Crowns West Restoration Project Mitigation Plan Report

Onslow County, North Carolina

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Date Submitted:	April 2007

Ecosystem Enhancement PROGRAM

EXECUTIVE SUMMARY

The Crowns West site was restored through a full delivery contract with the North Carolina Ecosystem Enhancement Program (NCEEP). This report documents the completion of the restoration construction and presents base-line as-built monitoring data for the five-year monitoring period. Table 1 summarizes site conditions before and after restoration as well as the conditions predicted in the previously completed site restoration plan. The monitoring plan and as-built baseline data are discussed in detail in Sections 2.1 through 2.5 of this report.

Table 1
Background Information

Preconstruction Site Conditions			
Site			
Location	Onslow County, NC (Exhibit 1), approximately six miles northwest of the town of Richlands.		
USGS Hydro Unit	03030001010010		
NCDWQ Sub-basin	03-05-02		
Contract Mitigation Units	**3,800 SMU**		
Stream			
Reach	**Length**	**Condition**	**Drainage Area**
M1	1,938 LF	Straightened, Channelized, & Incised E/G5	0.65 Mi^2
M2	1,396 LF	Straightened, Channelized, & Incised E/G5	0.98 Mi^2
Restoration Plan			
Stream			
Reach	**Restoration/Enhancement Type**	**Length**	
M1	Restoration – Priority I and II	2,366 LF	
M2	Restoration – Priority II	1,538 LF	
Post-Construction Site Conditions			
Stream			
Reach	**Restoration/Enhancement Type**	**Length**	**SMU**
M1	Restoration – Priority I and II	2,320LF	2,320
M2	Restoration – Priority II	1,515 LF	1,515
Riparian Buffer Acreage			
Planted Riparian Buffer Acreage	10.8 Ac		

Ecological Benefits	
Water Quality	Nutrient removal; erosion reduction; increased dissolved oxygen concentrations; and improved stream bank stability.
Water Quantity/Flood Attenuation	Increased water storage/flood control; reduced downstream flooding by reconnecting stream with its floodplain; improved groundwater recharge; improved/restored hydrologic connections.
Aquatic and Terrestrial Habitat	Improved substrate and in-stream cover; addition of large woody debris; reduced water temperature by increasing shading; restoration of terrestrial habitat; improved aesthetics.
Monitoring Plan	
Success Criteria	Success is measured with permanent cross-section, vegetation plots, and longitudinal profile conducted annually for a period of five years.
Methodology	Cross-sections and longitudinal profile are surveyed annually and tied to a common benchmark. Each tree within the 100-square-meter vegetation plots are flagged and identified. Measurements of height and diameter are also taken and annual survival rates are recorded.
Remedial Action	N/A

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Tables and Exhibits

Appendices

1.0 BACKGROUND INFORMATION

The Crowns West Branch is located in Onslow County, NC (Exhibit 1), approximately six miles northwest of the town of Richlands. The site lies in the White Oak River Basin within North Carolina Division of Water Quality sub-basin 03-05-02 and targeted local watershed 03030001010010 (Exhibit 1). Land use on the site consists primarily of row crop agriculture with adjacent woodlands. Crowns West Branch had been channelized and riparian vegetation had been cleared in the lower half of the site. The upstream area had a narrow, early successional buffer that included several exotic species. Prior to restoration, Crowns West Branch was incised and lacked bedform diversity. As a result, channel degradation was widespread throughout the site.

The project involved the proposed restoration of 3,835 linear feet (LF) of stream. Exhibit 2 summarizes the restoration zones on the project site. Selected site photographs are shown in Appendix A. A total of 10.8 acres of stream and riparian buffer are protected through a conservation easement

1.1 Restoration Summary

Directions to the site are as follows: To access the site, take I-40 East to exit 373 to Kenansville then take highway 24 towards Beulaville and Richlands. Turn left at Haw Branch Rd and go one mile and M1 is on the left and M2 is to the right.

1.1.1 Mitigation Goals Restoration Approach

The specific goals for the Crowns West Site Restoration Project were as follows:

- Restore 3,800 LF of channel dimension, pattern, and profile.
- Improve floodplain function by matching floodplain elevation with bankfull stage.
- Establish native stream bank and floodplain vegetation in the 10.8-acre permanent conservation easement.
- Improve water quality in the Crowns West and New River watershed by reducing sediment and nutrient inputs.
- Improve aquatic and riparian habitat by creating deeper pools and areas of re-aeration, planting a riparian buffer, and reducing bank erosion.

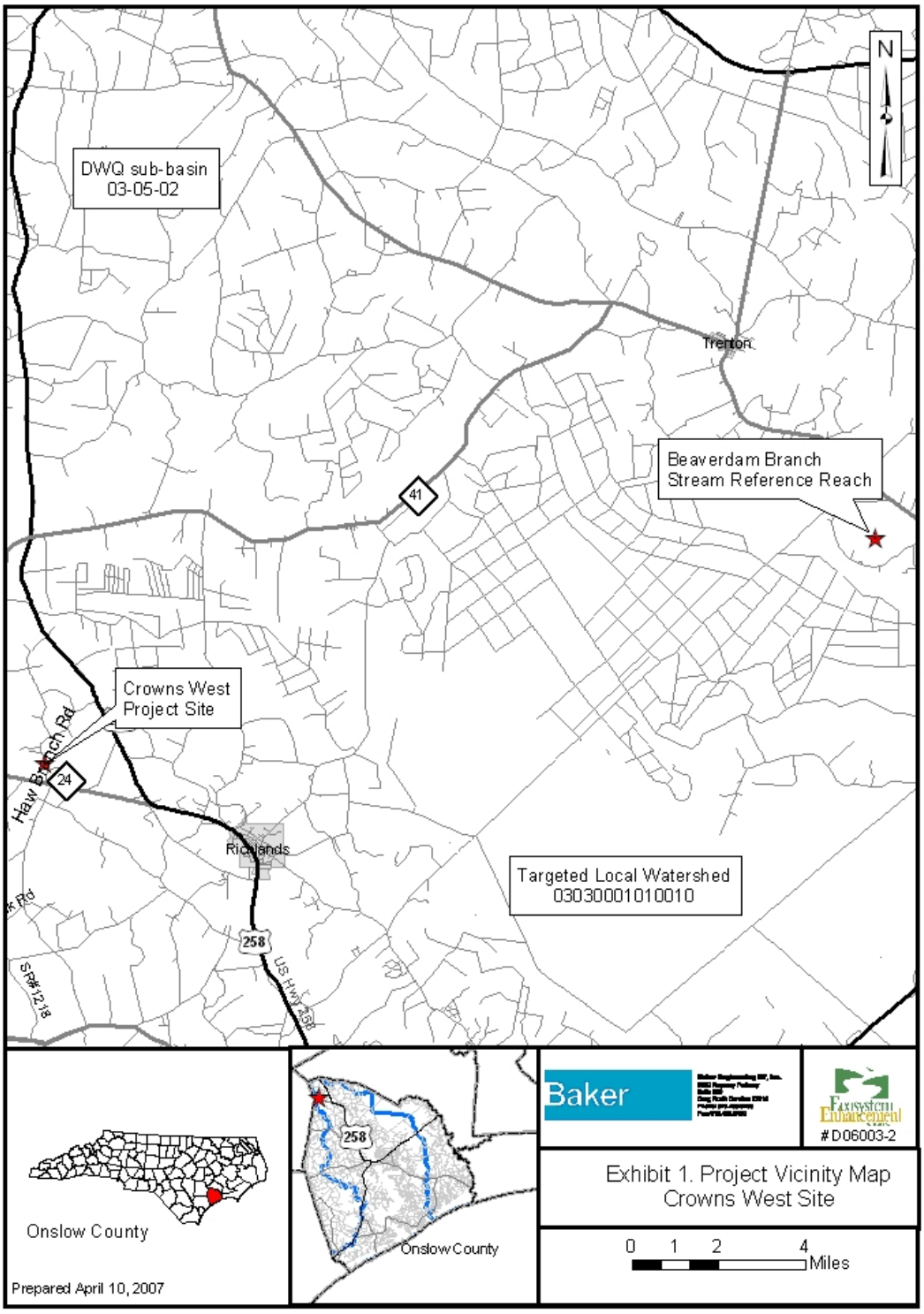
1.1.2 Projection Description and Restoration approach

