Year 5 Monitoring Report

Tulula Stream & Wetland Restoration

March 2008
EEP Project No. 392

Prepared for

Ecosystem Enhancement PROGRAM

NCEEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

Table of Contents

I. Executive Summary / Project Abstract

This report summarizes the monitoring efforts for Year 5 (2007) of the Tulula Stream and Wetland Restoration, located in Graham County, NC. Monitoring was performed by Soil & Environmental Consultants, PA (S&EC) of Raleigh, NC.

Monitoring of the restored vegetated buffer was performed during the growing season and included stem counts within the established vegetation monitoring plots. Counts revealed an average live stem density of approximately 410 stems per acre, indicating vegetative success.

In the late Fall of 2007, the stream channel was surveyed, and a visual stability assessment was performed for the project. Beaver activity along the restoration reach continues to be a problem. The area affected by this activity has increased over that observed by S&EC in 2006. According to EEP, additional control and dam removal efforts are being implemented by the agencies wildlife control contractor to remove beaver from the site and remove remnant dam materials. While there are several problem areas along the restored channel, the overall channel appears stable and successful. 2007 serves as Year 5 Monitoring and we understand will be the final year of monitoring for the Tulula restoration site.

An assessment of the general success of the wetland was performed during monthly visits that occurred from January through December, 2007. Groundwater gauges were downloaded monthly and data compiled. Twenty (20) of the twenty-nine (29) gauges onsite achieved wetland success criteria of saturation for 12.5% of the growing season (29 days).

II. Project Background

The background information for this report was obtained from previous monitoring reports submitted to the North Carolina Ecosystem Enhancement Program (NCEEP) by the Office of Natural Environment & Roadside Environmental Unit of the North Carolina Department of Transportation (NCDOT).

A. Location and Setting

The Tulula Bog Mitigation Site is a 222 acre tract located in Graham County, NC. The site it located off of Highway 129 between Topton, NC, and Robbinsville, NC, as shown in Figure 1. To visit the site from I-40, take NC Highway 19/74 eastbound. Turn right onto NC Highway 129, just before reaching Andrews, NC. Continue for approximately 2 miles then turn right onto Ledbetter Road. The entrance is a gated gravel drive to the left, approximately 1,000 feet from the intersection off of Ledbetter Rd. and NC Highway 129.

B. Structure and Objectives

The site was developed as mitigation for impacts created from the construction of various roadways in the surrounding areas. The mitigation site contains 102 acres of wetland restoration, 121 acres of upland buffer protection, 8,639 linear feet of stream restoration, and 1,248 linear feet of stream preservation.

Table I: Project Structure Table
Tulula Stream and Wetland Mitigation Site (EEP Project # 392)

Segment/Reach ID	Linear Feet or Acreage
Wetland Restoration	102 ac
Reach 1 - Restoration	8,639 lf
Reach 2 - Preservation	1,248 lf
Buffer Protection	121 ac

Table II: Project Structure and Objectives Table
Tulula Stream and Wetland Mitigation Site (EEP Project # 392)

Segment/Reach ID	Objectives	Linear Feet or Acreage	Comment
Wetland Restoration	Restoration	102 ac	
Reach 1 - Restoration	Restoration	8,639 lf	
Reach 2 - Preservation	Preservation	1,248 lf	
Buffer	Preservation	121 ac	

C. Project History and Background

Project monitoring was performed from 2003 through 2007. We understand that 2007 serves as Monitoring Year 5 of 5, the final year of site monitoring. Additional details regarding the timeline of the project are included as Table III.

Table III: Project Activity and Reporting History
Tulula Stream and Wetland Mitigation Site (EEP Project # 392)

Activity or Report	Calendar Year of Completion or Planned Completion	Actual Completion Date
Restoration Plan	Unknown	Unknown
Monitoring Gauges Installed	2000	Jun-00
Phase I Planted	2002	Apr-02
Phase II Planted	2003	Mar-03
Initial-Year 1 monitoring	2003	Dec-03
Year 1 Vegetation Monitoring	2003	Sep-03
Year 2 monitoring	2004	Nov-04
Year 2 Vegetation Monitoring	2004	Jul-04
Four additional plots set	2004	Nov-04
Year 3 Monitoring	2005	Dec-05
Year 3 Vegetation Monitoring	2005	May-05
Year 4 Monitoring	2006	Dec-06
Year 4 Vegetation Monitoring	2006	Aug-06
Year 5 Monitoring	2007	Dec-07
Year 5 Vegetation Monitoring	2007	Jun-07

The project was designed by HSMM. The original construction contractor was Robbinsville Construction. Construction was completed by NCDOT Maintenance. Monitoring activities for Years 3, 4 and 5 were performed by S&EC. A summary of project contractors is provided in Table IV.

Table IV: Project Contact Table Tulula Stream and Wetland Mitigation Site (EEP Project # 392)	
Designer	HSMM 1305 Navaho Drive Raleigh, NC 27609
Monitoring Performers	Soil & Environmental Consultants, PA 11010 Raven Ridge Road Raleigh, NC 26714
Stream Monitoring POC	Jessica Regan, S&EC
Vegetation Monitoring POC	
Wetland Monitoring POC	

The project is located within Graham County, a rural area of the Blue Ridge Belt of the Mountains of North Carolina. Additional information regarding the stream is provided in Table V.

Table V: Project Background Table Tulula Stream and Wetland Mitigation Site (EEP Project # 392)	
Project County	Graham
Drainage Area	2.41 sq. mi.
Drainage impervious cover estimate (%)	0.1
Stream Order	$1^{st}/2^{nd}$
Physiographic Region	Mountain
Ecoregion	Blue Ridge
Rosgen Classification of As-Built	E4
Dominant Soil Types	Rc, Rd, Tf, Tg, Wa
USGS HUC for Project and Reference	06010204
NCDWQ Sub-basin for Project and Reference	04-04-04
NCDWQ classification for Project and Reference	WS-III, Tr
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	No
% of project easement fenced	N/A

D. Monitoring Plan View

A series of monitoring devices were previously established onsite by others, including seven (7) vegetation monitoring plots.

A total of eight (8) longitudinal survey reaches were established by UNC-Asheville along the length of the restorated channel. Within each of these reaches, four (4) cross-sections (2 pools and 2 riffles) were permanently marked for a total of thirty-

two (32) cross sections onsite. Each cross-section is also a designated photo point that is to be photographed annually.

Twenty-nine (29) electronic groundwater monitoring gauges were previously installed onsite by others. The gauges were configured to record daily groundwater levels. A rain gauge is also present onsite. The location of site gauges along with the locations of all monitoring devices and are shown on Sheets 1 through 4 (Monitoring Plan View). During our site visit on April 13, 2007 one (1) groundwater monitoring gauge was replaced due to a gauge malfunction.

III. Project Condition and Monitoring Results

A. Vegetation Assessment

The 33.3 acre wetland restoration area was planted with various hardwood tree and shrub species, native to the area. Initial planting occurred in April 2002, with the remainder planted in March 2003.

Three (3) vegetation monitoring plots were established onsite in 2003. In 2004, four (4) additional plots were installed. The success criteria for the site require a minimum of 320 live stems per acre for the first three (3) years of monitoring. At the end of Year 4, a density of 290 stems per acre is required. At the end of the 5-year monitoring period, a live stem density of 260 stems per acre must be achieved.

1. Problem Areas Plan View (vegetation)

During a field evaluation in June, 2007, a single area of bare streambank was observed. It appears this may be due to excessive wildlife grazing, traffic, and/or undercutting banks. A representative photo is included in Appendix A.

Table VII: Vegetative Problem Areas
Tulula Stream and Wetland Restoration Site (EEP Project #392)

Feature Issues	Number	Suspected Cause	Photo number
Bare Bank	1 Reach 1 (0+98 - 1+20)	Undercut Banks/Beaver Activity/Bank Gradient	1

2. Vegetative Problem Areas Plan View

Vegetative problem areas are shown on Sheets 5 through 8 (Problem Area Plan View).

3. Stem Counts

Records show the following tree species were planted in the Wetland Creation Area: *Nyssa sylvatica* var. *sylvatica* (Black Gum), *Quercus rubra* (Northern

Red Oak), *Betula nigra* (River Birch), *Liriodendron tulipifera* (Tulip Poplar), *Quercus alba* (White Oak), and *Prunus serotina* (Black Cherry). The taxonomic standard used for the counts is "Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas" by Alan S. Weakley.

On June 13, 2007, S&EC performed vegetation counts within each plot. The results of this survey are shown below in Table VIII.

Table VIII: Stem Counts for Each Species Arranged by Plot
Tulula Bog Stream and Wetland Mitigation Site (EEP Project # 392)

Species	Plots							Year 5 Totals
	1	**2**	**3**	**4**	**5**	**6**	**7**	
***Nyssa sylvatica* (Black Gum)**								0
***Quercus rubra* (Northern Red Oak)**	5		0		0	3	1	9
***Betula nigra* (River Birch)**		4						4
***Liriodendron tulipifera* (Tulip Poplar)**		3	0	14	0	13	1	31
***Quercus alba* (White Oak)**	9	6		3	0	1		19
***Prunus serotina* (Black Cherry)**							8	8
Year 5 Totals	**14**	**13**	**0**	**17**	**0**	**17**	**10**	**71**
Year 4 Totals	17	13	11	17	0	18	11	87
Year 3 Totals	21	13	14	18	4	18	11	99
Year 2 Totals	32	26	25	22	4	23	15	147
Planted Live Stem Density	567	526	0	688	0	688	405	
Average Live Stem Density								**410**
Survival % Per Plot (from Year 4)	82%	100%	0%	100%	-	94%	91%	82%

The average number of stems per sample plot is approximately 10 stems. The 2007 vegetation monitoring of the site revealed an average tree density of 410 stems per acre. The low survival in certain plots can be attributed to high levels of inundation in areas that have been impounded by beaver activity.

The two plots with no original planted stems remaining (Plot 3 and Plot 5) are close to the lower end of the site where the largest beaver dams are located and where water levels have continued to rise during the monitoring period. Tree species that cannot tolerate these water depths have died and been replaced by areas of open water, soft rush (*Juncus effusus*), willow (*Salix sp.*) and tag alder (*Alnus serrulata*). Excluding Plots 3 and 5, the Average Stem Density for the remaining plots is 575 stems per acre. All observations to date indicate strong vegetative success on the project site. According to EEP,

additional control and dam removal efforts are being implemented by the agencies wildlife control contractor to remove beaver from the site and remove remnant dam materials.

4. Vegetation Photo Plots

Photos taken during the June 13, 2007 Vegetation Sampling event are included as Appendix A.

B. Stream Assessment

1. Problem Areas Plan View (Stream)

An assessment of channel stability was performed in June, 2007, by S&EC. Areas of concern that were observed and documented included localized bank scour, debris and beaver dams, and stressed or failing structures. These problem areas are shown on Sheets 5 through 8 (Problem Area Plan View). According to EEP, additional control and dam removal efforts are being implemented by the agencies wildlife control contractor to remove beaver from the site and remove remnant dam materials.

2. Problem Areas Table Summary

Table IX: Stream Problem Areas
Tulula Stream and Wetland Restoration Site (EEP Project #392)

Feature Issues	Number	Suspected Cause	Photo number
Bank Scour	1 Reach I (1+10 – 1+30)	Coir failure	1-6
	2 N/A	Coir Failure	
	3 Reach IA (0+00 – 0+15)	Undercut banks / coir failure	
	4 Reach IA (0+30 – 0+60)	Outside meander / coir failure	
	5 Reach IA (1+00 - 1+20)	Undercut banks / coir failure	
	6 N/A	Undercut banks / coir failure	
	7 Reach II (0+45 - 0+65)	Outside meander / coir failure	
	8 Reach II (1+00 - 1+35)	Coir failure	
Failing Structures	1 N/A N/A	Undercut Crossvane	N/A

3. Numbered Issues Photo Section

Representative photos of each category of stream problem area were taken and are shown in Appendix B.

4. Fixed Photo Station Photos

Photos from established photo stations (at each cross-section) were collected during the stream survey (November 2007). These photos are included in Appendix B along with photos from the Year 4 stream survey (November 2006).

5. Stability assessment

A visual qualitative assessment was performed to inspect channel facets, meanders, bed, banks, and installed structures. This visual assessment was confirmed and supplemented with a quantitative assessment from the physical stream survey. The purpose of this assessment is to provide a percentage of the features listed in Table X that are in a state of stability. Table X was compiled from the data in Table B1 in Appendix B of this report.

Table X: Categorical Stream Feature Visual Stability Assessment
Tulula Stream and Wetland Restoration Site (EEP #392)

Feature	MY-1 2003	MY-2 2004	MY-3 2005	MY-4 2006	MY-5 2007
A. Riffles	*	*	96%	95%	95%
B. Pools	*	*	100%	100%	100%
C. Thalweg	*	*	100%	100%	100%
D. Meanders	*	*	79%	100%	100%
E. Bed General	*	*	96%	97%	97%
F. Channel General	*	*	N/A	N/A	N/A
G. Banks	*	*	100%	99%	99%
H. Vanes/ J Hooks, etc.	*	*	N/A	N/A	N/A
I. Wads and Boulders	*	*	N/A	N/A	N/A

* Items denoted with an asterisk have not been provided due to: lack of data provided for previous monitoring years, incorrect data provided for previous monitoring years, or these are items outside the scope of this year's monitoring effort.

6. Quantitative Morphology

The following tables (Table XI and Table XII) summarize the quantitative data collected from the cross-sectional and longitudinal stream survey. This data was analyzed and summarized, and then compared with baseline data types available for this project.

The Quantitative Morphology Tables illustrate the degree of departure, if any, of the current channel from the baseline data. Cross-sections from 2004, 2005, and 2006 were provided for comparison with the data from 2007.

Four of the survey reaches (Reaches IV, IVA, V, and VA) were consistently inundated throughout the 2007 monitoring period due to beaver activity onsite. Permanent markers for the cross-sections in these areas were not able to be located and therefore, not surveyed for the 2007 or 2006 monitoring years. In 2005 only two reaches were consistently inundated, however, as shown on the Problem Area Plan View, the extents of the beaver impoundment continued to increase. The beaver impoundment located at the lower end of the site has increased from 9.5 acres in 2005, 15.5 acres in 2006, to 20.25 acres in 2007. This is a 200% increase in size since 2005. According to EEP, additional control and dam removal efforts are being implemented by the agencies wildlife control contractor to remove beaver from the site and remove remnant dam materials.

Based on a review of available site data and site observations, no crest gauge exists on the site. A review of available on-line USGS gauge sites was performed to determine if a suitable surrogate gauge was present in the area. No nearby gauge was identified. The closest USGS gauge to the site was on the Nantahala River (new Hewitt, NC, Gauge Identification Number 03505550) which is approximately 3.47 miles from the project site. Based on this large distance, significant disparity in watershed sizes, and topographic variation, it is unlikely that a conclusive determination regarding the number of bankfull events experienced on the restoration site could be made.

Based on the location of existing groundwater gauges, any comparison would be inappropriate for the verification of bankfull events. However, during monthly site visits, general site observations were made to include wrack lines, staining of vegetation, displaced/flattened vegetation, and observable sediment deposition. Based on these observations, it is apparent that one or more overbank events have occurred during this monitoring year. Similar observations were made during 2005 and 2006 indicating that one or more bankfull events have occurred onsite in each of the last three monitoring years.

Table XI. Baseline Morphology and Hydraulic Summary
TULULA STREAM AND WETLAND RESTORATION SITE (EEP Project #388)

Parameter	Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
BF Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Floodprone Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*
BF Cross Sectional Area (ft^2)	*	*	*	*	*	*	*	*	*	*	*	*
BF Mean Depth (ft)	*	*	*	*	*	*	*	*	*	*	*	*
BF Max Depth (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Width/Depth Ratio	*	*	*	*	*	*	*	*	*	*	*	*
Entrenchment Ratio	*	*	*	*	*	*	*	*	*	*	*	*
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic radius (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Pattern												
Channel Beltwidth (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Radius of Curvature (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Meander Wavelength (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Meander Width ratio	*	*	*	*	*	*	*	*	*	*	*	*
Profile												
Riffle length (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Riffle slope (ft/ft)	*	*	*	*	*	*	*	*	*	*	*	*
Pool length (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Pool spacing (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Substrate												
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*
Additional Reach Parameters												
Valley Length (ft)		*			*			*			*	
Channel Length (ft)		*			*			*			*	
Sinuosity		*			*			*			*	
Water Surface Slope (ft/ft)		*			*			*			*	
BF slope (ft/ft)		*			*			*			*	
Rosgen Classification		*			*			*			E4	
*Habitat Index		*			*			*			*	
*Macrobenthos		*			*			*			*	

* Items denoted with an asterisk have not been provided due to: lack of data provided for previous monitoring years, incorrect data provided for previous monitoring years, or these are items outside the scope of this year's monitoring effort.

Exhibit Table XII. Morphology and Hydraulic Monitoring Summary
TULULA STREAM AND WETLAND RESTORATION SITE (EEP Project #388)

Parameter	REACH I																							
	RIFFLE 1						POOL 1						RIFFLE 2						POOL 2					
Dimension	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
BF Width (ft)	13.8	13.8	13.8	6.42	7.26	6.39	15.7	15.7	15.7	11.02	8.23	9.63	11.8	11.8	11.8	7.16	6.54	7.28	15.7	15.7	15.7	8.64	7.42	7.72
Floodprone Width (ft)	*	*	*	50	50	50	*	*	*	50	50	50	*	*	*	50	50	50	*	*	*	50	50	50
BF Cross Sectional Area (ft^2)	18.8	21.92	19.04	6.76	8	6.66	27.93	24.22	25.23	11.63	9.29	12.28	13.99	15.69	15.12	10.07	5.92	9.8	27.59	28.02	26.23	11.69	8.96	10.41
BF Mean Depth (ft)	1.36	1.59	1.38	1.05	1.1	1.04	1.78	1.54	1.61	1.06	1.13	1.28	1.19	1.33	1.28	1.41	0.91	1.35	1.76	1.78	1.67	1.35	1.21	1.35
BF Max Depth (ft)	2.39	2.79	2.62	1.52	1.78	1.69	3.25	2.92	2.98	2.05	1.75	2.04	2.23	2.89	3.12	3.02	2.65	3.1	3.21	3.25	3.28	2.12	2	2.18
Width/Depth Ratio	*	*	*	6.1	6.6	6.14	*	*	*	10.43	7.28	7.52	*	*	*	5.09	7.19	5.39	*	*	*	6.38	6.13	5.72
Entrenchment Ratio	*	*	*	7.78	6.89	7.82	*	*	*	4.54	6.07	5.19	*	*	*	6.98	7.65	6.86	*	*	*	5.79	6.74	6.47
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	7.44	8.32	7.48	*	*	*	12.37	9.32	10.96	*	*	*	9.88	8.84	10.42	*	*	*	9.97	8.57	9.14
Hydraulic radius (ft)	*	*	*	0.91	0.96	0.89	*	*	*	0.94	1	1.12	*	*	*	1.02	0.67	0.94	*	*	*	1.17	1.04	1.14
Substrate																								
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH 1A																							
	RIFFLE 1						POOL 1						RIFFLE 2						POOL 2					
Dimension	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
BF Width (ft)	10.5	10.5	10.5	7.02	9.43	8.83	10.5	10.5	10.5	7.36	7.9	8.72	13.1	13.1	13.1	7.99	8.33	8.89	12.5	13.1	13.1	7.29	8.6	10.59
Floodprone Width (ft)	*	*	*	50	50	50	*	*	*	50	50	50	*	*	*	50	50	50	*	*	*	50	50	50
BF Cross Sectional Area (ft^2)	13.84	16.37	15.91	10.61	16.99	14.52	18.35	19.69	18.55	11.3	13.69	12.95	20.33	22.11	22.04	10.4	11.74	14.54	18.29	18.36	18.84	11.4	14.25	14.67
BF Mean Depth (ft)	1.32	1.56	1.52	1.51	1.8	1.64	1.75	1.88	1.77	1.54	1.73	1.49	1.55	1.69	1.68	1.3	1.41	1.64	1.46	1.4	1.44	1.56	1.66	1.39
BF Max Depth (ft)	2.62	3.25	3.28	2.42	3.13	2.69	2.95	3.12	2.98	2.41	2.42	2.6	2.72	2.98	3.02	1.74	2.15	2.49	2.49	2.59	2.66	1.93	2.27	2.3
Width/Depth Ratio	*	*	*	4.64	5.24	5.38	*	*	*	4.79	4.57	5.85	*	*	*	6.14	5.91	5.42	*	*	*	4.67	5.18	7.62
Entrenchment Ratio	*	*	*	7.12	5.3	5.66	*	*	*	6.79	6.33	5.73	*	*	*	6.29	6	5.62	*	*	*	6.86	5.81	4.72
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	9.18	11.72	10.85	*	*	*	9.62	10.5	11.02	*	*	*	9.41	9.71	10.84	*	*	*	9.5	10.79	12.66
Hydraulic radius (ft)	*	*	*	1.16	1.45	1.34	*	*	*	1.18	1.3	1.18	*	*	*	1.1	1.21	1.34	*	*	*	1.2	1.32	1.16
Substrate																								
d50 (mm)	*	*	*	*	*		*	*	*	*	*		*	*	*	*	*		*	*	*	*		*
d84 (mm)	*	*	*	*	*		*	*	*	*	*		*	*	*	*	*		*	*	*	*		*

Parameter	REACH II																							
	RIFFLE 1						POOL 1						RIFFLE 2						POOL 2					
Dimension	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
BF Width (ft)	16.4	16.4	16.4	8.42	8.49	11.82	16.4	16.4	16.4	9.15	10.31	11.43	13.1	13.1	13.1	10.13	8.11	10.32	14.4	14.4	14.4	11.74	11.08	11.97
Floodprone Width (ft)	*	*	*	50	50	50	*	*	*	50	50	50	*	*	*	50	50	50	*	*	*	50	50	50
BF Cross Sectional Area (ft^2)	20.33	21.92	21.88	9.83	10.15	14.38	25.02	27.83	26.03	11.52	13.57	16.22	14.8	16.35	16.29	11.29	9.87	12.47	23.34	24.76	24.4	16.38	15.99	18.17
BF Mean Depth (ft)	1.24	1.34	1.33	1.17	1.2	1.22	1.53	1.7	1.59	1.26	1.32	1.42	1.13	1.25	1.24	1.11	1.22	1.21	1.62	1.72	1.69	1.39	1.44	1.52
BF Max Depth (ft)	2.1	2.56	2.69	1.85	2.01	2.39	2.95	3.21	3.18	1.94	2.21	2.55	1.9	2.23	2.36	1.99	2.11	2.32	2.62	2.79	2.79	2.22	2.11	2.29
Width/Depth Ratio	*	*	*	7.21	7.08	9.69	*	*	*	7.27	7.81	8.05	*	*	*	9.09	6.65	8.53	*	*	*	8.42	7.69	7.88
Entrenchment Ratio	*	*	*	5.94	5.89	4.23	*	*	*	5.46	4.85	4.35	*	*	*	4.94	6.17	4.84	*	*	*	4.26	4.51	4.17
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	9.42	9.62	13.05	*	*	*	10.22	11.5	13.13	*	*	*	11.08	9.26	11.51	*	*	*	12.77	12.25	13.25
Hydraulic radius (ft)	*	*	*	1.04	1.06	1.1	*	*	*	1.13	1.18	1.24	*	*	*	1.02	1.07	1.08	*	*	*	1.28	1.31	1.37
Substrate																								
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH III																							
	RIFFLE 1						POOL 1						RIFFLE 2						POOL 2					
Dimension	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
BF Width (ft)	13.1	13.1	13.8	10.45	8.57	9.57	19	19	19	11.19	14.07	14.72	17.1	16.4	17.1	11.06	11.74	12.85	17.7	17.7	18.4	11.61	10.65	11.62
Floodprone Width (ft)	*	*	*	50	50	50	*	*	*	50	50	50	*	*	*	50	50	50	*	*	*	50	50	50
BF Cross Sectional Area (ft^2)	18.25	20.07	21.07	15.76	13.24	16.25	30.8	32.79	30.62	17.95	22.07	22.49	25.5	24.73	25.53	15.51	17.19	18.55	21.26	22.48	21.23	13	14.44	13.94
BF Mean Depth (ft)	1.39	1.53	1.53	1.51	1.55	1.7	1.62	1.73	1.61	1.6	1.57	1.53	1.49	1.51	1.49	1.4	1.46	1.44	1.2	1.27	1.15	1.12	1.36	1.2
BF Max Depth (ft)	2.39	3.15	3.21	2.92	2.73	2.94	3.08	3.28	3.25	2.25	2.68	2.83	2.76	2.82	2.95	2.49	2.57	2.6	2.46	3.08	3.12	2.41	2.43	2.42
Width/Depth Ratio	*	*	*	6.93	5.53	5.63	*	*	*	6.98	8.96	9.62	*	*	*	7.89	8.04	8.92	*	*	*	10.37	7.83	9.68
Entrenchment Ratio	*	*	*	4.78	5.83	5.24	*	*	*	4.47	3.55	3.39	*	*	*	4.52	4.26	3.89	*	*	*	4.31	4.7	4.3
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	13.15	10.54	11.71	*	*	*	12.91	15.79	16.39	*	*	*	12.55	13.1	14.59	*	*	*	13.07	12.04	12.78
Hydraulic radius (ft)	*	*	*	1.2	1.26	1.39	*	*	*	1.39	1.4	1.37	*	*	*	1.24	1.31	1.27	*	*	*	0.99	1.2	1.09
Substrate																								
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH IV																							
	RIFFLE 1						POOL 1						RIFFLE 2						POOL 2					
Dimension	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
BF Width (ft)	12.5	12.5	12.5	11.15			14.4	14.4	14.4	12.06			13.1	13.1	13.1	10.23			15.1	14.4	18.4	11.44		
Floodprone Width (ft)	*	*	*	50	*	*	*	*	*	50	*	*	*	*	*	50	*	*	*	*	*	50	*	*
BF Cross Sectional Area (ft^2)	17.15	17.49	17.5	16.03	*	*	24.73	23.35	23.62	18.4	*	*	23.33	22.13	20.63	16.83	*	*	27.29	27.5	26.76	18.3	*	*
BF Mean Depth (ft)	1.37	1.4	1.38	1.44	*	*	1.72	1.62	1.64	1.53	*	*	1.78	1.69	1.57	1.64	*	*	1.81	1.91	1.45	1.6	*	*
BF Max Depth (ft)	2.3	2.43	2.64	2.7	*	*	3.05	3.02	3.15	2.69	*	*	3.25	3.08	3.18	3.4	*	*	3.25	3.28	3.25	2.69	*	*
Width/Depth Ratio	*	*	*	7.76	*	*	*	*	*	7.91	*	*	*	*	*	6.22	*	*	*	*	*	7.16	*	*
Entrenchment Ratio	*	*	*	4.48	*	*	*	*	*	4.15	*	*	*	*	*	4.89	*	*	*	*	*	4.37	*	*
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	12.69	*	*	*	*	*	13.5	*	*	*	*	*	12.58	*	*	*	*	*	12.92	*	*
Hydraulic radius (ft)	*	*	*	1.26	*	*	*	*	*	1.36	*	*	*	*	*	1.34	*	*	*	*	*	1.42	*	*
Substrate																								
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH IVA																							
	RIFFLE 1						POOL 1						RIFFLE 2						POOL 2					
Dimension	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
BF Width (ft)	12.5	12.5	12.5	*	*	*	13.8	13.8	13.8	*	*	*	15.1	15.1	15.7	*	*	*	13.8	13.8	13.8	*	*	*
Floodprone Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BF Cross Sectional Area (ft^2)	14.66	15.4	15.54	*	*	*	19.49	21.11	20.5	*	*	*	21.9	21.52	20.16	*	*	*	19.17	21.73	20.88	*	*	*
BF Mean Depth (ft)	1.17	1.23	1.24	*	*	*	1.41	1.53	1.49	*	*	*	1.45	1.42	1.28	*	*	*	1.39	1.57	1.51	*	*	*
BF Max Depth (ft)	1.97	2.49	2.49	*	*	*	3.02	3.25	3.25	*	*	*	2.69	2.82	2.59	*	*	*	2.85	3.15	3.18	*	*	*
Width/Depth Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Entrenchment Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic radius (ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Substrate																								
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH V																							
	RIFFLE 1						POOL 1						RIFFLE 2						POOL 2					
Dimension	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
BF Width (ft)	15.1	15.1	15.1	12.48	*	*	16.4	15.78	16.4	11.93	*	*	13.8	13.8	13.8	11.69	*	*	16.4	16.4	16.4	10.37	*	*
	*	*	*	50	*	*	*	*	*	80	*	*	*	*	*	50	*	*	*	*	*	100	*	*
BF Cross Sectional Area (ft^2)	17.14	20.52	19.62	16.06	*	*	24.09	25.43	24.74	13.69	*	*	15.44	16.67	16.64	16.48	*	*	28.33	29.24	27.22	14.03	*	*
BF Mean Depth (ft)	1.13	1.36	1.3	1.29	*	*	1.47	1.61	1.51	1.17	*	*	1.12	1.21	1.21	1.41	*	*	1.73	1.78	1.66	1.35	*	*
BF Max Depth (ft)	1.9	2.62	2.49	2	*	*	2.43	2.66	2.56	2.13	*	*	1.94	2.79	2.79	2.29	*	*	3.02	3.12	3.15	2.36	*	*
Width/Depth Ratio	*	*	*	9.7	*	*	*	*	*	10.2	*	*	*	*	*	8.29	*	*	*	*	*	7.66	*	*
Entrenchment Ratio	*	*	*	4.01	*	*	*	*	*	6.7	*	*	*	*	*	4.28	*	*	*	*	*	9.65	*	*
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	13.3	*	*	*	*	*	12.96	*	*	*	*	*	12.94	*	*	*	*	*	11.62	*	*
Hydraulic radius (ft)	*	*	*	1.21	*	*	*	*	*	1.08	*	*	*	*	*	1.27	*	*	*	*	*	1.21	*	*
Substrate																								
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH VA																							
	RIFFLE 1						POOL 1						RIFFLE 2						POOL 2					
Dimension	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5	AS BUILT	MY1	MY2	MY3	MY4	MY5
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
BF Width (ft)	9.8	*	9.8	*	*	*	11.8	*	11.8	*	*	*	15.1	*	15.1	*	*	*	10.5	*	10.5	*	*	*
Floodprone Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BF Cross Sectional Area (ft^2)	15.21	*	16.94	*	*	*	18.16	*	19.61	*	*	*	18.56	*	19.44	*	*	*	16.62	*	18.11	*	*	*
BF Mean Depth (ft)	1.55	*	1.73	*	*	*	1.54	*	1.66	*	*	*	1.23	*	1.29	*	*	*	1.58	*	1.72	*	*	*
BF Max Depth (ft)	2.46	*	2.72	*	*	*	2.72	*	3.05	*	*	*	2.23	*	2.46	*	*	*	2.43	*	3.12	*	*	*
Width/Depth Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Entrenchment Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic radius (ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Substrate																								
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	As-built (2002)			MY-1 (2003)			MY-2 (2004)			MY-3 (2005)			MY-4 (2006)			MY-5 (2007)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	*	*	*	*	*	*	*	*	*	30.12	108.9	55.83	23.38	92.77	52.6	26.78	98.25	54.28
Radius of Curvature (ft)	*	*	*	*	*	*	*	*	*	18.1	76.34	29.21	15.91	59.48	33.62	15.63	65.45	35.67
Meander Wavelength (ft)	*	*	*	*	*	*	*	*	*	35.68	125.91	81.86	38.01	125.21	87.56	38.5	130.25	88.26
Meander Width ratio	*	*	*	*	*	*	*	*	*	3.16387	11.43908	5.8645	3.85652	12.14638	6.68956	3.9624	12.5326	7.0125
Profile																		
Riffle length (ft)	*	*	*	*	*	*	*	*	*	*	*	*	5	21	12.75	6.08	10.94	8.28
Riffle slope (ft/ft)	*	*	*	*	*	*	*	*	*	0.00124	0.00669	0.00338	0.00245	0.00625	0.00423	0.00572	0.0207	0.01219
Pool length (ft)	*	*	*	*	*	*	*	*	*	9.27	21.03	13.6	4.025	14.4	10.9	7.64	17.54	13.43
Pool spacing (ft)	*	*	*	*	*	*	*	*	*	15.6	43.65	25.74	35.853	67.17	48.71	58	77.8	65.35
Additional Reach Parameters																		
Valley Length (ft)		*			*			*			6,062			6,062			6,062	
Channel Length (ft)		*			*			*			8,715			8,715			8,715	
Sinuosity		*			*			*			1.44			1.44			1.44	
Water Surface Slope (ft/ft)		*			*			*			*			*			*	
BF slope (ft/ft)		*			*			*			0.0040			0.0040			0.0040	
Rosgen Classification		*			*			*			E4			E4			E4	
Habitat Index*		*			*			*			*			*			*	
Macrobenthos*		*			*			*			*			*			*	

C. Wetland Assessment

Ten (10) groundwater monitoring gauges along with one (1) surface gauge and one (1) rain gauge were installed onsite in May 1998. The original rain gauge was replaced in May 2000. Additional surface gauges were installed in April 2003. Groundwater gauges record daily readings of groundwater depth. A total of twenty-nine (29) groundwater gauges are present onsite.

During the site visit on April 13, 2007 gauge E1 was replaced due to damage to the gauge. The cause of the damage is unknown. This gauge was replaced with an EcotoneWM gauge and its' approximate location marked using GPS technology. The locations of all monitoring devices are shown on Sheets 1 through 4 (Monitoring Plan View).

Success criteria for wetland hydrology require that the area be inundated or saturated within 12-inches of the ground surface for a period of 12.5% of the growing season. The growing season in Graham County begins on or about March 26 and ends on or about November 11 (230 days). In order to achieve hydrologic success, saturation within 12 inches of the ground surface is required for 29 consecutive days.

1. Problem Areas Plan View (Wetland)

An assessment of the stability of the wetland was preformed on during monthly visits that occurred from January through December 2007, by S&EC. Groundwater gauges were downloaded monthly.

As shown on the Problem Area Plan View (Sheets 5 through 8), twenty (20) of the twenty-nine (29) gauges on-site achieved wetland success criteria of saturation for 12.5% of the growing season (29 days). Nine (9) gauges did not meet hydrology in 2007, to include gauges: A2, B1, B3, D1, F2, F3, G2, H3, and I1. The nine (9) gauges that did not meet criteria were consistent with those failing to meet hydrology in 2006 and 2005.

It appears that gauges A2, B1, B3, D1, H3, and I1, did not make hydrology based on the relatively elevated topography surrounding those gauges. Gauges F2 and F3 appear to be statistical anomalies, as they are located adjacent to the restored channel. This could be to a topographic high in the floodplain, subsurface drawdown of hydrology in close proximity to the restored stream channel, or a combination of the two. It appears that gauge F2 is functioning properly.

During the November 2007 download it was noted that gauge F3 had sustained some water damage (deteriorated seals allowed water into the battery compartment). Gauge G2 was replaced in 2006, but appears to have sustained damage as well. It is recommended that both these gauges be replaced.

It should be noted that gauge A4 has met hydrology requirements, although no data has been collected from the gauge since March 2007. Due to frequent inundation due to the beaver activity observed onsite, this gauge has also been damaged. Due to the high water levels in this area, we do not recommend that this gauge be replaced.

