

**KEY BRANCH MITIGATION SITE
(Project No. .00013)**

MONITORING YEAR 3 (2006)



Original Design Firm:

KCI Associates of North Carolina, P.A.

Submitted to:

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina



January 2007

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I. Executive Summary / Project Abstract

The Key Branch Mitigation Site encompasses approximately 119 acres on the floodplain of Brown Creek. The site is within the Pee Dee River basin in Anson County, North Carolina. Between the years of 1938 and 1993, conversion of the site from a functioning bottomland hardwood ecosystem to agricultural fields resulted in the loss of most wetland functions and values, including nutrient removal/transformation, flood flow alteration and aquatic and wildlife species diversity/abundance. Restoration of wetland ecosystem processes, structures, and composition entailed specific actions, including limiting offsite drainage, increasing discharge onto the site, reconnecting the stream to the floodplain, restoring over 6,000 linear feet of Key Branch through the site, and replanting with bottomland hardwood tree species. Stream construction and restoration was completed in Fall 2003, and included the installation of rootwads and various rock structures, sloping the adjacent streambanks to reduce overall erosion, and installation of native vegetation. Approximately 47,800 bottomland hardwood trees were planted on 70.2 acres of the site during the subsequent season (2004) at an average tree density of 680 trees per acre. First-year monitoring of both hydrology and vegetation was completed in Fall 2004. This report presents the results of the third year of monitoring (2006).

The dimension, pattern, and profile of the Key Branch channel appear stable. The frequent flooding in portions of the reach during this monitoring year did not cause any serious instability in the channel. The floodplain adjacent to Key Branch is also stable and appears to contain regular over-bank (2 events this year and 6 last year) flows within the wetlands. There is some difficulty in determining whether the floods are caused by Key Branch or Brown Creek, which adjoins the site.

Two of the 14 monitoring gauges met the criteria for a wetland (saturation within 12 inches of the soil surface for greater than 12.5 percent of the growing season, or more than 30 consecutive days). Gauges 2 and 3, which met the criteria in monitoring Year 2 (2005), failed to do so in the current monitoring year. In addition, 2 of the 5 wetland reference gauges did not meet the wetland hydrology criteria in monitoring Year 3. The remaining three wetland gauges failed before the growing season. Changes in monthly precipitation from 2005 to 2006 could explain the discrepancies between the annual results. Hydrology monitoring will continue in 2007.

Six bottomland hardwood species were planted at a density of 680 trees per acre on 70.2 acres of the site in 2004. An additional 24 acres in the northern portion of the site were purposely not planted, and approximately 6.1 acres consisted of existing forested wetlands. Additional planting was conducted in February 2005.

One hundred thirty new sample plots were added in 2005 to the original 8 plots established in 2004, increasing the sampling area to the required 5 percent sample of the total planted area. In 2006a total of, 138 plots were sampled; 18 riparian and 120 wetland restoration. Survival for 2006 was compared to survival for 2005 as these numbers account for all additional plantings and plots that had been established in 2005.

Stem counts, within the 120 wetland restoration plots, ranged from 0 to 67 trees per plot, only 4 of these plots contained 0 stems. Species-specific survival numbers corresponding to the 120 wetland restoration plots monitored in 2006 range from 56 to 139 percent. Species-specific survival for riparian plots ranged from 44 percent to 288 percent. Competition-induced tree mortality explain survival numbers that fell below the minimum survival criteria of 80 percent

and tree densities less than 6 trees per plot. Sampling error may account for the survival percentages reported greater than one hundred percent.

Average tree density for the wetland restoration area was 486 trees per acre and 362 trees per acre for the riparian area or 14 trees /plot for the wetland restoration areas and 9 trees/plot for the riparian areas. Sixty-six percent of wetland restoration plots and 67 percent of riparian vegetation plots met the minimum success density criteria of 260 trees per acre or 6 trees per plot. Herbaceous cover averaged nearly 100 percent over the site, with a range from 70 to 100 percent. Vegetation monitoring will continue in 2007.

II. Project Background

1. Project Objectives

The goal of the project was to transform agricultural land to its historical form, a large wetland and stream complex through the following objectives.

- Improve wetland functions, processes, and values, including nutrient removal, flood flow attenuation, and aquatic and wildlife species diversity/abundance,
- Limit offsite drainage by increasing discharge onto the site,
- Reconnect the stream to the floodplain by restoring over 6,000 linear feet of Key Branch through the site, and
- Replant bottomland hardwood tree species.

2. Project Structure, Restoration Type, and Approach

On-site efforts focused on restoring 108.9 acres of agricultural land to bottomland hardwood forest, and 4,313.8 linear feet of ditched Key Branch stream. The entire stream restoration project was Priority Level 1. All of the riparian buffer mitigation was categorized as Level II – Enhancement. Additional mitigation provided for the preservation of 3.6 acres of piedmont swamp hardwood forest and preservation of 6.1 acres of existing piedmont levee forest along Brown Creek. The balance of the mitigation on site was wetland restoration. Project structure is summarized in Table I.

Exhibit Table I. Project Restoration Components								
Project Number: .00013 (Key Branch Mitigation Site)								
Project Segment or Reach ID	Existing Feet or Acreage	Mitigation Type	Approach	Linear Feet or Acreage	Mitigation Ratio	Mitigation Units	Stationing	Comment
KB Stream Restoration		R	P1	4,313 lf	1.0	4,313	0+00 - 43+13	
KB Riparian Buffer	14.2	EII	-	14.2 ac	2.0	7.1	NA	
KB Wetland Restoration		R	-	91.4 ac	1.0	91.4	NA	
Mitigation Unit Summations								
Stream (lf)	Riparian Wetland (Ac)		Non-Riparian Wetland (Ac)		Total Wetland (Ac.)	Buffer (Ac)		Comment
4,313	0		91.4		91.4	14.2		

