Chapel Creek Stream Restoration Project
Orange County, North Carolina
EEP Project #77

MY-03 Monitoring Report
Data Collected: August 17, 2011
Submitted: December 20, 2011

Prepared for:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Parker Lincoln Building
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Raleigh, NC 27606

Chapel Creek Stream Restoration
EEP Project #77
Chapel Hill, North Carolina
Orange County

MY-03 Monitoring Report
Prepared By:

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APPENDICES

I. Executive Summary

The North Carolina Ecosystem Enhancement Program (EEP) has completed a stream restoration project along approximately 1,350 linear feet of Chapel Creek, located on University of North Carolina property in Chapel Hill, Orange County, North Carolina. The project is located in the Morgan Creek Local Watershed planning area, within the 14-digit HUC 03030002060080. The drainage area for Chapel Creek is approximately 0.42 square miles at the downstream limit of the project where a drainage channel through the A.E. Finley Golf Course flows into Chapel Creek. The land use in the watershed consists of University of North Carolina facilities, single family residential, elementary schools, roadways, and forested land. The Morgan Creek LWP noted water quality degradation and impaired biological community in the watershed and identified major watershed stressors as: streambank erosion, excess stormwater runoff, and disturbed riparian buffers. The goals of the restoration project are to improve water quality in Chapel Creek and the Cape Fear river basin by:

- Channel restoration of pattern, profile, and dimension for approximately 960 linear feet of Chapel Creek.
- Channel enhancement/stabilization for approximately 330 feet with a Priority Two restoration approach, bankfull bench and stream bank repairs.
- Restore reach to a stable stream channel, capable of transporting flows and sediment load efficiently.
- Improve aquatic habitat by planting trees along the banks in the cleared section to increase shade and adding more sinuosity to create more pool and riffle sections.
- Reduce sediment inputs to the stream from bank erosion by re-vegetating the banks.

Four vegetation monitoring plots (1-4) were monitored in August 2011 for MY-03. Of these four plots, 100% of the plots meet the vegetation success criteria. The success criterion for planted woody species is 320 stems/acre after MY-03. A mortality rate of ten percent will be allowed after MY-04 (288 stems/acre), with another ten percent allowed after MY-05 (260 stems/acre). Currently the vegetation criteria for the site are being met with an average of 779 planted stems/acre. According to the CVS Data there is an average of 80129 stems/acre. The seedling layer within plots 3 and 4 contained a high number of volunteer species such as tag alder (*Alnus serrulata*) , loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), river birch (*Betula nigra*), and ironwood (*Carpinus caroliniana*). Two bare banks with low threat levels, vegetation problem area (VPA) 5 and 7, and invasive exotics, VPA's 1-4, 6, and 8-15 are the only notable VPA's for MY-03. VPA 5 is a bare area with some erosion located on the left descending bank at Station 6+75. VPA 7 is a bare area along the right descending bank with some erosion located at Station 7+50. Invasive exotics within the conservation easement include Chinese lespedeza (*Lespedeza cuneata*), Japanese stiltgrass (*Microstegium vimineum*), Japanese honeysuckle (*Lonicera japonica*), Chinese privet (*Ligustrum sinense*), and Oriental bittersweet (*Celastrus orbiculatu*s). Chinese lespedeza is scattered in patches throughout the conservation easement. Several small patches and a large area were treated with herbicide during the MY-02. Japanese stiltgrass was observed in patches in shady areas adjacent to the forest margins. Several stems of chinese privet were observed sparsely scattered within the conservation easement with most locations observed along the forest margin. Japanese honeysuckle was observed scattered along the forest margins from Station 10+00 to 14+00. Although these

invasive species have been given different ranks of severity, the functionality of the project is not expected to be impaired significantly. It is likely that all of these species were present in and adjacent to the conservation easement prior to construction. Some stems of lespedeza were observed sparsely scattered in the areas identified as vegetation problem areas. For additional information relating to vegetation, see Appendix C.

Overall, the stream is functioning properly and as designed. The comparison between MY-02 and the current monitoring year MY-03 created complexities based on differing conditions. MY-02 data was collected during a notable drought and the stream was completely dry. The stream in MY-03, although lacking significant flow, maintained pockets of standing water and short segments of minor flow. The pavement particles showed a less embedded nature in MY-03 with less vegetation interference within the channel bottom facilitating easier data collection. Few significant changes are present in the stream pattern, profile or dimension between MY-02 and the present monitoring year MY-03. The stream thalweg through the riffle at approximate station 1+50, under the upstream pedestrian bridge, has meandered to the right side. As a result of this migration of the thalweg the vertical profile shows a drop in elevation through this riffle feature. Although the thalweg has shifted the toe of the right stream bank does not show evidence of additional stress, instability, or active erosion. The riffle structure is holding its constructed elevation, is intact, and appears to be functioning properly during storm events. The appearance of a drop in the elevation of the thalweg of the two riffles immediately downstream (approximate stations 2+00 and 2+60) is most likely due to the loss of entrained fines which were present in MY-02. The drop in profile elevation through these riffles is a function of the courser riffle surface and survey data collection points. These two riffles appear to be stable and functioning properly. In the MY-02 monitoring report, the pool at station 6+75 showed significant scouring but has stabilized and the pattern and geometry has not shown signs of further degrading at the time of the current monitoring year's data collection. Only two cross sections are showing a fluctuation in geometry. Cross sections 1 and 3 have both increased in area by approximately 10%. The increase in riffle area at cross section 1 is mostly due to the less embedded nature of the substrates; reinforced by the coarser pebble count at this location. The increase in area of pool cross section 3 is a function of increased pool depth. Vegetation in the channel although not as prevalent this year continues to contribute to the fining of some riffle pebble counts. The vegetation is minor and not expected to create flow diversions or contribute to major stability issues. Throughout the reach, 100% of the engineered structures are stable and functioning as designed. The bank erosion areas indicated on the current conditions plan view were scoured in previous monitoring years. Most of these banks are not continuing to actively erode.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report (formerly Mitigation Plan) and in the Mitigation Plan (formerly Restoration Plan) documents available on EEP's website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

II. Methodology

Methodologies follow EEP monitoring report template Version 1.3 (1/15/2010) and guidelines (Lee et al 2008). Photos were taken with a digital camera. A Trimble Geo XT handheld unit with sub-meter accuracy was used to collect vegetation monitoring plot origins, and problem area locations. Cross sectional and longitudinal surveys were conducted using total station survey equipment. Data was entered into AutoCAD Civil3D to obtain dimensions of the cross sections and parameters applicable to the longitudinal profile. Reports were then generated to display summaries of the stream survey.

A. Vegetation Methodologies

Level II of the EEP/CVS protocol Version 4.2 was used to collect data for the four representative vegetation monitoring plots within the conservation easement for MY-03. Data collected for these plots are in Appendix C. Vegetation data collection occurred August 24, 2011.

B. Stream Methodologies

Stream profile and cross-sections were surveyed using total station equipment and methods. The survey data was plotted using AutoCAD Civil3D. The longitudinal profile was generated using the MY-01 alignment. Cross sectional data was extracted based on a linear alignment between the end pins. Stream data collection occurred on August 17, 2011.

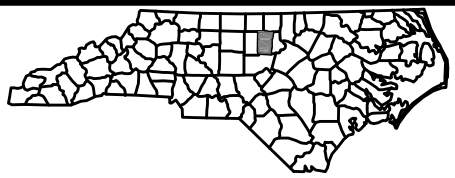
III. References

Lee, Michael T. Peet, Robert K. Roberts, Steven D., Wentworth, Thomas R. (2008). *CVS-EEP Protocol for Recording Vegetation Version 4.2.*

Weakley, Alan (2007). *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas*. http://www.herbarium.unc.edu/flora.htm.

Wolman, M.G., 1954. A Method of Sampling Coarse River-Bed Material, Transactions of American Geophysical Union 35:951-956.

Appendix A. Project Vicinity Map and Background Tables



Ecosystem Enhancement PROGRAM

North Carolina – Ecosystem Enhancement Program

Chapel Creek Stream Reference Site
Orange County, North Carolina
EEP ID #77

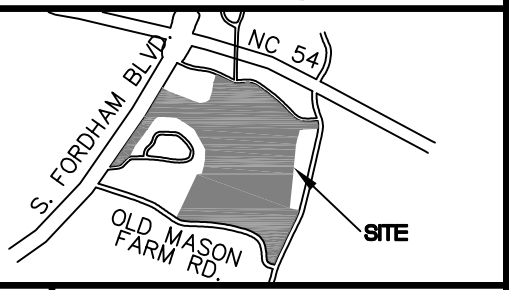


FIGURE 1
RESTORATION SITE
CHAPEL CREEK
AERIAL VICINITY MAP

N

500 250 0 500

SCALE 1" = 500'

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Table 1a. Project Components
Chapel Creek Stream Restoration-Project No. 77

Project Component or Reach ID	Existing Feet/ Acres	Restoration Level	Approach	Footage or Acreage	Stationing	Mitigation Ratio	Mitigation Units	BMP Elements[1]	Comment
Reach I	961 lf	R	P1	994 lf[2]	00+00 - 9+94	1:1	961		Includes 900 lf of channel relocation.
Reach II	330 lf	E2	P3	356 lf[2]	9+94 - 13+50	2.5:1	132		Reach II consists of a mix of P2 and P3 with a dominance of the approaches indicated over the stationing indicated.

1 = BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed Swale; LS = Level Spreader; NI = Natural Infiltration Area, O = Other, CF = Cattle Fencing; WS = Watering System; CH = Livestock Housing
2 = Easement exclusion for pedestrian bridges not included in mitigation credit calculations. Bridge 1 - Sta 1+20 - 1+50. Bridge 2 - 12+50 - 12+75

Table 1b. Component Summations
Chapel Creek Stream Restoration-Project No. 77

Restoration Level	Stream (lf)	Riparian Wetland (Ac)		Non-Riparian (Ac)	Upland (Ac)	Buffer (Ac)	BMP
		Riverine	Non-Riverine				
Restoration	961						
Enhancement							
Enhancement I							
Enhancement II	330						
Creation							
Preservation							
HQ Preservation							
		0	0				
Totals (Feet/Acres)	**1291**	**0**		**0**	**0**	**0**	**0**
MU Totals	**1093**					**0**	
	Non-Applicable						

Table 2. Project Activity and Reporting History
Chapel Creek Stream Restoration-Project No. 77

Elapsed Time Since Grading Complete: 3 yrs 3 months
Elapsed Time Since Planting Complete: 3 yrs 3 Months
Number of Reporting Years[1]: 3

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Restoration Plan		Aug-06
Final Design – Construction Plans		Jun-07
Construction		Jul-08
Temporary S&E mix applied to entire project area		Jul-08
Permanent seed mix applied to enitre project area		Jul-08
Repairs to stream due to damages from storm events		Mar-09
Temporary S&E mix applied to area disturbed by repairs		Mar-09
Permanent seed mix applied to area disturbed by repairs		Mar-09
Containerized and B&B plantings for entire reach		Mar-09
Mitigation Plan / As-built (Year 0 Monitoring – baseline)	Mar-09	Mar-09
Year 1 Monitoring	Sept-09	Nov-09
Year 2 Monitoring	Oct-10	Nov-10
Year 3 Monitoring	Aug-11	Nov-11
Year 4 Monitoring		
Year 5 Monitoring		
Year 5+ Monitoring		

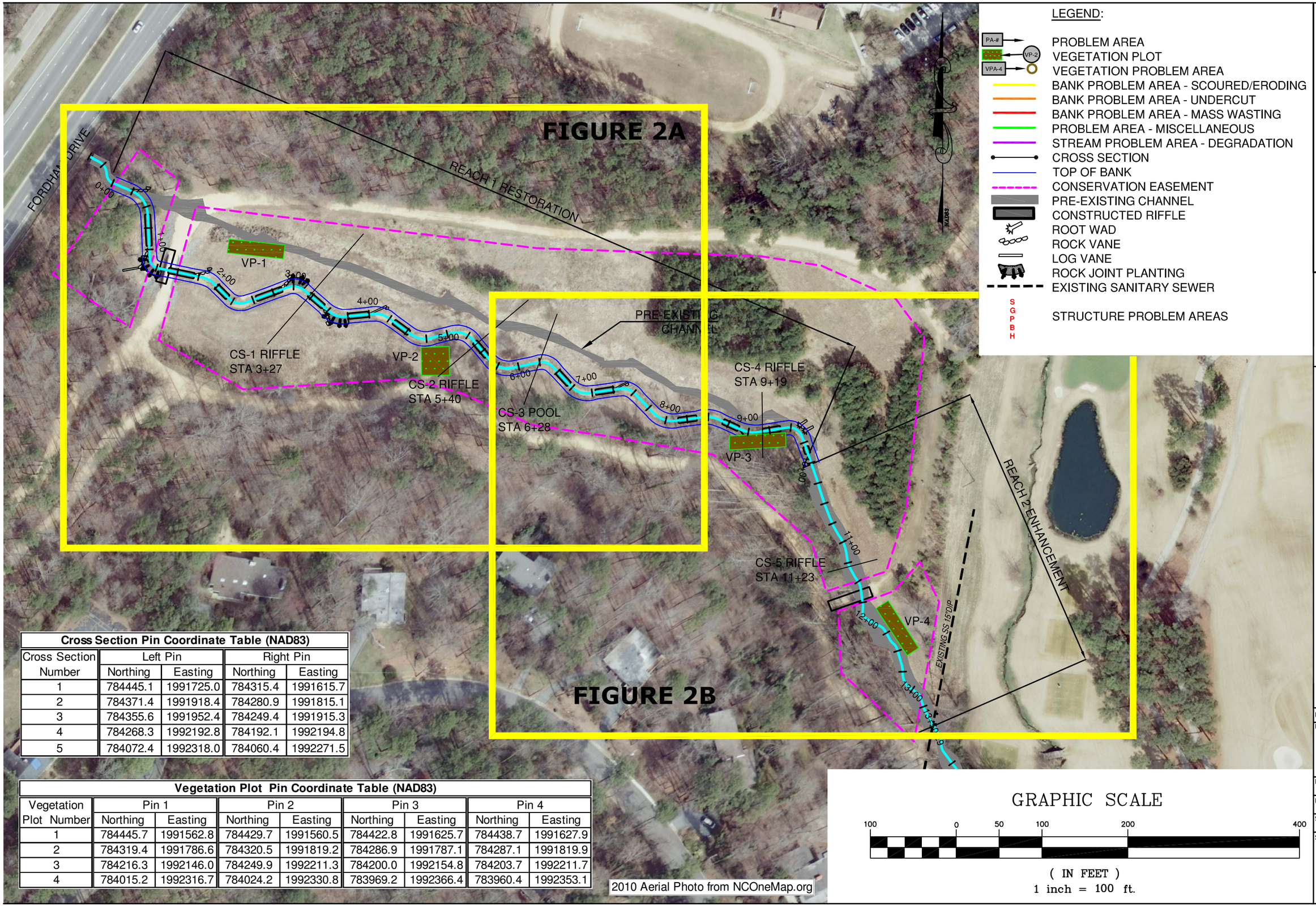
1 = Equals the number of reports or data points produced excluding the baseline

Table 3. Project Contacts Table Chapel Creek Stream Restoration-Project No. 77	
Designer	Ward Consulting Engineers, P.C. 8368 Six Forks Road Suite 104 Raleigh, NC 27615-5083
Primary project design POC	Becky Ward 919-870-0526
Construction Contractor	River Works, Inc. 800 Regency Parkway, Suite 200 Cary, NC 27518
Construction contractor POC	Will Pederson 919-459-9001
Survey Contractor	Level Cross Surveying, PLLC (all surveying) 668 Marsh County Lane Randleman, NC 27317
Survey contractor POC	Sherie Willard 336-495-1713
Planting Contractor	River Works, Inc. 800 Regency Parkway, Suite 200 Cary, NC 27518
Planting contractor POC	Will Pederson 919-459-9001
Seeding Contractor	River Works, Inc. 800 Regency Parkway, Suite 200 Cary, NC 27518
Contractor point of contact	Will Pederson 919-459-9001
Seed Mix Sources	Green Resource 336-855-6363
Nursery Stock Suppliers	Mellow Marsh Farm, Inc. 919-742-1200 Cure Nursery 919-542-6186
Monitoring Performers	Ward Consulting Engineers, P.C. 8368 Six Forks Road Suite 104 Raleigh, NC 27615-5083
Stream Monitoring POC	Becky Ward 919-870-0526
Vegetation Monitoring POC	Chris Sheats - The Catena Group - 919-732-1300
Wetland Monitoring POC	Chris Sheats - The Catena Group - 919-732-1300

