City Pond Mitigation Project
Anson County, North Carolina

Year 4 Monitoring Report

Prepared for
Environmental Banc and Exchange, LLC
909 Capability Drive, Suite 3100
Raleigh, NC 27606

Prepared by
WK Dickson and Co., Inc.
720 Corporate Center Drive
Raleigh, NC 27607
(919) 782-0495

And

Ecosystem & Land Trust Monitoring
PO Box 1492
3674 Pine Swamp Road
Sparta, NC 28675

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1.0 SUMMARY

The City Pond Stream Mitigation Project site is located near the town of Wadesboro in Anson County, North Carolina. The project involved the restoration and enhancement of 10,574 linear feet of channelized stream on several unnamed tributaries to City Pond. All restoration is being monitored for five years to document success. Baseline data on stream morphology and vegetation were collected immediately after construction and planting were complete. This information is documented in the As-Built Report completed in 2005. The As-Built survey is included as Appendix A of this report. Information on stream morphology and vegetation will be collected each year and compared to the baseline data and data from previous monitoring years.

This Annual Monitoring Report presents the monitoring data collected during Year 4 at the City Pond Stream Restoration Site. Data collected for 2008 include: monthly crest gauge readings, monthly on-site rain gauge readings, monthly observations of current conditions, as well as annual benthic macroinvertebrate survey, cross sections, digital images, and observations of potential stream stability problems.

The design for the City Pond project involved the restoration of channel dimension, pattern, and profile on eight separate reaches, and the enhancement of dimension and profile on one reach. After construction, it was documented that 9,869 linear feet of stream had been restored, and 705 linear feet of stream had been enhanced.

The data presented in this Annual Monitoring Report is from 3 crest gauges, 20 cross sections, and 3,400 linear feet of longitudinal profile on 8 reaches, as required in the approved Restoration Plan for this site. Digital images were recorded at all 20 cross sections and all in-stream structures that could be located.

The 2008 stream monitoring data documents that little has changed in the stream channel pattern and cross-sectional dimensions since last year's monitoring efforts. Most in-stream structures continue to function as designed. There were minor cases of bed erosion throughout the various reaches. In other areas of the stream, sediment and vegetation has accumulated in the channel bottom. During 2008, the stream channel experienced multiple bankfull events. It was concluded that the site remains on track to achieve the stream success criteria as specified in the Restoration Plan.

Five 0.1 acre monitoring plots were used to measure survival of the planted woody vegetation. The vegetation monitoring documented a range of survival between 500 and 650 stems per acre for 2008. With an average of 568 stems per acre, the site has met the interim vegetation survival criteria of 320 stems per acre after the third growing season. The planted woody vegetation appears vigorous throughout the site.

2.0 INTRODUCTION

2.1 PROJECT DESCRIPTION

The City Pond Stream Restoration Project is located near the town of Wadesboro in Anson County, North Carolina (**Figure 1** & **Figure 2**). The stream systems that historically flowed through the site were channelized and highly incised prior to restoration. The design for the restored streams involved the construction of new meandering channels across the low slope valleys, and restored step pool channels in the higher slope valleys.

The site has a history of pasture and hay production, preceded by row crop production. Ditches were used to increase land use and improve drainage when the land was under crop production. The streams on the project site were channelized, and riparian vegetation was cleared in most locations. Stream and riparian functions on the site had been severely impacted as a result of agricultural conversion.

The project involved the restoration and enhancement of 10,574 linear feet of channelized stream on several unnamed tributaries to City Pond. The project restored 9,869 linear feet of channel dimension, pattern, and profile, and enhanced 705 linear feet of channel dimension and/or profile. **Table 1** shows the as-built lengths and restoration type for each reach. The 2008 monitoring season represents the fourth year of monitoring for this site.

Table 1. Project Mitigation Structure and Objectives

Reach Name	As-Built Length (feet)	Restoration Approach
R1	705	Enhancement I
R2	2,611	Restoration
R3	777	Restoration
S1	734	Restoration
S2	1,150	Restoration
S3	710	Restoration
S4	1,711	Restoration
S5	1,744	Restoration
S6	432	Restoration
Total	**10,574**	

2.2 PROJECT PURPOSE

Monitoring of the City Pond Mitigation Site is required to demonstrate successful mitigation based on the criteria described in the City Pond Mitigation Plan. Both stream and vegetation monitoring are conducted throughout the growing season. Success criteria must be met for five consecutive years. This Annual Report details the results of the stream monitoring for 2008 at the City Pond Stream Mitigation Site.

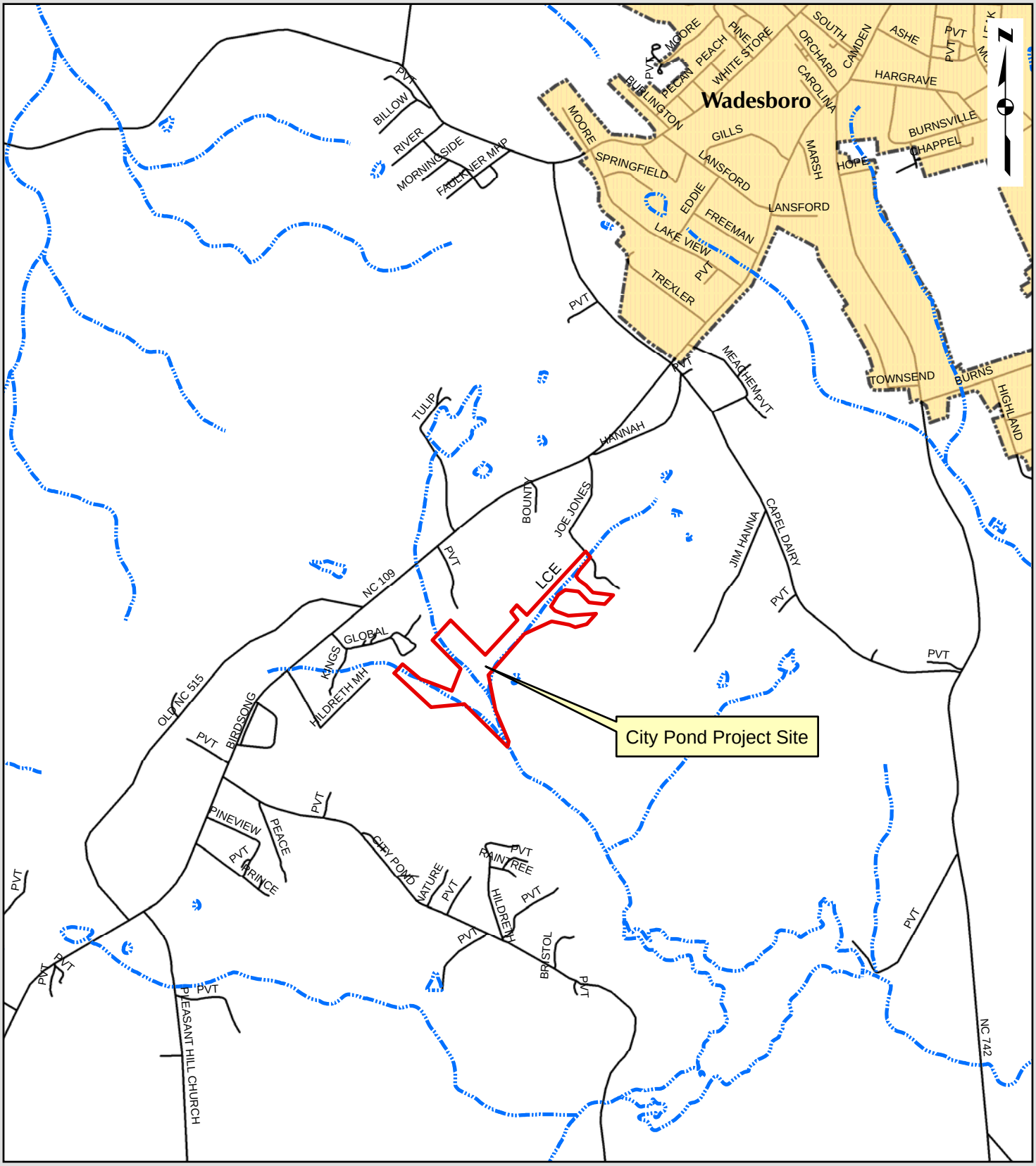

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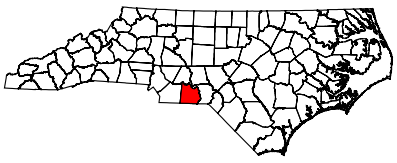
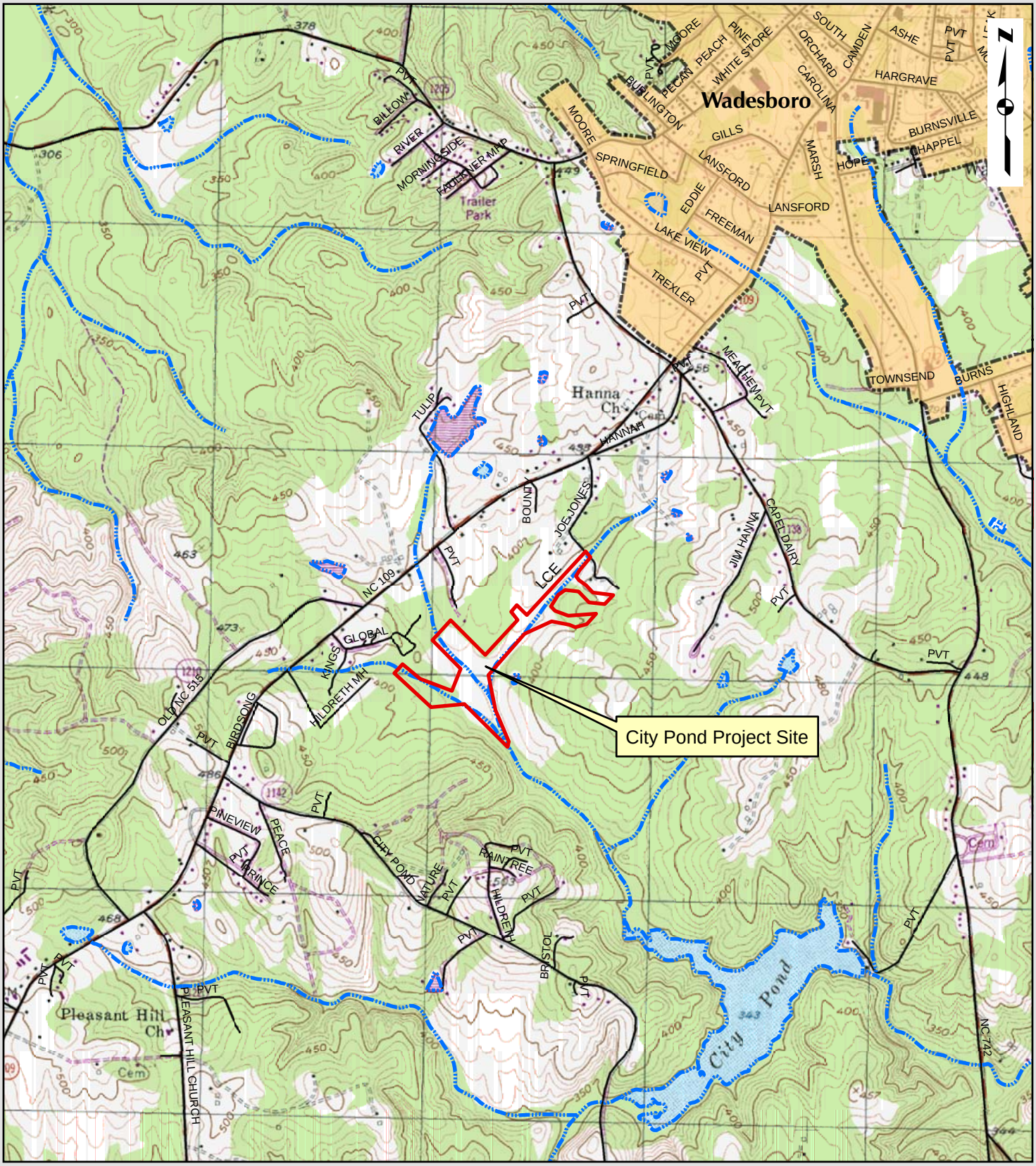
Figure 1.
City Pond Stream Mitigation Site
Project Location Map
Anson County, NC

1 inch equals 2,000 feet

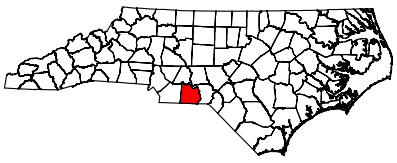




EBX

Figure 2.
City Pond Stream Mitigation Site
USGS Topographic Map
Anson County, NC

1 inch equals 2,000 feet



2.3 PROJECT HISTORY & SCHEDULE

This project was identified by EBX in the spring of 2004. The following table outlines project history and milestones, as well as background information (**Table 2**).

Table 2. Project Activity and Reporting History

Date	Action Performed
November 2004	Construction Began
May 2005	Construction Completed
May 2005	Planting Completed
June 2005	Post Construction Monitoring Gauges Installed
August 2005	As-Built Report Submitted
November 2005	1st Annual Monitoring Report
February 2006	Replanted 3.5 acres with two year old trees
November 2006	2nd Annual Monitoring Report
November 2007	3rd Annual Monitoring Report
November 2008 (Scheduled)	4th Annual Monitoring Report
November 2009 (Scheduled)	5th Annual Monitoring Report

Table 3. Project Contacts

Contact	Firm Information
Project Manager Norton Webster	EBX-Neuse 1, LLC (919) 608-9688
Designer Kevin Tweedy, PE	Buck Engineering PC (919) 463-5488
Monitoring Contractor Daniel Ingram	WK Dickson and Co., Inc (919) 782-0495

3.0 VEGETATION

3.1 VEGETATION SUCCESS CRITERIA

The interim measure of vegetative success for the City Pond Mitigation Plan was the survival of at least 320 3-year-old planted trees per acre at the end of Year 3 of the monitoring period. The final vegetative success criteria will be the survival of 260 5-year-old planted trees per acre at the end of Year 5 of the monitoring period.

Up to 20% of the site species composition may be comprised of volunteers. Remedial action may be required should volunteers (i.e., sweetgum, red maple, etc.) exceed 20% composition.

3.2 DESCRIPTION OF SPECIES AND VEGETATION MONITORING

The following tree species were planted in the riparian buffer:

Table 4. Planted Tree Species

No.	Common Name	Scientific Name	FAC Status
1	Shagbark Hickory	*Carya ovata*	FACU
2	Willow Oak	*Quercus phellos*	FACW-
3	Persimmon	*Diospyrus virginiana*	FAC
4	Green Ash	*Fraxinus pennsylvan.*	FACW
5	Yellow poplar	*Liriodendron tulipifera*	FAC
6	Sycamore	*Platanus occidentalis*	FACW-
7	Water Oak	*Quercus nigra*	FAC
8	American Elm	*Ulmus americana*	FACW
9	Laurel Oak	*Quercus laurifolia*	FACW

The following monitoring protocol was designed to predict vegetative survivability. Five plots were established on the City Pond Mitigation Site, and cover approximately 2% of the site. The vegetation monitoring plots were designed to be 1/10th of an acre in size, or 50 feet x 87 feet dimensionally. The plots were randomly located and randomly oriented within the riparian buffer.

Plot construction involved using metal fence posts at each of the four corners to clearly and permanently establish the area to be sampled. Ropes were then hung connecting all four corners to help in determining if trees close to the plot boundary were inside or outside of the plot. Trees right on the boundary and trees just outside of the boundary that appear to have greater than 50% of their canopy inside the boundary were counted inside the plot. A ten-foot piece of white PVC pipe was placed over the metal post on one corner to facilitate visual location of the site throughout the five-year monitoring period.

All of the planted stems inside the plot were marked with orange flagging and a 3-foot-tall piece of half-inch PVC to distinguish them from any colonizers, and to help in locating them in the future. Each stem was then tagged with a permanent, numbered aluminum tag.

3.3 RESULTS OF VEGETATION MONITORING

Table 5 presents stem counts for each of the monitoring plots. The species ID numbers across the top row correspond to the numbered species listed in Table 4. Each plot is identified down the left column.

Table 5. Results of Vegetation Monitoring

	Species ID Number (from Table 4)										
Plot	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**	**Stems/acre**
CP1	0	20	8	1	4	9	6	11	0	59	590
CP2	0	23	0	1	1	4	0	28	0	57	570
CP3	2	4	27	2	2	8	0	8	0	53	530
CP4	0	8	10	20	0	1	13	13	0	65	650
CP5	0	10	3	5	9	9	6	4	4	50	500

Average Stems/Acre: 568
Range of Stems per Acre: 500-650

Volunteer woody species were observed in most of the vegetation plots, but were deemed too small to tally. If these trees persist into the next growing season and exceed 12 inches tall, they will be flagged and added to the overall stems per acre assessment of the site. Sweetgum (*Liquidambar styraciflua*) is the most common volunteer, though privet (*Ligustrum spp.*), loblolly pine (*Pinus taeda*) and red maple (*Acer rubrum*) was also observed.

3.4 VEGETATION OBSERVATIONS & CONCLUSIONS

This site was planted in bottomland hardwood forest species in March 2005. There were five 0.1-acre vegetation monitoring plots established throughout the planting areas. The 2008 vegetation monitoring revealed that the site has an average tree density of 568 stems per acre. This site met the minimum success interim criteria of 320 trees per acre at the end of year three and is on trajectory to meet the final success criteria of 260 trees per acre by the end of year five.

At the beginning of the 2006 growing season, two-year-old trees were replanted in and around Plot 5 due to exaggerated mortality the previous year. The mortality was attributed to dry conditions shortly after the planting occurred, and to lower quality trees. These trees were part of a separate delivery and were dry at planting time. The two-year-old saplings are generally healthy, and their mortality rate is consistent with that of the site as a whole.

After construction of the mitigation site, a permanent ground cover seed mixture of Virginia wild-rye (*Elymus virginicus*), switch grass (*Panicum virgatum*), and fox sedge (*Carex vulpinoidea*) was broadcast on the site at a rate of 10 pounds per acre. These species are found on the site. Naturally occurring hydrophytic herbaceous vegetation, including cattails (*Typha spp.*), rush (*Juncus effusus*), spikerush (*Eleocharis obtusa*), knotweed (*Polygonum persicaria*), iris (*Iris spp.*), arrow-leaf tearthumb (*Polygonum sagittatum*), and sedge (*Carex spp.*) are observed across the site, particularly in inundated areas. Woolgrass (*Scirpus cyperinus*), an obligate wetland plant, is dominant in the central wetter zone of the site. The presence of these herbaceous wetland plants indicates the presence of wetland hydrology on the site.

There are zones of weedy species occurring on the site, though none seem to be posing any problems for the woody or herbaceous hydrophytic vegetation. The majority of the weedy species are annuals and seem to pose very little threat to survivability onsite. Commonly seen weedy vegetation includes hay, dallisgrass (*Paspalum dilatatum*), dogfennel (*Eupatorium*

capillifolium), broomsedge (*Andropogon spp.*), buttercup (*Ranunculus spp.*) and blackberry (*Rubus spp*.).