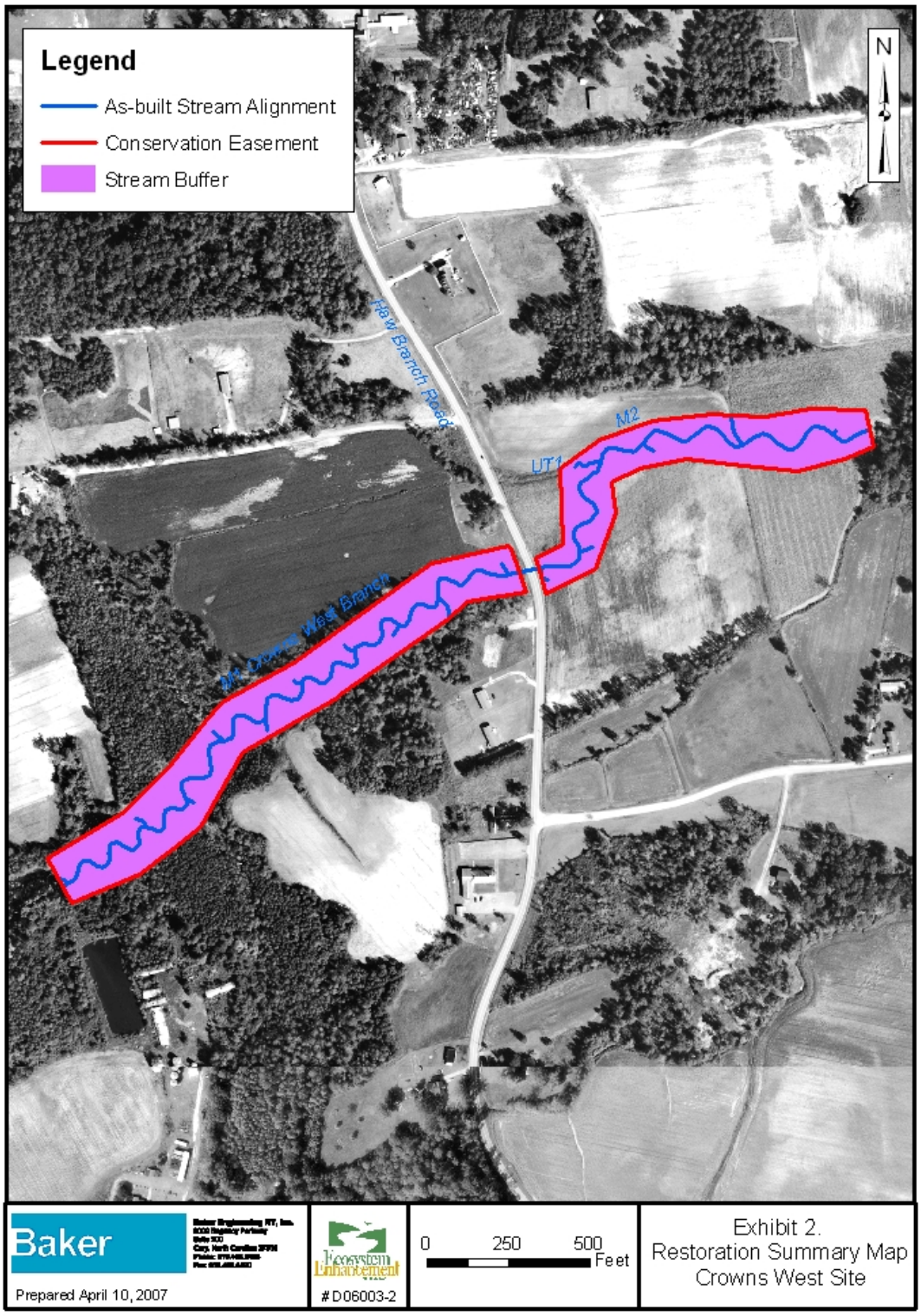
For analysis and design purposes, Baker Engineering divided on-site streams into reaches. The reaches were numbered sequentially from east to west, with a “M” designation for “mainstem.” M1 begins on upstream side of the project, and flows east, ending at Haw Branch Road. M2 begins at Haw Branch Road and flows east, to the end of the wood line at the downstream end of the project. One tributary (UT1) flowing from Haw Branch Road to the confluence with Crowns West Branch was originally proposed for restoration and was included in the 3,800 LF of stream restoration proposed for the site. The landowner withdrew this short section of UT1 in exchange for additional property and stream length at the upstream section of M1 on Crowns West Branch. UT1 was to be tied into the project and the tie in was stabilized.

The restoration design allows stream flows larger than bankfull flows to spread onto the floodplain, dissipating flow energies and reducing stress on streambanks. In-stream structures were used to control streambed grade, reduce streambank stress, and promote bedform sequences and habitat diversity. The in-stream structures consisted of root wads, log vanes, log weirs, and constructed riffles, which promote a diversity of habitat features in the restored channel. Where grade control was a consideration, constructed riffles were installed to provide long-term stability. Streambanks were stabilized using a combination of

erosion control matting, temporary and permanent seeding, bare-root planting, and transplants. Transplants provide living root mass to increase streambank stability and create holding areas for fish and aquatic biota. The purpose of the project is to restore stream functions to the impaired reaches at the site. Native vegetation was planted across the site, and the entire restoration site is protected through a permanent conservation easement.

1.2 Project Maps




Legend
As-built Stream Alignment
Conservation Easement
Stream Buffer
N
Haw Branch Road
M2
UT1
Mt. Olivet West Branch
Baker
Prepared April 10, 2007
#D06003-2
0
250
500
Feet
Exhibit 2.
Restoration Summary Map
Crowns West Site

1.3 Construction Summary and Tables

Construction activities, in accordance with the approved restoration plan for the site, began in November 2006 with site preparation, harvesting of root wads, and establishment of access sites and stockpile areas. Materials were stockpiled as needed for the initial stages of construction. Construction stakeout began in December 2006.

The next step was the grading of the floodplain areas to reach design grades across the site. Grade stakes were installed along design contours to direct the grading activities. The excavated material was stockpiled in specified areas near field ditches and existing channels that were to be filled. Where necessary, silt fencing was installed between stockpiles and the active ditches to prevent erosion of sediment into the channel.

Once the design floodplain grades were achieved, the new stream channel was sculpted and constructed in the dry. Construction of the stream channel began at the upstream end of M1 and moved in a downstream direction for the entire length of the channel. Upon completion of new channel segments, in-stream structures, matting, and transplants were installed. The new channel was then tied into the existing streambed and prepared to accept flow. Once fully prepared, temporary sediment traps at the downstream ends of the channels were removed, and water was directed into the newly constructed channel. Abandoned field ditches and remnant channels were immediately filled and graded. As-built cross-sections and longitudinal profiles are shown in Appendix B.

