Harrell Stream and Wetland Restoration Site

EEP Project # 92230
Contract # D05025-1
USACE Action ID # SAW-2006-40345-233
DWQ Project # 06-1334

Monitoring Year 05
CLOSEOUT REPORT

Project Type: Stream and Wetland Restoration

Submitted: December 2012

Table 1a. Project Setting and Classifications Harrell Stream and Wetland Restoration	
County	Edgecombe
General Location	Battleboro
Basin	Tar-Pamlico
Physiographic Region	Coastal Plain
USGS Hydro Unit	03020101130090
NCDWQ Sub-basin	03-03-02
Wetland Classification	Coastal Plain Small Stream Swamp Wetland
Trout Water	No
Project Performers	
Source Agency	NCEEP
Provider	KCI Technologies
Designer	KCI Technologies
Monitoring Firm	KCI Technologies
Planting	H & J Forest Service
Property Interest Holder	NCEEP

Table 1b. Project Activity and Reporting History Harrell Stream and Wetland Restoration		
Activity or Report	**Data Collection Complete**	**Completion or Delivery**
Final Design - Wetland	2005 - 2006	Aug 06
Construction - Wetland	N/A	Oct 06
Planting - Wetland	N/A	Feb 07
Restoration Plan	2005 - 2006	Apr 07
Final Design - Stream	2005 - 2006	Apr 07
Construction - Stream	N/A	Sep 07
Planting - Stream	N/A	Jan 08
Mitigation Plan / As-Built (Year 0 Monitoring - Baseline)	Oct 07 / Jan 08*	Feb 08
Year 1 Monitoring	Oct 08	Nov 08
Year 2 Monitoring	Nov 09	Dec 09
Invasive Plant Control		Aug 09
Cleared pine trees in wetland		Oct 09
Supplemental Planting	N/A	Feb 10
Year 3 Monitoring	Nov 10	Dec 10
Supplemental Planting		Mar 10
Minor bank and structure repair		Apr 10
Additional Easement Acquired and Supplemental Planting	N/A	Feb 11
Year 4 Monitoring	Nov 11	Jan 12
Supplemental Planting		Apr 11
Invasive Plant Control		Jun 11
Year 5 Monitoring	June / July 12	Dec 12

*The wetland restoration was constructed one year prior to the stream restoration and as-built

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1.0 PROJECT SETTING AND BACKGROUND SUMMARY

The Harrell Stream and Wetland Restoration Site is a full-delivery project that was developed for the North Carolina Ecosystem Enhancement Program (EEP). Construction was completed in September 2007 on an Unnamed Tributary to Swift Creek and 15.0 acres of Coastal Plain Small Stream Swamp wetland community. The project restored 6,808 linear feet of channel (441 acre watershed) using a combination of Priority 2 and 3 approaches, and 15.0 acres of Coastal Plain Small Stream Swamp wetland community (57 acre watershed).

Prior to restoration, UT to Swift Creek had been channelized and straightened since at least 1948. The entire site, including where the wetland was restored, was under agricultural production. There were fields adjacent to the stream and the wetland that had been drained by a network of ditches. There were no remaining vegetated buffers or in-stream features in the channel and the banks were nearly vertical. The channel was characterized as having poor streambed variability and habitat diversity. The restoration goals and objectives are below. To further improve the water quality at the site, at each of the incoming ditches, a water detention structure was built in the floodplain to hold the first flush of water coming from the surrounding agricultural fields.

Supplemental planting has occurred to address poor vigor and survivability along the stream, specifically in the lower reach, which can become backwatered from Swift Creek in the winter and spring. Invasives, such as cattails and multiflora rose have been treated. Repair work has focused on stabilizing banks at the confluence with the incoming tributary and repairing piping log drop structures. Since the repairs, these areas have continued to be stable.

2.0 PROJECT GOALS AND OBJECTIVES

The goals and objectives of the restoration project are as follows:

Restoration Goals:

- Protect aquatic resources from excess nutrients, sediment, and other pollutants coming from the agricultural watershed.
- Reestablish terrestrial and aquatic habitat and connect the site to the existing floodplain corridor along Swift Creek.

Restoration Objectives:

- Restore 6,808 linear feet of stable stream channel with the appropriate pattern, profile, and dimension that can support a sand transport system.
- Connect the stream to a functioning floodplain.
- Fill and plug ditches in the drained hydric soils to restore saturated hydrologic conditions for 5% of the growing season.
- Plant tree species typical of a Coastal Plain Small Swamp Stream along the stream riparian corridor and floodplain as well as in the restored wetland.

3.0 SUCCESS CRITERIA

Table 2. Success Criteria **Harrell Stream and Wetland Restoration Site**	
Feature	**Success Criteria**
Stream	Minimal changes to the measured stream characteristics, demonstrating system stability. At least two bankfull events occurring in separate years over the course of the monitoring period.
Wetland	Continual wetland hydrology for 5% of the growing season (12 of 223 days) within a normal precipitation year.
Vegetation	Average of 260 stems/acre, as indicated by permanent vegetation plots after 5 years of monitoring.

Table 3. Project Asset **Harrell Stream and Wetland Restoration Site**					
Project Segment / Reach ID	**Pre-Construction (Feet/Acres)**	**Mitigation Approach**	**As - Built Footage/Acreage**	**Mitigation Units (SMU/WMU)***	**Mitigation Unit Total**
Reach 1	1,224 lf	R-P3	1,226 lf	1,226 SMU	6,808 SMU
Reach 2	1,389 lf	R-P2	1,465 lf	1,432 SMU	
Reach 3	1,231 lf	R-P2	1,491 lf	1,491 SMU	
Reach 4	2,494 lf	R-P2	2,698 lf	2,659 SMU	
Wetland	15.0 ac	R	15.0 ac	15 WMU	15 WMU

R = Restoration P2 = Priority 2
P3 = Priority 3

* Two 30' farm crossings and one 10' irrigation crossing are excluded from the mitigation unit calculations.

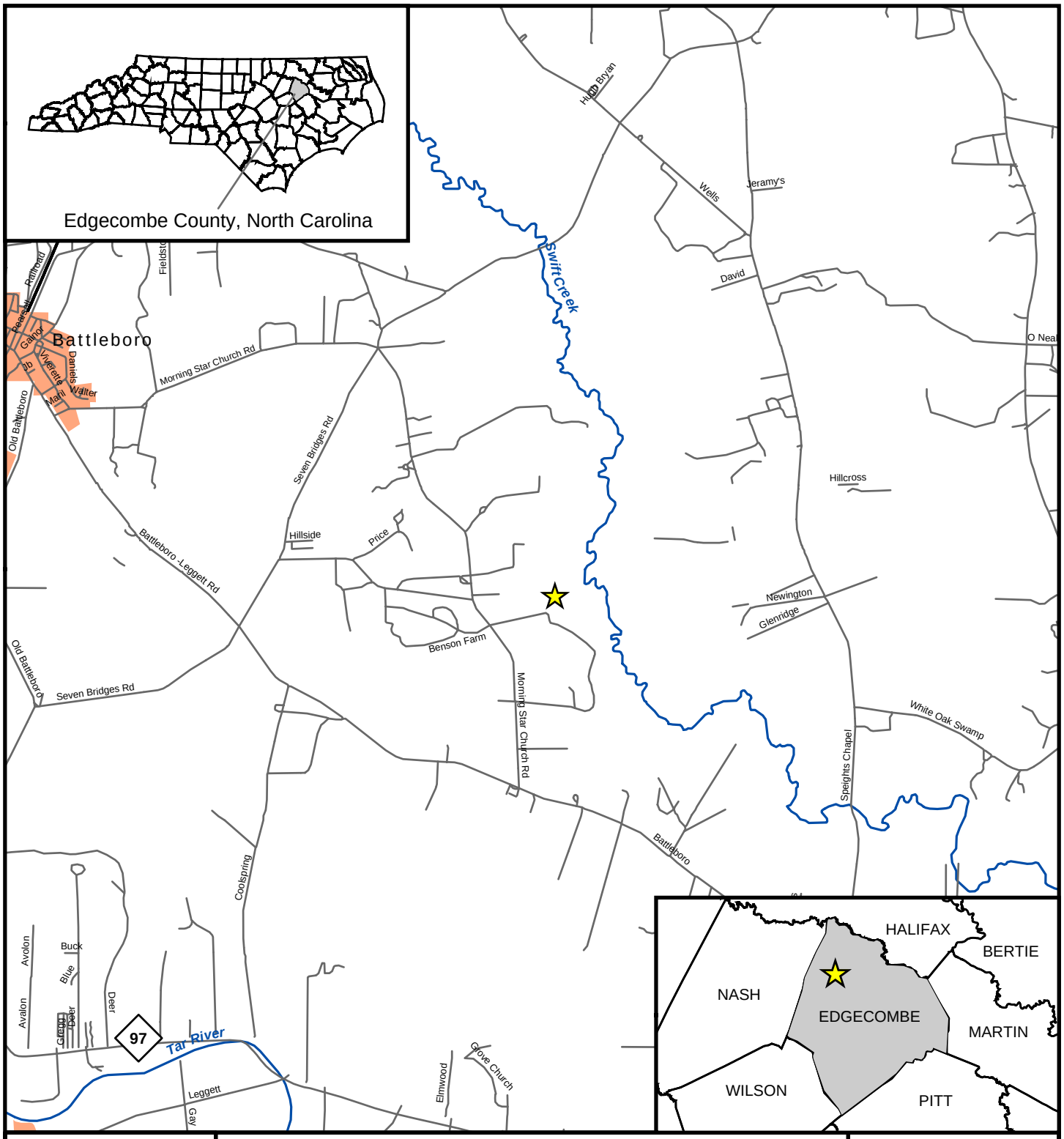

Figure 1. Vicinity Map

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Ecosystem Enhancement PROGRAM

KCI ASSOCIATES OF NC

Figure 2. Project Reaches

Reach 1
Reach 2
Reach 3
Reach 4
Easement Exception
Project Site Boundary

N
W
E
S

1:8,400

700 350 0 700 Feet

Image Source: NC Statewide Orthoimagery, 2010.

Ecosystem Enhancement PROGRAM

Figure 3. Project Site Watershed

Stream Project Boundary

Wetland Project Boundary

Stream Project Watershed (387.2 acres)

Wetland Project Watershed (56.9 acres)