2. Wetland Criteria Attainment

Table XIII: Wetland Criteria Attainment
Tulula Stream and Wetland Mitigation Site (EEP Project # 392)

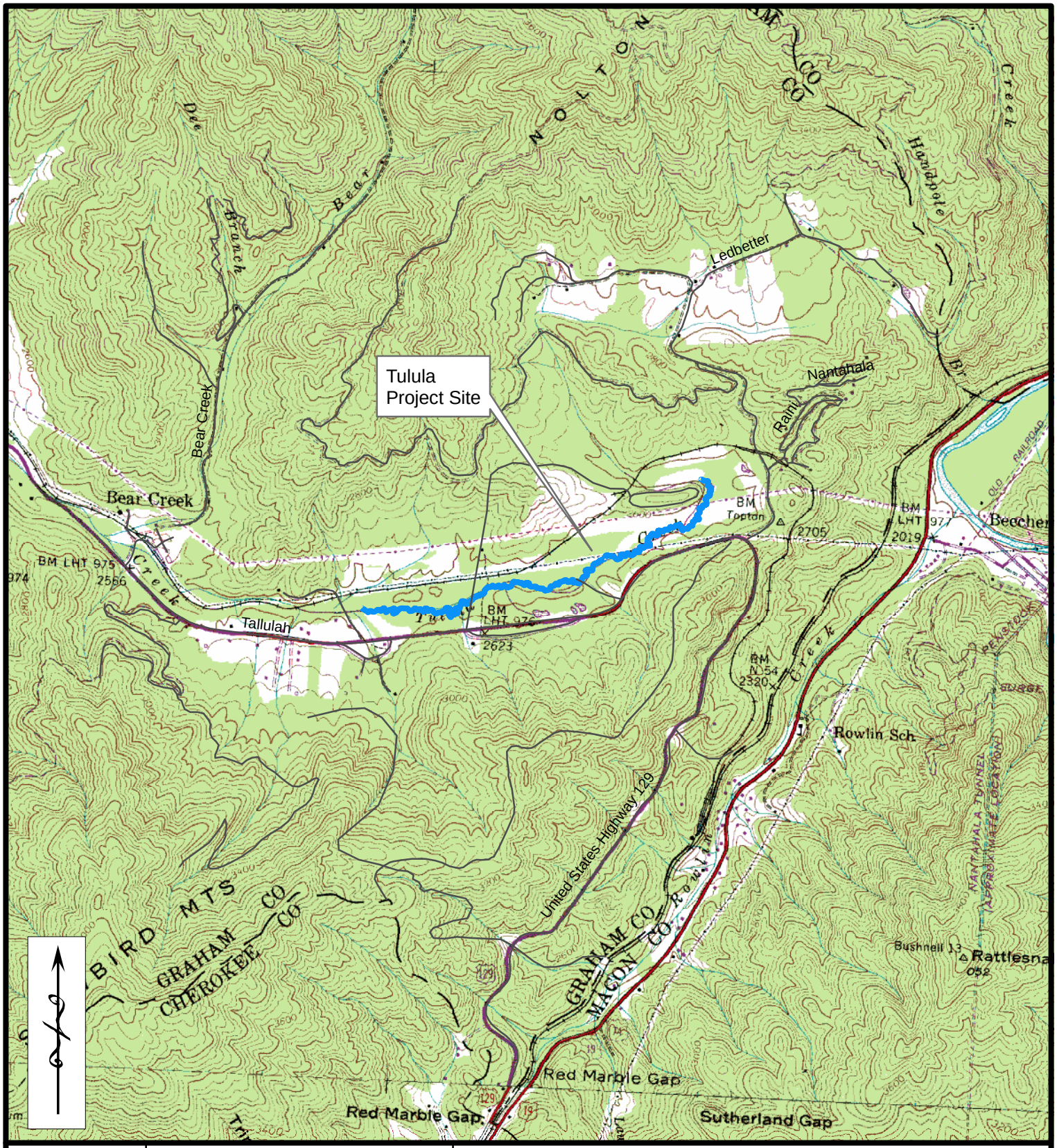
Well ID	Well Hydrology Threshold Met?	Transect Mean	Vegetation Plot ID	Vegetation Survival Threshold Met?
A1	Y	80%	Plot 1	Y
A2	N		Plot 2	Y
A3	Y		Plot 3	N
A4	Y		Plot 4	Y
A5	Y		Plot 5	N
B1	N	60%	Plot 6	Y
B2	Y		Plot 7	Y
B3	N			
B4	Y			
B5	Y			
C1	Y	100%		
C2	Y			
D1	N	66%		
D2	Y			
D3	Y			
E1	Y	100%		
E2	Y			
E3	Y			
E4	Y			
F1	Y	33%		
F2	N			
F3	N			
G1	Y	50%		
G2	N			
H1	Y	66%		
H2	Y			
H3	N			
I1	N	0%		
X1	Y	100%		

IV. Methodology Section

No unavoidable deviations from initially prescribed methodologies were implemented as a part of monitoring Year 5 (2007) activities. Vegetation counts were completed according to EEP 2004 Stem Counting Protocol.

References

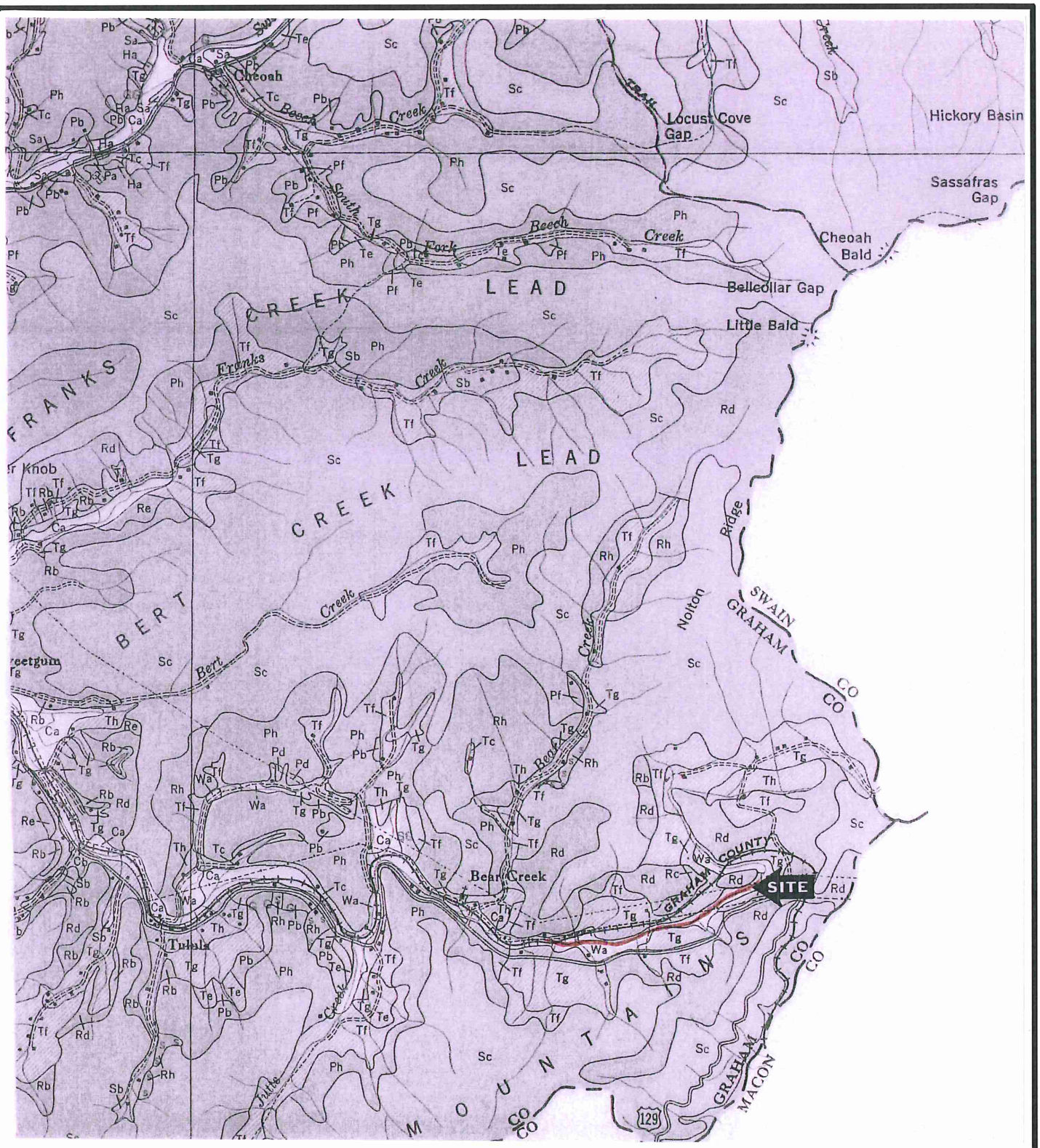
Weakley, Alan S. 2004. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas.



Project No. 9444.D3	Figure 1 - Vicinity Map
Project Mgr.: JER	Tulula Stream and Wetland Restoration NCEEP Year 5 of 5 Graham County, NC
Scale: 1" = 2,000'	Hewitt Quadrangle
January 2008	

S&EC
Soil & Environmental Consultants, PA
11010 Raven Ridge Rd. • Raleigh, NC 27614
(919) 846-5900 • (919) 846-9467
Web Page: www.SandEC.com

Ecosystem Enhancement Program



Project No. 9444.D3	Figure 2 - Soils Map Tulula Stream and Wetland Restoration NCEEP Year 5 of 5 Graham County, NC	S&EC Soil & Environmental Consultants, PA 11010 Raven Ridge Rd. • Raleigh, NC 27614 (919) 846-5900 • (919) 846-9467 Web Page: www.SandEC.com
Project Mgr.: JER		
Scale: 1" = 4000'		
JANUARY 2008	GrahamCounty 1942 Soil Survey	

Ecosystem Enhancement PROGRAM

Tulula Bog Stream and Wetland Restoration
Monitoring Year 5 of 5

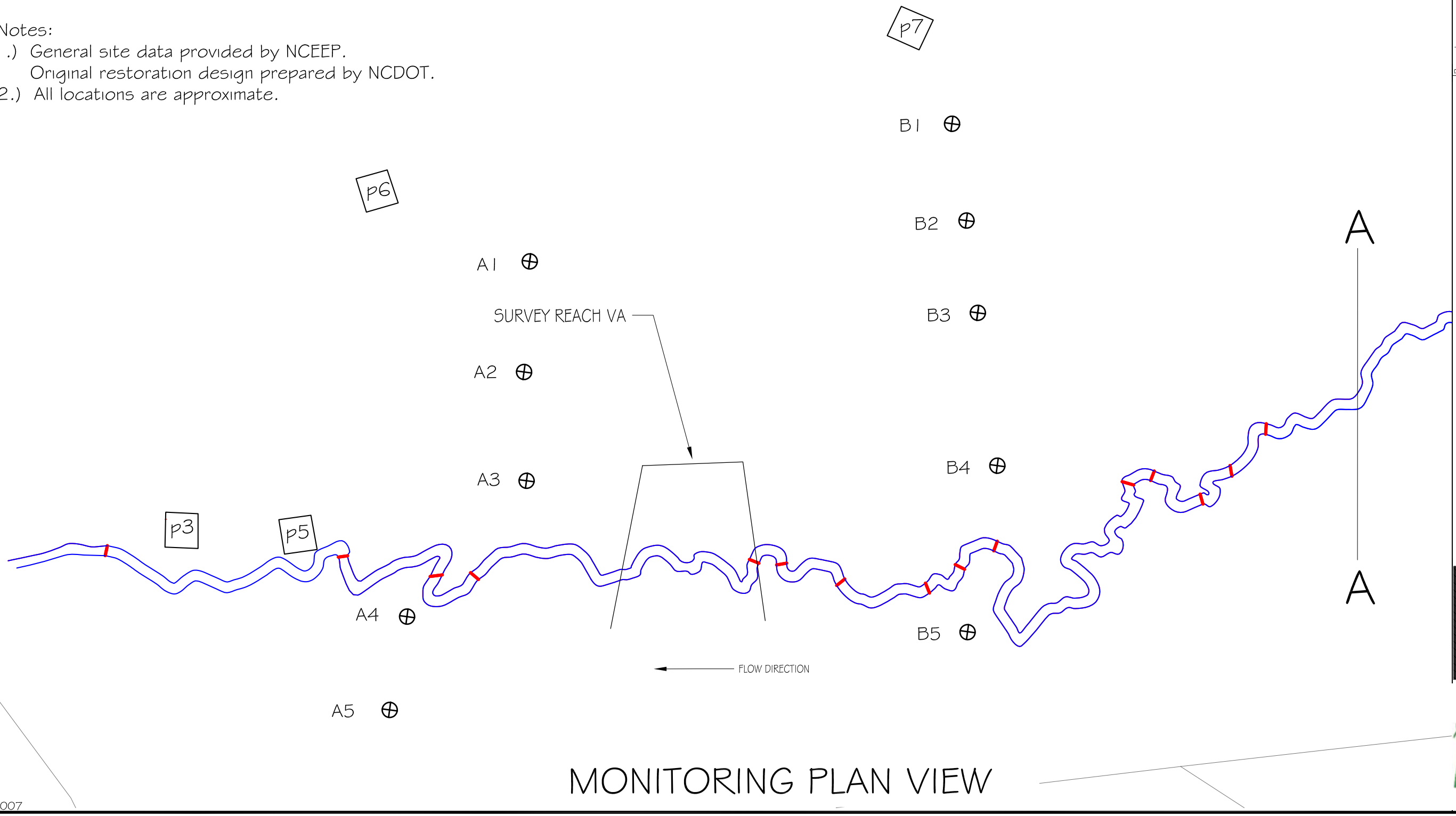
LEGEND
- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam
- P — Vegetation Plot
- Survey Reach
- Cross Section

NORTH

SCALE 1" = 150'

75 0 150

Notes:
1.) General site data provided by NCEEP.
Original restoration design prepared by NCDOT.
2.) All locations are approximate.



MONITORING PLAN VIEW

JUNE 2007

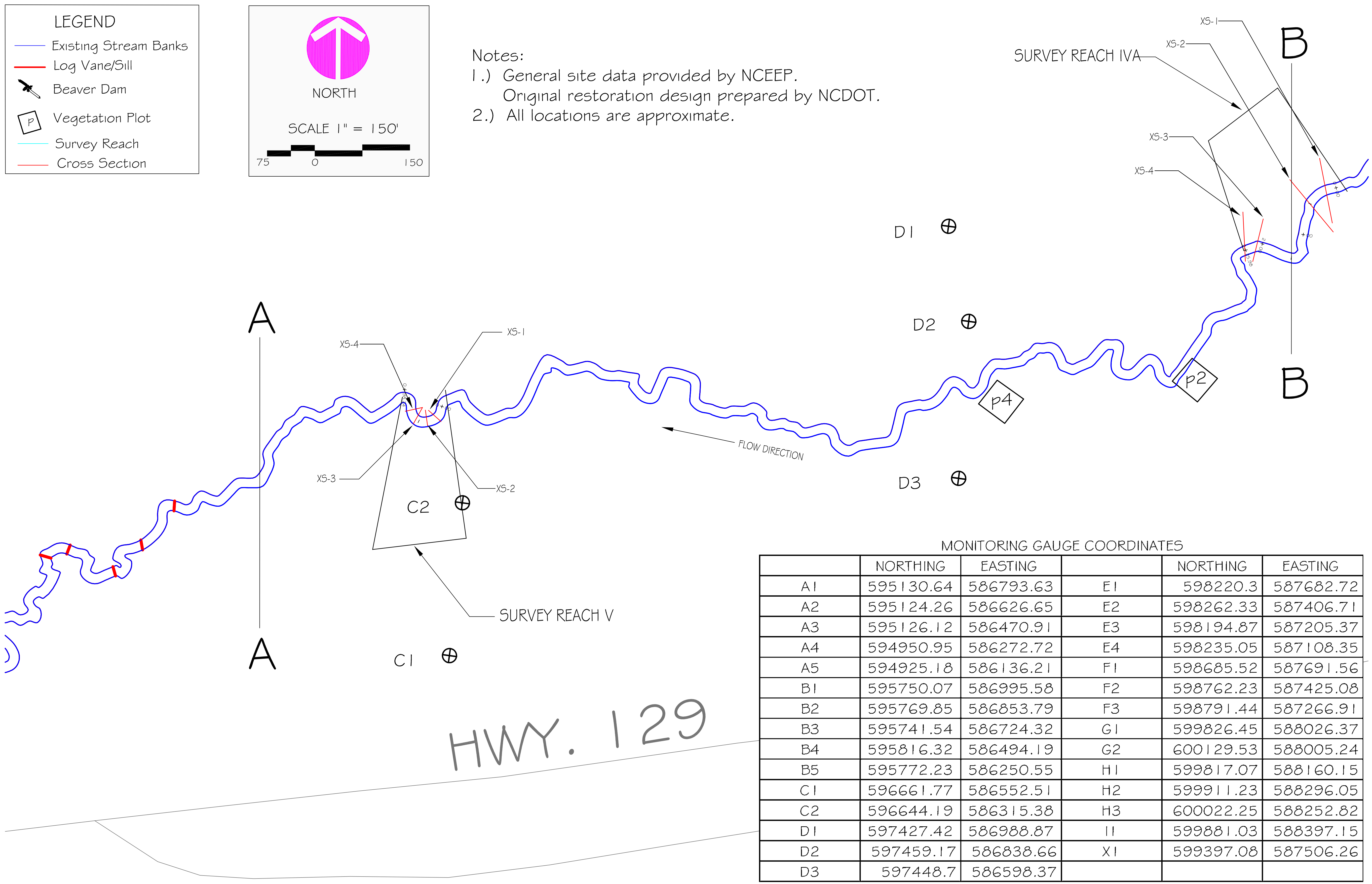
Project: TULULA STREAM AND WETLAND RESTORATION
Location: GRAHAM CO., NC
Client: NCEEP
Sheet Title: MONITORING PLAN VIEW-SEGMENT 1
Project No.: 9444.D3
Proj. Mgr.: PKS
Drawn: JER
Scale: 1" = 150'
Sheet No.: 1 OF 8

Soil & Environmental Consultants, PA
11010 Raven Ridge Road · Raleigh, North Carolina 27614 · Phone: (919) 846-5900 · Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

File: Sec\Dgns7-9k\9444.D3\PAP\TULULA 2007 MONT. AND PAP.dwg



Notes:
1.) General site data provided by NCEEP. Original restoration design prepared by NCDOT.
2.) All locations are approximate.

MONITORING GAUGE COORDINATES

	NORTHING	EASTING		NORTHING	EASTING
A1	595130.64	586793.63	E1	598220.3	587682.72
A2	595124.26	586626.65	E2	598262.33	587406.71
A3	595126.12	586470.91	E3	598194.87	587205.37
A4	594950.95	586272.72	E4	598235.05	587108.35
A5	594925.18	586136.21	F1	598685.52	587691.56
B1	595750.07	586995.58	F2	598762.23	587425.08
B2	595769.85	586853.79	F3	598791.44	587266.91
B3	595741.54	586724.32	G1	599826.45	588026.37
B4	595816.32	586494.19	G2	600129.53	588005.24
B5	595772.23	586250.55	H1	599817.07	588160.15
C1	596661.77	586552.51	H2	599911.23	588296.05
C2	596644.19	586315.38	H3	600022.25	588252.82
D1	597427.42	586988.87	I1	599881.03	588397.15
D2	597459.17	586838.66	X1	599397.08	587506.26
D3	597448.7	586598.37			

MONITORING PLAN VIEW

File: Sec\Jobs7-9k\9444.D3\PAPV\TULULA 2007 MONT. AND PAPV.dwg
JUNE 2007

Ecosystem Enhancement Program

S&EC
Soil & Environmental Consultants, PA
11010 Raven Ridge Road · Raleigh, North Carolina 27614 · Phone: (919) 846-5900 · Fax: (919) 846-9467
www.SandEC.com

Project: TULULA STREAM AND WETLAND RESTORATION
Location: GRAHAM CO., NC
Client: NCEEP
Sheet Title: MONITORING PLAN VIEW-SEGMENT 2
Project No.: 9444.D3
Proj. Mgr.: PKS
Drawn: JER
Scale: 1" = 150'
Sheet No.: 2 OF 8

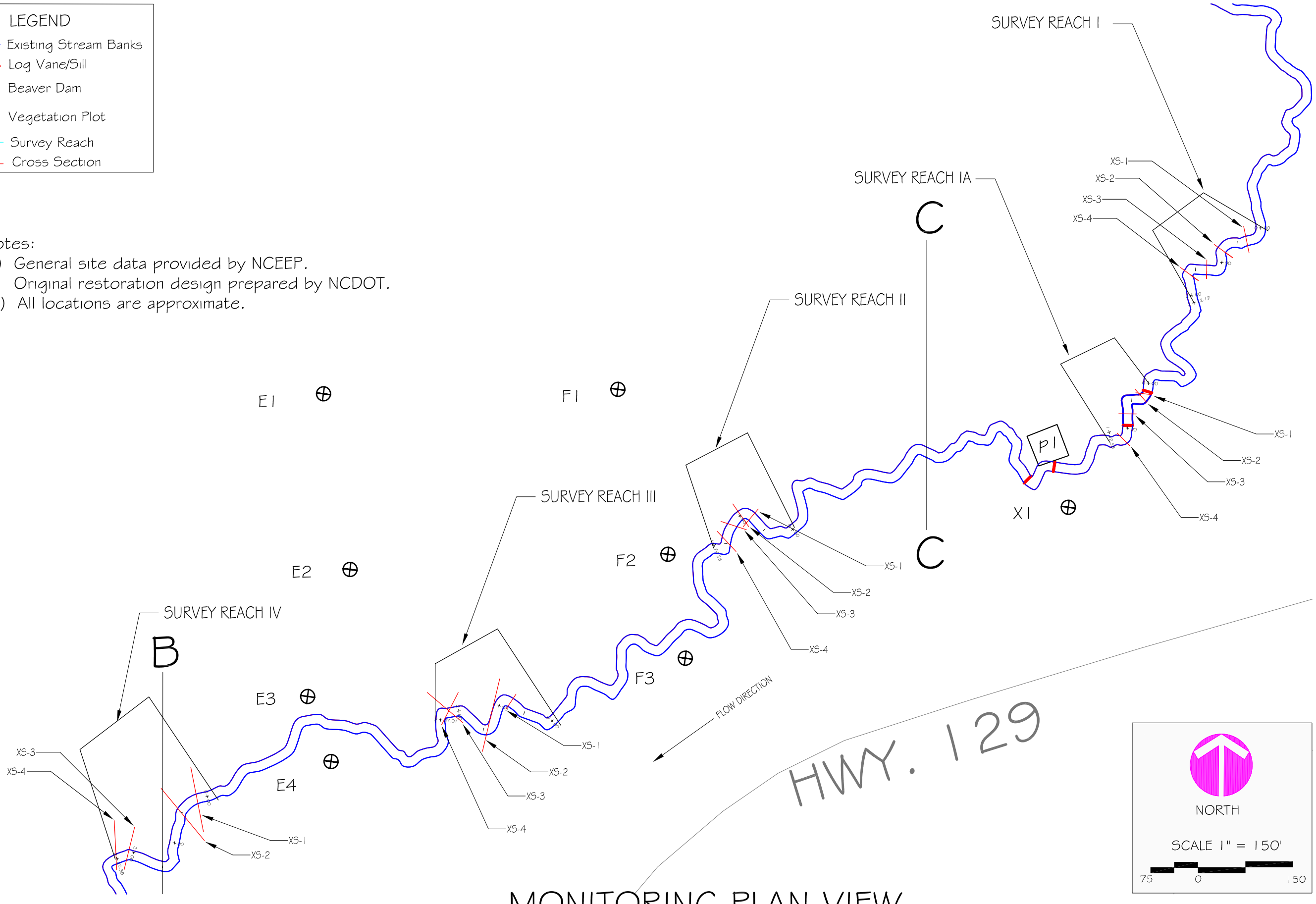
LEGEND

- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam
- Vegetation Plot
- Survey Reach
- Cross Section

Notes:

1.) General site data provided by NCEEP.
Original restoration design prepared by NCDOT.

2.) All locations are approximate.



MONITORING PLAN VIEW

JUNE 2007

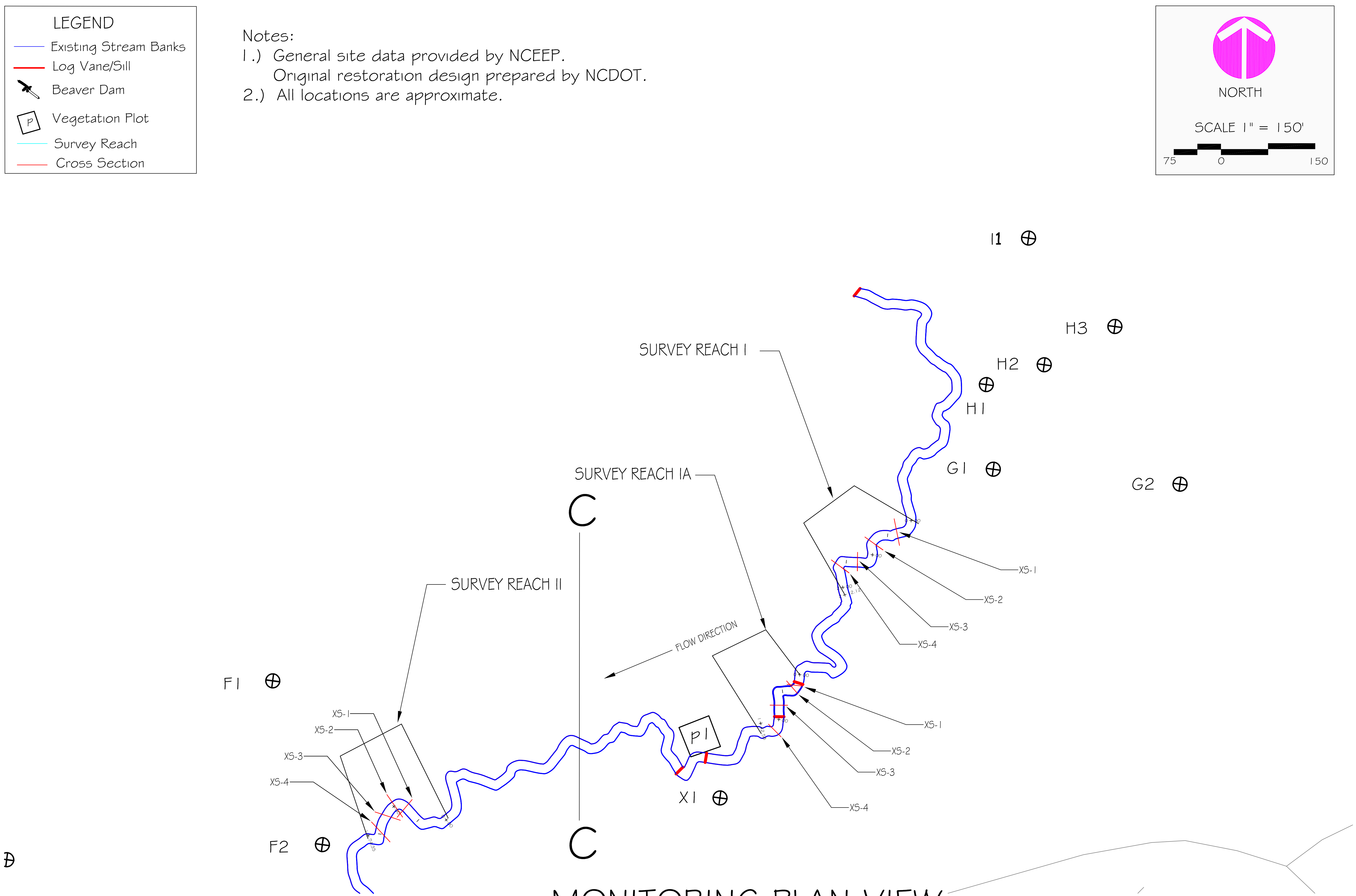
File: SecUobs7-9k\9444.D3\PAP\TULULA 2007 MONT. AND PAPV.dwg

Project:	TULULA STREAM AND WETLAND RESTORATION
Location:	WAKE CO., NC
Client:	NCEEP
Sheet Title:	MONITORING PLAN VIEW-SEGMENT 3
Project No.:	9444.D3
Proj. Mgr.:	PKS
Drawn:	JER
Scale:	1" = 150'
Sheet No.:	3 OF 8

Soil & Environmental Consultants, PA
11010 Raven Ridge Road · Raleigh, North Carolina 27614 · Phone: (919) 846-5900 · Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program



Notes:
1.) General site data provided by NCEEP.
Original restoration design prepared by NCDOT.
2.) All locations are approximate.

MONITORING PLAN VIEW

JUNE 2007

File: Sec\Jobs7-9k\9444.D3\PAPV\TULULA 2007 MONT. AND PAPV.dwg

Ecosystem Enhancement PROGRAM

S&EC

Soil & Environmental Consultants, PA
11010 Raven Ridge Road · Raleigh, North Carolina 27614 · Phone: (919) 846-5900 · Fax: (919) 846-9467
www.SandEC.com

Project: TULULA STREAM AND WETLAND RESTORATION		Project No.: 9444.D3	
Location: GRAHAM CO., NC	Client: NCEEP	Proj. Mgr.: PKS	Drawn: JER
Sheet Title: MONITORING PLAN VIEW-SEGMENT 4		Scale: 1" = 150'	
		Sheet No.: 4 OF 8	

LEGEND

Existing Stream Banks

Log Vane/Sill

Beaver Dam

PAPV LEGEND

STREAM PROBLEM AREAS-STRESSED

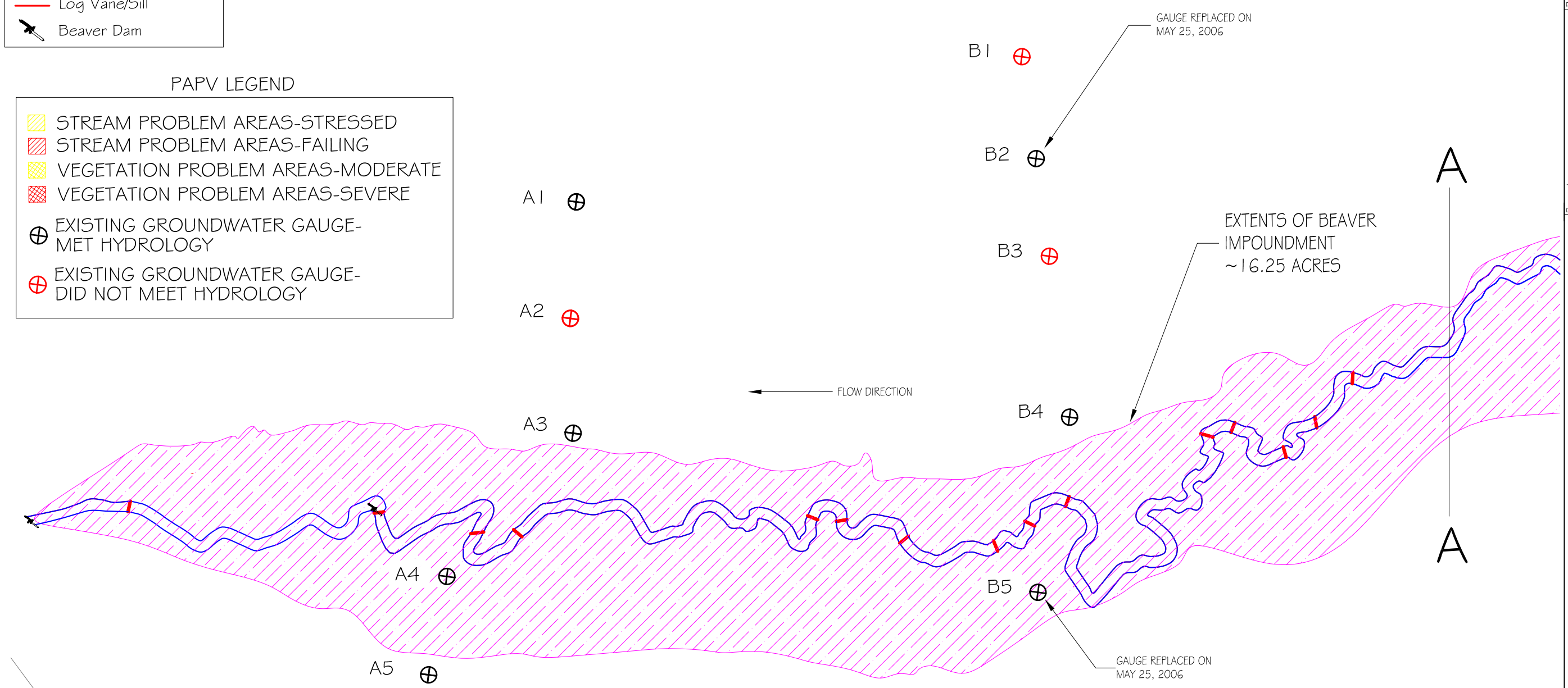
STREAM PROBLEM AREAS-FAILING

VEGETATION PROBLEM AREAS-MODERATE

VEGETATION PROBLEM AREAS-SEVERE

EXISTING GROUNDWATER GAUGE-
MET HYDROLOGY

EXISTING GROUNDWATER GAUGE-
DID NOT MEET HYDROLOGY



Notes:

1.) General site data provided by NCEEP.
Original restoration design prepared by NCDOT.

2.) Site evaluation performed by Soil and Environmental Consultants, PA on June 12, 2007.

3.) All locations are approximate.

4.) Those segments of restored channel which have been inundated due to beaver impoundments have NOT been evaluated for stability or vegetative cover.

5.) GPS boundary of beaver impoundment surveyed by S&EC.

NORTH

SCALE 1" = 150'

75 0 150

PROBLEM AREA PLAN VIEW

JUNE 2007

File: S:\Clients\7-9\9444.D3\PAPV\TULULA 2007 MONT. AND PAPV.dwg

Project No.: 9444.D3
Proj. Mgr.: PKS
Drawn: JER
Scale: 1" = 150'
Sheet No.: 5 OF 8

Project: TULULA STREAM AND WETLAND RESTORATION
Location: GRAHAM CO., NC
Client: NCEEP
Sheet Title: PAPV-SEGMENT 1

Soil & Environmental Consultants, PA
11010 Raven Ridge Road · Raleigh, North Carolina 27614 · Phone: (919) 846-5900 · Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

LEGEND

- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam

PAPV LEGEND

- STREAM PROBLEM AREAS-STRESSED
- STREAM PROBLEM AREAS-FAILING
- VEGETATION PROBLEM AREAS-MODERATE
- VEGETATION PROBLEM AREAS-SEVERE
- EXISTING GROUNDWATER GAUGE-MET HYDROLOGY
- EXISTING GROUNDWATER GAUGE-DID NOT MEET HYDROLOGY

EXTENTS OF BEAVER IMPOUNDMENT ~16.25 ACRES

EXTENTS OF BEAVER IMPOUNDMENT ~2 ACRES

A

A

B

B

D1

D2

D3

C1

C2

FLOW DIRECTION

HWY. 129

Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by NCDOT.
2.) Site evaluation performed by Soil and Environmental Consultants, PA on June 12, 2007.
3.) All locations are approximate.
4.) Those segments of restored channel which have been inundated due to beaver impoundments have NOT been evaluated for stability or vegetative cover.
5.) GPS boundary of beaver impoundment surveyed by S&EC.

NORTH

SCALE 1" = 150'

75 0 150

PROBLEM AREA PLAN VIEW

JUNE 2007

File: S:\eCJobs\7-9\9444 D3\PAPV\TULULA 2007 MONT. AND PAPV.dwg

Project No.: 9444.D3
Proj. Mgr.: PKS
Drawn: JER
Scale: 1" = 150'
Sheet No.: 6 OF 8

Project: TULULA STREAM AND WETLAND RESTORATION
Location: GRAHAM CO., NC
Client: NCEEP
Sheet Title: PAPV-SEGMENT 2

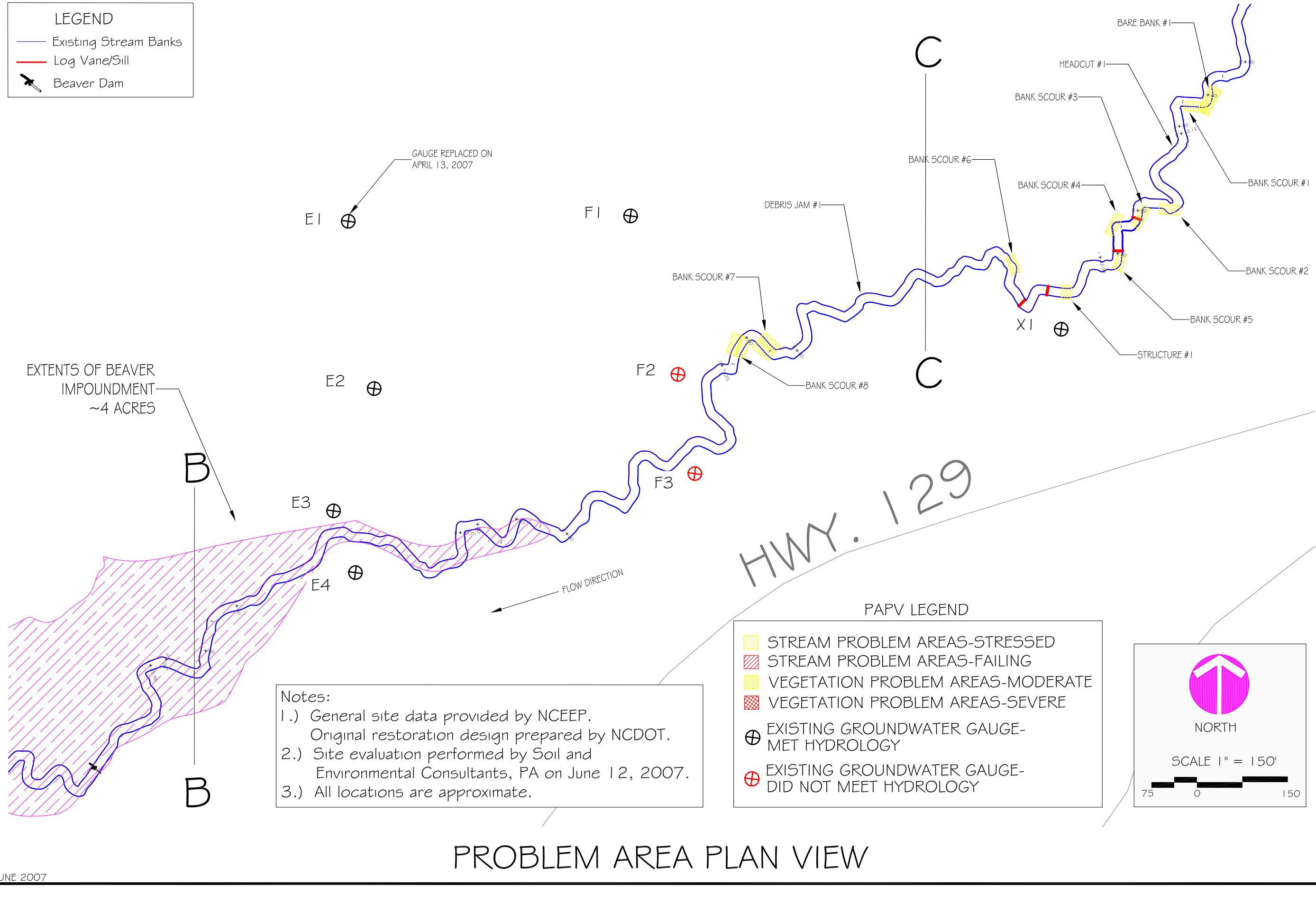
Soil & Environmental Consultants, PA
11010 Raven Ridge Road · Raleigh, North Carolina 27614 · Phone: (919) 846-5900 · Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

LEGEND

- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam



Notes:
1.) General site data provided by NCEEP. Original restoration design prepared by NCDOT.
2.) Site evaluation performed by Soil and Environmental Consultants, PA on June 12, 2007.
3.) All locations are approximate.

