OVERHILLS STREAM AND WETLAND RESTORATION

MITIGATION PLAN

Harnett County, North Carolina
EEP Project Number 199

Monitoring Firm: Stantec Consulting Services Inc.
Monitoring Firm POC: David Bidelspach
EEP Project Manager: Melonie Allen

Prepared for:
North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

November 2007

Prepared by:

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801 Jones Franklin Road, Suite 300
Raleigh, NC 27606

EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) restored 4,482 linear feet of Jumping Run Creek and 70 acres of adjacent riparian wetlands located on the Fort Bragg Overhills tract, north of Spring Lake, in Harnett County, North Carolina. Construction of the project began on July 12, 2004 and the restoration was completed on May 30, 2006. The as-built survey included in this report was conducted in July 2007.

PRE-CONSTRUCTION SITE CONDITIONS

The restoration project is located on the north side of Nursery Road (SR 1120) and has a total drainage area of 15.9 square miles. The site had been significantly altered from its natural state. Prior to 1955, the stream was straightened and moved to the west to provide more room for agricultural practices. Previous to restoration activities, the stream was deeply incised with only the largest rain events resulting in overbank flow. The associated wetlands had been drained and cultivated in various row crops for many years. Jumping Run Creek was classified as a G4/G5 channel type.

RESTORATION PLAN

Priority 1 stream restoration was carried out on the project resulting in a restored C type channel. It is expected that the channel may naturally evolve into a lower width-to-depth channel that could be classified as E5. Priority 1 is the highest level of stream restoration and involves reestablishing a new stream channel near its original elevation and reconnecting it with its historical floodplain. The entire restoration area including streambanks and riparian wetlands were planted with vegetation to stabilize the channel and provide shading, food, and habitat. Berms were installed across the site perpendicular to the valley to promote wetland hydrology and create microtopography beneficial for wildlife habitat. Overbank flooding that may occur during stormevents will cause stormwater to be held in the riparian wetland providing an opportunity for treatment.

POST CONSTRUCTION SITE CONDITIONS

Project goals and objectives for the Overhills stream restoration project included:

1. restore stream dimension, pattern and profile
2. restore riparian wetland hydrology and vegetation
3. improve water quality
4. protect future water quality

The following table summarizes pre- and post-construction stream lengths and wetland acreages as well as the restoration approach implemented.

Table 1. Project Reaches Summary Table

Project Segment or Reach	Pre-Construction Length/Area (ft/ac)	Restored Length/Area (ft/ac)	Restoration Approach
Jumping Run Creek	3064	4482	Changed dimension, pattern, and profile using Priority 1 restoration.
Riparian Wetlands		70 acres	Hydrologic restoration and revegetation

MONITORING PLAN

A partial as-built survey was conducted after the final inspection in 2006 by BLUE: Land, Water, Infrastructure, P.A.. As requested by EEP, Stantec Consulting Services, Inc. conducted a new as-built survey in July 2007. Stantec will monitor the site as per the monitoring schedule submitted in this mitigation plan for the first and second year (2007 and 2008). The monitoring will include one visual assessment of the site in the first year (due to time restrictions) and three times in the second year. These assessments are intended to identify any problem areas early, in order to allow for quick remedial measures. At the end of the first two years following construction, Stantec will carry out a technical assessment of the site (e.g., detailed surveys, stem counts, photographs, pebble counts) and compile the data. Eight permanent cross-sections and ten vegetative sampling plots were installed. The stream will be monitored based on an adapted methodology that utilizes 3-D survey technology with the methodology contained in the USDA Forest Service Manual, Stream Channel Reference Sites (Harrelson, et. al, 1994). Vegetation will be monitored based on the Carolina Vegetative Survey methodology version 4.0. Baseline "as-built" information including cross-sectional measurements, longitudinal surveys, and vegetation data was gathered from each reach in late June / early July 2007 and is presented in this report. Fifteen Ecotone groundwater monitoring wells and one Infinity rain gauge are located across the site and will be downloaded on a monthly basis.

Table of Contents

1.0 Narrative

1.1 INTRODUCTION

The Overhills Restoration Site (Jumping Run Creek) is located on the Fort Bragg Overhills tract off Nursery Road (SR 1120) north of Spring Lake, North Carolina. (Figure 1.1). The project is located in Harnett County, North Carolina, in the Cape Fear River 03030004 Cataloging Unit (CU).

The Jumping Run Creek watershed is comprised of a mixture of undeveloped forested land, wetlands, suburban residential areas, commercial areas, and a large golf course community. The watershed has a total drainage area of 15.9 square miles. The topography of the watershed is typical sandhills type topography which is largely rolling in nature.

Jumping Run Creek has been significantly altered from its natural path prior to the restoration effort. The channel was relocated from its natural path to the far edge of its floodplain. The purpose of this type of relocation was typically to improve drainage of the surrounding area for agricultural purposes. The pre-restoration channel was approximately 5-8 feet deep and about 15 feet wide at the stream bed to 20+ feet wide at the top of bank. The stream classification system for the existing reach of this project was a G4/G5c. The adjacent riparian wetlands were also significantly altered due to the stream relocation as well as a ditch that was created on the eastern edge of the property.

1.2 LOCATION MAP

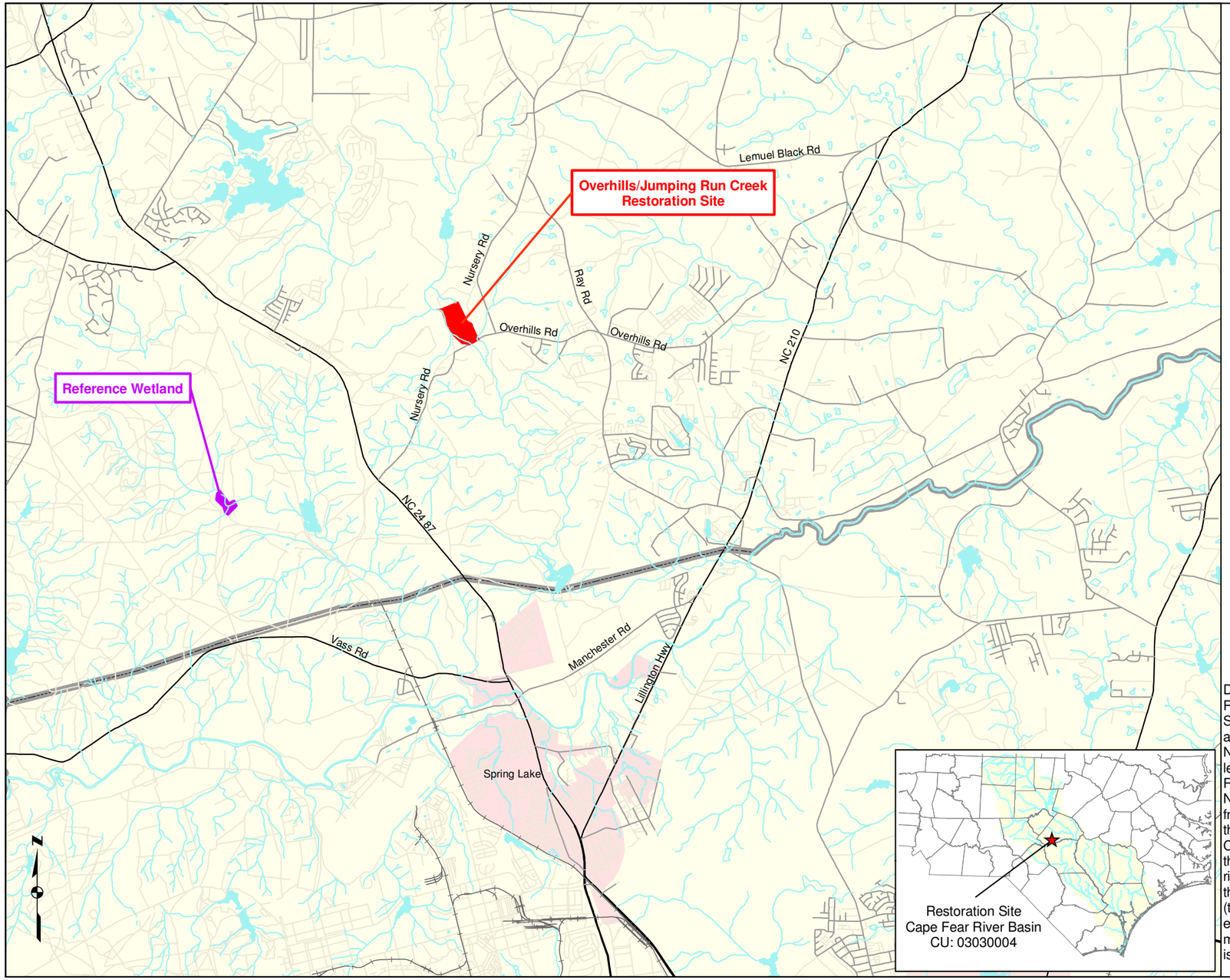


Figure 1. Location Map

Overhills/Jumping Run Creek Stream and Wetland Restoration Project
EEP #: 0199
Harnett County, North Carolina

Mitigation Plan
November 2007

0 0.5 1 2 3 Miles

- 1:24000 Hydrography
- NCDOT Primary Roads
- NCDOT Secondary Roads
- Railroads
- Overhills/Jumping Run Creek 35.258N, 79.000W
- Reference Wetland 35.227N, 79.050W

Directions to Overhills/Jumping Run Creek Restoration Site: From Raleigh, take US401 South following signs through Fuquay-Varina and into downtown Lillington. Turn right onto NC 27 and follow for about 9 miles, then turn left onto Nursery Rd. After 6.5 miles, Nursery Rd will come to a T, turn right to stay on Nursery Rd. The restoration site is half a mile from the T on the right hand side. To get to the reference site from the restoration site: Continue travelling east on Nursery Rd for 2 miles, then turn left onto NC24/NC87 for 3 miles. Turn right onto Vass Rd/NC 690. Continue for 3.5 miles, then turn right at sign that states "NO POVs" (this is part of Fort Bragg, need permission to enter). Follow the dirt road straight, at least 1.7 miles (do not turn or veer). The reference well is in the woods, about 100 feet from the end of the road.

1.3 RESTORATION SUMMARY

The stream restoration was based upon a hybrid analysis and design approach, utilizing aspects of the Analog (reference reach) and Empirical (regime reach) methodologies with the Analytical (system simulation) approach at the core. The approach developed involved a combination of a variety of stream restoration and hydraulic design techniques. The specific methods used included natural channel design, sandbed stream design methods, and other stable channel engineering methods.

Every effort was made to consider future land use changes within the watershed while completing the design. Priority 1 stream restoration was carried out on the entire reach resulting in restored C type channel. The pattern, dimension, and profile were restored throughout the project site by relocating the entire reach of stream. Log structures and root wads were installed to provide grade control, extra bank protection, and encourage development of bedform features. In wetland areas, a mixture of grading to create microtopography, channel plugs, and berms were used manipulate and enhance the hydrology of the site.

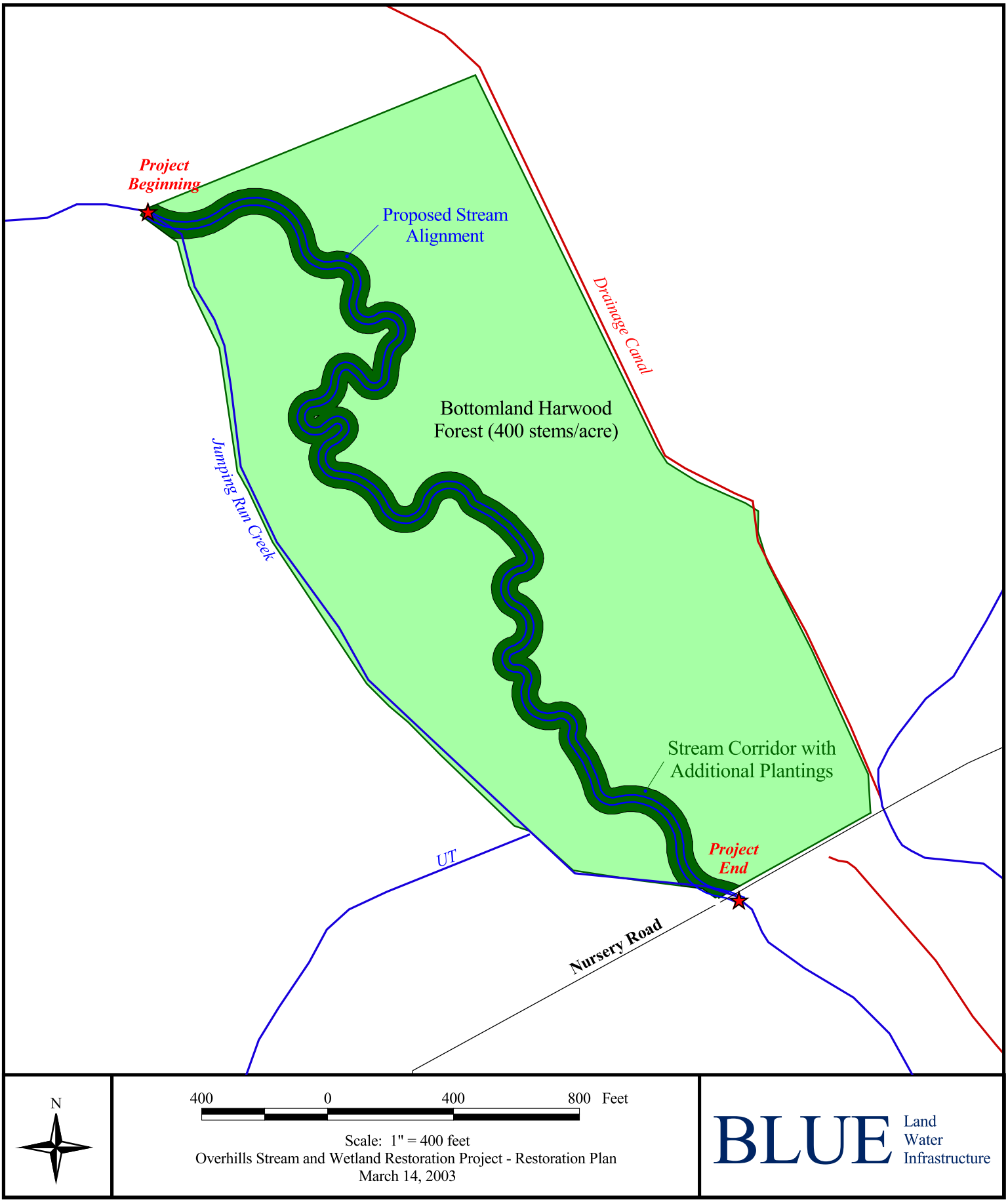
1.4 PLANTING PLAN

Two vegetative communities or zones were planted in the project area. One was the bottomland hardwood forest planted through the riparian wetland and the second was the stream corridor. The planting list is available in Table 2. The planting plan is provided in Figure 1.4.