N

W E

S

1:24,000

1 inch = 2,000 feet

2,000 1,000 0 2,000

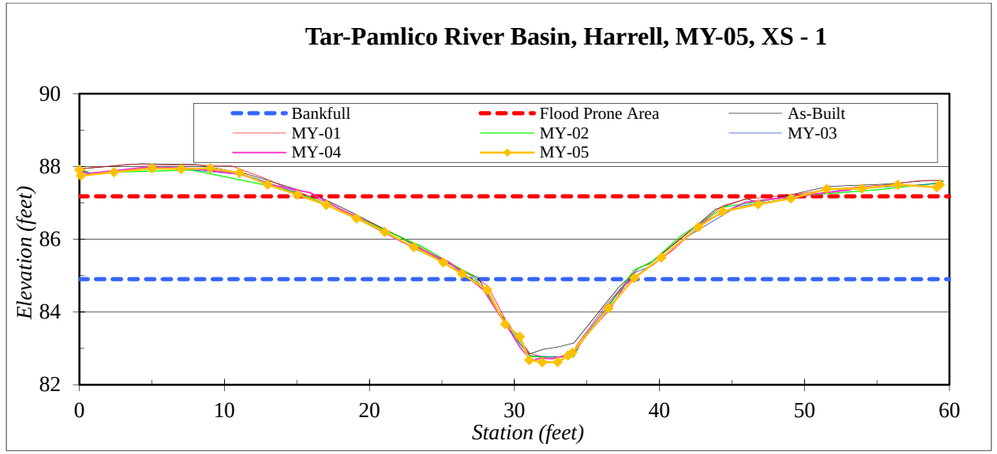
Feet

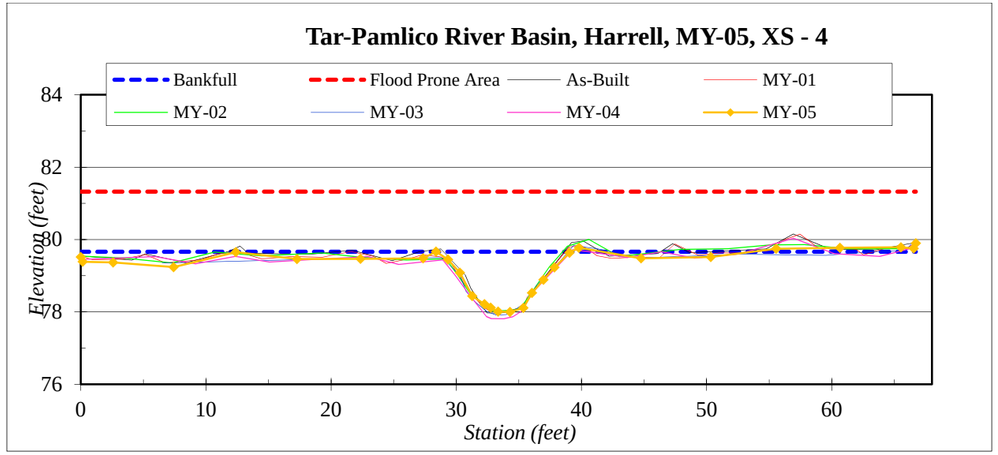
Source: NC Statewide Orthoimagery, 2010

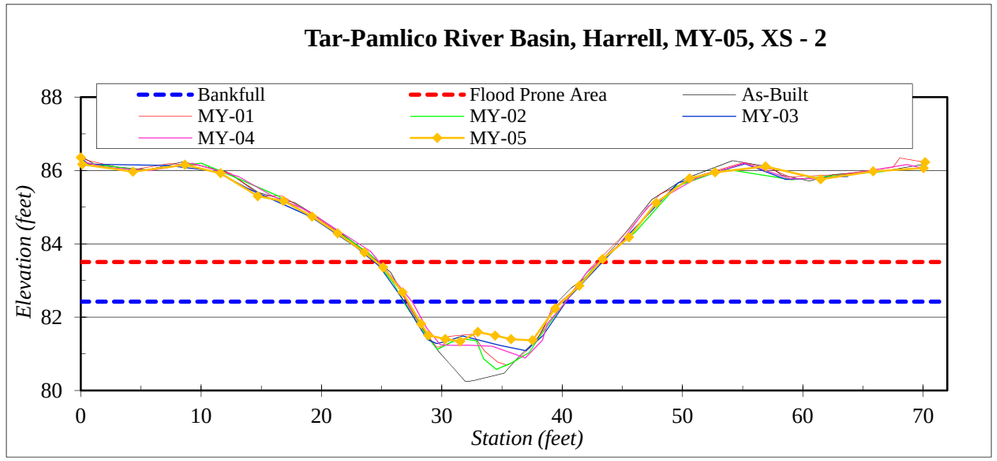
KCI TECHNOLOGIES

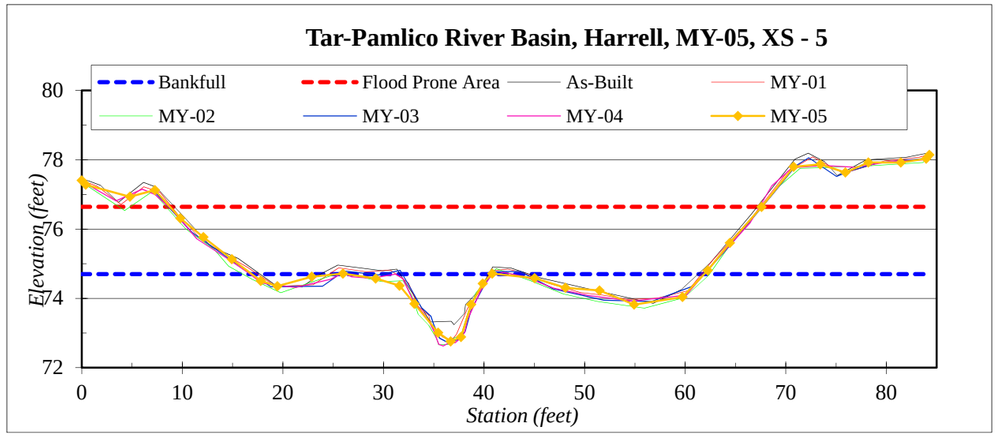
KCI ASSOCIATES OF NC

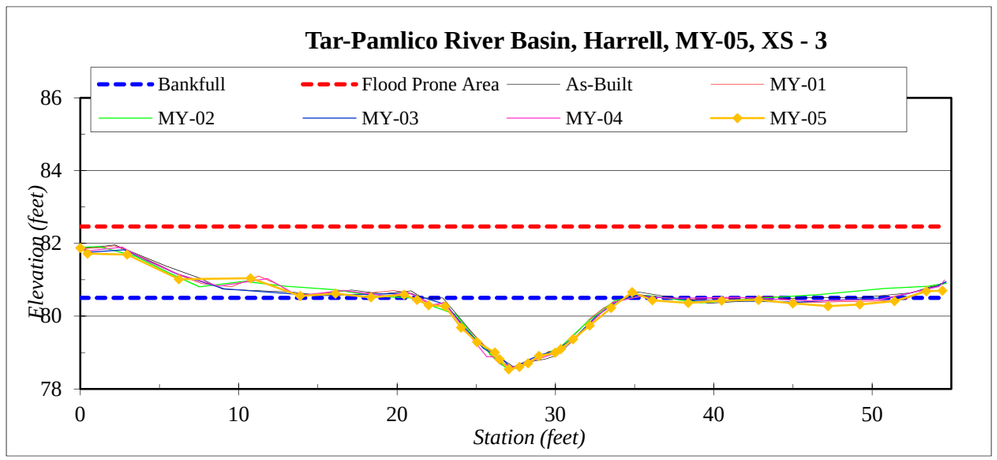
ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.

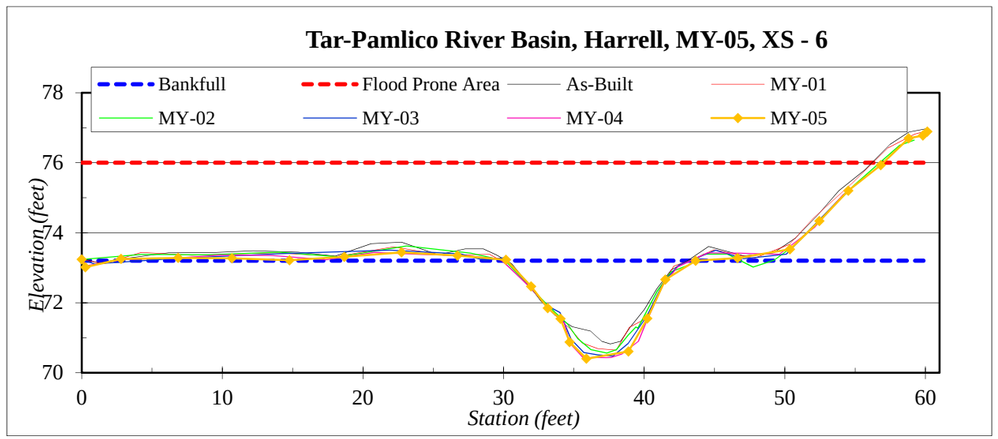

Tar-Pamlico River Basin, Harrell, MY-05, XS - 1
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)

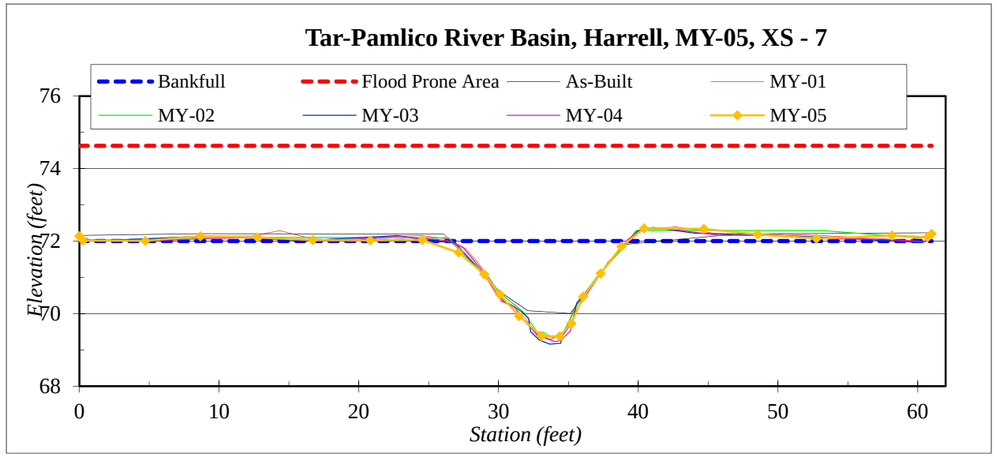

Tar-Pamlico River Basin, Harrell, MY-05, XS - 4
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)

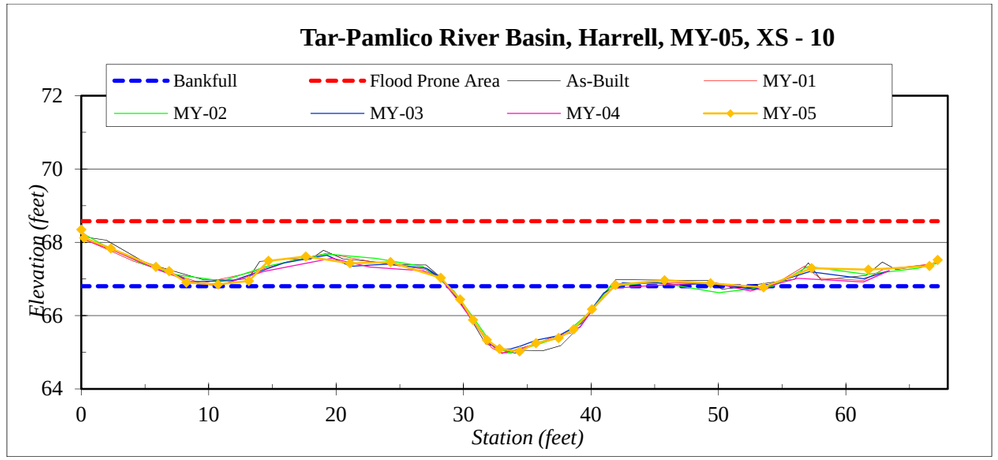

Tar-Pamlico River Basin, Harrell, MY-05, XS - 2
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)

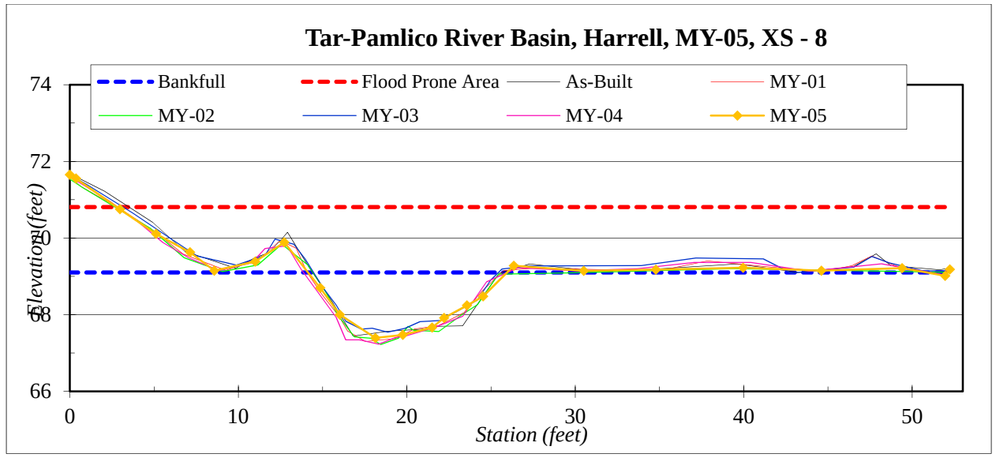

Tar-Pamlico River Basin, Harrell, MY-05, XS - 5
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)

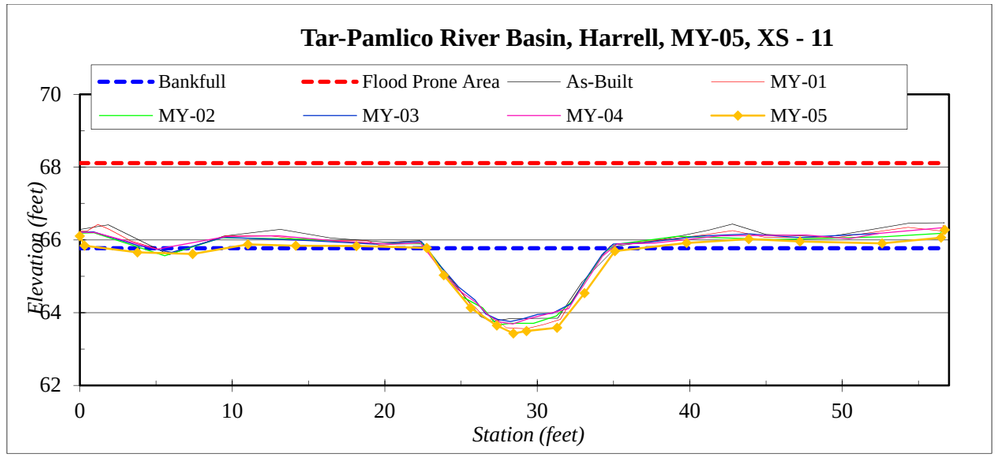

Tar-Pamlico River Basin, Harrell, MY-05, XS - 3
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)

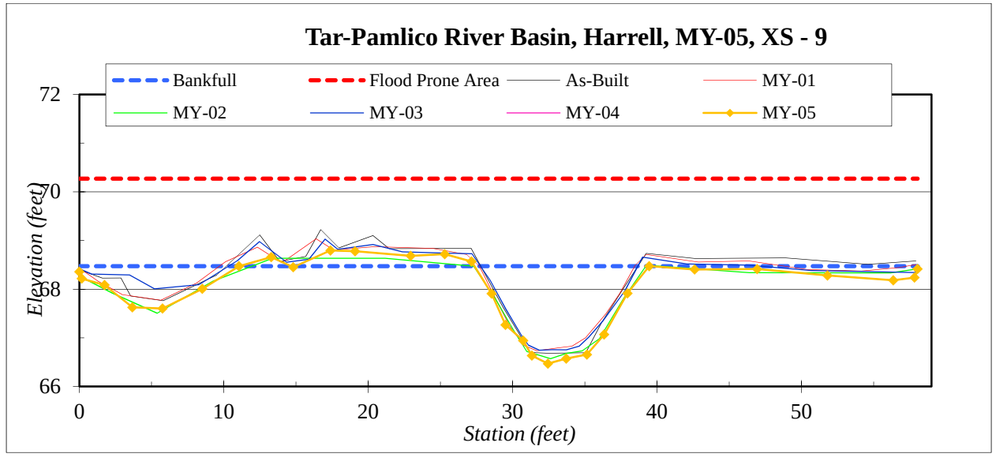

Tar-Pamlico River Basin, Harrell, MY-05, XS - 6
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)

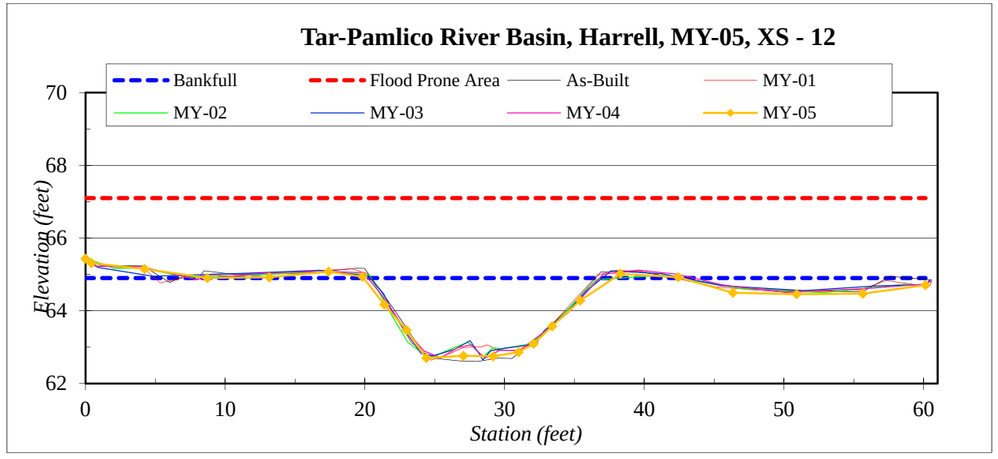

Tar-Pamlico River Basin, Harrell, MY-05, XS - 7
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)
76
74
72
70
68
0
10
20
30
40
50
60

