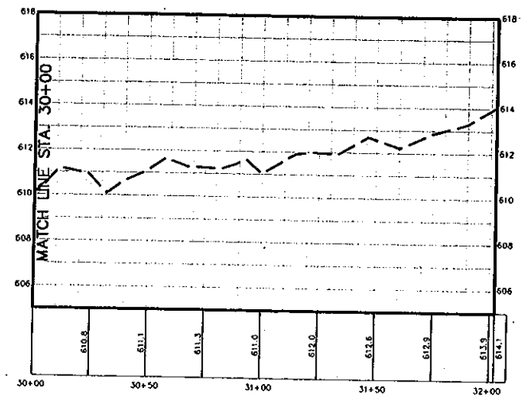
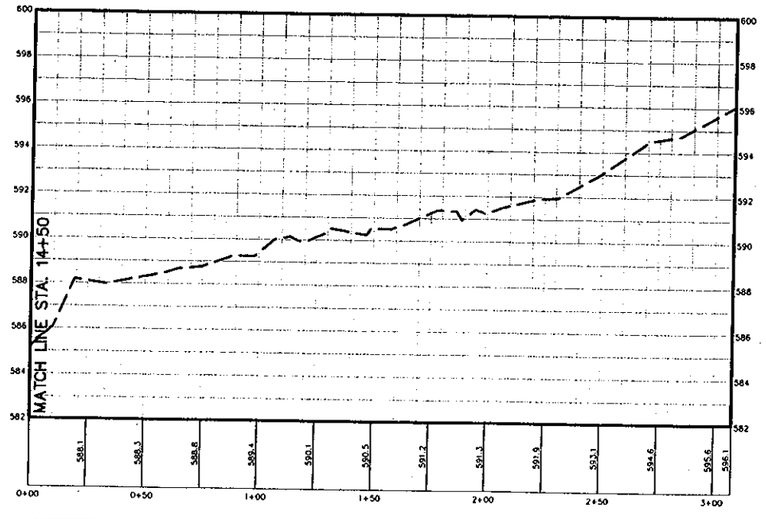
- STEP POOL
- CROSS WEIR







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DRAWING SCALE	1" = 30'
PROJECT DATE	05/31/2005
PROJECT NUMBER	3044.00.RA
AS OF DATE	07/28/05