4.0 STREAM MONITORING

4.1 STREAM SUCCESS CRITERIA

As stated in the approved Restoration Plan, the stream restoration success criteria for the site includes the following:

- *Bankfull Events:* Two bankfull flow events must be documented within the five-year monitoring period.
- *Cross sections*: There should be little change in as-built cross sections. Cross sections shall be classified using the Rosgen stream classification method and all monitored cross sections should fall within the quantitative parameters defined for "E" or "C" type channels. Cross section data will be collected annually.
- *Longitudinal Profile*: The longitudinal profiles should show that the bedform features are remaining stable, i.e. they are not aggrading or degrading. Bedforms observed should be consistent with those observed in "E" or "C" type channels. Profile data will be collected in monitoring Years 1, 3, 4, and 5.
- *Photo Reference Stations*: Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures. Photos will be taken annually at permanent cross sections and grade control structures.
- *Benthic Macroinvertebrate Sampling*: Benthic macroinvertebrates will be sampled annually in monitoring years 1, 2, and 3. Benthic macroinvertebrate samples will be identified, and a tolerance value will be calculated.

4.2 STREAM MORPHOLOGY MONITORING PLAN

To document the stated success criteria, the following monitoring program was instituted following completion of construction on the City Pond Site:

Benthic Macroinvertebrates: Benthic macroinvertebrate data will be collected from the reference reach (Beaverdam Branch) and within the project reach. Year 3 post-restoration sampling was done in early 2008. Sample collections follow protocols described in the standard operating procedures of the Biological Assessment Unit of the NC Division of Water Quality. The Qual-4 collection method is used for the collection of macroinvertebrate samples. The metrics to be calculated include total and EPT taxa richness, EPT abundance, and biotic index values.

4.2.1 Cross Sections

According to the As-Built Report written in August 2005, 20 cross sections are to be monitored along the restored tributaries R2, R3, S3, S4, S5, and S6. Locations of these cross sections are specified in **Figure 3**. Each cross section was marked on both banks with permanent pins to establish the exact transect used. Permanent cross section pins were surveyed and located relative to a common benchmark to facilitate easy comparison of year-to-year data. The annual cross section surveys include points measured at all breaks in slope, including floodplain, top of bank, bankfull, inner berm, edge of water, and thalweg. In addition, any fluvial features present will be documented. Permanent cross sections for 2008 (Year 4) were surveyed in July 2008. Data and photos of each cross section are included as **Appendix B**.

4.2.2 Longitudinal Profile

Longitudinal profile will be surveyed in years one, three, four, and five of the five-year monitoring period. The profile will be conducted for a length of restored channel of at least 30% of the total restoration length or 3,000 feet, whichever is greater. Features measured will include thalweg, inverts of located stream structures, water surface, and top of bank on either side of the channel. The longitudinal survey of 3,400 linear feet of stream channel was conducted for 2008 (Year 4) in July of 2008.

4.2.3 Hydrology

Three crest gauges were installed on the site to document bankfull events. These gauges record the highest out-of-bank flow event that occurs each month and are checked in the last week of every month during the growing season. The gauges are located on the downstream portions of R1, R2, and S4 (**Figure 3**).

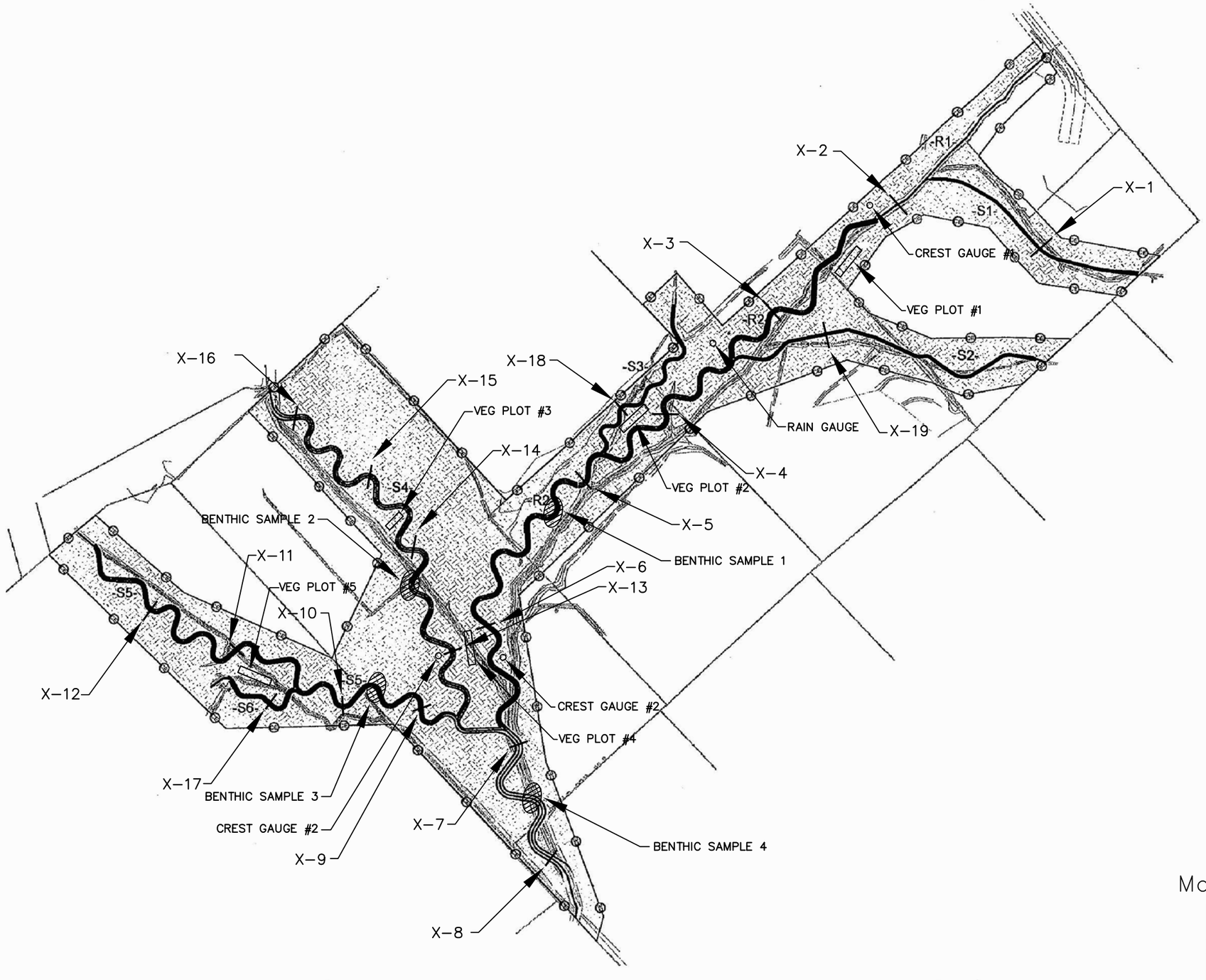
4.2.4 Photo Reference Stations

Photographs are used to visually document restoration success. Although specific photo points are not set up across the City Pond site, photos were taken at every located structure. Reference photos are taken at each permanent cross section from both stream banks, as well as facing upstream and downstream. The survey tape is centered in the photographs of the bank, and the water line is located in the lower edge of the frame with as much of the bank as possible included in each photo. Problem area photos and general photos of the site are located in **Appendix D**.

4.3 STREAM MORPHOLOGY MONITORING RESULTS

4.3.1 Cross Sections

The cross sections were surveyed during the monitoring set-up, Year 1, Year 2, Year 3, and in July 2008 for Year 4. The baseline data has been compared with the Year 1 and Year 2 monitoring data in **Appendix B**. Also included in Appendix B are the surveyed cross sections for Year 3 and Year 4. Compared to the documented data from the Year 3 survey, the Year 4 channel cross sections showed that overall stream dimensions remained stable during this fourth growing season. Some localized areas of bed scour and/or aggradation were noted; however, these adjustments are common and indicate a movement toward greater stability. There is very little difference between the baseline cross sections, and Years 1-4 cross sections.



City Pond Monitoring Overview

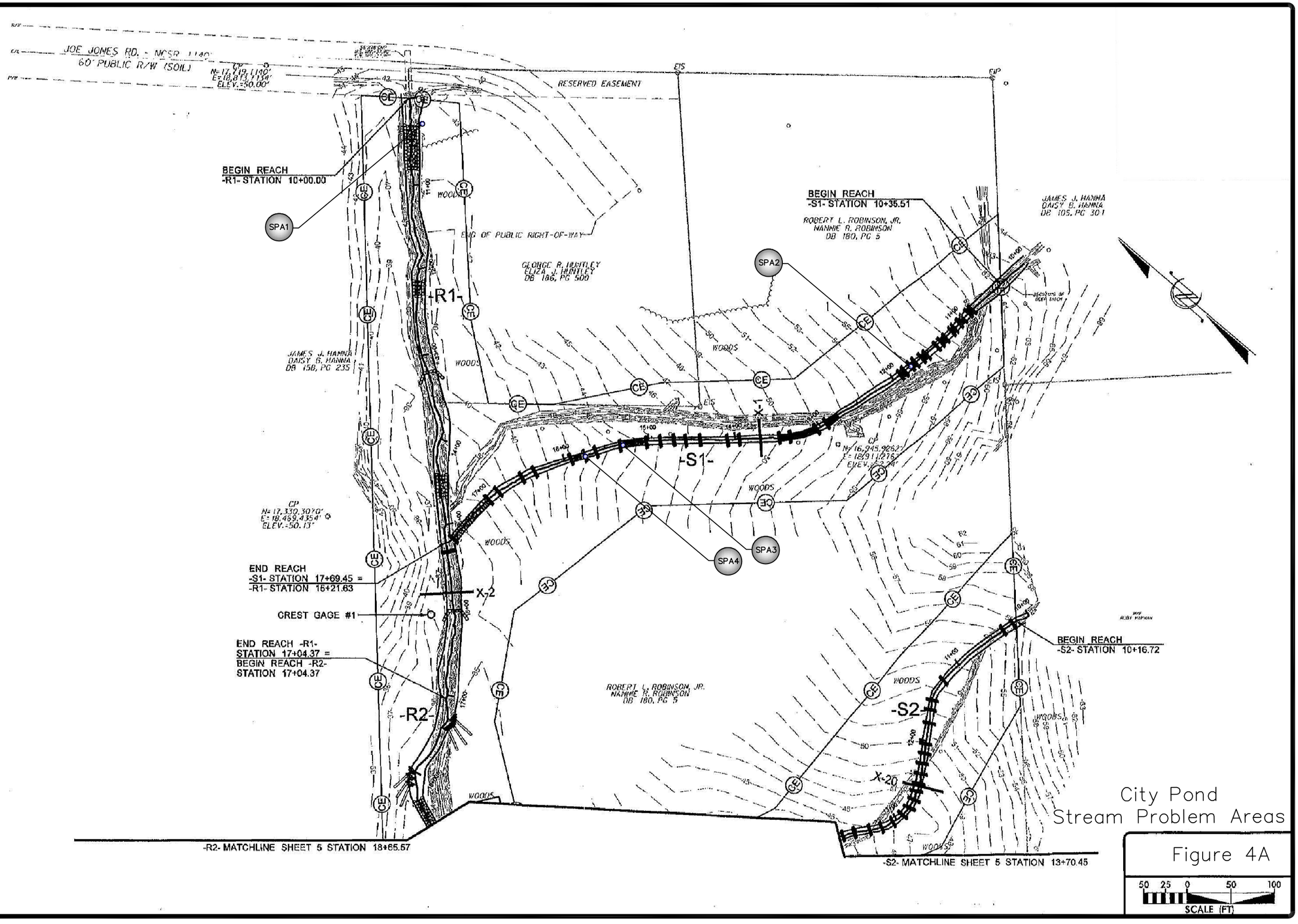
Figure 3

4.3.2 Longitudinal Profile

A longitudinal profile survey was conducted along four separate reaches of the restoration project, totaling approximately 3,400 linear feet. Survey was conducted in reach R2 from STA 27+50 (XS 4) to STA 39+50 (XS 6), in reach R3 from STA 44+00 (XS 7) to STA 49+00 (XS 8), in reach S4 from STA 15+50 (XS 13) to STA 23+50 (XS 15), and in reach S5 from STA 14+00 (XS 10) to STA 23+00 (XS 12). The longitudinal profile information documents the elevations and locations of known streambed features and in-stream grade control structures according to the As-Built survey plans, as shown in Appendix A. The profile and cross sections show that there has been very little adjustment to stream profile or dimension since construction. **Table 6** summarizes stream areas requiring observation. **Figures 4a-4e** show the locations of the stream areas that require observation.

Table 6. Stream Areas Requiring Observation

ID	Station	Feature	Problem	Severity	Recommended Action
SPA1	R1 10+20	Culvert	Left bank erosion at culvert outlet	Moderate	Monitor
SPA2	S1 11+80	Log weir	Erosion US of structure	Minor	Monitor
SPA3	S1 15+30	Log weir	Headcut	Minor	Monitor
SPA4	S1 15+80	Log weir	Erosion, potential problem	Minor	Monitor
SPA5	S5 18+50	Left bank	Erosion behind matting	Minor	None
SPA6	R2 23+90	Left bank	Undercut, approx. 15' long	Moderate	Monitor
SPA7	R2 34+50	Right bank	Erosion behind matting	Minor	None
SPA8	R3 47+80	Left bank	Erosion	Minor	Monitor
SPA9	R3 48+50	Floodplain	Lack of vegetation on right bank	Moderate	None
SPA10	S3 13+20	Left bank	Erosion behind matting	Heavy	Monitor


JOE JONES RD. - NCSR 1140
60' PUBLIC R/W (SOIL)
CP
N=17,419,1180'
E=18,815,1158'
ELEV.=50.00'
RESERVED EASEMENT
EIS
EIP
BEGIN REACH
-R1- STATION 10+00.00
SPA1
WOODS
END OF PUBLIC RIGHT-OF-WAY
GEORGE R. HUNTLEY
ELIZA J. HUNTLEY
DB 186, PG 500
-R1-
JAMES J. HANNA
DAISY B. HANNA
DB 158, PG 235
BEGIN REACH
-S1- STATION 10+35.51
ROBERT L. ROBINSON, JR.
NANNIE R. ROBINSON
DB 180, PG 5
SPA2
JAMES J. HANNA
DAISY B. HANNA
DB 105, PG 301
-S1-
CP
N=16,945,926.2'
E=18,911,878.2'
ELEV.=52.24'
SPA3
SPA4
CP
N=17,330,307.0'
E=18,469,435.4'
ELEV.=50.13'
END REACH
-S1- STATION 17+69.45 =
-R1- STATION 16+21.63
X-2
CREST GAGE #1
END REACH -R1-
STATION 17+04.37 =
BEGIN REACH -R2-
STATION 17+04.37
-R2-
ROBERT L. ROBINSON, JR.
NANNIE R. ROBINSON
DB 180, PG 5
BEGIN REACH
-S2- STATION 10+16.72
-S2-
X-20
-R2- MATCHLINE SHEET 5 STATION 18+65.57
-S2- MATCHLINE SHEET 5 STATION 13+70.45
City Pond
Stream Problem Areas
Figure 4A
50 25 0 50 100
SCALE (FT)