Table 2. Planted Vegetation List
Overhills/Jumping Run Creek Restoration Project

Zone	Common Name	Scientific Name
Streambank Community	Silky dogwood	*Cornus amomum*
	Buttonbush	*Cephalanthus occidentalis*
	Black willow	*Salix nigra*
	Titi	*Cyrilla racemiflora*
	Elderberry	*Sambucus canadensis*
	Southern magnolia	*Magnolia grandiflora*
	Wax myrtle	*Morella cerifera*
	Willow oak	*Quercus phellos*
	Water oak	*Quercus nigra*
Bottomland Hardwood Forest	Swamp tupelo	*Nysa biflora*
	Bald cypress	*Taxodium distichum*
	Tulip poplar	*Liriodendron tulipifera*
	Willow oak	*Quercus phellos*
	Water oak	*Quercus nigra*
	Green ash	*Fraxinus pennsylvanica*

Proposed Vegetative Communities



1.5 SITE MAP

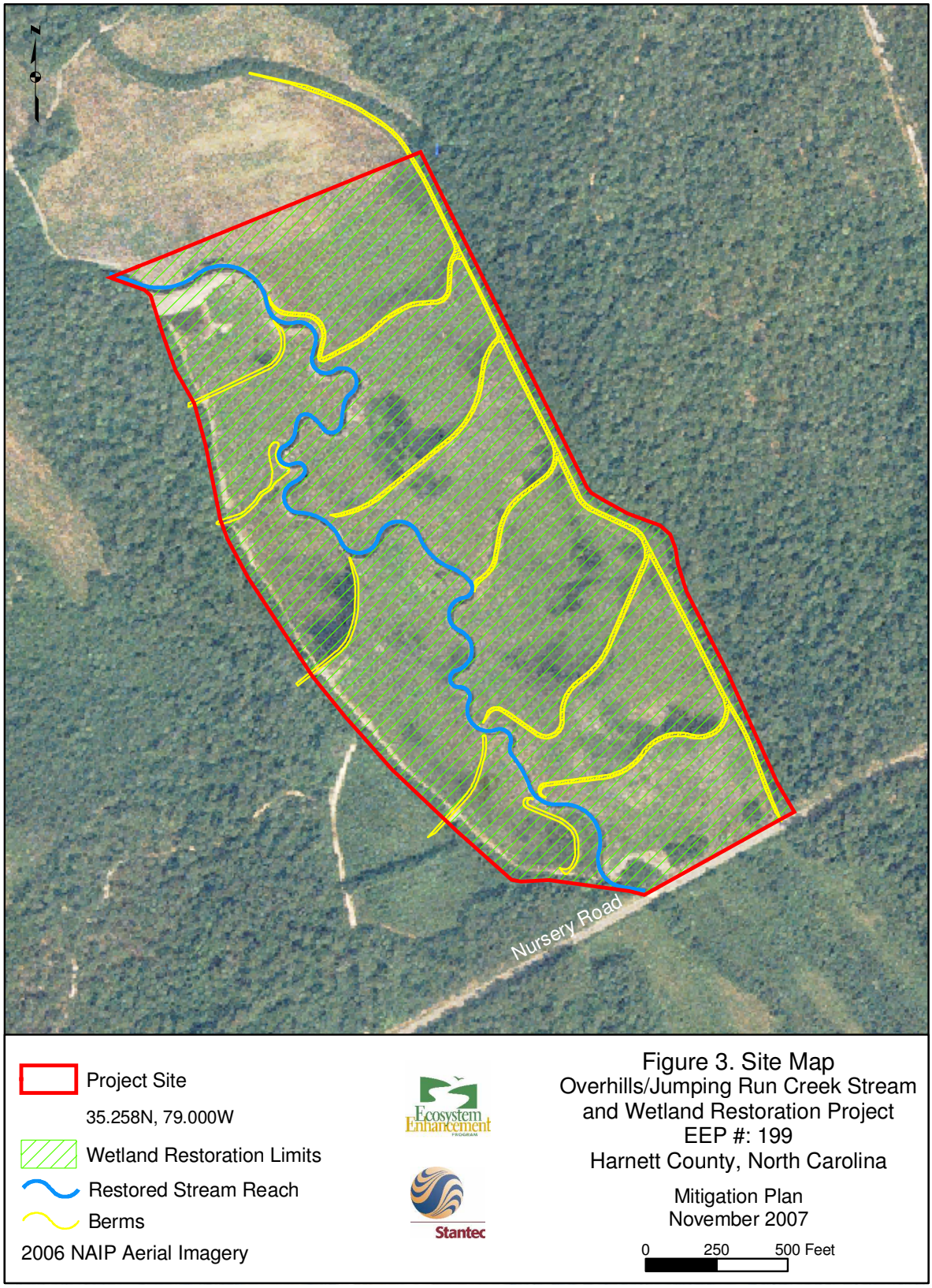


Figure 3. Site Map
Overhills/Jumping Run Creek Stream and Wetland Restoration Project
EEP #: 199
Harnett County, North Carolina

Mitigation Plan
November 2007

1.6 SUMMARY TABLE

Exhibit Table I. Project Restoration Components Overhills/Jumping Run Creek Restoration Project - EEP Project No. 199								
	Existing Feet/Acres	Type	Approach	Footage or Acreage	Mitigation Ratio	Mitigation Units	Stationing	Comment
Stream	3064	R	P1	4482	1.0	4482	10+00.0 to 55+00.0	includes log structures and root wads
Riparian Wetlands	NA	R	-	70.0	1.0	70.0		floodplain of restored stream

R = Restoration
P1 = Priority 1
P = Preservation

2.0 As-Builts

An as-built survey was not provided by the design firm after construction was completed on the site. The following sheets contain survey data collected in July 2007 (pages 9-16). The survey data focused on the stream channel and did not include a topographic survey of the entire site.

OVERHILLS

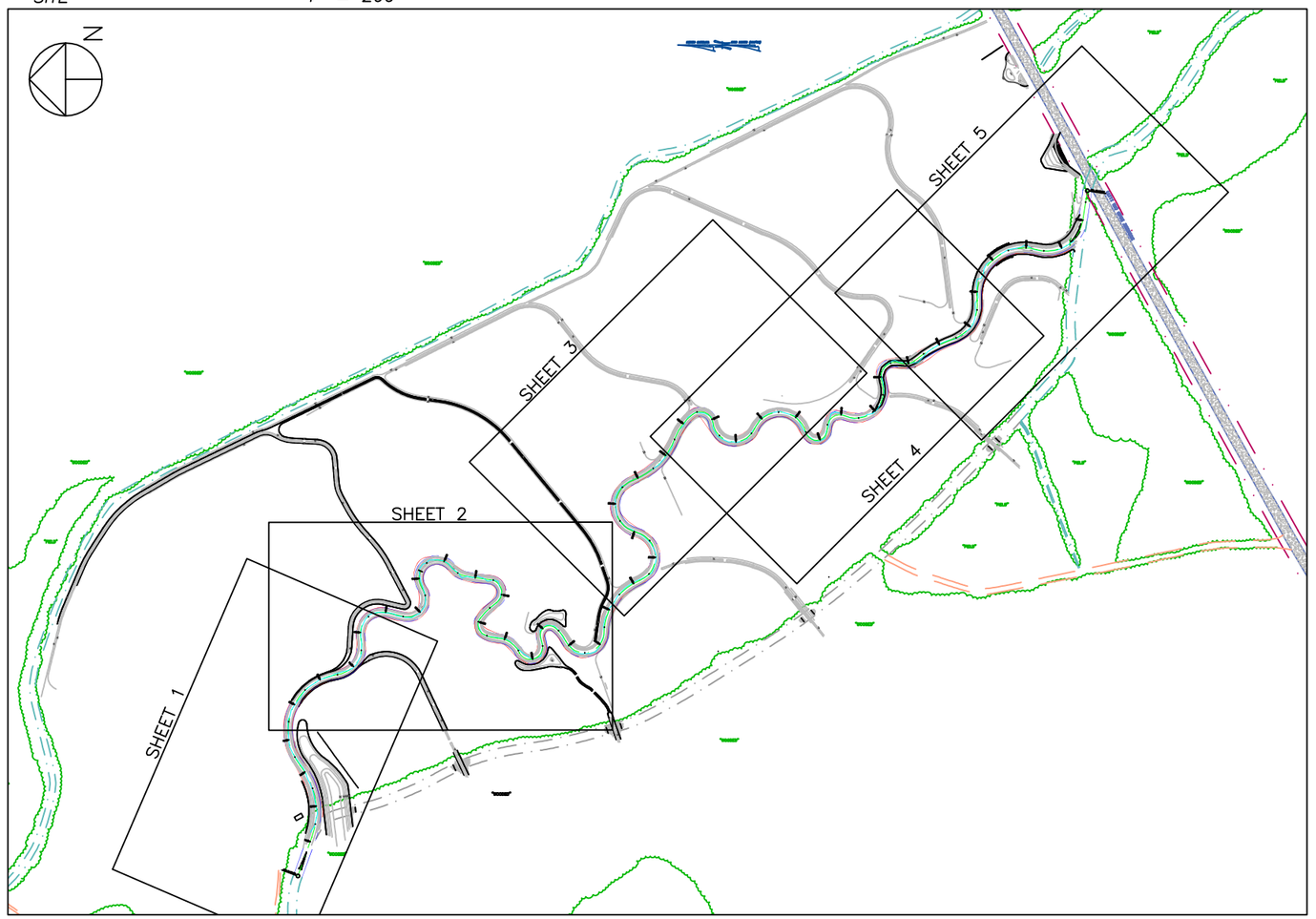
(Nursery Road)

Jumping Run Creek / McLeod's Creek

Stream and Wetland Restoration Project

Barnett County, North Carolina

SITE 1" = 200'



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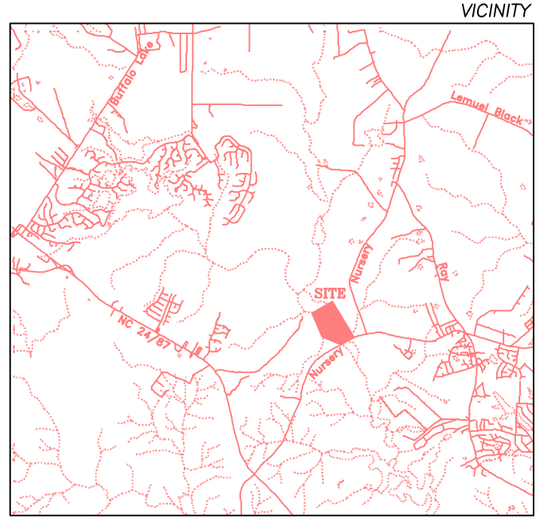

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AS–BUILT PROJECT ENGINEER SIGNATURE

ORIGINAL STREAM RESTORATION DESIGN BY:
BLUE: LAND, WATER, INFRASTRUCTURE, PA

Prepared For: The NC Ecosystem Enhancement Program (NCEEP)

NOVEMBER, 2007

LEGEND

- DESIGN THALWEG
- AS-BUILT BANKFULL
- DESIGN BANKFULL
- MONITORING LONGITUDINAL PROFILE
- DESIGN GRADE
- DESIGN LOG CROSS VANE
- DESIGN ROOT WAD
- VEG PLOT PINS
- VEG PLOTS
- CROSS-SECTIONS
- PHOTO POINTS

CROSS SECTION PIN LOCATIONS		
PIN	LAT	LONG
XS1PL	35.26109096	-79.00252352
XS1PR	35.26124247	-79.00249424
XS2PL	35.26081361	-79.00061178
XS2PR	35.26072332	-79.00069698

VEG PLOT PIN COORDINATES		
PIN	LAT	LONG
VP1	35.26080136	-79.00066535
VP1	35.26092137	-79.00083395
VP7	35.26053462	-79.00144889
VP7	35.26064411	-79.00136751

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PROJECT NO.	SHEET NO.
SCO#070695701	01
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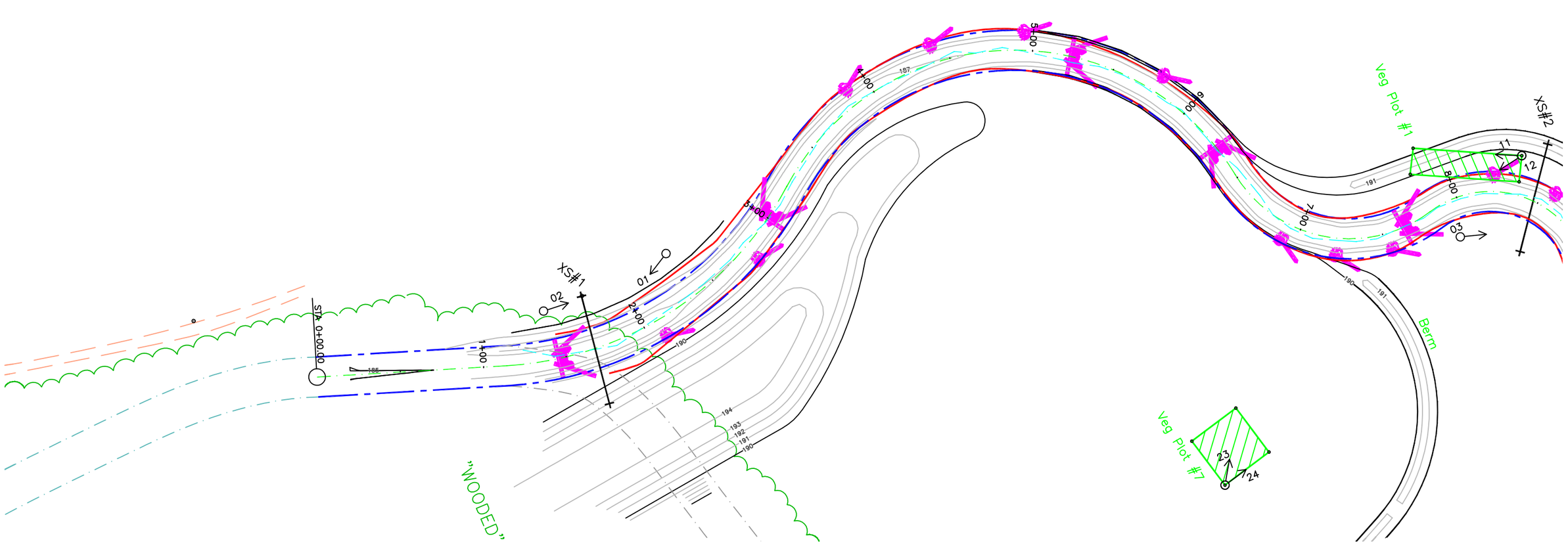

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AS-BUILT PROJECT ENGINEER	

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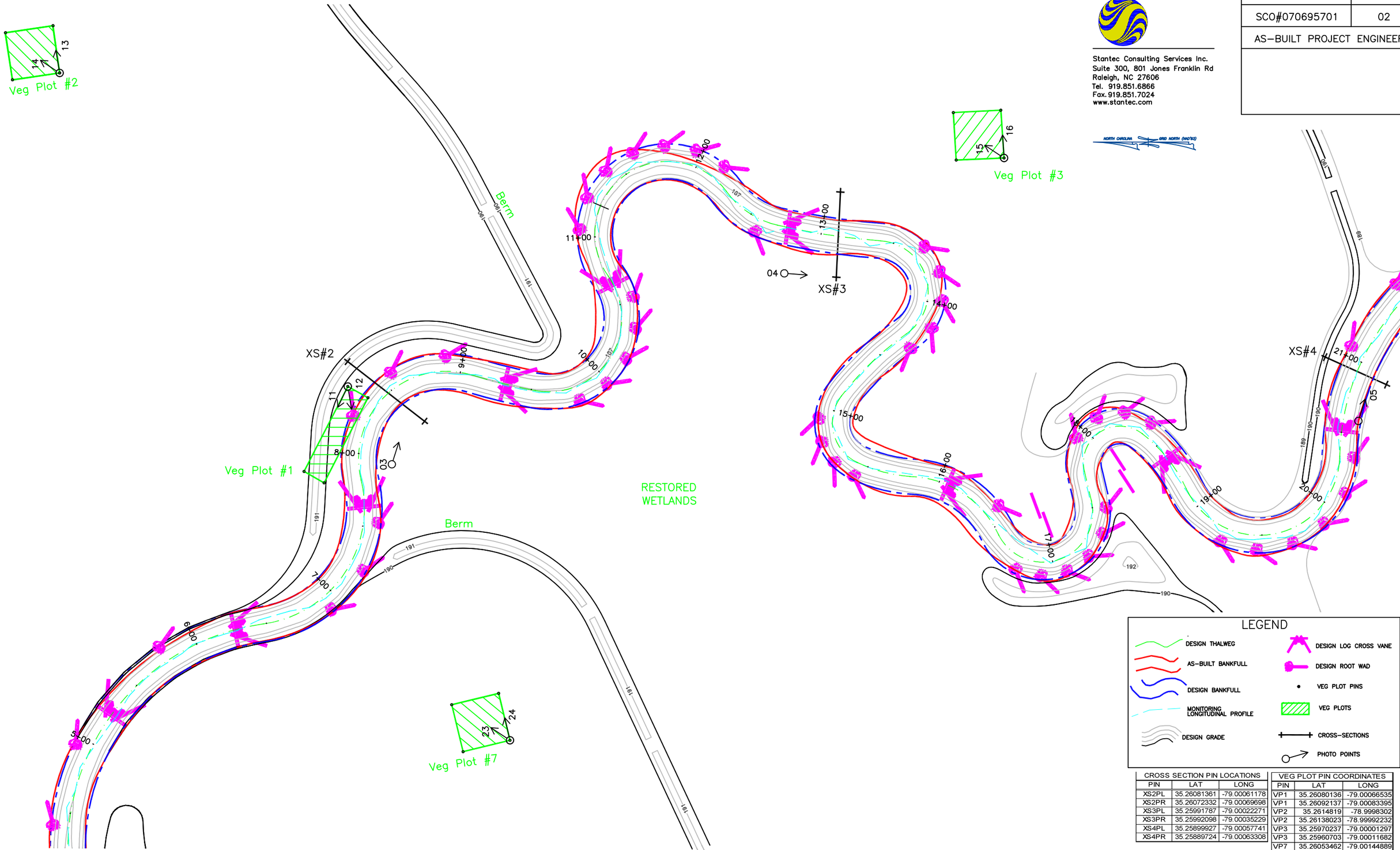
NORTH CAROLINA GRID NORTH (NAD'83)