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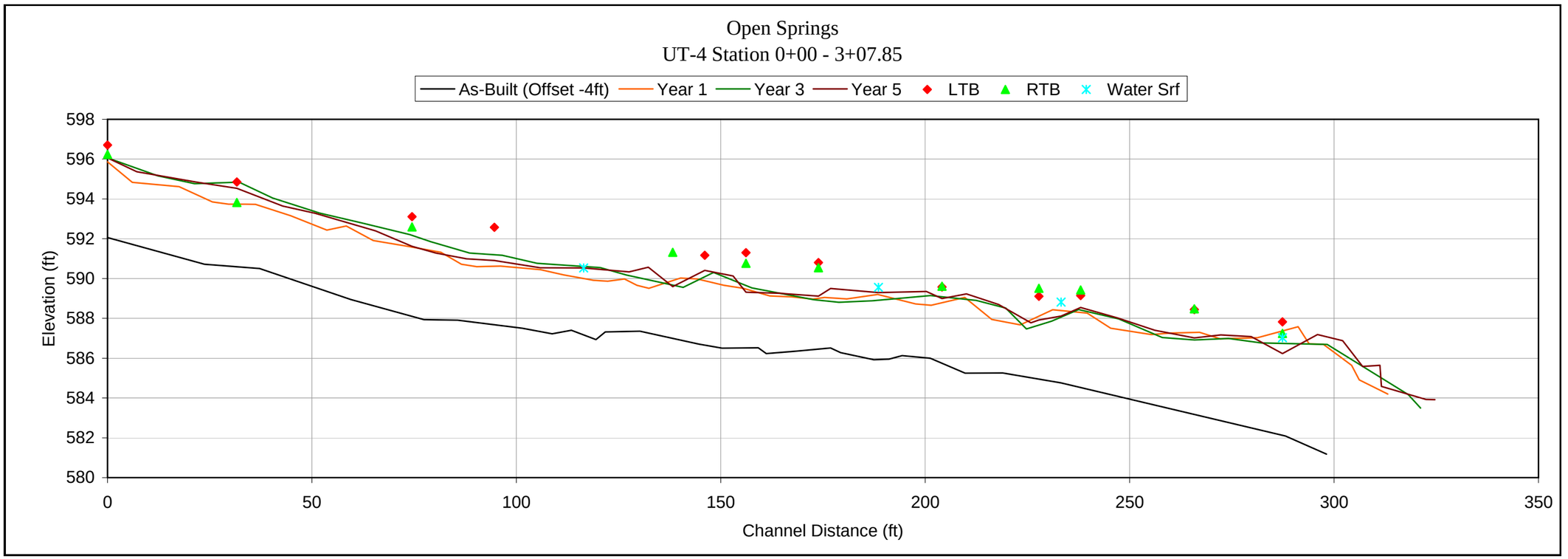
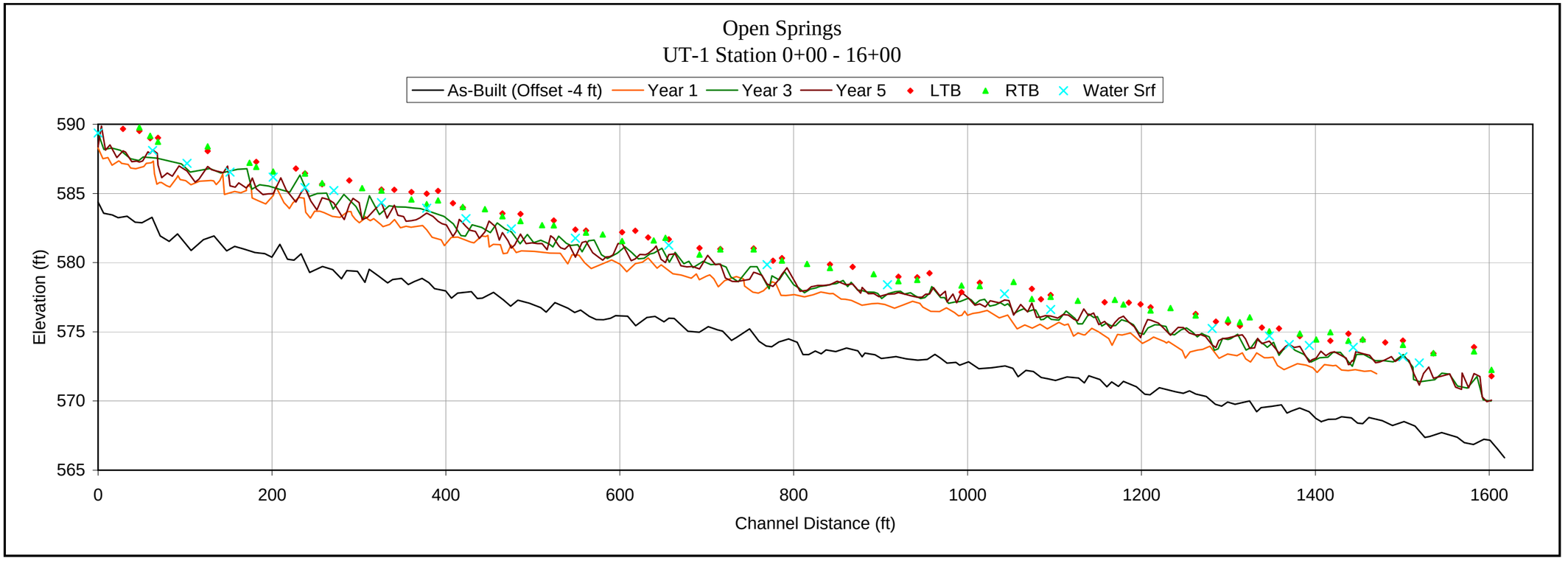
UT-1 STA. 30+00 TO STA. 32+02.33
UT-4 STA. 0+00 TO STA. 3+07.85

