Johnson Site Stream Restoration
Mitigation Plan / As-Built Report
EEP Project # 197
2008

Submitted to:

Ecosystem Enhancement PROGRAM

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EXECUTIVE SUMMARY

The Johnson Site Stream Restoration restored 2,209 linear feet of channel on a dairy farm in Iredell County, NC, in the Upper Yadkin River Basin. The goals of the project included restoring stable channel morphology, improving water quality, and enhancing aquatic and terrestrial habitat. In order to reach these goals, the project objectives included building an appropriate B4c channel with stable dimensions; excluding livestock from the stream and riparian buffer; installing in-stream structures to promote bed feature diversity and prevent vertical instability, and planting a riparian buffer of native trees and shrubs.

The project reach is located within USGS Hydrologic Unit Code 03040102020030 and is in the NCDWQ Sub-basin 03-07-06. The North Carolina Ecosystem Enhancement Program (EEP) identifies this HUC as a Targeted Local Watershed. The site is located on a 197-acre parcel owned by Mrs. Lottie V. Johnson, which is located west of Harmony Highway (NC 21) and north of Hunting Creek Road (SR 1111) in rural Iredell County, North Carolina. The primary land uses on the property include a dairy operation, rangeland, agriculture (small grain), and forest. The unnamed tributary to Little Hunting Creek (UTLHC) is a first-order, perennial stream that drains in a south-southwest direction across the subject property before joining Little Hunting Creek. The restoration plan was approved in February 2006, construction was completed in November 2007, and the site was planted in December 2007.

Stream restoration included 2,209 linear feet of channel based on a Priority Level 3 approach. The restoration established a bankfull channel within the existing stream corridor/belt width through adjustments to the stream dimension and profile and minor adjustments to the planform. Cross vanes and rock sill grade control structures were used to control grade throughout the profile. The UTLHC was restored to a "B4c" stream type. The as-built survey and baseline monitoring found that there were minimal deviations from the designed cross-sections and profile. The pool cross-sections are slightly larger than designed, but this is not expected to affect stability. Visual monitoring revealed that sedimentation has occurred in some pools, while bed degradation has occurred in other isolated areas. Future monitoring will determine whether these pools will be capable of maintaining their designed depth. Other slight variations in the as-built conditions are documented within this report.

The riparian buffer was planted with three distinct planting zones at a density of 436 stems/acre, which is approximately 10'x10' spacing. Some substitutions were made due to the unavailability of certain tree species. The baseline vegetation monitoring found an average planting density of 440 stems/acre based on the seven plots established at the site.

The site will be monitored for at least five years beginning in 2008 through 2012 or until the success criteria are achieved. Reports will be submitted to the EEP each year. Monitoring shall consist of the collection and analysis of stream stability and riparian/stream bank vegetation survivability data. Specifically, project success will be assessed utilizing measurements of stream dimension, pattern, profile, site photographs, and vegetation sampling. Cross-section and profile measurements should show little or no change from the as-built conditions. If changes do occur, they will be evaluated to determine whether they are minor adjustments associated with settling and increased stability or whether they indicate movement toward an unstable condition. Baseline monitoring of the as-built conditions was conducted in December 2007 and January 2008. Riparian vegetation must meet a minimum survival success rate of 260 stems/acre after five years. If monitoring indicates that the specified survival rate is not being met, corrective actions will be taken. Further baseline monitoring conditions are described in this report.

1.0 PROJECT BACKGROUND

1.1 Location and Setting

The Johnson Site Stream Restoration is located approximately three miles north of the Town of Harmony on Hunting Creek Road and is approximately 500 ft west of the intersection with US 21 (Harmony Highway) in Iredell County, North Carolina. From Raleigh, take I-40 west to Winston-Salem. Take exit 188 onto US 421 west. Approximately six miles after passing Yadkinville take the exit for US 21 (Harmony Highway). Travel south on US 21 for approximately eight miles. Turn right onto Hunting Creek Road after passing the Johnson Dairy Farm on the right. The culvert on Hunting Creek Road bisects the project stream (Figure 1).

1.2 Project Goals and Objectives

The goals and objectives of the Johnson Site Stream Restoration Project are as follows:

Restoration Goals:

- Restore a stable channel that is capable of moving the flows and sediment provided by its watershed.
- Improve water quality and reduce land and riparian vegetation loss resulting from lateral erosion and bed degradation.
- Enhance aquatic and terrestrial habitat.

Restoration Objectives:

- Build an appropriate B4c type channel with stable dimensions.
- Plant a riparian buffer of native trees and shrubs.
- Install in-stream structures that will promote bed feature diversity and prevent vertical instability.
- Exclude livestock from the riparian buffer.

1.3 Project Structure, Restoration Type and Approach

The project stream, an Unnamed Tributary to Little Hunting Creek (UTLHC), became impaired from poor grazing management. Sedimentation from bank erosion and stream bed degradation were widespread throughout the site. In many parts of the existing channel, the livestock had trampled the stream banks so that there did not appear to be an existing defined channel. The livestock impacts also ruined any natural stream planform so that any existing meanders were almost imperceptible. Restoration of the existing 2,156 linear feet of channel was based on a Priority Level 3 approach (Table 1). UTLHC was restored to a B4c stream type. The design maintained a bed elevation similar to the existing stream, adding distinct pools and riffles while incorporating the existing bedrock into the new profile. The new stream cross-section dimensions were designed to accommodate the bankfull flow and maintain the sediment transport regime. The width/depth ratio for the restored channel was designed to be slightly less than a typical B4c stream to accurately reflect a combination of the reference reach conditions and the setting of the restored stream, which is in a slightly confined valley. This lower width/depth ratio will also help the restored stream move more of the fine sediment through the channel at low flows. The design bankfull stage equals the top of bank (bank height ratio = 1.0), which is where the valley begins at a 2:1 or 3:1 slope, depending on the location. Although the designed discharge of 22 cfs is slightly higher than the Piedmont Rural regional curve would indicate for the site's drainage size, this will accommodate the slightly higher discharge that the watershed produces given that over half of it has been cleared for agriculture. The stream pattern was reconstructed to create distinct meanders to correspond with the restored profile and incorporate the existing valley morphology. The stream dimension, pattern, and profile are based on the morphological criteria and hydraulic geometry relationships developed from the reference streams. Photos depicting the restored channel, profile, and planform can be found in Appendix E. Two tributaries, one starting at a groundwater seep and the other draining a farm pond, were also stabilized during construction. These two tributaries enter the project stream at the upstream portion of the project.

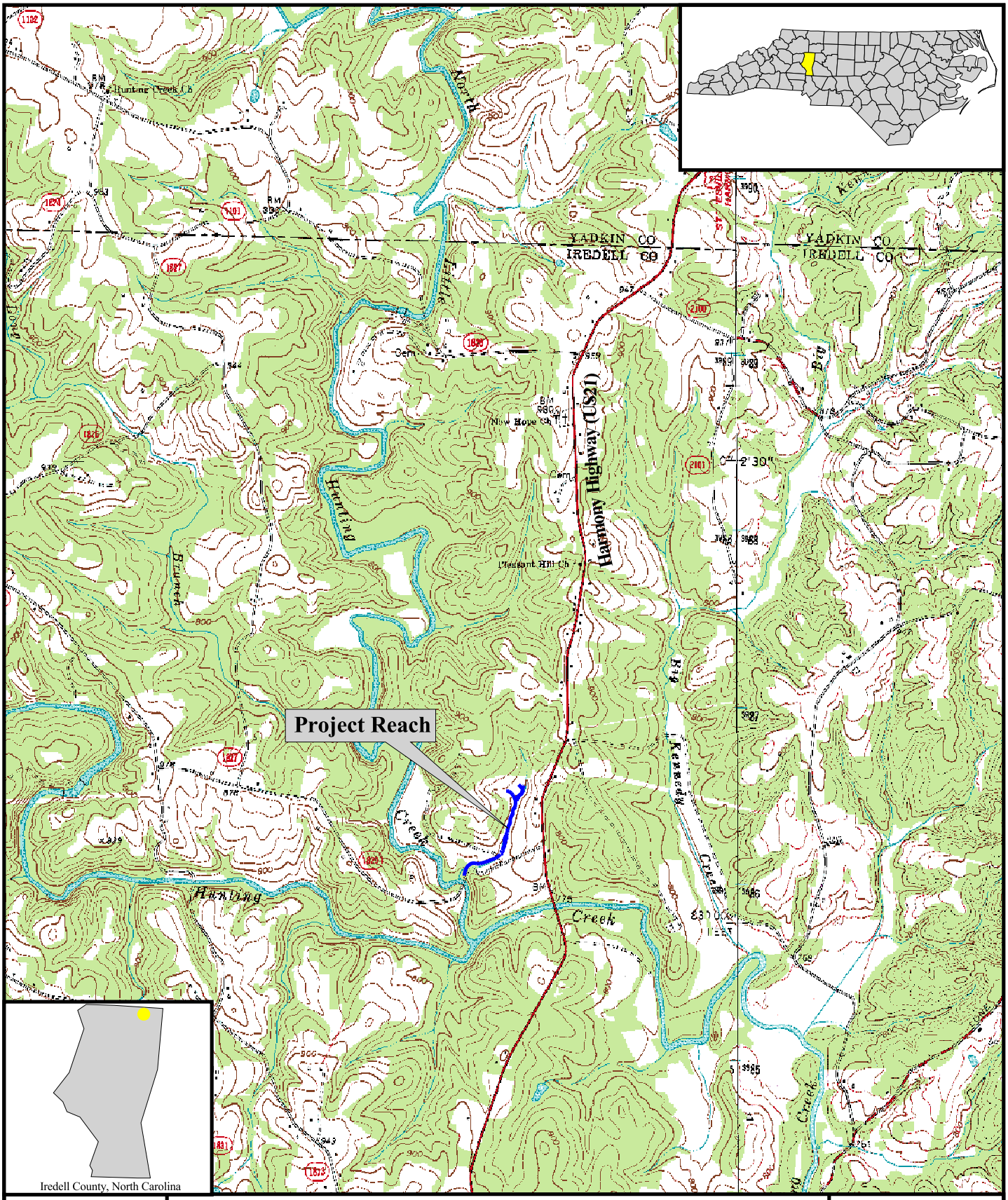

Figure 1. Vicinity Map **Johnson Site**

Project Reach Location

N

1000 0 1000 2000 Feet

Source: Brooks Crossroads and Lone Hickory USGS 7.5' Topographic Quadrangles

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Table I. Project Restoration Components Project Name and Number: Johnson Site - 197						
Project Segment / Reach ID	**Existing Feet/Acres**	**Type**	**Approach**	**Footage or Acreage**	**Stationing**	**Comment**
UTLHC	2,156	R	P3	2,209	10+00 - 32+09	Project length includes a 27-foot wide easement exception

R = Restoration P3 = Priority 3

1.4 Project History, Contacts and Data

The project was initiated by the North Carolina Department of Transportation in 2002. In that same year, a feasibility study was conducted for the site. After the feasibility study was completed, the site was transferred to the North Carolina Ecosystem Enhancement Program (EEP) and the restoration plan was produced. Design of the project was completed in October 2006 and construction began in August 2007 (Tables II & III).

The project watershed drains approximately 0.17 square mile (111 acres) and forms part of the headwaters of the High Rock Lake Drainage area. The project watershed is located west of US 21 near the Iredell and Yadkin County Line. An Anderson Level I classification indicates that the contributing drainage area consists of: forest (43%), rangeland (34%), agriculture (19%), urban (3%), and wetlands / open water (<1%) land use / land cover. The site is located in a rural setting within the Northern Inner Piedmont ecoregion of the Piedmont physiographic province (Table IV).