PAPV LEGEND

- STREAM PROBLEM AREAS-STRESSED
- STREAM PROBLEM AREAS-FAILING
- VEGETATION PROBLEM AREAS-MODERATE
- VEGETATION PROBLEM AREAS-SEVERE
- ⊕ EXISTING GROUNDWATER GAUGE-MET HYDROLOGY
- ⊕ EXISTING GROUNDWATER GAUGE-DID NOT MEET HYDROLOGY

NORTH

SCALE 1" = 150'

75 0 150

PROBLEM AREA PLAN VIEW

JUNE 2007

Project No.: 9444.D3
Proj. Mgr.: PKS
Drawn: JER
Project: TULULA STREAM AND WETLAND RESTORATION
Location: WAKE CO., NC
Client: NCEEP
Scale: 1" = 150'
Sheet Title: PAPV-SEGMENT 3
Sheet No.: 7 OF 8

Soil & Environmental Consultants, PA
11010 Raven Ridge Road • Raleigh, North Carolina 27614 • Phone: (919) 846-5900 • Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

File: S:\cJobs\7-9k\9444.D3\PAPV\TULULA 2007 MONT. AND PAPV.dwg

LEGEND

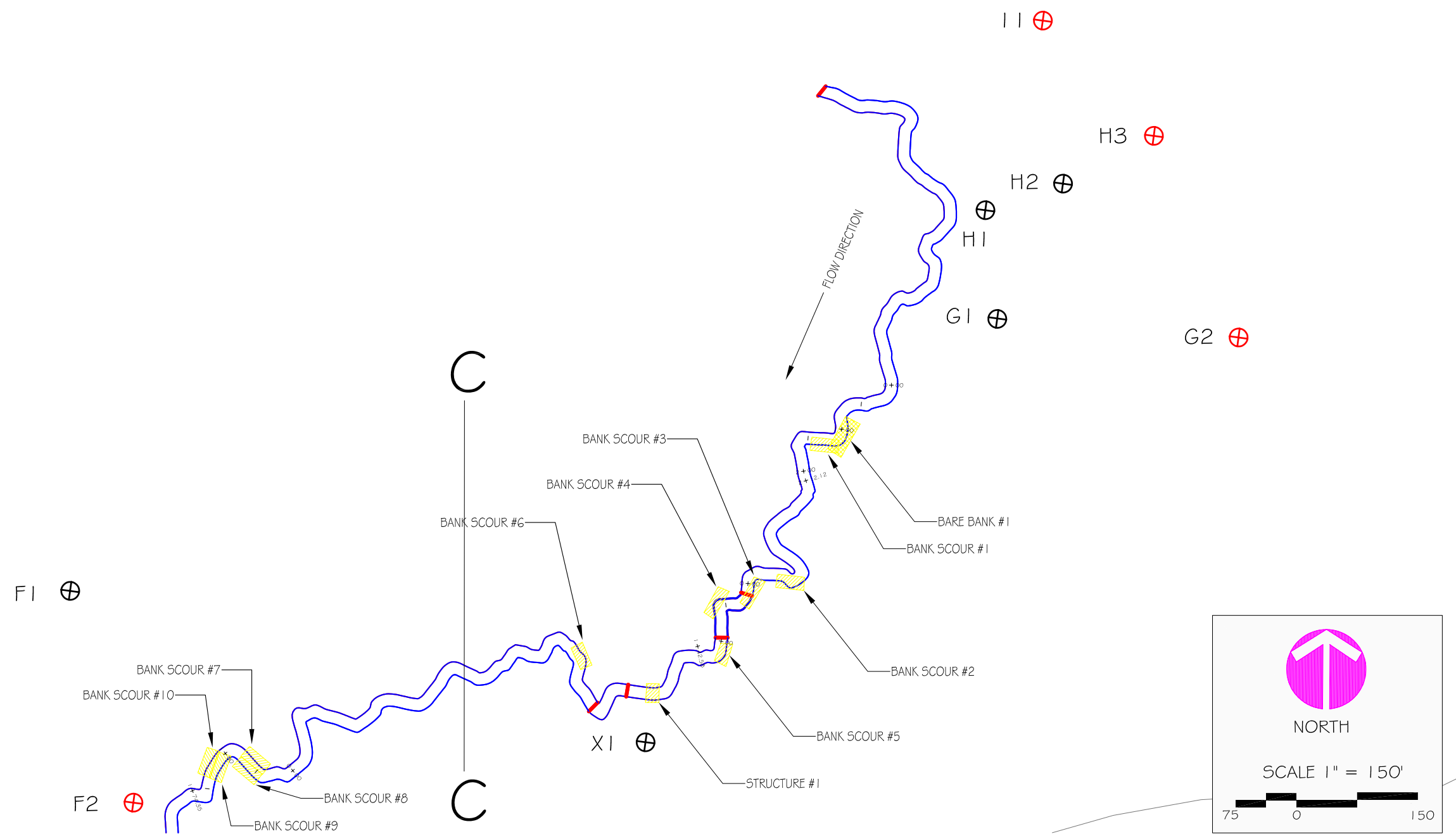
- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam

PAPV LEGEND

- STREAM PROBLEM AREAS-STRESSED
- STREAM PROBLEM AREAS-FAILING
- VEGETATION PROBLEM AREAS-MODERATE
- VEGETATION PROBLEM AREAS-SEVERE
- EXISTING GROUNDWATER GAUGE- MET HYDROLOGY
- EXISTING GROUNDWATER GAUGE- DID NOT MEET HYDROLOGY

Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by NCDOT.
2.) Site evaluation performed by Soil and Environmental Consultants, PA on June 12, 2007.
3.) All locations are approximate.



PROBLEM AREA PLAN VIEW

JUNE 2007

File: Sec\dwgs7-9\9444 DS\PAPV\TULULA 2007 MONT AND PAPV.dwg

Project: TULULA STREAM AND WETLAND RESTORATION
Location: GRAHAM CO., NC
Client: NCEEP
Sheet Title: PAPV-SEGMENT 4

Project No.: 9444.03
Proj. Mgr.: PKS
Drawn: JER
Scale: 1" = 150'
Sheet No.: 8 OF 8

Soil & Environmental Consultants, PA
11010 Raven Ridge Road · Raleigh, North Carolina 27614 · Phone: (919) 846-5900 · Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

APPENDIX A

APPENDIX A –

Vegetation Survey Data Tables

Table VIII: Stem Counts for Each Species Arranged by Plot Tulula Bog Stream and Wetland Mitigation Site (EEP Project # 392)								
	Plots							Year 5
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
***Nyssa sylvatica* (Black Gum)**								0
***Quercus rubra* (Northern Red Oak)**	5		0		0	3	1	9
***Betula nigra* (River Birch)**		4						4
***Liriodendron tulipifera* (Tulip Poplar)**		3	0	14	0	13	1	31
***Quercus alba* (White Oak)**	9	6		3	0	1		19
***Prunus serotina* (Black Cherry)**							8	8
Year 5 Totals	**14**	**13**	**0**	**17**	**0**	**17**	**10**	**71**
Year 4 Totals	**17**	**13**	**11**	**17**	**0**	**18**	**11**	87
Year 3 Totals	21	13	14	18	4	18	11	99
Year 2 Totals	32	26	25	22	4	23	15	147
Planted Live Stem Density	567	526	0	688	0	688	405	
Average Live Stem Density								410
Survival % Per Plot	**82%**	**100%**	**0%**	**100%**	**0%**	**94%**	**91%**	**82%**
Survival % Per Plot (from Year 2)	44%	50%	0%	77%	0%	74%	67%	48%

APPENDIX A –

Vegetation Problem Area Photos

Figure 1— Bare Bank 1 (July 12, 2007)

APPENDIX A –

Vegetation Monitoring Plot Photos

Vegetation Monitoring Plot #1—Year 5 (June 12, 2007)

Vegetation Monitoring Plot #1—Year 4 (August 22, 2006)

Vegetation Monitoring Plot #2—Year 5 (June 12, 2007)

Vegetation Monitoring Plot #2—Year 4 (August 22, 2006)

Vegetation Monitoring Plot #3—Year 5 (June 12, 2007)

Vegetation Monitoring Plot #3—Year 4 (August 22, 2006)

Vegetation Monitoring Plot #4—Year 5 (June 12, 2007)

Vegetation Monitoring Plot #4—Year 4 (August 22, 2006)

Vegetation Monitoring Plot #5—Year 5 (June 12, 2007)

Vegetation Monitoring Plot #5—Year 4 (August 22, 2006)

Vegetation Monitoring Plot #6—Year 5 (June 12, 2007)

Vegetation Monitoring Plot #6—Year 4 (August 22, 2006)

Vegetation Monitoring Plot #7—Year 5 (June 12, 2007)

Vegetation Monitoring Plot #7—Year 4 (August 22, 2006)

APPENDIX B

APPENDIX B –

Representative Stream Problem Area Photos

Figure 1— Typical Bank Scour (November 13, 2007)

Figure 2—Typical Bank Scour (November 13, 2007)

Figure 3— Typical Bank Scour (November 13, 2007)

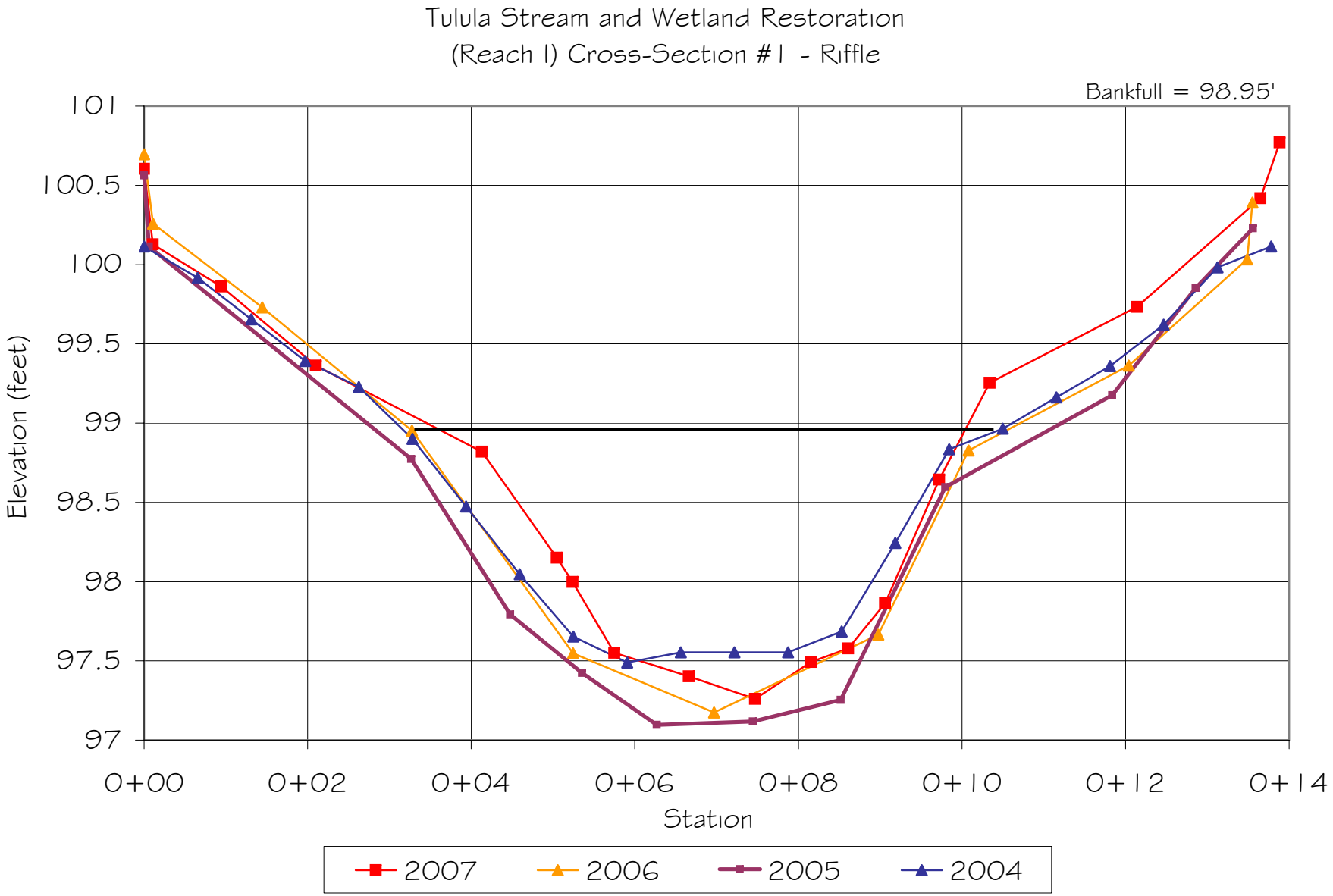
Figure 4—Typical Bank Scour (November 13, 2007)

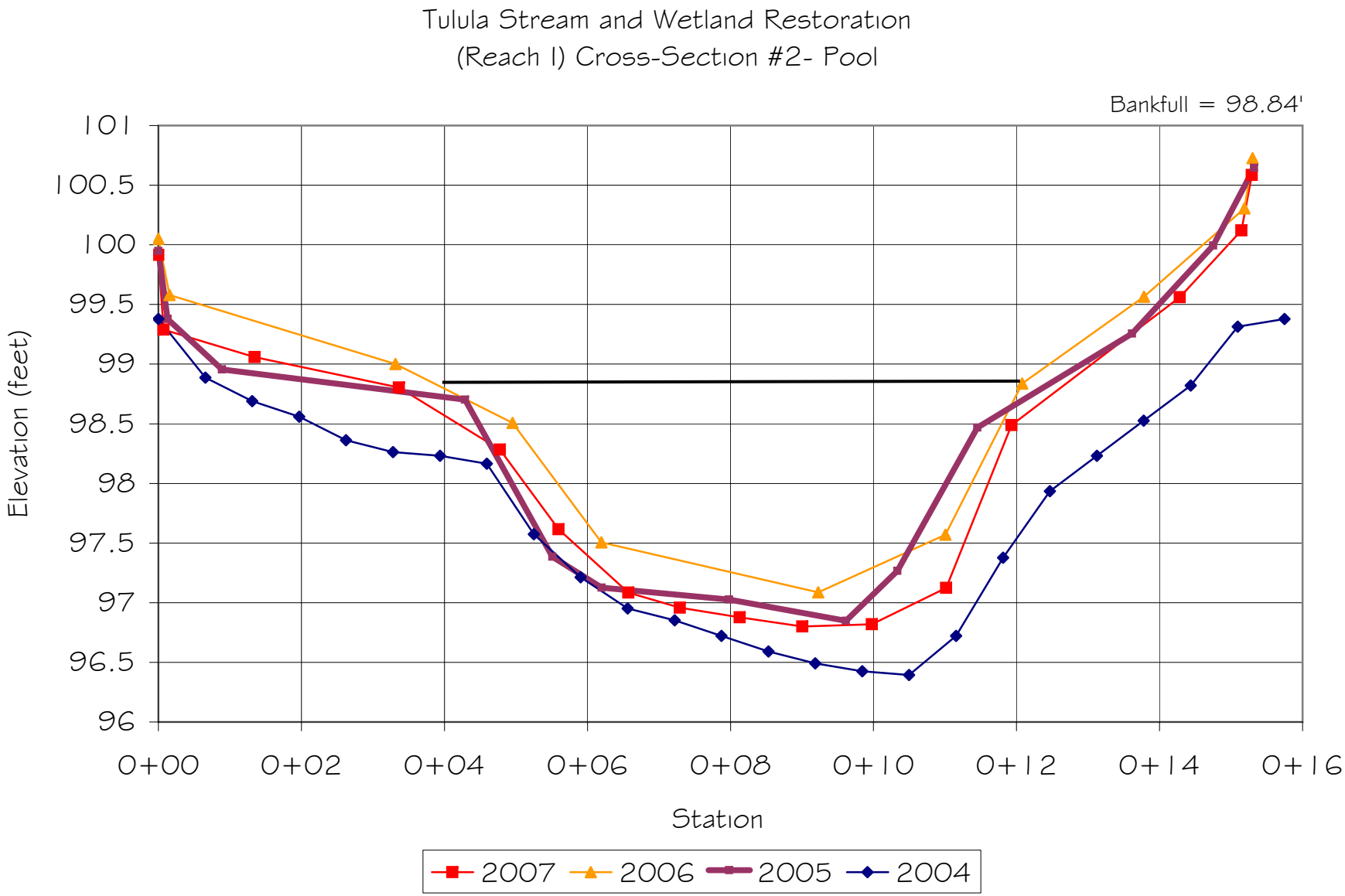
Figure 5—Typical Bank Scour (November 13, 2007)

Figure 6—Typical Bank Scour (November 13, 2007)

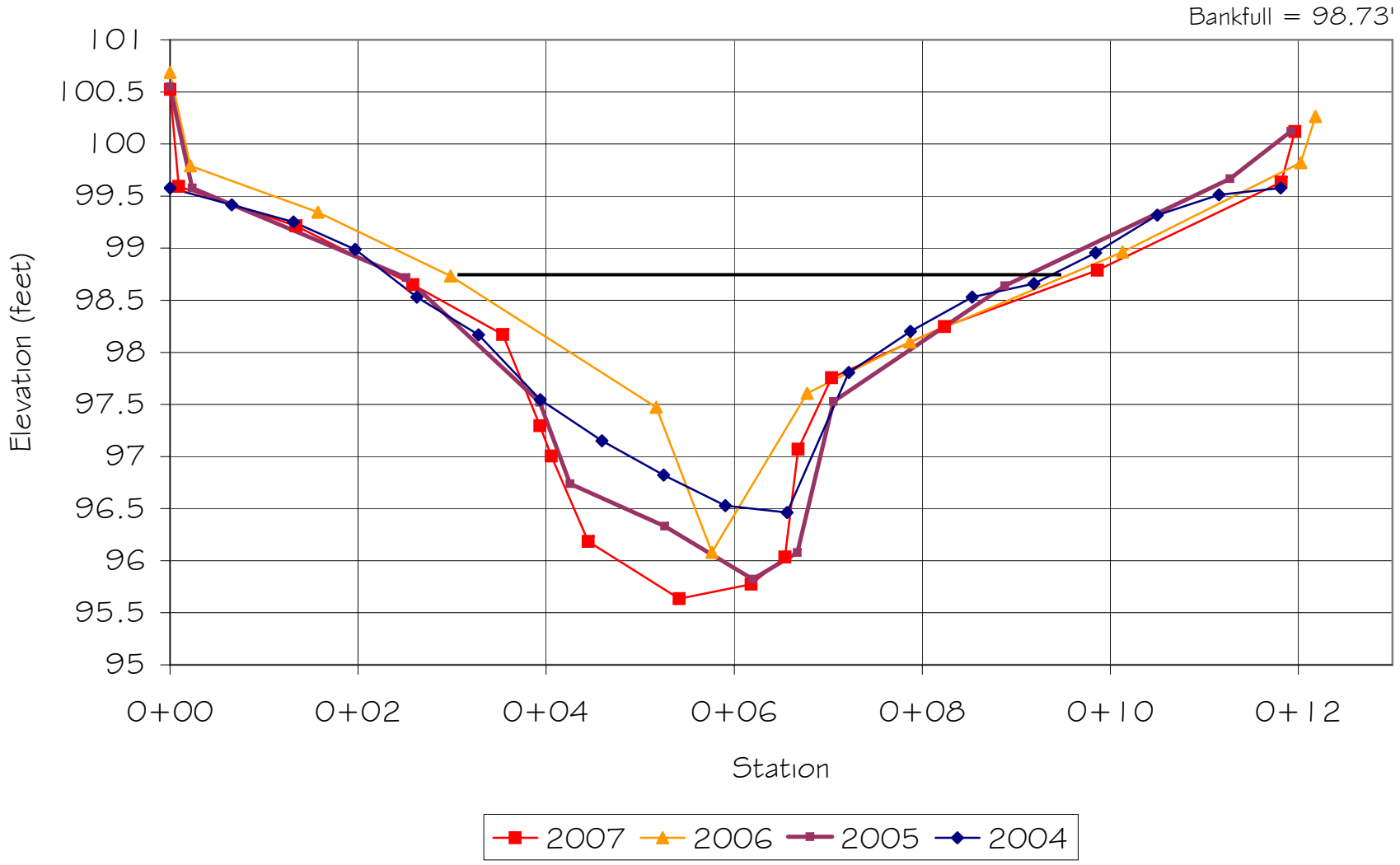
APPENDIX B –

Cross-section Data

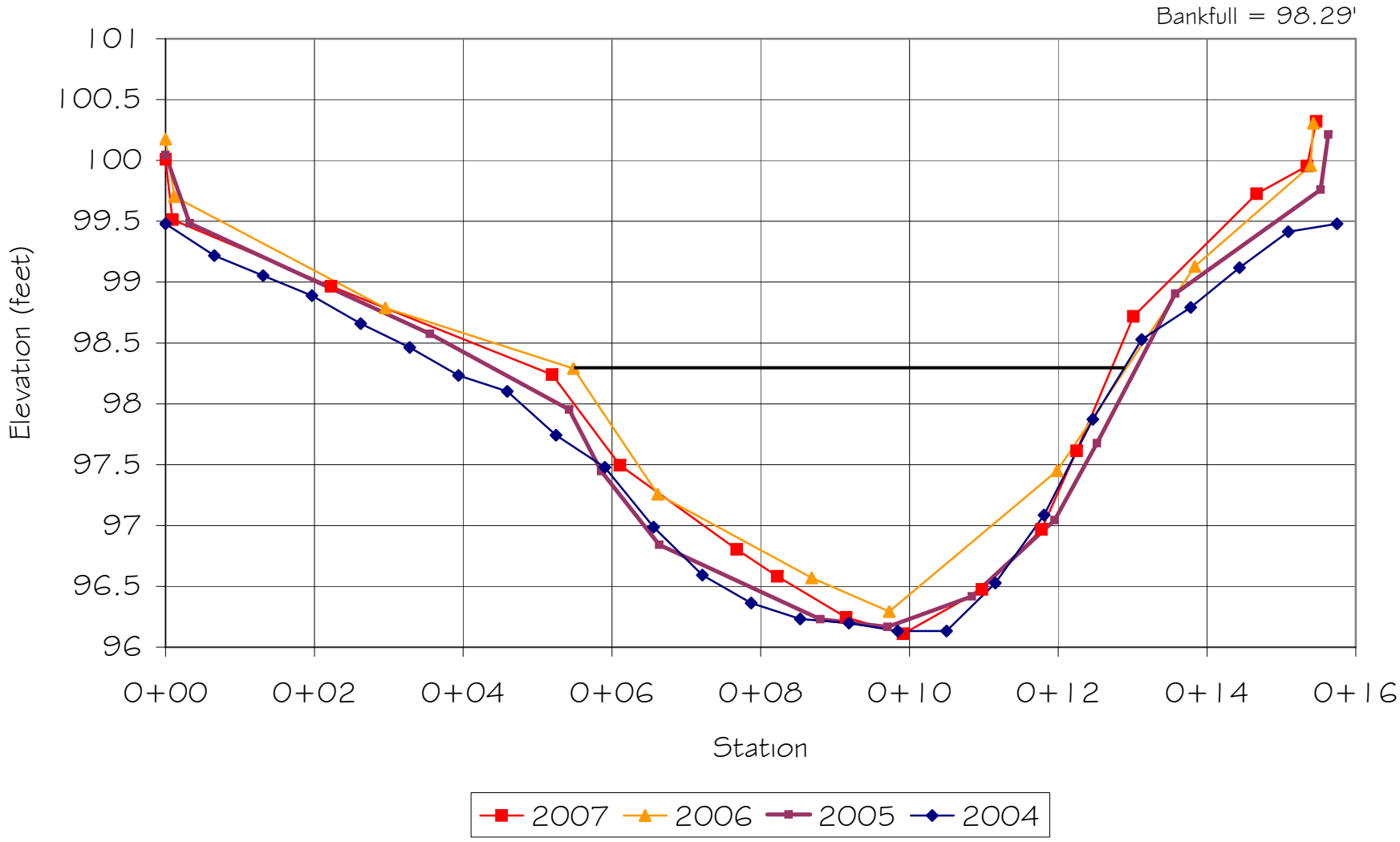

Tulula Stream and Wetland Restoration
(Reach 1) Cross-Section #1 - Riffle
Bankfull = 98.95'
101
100.5
100
99.5
99
98.5
98
97.5
97
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
Station
2007
2006
2005
2004

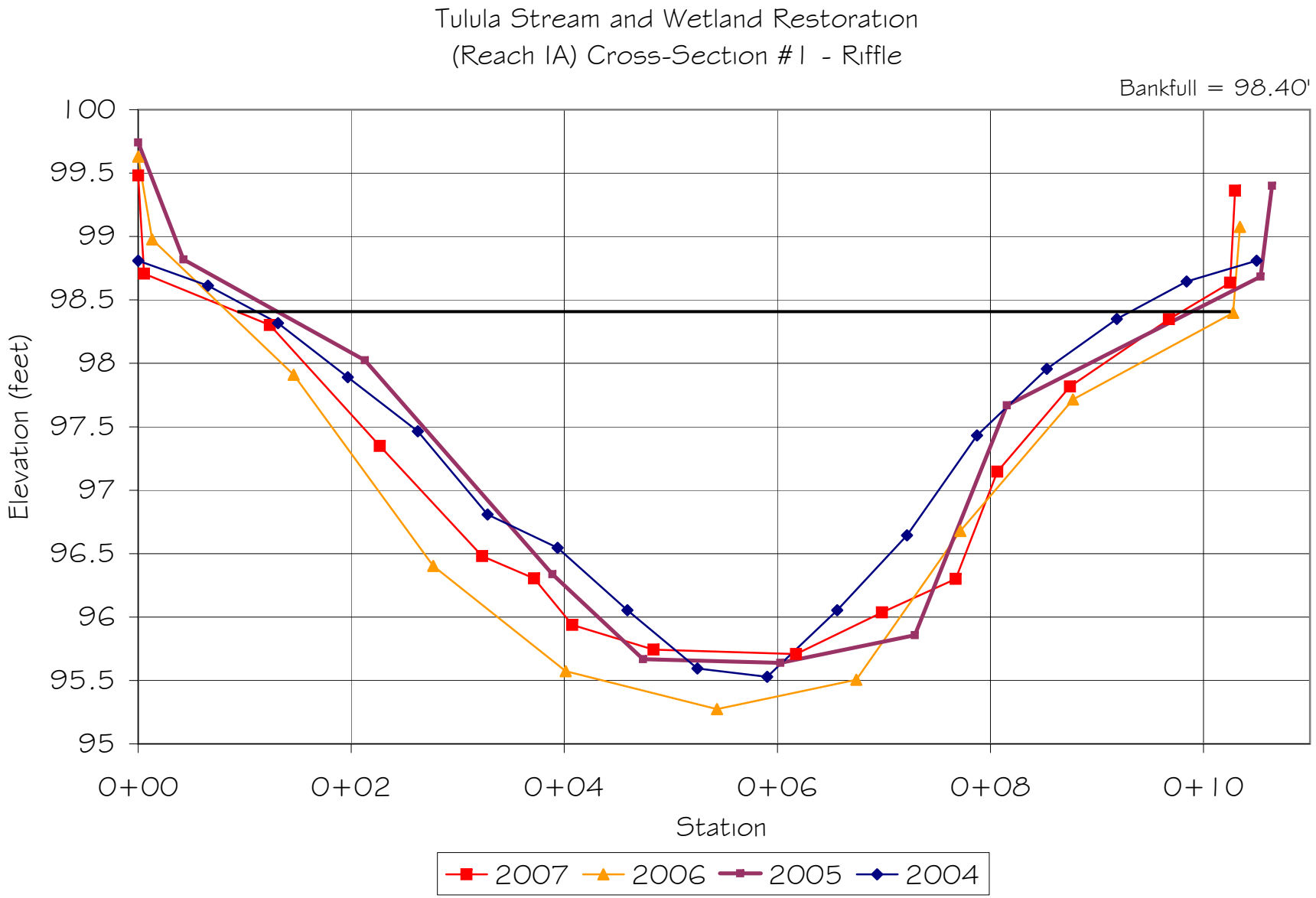

Tulula Stream and Wetland Restoration
(Reach 1) Cross-Section #2- Pool
Bankfull = 98.84'
101
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
0+16
Station
2007
2006
2005
2004

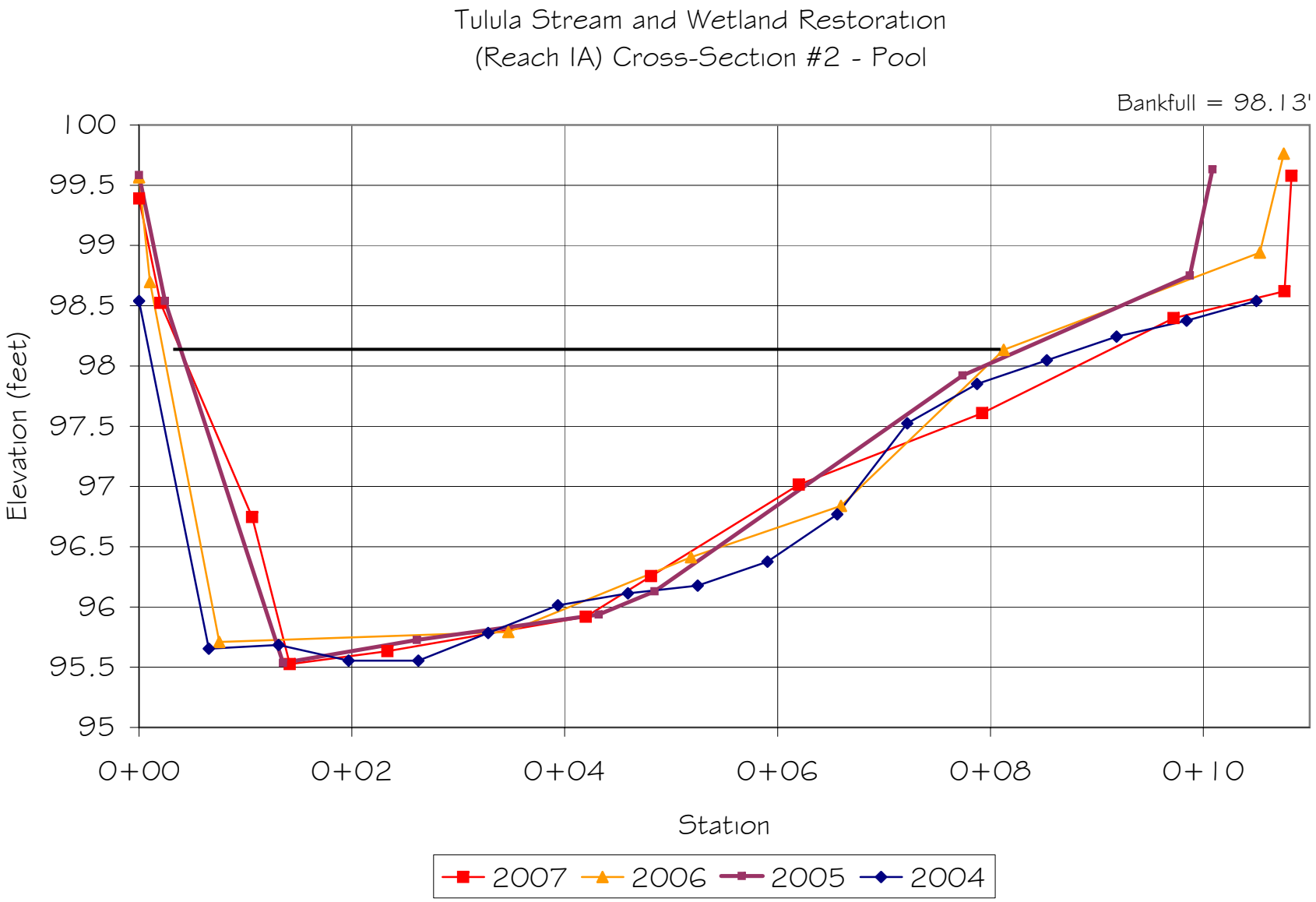
Tulula Stream and Wetland Restoration
(Reach 1) Cross-Section #3 - Riffle

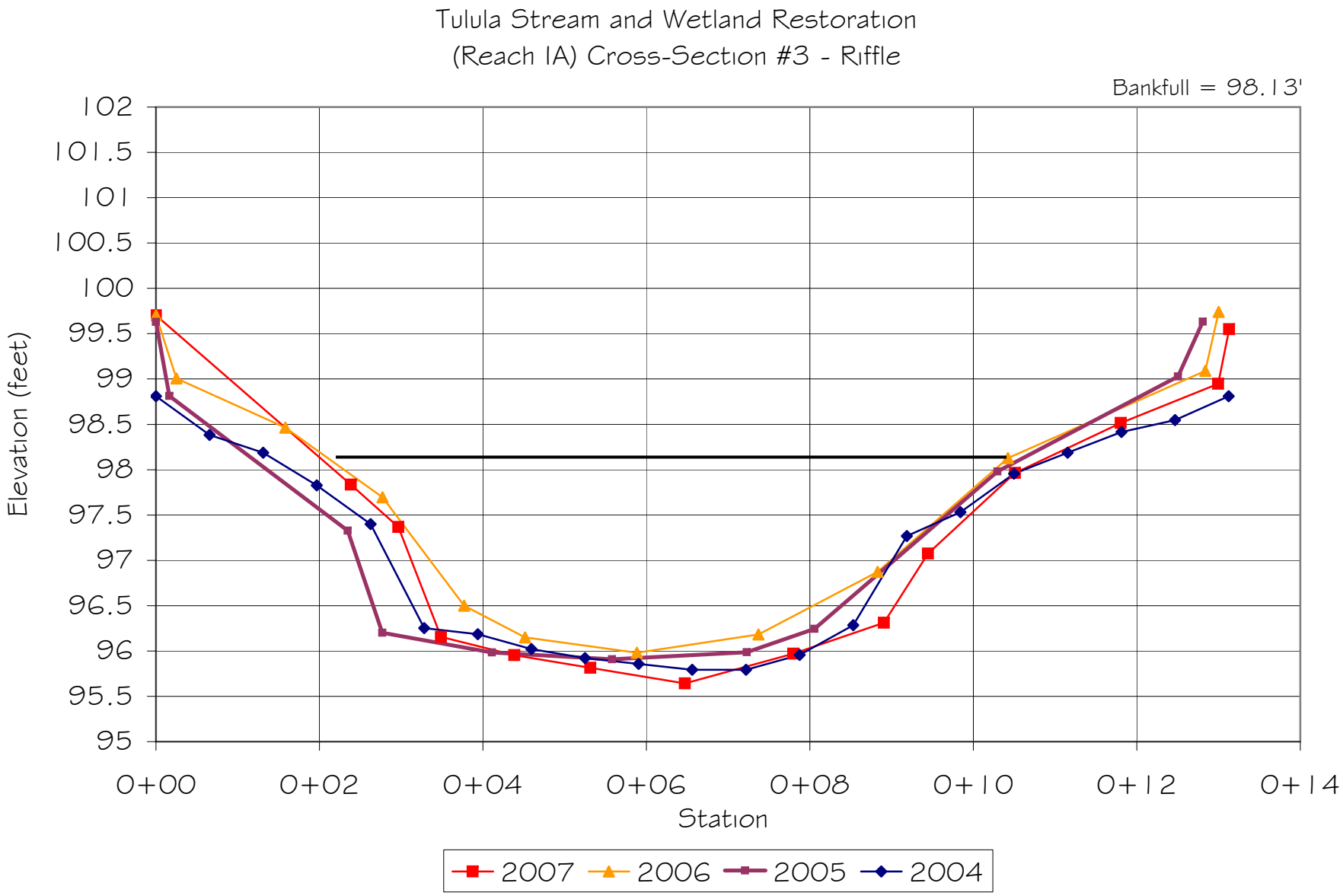


Tulula Stream and Wetland Restoration
(Reach 1) Cross-Section #4 - Pool

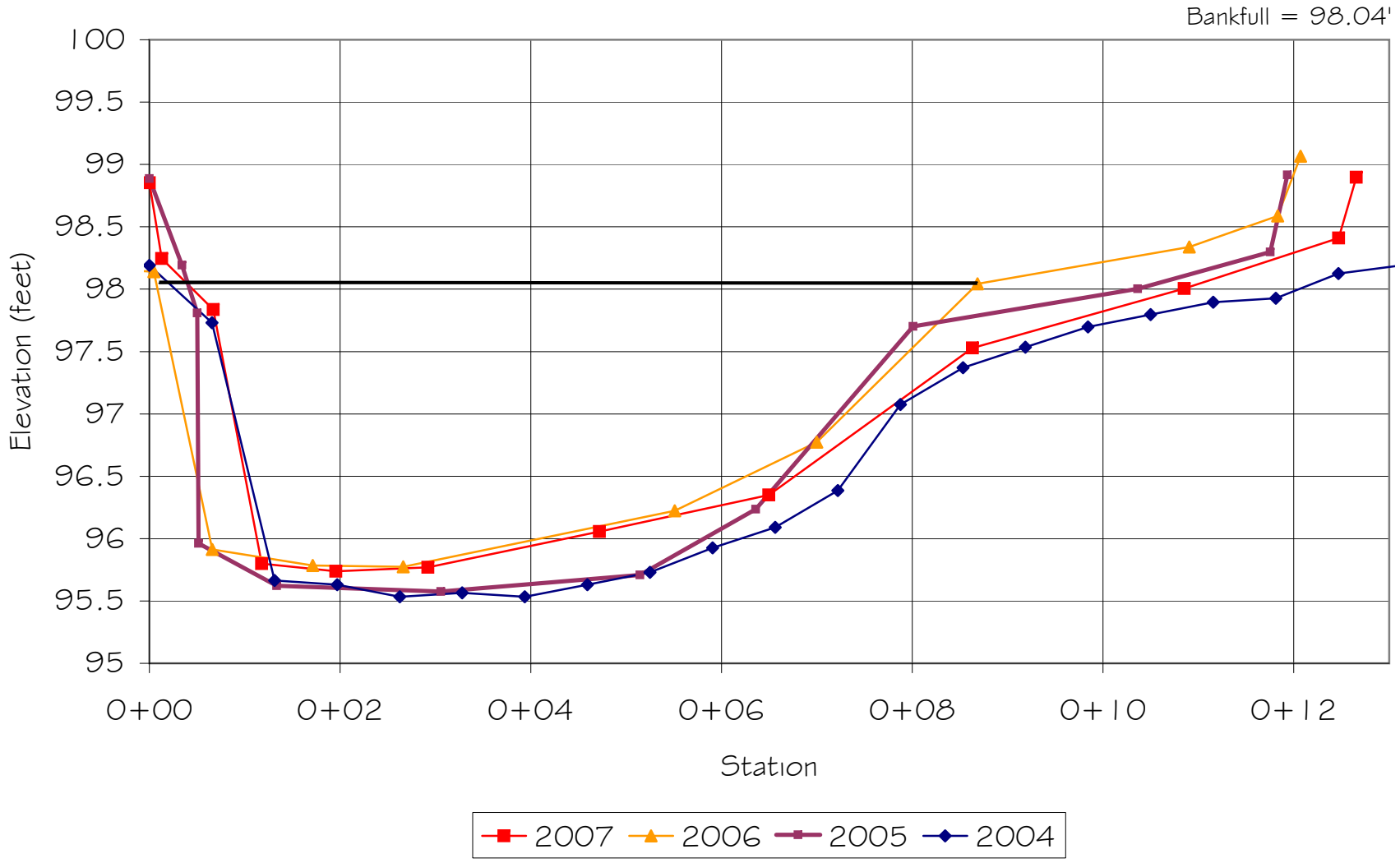



Tulula Stream and Wetland Restoration
(Reach 1A) Cross-Section #1 - Riffle
Bankfull = 98.40'
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
Station
2007
2006
2005
2004