6/6

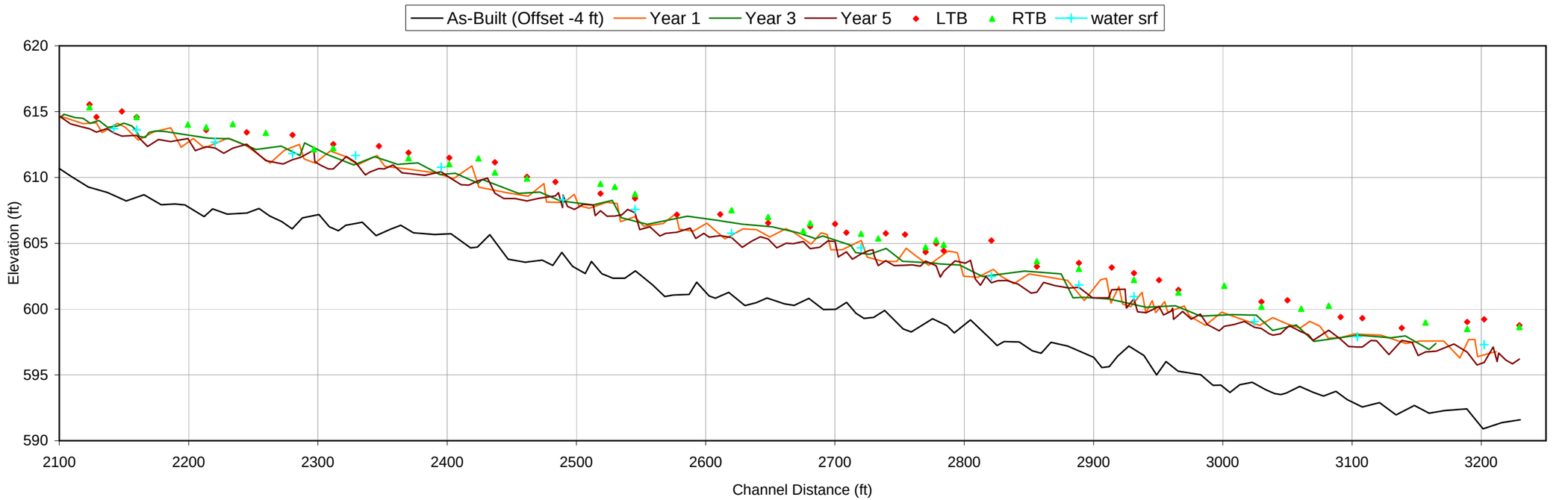
APPENDIX B

2009 Profile and Cross Section Data


Open Springs
UT-4 Station 0+00 - 3+07.85
As-Built (Offset -4ft)
Year 1
Year 3
Year 5
LTB
RTB
Water Srf
Elevation (ft)
598
596
594
592
590
588
586
584
582
580
0
50
100
150
200
250
300
350
Channel Distance (ft)

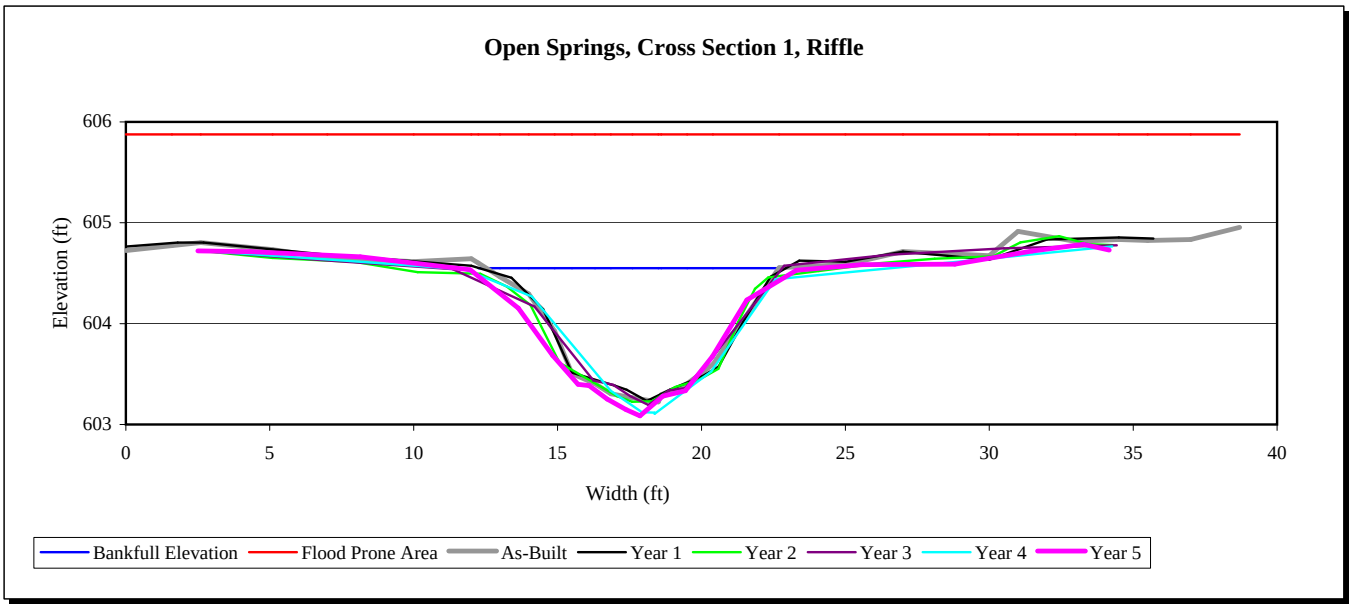

Open Springs
UT-1 Station 0+00 - 16+00
As-Built (Offset -4 ft)
Year 1
Year 3
Year 5
LTB
RTB
Water Srf
590
585
580
575
570
565
Elevation (ft)
0
200
400
600
800
1000
1200
1400
1600
Channel Distance (ft)