Modifications made during construction consisted of changes in the order of the construction sequence to increase efficiency during wet or high flow conditions. Other modifications involved the location and selection of in-stream structures and bank stabilization practices. Substitutions were made based on availability of materials and professional judgment. These changes are documented in the attached as-built drawings. The final as-built stream length for the project, as indicated on Table 2 and Sheet 1 in Appendix C, was 3,835 LF.

Table 2
Summary of As-built Lengths, Mitigation Units, and Restoration Approaches

Reach Name	As-built Length (ft)	Existing Length (ft)	SMU	Restoration Approach
M1	2,320	1,938	2,320	Restoration – Priority I and II
M2	1,515	1,396	1,515	Restoration – Priority II
Total Length	**3,835**	**3,334**	**3,835**	

2.0 Monitoring Plan

The five-year monitoring plan for the Crows West Site includes criteria to evaluate the success of the vegetation, wetland, and stream components of the project. The specific locations of vegetation plots, permanent cross-sections, and a crest gauge are shown on the as-built drawing sheets. Photo points are located at each of the grade control structures along the restored stream channel.

2.1 Stream Monitoring

Geomorphic monitoring of restored stream reaches will be conducted for five years to evaluate the effectiveness of the restoration practices. Monitored stream parameters include bankfull flows, stream dimension (cross-sections), pattern (longitudinal survey), profile (profile survey), and photographic documentation. The methods used and any related success criteria are described below for each parameter. For monitoring stream success criteria, nine permanent cross-sections, and one crest gauge were installed.

2.1.1 Bankfull Events

The occurrence of bankfull events within the monitoring period will be documented by the use of a crest gauge and photographs. A crest gauge was installed on the floodplain within 10 feet of Reach M2. The crest gauge will record the highest watermark between site visits and will be checked at each site visit to determine if a bankfull event has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits.

Two bankfull flow events must be documented at the crest gauge within the 5-year monitoring period. The two bankfull events must occur in separate years; otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years.

2.1.2 Cross-sections

For monitoring stream success criteria, nine permanent cross-sections were installed. Approximately two permanent cross-sections were installed per thousand LF of stream restoration work, with one located at a riffle cross-section and one located at a pool cross-section. Each cross-section was marked on both banks with permanent pins to establish the exact transect used. A common benchmark will be used for cross-sections and consistently referenced to facilitate comparison of year-to-year data. The annual cross-sectional survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen Stream Classification System.

There should be little change in the as-built cross-sections. If changes do take place they should be evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio).

2.1.3 Longitudinal Profile

A complete longitudinal survey was completed for the restored stream channels to provide a baseline for evaluating changes in bed conditions over time. The longitudinal profile included the elevations of all grade control structures. The permanent cross-section and longitudinal data are provided in Appendix B. A longitudinal profile will be completed in years one, three, and five of the monitoring period. The profile will be conducted for the entire length of the project, or for at least 3,000 LF of restored channel. Measurements will include thalweg, water surface, inner berm, bankfull, and top of low bank. All measurements will be taken at the head of each feature (e.g., riffle, run, pool, and glide) and the maximum pool depth. The survey will be tied to a permanent benchmark.

2.1.4 Benthic Macroinvertibrates

Benthic macroinvertebrate data will be collected from the reference reach and within the restored Crowns West project reaches. Post-restoration sampling will begin at least one year after construction activities have been completed, and annually thereafter for a total of three years. Sampling will be conducted each year during the same season as the pre-construction sampling. Sample collection follows protocols described in the standard operating procedures of the Biological Assessment Unit of the North Carolina Division of Water Quality (NCDWQ). The Qual-4 collection method is used for the collection of macroinvertebrate samples, and a North Carolina-certified laboratory performs the identification of the macroinvertebrate samples. The metrics calculated include total and Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness, EPT abundance and biotic index values.

2.1.5 Photo Reference Sites

Photographs will be used to document restoration success visually. Reference stations will be photographed immediately after construction and for at least five years following construction. Reference photos will be taken once a year, from a height of approximately five to six feet. Permanent markers will be established to ensure that the same locations (and view directions) on the site are monitored during each monitoring period. Selected site photographs are shown in Appendix A.

2.1.5.1 Lateral Reference Photos

Reference photo transects will be taken at each permanent cross-section. Photographs will be taken of both banks at each cross-section. The survey tape will be centered in the photographs of the bank. The water line will be located in the lower edge of the frame, and as much of the bank as possible will be included in each photo. Photographers should make an effort to consistently maintain the same area in each photo over time.

2.1.5.2 Structure Photos

Photographs will be taken at each grade control structure along the restored stream. Photographers should make every effort to consistently maintain the same area in each photo over time. Photographs will be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures subjectively. Lateral photos should not indicate excessive erosion or continuing degradation of the banks. A series of photos over time should indicate successive maturation of riparian vegetation.

2.2 Vegetation Monitoring

Successful restoration of the vegetation on a mitigation site is dependent upon active planting of preferred canopy species and volunteer regeneration of the native plant community. In order to determine if the criteria have been met, vegetation monitoring quadrants were installed across the restoration site, as directed by NCEEP. The number of quadrants required was based on the species/area curve method, as described in NCEEP monitoring guidance documents. A total of eleven plots were installed, which constitutes one percent of the total site. The size of individual quadrants was 100 square meters for woody tree species, and 1 square meter for herbaceous vegetation. Vegetation monitoring will occur in the fall of each year. Individual quadrant data will be provided and will include diameter, height, density, and coverage quantities. Individual seedlings will be marked such that they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

At the end of the first growing season, species composition, density, and survival will be evaluated. For each subsequent year, until the final success criteria are met, the restored site will be evaluated between July and November.

The interim measure of vegetative success for the site will be the survival of at least 320, 3-year old, planted trees per acre at the end of year three 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 five of the monitoring period.

2.3 Maintenance and Contingency Plan

Maintenance requirements vary from site to site and are generally driven by the following conditions:

- Projects without established, woody floodplain vegetation are more susceptible to erosion from floods than those with a mature, hardwood forest.
- Projects with sandy, non-cohesive soils are more prone to short-term bank erosion than cohesive soils or soils with high gravel and cobble content.
- Alluvial valley channels with wide floodplains are less vulnerable than confined channels.
- Wet weather during construction can make accurate channel and floodplain excavations difficult.
- Extreme and/or frequent flooding can cause floodplain and channel erosion.
- Extreme hot, cold, wet, or dry weather during and after construction can limit vegetation growth, particularly temporary and permanent seed.
- The presence and aggressiveness of invasive species can affect the extent to which a native buffer can be established.

Maintenance issues and recommended remediation measures will be detailed and documented in the monitoring reports. Factors that may have caused any maintenance needs, including any of the conditions listed above, shall be discussed. NCEEP approval will be obtained prior to any remedial action.

2.4 Monitoring Results – 2006 As-Built Data

The five-year monitoring plan for the Crowns West Site includes criteria to evaluate the success of the vegetation and stream components of the project. The specific locations of vegetation plots, permanent cross-sections, and crest gauge are shown on the as-built drawing sheets. Photo points, located at each of the grade control structures along the restored stream channel, are also located on the as-built drawing sheets.

2.4.1 Morphology

For monitoring stream success criteria, 9 permanent cross-sections, and 1 crest gauge were installed. The permanent cross-sections will be used to monitor channel dimension and bank erosion over time. The crest gauge will be used to document the occurrence of bankfull events. In addition, a complete longitudinal survey was completed for the restored stream channels to provide a base-line for evaluating changes in bed conditions over time. The longitudinal profile included the elevations of all grade control structures. The permanent cross-section and longitudinal data are provided in Appendix B. The location of the permanent cross-sections and the crest gauge are shown on the as-built plan sheets in Appendix C.