Table II. Project Activity and Reporting History Project Name and Number: Johnson Site - 197		
Activity or Report	**Data Collection**	**Completion or Delivery**
Feasibility Study	Dec 02	Jun 03
Restoration Plan	Nov 05	Feb 06
Final Design - Construction Plans	N/A	Nov 05
Construction	N/A	Nov 07
Temporary seed mix applied to entire project area	N/A	Nov 07
Permanent seed mix applied to entire project area	N/A	Nov 07
Tree plantings completed	N/A	Dec 07
Mitigation Plan / As-Built (Year 0 Monitoring - Baseline)	Dec 07	Jun 08

Table III. Project Contact Table Project Name and Number: Johnson Site - 197	
Design Firm	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 783-9214 Fax: (919) 783-9266
Construction Contractor	Quartermaster Environmental Inc. P.O. Drawer 400 Shelby, NC 28150 Contact: Mr. Brooks Cole Phone: (704) 473-5021
Planting Contractor	Carolina Wetland Services 550 E. Westinghouse Blvd. Charlotte, NC 28273 Contact: James Collins Phone: (704) 527-1177 Fax: (704) 527-1133
Seeding Contractor	Quartermaster Environmental Inc. P.O. Drawer 400 Shelby, NC 28150 Contact: Mr. Brooks Cole Phone: (704) 473-5021
Seed Mix Sources	Ernst Conservation Seed Meadville, PA Phone: (814) 336-2404
	Green Resource LLC Colfax, NC Phone: (336) 855-6363
Nursery Stock Suppliers	South Carolina Forestry Commission Trenton, SC Phone: (803) 275-5227
	International Paper Blenheim, SC Phone: (843) 528-3203
As-Built Surveyor	Level Cross Surveying, PLLC 668 Marsh Country Lane Randleman, NC 27317 Contact: Mr. Robert Kirkman Phone: (336) 495-1713 Fax: (336) 495-1745
Monitoring Performers	
MY-00	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 783-9214 Fax: (919) 783-9266

Table IV. Project Background Table Project Name and Number: Johnson Site - 197	
Project County	Iredell County
Physiographic Region	Piedmont
Ecoregion	Northern Inner Piedmont
Project River Basin	Upper Yadkin
USGS HUC for Project	03040102020030
NCDWQ Sub-basin for Project	03-07-06
Drainage Area	0.17 sq. mi.
Stream Order	First Order
Watershed Type (Rural, Urban, Developing, etc.)	Agriculture, Forested
Watershed LULC Distribution	
Urban	3%
Ag-Row Crop	19%
Ag-Livestock	34%
Forested	43%
Open Water	<1%
Watershed impervious cover (%)	3%
Rosgen Classification of As-built	B4c
Reference Site ID	UT to Fisher River
NCDWQ AU/Index Number	12-108-16-6 (Little Hunting Creek)
NCDWQ Classification for Project and Reference	WS-III - Project Stream
	N/A - Reference Stream
Within EEP Watershed Plan?	No
Any portion of any project segment 303d listed?	No
Any portion of the project segment upstream of a 303d listed segment?	Yes, South Yadkin River
Reasons for 303d Listing or Stressor	Turbidity
Total project acreage of easement	9.8 Acres
Total vegetated acreage within easement	9.5 Acres
Total planted acreage	7.4 Acres
WRC Class (Warm, Cool, Cold)	warm
Trout Designation	No
Species of concern, endangered etc.	N/A
Pre-construction Beaver activity?	No
Dominant Soil Types	Cecil soils
Project soil characteristics	Cecil variants, with Chewacla and Colfax and other sandy loams
% of Project Easement Fenced	100%

2.0 PROJECT MONITORING / AS-BUILT CONDITIONS

2.1 Monitoring Features

Permanent monuments, marking monitoring feature locations, were established on-site. The beginning and end of each permanent cross-section was marked with rebar set in concrete monuments. Vegetation plots were installed with flagged metal conduit at each corner and flagged PVC pipe at the photo corner. The locations of the permanent photo points are marked in the Monitoring Plan View (Appendix A).

2.2 Monitoring Guidelines

Five permanent cross-sections, three riffles and two pools, were established and will be used to evaluate stream dimension. Pebble counts will be performed at each cross-section. Cross-sections will be surveyed each year using a total station and data such as area and width to depth ratio will be calculated. Longitudinal profile will be conducted on UTLHC. The profile will be surveyed with a total station and will record feature changes, water surface levels, and bankfull elevations. These data will be used to obtain feature lengths and slopes, pool-to-pool spacing and other longitudinal measurements. The tributaries will be visually monitored each year. Stem counts of planted trees and shrubs will be conducted in the seven vegetation monitoring plots, which were established following the CVS-EEP Protocol for Recording Vegetation Version 4.0 (Lee et al. 2006. http://cvs.bio.unc.edu/methods.htm). Visual monitoring of the entire site will be conducted with annual site walks and site photos will be taken from twelve permanent photo points located throughout the site.

2.3 As-Built Conditions

2.3.1 Stream

Baseline stream monitoring data were collected in December 2007. These data are included in Tables V and VI and Appendices C, D and E.

The final design plans for the project stream called for 32 riffles and 25 pools. The baseline monitoring counted 32 riffles and 22 pools. The discrepancy between the number of pools stems from sedimentation post-construction that occurred before ground cover had stabilized the soils. Future monitoring will determine whether these pools will be capable of maintaining their designed depth. The designed structures, which serve as grade control, are located as depicted in the plans. The as-built survey and baseline monitoring found that there were minimal deviations from the designed cross-sections, profile, and planform.

The as-built sediment data reflects that the fine materials that dominated the existing stream have begun to wash through the restored stream more efficiently. This is apparent from the fewer silt counts in the as-built pebble counts. The existing stream had a layer of fine sediment that covered much of the bed as a result of the sedimentation from the livestock impacts. The restored channel should have fewer fine sediment inputs and the embedded gravel and cobble bottom should become more visible. The restored channel should transition to a gravel dominated stream as it settles.

The stream depicted in the monitoring plan view was stationed in CAD software using the as-built survey centerline data. The stationing for the detailed longitudinal profile in Appendix D was generated in Microsoft Excel from the total station survey data of the detailed longitudinal profile.

Table V. Baseline Stream Summary
Project Name and Number: Johnson Site - 197

Parameter	Pre-Existing Condition					Reference Reach Data					Design		As-built				
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Mean	Med	Max	n
Bankfull Width (ft)	4.0	9.4	8.4	15.0	6	9.0	9.5		10.0	2	8.4		8.2	8.5	8.7	8.7	3
Floodprone Width (ft)	7	13	12	21	6	13	17		21	2	10	11	15	17	18	18	3
Bankfull Mean Depth (ft)	0.5	0.8	0.8	1.0	6	1.1	1.2		1.2	2	0.8		0.9	1.0	0.9	1.1	3
Bankfull Max Depth (ft)	0.7	1.2	1.2	1.7	6	1.3	1.4		1.5	2	0.9	1.0	1.1	1.2	1.1	1.4	3
Bankfull Cross-Sectional Area (ft^2)	3.5	6.7	6.5	7.4	6	10.4	10.6		10.7	2	7.0		7.2	8.2	7.6	9.7	3
Width/Depth Ratio	4.2	14.3	10.7	30.1	6	8.0	10.0		12.0	2	10.0		7.7	9.0	9.4	10.0	3
Entrenchment Ratio	1.1	1.4	1.3	5.4	6	1.3	1.8		2.3	2	1.3	2.3	2.0	2.0	2.0	2.1	3
Bank Height Ratio	2.6	5.2	5.1	9.1	6	0.9	1.5		2.1	2	1.0		1.0	1.0	1.0	1.0	3
Bankfull Velocity (fps)	1.9	3.1	3.2	5.2	6	4.1	4.3		4.5	2	3.1	3.6					
Pattern																	
Channel Beltwidth (ft)		30					45				38	42	16	26	23	39	9
Radius of Curvature (ft)	11			20		13			42		11	37	16	27	28	41	14
Rc:Bankfull width (ft/ft)	0.7			5		1.3			4.4		1.3	4.4	1.9	3.2	3.3	4.8	14
Meander Wavelength (ft)	40			140		93			136		76	126	47	69	70	97	10
Meander Width Ratio	2			7.5		4.5			5		4.5	5.0	1.9	3.1	2.7	4.6	9
Profile																	
Riffle Length (ft)													16	44	43	86	32
Riffle Slope (ft/ft)	0.0070			0.0860*		0.0130			0.0280		0.0100	0.0220	0.0025	0.0198	0.0170	0.0888*	32
Pool Length (ft)	2			15		3			25		3	21	3	9	8	36	22
Pool Spacing (ft)	15			132		30			59		28	50	18	102	68	364	22
Substrate and Transport Parameters																	
SC% / Sa% / G% / C% / B% / Be%	26% / 39% / 30% / 2% / - / 3%					0.5% / 18.5% / 77% / 4% / - / -							13.7% / 46.3% / 37.7% / 0.7% / - / 1.7%				
d16 / d35 / d50 / d84 / d95 / di^p / di^{sp} (mm)	<0.062 / 0.15 / 0.31 / 12.1 / 48 / - /-					1.6 / 4.0 / 6.7 / 34 / 60 / - / -							0.1 / 0.2 / 1.3 / 20 / 37 / - / -				
Reach Shear Stress (competency) lb/ft^2											0.95		1.01				
Additional Reach Parameters																	
Channel length (ft)	2,260										2,156		2,209				
Drainage Area (mi^2)	0.17					0.37					0.17		0.17				
Rosgen Classification	F5/B5c/G5c					B4c					B4c		B4c				
Bankfull Discharge (cfs)	22					44					22		22				
Sinuosity	1.1					1.2					1.1		1.1				
Water Surface Slope (ft/ft)	0.018					0.013					0.019		0.018				
BF slope (ft/ft)	0.019					0.016					0.019		0.019				

*Maximum value includes bedrock steps

Table VI. Morphology and Hydraulic Monitoring Summary
Project Name and Number: Johnson Site - 197

Parameter	Cross-Section 1 Riffle			Cross-Section 2 Pool			Cross-Section 3 Riffle			Cross-Section 4 Riffle			Cross-Section 5 Pool		
Dimension	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2
Current Bankfull Width (ft)	8.7			11.0			8.2			8.7			9.0		
Current Floodprone Width (ft)	18.0			25.7			14.7			17.6			21.0		
Current Bankfull Mean Depth (ft)	0.9			1.2			0.9			1.1			1.3		
Current Bankfull Max Depth (ft)	1.1			2.0			1.1			1.4			2.2		
Current Bankfull Cross-Sectional Area (ft^2)	7.6			13.7			7.2			9.7			11.9		
Current Bankfull Width/Depth Ratio	10.0			8.9			9.4			7.7			6.8		
Current Bankfull Entrenchment Ratio	2.1			2.3			2.0			2.0			2.3		
Current Bankfull Bank Height Ratio	1.0			1.0			1.0			1.0			1.0		
As-built Bkf Elevation Width (ft)	8.7			11.0			8.2			8.7			9.0		
As-built Bkf Elevation Floodprone Width (ft)	18.0			25.7			14.7			17.6			21.0		
As-built Bkf Elevation Mean Depth (ft)	0.9			1.2			0.9			1.1			1.3		
As-built Bkf Elevation Max Depth (ft)	1.1			2.0			1.1			1.4			2.2		
As-built Bkf Elevation Cross-Sectional Area (ft^2)	7.6			13.7			7.2			9.7			11.9		
As-built Bkf Elevation Width/Depth Ratio	10.0			8.9			9.4			7.7			6.8		
As-built Bkf Elevation Entrenchment Ratio	2.1			2.3			2.0			2.0			2.3		
As-built Bkf Elevation Bank Height Ratio	1.0			1.0			1.0			1.0			1.0		
Cross-Sectional Area between cross-section end pins (ft^2)*	66			165			180			128			108		
Substrate															
d50 (mm)	0.095			0.44			3.2			1.3			0.26		
d84 (mm)	8.8			10			26			20			0.45		
Channel Length (ft)	2,209														
Sinuosity	1.1														
Water Surface Slope (ft/ft)	0.018														
BF Slope (ft/ft)	0.018														
Rosgen Classification	B4c														

*Area taken from lowest pin elevation

There is a discrepancy between the existing linear footage being slightly longer than both the designed and as-built stream that is due to the method of stationing the existing stream. Because the existing stream lacked a distinct channel centerline in places, the thalweg was used to station the stream instead. In many of the areas where there was no defined channel due to livestock impacts, the thalweg was highly sinuous through unconsolidated soil. This method of stationing made the total length of the existing stream seem longer than the designed stream even though this was not the case.