Open Springs
UT-1 Station 21+00 - 32+02.33



Left bank

Right bank



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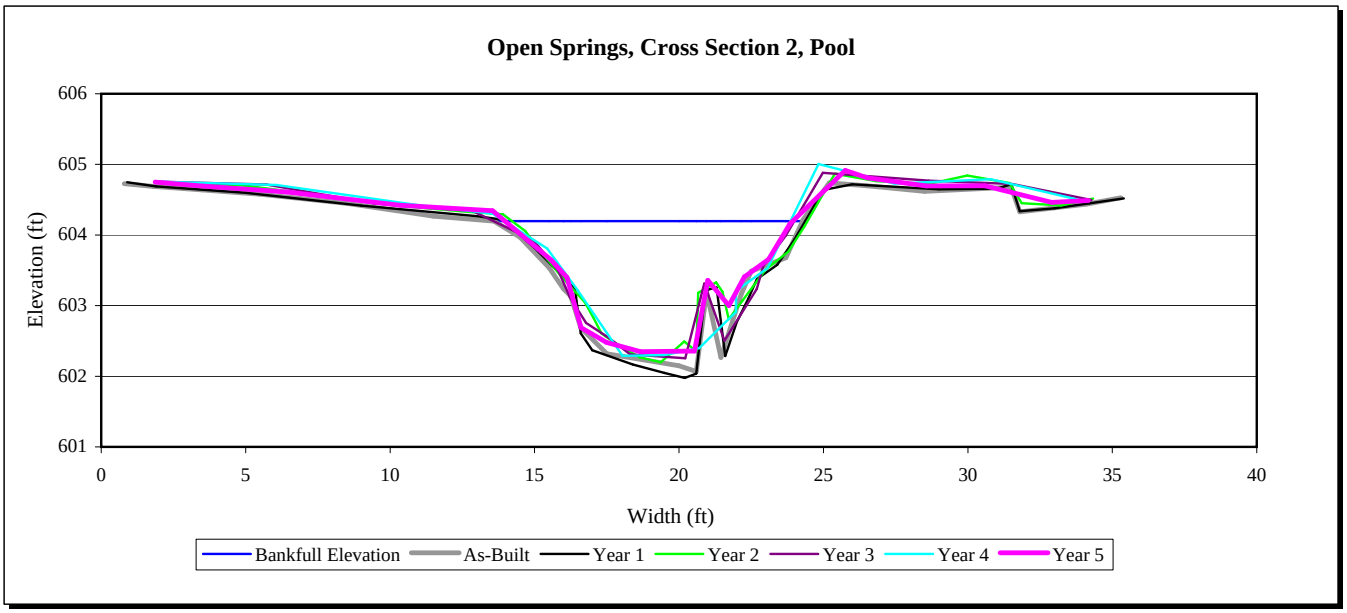
Right bank