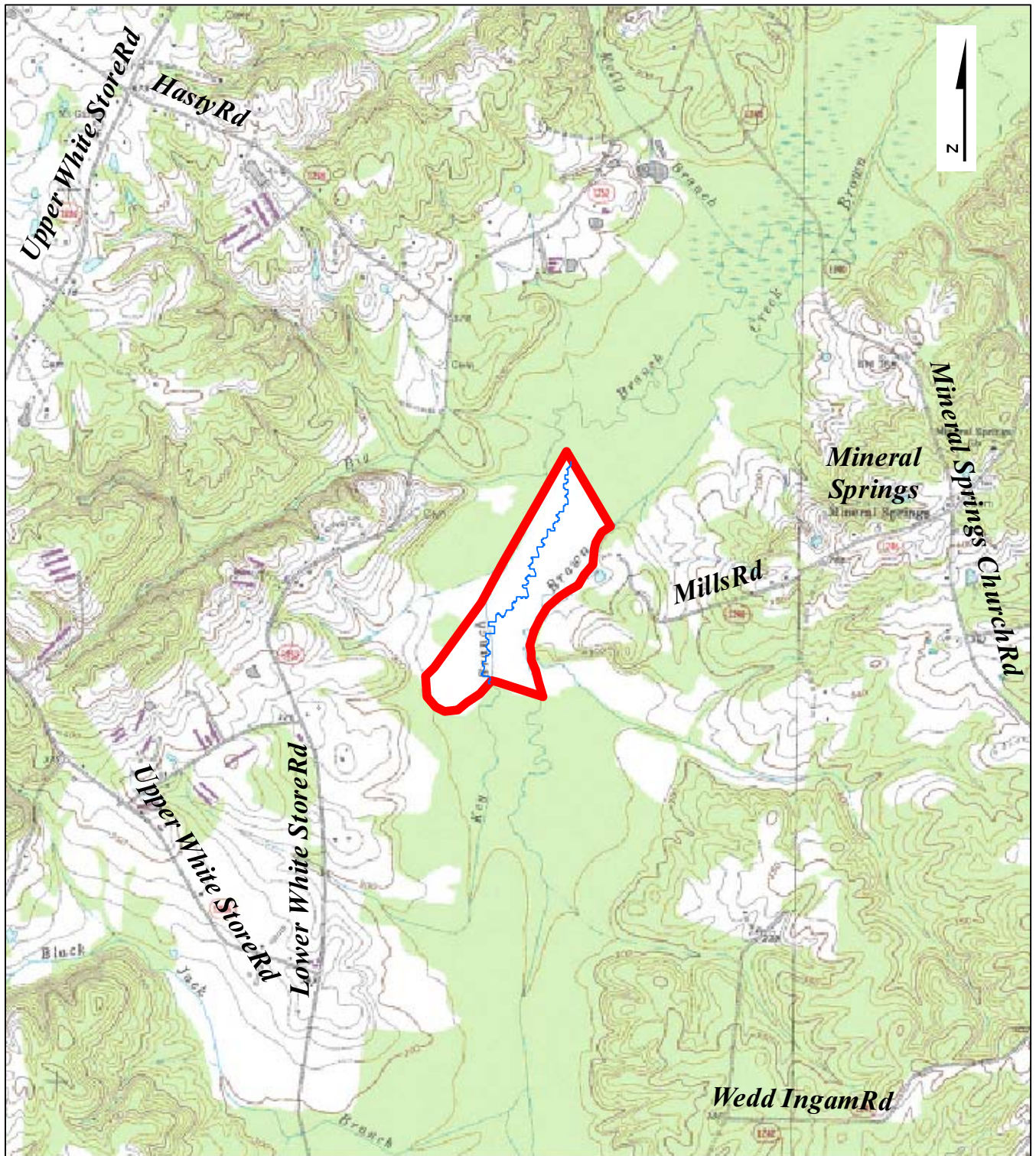
R = Restoration EII = Enhancement II P1 = Priority I P3 = Priority III
 EI = Enhancement I S = Stabilization P2 = Priority II SS = Stream Bank Stabilization

3. Location and Setting

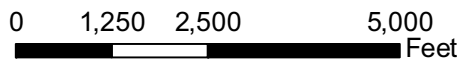
The Key Branch Mitigation Site is located within the Brown Creek watershed (USGS HUC 03040104; NCDWQ sub-basin 030710) of the Pee Dee River basin and occupies approximately 118 acres between Lower White Store Road (SR 1252) and Mineral Springs Church Road (SR 1240) (Figure 1). It is approximately 7 mi (11 km) southeast of Marshville, NC and 12 mi (20 km) southwest of Wadesboro, NC. The watershed is contained within the Triassic Basin of the Piedmont physiographic region and is in close proximity to the contact line between the Triassic Basin and the Carolina Slate Belt. The site represents an inclusion of agricultural land in the otherwise expansive Brown Branch wetland/floodplain complex that extends from the North Carolina/South Carolina line to its confluence with the Yadkin River at the Pee Dee National Wildlife Refuge.

4. History and Background

Extensive site disturbances between 1938 and 1993 resulted from the conversion of the bottomland hardwood wetland ecosystem to agricultural fields. Approximately 45 percent of the property had been logged, grubbed, and cleared by 1956. Key Branch was ditched and relocated during the 1950s and 1960s, while Brown Creek was channelized and relocated to its current position during the 1970s. By 1984, most of the lateral ditches were extended half the length of the site, and logging operations ceased. During the 1990s, the westernmost lateral ditches were extended to intersect Key Branch while the easternmost lateral ditches were extended to the southern boundary.



Directions:
 Go west on Hwy 74 from Wadesboro in Anson County to Peachland.
 Turn onto Mineral Springs Rd. and follow south turn right onto Lower White Store Rd.
 You will pass Hasty Rd. on the right and Turkey Growing Rd. on the
 right then turn left into the Key Branch site .
 If you see Upper White Store Rd. on the right you've gone too far.



Source: NCDOT USGS Quadrangle Images, 146.

	Ecosystem Enhancement Program
<p>FIGURE 1 PROJECT VICINITY MAP KEY BRANCH WETLAND & STREAM RESTORATION Project No. 00013 Monitoring Year 4 of 5 Anson County, North Carolina</p>	
	THE LOUIS BERGER GROUP, INC. 30A Vreeland Road Florham Park, NJ 07932
January 2007	

Completed project activities, reporting history, and completion dates are summarized in Table II.

Exhibit Table II. Project Activity and Reporting History		
Project Number: .00013 (Key Branch Mitigation Site)		
Activity or Report	Data Collection Complete	Actual Completion or Delivery
Site Acquisition	NA*	NA*
Mitigation Planning	Completed	NA*
Site Design	Winter 2001-2002	August 2004
Site Construction	Summer 2002	
Site Planting	Winter 2002-2003	February 2004
Year 1 Hydrological Monitoring	Summer-Fall 2004	October 2004
Year 1 Vegetation Monitoring	Summer 2004	July 2004
Site Replanting		February 2005
Year 2 Hydrological Monitoring	Summer-Fall 2005	October 2005
Year 2 Vegetation Monitoring	Summer 2005	October 2005
Year 3 Hydrological Monitoring	Summer-Fall 2006	October 2006
Year 3 Vegetation Monitoring	Summer 2006	October 2006
Year 4 Hydrological Monitoring	Summer-Fall 2007	
Year 4 Vegetation Monitoring	Summer 2007	
Year 5 Hydrological Monitoring	Summer-Fall 2008	
Year 5 Vegetation Monitoring	Summer 2008	

NA* - Historical project documents necessary to provide this data were unavailable at the time of this report submission

Contact information regarding project designer, construction, planting and seeding contractor, and monitoring personnel are summarized in Table III.