The entire easement has been fenced except for a narrow portion of easement immediately upstream of the farm road crossing near Station 23+25. Special attention should be paid to this area to make sure that the terms of the easement are not being violated. Some of the easement fencing upstream of the farm road crossing is electrified.

2.3.2 Vegetation

Baseline vegetation monitoring data were collected in January 2008. A total of 7 vegetation monitoring plots were established. All plots followed the CVS-EEP Protocol for Recording Vegetation Version 4.0 (Lee et al. 2006. http://cvs.bio.unc.edu/methods.htm). Plot photos can be found in Appendix B.

Results of baseline monitoring include an average of 440 trees per acre (see Appendix B). The planting plan was followed with the exception of approved substitutions for tree species that were unavailable at the time of planting. The substitutions replaced *Acer negundo* with additional *Fraxinus pennsylvanica* and *Betula nigra, Hamamelis virginiana* with additional *Liriodendron tulipifera* and *Asimina triloba*, *Carya cordiformis* with additional *Carya glabra*, *Quercus rubra* with additional *Quercus falcata* and *Quercus prinus*, *Juglans nigra* with additional *Quercus prinus* and *Carya glabra*, and *Helsia carolina* with additional *Liriodendron tulipifera* and *Quercus falcata*.

3.0 SUCCESS CRITERIA

3.1 Channel Stability

Stream restoration involves altering an impaired morphology to better approximate a stable stream type and reference and verifying the design form against process-based assessments. The morphologic contribution to uplift in hydrologic, water quality and habitat functions stem from two main morphologic objectives. The first being the maintenance of a restored valley connection and associated dimension that facilitates the transport of in-stream sediment loads in equilibrium and dissipates energy associated with flood flows. The second is the maintenance of a longitudinal profile/gradient, which supports these same transport and energy management outcomes. In concert with adequate vegetation, these objectives promote the lateral and vertical stability that permits maintenance of in-stream habitat (bedform), reduces water quality stressors to the reach and watershed in the form of bank sediment export reductions and better manages storm flow energies.

Restored streams should therefore demonstrate morphologic stability to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that is also to be expected. However, the observed change should not be unidirectional such that it represents a robust trend. If some trend is evident, it should be very modest or indicate migration to another stable form. Annual variation is to be expected, but over time this should demonstrate maintenance around some acceptable baseline with maintenance of or even a reduction in the

amplitude of variation. Lastly, all of this must be evaluated in the context of hydrologic events to which the system is exposed (EEP, 2008).

3.2 Dimension

General maintenance of a stable cross-section and hydrologic access to the floodplain features over the course of the monitoring period will generally represent success in dimensional stability. However, some change is natural and expected and can even indicate that the design was successful and appropriate for the hydrologic and sediment regime. Examples include depositional processes resulting in the development of constructive features on the banks and valley slopes, such as an inner berm, a slightly narrower channel, modest natural levees, and general valley deposition.

For stream dimension, cross-sectional overlays and key parameters such as cross-sectional area, and the channel's width to depth ratios should demonstrate modest overall change and patterns of variation that are in keeping with the descriptions in section 3.1. Significant widening of the channel cross-section or trends of increase in the cross-sectional area generally represent concern, although some adjustment in this direction is acceptable if the process is arrested after a period of modest adjustment. In the case of riffle cross sections, maintenance of depths that represent small changes to target competency (e,g, consistently low BHRs <1.2) would also reflect stability.

Although a pool cross-section may experience periodic infilling due to watershed activity and the timing of events relative to monitoring, the majority of pools within a project stream reach/component should demonstrate maintenance of greater depths and low water surface slopes over time. The habitat aspect (depth) of the pool cross-sections need to be maintained over time and the rates of lateral migration need to be moderate (EEP, 2008).

3.3 Pattern and Profile

For the channels' profile, the reach under assessment should not demonstrate any trends in thalweg aggradation or degradation over any significant continuous portion of its length. Over the monitoring period, the profile should also demonstrate the maintenance or development of bedform (facets) more in keeping with reference level diversity and distributions for the stream type in question. It should also provide a meaningful contrast in terms of bedform diversity against the pre-existing condition. Bedform distributions, riffle/pool lengths and slopes will vary, but should do so with maintenance around design distributions. This requires that the majority of pools are maintained at greater depths with lower water surface slopes and riffles are shallow with greater water surface slopes. Pattern features should show little adjustment over the standard five year monitoring period (EEP, 2008).

3.4 Substrate and Sediment Transport

Substrate measurements should indicate the progression towards, or the maintenance of the known distributions from the design phase. In this case the substrate measurements should become more gravel centric. The signs of sediment transport should indicate neither extensive aggradation nor degradation, which is mentioned above (EEP, 2008).

3.5 Vegetation

Planted woody vegetation must meet a minimum survival success rate of 320 stems/acre after three years, 288 stems/acre after four years, and 260 stems/acre after five years (USACOE, 2003). If monitoring indicates that the specified survival rate is not being met, appropriate corrective actions will be developed, which could include invasive species control, the removal of dead/dying plants, and replanting.

3.6 Hydrology

A minimum of two bankfull events must occur in separate years within the five-year monitoring period. If stream gauge data reveal that this criterion is not met, probable causes for this will be determined.

4.0 MAINTENANCE AND CONTINGENCY PLAN

Aspects of the restoration deemed problem areas will be dealt with accordingly based on the severity of the problem. Site maintenance may include reinstallation of coir matting, removal of debris from the channel, stabilization of bank erosion with protective structures, or adjustments to in-stream structures. All maintenance activities will be documented in the yearly monitoring reports and any major repairs will be completed after consultation with the EEP.

5.0 REFERENCES

EEP. 2008. *Mitigation Plan Document Format, Content, Data Requirements, and Guidance*. Ver. 2.0.

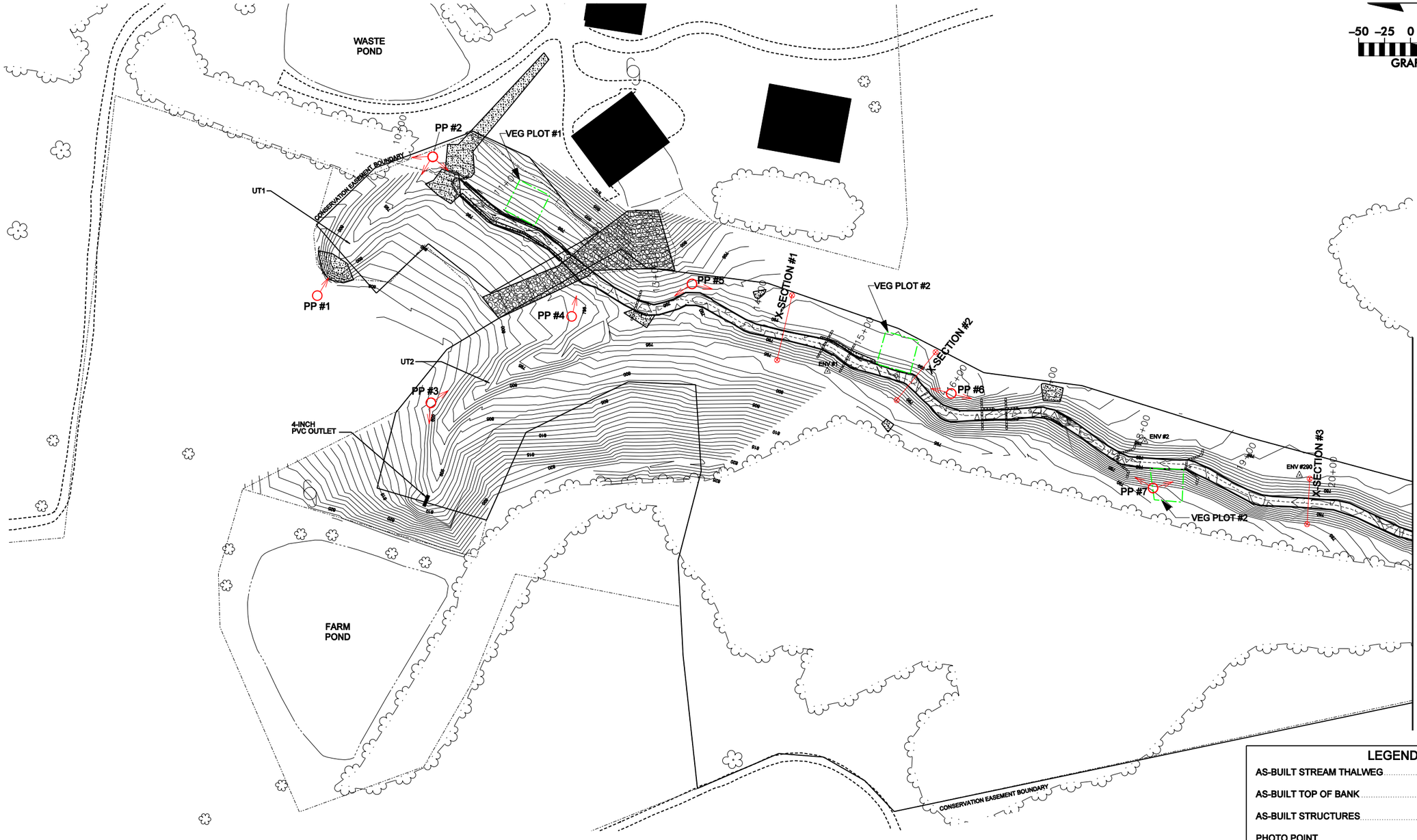
Lee, M T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0 (http://cvs.bio.unc.edu/methods.htm)

USACOE, Wilmington District, USEPA, NCWRC, and NCDENR DWQ. 2003. Stream Mitigation Guidelines. Wilmington, NC.

Weakley, A S. 2008. *Flora of the Carolinas, Virginia, and Georgia, and Surrounding Areas*. UNC Herbarium, North Carolina Botanical Garden, University of North Carolina at Chapel Hill, April 2008.

Appendix A

Monitoring Plan View



JOHNSON SITE CONTROL POINTS

Point	Northing	Easting	Elevation	Description
100	831051.5981	1477496.7465	772.84	NAIL
101	831170.6176	1477554.3419	776.50	NAIL
105	831187.1005	1477823.9085	768.69	NAIL_FND@
106	831308.3751	1478172.6098	779.20	NAIL
219	831211.2370	1477514.4136	761.68	ENV5
271	831569.8763	1478219.2980	780.31	ENV3
290	831724.5549	1478269.6672	783.61	ENV290
291	831873.7863	1478300.4162	785.90	ENV2
292	832180.0985	1478368.0765	794.78	ENV1

LEGEND

- AS-BUILT STREAM THALWEG
- AS-BUILT TOP OF BANK
- AS-BUILT STRUCTURES
- PHOTO POINT — PP #3
- CONSERVATION EASEMENT BOUNDARY
- CROSS-SECTION
- VEGETATION PLOT
- ROCK FORD CROSSING
- MINOR CONTOUR
- MAJOR CONTOUR
- EXISTING VEGETATION
- FENCING
- STONE PROTECTION