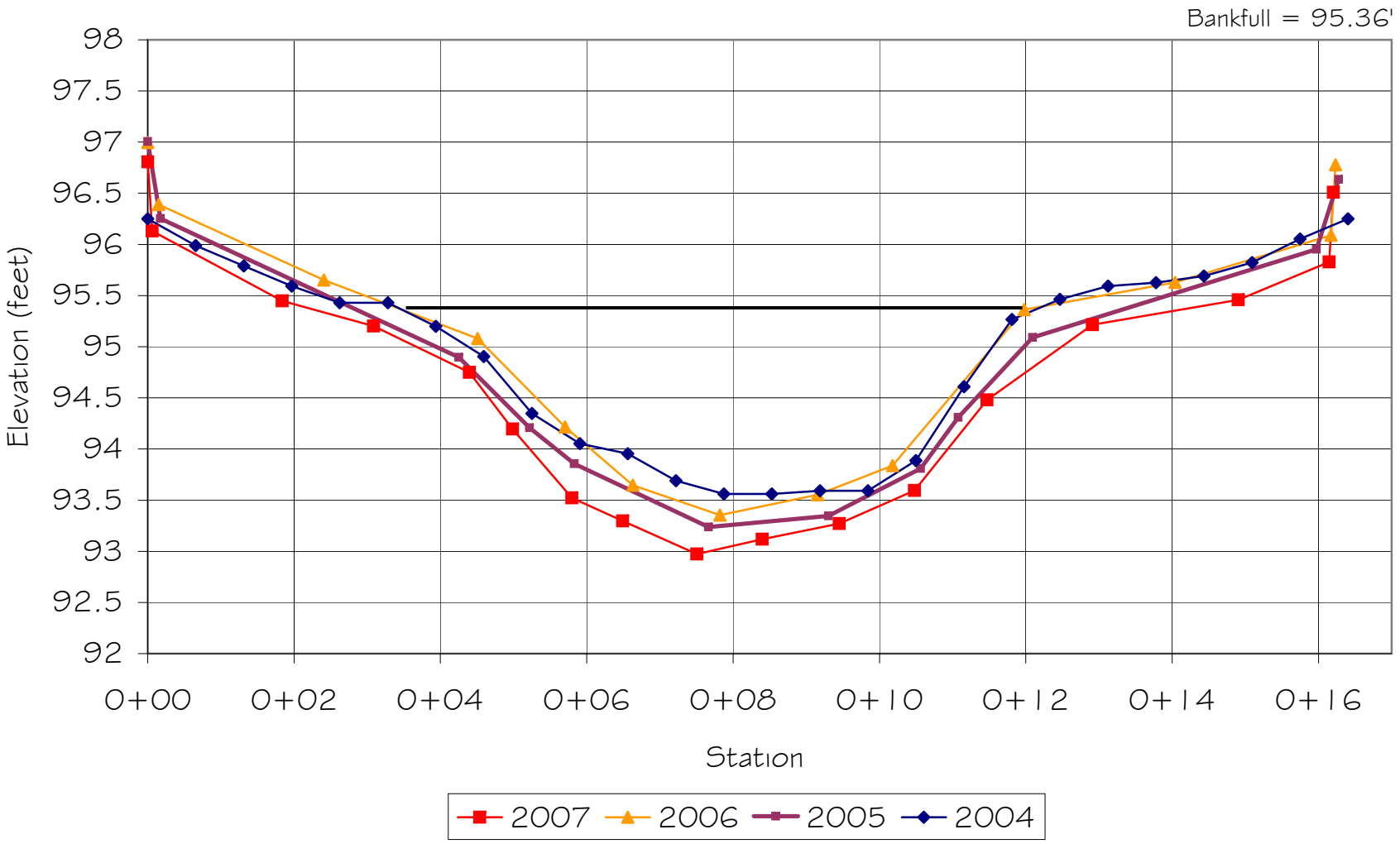

Tulula Stream and Wetland Restoration
(Reach 1A) Cross-Section #2 - Pool
Bankfull = 98.13'
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
Station
2007
2006
2005
2004


Tulula Stream and Wetland Restoration
(Reach 1A) Cross-Section #3 - Riffle
Bankfull = 98.13'
Elevation (feet)
102
101.5
101
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
Station
2007
2006
2005
2004

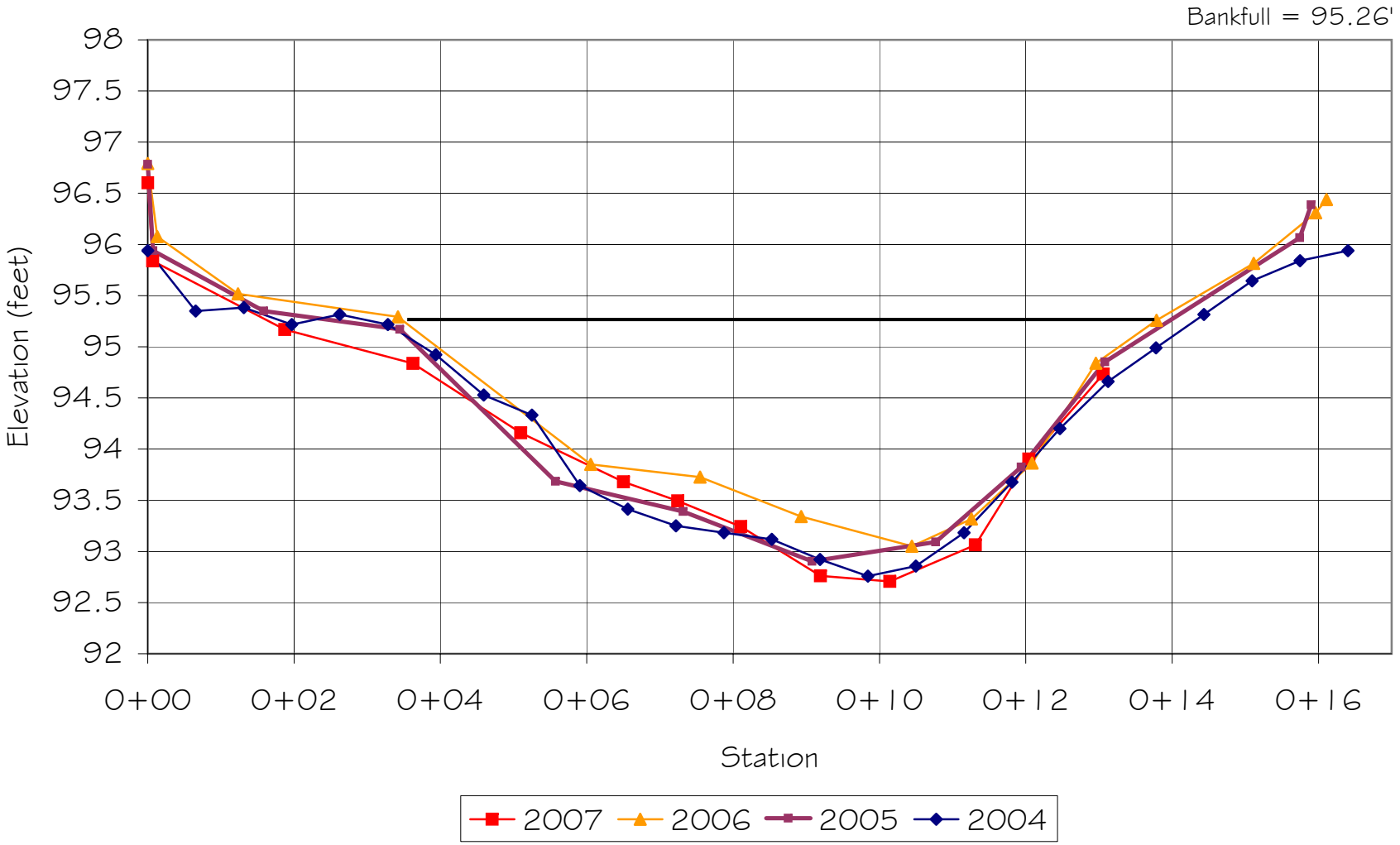
Tulula Stream and Wetland Restoration
(Reach 1A) Cross-Section #4 - Pool



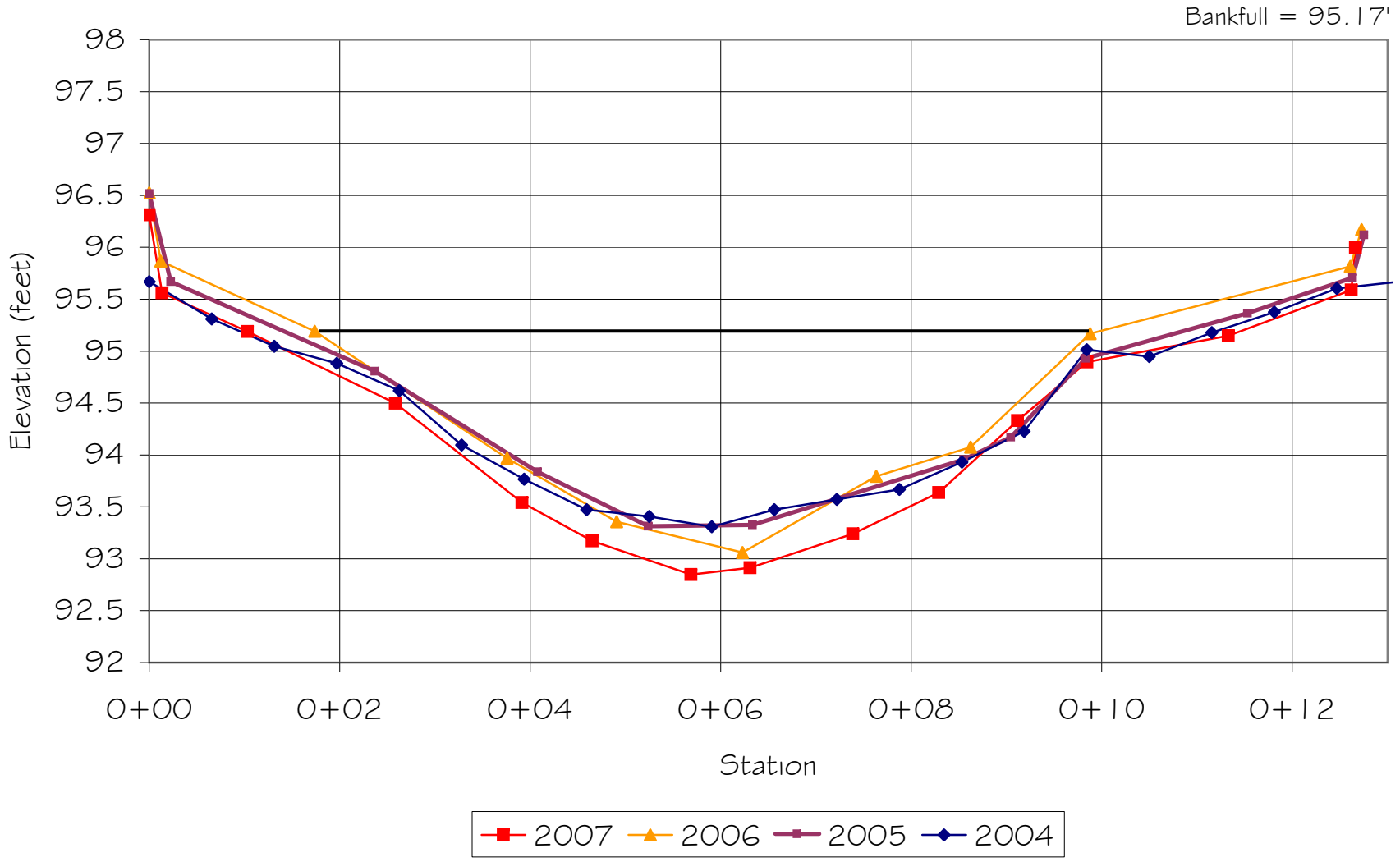
Tulula Stream and Wetland Restoration
(Reach II) Cross-Section #1 - Riffle

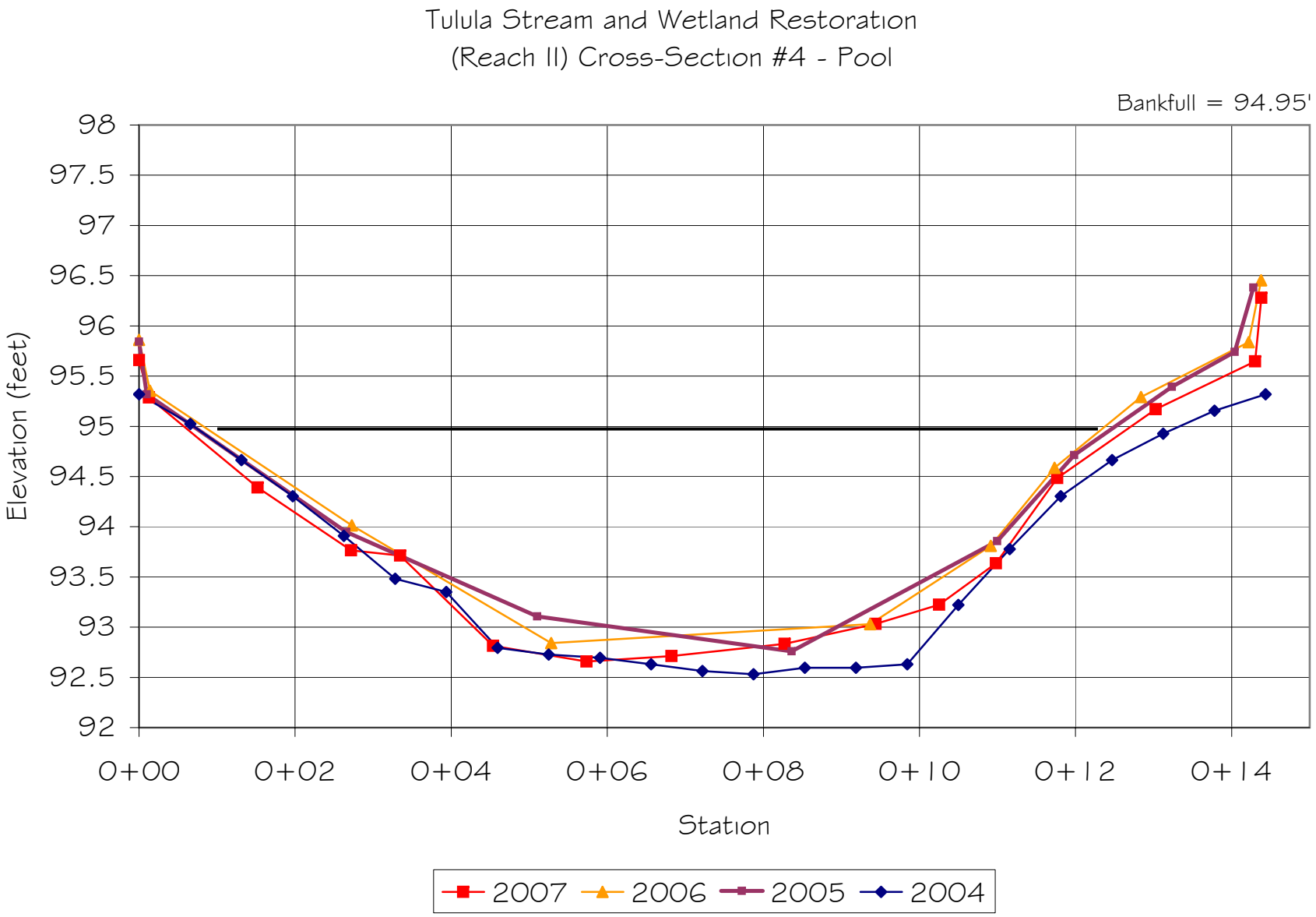


Tulula Stream and Wetland Restoration
(Reach II) Cross-Section #2 - Pool

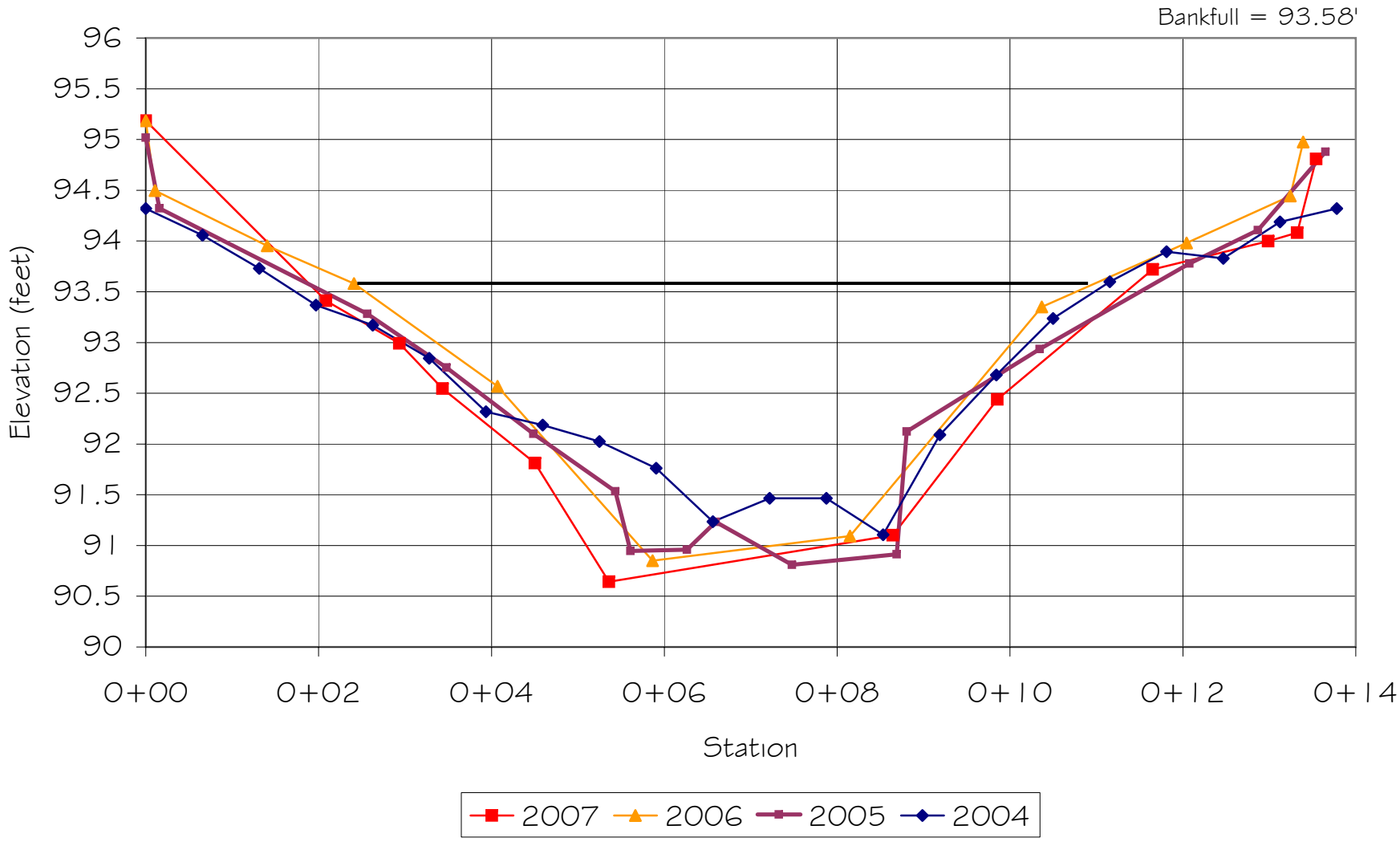


Tulula Stream and Wetland Restoration
(Reach II) Cross-Section #3 - Riffle

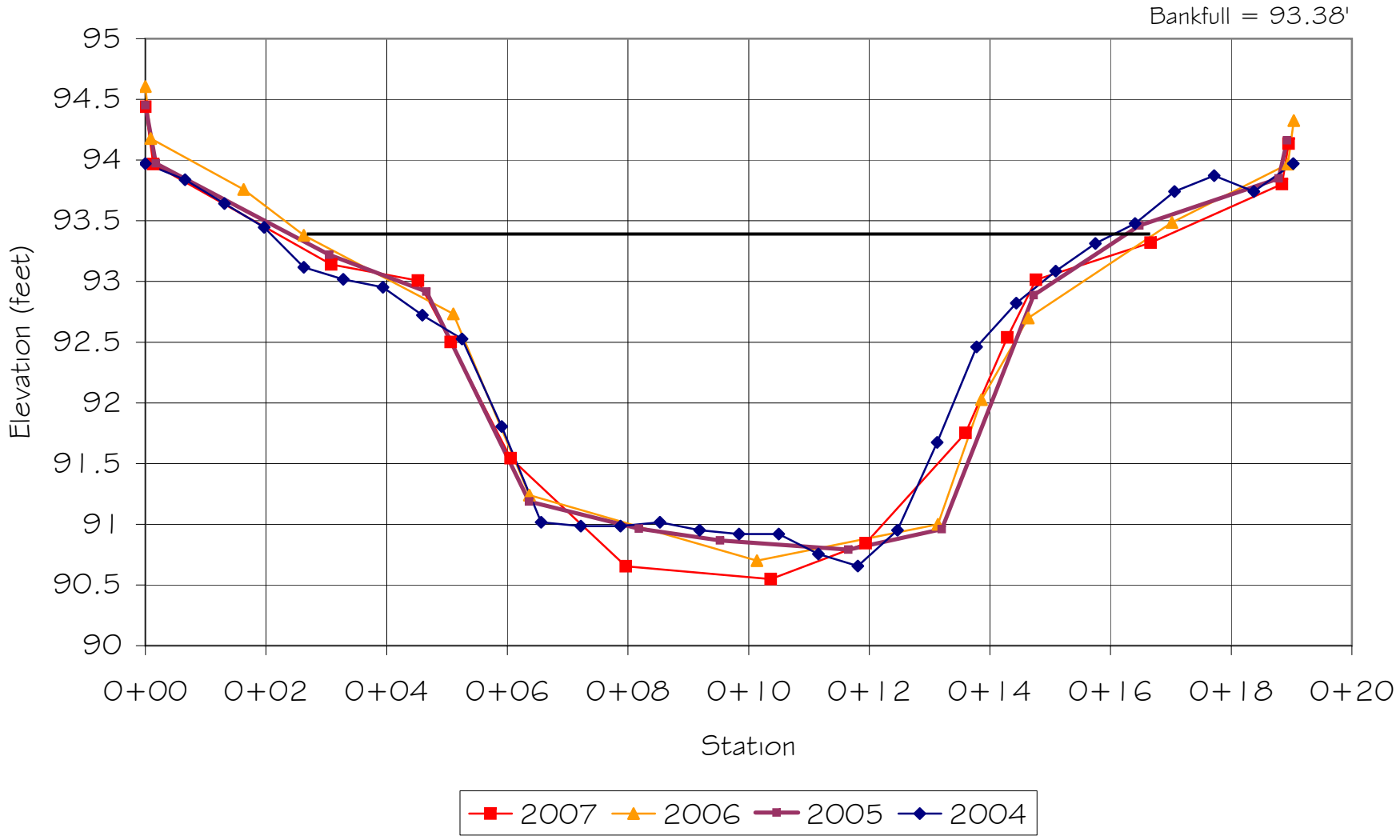



Tulula Stream and Wetland Restoration
(Reach II) Cross-Section #4 - Pool
Bankfull = 94.95'
Elevation (feet)
98
97.5
97
96.5
96
95.5
95
94.5
94
93.5
93
92.5
92
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
Station
2007
2006
2005
2004

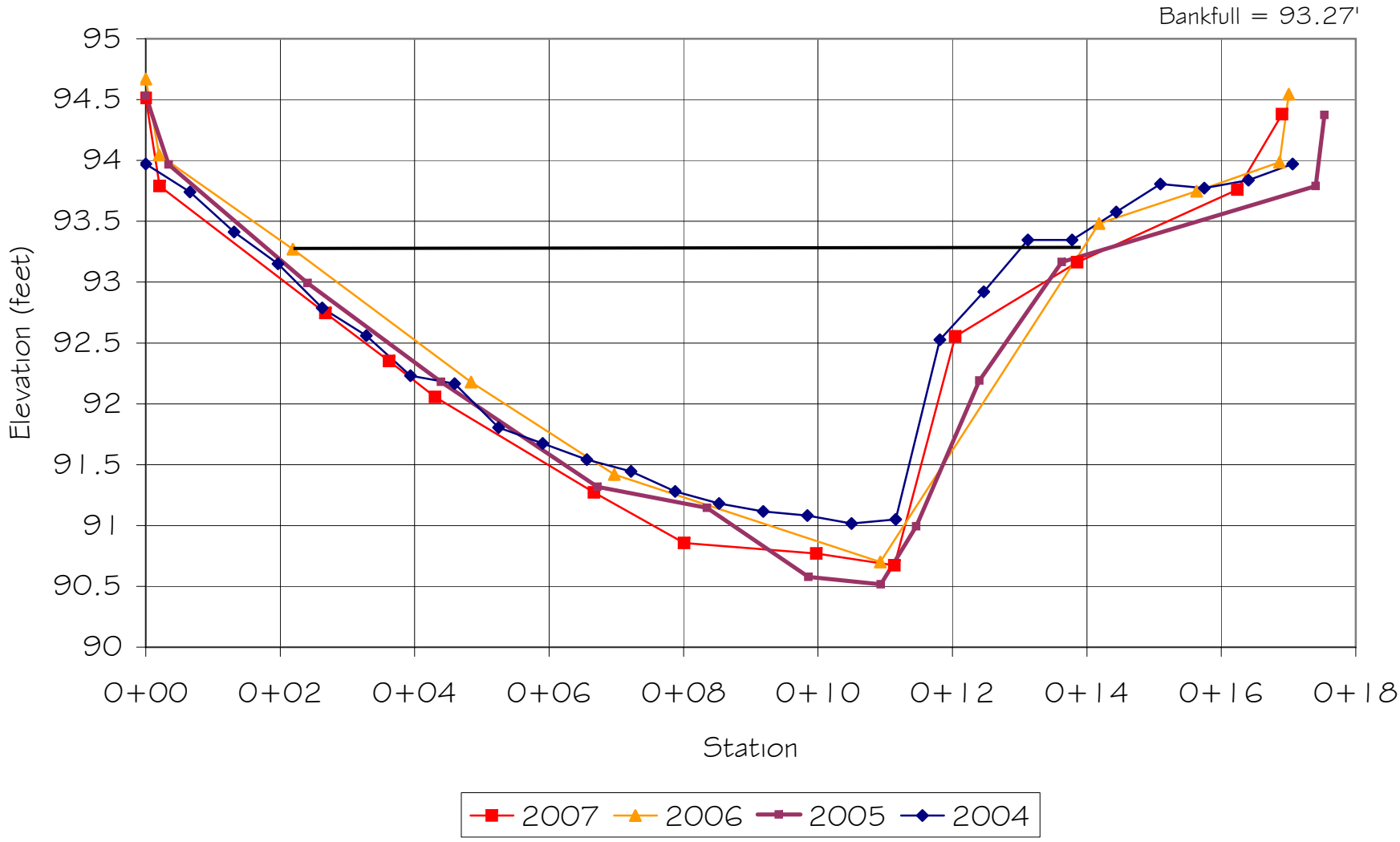
Tulula Stream and Wetland Restoration
(Reach III) Cross-Section #1 - Riffle



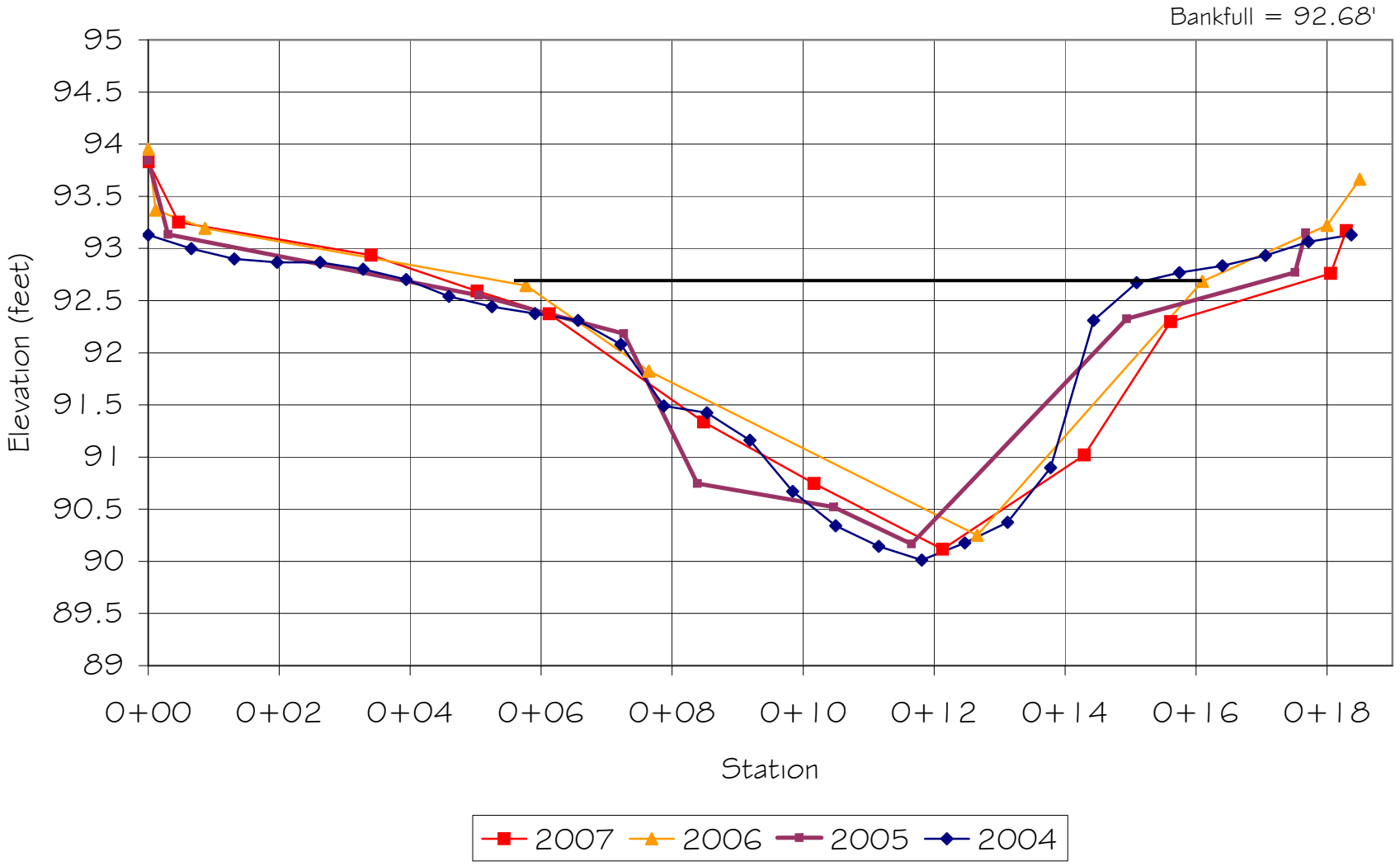
Tulula Stream and Wetland Restoration
(Reach III) Cross-Section #2 - Pool



Tulula Stream and Wetland Restoration
(Reach III) Cross-Section #3 - Riffle



Tulula Stream and Wetland Restoration
(Reach III) Cross-Section #4 - Pool



Reach 1, Cross-section #1, Riffle 1 (November 13, 2007)

Reach 1, Cross-section #1, Riffle 1 (November 15, 2006)

Reach 1, Cross-section #2, Pool 1 (November 13, 2007)

Reach 1, Cross-section #2, Pool 1 (November 15, 2006)

Reach 1, Cross-section #3, Riffle 2 (November 13, 2007)

Reach 1, Cross-section #3, Riffle 2 (November 15, 2006)

Reach 1, Cross-section #4, Pool 2 (November 13, 2007)

Reach 1, Cross-section #4, Pool 2 (November 15, 2006)

Reach 1A, Cross-section #1, Riffle 1 (November 13, 2007)

Reach 1A, Cross-section #1, Riffle 1 (November 15, 2006)

Reach 1A, Cross-section #2, Pool 1 (November 13, 2007)

Reach 1A, Cross-section #2, Pool 1 (November 15, 2006)

Reach 1A, Cross-section #3, Riffle 2 (November 13, 2007)

Reach 1A, Cross-section #3, Riffle 2 (November 15, 2006)

Reach 1A, Cross-section #4, Pool 2 (November 13, 2007)

Reach 1A, Cross-section #4, Pool 2 (November 15, 2006)

Reach 11, Cross-section #1, Riffle 1 (November 13, 2007)

Reach 11, Cross-section #1, Riffle 1 (November 15, 2006)

Reach II, Cross-section #2, Pool 1 (November 13, 2007)

Reach II, Cross-section #2, Pool 1 (November 15, 2006)

Reach 11, Cross-section #3, Riffle 2 (November 13, 2007)

Reach 11, Cross-section #3, Riffle 2 (November 15, 2006)

Reach II, Cross-section #4, Pool 2 (November 13, 2007)

Reach II, Cross-section #4, Pool 2 (November 15, 2006)

Reach III, Cross-section #1, Riffle 1 (November 13, 2007)

Reach III, Cross-section #1, Riffle 1 (November 15, 2006)

Reach III, Cross-section #2, Pool 1 (November 13, 2007)

Reach III, Cross-section #2, Pool 1 (November 15, 2006)

Reach III, Cross-section #3, Riffle 2 (November 13, 2007)

Reach III, Cross-section #3, Riffle 2 (November 15, 2006)

Reach III, Cross-section #4, Pool 2 (November 13, 2007)