Exhibit Table III. Project Contact Table	
Project Number: .00013 (Key Branch Mitigation Site)	
Designer	KCI Associates of North Carolina, P.A. Landmark Center One, Suite 201 4601 Six Forks Road Raleigh, North Carolina 27609-5210 Gary Mryncza - (919) 783-9214
Construction Contractor	AVR Group, Inc. (formerly Vaughn Contracting Inc.) P.O. Box 796 Wadesboro, NC 28710 Don Vaughn - (704) 694-6450
Planting Contractor	Professional Tree Forestry Services 640 Butler Ford Rd. Vanceboro, NC 28586 (252) 244-2258
Seeding Contractor	Professional Tree Forestry Services 640 Butler Ford Rd. Vanceboro, NC 28586 (252) 244-2258
Monitoring Performers	The Louis Berger Group 1513 Walnut Street Suite 250 Cary, North Carolina 27511
Stream Monitoring	Ed Samanns - (973) 765-1992
Vegetation Monitoring	Ed Samanns - (973) 765-1992
Wetland Monitoring	Ed Samanns - (973) 765-1992

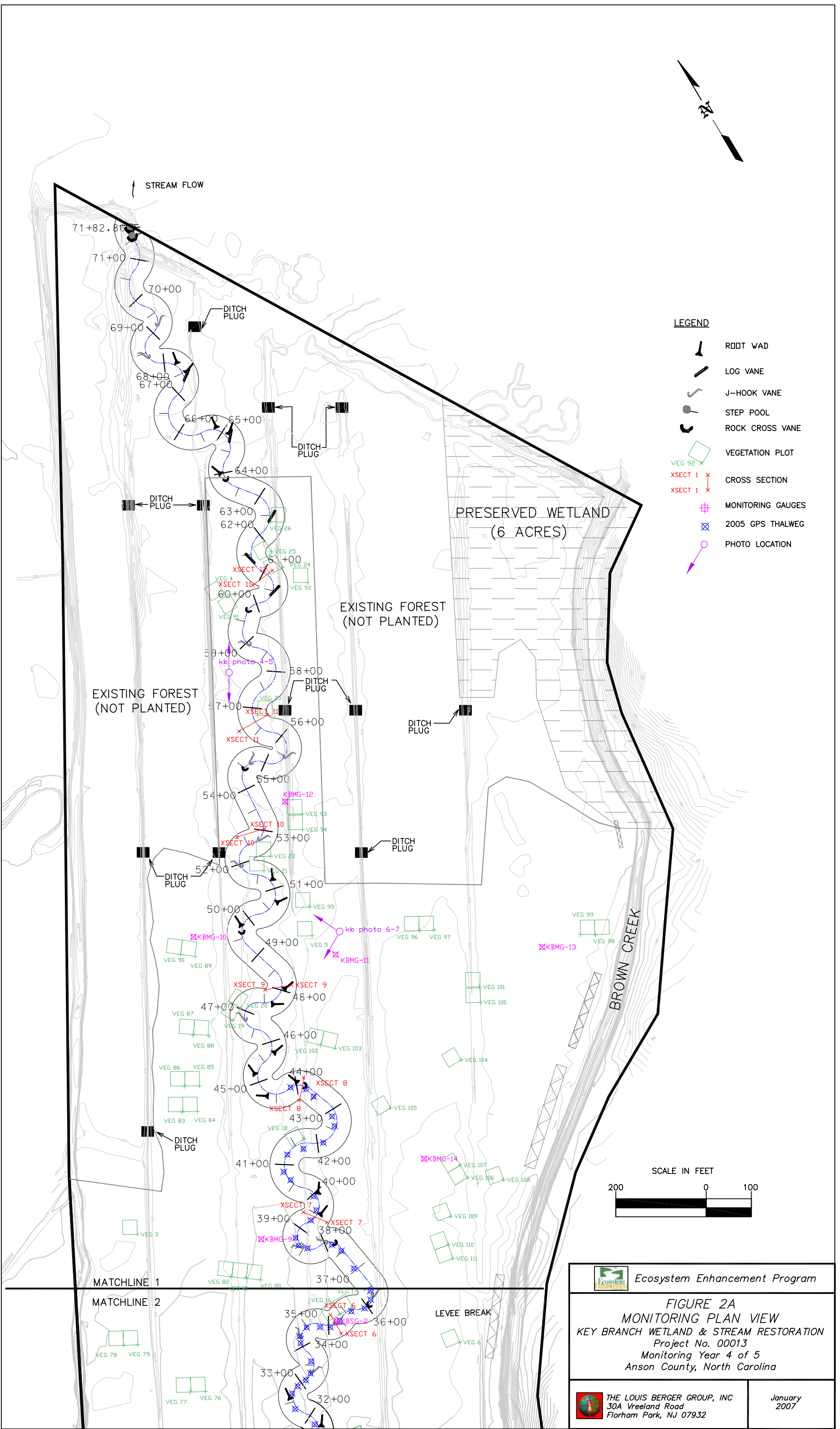
Relevant project background information is summarized in Table IV.

Exhibit Table IV. Project Background Table Project Number: .00013 (Key Branch Mitigation Site)	
Project County	Anson
Drainage Area	50.06 sq mi
Drainage impervious cover estimate (%)	< 5.0%
Stream Order	First
Physiographic Region	Piedmont
Ecoregion	Triassic Basins
Rosgen Classification of As-built	C6
Cowardin Classification	PFO1A, PFO1C, PSS1C
Dominant soil types	Chewacla, Tetotum
Reference site ID	Brown Creek
USGS HUC for Project and Reference	03040104
NCDWQ Sub-basin for Project and Reference	030710
NCDWQ classification for Project and Reference	Class C
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	N/A
% of project easement fenced	100

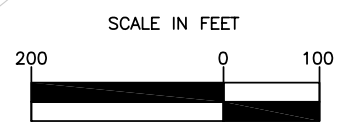
Classification assumed from earliest available data.