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

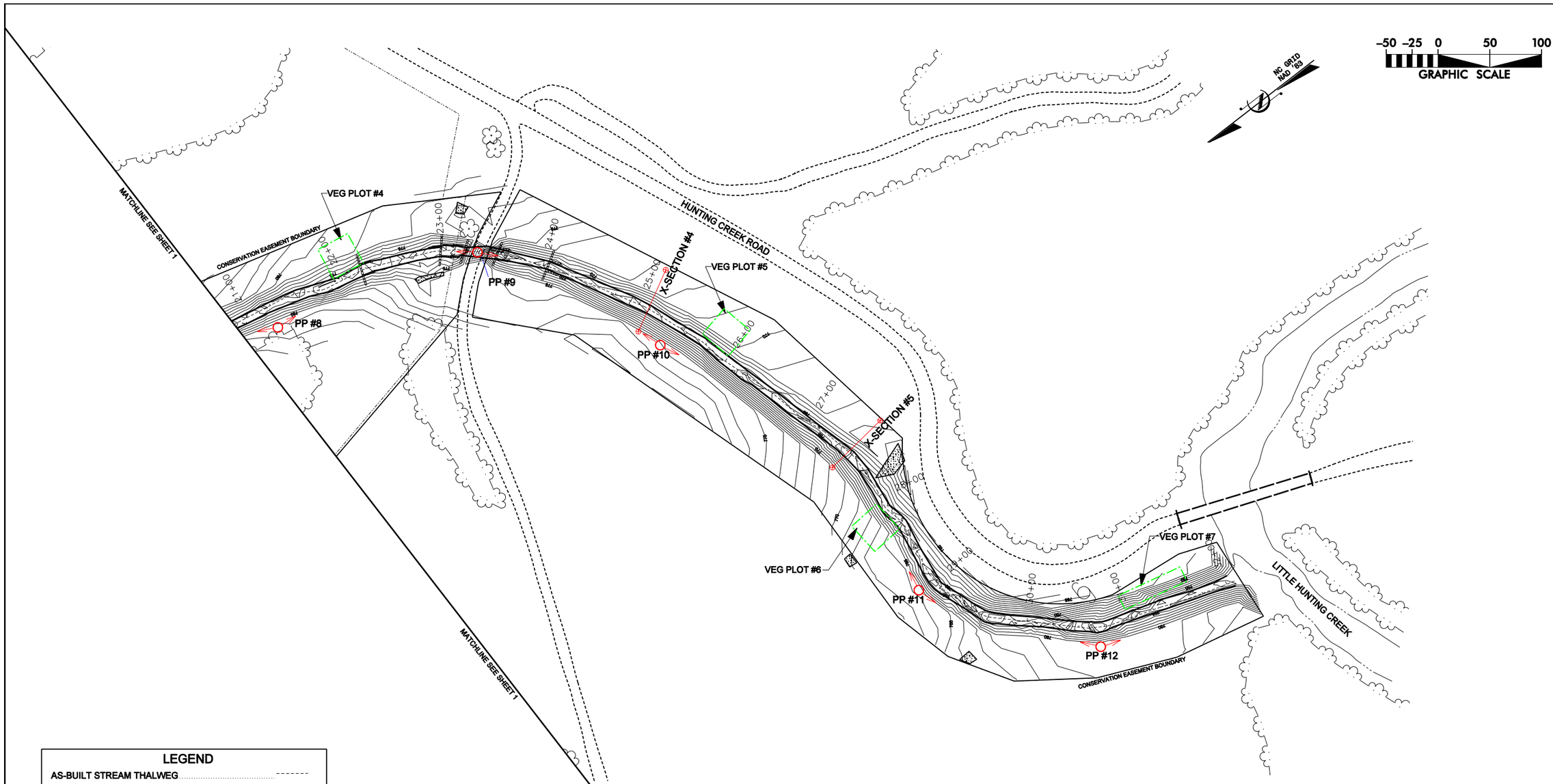
Ecosystem Enhancement Program

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

JOHNSON SITE - UT TO LITTLE HUNTING CREEK
EEP PROJECT NUMBER 197 - MY00
IREDELL COUNTY, NORTH CAROLINA
STATION 10+00 TO 20+86

DATE: FEB 2008
SCALE: SEE SHEET

MONITORING PLAN VIEW



LEGEND

- AS-BUILT STREAM THALWEG
- AS-BUILT TOP OF BANK
- AS-BUILT STRUCTURES
- PHOTO REFERENCE POINT (PP #3)
- CONSERVATION EASEMENT BOUNDARY
- CROSS-SECTION
- VEGETATION PLOT
- ROCK FORD CROSSING
- MINOR CONTOUR
- MAJOR CONTOUR
- EXISTING VEGETATION
- FENCING
- STONE PROTECTION

MONITORING FEATURE COORDINATES
(NC STATE PLANE, NAD 83 FT DATUM)

		NORTHING	EASTING	ELEVATION
CROSS-SECTION #1	LB	832214.32	1478441.27	791.36
	RB	832228.74	1478378.66	796.15
CROSS-SECTION #2	LB	832075.71	1478386.39	791.48
	RB	832113.32	1478340.13	792.84
CROSS-SECTION #3	LB	831714.77	1478264.25	783.69
	RB	831717.27	1478220.22	785.16
CROSS-SECTION #4	LB	831253.55	1477995.81	773.11
	RB	831310.83	1477964.87	776.53
CROSS-SECTION #5	LB	831178.51	1477754.12	767.80
	RB	831242.83	1477746.51	770.66

MONITORING FEATURE COORDINATES
(NC STATE PLANE, NAD 83 FT DATUM)

	NORTHING	EASTING
VEGETATION PLOT #1	832491.55	1478523.54
	832462.67	1478508.69
	832448.08	1478537.55
	832477.06	1478552.55
VEGETATION PLOT #2	832100.24	1478365.87
	832132.60	1478375.10
	832092.13	1478397.47
	832123.82	1478406.44
VEGETATION PLOT #3	831836.34	1478273.07
	831868.77	1478274.32
	831.864.71	1478243.88
	831837.81	1478241.51
VEGETATION PLOT #4	831480.03	1478179.51
	831512.74	1478185.01
	831475.01	1478211.49
	831507.29	1478216.84
VEGETATION PLOT #5	831224.86	1477899.91
	831231.70	1477931.87
	831258.64	1477892.96
	831263.53	1477925.26
VEGETATION PLOT #6	831260.10	1477657.26
	831262.81	1477690.15
	831230.67	1477692.56
	831227.58	1477659.82
VEGETATION PLOT #7	831100.27	1477479.88
	831103.01	1477485.16
	831039.35	1477450.27
	831038.02	1477465.33

NO.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

Ecosystem Enhancement

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

JOHNSON SITE - UT TO LITTLE HUNTING CREEK
EEP PROJECT NUMBER 197 - MY00
IREDELL COUNTY, NORTH CAROLINA
STATION 20+86 TO 22+09

DATE: FEB 2008
SCALE: SEE SHEET

MONITORING PLAN VIEW

SHEET 2 OF 2

Appendix B

Vegetation Data and Plot Photos

Table B1.

Report Prepared By	Brian Roberts
Date Prepared	3/7/2008 15:54
database name	KCI-2007-A.mdb
database location	M:\2005\12053743_EEP_OpenEnd_Design\F_EEPMon0607\Vegetation database
computer name	KCIRAL-8XY1T71
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	This worksheet, which is a summary of the project and the project data.
Proj, planted	Each project is listed with its PLANTED stems, for each year. This excludes live stakes and lists stems per acre.
Proj, total stems	Each project is listed with its TOTAL stems, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems. Listed in stems per acre.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	Count of planted living stems of each species for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	197
project Name	Johnson Site
Description	Stream Restoration in Iredell County, North Carolina
River Basin	
length(ft)	2200
stream-to-edge width (ft)	50
area (sq m)	20436.6
Required Plots (calculated)	7
Sampled Plots	7

Table B2.							
	Species	**4**	**3**	**2**	**1**	**0**	**Missing**
	DONTKNOW: unsure record	6					
	Betula nigra	7					
	Cornus amomum	16					
	Fraxinus pennsylvanica	8					
	Quercus falcata	14					
	Liriodendron tulipifera	10					
	Platanus occidentalis	9					
	Asimina triloba	7					
TOT:	**8**	**77**					

Table B3.

	Species	All Damage Categories	(no damage)
	Betula nigra	7	7
	Cornus amomum	16	16
	DONTKNOW: unsure record	6	6
	Fraxinus pennsylvanica	8	8
	Liriodendron tulipifera	10	10
	Platanus occidentalis	9	9
	Quercus falcata	14	14
	Asimina triloba	7	7
TOT:	**8**	**77**	**77**

Table B4.

	plot	All Damage Categories	(no damage)
	197-A-0001	11	11
	197-A-0002	11	11
	197-A-0003	11	11
	197-A-0004	9	9
	197-A-0005	8	8
	197-A-0006	12	12
	197-A-0007	15	15
TOT:	**7**	**77**	**77**

Table B5.

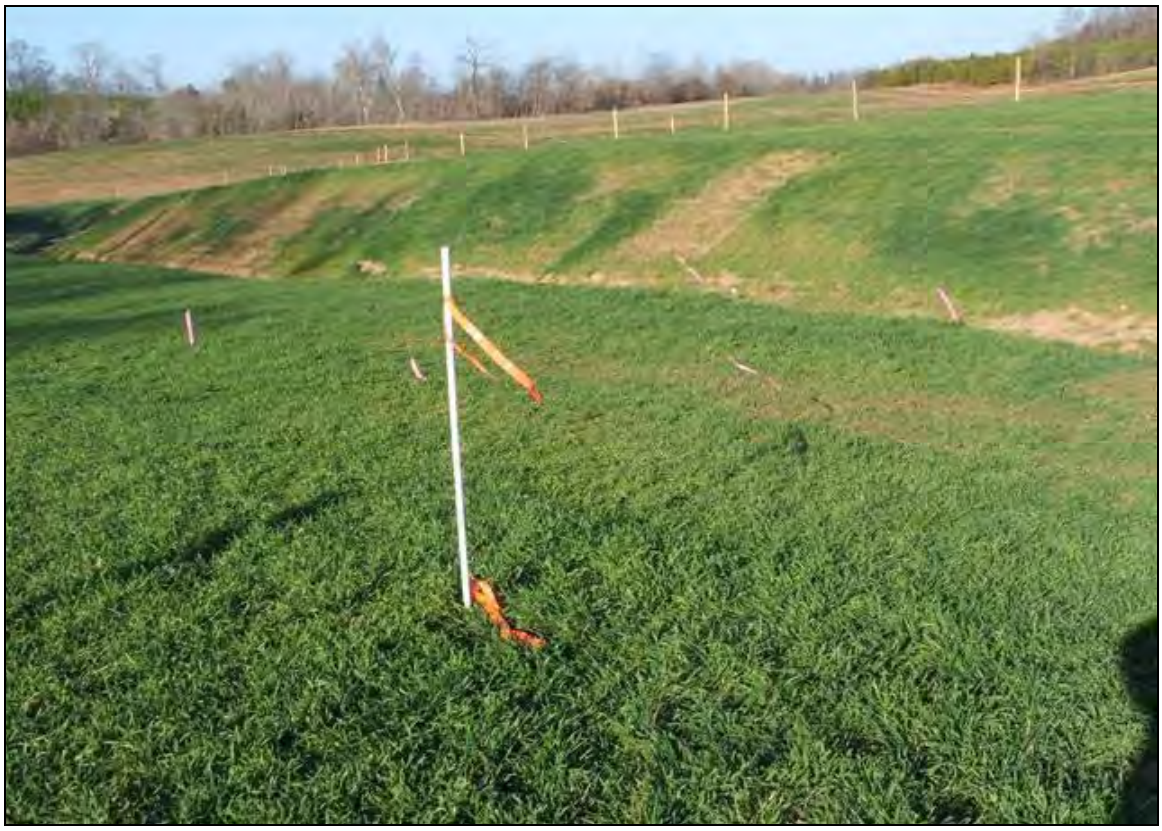
	Species	Total Planted Stems	# plots	avg# stems	plot 197-A-0001	plot 197-A-0002	plot 197-A-0003	plot 197-A-0004	plot 197-A-0005	plot 197-A-0006	plot 197-A-0007
	Betula nigra	7	7	1	1	1	1	1	1	1	1
	Cornus amomum	16	6	2.67	1	3	4	3	2	3	
	DONTKNOW: unsure record	6	3	2		2			2		2
	Fraxinus pennsylvanica	8	6	1.33	2	1	1	1		1	2
	Liriodendron tulipifera	10	4	2.5	6	2	1	1			
	Platanus occidentalis	9	5	1.8			2	1	2	1	3
	Quercus falcata	14	5	2.8		2	1	1		3	7
	Asimina triloba	7	5	1.4	1		1	1	1	3	
TOT:	**8**	**77**	**8**		**11**	**11**	**11**	**9**	**8**	**12**	**15**