CROSS SECTION PIN LOCATIONS		
PIN	LAT	LONG
XS2PL	35.26081361	-79.00061178
XS2PR	35.26072332	-79.00069698
XS3PL	35.25991787	-79.00022271
XS3PR	35.25992098	-79.00035229
XS4PL	35.25899927	-79.00057741
XS4PR	35.25889724	-79.00063308

VEG PLOT PIN COORDINATES		
PIN	LAT	LONG
VP1	35.26080136	-79.00066535
VP1	35.26092137	-79.00083395
VP2	35.2614819	-78.9998302
VP2	35.26138023	-78.99992232
VP3	35.25970237	-79.00001297
VP3	35.25960703	-79.00011682
VP7	35.26053462	-79.00144889
VP7	35.26064411	-79.00136751

PROJECT NO.	SHEET NO.
SCO#070695701	03
AS-BUILT PROJECT ENGINEER	

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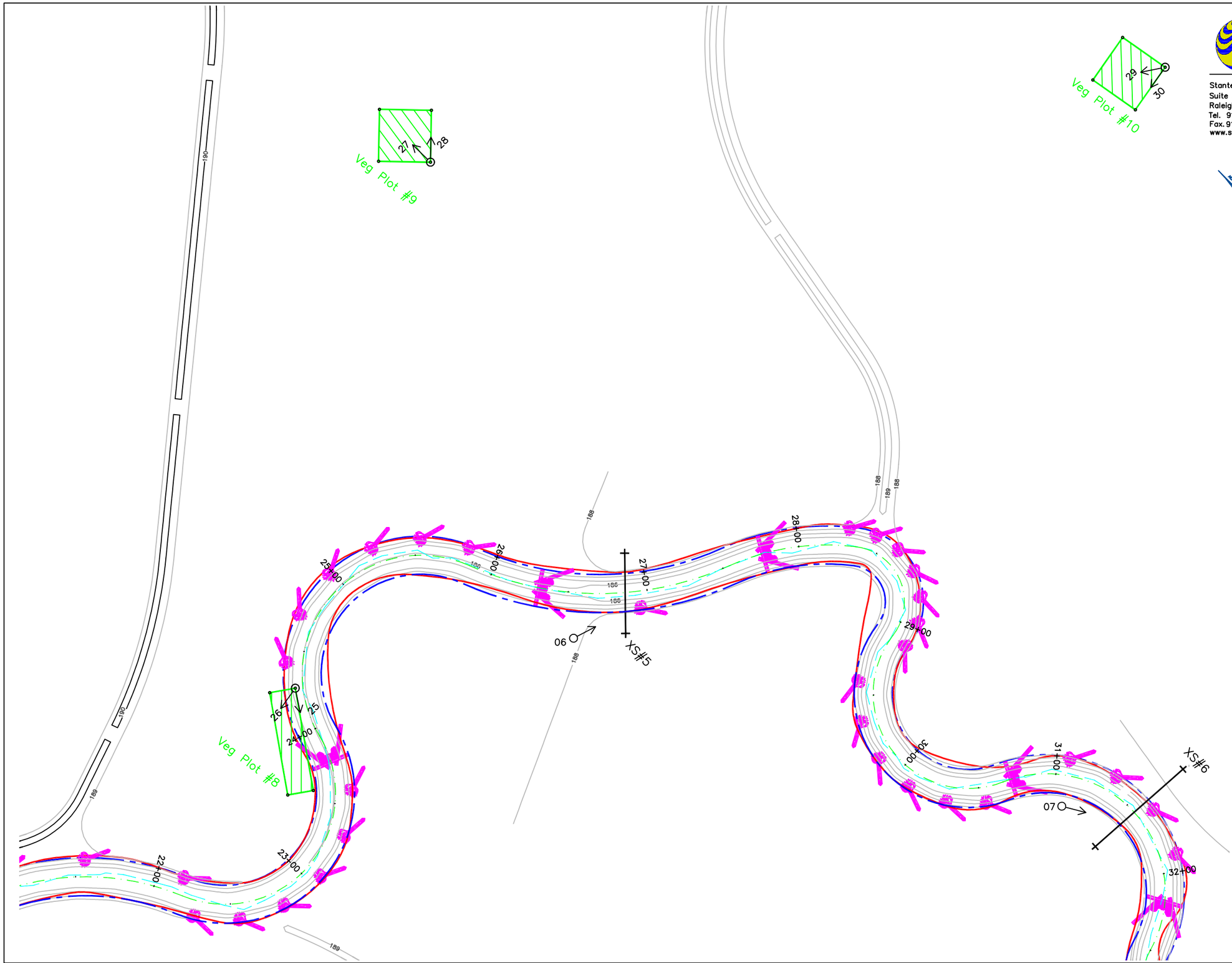

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- DESIGN BANKFULL
- MONITORING LONGITUDINAL PROFILE
- DESIGN GRADE
- DESIGN LOG CROSS VANE
- DESIGN ROOT WAD
- VEG PLOT PINS
- VEG PLOTS
- CROSS-SECTIONS
- PHOTO POINTS

CROSS SECTION PIN LOCATIONS

PIN	LAT	LONG
XS5PL	35.25857955	-78.99914964
XS5PR	35.25849085	-78.99925158
XS6PL	35.25763716	-78.99869711
XS6PR	35.25764396	-78.99883106

VEG PLOT PIN COORDINATES

PIN	LAT	LONG
VP8	35.25882237	-78.99983412
VP8	35.25870055	-79.00000515
VP9	35.25930164	-78.99884514
VP9	35.25942907	-78.99884242
VP10	35.25851643	-78.99760386
VP10	35.25858954	-78.99773114

PROJECT NO.	SHEET NO.
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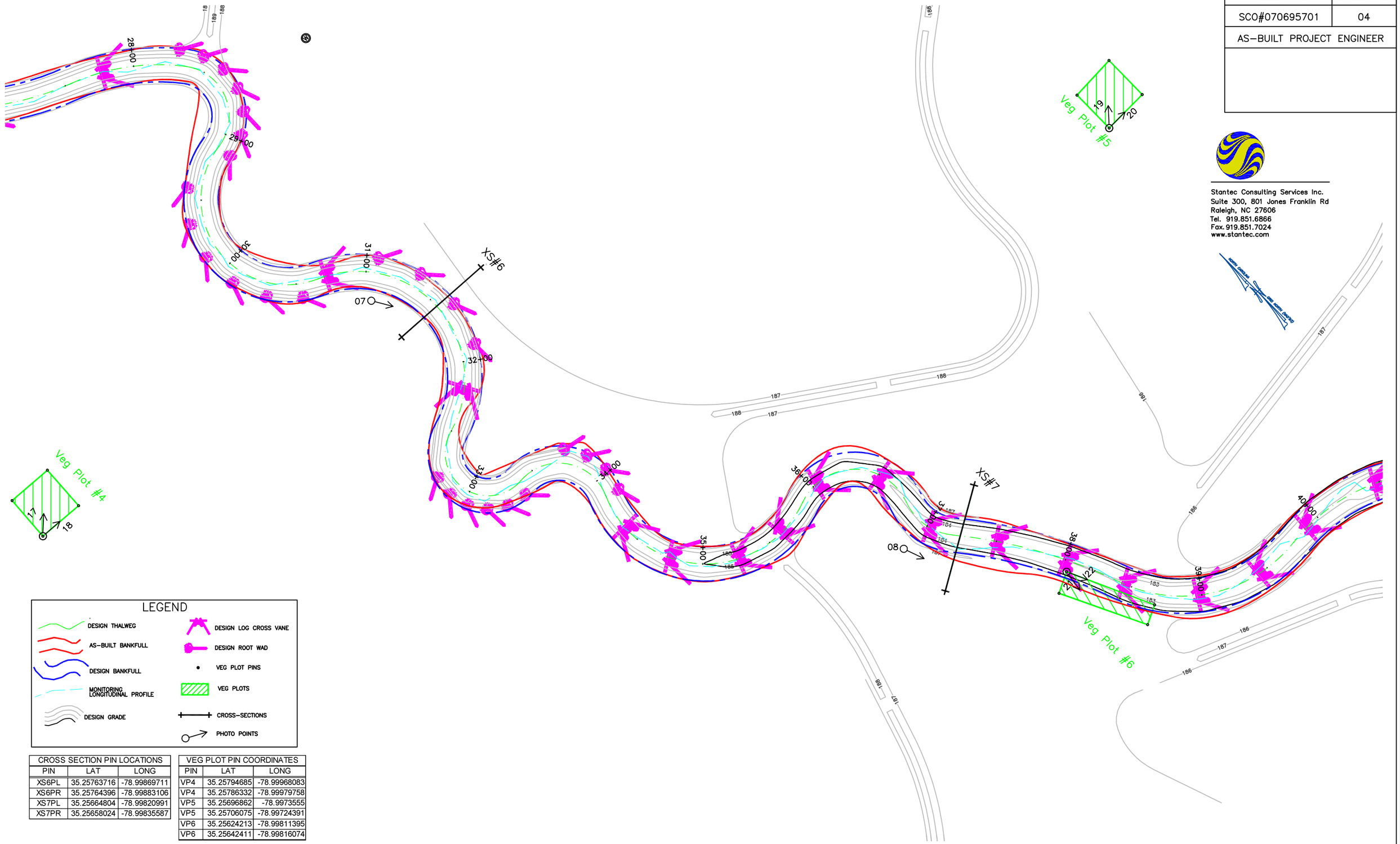

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- DESIGN ROOT WAD
- VEG PLOT PINS
- VEG PLOTS
- CROSS-SECTIONS
- PHOTO POINTS

CROSS SECTION PIN LOCATIONS		
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XS6PL	35.25763716	-78.99869711
XS6PR	35.25764396	-78.99883106
XS7PL	35.25664804	-78.99820991
XS7PR	35.25658024	-78.99835587

VEG PLOT PIN COORDINATES		
PIN	LAT	LONG
VP4	35.25794685	-78.99968083
VP4	35.25786332	-78.99979758
VP5	35.25696862	-78.9973555
VP5	35.25706075	-78.99724391
VP6	35.25624213	-78.99811395
VP6	35.25642411	-78.99816074

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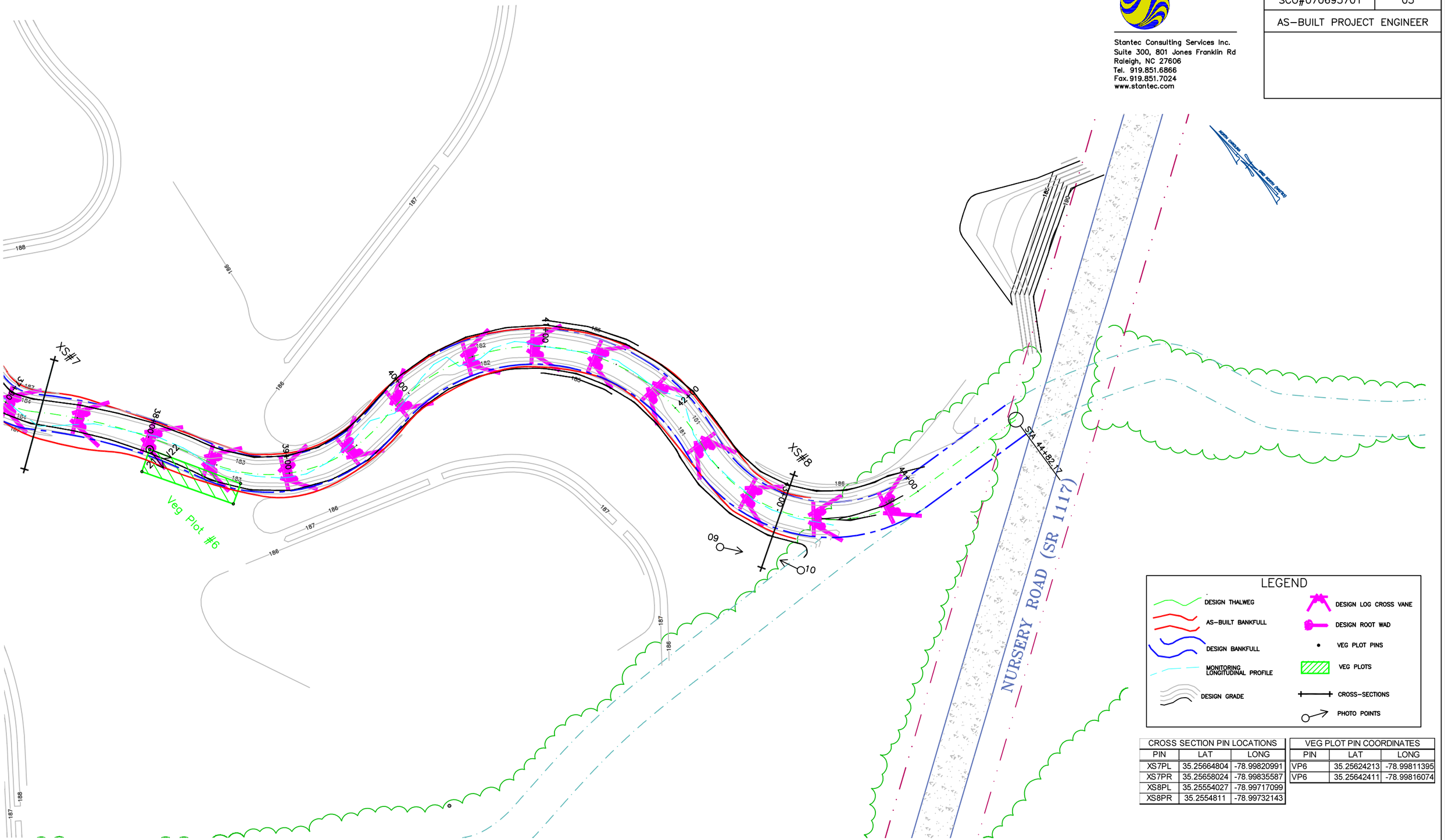

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- DESIGN ROOT WAD
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- VEG PLOTS
- CROSS-SECTIONS
- PHOTO POINTS

CROSS SECTION PIN LOCATIONS		
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XS7PL	35.25664804	-78.99820991
XS7PR	35.25658024	-78.99835587
XS8PL	35.25554027	-78.99717099
XS8PR	35.2554811	-78.99732143

VEG PLOT PIN COORDINATES		
PIN	LAT	LONG
VP6	35.25624213	-78.99811395
VP6	35.25642411	-78.99816074

LEGEND

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- DESIGN GRADE
- DESIGN LOG CROSS VANE
- DESIGN ROOT WAD
- VEG PLOT PINS
- VEG PLOTS
- CROSS-SECTIONS
- × JR10 MONITORING WELLS

MONITORING WELL LOCATIONS		
NAME	LAT	LONG
JR1	35.25633325	-78.99619887
JR2	35.25704509	-78.99613104
JR3	35.25664382	-78.99728101
JR4	35.25619691	-78.99852738
JR5	35.25784127	-78.99692474
JR6	35.25862538	-78.99752997
JR7	35.25818234	-78.99853736
JR8	35.25781716	-78.99941543
JR9	35.25748554	-79.00022606
JR10	35.26158413	-78.99927614
JR11	35.26140403	-78.99991026
JR12	35.26115267	-79.00070518
JR13	35.26069372	-79.00165278
JR14	35.26164227	-79.00115399
JR15	35.2615367	-79.00177709
RG1	35.26235615	-79.00249699