5. Monitoring Plan View

Monitoring activities for the site, including relevant structures and utilities, project features, specific project structures, and monitoring features are detailed in Figures 2A-2C.



- LEGEND**
- ROOT WAD
 - LOG VANE
 - J-HOOK VANE
 - STEP POOL
 - ROCK CROSS VANE
 - VEGETATION PLOT
 - CROSS SECTION
 - MONITORING GAUGES
 - 2005 GPS THALWEG
 - PHOTO LOCATION

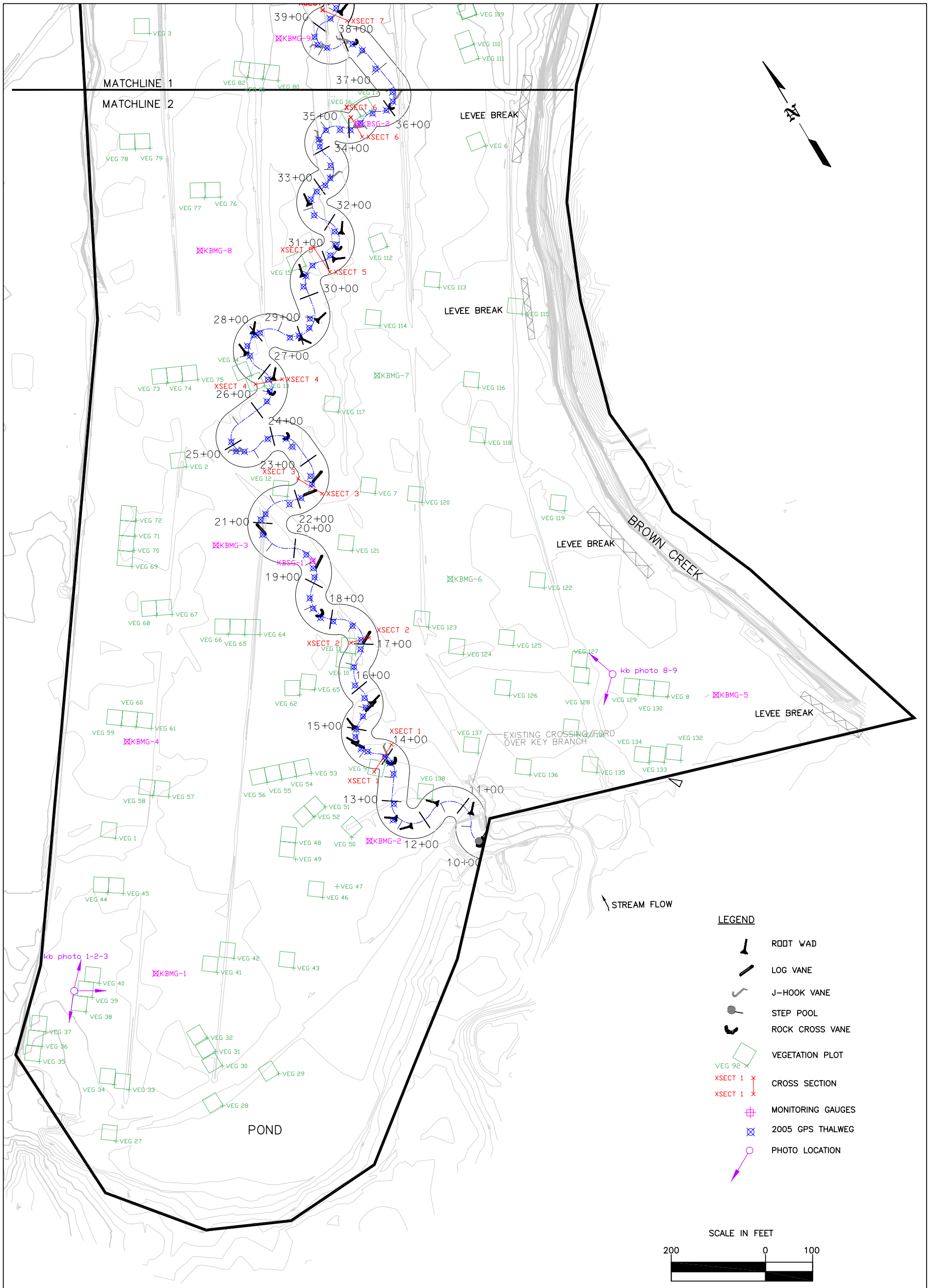


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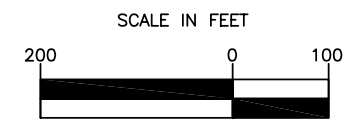
FIGURE 2A
MONITORING PLAN VIEW
 KEY BRANCH WETLAND & STREAM RESTORATION
 Project No. 00013
 Monitoring Year 4 of 5
 Anson County, North Carolina

THE LOUIS BERGER GROUP, INC
 30A Vreeland Road
 Florham Park, NJ 07932

January 2007



- LEGEND**
- ROOT WAD
 - LOG VANE
 - J-HOOK VANE
 - STEP POOL
 - ROCK CROSS VANE
 - VEGETATION PLOT
 - CROSS SECTION
 - MONITORING GAUGES
 - 2005 GPS THALWEG
 - PHOTO LOCATION



Ecosystem Enhancement Program	
FIGURE 2B MONITORING PLAN VIEW KEY BRANCH WETLAND & STREAM RESTORATION Project No. 00013 Monitoring Year 4 of 5 Anson County, North Carolina	
THE LOUIS BERGER GROUP, INC 30A Vreeland Road Florham Park, NJ 07932	January 2007