Vegetation Plot 1. 1/14/08 – As-Built

Vegetation Plot 2. 1/14/08 – As-Built

Vegetation Plot 3. 1/14/08 – As-Built

Vegetation Plot 4. 1/14/08 – As-Built



Vegetation Plot 5. 1/14/08 – As-Built

Vegetation Plot 6. 1/14/08 – As-Built

Vegetation Plot 7. 1/14/08 – As-Built

Appendix C

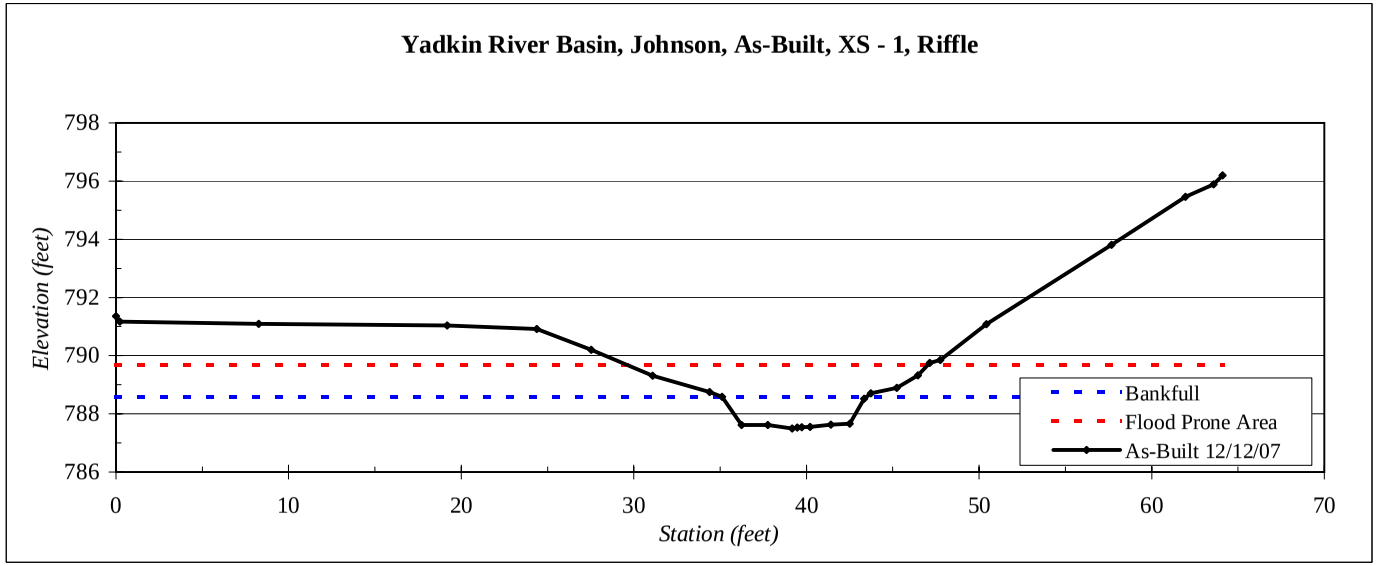
Cross-Section Plots and Pebble Counts

River Basin:	Yadkin
Watershed:	Johnson, As-Built
XS ID	XS - 1, Riffle
Drainage Area (sq mi):	0.17
Date:	12/12/2007
Field Crew:	B. Roberts, T. King

Station	Elevation
0.0	791.36
0.2	791.17
8.3	791.09
19.2	791.04
24.4	790.92
27.5	790.20
31.1	789.31
34.4	788.75
35.1	788.58
36.2	787.61
37.8	787.62
39.2	787.49
39.5	787.53
39.7	787.54
40.2	787.55
41.4	787.63
42.5	787.66
43.3	788.52
43.7	788.71
45.2	788.89
46.5	789.32
47.1	789.75
47.8	789.85
50.4	791.08
57.7	793.81
62.0	795.46
63.6	795.89
64.1	796.19

SUMMARY DATA	
Bankfull Elevation:	788.6
Bankfull Cross-Sectional Area:	7.6
Bankfull Width:	8.7
Flood Prone Area Elevation:	789.7
Flood Prone Width:	18
Max Depth at Bankfull:	1.1
Mean Depth at Bankfull:	0.9
W / D Ratio:	10.0
Entrenchment Ratio:	2.1
Bank Height Ratio:	1.0

Stream Type	B4c

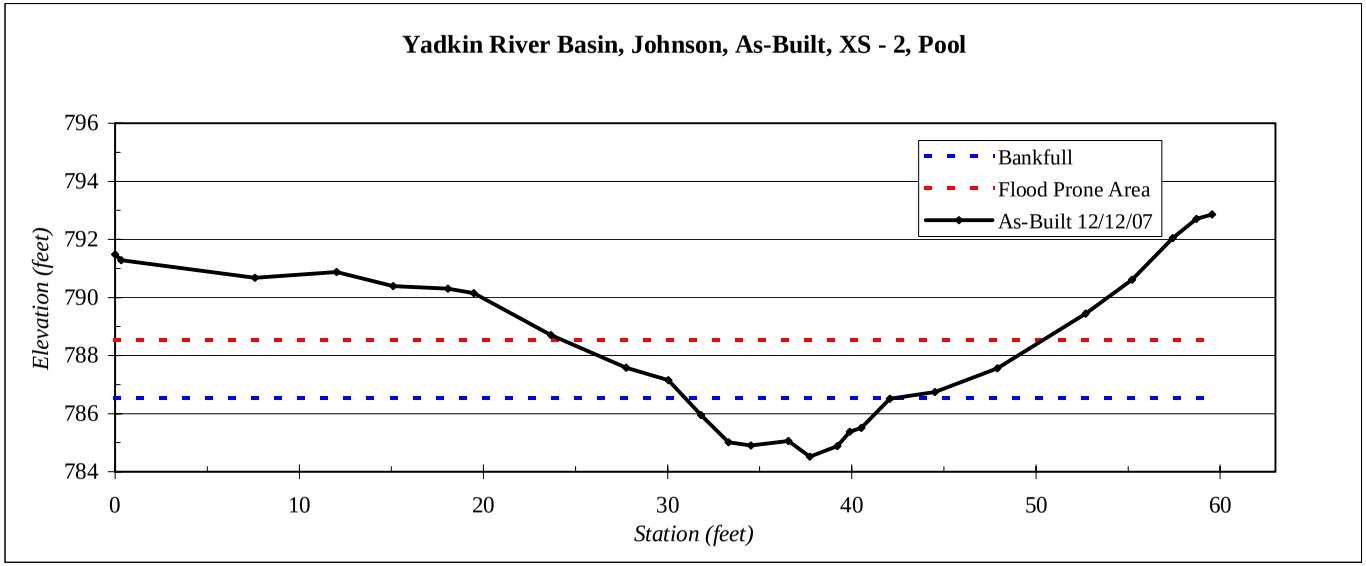


River Basin:	Yadkin
Watershed:	Johnson, As-Built
XS ID	XS - 2, Pool
Drainage Area (sq mi):	0.17
Date:	12/12/2007
Field Crew:	B. Roberts, T. King

Station	Elevation
0.0	791.48
0.3	791.28
7.6	790.68
12.0	790.88
15.1	790.39
18.1	790.30
19.5	790.15
23.7	788.71
27.7	787.58
30.0	787.15
31.8	785.95
33.3	785.02
34.5	784.90
36.5	785.05
37.7	784.52
39.2	784.88
39.9	785.38
40.5	785.51
42.1	786.52
44.5	786.75
47.9	787.56
52.7	789.44
55.2	790.61
57.4	792.04
58.7	792.70
59.6	792.86

SUMMARY DATA	
Bankfull Elevation:	786.5
Bankfull Cross-Sectional Area:	13.7
Bankfull Width:	11.0
Flood Prone Area Elevation:	788.5
Flood Prone Width:	25.7
Max Depth at Bankfull:	2.0
Mean Depth at Bankfull:	1.2
W / D Ratio:	8.8
Entrenchment Ratio:	2.3
Bank Height Ratio:	1.0

Stream Type	B4c

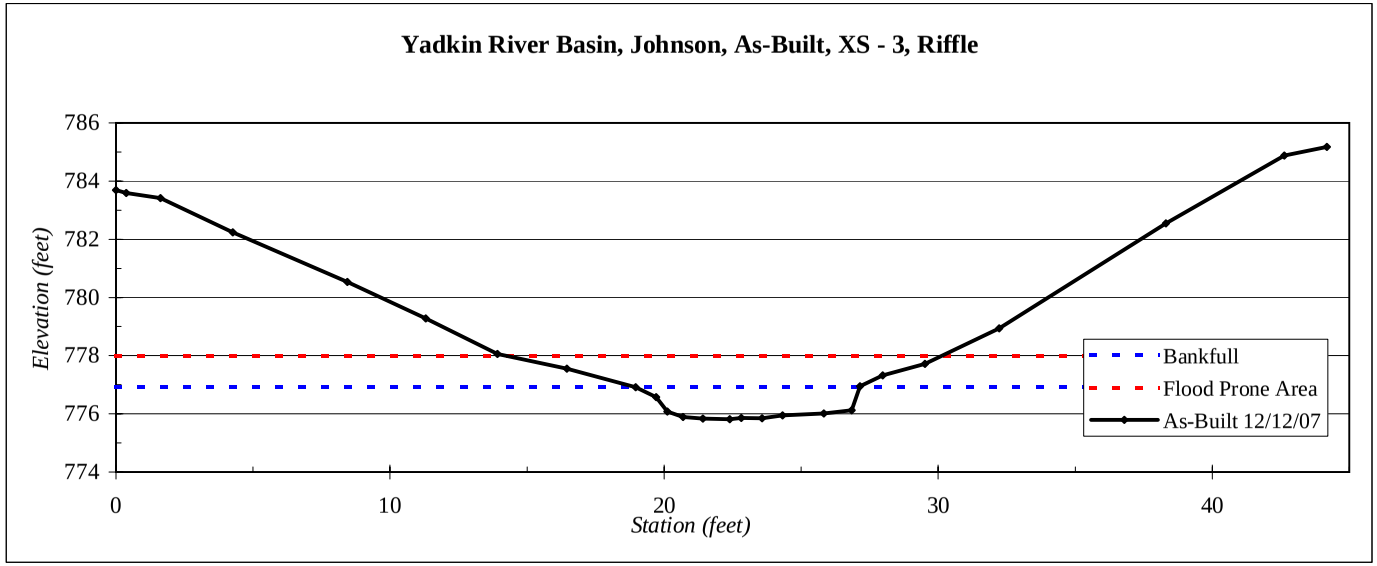


River Basin:	Yadkin
Watershed:	Johnson, As-Built
XS ID	XS - 3, Riffle
Drainage Area (sq mi):	0.17
Date:	12/12/2007
Field Crew:	B. Roberts, T. King

Station	Elevation
0.0	783.69
0.4	783.59
1.6	783.41
4.3	782.24
8.4	780.54
11.3	779.28
13.9	778.06
16.5	777.55
19.0	776.91
19.7	776.57
20.1	776.08
20.7	775.89
21.4	775.83
22.4	775.81
22.8	775.86
23.6	775.85
24.3	775.95
25.8	776.01
26.8	776.12
27.1	776.95
28.0	777.32
29.5	777.72
32.2	778.94
38.3	782.55
42.6	784.88
44.2	785.18

SUMMARY DATA	
Bankfull Elevation:	776.9
Bankfull Cross-Sectional Area:	7.2
Bankfull Width:	8.2
Flood Prone Area Elevation:	778.0
Flood Prone Width:	15
Max Depth at Bankfull:	1.1
Mean Depth at Bankfull:	0.9
W / D Ratio:	9.3
Entrenchment Ratio:	1.8
Bank Height Ratio:	1.0