Table 4. Project Attribute Table Chapel Creek Stream Restoration Site-Project No. 77		
Project County	Orange	
Physiographic Region	Piedmont (Triassic Basin)	
Ecoregion	Central Piedmont	
Project River Basin	Cape Fear River Basin	
USGS HUC for Project (14 digit)	03030002060080	
NCDWQ Sub-basin for Project	03-06-06	
Within extent of EEP Watershed Plan?	Yes	
WRC Hab Class (Warm, Cool, Cold)	Warm	
% of project easement fenced or demarcated	100%	
Beaver activity observed during design phase?	No	
Restoration Component Attribute Table		
	Reach 1	**Reach 2**
Drainage area	0.42 sq mi	
Stream order	2	
Restored length (feet)	961	330
Perennial or Intermittent	Perennial	
Watershed type (Rural, Urban, Developing etc.)	Urban	
Watershed LULC Distribution (e.g.)		
Residential	32%	
Ag-Row Crop	0%	
Ag-Livestock	0%	
Forested	50%	
Open Space, grass cover >75%	9%	
Watershed impervious cover (%)	9%	
NCDWQ AU/Index number	16-41-2-8	
NCDWQ classification	WS-IV;NSW	
303d listed?	No	
Upstream of a 303d listed segment?	Yes	
Reasons for 303d listing or stressor	Standard Violation	
Total acreage of easement	5.15 ac	
Total vegetated acreage within the easement	4.99 ac	
Total planted acreage as part of the restoration	3.34 ac	
Rosgen classification of pre-existing	G4	C4/G4
Rosgen classification of As-built	C4	C4
Valley type	VIII	VIII
Valley slope	0.0136	0.017
Valley side slope range (e.g. 2-3.%)	7.8% - 19.5%	
Valley toe slope range (e.g. 2-3.%)	2.56% - 6.45%	
Cowardin classification	Riverine	
Trout waters designation	No	No
Species of concern, endangered etc.? (Y/N)	No	No
Dominant soil series and characteristics		
Series	Chewacla	Chewacla
Depth	-	-
Clay%	-	-
K	-	-
T	-	-

Use N/A for items that may not apply. Use "-" for items that are unavailable and "U" for items that are unknown

Appendix B. Visual Assessment Data



LEGEND:

- PROBLEM AREA
- VEGETATION PLOT
- VEGETATION PROBLEM AREA
- BANK PROBLEM AREA - SCOURED/ERODING
- BANK PROBLEM AREA - UNDERCUT
- BANK PROBLEM AREA - MASS WASTING
- PROBLEM AREA - MISCELLANEOUS
- STREAM PROBLEM AREA - DEGRADATION
- CROSS SECTION
- TOP OF BANK
- CONSERVATION EASEMENT
- PRE-EXISTING CHANNEL
- CONSTRUCTED RIFFLE
- ROOT WAD
- ROCK VANE
- LOG VANE
- ROCK JOINT PLANTING
- EXISTING SANITARY SEWER

S G P B H — STRUCTURE PROBLEM AREAS

Cross Section Pin Coordinate Table (NAD83)

Cross Section Number	Left Pin		Right Pin	
	Northing	Easting	Northing	Easting
1	784445.1	1991725.0	784315.4	1991615.7
2	784371.4	1991918.4	784280.9	1991815.1
3	784355.6	1991952.4	784249.4	1991915.3
4	784268.3	1992192.8	784192.1	1992194.8
5	784072.4	1992318.0	784060.4	1992271.5

Vegetation Plot Pin Coordinate Table (NAD83)

Vegetation Plot Number	Pin 1		Pin 2		Pin 3		Pin 4	
	Northing	Easting	Northing	Easting	Northing	Easting	Northing	Easting
1	784445.7	1991562.8	784429.7	1991560.5	784422.8	1991625.7	784438.7	1991627.9
2	784319.4	1991786.6	784320.5	1991819.2	784286.9	1991787.1	784287.1	1991819.9
3	784216.3	1992146.0	784249.9	1992211.3	784200.0	1992154.8	784203.7	1992211.7
4	784015.2	1992316.7	784024.2	1992330.8	783969.2	1992366.4	783960.4	1992353.1

2010 Aerial Photo from NCOneMap.org

GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)
1 inch = 100 ft.

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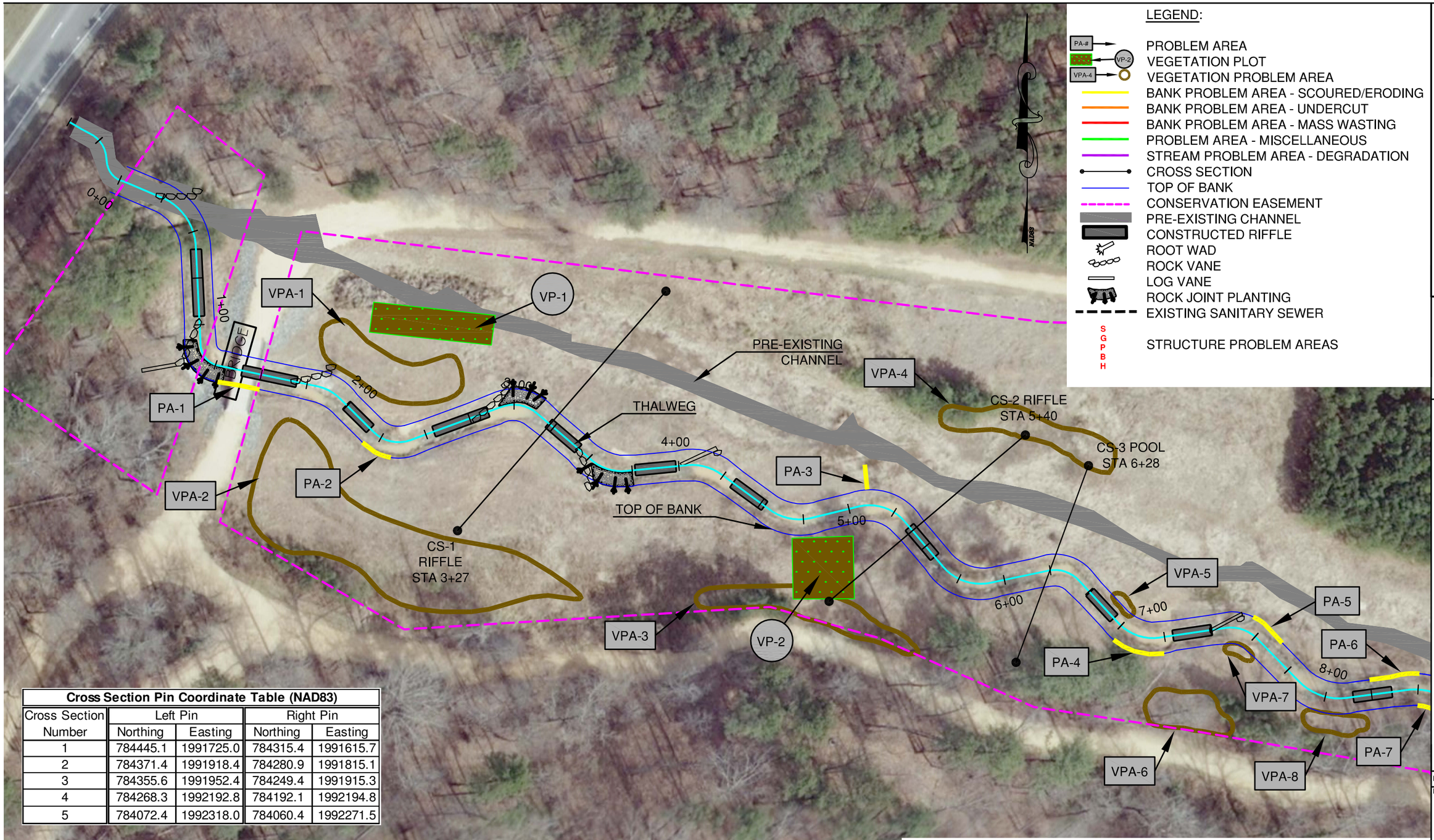
Ecosystem Enhancement Program

CHAPEL CREEK (EEP #77)
CURRENT CONDITIONS PLAN VIEW

CHAPEL HILL, NORTH CAROLINA

DATE: 15 April 2011
REVISIONS: 31 October 2011
PROJECT NAME: CHAPEL CREEK
DWG NAME: CCPV
SCALE: 1' = 100'
SHEET NO.

FIGURE 2
OVERALL



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2	784319.4	1991786.6	784320.5	1991819.2	784286.9	1991787.1	784287.1	1991819.9
3	784216.3	1992146.0	784249.9	1992211.3	784200.0	1992154.8	784203.7	1992211.7
4	784015.2	1992316.7	784024.2	1992330.8	783969.2	1992366.4	783960.4	1992353.1

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50 0 25 50 100 200

(IN FEET)

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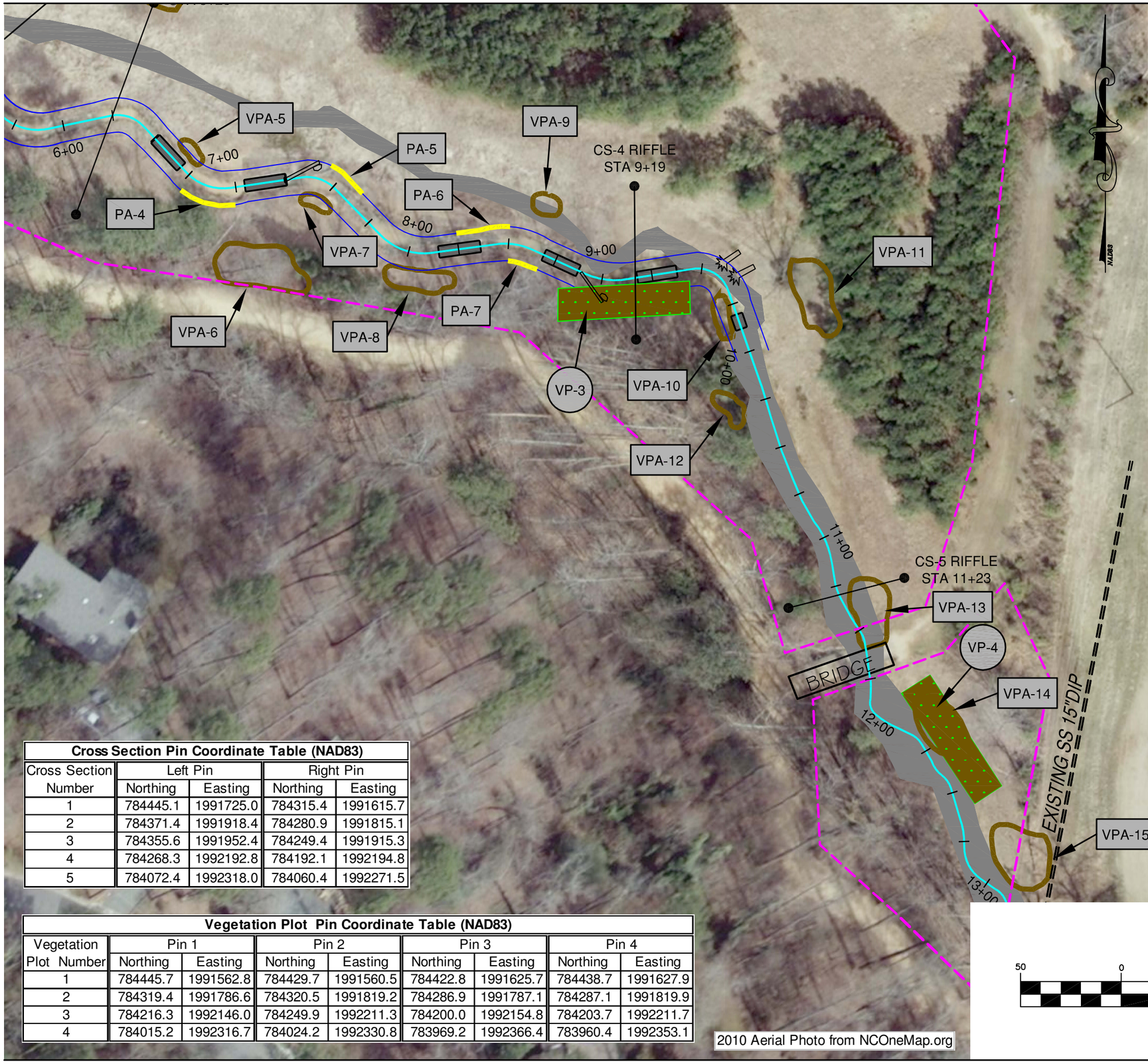
SHEET NO.

FIGURE 2A



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- STRUCTURE PROBLEM AREAS

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3	784216.3	1992146.0	784249.9	1992211.3	784200.0	1992154.8	784203.7	1992211.7
4	784015.2	1992316.7	784024.2	1992330.8	783969.2	1992366.4	783960.4	1992353.1

2010 Aerial Photo from NCOneMap.org

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)

1 inch = 50 ft.

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Ecosystem Enhancement Program

CHAPEL CREEK (EEP #77)
CURRENT CONDITIONS PLAN VIEW

CHAPEL HILL, NORTH CAROLINA

DATE: 15 April 2011

REVISIONS: 31 October 2011

PROJECT NAME: CHAPEL CREEK

DWG NAME: CCPV

SCALE: 1' = 50'

SHEET NO.

FIGURE 2B

Table 5 **Visual Stream Morphology Stability Assessment**

Reach ID **Reach 1 (Restoration)**

Assessed Length **961**

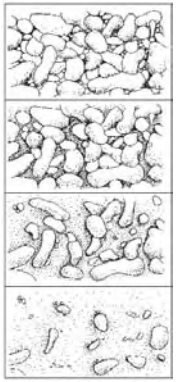
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)					100%			
		2. Degradation - Evidence of downcutting			1	20	98%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	17	17			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	17	17			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	17	17			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	16	17			94%			
		2. Thalweg centering at downstream of meander (Glide)	17	17			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			4	40	98%			98%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.					100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse					100%			100%
				Totals	4	40	98%	0	0	98%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	8	8			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	8	8			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	8	8			100%			