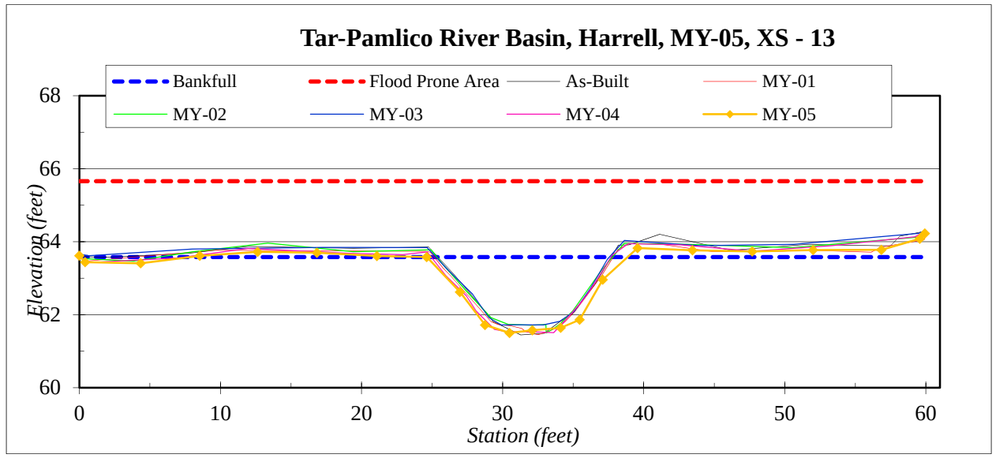

Tar-Pamlico River Basin, Harrell, MY-05, XS - 10
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)
72
70
68
66
64
0
10
20
30
40
50
60

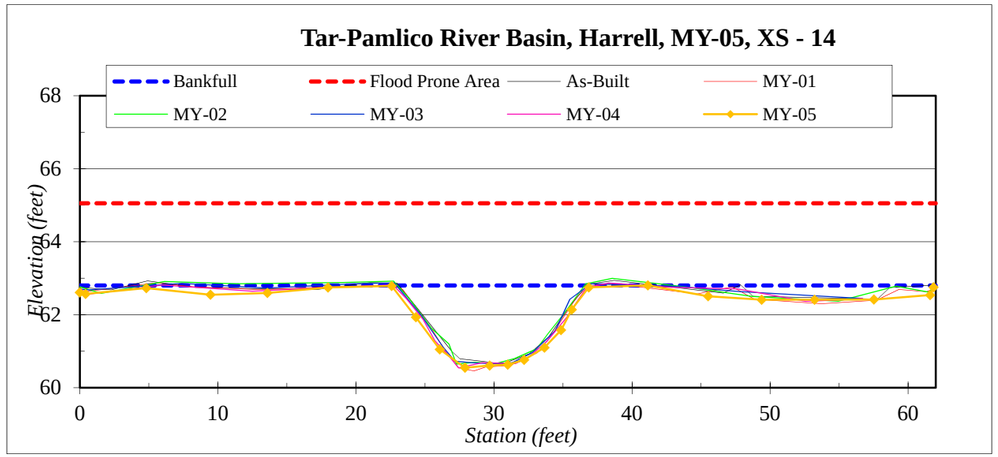

Tar-Pamlico River Basin, Harrell, MY-05, XS - 8
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)
74
72
70
68
66
0
10
20
30
40
50

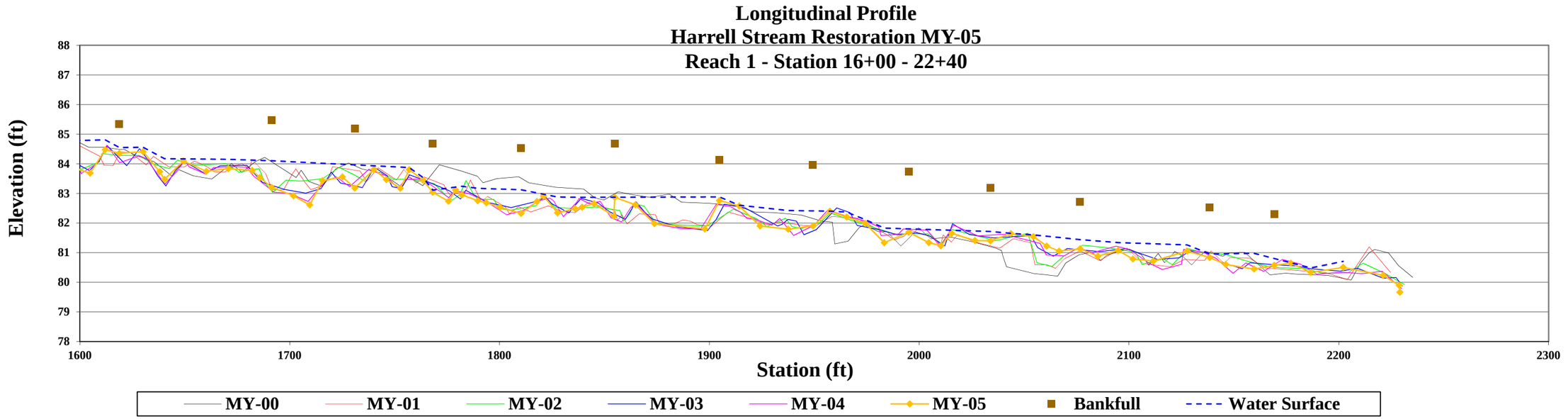

Tar-Pamlico River Basin, Harrell, MY-05, XS - 11
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)
70
68
66
64
62
0
10
20
30
40
50

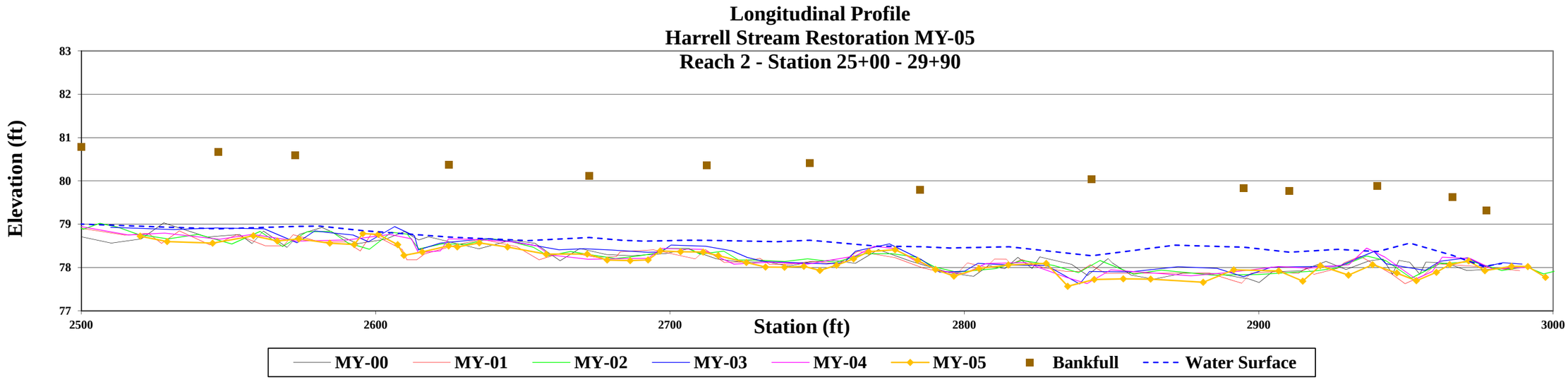

Tar-Pamlico River Basin, Harrell, MY-05, XS - 9
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)
72
70
68
66
0
10
20
30
40
50

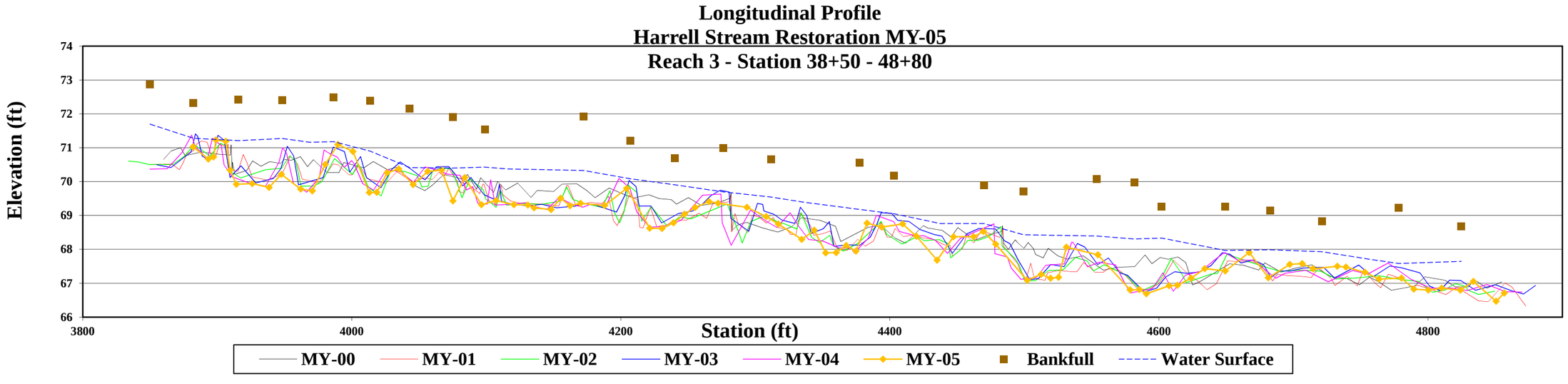

Tar-Pamlico River Basin, Harrell, MY-05, XS - 12
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
Elevation (feet)
Station (feet)
70
68
66
64
62
0
10
20
30
40
50
60


Tar-Pamlico River Basin, Harrell, MY-05, XS - 13
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
68
66
64
62
60
Elevation (feet)
0
10
20
30
40
50
60
Station (feet)


Tar-Pamlico River Basin, Harrell, MY-05, XS - 14
Bankfull
Flood Prone Area
As-Built
MY-01
MY-02
MY-03
MY-04
MY-05
68
66
64
62
60
Elevation (feet)
0
10
20
30
40
50
60
Station (feet)


Longitudinal Profile
Harrell Stream Restoration MY-05
Reach 1 - Station 16+00 - 22+40
Elevation (ft)
88
87
86
85
84
83
82
81
80
79
78
1600
1700
1800
1900
2000
2100
2200
2300
Station (ft)
MY-00
MY-01
MY-02
MY-03
MY-04
MY-05
Bankfull
Water Surface


Longitudinal Profile
Harrell Stream Restoration MY-05
Reach 2 - Station 25+00 - 29+90
Elevation (ft)
83
82
81
80
79
78
77
2500
2600
2700
2800
2900
3000
Station (ft)
MY-00
MY-01
MY-02
MY-03
MY-04
MY-05
Bankfull
Water Surface


Longitudinal Profile
Harrell Stream Restoration MY-05
Reach 3 - Station 38+50 - 48+80
Elevation (ft)
74
73
72
71
70
69
68
67
66
3800
4000
4200
4400
4600
4800
Station (ft)
MY-00
MY-01
MY-02
MY-03
MY-04
MY-05
Bankfull
Water Surface

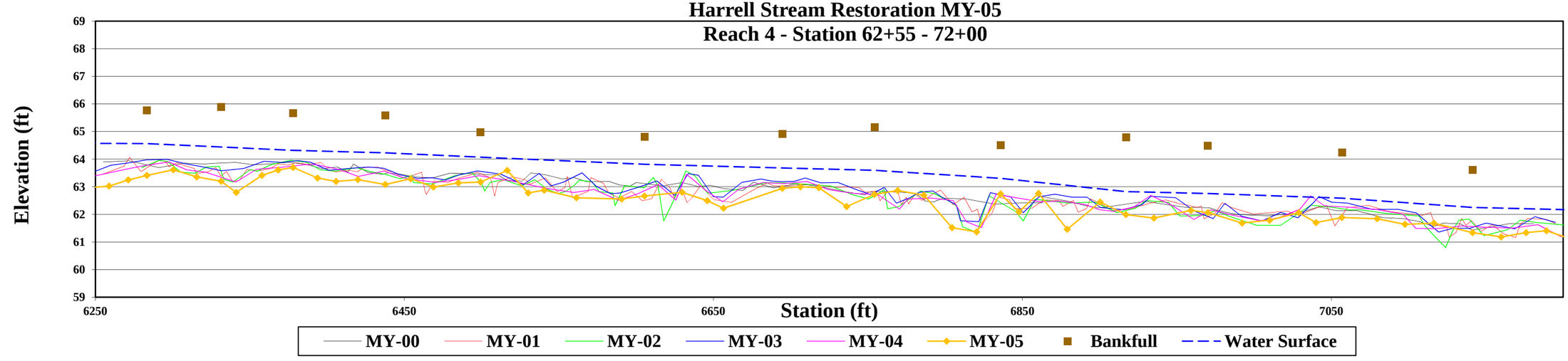

Longitudinal Profile
Harrell Stream Restoration MY-05
Reach 4 - Station 62+55 - 72+00
Elevation (ft)
69
68
67
66
65
64
63
62
61
60
59
6250
6450
6650
6850
7050
Station (ft)
MY-00
MY-01
MY-02
MY-03
MY-04
MY-05
Bankfull
Water Surface

Table 4. Morphology and Hydraulic Monitoring Summary
Harrell Stream and Wetland Restoration

Parameter	Cross-Section 1 Reach 1						Cross-Section 2 Reach 1						Cross-Section 3 Reach 2					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
Bankfull Width (ft)	10.2	10.4	10.5	10.8	11.2	11.2	12.4	12.7	13.4	13.4	12.8	12.8	11.5	13.1	12.4	12.8	13.3	13.4
Floodprone Width (ft)	22	27	30	31	32	34	25	25	24	20	21	19	>55	>55	>55	>55	>55	>55
Bankfull Cross-Sectional Area (ft^2)	12.6	13.4	14.3	14.0	14.7	14.6	17.1	12.9	14.3	12.3	13.1	10.5	12.5	12.6	11.9	12.6	13.2	13.3
Bankfull Mean Depth (ft)	1.2	1.3	1.4	1.3	1.3	1.3	1.4	1.0	1.1	0.9	1.0	0.8	1.1	1.0	1.0	1.0	1.0	1.0
Bankfull Maximum Depth (ft)	2.1	2.1	2.1	2.1	2.2	2.3	2.2	1.7	1.8	1.3	1.5	1.1	1.9	1.9	1.9	1.9	1.9	2.0
Width/Depth Ratio	8.3	8.1	7.7	8.3	8.5	8.6	9.0	12.5	12.6	14.5	12.5	14.4	10.6	13.7	12.9	13.5	13.3	13.5
Entrenchment Ratio	2.7	2.6	2.9	2.9	2.8	3.1	2.8	2.0	1.9	1.5	1.7	1.5	>4.4	>4.3	>4.6	>4.3	>4.1	>4.1
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Wetted Perimeter (ft)	11.2	11.5	11.6	11.9	12.3	12.4	13.3	13.6	14.2	13.9	13.5	12.7	12.2	13.9	13.0	13.5	14.0	14.1
Hydraulic Radius (ft)	1.1	1.2	1.2	1.2	1.2	1.2	1.3	0.9	1.0	0.9	1.0	0.8	1.0	0.9	0.9	0.9	0.9	0.9
Substrate																		
d50 (mm)	0.5	1.8	0.1	0.8	4.4	4.9	1.1	1.8	0.1	1.4	2.1	5.4	0.6	2.3	0.4	0.8	0.6	3.1
d84 (mm)	1.1	14.0	1.8	6.4	9.8	12.0	1.8	5.3	0.9	1.8	5.0	9.6	1.4	4.3	1.3	1.3	4.9	7.3