Stream Type	B4c

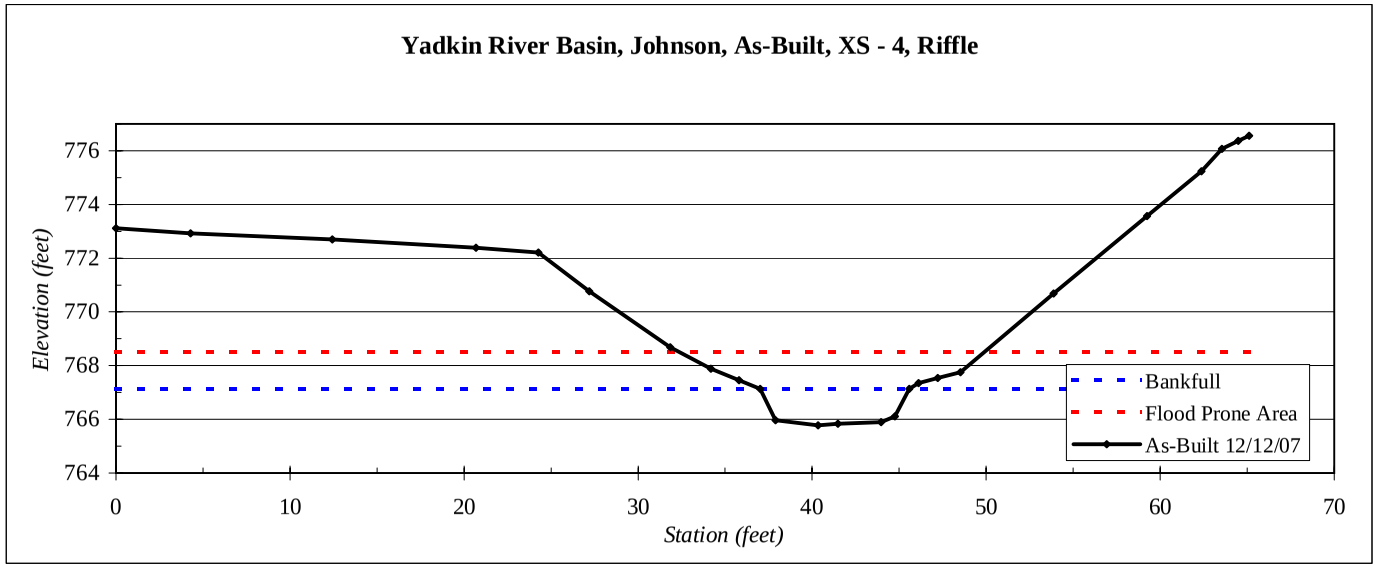


River Basin:	Yadkin
Watershed:	Johnson, As-Built
XS ID	XS - 4, Riffle
Drainage Area (sq mi):	0.17
Date:	12/13/2007
Field Crew:	B. Roberts, T. King

Station	Elevation
0.0	773.11
4.3	772.93
12.4	772.70
20.7	772.39
24.3	772.21
27.2	770.76
31.8	768.68
34.2	767.89
35.8	767.45
37.0	767.13
37.9	765.97
40.3	765.77
41.5	765.84
44.0	765.89
44.8	766.10
45.6	767.14
46.1	767.35
47.2	767.54
48.5	767.76
53.9	770.69
59.2	773.56
62.4	775.24
63.5	776.07
64.5	776.37
65.1	776.56

SUMMARY DATA	
Bankfull Elevation:	767.1
Bankfull Cross-Sectional Area:	9.7
Bankfull Width:	8.7
Flood Prone Area Elevation:	768.5
Flood Prone Width:	18
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	1.1
W / D Ratio:	7.8
Entrenchment Ratio:	2.0
Bank Height Ratio:	1.0

Stream Type	B4c

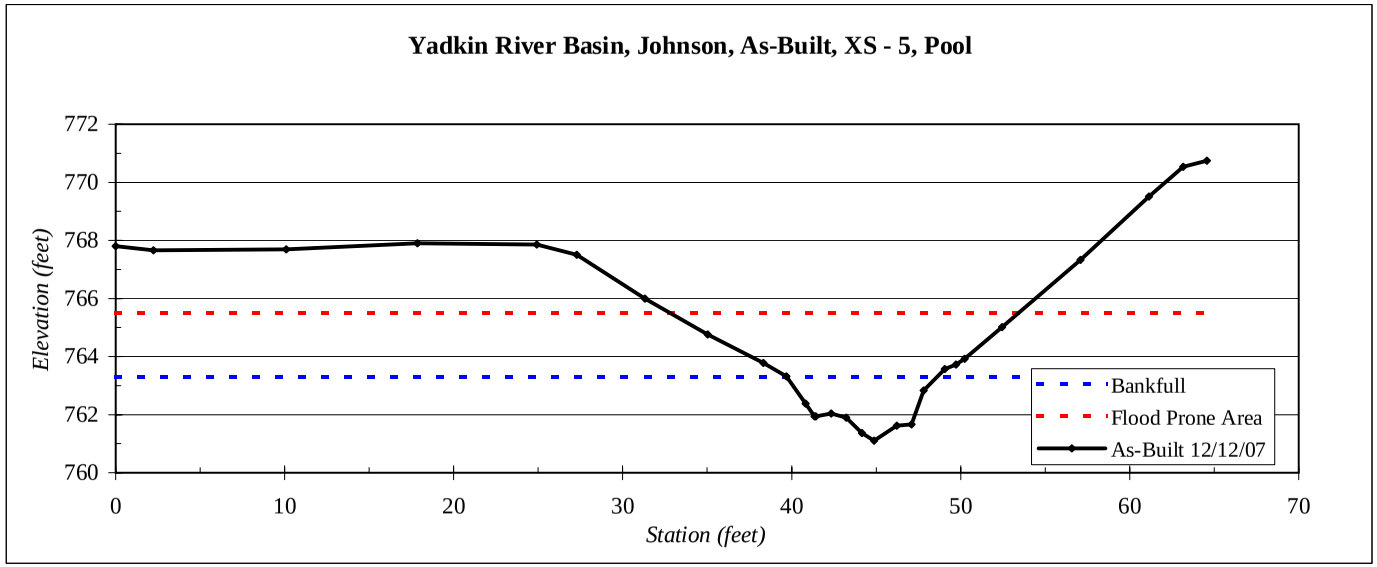


River Basin:	Yadkin
Watershed:	Johnson, As-Built
XS ID	XS - 5, Pool
Drainage Area (sq mi):	0.17
Date:	12/13/2007
Field Crew:	B. Roberts, T. King

Station	Elevation
0.0	767.80
2.2	767.66
10.1	767.69
17.8	767.90
24.9	767.85
27.3	767.50
31.3	766.00
35.0	764.76
38.3	763.78
39.7	763.31
40.8	762.38
41.4	761.94
41.4	761.94
42.3	762.04
43.2	761.89
44.2	761.37
44.9	761.10
46.2	761.62
47.1	761.67
47.8	762.83
49.1	763.57
49.7	763.73
50.2	763.93
52.4	765.02
57.1	767.33
61.1	769.50
63.2	770.54
64.6	770.74

SUMMARY DATA	
Bankfull Elevation:	763.3
Bankfull Cross-Sectional Area:	11.9
Bankfull Width:	9.0
Flood Prone Area Elevation:	765.5
Flood Prone Width:	21.0
Max Depth at Bankfull:	2.2
Mean Depth at Bankfull:	1.3
W / D Ratio:	6.8
Entrenchment Ratio:	2.3
Bank Height Ratio:	1.0

Stream Type	B4c

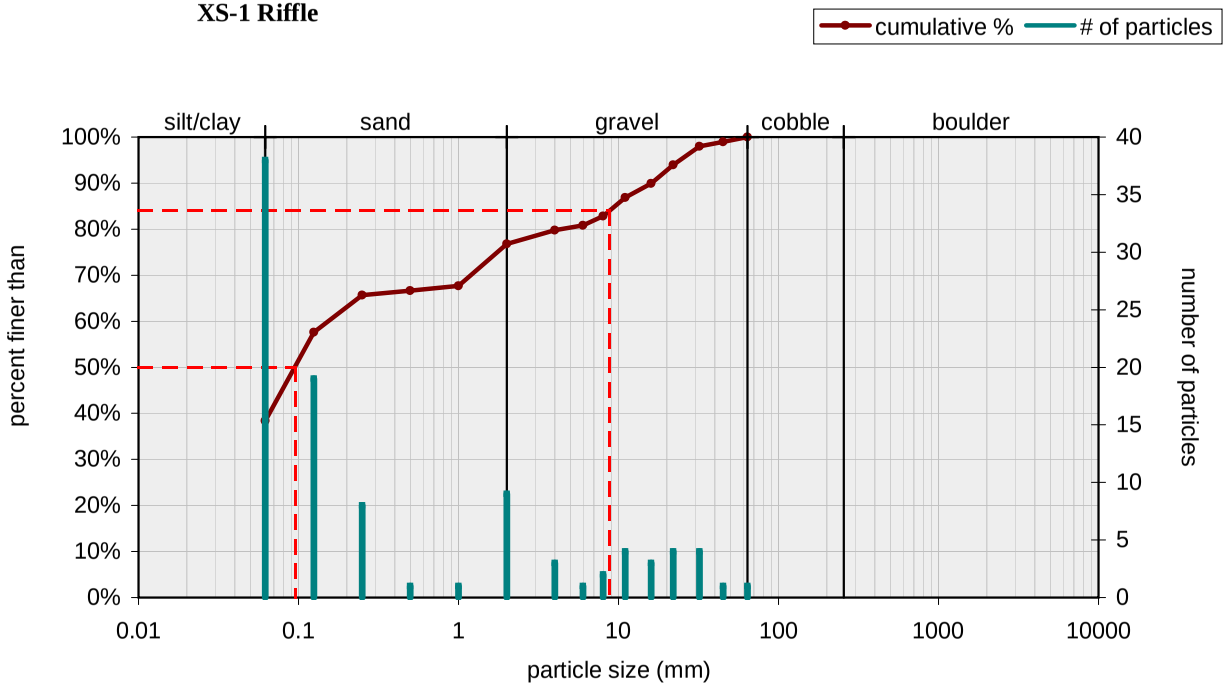


Riffle Surface

Material	Size Range (mm		Count
silt/clay	0	- 0.062	**38**
very fine sand	0.062	- 0.125	**19**
fine sand	0.125	- 0.25	**8**
medium sand	0.25	- 0.5	**1**
coarse sand	0.5	- 1	**1**
very coarse sand	1	- 2	**9**
very fine gravel	2	- 4	**3**
fine gravel	4	- 6	**1**
fine gravel	6	- 8	**2**
medium gravel	8	- 11	**4**
medium gravel	11	- 16	**3**
coarse gravel	16	- 22	**4**
coarse gravel	22	- 32	**4**
very coarse gravel	32	- 45	**1**
very coarse gravel	45	- 64	**1**
small cobble	64	- 90	
medium cobble	90	- 128	
large cobble	128	- 180	
very large cobble	180	- 256	
small boulder	256	- 362	
small boulder	362	- 512	
medium boulder	512	- 1024	
large boulder	1024	- 2048	
very large boulder	2048	- 4096	
total particle count:			99
bedrock ----------			**1**
clay hardpan ----------			
detritus/wood ----------			
artificial ----------			
total count:			100

Note:

Johnson, As-Built
XS-1 Riffle



Size (mm)	
D16	0.062
D35	0.062
D50	0.095
D65	0.24
D84	8.8
D95	24

Size Distribution	
mean	0.7
dispersion	47.1
skewness	0.61

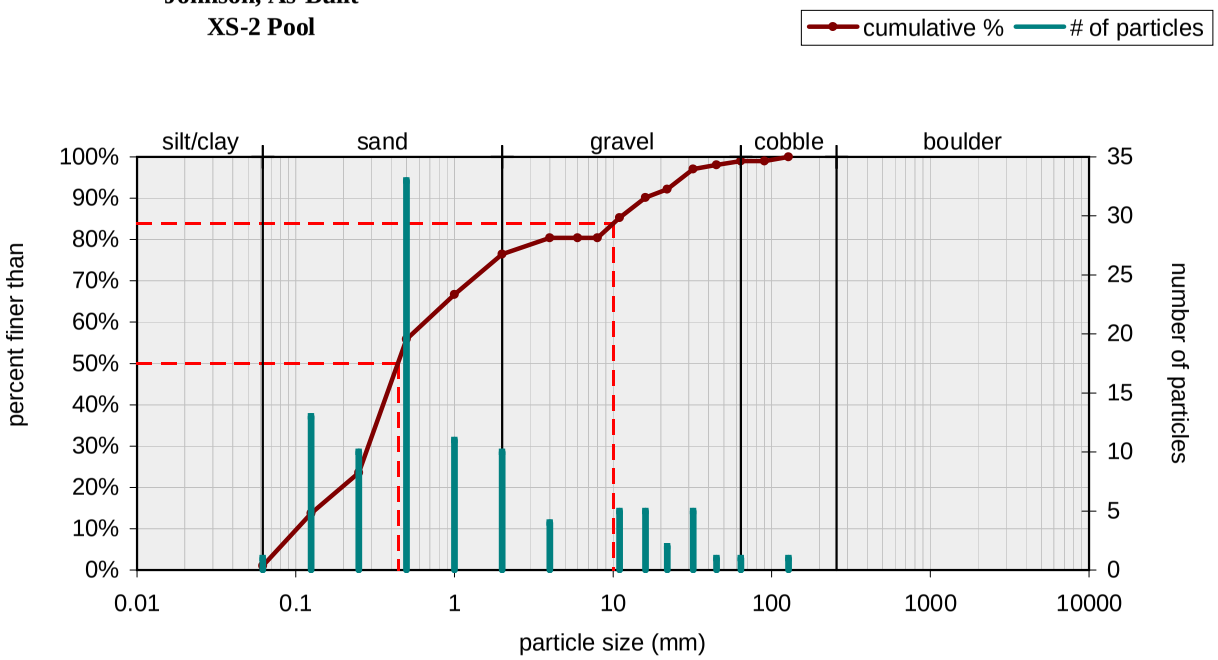
Type			
silt/clay	38%	bedrock	1%
sand	38%		
gravel	23%		
cobble	0%		
boulder	0%		