GROUNDEWATER WELLS			VEGETATION PLOTS		
KB WRGW-1	433215.96	1621550.43	VEG 2	434933.69	1620095.24
KB WRGW-2	433254.28	1621548.44	VEG 20	436077.32	1620951.72
KB WRGW-4	433295.93	1621436.87	VEG 21	436306.66	1621138.31
KB WRGW-5	433261.21	1621422.40	VEG 22	436325.61	1621167.16
KBMG-1	434216.54	1619760.35	VEG 23	436615.42	1621315.68
KBMG-10	436266.76	1620942.39	VEG 24	436877.58	1621490.00
KBMG-11	436072.24	1621192.90	VEG 25	436881.51	1621522.12
KBMG-12	436420.27	1621269.98	VEG 26	436968.96	1621559.94
KBMG-13	435852.56	1621594.67	VEG 27	433779.25	1619234.78
KBMG-14	435583.59	1621130.03	VEG 28	433728.20	1619467.73
KBMG-2	434052.06	1620022.90	VEG 29	433725.50	1619604.55
KBMG-3	434758.19	1620063.85	VEG 3	435764.47	1620498.61
KBMG-4	433701.88	1619849.46	VEG 30	433801.11	1619510.25
KBMG-5	433942.03	1620814.19	VEG 31	433834.68	1619513.59
KBMG-6	434442.07	1620454.90	VEG 32	433869.16	1619513.14
KBMG-7	434892.96	1620542.46	VEG 33	433858.76	1619314.35
KBMG-8	435313.40	1620354.78	VEG 34	433884.02	1619292.72
KBMG-9	435615.08	1620729.05	VEG 35	434007.79	1619180.91
KBSG-1	434624.22	1620223.08	VEG 36	434032.54	1619202.50
KBSG-2	435373.48	1620780.60	VEG 37	434055.00	1619224.85
PHOTOS LOCATIONS			VEG 38	434047.75	1619319.97
kb photo 1-2-3	434098.95	1619321.29	VEG 39	434067.29	1619347.22
kb photo 4-5	436729.27	1621309.24	VEG 4	436885.49	1621389.65
kb photo 6-7	436111.69	1621226.47	VEG 40	434085.51	1619375.38
kb photo 8-9	434092.40	1620647.81	VEG 41	433977.57	1619602.19
CROSS SECTIONS			VEG 42	433984.87	1619648.14
XSECT 1	434173.02	1620106.81	VEG 43	433902.17	1619746.75
XSECT 1	434203.54	1620167.82	VEG 44	434241.65	1619488.85
XSECT 10	436406.83	1621137.91	VEG 45	434223.35	1619516.77
XSECT 10	436392.44	1621200.02	VEG 46	433999.42	1619876.41
XSECT 11	436605.98	1621261.86	VEG 47	434003.91	1619914.46
XSECT 11	436868.92	1621453.11	VEG 48	434128.80	1619885.92
XSECT 11	436605.62	1621334.69	VEG 49	434098.78	1619868.52
XSECT 12	436874.95	1621507.29	VEG 5	436134.79	1621169.80
XSECT 2	434433.49	1620204.62	VEG 50	434077.62	1619994.47
XSECT 2	434423.32	1620243.51	VEG 51	434162.05	1619979.32
XSECT 3	434737.15	1620313.78	VEG 52	434155.88	1619948.45
XSECT 3	434790.82	1620286.47	VEG 53	434246.90	1619992.38
XSECT 4	434989.31	1620365.00	VEG 54	434249.15	1619960.15
XSECT 4	435009.10	1620311.04	VEG 55	434259.82	1619930.29
XSECT 5	435195.87	1620565.56	VEG 56	434266.28	1619895.89
XSECT 5	435133.11	1620568.37	VEG 57	434350.55	1619704.54
XSECT 6	435392.49	1620774.64	VEG 58	434369.75	1619676.43
XSECT 6	435344.48	1620774.40	VEG 59	434532.81	1619695.46
XSECT 7	435618.93	1620839.92	VEG 6	435194.06	1620990.45
XSECT 7	435572.59	1620872.93	VEG 60	434513.79	1619720.89
XSECT 8	435836.32	1620958.85	VEG 61	434494.23	1619747.30
XSECT 8	435874.36	1620992.47	VEG 62	434394.36	1620054.37
XSECT 9	436084.82	1621018.70	VEG 64	434547.55	1620047.69
XSECT 9	436064.67	1621074.60	VEG 65	434388.20	1620086.92
VEGETATION PLOTS			VEG 65	434563.54	1620019.54
VEG 1	434332.52	1619562.48	VEG 66	434582.39	1619989.65
VEG 10	434387.07	1620176.11	VEG 67	434679.62	1619908.87
VEG 100	435817.51	1621414.70	VEG 68	434694.92	1619879.35
VEG 101	435847.51	1621430.39	VEG 69	434810.42	1619887.64
VEG 102	435917.28	1621061.27	VEG 7	434679.81	1620410.72
VEG 103	435894.43	1621085.62	VEG 70	434837.36	1619908.94
VEG 104	435729.36	1621312.90	VEG 71	434862.69	1619926.75
VEG 105	435718.54	1621123.74	VEG 72	434890.08	1619945.44
VEG 106	435498.03	1621191.75	VEG 73	435107.20	1620150.07
VEG 107	435526.06	1621175.01	VEG 74	435094.20	1620180.28
VEG 108	435453.68	1621257.73	VEG 75	435079.73	1620210.89
VEG 109	435444.12	1621116.31	VEG 76	435388.84	1620450.50
VEG 11	434409.08	1620200.12	VEG 77	435404.93	1620420.32
VEG 110	435392.59	1621079.41	VEG 78	435568.92	1620347.61
VEG 111	435361.28	1621072.02	VEG 79	435554.24	1620374.93
VEG 112	435117.60	1620701.29	VEG 8	434022.41	1620729.54
VEG 113	434986.43	1620751.64	VEG 80	435538.33	1620681.68
VEG 114	434980.47	1620601.74	VEG 81	435558.77	1620655.92
VEG 115	434847.43	1620874.00	VEG 82	435578.40	1620629.84
VEG 116	434760.67	1620714.13	VEG 83	435946.31	1620722.86
VEG 117	434868.66	1620431.92	VEG 84	435930.51	1620752.36
VEG 118	434653.40	1620665.61	VEG 85	435976.50	1620785.21
VEG 119	434442.57	1620738.31	VEG 86	435992.93	1620756.08
VEG 12	434759.42	1620245.21	VEG 87	436080.20	1620829.80
VEG 120	434612.62	1620486.54	VEG 88	436060.54	1620859.56
VEG 121	434600.27	1620307.05	VEG 89	436228.10	1620923.27
VEG 122	434324.05	1620617.08	VEG 9	434177.75	1620137.59
VEG 123	434377.76	1620362.88	VEG 90	436247.64	1620898.53
VEG 124	434290.42	1620397.12	VEG 91	436877.44	1621399.32
VEG 125	434252.35	1620497.71	VEG 92	436811.59	1621561.32
VEG 126	434165.31	1620436.35	VEG 93	436377.57	1621288.63
VEG 127	434132.87	1620603.25	VEG 94	436347.54	1621271.41
VEG 128	434102.28	1620593.50	VEG 95	436192.53	1621197.55
VEG 129	434025.46	1620673.53	VEG 96	436022.42	1621379.63
VEG 13	434996.05	1620326.32	VEG 97	436007.66	1621408.32
VEG 130	434008.55	1620698.38	VEG 98	435815.39	1621709.70
VEG 131	434019.13	1620518.38	VEG 99	435832.61	1621681.68
VEG 132	433860.45	1620678.67			
VEG 133	433875.36	1620646.29			
VEG 134	433891.24	1620618.23			
VEG 135	433929.81	1620512.34			
VEG 136	433997.97	1620387.84			
VEG 137	434094.37	1620316.59			
VEG 138	434058.62	1620182.09			
VEG 14	435026.62	1620329.64			
VEG 15	435170.17	1620531.05			
VEG 16	435383.41	1620794.36			
VEG 17	435382.20	1620820.68			
VEG 18	435744.81	1620922.41			
VEG 19	436063.21	1620922.97			