-R2- MATCHLINE SHEET 4 STATION 18+65.57

-S2- MATCHLINE SHEET 4 STATION 13+70.45

VEG. PLOT #1

BEGIN REACH
-S2A- STATION 10+00.00

END REACH
-S2A- STATION 11+30.98

-S2-

-S2A-

-R2-

X-19

X-3

SPA5

BEGIN REACH
-S3- STATION 9+66.11

RAIN GAGE

END REACH
-S2- STATION 20+36.05 =
-R2- STATION 24+37.20

-R2-

-S3-

SPA9

VEG. PLOT #2

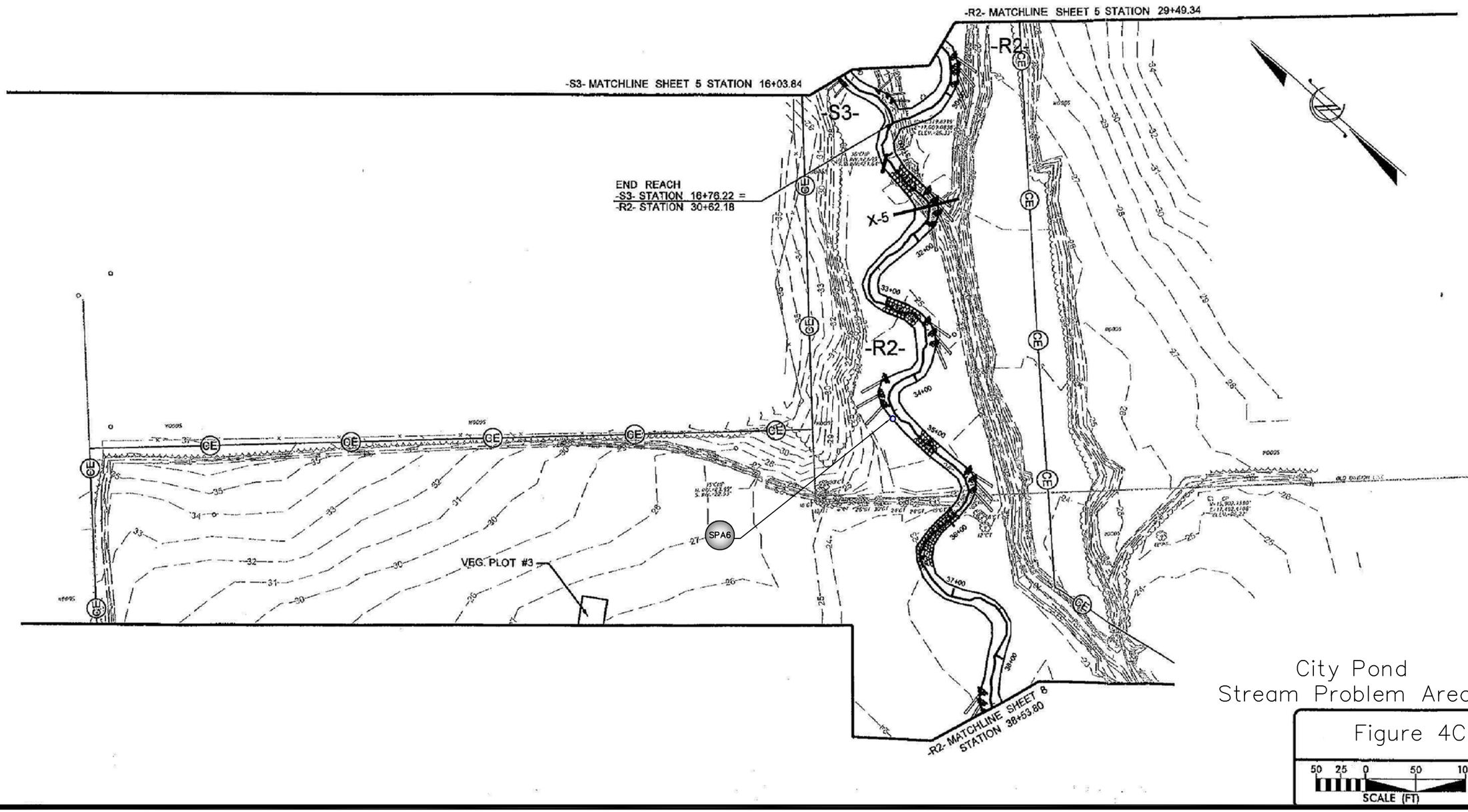
-R2- MATCHLINE SHEET 6 STATION 29+49.34

-S3- MATCHLINE SHEET 6 STATION 16+03.84

City Pond
Stream Problem Areas

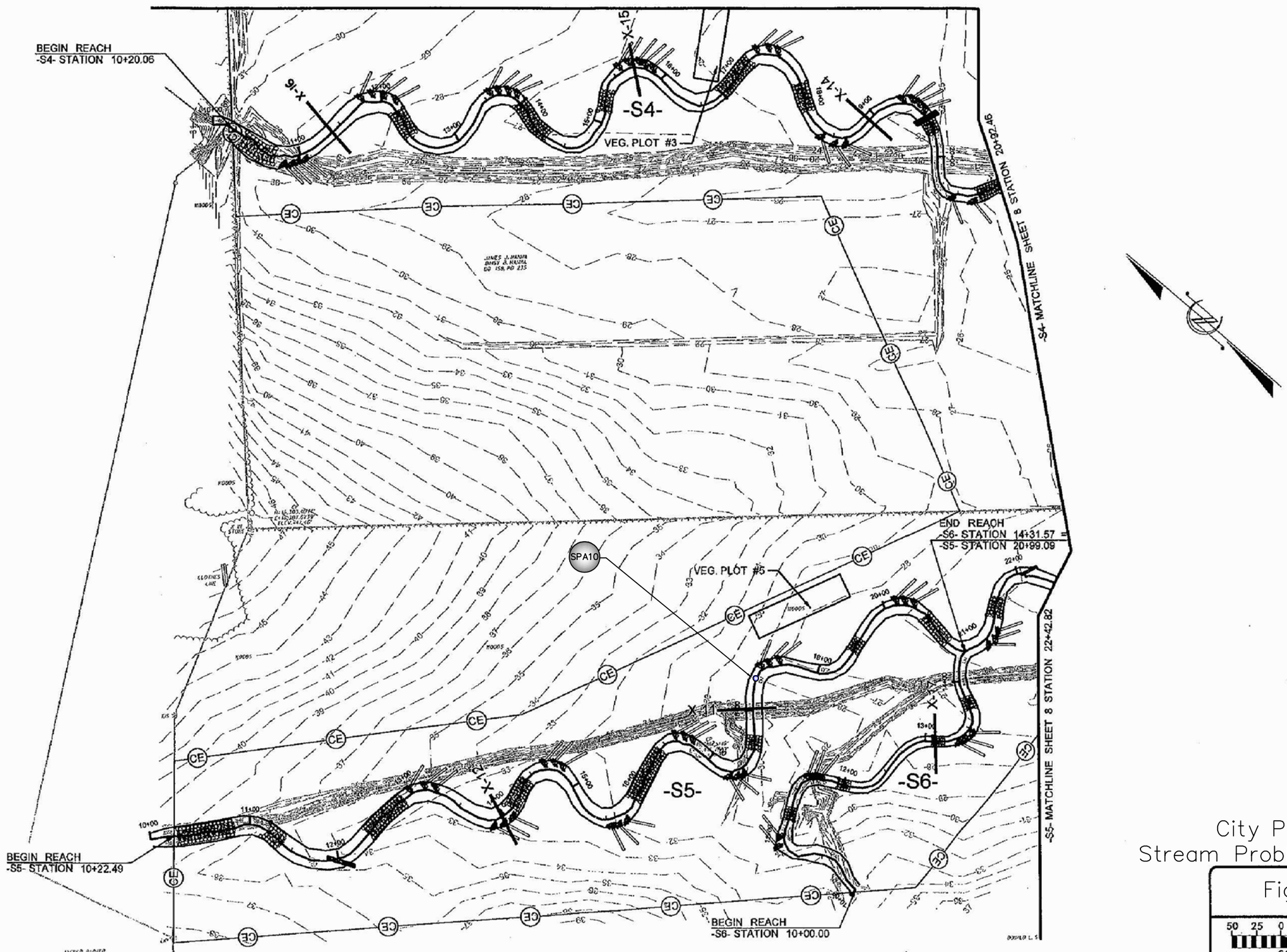
Figure 4B

50 25 0 50 100
SCALE (FT)



City Pond
Stream Problem Areas

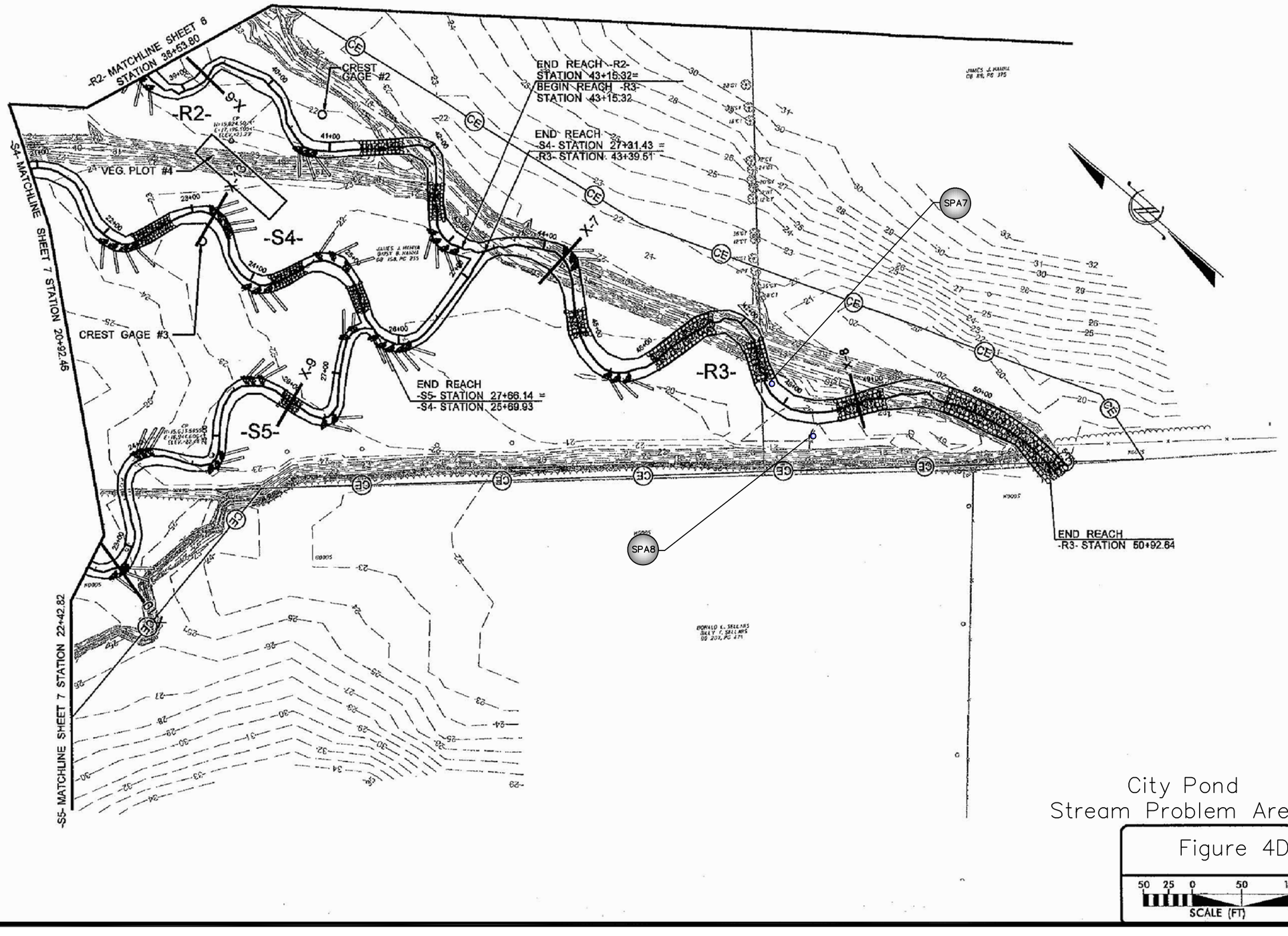
Figure 4C



City Pond
Stream Problem Areas

Figure 4E

50 25 0 50 100
SCALE (FT)



City Pond
Stream Problem Areas

Figure 4D

50 25 0 50 100
SCALE (FT)

4.3.3 Hydrology

During the 2008 monitoring season, three crest gauges were monitored to determine if there were any out-of-bank flow events in the City Pond stream channel. Between the months of February and September, six bankfull events have been documented during the monthly onsite visits. Crest gauges 1 (in Reach R1) and 3 (in Reach S4) each registered 2 out-of-bank flows, while crest gauge 2 (Reach R2) registered six out-of-bank flows. The largest stream flow documented for Year 4 by the onsite crest gauges was a flow that occurred during July and was 3.5 feet above the bankfull stage. Based on observations of ponded water, debris lines, and sediment deposition on the floodplain, it has been determined that this bankfull event spread over much of the riparian areas adjacent to the stream. The hydrology success criteria have already been satisfied by bankfull events in previous monitoring years.

Table 7. Crest Gauge Data

Month Recorded	Crest Gauge 1	Crest Gauge 2	Crest Gauge 3
January	---	---	---
February	0.00	0.60	0.00
March	0.00	0.65	0.00
April	0.00	1.05	0.20
May	0.00	0.00	0.00
June	0.00	0.00	0.00
July	0.00	3.50	0.00
August	0.40	1.50	0.70
September	0.70	2.30	0.00
October	0.00	0.00	0.00
November	---	---	---
December	---	---	---

Table 8. Summary of Morphologic Monitoring Parameters

Parameter	Year 4 Reach R1	Year 4 Reach R2	Year 4 Reach R3	Year 4 Reach S1	Year 4 Reach S2	Year 4 Reach S3	Year 4 Reach S4	Year 4 Reach S5	Year 4 Reach S6
Bankfull Xsec Area, Abkf (sq ft)	15.4	9.7	9.9	3.8	2.5	14.2	9.9	14.7	5.3
Avg. Bankfull Width, Wbkf (ft)	9.5	11.6	9.0	7.6	6.5	10.1	14.0	12.3	8.8
Bankfull W/D	5.8	13.9	8.3	15.0	16.9	7.2	20.9	10.4	14.6
Bankfull Mean Depth, Dbkf (ft)	1.6	0.8	1.1	0.5	0.4	1.4	0.8	1.2	0.6
Bankfull Max Depth, Dmax (ft)	2.9	1.5	1.9	1.0	0.9	2.4	1.4	2.1	0.9

4.3.4 Climate Data

In 2008 the City Pond restoration site experienced drought conditions consistent with state-wide trends, which were similar to those that occurred in 2007. Precipitation levels at the Wadesboro

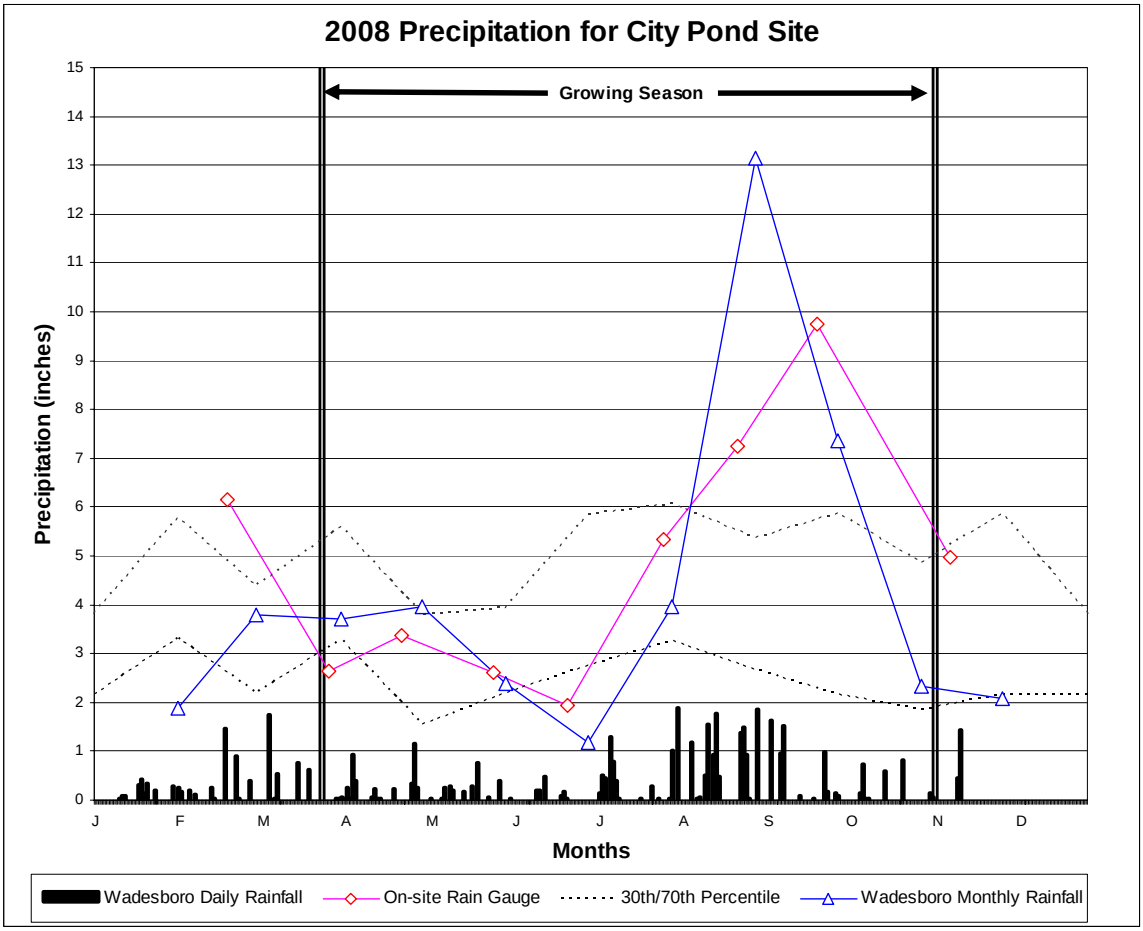
monitoring station near the City Pond site fell within the normal range for much of the spring and summer. In June, the precipitation level fell below the normal range, to 1.19 inches (**Figure 5** and **Table 9**). During July, the Wadesboro station received 3.95 inches—1.31 inches below the historic monthly average. Above average rainfall in August and September reversed the rainfall deficit that had been accumulating from January through July.

Table 9. County and On-site Rainfall Data

Month	Average	Normal Limits		Wadesboro Precipitation	On-Site Precipitation
		30 Percent	70 Percent		
January	4.66	3.31	5.78	1.88	---
February	3.56	2.18	4.37	3.79	6.15
March	4.61	3.28	5.58	3.71	2.63
April	2.94	1.54	3.78	3.96	3.38
May	3.44	2.18	3.93	2.39	2.60
June	4.56	2.74	5.84	1.19	1.95
July	5.26	3.26	6.06	3.95	5.35
August	4.41	2.67	5.36	13.16	7.25
September	4.25	2.15	5.87	7.36	9.74
October	3.66	1.85	4.87	2.33	4.98
November	3.1	2.14	3.86	---	---
December	3.28	2.16	3.83	---	---
Total	**47.73**	**29.46**	**59.13**	**43.72**	**44.03**

October on-site rainfall data includes data collected through the end of the growing season

Figure 5. 2008 Precipitation for City Pond



4.4 BENTHIC MACROINVERTEBRATE SURVEY RESULTS

On both the R and S streams, there was a distinct downstream decline in tolerance value of the organisms, with higher EPT taxa richness and lower biotic index values at the upstream sampling sites. The 2007/2008 drought had a severe affect, producing low total taxa richness at all sampling sites (8-12 taxa). Similar results had been seen in 2007, with only 10-13 taxa per site. There was a conspicuous absence of two very common stream taxa: *Cheumatopsyche* and *Stenonema modestum*. Flow dependent organisms (esp. *Simuliidae*) were present at the downstream sites, but more time would be required to establish a normal stream fauna.

Table 10. Macroinvertebrate Data

Taxon		**Tolerance Value**	**Count**			
Order	EPHEMEROPTERA		R2	R3	S4	S5
Genus Species	*Paraleptophlebia sp*	0.9	2	-	1	-
Genus Species	*Plauditus dubius gr*	5.8	6	4	-	3
Genus Species	*Siphlonurus sp*	5.8	2	-	-	-
Genus Species	*Caenis sp*	7.4	-	-	1	-
Order	PLECOPTERA					
Genus Species	*Perlesta sp*	4.7	23	16	27	2

Genus Species	*Amphinemura sp*	3.3	12	-	3	-
Order	TRICHOPTERA					
Genus Species	*Neophylax oligius*	2.2	1	-	-	-
Order	COLEOPTERA					
Genus Species	*Neoporus mellitus gr*	4.0	4	-	3	-
Genus Species	*Peltodytes spp*	8.7	-	4	-	-
Order	DIPTERA: MISC					
Genus Species	*Simulium sp*	6.0	3	18	-	11
Order	DIPTEA					
Family	CHIRONOMIDAE					
Genus Species	*Conchapelopia group*	8.4	5	2	3	2
Genus Species	*Zavrelimyia sp*	9.1	-	-	-	2
Genus Species	*Orthocladius dorenus*	5.6	-	3	1	-
Genus Species	*O. robacki*	6.6	-	1	-	-
Genus Species	*O. nigritus*	4.6	-	1	-	-
Genus Species	*Cricotopus bicinctus*	8.5	-	3	1	-
Genus Species	*Psectrocladius sordidellus gr*	-	-	-	2	-
Genus Species	*Parachironomus sp*	9.4	-	-	2	-
Order	OLIGOCHAETA					
Genus Species	*Lumbriiculidae*	7	7	-	-	-
Genus Species	*Megadriles*	9	-	-	-	1
Genus Species	*Limnodrilus sp*	9.5	-	-	1	-
Order	CRUSTACEA					
Genus Species	*Crangonyx spp*	7.9	11	-	1	-
Genus Species	*Procambarus sp*	7	-	1	-	1
Order	MOLLUSCA					
Genus Species	*Physella sp*	8.8	-	3	1	-
Genus Species	*Pseudosuccinea columella*	7.7	-	1	-	-
Genus Species	*Menetus dilatatus*	8.2	-	-	-	1
Order	OTHER					
Genus Species	*Corixidae (Hemiptera)*	9	-	1	-	-
	Total Taxa Richness		12	12	12	8
	EPT Taxa Richness		6	2	4	2
	Number of organisms		77	55	46	23
	NC Biotic Index		5.6	6.3	5.7	6.6
	BI rating (not a bioclassification)		Good	Good-Fair	Good-Fair	Fair

4.5 STREAM CONCLUSIONS

In-stream structures installed within the channel include constructed riffles, cross vanes, log vanes, log weirs, root wads, and step-pools. Visual observations of structures throughout the 2008 growing season indicated that most structures are functioning as designed. Three separate log weirs on reach S1 were undercutting and allowing water to flow underneath. Headcuts have started to form in various spots in S1 as well as erosion along banks just downstream of log weir structures. There are several other areas of minor bank erosion throughout the rest of the project due to improperly installed coir matting and low vegetation density. Many of these banks appear to be stabilizing and no immediate action is required. The banks will be monitored to ensure that they remain stable.

5.0 CONCLUSIONS AND RECOMMENDATIONS

- Data collected during monitoring Year 4 and observations of conditions at the site indicate that the project continues to be successful. The stream morphology is generally stable. Several in-stream structures are experiencing slight scour, but appear to still be functioning properly. Some siltation is occurring throughout the various reaches, resulting in vegetation growth in the channel. These vegetated areas are accumulating more sediment which is causing slight downcutting to either side of these mid-channel bars. It was concluded that the site continues to be on track to achieve the stream success criteria specified in the Restoration Plan.

- Vegetation monitoring efforts have documented the average number of stems per acre on site to be 568, which is a survival rate of 90% based on the initial planting count of 632 stems per acre. The vegetation survivability is acceptable and the final vegetative success criteria should be met for the end of the fifth growing season.

