As-built report for the Phillips/Willis Mitigation Site, Middle Fork Creek and tributaries, Madison County

North Carolina Wildlife Resources Commission
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Project Objectives

The general objectives of this stream mitigation project were to improve water quality, fisheries habitat, bank stability, and riparian habitat quality of Middle Fork Creek (MFC) and various tributaries located within the project property. A number of activities were undertaken to accomplish these primary objectives. At eroding sections, the stream banks were reshaped to a more stable cross-sectional dimension and longitudinal profile. The channel, which had been altered and straightened in the past, was modified to a more sinuous pattern. Areas of high bank stress were protected using boulder vanes. Structural improvements were also made to improve aquatic habitat. The riparian zone was sloped and planted with native vegetation. On the only tributary where livestock were pastured, they were fenced out of the riparian zone to protect vegetation. Alternative livestock watering sources and feeding areas were developed. Grasses, sedges, rushes, and other herbaceous vegetation were seeded throughout the riparian zone. During the winter when woody vegetation was dormant, bare-rooted trees and live stakes were planted within the easement area up-slope of the bankfull elevation. These activities should stabilize the morphology of MFC and the tributaries at this location.

Specific objectives for the Phillips/Willis site are described below. A more extensive discussion of the methods used to achieve these objectives is described in the following sections.

1. Establish a conservation easement along Middle Fork Creek and tributaries to protect vegetation and channel morphology.

2. Stop excessive erosion occurring along the banks of Middle Fork Creek. Realign the eroding channel reach to a more sinuous pattern to increase channel length and decrease channel slope. This will reduce the erosion that is occurring and allow the stream to move sediment through the reach.

3. Remove automobile bodies from the banks of Middle Fork Creek and slope vertical banks to provide stability. Install natural structures to protect banks and enhance aquatic habitat. Lower the bank height in areas where the floodplain cannot be accessed by flood flows.

4. Where the southernmost tributary is incised it will be connected to a floodplain by lowering the banks (priority 2 restoration). Other areas where banks are eroding along this tributary are primarily due to livestock access or past dredging. Reestablishing the appropriate stream dimension, pattern and profile will repair these.

5. Repair minor erosion problems on the two northernmost tributaries and protect their existing habitat value.

6. Place fish habitat improvement structures where needed in and along the channel.

7. Plant native trees, shrubs, and ground cover to stabilize the creek banks, shade the stream, and provide wildlife cover and food.

8. Construct fences and a stream crossing along the conservation easement to protect the stream riparian buffer.

9. Install a livestock watering system and feeding structure in fenced fields so that livestock will no longer need to drink from the creek and be fed along the stream banks.

General Construction Narrative

Plans for conducting stream restoration at this site began in the summer of 2002 with initial data collection and preparation of a conceptual restoration plan. More extensive data was collected during the winter and spring of 2003 and a restoration construction plan was prepared in May 2003. After the plan was developed it was provided to all Madison County Stream Mitigation Review Team members for review and editing. N.C. Department of Transportation (NCDOT) conducted a cultural resources review of the site that was submitted to the N.C. State Historic Preservation Office for their concurrence. An erosion control plan was submitted to and approved by the N.C. Department of Environment and Natural Resources, Land Quality Section. Easement acquisition began in late 2003 and was facilitated by NCDOT. Final easement signing occurred just prior to construction in late summer 2003.

The restoration construction plan was implemented under an informal contract with J & N Mowing, of Boomer, NC. This informal contract was advertised, a pre-bid meeting held with potential bidders and J & N Mowing, the lowest bidder, was awarded the contract. Construction began August 18, 2003 and was completed on October 1, 2003. The contractor provided two track-hoes, dump trucks, and hand labor as needed. Access to the site was from Beech Glenn Road (SR1540), McKinney Road (SR1538), and farm paths across the landowner's property (Appendix 1). Boulders used to construct vanes were hauled from the Interstate 26 construction project and root-wads were obtained from trees that had been stock-piled on the highway project and collected onsite.

Middle Fork Creek had a low valley slope and was developed as a C channel with increased sinuosity and an accessible floodplain. McKinney Branch had a steeper valley slope, but existing E channel segments and was constructed as an E_b type channel with some cross-vanes, increased access of the channel to its floodplain, and improved riparian vegetation. Construction began at the upstream end of Middle Fork creek and continued downstream with work on Walker Branch and Willis Branch being done as they were encountered. When work on Middle Fork Creek was completed, construction activities on McKinney Branch began. Work on this tributary was first carried out on the reach below Beech Glenn Road and then the barnyard area upstream. Old vehicles were removed from the project site, crushed and hauled to a metal recycling center. Vertical eroding banks were sloped, seeded, and erosion control materials installed. Excess soil was graded into the existing crop fields at locations identified by the landowner. J-hook vanes, rootwad revetments, channel narrowing, and floodplain benches were constructed along the channel to improve stability and habitat quality.

On McKinney Branch where livestock were pastured, livestock management practices were implemented to improve habitat conditions of the tributary. These livestock management practices included a watering system, woven wire fencing to exclude livestock from the easement, and stream crossings to allow movement of cattle through the easement area. The site was planted with native riparian vegetation and an annual cover crop. The cover crop developed well and stabilized the ground surface. During the winter of 2004, bare rooted trees and live stakes

were planted throughout the project site. A flood occurred during the spring of 2004 that caused bank erosion at one spot on the site. This erosion was below the bend near Line 40 on the survey (Appendix 2) and resulted in a tree falling into the creek that, in turn, caused greater erosion. In part, this instability was caused by the fact that the bank at this site was not sloped to the degree needed. Within a few weeks of this problem developing we returned to repair the damage. The tree was removed and a vane was added at the lower end of the meander to protect the bank. The bank was also sloped so that water could access the floodplain as it moved out of the meander. The entire site has now been stable through multiple high flow events.

Preconstruction Site Conditions:

Channel Condition - This site is located in the Little Ivy Creek watershed and starts 0.3 miles upstream of the confluence of Middle Fork Creek and California Creek. Middle Fork Creek has suffered from land disturbing activities within the watershed. Primary land disturbing activities include agriculture, road construction and residential/commercial development. Within this watershed forested valleys were converted to agricultural land during the1800's and early 1900's. Agricultural land is primarily used to raise tobacco and other crops, and cattle are grazed on steeper pastureland. A significant portion of the watershed has a second or third growth forest.

Sedimentation of the creek has occurred over many years as soil from fields, pastures and gravel roads eroded into streams. This creek and many tributaries have also been channelized or moved in the past. At the present time, there is some conversion of agricultural and forest land to single family home sites. Construction of Interstate 26 through the county should increase this kind of development. NCDOT is planning for the expansion of US Highway 19 within the watershed in the next few years. The expansion of this roadway will result in an increase in the quantity and rate of runoff to Middle Fork Creek. Channel alteration from higher flows may cause increased erosion of stream banks.