Bed Surface

Material	Size Range (mm		Count
silt/clay	0	- 0.062	**1**
very fine sand	0.062	- 0.125	**13**
fine sand	0.125	- 0.25	**10**
medium sand	0.25	- 0.5	**33**
coarse sand	0.5	- 1	**11**
very coarse sand	1	- 2	**10**
very fine gravel	2	- 4	**4**
fine gravel	4	- 6	
fine gravel	6	- 8	
medium gravel	8	- 11	**5**
medium gravel	11	- 16	**5**
coarse gravel	16	- 22	**2**
coarse gravel	22	- 32	**5**
very coarse gravel	32	- 45	**1**
very coarse gravel	45	- 64	**1**
small cobble	64	- 90	
medium cobble	90	- 128	**1**
large cobble	128	- 180	
very large cobble	180	- 256	
small boulder	256	- 362	
small boulder	362	- 512	
medium boulder	512	- 1024	
large boulder	1024	- 2048	
very large boulder	2048	- 4096	
total particle count:			102
bedrock ----------			**1**
clay hardpan ----------			
detritus/wood ----------			
artificial ----------			
total count:			103

Note:

Johnson, As-Built
XS-2 Pool



Size (mm)	
D16	0.15
D35	0.32
D50	0.44
D65	0.9
D84	10
D95	27

Size Distribution	
mean	1.2
dispersion	12.8
skewness	0.33

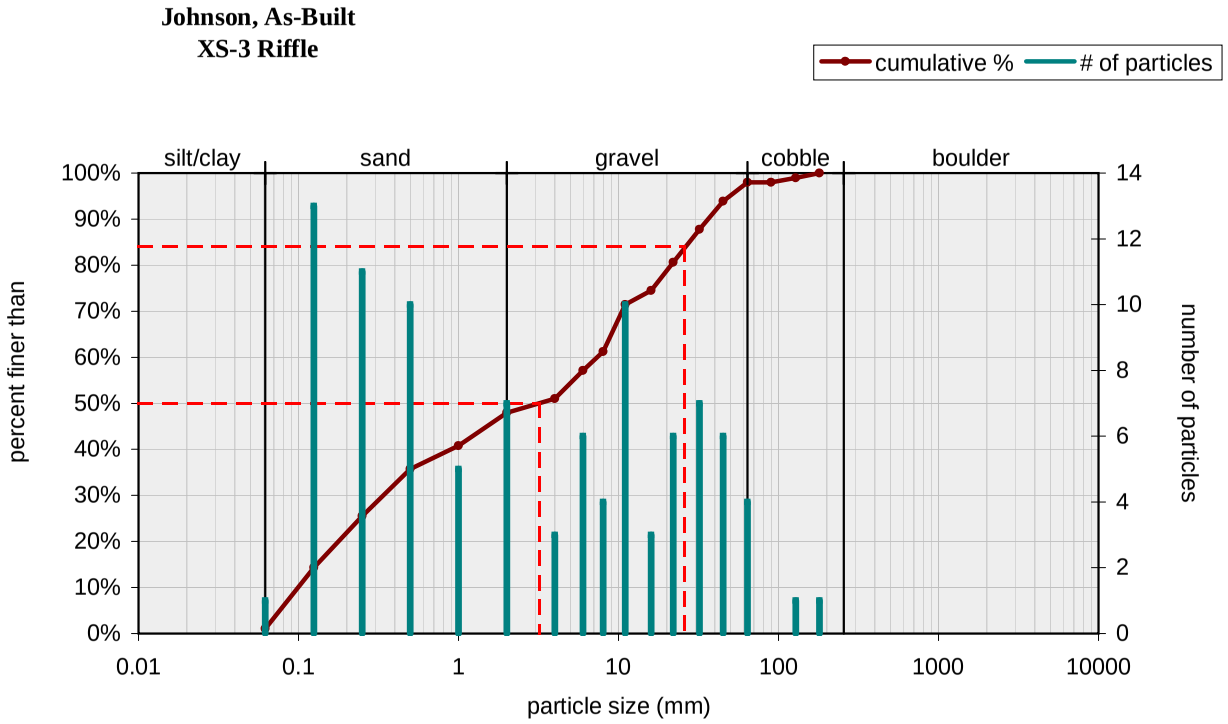
Type			
silt/clay	1%	bedrock	1%
sand	75%		
gravel	22%		
cobble	1%		
boulder	0%		

Riffle Surface

Material	Size Range (mm		Count
silt/clay	0	- 0.062	**1**
very fine sand	0.062	- 0.125	**13**
fine sand	0.125	- 0.25	**11**
medium sand	0.25	- 0.5	**10**
coarse sand	0.5	- 1	**5**
very coarse sand	1	- 2	**7**
very fine gravel	2	- 4	**3**
fine gravel	4	- 6	**6**
fine gravel	6	- 8	**4**
medium gravel	8	- 11	**10**
medium gravel	11	- 16	**3**
coarse gravel	16	- 22	**6**
coarse gravel	22	- 32	**7**
very coarse gravel	32	- 45	**6**
very coarse gravel	45	- 64	**4**
small cobble	64	- 90	
medium cobble	90	- 128	**1**
large cobble	128	- 180	**1**
very large cobble	180	- 256	
small boulder	256	- 362	
small boulder	362	- 512	
medium boulder	512	- 1024	
large boulder	1024	- 2048	
very large boulder	2048	- 4096	

total particle count:	98
bedrock ----------	**4**
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	102

Note:



Size (mm)	
D16	0.14
D35	0.48
D50	3.2
D65	9
D84	26
D95	50

Size Distribution	
mean	1.9
dispersion	15.5
skewness	-0.15

Type			
silt/clay	1%	bedrock	4%
sand	45%		
gravel	48%		
cobble	2%		
boulder	0%		

Riffle Surface

Material	Size Range (mm		Count
silt/clay	0	- 0.062	**2**
very fine sand	0.062	- 0.125	**29**
fine sand	0.125	- 0.25	**8**
medium sand	0.25	- 0.5	**5**
coarse sand	0.5	- 1	**6**
very coarse sand	1	- 2	**13**
very fine gravel	2	- 4	**4**
fine gravel	4	- 6	**3**
fine gravel	6	- 8	**2**
medium gravel	8	- 11	**7**
medium gravel	11	- 16	**8**
coarse gravel	16	- 22	**6**
coarse gravel	22	- 32	**9**
very coarse gravel	32	- 45	**4**
very coarse gravel	45	- 64	**3**
small cobble	64	- 90	
medium cobble	90	- 128	
large cobble	128	- 180	
very large cobble	180	- 256	
small boulder	256	- 362	
small boulder	362	- 512	
medium boulder	512	- 1024	
large boulder	1024	- 2048	
very large boulder	2048	- 4096	

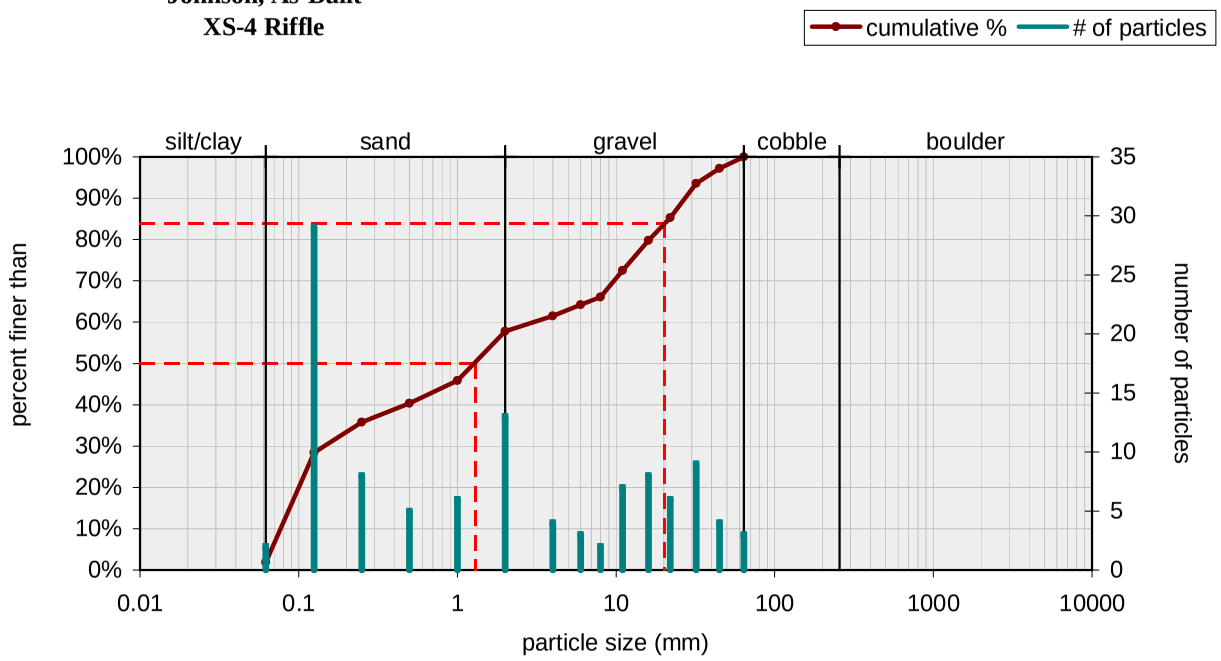
total particle count: 109

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	

total count: 109

Note:

Johnson, As-Built
XS-4 Riffle



Size (mm)	
D16	0.09
D35	0.23
D50	1.3
D65	6.8
D84	20
D95	37

Size Distribution	
mean	1.3
dispersion	14.9
skewness	0.01

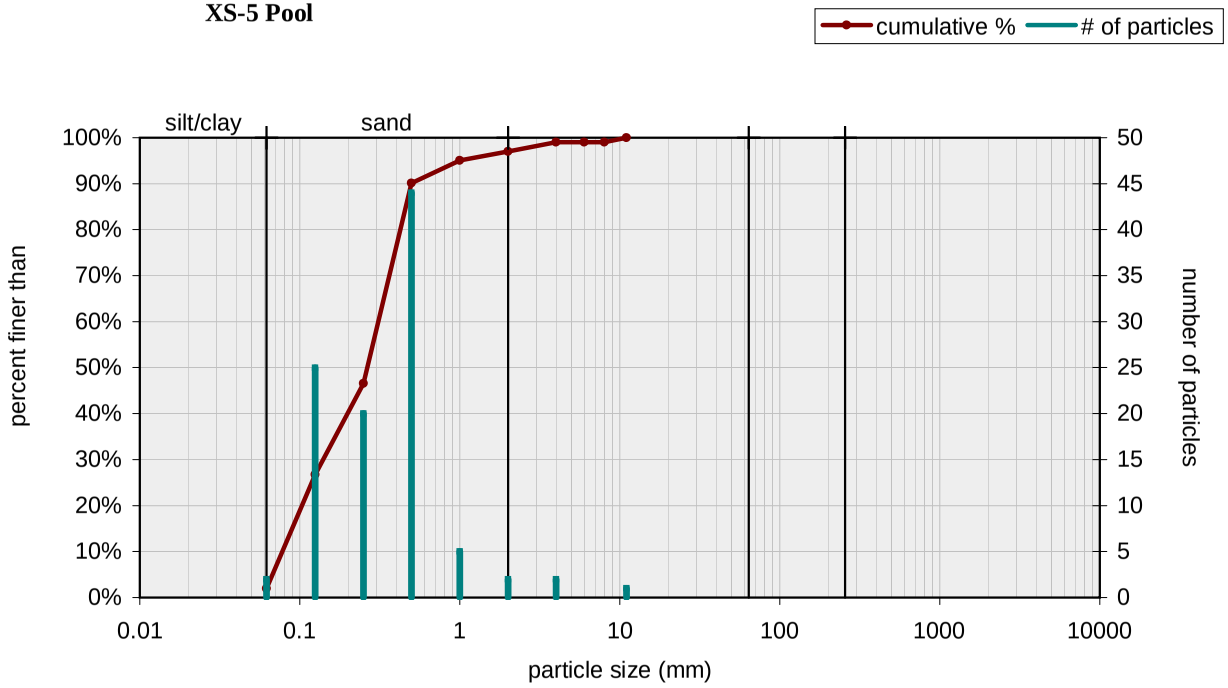
Type	
silt/clay	2%
sand	56%
gravel	42%
cobble	0%
boulder	0%