- On both the R and S streams, there was a distinct downstream decline in water and/or habitat quality, with higher EPT taxa richness and lower biotic index values at the upstream sites. The 2007/2008 drought had a severe affect, producing low total taxa richness at all sampling sites (8-12 taxa).

- Monitoring of stream and vegetation will continue through the 2009 season (Year 5).

APPENDIX A

As-Built Survey

2/26/03

PROJECT REFERENCE NO.	SHEET NO.
0166R	5

PROJECT ENGINEER

THIS DOCUMENT ORIGINALLY ISSUED AND SEALED BY:

KEVIN L. TWEEDY
027337
NOVEMBER 22, 2004

THIS MEDIA SHALL NOT BE CONSIDERED A CERTIFIED DOCUMENT

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

-R2- MATCHLINE SHEET 4 STATION 18+65.57

-S2- MATCHLINE SHEET 4 STATION 13+70.45

VEG. PLOT #1

BEGIN REACH
-S2A- STATION 10+00.00

END REACH
-S2A- STATION 11+30.98

-S2-

-S2A-

-R2-

X-19

X-3

JAMES J. HARRIS
DAISY B. HARRIS
DB 158, PG 235

JAMES J. HARRIS
DB 86, PG 505

JAMES J. HARRIS
DB 105, PG 501

BEGIN REACH
-S3- STATION 9+66.11

RAIN GAGE

END REACH
-S2- STATION 20+36.05 =
-R2- STATION 24+37.20

-S3-

-R2-

X-4

X-18

OLD DIVISION LINE

JAMES J. HARRIS
DB 294, PG 167

JAMES J. HARRIS
DAISY B. HARRIS
DB 126, PG 439

GEORGIA WAYNE
AND OTHERS
DB 235, PG 1

VEG. PLOT #2

-R2- MATCHLINE SHEET 6 STATION 29+49.34

-S3- MATCHLINE SHEET 6 STATION 16+03.84

AS - BUILT PLAN

50 25 0 50 100
SCALE (FT)

10/18/2005
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PROJECT REFERENCE NO.	SHEET NO.
0166R	6

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8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

-R2- MATCHLINE SHEET 5 STATION 29+49.34

-S3- MATCHLINE SHEET 5 STATION 16+03.84

END REACH
-S3- STATION 16+76.22 =
-R2- STATION 30+62.18

VEG. PLOT #3

-R2- MATCHLINE SHEET 8
STATION 38+53.80

AS - BUILT PLAN

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SCALE (FT)

2/25/03

10/18/2005
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PROJECT REFERENCE NO.	SHEET NO.
0166R	7

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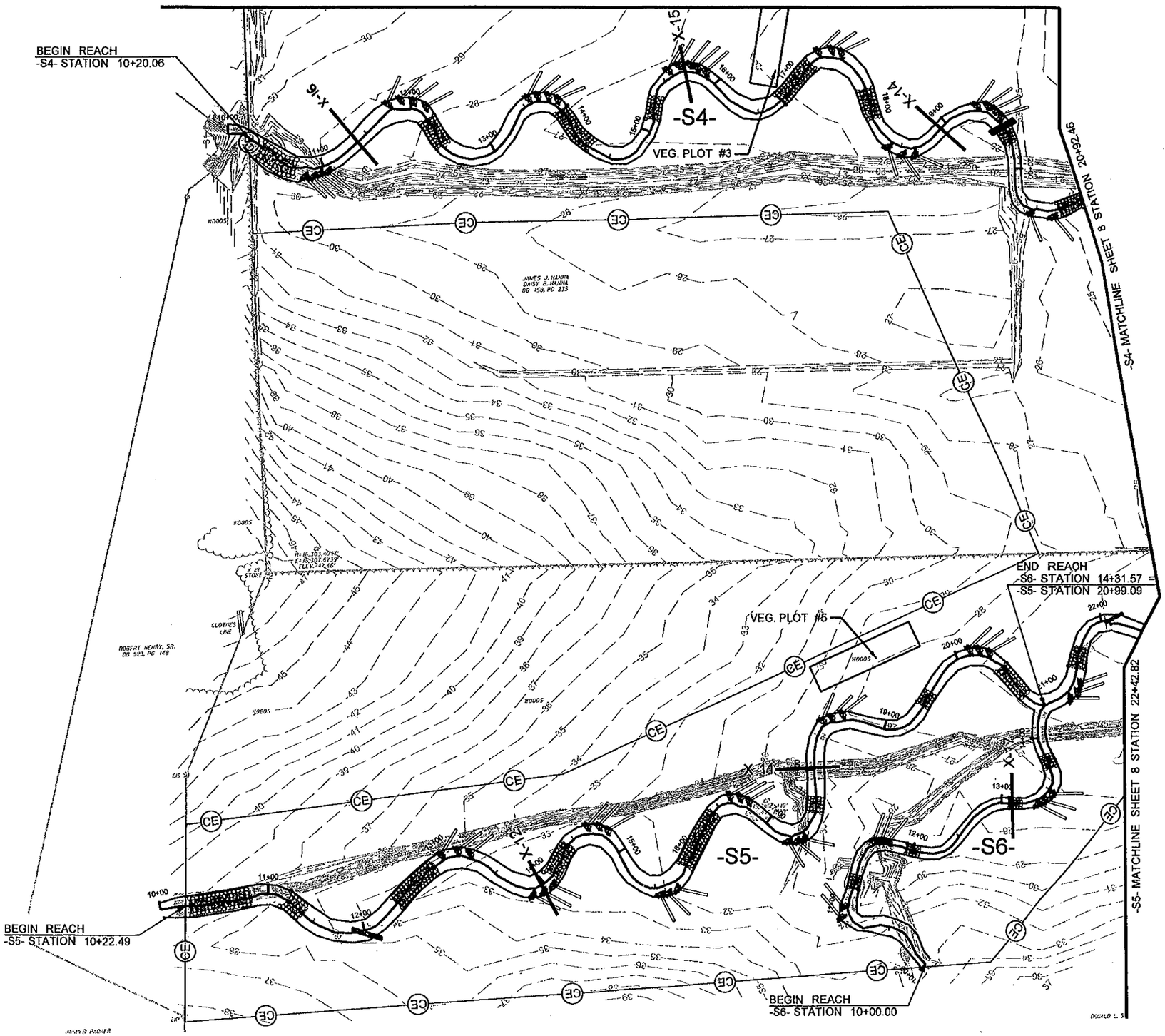
6000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490



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PROJECT REFERENCE NO.	SHEET NO.
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Cary, North Carolina 27511
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Fax: 919-463-5490

-R2- MATCHLINE SHEET 6 STATION 38+53.80

-S4- MATCHLINE SHEET 7 STATION 20+92.46

-S5- MATCHLINE SHEET 7 STATION 22+42.82

-R2-

-S4-

-S5-

-R3-

CREST GAGE #2

CREST GAGE #3

VEG. PLOT #4

END REACH -R2- STATION 43+15.32= BEGIN REACH -R3- STATION 43+15.32

END REACH -S4- STATION 27+31.43 = -R3- STATION 43+39.51

END REACH -S5- STATION 27+66.14 = -S4- STATION 25+69.93

END REACH -R3- STATION 50+92.64

JAMES J. HARRIS DAISY B. HARRIS DB 158, PG 255

DONALD L. SELLARS SKEET T. SELLARS DB 207, PG 874

JAMES J. HARRIS DB 89, PG 375

AS - BUILT PLAN

50 25 0 50 100
SCALE (FT)

10/18/2005
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2/25/03

VEGETATION SELECTION

TREES

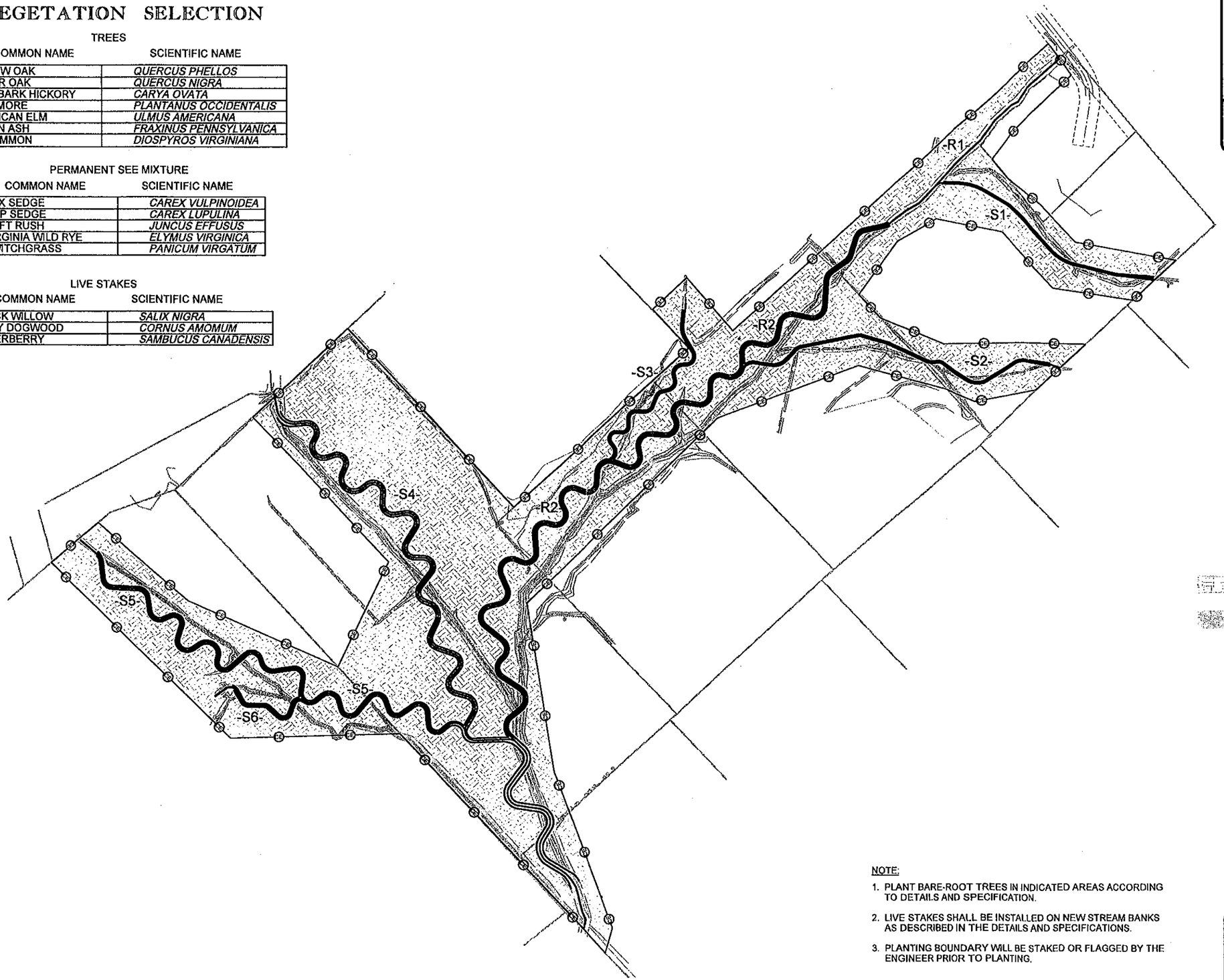
COMMON NAME	SCIENTIFIC NAME
WILLOW OAK	*QUERCUS PHELLOS*
WATER OAK	*QUERCUS NIGRA*
SHAGBARK HICKORY	*CARYA OVATA*
SYCAMORE	*PLANTANUS OCCIDENTALIS*
AMERICAN ELM	*ULMUS AMERICANA*
GREEN ASH	*FRAXINUS PENNSYLVANICA*
PERSIMMON	*DIOSPYROS VIRGINIANA*

PERMANENT SEE MIXTURE

COMMON NAME	SCIENTIFIC NAME
FOX SEDGE	*CAREX VULPINOIDEA*
HOP SEDGE	*CAREX LUPULINA*
SOFT RUSH	*JUNCUS EFFUSUS*
VIRGINIA WILD RYE	*ELYMUS VIRGINICA*
SWITCHGRASS	*PANICUM VIRGATUM*

LIVE STAKES

COMMON NAME	SCIENTIFIC NAME
BLACK WILLOW	*SALIX NIGRA*
SILKY DOGWOOD	*CORNUS AMOMUM*
ELDERBERRY	*SAMBUCUS CANADENSIS*



NAD 83

BARE ROOT PLANTING BOUNDARY

EXISTING CHANNEL FILL BOUNDARY

NOTE:

1. PLANT BARE-ROOT TREES IN INDICATED AREAS ACCORDING TO DETAILS AND SPECIFICATION.
2. LIVE STAKES SHALL BE INSTALLED ON NEW STREAM BANKS AS DESCRIBED IN THE DETAILS AND SPECIFICATIONS.
3. PLANTING BOUNDARY WILL BE STAKED OR FLAGGED BY THE ENGINEER PRIOR TO PLANTING.

REVEGETATION PLAN

150 75 0 150 200
SCALE (FT)

PROJECT REFERENCE NO.	SHEET NO.
0166R	13

PROJECT ENGINEER

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Cary, North Carolina 27511
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Fax: 919-463-5490

2/26/03

10/20/2005
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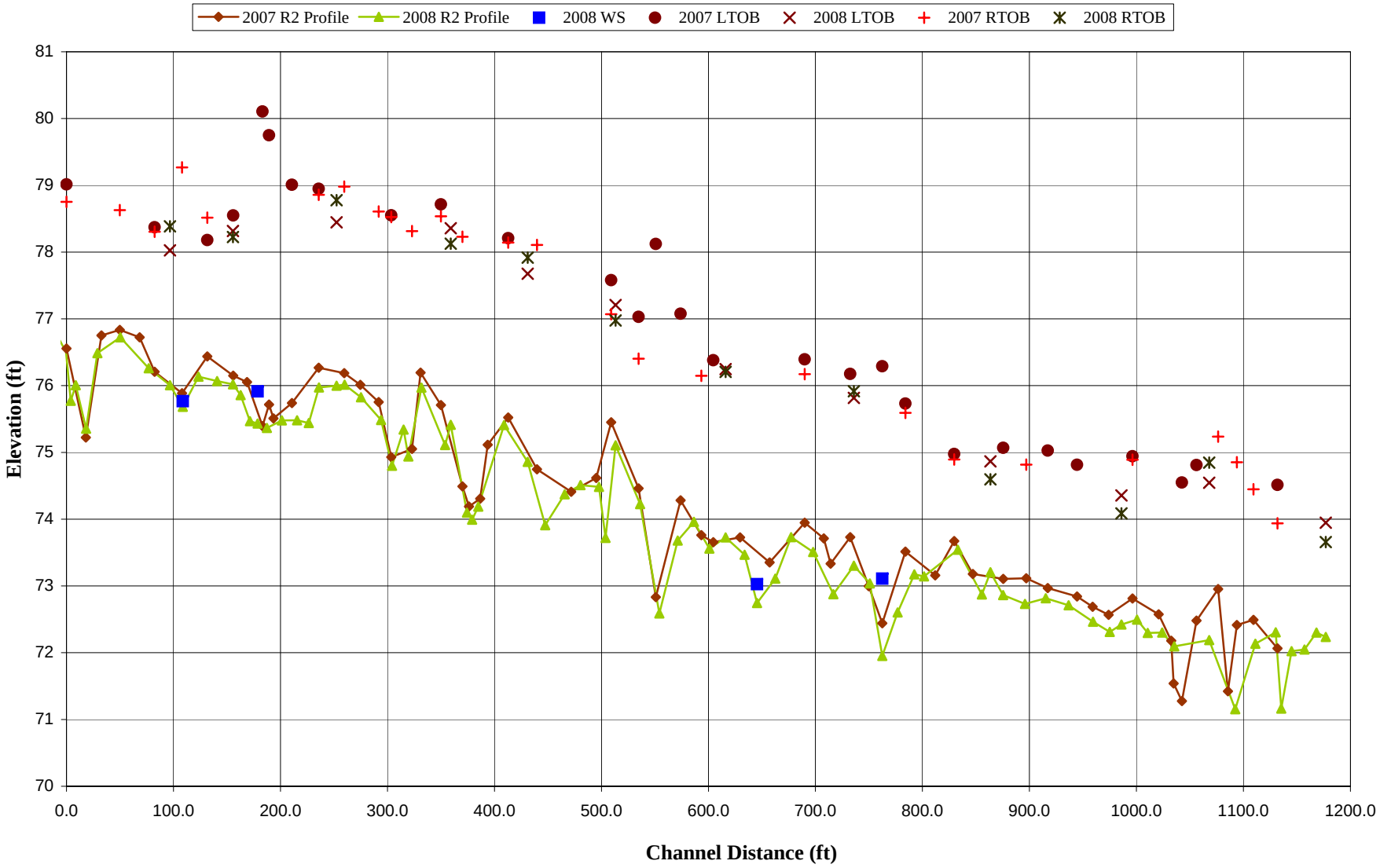
APPENDIX B