Reach III, Cross-section #4, Pool 2 (November 15, 2006)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R1XS1
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	100.603	
0.11	0	100.128	
0.94	0	99.861	
2.1	0	99.363	
4.13	0	98.82	
5.05	0	98.15	
5.24	0	97.998	
5.75	0	97.551	
6.66	0	97.403	
7.47	0	97.26	
8.15	0	97.492	
8.61	0	97.579	
9.06	0	97.863	
9.72	0	98.644	
10.34	0	99.254	
12.14	0	99.733	
13.65	0	100.418	
13.88	0	100.77	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	100.64	100.64	100.64
Bankfull Elevation (ft)	98.95	98.95	98.95
Floodprone Width (ft)	13.8	-----	-----
Bankfull Width (ft)	6.39	3.19	3.19
Entrenchment Ratio	2.16	-----	-----
Mean Depth (ft)	1.04	0.89	1.19
Maximum Depth (ft)	1.69	1.58	1.69
Width/Depth Ratio	6.14	3.58	2.68
Bankfull Area (sq ft)	6.66	2.84	3.81
Wetted Perimeter (ft)	7.48	5.24	5.4
Hydraulic Radius (ft)	0.89	0.54	0.71
Begin BKF Station	3.64	3.64	6.84
End BKF Station	10.03	6.84	10.03

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: r1xs2
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	99.916	
0.07	0	99.289	
1.35	0	99.058	
3.36	0	98.804	
4.78	0	98.284	
5.59	0	97.615	
6.57	0	97.085	
7.29	0	96.959	
8.13	0	96.878	
9.01	0	96.801	
9.98	0	96.819	
11.02	0	97.125	
11.93	0	98.488	
14.28	0	99.561	
15.15	0	100.121	
15.29	0	100.585	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	100.88	100.88	100.88
Bankfull Elevation (ft)	98.84	98.84	98.84
Floodprone Width (ft)	15.29	-----	-----
Bankfull Width (ft)	9.63	4.81	4.81
Entrenchment Ratio	1.59	-----	-----
Mean Depth (ft)	1.28	1.05	1.5
Maximum Depth (ft)	2.04	1.94	2.04
Width/Depth Ratio	7.52	4.58	3.21
Bankfull Area (sq ft)	12.28	5.06	7.22
Wetted Perimeter (ft)	10.96	7.23	7.61
Hydraulic Radius (ft)	1.12	0.7	0.95
Begin BKF Station	3.08	3.08	7.89
End BKF Station	12.7	7.89	12.7

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R1XS3
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	100.523	
0.09	0	99.594	
1.34	0	99.214	
2.58	0	98.649	
3.54	0	98.17	
3.93	0	97.295	
4.05	0	97.005	
4.45	0	96.184	
5.42	0	95.634	
6.18	0	95.774	
6.54	0	96.034	
6.68	0	97.069	
7.04	0	97.756	
8.24	0	98.247	
9.86	0	98.789	
11.82	0	99.634	
11.96	0	100.12	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	101.83	101.83	101.83
Bankfull Elevation (ft)	98.73	98.73	98.73
Floodprone Width (ft)	11.96	-----	-----
Bankfull Width (ft)	7.28	3.64	3.64
Entrenchment Ratio	1.64	-----	-----
Mean Depth (ft)	1.35	1.75	0.94
Maximum Depth (ft)	3.1	3.1	2.98
Width/Depth Ratio	5.39	2.08	3.87
Bankfull Area (sq ft)	9.8	6.38	3.43
Wetted Perimeter (ft)	10.42	8.18	8.2
Hydraulic Radius (ft)	0.94	0.78	0.42
Begin BKF Station	2.4	2.4	6.04
End BKF Station	9.68	6.04	9.68

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R1XS4
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	100.009	
0.09	0	99.513	
2.23	0	98.965	
5.2	0	98.239	
6.11	0	97.495	
7.68	0	96.804	
8.22	0	96.582	
9.15	0	96.245	
9.91	0	96.11	
10.97	0	96.474	
11.78	0	96.967	
12.25	0	97.614	
13.01	0	98.719	
14.67	0	99.726	
15.35	0	99.954	
15.47	0	100.321	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	100.47	100.47	100.47
Bankfull Elevation (ft)	98.29	98.29	98.29
Floodprone Width (ft)	15.47	-----	-----
Bankfull Width (ft)	7.72	3.86	3.86
Entrenchment Ratio	2	-----	-----
Mean Depth (ft)	1.35	1.09	1.61
Maximum Depth (ft)	2.18	1.94	2.18
Width/Depth Ratio	5.72	3.54	2.4
Bankfull Area (sq ft)	10.41	4.2	6.21
Wetted Perimeter (ft)	9.14	6.3	6.71
Hydraulic Radius (ft)	1.14	0.67	0.93
Begin BKF Station	4.99	4.99	8.85
End BKF Station	12.71	8.85	12.71

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R1A XS1
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	99.48	
0.06	0	98.707	
1.24	0	98.301	
2.27	0	97.348	
3.23	0	96.48	
3.72	0	96.304	
4.07	0	95.937	
4.84	0	95.742	
6.17	0	95.708	
6.98	0	96.037	
7.67	0	96.301	
8.06	0	97.145	
8.75	0	97.818	
9.68	0	98.348	
10.25	0	98.635	
10.3	0	99.361	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	101.09	101.09	101.09
Bankfull Elevation (ft)	98.4	98.4	98.4
Floodprone Width (ft)	10.3	-----	-----
Bankfull Width (ft)	8.83	4.42	4.41
Entrenchment Ratio	1.17	-----	-----
Mean Depth (ft)	1.64	1.63	1.66
Maximum Depth (ft)	2.69	2.67	2.69
Width/Depth Ratio	5.38	2.71	2.66
Bankfull Area (sq ft)	14.52	7.19	7.32
Wetted Perimeter (ft)	10.85	8.02	8.16
Hydraulic Radius (ft)	1.34	0.9	0.9
Begin BKF Station	0.95	0.95	5.37
End BKF Station	9.78	5.37	9.78

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R1A XS2
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	99.39	
0.2	0	98.523	
1.06	0	96.746	
1.42	0	95.525	
2.34	0	95.632	
4.2	0	95.918	
4.81	0	96.256	
6.2	0	97.014	
7.92	0	97.608	
9.72	0	98.396	
10.76	0	98.62	
10.83	0	99.577	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	100.73	100.73	100.73
Bankfull Elevation (ft)	98.13	98.13	98.13
Floodprone Width (ft)	10.83	-----	-----
Bankfull Width (ft)	8.72	4.36	4.36
Entrenchment Ratio	1.24	-----	-----
Mean Depth (ft)	1.49	2.07	0.9
Maximum Depth (ft)	2.6	2.6	1.91
Width/Depth Ratio	5.85	2.11	4.84
Bankfull Area (sq ft)	12.95	9.04	3.91
Wetted Perimeter (ft)	11.02	8.16	6.68
Hydraulic Radius (ft)	1.18	1.11	0.59
Begin BKF Station	0.39	0.39	4.75
End BKF Station	9.11	4.75	9.11

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R1A XS3
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	99.7026	
2.39	0	97.836	
2.97	0	97.367	
3.49	0	96.156	
4.39	0	95.955	
5.31	0	95.813	
6.47	0	95.641	
7.8	0	95.969	
8.91	0	96.311	
9.44	0	97.074	
10.51	0	97.963	
11.8	0	98.516	
13	0	98.947	
13.13	0	99.55	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	100.62	100.62	100.62
Bankfull Elevation (ft)	98.13	98.13	98.13
Floodprone Width (ft)	13.13	-----	-----
Bankfull Width (ft)	8.89	4.44	4.44
Entrenchment Ratio	1.48	-----	-----
Mean Depth (ft)	1.64	1.75	1.53
Maximum Depth (ft)	2.49	2.49	2.49
Width/Depth Ratio	5.42	2.54	2.9
Bankfull Area (sq ft)	14.54	7.76	6.78
Wetted Perimeter (ft)	10.84	8.04	7.78
Hydraulic Radius (ft)	1.34	0.97	0.87
Begin BKF Station	2.01	2.01	6.46
End BKF Station	10.9	6.46	10.9

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R1A XS4
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	98.853	
0.13	0	98.246	
0.67	0	97.836	
1.18	0	95.8	
1.96	0	95.738	
2.92	0	95.769	
4.72	0	96.056	
6.5	0	96.35	
8.63	0	97.529	
10.85	0	98.005	
12.47	0	98.409	
12.66	0	98.898	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	100.34	100.34	100.34
Bankfull Elevation (ft)	98.04	98.04	98.04
Floodprone Width (ft)	12.66	-----	-----
Bankfull Width (ft)	10.59	5.29	5.29
Entrenchment Ratio	1.2	-----	-----
Mean Depth (ft)	1.39	1.95	0.82
Maximum Depth (ft)	2.3	2.3	1.82
Width/Depth Ratio	7.62	2.71	6.45
Bankfull Area (sq ft)	14.67	10.3	4.37
Wetted Perimeter (ft)	12.66	8.81	7.49
Hydraulic Radius (ft)	1.16	1.17	0.58
Begin BKF Station	0.4	0.4	5.7
End BKF Station	10.99	5.7	10.99

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R2 XS1
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	96.807	
0.06	0	96.132	
1.84	0	95.447	
3.09	0	95.203	
4.4	0	94.749	
4.99	0	94.196	
5.8	0	93.521	
6.49	0	93.298	
7.51	0	92.974	
8.4	0	93.117	
9.45	0	93.271	
10.48	0	93.595	
11.47	0	94.479	
12.91	0	95.214	
14.91	0	95.459	
16.15	0	95.828	
16.2	0	96.51	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	97.75	97.75	97.75
Bankfull Elevation (ft)	95.36	95.36	95.36
Floodprone Width (ft)	16.2	-----	-----
Bankfull Width (ft)	11.82	5.91	5.91
Entrenchment Ratio	1.37	-----	-----
Mean Depth (ft)	1.22	1.27	1.16
Maximum Depth (ft)	2.39	2.39	2.28
Width/Depth Ratio	9.69	4.65	5.09
Bankfull Area (sq ft)	14.38	7.51	6.86
Wetted Perimeter (ft)	13.05	8.83	8.77
Hydraulic Radius (ft)	1.1	0.85	0.78
Begin BKF Station	2.29	2.29	8.19
End BKF Station	14.1	8.19	14.1

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R2 XS2
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	96.602	
0.07	0	95.839	
1.87	0	95.169	
3.63	0	94.838	
5.1	0	94.158	
6.5	0	93.681	
7.25	0	93.494	
8.1	0	93.243	
9.19	0	92.762	
10.14	0	92.706	
11.31	0	93.064	
12.04	0	93.903	
13.06	0	94.733	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	97.81	97.81	97.81
Bankfull Elevation (ft)	95.26	95.26	95.26
Floodprone Width (ft)	13.06	-----	-----
Bankfull Width (ft)	11.43	5.72	5.72
Entrenchment Ratio	1.14	-----	-----
Mean Depth (ft)	1.42	0.85	1.98
Maximum Depth (ft)	2.55	1.79	2.55
Width/Depth Ratio	8.05	6.73	2.89
Bankfull Area (sq ft)	16.22	4.88	11.34
Wetted Perimeter (ft)	13.13	7.81	8.9
Hydraulic Radius (ft)	1.24	0.62	1.27
Begin BKF Station	1.63	1.63	7.34
End BKF Station	13.06	7.34	13.06

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R2 XS3
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	96.311	
0.14	0	95.561	
1.03	0	95.188	
2.58	0	94.497	
3.91	0	93.541	
4.65	0	93.171	
5.69	0	92.849	
6.31	0	92.914	
7.39	0	93.241	
8.29	0	93.638	
9.12	0	94.33	
9.84	0	94.895	
11.33	0	95.149	
12.62	0	95.589	
12.66	0	95.997	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	97.49	97.49	97.49
Bankfull Elevation (ft)	95.17	95.17	95.17
Floodprone Width (ft)	12.66	-----	-----
Bankfull Width (ft)	10.32	5.16	5.16
Entrenchment Ratio	1.23	-----	-----
Mean Depth (ft)	1.21	1.33	1.09
Maximum Depth (ft)	2.32	2.32	2.26
Width/Depth Ratio	8.53	3.88	4.73
Bankfull Area (sq ft)	12.47	6.87	5.6
Wetted Perimeter (ft)	11.51	8.02	8.03
Hydraulic Radius (ft)	1.08	0.86	0.7
Begin BKF Station	1.07	1.07	6.23
End BKF Station	11.39	6.23	11.39

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R2 XS4
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	95.659	
0.13	0	95.286	
1.52	0	94.39	
2.72	0	93.765	
3.35	0	93.712	
4.54	0	92.814	
5.73	0	92.657	
6.82	0	92.713	
8.27	0	92.833	
9.44	0	93.033	
10.25	0	93.223	
10.98	0	93.635	
11.77	0	94.485	
13.03	0	95.17	
14.3	0	95.647	
14.38	0	96.28	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	97.24	97.24	97.24
Bankfull Elevation (ft)	94.95	94.95	94.95
Floodprone Width (ft)	14.38	-----	-----
Bankfull Width (ft)	11.97	5.99	5.99
Entrenchment Ratio	1.2	-----	-----
Mean Depth (ft)	1.52	1.46	1.57
Maximum Depth (ft)	2.29	2.29	2.25
Width/Depth Ratio	7.88	4.1	3.82
Bankfull Area (sq ft)	18.17	8.76	9.41
Wetted Perimeter (ft)	13.25	8.87	8.87
Hydraulic Radius (ft)	1.37	0.99	1.06
Begin BKF Station	0.65	0.65	6.64
End BKF Station	12.63	6.64	12.63

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R3 XS1
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	95.1859	
2.08	0	93.411	
2.94	0	92.99	
3.43	0	92.546	
4.5	0	91.811	
5.36	0	90.643	
8.64	0	91.102	
9.85	0	92.44	
11.65	0	93.719	
12.99	0	93.999	
13.32	0	94.081	
13.54	0	94.808	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	96.52	96.52	96.52
Bankfull Elevation (ft)	93.58	93.58	93.58
Floodprone Width (ft)	13.54	-----	-----
Bankfull Width (ft)	9.57	4.79	4.78
Entrenchment Ratio	1.41	-----	-----
Mean Depth (ft)	1.7	1.67	1.73
Maximum Depth (ft)	2.94	2.94	2.75
Width/Depth Ratio	5.63	2.87	2.76
Bankfull Area (sq ft)	16.25	7.99	8.26
Wetted Perimeter (ft)	11.71	8.7	8.51
Hydraulic Radius (ft)	1.39	0.92	0.97
Begin BKF Station	1.88	1.88	6.67
End BKF Station	11.45	6.67	11.45

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R3 XS2
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	94.439	
0.13	0	93.966	
3.08	0	93.141	
4.52	0	93.007	
5.06	0	92.502	
6.06	0	91.544	
7.97	0	90.653	
10.37	0	90.548	
11.94	0	90.843	
13.6	0	91.753	
14.29	0	92.539	
14.76	0	93.014	
16.67	0	93.319	
18.84	0	93.802	
18.95	0	94.135	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	96.21	96.21	96.21
Bankfull Elevation (ft)	93.38	93.38	93.38
Floodprone Width (ft)	18.95	-----	-----
Bankfull Width (ft)	14.72	7.36	7.36
Entrenchment Ratio	1.29	-----	-----
Mean Depth (ft)	1.53	1.5	1.55
Maximum Depth (ft)	2.83	2.8	2.83
Width/Depth Ratio	9.62	4.91	4.75
Bankfull Area (sq ft)	22.49	11.06	11.43
Wetted Perimeter (ft)	16.39	10.98	11
Hydraulic Radius (ft)	1.37	1.01	1.04
Begin BKF Station	2.23	2.23	9.58
End BKF Station	16.94	9.58	16.94

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R3 XS3
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	94.513	
0.21	0	93.789	
2.67	0	92.745	
3.62	0	92.352	
4.31	0	92.056	
6.67	0	91.271	
8.01	0	90.857	
9.98	0	90.769	
11.14	0	90.673	
12.04	0	92.554	
13.86	0	93.164	
16.24	0	93.761	
16.9	0	94.381	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	95.87	95.87	95.87
Bankfull Elevation (ft)	93.27	93.27	93.27
Floodprone Width (ft)	16.9	-----	-----
Bankfull Width (ft)	12.85	6.42	6.42
Entrenchment Ratio	1.32	-----	-----
Mean Depth (ft)	1.44	1.27	1.62
Maximum Depth (ft)	2.6	2.37	2.6
Width/Depth Ratio	8.92	5.06	3.96
Bankfull Area (sq ft)	18.55	8.13	10.42
Wetted Perimeter (ft)	14.59	9.22	10.1
Hydraulic Radius (ft)	1.27	0.88	1.03
Begin BKF Station	1.43	1.43	7.86
End BKF Station	14.28	7.86	14.28

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tulula
Reach Name: 2007
Cross Section Name: R3 XS4
Survey Date: 12/01/2007

TAPE	FS	ELEV	NOTE
0	0	93.832	
0.46	0	93.252	
3.4	0	92.934	
5.02	0	92.59	
6.12	0	92.373	
8.48	0	91.335	
10.17	0	90.747	
12.13	0	90.117	
14.3	0	91.02	
15.61	0	92.298	
18.06	0	92.76	
18.29	0	93.17	

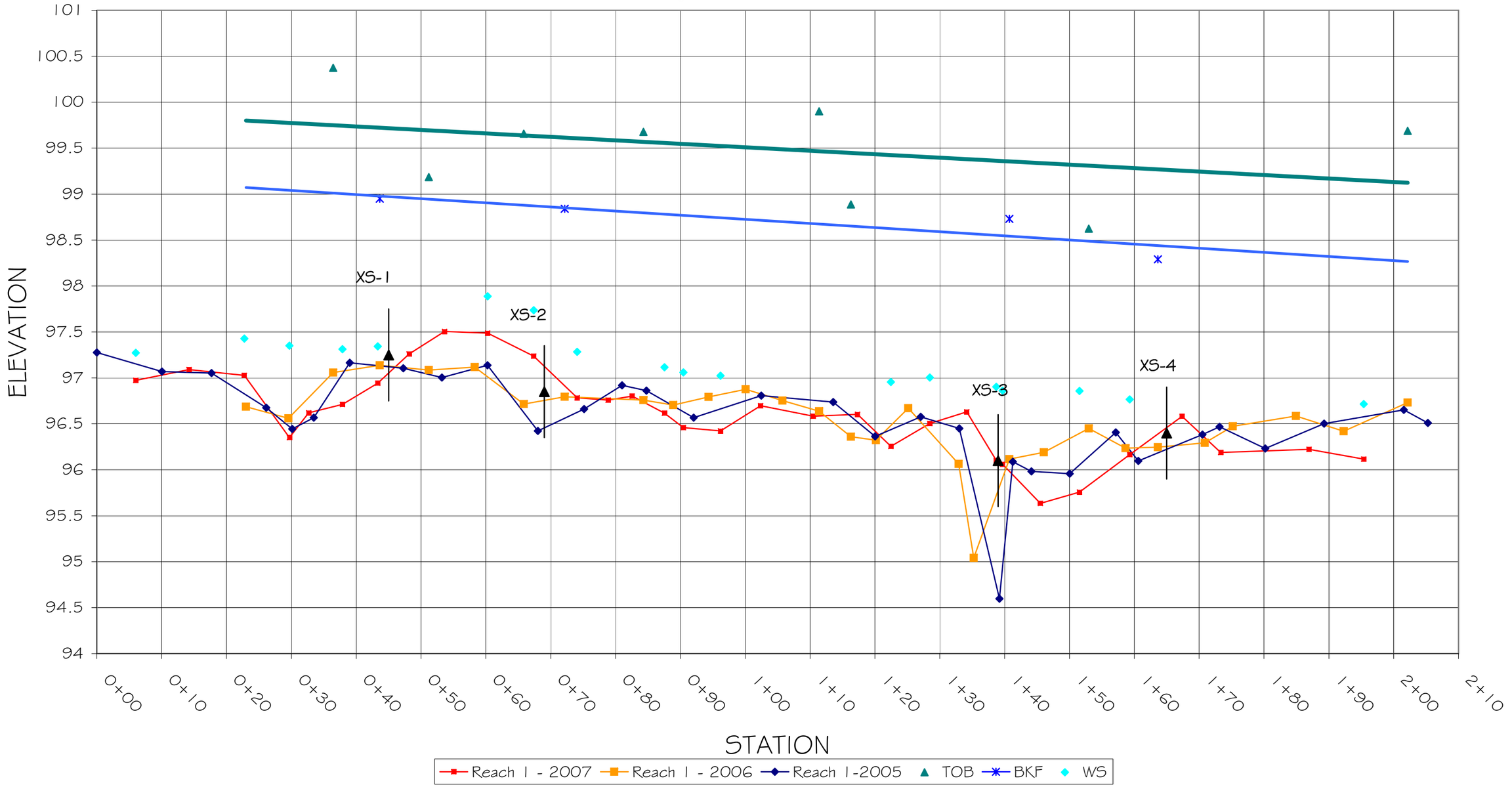
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	94.96	94.96	94.96
Bankfull Elevation (ft)	92.54	92.54	92.54
Floodprone Width (ft)	18.29	-----	-----
Bankfull Width (ft)	11.62	5.81	5.81
Entrenchment Ratio	1.57	-----	-----
Mean Depth (ft)	1.2	1.03	1.37
Maximum Depth (ft)	2.42	2.09	2.42
Width/Depth Ratio	9.68	5.64	4.24
Bankfull Area (sq ft)	13.94	5.99	7.95
Wetted Perimeter (ft)	12.78	8.28	8.67
Hydraulic Radius (ft)	1.09	0.72	0.92
Begin BKF Station	5.27	5.27	11.08
End BKF Station	16.89	11.08	16.89

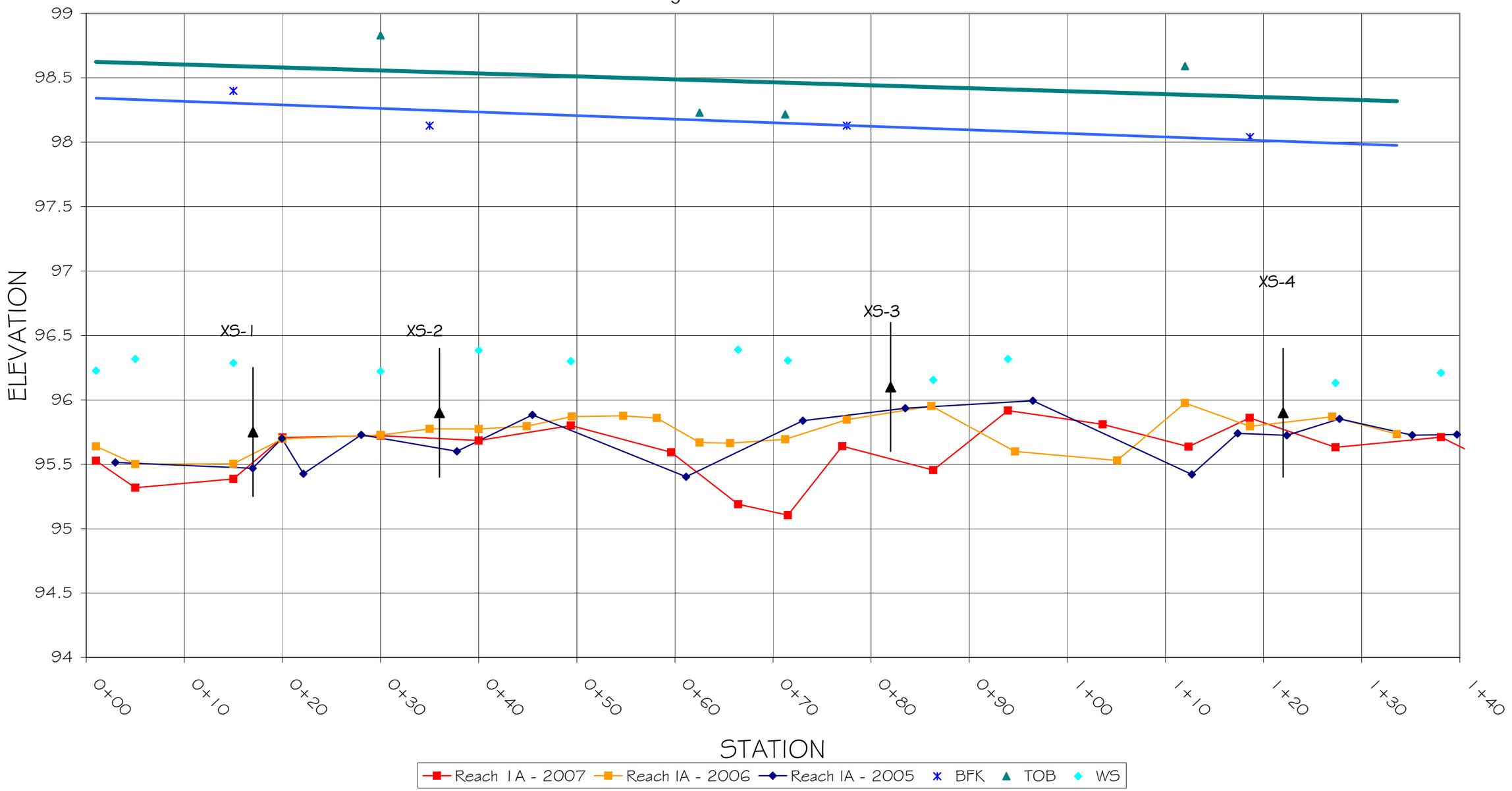
APPENDIX B –

Longitudinal Profile

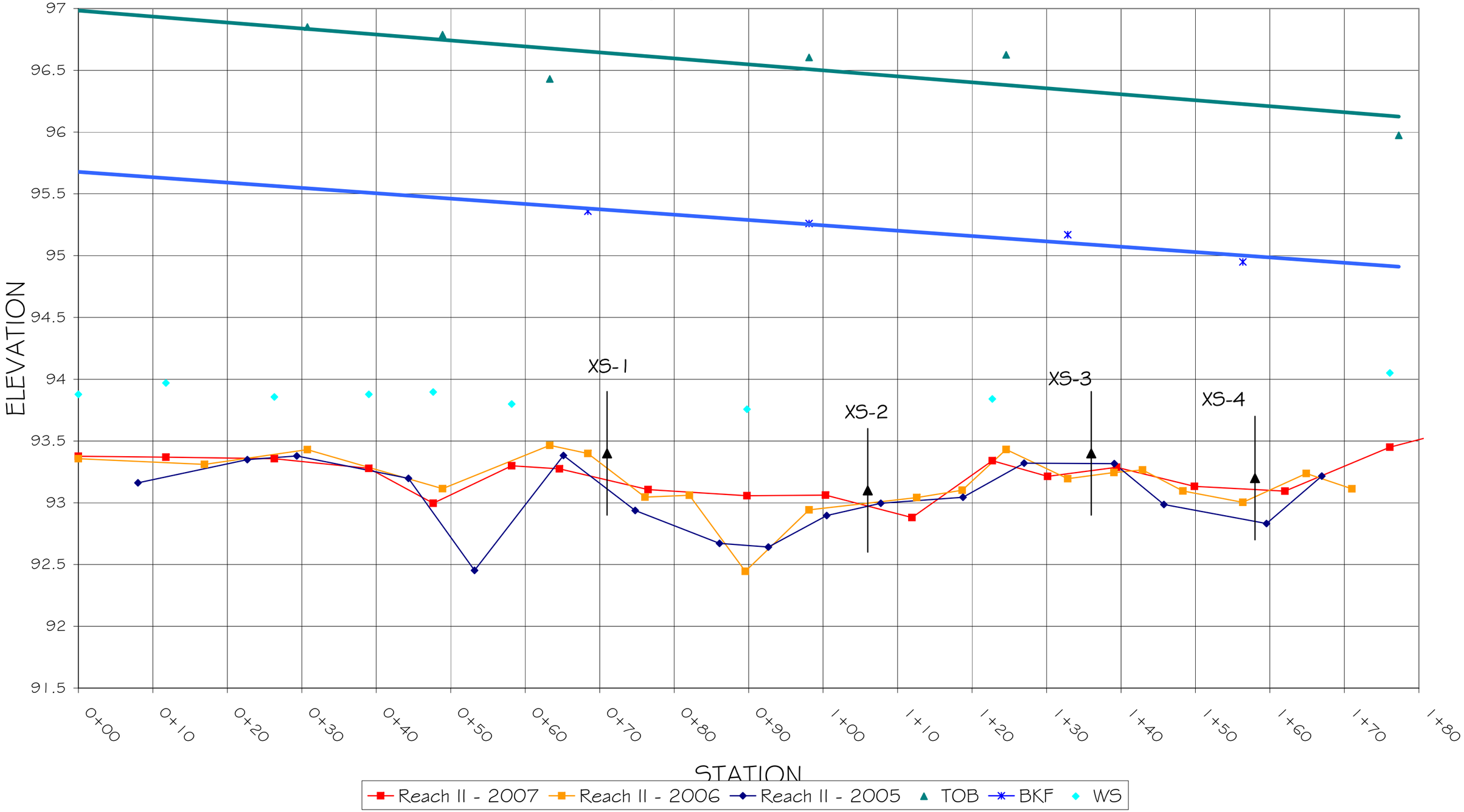
Tulula Stream and Wetland Restoration
Longitudinal Profile - Reach 1



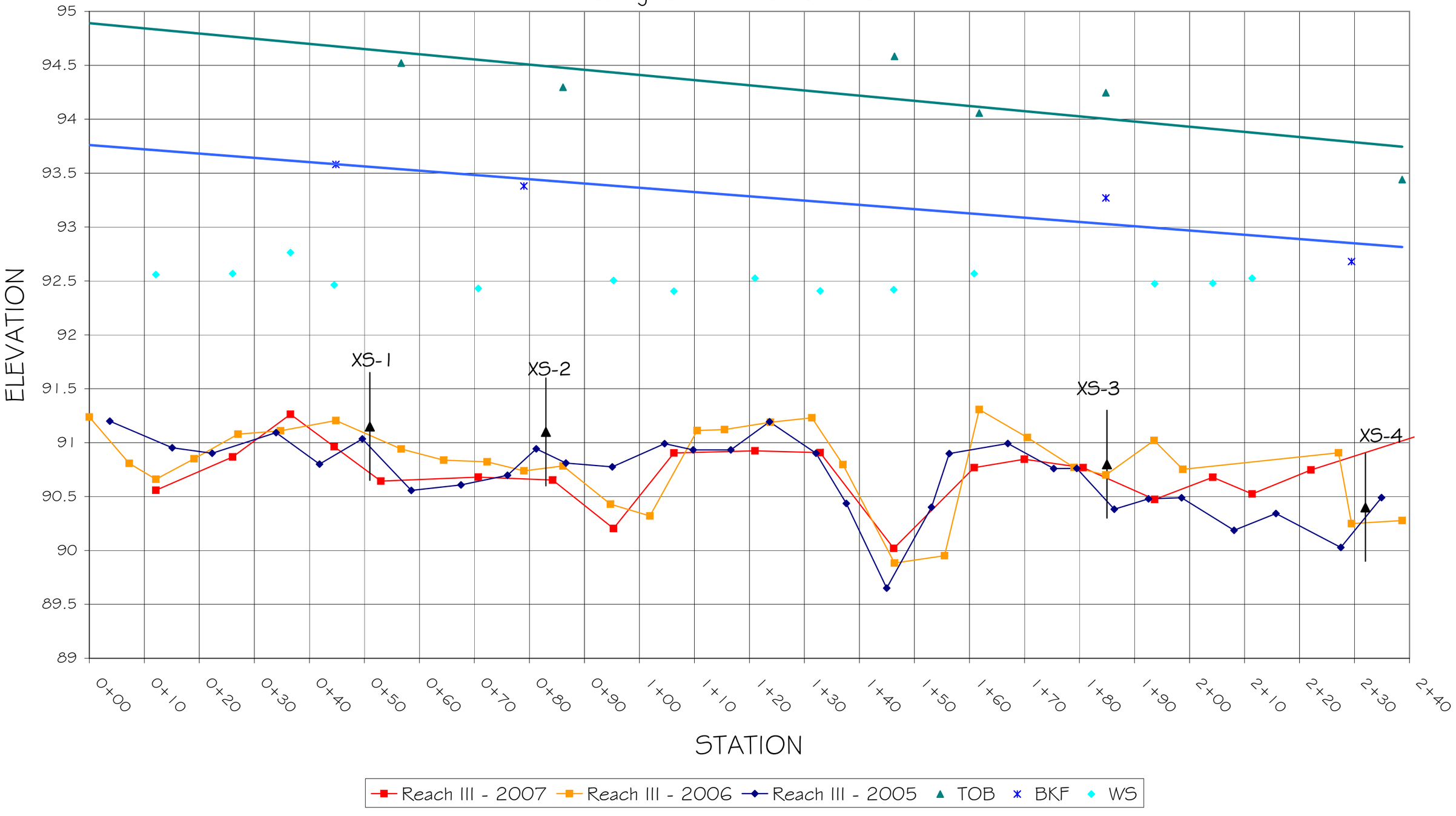
Tulula Stream and Stream Restoration
Longitudinal Profile - Reach 1A



Tulula Stream and Wetland Restoration
Longitudinal Profile - Reach II



Tulula Stream and Wetland Restoration
Longitudinal Profile - Reach III



RIVERMORPH PROFILE SUMMARY

River Name: Tulula
Reach Name: 2007
Profile Name: REACH 1
Survey Date: 12/01/2007

DIST	CH	WS	BKF	P1	P2	P3	P4
6	96.973	97.273					
14	97.091						
23	97.028	97.428					
30	96.35	97.35					
33	96.619						
38	96.712	97.312					
43	96.943	97.343					
48	97.26						
54	97.506						
60	97.488	97.888					
67	97.237	97.737					
74	96.783	97.283					
79	96.758						
83	96.801						
88	96.616	97.116					
90	96.459	97.059					
96	96.423	97.023					
102	96.697						
110	96.584						
117	96.604						
122	96.255	96.955					
128	96.504	97.004					
134	96.631						
139	96.102	96.902					
140	96.061	96.861					
146	95.634						
152	95.757	96.857					
159	96.165	96.765					
167	96.582						
173	96.188						
187	96.223						
195	96.116	96.716					

Cross Section / Bank Profile Locations

Name	Type	Profile Station

R1XS1	Riffle XS	46.37
R1 XS2	Pool XS	81.4
R1XS3	Riffle XS	142.4
R1XS4	Pool XS	164.94

Measurements from Graph

Bankfull Slope: 0.00352

Variable	Min	Avg	Max
S riffle	0.01428	0.01678	0.02117
S pool	0.00412	0.00872	0.01544
S run	0.01258	0.01929	0.03189
S glide	0.00963	0.02894	0.06643
P - P	55.05	58.47	64.95
Pool length	12.68	17.14	25.53
Riffle length	7.99	9.51	10.42
Dmax riffle	0.2	0.24	0.31
Dmax pool	0.69	0.99	1.23
Dmax run	0.26	0.38	0.51
Dmax glide	0.4	0.49	0.55
Low bank ht	0	0	0

Length and depth measurements in feet, slopes in ft/ft.

RIVERMORPH PROFILE SUMMARY

River Name: Tulula
Reach Name: 2007
Profile Name: REACH 1A
Survey Date: 12/01/2007

DIST	CH	WS	BKF	P1	P2	P3	P4
1	95.527	96.227					
5	95.317	96.317					
15	95.386	96.286					
20	95.708						
30	95.722	96.222					
40	95.684	96.384					
49	95.801	96.301					
60	95.592						
66	95.189	96.389					
72	95.105	96.305					
77	95.641						
86	95.455	96.155					
94	95.917	96.317					
104	95.809						
112	95.637						
119	95.86						
127	95.631	96.131					
138	95.71	96.21					
147	95.39	96.09					
150	95.732	96.232					

Cross Section / Bank Profile Locations

Name	Type	Profile Station
R1A XS1	Riffle XS	17.5
R1A XS2	Pool XS	29.2
R1A XS3	Riffle XS	72.26
R1A XS4	Pool XS	113.16

Measurements from Graph

Bankfull Slope: 0.00413

Variable	Min	Avg	Max
S riffle	0.00572	0.01219	0.02068
S pool	0.00517	0.0054	0.00566
S run	0.00354	0.01479	0.02135
S glide	0.01416	0.02668	0.04244
P - P	58	65.35	77.8
Pool length	7.64	13.43	17.54
Riffle length	6.08	8.28	10.94
Dmax riffle	0.42	0.48	0.56
Dmax pool	0.55	0.86	1.27
Dmax run	0.5	0.62	0.74
Dmax glide	0.36	0.51	0.61
Low bank ht	0	0	0

Length and depth measurements in feet, slopes in ft/ft.