2.4.1.1 Results and Discussion

No results are available at the submittal of this report. Vegetation survival will be compared with first year monitoring data in the Year 1 Monitoring Report, scheduled for submittal to NCEEP during December 2007.

2.4.2 Vegetation

Bare-root trees were planted within all areas of the conservation easement. A minimum 30-foot buffer was established along all restored stream reaches. In general, bare-root vegetation was planted at a target density of 680 stems per acre, in an 8-foot by 8-foot grid pattern. Planting of bare-root trees was completed in March 2007. Species planted are summarized in Table 3.

Table 3
Vegetation Species Planted Across the Restoration Site

Scientific Name	Common Name	Percent Planted by Species	Total Number of Stems
Bare Root Trees Species			
Betula nigra	River Birch	15%	1,110
Celtis laevigata	Sugarberry	5%	370
Fraxinus pennsylvanica	Green Ash	7.5%	555
Juglans nigra	Black Walnut	5%	370
Nyssa sylvatica var. biflora	Swamp Tupelo	10%	740
Platanus occidentalis	Sycamore	20%	1,480
Quercus lyrata	Overcup Oak	10%	740
Quercus michauxii	Swamp Chestnut Oak	10%	740
Quercus phellos	Willow Oak	7.5%	555
Taxodium distichum	Bald Cypress	10%	7,40
Native Herbaceous Species			
Elymus virginicus	Virginia wildrye	15%	NA
Panicum virgatum	Switchgrass	15%	NA
Carex vulpinoidea	Fox sedge	5%	NA
Polygonum pennsylvanicum	Smart Weed	5%	NA
Juncus effusus	Soft rush	10%	NA
Carex lupulina	Hop sedge	10%	NA
Agrostis alba	Redtop	10%	NA
Bidens frondosa	Tick seed	10%	NA
Coreopsis lanceolata	Lance leaf coreopsis	10%	NA
Carex lurida	Shallow sedge	10%	NA
Woody Vegetation for Live Stakes			
Salix sericia	Silky Willow	40%	1,040
Cornus amomum	Silky Dogwood	40%	1,040

Table 3
Vegetation Species Planted Across the Restoration Site

Scientific Name	Common Name	Percent Planted by Species	Total Number of Stems
Sambucus canadensis	Elderberry	20%	520

The restoration plan for the Crowns West Site specifies that the number of quadrants required were based on the species/area curve method, as described in NCEEP monitoring guidance documents, with a minimum of three quadrants. The sizes of individual quadrants are 100 square meters for woody tree species, and 1 square meter for herbaceous vegetation. A total of 11 vegetation plots, each 10 meters by 10 meters in size, were established across the restored site. The initial planted density within each of the vegetation monitoring plots is given in Table 4. The average density of planted bare root stems, based on the data from the 11 monitoring plots, is 821 stems per acre. The locations of the vegetation plots are shown on the as-built plan sheets.

Table 4
Crowns West Initial Stem Counts for Each Species Arranged by Plot

	10m X 10m PLOTS										
Tree Species	1	2	3	4	5	6	7	8	9	10	11
Betula nigra											
Celtis laevigata											
Fraxinus pennsylvanica											
Juglans nigra											
Nyssa sylvatica var.biflora											
Platanus occidentalis											
Quercus lyrata											
Quercus michauxii											
Quercus phellos											
Taxodium distichum											
unknown	18	18	15	16	24	19	16	26	21	27	23
Totals:	18	18	15	16	24	19	16	26	21	27	23
Stems / Acre	729	729	607	648	972	769	648	1053	850	1093	931

*Bare root trees were left unidentified until leaf out to ensure proper identification.

2.4.2.1 Results and Discussion

No results are available at the submittal of this report. As-built data will be compared with first year monitoring data in the Year 1 Monitoring Report, scheduled for submittal to NCEEP during December 2007.

2.5 Areas of Concern

No areas of concern have been identified during the first months following completion of the project.

Appendix A

Selected Project Photographs

Crowns West As-built Photolog

3/21/2007
Photo Point 1 Constructed Riffle 1

3/21/2007
Photo Point 2 Log Weir 1

3/21/2007
Photo Point 3 Constructed Riffle 2

3/21/2007
Photo Point 4 Log Weir 2

3/21/2007
Photo Point 5 Log Weir 3

3/21/2007
Photo Point 6 Log Weir 4

3/21/2007
Photo Point 7 Constructed Riffle 3

3/21/2007
Photo Point 8 Log Weir 5

3/21/2007
Photo Point 9 Constructed Riffle 4

3/21/2007
Photo Point 10 Log Weir 6

3/21/2007
Photo Point 11 Constructed Riffle 5

3/21/2007
Photo Point 12 Constructed Riffle 6

3/21/2007
Photo Point 13 Constructed Riffle 7

3/21/2007
Photo Point 14 Constructed Riffle 8

3/21/2007
Photo Point 15 Constructed Riffle 9

3/21/2007
Photo Point 16 Constructed Riffle 10

3/21/2007
Photo Point 17 Constructed Riffle 11

3/21/2007
Photo Point 18 Constructed Riffle 12

3/21/2007
Photo Point 19 Constructed Riffle 13

3/21/2007
Photo Point 20 Constructed Riffle 14

3/21/2007
Photo Point 21 Constructed Riffle 15

3/21/2007
Photo Point 22 Constructed Riffle 16

3/21/2007
Photo Point 23 Constructed Riffle 17

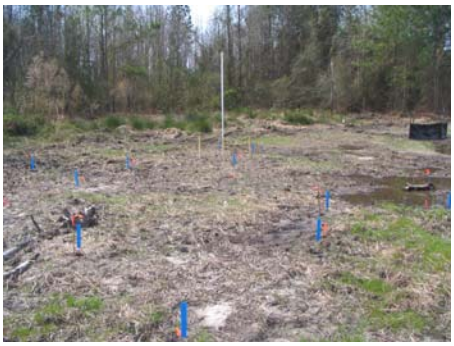
3/21/2007
Vegetation Plot 1

3/21/2007
Vegetation Plot 1

3/21/2007
Vegetation Plot 1

3/21/2007
Vegetation Plot 2

3/21/2007
Vegetation Plot 2



3/21/2007
Vegetation Plot 2

3/21/2007
Vegetation Plot 3

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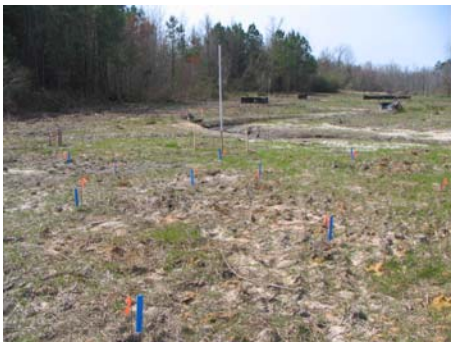
Vegetation Plot 3



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Vegetation Plot 3

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Vegetation Plot 7

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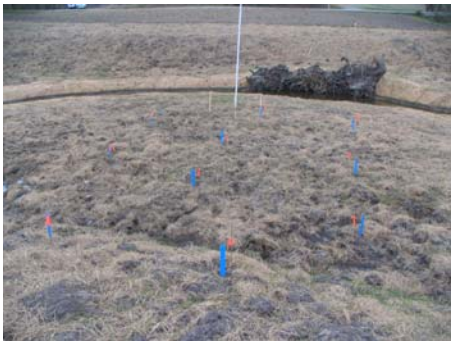
Vegetation Plot 7