Criteria, Definitions and Thresholds for Visual Stream Morphology Assessments

Major Channel Category	Channel Sub-Category	Metric	Definitions	Cataloging Threshold	CCPV Depiction
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)	"Aggradation refers to at least moderate increases in reach stored sediment. It is NOT simply constituted by minor fining of riffles or filling of pools at or below baseflow elevations. An aggrading reach is often characterized by sand or gravel bar formation/growth with associated fining of reach substrate and smoothing of the reach long profile. Bars/aggraded areas significant enough to deflect flow against banks should be catalogued. Repeat channel photopoints are a key tool in assessing project aggradation. (See photo exhibit 1 below for range of example bar development/aggradation)	Catalog only if feature has most of the characteristics described to the left (cell E11) and is at least 15 feet in length or 20% of the riffle/run length, whichever is less.	NA
		2. Degradation - Number and size of evident downcuts within Riffle/Run units.	Where projects have regularly-spaced engineered grade control, degredation/downcutting is expected only in short, discreet lengths. "Indicators include perched sill structures, channel bed "steps" in clay-rich parent material, evidence of bed retreat at the bank toe (parent material may be exposed); mobilization of coarse riffle substrate in to pools downstream, and perhaps riffles with run morphology. Long-profile surveys should support an assessment of bed degradation where the visual assessment and survey overlap.	Catalog only if feature has most of the characteristics described to the left (cell E12) and is at least 15 feet in length or 20% of the riffle/run length, whichever is less.	Dark Red or Purple Color to be certain to distinguish from Mass Wasting Color Code
	2. Riffle Condition	1. Texture	Riffles should maintain a coarseness similar to the design distribution. Significant fining of the riffle surface indicates non-attainment for the riffle. Repeat pebble counts should support an assessment of riffle fining where overlap occurs (see exhibit graphic 2 below describing embedding for gravel-cobble systems).	NA	NA
	3. **Meander Pool Condition**	1. Depth Sufficient?	This metric is used to assess meander pools and also step-pools along a Rosgen B-type channel reaches. For stepped reaches the pools will be evaluated and tallied here and under the Habitat Sub-Category below. The max pool bankfull depth should be 1.6 times the mean bankfull depth (Max Pool Depth : Mean Bankfull Depth > 1.6). The mean bankfull depth from the As-built/baseline survey can be utilized to make this determination. Exhibit 3 provides residual pool depths using the 1.6 multiplier for a range of mean channel riffle depths that typify restoration projects.	NA	NA
		2. Length appropriate?	This metric will only be applied to meander pools. The meander pool length should be >30% of the ~ linear centerline distance between the tail of the upstream riffle and the head of the downstream rifle.	NA	NA
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)?	This metric is used to characterize flow paths along riffle-run-pool transitions. The thalweg is expected to be against the outer bank in the bend apex, but vectors oriented towards the outer bank too far above the bend apex may indicate the potential for increased bank erosion. Similarly, the pool-glide-riffle transition is also expected to demonstrate flow path centering (Metric 4.2 below). The current-year thalweg rendered on the CCPV figure can assist in this assessment.	NA	NA
		2. Thalweg centering at downstream of meander bend (Glide)?	See Metric 4.1 above	NA	NA
2. Bank	**1. Scoured/Eroding Bank**	In order to better assess continued bank erosion risk, tallied bank segments are also characterized with respect to the proximity and integrated extent of stabilizing vegetation. Continued erosion risk for a given bank instability object is essentially adjusted downwards by adjacent mature vegetation and/or stabilizing roots. One or more mature trees in close proximity (e.g. 10 feet or less) or obvious integration of root mass within the bank failure are characteristics that would prompt the tallying of a given bank object into the additional sub-category related to risk of further instability (columns J-L of the actual data table). Essentially, the vegetative elements of rooting density and depth (e.g. from a BEHI assessment) need to be considered here.	Banks with evident scour /erosion	<table><tr><th>Bank Height</th><th>Minimum Length</th></tr><tr><td>>6</td><td>6</td></tr><tr><td>3-6</td><td>8</td></tr><tr><td><3</td><td>10</td></tr></table> See Footnote/Exhibit 5 below also This table provides a guide for working thresholds for bank erosion cataloging/mapping based on bank height. For the bank height ranges above, the minimum length of bank to be mapped and tallied is specified. For example, where banks are <3 feet high, only map an unstable segment if it is ≥ 10 feet.[5]	Yellow.
	2. Undercut		Banks undercut/overhanging to the extent that mass wasting appears likely? Does NOT include undercuts that modest, appear sustainable/stable and are providing habitat.		Orange.
	3. Mass Wasting		Bank slumping/calving/collapse?		Red.
3. Structures	**1. Overall Integrity**	The assessment of engineered structure performance should include all structures that provide grade control, bank protection, or habitat functions. These include Vanes, J-hooks, and rootwads, etc.	Bulk of structure physically intact with no dislodged boulders or logs?		Using callouts or some other means to maintain legibility, annotate structure with red **"S"** if structural failure has occurred
	2. Grade Control		Bed grade control maintained across the sill structure? No evident loss of bed elevation immediately upstream of structure? Some piping alone will not constitute a loss of grade control.		Using callouts or some other means to maintain legibility, annotate structure with red **"G"** if structure has lost grade control
	2a. Piping		Catalog structures lacking any substantial flow underneath sills or around arms?		Using callouts or some other means to maintain legibility, annotate structure with red **"P"** if significant piping has occurred
	3. Bank Protection		See exhibit 4 below for determining structural sphere of influence. If the amount of bank that is deemed to be actively eroding within the structures sphere of influence exceeds 15% of the total bank footage within the structures sphere of influence, then the structure should be classified as not providing adequate bank protection in the data table.		Using callouts or some other means to maintain legibility, annotate structure with red **"B"** if structure has failed to provide bank protection
	4. Habitat		Are pools maintained @ ~ Max Pool Depth : Mean Bankfull Depth > 1.6? For rootwads, habitat provision means interacting with baseflow and providing cover.		Using callouts or some other means to maintain legibility, annotate structure with red **"H"** if structure is not providing habitat

Exhibit 1. Examples of bar features warranting concerning related to cataloging item 1.1.1 of the assessment

Exhibit 2. Graphic depicting embedding of riffles with fine material



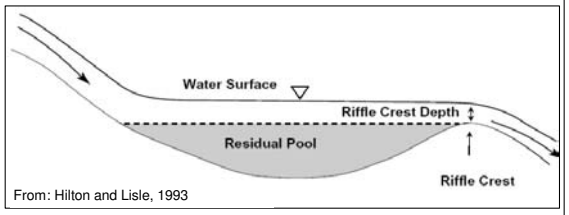
Progressing from top to bottom, the series of graphics to the left depicts the fining of interstial spaces between coarser particles. This describes increasing levels of embededness in riffles. The observer must have an understanding of the intended substrate distributions/texture of the bed for the projects riffles when assessing this. However, as a guideline for streams in the coarse gravel to cobble range, the 2nd panel from the top represents a visual guideline for the condition that would begin to elicit concern for this parameter, but still contains a good deal of coarse material. Progressing from that state to the conditions depicted in the the 3rd and 4th panel represents a visual que for significant emdedding.

From USEPA (EPA 841-B-97-003 - Nov 1997)

Exhibit 3. Residual Pool Depth Table - Relating 1.6 criterion for typical mean riffle depths to residual pool depths

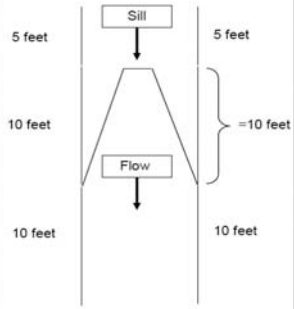
This residual pool table was provided in the event the tracking of bankfull at each pool feature to estimate a Dmax was inconvenient. Estimating the residual pool depth by measuring the max pool depth to water surface and subtracting the water depth at the riffle head may provide a more convenient way under certain circumstances to estimate in the field. For this reason the exhibit table provides a relationship between the 1.6 criterion applied to mean riffle depth for the site and the resulting residual pool depths.

Mean Riffle Depth D_{bkf}	Multiplier	Target Bankfull Pool Max	Residual Pool Depth
1.0	1.6	1.6	0.6
1.5	1.6	2.4	0.9
2.0	1.6	3.2	1.2
2.5	1.6	4.0	1.5
3.0	1.6	4.8	1.8
3.5	1.6	5.6	2.1
4.0	1.6	6.4	2.4
4.5	1.6	7.2	2.7
5.0	1.6	8.0	3.0



From: Hilton and Lisle, 1993

Exhibit 4. Extent of Structural Influence for Bank Protection



The drawing is a guideline for the extent of influence vane arms exert on stream banks. The bracketed segment (10ft) immediately adjacent to the vane arm is multiplied by 5 to determine the total length of bank influenced by a cross vane. This includes the bank length adjacent to each vane arm, 1 length (10 feet) below each van arm, and ½ length (5 feet) on each bank above the uppermost structural element (in this case the vane sill), yielding 50 feet in this example case. In this example a single arm vane or j-hook would only influence 25ft of bank.

If the amount of recent bank erosion observed within the extent of influence exceeds 15% then the structure is deemed not to be providing adequate bank protection. In the above examples this would amount to ~ 8 and 4 feet, respectively.

If in an earlier assessment the structure failed the 15% bank protection criteria but the erosion has subsequently stabilized, then the observer can use best professional judgment to determine if the structure is currently meeting the bank protection criteria.

5 = The above was developed because of the need to have a threshold given the large number of performers and to avoid spending time trying to catalog and map small objects that if excluded would have minimal overall impacts on the performance percentages. It is a guide that tries to strike a balance between the obvious need to have a threshold, yet provide confidence that the site conditions are accurately represented. For example, a scenario where 1 object nearly exceeding the threshold were to occur every 100 feet of bank height (which would be a high frequency and unlikely) with a bank height of 5 feet, would yield an error of ~3%. However, if the observer is encountering a truly high number of objects just below the threshold in the above table (e.g. > 1 per 100 feet of bank channel on average) and is concerned that the exclsuion of such objects is going to misrepresent the site conditions, then judgement should be applied and objects below the threshold may be cataloged. If a rare condition as described does occur and the thresholds are not utilized then a table footnote explaining this should be included.

Lastly, given the increase in overall area and the implications to stability, greater banks heights required smaller threshold minimums.

Table 6 Vegetation Condition Assessment

Planted Acreage[1] **4**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres	Brown Line	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Brown Line	0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Brown Line	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] **5.153**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF	Brown Line	13	0.34	6.6%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	Brown Line	0	0.00	0.0%

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particulalry for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

High Concern:				**Low/Moderate Concern:**	
Vines	**Genus/Species**	**Shrubs/Herbs**	**Genus/Species**	**Shrubs/Herbs**	**Genus/Species**
Kudzu	*Pueraria lobata*	Japanese Knotweed	Polygonum cuspidatum	Japanese Privet	Ligustrum Japonicum
Porcelain Berry	Ampelopsis brevipeduncu	Oriental Bittersweet	Celastrus orbiculatus	Glossy Privet	Ligustrum lucidum
Japanese Honeysuckle	Lonicera japonica	Multiflora Rose	Rosa multiflora	Fescue	Festuca spp.
Japanese Hops	Humulus japonicus	Russian olive	Elaeagnus angustifolia	English Ivy	Hedera helix
Wisterias	Wisteria spp.	Chinese Privet	Ligustrum sinense	Microstegium	Microstegium vimineum
Winter Creeper	Euonymus fortunei	Chinese Silvergrass	Miscanthus sinensis	Burning Bush	Euonymus alatus
Bush Killer (Watch List)	Cayratia japonica	Phragmites	Phragmites australis	Johnson Grass	Sorghum halepense
		Bamboos	Phyllostachys spp	Bush Honeysuckles	Lonicera, spp.
Trees		Sericea Lespedeza	Sericea Lespedeza	Periwinkles	Vinca minor
Tree of Heaven	Ailanthus altissima	Garlic Mustard (Watch List)	Alliaria petiolata	Morning Glories	Morning Glories
Mimosa	Albizia julibrissin	Cogon Grass (Watch List)	Imperata cylindrica	Bicolor Lespedeza (Watch List)	Lespedeza bicolor
Princess Tree	Paulownia tomentosa	Giant Reed (Watch List)	Arundo donax	Chinese Yams (Watch List)	Dioscorea oppositifolia
China Berry	Melia azedarach	Tropical Soda Apple (Watch List)	Solanum viarum	Air Potato (Watch List)	Dioscorea bulbifera
Callery Pear	Pyrus calleryana	Japanese Spirea (Watch List)	Spiraea japonica	Japanese Climbing Fern (Watch List)	Lygodium japonicum
White Mulberry	Morus alba	Japanese Barberry (Watch List)	Berberis thunbergii		
Tallow Tree (Watch List)	Triadica sebifera				

Stream Station Photos

Photo 1. Looking downstream at XS-1

Photo 2. Looking downstream at XS-2

Photo 3. Looking downstream at XS-3

Photo 4. Looking downstream at XS-4

Photo 5. Looking downstream at XS-5

Vegetation Monitoring Plots Photos

Photo 6. Vegetation Plot 1 (MY3-August 24, 2011)

Photo 7. Vegetation Plot 2 (MY3-August 24, 2011)

Photo 8. Vegetation Plot 3 (MY3-August 24, 2011)

Photo 9. Vegetation Plot 4 (MY3-August 24, 2011)

Appendix C. Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment		
Vegetation Plot ID	**Vegetation Survival Threshold Met?**	**Tract Mean**
VP1	Yes	100%
VP2	Yes	
VP3	Yes	
VP4	Yes	

Table 8. CVS Vegetation Plot Metadata	
Report Prepared By	Chris Sheats
Database name	TheCatenaGroup-2010-C-ChapelCreek.mdb
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
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	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	77
project Name	Chapel Creek
Description	Stream Restoration
River Basin	Cape Fear
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	4
Sampled Plots	0

EEP Project Code 77. Project Name: Chapel Creek

Table 9: Planted and Total Stem Counts

			Current Plot Data (MY3 2011)												Annual Means					
			E077-01-0001			E077-01-0002			E077-01-0003			E077-01-0004			MY3 (2011)			MY2 (2010)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Alnus serrulata	hazel alder	Shrub Tree			1						65						66			63
Baccharis halimifolia	eastern baccharis	Shrub Tree			15			2			25			2			44			17
Betula nigra	river birch	Tree				2	2	4	3	3	3	6	6	1756	11	11	1763	12	12	18.9
Calycanthus	sweetshrub													1			1	1	1	1
Calycanthus floridus	eastern sweetshrub	Shrub										1	1	1	1	1	1			
Carpinus caroliniana	American hornbeam	Shrub Tree									1775	2	2	2	2	2	1777	2	2	13
Cephalanthus occidentalis	common buttonbush	Shrub Tree																1	1	1
Cornus amomum	silky dogwood	Shrub							2	2	2				2	2	2			
Diospyros virginiana	common persimmon	Tree	1	1	1	3	3	3	1	1	1				5	5	5	9	9	10
Elaeagnus umbellata	autumn olive	Shrub									2						2			1
Fraxinus pennsylvanica	green ash	Tree			4	4	4	5	2	2	3	7	7	7	13	13	19	13	13	15
Hibiscus moscheutos	crimsoneyed rosemallow	Shrub	5	5	5										5	5	5	5	5	5
Juglans nigra	black walnut	Tree																		2
Ligustrum sinense	Chinese privet	Shrub Tree									1			2			3			1
Lindera benzoin	northern spicebush	Shrub Tree							5	5	5	1	1	1	6	6	6	9	9	9
Liquidambar styraciflua	sweetgum	Tree			4			5			1075			650			1734			94
Liriodendron tulipifera	tuliptree	Tree									3			9			12			
Magnolia virginiana	sweetbay	Shrub Tree	1	1	1										1	1	1	3	3	3
Morella cerifera	wax myrtle	Shrub Tree									4			9			13			6
Pinus taeda	loblolly pine	Tree			125						2175			54			2354			178
Platanus occidentalis	American sycamore	Tree				3	3	3	1	1	2				4	4	5	3	3	7
Prunus serotina	black cherry	Shrub Tree									5						5			
Quercus lyrata	overcup oak	Tree										2	2	2	2	2	2			
Quercus nigra	water oak	Tree				1	1	1							1	1	1	3	3	3
Quercus phellos	willow oak	Tree												1			1			
Rosa multiflora	multiflora rose	Shrub Vine									2						2			1
Rosa palustris	swamp rose	Shrub	5	5	5										5	5	5	5	5	5
Salix nigra	black willow	Tree			69												69			52
Ulmus	elm	Tree			1			4									5			
Ulmus alata	winged elm	Tree																		2
Vaccinium corymbosum	highbush blueberry	Shrub	1	1	1										1	1	1	1	1	1
Viburnum	viburnum	Shrub Tree																		2
Viburnum dentatum	southern arrowwood	Shrub Tree	1	1	1	1	1	1	13	13	13				15	15	15	15	15	15
Viburnum nudum	possumhaw	Shrub Tree							2	2	2				2	2	2	2	2	2
Xanthorhiza simplicissima	yellowroot	Shrub							1	1	1				1	1	1	1	1	1
Color for Density		**Stem count**	14	14	233	14	14	28	30	30	5164	19	19	2497	77	77	7922	85	85	528.9
Exceeds requirements by 10%		**size (areas)**	1			1			1			1			4			4		
Exceeds requirements, but by less than 10%		**size (ACRES)**	0.02			0.02			0.02			0.02			0.10			0.10		
Fails to meet requirements, by less than 10%		**Species count**	6	6	13	6	6	9	9	9	20	6	6	14	17	17	31	16	16	28
Fails to meet requirements by more than 10%		**Stems per ACRE**	566.6	566.6	9429	566.6	566.6	1133	1214	1214	208979.7	768.9	768.9	101050	779	779	80148	859.957	859.957	5350.956