Ecosystem Enhancement Program

FIGURE 2C
MONITORING PLAN VIEW
KEY BRANCH WETLAND & STREAM RESTORATION
Project No. 00013
Monitoring Year 4 of 5
Anson County, North Carolina

THE LOUIS BERGER GROUP, INC
30A Vreeland Road
Florham Park, NJ 07932

January
2007

III. Project Condition and Monitoring Results

A. Vegetation Assessment

1. Vegetative Problem Areas

No problem areas were observed regarding lack of vegetation. There is evidence of an occasional mud wallow, suggesting wild boars are entering the property. Overall, there was an absence of exotic/invasive vegetation with the exception of two common privet stems that were observed in two separate vegetation plots within the restored wetland areas. Information regarding vegetative problem areas is summarized in Table VI. All vegetation related data is located in Appendix A.

2. Vegetative Problem Areas Plan View

A plan view illustrating vegetative problem areas was not included in this report due to an absence of observed vegetative problems. Other vegetation related data is located in Appendix A.

B. Stream Assessment

1. Hydrologic Criteria

In Monitoring Year 3, two bankfull events were recorded by stream gauge KBSG-1 (Serial No. N406360B). Both events occurred in the month of June. The stream bed and banks appear to have weathered each storm without significant damage. A plot of the stream gauge data is provided in Appendix B. Monitoring Year 3 bankfull events and data collection methods are summarized in Table V.

Exhibit Table V. Hydrological (Bankfull) Verifications Project Number .00013 (Key Branch Mitigation Site)			
Date of Data Collection	Date of Occurrence	Method	Photo Number (if available)
July 3, 2006	June 15, 2006	Gauge	
July 3, 2006	June 28, 2006	Gauge	

2. Stream Problem Areas Plan View

The position of each structural problem area is shown in Appendix B2.

3. Stream Problem Area Table

Table B.1 – Stream Problem Areas is located in Appendix B.

4. Numbered Issue Photos Section

A photograph of each structural problem area is provided in Appendix B3.

5. Fixed Station Photos

Photographs taken at each established photograph station are provided in Appendix B4.

6. Stability Assessment Table

There are few stream problem areas observed onsite. The problem areas (Sta. 44+70 and Sta. 45+40) refer to bank scour behind two rootwads on the outside of the same meander bend (Appendix B1). This meander bend appears to constrict flow during over bank events, and in a twenty foot section, some vertical scour is present. Comparing photos from last year to this year, the scour pocket does not appear to have expanded, so no maintenance is recommended for either structure.

Stream problem areas, respective station numbers, and probable causes are summarized in Table VII.

Exhibit Table VII. Categorical Stream Feature Visual Stability Assessment Project Number .00013 (Key Branch Mitigation Site)						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles	NA*	100%	100%	100%		
B. Pools	NA*	100%	100%	100%		
C. Thalweg	NA*	100%	99%	99%		
D. Meanders	NA*	100%	99%	99%		
E. Bed General	NA*	100%	100%	100%		
F. Channel General	NA*	100%	100%	100%		
G. Banks	NA*	100%	100%	100%		
H. Vanes / J Hooks etc.	NA*	100%	100%	100%		
I. Wads and Boulders	NA*	97%	97%	97%		

NA* - Historical project documents necessary to provide this data were unavailable at the time of this report submission

7. Quantitative Measurements

When comparing the survey data from 2004 and 2005 there was very little change in cross sectional area and channel dimension within comparable cross sections. The mean depth at bankfull and bankfull width at all comparable cross sections is approximately the same as in Monitoring Year 1. The dimension of the channel appears stable throughout the restored reach. The dissimilarities were mostly assumed associated with surveying error in the 2004 data collection. The 2004 and 2005 data contained one major variation – the survey data for cross-

section 2 did not have similar vertical or horizontal measurements, not did the data produce a similar shaped section. The 2006 data produces a section nearly identical to the 2005 section and confirms that the error is in the 2004 data. It is assumed that the 2004 section was either collected in a different location or collected incorrectly.

The 2005 and 2006 cross-sectional data correspond well in both horizontal and vertical directions, indicating that the stream is stable. The 2006 data shows that the six riffle sections have enlarged by roughly 0.30 square feet on average, while the six pool sections have enlarged by just less than 1.30 square feet on average. Graphical interpretations of cross sections, the longitudinal profile, and sediment distribution are provided in Appendix B.

Baseline morphology and pre-restoration hydraulic conditions are summarized in Table VIII, and current morphology and hydraulic monitoring information follows in Table IX.