RIVERMORPH PROFILE SUMMARY

River Name: Tulula
Reach Name: 2007
Profile Name: REACH 2
Survey Date: 12/01/2007

DIST	CH	WS	BKF	P1	P2	P3	P4
0	93.077	93.877					
12	93.069	93.969					
26	93.056	93.856					
39	92.978	93.878					
48	92.696	93.896					
58	92.999	93.799					
65	92.974						
76	92.806						
90	92.757	93.757					
100	92.762						
112	92.58						
123	93.04	93.84					
130	92.914						
139	92.987						
150	92.833						
162	92.794						
176	93.15	94.05					
187	93.32	94.22					

Cross Section / Bank Profile Locations

Name	Type	Profile Station
R2 XS1	Riffle XS	41.33
R2 XS2	Pool XS	76.1
R2 XS3	Riffle XS	105.78
R2 XS4	Pool XS	125.112

Measurements from Graph

Bankfull Slope: 0.00431

Variable	Min	Avg	Max
S riffle	0.00179	0.00616	0.01027
S pool	0.00068	0.00081	0.00095
S run	0.00381	0.00864	0.01656
S glide	0.00505	0.00702	0.00814
P - P	53.49	63.73	71.89
Pool length	21.19	24.54	30.56
Riffle length	4.86	5.73	6.77
Dmax riffle	0.79	0.86	0.93
Dmax pool	1.19	1.22	1.26
Dmax run	0.91	0.99	1.05
Dmax glide	0.89	0.99	1.09
Low bank ht	0	0	0

Length and depth measurements in feet, slopes in ft/ft.

RIVERMORPH PROFILE SUMMARY

River Name: Tulula
Reach Name: 2007
Profile Name: REACH 3
Survey Date: 12/01/2007

DIST	CH	WS	BKF	P1	P2	P3	P4
12.1	90.559	92.559					
26	90.868	92.568					
36.6	91.264	92.764					
44.5	90.963	92.463					
53	90.643						
70.7	90.68	92.43					
84.2	90.653						
95.3	90.204	92.504					
106.3	90.905	92.405					
121	90.925	92.525					
132.9	90.907	92.407					
146.2	90.019	92.419					
160.9	90.768	92.568					
170	90.846						
180.7	90.769						
193.7	90.474	92.474					
204.2	90.679	92.479					
211.4	90.525	92.525					
222.1	90.747						
247	91.153	93.153					

Cross Section / Bank Profile Locations

Name	Type	Profile Station
R3 XS1	Riffle XS	46.37
R3 XS2	Pool XS	69.98
R3 XS3	Riffle XS	169.514
R3 XS4	Pool XS	210.61

Measurements from Graph

Bankfull Slope: 0.00413

Variable	Min	Avg	Max
S riffle	0.00782	0.01281	0.01964
S pool	0	0.00143	0.00313
S run	0.0067	0.01744	0.03364
S glide	0.00726	0.01156	0.01866
P - P	47.97	62.95	84.22
Pool length	23.01	31.26	43.2
Riffle length	10.64	11.65	12.37
Dmax riffle	1.53	1.71	1.98
Dmax pool	2	2.23	2.41
Dmax run	1.53	1.7	1.94
Dmax glide	1.56	1.64	1.77
Low bank ht	0	0	0

Length and depth measurements in feet, slopes in ft/ft.

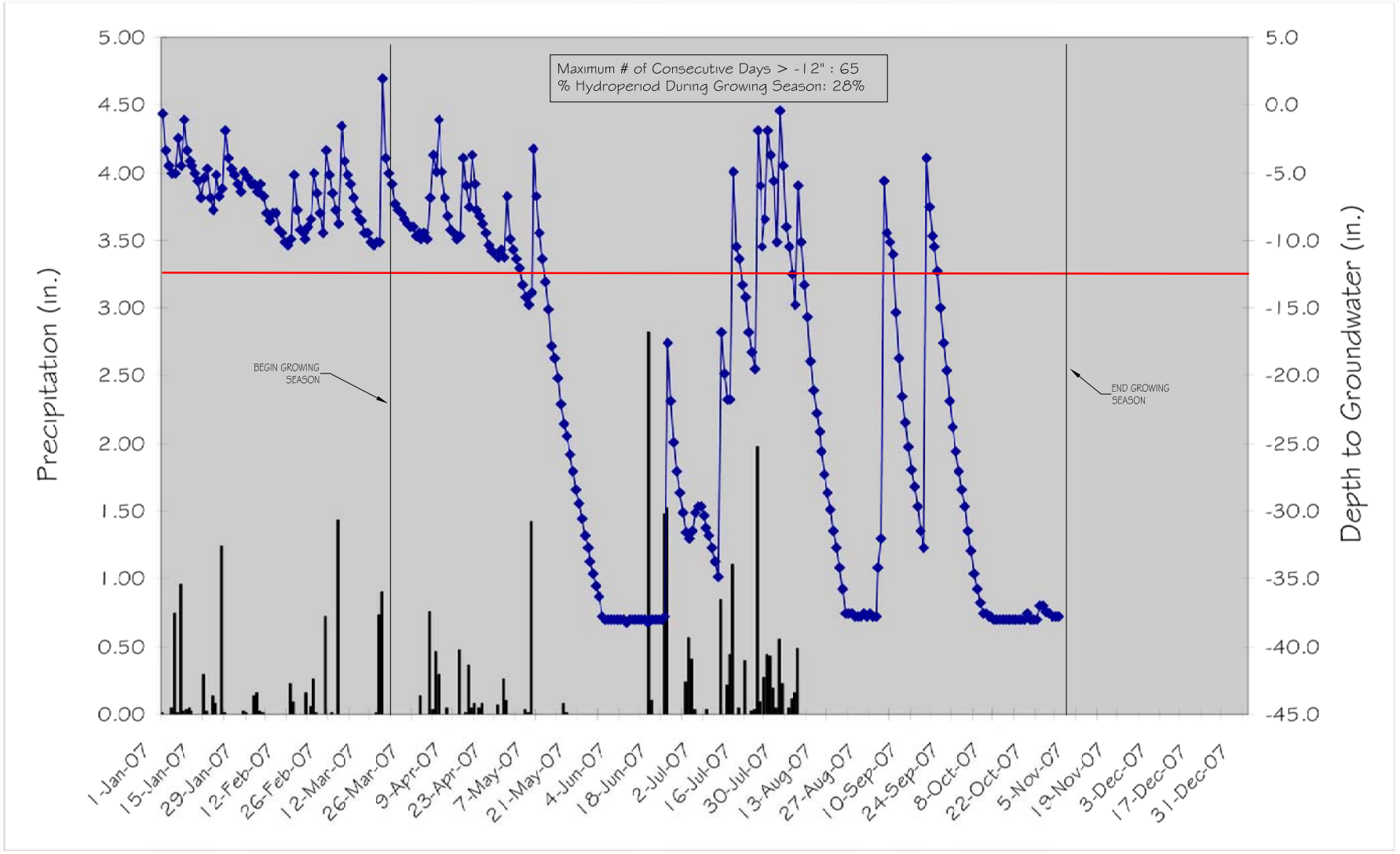
Table B1. Qualitative Visual Stability Assessment
Date: Novemeber 2007 Project # 9444.D3

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	% perfor. in stable condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	11	11	N/A	100%	
	2. Armor stable (e.g. no displacement)?	10	11	N/A	91%	
	3. Facet grade appears stable?	11	11	N/A	100%	
	4. Stable interval grade?	11	11	N/A	100%	
	5. Feature spacing appropriate?	11	11	N/A	100%	
	6. Minimal evidence of embedding/fining?	9	11	N/A	82%	
	7. Depth appears appropriate for current discharge?	N/A	11	N/A	N/A	
	8. Length appropriate?	N/A	11	N/A	N/A	**95%**
B. Pools	1. Present? (e.g. not subject to severe aggradation?)	10	10	N/A	100%	
	2. Suffieciently deep (Max Pool D:Mean Bkf>1.6)	10	10	N/A	100%	
	3. Thalweg located outer bend?	10	10	N/A	100%	
	4. Spacing appropriate?	10	10	N/A	N/A	
	5. Non-aggrading (not filling)?	10	10	N/A	100%	
	6. Length appropriate?	10	10	N/A	N/A	**100%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	10	10	N/A	100%	
	2. Downstream of meander (glide/inflection) centering?	10	10	N/A	100%	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	10	10	N/A	100%	
	2. Of those eroding, # w/ concomitant point bar formation?	10	10	N/A	100%	
	3. Apparent Rc within spec?	10	10	N/A	N/A	
	4. Sufficient floodplain access and relief?	10	10	N/A	100%	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	100	99%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	900	94%	**97%**
F. Channel Capac./Dimen	1. Channel width: depth appears out of design/type spec?	N/A	N/A	N/A	N/A	**N/A**
G. Banks	1. Apparent scour points from channel processes	N/A	N/A	150	99%	
	2. Apparent cut points from overland flow	N/A	N/A	0	100%	
	3. Apparent cut or scour from flood water re-entry to channel (e.g. inadequate floodplain access?)	N/A	N/A	0	100%	
	4. Tension cracks	N/A	N/A	0	100%	
	5. Bank gradient in excess of 40%?	N/A	N/A	880	94%	
	6. Collapse/slumping	N/A	N/A	0	100%	
	7. Ratio of bank height: bankfull height elevated	N/A	N/A	0	100%	**99%**
H. Vanes	1. Free of back or arm scour?	N/A	N/A	N/A	N/A	
	2. Height appropriate?	N/A	N/A	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	N/A	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	N/A	N/A	N/A	**N/A**
I. Wads/Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

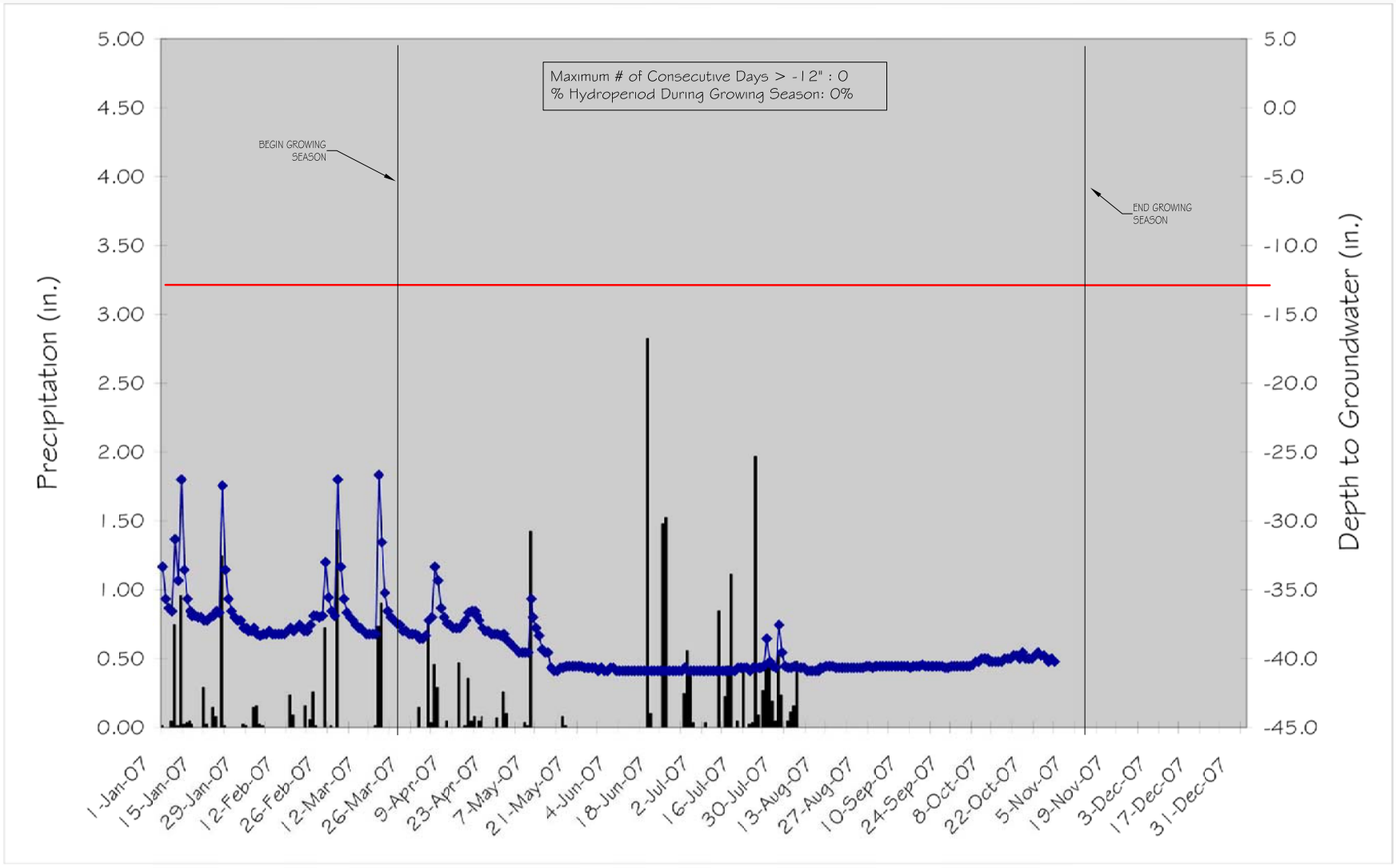
Notes:

APPENDIX C

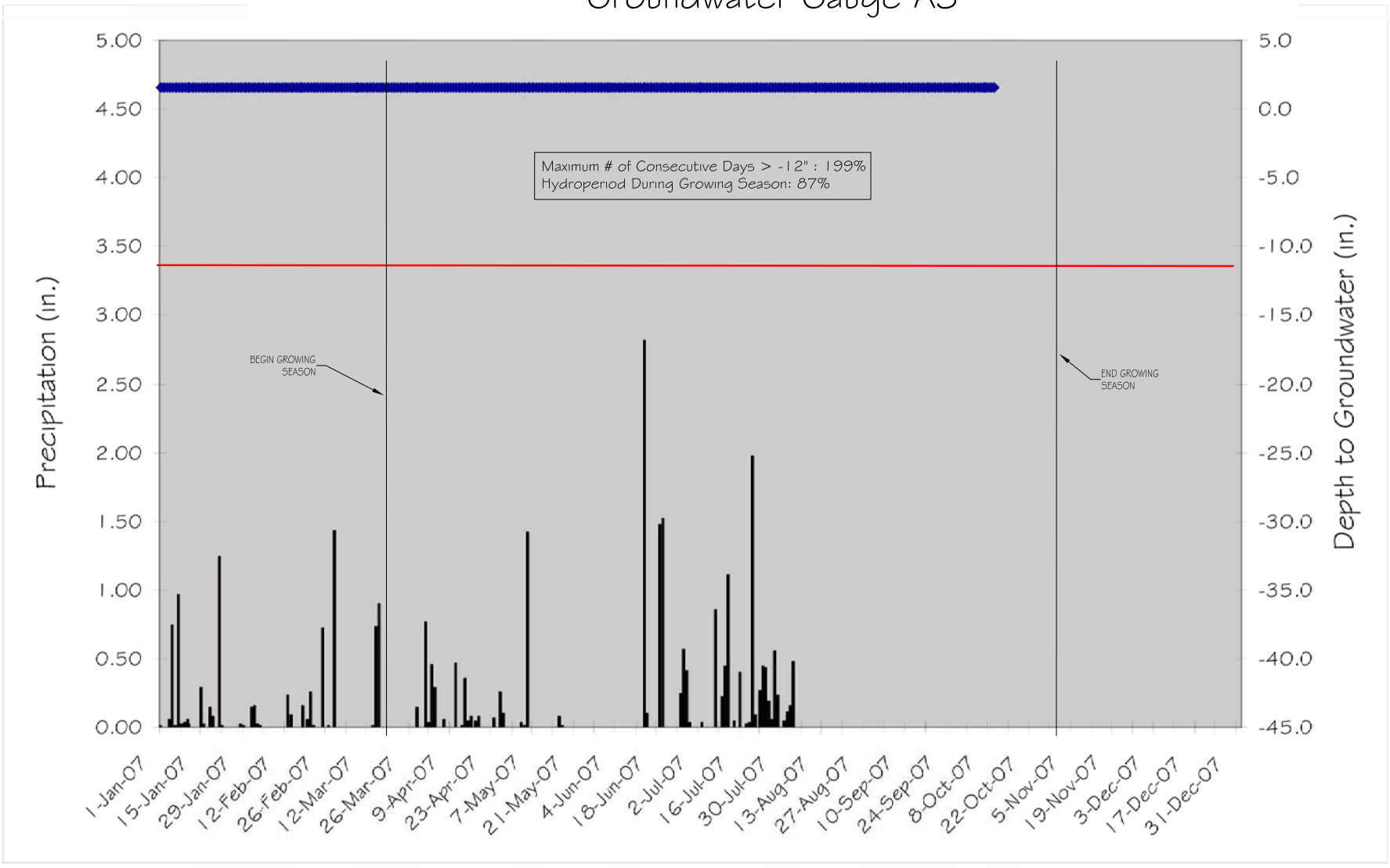
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A1



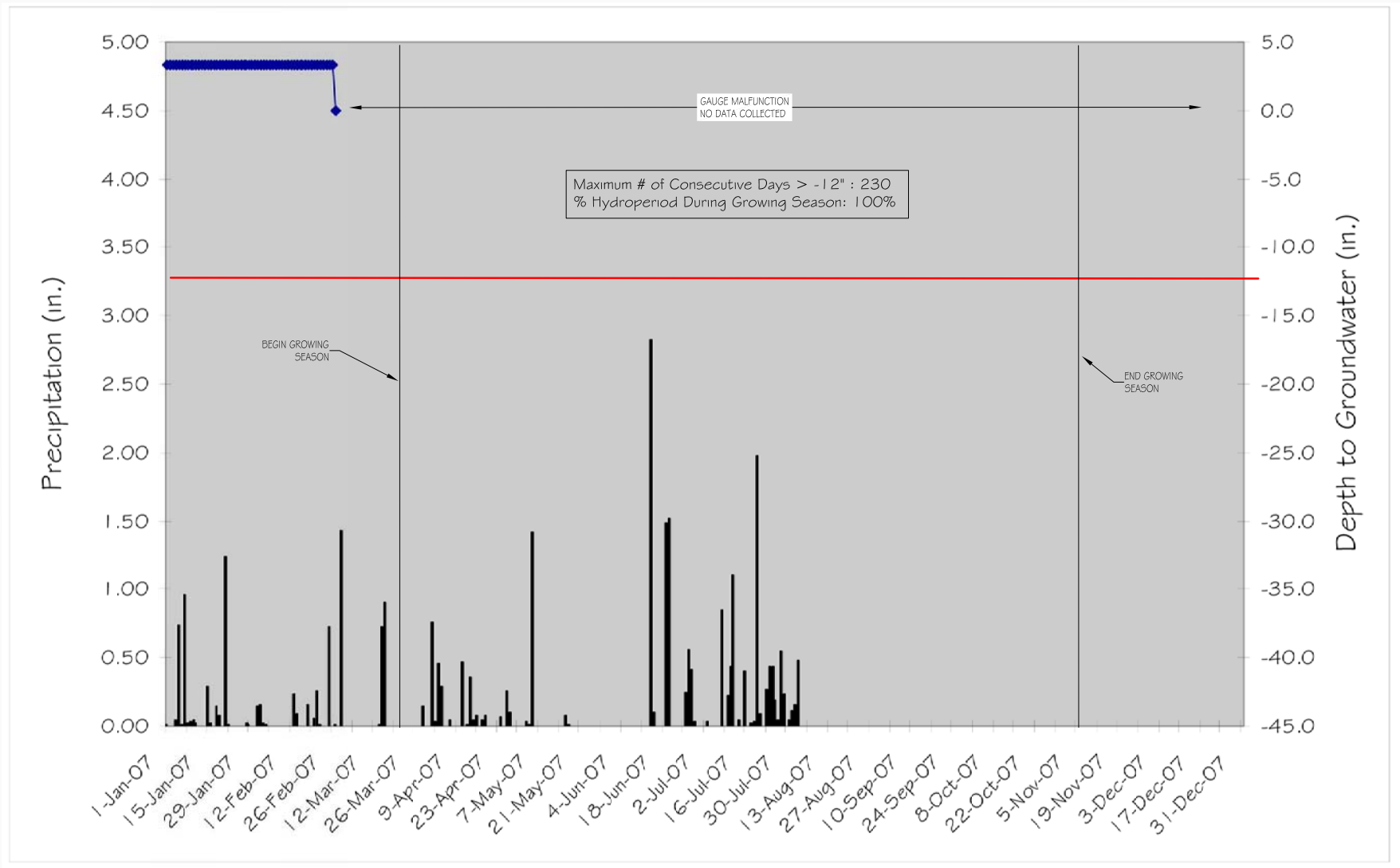
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A2



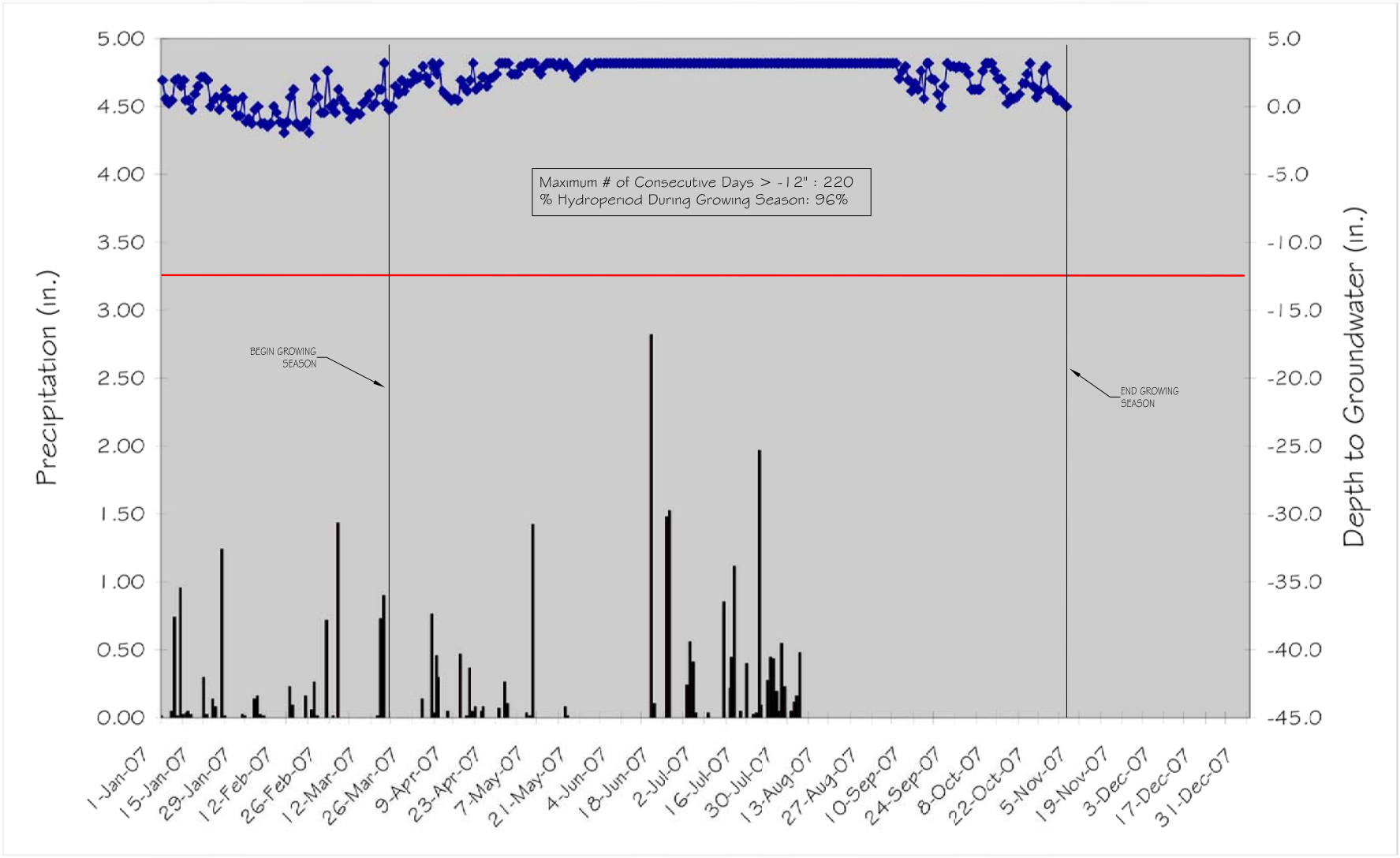
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A3



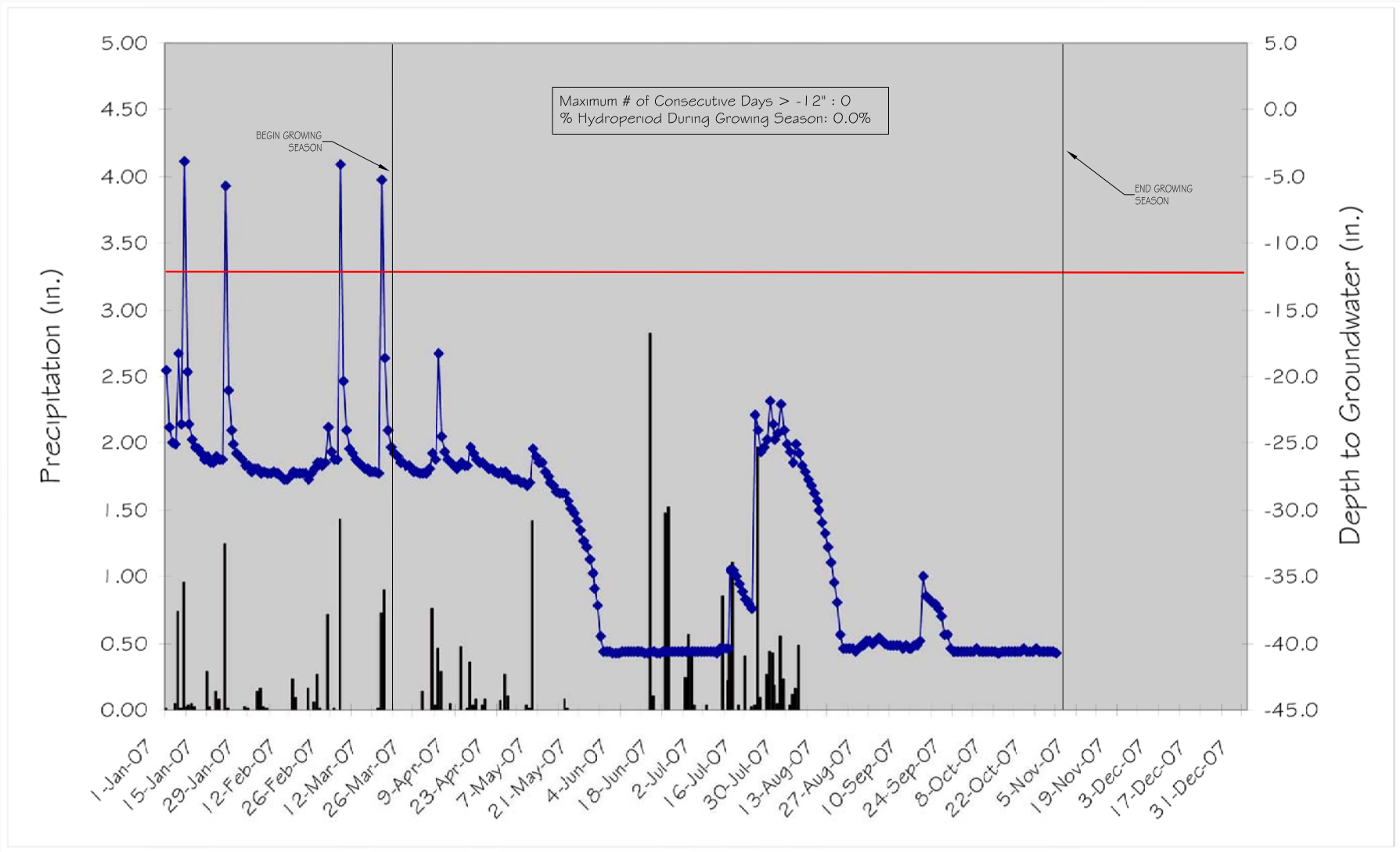
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A4



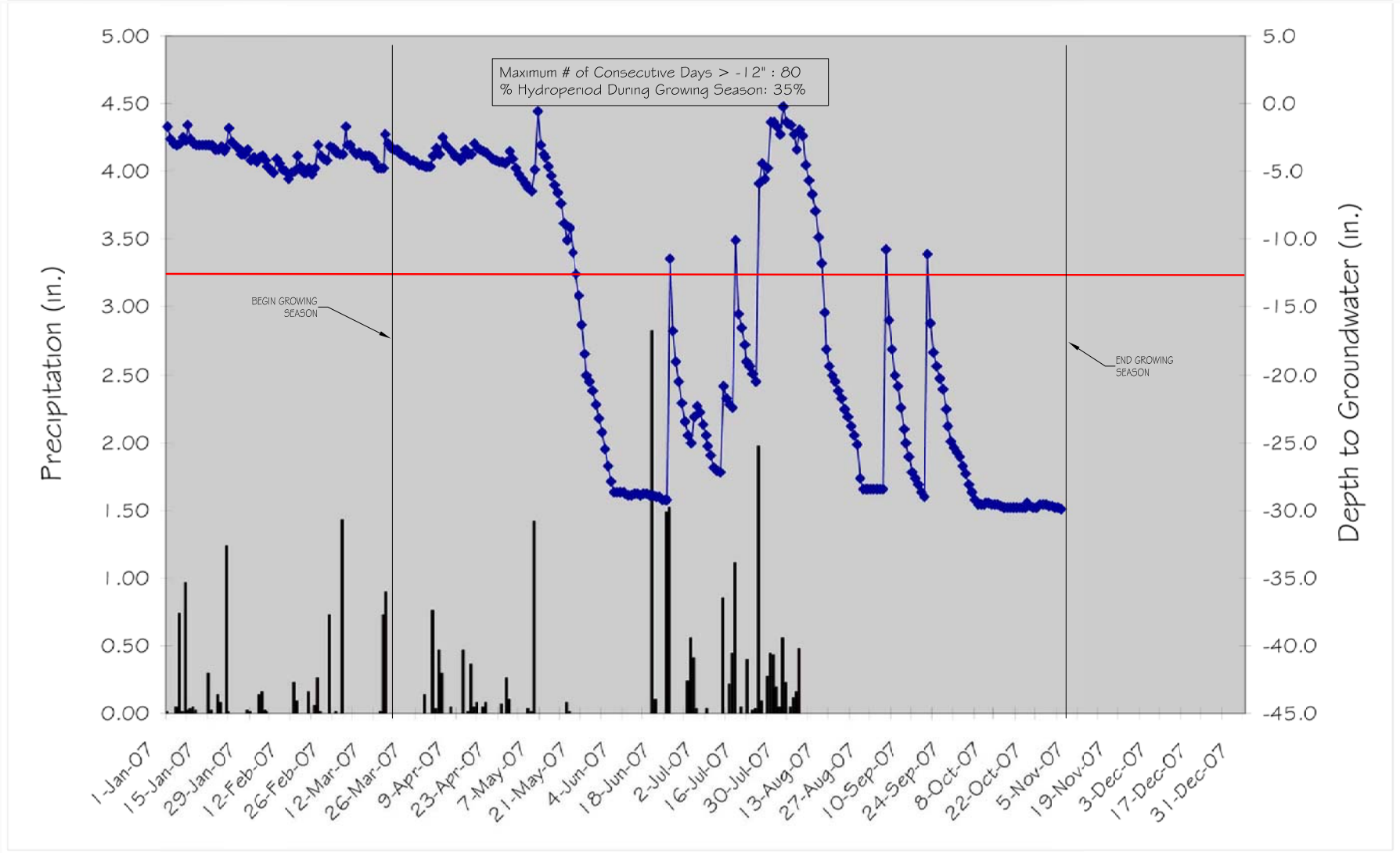
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A5



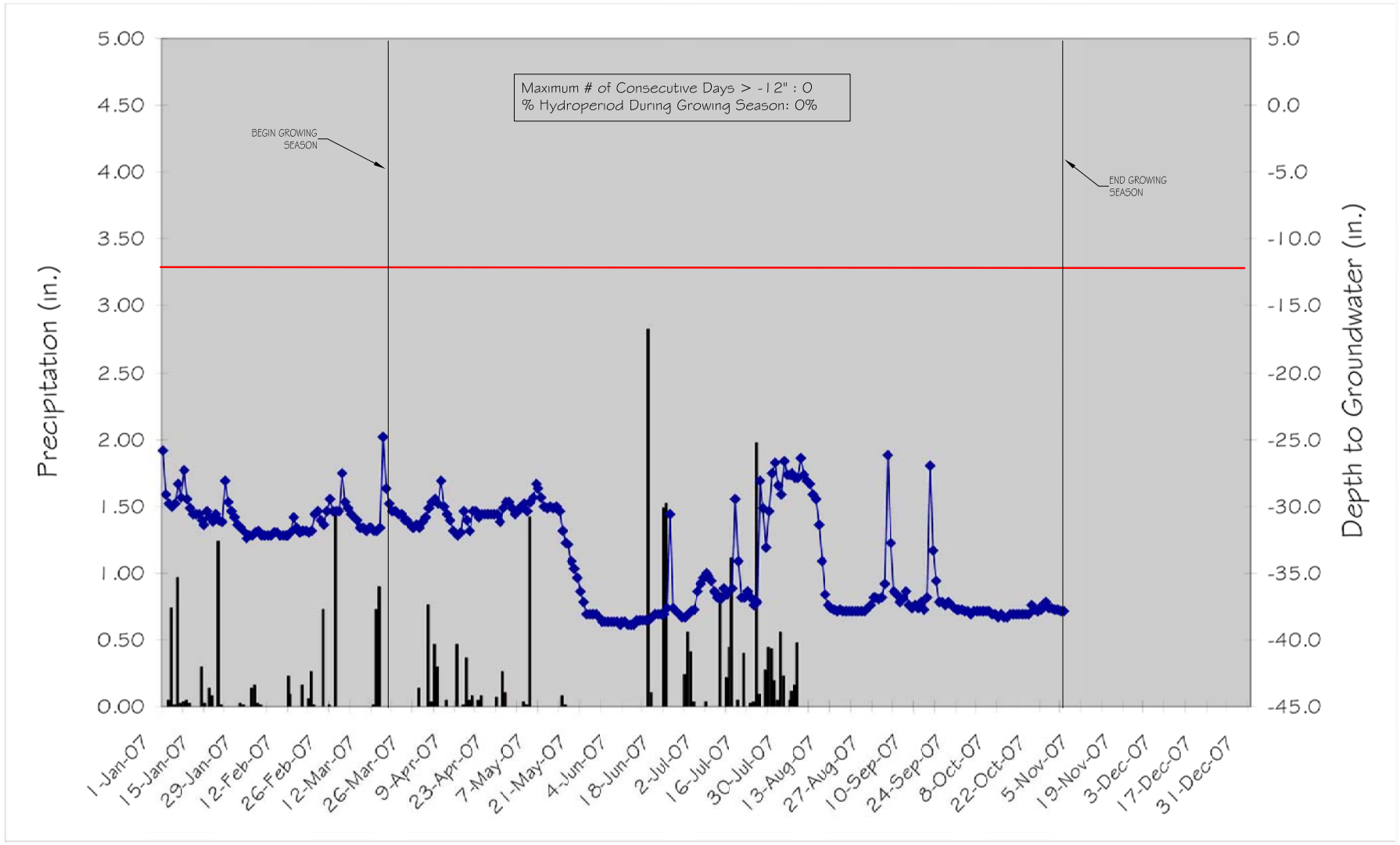
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B1



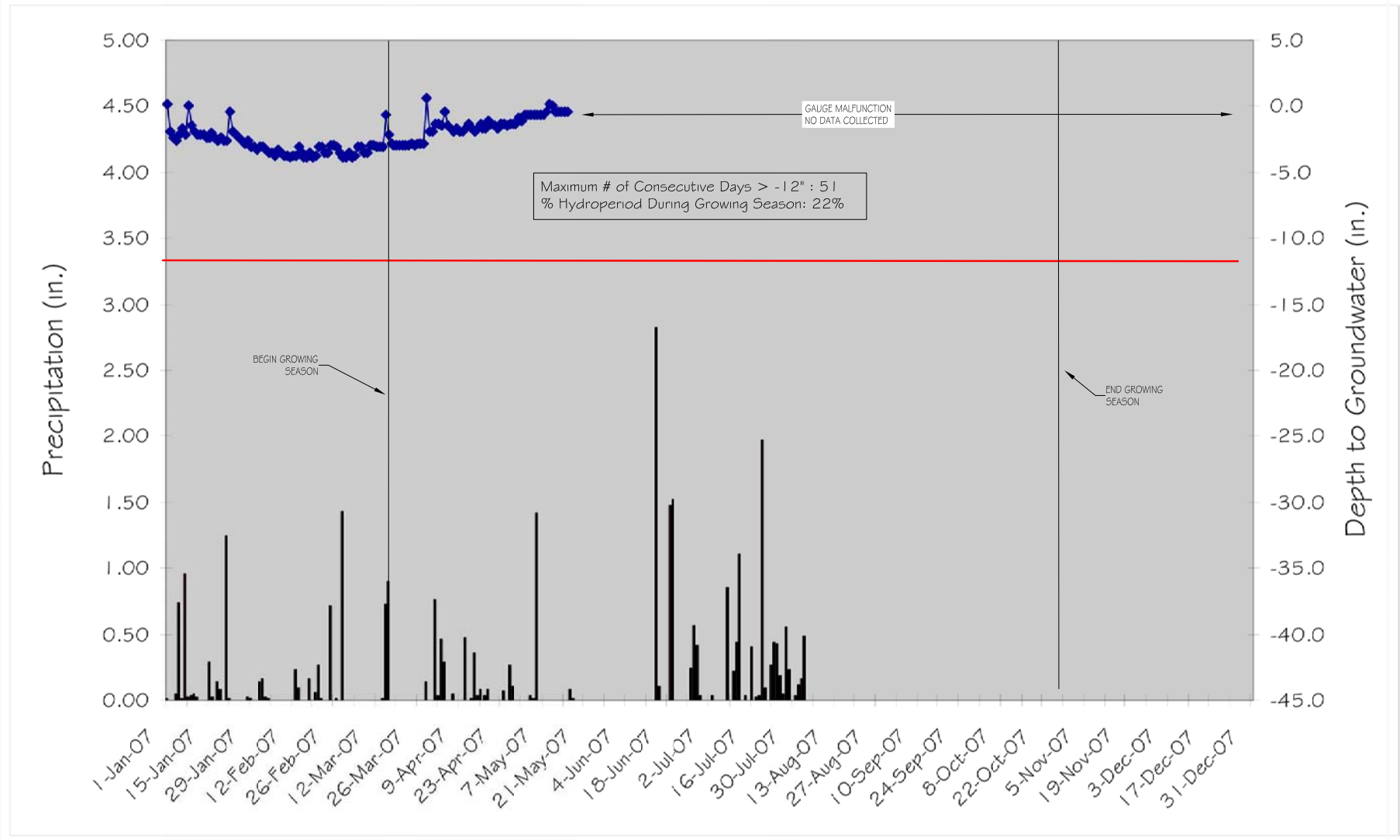
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B2