Table 4. cont. Morphology and Hydraulic Monitoring Summary
Harrell Stream and Wetland Restoration

Parameter	Cross-Section 4 Reach 2						Cross-Section 5 Reach 2						Cross-Section 6 Reach 3					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
Bankfull Width (ft)	9.8	11.5	8.8	9.3	9.6	10.8	9.2	9.9	8.2	9.2	11.4	14.4	14.1	15.0	13.4	12.9	13.4	13.4
Floodprone Width (ft)	>67	>67	>67	>67	>67	>67	56	56	57	60	60	59	>56	>56	>56	>56	>56	>56
Bankfull Cross-Sectional Area (ft^2)	10.3	10.8	8.1	8.8	9.2	10.3	8.8	10.2	8.8	10.7	10.8	10.9	19.1	20.8	18.6	19.5	20.8	20.5
Bankfull Mean Depth (ft)	1.1	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.1	1.2	0.9	0.8	1.4	1.4	1.4	1.5	1.5	1.5
Bankfull Maximum Depth (ft)	1.7	1.7	1.5	1.6	1.6	1.7	1.6	2.0	1.8	2.1	2.1	1.9	2.5	2.7	2.6	2.7	2.8	2.8
Width/Depth Ratio	9.3	12.2	9.6	9.9	10.0	11.3	9.6	9.7	7.6	7.8	12.1	19.0	10.4	10.8	9.7	8.5	8.7	8.8
Entrenchment Ratio	>7.0	>7.0	>7.0	>7.0	>7.0	>6.2	6.1	5.7	7.0	6.6	5.2	4.1	>4.0	>3.7	>4.2	>4.3	>4.2	>4.2
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Wetted Perimeter (ft)	10.7	12.2	9.4	9.9	10.3	11.4	10.0	10.9	9.3	10.3	12.5	15.3	15.2	16.3	14.7	14.4	15.0	14.9
Hydraulic Radius (ft)	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.7	1.3	1.3	1.3	1.4	1.4	1.4
Substrate																		
d50 (mm)	1.3	3.4	0.1	0.1	0.2	3.7	0.9	0.8	0.1	0.1	0.1	0.1	0.6	0.2	0.1	0.1	0.6	8.0
d84 (mm)	4.4	6.2	1.2	0.2	2.4	8.9	4.6	3.8	0.3	0.1	0.3	6.0	2.0	7.7	1.0	0.1	8.9	13.0

Table 4. cont. Morphology and Hydraulic Monitoring Summary
Harrell Stream and Wetland Restoration

Parameter	Cross-Section 7 Reach 3						Cross-Section 8 Reach 3						Cross-Section 9 Reach 3					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
Bankfull Width (ft)	12.1	12.0	13.0	12.4	12.7	14.5	13.0	11.9	11.0	11.2	12.1	11.8	11.8	12.4	11.9	11.6	12.1	12.1
Floodprone Width (ft)	>61	>61	>61	>61	>61	>61	>50	>50	>50	>50	>50	>50	>58	>58	>58	>58	>58	>58
Bankfull Cross-Sectional Area (ft^2)	14.4	16.2	18.5	18.2	18.2	18.4	15.6	15.8	13.2	11.2	14.2	12.8	15.6	15.2	14.3	14.4	15.0	13.8
Bankfull Mean Depth (ft)	1.2	1.4	1.4	1.5	1.4	1.3	1.2	1.3	1.2	1	1.2	1.1	1.3	1.2	1.2	1.2	1.2	1.1
Bankfull Maximum Depth (ft)	1.9	2.6	2.8	2.8	2.8	2.6	1.9	2.0	1.8	1.5	1.9	1.7	2.0	2.0	1.9	1.9	2.0	1.8
Width/Depth Ratio	10.2	8.8	9.1	8.4	8.9	11.4	10.8	8.9	9.2	10.4	10.3	10.9	8.9	10.1	9.9	9.3	9.8	10.7
Entrenchment Ratio	>5.0	>5.0	>5.0	>4.9	>4.8	>4.2	>4.0	>5.0	>5.0	>4.6	>4.4	>4.2	>5.0	>5.0	>5.0	>5.0	>4.8	>4.8
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Wetted Perimeter (ft)	12.8	13.2	14.3	14.0	14.2	15.7	14.0	12.8	11.9	11.5	13.0	12.4	12.8	13.2	12.7	12.4	12.9	12.9
Hydraulic Radius (ft)	1.1	1.2	1.3	1.3	1.3	1.2	1.1	1.2	1.1	1.0	1.1	1.0	1.2	1.2	1.1	1.2	1.2	1.1
Substrate																		
d50 (mm)	0.8	0.7	0.1	0.1	0.2	0.1	1.0	1.0	1.1	0.1	0.1	0.1	0.9	0.8	0.6	0.1	0.1	0.1
d84 (mm)	2.0	7.3	0.7	0.1	7.2	3.4	1.9	5.5	3.2	0.1	0.1	0.1	1.7	1.7	1.0	0.1	0.1	0.7

Table 4. cont. Morphology and Hydraulic Monitoring Summary
Harrell Stream and Wetland Restoration

Parameter	Cross-Section 10 Reach 4						Cross-Section 11 Reach 4						Cross-Section 12 Reach 4					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
Bankfull Width (ft)	13.5	13.9	12.7	13.1	12.9	13.0	14.0	13.3	12.8	12.7	13.3	14.0	16.8	17.6	16.1	16.9	17.0	17.9
Floodprone Width (ft)	>67	>67	>67	>67	>67	>67	>57	>57	>57	>57	>57	>57	>61	>61	>61	>61	>61	>60
Bankfull Cross-Sectional Area (ft^2)	17.9	16.9	14.2	14.0	14.2	14.6	18.2	18.7	18.0	17.1	17.8	19.1	28.2	27.2	23.4	24.7	25.8	25.8
Bankfull Mean Depth (ft)	1.3	1.2	1.1	1.1	1.1	1.1	1.3	1.4	1.4	1.3	1.3	1.4	1.7	1.5	1.5	1.5	1.5	1.4
Bankfull Maximum Depth (ft)	2.0	2.0	1.8	1.7	1.8	1.8	2.1	2.3	2.2	2.1	2.2	2.3	2.5	2.5	2.2	2.3	2.3	2.2
Width/Depth Ratio	10.2	11.5	11.4	12.3	11.7	11.6	10.8	9.5	9.1	9.4	9.9	10.2	10.0	11.4	11.1	11.6	11.2	12.4
Entrenchment Ratio	>5.0	>5.0	>5.0	>5.0	>4.8	>5.2	>4.0	>4.0	>4.0	>4.0	>4.0	>4.1	>4.0	>4.0	>4.0	>4.0	>3.6	>3.4
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Wetted Perimeter (ft)	14.3	14.7	13.3	13.7	13.5	13.6	15.0	14.4	13.9	13.6	14.3	15.0	17.8	18.7	17.1	18.0	18.0	18.7
Hydraulic Radius (ft)	1.2	1.2	1.1	1.0	1.0	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.6	1.5	1.4	1.4	1.4	1.4
Substrate																		
d50 (mm)	1.0	2.0	0.1	0.1	0.1	0.1	1.4	1.6	0.1	0.3	0.3	1.1	1.4	0.9	1.3	0.1	0.4	1.6
d84 (mm)	2.6	4.2	3.0	0.1	0.9	1.5	2.0	5.9	1.6	0.6	1.1	3.6	3.0	2.7	2.8	0.1	0.9	2.9

Table 4. cont. Morphology and Hydraulic Monitoring Summary
Harrell Stream and Wetland Restoration

Parameter	Cross-Section 13 Reach 4						Cross-Section 14 Reach 4					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
Bankfull Width (ft)	13.1	13.4	13.3	13.3	13.4	14.2	13.6	14.0	13.8	14.2	15.0	14.3
Floodprone Width (ft)	>60	>60	>60	>60	>60	>60	>62	>62	>62	>62	>62	>62
Bankfull Cross-Sectional Area (ft^2)	19.4	20.0	18.4	18.5	19.5	19.2	19.0	20.5	19.1	20.3	21.0	21.7
Bankfull Mean Depth (ft)	1.5	1.5	1.4	1.4	1.5	1.4	1.4	1.5	1.4	1.4	1.4	1.5
Bankfull Maximum Depth (ft)	2.4	2.3	2.3	2.1	2.2	2.1	2.1	2.3	2.2	2.2	2.3	2.3
Width/Depth Ratio	8.8	8.9	9.6	9.6	9.2	10.5	9.7	9.6	10.0	9.9	10.7	9.4
Entrenchment Ratio	>4.0	>4.0	>4.0	>4.0	>4.0	>4.2	>4.0	>4.0	>4.0	>4.0	>3.9	>4.3
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Wetted Perimeter (ft)	14.1	14.3	14.4	14.3	14.4	15.1	14.5	15.1	15.6	15.2	16.0	15.2
Hydraulic Radius (ft)	1.4	1.4	1.3	1.3	1.4	1.3	1.3	1.4	1.2	1.3	1.3	1.4
Substrate												
d50 (mm)	1.5	1.6	1.1	0.7	0.4	1.8	1.3	0.1	0.1	0.6	0.2	1.1
d84 (mm)	2.6	4.7	1.8	0.9	5.8	7.0	1.8	0.4	0.1	0.9	0.5	2.8

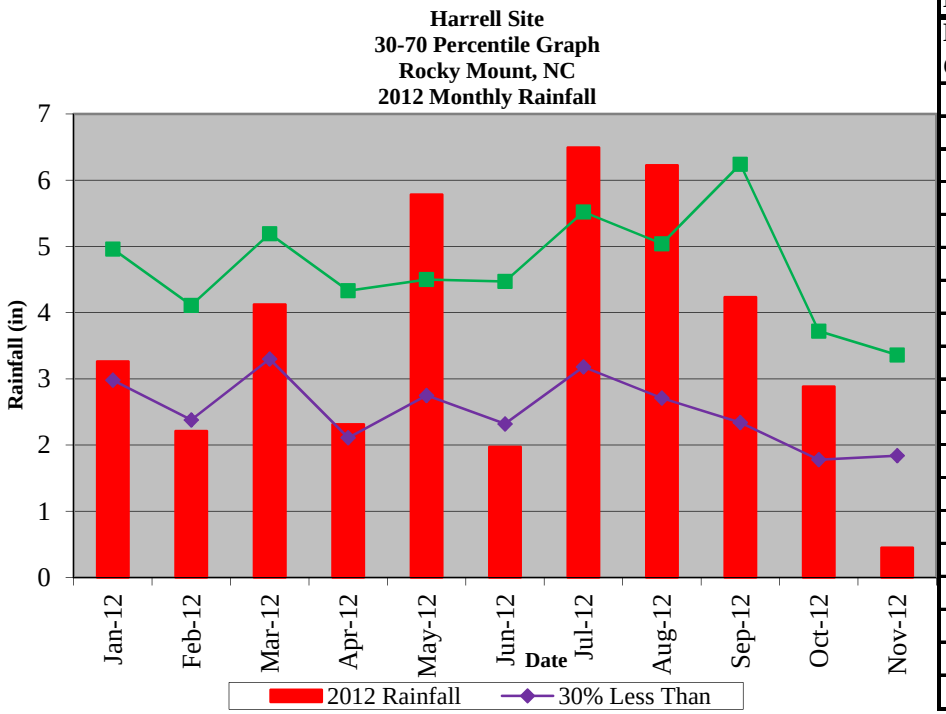


Table 5. Hydrological (Bankfull) Verifications
Harrell Stream and Wetland Restoration Site

Date of Data Collection	Date of Occurrence	Method	Photo Number
10/10/2007	10/10/2007	Stream Gauge	N/A
10/27/2007	10/27/2007	Stream Gauge	N/A
7/6/2008	7/6/2008	Stream Gauge	N/A
6/9/2009	6/9/2009	Stream Gauge	N/A
1/25/2010	1/25/2010	Stream Gauge	N/A
3/29/2010	3/29/2010	Stream Gauge	N/A
9/30/2010	9/30/2010	Stream Gauge	N/A
7/27/2011	6/27/2011	Stream Gauge	N/A
7/27/2011	7/5/2011	Stream Gauge	N/A
7/27/2011	7/6/2011	Stream Gauge	N/A
10/17/2011	7/31/2011	Stream Gauge	N/A
10/17/2011	8/6/2011	Stream Gauge	N/A
10/17/2011	8/27/2011	Stream Gauge	N/A
12/13/2011	11/4/2011	Stream Gauge	N/A
6/25/2012	5/30/2012	Stream Gauge	N/A
9/13/2012	7/9/2012	Stream Gauge	N/A
9/13/2012	7/27/2012	Stream Gauge	N/A
9/13/2012	8/11/2012	Stream Gauge	N/A
9/13/2012	8/25/2012	Stream Gauge	N/A

Table 6. Wetland Hydrology Criteria Attainment Table
Harrell Stream and Wetland Restoration Site

Gauge	Success Criteria Achieved / Max Consecutive Days During Growing Season (Percentage)				
	Year 1 (2008)	Year 2 (2009)	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)
Well 1	Yes/16 (7.2%)	Yes/23 (10.1%)	Yes/18 (8.1%)	Yes/21 (9.4%)	No/9 (4.0%)
Well 2	Yes/39 (17.5%)	Yes/29 (12.8%)	Yes/22 (9.6%)	Yes/43 (19.1%)	Yes/31 (13.9%)
Well 3	Yes/16 (7.2%)	Yes/23 (10.1%)	Yes/19 (8.5%)	Yes/16 (7.2%)	No/7 (2.9%)
Well 4	Yes/32 (14.3%)	Yes/28 (12.3%)	Yes/20 (8.7%)	Yes/16 (7.2%)	No/10 (4.3%)