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Vegetation Plot 7

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Vegetation Plot 8

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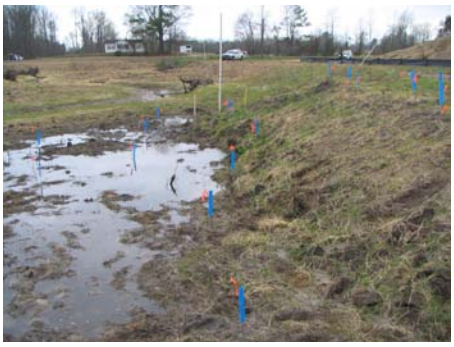
Vegetation Plot 8



3/21/2007
Vegetation Plot 8

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Vegetation Plot 9

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Vegetation Plot 9

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Vegetation Plot 9

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Vegetation Plot 10

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Vegetation Plot 10

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Vegetation Plot 10

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Vegetation Plot 11

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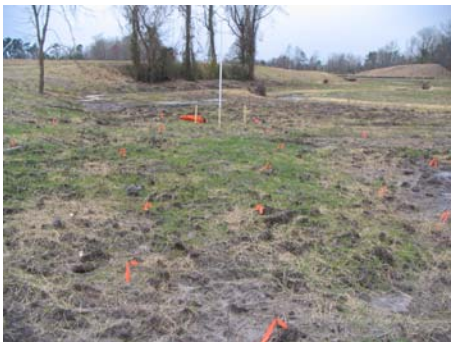
Vegetation Plot 11



3/21/2007
Vegetation Plot 11

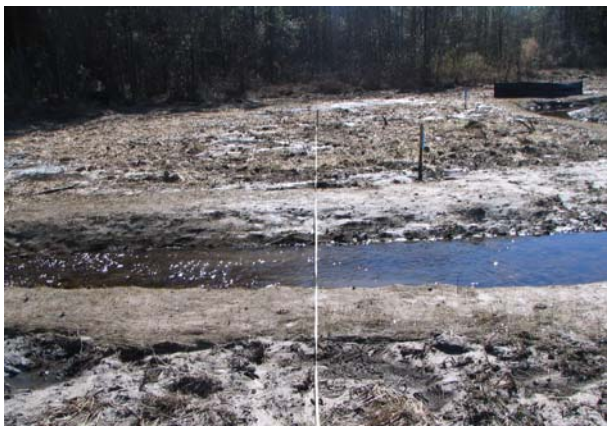
Appendix B

As-Built Cross-Sections and Longitudinal Profile

Permanent Cross-section 1

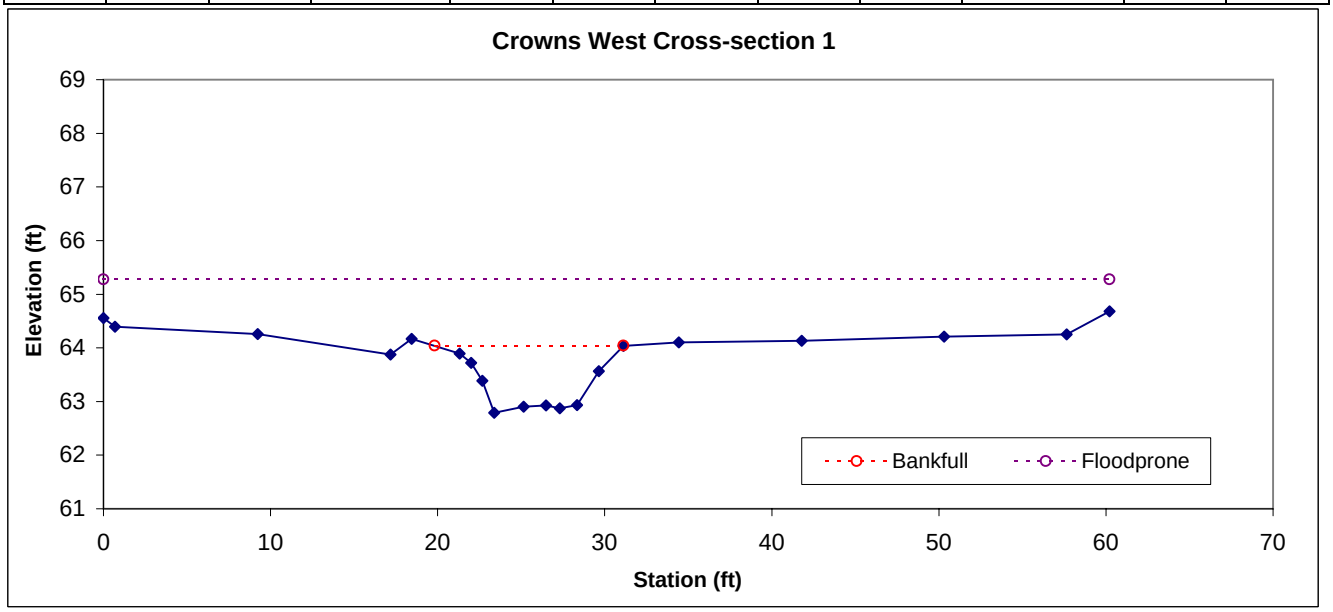
(As-Built Data - collected Feb. 2007)

Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Riffle	C	8.4	11.31	0.74	1.25	15.3	1	5.3	64.04	64.04	60.22



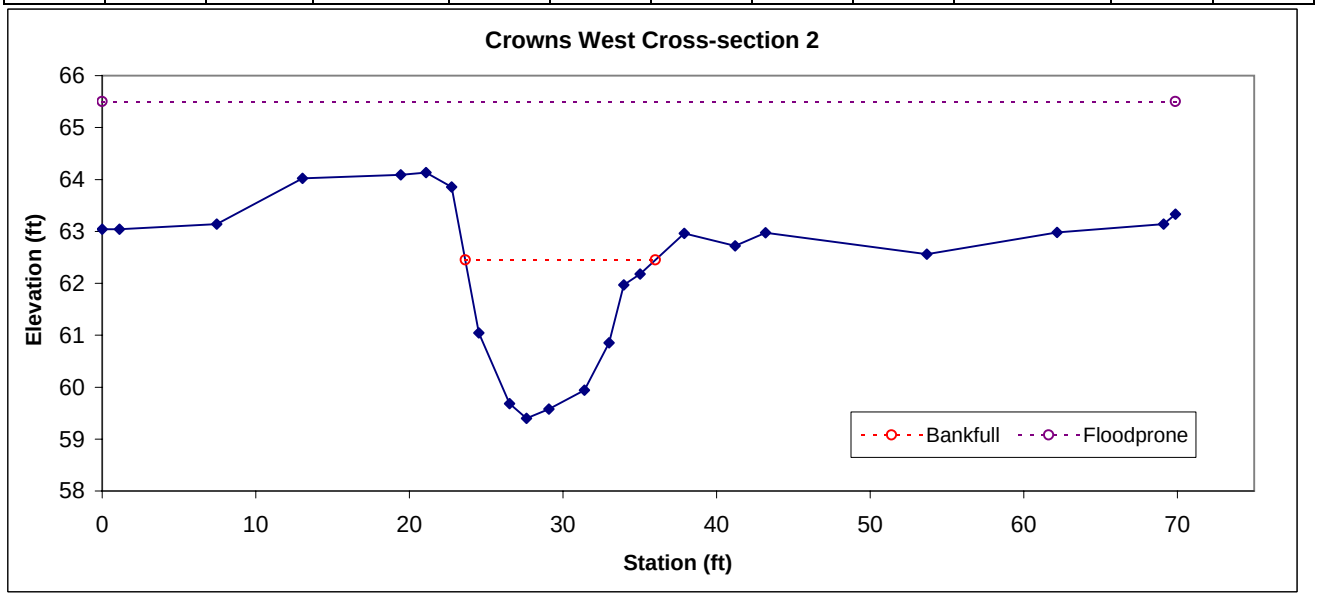
Permanent Cross-section 2

(As-Built Data - collected Feb. 2007)