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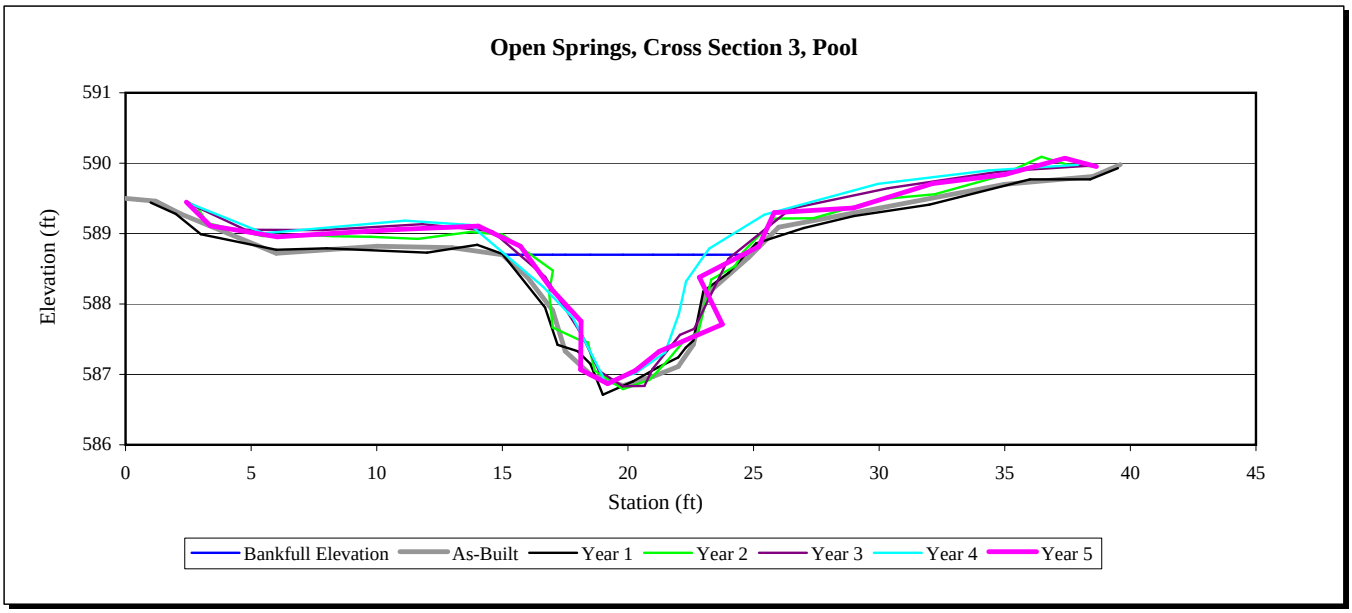
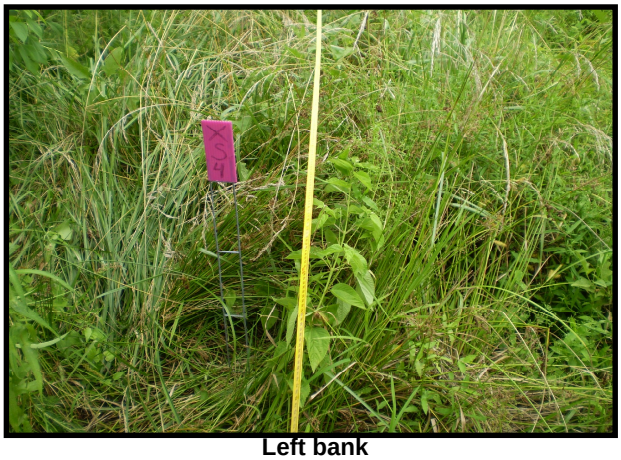
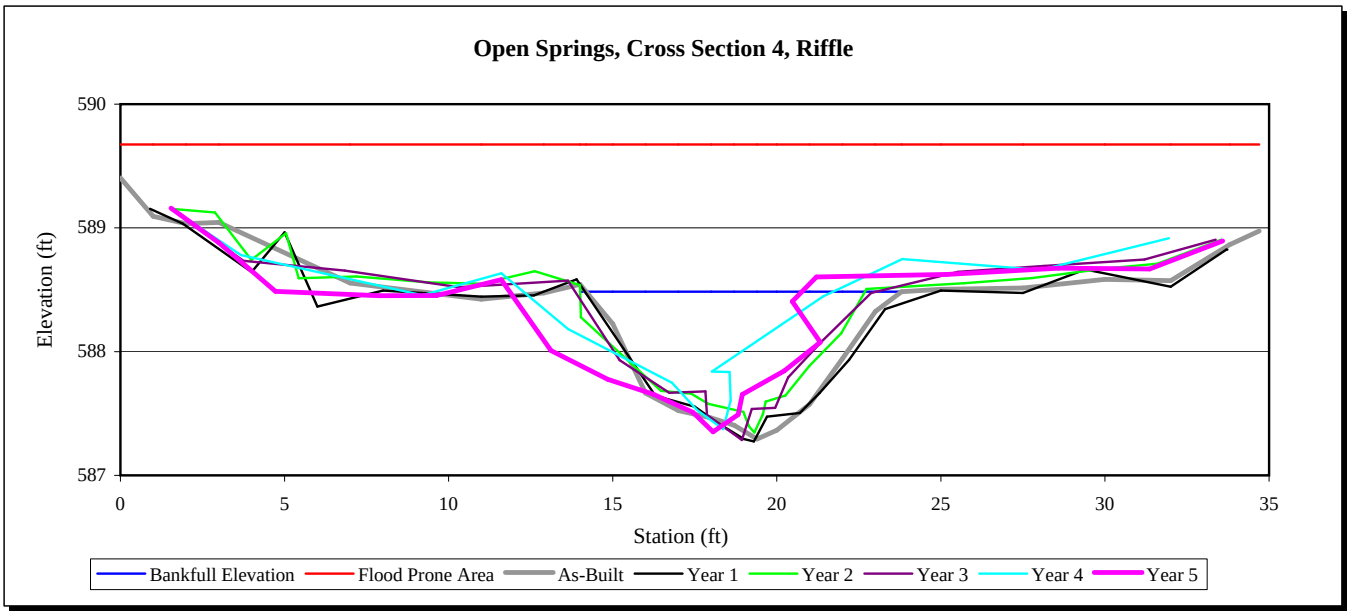
Right bank