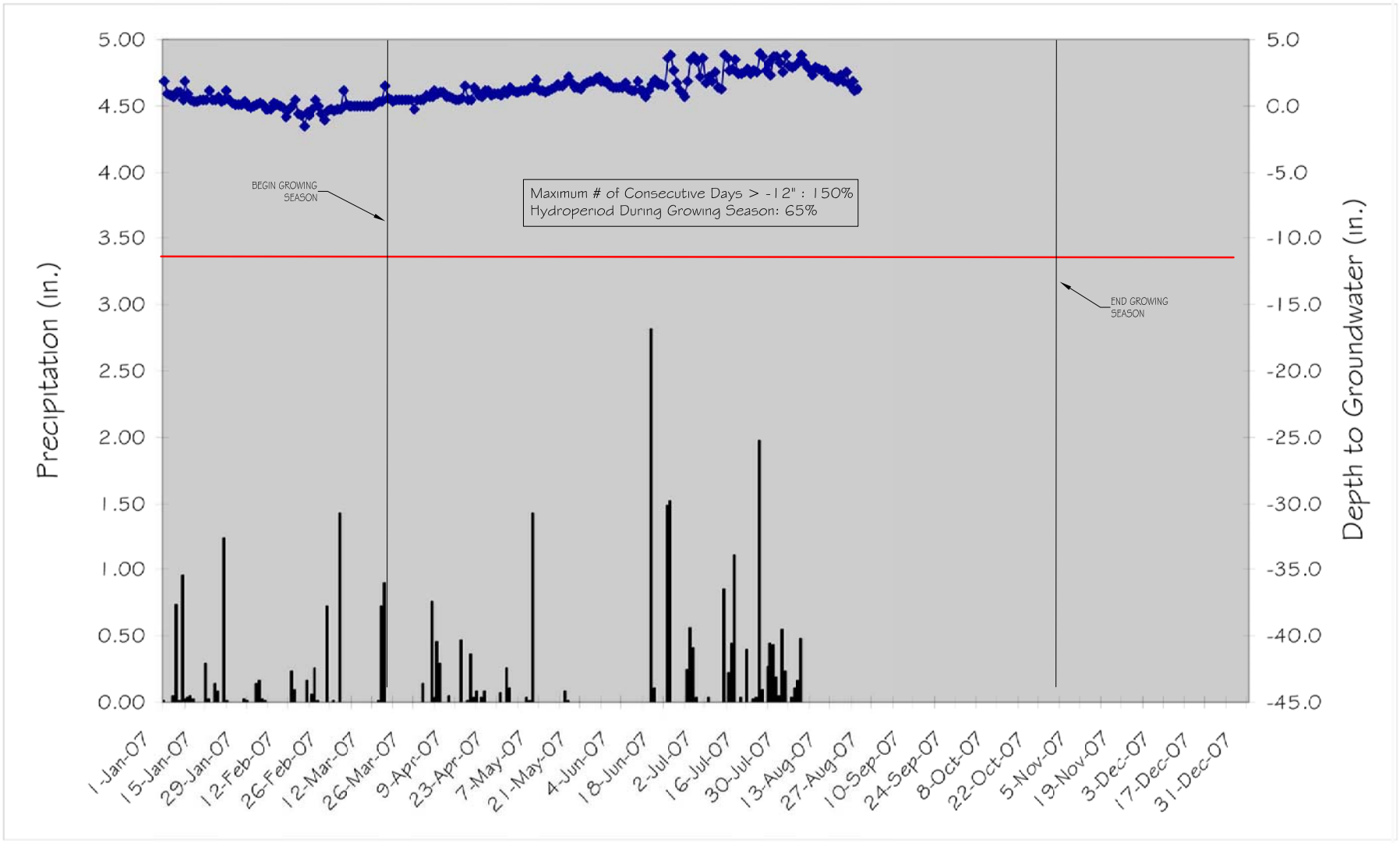
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B3



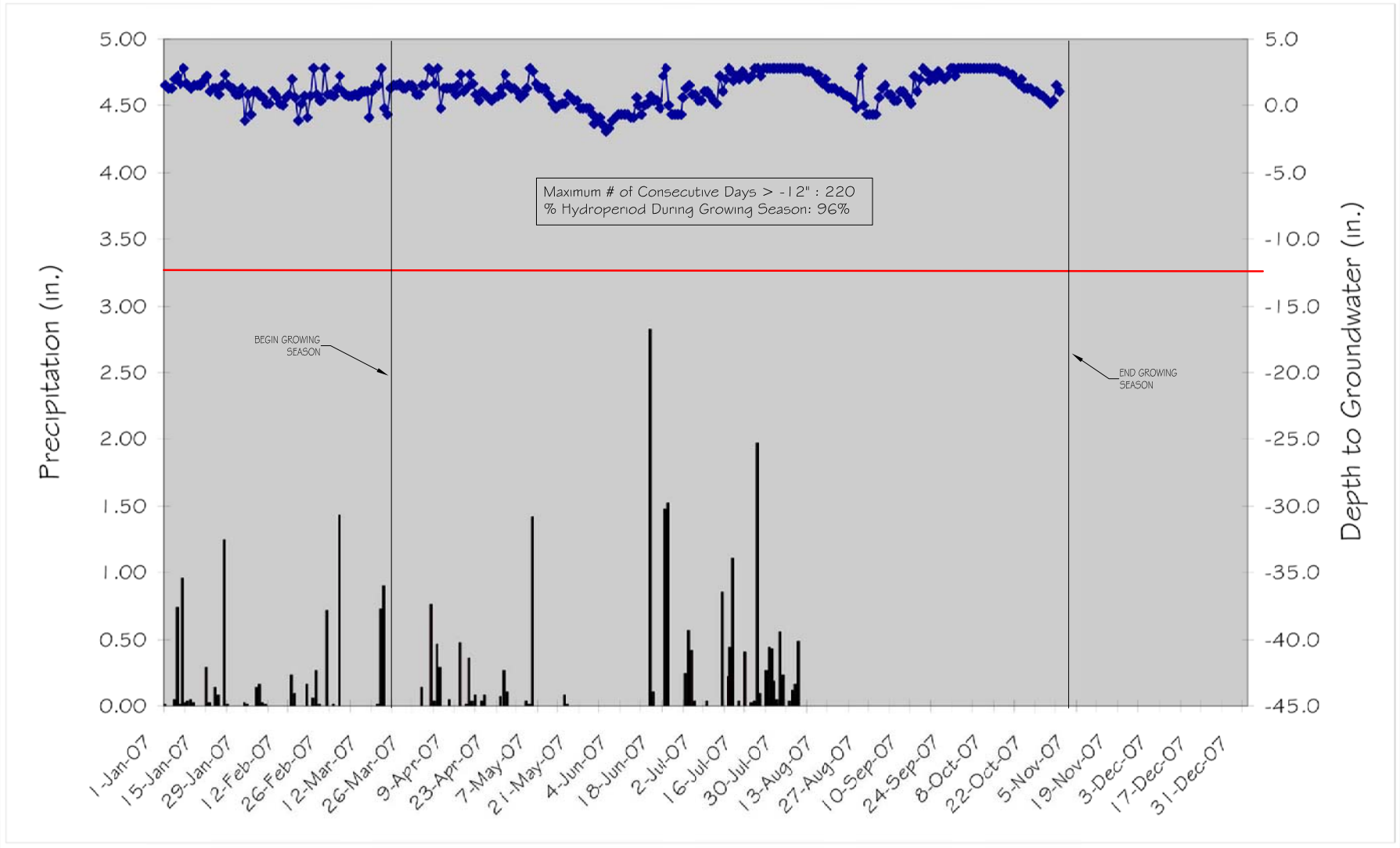
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B4



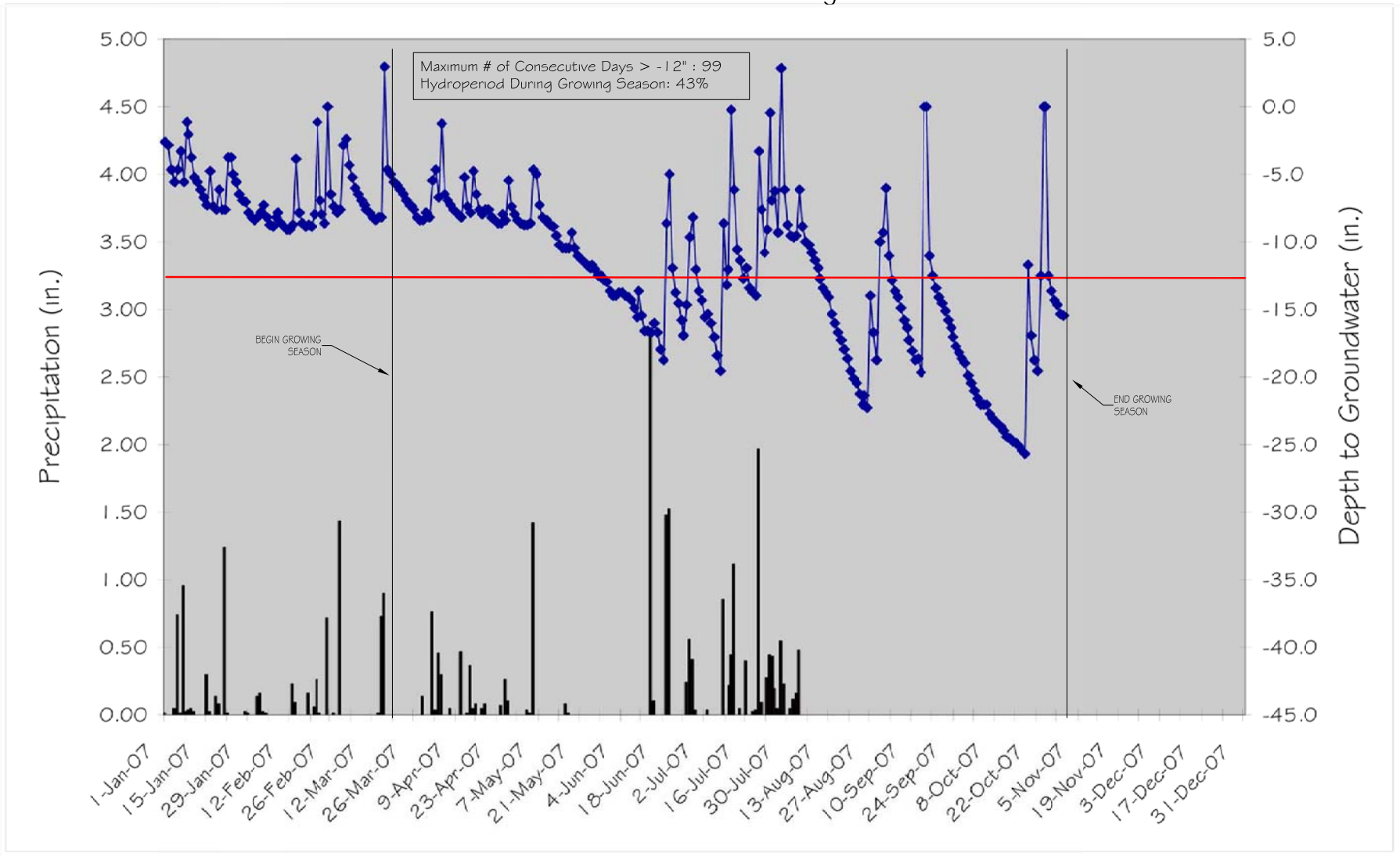
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B5



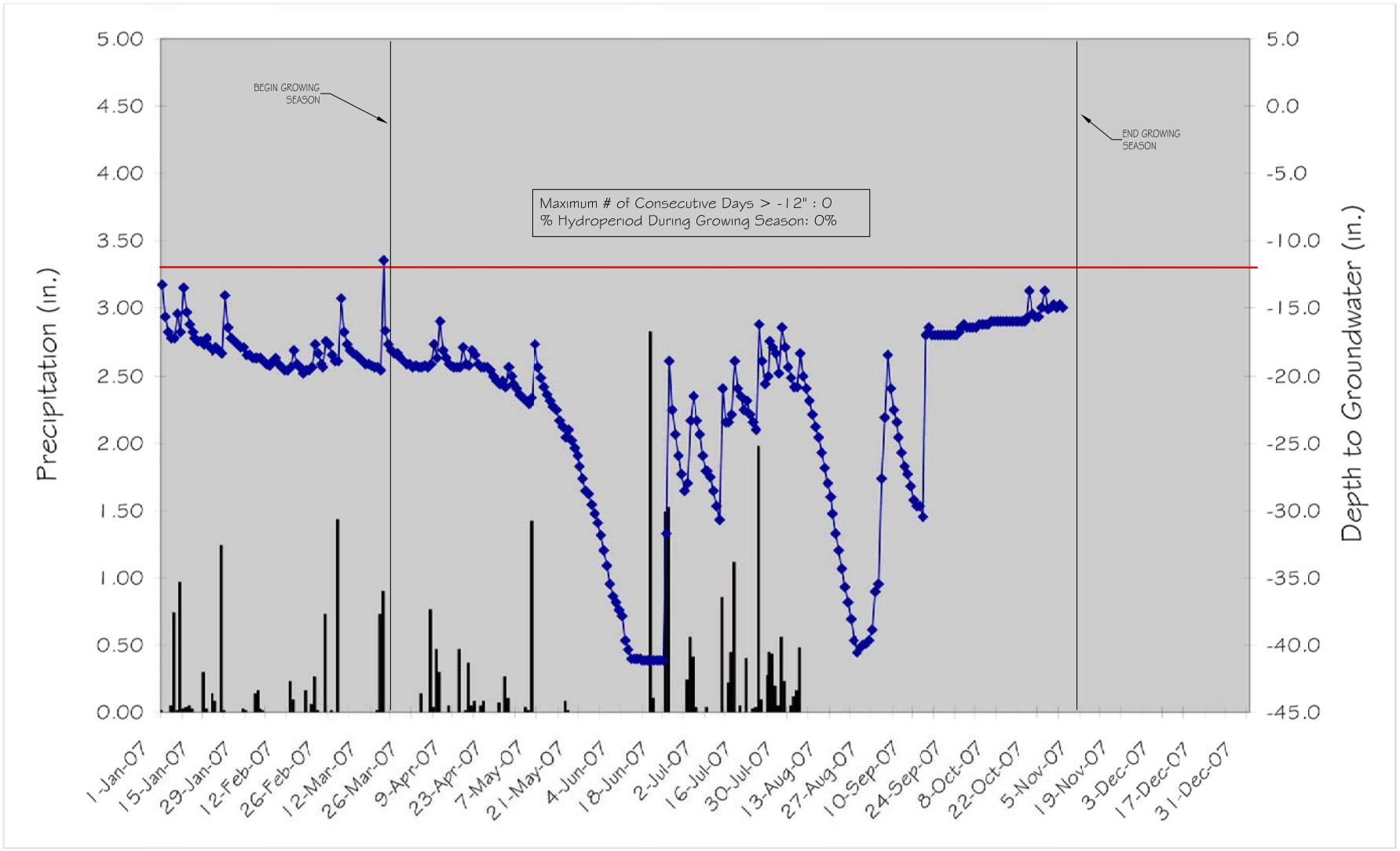
Tulula Stream and Wetland Restoration Site
Groundwater Gauge C1



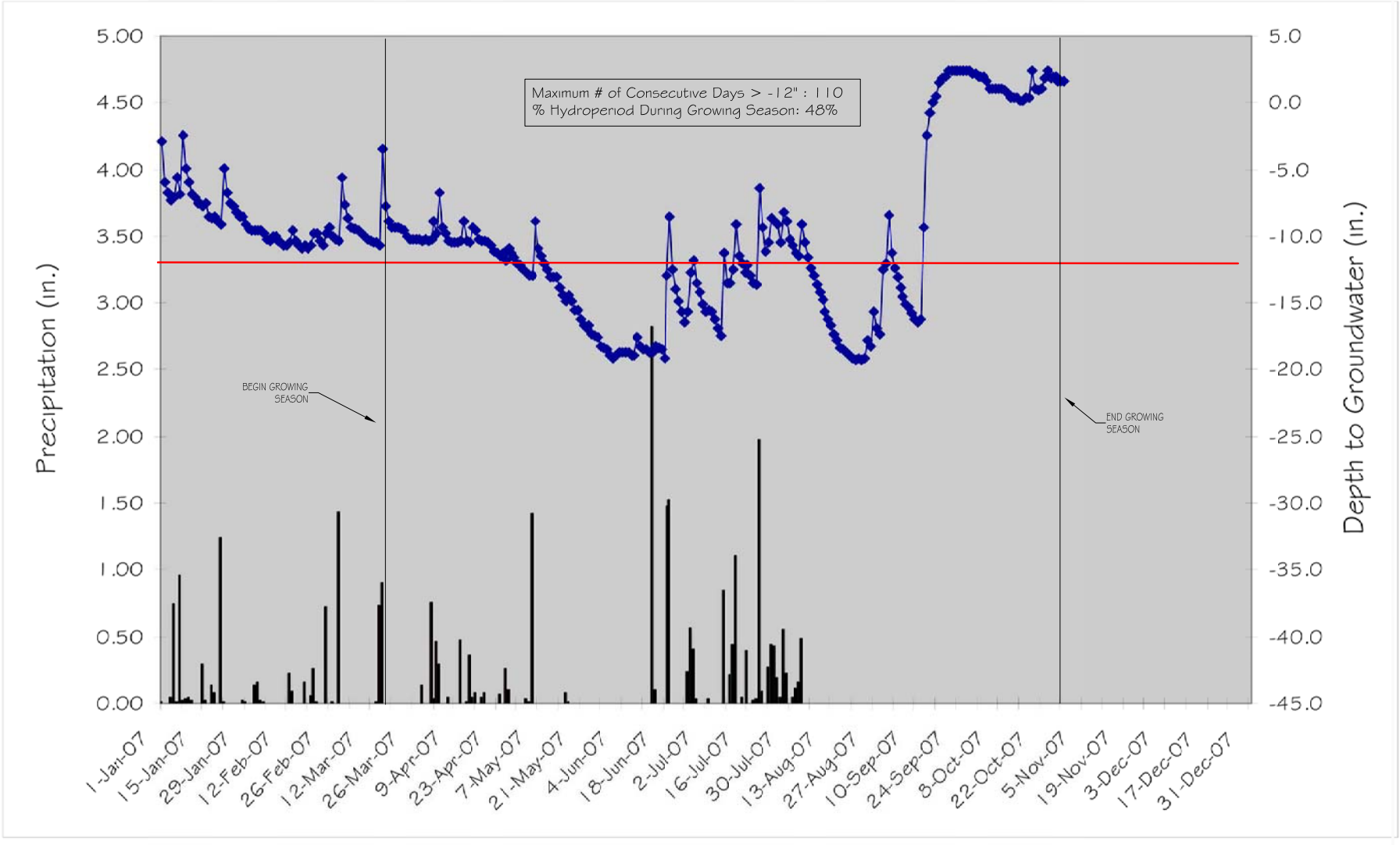
Tulula Stream and Wetland Restoration Site
Groundwater Gauge C2



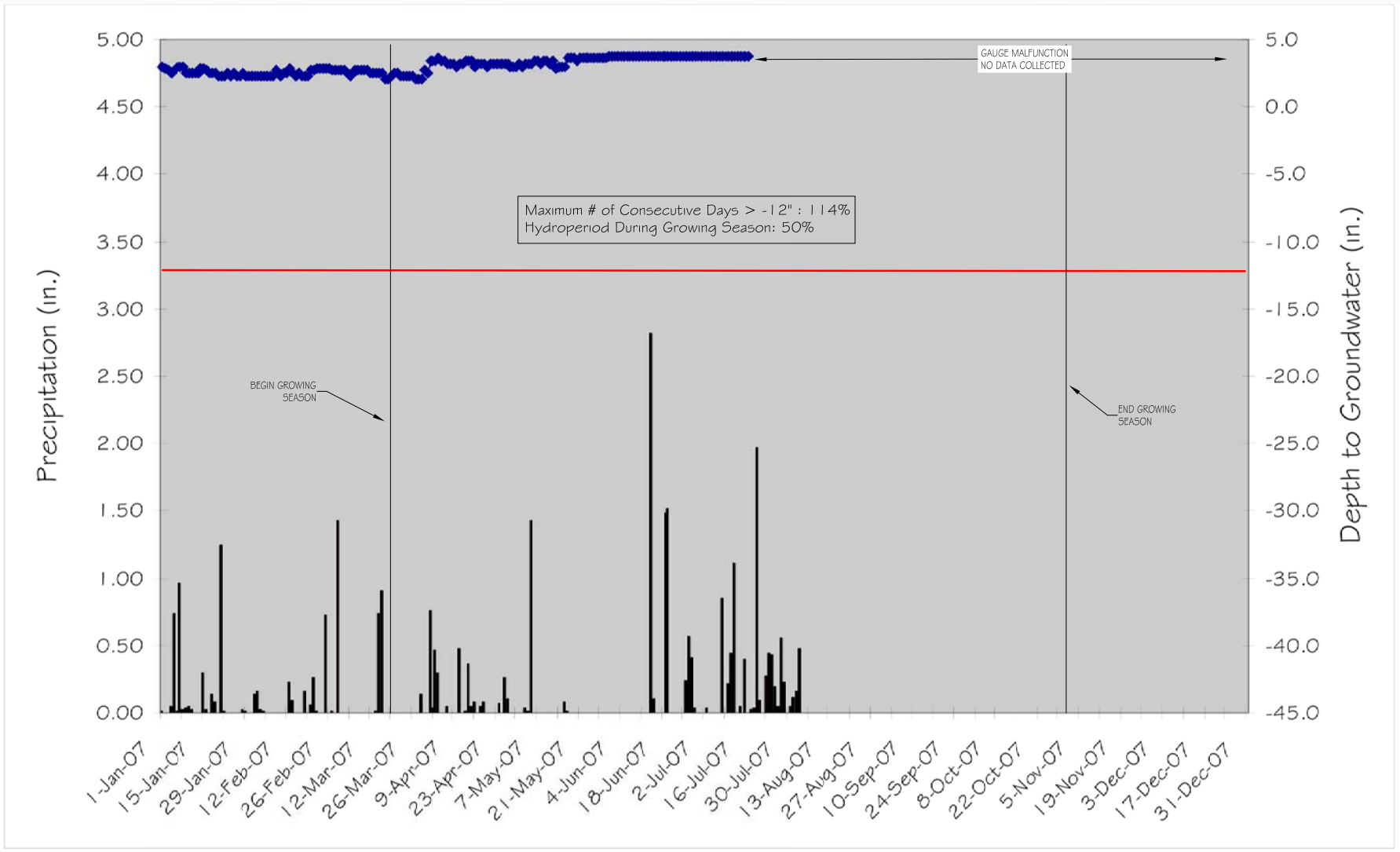
Tulula Stream and Wetland Restoration Site
Groundwater Gauge D1



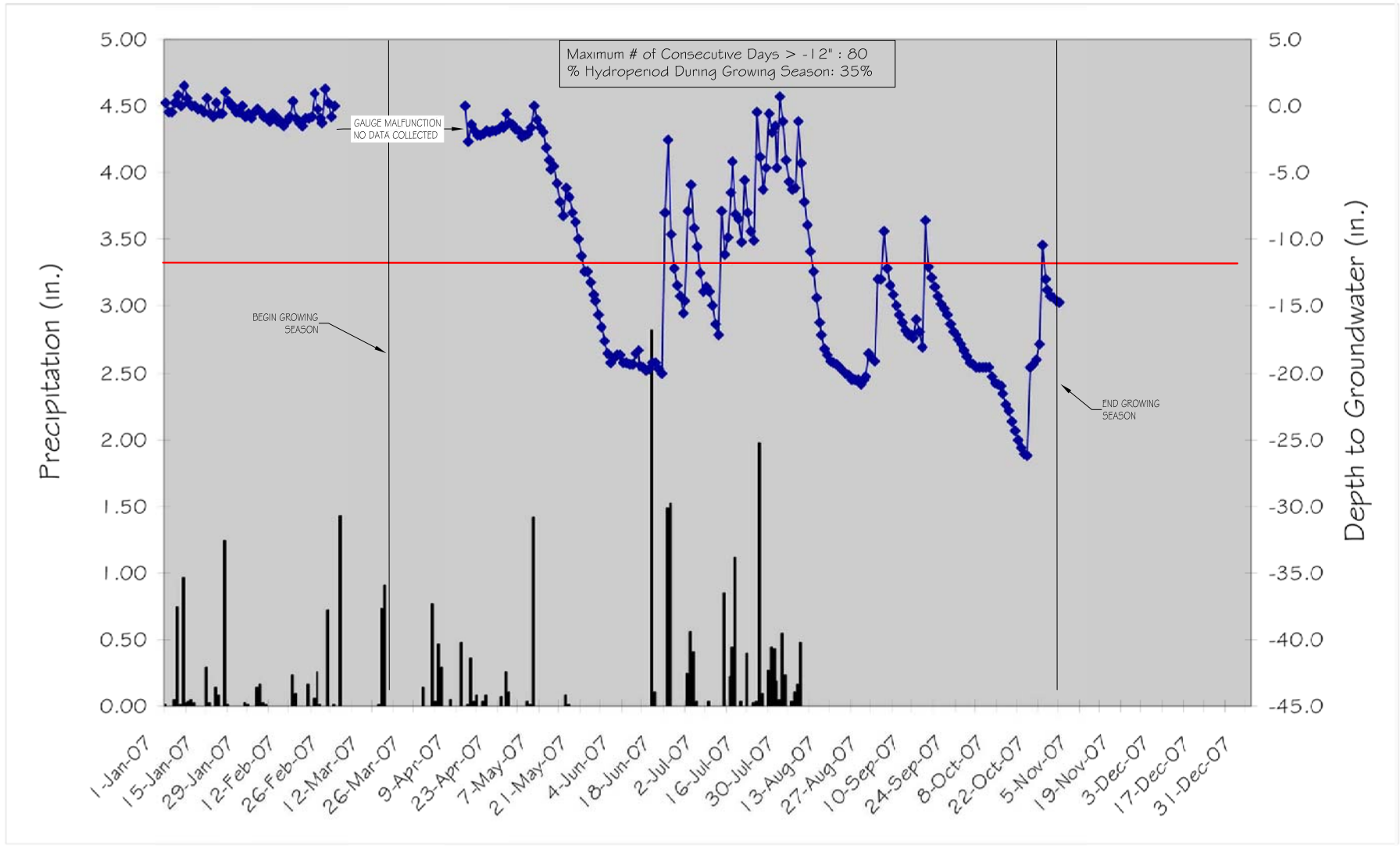
Tulula Stream and Wetland Restoration Site
Groundwater Gauge D2



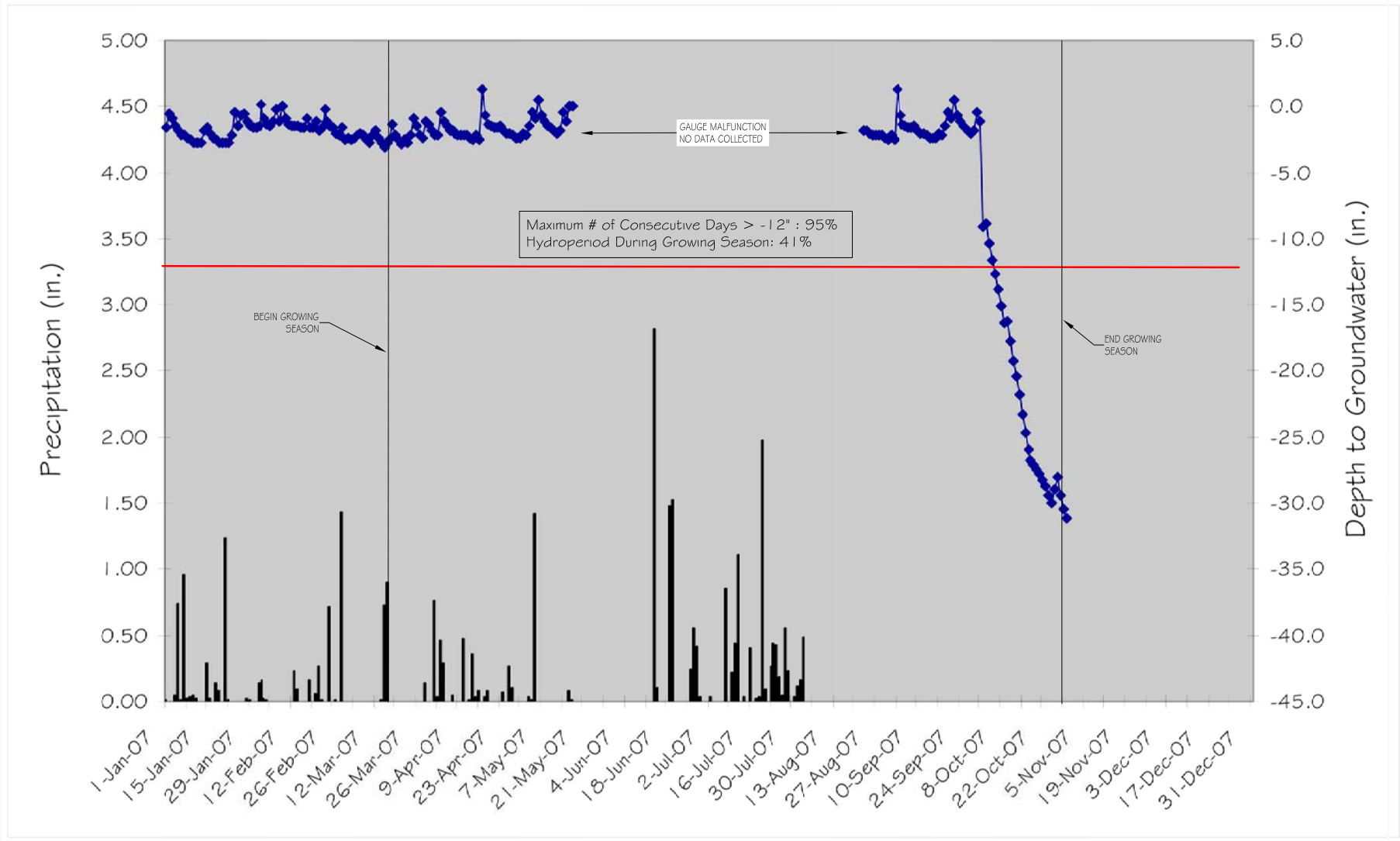
Tulula Stream and Wetland Restoration Site
Groundwater Gauge D3



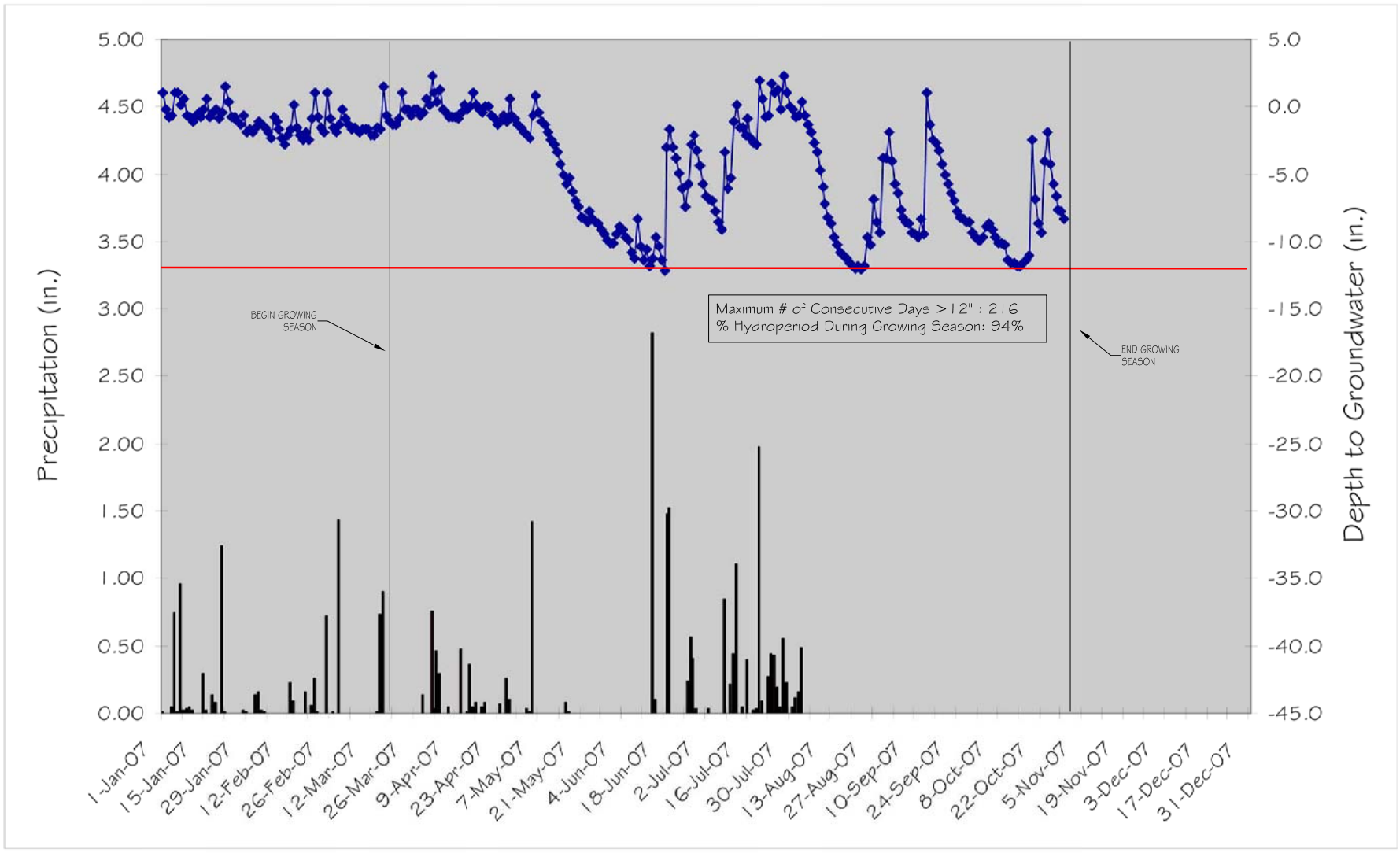
Tulula Stream and Wetland Restoration Site
Groundwater Gauge E1