This project site has four channels including Middle Fork Creek, an unnamed tributary along McKinney Road, an unnamed tributary that flows by the Willis home, and Walker Branch, the northernmost tributary. The two southern tributaries are unnamed on USGS maps, but are called McKinney Branch and Willis Branch in this plan. These tributaries were given these names because McKinney Branch follows McKinney Road, SR 1536; and Willis Branch flows from the Willis property.

Middle Fork Creek flows across a relatively flat floodplain valley and has a low slope of 0.6% The project reach on Middle Fork Creek consists of 2,017 linear feet of which 822 linear feet are on the property line between the Phillips and Willis properties. The drainage area of this perennial stream, at the project site is 14.00 mi^2. Evaluation of the Middle Fork Creek channel along this site indicates that it is a C4 stream type based on the Rosgen stream classification system (Rosgen 1996). The channel morphology along the project reach demonstrates characteristics of a C, E, and B stream type based on some of the classification criteria; however, when taken in total and past disturbance is considered, a C stream type best describes the stable condition for the reach. The primary problem of this project reach was that past channelization and bank-stabilizing activities had removed channel meanders, reducing stream length and increasing stream slope. The channel was attempting to dissipate energy by extending meanders, cutting the stream banks and depositing sediment, which formed depositional bars. The presence of a mid-channel bar at

one location indicated it was carrying a high sediment load and did not have the capacity to carry this material through the entire site. The channel was extending meanders in those areas where the riparian vegetation was narrow or absent and could not stabilize the bank material. While entrenchment ratios for this reach were high, indicating a wide flood-prone area relative to the bankfull width, the bank height ratios averaged 1.5. Floods of a significant stage were required before the floodplain was utilized. The confining of these high flows within the incised channel caused significant bank erosion.

Willis Branch and Walker Branch contained stable channels with good quality riparian buffer zones at the project site. These two tributary reaches are 295 and 387 linear feet, respectively. Walker Branch has a 1.00 mi^2 watershed that is developed primarily as pasture land, but it is rapidly changing to developed home sites. Willis Branch is a 0.20 mi^2 watershed that is completely forested. Walker Branch has some minor bank erosion due to limited woody vegetation at one spot along the stream. McKinney Branch has a relatively steep channel with a slope of 4.0%. This tributary is small and drains only 0.14 mi^2 at the confluence and 0.04 mi^2 where it enters the project. The watershed is about half pasture and half forest, with less than six home sites. The entire length of McKinney Branch on the Phillips property is perennial and totals 2,806 linear feet. Livestock had impacted this channel as they had access to the stream for drinking. A short section on this tributary was protected by a wooded buffer and served as a reference for stable conditions. McKinney Branch varied in morphology over its length and had sections that were G, F, E, and B; however, if stable it would most likely be a B stream type based on the Rosgen stream classification system (Rosgen 1996). McKinney Branch below Beech Glenn Road (SR 1540) was deeply incised with an entrenchment ratio of 1.9 and a bank height ratio of 2.0. Above Beech Glenn Road the stream flows through a barnyard where the channel was completely degraded with no natural channel morphology. Above the barnyard area was the reach used to collect reference reach data. The portion of the stream above this wooded area flows through pastures where livestock had degraded the channel to varying degrees.

Pebble counts and pavement/subpavement samples were taken on Middle Fork Creek and McKinney Branch (Appendix 10). In addition, a bar sample was taken on Middle Fork Creek. Middle Fork Creek pebble count data indicated that bedload is dominated by gravel and small cobble. The D_{50} was 32 mm and the D_{84} was 128 mm. A plot of the percentage of the pebble count sample (by count) and subpavement samples (by weight), in each size group, indicated a bimodal size distribution of bed material. Most of the sand or smaller material was sampled between the normal flow elevation and the bankfull elevation. The bar material was somewhat smaller than the subpavement material, but they were similar. The largest particle in the bar sample was 125 mm. Bed material sampling was also done on McKinney Branch. A bar sample could not done because this feature was not present on the tributary. Two pebble counts were made on McKinney Branch, one in the lower field just upstream of the confluence and one in the middle pasture. In general there was a greater percentage of smaller particles found in the lower pasture sample where the D_{50} = 8 mm and D_{84} = 70 mm; whereas, in the middle pasture the D_{50} = 16 mm and D_{84} = 80 mm. However, in both cases the D_{50} was classified medium gravel and the D_{84} as small cobble. The pavement/subpavement sample indicated similar size bed material as the pebble count that was also taken in the middle pasture. There was far less fine material found in the pavement and subpavement samples than was revealed in the pebble count. The largest particle collected in the pavement was 105mm.

Riparian Condition - The riparian zones on these project channels varied in quality from areas with excellent riparian vegetation and good stability, to areas with no vegetation and low stability. The valley where the project channels are located is actively used for agriculture. Tobacco, potatoes and corn are grown in the fields that border Middle Fork Creek, Willis Branch and Walker Branch. Livestock were grazed along most of the length of McKinney Branch and the riparian buffer varies from nonexistent to fully forested on one bank. In those areas where a forested buffer exists it is limited to one side of the creek and livestock have access to the channel. The buffer along this tributary was in the greatest need of improvement.

Middle Fork Creek had a vegetated buffer of varying width along most of the reach. There were a few points along the stream where the buffer was absent and the creek had eroded into the adjacent field. Riparian vegetation included tag alder *Alnus serrulata*, sycamore *Platanus occidentalis*, black walnut *Juglans nigra*, river cane *Arundinaria gigantea* , reed canary grass *Phalaris arundinacea*, and nonnative multiflora rose *Rosa multiflora*. Reed canary grass, multiflora rose, river cane, and black walnut were the dominant species and were limiting the ability of other species to become established along the stream. Beaver were actively cutting the few trees that made up the buffer along Middle Fork Creek. They had created at least three short-lived dams along the project reach in the 5 years preceding the project. Middle Fork Creek does not access a significant floodplain until it floods into the adjacent fields over most of the project reach. Past erosion had been addressed by placing crushed automobiles on the stream bank. This was a common practice in this area in the past and was promoted by some government agencies. The right bank, just upstream of the confluence with McKinney Branch, was extensively armored with crushed automobiles. This section, which was relatively straight, probably experienced erosion in the past and required protection. The landowners have used a historical ford located at the downstream end of the project site on Middle Fork Creek.