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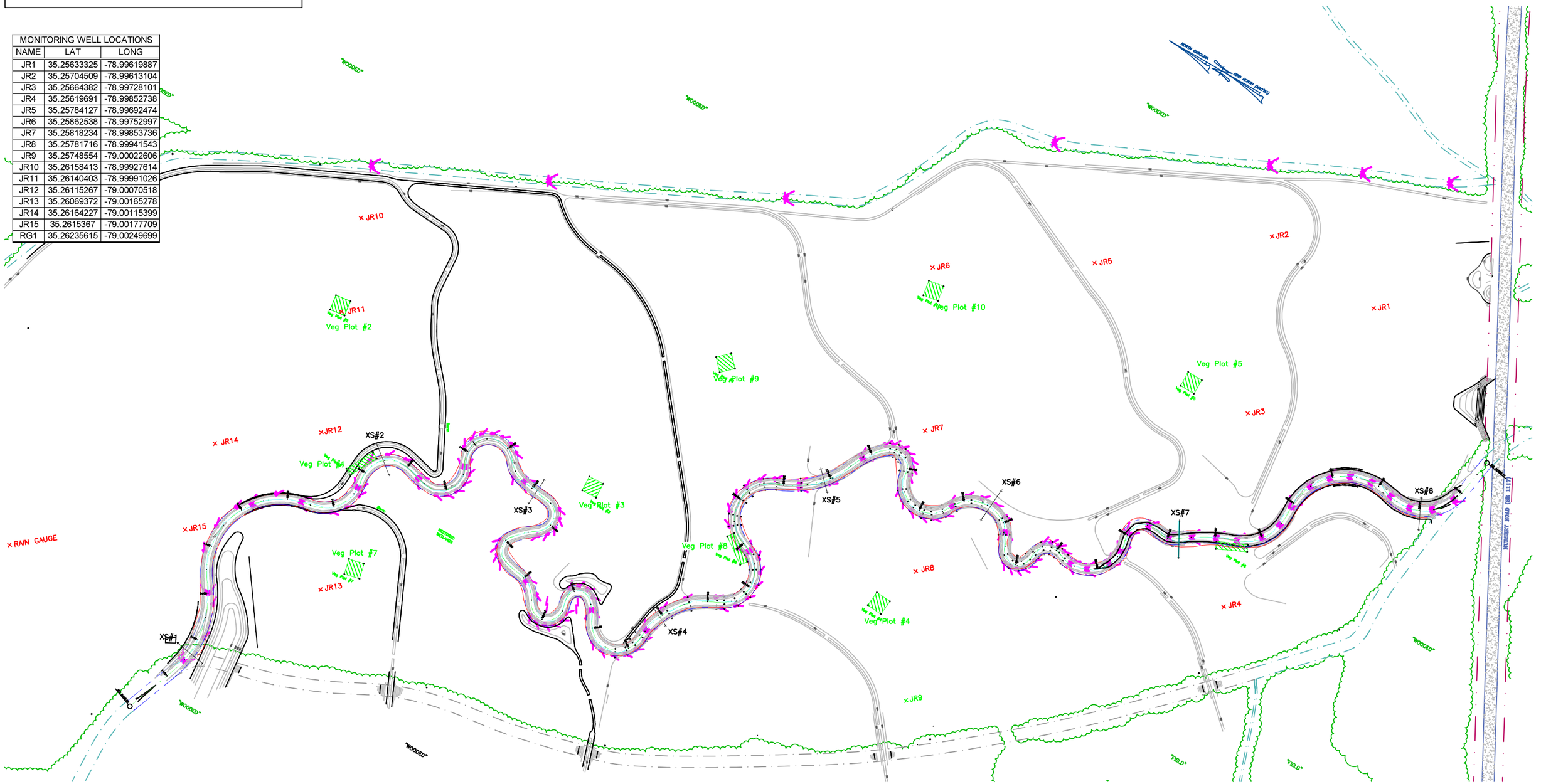


3.0 Monitoring Plan

The stability of the stream channel will be monitored annually for five years or until success criteria are met. The entire reach (4,482 linear feet) along with the eight permanent set cross-sections will be monitored for dimension, pattern and profile as detailed below. The longitudinal profile will be a minimum of 3000 feet. As vegetation establishes and the channel stabilizes, the channel's cross-section is expected to tighten slightly; however, the cross-section should not indicate downcutting or widening. Monitoring efforts will evaluate any changes by overlaying each year's cross-section and longitudinal profile with the previous years' for comparison. Locations of cross sections, vegetation plots, and photo reference points are shown on the as-builts (Section 2.0). Photos were taken at each point in June/July 2007 when Stantec performed the as-built survey and the baseline vegetation monitoring.

3.1 HYDROLOGY

Any changes to land use in the watershed that could result in altered flow patterns within the project streams will be assessed over the five-year monitoring period. There is no peak stage recorder on site. There are 15 groundwater gages that will be downloaded throughout the growing season for five years to monitor the hydrologic success of the restored wetland. According to the US Army Corps of Engineers, hydrologic monitoring will be considered successful when the soil is saturated within 12 inches of the surface for a period equivalent to 12.5% of the growing season. The growing season for Harnett County is 240 days in length starting on March 16 and ending on November 11.

3.2 PROFILE

A longitudinal profile survey 3000 feet in length will be completed each monitoring year. Additional data collected will include riffle length, riffle slope, pool length and pool spacing. Success will be measured based on whether the channel features stay within the natural variability of the dimensionless ratios of the reference reaches. The "as-built" longitudinal survey for the stream is included in Appendix 2.

3.3 PATTERN

During the longitudinal survey each year, additional pattern data will be collected including channel beltwidth, radius of curvature, meander wavelength and meander width ratio. Stability will be visually assessed. Success will be measured based on whether the channel features stay within the natural variability of the dimensionless ratios of the reference reaches.

3.4 DIMENSION

A total of eight cross-sections will be characterized each monitoring year for the entire reach. Permanent cross-section pins were installed at each of the eight cross sections at the left and right banks. Data collected will include, at a minimum, cross-sectional area, bankfull width, bankfull mean depth, bankfull max depth, floodprone width, width to depth ratio, and entrenchment ratio. Stream type will be determined in riffle cross-sections only. Success will be measured based on whether the channel features

stay within the natural variability of the dimensionless ratios of the reference reaches. The "as built" cross-sections preformed in July of 2007 are included in Appendix 3.

3.5 BED MATERIAL

Pebble counts will be completed in three typical riffle sections of the stream each monitoring year using the modified Wolman Pebble Count procedure (Rosgen, 1994). Data reported will include the d50 and d84 particle sizes. The "as-built" pebble counts preformed in July of 2007 are included in Appendix 4.

3.6 VEGETATION

Vegetation will be monitored during the growing season based on the Carolina Vegetative Survey methodology version 4.0. Ten 100m^2 plot were established scattered throughout the project site consisting of three along the streambanks and seven in the riparian wetland. Species composition, density, and survival will be monitored. In each plot, two plot corners, opposite one another, were permanently located with conduit and/or rebar and included in the monitoring plan sheets.

The vegetative success of the riparian buffer will be evaluated based on the species density and survival rates. According to the US Army Corps of Engineers Stream Mitigation Guidelines (USACE, 2003), vegetation monitoring will be considered successful if at least 260 trees/acre are surviving at the end of five years. The "as-built" stem counts within each of the vegetative monitoring plots are included in Appendix 5.

Any vegetative problem area in the project will be noted and reported in each subsequent monitoring report. Vegetative problem areas include areas that either lack vegetation or include populations of exotic vegetation.

3.7 BENTHOS

As per the project scope, Stantec will not monitor macrobenthic invertebrates.

3.8 BEHI

Using Rosgen (1996) methodology, Stantec will monitor the near bank stress (NBS) and/or bank erodibility hazard index (BEHI) as needed at any problem areas during the first year monitoring effort.

4.0 Maintenance and Contingency Plans

Any maintenance needs will be determined during monitoring visits. During the first year after construction, Stantec will perform any small maintenance tasks that can be quickly done by hand as soon as conditions allow after the need is identified. Any large maintenance items will be coordinated with NCEEP to determine the appropriate course of action.

Stantec will monitor the structures within the first year to verify that they are functioning as needed and to note any adjustments that may be necessary.

NCEEP will oversee monitoring in subsequent years to provide a total of at least five years of monitoring.

5.0 References

Harrelson, C.C., C.L. Rawlins and J.P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. United States Department of Agriculture, Fort Collins, CO.

NCEEP. 2005. Content, Format and Data Requirements for EEP Monitoring Reports. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, NC. Version 1.1 September 16, 2005.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

United States Army Corps of Engineers – Wilmington District, North Carolina Division of Water Quality, United States Environmental Protection Agency – Region IV, Natural Resources Conservation Service, North Carolina Wildlife Resources Commission. 2003. Stream Mitigation Guidelines.

6.0 Appendices

Appendix 1. Photos (Year 0)

Appendix 2. Longitudinal Survey (Year 0)

Appendix 3. Cross-Sections (Year 0)

Appendix 4. Pebble Counts (Year 0)

Appendix 5. Vegetation Plots (Year 0)

Appendix 6. Project Morphological Data (Year 0)

Appendix 7. Reference Reach Morphological Data

Appendix 1. Photos (Year 0)

Photo Station 1. Beginning of Reach – Upstream

(Note: Locations of stations are shown on the as-builts)

Photo Station 2. Beginning of Reach and Cross-section 1 – Downstream

Photo Station 3. Cross-section 2 – Downstream

Photo Station 4. Cross-section 3 – Downstream

Photo Station 5. Cross-section 4 – Downstream

Photo Station 6. Cross-section 5 – Downstream

Photo Station 7. Cross-section 6 – Downstream

Photo Station 8. Cross-section 7 – Downstream

Photo Station 9. Cross-section 8 – Downstream and End of Project

Photo Station 10. End of Project – Upstream

Photo Station 11. Veg Plot 1 – looking north

Photo Station 12. Veg Plot 1

Photo Station 13. Veg Plot 2 – looking northeast

Photo Station 14. Veg Plot 2

Photo Station 15. Veg Plot 3 – looking northeast

Photo Station 16. Veg Plot 3

Photo Station 17. Veg Plot 4 – looking northeast

Photo Station 18. Veg Plot 4

Photo Station 19. Veg Plot 5 – looking northeast

Photo Station 20. Veg Plot 5

Photo Station 21. Veg Plot 6 – looking south

Photo Station 22. Veg Plot 6

Photo Station 23. Veg Plot 7 – looking north

Photo Station 24. Veg Plot 7

Photo Station 25. Veg Plot 8 – looking west

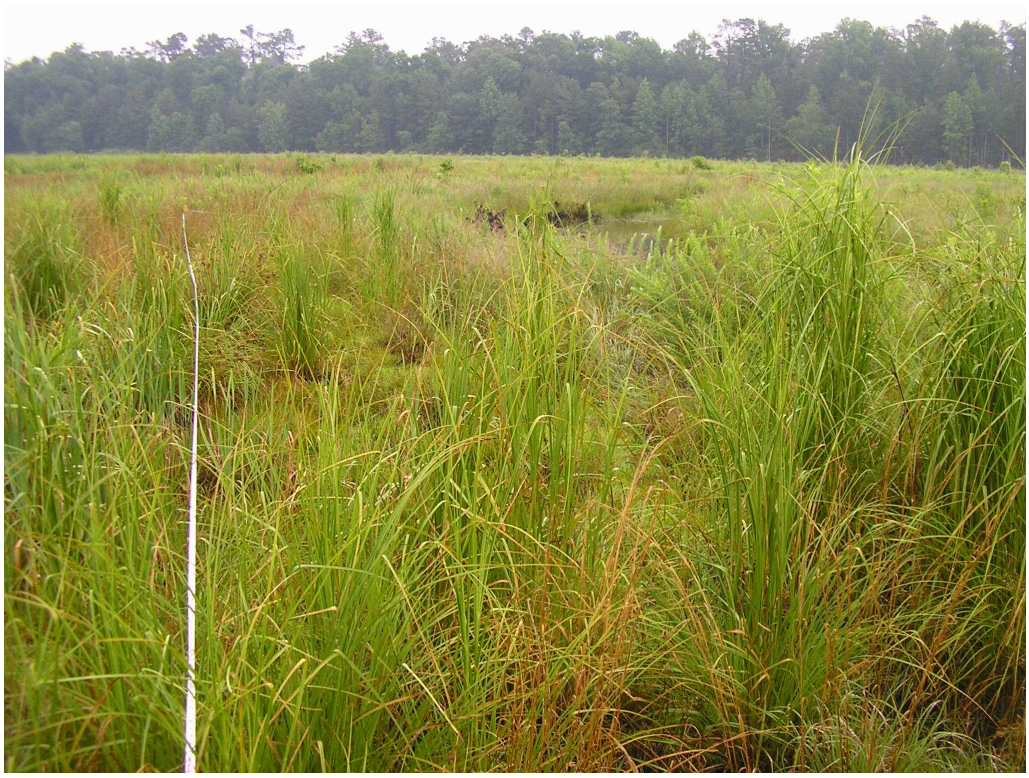


Photo Station 26. Veg Plot 8

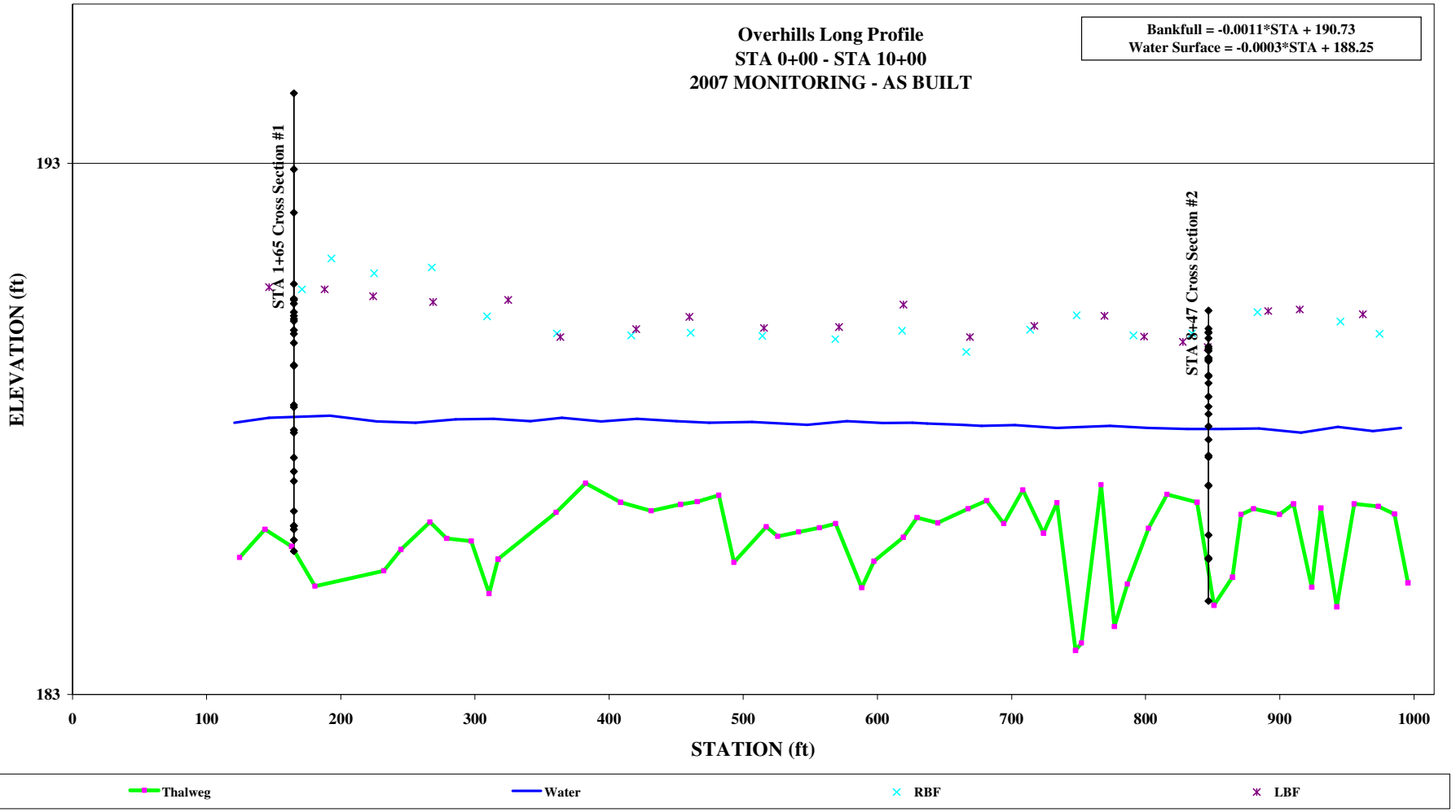
Photo Station 27. Veg Plot 9 – looking northwest