2008 Profile and Cross Section Data

City Pond
Reach R2 Station 27+50 to 39+50



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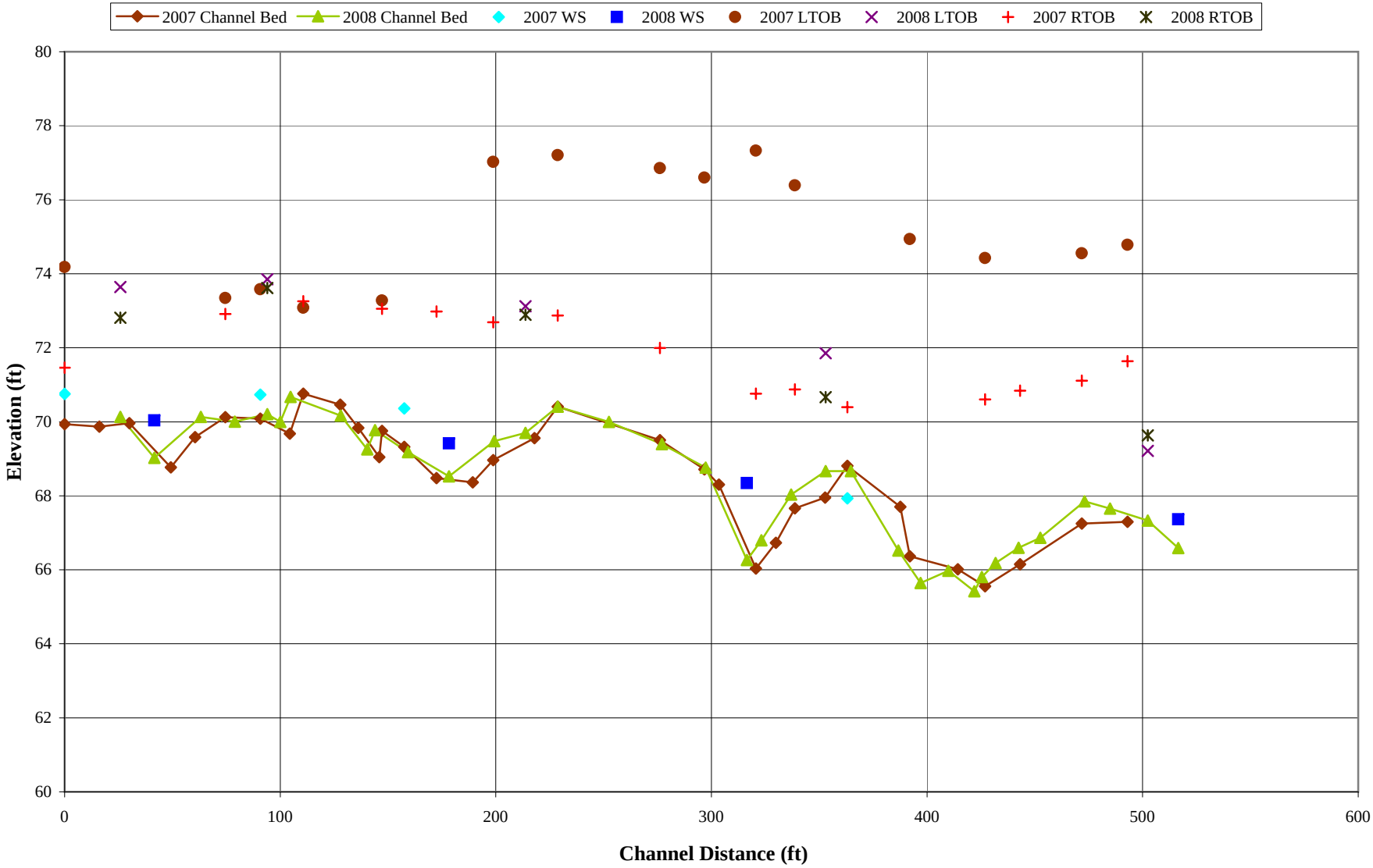
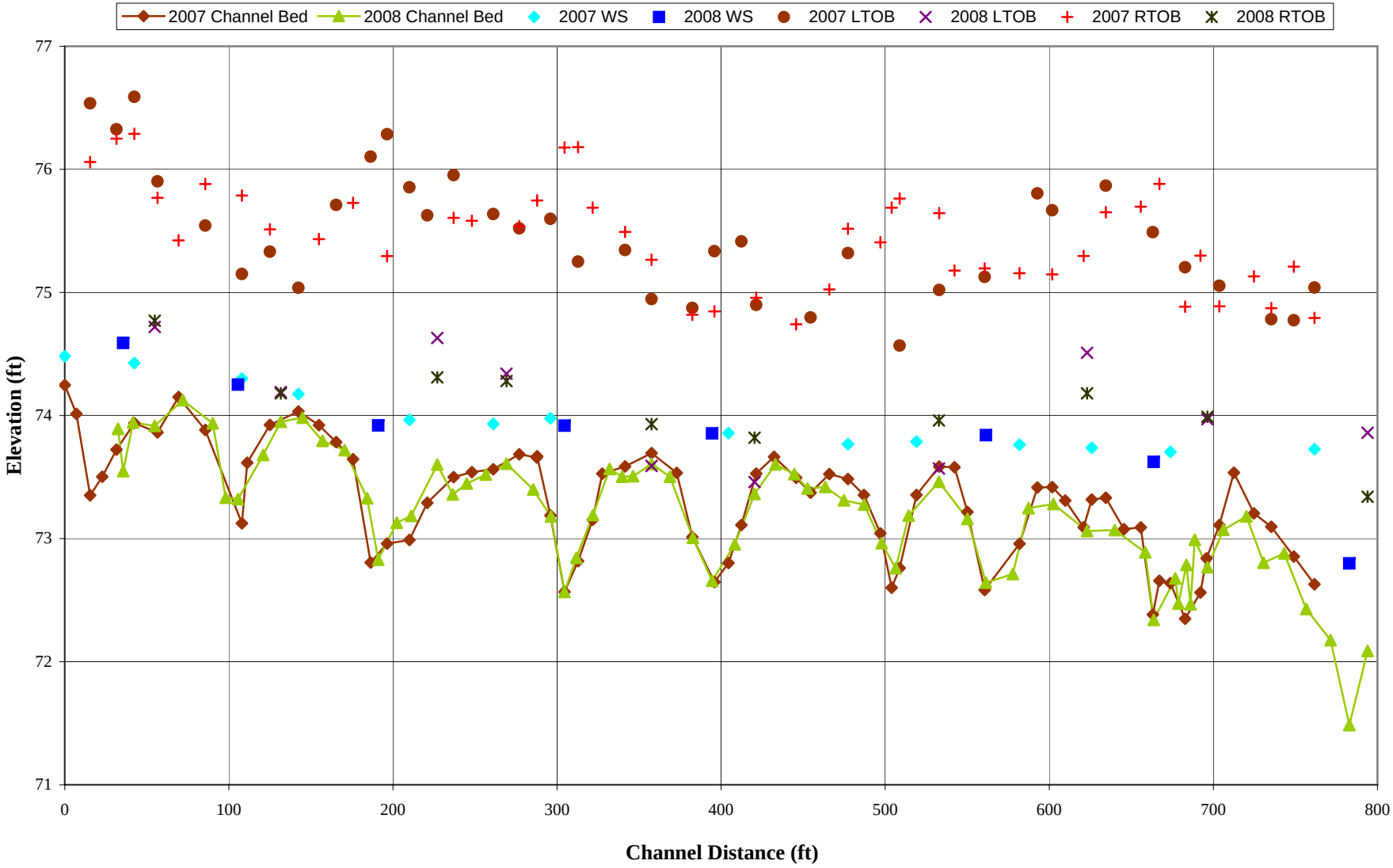
Reach R3 Station 44+00 to 49+00



City Pond
Reach S4 Station 15+50 to 23+50



City Pond
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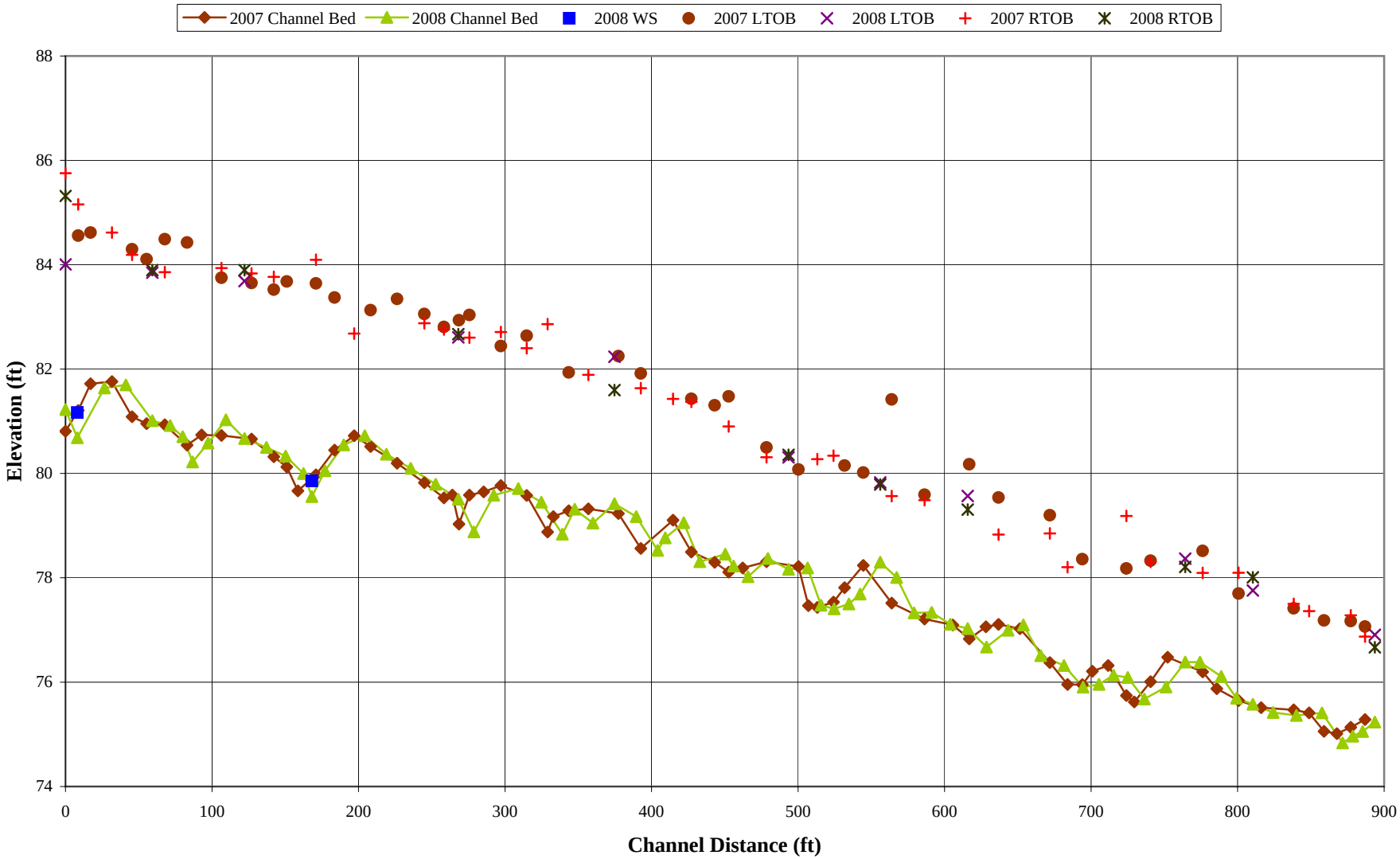

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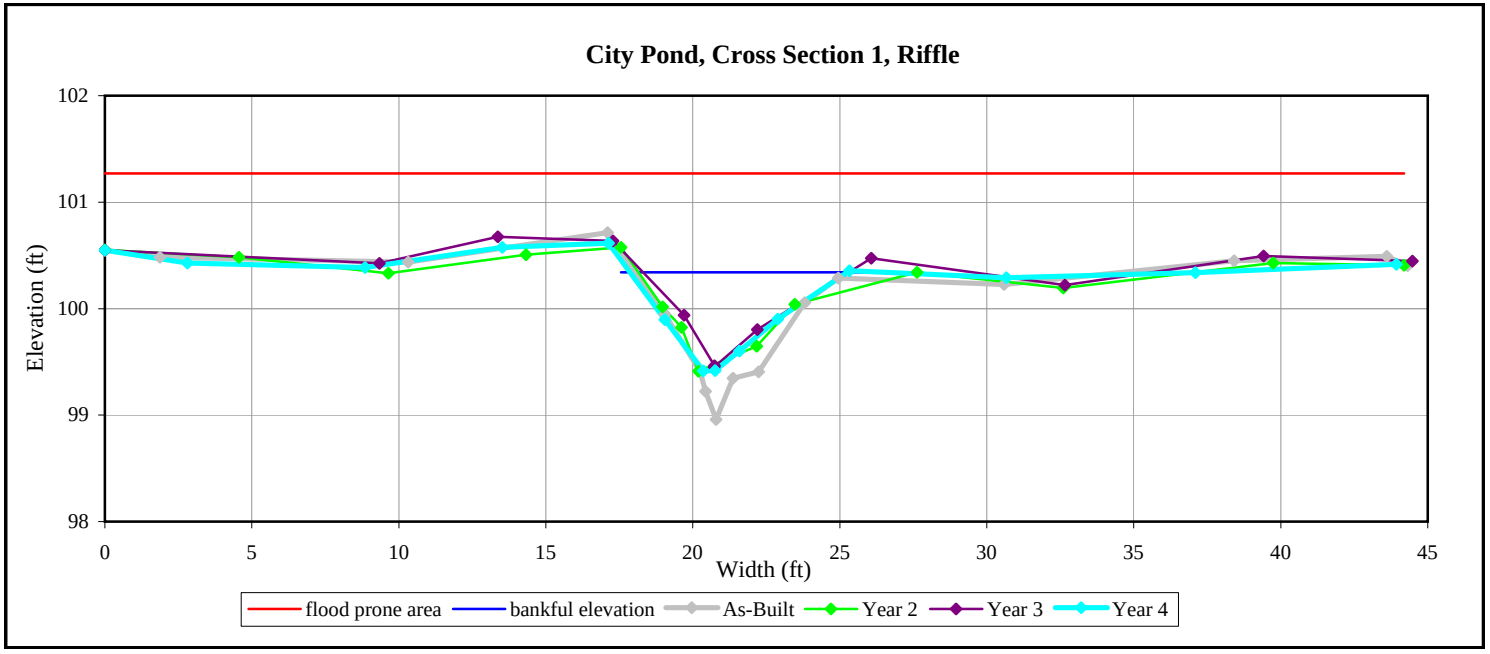

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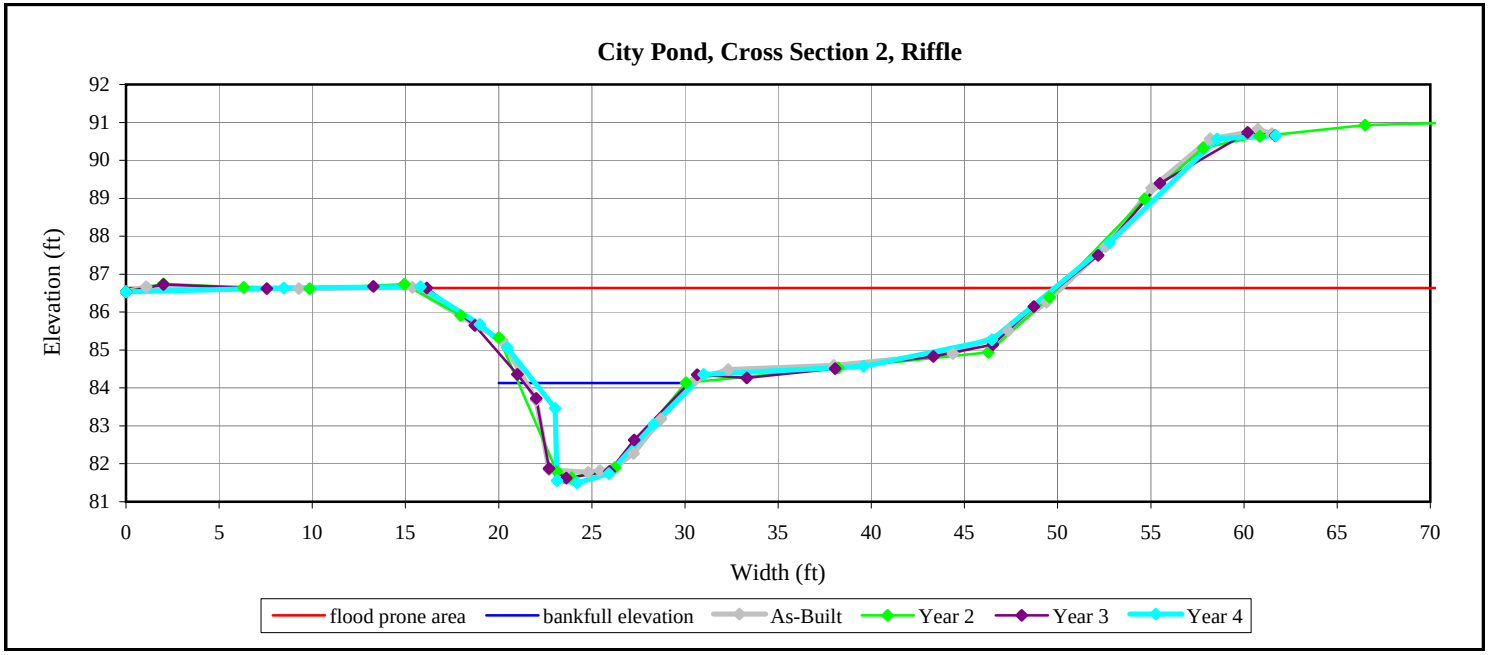

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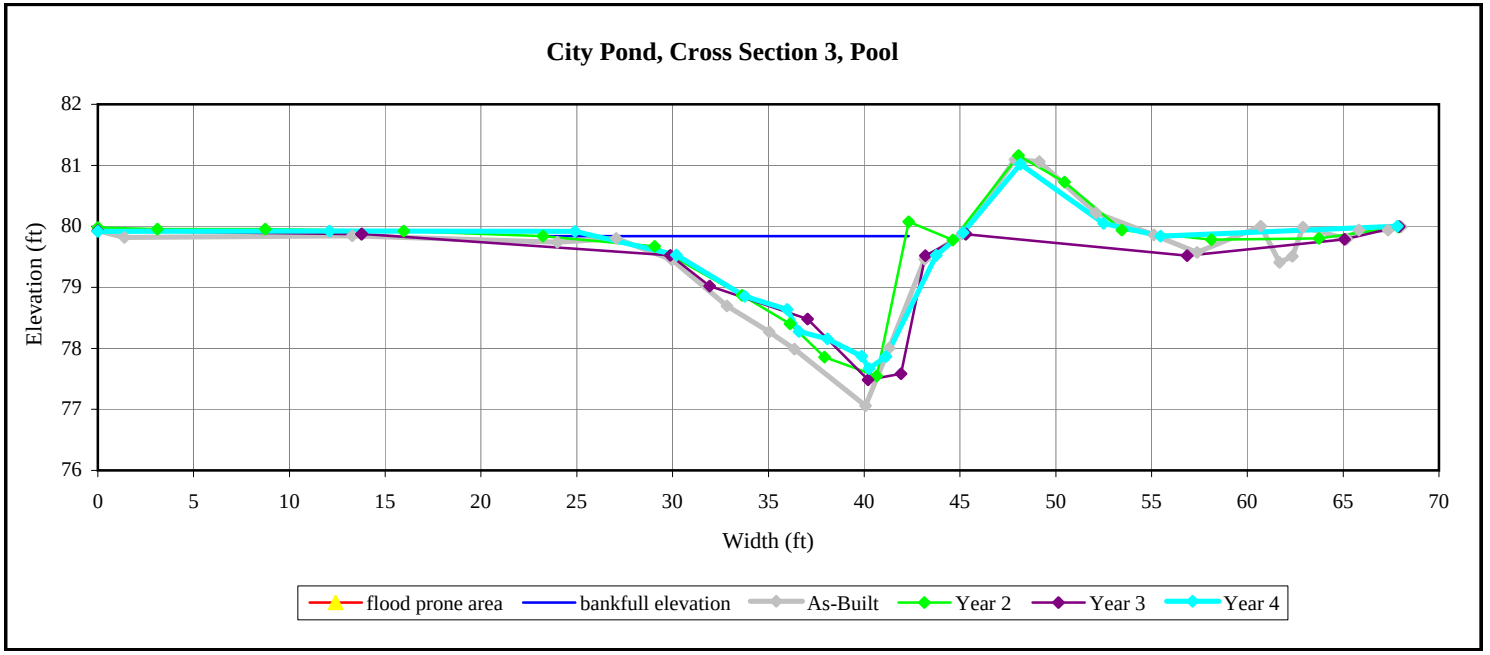