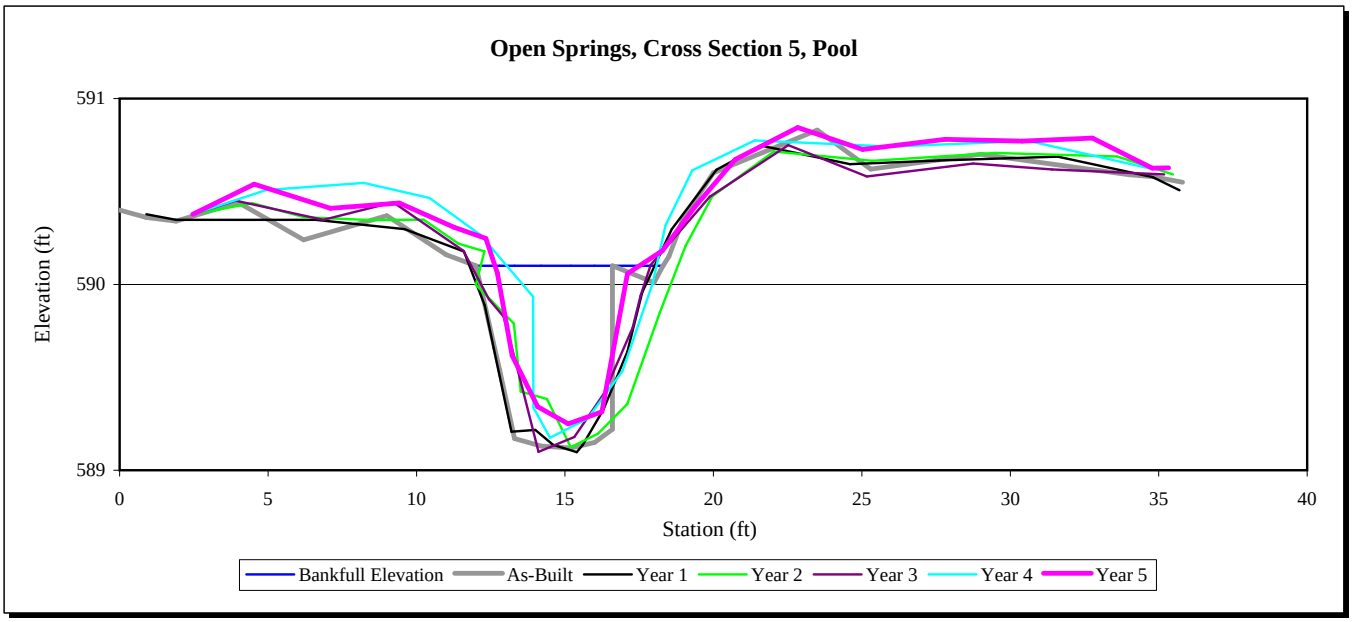
Left bank

Right bank



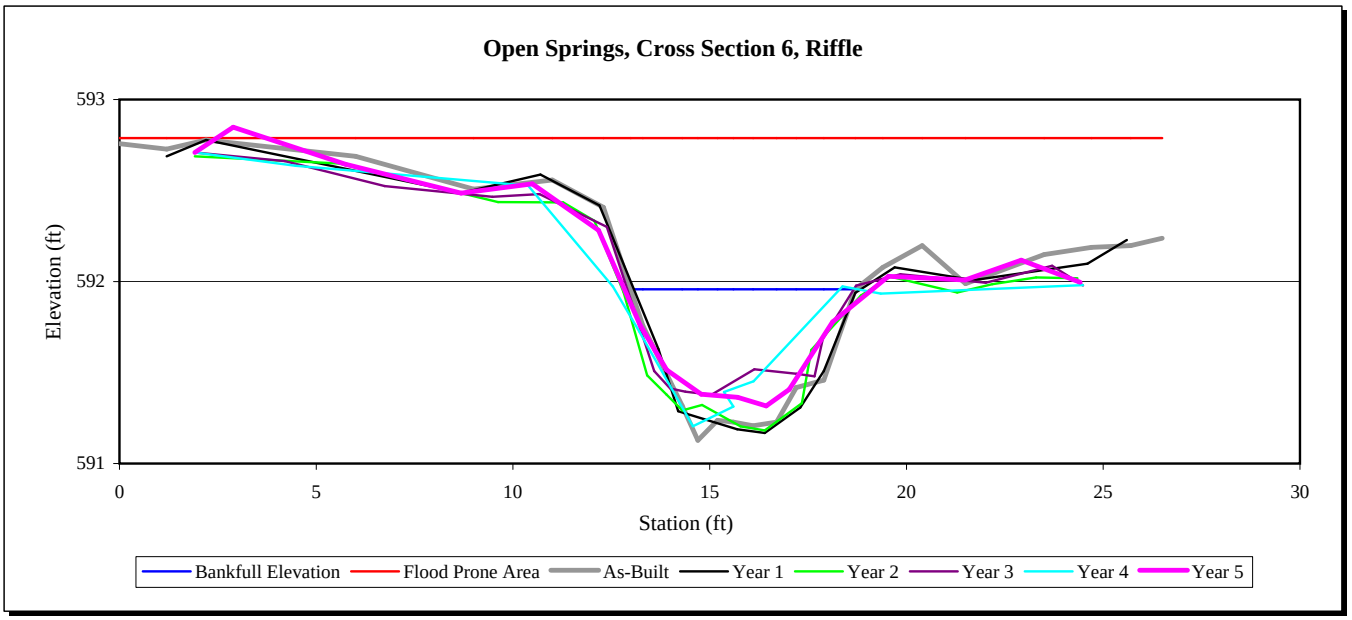
Left bank

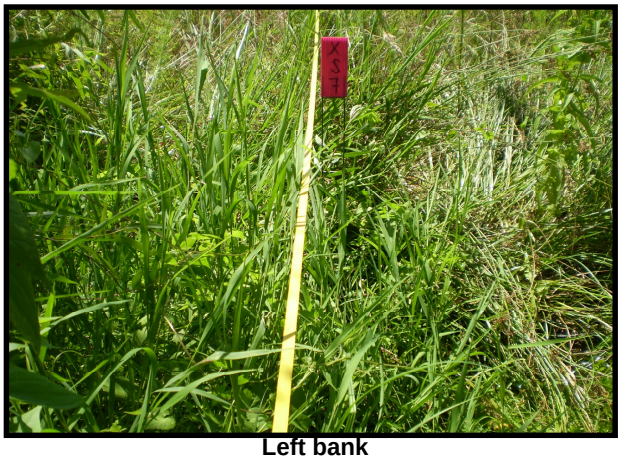