Looking at the Left Bank

Looking at the Right Bank

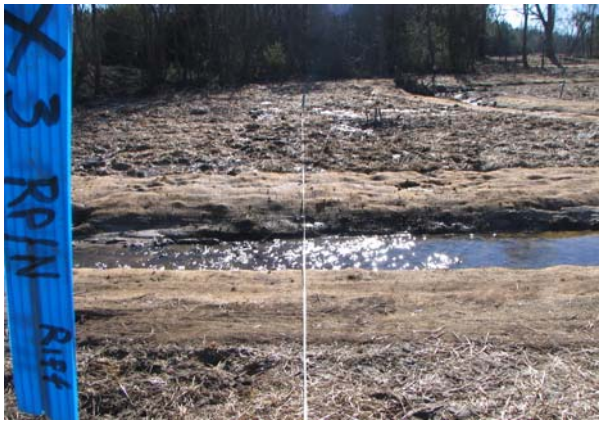
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Pool	E	23.3	12.38	1.89	3.05	6.57	1.2	5.6	62.45	62.96	69.87



Permanent Cross-section 3

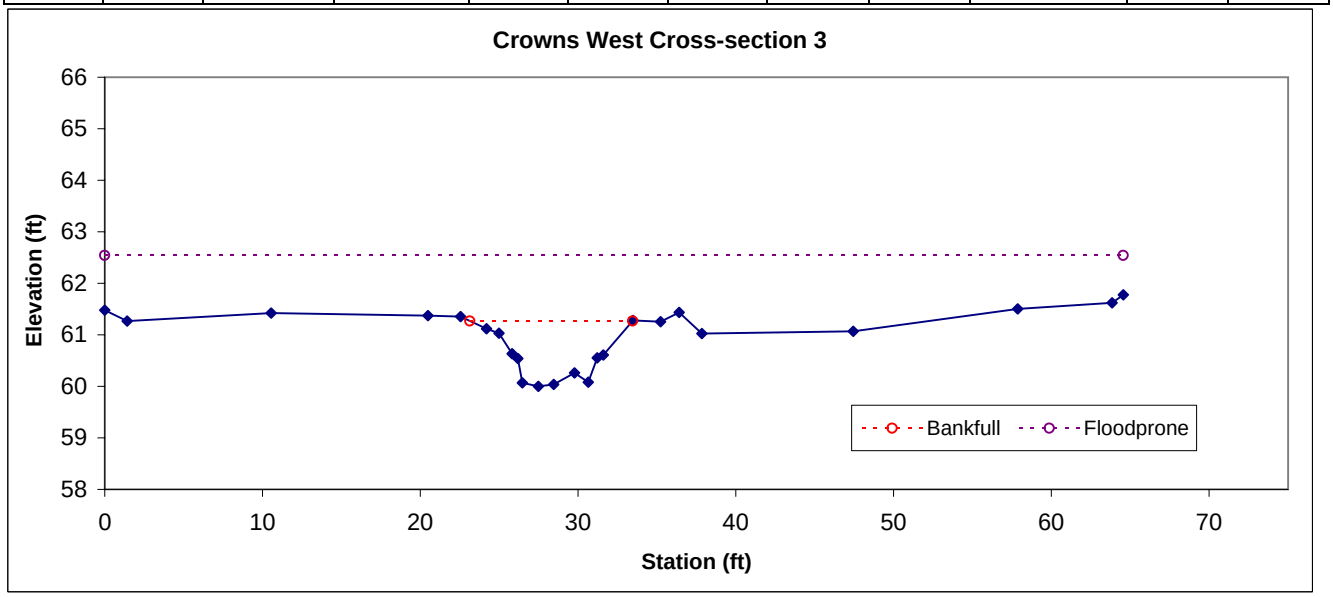
(As-Built Data - collected Feb. 2007)

Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Riffle	C	7.5	10.32	0.72	1.27	14.26	1	6.3	61.27	61.28	64.56



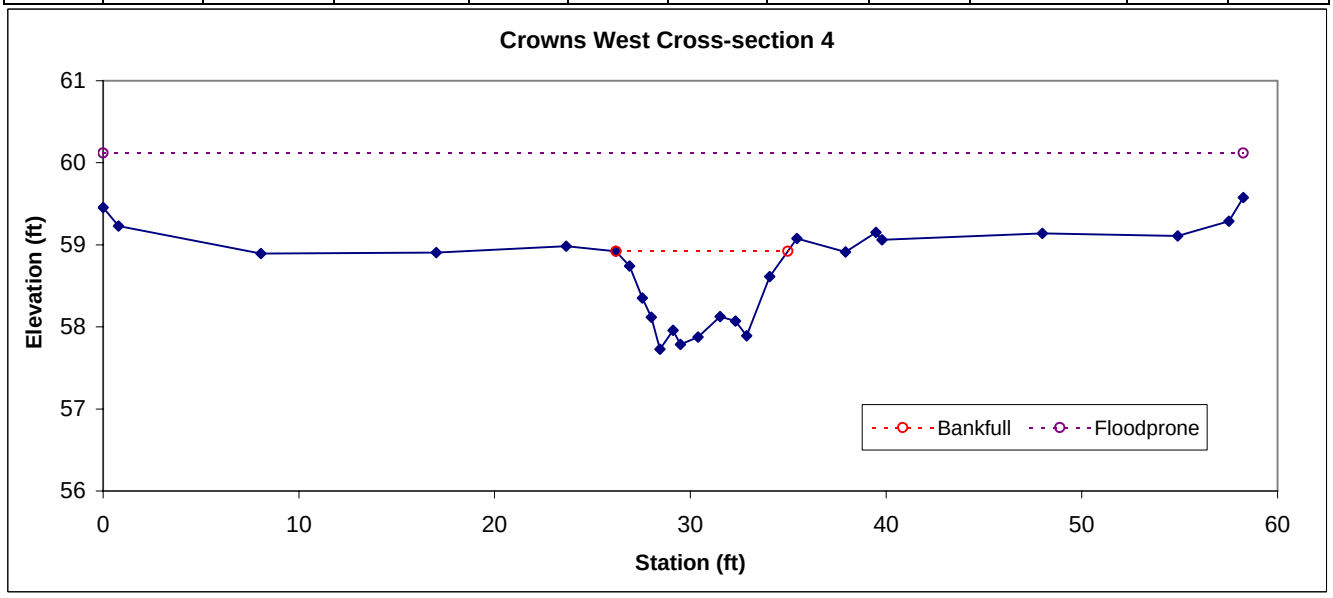
Permanent Cross-section 4

(As-Built Data - collected Feb 2007)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Riffle	C	6.3	8.79	0.72	1.2	12.19	1	6.6	58.92	58.92	58.25