Willis Branch and Walker Branch both have stable riparian zones with extensive woody and herbaceous vegetation. The northern bank on Walker Branch had a limited area of bank erosion where plowing of the adjacent field had narrowed the buffer zone and removed woody vegetation. McKinney Branch had varying amounts of riparian vegetation along its banks. Along the reach in the lower field there were a number of trees but overall the vegetated buffer was very narrow (less than 10-feet in width). Much of the vegetation did not have a rooting depth that reached the level of the stream. Some trees were also present along the middle reach of this tributary and they were protecting the banks. There was a small berm along the creek in the middle pasture indicating past channelizing.

Implementation of Restoration Plans

Easement Acquisition:

We worked with NCDOT to survey and record the two easements needed to permantly protect this restoration site. NCDOT contracted with Mattern & Craig surveyors to survey this site, prepare a plat, and have it recorded. The NCDOT Right-of-Way office negotiated the easement payment and recorded the easement after it was signed. Copies of the easement (Appendix 2) were provided to NCDOT, NCWRC Balsam office and the landowners. Survey points, as shown on the survey, are marked on the ground with rebar and caps that say "State of North Carolina Conservation Easement". Because these caps are located on turns in the easement line, 4 in. x 4

in. posts were installed in the fence line at all survey cap markers to identify their location. A 5-strand barbed wire fence was installed on the easement line along McKinney Branch, on the side of the creek away from the road. Posts were also installed next to survey caps along the easement line on Middle Fork Creek and the other tributaries; easement signs were placed on these posts. The road right-of-way is the boundary of the easement on the road side of the creek.

Two unique agreements were made with the landowner of this site in order to facilitate easement acquisition. Initially the landowner wanted to exclude the small, middle pasture on McKinney Branch from the easement. If a fence had been constructed on the left bank in this pasture it would have left only a narrow strip of pasture and would have required installation of a stream crossing. Rather than doing this, the landowner agreed to place the entire area in the easement if we would plant the area with apple trees. We agreed to do this and planted the area with 60 trees, giving the landowner permission to maintain the apple trees for fruit production. No other activity is allowed in this area in keeping with the easement. We did not require a fence be constructed along the easement on Middle Fork Creek since no livestock are in this area. However, if the easement is not protected from farm operations we do have the option to have this easement line fenced. Since tractors are used next to the easement, the line will need to be monitored to insure that encroachment does not occur. The landowner requested that a grass strip be maintained along the easement line on Middle Fork Creek to delineate its location. We agreed that his would be planted and the North Carolina Wildlife Resources Commission (NCWRC) would mow it on a yearly basis.

Channel Modifications:

A reference reach in the immediate vicinity of Middle Fork Creek could not be located. Design specifications were determined from stable areas on the existing channel, from a surveyed reference reach on Basin Creek in northwestern Wilkes County (Dan Clinton, North Carolina State University Extension, personal communication), from a reference reach on Raccoon Creek in Haywood County, and from information collected at the Fosson mitigation site (Clemmons and Burgess 2000). Design specification for McKinney Branch were determined from the stable area on the existing channel, from reference reach information taken from Wiggins Branch in Macon County, and a reference reach on an unnamed tributary to the French Broad River in Buncombe County. Dimensionless ratios of measurements taken at these sites were compared with information taken onsite. The design was also compared to both the Mountain and Piedmont Regional Curve information (Harman et al. 1999; Harman et al. 2000). Streams in this area generally fall slightly below the regional curves, probably due to this part of Madison County being dryer than the rest of western North Carolina, and our design parameters reflect this situation. All of this information was used to develop the design for the project (Appendix 3). A copy of the surveyed easement is attached (Appendix 2) as well as maps that show structures installed and pattern modifications made (Appendix 4) during the course of this project. Photographs of the project are included to show representative sites along the project reach before, just after construction, and one year later (Appendix 5). Photographs showing panoramic views of each as-built cross-section are also included (Appendix 6). The locations of all cross-sections and profiles are shown in Appendix 7 and the cross-sections (Appendix 8) and longitudinal profiles (Appendix 9) are also attached detailing the modifications described below. Bedload descriptions were not made when as-built data was collected because it would describe

construction impacts and not sorting from the new channel morphology. We have included pre-construction bedload descriptions (Appendix 10) for comparison with future monitoring data.

Prior to implementation of the restoration plan Middle Fork Creek was already moving toward developing the dimension, pattern, and profile indicative of a C type stream. We sped up this natural channel evolution by fully developing the meanders that were forming and connecting the channel to its floodplain. In those areas where the channel was cutting into the bank causing erosion of the adjoining field we expanded the meander to the appropriate radius of curvature (44.1 to 69.3 feet). On most meanders one vane was constructed at the beginning of the meander to protect the bank, begin to turn the water around the bend and to contribute to the development of scour pools. Rootwads were installed in each bend to provide bank stabilization and fish habitat. In some meanders bedrock outcrops limited our ability to get the rootwads very deep in the pool. However, in each case the rootwads were installed by digging a trench as low as possible and installing them such that the root mass was as deep as possible. Where bedrock was present in meanders, we attempted to construct vanes that incorporated the bedrock by making the bedrock the point rock in the vane. On two meanders, vanes were also constructed at the tail of pools. This was done to protect banks downstream of these vane sites.

Because the stream could not access its floodplain during flood flows, erosion of the stream banks was occurring. Crushed cars had been installed in the past to arrest this problem. While they probably had improved conditions for a time, they were beginning to rust into pieces and were falling into the creek. Two truckloads of metal from these cars were hauled to a metal recycler for disposal. We lowered the banks along the channel to a bankfull elevation appropriate for the C-type stream that we constructed. The constructed channel had a cross-sectional area of approximately 88 ft^2 and a bankfull width of 34 feet. Construction of one meander and riffle sequence was completed before the next sequence was started.

Part of the natural evolution of a C stream type is over widening of the incised channel. Over wide sections existed on the channel and we addressed this problem by narrowing the channel to our design parameters. An inner berm bench was constructed by placing small boulders to delineate the new edge of channel. The area behind the boulders was back filled with clean cobble and rock material excavated from the new meander bends. The bench was then covered with soil and compacted to form a surface that was vegetated and matted with erosion control materials. We constructed interberm benches on this channel because an interberm was evident on the existing channel and we usually find this feature on streams carrying high sediment loads.