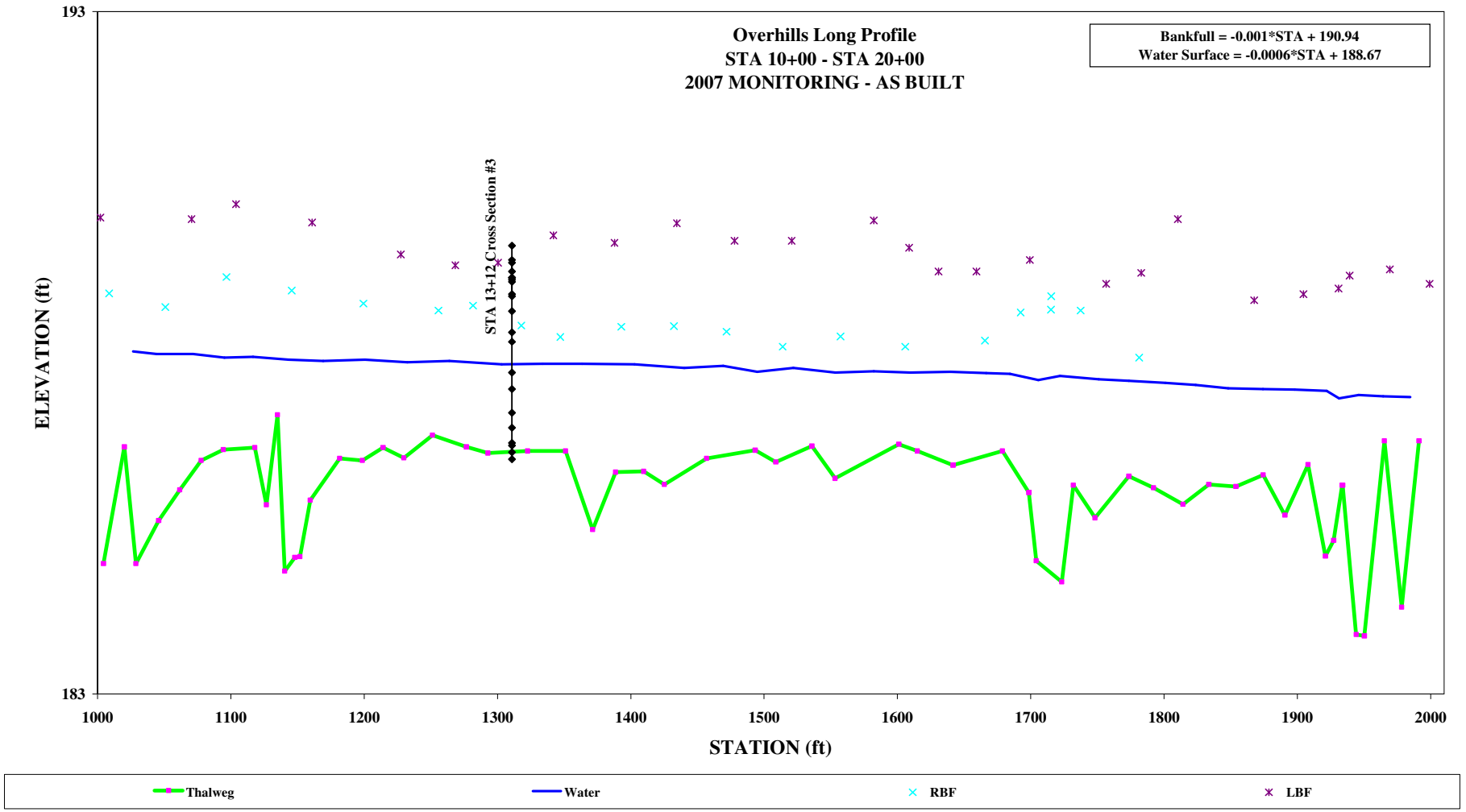
Photo Station 28. Veg Plot 9

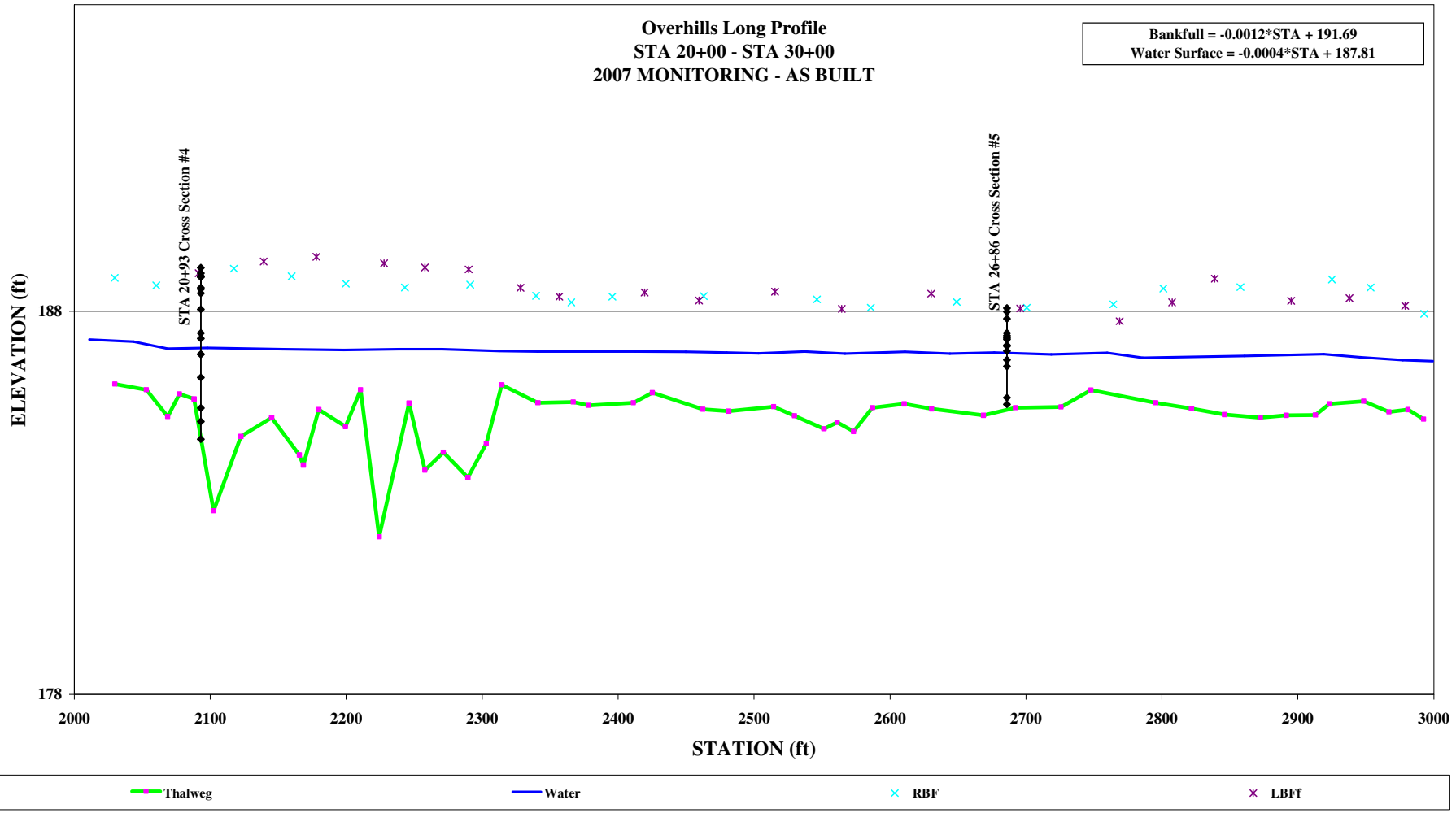
Photo Station 29. Veg Plot 10 – looking northwest

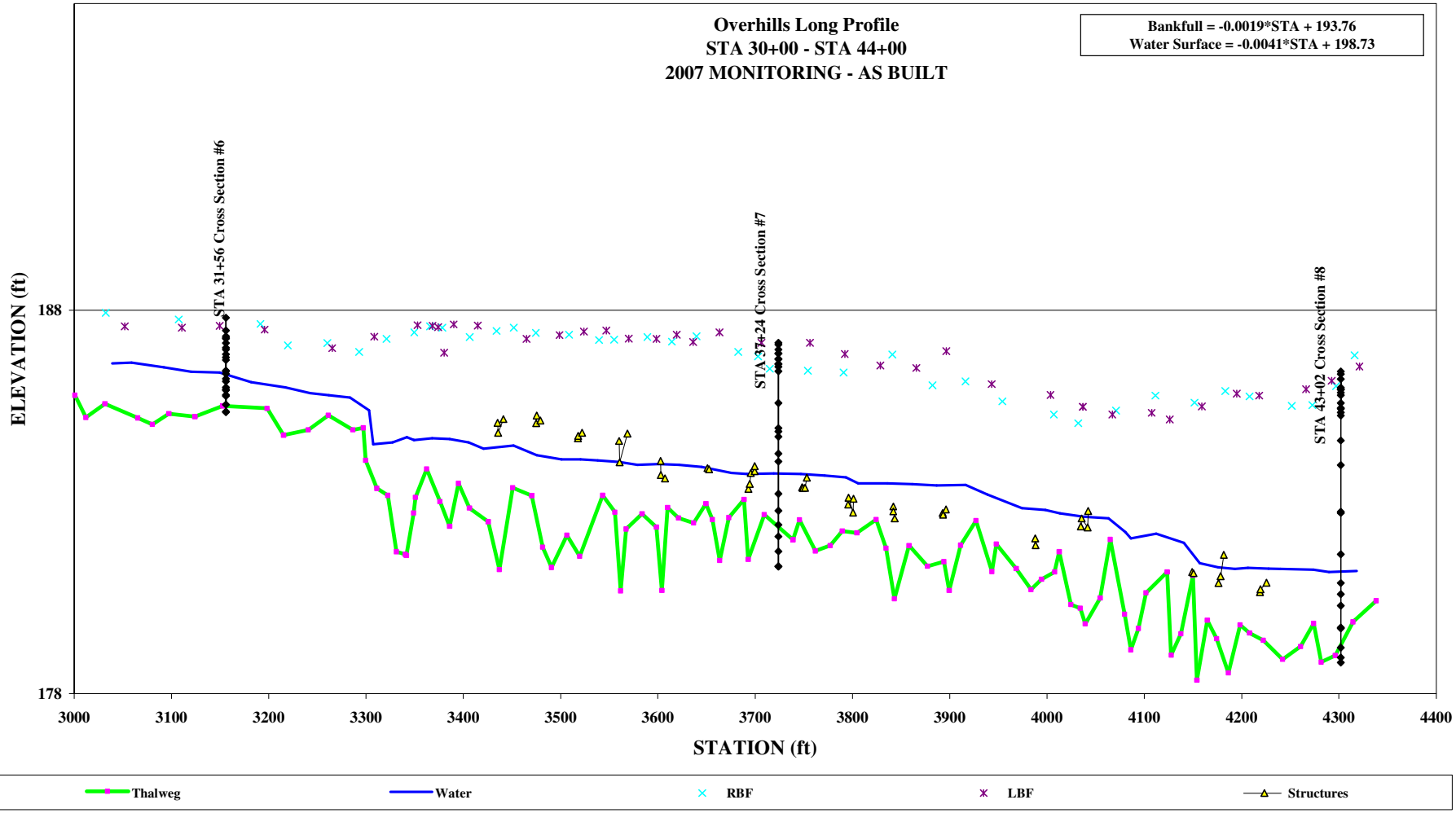
Photo Station 30. Veg Plot 10

Appendix 2. Longitudinal Survey (Year 0)


Overhills Long Profile
STA 0+00 - STA 10+00
2007 MONITORING - AS BUILT
Bankfull = -0.0011*STA + 190.73
Water Surface = -0.0003*STA + 188.25
STA 1+65 Cross Section #1
STA 8+47 Cross Section #2
ELEVATION (ft)
193
183
0
100
200
300
400
500
600
700
800
900
1000
STATION (ft)
Thalweg
Water
RBF
LBF


Overhills Long Profile
STA 10+00 - STA 20+00
2007 MONITORING - AS BUILT
Bankfull = -0.001*STA + 190.94
Water Surface = -0.0006*STA + 188.67
STA 13+12 Cross Section #3
ELEVATION (ft)
193
183
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
STATION (ft)
Thalweg
Water
RBF
LBF


Overhills Long Profile
STA 20+00 - STA 30+00
2007 MONITORING - AS BUILT
Bankfull = -0.0012*STA + 191.69
Water Surface = -0.0004*STA + 187.81
STA 20+93 Cross Section #4
STA 26+86 Cross Section #5
ELEVATION (ft)
188
178
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
STATION (ft)
Thalweg
Water
RBF
LBFf


Overhills Long Profile
STA 30+00 - STA 44+00
2007 MONITORING - AS BUILT
Bankfull = -0.0019*STA + 193.76
Water Surface = -0.0041*STA + 198.73
STA 31+56 Cross Section #6
STA 37+24 Cross Section #7
STA 43+02 Cross Section #8
ELEVATION (ft)
188
178
3000
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
STATION (ft)
Thalweg
Water
RBF
LBF
Structures

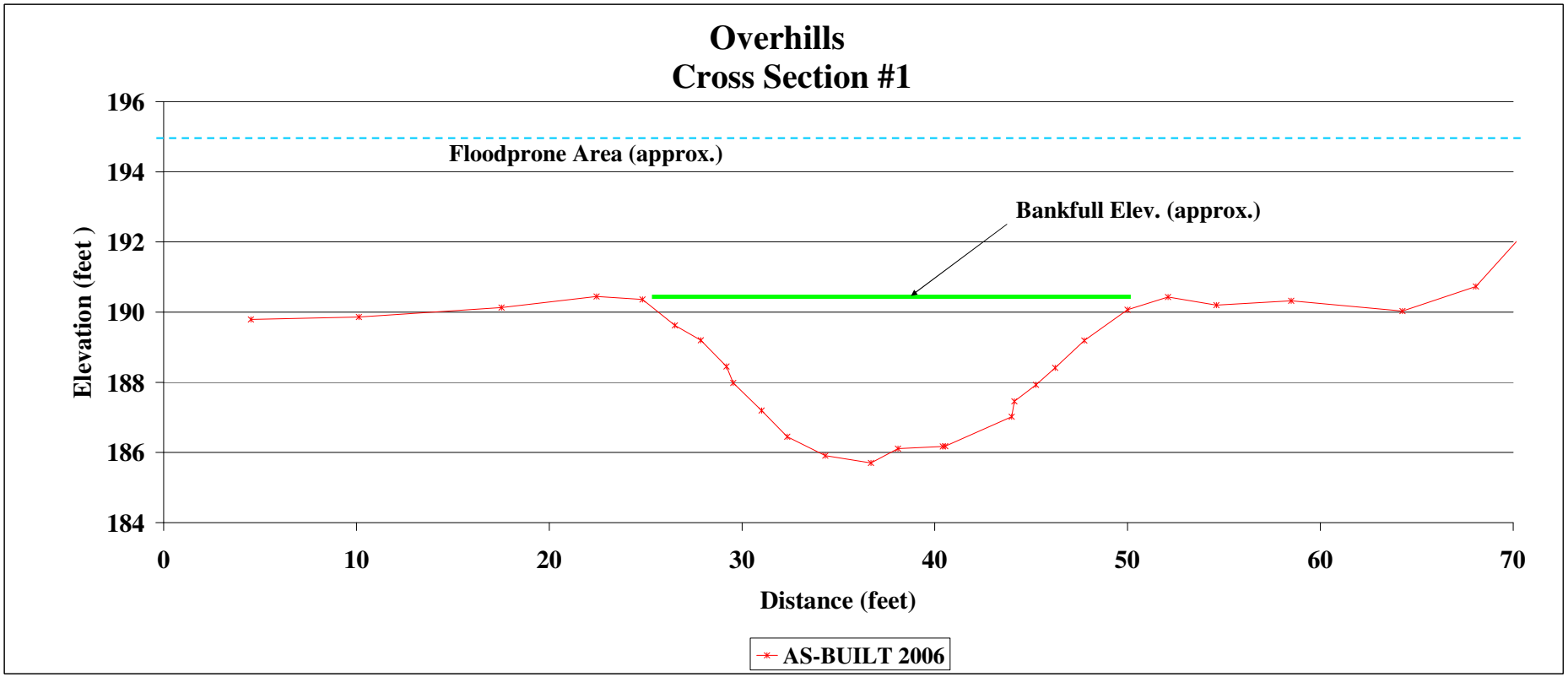
Appendix 3. Cross-Sections (Year 0)

Project Name:	Overhills	**Feature:**	Riffle	**Date:**	As Built -7/4/2007
Cross Section:	Cross Section 1			**Crew:**	AS Built - Bidelspach, Jean, Geenen