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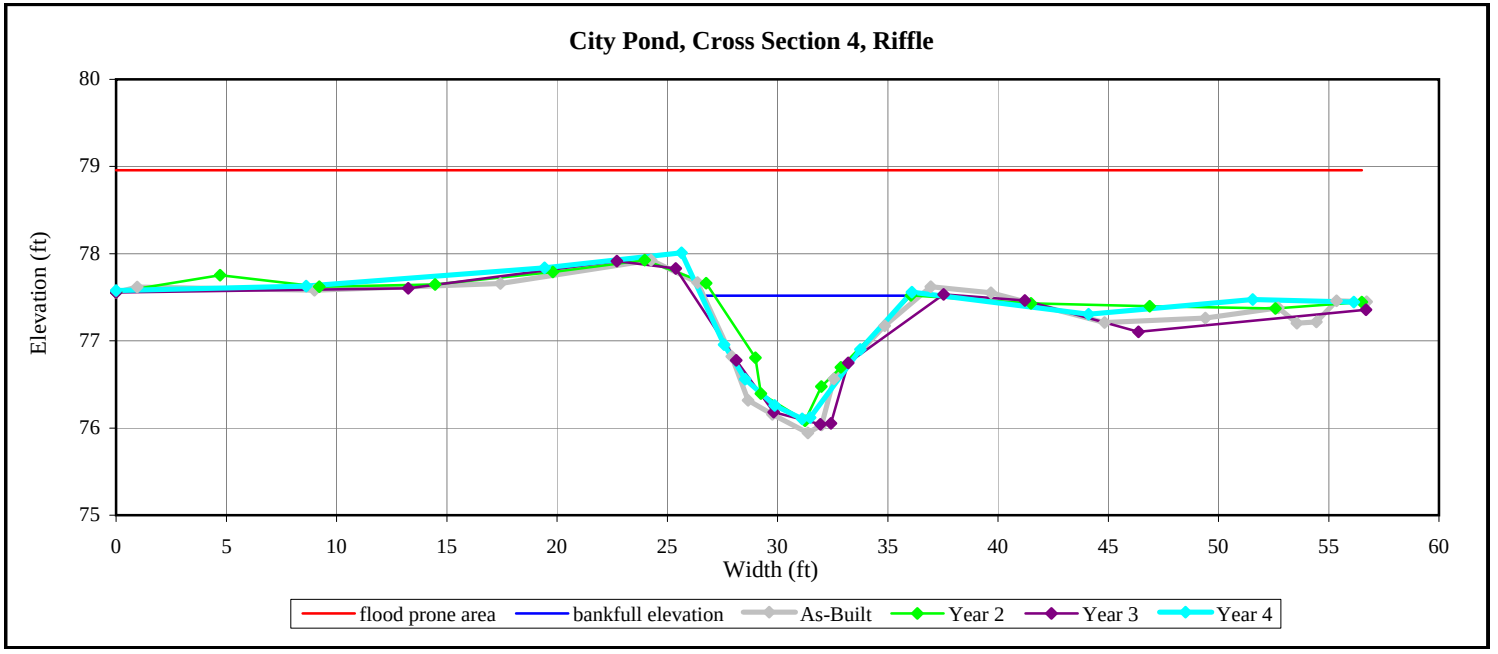

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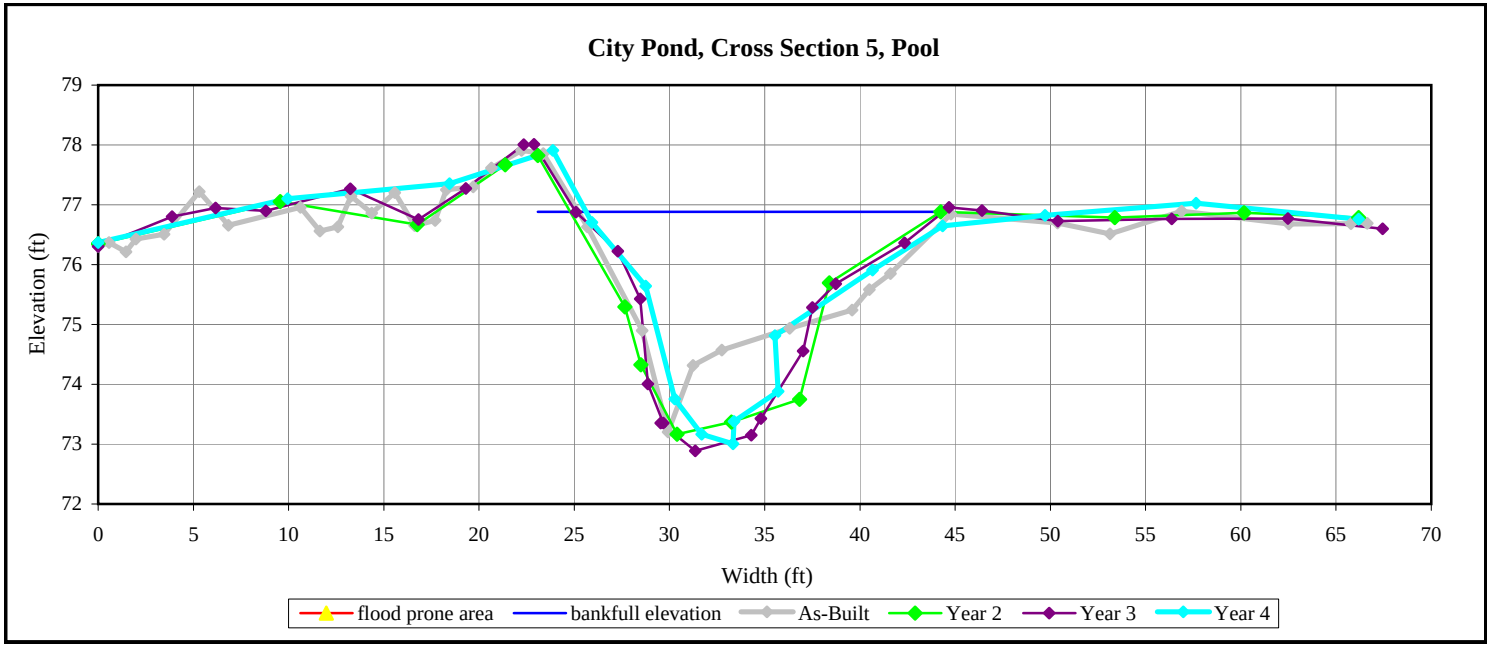

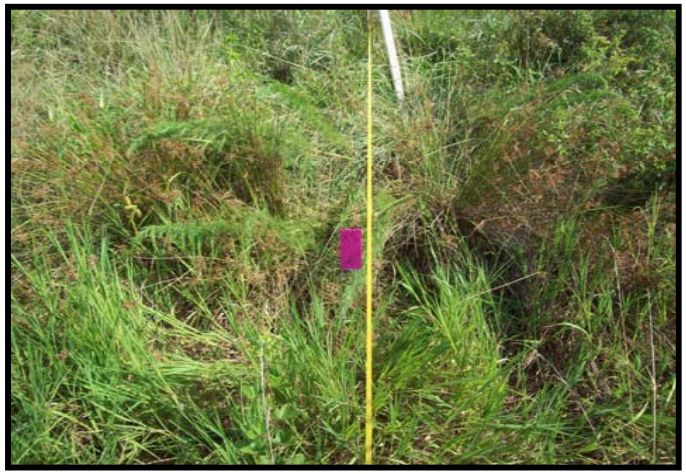

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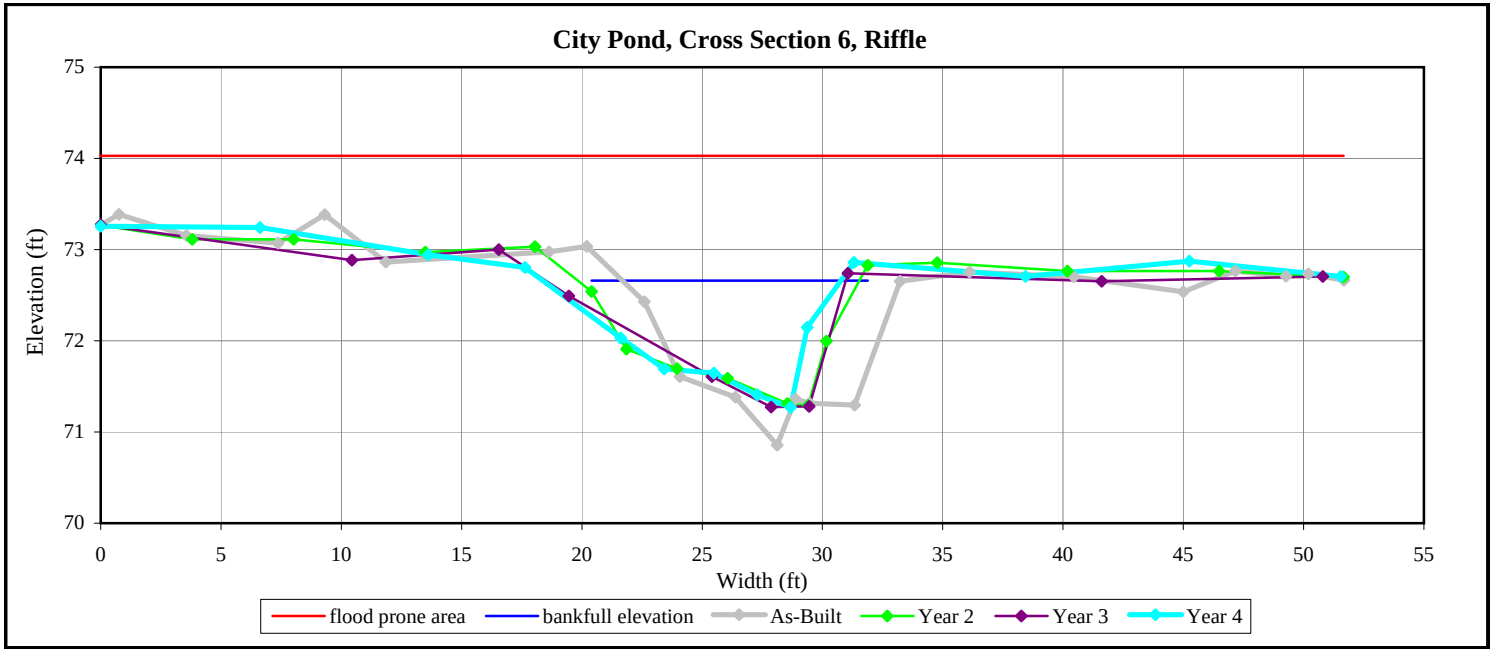

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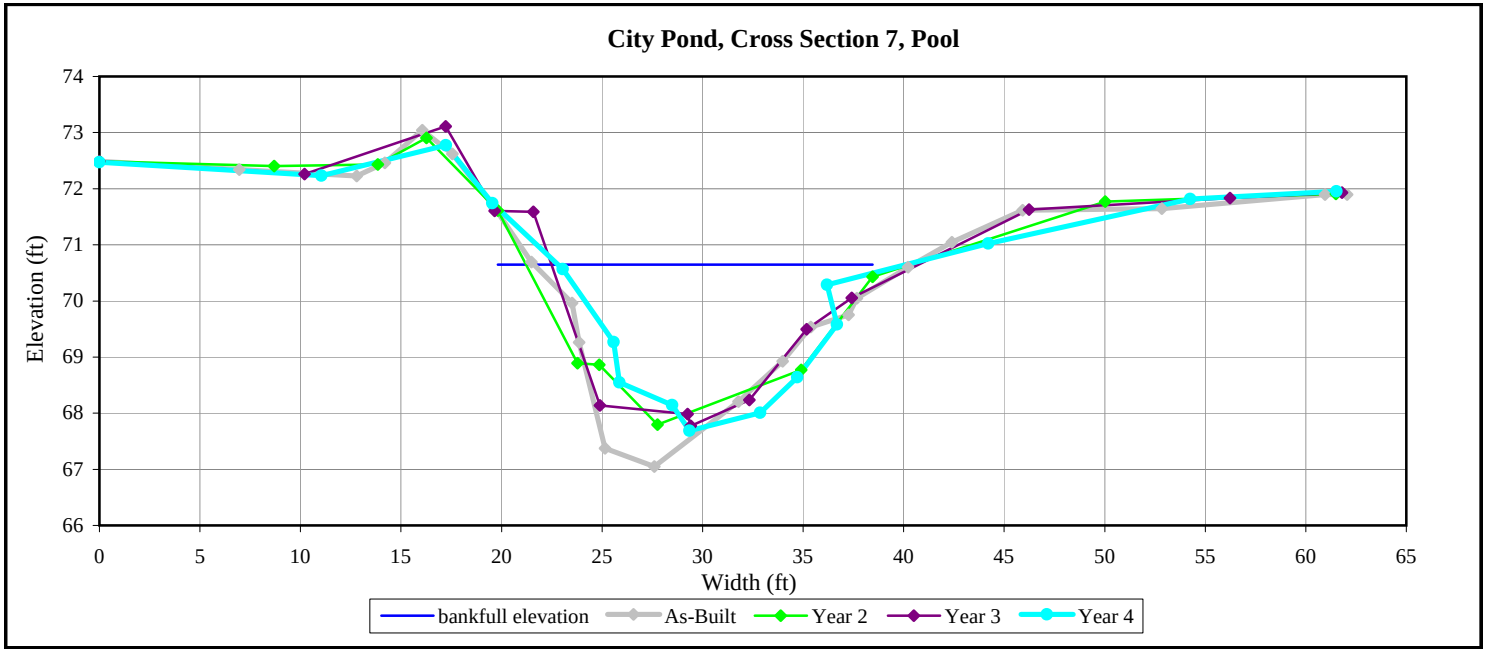

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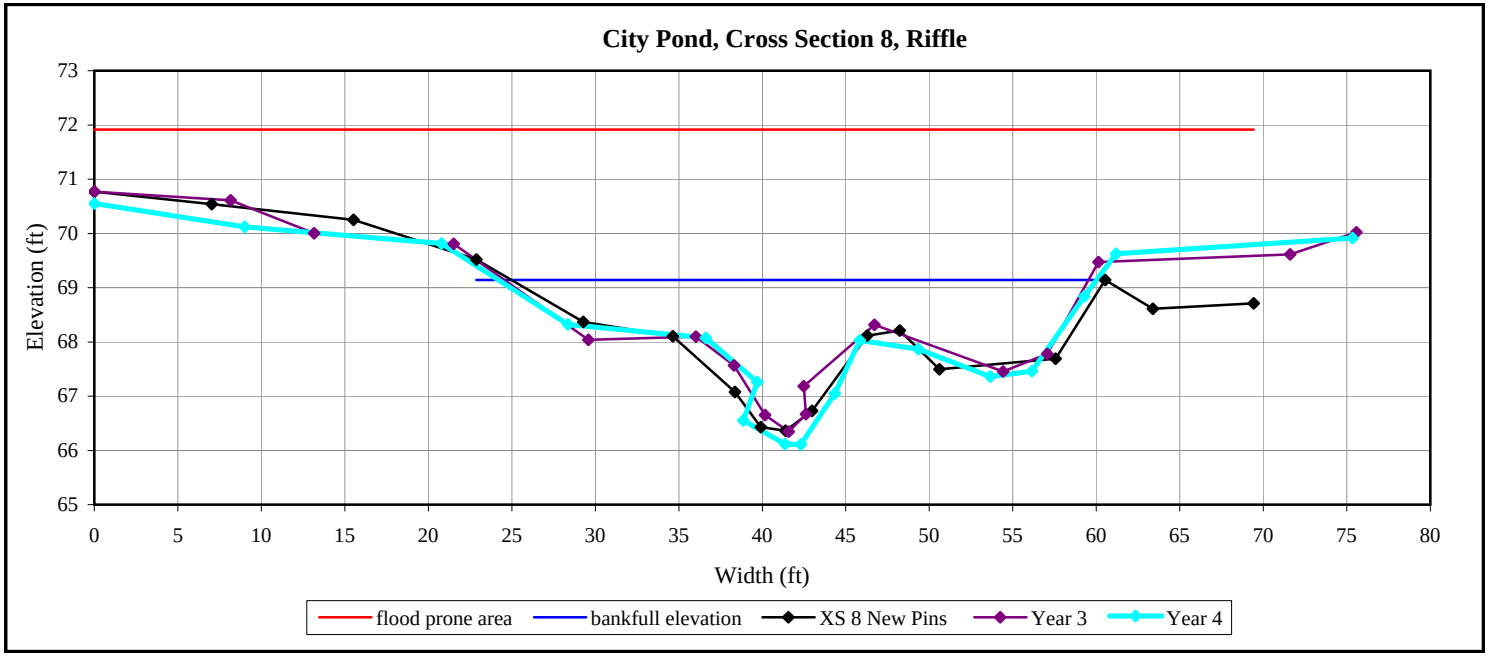

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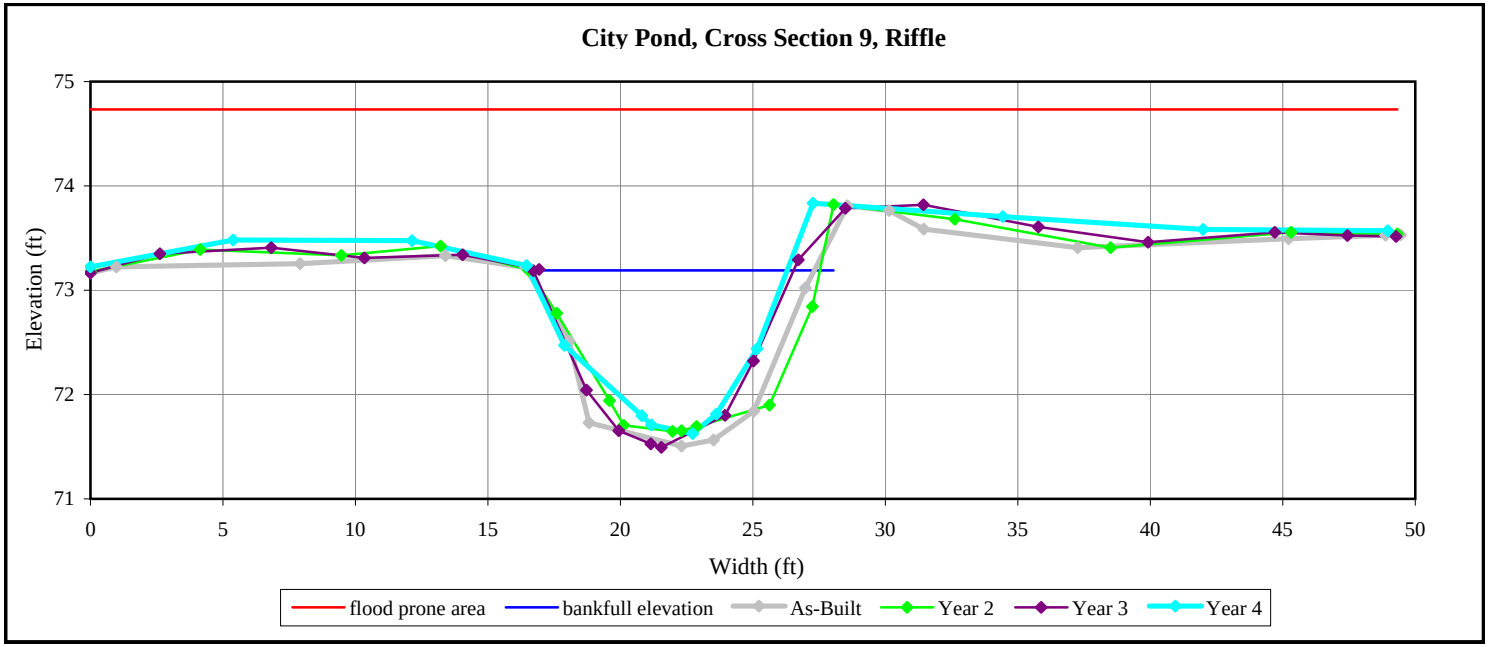