Bed Surface

Material	Size Range (mm	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	**25**
fine sand	0.125 - 0.25	**20**
medium sand	0.25 - 0.5	**44**
coarse sand	0.5 - 1	**5**
very coarse sand	1 - 2	**2**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	**1**
medium gravel	11 - 16	
coarse gravel	16 - 22	
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		101
bedrock ----------		
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		101

Note:

Johnson, As-Built
XS-5 Pool



Size (mm)	
D16	0.092
D35	0.17
D50	0.26
D65	0.34
D84	0.45
D95	0.99

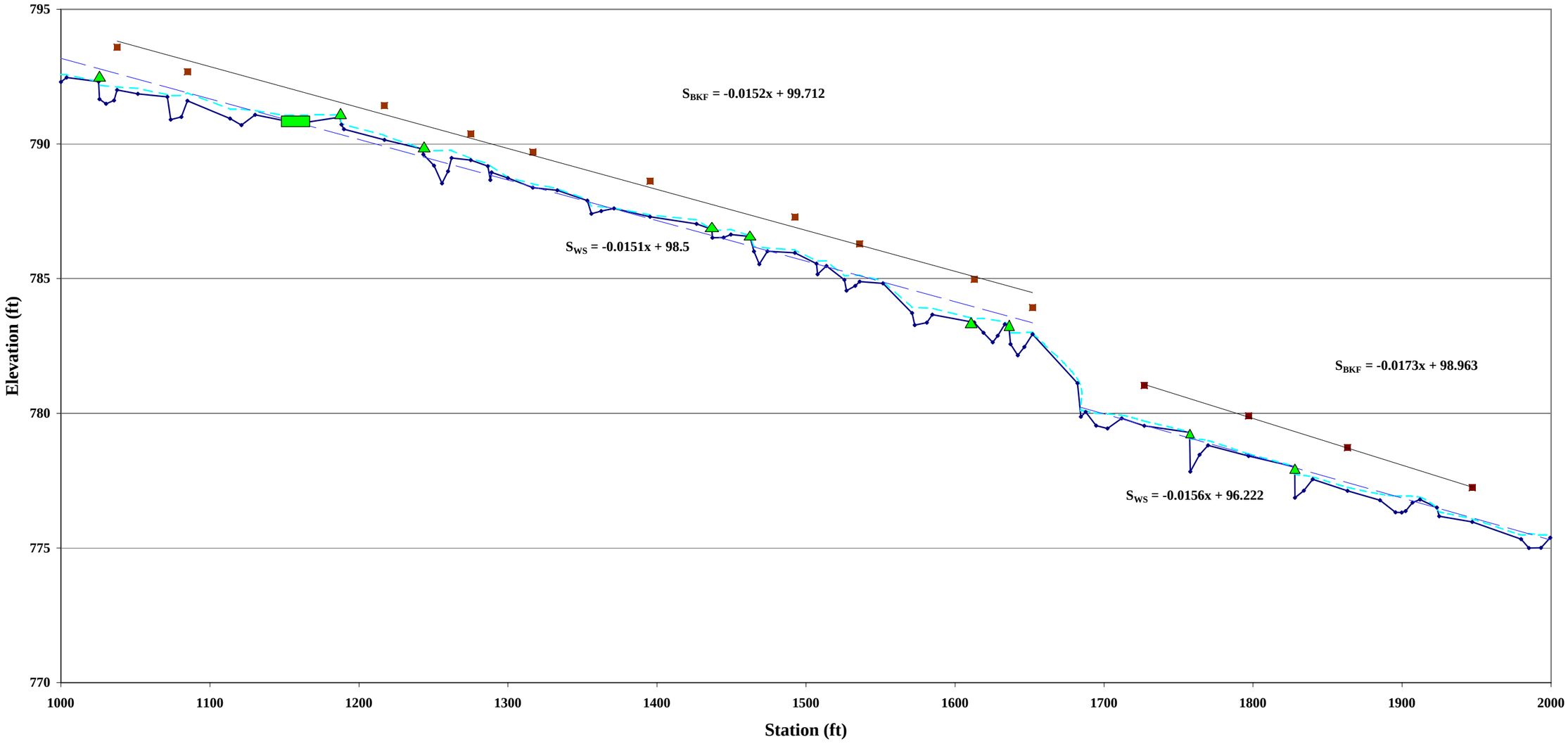
Size Distribution	
mean	0.2
dispersion	2.3
skewness	-0.13

Type	
silt/clay	2%
sand	95%
gravel	3%
cobble	0%
boulder	0%

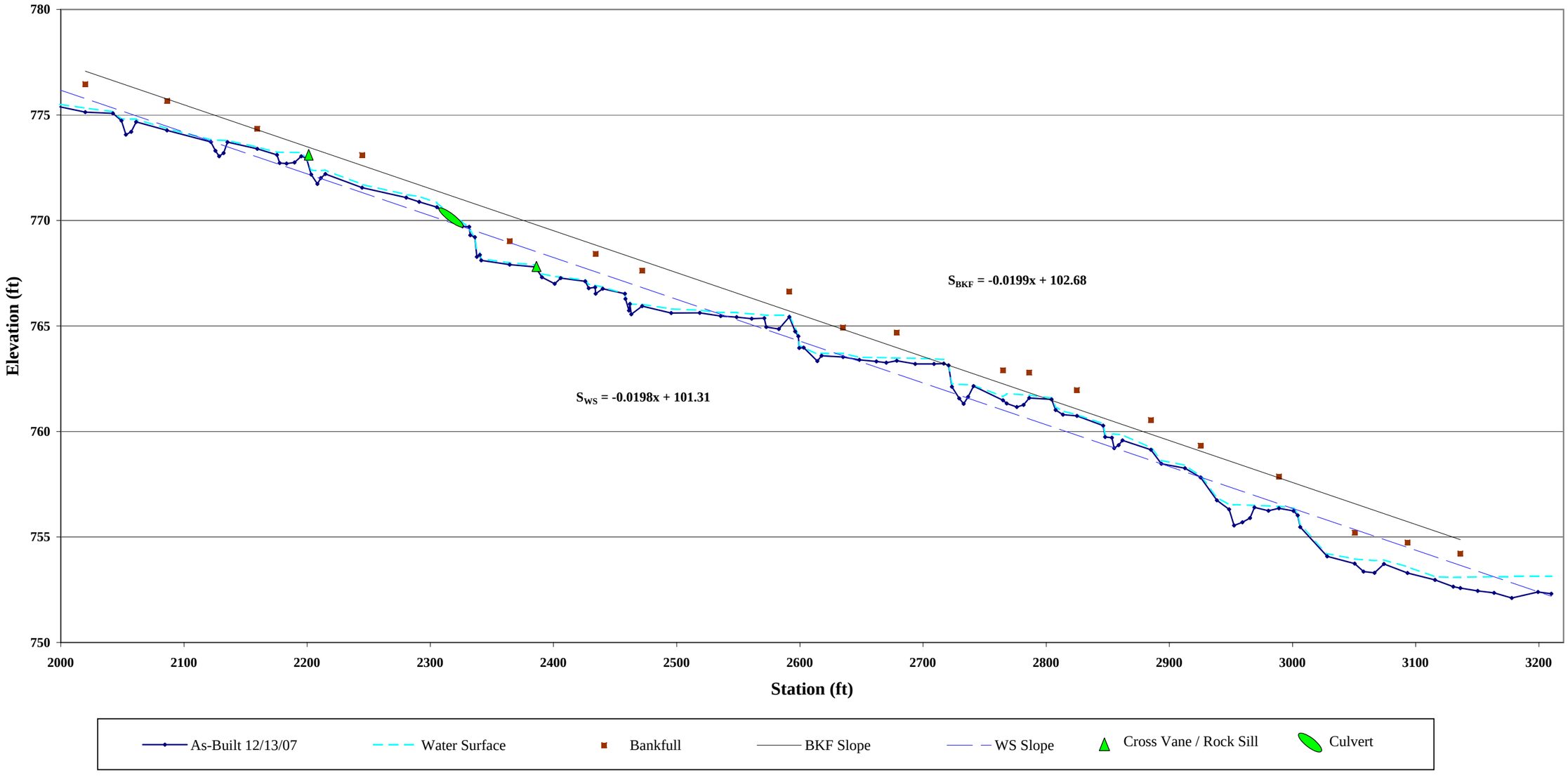
Appendix D

Longitudinal Profile

Longitudinal Profile
Unnamed Tributary to Little Hunting Creek
EEP Project Number - 197
Station 10+00 - 20+00



Longitudinal Profile
Unnamed Tributary to Little Hunting Creek
EEP Project Number - 197
Station 20+00 - 32+10



Appendix E

Permanent Photo Points

Photo Point 1: View looking towards main stem on Tributary 1. 12/13/07 – As-Built

Photo Point 2a: Looking upstream on Tributary 1 at Station 10+00. 12/13/07 – As-Built

Photo Point 2b: View looking downstream taken at Station 10+00. 12/13/07 – As-Built

Photo Point 3: View looking upstream at ford crossing. 12/13/07 – As-Built

Photo Point 4a: View looking upstream towards pond on Tributary 2. 12/13/07 – As-Built

Photo Point 4b: View looking downstream on Tributary 2. 12/13/07 – As-Built

Photo Point 5a: View looking upstream towards Tributary 2 on main stem near Station 12+50. 12/13/07 – As-Built

Photo Point 5b: View looking downstream taken near Station 12+50. 12/13/07 – As-Built

Photo Point 6a: View looking upstream taken near Station 15+75. 12/13/07 – As-Built

Photo Point 6b: View looking downstream taken near Station 15+75. 12/13/07 – As-Built

Photo Point 7a: View looking upstream taken near Station 17+80. 12/13/07 – As-Built

Photo Point 7b: View looking downstream taken near Station 17+80. 12/13/07 – As-Built

Photo Point 8a: View looking upstream taken near Station 20+75. 12/13/07 – As-Built

Photo Point 8b: View looking downstream taken near Station 20+75. 12/13/07 – As-Built

Photo Point 9a: View looking upstream from culvert. 12/13/07 – As-Built

Photo Point 9b: View looking downstream from culvert. 12/13/07 – As-Built

Photo Point 10a: View looking upstream taken near Station 25+00. 12/13/07 – As-Built

Photo Point 10b: View looking downstream taken near Station 25+00. 12/13/07 – As-Built

Photo Point 11a: View looking upstream taken near Station 27+65. 12/13/07 – As-Built

Photo Point 11b: View looking downstream taken near Station 27+65. 12/13/07 – As-Built

Photo Point 12a: View looking upstream taken near Station 30+25. 12/13/07 – As-Built

Photo Point 12b: View looking toward confluence with Little Hunting Creek. 12/13/07 – As-Built