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 - 2007 2007 Survey			AS-BUILT 2006 AS-BUILT Survey		
Station	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**
															4.52	189.79	Left Pin
															10.13	189.86	
															17.52	190.13	
															22.45	190.45	
															24.83	190.36	LBK
															26.52	189.62	
															27.86	189.2	
															29.2	188.45	
															29.55	187.98	
															31.02	187.2	
															32.34	186.45	
															34.32	185.91	
															36.69	185.7	
															38.09	186.11	
															40.41	186.17	
															40.54	186.18	
															43.99	187.02	
															44.12	187.46	
															45.25	187.93	
															46.24	188.41	
															47.76	189.19	
															49.99	190.07	
															52.1	190.43	RBK
															54.6	190.2	
															58.49	190.32	Right Pin
															64.25	190.03	
															68.06	190.73	
															70.27	192.07	
															73.77	192.89	

Photo of Cross-Section 1 - Looking Downstream @ STA 1+64

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1 - 2007	AS-BUILT 2006
Area						71.89
Width						26.87
Mean Depth						2.68
Max Depth						4.66
W/D						10.04

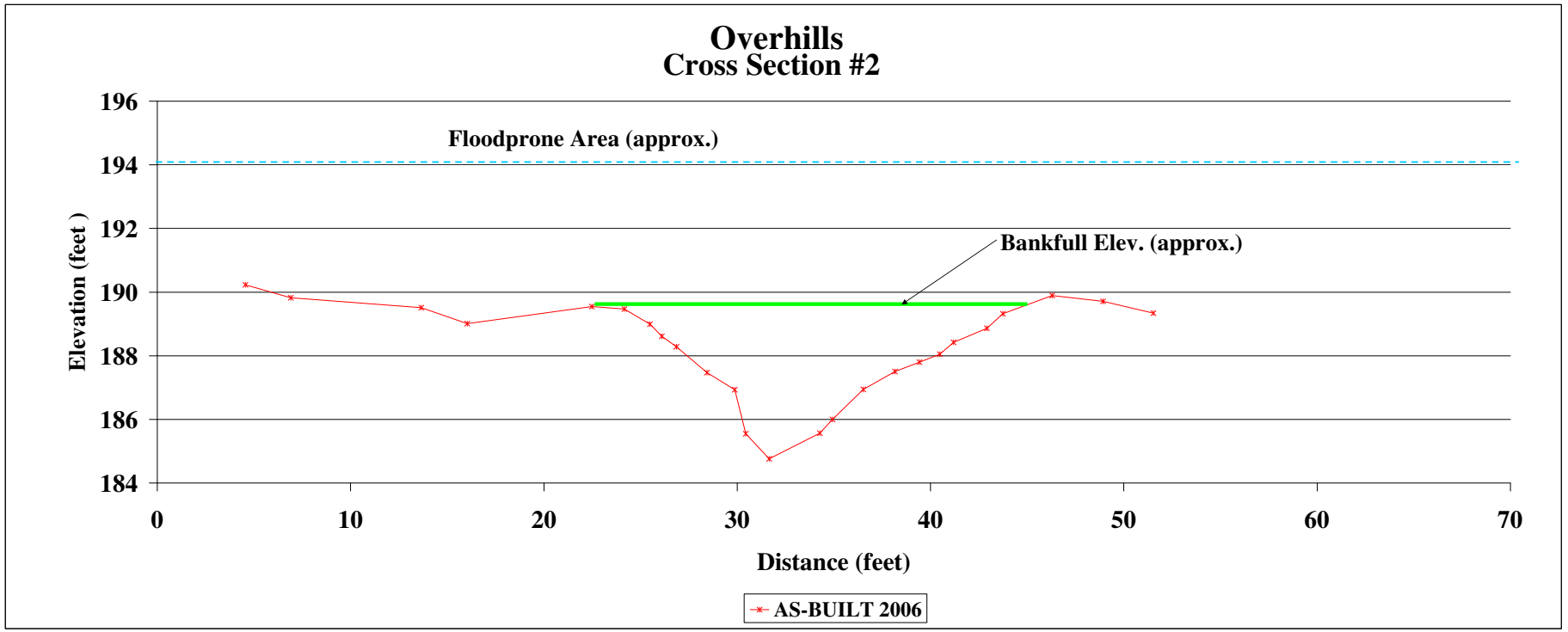


Project Name:	Overhills	**Feature:**	Pool	**Date:**	As Built -7/4/2007
Cross Section:	Cross Section 2			**Crew:**	AS Built - Bidelspach, Jean, Geenen

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 - 2007 2007 Survey			AS-BUILT 2006 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
															4.56	190.23	
															6.9	189.82	
															13.65	189.51	Left Pin
															16.04	189.01	
															22.49	189.55	LBK
															24.16	189.47	
															25.49	188.99	
															26.1	188.61	
															26.85	188.28	
															28.44	187.47	
															29.87	186.93	
															30.45	185.55	
															31.66	184.76	
															34.28	185.57	
															34.93	186	
															36.53	186.94	
															38.16	187.5	
															39.43	187.8	
															40.48	188.05	
															41.2	188.42	
															42.91	188.86	
															43.74	189.32	
															46.29	189.89	RBK
															48.93	189.71	
															51.53	189.34	
															54.39	189.81	Right Pin
															57.19	189.28	
															62.87	189.3	

Photo of Cross-Section 2 - Looking Downstream @ STA 8+47

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1 - 2007	AS-BUILT 2006	Bench
Area						44.82	
Width						22.27	
Mean Depth						2.01	
Max Depth						4.79	
W/D						11.07	

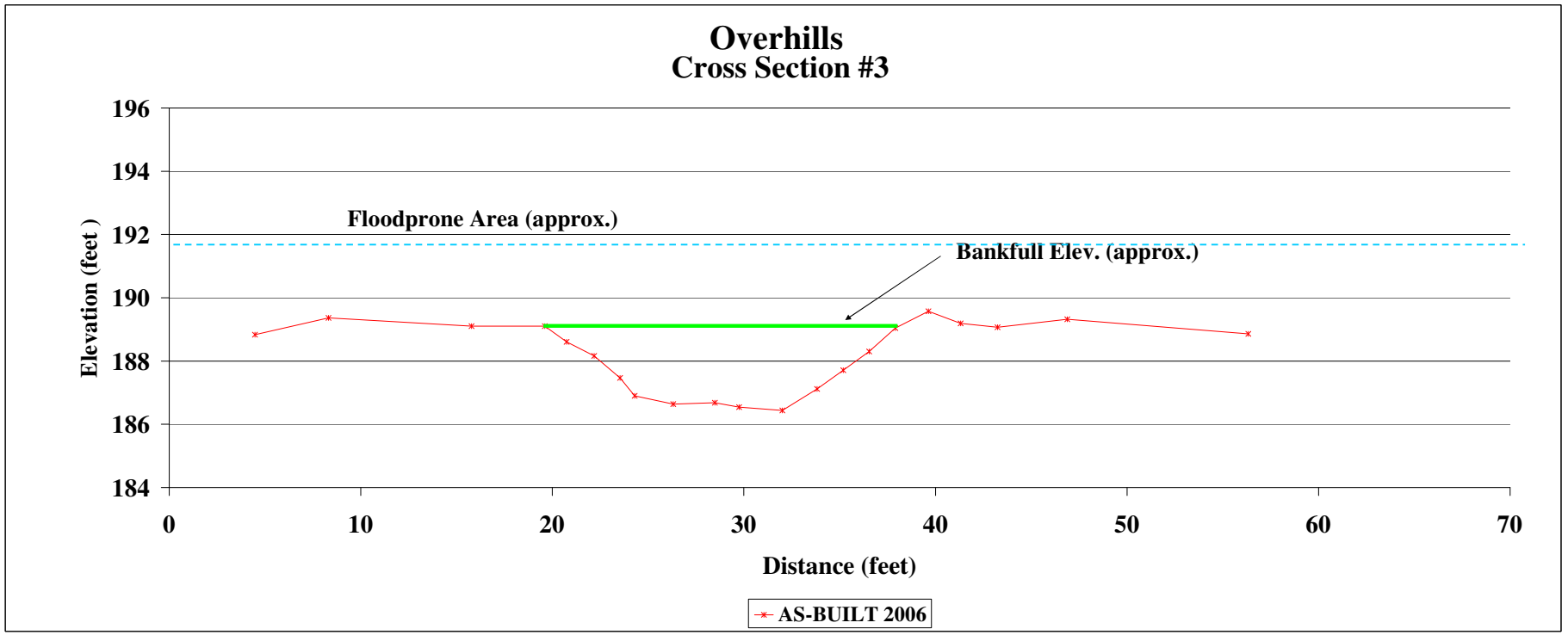


Project Name:	Overhills	**Feature:**	Riffle	**Date:**	As Built -7/4/2007
Cross Section:	Cross Section 3			**Crew:**	AS Built - Bidelspach, Jean, Geenen

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey		Year 1 - 2007 2007 Survey		AS-BUILT 2006 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
															4.48	188.83	
															8.32	189.36	Left Pin
															15.78	189.1	
															19.61	189.1	
															20.74	188.61	LBK
															22.18	188.16	
															23.54	187.47	
															24.3	186.9	
															26.31	186.64	
															28.49	186.68	
															29.75	186.54	
															32.01	186.44	
															33.82	187.12	
															35.19	187.71	
															36.54	188.3	
															37.91	189.04	RBK
															39.63	189.57	
															41.31	189.19	
															43.25	189.07	
															46.88	189.32	Right Pin
															56.34	188.86	

Photo of Cross-Section 3 - Looking Downstream @ STA 13+12

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1 - 2007	AS-BUILT 2006	Bench
Area						31.03	
Width						18.15	
Mean Depth						1.71	
Max Depth						2.60	
W/D						10.62	

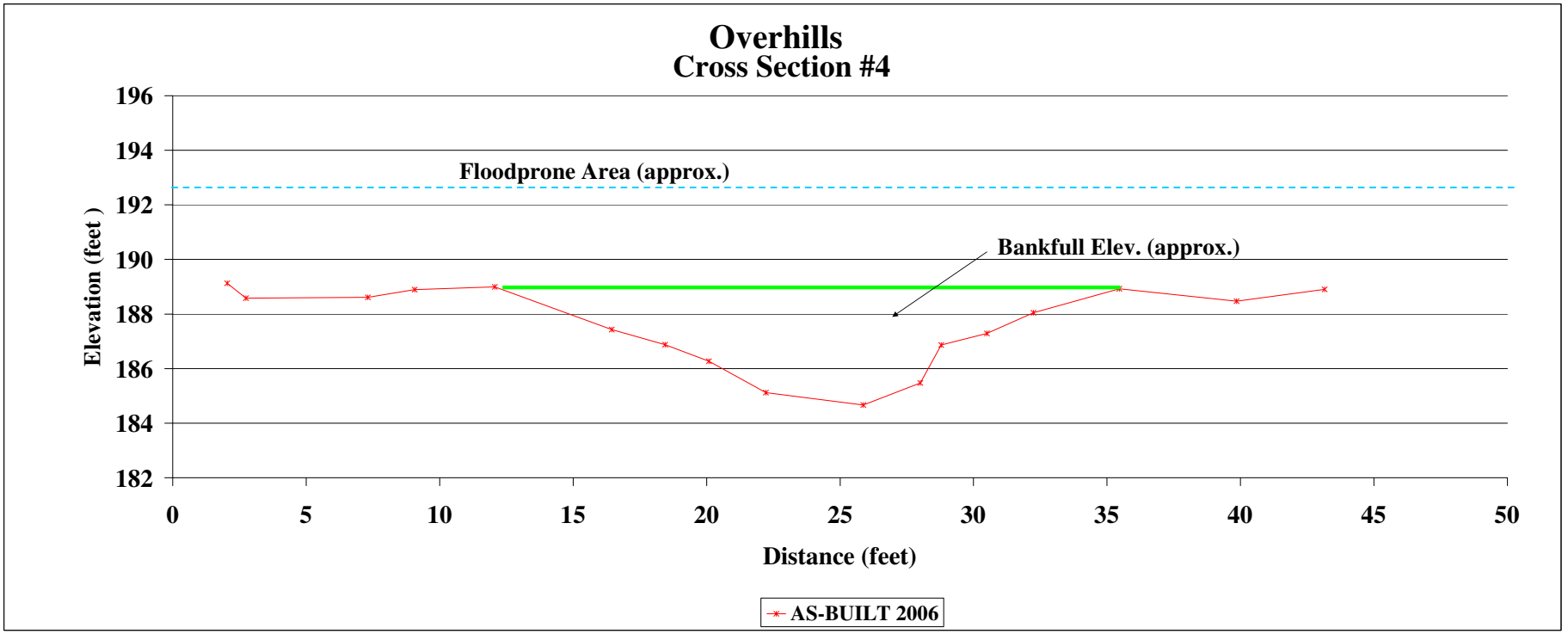


Project Name:	Overhills	**Feature:**	Pool	**Date:**	As Built -7/4/2007
Cross Section:	Cross Section 4			**Crew:**	AS Built - Bidelspach, Jean, Geenen

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 - 2007 2007 Survey			AS-BUILT 2006 AS-BUILT Survey		
Station	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**
															2.04	189.13	Left Pin
															2.74	188.58	
															7.31	188.61	
															9.06	188.89	
															12.06	188.99	LBK
															16.45	187.43	
															18.45	186.88	
															20.09	186.27	
															22.22	185.12	
															25.87	184.66	
															28.01	185.47	
															28.79	186.87	
															30.5	187.29	
															32.24	188.05	
															35.46	188.92	RBK
															39.85	188.47	
															43.15	188.9	Right Pin

Photo of Cross-Section 4 - Looking Upstream @ STA 20+93

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1 - 2007	AS-BUILT 2006	Bench
Area						49.19	
Width						23.19	
Mean Depth						2.12	
Max Depth						4.26	
W/D						10.93	

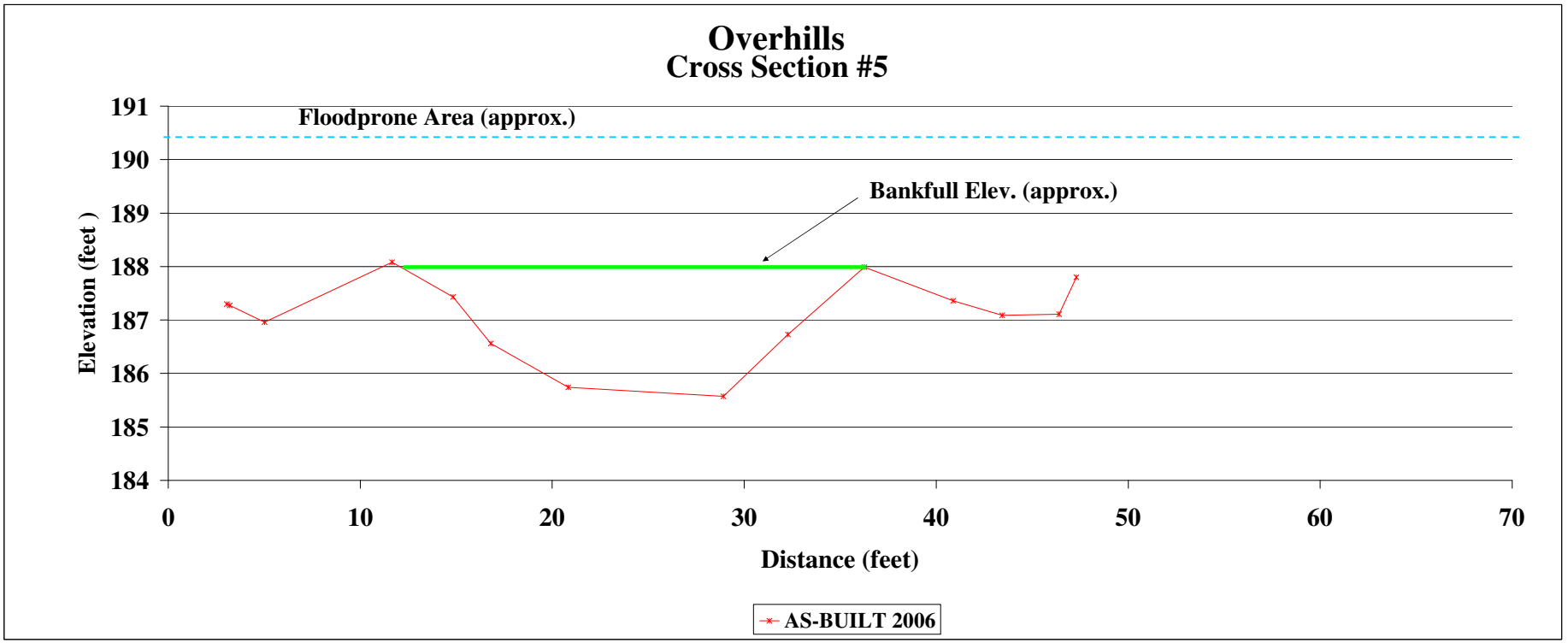


Project Name:	Overhills	**Feature:**	Riffle	**Date:**	As Built -7/4/2007
Cross Section:	Cross Section 5			**Crew:**	AS Built - Bidelspach, Jean, Geenen