Table 7a. Riparian Buffer Stem Density and Species Count by Plot
Harrell Stream and Wetland Restoration

Plot Number	**River Birch** *Betula nigra*	**American Beautyberry** *Callicarpa americana*	**Shagbark Hickory** *Carya ovata*	**Sugarberry** *Celtis laevigata*	**Silky Dogwood** *Cornus amomum*	**Persimmon** *Diospyros viginiana*	**Green Ash** *Fraxinus pennsylvanica*	**Sycamore** *Platanus occidentalis*	**Southern Red Oak** *Quercus falcata*	**Swamp Chestnut Oak** *Quercus michauxii*	**Willow Oak** *Quercus phellos*	**Black Willow** *Salix nigra*	**Elderberry** *Sambucus canadensis*	**Bald Cypress** *Taxodium distichum*	**Cherrybark Oak** *Quercus pagoda*	**Total (Year 5)**	**Density-Year 5 (Stems/Acre)**
S1					6				3		2					11	440
S2		4	3												1	8	320
S3		2	1		3	5					1		5		1	18	720
S4		2		3						3	3					11	440
S5	4			1	8					4	2		1			20	800
S6	2	2								4						8	320
S7		7		3	7				1	2	4		2			26	1,040
S8		6									1					7	280
S9	4				4	5				2	4	3				22	880
S10				1		1		4			2					8	320
S11		3		2	6	2			1	2	1	1				18	720
S12	5	1		1				1								8	320
S13		3		2	2		1	1		4						13	520
S14	2	1				7				2						12	480
S15	4			2	8			3		1						18	720
S16	1					1		1		3						6	240
S17						1	3			3				2		9	360
S18	4			4			6				2					16	640
															Average Density		531

Table 7b. Wetland Stem Density and Species Count by Plot
Harrell Stream and Wetland Restoration

Plot Number	**Green Ash** *Fraxinus pennsylvanica*	**American Beautyberry** *Callicarpa americana*	**Water Hickory** *Carya aquatica*	**Buttonbush** *Cephalanthus occidentalis*	**Cherrybark Oak** *Quercus pagoda*	**Swamp Chestnut Oak** *Quercus michauxii*	**Willow Oak** *Quercus phellos*	**Laurel Oak** *Quercus laurifolia*	**Bald Cypress** *Taxodium distichum*	**Total (Year 5)**	**Density-Year 5 (Stems/Acre)**
W1	4			1	1	1		2		9	360
W2				1	5		2	1		9	360
W3				1	1	1			6	9	360
W4	2			4	5	1	2	1		15	600
W5	4				1	4			4	13	520
W6				5	3		5		3	16	640
W7					2	3	4			9	360
W8			9	3	1				3	16	640
W9	2			1	4	1	1	3		12	480
W10	3			4				6	1	14	560
W11		1	4	4					6	15	600
W12			5	4		1			9	19	760
										Average Density	520

Table 8a. Riparian Buffer Vegetation History (stems/acre)
Harrell Stream and Wetland Restoration

Plot Number	MY-00	MY-01	MY-02	MY-03	MY-04		MY-05	
	Planted	Planted	Planted	Planted	Planted	Total	Planted	Total
S1	1,120	640	560	440	520	560	440	520
S2	720	360	400*	360	360	360	280	320
S3	1,120	880	880	840	800	800	800	800
S4	480	560*	560	520	480	640	440	680
S5	1,200	840	800	800	800	840	800	1,120
S6	480	280	280	280	320	680	320	720
S7	1,120	1,120	1,120	1,080	1,080	1,920	1040	3,240
S8	480	320	240	240	240	960	280	1,240
S9	1,240	920	920	880	840	1,440	880	1,520
S10	600	360	360	360	320	1,000	320	1,200
S11	880	760	800*	800	760	1,160	720	1,400
S12	600	440	360	360	320	760	320	640
S13	1,160	840	800	720	560	1,200	520	1,160
S14	640	520	520	520	520	840	480	1,160
S15	1,120	1,000	960	960	920	1,200	720	1,800
S16	600	480	480	480	360	800	240	800
S17	880	200	200	400**	400**	440	360	560
S18	680	320	280	720**	720**	760	680	880

*Uncounted plants during baseline and MY01 were added to total

** Includes plants from supplemental planting

Table 8b. Wetland Vegetation History (stems/acre)
Harrell Stream and Wetland Restoration

Plot Number	MY-00	MY-01	MY-02	MY-03	MY-04		MY-05	
	Planted	Planted	Planted	Planted	Planted	Total	Planted	Total
W1	520	400	400	400	360	400	360	560
W2	640	360	360	360	400	400	360	400
W3	600	400	400	360	360	440	360	480
W4	800	640	640	640	600	680	600	720
W5	600	560	560	520	520	680	520	680
W6	720	600	600	600	640	680	640	720
W7	680	240	240	320	360	520	360	640
W8	760	680	680	640	640	680	640	720
W9	640	560	560	520	480	520	480	480
W10	600	600	600	560	560	1,240	560	1,080
W11	680	560	560	560	520	760	600	960
W12	1,080	800	800	760	760	1,120	760	920

4.0 EEP RECOMMENDATIONS AND CONCLUSIONS

The stream assessment found the stream to be generally stable, with no significant changes from the previous monitoring year. Periodic storm events caused isolated bed degradation in reaches 1 and 2. Some of these areas are visible on the longitudinal profile and cross-section plots. These patterns are typical for a stream like UT to Swift Creek. This is a sand bed system and the bed is highly mobile. Because of this, it is expected that patterns of aggradation and degradation are more dynamic within these systems. These dune/anti-dune streams will experience bed variation over time. The stream banks and floodplain experienced little to no erosion throughout the project. The in-stream structures are performing as designed. The water quality treatment areas are stable and retaining water.

With multiple bankfull events since construction, the stream has met the success criterion of at least two bankfull events occurring in separate years over the course of the monitoring period.

The monitored vegetation plots within the stream buffer and wetland revealed that the planted vegetation is growing well with 531 and 520 stems/acre, respectively. Only a few monitoring plots have low stem counts. The overall vegetation assessment found the site has met the vegetative success criteria for monitoring year 5.

During the fifth year of monitoring wetland hydrology was achieved at one of the four monitoring wells on the site. Groundwater gauge 4 experienced multiple gauge malfunctions in May-October, during which the well could have met the jurisdictional hydrology, especially during May, which was particularly wet this year. The overall below average rainfall for January through March likely had a significant effect on the attainment of wetland hydrology this year. With normal rainfall during these months, the site typically has wetland hydrology during the beginning of the growing season.

Overall the wetland, stream, and the site's vegetation condition indicate that it is on a path to success. The EEP recommends that this site be closed out.

Pre-Construction Photos (2004)

Post-Construction Photos MY-05

Stream Photo Points

Photo Point S1: View looking upstream near Station 12+75. 12/18/12 – MY-05

Photo Point S2: View looking upstream from farm road near Station 21+30. 12/18/12 – MY-05

Photo Point S4: View of water quality treatment structure, near Station 32+25. 12/18/12 – MY-05

Photo Point S5: View looking downstream near Station 33+35. 12/18/12 – MY-05

Photo Point S7: View looking upstream near Station 39+00. 12/18/12 – MY-05

Photo Point S9: View of water quality treatment structure near Station 41+75. 12/18/12 – MY-05

Photo Point S11: View of water quality treatment structure near Station 47+00. 12/18/12 – MY-05

Photo Point S13: View looking upstream near Station 61+50. 12/18/12 – MY-05

Photo Point S15: View looking downstream near Station 69+00. 12/18/12 – MY-05

Photo Point S16: View looking upstream near Station 76+75. (Photo taken farther away from stream due to water depth) 12/18/12 – MY-05

Wetland Photo Points

Photo Point W1: View looking north from southwest corner of wetland. 6/27/12 – MY-05

Photo Point W1: View looking east from southwest corner of wetland. 6/27/12 – MY-05

Photo Point W3: View looking west from middle corner of wetland. 6/27/12 – MY-05

Photo Point W4: View looking north toward Wetland Gauge 1. 6/27/12 – MY-05

Photo Point W5: View looking west toward the downstream end of site. 6/27/12 – MY-05

Appendix A
Watershed Planning Summary

To be completed by the EEP Watershed Planner.

Appendix B
Land Ownership and Protection

To be completed by the EEP Property Section.

Appendix C
NCDWQ 401/USACE Section 404

Michael F. Easley, Governor

William G. Ross Jr., Secretary
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director
Division of Water Quality

September 25, 2006

DWQ Project # 06-1334
Edgecombe County

KCI Technologies, Inc.
Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609

Subject Property: **Harrell Wetland Restoration Site**
Swift Creek [030302, 28-78-(2.5), C, NSW]

Approval of 401 Water Quality Certification and Authorization Certificate per the Neuse River Buffer Protection Rules (15A NCAC 2B .0233) with Additional Conditions

Dear Sir or Madam:

You have our approval, in accordance with the attached conditions and those listed below, to place fill within or otherwise impact 0.24 acres of wetland to perform a wetland restoration at the site as described within your application dated August 14, 2006, which was received by the N.C. Division of Water Quality (DWQ) on August 17, 2006. After reviewing your application, we have decided that the impacts are covered by General Water Quality Certification Number(s) 3495 (GC3495). The Certification(s) allows you to use Nationwide Permit(s) NW27 when issued by the US Army Corps of Engineers (USACE). This letter shall also act as your approved Authorization Certificate for impacts to the protected riparian buffers per 15A NCAC 2B .0233. In addition, you should obtain or otherwise comply with any other required federal, state or local permits before you go ahead with your project including (but not limited to) Erosion and Sediment Control, and Non-discharge regulations. **Also, this approval to proceed with your proposed impacts or to conduct impacts to waters as depicted in your application shall expire upon expiration of the 404 or CAMA Permit.**

This approval is for the purpose and design that you described in your application. If you change your project, you must notify us and you may be required to send us a new application. If the property is sold, the new owner must be given a copy of this Certification and approval letter and is thereby responsible for complying with all conditions. If total fills for this project (now or in the future) exceed one acre of wetland or 150 linear feet of stream, compensatory mitigation may be required as described in 15A NCAC 2H .0506 (h). **This approval requires you to follow the conditions listed in the attached certification and any additional conditions listed below.**

The Additional Conditions of the Certification are:

1. Impacts Approved

   The following impacts are hereby approved as long as all of the other specific and general conditions of this Certification (or Isolated Wetland Permit) are met. No other impacts are approved including incidental impacts:

	Amount Approved (Units)	Reference
404/Wetland	0.24 (acres)	PCN page 8 of 12

Violations of any condition herein set forth may result in revocation of this Certification and may result in criminal and/or civil penalties. The authorization to proceed with your proposed impacts or to conduct impacts to waters as depicted in your application and as authorized by this Certification shall expire upon expiration of the 404 or CAMA Permit.

If you do not accept any of the conditions of this Certification (associated with the approved wetland or stream impacts), you may ask for an adjudicatory hearing. You must act within 60 days of the date that you receive this letter. To ask for a hearing, send a written petition, which conforms to Chapter 150B of the North Carolina General Statutes to the Office of Administrative Hearings, 6714 Mail Service Center, Raleigh, N.C. 27699-6714. This certification and its conditions are final and binding unless you ask for a hearing.

This letter completes the review of the Division of Water Quality under Section 401 of the Clean Water Act. If you have any questions, please telephone Cyndi Karoly or Ian McMillan in the Central Office in Raleigh at 919-733-1786 or Eric Kulz in the DWQ Raleigh Regional Office at 919-791-4200.

Sincerely,

Alan W. Klimek, P.E.

AWK/cbk/*ijm*

Enclosures: GC 3495
Certificate of Completion

cc: USACE Raleigh Regulatory Field Office
DWQ Raleigh Regional Office
DLR Raleigh Regional Office
File Copy
Central Files

Filename: 061334HarrellWetlandRestorationSite(Edgecombe)401

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action ID. **SAW-2006-40345-233** County: **Edgecombe** USGS Quad: **Whitakers**

GENERAL PERMIT (REGIONAL AND NATIONWIDE) VERIFICATION

Property Owner / Authorized Agent: **KCI Technologies, Inc. attn: Steve Stokes**
Address: **Landmark Center II, Suite 220**
4601 Six Forks Rd.
Raleigh, NC 27609

Telephone No.: **919 783-9214 x 187**
Size and location of property (water body, road name/number, town, etc.): **22.3 acres of agricultural land draining to Swift Creek, just east of the intersection of SR1415 (Morningstar Church) and SR 1414 (Benson Farm), six miles northeast of Rocky Mount, NC.**

Description of projects area and activity: **Fill approximately 0.24 acres (~3,485 linear feet by 3 foot wide) agricultural drainage ditch bottoms to raise water table.**

Applicable Law: ☒ Section 404 (Clean Water Act, 33 USC 1344)
☐ Section 10 (Rivers and Harbors Act, 33 USC 403)
Authorization: Regional General Permit Number: ____
Nationwide Permit Number: 27

Your work is authorized by the above referenced permit provided it is accomplished in strict accordance with the attached conditions and your submitted plans. Any violation of the attached conditions or deviation from your submitted plans may subject the permittee to a stop work order, a restoration order and/or appropriate legal action.

This verification is valid until the NWP is modified, reissued, or revoked. All of the existing NWPs are scheduled to be modified, reissued, or revoked prior to March 18, 2007. It is incumbent upon you to remain informed of changes to the NWPs. We will issue a public notice when the NWPs are reissued. Furthermore, if you commence or are under contract to commence this activity before the date that the relevant nationwide permit is modified or revoked, you will have twelve (12) months from the date of the modification or revocation of the NWP to complete the activity under the present terms and conditions of this nationwide permit. If, prior to the expiration date identified below, the nationwide permit authorization is reissued and/or modified, this verification will remain valid until the expiration date identified below, provided it complies with all new and/or modified terms and conditions. The District Engineer may, at any time, exercise his discretionary authority to modify, suspend, or revoke a case specific activity's authorization under any NWP.

Activities subject to Section 404 (as indicated above) may also require an individual Section 401 Water Quality Certification. You should contact the NC Division of Water Quality (telephone (919) 733-1786) to determine Section 401 requirements.

For activities occurring within the twenty coastal counties subject to regulation under the Coastal Area Management Act (CAMA), prior to beginning work you must contact the N.C. Division of Coastal Management .

This Department of the Army verification does not relieve the permittee of the responsibility to obtain any other required Federal, State or local approvals/permits.