Riparian Improvements:

Improvements made to the riparian zones of these project channels were similar and included the following practices. The stream was reconnected to the floodplain, which resulted in a natural condition where high water can overflow the floodplain reducing water velocity, causing suspended soil to deposit, and improving water quality. Banks at the back of the created floodplains were graded to approximately a 2:1 slope. Recognizing the importance of woody vegetation to the stability of the stream banks, we avoided removing as many of the existing trees as possible. When trees had to be removed we tried replanting smaller trees and used large trees that had minimal chance of surviving if moved, as rootwads. We did replant several larger black willow trees or parts of these trees hoping that they would sprout. After the creek bank had been

shaped, and before erosion control materials were installed, it was seeded. A soil test of the site was analyzed by the N.C. Department of Agriculture, Agronomic Division and they concluded that no fertilize or lime was necessary for riparian buffer establishment. A temporary ground cover of millet, winter wheat, and annual rye was seeded wherever soil disturbance occurred. A perennial seed mix of 17 native riparian species was planted throughout the easement area (Appendix 11). We expect this mixture to be slow in developing and recognize that it is often 1 to 2 years before a good stand of the perennial plants develop. In addition to the seed mixtures, during the dormant season of late winter 2004, the riparian area close to the creek was planted with native woody species, adapted to wet areas; these included species such as silky willow *Salix sericea*, silky dogwood *Cornus amomum*, and black willow *Salix nigra*. On the upper banks, we planted taller growing trees that will provide shade, wildlife cover and food, and stability to the creek banks (Appendix 11). Woody species were planted as bare-rooted trees and live stakes.

In addition to providing for stream bank stability through structural and vegetative improvements, we also used biodegradable erosion control materials such as coir rolls and coir matting to provide stability while vegetation grew. Coir rolls were used to establish a bankfull elevation, an interberm/normal flow interface or to delineate channels when they had been completely degraded by livestock, such as in the barnyard. Coir and jute matting was used as ground stabilization along the entire new channel. Straw was used in seeded, bare ground areas outside of the channel. Where old field drains could be located we tied into them and directed this flow to areas that would do the least channel damage.

Livestock Management:

An important part of this stream mitigation plan was the exclusion of livestock from the riparian zone of McKinney Branch. In part, livestock management will determine the success of the project along this tributary. The Natural Resource Conservation Service (NRCS) developed a livestock management proposal in consultation with the landowner and the NCWRC. This plan was for the entire farm and included addressing issues on all watercourses on the farm. The estimated total cost of the livestock practices proposed for this site was $30,238.00. The actual cost to date for implementing livestock management practices has been $25,894.44. The attached map details the agricultural practices that have been installed (Appendix 12). At this site the landowner chose to hire a contractor to install the agricultural practices. Most of the planned activities have been completed; however, the feeding structure has not been completed. The NRCS administers construction of all phases of this part of the mitigation plan. The WRC and NRCS will monitor the functioning of these practices during their initial 2 years of operation. After this period, the landowner is responsible for maintenance of agricultural facilities that are not within the easement. This primarily refers to the watering system and if built, the feeding structure. The NCWRC will continue to maintain the fence and crossings. Landowners are expected to do minor fence and crossing maintenance as needed, such as tightening due to cattle pushing the wire, farm equipment damaging the fence or gates and removing debris that may block crossings.

Fencing: Approximately 2,258 linear feet of fencing was installed to protect the easement along McKinney Branch (Appendix 4). This was a 5-strand barbed wire fence with 4 in x 4 in posts, H-bracing, and steel posts on 10 foot centers. The cost of constructing this fence was $7,237.62. The fields along Middle Fork Creek, Willis Branch and Walker Branch are areas

where livestock are not pastured and a fence was not required. Where no fence was constructed, a provision in the easement agreement leaves this option open to the NCWRC if needed to protect the easement in the future. Pressure treated 4 in x 4 in posts with boundary signs demarcate the easement line where fencing was not installed.

Watering facilities: Excluding livestock from the stream denied them their only source of water. A watering system was installed to provide an alternative water supply that should be sufficient for the number of cattle that these pastures can support. This system should provide better quality drinking water than the creek provides and improve livestock health. Five watering tanks were installed in the various pastures along McKinney Branch. The division of these tanks by pasture can be seen on the accompanying map (Appendix 12). A well was drilled to supply water under pressure to all of the watering tanks on the system. Tanks were connected to the well by the installation of 4,900 feet of water line. Water supply lines are all buried and should not freeze. Tanks are rectangular two-hole tanks, constructed of thick walled plastic. The tanks are insulated and should not freeze if the cattle use them enough to keep water flowing through the system. Tank locations are hardened for high use and were kept well away from the easement. Installation of this watering system cost $17,156.82.

Stream Ford: The existing ford was improved by hardening the upper banks. The bottom of the channel at the crossing was naturally hardened by the presence of compacted cobble. The upper banks were sand and would easily erode into the stream. The sand area was hardened by installing a Terra-cell structure on grade with the existing farm path. This structure was then backfilled with washed gravel to fill the cells and put the structure on grade with the existing path. This provided a firm surface that would stand up to high water, movement of equipment during construction, and long-term farm use. This crossing was installed by the restoration contractor, under WRC supervision, as we prepared for implementing the construction plan. The cost of installing this crossing was approximately $1500.00.

Summary:

Stream restoration activities at the Phillips/Willis Mitigation Site accomplished all of the objectives established for this project. Stream stability, water quality, and fish and wildlife habitat have been improved at this site. Long-term monitoring of this site by NCDOT should determine if these improvements will continue into the future. This has been the fifth project completed under the 1996 agreement between NCDOT and the NCWRC to accomplish stream restoration as mitigation for stream impacts from the Interstate 26 construction project in Madison County. With the completion of this project the NCWRC has accomplished 14,679 linear feet of restored streams. This is 56% of our initial goal of accomplishing 26,345 linear feet of restoration.