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 - 2007 2007 Survey			AS-BUILT 2006 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
															3.05	187.3	Left Pin
															3.21	187.27	
															5.01	186.96	
															11.66	188.08	LBK
															14.84	187.43	
															16.8	186.56	
															20.84	185.74	
															28.91	185.57	
															32.28	186.73	
															36.26	187.99	RBK
															40.89	187.36	
															43.43	187.09	
															46.4	187.11	Right Pin
															47.3	187.8	

Photo of Cross-Section 5 - Looking Downstream @ STA 26+86

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1 - 2007	AS-BUILT 2006	Bench
Area						37.70	
Width						24.16	
Mean Depth						1.56	
Max Depth						2.42	
W/D						15.48	

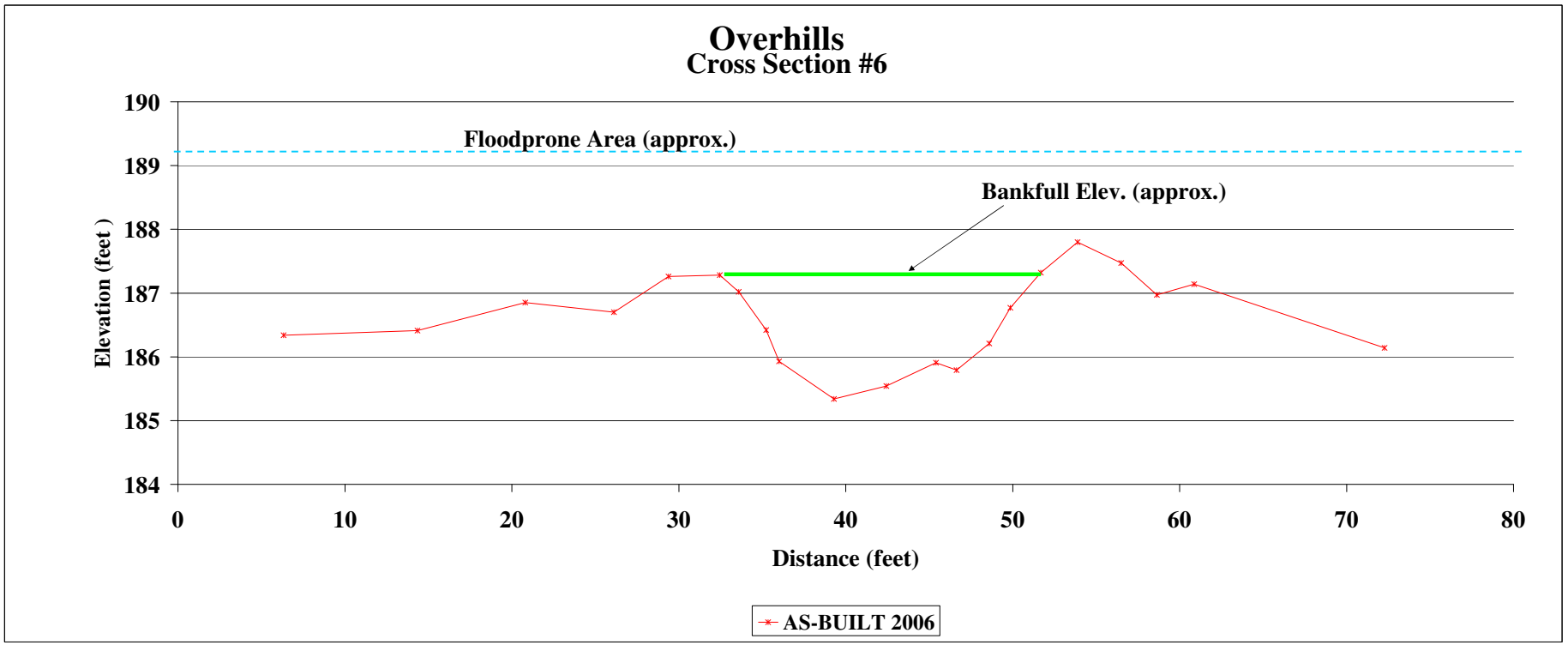


Project Name:	Overhills	**Feature:**	Pool	**Date:**	As Built -7/4/2007
Cross Section:	Cross Section 6			**Crew:**	AS Built - Bidelspach, Jean, Geenen

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 - 2007 2007 Survey			AS-BUILT 2006 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
															6.32	186.34	
															14.35	186.41	
															20.81	186.85	Left Pin
															26.11	186.7	
															29.39	187.26	
															32.45	187.28	LBK
															33.59	187.02	
															35.23	186.42	
															36.01	185.93	
															39.3	185.34	
															42.44	185.54	
															45.4	185.91	
															46.64	185.79	
															48.59	186.21	
															49.86	186.77	
															51.69	187.32	RBK
															53.89	187.8	
															56.5	187.47	
															58.64	186.97	
															60.87	187.14	Right Pin
															72.27	186.14	

Photo of Cross-Section 6 - Looking Downstream @ STA 31+56

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1 - 2007	AS-BUILT 2006	Bench
Area						23.43	
Width						19.06	
Mean Depth						1.23	
Max Depth						1.94	
W/D						15.51	

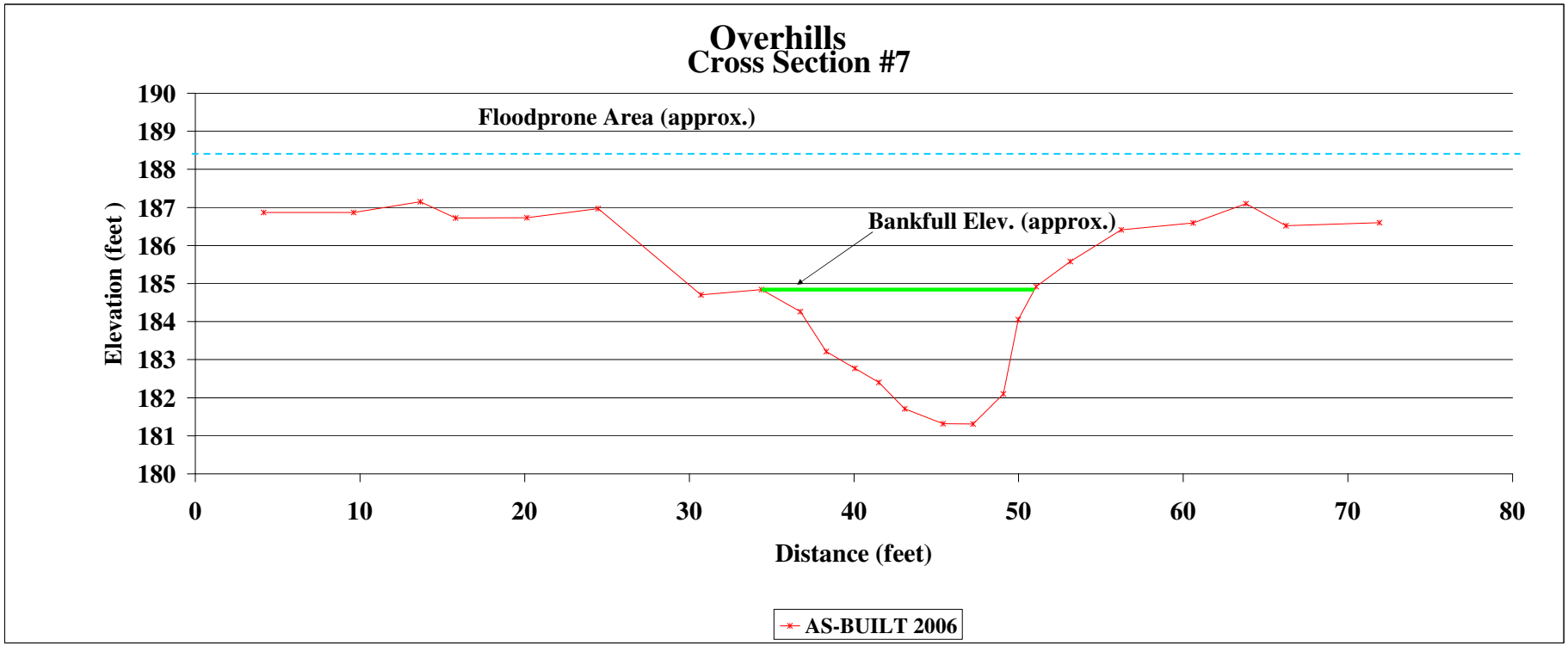


Project Name:	Overhills	**Feature:**	Riffle	**Date:**	As Built -7/4/2007
Cross Section:	Cross Section 7			**Crew:**	AS Built - Bidelspach, Jean, Geenen

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 - 2007 2007 Survey			AS-BUILT 2006 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
															4.15	186.87	
															9.61	186.87	
															13.66	187.15	Left Pin
															15.81	186.72	
															20.13	186.73	
															24.47	186.97	
															30.71	184.7	
															34.39	184.84	LBK
															36.75	184.26	
															38.32	183.21	
															40.06	182.77	
															41.51	182.4	
															43.08	181.71	
															45.41	181.32	
															47.24	181.31	
															49.08	182.1	
															49.97	184.05	
															51.07	184.92	RBK
															53.14	185.58	
															56.23	186.41	
															60.6	186.59	
															63.81	187.1	Right Pin
															66.24	186.52	
															71.92	186.6	

Photo of Cross-Section 7 - Looking Downstream @ STA 37+24

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1 - 2007	AS-BUILT 2006	Bench
Area						35.21	
Width						16.54	
Mean Depth						2.13	
Max Depth						3.53	
W/D						7.77	

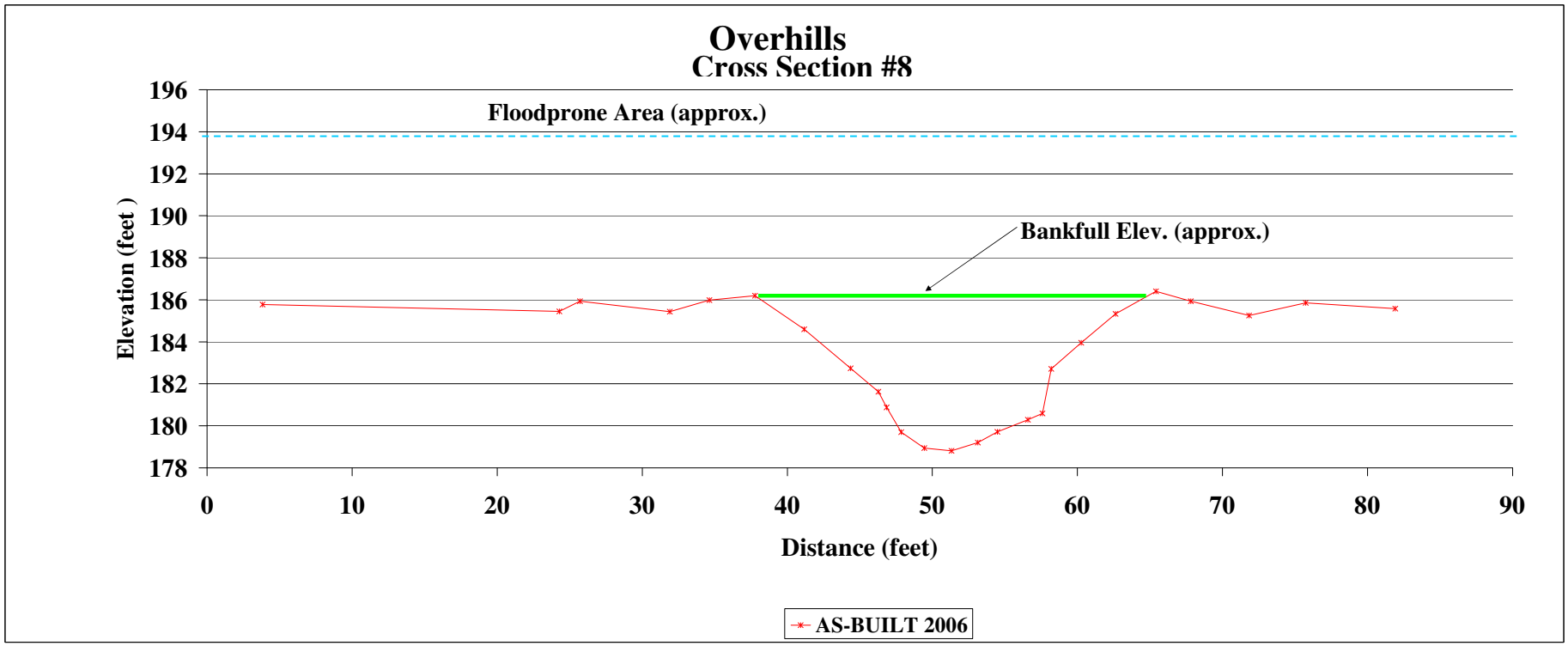


Project Name:	Overhills	**Feature:**	Pool	**Date:**	As Built -7/4/2007
Cross Section:	Cross Section 8			**Crew:**	AS Built - Bidelspach, Jean, Geenen

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 - 2007 2007 Survey			AS-BUILT 2006 AS-BUILT Survey		
Station	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**
															3.83	185.78	
															24.28	185.45	
															25.7	185.93	Left Pin
															31.91	185.43	
															34.62	185.98	
															37.77	186.2	LBK
															41.17	184.6	
															44.37	182.74	
															46.27	181.63	
															46.85	180.88	
															47.86	179.7	
															49.44	178.94	
															51.31	178.81	
															53.14	179.2	
															54.48	179.72	RBK
															56.58	180.29	
															57.59	180.59	
															58.19	182.71	
															60.26	183.96	
															62.63	185.33	
															65.42	186.4	
															67.81	185.93	
															71.84	185.25	
															75.73	185.85	Right Pin
															81.92	185.58	
															89.04	186.33	

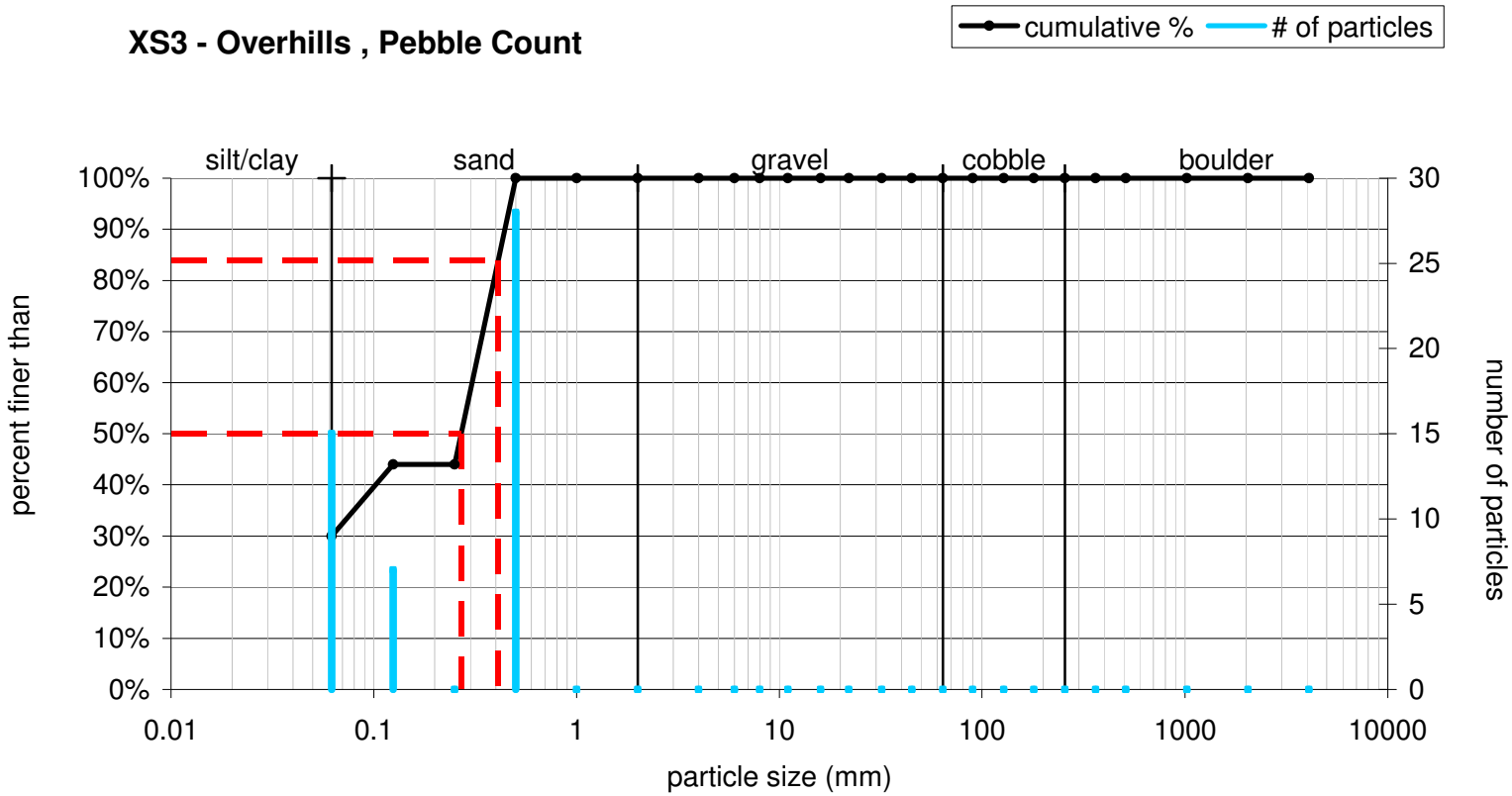
Photo of Cross-Section 8 - Looking Downstream @ STA 43+02