If there are any questions regarding this verification, any of the conditions of the Permit, or the Corps of Engineers regulatory program, please contact Jamie Shern at 919 876-8441 x 31.

Corps Regulatory Official _____ Date: **8/16/06**

Expiration Date of Verification: **March 18, 2007**

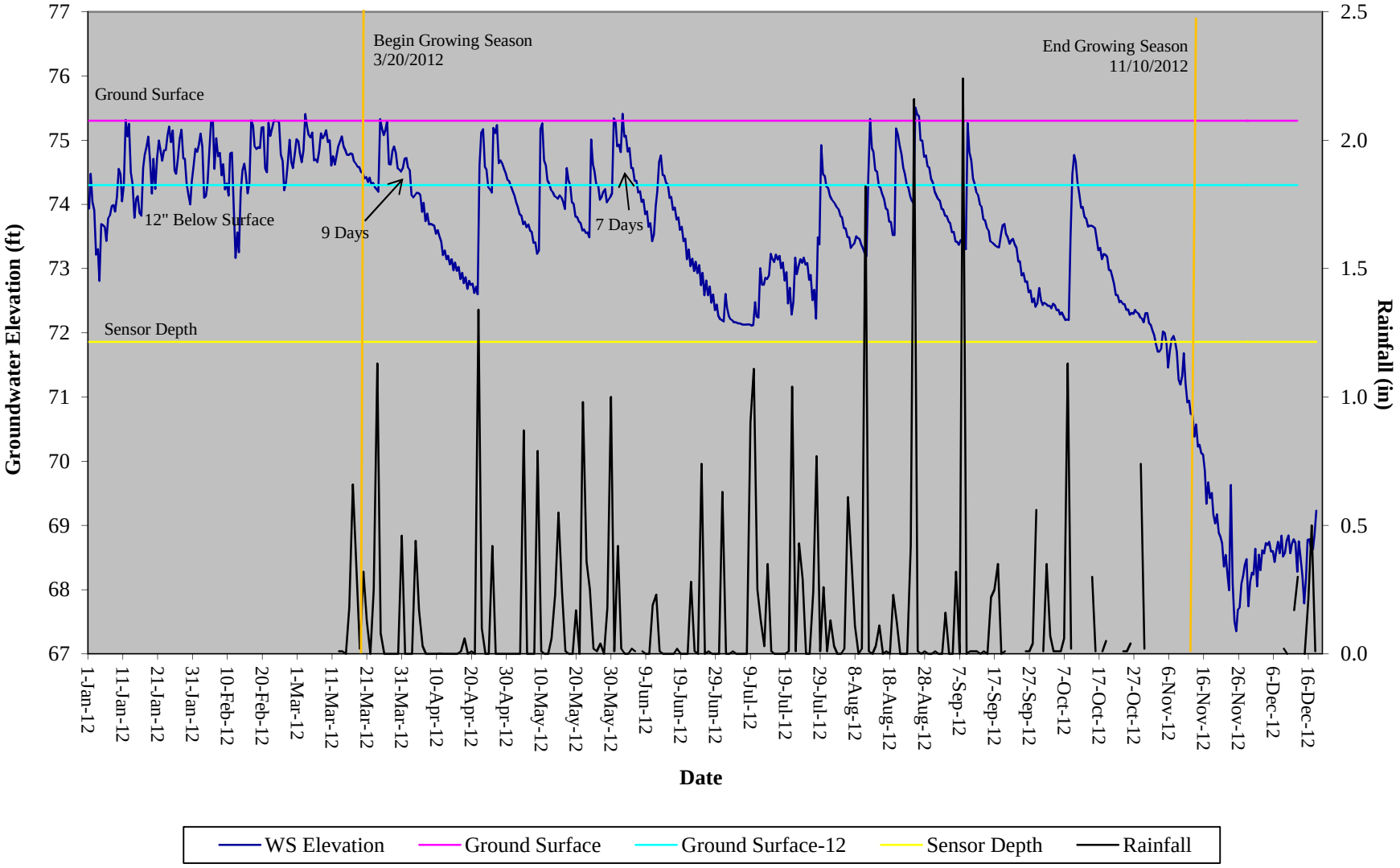
Appendix D
Debit Ledger

Closeout Coordinator to obtain.

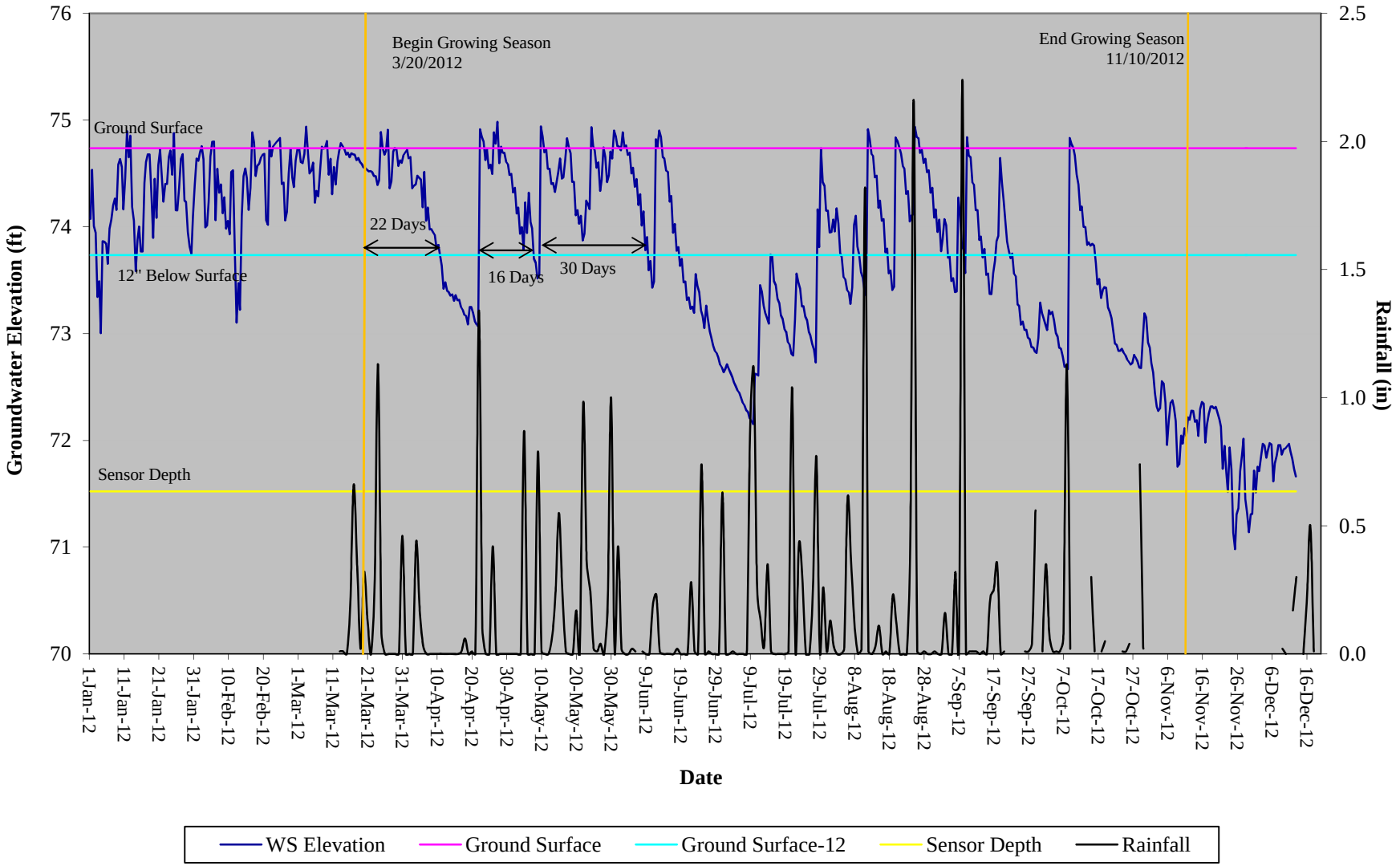
Appendix E
Additional Data

Wetland and Stream Hydrographs

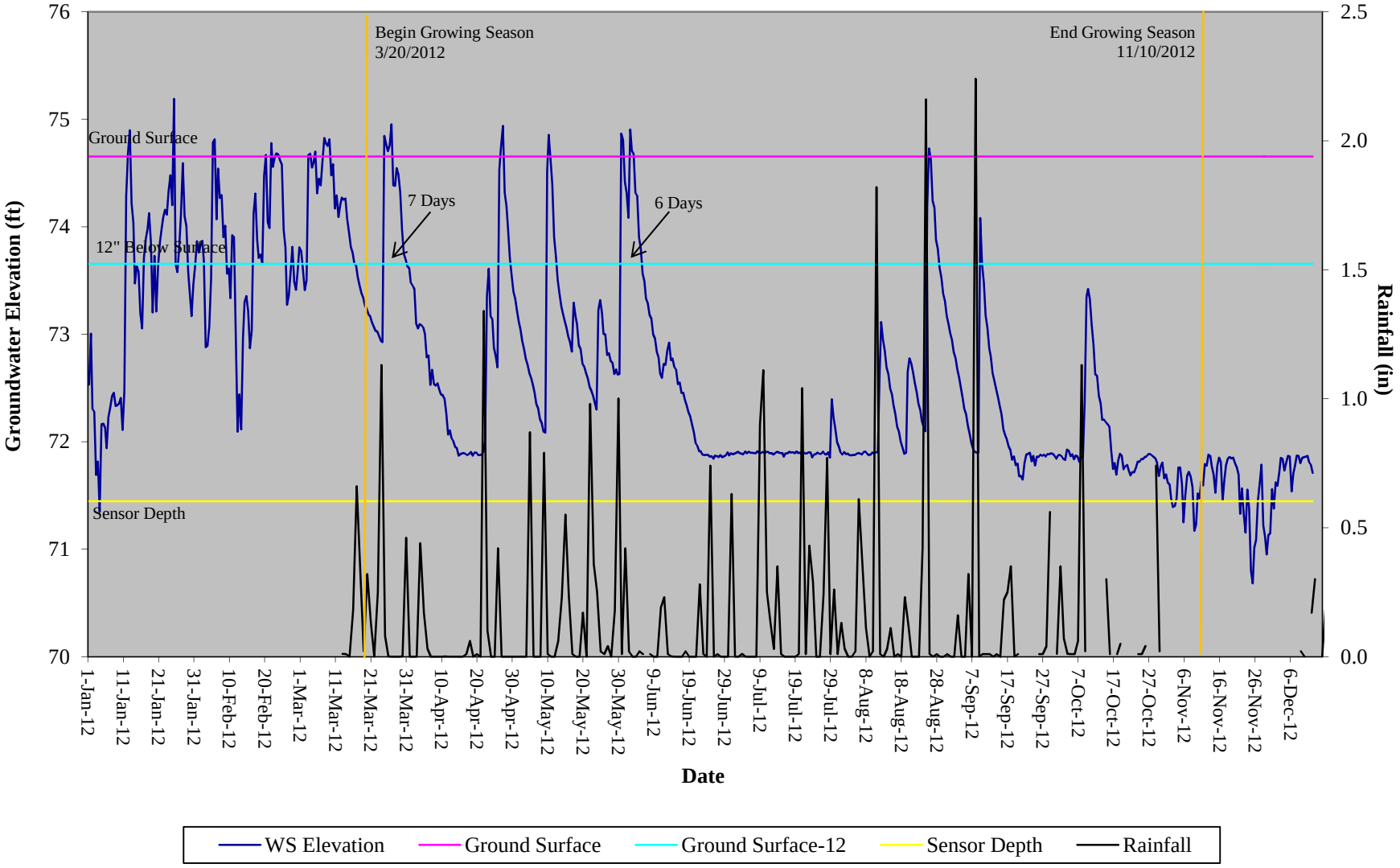
Harrell Farm Gauge 1 Wetland Hydrograph
MY-05 2012



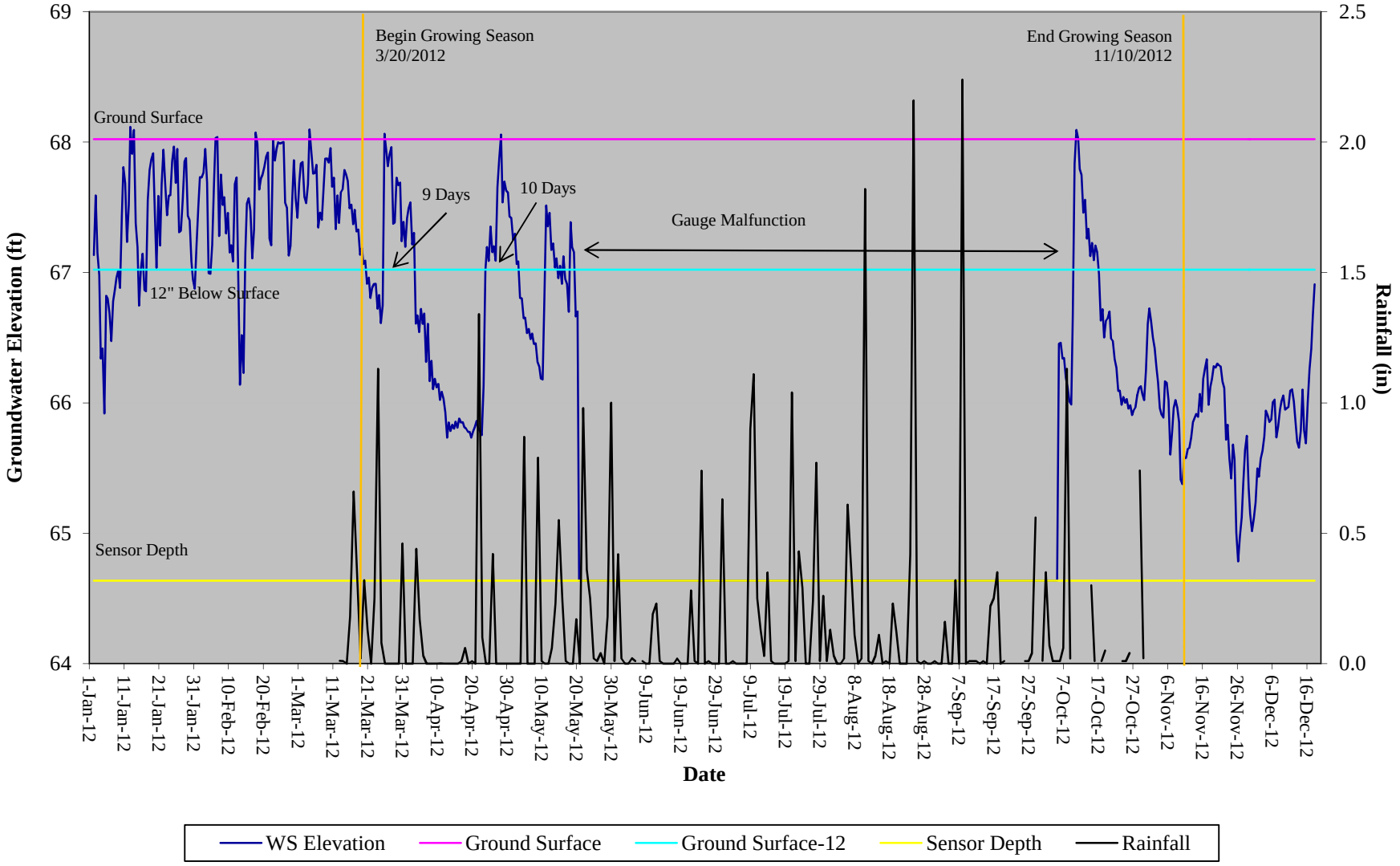
Harrell Farm Gauge 2 Wetland Hydrograph
MY-05 2012