Right bank



Left bank

Right bank





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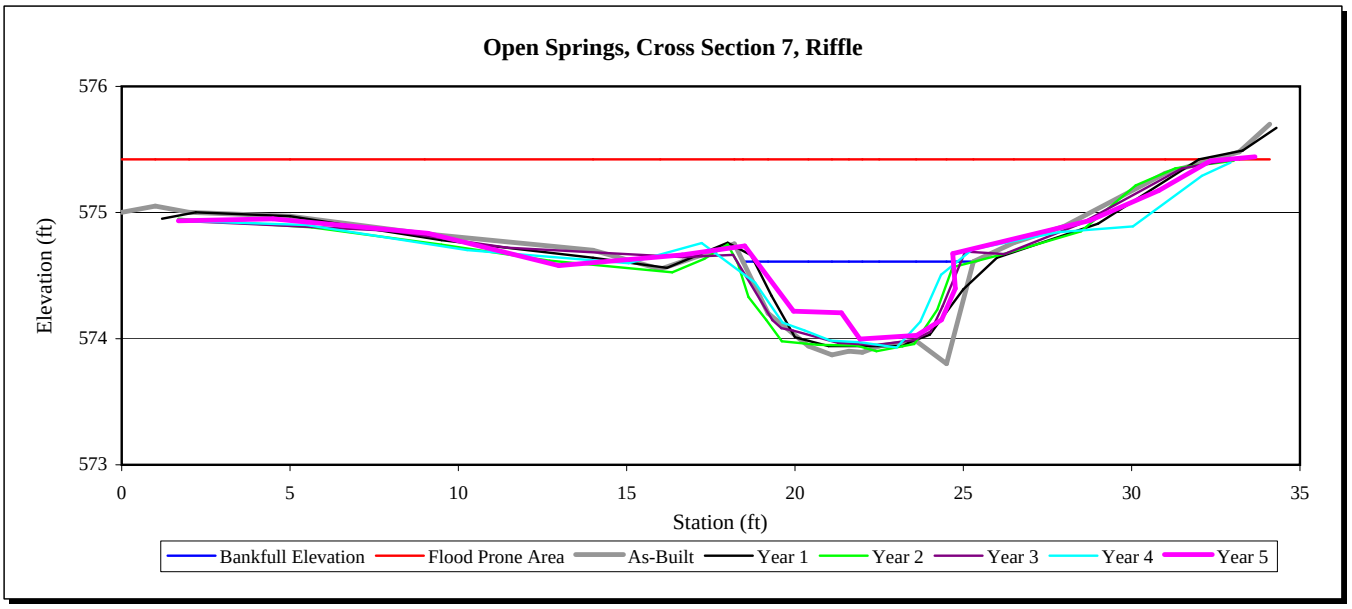
Right bank