Appendix D. Stream Survey Data

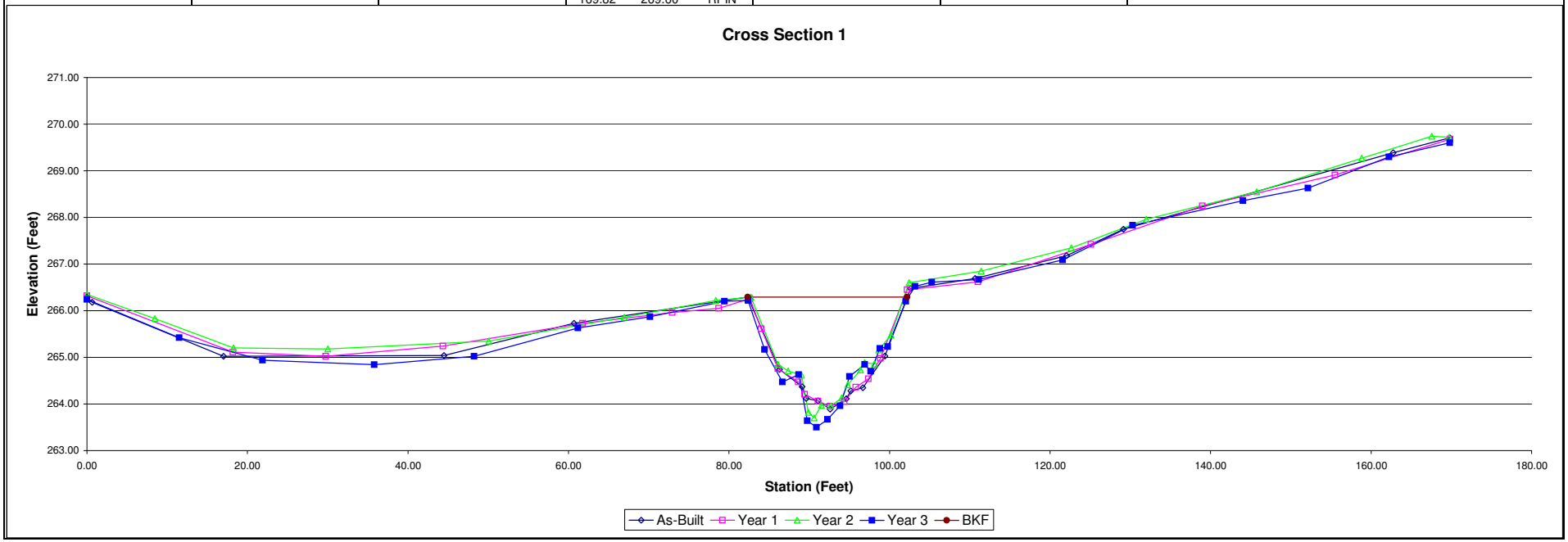
Project:	Chapel Creek
Cross Section:	Cross Section 1
Feature	Riffle
Station:	3+27
Date:	8/18/11
Crew:	ZP, SV

Summary (bankfull)

	MY0	MY1	MY2	MY3	MY4	MY5
A (BKF)	30.6	29.2	28.2	31.3		
W (BKF)	19.9	19.2	19.1	20.0		
Max d	2.4	2.3	2.6	2.8		
Mean d	1.5	1.5	1.5	1.6		
W/D	12.9	12.6	12.9	12.7		

MY00-2009			MY01-2009			MY02-2010			MY03-2011		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
0.00	266.30	LPIN	0.00	266.32	LPIN	0.00	266.35	LPIN		266.24	LPIN
0.64	266.18		18.18	265.11		8.46	265.83		11.51	265.42	
17.02	265.02		29.77	265.02		18.26	265.20		21.88	264.94	
44.50	265.04		44.34	265.24		30.00	265.18		35.79	264.84	
60.68	265.73		61.77	265.73		50.07	265.35		48.23	265.02	
82.33	266.29	TOBL	72.92	265.96		66.96	265.86		61.16	265.63	
86.28	264.74		78.71	266.05		78.34	266.22		70.17	265.87	
89.10	264.37		82.59	266.26	TOBL	82.72	266.29	TOBL	79.43	266.20	
89.64	264.12		84.02	265.61		86.10	264.85		82.36	266.22	TOBL
91.09	264.07		86.10	264.76		87.38	264.71		84.43	265.17	
92.60	263.89	TW	88.63	264.47		89.05	264.62		86.66	264.47	
94.63	264.11		89.44	264.21		89.90	263.82	TOE L	88.68	264.63	
95.18	264.28		91.09	264.06		90.61	263.70	TW	89.75	263.64	TOE L
96.67	264.35		92.55	263.95	TW	91.53	263.97		90.91	263.50	
99.42	265.03		94.36	264.05		92.69	263.96		92.27	263.67	TW
102.61	266.48	TOBR	95.80	264.36		94.04	264.13	TOE R	93.84	263.96	TOE R
110.65	266.69		97.38	264.54		94.78	264.41		95.00	264.59	
122.07	267.18		98.88	264.98		96.37	264.73		96.90	264.85	
129.16	267.75		102.19	266.45	TOBR	96.92	264.89		97.67	264.70	
162.74	269.39		111.02	266.62		98.11	264.86		98.80	265.19	
169.80	269.71	RPIN	125.08	267.42		98.64	265.16		99.78	265.23	
			138.99	268.25		100.16	265.48		102.02	266.20	
			155.50	268.91		102.42	266.60	TOBR	103.19	266.52	TOBR
			169.83	269.68	RPIN	111.42	266.85		105.27	266.61	
						122.66	267.35		111.12	266.67	
						131.99	267.96		121.57	267.09	
						145.75	268.55		130.29	267.83	
						158.85	269.27		144.03	268.36	
						167.57	269.74		152.14	268.63	
						169.70	269.72	RPIN	162.23	269.30	
									169.82	269.60	RPIN

Photo of XS-1, looking in the downstream direction



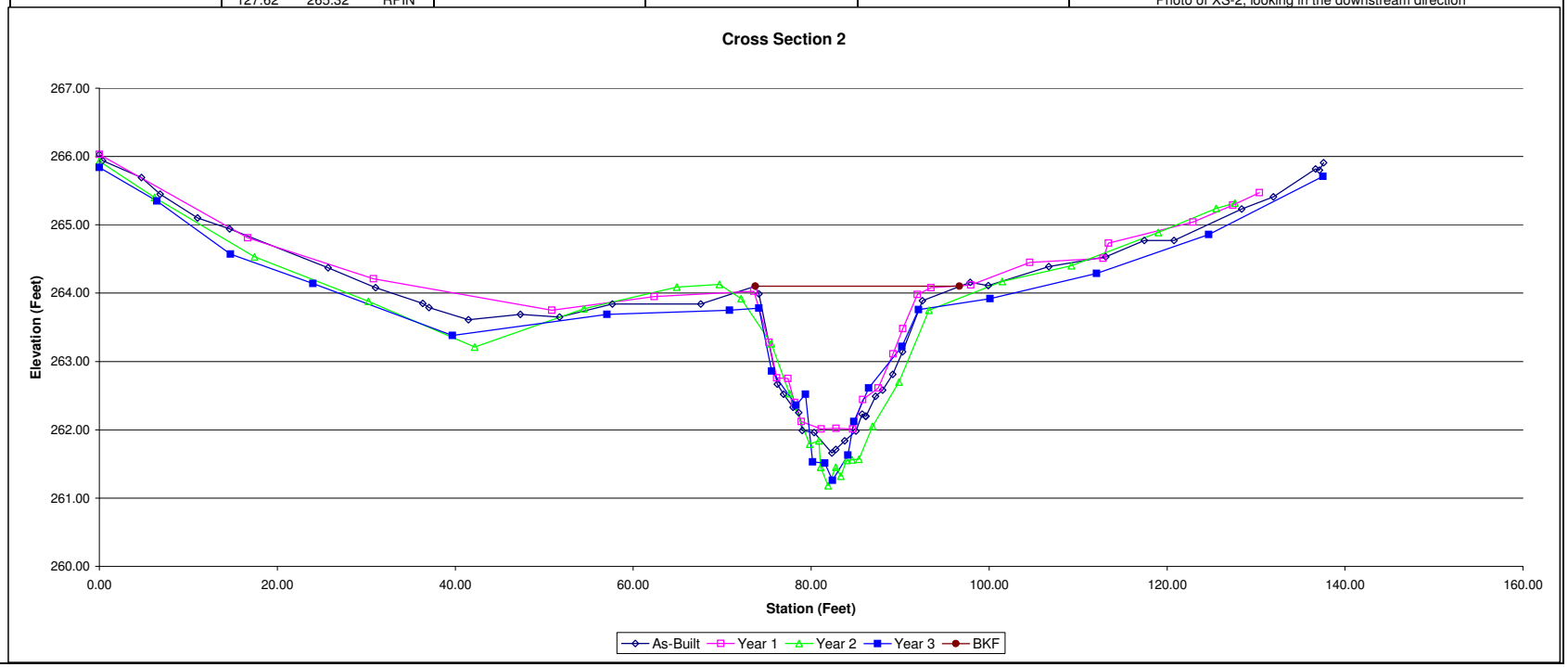
Project:	Chapel Creek
Cross Section:	Cross Section 2
Feature	Riffle
Station:	5+40
Date:	8/18/11
Crew:	ZP, SV

Summary (bankfull)

	MY0	MY1	MY2	MY3	MY4	MY5
A (BKF)	29.9	25.0	36.9	28.5		
W (BKF)	23.0	19.1	31.0	28.6		
Max d	2.4	2.0	2.9	2.7		
Mean d	1.3	1.3	1.2	1.0		
W/D	17.6	14.6	26.1	28.6		

Photo of XS-2, looking in the downstream direction

MY00-2009			MY01-2009			MY02-2010			MY03-2011		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
0.00	266.03	LPIN	0.00	266.03	LPIN	0.00	265.93	LPIN		265.84	LPIN
0.38	265.94		16.68	264.81		6.21	265.40		6.47	265.35	
4.75	265.69		30.81	264.21		17.44	264.53		14.75	264.57	
6.82	265.45		50.86	263.75		30.23	263.88		24.01	264.14	
11.04	265.10		62.35	263.95		42.18	263.21		39.68	263.38	
14.64	264.94		73.58	264.03	TOBL	54.45	263.77		57.05	263.69	
25.70	264.37		75.25	263.28		64.88	264.09		70.82	263.75	
31.04	264.08		76.14	262.76		69.68	264.13		74.13	263.78	TOBL
36.34	263.85		77.41	262.75		72.12	263.92	TOBL	75.57	262.86	
37.06	263.79		78.13	262.40		75.52	263.26		78.30	262.36	
41.50	263.61		78.89	262.12		77.55	262.53		79.38	262.52	
47.31	263.69		81.12	262.01	TOE L	79.82	261.79		80.18	261.53	TOE L
51.71	263.65		82.79	262.02		80.88	261.84		81.52	261.51	
57.67	263.84		84.67	262.01	TOE R	81.07	261.45	TOE L	82.40	261.26	TW
67.59	263.84		85.80	262.44		81.90	261.18	TW	84.15	261.63	TOE R
73.72	264.10	TOBL	87.54	262.61	TW	82.76	261.45		84.79	262.12	
74.13	263.99		89.21	263.11		83.33	261.32		86.47	262.61	
76.20	262.67		90.31	263.48		83.97	261.55		90.21	263.22	
76.90	262.52		91.93	263.98	TOBR	84.61	261.56		92.08	263.76	TOBR
77.98	262.33		93.46	264.08		85.37	261.57	TOE R	100.11	263.92	
78.59	262.25		97.93	264.12		86.89	262.05		112.07	264.29	
79.00	261.99		104.58	264.45		89.87	262.70		124.67	264.86	
80.33	261.96		112.83	264.51		93.23	263.75	TOBR	137.52	265.71	RPIN
82.32	261.66	TW	113.42	264.73		101.49	264.17				
82.76	261.71		122.91	265.04		109.26	264.40				
83.77	261.84		127.37	265.29	RPIN	119.00	264.89				
85.02	261.98		130.38	265.47		125.53	265.24				
85.73	262.23					127.62	265.32	RPIN			
86.10	262.20										
86.17	262.20										
87.25	262.49										
88.04	262.58										
89.18	262.81										
90.27	263.14										
92.52	263.89										
97.87	264.16	TOBR									
99.91	264.11										
106.72	264.39										
113.11	264.53										
117.44	264.77										
120.77	264.77										
128.39	265.23										
131.96	265.41										
136.68	265.82										
137.13	265.80										
137.60	265.91	RRPIN									



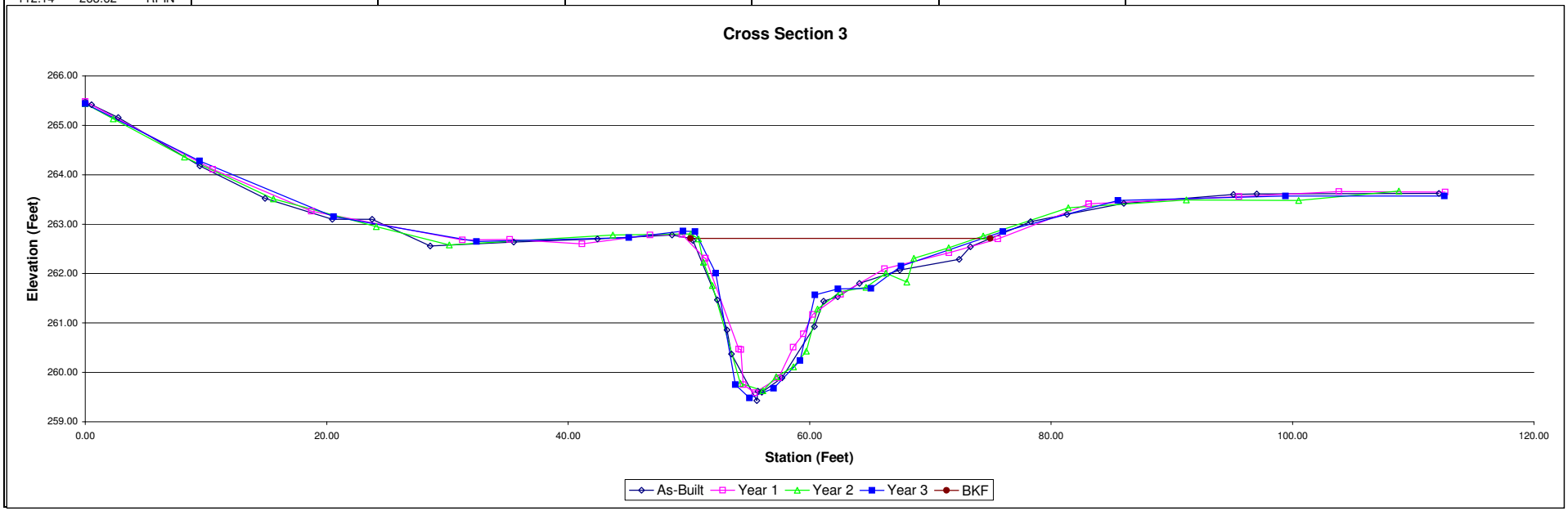
Project:	Chapel Creek
Cross Section:	Cross Section 3
Feature	Pool
Station:	6+28
Date:	8/18/11
Crew:	ZP, SV

Summary (bankfull)

	MY0	MY1	MY2	MY3	MY4	MY5
A (BKF)	31.7	31.1	30.7	30.3		
W (BKF)	24.8	27.1	22.9	23.0		
Max d	3.3	3.2	3.1	3.2		
Mean d	1.3	1.1	1.3	1.3		
W/D	19.4	23.6	17.0	17.4		

MY00-2009			MY01-2009			MY02-2010			MY03-2011		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
0.00	265.48	LPIN	0.00	265.48	LPIN	0.00	265.44	LPIN		265.44	LPIN
0.52	265.42		10.55	264.11		2.33	265.13		9.48	264.28	
2.73	265.16		18.73	263.26		8.21	264.36		20.58	263.15	
9.49	264.18		31.24	262.68		15.58	263.51		32.42	262.65	
14.90	263.52		35.17	262.69		24.11	262.95		45.03	262.73	
20.47	263.10		41.14	262.60		30.15	262.58		49.51	262.86	
23.77	263.10		46.79	262.78		43.70	262.78		50.51	262.85	TOBL
28.58	262.56		49.43	262.79	TOBL	50.17	262.80	TOBL	52.22	262.01	
35.48	262.64		51.32	262.31		50.79	262.70		53.85	259.75	TOE L
42.42	262.70		51.38	262.31		51.21	262.23		55.03	259.48	TW
48.60	262.78		54.13	260.47		51.94	261.76		57.02	259.68	
50.14	262.71	TOBL	54.31	260.46		54.27	259.78	TOE L	59.20	260.24	TOE R
50.34	262.67		54.51	259.75		56.14	259.63	TW	60.45	261.57	TOBR
52.36	261.47		55.46	259.59	TW	57.23	259.91		62.36	261.69	
53.15	260.86		57.44	259.89		58.67	260.11		65.09	261.70	
53.53	260.37		58.64	260.51		59.72	260.43	TOE R	67.57	262.15	
55.64	259.43	TW	59.48	260.78		60.66	261.28	TOBR	76.01	262.85	
55.72	259.62		60.26	261.17		62.52	261.63		85.54	263.48	
56.04	259.60		62.56	261.58		64.67	261.72		99.43	263.57	
57.72	259.89		66.21	262.10		66.31	262.01		112.58	263.57	RPIN
60.40	260.93		71.54	262.42		68.06	261.83				
61.16	261.44		75.60	262.70		68.63	262.31				
62.34	261.53		83.12	263.41	TOBR	71.52	262.52				
64.14	261.80		83.12	263.41		74.38	262.76				
67.47	262.07		95.56	263.56		81.44	263.33				
72.39	262.29		103.84	263.66		91.21	263.49				
73.32	262.54		112.64	263.65	RPIN	100.50	263.48				
78.30	263.05	TOBR				108.81	263.67	RPIN			
81.32	263.20										
86.02	263.42										
95.12	263.60										
97.05	263.61										
112.14	263.62	RPIN									