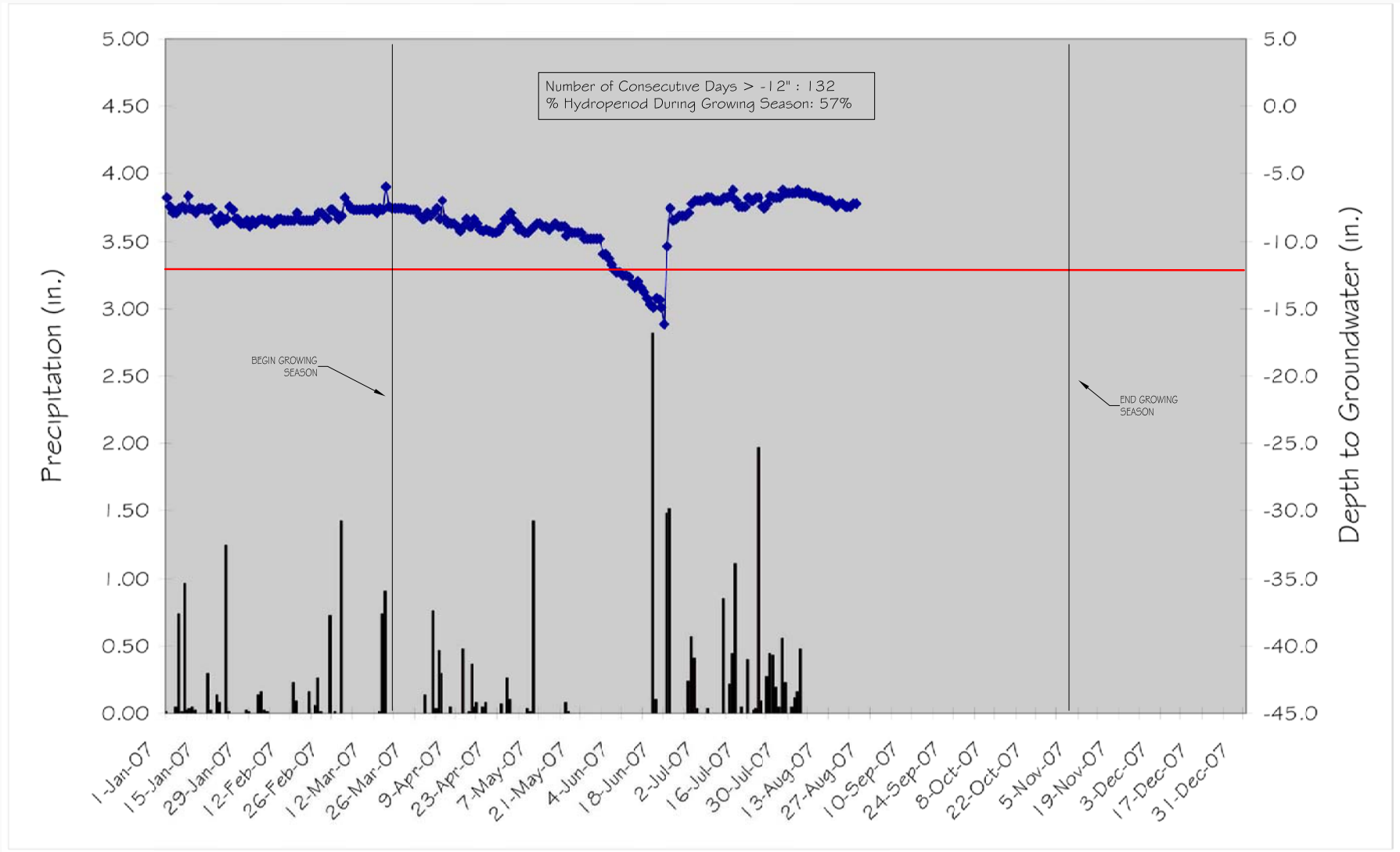
Tulula Stream and Wetland Restoration Site
Groundwater Gauge E2



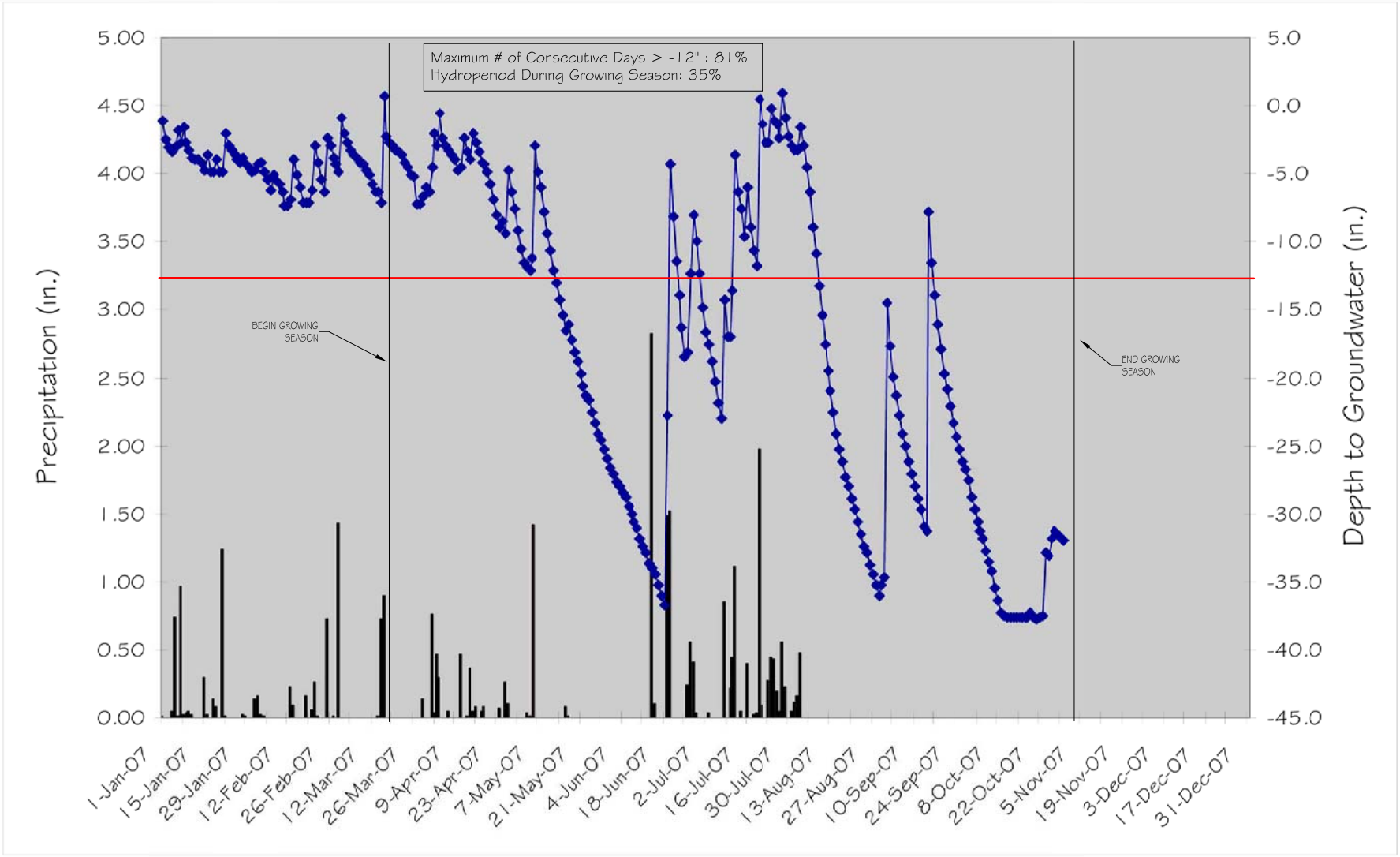
Tulula Stream and Wetland Restoration Site
Groundwater Gauge E3



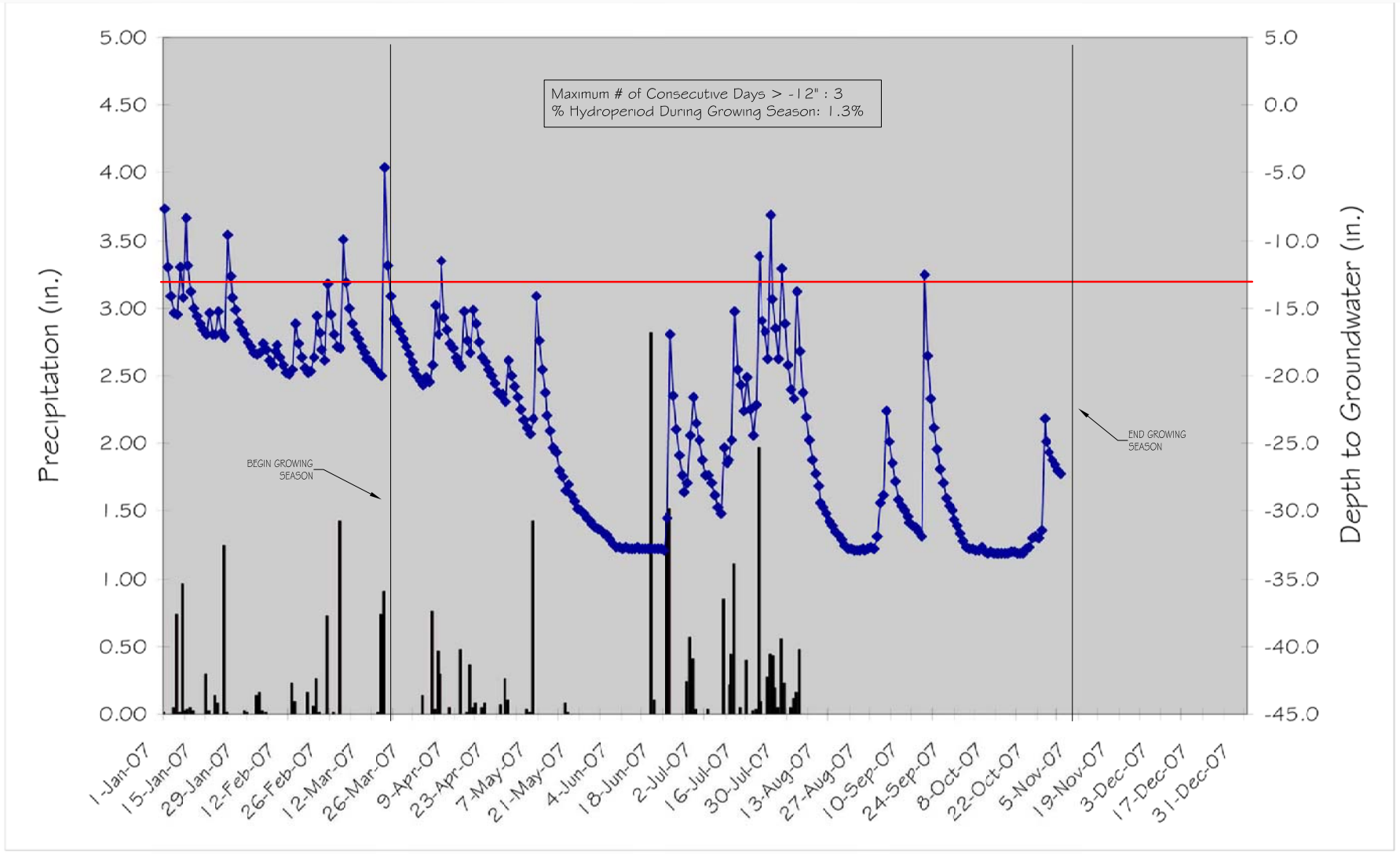
Tulula Stream and Wetland Restoration Site
Groundwater Gauge E4



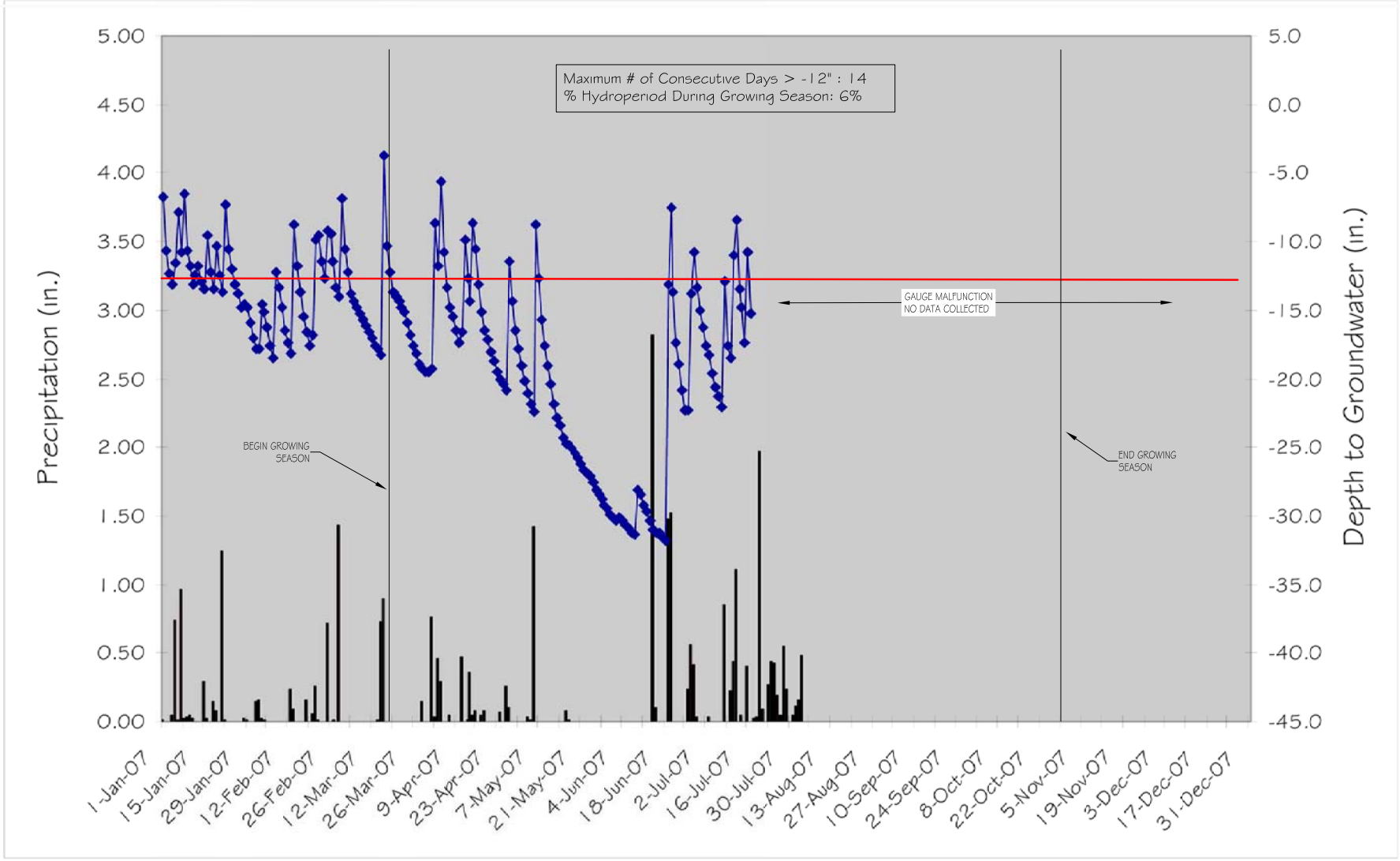
Tulula Stream and Wetland Restoration Site
Groundwater Gauge F1



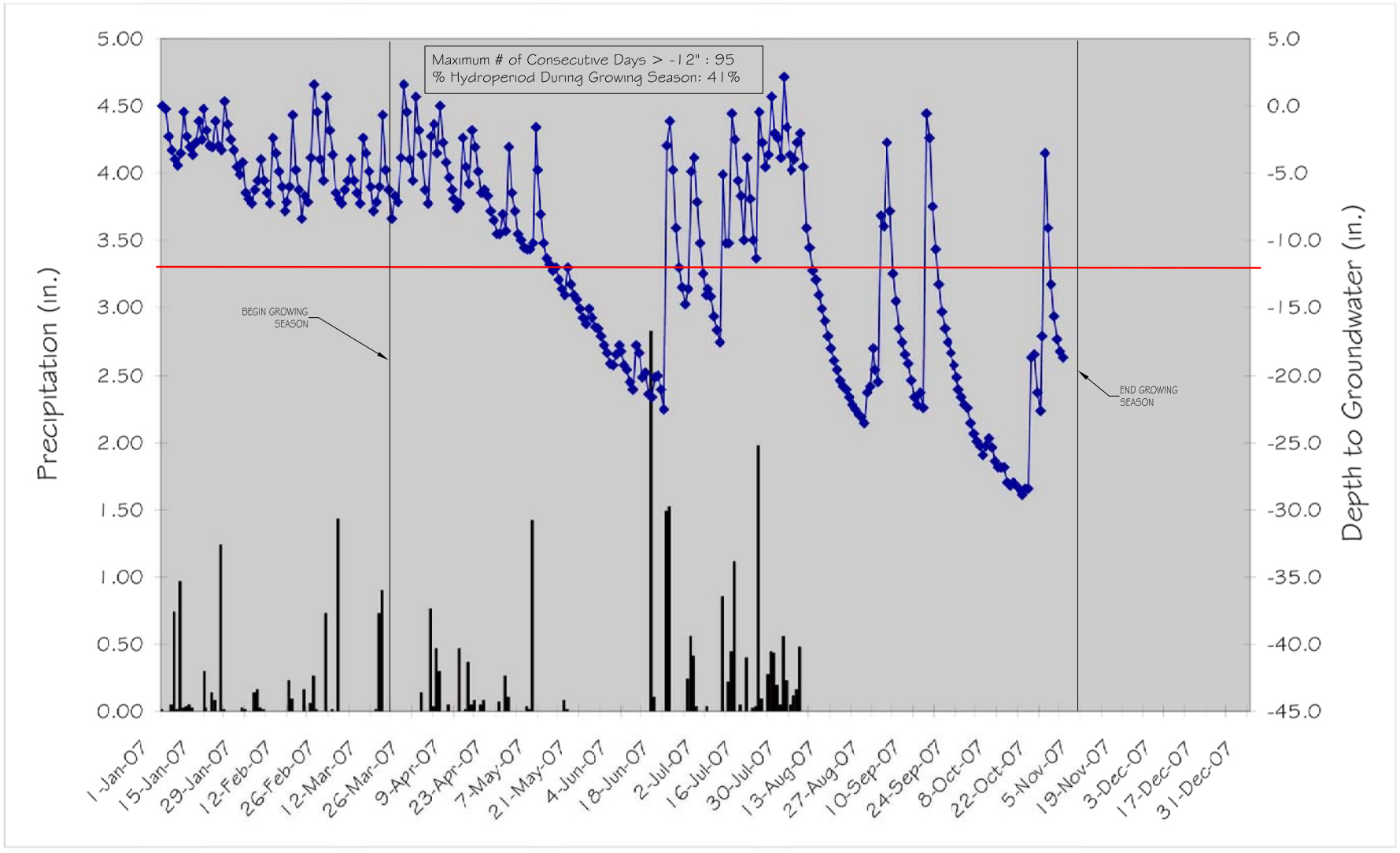
Tulula Stream and Wetland Restoration Site
Groundwater Gauge F2



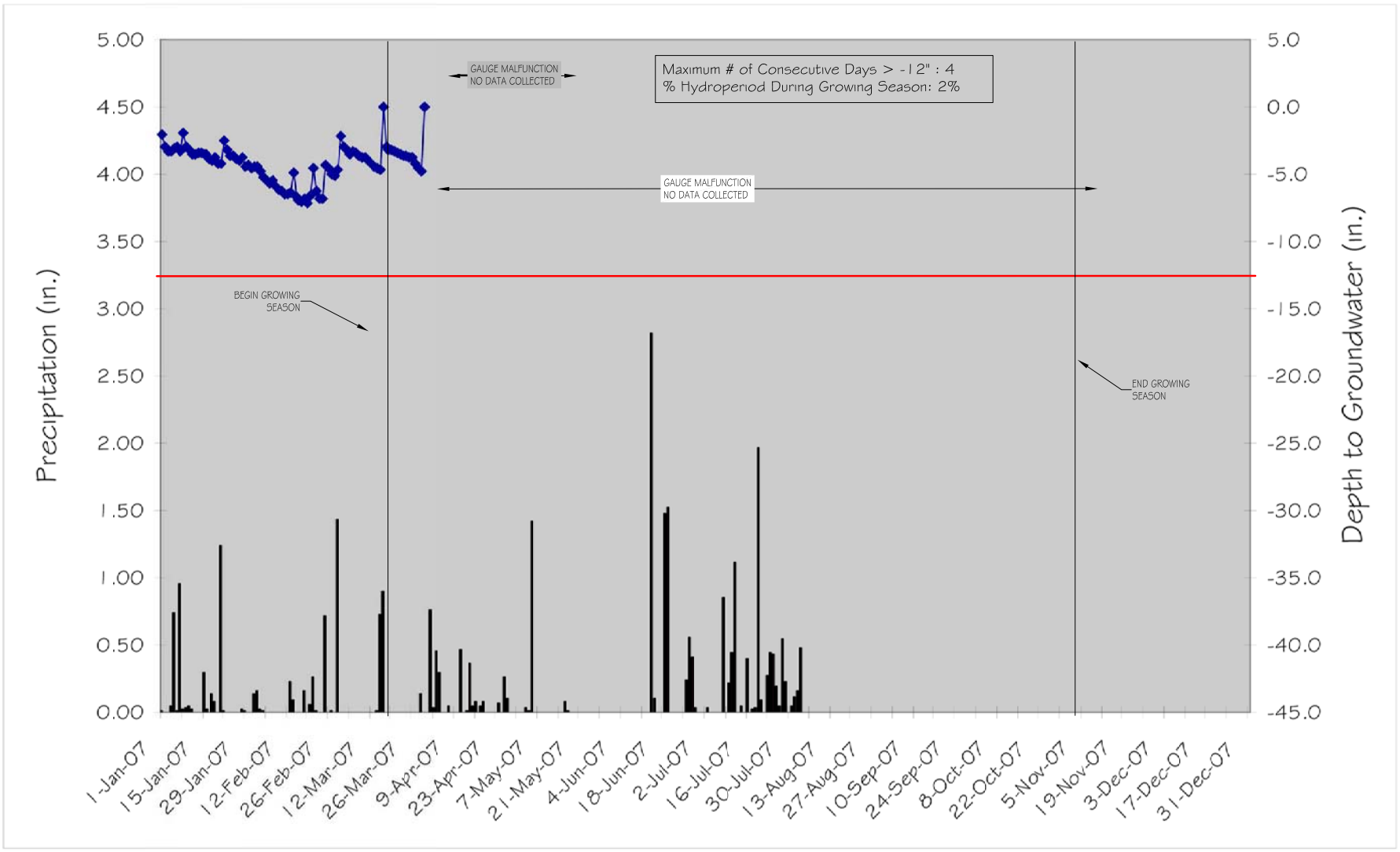
Tulula Stream and Wetland Restoration Site
Groundwater Gauge F3



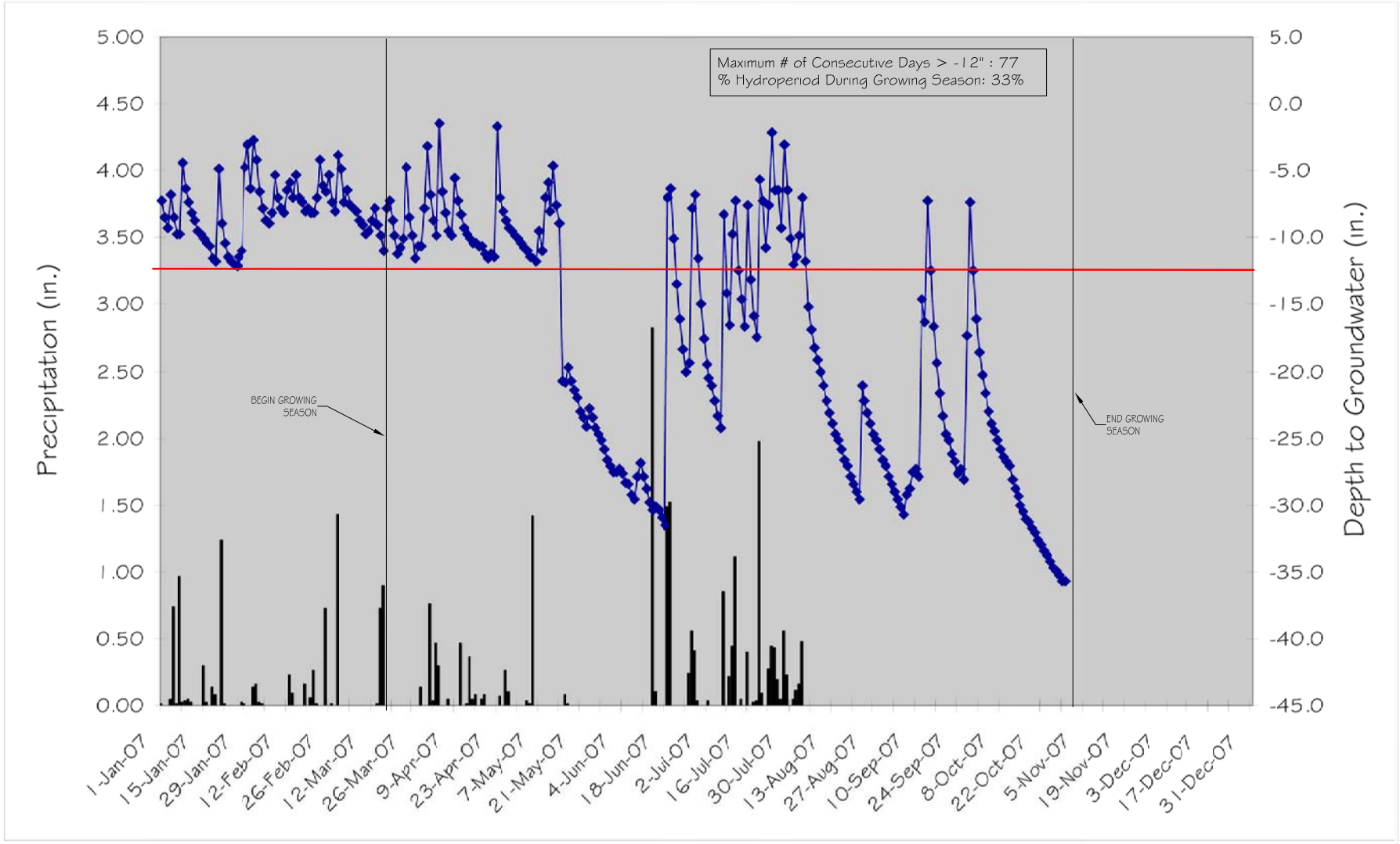
Tulula Stream and Wetland Restoration Site
Groundwater Gauge G1



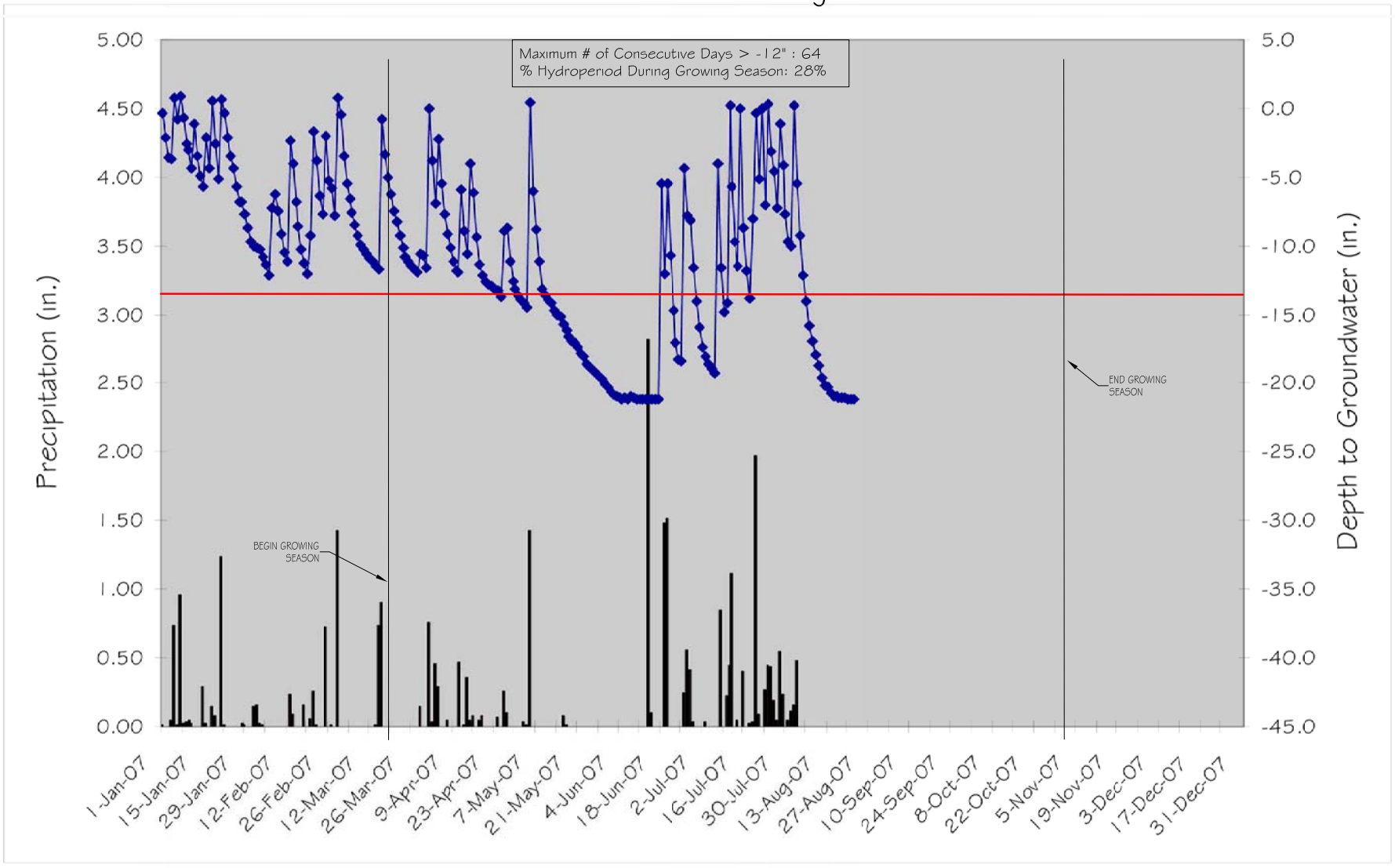
Tulula Stream and Wetland Restoration Site
Groundwater Gauge G2



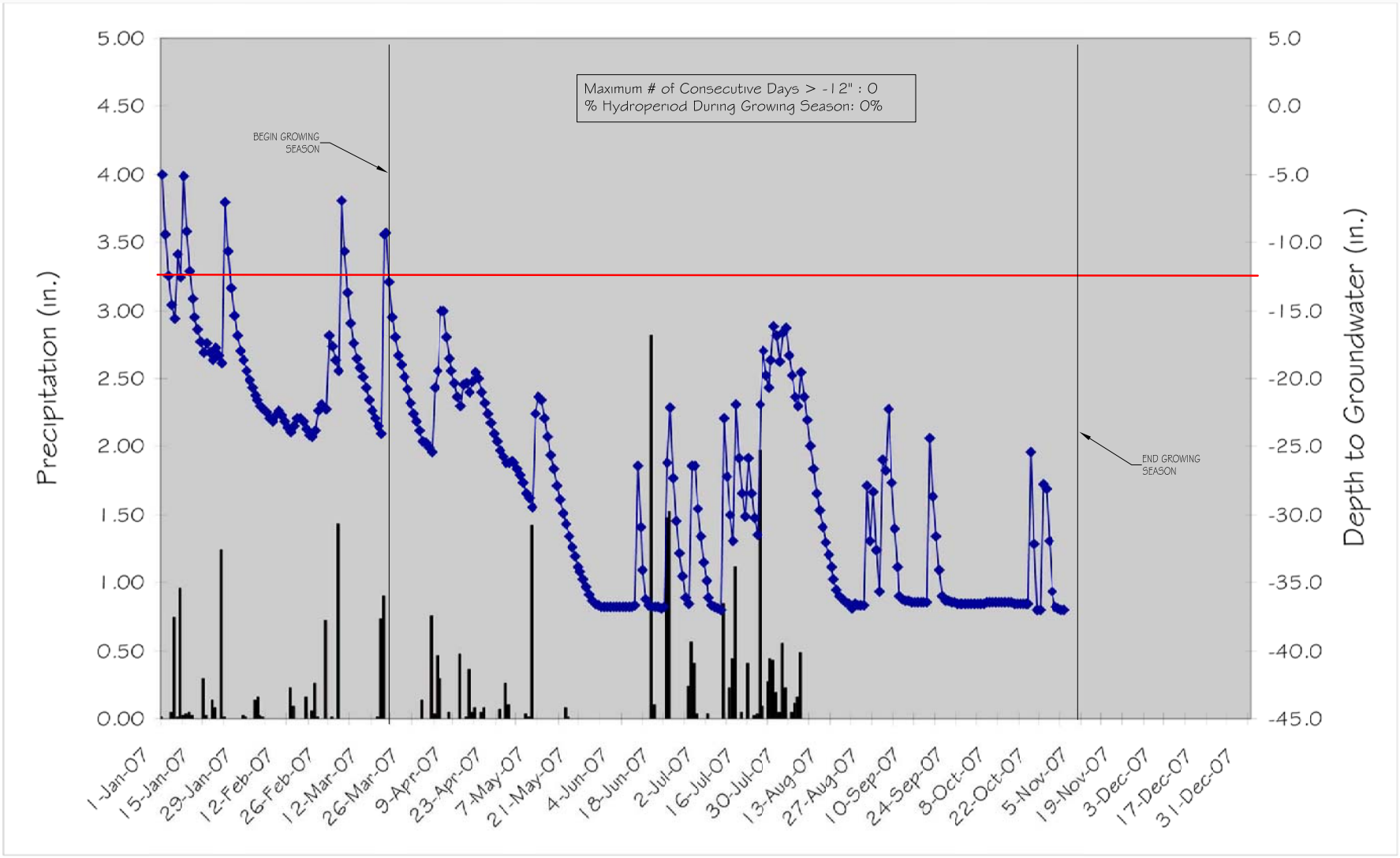
Tulula Stream and Wetland Restoration Site
Groundwater Gauge H1



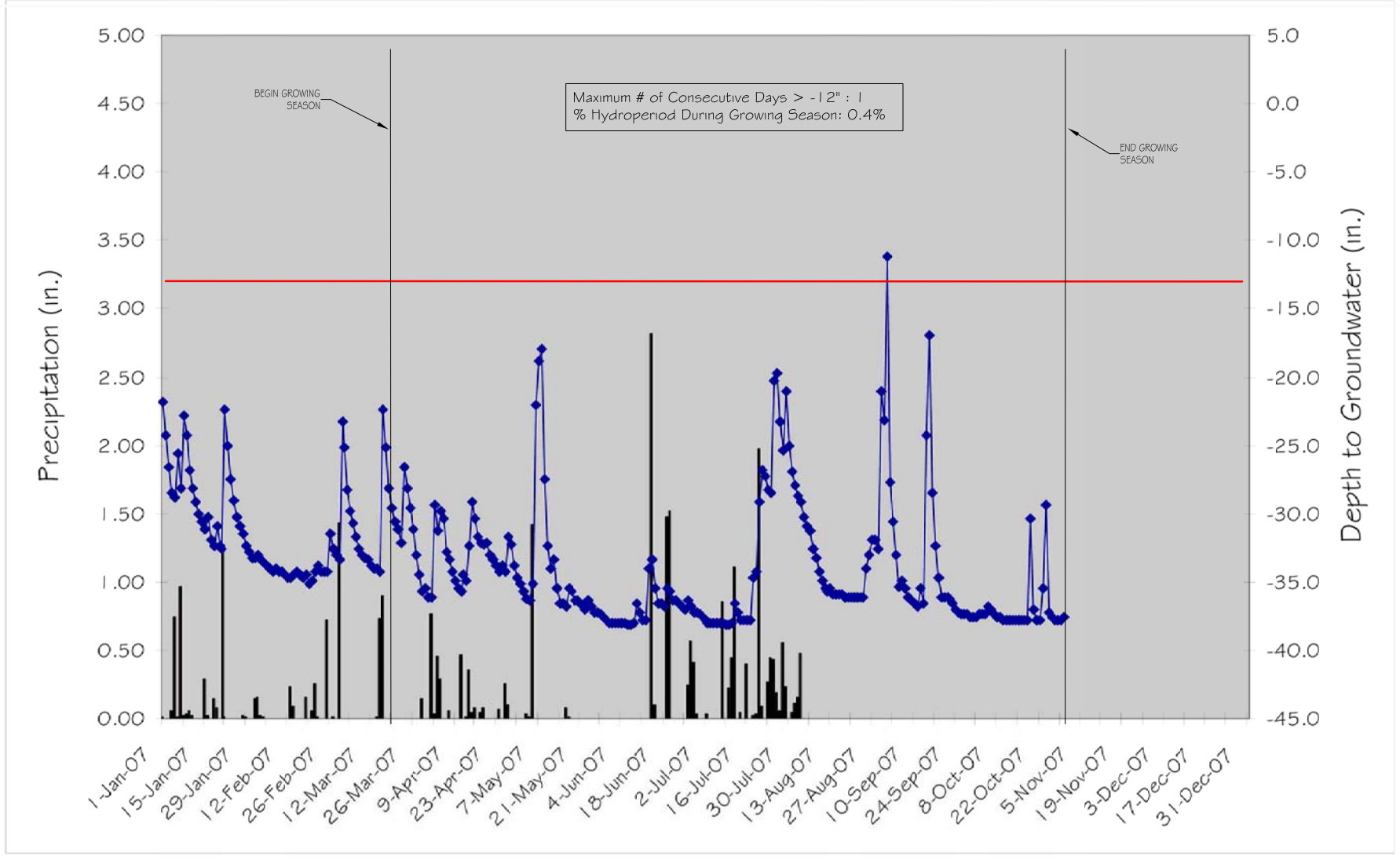
Tulula Stream and Wetland Restoration Site
Groundwater Gauge H2



Tulula Stream and Wetland Restoration Site
Groundwater Gauge H3



Tulula Stream and Wetland Restoration Site
Groundwater Gauge 11



Tulula Stream and Wetland Restoration Site
Groundwater Gauge X1