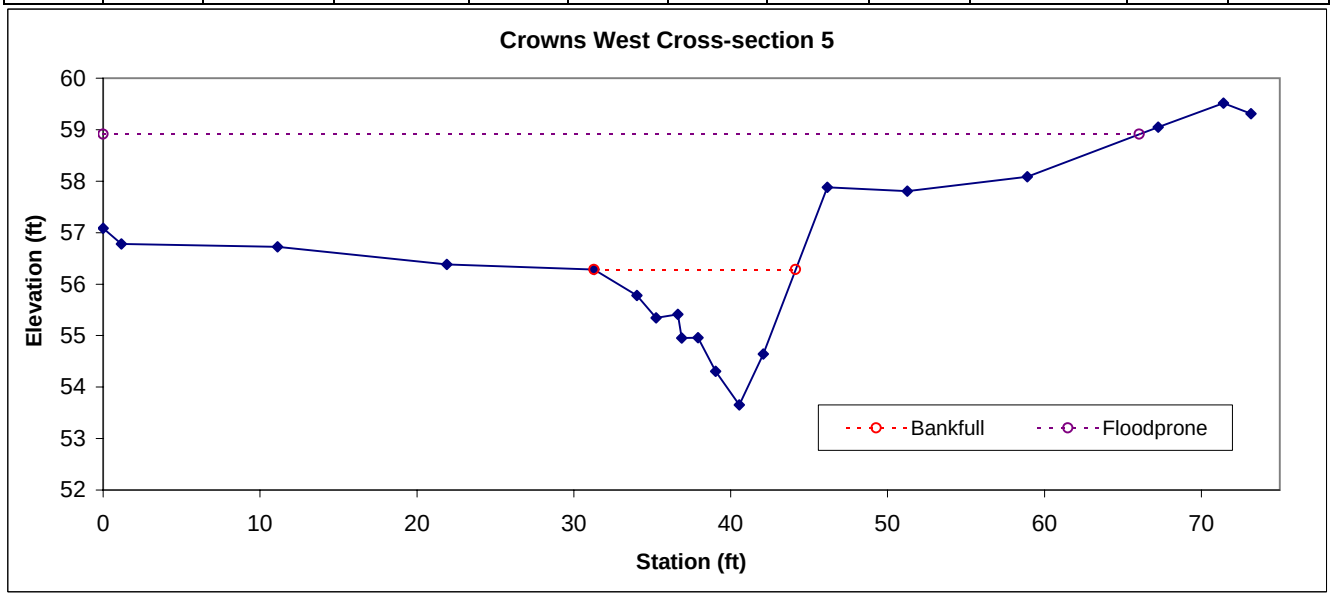
Permanent Cross-section 5

(As-Built Data - collected Feb. 2007)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Pool	E	14.7	12.84	1.15	2.63	11.2	1	5.1	56.28	56.28	66.04



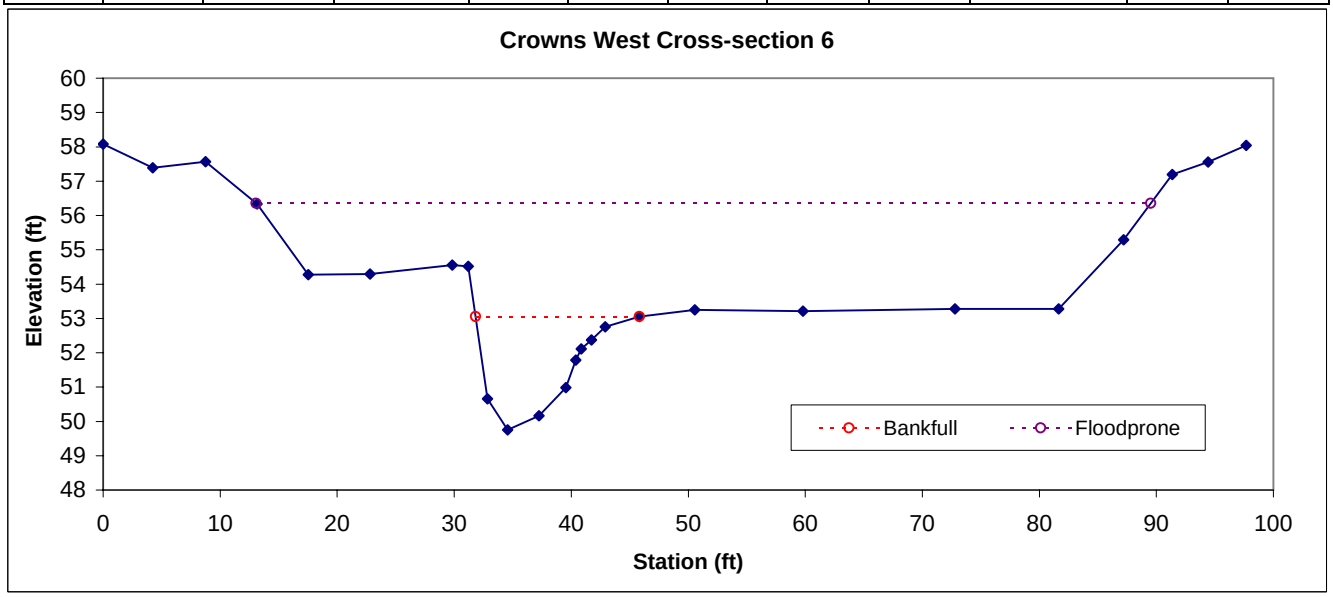
Permanent Cross-section 6

(As-Built Data - collected March 2007)

Looking at the Left Bank

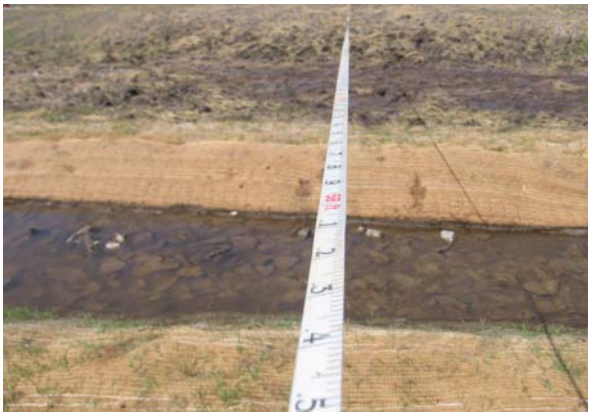
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Pool	E	23.8	14	1.7	3.3	8.24	1	5.5	53.05	53.05	76.44



Permanent Cross-section 7

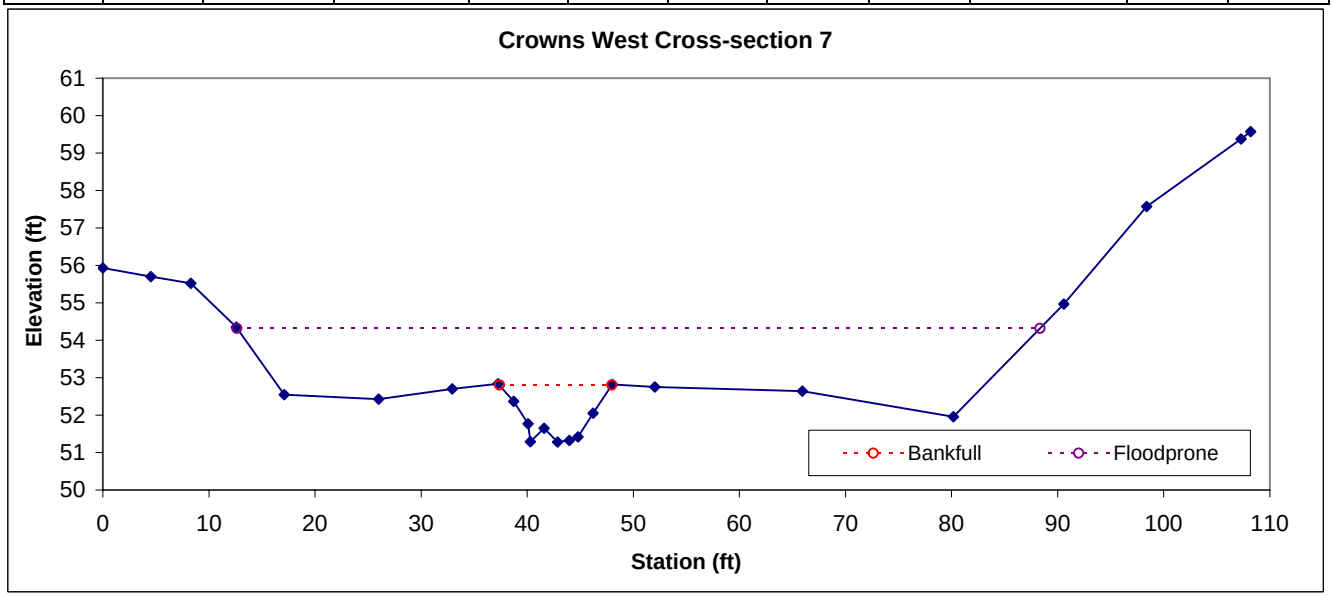
(As-Built Data - collected March 2007)



Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Riffle	E	10	10.6	0.94	1.52	11.25	1	7.1	52.8	52.82	75.71



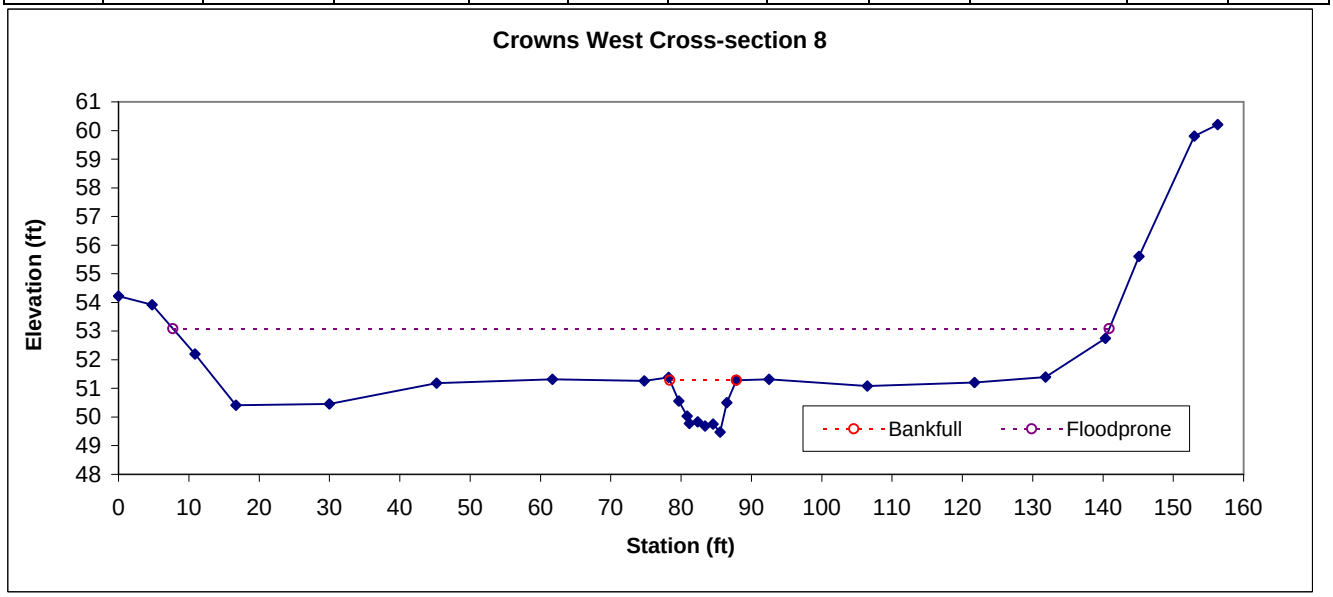
Permanent Cross-section 8

(As-Built Data - collected March. 2007)

Looking at the Left Bank

Looking at the Right Bank

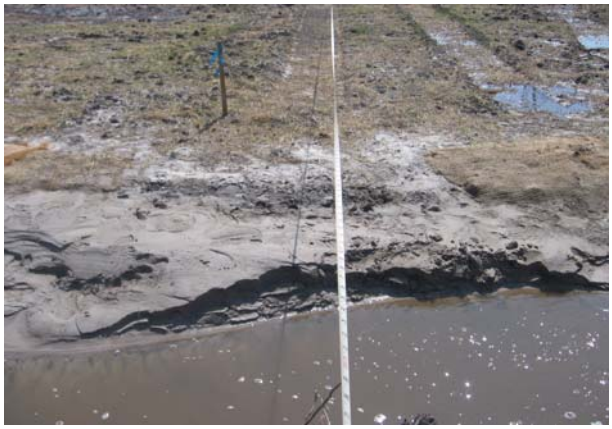
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Riffle	E	10.6	9.46	1.12	1.8	8.46	1	14.1	51.28	51.28	133.14



Permanent Cross-section 9

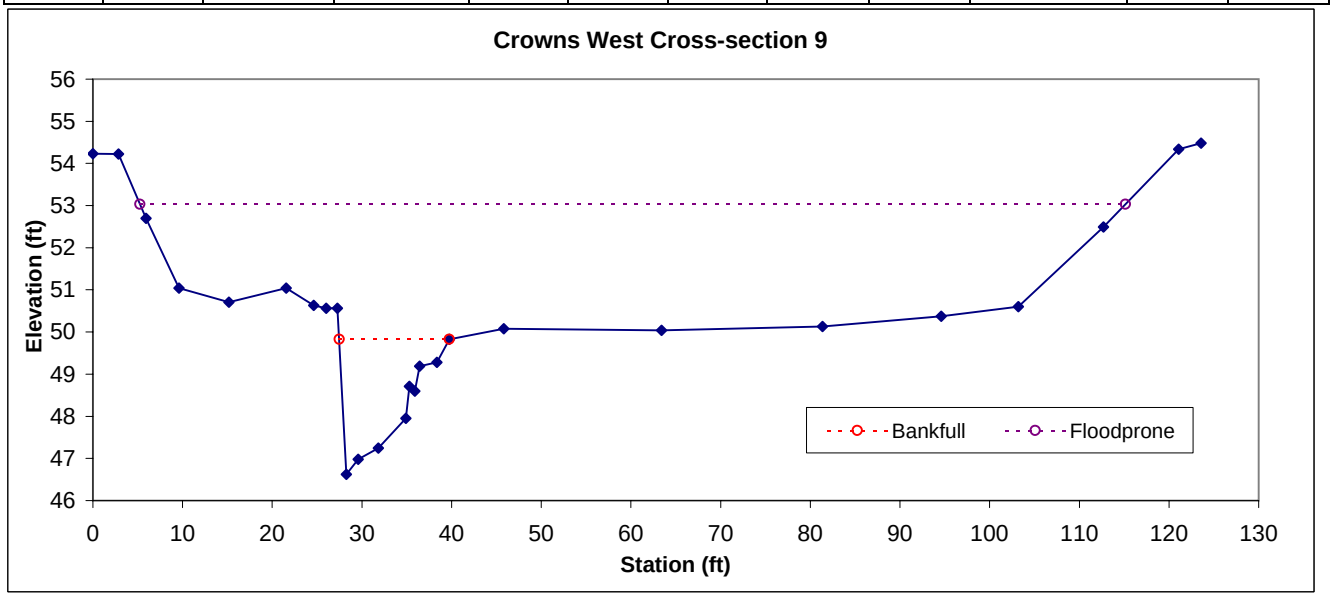
(As-Built Data - collected March. 2007)

Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	W-fpa
Pool	E	21.5	12.31	1.75	3.21	7.03	1	8.9	49.83	49.83	109.89



Appendix C

As-Built Plan Sheets