Photo of XS-3 looking in the downstream direction



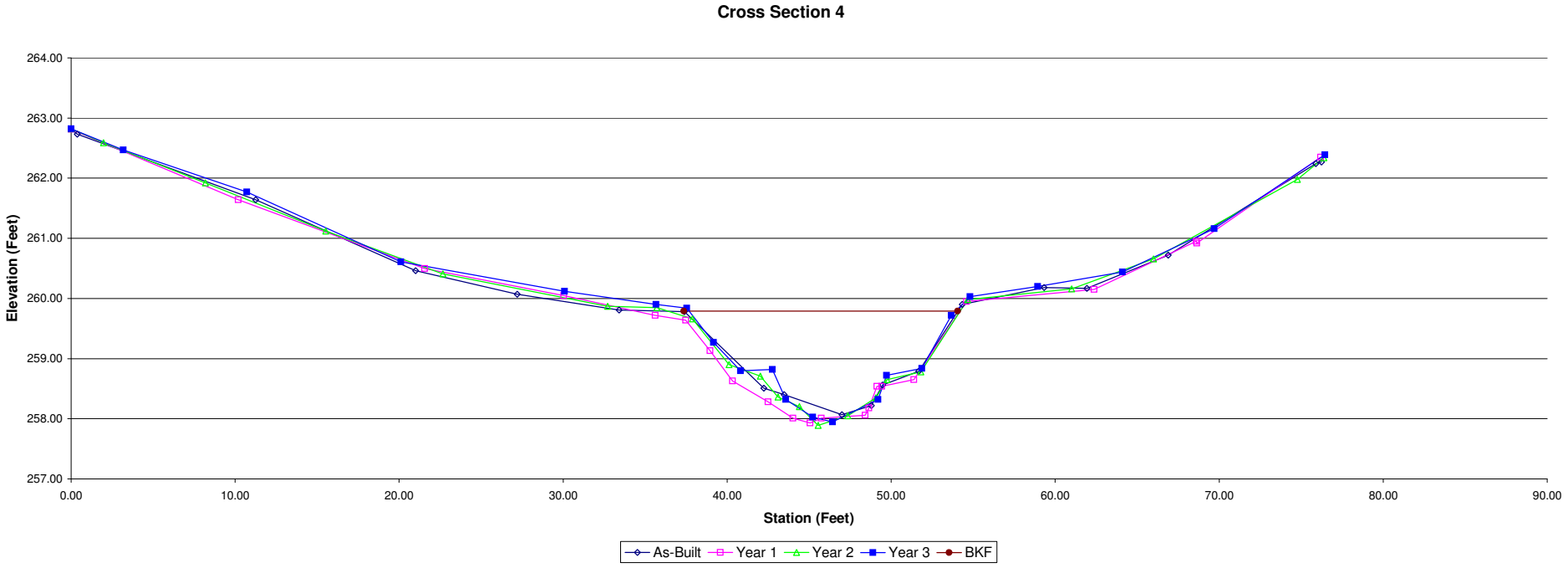
Project:	Chapel Creek
Cross Section:	Cross Section 4
Feature	Riffle
Station:	9+19
Date:	8/18/11
Crew:	ZP, SV

Summary (bankfull)

	MY0	MY1	MY2	MY3	MY4	MY5
A (BKF)	17.8	19.4	19.8	18.8		
W (BKF)	16.7	18.4	18.6	16.9		
Max d	1.7	1.8	2.0	1.9		
Mean d	1.1	1.1	1.1	1.1		
W/D	15.7	17.5	17.5	15.2		

MY00-2009			MY01-2009			MY02-2010			MY03-2011		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
0.00	262.82	LPIN	0.00	262.81	LPIN	0.00	262.82	LPIN		262.82	LPIN
0.37	262.73		10.20	261.64		1.98	262.59		3.18	262.47	
11.25	261.64		21.56	260.50		8.18	261.92		10.72	261.77	
21.00	260.46		30.04	260.05		15.52	261.12		20.11	260.61	
27.20	260.07		35.61	259.72		22.67	260.41		30.09	260.12	
33.42	259.81		37.48	259.64	TOBL	32.71	259.87		35.67	259.90	
37.40	259.78		38.96	259.13		35.71	259.85		37.54	259.84	TOBL
37.36	259.79	TOBL	40.32	258.63		37.89	259.66	TOBL	39.17	259.27	
42.23	258.51		42.50	258.28		40.12	258.90		40.81	258.80	
43.48	258.40		44.02	258.01		42.02	258.71		42.75	258.82	
46.99	258.07	TW	45.06	257.93	TW	43.10	258.36		43.58	258.32	TOE L
48.79	258.22		45.75	258.01		44.41	258.20	TOE L	45.22	258.03	
49.47	258.56		48.42	258.06		45.55	257.89	TW	46.43	257.95	TW
51.67	258.79		48.64	258.18		47.36	258.05		49.20	258.32	TOE R
54.33	259.90	TOBR	49.13	258.54		49.07	258.35	TOE R	49.72	258.72	
59.33	260.18		49.42	258.54		49.75	258.65		51.87	258.84	
61.93	260.17		51.39	258.65		51.81	258.78		53.67	259.72	
66.89	260.72		54.59	259.95	TOBR	54.66	259.98	TOBR	54.81	260.03	TOBR
75.89	262.24		62.38	260.15		61.00	260.16		58.93	260.20	
76.23	262.27	RPIN	68.60	260.95		65.99	260.66		64.10	260.44	
			68.64	260.92		74.77	261.98		69.69	261.16	
			76.18	262.35	RPIN	76.39	262.34	RPIN	76.45	262.39	RPIN

Photo of XS-4, looking in the downstream direction



Project:	Chapel Creek
Cross Section:	Cross Section 5
Feature	Riffle
Station:	11+23
Date:	8/18/11
Crew:	ZP, SV

Summary (bankfull)

	MY0	MY1	MY2	MY3	MY4	MY5
A (BKF)	28.9	29.8	32.5	26.7		
W (BKF)	15.4	16.3	17.5	15.9		
Max d	2.9	2.7	2.8	2.4		
Mean d	1.9	1.8	1.9	1.7		
W/D	8.2	8.9	9.4	9.5		

MY00-2009			MY01-2009			MY02-2010			MY03-2011		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
0.00	263.84		11.46	263.25	LPIN	11.46	263.25	LPIN	11.46	263.25	LPIN
11.46	263.25	LPIN	18.59	261.67		12.53	263.10		13.11	262.95	
11.90	263.17		25.70	260.34		14.95	262.59		19.34	261.62	
14.29	262.76		32.76	259.76		18.94	261.67		24.03	260.51	
17.16	262.06		34.95	259.71		23.47	260.70		31.75	259.92	
21.29	261.07		37.85	259.29	TOBL	27.38	260.23		35.60	259.59	
24.94	260.40		40.42	258.00		34.37	259.81		38.25	259.28	TOBL
29.43	260.09		41.37	257.54	TOE L	35.96	259.62		38.92	258.82	
38.04	259.37	TOBL	43.11	257.21		37.58	259.36	TOBL	41.10	257.48	
40.27	258.13		45.35	256.92		39.74	258.56		42.69	257.25	
41.78	257.51		47.47	256.79		41.08	257.57	TOE L	43.82	257.13	TOE L
43.14	257.19		49.40	256.63	TW	42.09	257.44		46.77	256.94	TW
43.92	257.16		50.91	256.66	TOE R	43.92	257.00		46.78	256.99	TOE R
46.07	256.88		56.60	261.24	TOBR	44.99	256.86	TW	51.17	257.48	
47.81	256.84		59.41	261.60	RPIN	46.54	257.13		51.72	258.30	
49.84	256.71					49.00	256.87		55.08	260.43	
50.92	256.50	TW				51.45	256.91	TOE R	56.21	261.11	TOBR
51.32	256.53					52.45	258.77		59.19	261.36	
51.55	256.86					55.08	260.93	TOBR	59.43	261.69	RPIN
51.59	257.39					57.25	261.28				
51.85	257.89					59.53	261.62	RPIN			
52.29	258.83										
53.88	259.61										
55.53	260.82										
57.29	261.32	TOBR									
59.48	261.63	RPIN									
70.78	263.00										

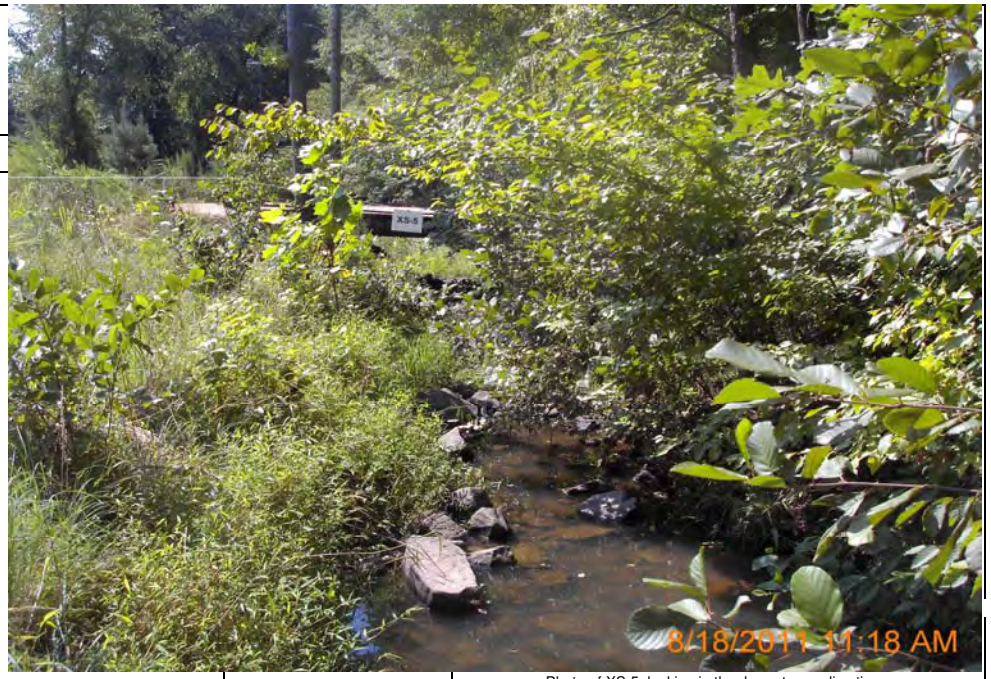
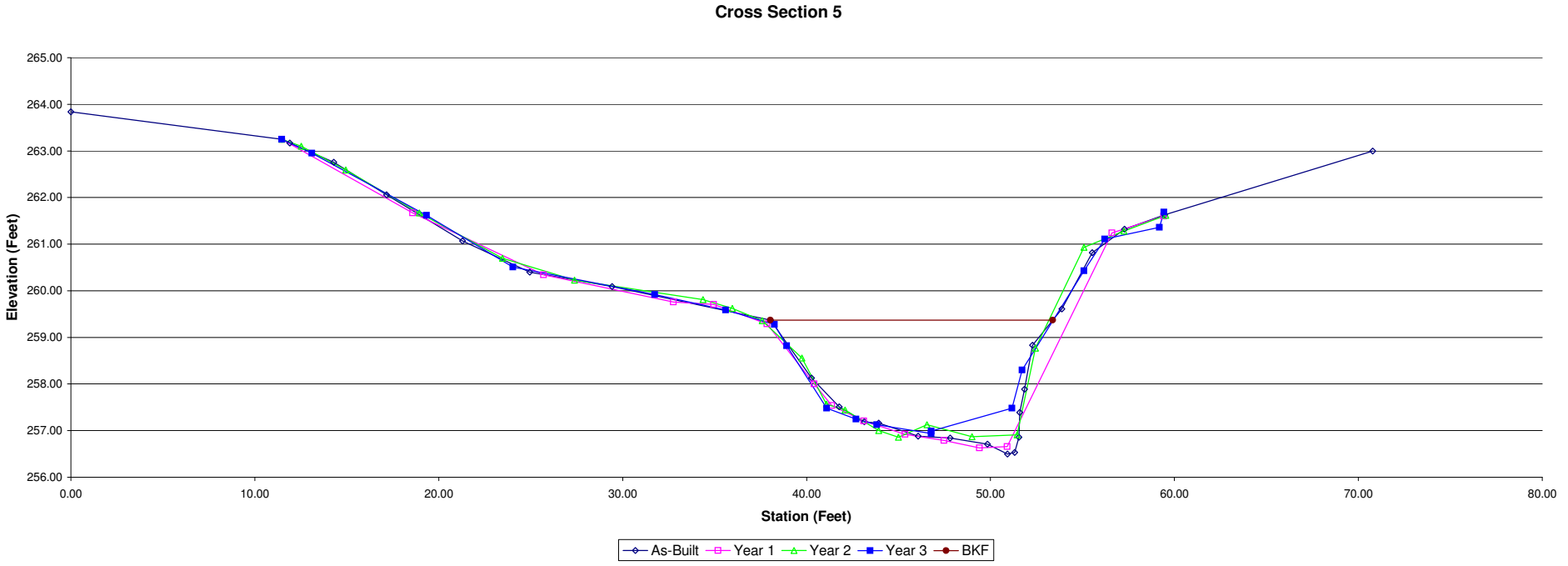
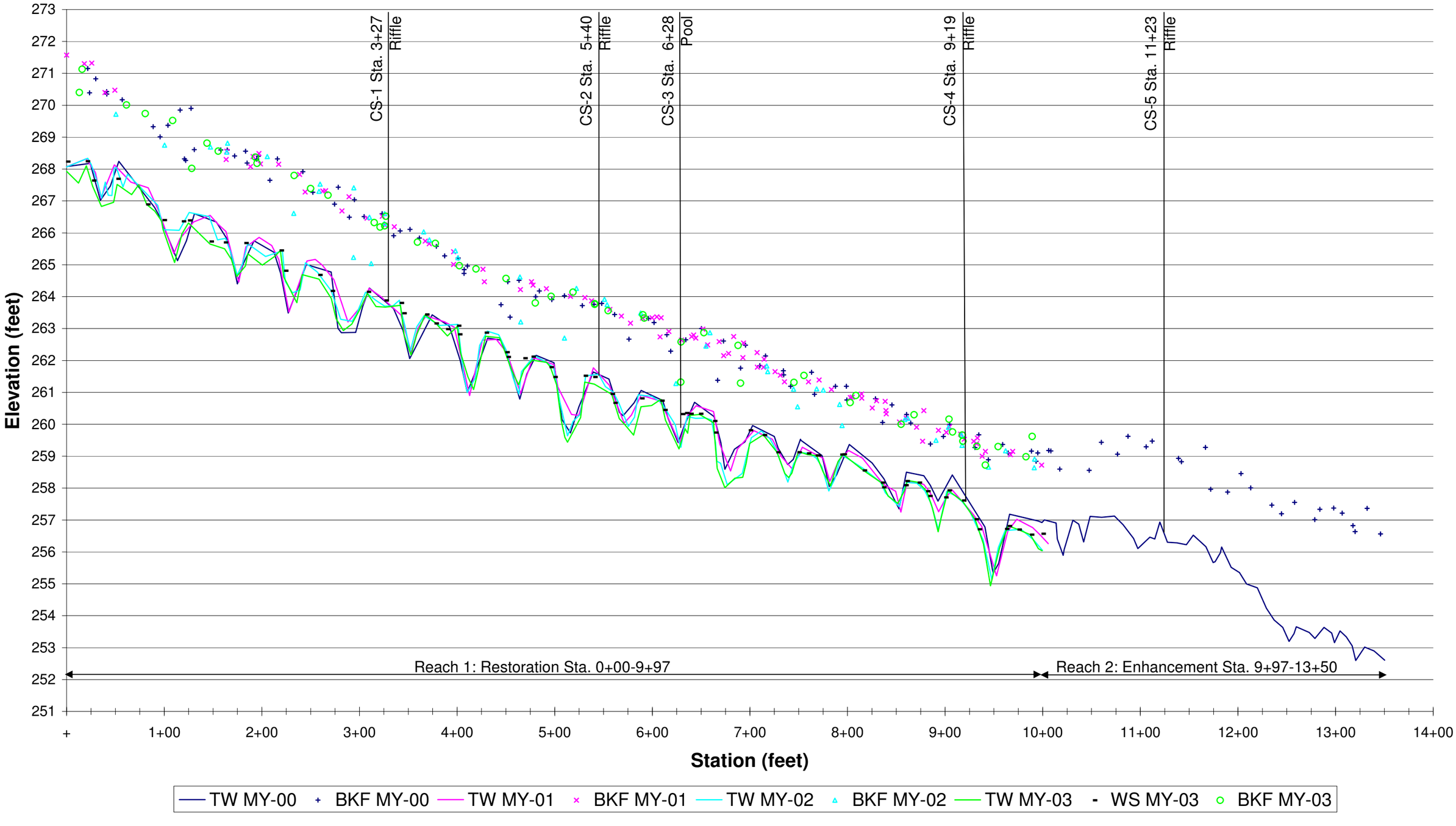