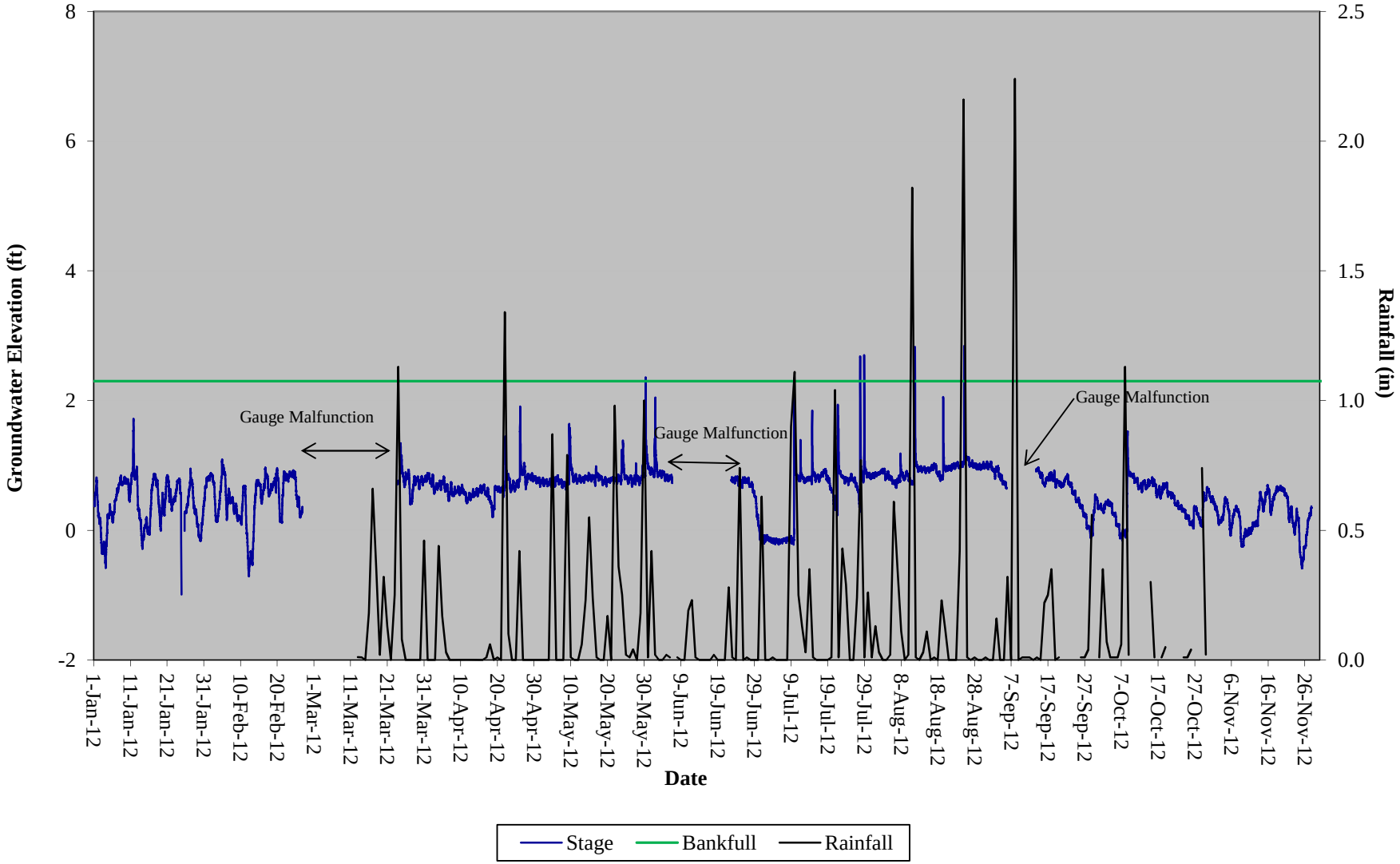
Harrell Farm Gauge 3 Wetland Hydrograph
MY-05 2012



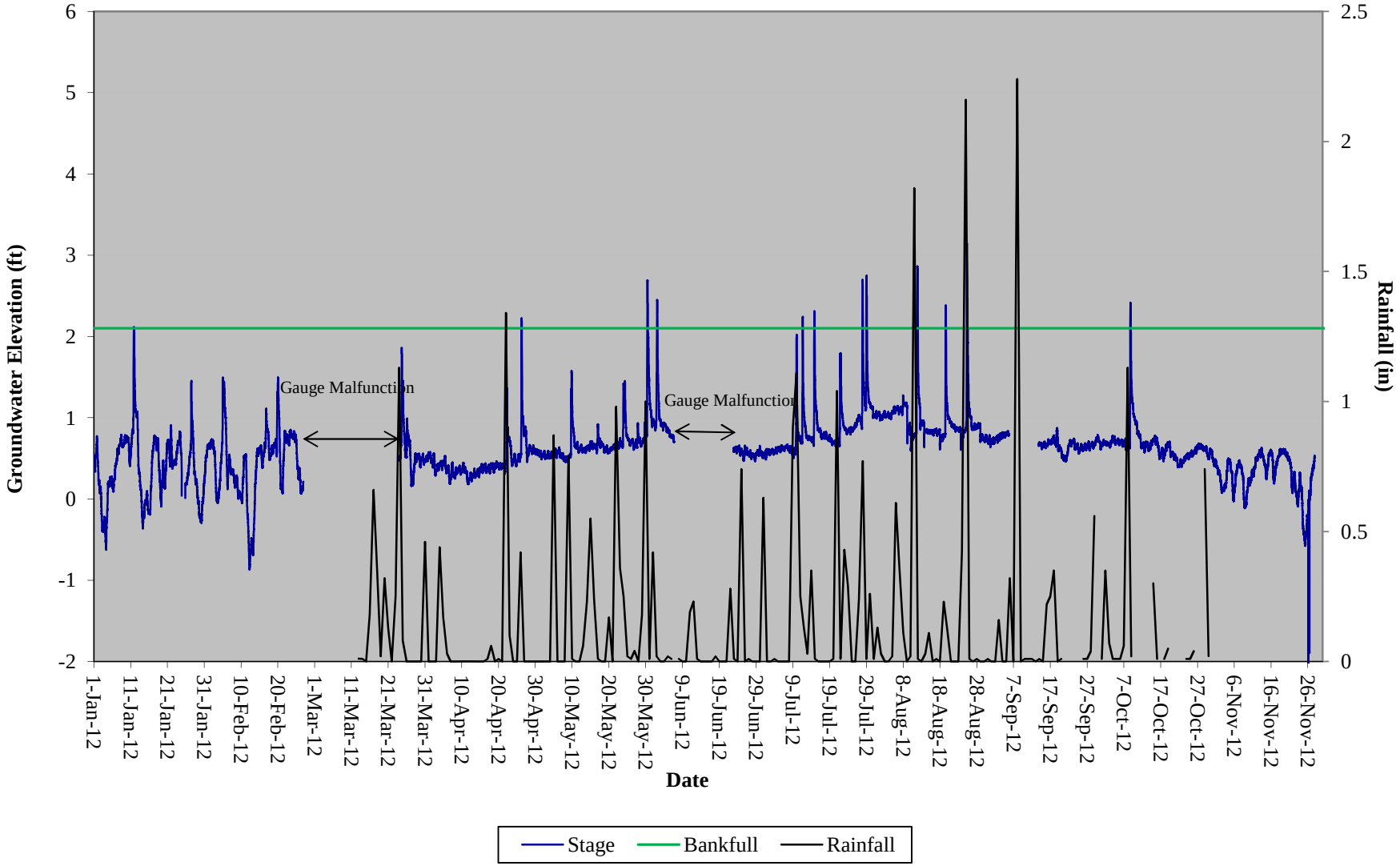
Harrell Farm Gauge 4 Wetland Hydrograph
MY-05 2012



Harrell Stream and Wetland Restoration
Stream Gauge 1 Hydrograph
MY-05 2012



Harrell Stream and Wetland Restoration
Stream Gauge 2 Hydrograph
MY-05 2012



CCPV

PP# W2
CONSERVATION EASEMENT
VEG PLOT W7
VEG PLOT W6
VEG PLOT W9
WETLAND GAUGE 2
WETLAND GAUGE 3
VEG PLOT W5
WETLAND RESTORATION BOUNDARY (15 ACRES)
VEG PLOT W8
VEG PLOT W10
VEG PLOT W11
PP# W3
VEG PLOT W3
VEG PLOT W2
WETLAND GAUGE 1
VEG PLOT W4
VEG PLOT W12
PP# W5
WETLAND GAUGE 4
VEG PLOT W1
PP# W1
PP# W4
80
75
70
NC GRID NAD 83
–60 –30 0 60 120
GRAPHIC SCALE

NO.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

Ecosystem Enhancement PROGRAM

KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

HARRELL SITE
STREAM AND WETLAND RESTORATION
EDGECOMBE CO., NORTH CAROLINA

DATE: DEC 2012
SCALE: 1"=120'

CURRENT CONDITION PLAN VIEW

SYM.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

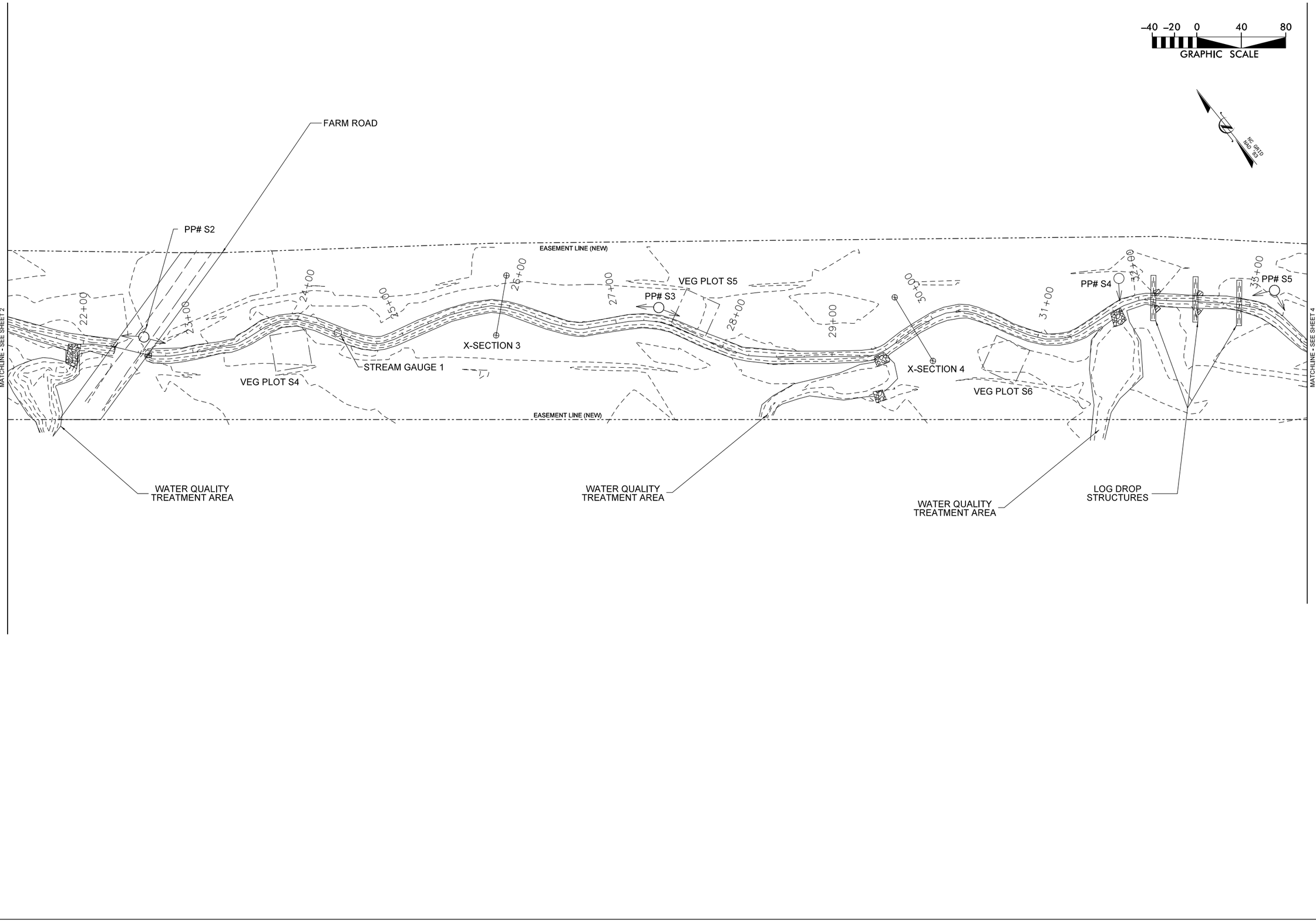
Ecosystem Enhancement PROGRAM

KCI
ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

HARRELL SITE
STREAM AND WETLAND RESTORATION
EDGECOMBE CO., NORTH CAROLINA
STATION 10+00 TO STATION 21+29

DATE: DEC 2012
SCALE: 1"=80'