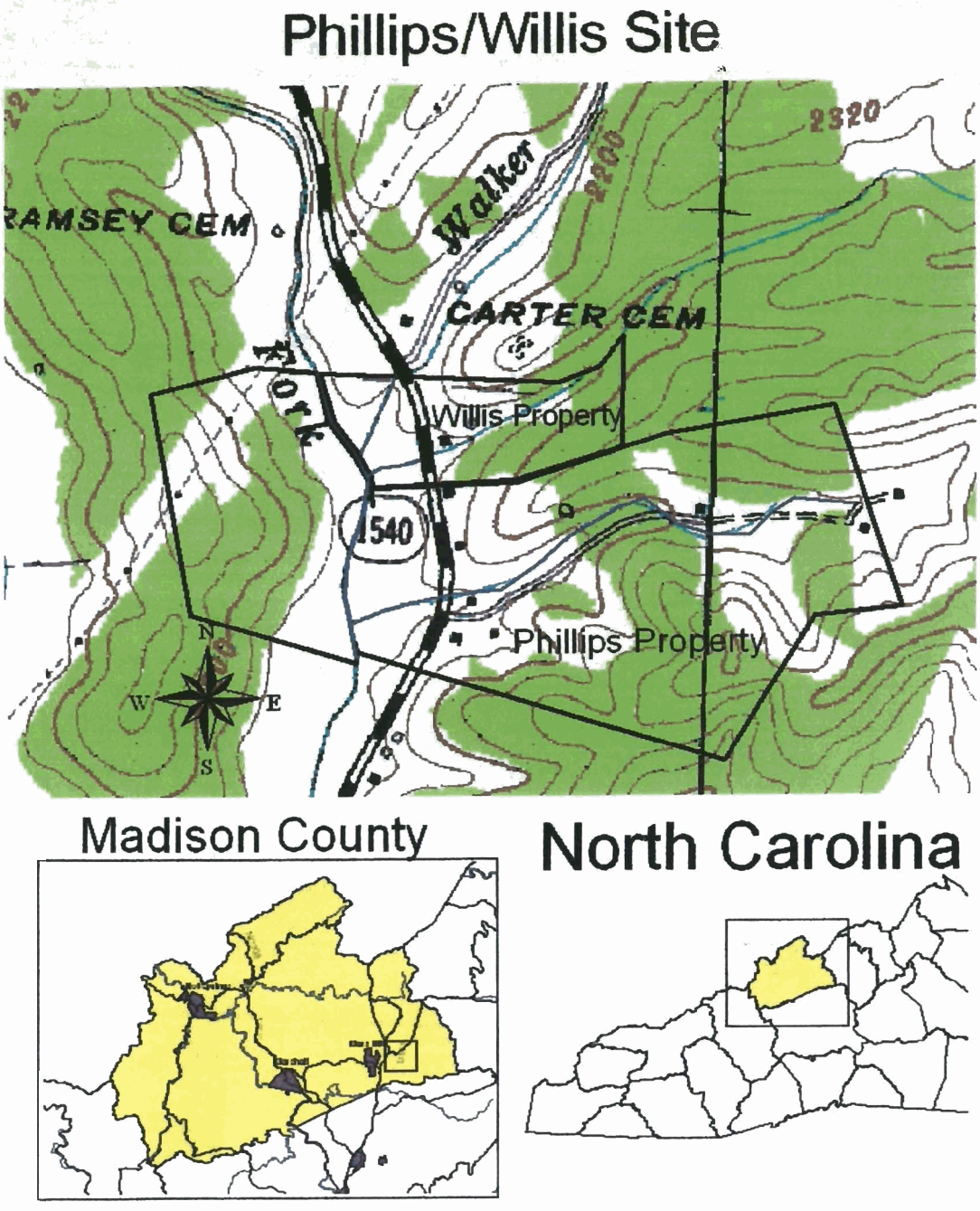
References

Rosgen, D. L. 1996. Applied river morphology. Printed Media Companies, Minneapolis, Minnesota.

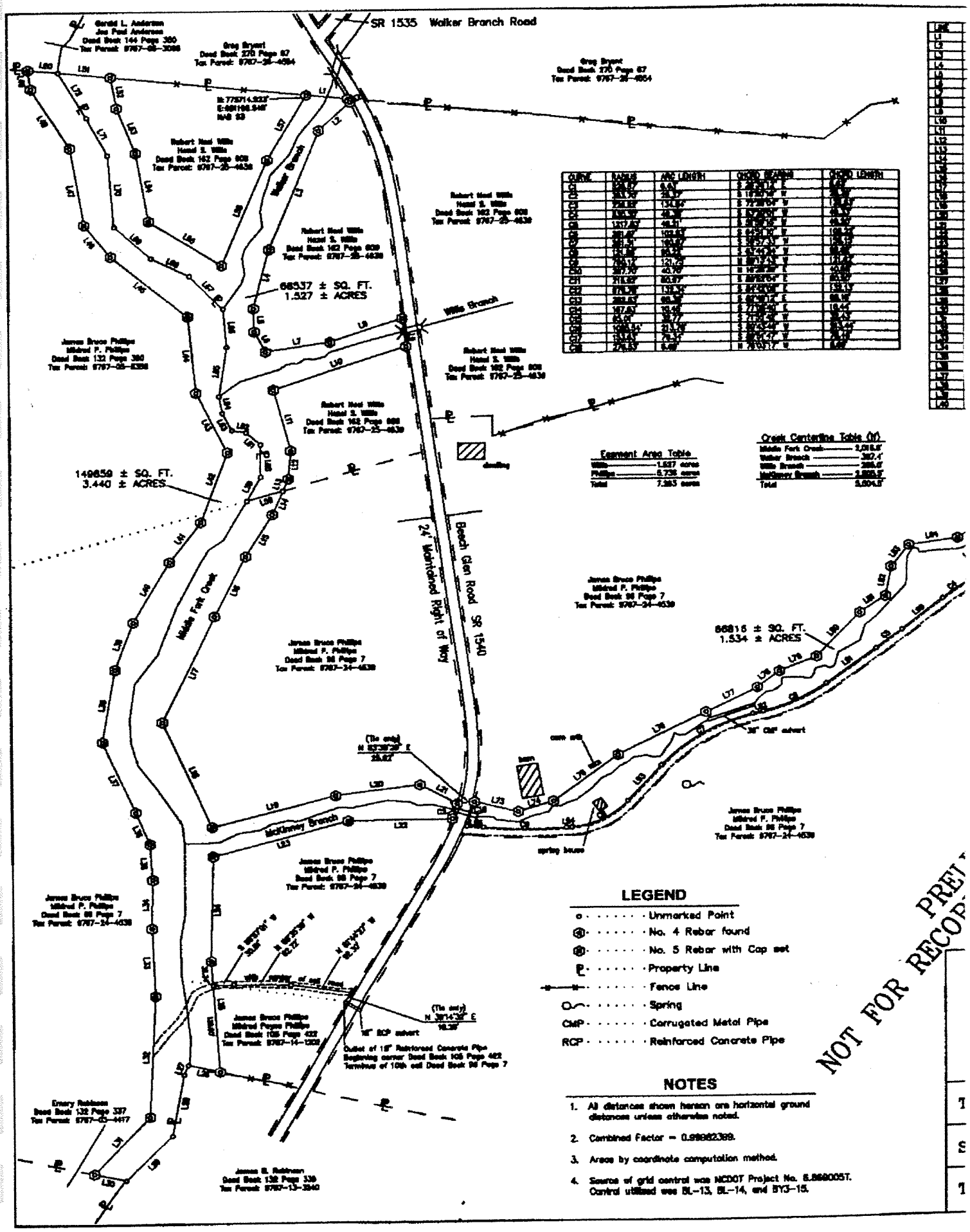
Clemmons, M.M. and A.B. Burgess. 2000. As-built report for the Fosson Mitigation Site, Paint Fork Cree, Madison County. North Carolina Wildlife Resources Commission. Final Report.