Photo of XS-5, looking in the downstream direction

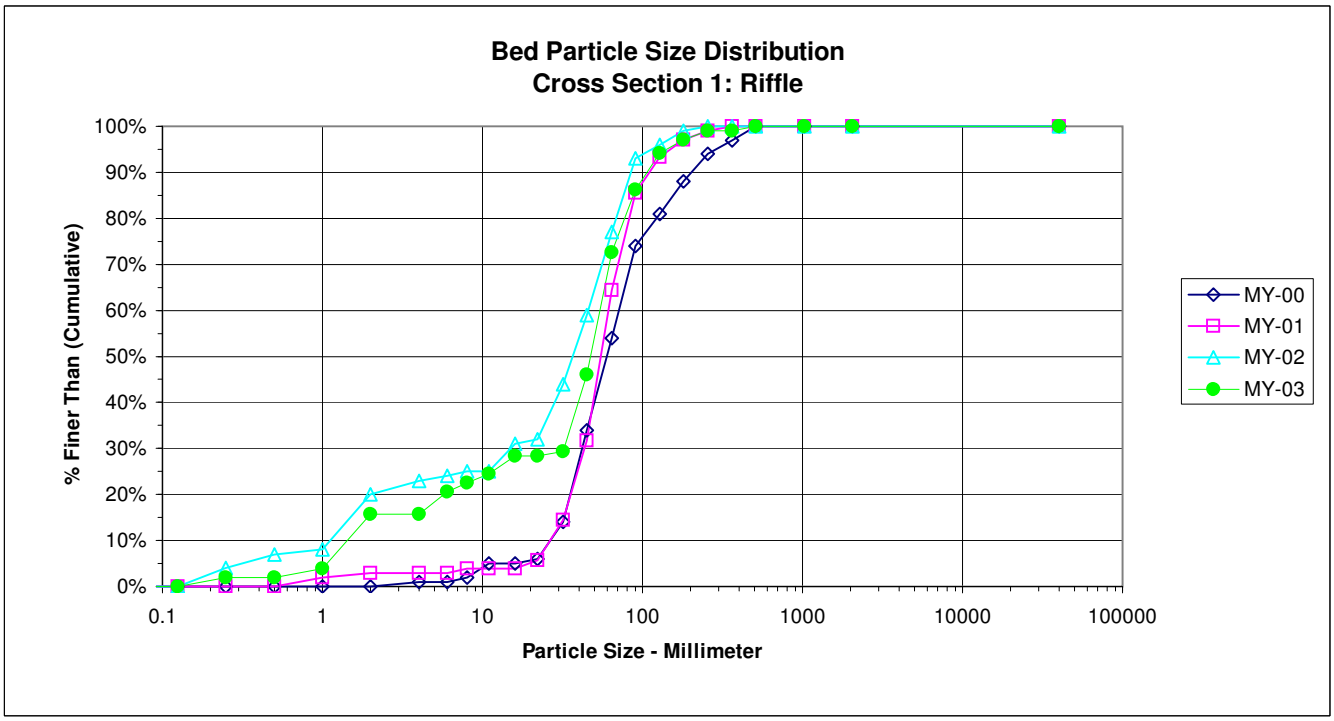


Chapel Creek
Longitudinal Profile
Main Channel: Station 0+00 - 14+00



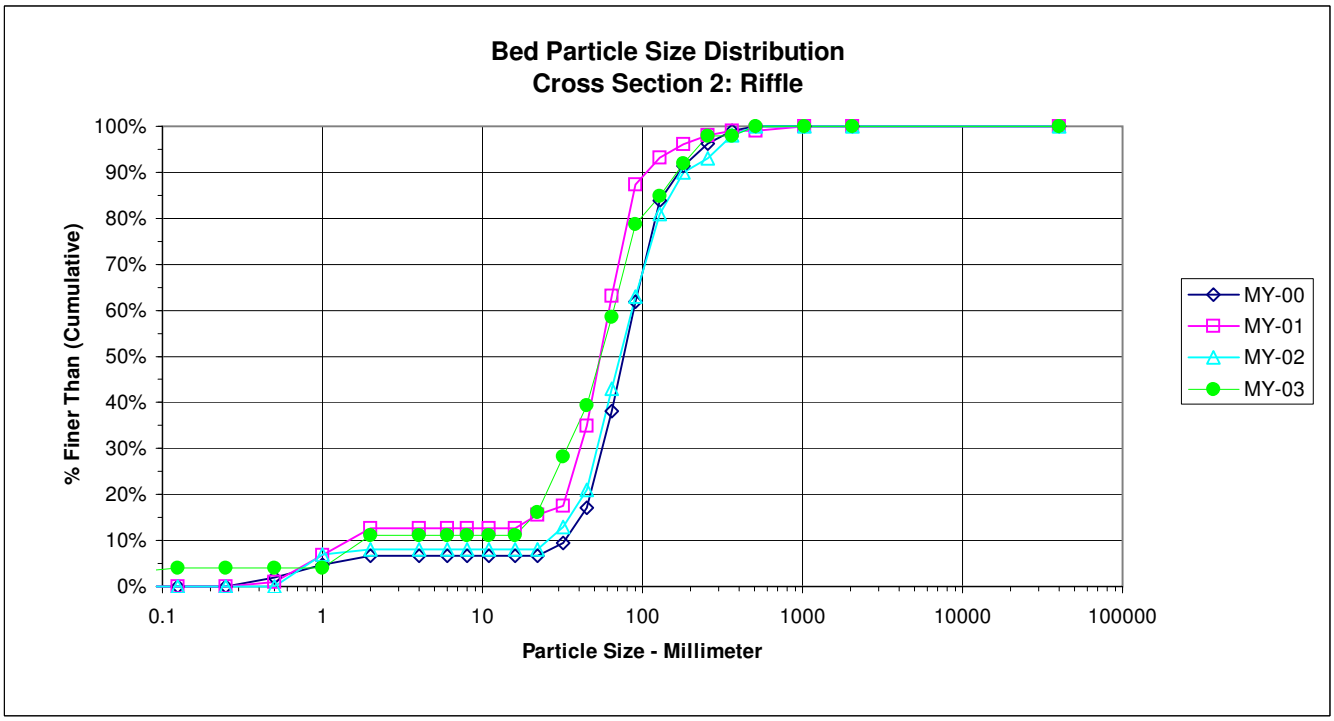
PEBBLE COUNT								
Project:	Chapel Creek					**Date:**	8/18/2011	
Location:	Cross Section #1							
				Particle Counts				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	0	0	0	0%	0%
	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	2	0	2	2%	2%
	Medium	.25 - .50	N	0	0	0	0%	2%
	Coarse	.50 - 1.0	D	2	0	2	2%	4%
.04 -.08	Very Coarse	1.0 - 2.0	S	12	0	12	12%	16%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	16%
.16 - .22	Fine	4.0 - 5.7	G	5	0	5	5%	21%
.22 - .31	Fine	5.7 - 8.0	R	2	0	2	2%	23%
.31 - .44	Medium	8.0 - 11.3	A	2	0	2	2%	25%
.44 - .63	Medium	11.3 - 16.0	V	4	0	4	4%	28%
.63 - .89	Coarse	16.0 - 22.6	E	0	0	0	0%	28%
.89 - 1.26	Coarse	22.6 - 32.0	L	1	0	1	1%	29%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	17	0	17	17%	46%
1.77 - 2.5	Very Coarse	45.0 - 64.0		27	0	27	26%	73%
2.5 - 3.5	Small	64 - 90	C	14	0	14	14%	86%
3.5 - 5.0	Small	90 - 128	O	8	0	8	8%	94%
5.0 - 7.1	Large	128 - 180	B	3	0	3	3%	97%
7.1 - 10.1	Large	180 - 256	L	2	0	2	2%	99%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	99%
14.3 - 20	Small	362 - 512	L	1	0	1	1%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
			Totals	**102**	**0**	**102**	**100%**	**100%**

d16	d35	d50	d84	d95
4.1	36.4	47.8	85.7	143.6



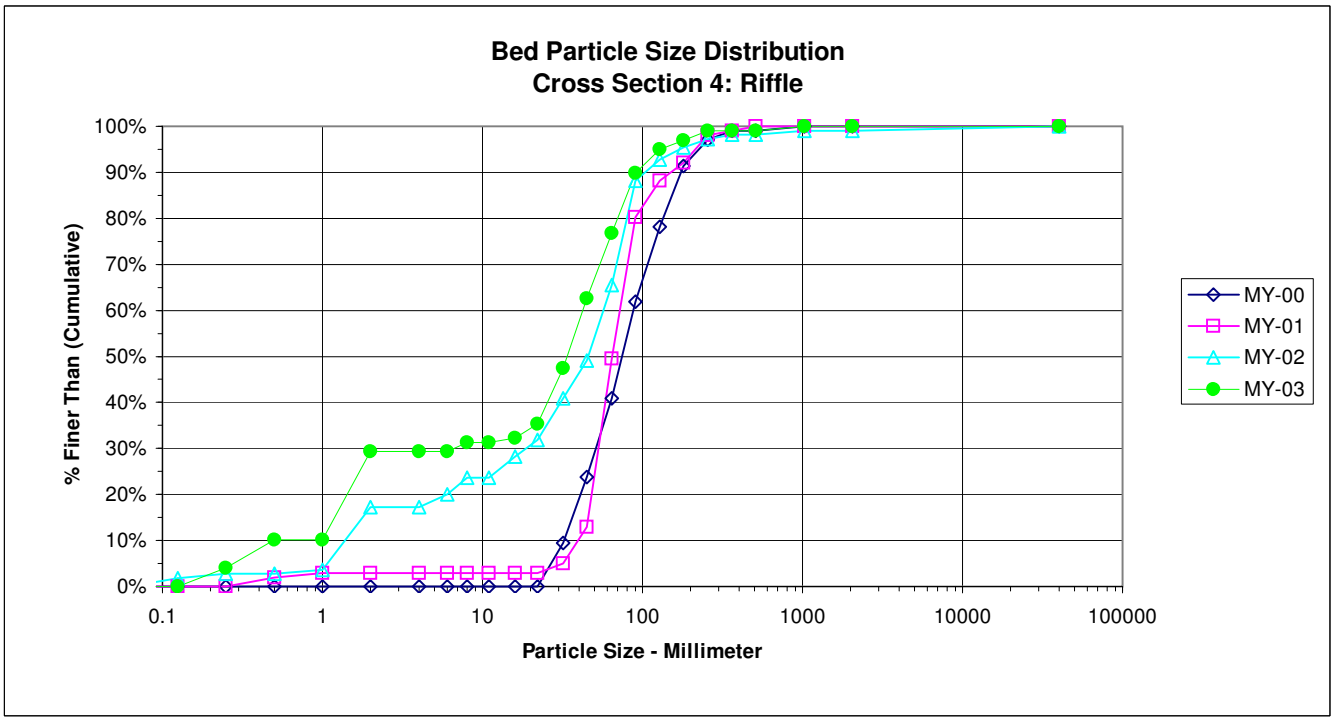
PEBBLE COUNT								
Project:	Chapel Creek					**Date:**	8/18/2011	
Location:	Cross Section #2							
				Particle Counts				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	3	0	3	3%	3%
	Very Fine	.062 - .125	S	1	0	1	1%	4%
	Fine	.125 - .25	A	0	0	0	0%	4%
	Medium	.25 - .50	N	0	0	0	0%	4%
	Coarse	.50 - 1.0	D	0	0	0	0%	4%
.04 -.08	Very Coarse	1.0 - 2.0	S	7	0	7	7%	11%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	11%
.16 - .22	Fine	4.0 - 5.7	G	0	0	0	0%	11%
.22 - .31	Fine	5.7 - 8.0	R	0	0	0	0%	11%
.31 - .44	Medium	8.0 - 11.3	A	0	0	0	0%	11%
.44 - .63	Medium	11.3 - 16.0	V	0	0	0	0%	11%
.63 - .89	Coarse	16.0 - 22.6	E	5	0	5	5%	16%
.89 - 1.26	Coarse	22.6 - 32.0	L	12	0	12	12%	28%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	11	0	11	11%	39%
1.77 - 2.5	Very Coarse	45.0 - 64.0		19	0	19	19%	59%
2.5 - 3.5	Small	64 - 90	C	20	0	20	20%	79%
3.5 - 5.0	Small	90 - 128	O	6	0	6	6%	85%
5.0 - 7.1	Large	128 - 180	B	7	0	7	7%	92%
7.1 - 10.1	Large	180 - 256	L	6	0	6	6%	98%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	98%
14.3 - 20	Small	362 - 512	L	2	0	2	2%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
			Totals	**99**	**0**	**99**	**100%**	**100%**

d16	d35	d50	d84	d95
21.8	39.9	55.5	122.7	218.6



PEBBLE COUNT								
Project:	Chapel Creek					**Date:**	8/18/2011	
Location:	Cross Section #4							
				Particle Counts				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	0	0	0	0%	0%
	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	4	0	4	4%	4%
	Medium	.25 - .50	N	6	0	6	6%	10%
	Coarse	.50 - 1.0	D	0	0	0	0%	10%
.04 -.08	Very Coarse	1.0 - 2.0	S	19	0	19	19%	29%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	29%
.16 - .22	Fine	4.0 - 5.7	G	0	0	0	0%	29%
.22 - .31	Fine	5.7 - 8.0	R	2	0	2	2%	31%
.31 - .44	Medium	8.0 - 11.3	A	0	0	0	0%	31%
.44 - .63	Medium	11.3 - 16.0	V	1	0	1	1%	32%
.63 - .89	Coarse	16.0 - 22.6	E	3	0	3	3%	35%
.89 - 1.26	Coarse	22.6 - 32.0	L	12	0	12	12%	47%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	15	0	15	15%	63%
1.77 - 2.5	Very Coarse	45.0 - 64.0		14	0	14	14%	77%
2.5 - 3.5	Small	64 - 90	C	13	0	13	13%	90%
3.5 - 5.0	Small	90 - 128	O	5	0	5	5%	95%
5.0 - 7.1	Large	128 - 180	B	2	0	2	2%	97%
7.1 - 10.1	Large	180 - 256	L	2	0	2	2%	99%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	99%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	99%
20 - 40	Medium	512 - 1024	D	1	0	1	1%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
			Totals	**99**	**0**	**99**	**100%**	**100%**