Exhibit Table VIII. Baseline Morphology and Hydraulic Summary Project Number .00013 (Key Branch Mitigation Site)																		
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)	NA*	NA*	NA*							27		35	22		25	NA*	NA*	NA*
Floodprone Width (ft)	NA*	NA*	NA*							>200		>200	>150		>150	NA*	NA*	NA*
BF Cross Sectional Area (ft ²)	NA*	NA*	NA*							35		37	17		21	NA*	NA*	NA*
BF Mean Depth (ft)	NA*	NA*	NA*							1.01		1.16	0.65		0.93	NA*	NA*	NA*
BF Max Depth (ft)	NA*	NA*	NA*							1.75		2.17	1.15		1.74	NA*	NA*	NA*
Width/Depth Ratio	NA*	NA*	NA*							27		34	27		34	NA*	NA*	NA*
Entrenchment Ratio	NA*	NA*	NA*							>7		>7	>7		>7	NA*	NA*	NA*
Wetted Perimeter (ft)	NA*	NA*	NA*													NA*	NA*	NA*
Hydraulic Radius (ft)	NA*	NA*	NA*													NA*	NA*	NA*
Pattern																		
Channel Beltwidth (ft)	NA*	NA*	NA*										160	180	NA*	NA*	NA*	NA*
Radius of Curvature (ft)	NA*	NA*	NA*							50.0		72.8	35	60	NA*	NA*	NA*	NA*
Meander Wavelength (ft)	NA*	NA*	NA*							370		465	265	378	NA*	NA*	NA*	NA*
Meander Width ratio	NA*	NA*	NA*							6.3		8.1	6.3	8.1	NA*	NA*	NA*	NA*
Profile																		
Riffle length (ft)	NA*	NA*	NA*													NA*	NA*	NA*
Riffle slope (ft/ft)	NA*	NA*	NA*													NA*	NA*	NA*
Pool length (ft)	NA*	NA*	NA*													NA*	NA*	NA*
Pool spacing (ft)	NA*	NA*	NA*													NA*	NA*	NA*
Substrate																		
d50 (mm)	NA*	NA*	NA*													NA*	NA*	NA*
d84 (mm)	NA*	NA*	NA*													NA*	NA*	NA*
Additional Reach Parameters																		
Valley Length (ft)										1590			4149					
Channel Length (ft)										1065			6182					
Sinuosity										1.49			1.49					
Water Surface Slope (ft/ft)										0.19			0.005					
BF slope (ft)																		
Rosgen Classification										C6			C6					
Number of Bankfull Events																		
Extent of BF floodplain (acres)										115+			115+					
*BEHI																		
*Habitat Index																		
*Macrobenthos																		

* Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria 35
NA* - Historical project documents necessary to provide this data were unavailable at the time of this report

Exhibit Table IXa. Morphology and Hydraulic Monitoring Summary																														
Project Number .00013 (Key Branch Mitigation Site)																														
Parameter	Cross Section 1 - Glide					Cross Section 2 - Run					Cross Section 3 - Pool					Cross Section 4 - Pool					Cross Section 5 - Riffle					Cross Section 6 - Glide				
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
Dimension																														
BF Width (ft)	18.6	18.4	19.0			20.2	23.8	26.1			18.1	28.3	29.0			17.3	21.3	19.5			20.9	22.9	22.0			19.7	21.0	21.0		
Floodprone Width (ft)	>100	>100	>100			>100	>100	>100			>100	>100	>100			>100	>100	>100			>100	>100	>100			>100	>100	>100		
BF Cross Sectional Area (ft ²)	13.0	16.2	19.5			22.2	35.2	34.2			18.1	33.4	35.1			20.8	24.2	23.0			20.9	23.3	25.2			21.7	23.8	23.3		
BF Mean Depth (ft)	0.7	0.9	1.0			1.1	1.5	1.3			1.0	1.2	1.2			1.2	1.1	1.2			1.0	1.0	1.1			1.1	1.1	1.1		
BF Max Depth (ft)	1.5	1.6	2.0			2.0	2.6	2.6			1.9	2.5	2.9			2.2	2.1	2.1			1.8	2.8	2.1			2.0	2.1	2.0		
Width/Depth Ratio	26.6	20.9	19.0			18.4	16.1	20.0			18.1	24.0	24.2			14.4	18.7	16.3			20.9	22.5	20.0			17.9	18.5	19.1		
Entrenchment Ratio	>5	>5	>5			>5	>5	>5			>5	>5	>5			>5	>5	>5			>5	>5	>5			>5	>5	>5		
Wetted Perimeter (ft)	NA*	18.7	19.5			NA*	24.6	26.8			NA*	29.2	29.8			NA*	22.1	20.1			NA*	23.3	22.5			NA*	21.5	21.4		
Hydraulic Radius (ft)	NA*	0.9	1.0			NA*	1.4	1.3			NA*	1.1	1.2			NA*	1.1	1.1			NA*	1.0	1.1			NA*	1.1	1.1		
Substrate																														
d50 (mm)	0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1		
d84 (mm)	0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1		

Parameter	Cross Section 7 - Run					Cross Section 8 - Pool					Cross Section 9 - Glide					Cross Section 10 - Riffle					Cross Section 11 - Run					Cross Section 12 - Riffle				
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
Dimension																														
BF Width (ft)	22.9	19.9	20.7			21.9	19.9	19.0			20.0	19.9	20.0			21.1	20.0	27.0			27.6	26.0	31.0			26.9	22.9	21.2		
Floodprone Width (ft)	>100	>100	>100			>100	>100	>100			>100	>100	>100			>100	>100	>100			>100	>100	>100			>100	>100	>100		
BF Cross Sectional Area (ft ²)	25.2	23.6	25.0			25.9	24.1	25.5			26.0	23.8	23.7			19.0	20.5	24.3			30.4	31.9	31.4			26.9	20.5	20.0		
BF Mean Depth (ft)	1.1	1.2	1.2			1.2	1.2	1.3			1.3	1.2	1.2			0.9	1.0	0.9			1.1	1.2	1.0			1.0	0.9	0.9		
BF Max Depth (ft)	2.0	1.8	1.9			2.3	2.3	2.5			2.2	2.0	2.0			1.6	1.7	1.8			2.2	2.4	2.3			2.1	1.9	2.0		
Width/Depth Ratio	20.8	16.8	17.3			18.5	16.4	14.6			15.4	16.6	16.7			23.4	19.5	30.1			25.1	21.2	30.6			26.9	25.6	23.5		
Entrenchment Ratio	>5	>5	>5			>5	>5	>5			>5	>5	>5			>5	>5	>5			>5	>5	>5			>5	>5	>5		
Wetted Perimeter (ft)	NA*	20.4	21.2			NA*	20.6	20.1			NA*	20.5	20.6			NA*	20.3	27.5			NA*	26.6	31.6			NA*	23.4	21.7		
Hydraulic Radius (ft)	NA*	1.2	1.2			NA*	1.2	1.3			NA*	1.2	1.1			NA*	1.0	0.9			NA*	1.2	1.0			NA*	0.9	0.9		
Substrate																														
d50 (mm)	0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1		
d84 (mm)	0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1			0.1	0.1	0.1		

NA* - Historical project documents necessary to provide this data were unavailable at the time of this report

Exhibit Table IXb. Morphology and Hydraulic Monitoring Summary (continued)
Project Number .00013 (Key Branch Mitigation Site)