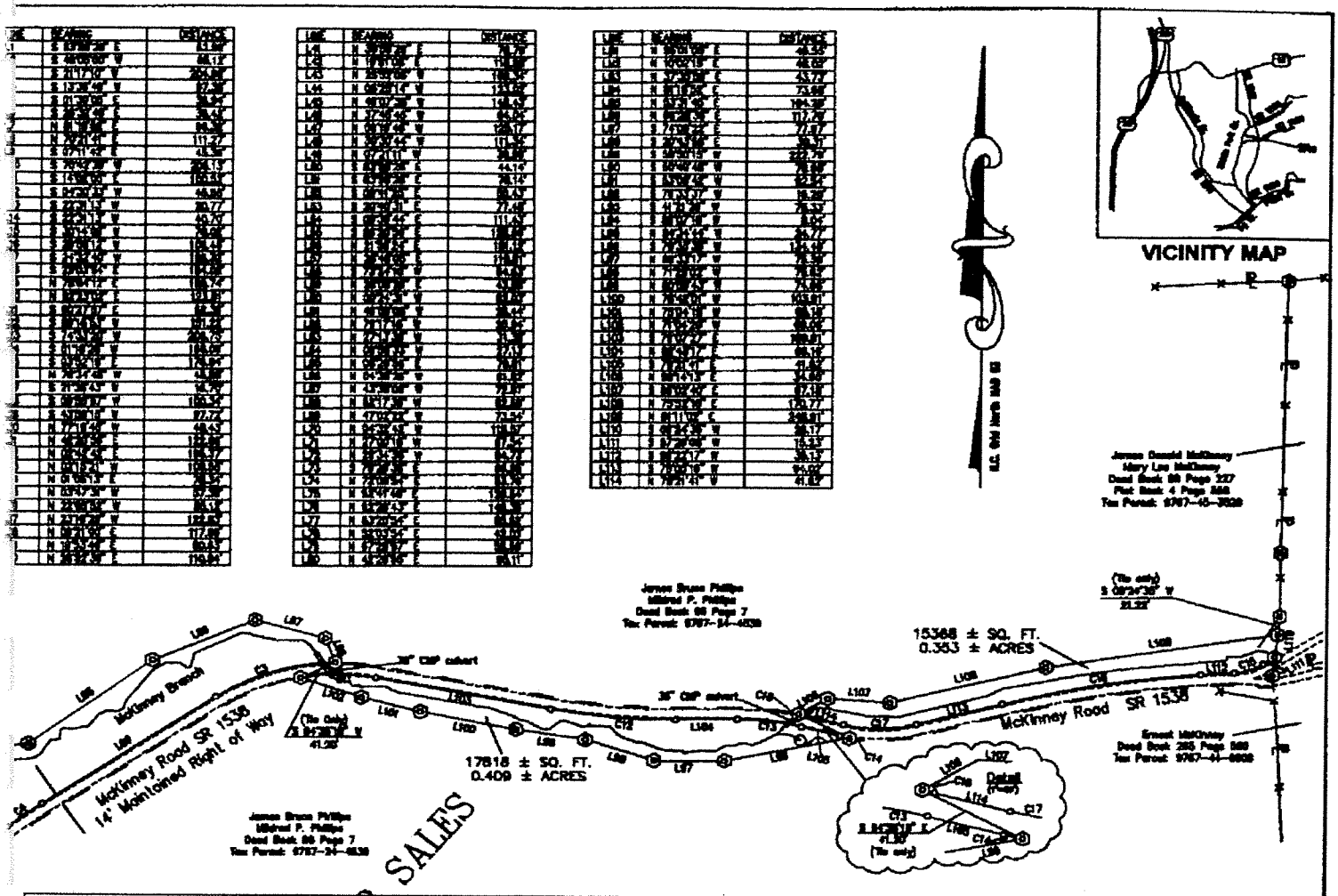
Harman, W. A, D. E. Wise, M. A. Walker, R. Morris, M. A. Cantrell, M. Clemmons, G. D. Jennings, D. Clinton, and J. Patterson. 2000. Bankfull regional curves for North Carolina mountain streams. Pages 185-190 *in* D.L. Kane, editor. Proceedings of the American Water Resources Association Conference: Water Resources in Extreme Environments. American Water Resources Association, Middleburg, Virginia.

Harman, W. A., G. D. Jennings, J. M. Patterson, D. R. Clinton, L. O. Slate, A G. Jessup, J. R. Everhart, and R. E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Pages 401-408 *in* D.S. Olsen and J.P. Potyondy, editors. American Water Resources Association, Wildland Hydrology Symposium Proceedings. American Water Resources Association, Middleburg, Virginia.



Appendix 1. The Phillips/Willis stream mitigation site location on Middle Fork Creek in Madison County, North Carolina.


SR 1535 Walker Branch Road
Gerald L. Anderson
Joe Paul Anderson
Deed Book 144 Page 355
Tax Parcel: 9787-05-3086
Greg Bryant
Deed Book 270 Page 67
Tax Parcel: 9787-26-4654
Robert Neal Wills
Hazel S. Wills
Deed Book 162 Page 609
Tax Parcel: 9787-25-4639
68537 ± SQ. FT.
1.527 ± ACRES
Wills Branch
James Bruce Phillips
Mildred P. Phillips
Deed Book 132 Page 388
Tax Parcel: 9787-05-8388
149659 ± SQ. FT.
3.440 ± ACRES
Middle Fork Creek
24' Maintained Right of Way
Beech Glen Road SR 1540
James Bruce Phillips
Mildred P. Phillips
Deed Book 88 Page 7
Tax Parcel: 9787-24-4639
66816 ± SQ. FT.
1.534 ± ACRES
36" cmp culvert
McKinney Branch
spring house
James Bruce Phillips
Mildred Pegram Phillips
Deed Book 105 Page 422
Tax Parcel: 9787-14-1209
18" RCP culvert
Outlet of 18" Reinforced Concrete Pipe
Beginning corner Deed Book 105 Page 422
Terminus of 10th call Deed Book 88 Page 7
Emory Robinson
Deed Book 132 Page 337
Tax Parcel: 9787-05-4417
James B. Robinson
Deed Book 138 Page 338
Tax Parcel: 9787-13-3940
dwelling
Easement Area Table
Wills 1.527 acres
Phillips 5.738 acres
Total 7.265 acres
Creek Centerline Table (ft)
Middle Fork Creek 3,018.6'
Walker Branch 387.1'
Wills Branch 288.0'
McKinney Branch 2,600.5'
Total 5,604.5'
LEGEND
Unmarked Point
No. 4 Rebar found
No. 5 Rebar with Cap set
Property Line
Fence Line
Spring
CMP Corrugated Metal Pipe
RCP Reinforced Concrete Pipe
NOTES
1. All distances shown hereon are horizontal ground distances unless otherwise noted.
2. Combined Factor = 0.99982389.
3. Areas by coordinate computation method.
4. Source of grid control was NCDOT Project No. 8.2680005T. Control utilized was BL-13, BL-14, and BY3-15.
NOT FOR RECORD



Appendix 2. Survey of the Easement line along Middle Fork Creek and unnamed tributaries at the Phillips/Willis Site.