d16	d35	d50	d84	d95
1.3	21.3	34.2	78.3	129.3



PEBBLE COUNT								
Project:	Chapel Creek					**Date:**	8/18/2011	
Location:	Cross Section #5							
				Particle Counts				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	0	0	0	0%	0%
	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	0	0	0	0%	0%
	Medium	.25 - .50	N	3	0	3	3%	3%
	Coarse	.50 - 1.0	D	0	0	0	0%	3%
.04 -.08	Very Coarse	1.0 - 2.0	S	11	0	11	11%	14%
.08 - .16	Very Fine	2.0 - 4.0		1	0	1	1%	15%
.16 - .22	Fine	4.0 - 5.7	G	4	0	4	4%	19%
.22 - .31	Fine	5.7 - 8.0	R	3	0	3	3%	22%
.31 - .44	Medium	8.0 - 11.3	A	8	0	8	8%	30%
.44 - .63	Medium	11.3 - 16.0	V	10	0	10	10%	40%
.63 - .89	Coarse	16.0 - 22.6	E	3	0	3	3%	43%
.89 - 1.26	Coarse	22.6 - 32.0	L	10	0	10	10%	54%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	10	0	10	10%	64%
1.77 - 2.5	Very Coarse	45.0 - 64.0		8	0	8	8%	72%
2.5 - 3.5	Small	64 - 90	C	13	0	13	13%	85%
3.5 - 5.0	Small	90 - 128	O	7	0	7	7%	92%
5.0 - 7.1	Large	128 - 180	B	4	0	4	4%	96%
7.1 - 10.1	Large	180 - 256	L	3	0	3	3%	99%
10.1 - 14.3	Small	256 - 362	B	1	0	1	1%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
			Totals	**99**	**0**	**99**	**100%**	**100%**

d16	d35	d50	d84	d95
4.4	13.3	28.5	88.3	167.7

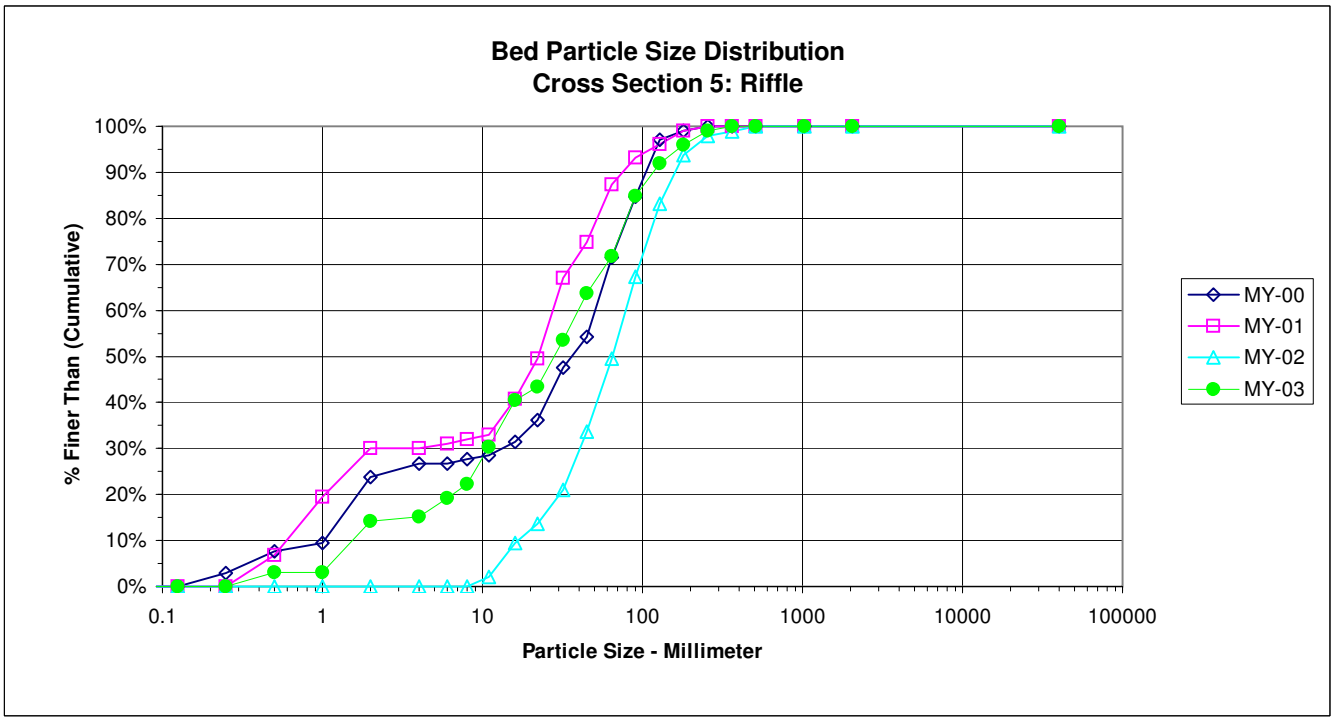


Table 10a. Baseline Stream Data Summary
Chapel Creek Stream Restoration Site-Project No. 77

Parameter	Gauge[2]	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
Dimension and Substrate - Riffle Only		LL	UL	Eq.	Min	Mean	Med	Max	SD[5]	n	Min	Mean	Med	Max	SD[5]	n	Min	Med	Max	Min	Mean	Med	Max	SD[5]	n
Bankfull Width (ft)	-	-	-	-	9.5	12.7	-	16.3	-	-	16.2	16.7	-	21.1	-	-	-	17.5	-	19.9	20.7	20.5	21.6	0.89	3
Floodprone Width (ft)					18	24.7	-	35	-	-	58	97	-	120	-	-	61	102	126	61	184	224	266	108	3
Bankfull Mean Depth (ft)	-	-	-	-	1.4	1.7	-	1.9	-	-	1.3	1.6	-	1.7	-	-	-	1.59	-	0.87	1.2	1.1	1.5	0.34	3
[1]Bankfull Max Depth (ft)	-				2.8	3.2	-	3.8	-	-	2.2	2.3	-	2.5	-	-	2.3	2.4	2.5	1.8	2.2	2.3	2.4	0.34	3
Bankfull Cross Sectional Area (ft^2)	-	-	-	-	17.5	21.6	-	29.2	-	-	27.2	27.5	-	27.8	-	-	-	27.8	-	18.9	24.1	22.7	30.6	6	3
Width/Depth Ratio	-				5	4.6	-	9.1	-	-	9.6	10.2	-	16	-	-	-	11	-	12.9	18.7	18.5	24.8	0.89	3
Entrenchment Ratio	-				1.5	2.1	-	3.2	-	-	3.5	5.8	-	7.2	-	-	3.5	5.8	7.2	2.8	9	11.3	13	5.5	3
[1]Bank Height Ratio	-				1.7	3.3	-	4.4	-	-	1.5	1.6	-	1.7	-	-	-	1	-	1	1	1	1	0	3
Profile																									
Riffle Length (ft)					3.5	6.8	-	13	-	-	7	21.2	-	42	-	-	7	21.2	42	13.7	23.1	22.91	36.6	6.2	17
Riffle Slope (ft/ft)					0	0.01	-	0.05	-	-	0	0.03	-	0.1	-	-	0	0.03	0.1	0	0.02	0.02	0.05	0.01	17
Pool Length (ft)					6	6.5	-	7	-	-	6.4	13.2	-	19.4	-	-	6.5	13.2	19.4	26.8	34.2	34.3	40.8	4.7	16
Pool Max depth (ft)					2.1	2.7	-	3.5	-	-	2.5	3	-	4.2	-	-	2.5	3	4.2	2.5	3.8	4	4.7	0.7	16
Pool Spacing (ft)					16	42	-	91	-	-	41	56	-	78	-	-	40	55	75	40	56	54	71	9.1	15
Pattern																									
Channel Beltwidth (ft)					15	17.7	-	20	-	-	28.7	22	-	40	-	-	21.2	27.6	38.5	31.9	43.8	40.9	75.9	10.9	14
Radius of Curvature (ft)					14.6	23.4	-	30.1	-	-	10.6	20	-	38.2	-	-	10.2	19.3	36.8	23.7	44.6	42.9	66.7	12.1	13
Rc:Bankfull width (ft/ft)					1.2	1.9	-	2.4	-	-	0.58	1.1	-	2.1	-	-	0.58	1.1	2.1	1.1	2.2	2.1	66.7	0.59	13
Meander Wavelength (ft)					55	58.3	-	65	-	-	113	125	-	140	-	-	109	120	135	90	104	104	121	9.1	13
Meander Width Ratio					1.2	1.43	-	1.62	-	-	1.2	1.6	-	2.2	-	-	1.2	1.6	2.2	1.6	2.2	2.1	2.8	0.55	14
Transport parameters																									
Reach Shear Stress (competency) lb/ft^2					0.98												-			-					
Max part size (mm) mobilized at bankfull					120												-			-					
Stream Power (transport capacity) W/m^2					-												-			-					
Additional Reach Parameters																									
Rosgen Classification	-				G4						C4/E4						C4			C4					
Bankfull Velocity (fps)	-	-	-	-	6.83												5.8			6.92					
Bankfull Discharge (cfs)	-	-	-	-	160																				
Valley length (ft)					870						350														
Channel Thalweg length (ft)					957						400						994			994					
Sinuosity (ft)					1.06						1.14						1.14			1.14					
Water Surface Slope (Channel) (ft/ft)	-				-						-						-			0.0105					
BF slope (ft/ft)	-				0.0128						0.011						0.012			0.0111					
[3]Bankfull Floodplain Area (acres)					-						-						-			-					
[4]% of Reach with Eroding Banks					-						-														
Channel Stability or Habitat Metric					-						-														
Biological or Other					-						-														

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section surveys and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing survey data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

Table 10b. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Chapel Creek Stream Restoration-Project No. 77 Reach 1 (961 feet)

Parameter	Pre-Existing Condition							Reference Reach(es) Data							Design							As-built/Baseline						
[1]Ri% / Ru% / P% / G% / S%															37%		61%					41%		57%				
[1]SC% / Sa% / G% / C% / B% / Be%																												
[1]d16 / d35 / d50 / d84 / d95 / di^{p} / di^{sp} (mm)	1.6	7.2	11.7	22	30.3			0.39	1.3	11.4	69.8	164.9																
[2]Entrenchment Class <1.5 / 1.5-1.99 / 2.0-4.9 / 5.0-9.9 / >10																												
[3]Incision Class <1.2 / 1.2-1.49 / 1.5-1.99 / >2.0																												

Shaded cells indicate that these will typically not be filled in.

1 = Riffle, Run, Pool, Glide, Step; Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock; dip = max pave, disp = max subpave

2 = Entrenchment Class - Assign/bin the reach footage into the classes indicated and provide the percentage of the total reach footage in each class in the table. This will result from the measured cross-sections as well as visual estimates

3 = Assign/bin the reach footage into the classes indicated and provide the percentage of the total reach footage in each class in the table. This will result from the measured cross-sections as well as the longitudinal profile

Footnotes 2,3 - These classes are loosley built around the Rosgen classification and hazard ranking breaks, but were adjusted slightly to make for easier assignment to somewhat coarser bins based on visual estimates in the field such that measurement of every segment for ER would not be necessary. The intent here is to provide the reader/consumer of design and monitoring information with a good general sense of the extent of hydrologic containment in the pre-existing and the rehabilitated states as well as comparisons to the reference distributions. ER and BHR have been addressed in prior submissions as a subsample (cross-sections as part of the design survey), however, these subsamples have often focused entirely on facilitating design without providing a thorough pre-constrution distribution of these parameters, leaving the reader/consumer with a sample that is weighted heavily on the stable sections of the reach. This means that the distributions for these parameters should include data from both the cross-section surveys and the longitudinal profile and in the case of ER, visual estimates. For example, the typical longitudinal profile permits sampling of the BHR at riffles beyond those subject to cross-sections and therefore can be readily integrated and provide a more complete sample distribution for these parameters, thereby providing the distribution/coverage necessary to provide meaningful comparisons.

Table 11a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

Chapel Creek Stream Restoration-Project No. 77 Reach 1 (961 feet)

	Cross Section 1 (Riffle)							Cross Section 2 (Riffle)							Cross Section 3 (Pool)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	266.29	266.26	266.29	266.29				264.00	264.01	264.00	264.00				262.67	262.79	262.67	262.67			
Bankfull Width (ft)	19.86	19.17	19.07	19.99				22.96	19.11	31.02	28.57				24.84	27.12	22.88	22.96			
Floodprone Width (ft)	224	224	224	224				266	266	266	266				95	95	95	95			
Bankfull Mean Depth (ft)	1.5416	1.5241	1.4766	1.5681				1.3016	1.3078	1.1881	0.9971				1.2771	1.1481	1.3418	1.321			
Bankfull Max Depth (ft)	2.4	2.31	2.59	2.79				2.44	2.02	2.95	2.74				3.28	3.2	3.07	3.19			
Bankfull Cross Sectional Area (ft^2)	30.619	29.221	28.165	31.346				29.886	24.998	36.858	28.483				31.724	31.14	30.694	30.335			
Bankfull Width/Depth Ratio	12.884	12.579	12.918	12.747				17.641	14.616	26.112	28.65				19.45	23.625	17.048	17.383			
Bankfull Entrenchment Ratio	11.278	11.684	11.743	11.206				11.585	13.916	8.5742	9.3118				3.8245	3.5025	4.153	4.137			
Bankfull Bank Height Ratio	1	1	1	0.914				1	0.6782	0.8712	0.9124				1	1	0.5375	0.6552			
Cross Sectional Area between end pins (ft^2)	339.13	327.85	321.93	328.30				245.58	193.07	211.96	242.96				188.14	186.78	186.23	180.07			
d50 (mm)	60.2	55.6	37.2	47.8				77	55.2	73.1	55.5				N/A	N/A	N/A	N/A			

	Cross Section 4 (Riffle)							Cross Section 5 (Riffle)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	259.85	259.80	259.85	259.85				259.37	259.29	259.37	259.37			
Bankfull Width (ft)	16.71	18.41	18.64	16.92				15.35	16.33	17.52	15.93			
Floodprone Width (ft)	92	92	92	92				48	48	48	48			
Bankfull Mean Depth (ft)	1.0659	1.0523	1.0642	1.1098				1.8823	1.8282	1.8573	1.6769			
Bankfull Max Depth (ft)	1.72	1.79	1.96	1.9				2.87	2.66	2.76	2.43			
Bankfull Cross Sectional Area (ft^2)	17.808	19.377	19.838	18.777				28.895	29.85	32.549	26.709			
Bankfull Width/Depth Ratio	15.673	17.498	17.516	15.246				8.1553	8.9308	9.4358	9.4979			
Bankfull Entrenchment Ratio	5.5069	4.9962	4.9353	5.4374				3.1269	2.9398	2.739	3.0137			
Bankfull Bank Height Ratio	1	0.9553	0.9031	0.9947				1	1	0.9058	0.963			
Cross Sectional Area between end pins (ft^2)	165.32	170.80	165.78	163.44				131.28	135.96	128.65	131.32			
d50 (mm)	75.8	64.4	46.1	34.2				36.6	22.3	64.8	28.5			

1 = Widths and depths for monitoring resurvey will be based on the baseline bankfull datum regardless of dimensional/depositional development. Input the elevation used as the datum, which should be consistent and based on the baseline datum established. If the performer has inherited the project and cannot acquire the datum used for prior years this must be discussed with EEP. If this cannot be resolved in time for a given years report submission a footnote in this should be included that states: “It is uncertain if the monitoring datum has been consistent over the monitoring history, which may influence calculated values. Additional data from a prior performer is being acquired to provide confirmation. Values will be recalculated in a future submission based on a consistent datum if determined to be necessary.”