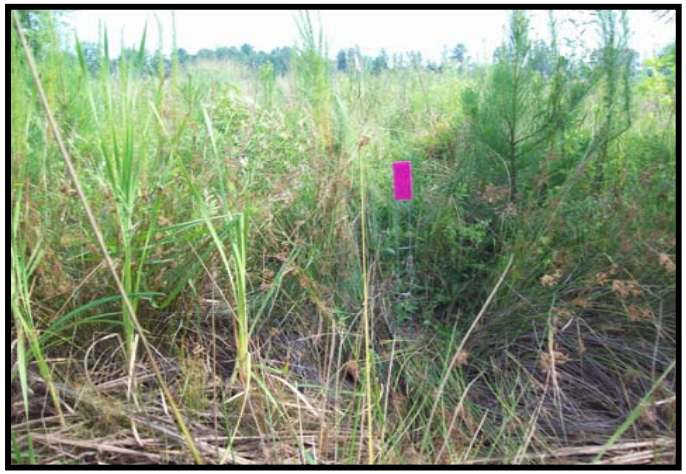

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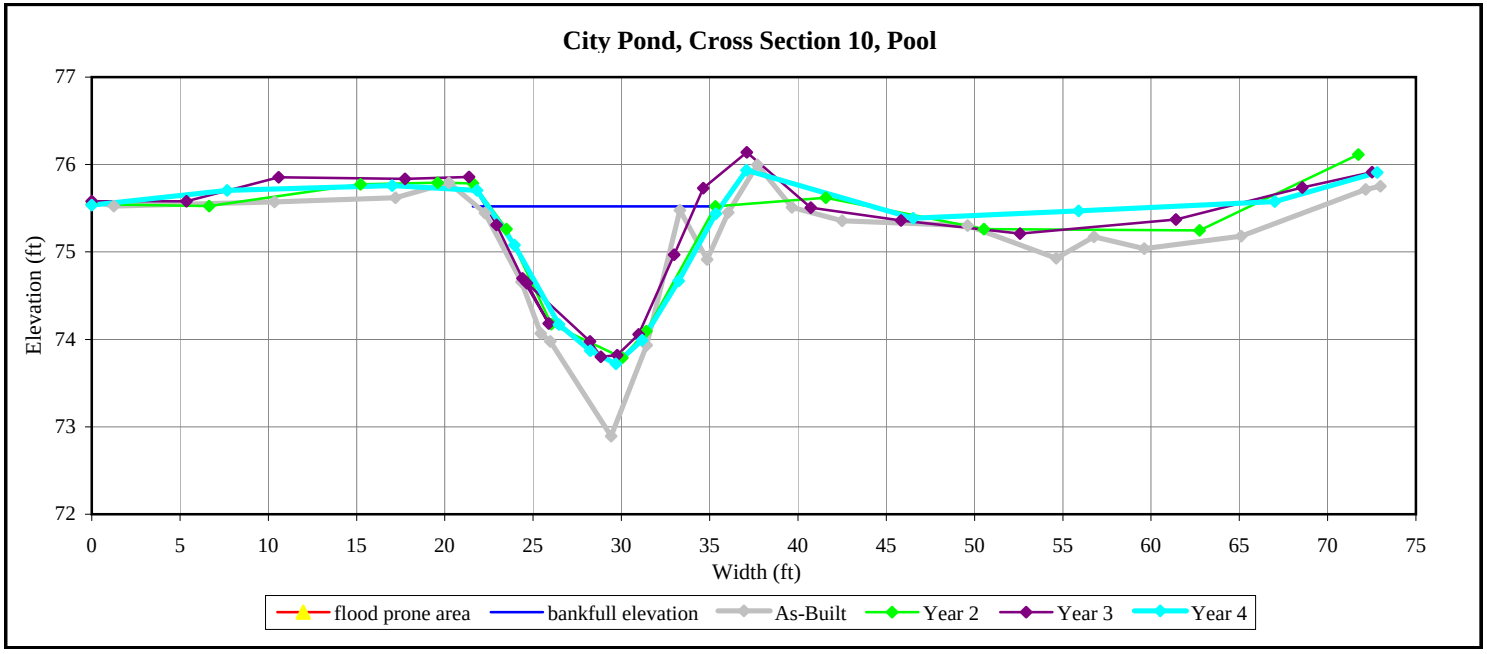

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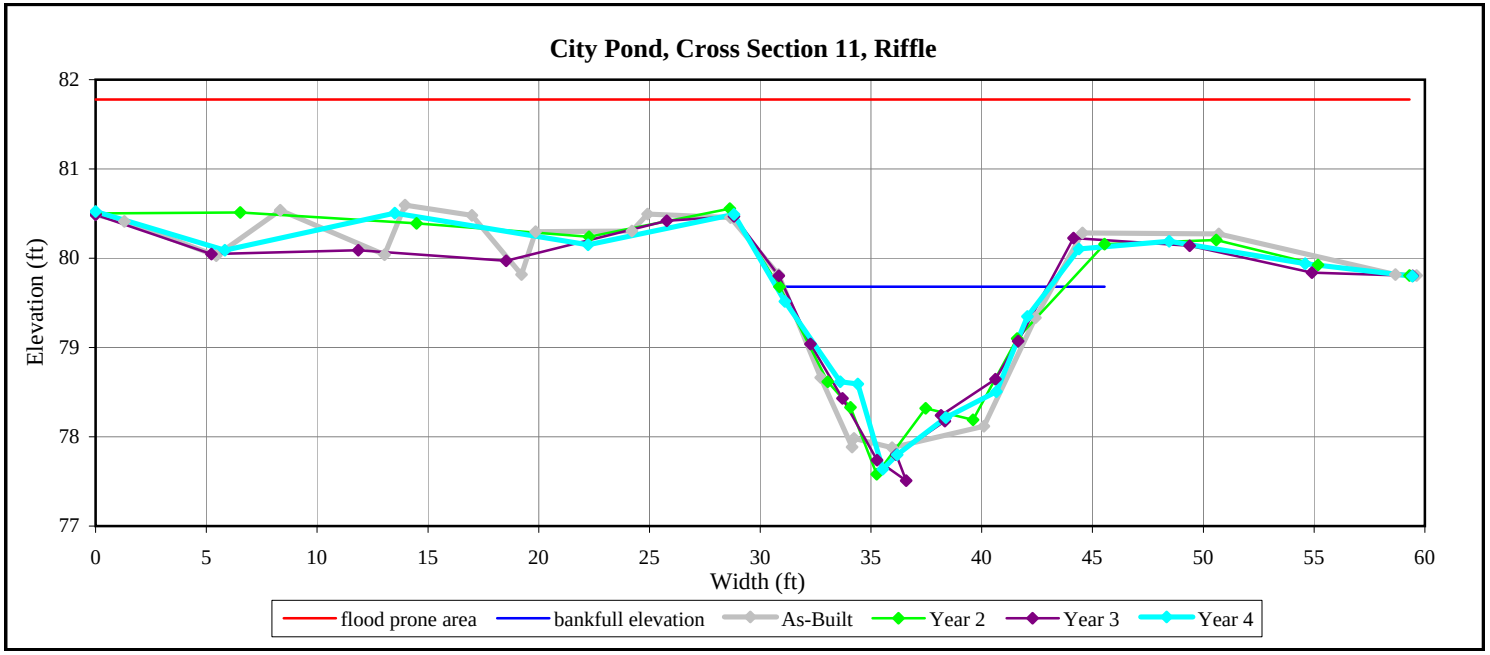

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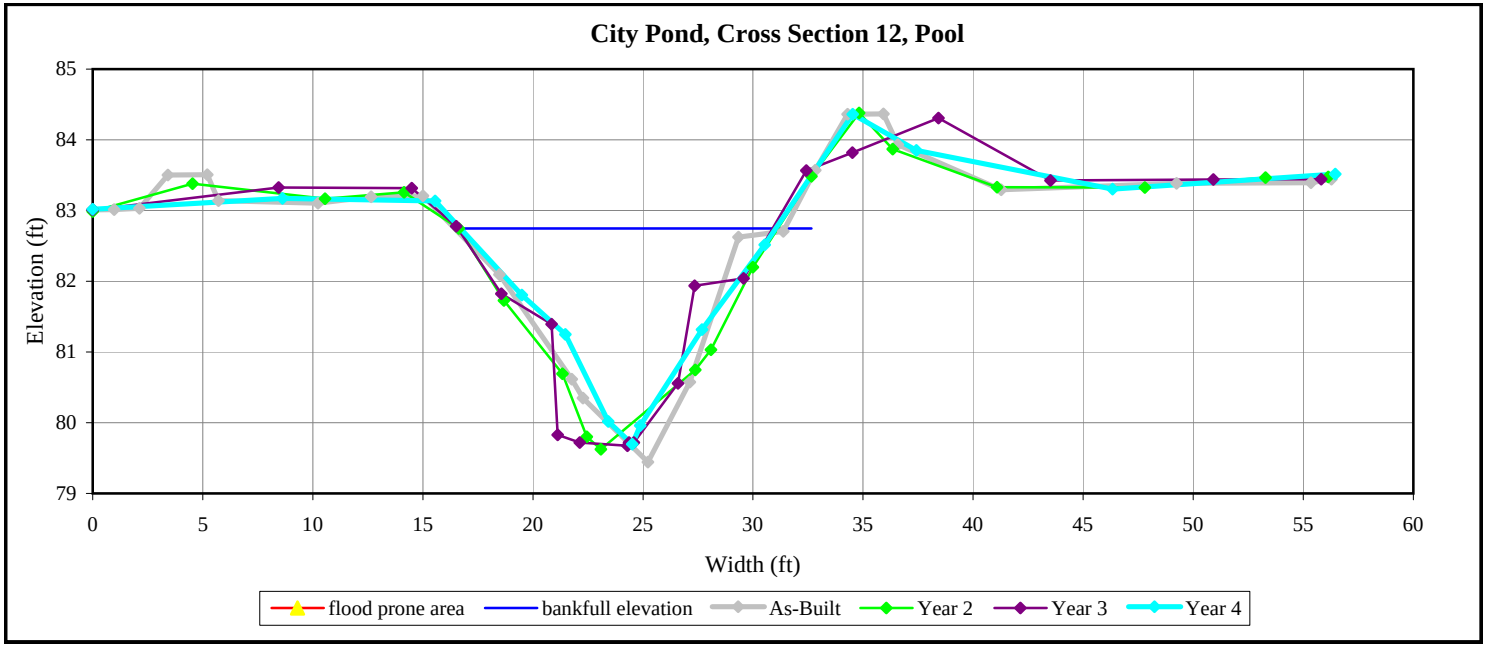

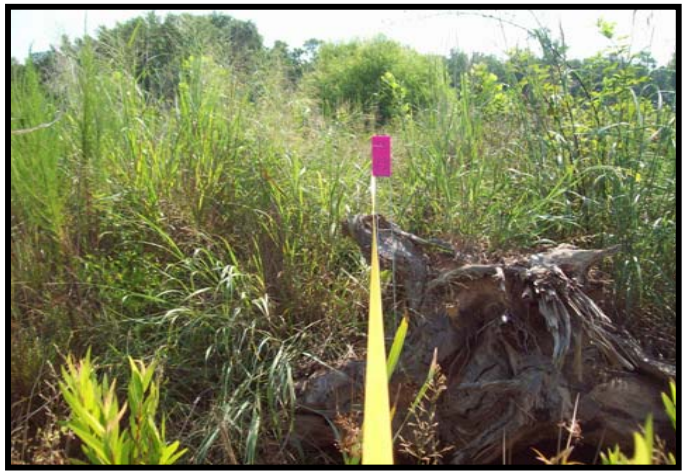

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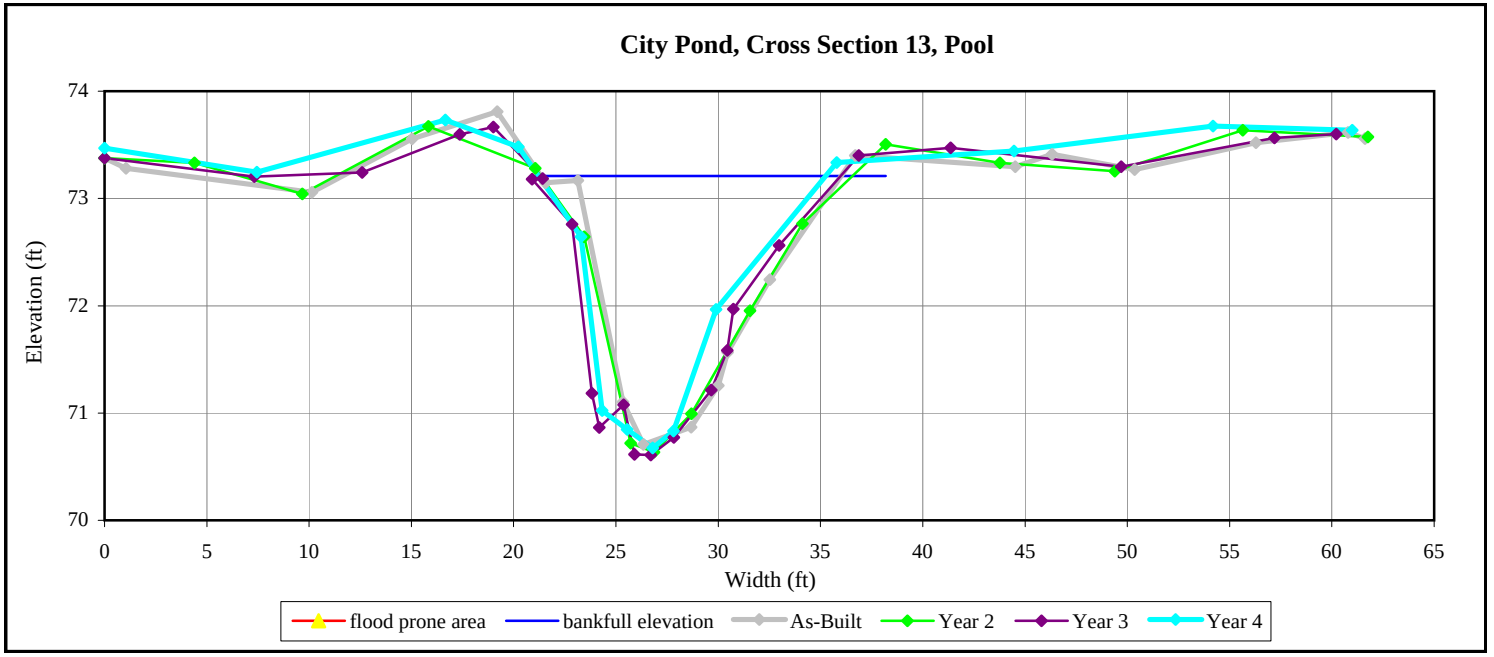

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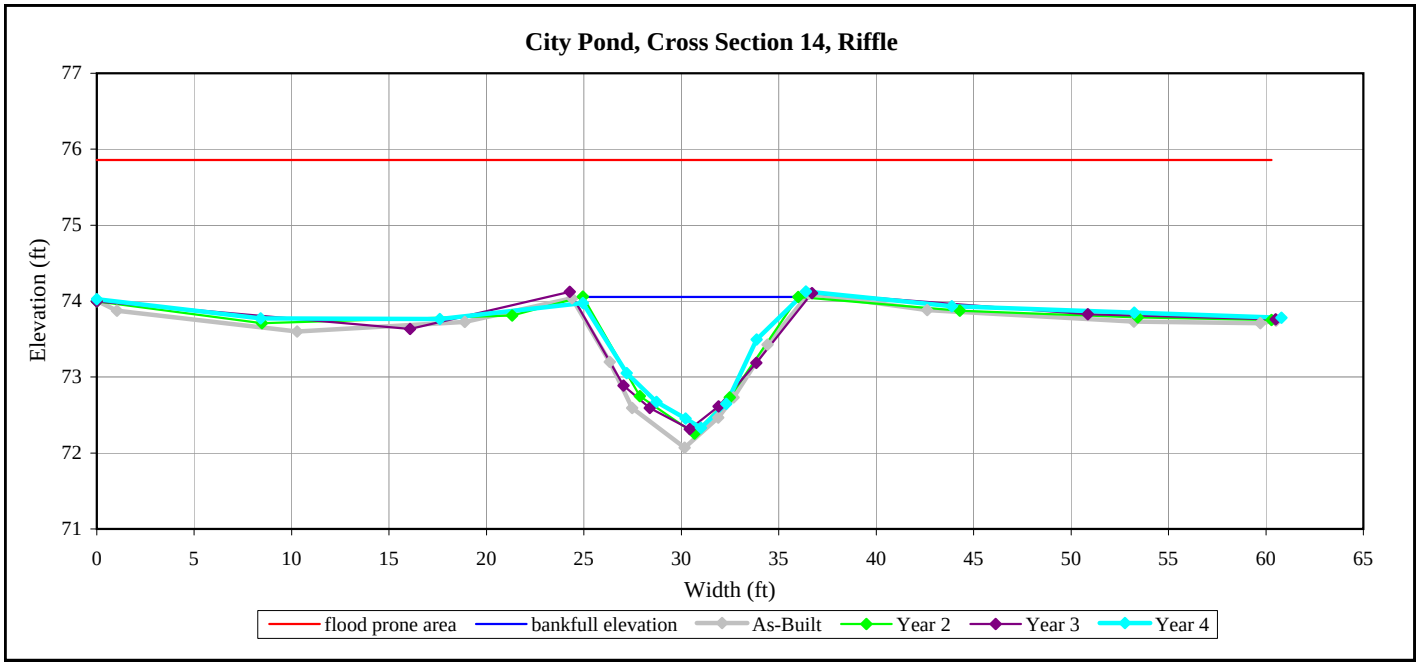

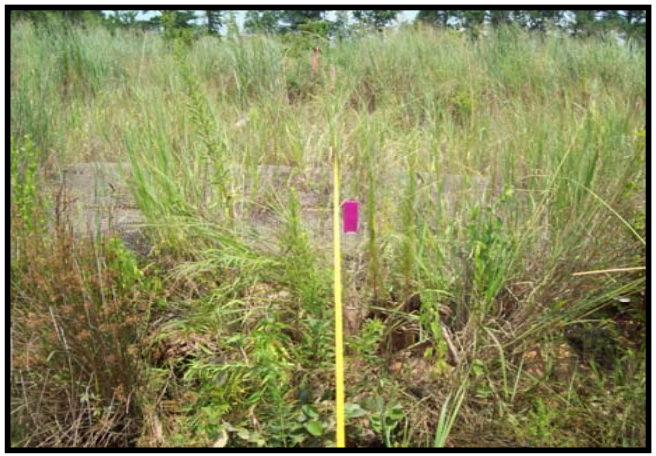

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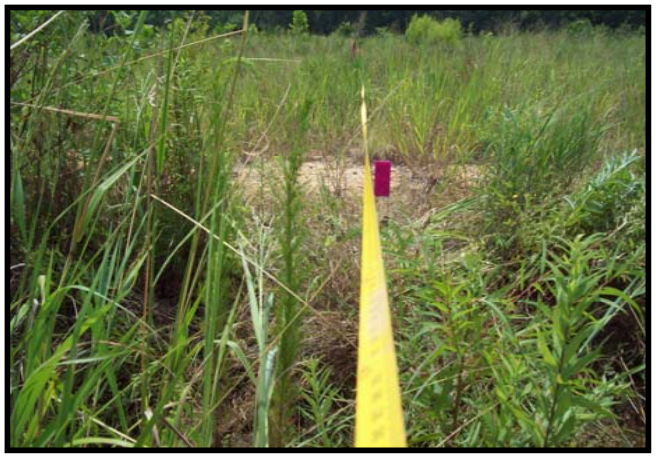