Points along the survey line are referenced in this report by the number of the survey line which that point begins. For example L18 is line 18 and begins and ends on surveyed calls or points. We have referred to the first point on this line as MFC18 (on Middle Fork Creek) and the second point as MFC 19. These references are primarily in the cross-section descriptions.

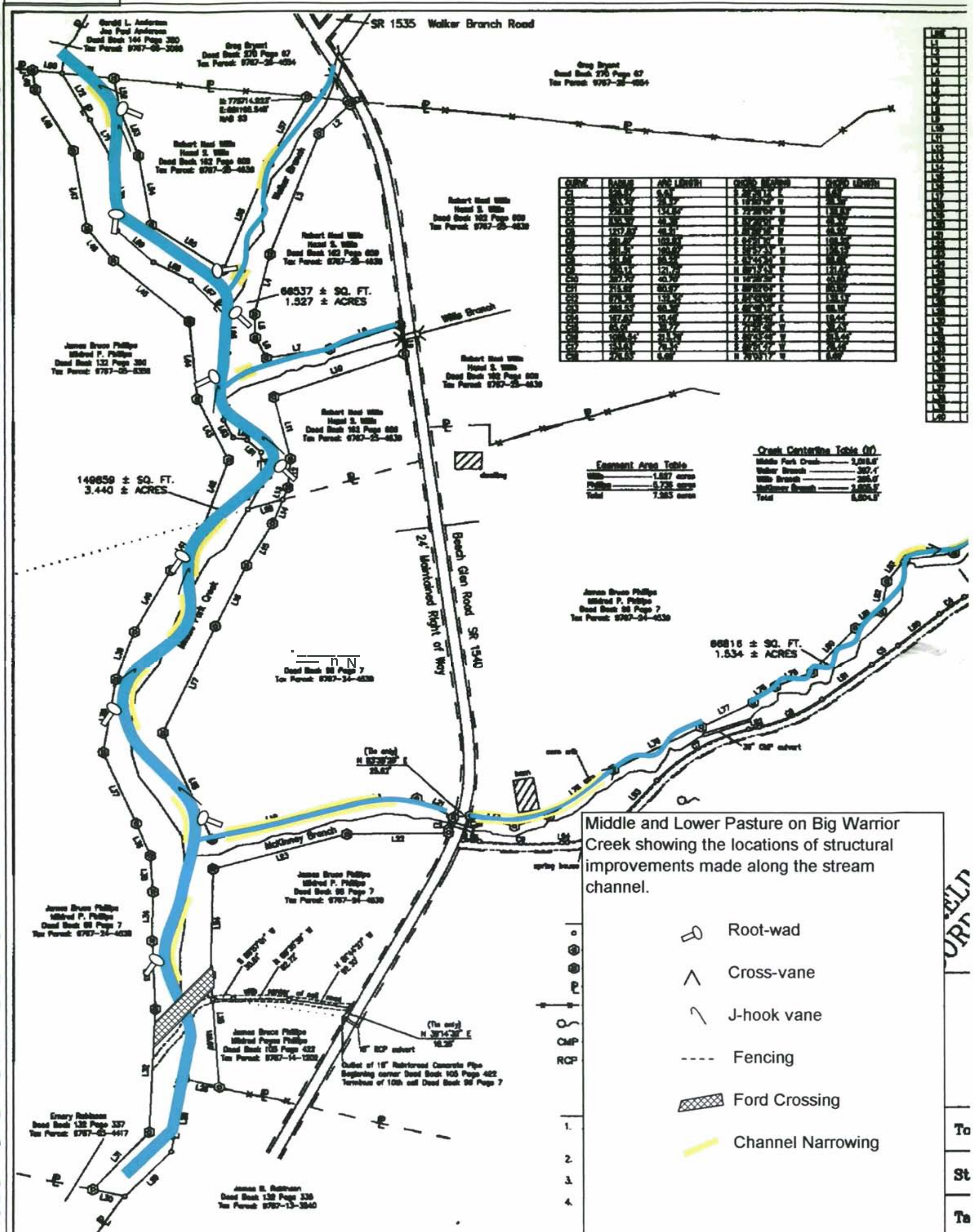
Survey of Conservation Easement **Acquired by North Carolina Department of Transportation for North Carolina Wildlife Resources Commission**	**North Carolina Department of Transportation** **Location and Surveys Unit** **81 Dogwood Road** **Asheville, NC 28806** **828-667-9616**
Township: Number 4 — **County: Madison**	**Survey Date: 1-10-03 through 2-13-03**
State: North Carolina — **TIP NO. A0010WM**	**Scale: 1"=100'**
Tax Parcels: 9767-25-4639 **9767-14-1202, 9767-24-4539, 9767-05-5358**	Mattern & Craig