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1 - 2007	AS-BUILT 2006	Bench
Area						106.10	
Width						27.10	
Mean Depth						3.92	
Max Depth						7.38	
W/D						6.92	



Appendix 4. Pebble Counts (Year 0)

XS3 - Overhills , Pebble Count

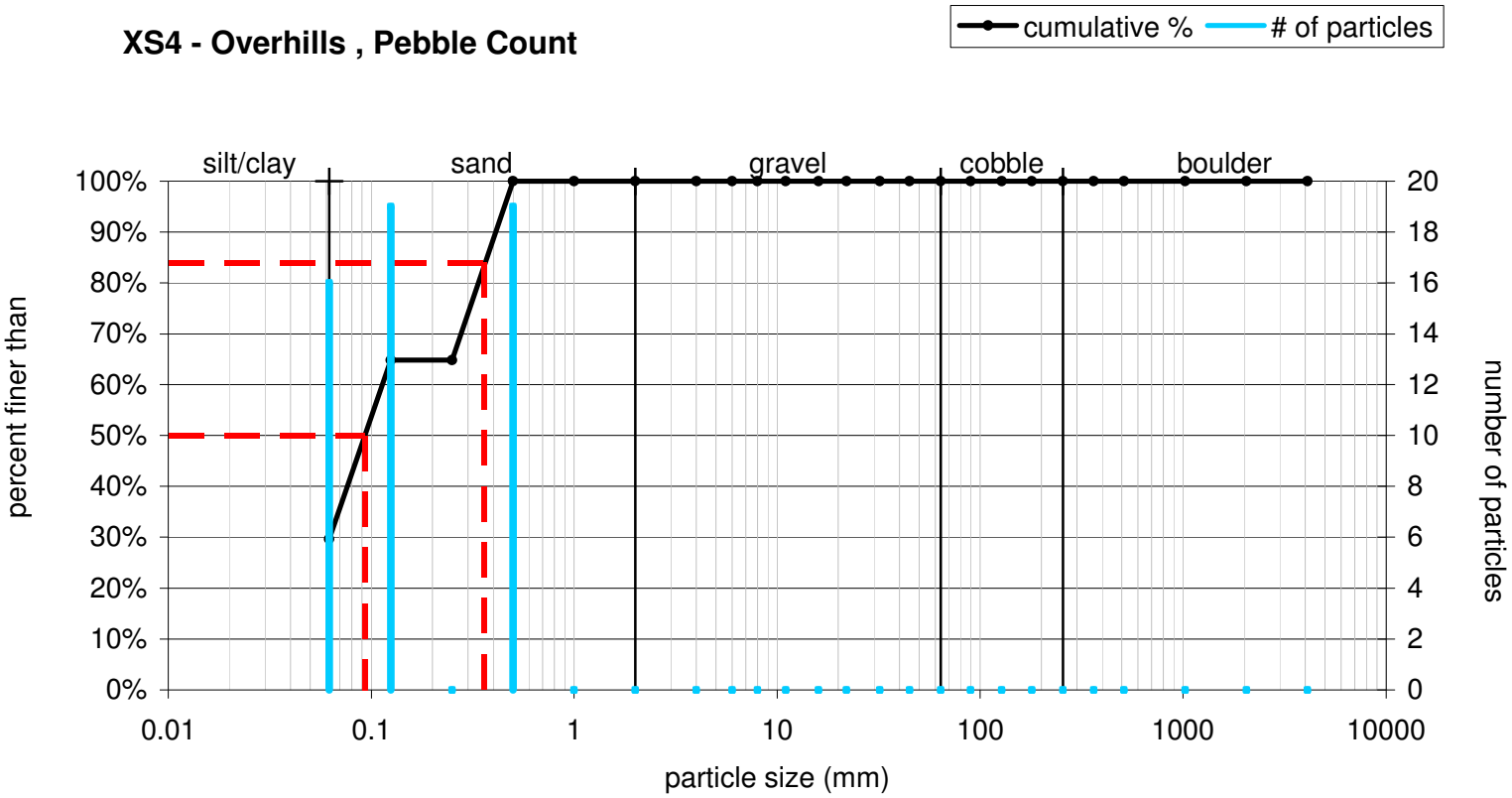


Size (mm)	
D16	0.062
D35	0.08
D50	0.27
D65	0.32
D84	0.41
D95	0.47

Size Distribution	
mean	0.2
dispersion	2.9
skewness	-0.25

Type	
silt/clay	30%
sand	70%
gravel	0%
cobble	0%
boulder	0%

XS4 - Overhills , Pebble Count

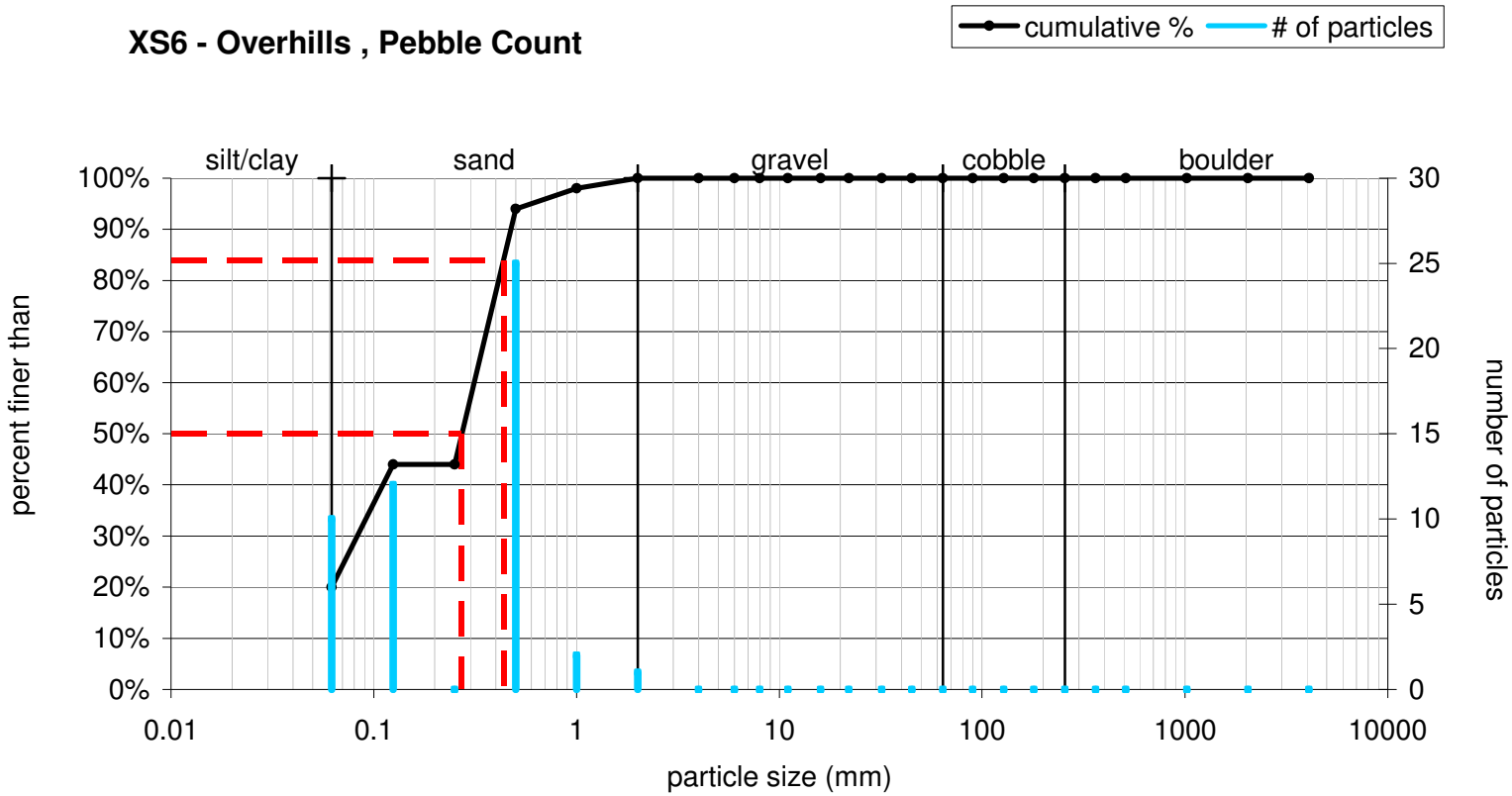


Size (mm)	
D16	0.062
D35	0.069
D50	0.093
D65	0.25
D84	0.36
D95	0.45

Size Distribution	
mean	0.1
dispersion	2.7
skewness	0.24

Type	
silt/clay	30%
sand	70%
gravel	0%
cobble	0%
boulder	0%

XS6 - Overhills , Pebble Count



Size (mm)	
D16	0.062
D35	0.096
D50	0.27
D65	0.33
D84	0.44
D95	0.59

Size Distribution	
mean	0.2
dispersion	3.0
skewness	-0.23

Type	
silt/clay	20%
sand	80%
gravel	0%
cobble	0%
boulder	0%

Appendix 5. Vegetation Plots (Year 0)

Metadata

Report Prepared By	Amber Coleman
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database name	Stantec-Overhills&MillBranch-2007-A.mdb
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DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------

Metadata	This worksheet, which is a summary of the project and the project data.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Stem Count by Plot and Spp	Count of living stems of each species for each plot; dead and missing stems are excluded.

PROJECT SUMMARY----------

Project Code	199
project Name	Overhills Stream and Wetland Restoration
Description	Stream and Wetland Restoration
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	10

Stem County by Plot and Species

	Species	Total Stems	# plots	avg# stems	plot Overhills-01-0001	plot Overhills-01-0002	plot Overhills-01-0003	plot Overhills-01-0004	plot Overhills-01-0005	plot Overhills-01-0006	plot Overhills-01-0007	plot Overhills-01-0008	plot Overhills-01-0009	plot Overhills-01-0010
	Cephalanthus occidentalis	11	2	5.5	4					7				
	Cornus amomum	13	3	4.33	1					7		5		
	Cyrilla racemiflora	1	1	1	1									
	Fraxinus pennsylvanica	7	4	1.75			2	3			1		1	
	Magnolia grandiflora	3	2	1.5						2		1		
	Morella cerifera	2	2	1						1		1		
	Nyssa biflora	21	8	2.62	1		2	3	1		4	4	1	5
	Quercus nigra	1	1	1								1		
	Quercus phellos	4	2	2	1					3				
	Salix nigra	7	3	2.33	2					2		3		
	Sambucus canadensis	12	2	6						10		2		
	Taxodium distichum	27	9	3		4	2	2	2	1	4	2	4	6
	Unknown	3	2	1.5							2		1	
TOT:	**13**	**112**	**13**		**10**	**4**	**6**	**8**	**3**	**33**	**11**	**19**	**7**	**11**

Appendix 6. Morphological Data

Morphological Data Overhills/Jumping Run Creek Restoration

	Variables		Reference Reach	Existing Steam Jumping Run Creek	Design Overhillls	Survey As Built July07 Overhills
1	1. Stream Type		E5	G4, G5c	E	C5
2	2. Drainage Area (sq. mi)		14.80	15.70	15.70	15.70
3	3. Bankfull Width (Wbkf) ft	Mean:	14.40	14.50	22.50	20.11
4	4. Bankfull Mean Depth (dbkf) ft	Mean:	**1.51**	**3.91**	**1.82**	1.72
5	5. Width/Depth Ratio (Wbkf/dbkf)	Mean:	**9.51**	**3.71**	**12.35**	11.71
6	6. Bankfull Cross-Sectional Area (Abkf) sq ft	Mean:	21.80	56.70	41.00	34.55
7	7. Bankfull Mean Velocity (Vbkf) fps	Mean:	n/a	n/a	n/a	n/a
8	8. Bankfull Discharge (Qbkf) cfs	Mean:	n/a	n/a	n/a	n/a
9	9. Maximum Bankfull Depth (dmax) ft	Mean:	3.20	2.50	2.50	2.93
10	10. Width of Flood Prone Area (Wfpa) ft	Mean:	200.0	16.5	200.0	n/a
11	11. Entrenchment Ratio (Wfpa/Wbkf)	Mean:	**13.89**	**1.1**	**8.9**	n/a
12	Mean Pool Depth (dbkfp) ft	Mean:	n/a	n/a	n/a	0.96
13	Mean Pool Depth/Mean Riffle Depth Ratio	Mean:	n/a	n/a	n/a	0.56
14	Pool Width (Wbkfp)ft	Mean:	n/a	n/a	n/a	20.99
15	Pool Width/Riffle Width Ratio (Wbkfp/Wbkf)	Mean:	n/a	n/a	n/a	1.04
16	Pool Cross-Sectional Area (Abkfp) ft2	Mean:	n/a	n/a	n/a	39.24
17	Pool Area/Riffle Area Ratio (Abkfp/Abkf)	Mean:	n/a	n/a	n/a	1.14
18	Max Pool Depth (dmbkfp) ft	Mean:	n/a	n/a	n/a	3.58
19	Max Pool Depth/Mean Riffle Depth Ratio	Mean:	n/a	n/a	n/a	2.09
20	Low Bank Height (LBH) ft		n/a	n/a	n/a	n/a
			n/a	n/a	n/a	n/a
			n/a	n/a	n/a	n/a
21	Low Bank Height/Max Riffle Depth Ratio (LBH/dbkf)		n/a	n/a	n/a	n/a
22	Meander Length (Lm) ft	Mean:	**150.0**	**487.5**	**187.5**	220
		Minimum:	125.0	315	125	130
		Maximum:	175.0	660	250	276
23	Meander Length to Bankfull Width Ratio (Lm/Wbkf)	Mean:	**10.4**	**33.6**	**8.3**	10.1
		Minimum:	**8.68**	**21.7**	**5.6**	6.4
		Maximum:	**12.15**	**45.5**	**11.1**	13.7
24	Radius of Curvature (Rc) ft	Mean:	**21**	**235**	**80**	68
		Minimum:	12.0	235.0	30.0	30.0
		Maximum:	30.0	235.0	175.0	167.0
25	Ratio of Radius of Curvature to Bankfull Width (Rc/Wbkf)	Mean:	**1.5**	**16.2**	**4.6**	4.9
		Minimum:	**0.8**	**16.2**	**1.3**	1.5
		Maximum:	**2.1**	**16.2**	**7.8**	8.3
26	Belt Width (Wblt) ft	Mean:	77	600	110	100
		Minimum:	45	600	80	48
		Maximum:	110	600	200	149
27	Meander Width Ratio (Wblt/Wbkf)	Mean:	**5.4**	**41.4**	**6.2**	4.9
		Minimum:	**3.13**	**41.4**	**3.6**	2.4
		Maximum:	**7.64**	**41.4**	**8.9**	7.4
28	Sinuosity (Stream length/valley distance)	Mean:	1.40	1.10	1.60	1.20
29	Valley Slope (ft/ft)	Mean:	0.0007	0.0005	0.0005	0.0173
30	AverageSlope - Water Surface	Mean:	0.0090	0.0016	0.0009	n/a