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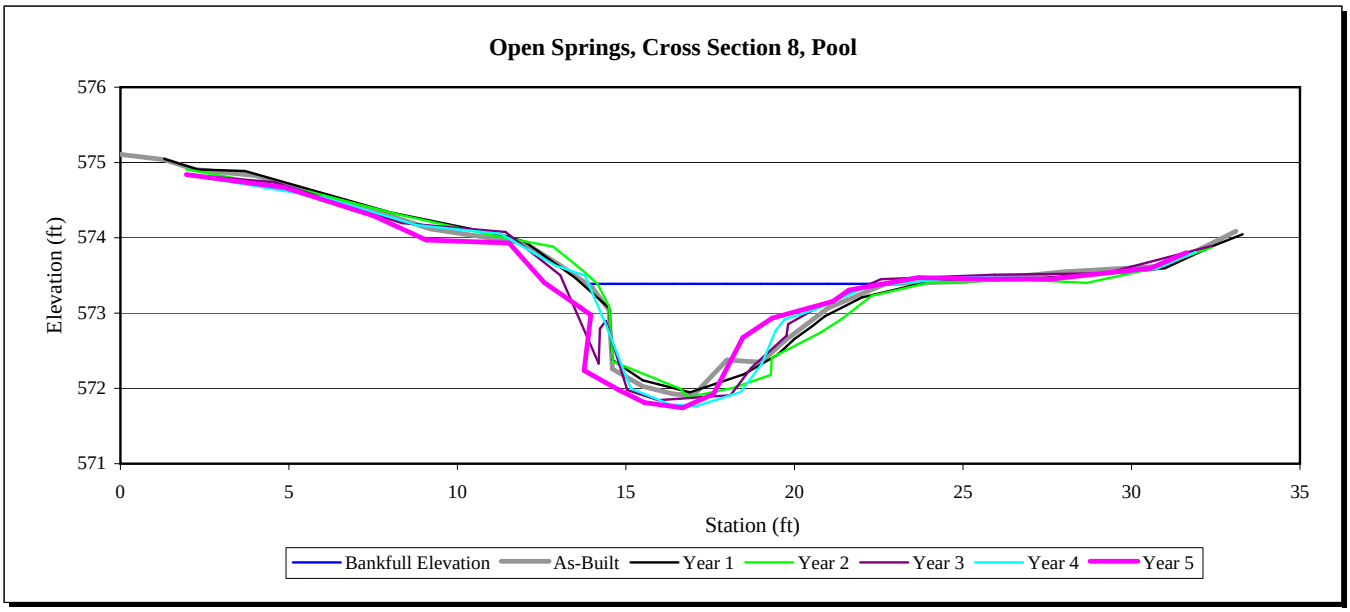
Right bank



APPENDIX C

2009 Site Photos

Stream Problem Area Photos

SPA 1 – Vegetation in channel, throughout UT1.

SPA 2 – Rocks displaced at cross weir, UT1 Sta. 8+65.

SPA 3 – Header rock on cross weir displaced, UT1 Sta. 28+00.

SPA 4 – Rock on cross weir displaced, UT1 Sta. 32+02.

SPA 5 – Vegetation in channel, throughout UT4.

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

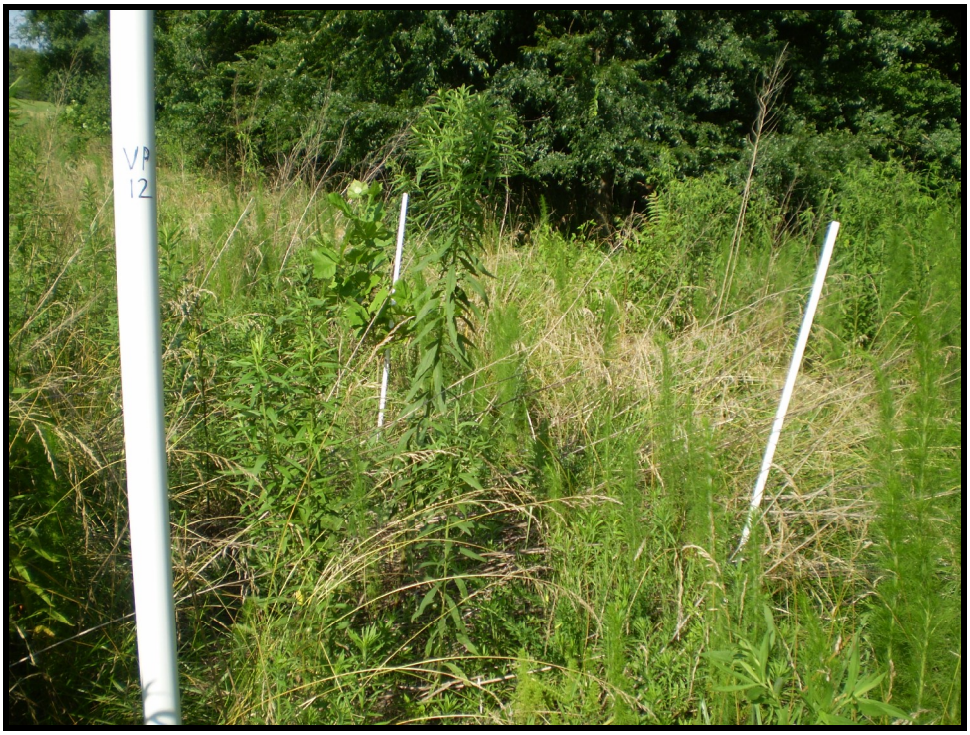
Vegetation Plot #10 – upstream

Vegetation Plot #10 – downstream

Vegetation Plot #11 – upstream

Vegetation Plot #11 – downstream

Vegetation Plot #12 – upstream



Vegetation Plot #12 – downstream