CURRENT CONDITION PLAN VIEW



REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

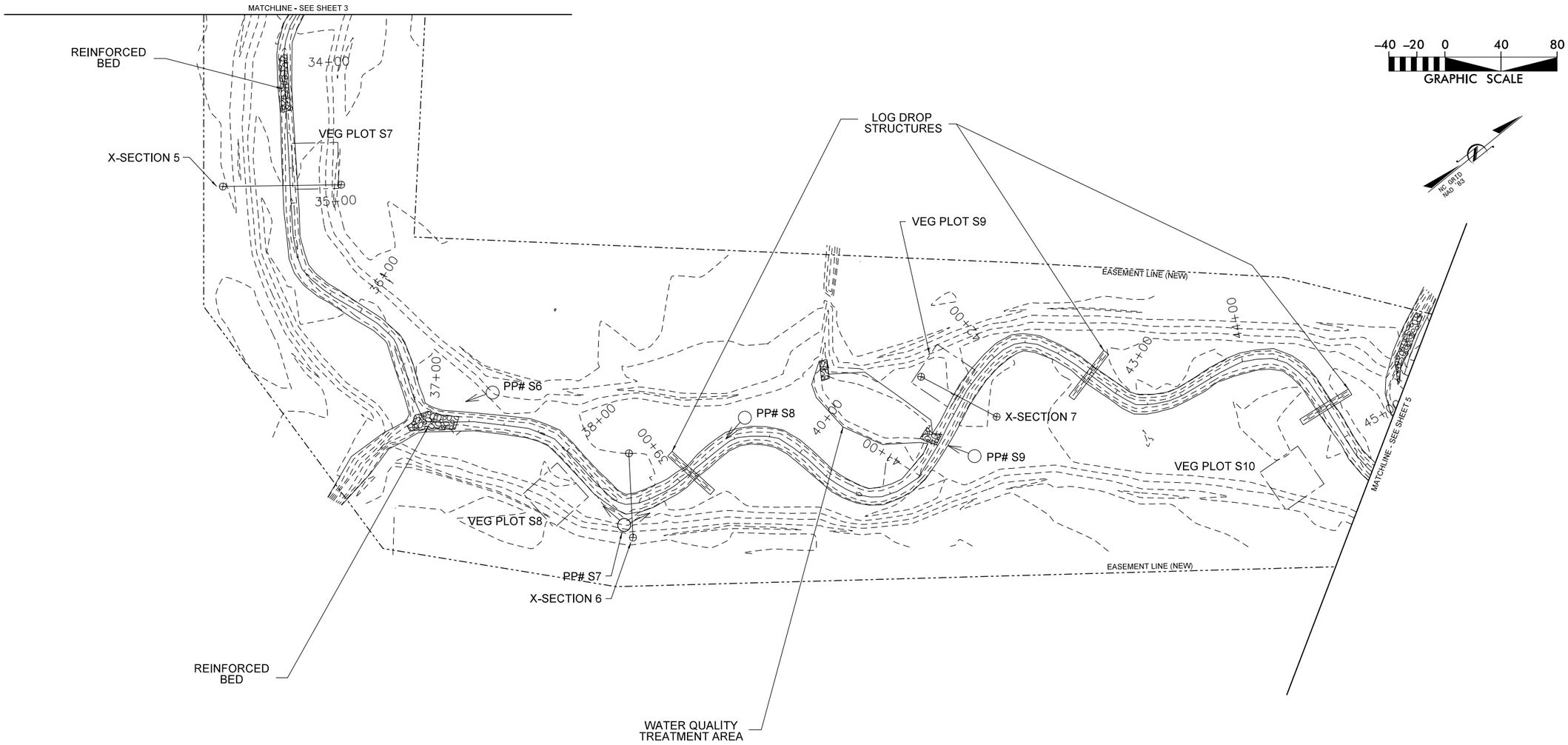
Ecosystem Enhancement Program

KCI
ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

HARRELL SITE
STREAM AND WETLAND RESTORATION
EDGECOMBE CO., NORTH CAROLINA
STATION 21+29 TO STATION 33+64

DATE: DEC 2012
SCALE: 1"=80'

CURRENT
CONDITION
PLAN VIEW



REVISIONS

STM.	DESCRIPTION	DATE	APPROVED

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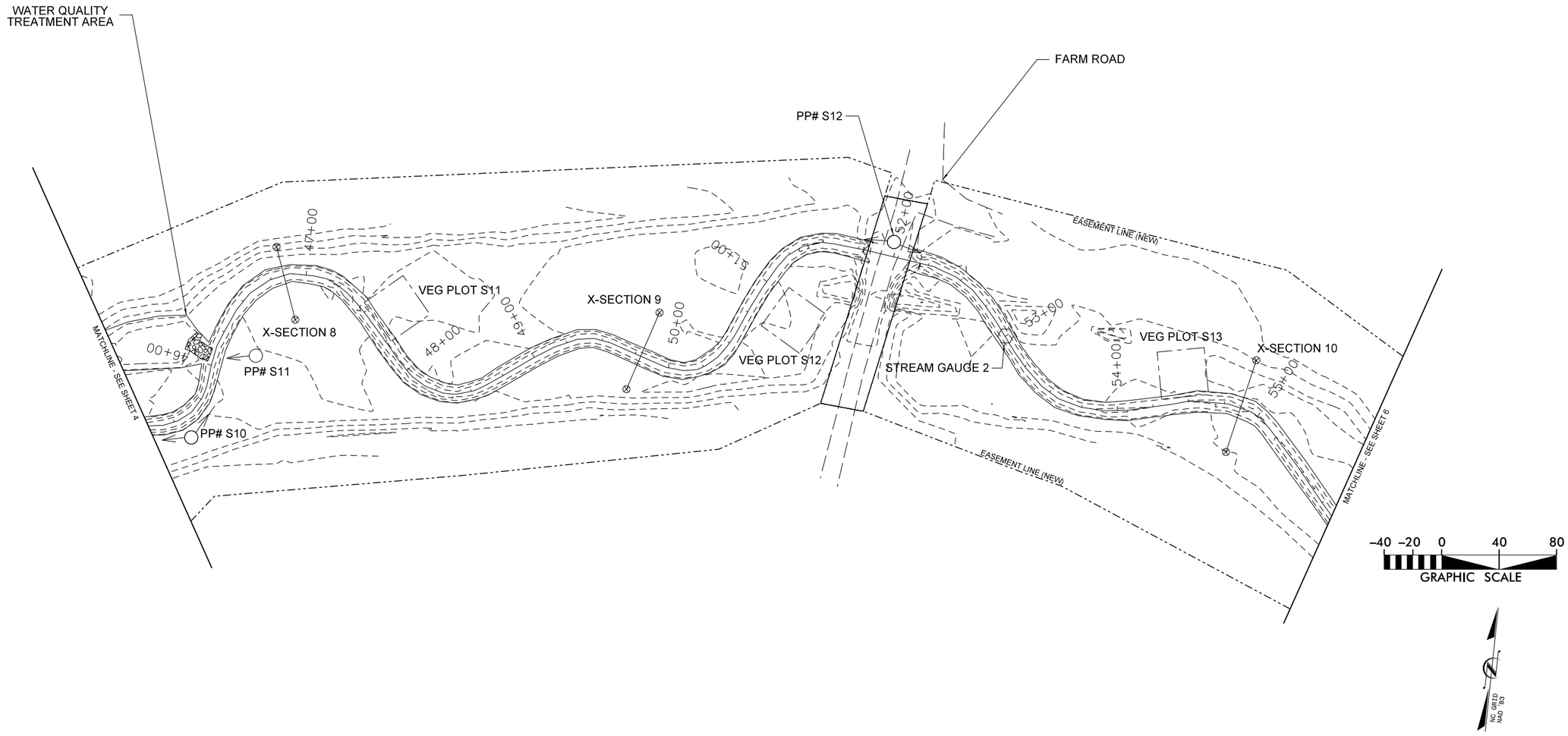
RALEIGH, NORTH CAROLINA 27609

HARRELL SITE
STREAM AND WETLAND RESTORATION
EDGECOMBE CO., NORTH CAROLINA
STATION 33+64 TO STATION 45+31

DATE: DEC 2012
SCALE: 1"=80'

CURRENT CONDITION PLAN VIEW



NO.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

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RALEIGH, NORTH CAROLINA 27609

HARRELL SITE
STREAM AND WETLAND RESTORATION

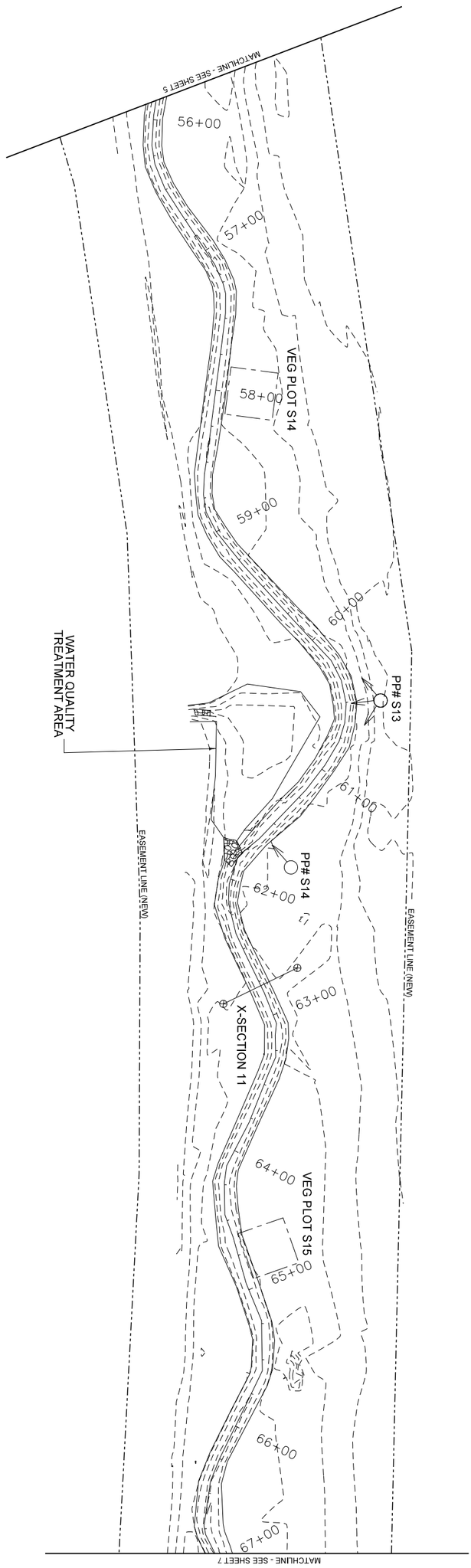
EDGECOMBE CO., NORTH CAROLINA

STATION 45+31 TO STATION 55+86

DATE: DEC 2012

SCALE: 1"=80'

CURRENT CONDITION PLAN VIEW



HARRELL SITE
STREAM AND WETLAND RESTORATION
EDGECOMBE CO., NORTH CAROLINA
STATION 55+86 TO STATION 66+94

KCI ASSOCIATES OF NC
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RALEIGH, NORTH CAROLINA 27609

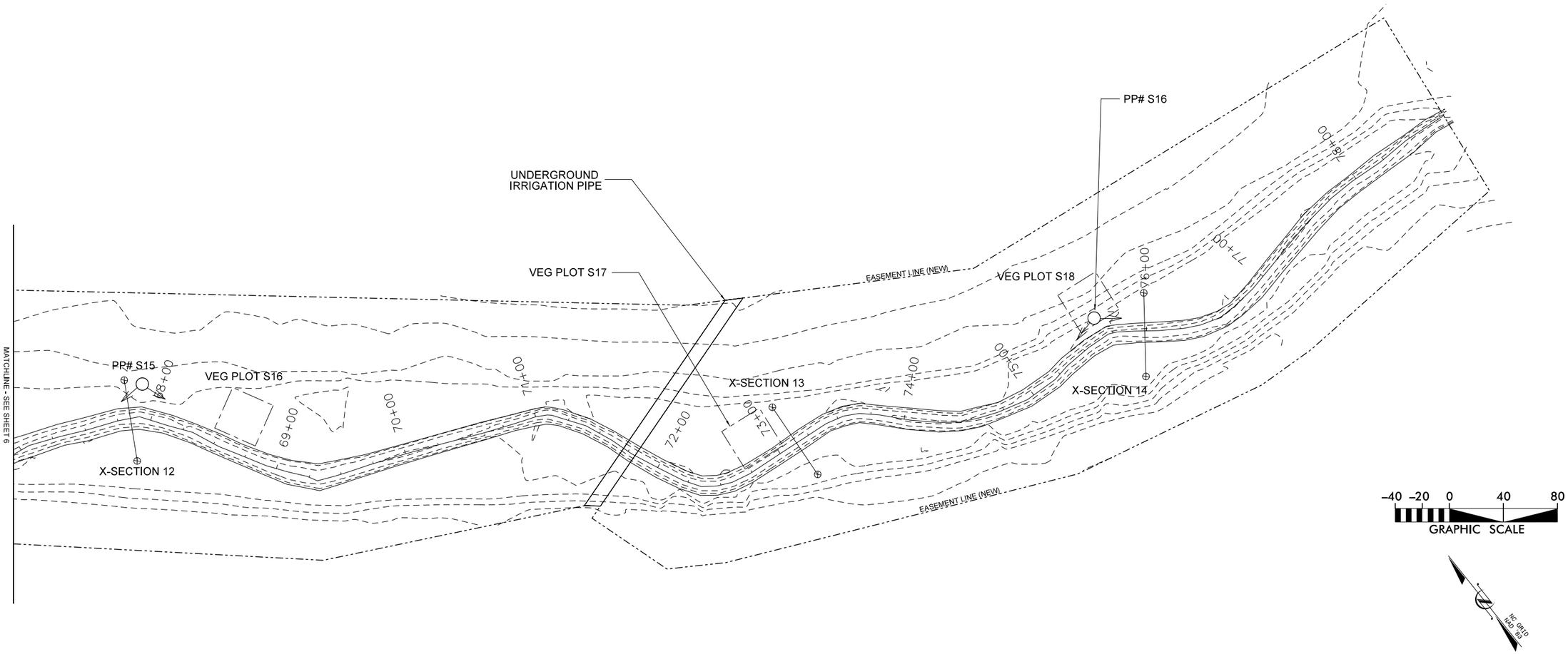
Ecosystem Enhancement PROGRAM

SYM.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

CURRENT CONDITION PLAN VIEW

SHEET 6 OF 7

DATE: DEC 2012
SCALE: 1"=80'



REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement PROGRAM

KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

HARRELL SITE
STREAM AND WETLAND RESTORATION
EDGECOMBE CO., NORTH CAROLINA
STATION 66+94 TO STATION 78+80

DATE: DEC 2012
SCALE: 1"=80'

CURRENT CONDITION PLAN VIEW

SHEET 7 OF 7