Parameter	MY-01 (2004)			MY-02 (2005)			MY-03 (2006)			MY-04 (2007)			MY-05 (2008)			MY+ (XXXX)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern																		
Channel Beltwidth (ft)	NA*	NA*	NA*	91	144	118	91	144	118									
Radius of Curvature (ft)	NA*	NA*	NA*	12	37	26	12	37	26									
Meander Wavelength (ft)	NA*	NA*	NA*	179	215	189	179	215	189									
Meander Width ratio	NA*	NA*	NA*	N/A	N/A	5.3	N/A	N/A	5.3									
Profile																		
Riffle length (ft)	NA*	NA*	NA*	11	120	61	40	135	65									
Riffle slope (ft/ft)	NA*	NA*	NA*	0.000	0.037	0.006	0.001	0.011	0.004									
Pool length (ft)	NA*	NA*	NA*	22	70	46	28	178	75									
Pool spacing (ft)	NA*	NA*	NA*	39	252	113	32	246	111									
Additional Reach Parameters																		
Valley Length (ft)				2003			2003											
Channel Length (ft)				3023			3023											
Sinuosity				1.5			1.5											
Water Surface Slope (ft/ft)				0.00041			0.00055											
BF slope (ft)				0.000245			0.00049											
Rosgen Classification				C6			C6											
Number of Bankfull Events				6 / 0			2/0											
Extent of BF floodplain (acres)				115+			115+											
*BEHI							Very Low (12)											
*Habitat Index																		
*Macrobenthos																		

NA* - Historical project documents necessary to provide this data were unavailable at the time of this report

* Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria.

C. Wetland Assessment

1. Wetland Problem Areas Plan View

The location of each wetland problem area is provided in Appendix C3.

2. Wetland Criteria Attainment

Only two of the 14 monitoring gauges (KBMG 6 and 12) met the wetland hydrology criteria, with the upper 12 inches of the soil surface remaining saturated for more than 30 consecutive days, or 12.5 percent of the growing season. Three additional gauges (KBMG 4, 7 and 8) missed the criteria by a few days. Comparative analysis of 2005 data found that monitoring gauges KBMG 2 and 3 met the wetland hydrology criteria in 2005 but failed to do so in 2006. Monitoring gauges which failed to meet the wetland hydrology criteria in 2006 (KBMG 1, 5, 7, 8, 9, 10, 11, 13, and 14) were considered non-functioning in 2005, resulting in incomplete comparisons of annual wetland hydrology patterns. However, changes in monthly precipitation could explain some of the discrepancies between 2005 and 2006 results. Recorded precipitation figures for 2005 were greater than 2006 for the months of February, March, April, May, July, and August. Less rainfall in 2006 could have resulted in shorter periods of soil saturation.

In addition, 2 of the 5 wetland reference gauges did not meet the wetland hydrology criteria in monitoring Year 3, with three of the gauges (WRGWs 3, 4, 5) failing before the growing season. Monitoring gauge WRGW 2, which met the wetland hydrology criteria in 2005, failed to do so in 2006 for apparently the same reason: less precipitation. The Data Table for Hydrologic Data and plots of each monitoring gauge data are provided in Appendices C

Monitoring gauge and vegetation sampling plot results are summarized in Table XIV for the wetland restoration area.

Exhibit Table X. Wetland Criteria Attainment

Project Number: .00013 (Key Branch Mitigation Site)

Tract Mean	Well ID	Well Hydrology Threshold Met?	Tract Mean	Vegetation Plot ID	Vegetation Density Threshold Met?	Tract Mean	Vegetation Plot ID	Vegetation Density Threshold Met?	Tract Mean	Vegetation Plot ID	Vegetation Density Threshold Met?	Tract Mean	Vegetation Plot ID	Vegetation Density Threshold Met?	Tract Mean	Vegetation Plot ID	Vegetation Density Threshold Met?	Tract Mean	Vegetation Plot ID	Vegetation Density Threshold Met?	Tract Mean		
	KBMG-1	N/A		1	Y		21	Y		41	Y		61	Y		81	N		101	Y		121	Y
	KBMG-2	N		2	N		22	Y		42	N		62	Y		82	Y		102	N		122	N
	KBMG-3	N		3	Y		23	Y		43	Y		63	Y		83	Y		103	N		123	Y
	KBMG-4	N		4	Y		24	Y		44	Y		64	Y		84	Y		104	Y		124	Y
	KBMG-5	N		5	Y		25	Y		45	N		65	Y		85	Y		105	Y		125	N
	KBMG-6	Y		6	Y		26	Y		46	Y		66	Y		86	Y		106	N		126	Y
	KBMG-7	N		7	Y		27	N		47	N		67	Y		87	Y		107	Y		127	Y
	KBMG-8	N		8	Y		28	N		48	Y		68	Y		88	Y		108	Y		128	N
	KBMG-9	N		9	N		29	Y		49	N		69	Y		89	Y		109	Y		129	Y
	KBMG-10	N		10	N		30	N		50	Y		70	Y		90	Y		110	Y		130	Y
	KBMG-11	Y		11	N		31	Y		51	Y		71	Y		91	N		111	Y		131	N
	KBMG-12	N		12	N		32	Y		52	N		72	Y		92	Y		112	Y		132	Y
	KBMG-13	N		13	Y		33	N		53	Y		73	N		93	Y		113	N		133	Y
	KBMG-14	N		14	N		34	Y		54	Y		74	Y		94	Y		114	Y		134	Y
				15	N		35	Y		55	Y		75	Y		95	Y		115	N		135	Y
				16	N		36	Y		56	Y		76	N		96	Y		116	Y		136	N
				17	Y		37	Y		57	Y		77	Y		97	N		117	Y		137	N
				18	Y		38	Y		58	Y		78	Y		98	N		118	Y		138	Y
				19	Y		39	Y		59	Y		79	Y		99	Y		119	Y			
				20	Y		40	Y		60	Y		80	N		100	N		120	Y			

N/A indicates monitoring gauge failure during growing season

IV. Methodology Section

There were no deviations from the established vegetation plot sampling procedures. Using GPS and pre-placed conduit, plots measuring 10m x 10m were located and all tagged woody stems were identified and tallied. The enclosed vegetation datasheets (Appendix A) list number of planted species in the upper section and number of volunteer species in the lower section.

Upon initial inspection of monitoring gauges in July 2005 it was noted and reported to EEP that the gauges had not been sealed at the ground surface with a bentonite seal. By late September all of the monitoring gauges had been properly sealed.

Appendix A
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