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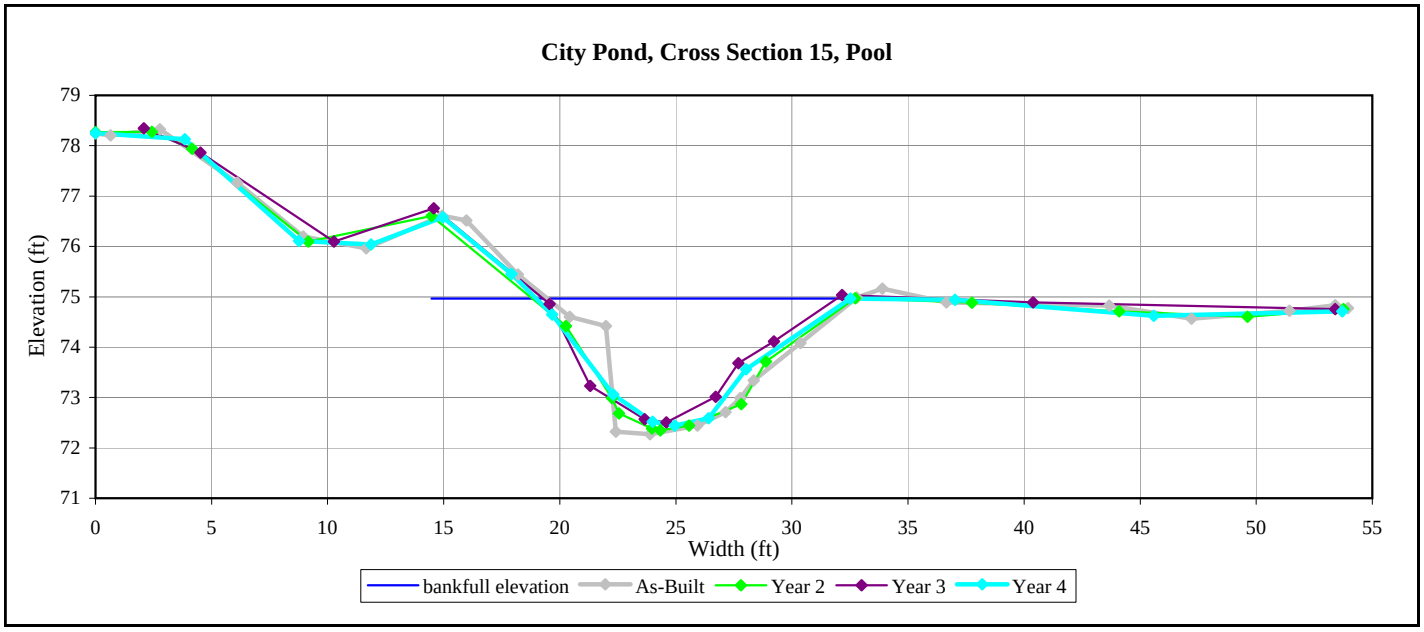

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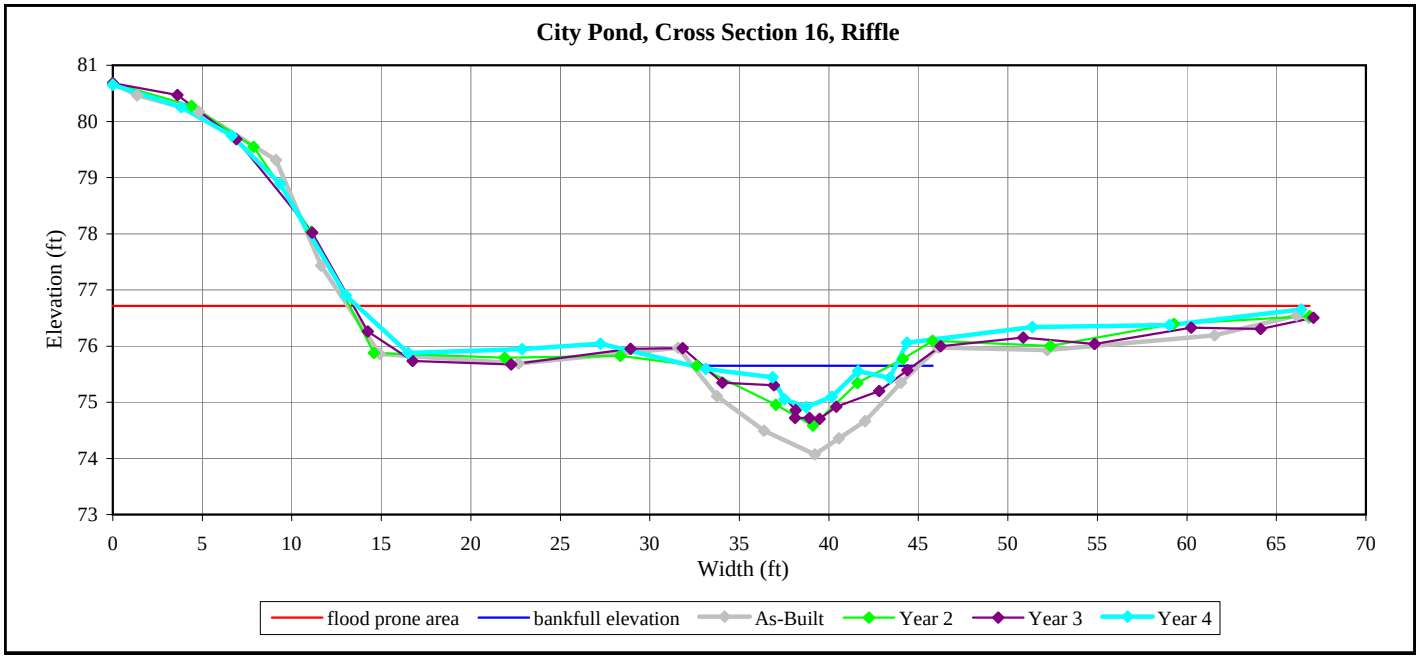

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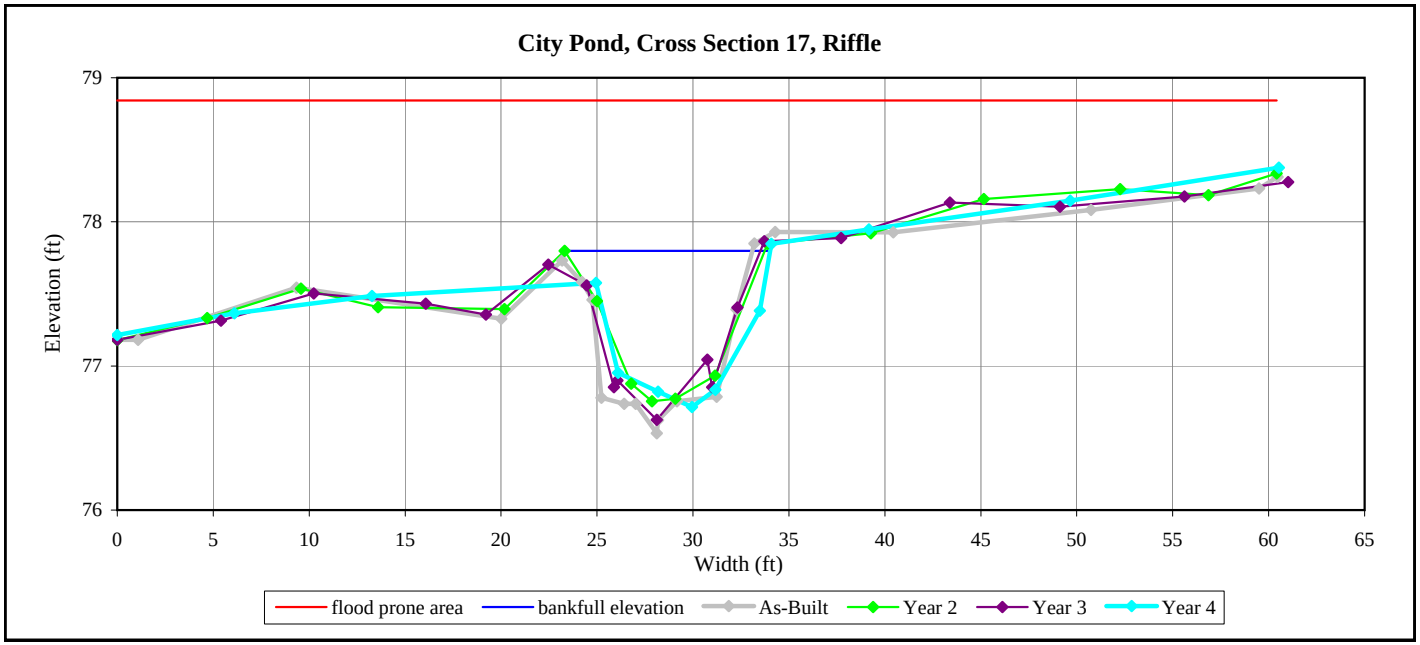

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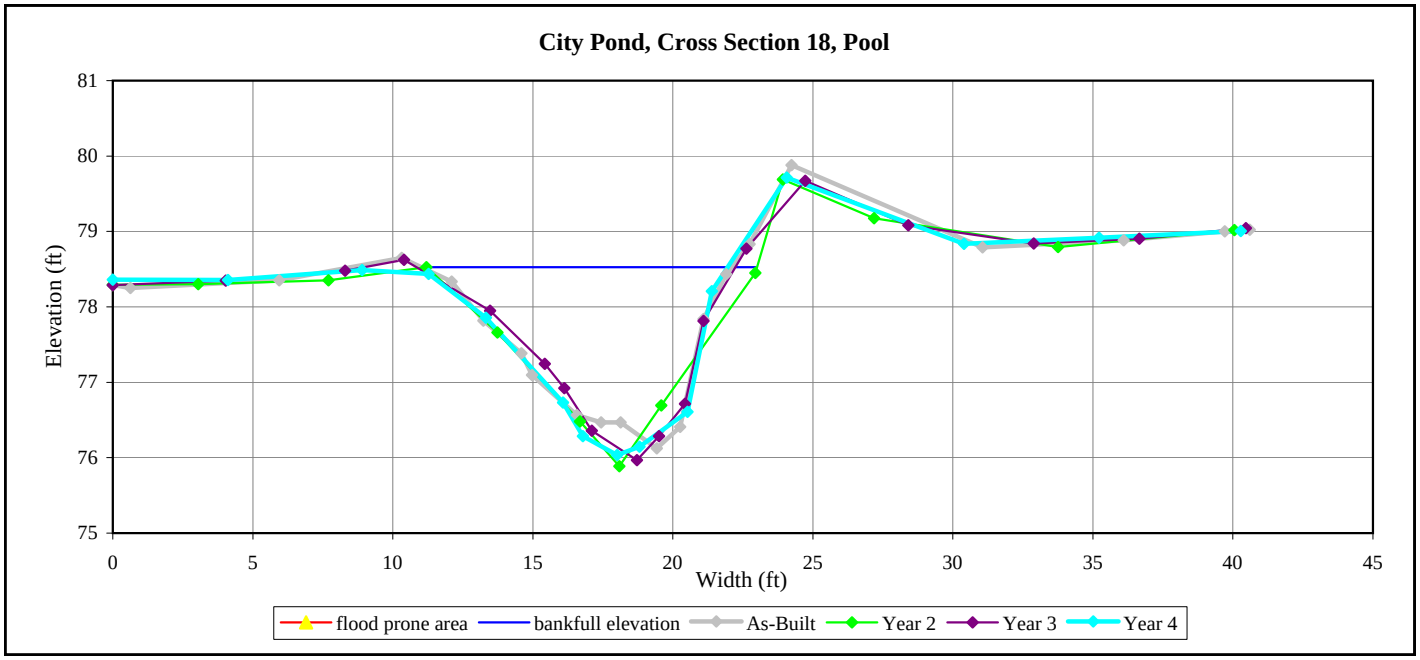
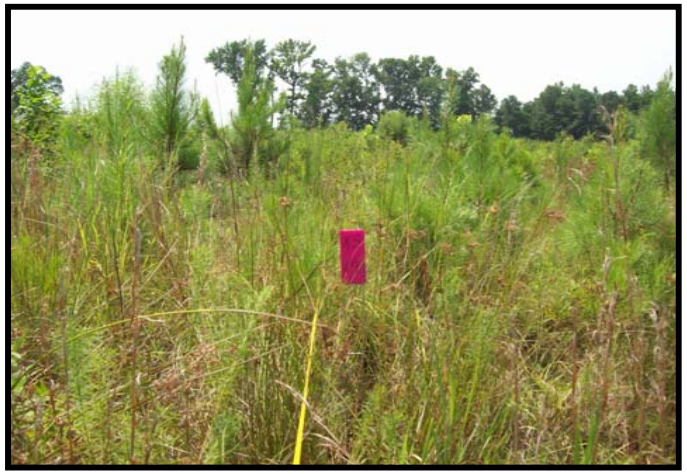
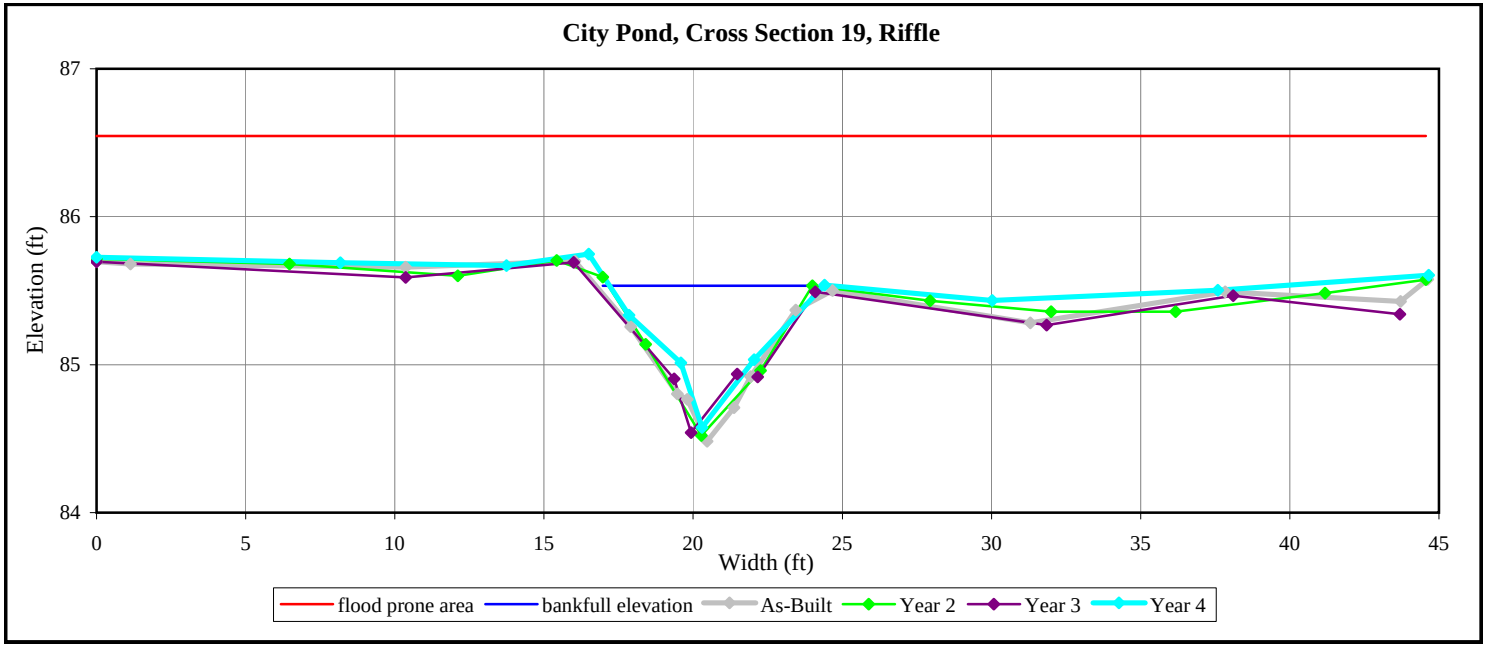




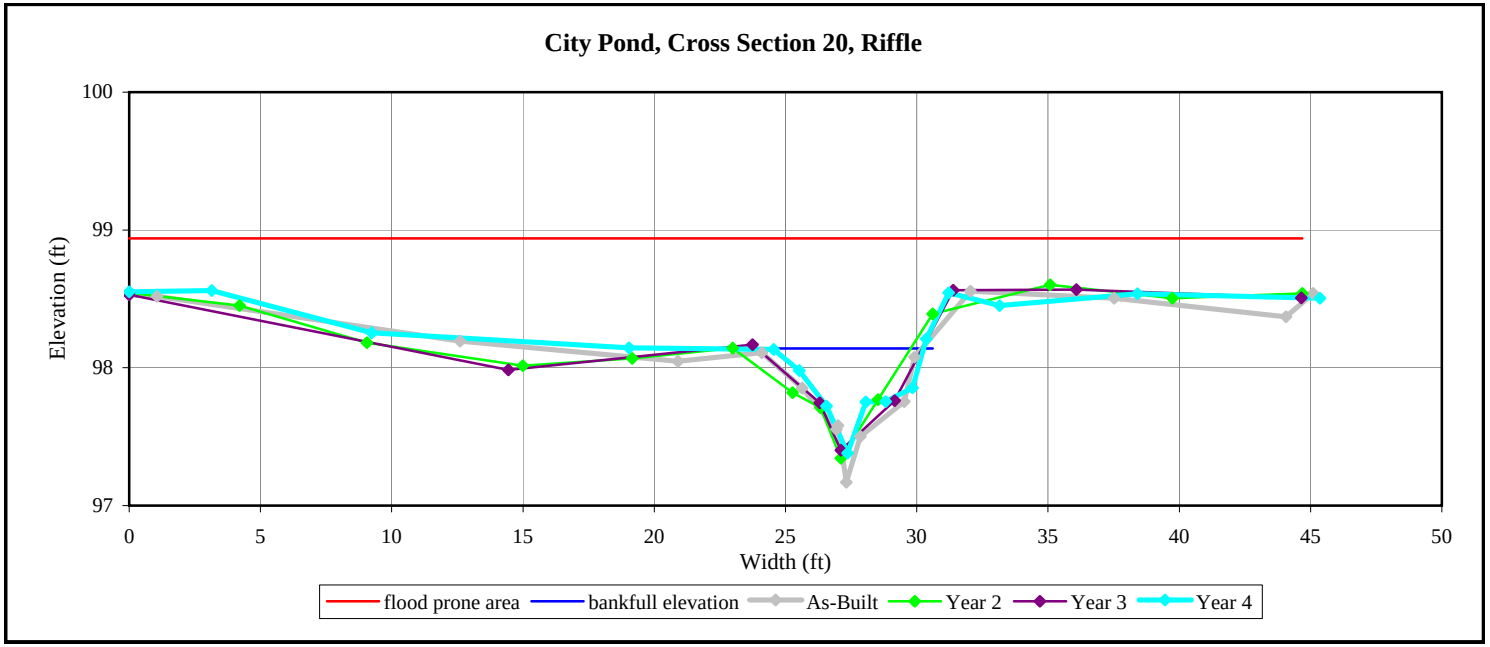
Looking at Left bank

Looking at Right bank



Looking at Left bank

Looking at Right bank



APPENDIX C

2008 Site Photos

Left bank erosion @ station 10+20 facing downstream (R1)

Left bank erosion @ station 10+20 facing upstream (R1)

Erosion behind log weir @ station 11+80 facing upstream (S1)

Headcut forming downstream of log weir @ station 15+30 (S1)

Channel erosion downstream of log weir @ station 15+80 (S1)

Erosion behind coir matting @ station 18+50 (S5)

Undercutting along left bank @ station 23+90 (R2)

Erosion behind matting along right bank @ station 34+50 (R2)

Erosion along left bank @ station 47+80 (R3)

Bare floodplain due to lack of vegetation @ station 48+50 (R3)

Erosion on left bank @ station 13+20 (S3)

Constructed Riffle (Typ.)

Root Wads (Typ.)

Overworked, underpaid employee (Typ.)

Vegetation Plot #1

Vegetation Plot #2

Vegetation Plot #3

Vegetation Plot #4

Vegetation Plot #5