Exhibit Table 11b. Monitoring Data - Stream Reach Data Summary
Chapel Creek Stream Restoration-Project No. 77 Reach 1 (961 feet)

Parameter	Baseline						MY-1						MY-2						MY- 3						MY- 4						MY- 5					
Dimension and Substrate - Riffle only	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n
Bankfull Width (ft)	15.4	19.6	20.7	21.6	2.906	4	16.33	18.51	18.92	19.86	1.535	4	17.52	21.57	18.86	31.02	6.339	4	15.93	20.35	18.45	28.57	5.743	4												
Floodprone Width (ft)	48	149.8	142.5	266	111.4	4	48.09	157.5	158	266	104	4	48	157.5	158	266	104	4	48	157.5	158	266	104	4												
Bankfull Mean Depth (ft)	0.87	1.35	1.325	1.88	0.449	4	1.047	1.429	1.421	1.828	0.33	4	1.064	1.397	1.332	1.857	0.352	4	0.997	1.338	1.339	1.677	0.335	4												
[1]Bankfull Max Depth (ft)	1.78	2.348	2.37	2.87	0.446	4	1.865	2.207	2.153	2.66	0.355	4	1.96	2.565	2.675	2.95	0.429	4	1.9	2.465	2.585	2.79	0.409	4												
Bankfull Cross Sectional Area (ft^2)	18.9	25.28	25.8	30.6	5.44	4	20.79	26.12	26.92	29.85	4.248	4	19.84	29.35	30.36	36.86	7.268	4	18.78	26.33	27.6	31.35	5.385	4												
Width/Depth Ratio	8.16	16.07	15.7	24.7	7.141	4	8.931	13.66	13.37	18.98	4.166	4	9.436	16.5	15.22	26.11	7.215	4	9.498	16.54	14	28.65	8.412	4												
Entrenchment Ratio	2.81	7.56	7.215	13	5.347	4	2.945	8.376	8.158	14.24	5.443	4	2.739	6.998	6.755	11.74	3.975	4	3.014	7.242	7.375	11.21	3.703	4												
[1]Bank Height Ratio	0.97	0.993	1	1	0.015	4	0.687	0.901	0.958	1	0.148	4	0.871	0.92	0.904	1	0.056	4	0.912	0.946	0.938	0.995	0.04	4												
Profile																																				
Riffle Length (ft)	13.7	23.1	22.91	36.6	6.2	17	12.96	22.04	20.37	34.75	6.42	17	15.09	27.92	26.54	44.53	8.84	17	18.51	28.18	27.68	45.62	7.72	17												
Riffle Slope (ft/ft)	0	0.02	0.02	0.05	0.01	17	0.007	0.019	0.016	0.036	0.009	17	0.004	0.017	0.016	0.04	0.011	16	1.03	2.359	2.375	3.225	0.491	17												
Pool Length (ft)	26.8	34.2	34.3	40.8	4.7	16	25.24	34.76	32.6	63.29	9.33	17	22.54	28.63	26.33	51.15	6.87	17	21.76	28.05	27.24	37.02	4.834	17												
Pool Max depth (ft)	2.5	3.8	4	4.7	0.7	16	2.64	3.64	6.75	4.6	0.57	17	2.59	3.34	3.29	4.36	0.57	17	2.48	3.655	3.83	4.56	0.63	17												
Pool Spacing (ft)	40	56	54	71	9.1	15	38.54	57.35	57.76	74.75	10.18	16	40.01	57	57.47	72.19	9.38	16	41.41	56.93	57.59	75.03	11.04	16												
Pattern																																				
Channel Beltwidth (ft)	31.9	43.8	40.9	75.9	10.9	14																														
Radius of Curvature (ft)	23.7	44.6	42.9	66.7	12.1	13																														
Rc:Bankfull width (ft/ft)	1.1	2.2	2.1	66.7	0.59	13																														
Meander Wavelength (ft)	90	104	104	121	9.1	13																														
Meander Width Ratio	1.6	2.2	2.1	2.8	0.55	14																														

Pattern data will not typically be collected unless visual data, dimensional data or profile data indicate significant shifts from baseline

Additional Reach Parameters																																				
Rosgen Classification	C4						C4						C4						C4																	
Channel Thalweg length (ft)	994						994						994						994																	
Sinuosity (ft)	1.14						1.14						1.14						1.14																	
Water Surface Slope (Channel) (ft/ft)	0.0105						0.0105						0.0117						0.0117																	
BF slope (ft/ft)	0.0111						0.0111						0.0132						0.0118																	
[3]Ri% / Ru% / P% / G% / S%	41%		57%				38%		59%				49%		51%				51%		48%															
[3]SC% / Sa% / G% / C% / B% / Be%													0%	11%	47%	38%	3%	0%	1%	17%	52%	29%	1%	0%												
[3]d16 / d35 / d50 / d84 / d95 /													16.4	38.42	55.28	109.5	197.2		7.916	27.71	41.5	93.75	164.8													
[2]% of Reach with Eroding Banks													9%						2%																	
Channel Stability or Habitat Metric																																				
Biological or Other																																				

Shaded cells indicate that these will typically not be filled in.
1 = The distributions for these parameters can include information from both the cross-section surveys and the longitudinal profile.
2 = Proportion of reach exhibiting banks that are eroding based on the visual survey from visual assessment table
3 = Riffle, Run, Pool, Glide, Step; Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock; dip = max pave, disp = max subpave
4. = Of value/needed only if the n exceeds 3

Appendix E. Hydrologic Data

Table 12. Verification of Bankfull Events

Table 12. Verification of Bankfull Events Chapel Creek Stream Restoration-Project No. 77			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo #**
30-Sep-10	30-Sep-10	Nearby NWS COOP station	N/A
30-Sep-10	30-Sep-10	Nearby USGS Stream gauge	N/A
27-Jul-11	28-May-11	Nearby NWS COOP station/site visit	10
6-Oct-11	7-Sep-11	Nearby NWS COOP station	N/A
6-Oct-11	22-Sep-11	Nearby NWS COOP station	N/A

The bankfull rainfall events in 2011 were documented at the NWS Cooperative Observer Station Chapel Hill 2 W (311677). A site visit conducted on July 27, 2011 confirmed the bankfull event of May 28, 2011 (photo 10) with a visual inspection of the height of wrack and debris buildup on the onsite stream crest gauge. The stream gauge is installed at station 9+08, in the vicinity of riffle cross section 4. The maximum water height as indicated by the stream crest gauge was 261.56', which exceeds the adjacent bankfull elevation of 260.16'.

Photo 10. Wrack and debris on the stream gauge

NOWData - NOAA Online Weather Data

CHAPEL HILL 2 W (311677)
Daily Almanac
Date: May 28, 2011

Daily Values	Observed	Normal	Record/Year	Prev Year
Max Temperature	79	81	95 in 1937+	89
Min Temperature	63	59	36 in 1961	65
Avg Temperature	71.0	70	83.5 in 1914	77.0
Precipitation	2.65	0.14	2.65 in 2011	0.00
New Snowfall	0.0	0.0	0.0 in 2011+	0.0
Snow Depth	0	-	0 in 2011+	0
HDD (base 65)	0	1	15 in 1961	0
CDD (base 65)	6	6	19 in 1914	12

Month-To-Date	Observed	Normal	Record/Year	Prev Year
Avg Max Temperature	77.3	77.9	86.3 in 1933	80.1
Avg Min Temperature	56.9	54.4	47.9 in 1989	60.1
Avg Temperature	66.9	66.2	73.9 in 1896	70.1
Total Precipitation	4.93	3.42	11.26 in 1901	5.03
Total Snowfall	0.0	0.0	0.0 in 2011	0.0
Avg Snow Depth	0	-	0 in 2010	0
Total HDD	48	70	143 in 1978	30
Total CDD	98	104	268 in 1896	182

+ indicates record also occurred in previous years (last occurrence listed).

Official data and data for additional locations and years are available from the Regional Climate Centers and the National Climatic Data Center.

NOWData - NOAA Online Weather Data

CHAPEL HILL 2 W (311677)
Daily Almanac
Date: Sep 7, 2011

Daily Values	Observed	Normal	Record/Year	Prev Year
Max Temperature	82	84	99 in 1954	88
Min Temperature	67	63	44 in 1984	61
Avg Temperature	74.5	73	84.0 in 1925	74.5
Precipitation	2.17	0.15	2.30 in 1974	0.00
New Snowfall	-	0.0	0.0 in 2010+	0.0
Snow Depth	-	-	0 in 2010+	0
HDD (base 65)	0	0	6 in 1984	0
CDD (base 65)	10	9	19 in 1925+	10

Month-To-Date	Observed	Normal	Record/Year	Prev Year
Avg Max Temperature	86.6	84.7	95.7 in 1932	90.4
Avg Min Temperature	66.3	63.6	51.6 in 1967	62.3
Avg Temperature	76.4	74.2	83.1 in 1899	76.4
Total Precipitation	2.72	1.13	12.52 in 1999	0.00
Total Snowfall	0.0	0.0	0.0 in 2011	0.0
Avg Snow Depth	0	-	0 in 2010	0
Total HDD	0	0	14 in 1967	0
Total CDD	82	66	129 in 1899	82

+ indicates record also occurred in previous years (last occurrence listed).

Official data and data for additional locations and years are available from the Regional Climate Centers and the National Climatic Data Center.

NOWData - NOAA Online Weather Data

CHAPEL HILL 2 W (311677)
Daily Almanac
Date: Sep 22, 2011

Daily Values	Observed	Normal	Record/Year	Prev Year
Max Temperature	81	79	101 in 1895	87
Min Temperature	67	57	42 in 1976	69
Avg Temperature	74.0	68	85.0 in 1895	78.0
Precipitation	2.11	0.11	2.11 in 2011	0.00
New Snowfall	-	0.0	0.0 in 2010+	0.0
Snow Depth	-	-	0 in 2010+	0
HDD (base 65)	0	1	10 in 1962	0
CDD (base 65)	9	5	20 in 1895	13

Month-To-Date	Observed	Normal	Record/Year	Prev Year
Avg Max Temperature	80.8	82.5	92.7 in 1925	89.1
Avg Min Temperature	62.2	61.1	51.3 in 1984	62.3
Avg Temperature	71.5	71.8	80.8 in 1925	75.7
Total Precipitation	5.15	3.26	17.43 in 1999	0.02
Total Snowfall	0.0	0.0	0.0 in 2011	0.0
Avg Snow Depth	0	-	0 in 2010	0
Total HDD	19	10	60 in 1984	0
Total CDD	128	163	353 in 1925	242

+ indicates record also occurred in previous years (last occurrence listed).

Official data and data for additional locations and years are available from the Regional Climate Centers and the National Climatic Data Center.

NOAA Atlas 14, Volume 2, Version 3
Location name: Chapel Hill, North Carolina, US*
Coordinates: 35.8930, -79.0174
Elevation: 245ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval(years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.410** (0.376–0.448)	**0.482** (0.442–0.527)	**0.553** (0.508–0.605)	**0.613** (0.561–0.668)	**0.673** (0.613–0.734)	**0.717** (0.651–0.781)	**0.756** (0.682–0.824)	**0.789** (0.707–0.861)	**0.824** (0.733–0.900)	**0.853** (0.752–0.933)
10-min	**0.655** (0.600–0.716)	**0.770** (0.706–0.843)	**0.886** (0.813–0.968)	**0.980** (0.897–1.07)	**1.07** (0.977–1.17)	**1.14** (1.04–1.24)	**1.20** (1.08–1.31)	**1.25** (1.12–1.37)	**1.30** (1.16–1.42)	**1.34** (1.18–1.47)
15-min	**0.818** (0.750–0.894)	**0.968** (0.888–1.06)	**1.12** (1.03–1.23)	**1.24** (1.13–1.35)	**1.36** (1.24–1.48)	**1.45** (1.31–1.58)	**1.52** (1.37–1.65)	**1.58** (1.42–1.72)	**1.64** (1.46–1.79)	**1.69** (1.49–1.84)
30-min	**1.12** (1.03–1.23)	**1.34** (1.23–1.46)	**1.59** (1.46–1.74)	**1.80** (1.64–1.96)	**2.01** (1.84–2.20)	**2.18** (1.98–2.37)	**2.33** (2.10–2.53)	**2.46** (2.20–2.68)	**2.61** (2.32–2.85)	**2.73** (2.41–2.99)
60-min	**1.40** (1.28–1.53)	**1.68** (1.54–1.84)	**2.04** (1.87–2.23)	**2.34** (2.14–2.55)	**2.68** (2.44–2.92)	**2.95** (2.68–3.21)	**3.20** (2.89–3.49)	**3.44** (3.09–3.76)	**3.75** (3.33–4.09)	**3.99** (3.51–4.36)
2-hr	**1.67** (1.52–1.83)	**2.01** (1.84–2.20)	**2.47** (2.25–2.71)	**2.85** (2.59–3.12)	**3.31** (2.99–3.62)	**3.68** (3.31–4.03)	**4.04** (3.61–4.42)	**4.40** (3.91–4.81)	**4.87** (4.28–5.33)	**5.25** (4.57–5.76)
3-hr	**1.77** (1.62–1.95)	**2.14** (1.96–2.35)	**2.64** (2.41–2.89)	**3.06** (2.79–3.35)	**3.59** (3.25–3.92)	**4.02** (3.63–4.40)	**4.45** (3.98–4.87)	**4.90** (4.34–5.34)	**5.48** (4.81–5.99)	**5.98** (5.19–6.55)
6-hr	**2.13** (1.96–2.33)	**2.57** (2.36–2.81)	**3.17** (2.91–3.46)	**3.68** (3.37–4.02)	**4.34** (3.95–4.73)	**4.90** (4.42–5.33)	**5.45** (4.88–5.93)	**6.03** (5.34–6.55)	**6.81** (5.94–7.40)	**7.47** (6.44–8.14)
12-hr	**2.52** (2.33–2.75)	**3.04** (2.80–3.31)	**3.76** (3.46–4.10)	**4.40** (4.03–4.79)	**5.24** (4.77–5.68)	**5.96** (5.37–6.44)	**6.69** (5.97–7.21)	**7.46** (6.58–8.04)	**8.52** (7.39–9.18)	**9.44** (8.06–10.2)
24-hr	**2.95** (2.76–3.15)	**3.56** (3.34–3.81)	**4.45** (4.17–4.75)	**5.15** (4.81–5.50)	**6.09** (5.67–6.51)	**6.84** (6.35–7.31)	**7.59** (7.04–8.13)	**8.38** (7.74–8.99)	**9.46** (8.69–10.2)	**10.3** (9.42–11.1)
2-day	**3.44** (3.22–3.68)	**4.15** (3.89–4.44)	**5.14** (4.82–5.50)	**5.92** (5.53–6.32)	**6.95** (6.47–7.43)	**7.76** (7.21–8.31)	**8.59** (7.95–9.21)	**9.44** (8.70–10.1)	**10.6** (9.72–11.4)	**11.5** (10.5–12.4)
3-day	**3.64** (3.41–3.90)	**4.38** (4.10–4.68)	**5.40** (5.06–5.78)	**6.21** (5.80–6.63)	**7.29** (6.79–7.80)	**8.14** (7.55–8.72)	**9.01** (8.33–9.66)	**9.90** (9.12–10.6)	**11.1** (10.2–12.0)	**12.1** (11.0–13.0)
4-day	**3.84** (3.60–4.11)	**4.61** (4.32–4.92)	**5.67** (5.31–6.05)	**6.50** (6.08–6.95)	**7.63** (7.10–8.16)	**8.52** (7.90–9.12)	**9.43** (8.71–10.1)	**10.4** (9.54–11.1)	**11.6** (10.7–12.5)	**12.7** (11.5–13.7)
7-day	**4.42** (4.16–4.70)	**5.27** (4.96–5.61)	**6.40** (6.03–6.82)	**7.29** (6.86–7.77)	**8.51** (7.98–9.08)	**9.48** (8.85–10.1)	**10.5** (9.74–11.2)	**11.5** (10.6–12.3)	**12.9** (11.9–13.8)	**14.0** (12.8–15.0)
10-day	**5.02** (4.74–5.34)	**5.97** (5.63–6.34)	**7.16** (6.75–7.61)	**8.10** (7.62–8.61)	**9.37** (8.79–9.96)	**10.4** (9.69–11.0)	**11.4** (10.6–12.1)	**12.4** (11.5–13.2)	**13.8** (12.7–14.8)	**14.9** (13.7–15.9)
20-day	**6.71** (6.34–7.11)	**7.92** (7.48–8.38)	**9.35** (8.82–9.89)	**10.5** (9.88–11.1)	**12.0** (11.3–12.8)	**13.2** (12.4–14.1)	**14.5** (13.5–15.4)	**15.7** (14.6–16.8)	**17.4** (16.1–18.6)	**18.7** (17.3–20.1)
30-day	**8.33** (7.89–8.82)	**9.81** (9.28–10.4)	**11.4** (10.8–12.0)	**12.6** (11.9–13.3)	**14.3** (13.4–15.1)	**15.5** (14.6–16.4)	**16.7** (15.7–17.7)	**18.0** (16.8–19.1)	**19.6** (18.3–20.9)	**20.9** (19.4–22.3)
45-day	**10.6** (10.1–11.2)	**12.4** (11.8–13.1)	**14.2** (13.5–14.9)	**15.6** (14.8–16.4)	**17.4** (16.5–18.3)	**18.8** (17.8–19.8)	**20.2** (19.0–21.3)	**21.5** (20.2–22.7)	**23.3** (21.8–24.6)	**24.6** (23.0–26.1)
60-day	**12.7** (12.2–13.4)	**14.9** (14.2–15.6)	**16.8** (16.0–17.6)	**18.2** (17.4–19.1)	**20.1** (19.2–21.1)	**21.6** (20.5–22.7)	**22.9** (21.7–24.1)	**24.3** (23.0–25.6)	**26.0** (24.5–27.4)	**27.3** (25.7–28.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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