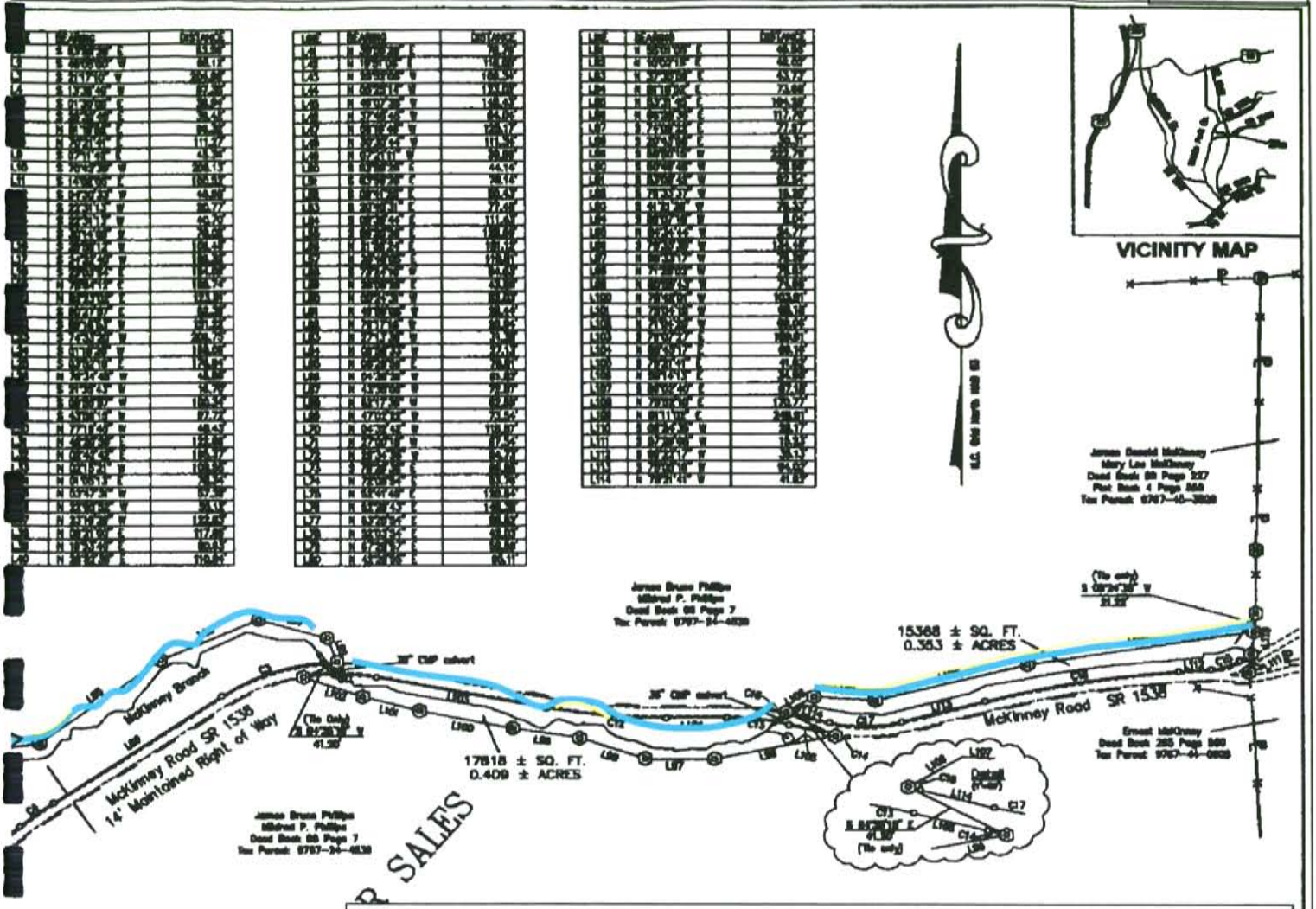
DESIGN FOR: Phillis/Willis Stream Mitigation Site

Parameter	Existing	Reference	Reference	Reference	Reference	Design		Reference	Reference	Design	Design
Reach Name or Info Source	Middle Fork	Raccoon Creek	Basin Creek	Fosson Site	ON SITE STABLE	Middle Fork		Wiggins Br.	UT to FBR	Mckinney Br.	Mckinney Br.
Stream Type	E4-C4	E5	C4	C4	C	C4		B3	E4b	B	$E4_b$
Drainage Area (sq mi)	14	2.9	7.2	13.6	14	14		0.15	0.1	0.14	0.14
Bankfull Width, Wbkf (ft)	30.6	15.7	33.2	34.0	28.9	34.0		5.3	4.4	5.5	5.5
Bkf Cross Sec Area, Abkf (sq ft)	73.5	23.8	68.4	88.1	78.3	88.0		4.78	2.4	5.0	5.0
Bankfull Mean Depth, Dbkf (ft)	2.4	1.5	2.1	2.6	2.7	2.6		0.9	0.6	0.9	0.9
Bankfull Max Depth, Dmax (ft)	4.6	2.6	3.1	4.0	3.9	4.0		1.4		1.5	1.7
Width Flood Prone Area, Wfpa (ft)	90	100	329	200	140	140		30		20	20
Width/Depth Ratio, Wbkf/Dbkf	12.7	10.4	16	13.1	10.7	13.1		5.74	7.0	6.1	6.0
Bank Height		3.4			5.5	5.5					
Avg. Riffle Length	137.0			48.0	130.0	49					
Riffle Slope, (ft/ft)	0.0117	0.019	0.021		0.011	0.015			0.076	0.0948	0.0948
Pool Depth	2.6		2.7	3.5	2.6	6.4					
Pool Width	30.5		50.3	27.0	30.5	34.9					
Max. Pool Depth	5.0	3.7	5.2	5.5	5.0	8.0					
Pool x-sect. Area	80.3	31.0	109.6	75.0	80.3	90.2					
Min. Pool length	28.0				66.0	46					
Max. Pool Length	130.0		17		73.0						
Avg. Pool Length	66.0		53	57.4	69	43.7					
Pool Slope, (ft/ft)	0.0024	0.0030	0.00194		0.0024	0.0368			0.0130	0.0162	0.01621
Avg. Pool to Pool Spacing	196.5	103	303	105	178	36			52	65	65
Min Pool Spacing, Lps (ft)	77.0	42.0	271		161	229			29.2	36.5	36.5
Max Pool Spacing, Lps (ft)	484.0	163	334		195	342			74.8	93.5	93.5
Min. Meander Length, Lm (ft)		30.0			234.0	250					40
Max. Meander Length, Lm (ft)		84.0			335.0	370			60.0	75.0	75
Avg. Meander Length, Lm (ft)		49.0	350		284.5	310					
Min Radius of Curvature, Rc (ft)		8.5	44.1		65	60			24.0	30.0	30
Max Radius of Curvature, Rc (ft)		15.8	69.3		82	82			35.0	43.8	44
Avg. Radius of Curvature, Rc (ft)		12.2	56.7		74	74			29.5	36.9	37
Min Belt Width, Wblt (ft)		51.8	59		80	60					

Max Belt Width, Wblt (ft)		53.4	75		95	94					25
Sinuosity, Ks=Sval/Schan	1.14	1.28	1	1.15	1.14	1.23				1.10	
Sinuosity, Kl=Lchan/Lval	1.26				1.24	1.33			1.19	1.10	1.29
Valley slope, Sval (ft/ft)	0.0075	0.0140		0.0069	0.0075	0.0075			0.0410	0.0465	
Water Surface Slope, Schan (ft/ft)	0.0066	0.0109		0.0060	0.0066	0.0061			0.0340	0.0424	
Valley Length, Lval (ft)	1175.0				1200.0	1200.0				2500.0	97.0
Channel Length, Lcha (ft)	1483.0				1483.0	1600.0				2755.0	125.0
Dimensionless RATIOS											
Width/Depth Ratio, Wbkf/Dbkf	12.7	10.4	15.8	13.1	10.7	13.1		5.9	7.3	6.1	6.0
Abkf/Wbkf	2.40	1.51	2.06	2.59	2.71	2.59		0.90	0.55	0.91	0.91
Entrenchment Ratio, Wfpa/Wbkf	2.9	6.4	9.9	5.9	4.8	4.1		5.7		3.6	3.5
Bank Height to Dmax		1.3			1.4	1.4					
Riffle length/Wbkf	4.5			1.4	4.5	1.4					
Max. riffle Depth/Dbkf	1.92	1.72	1.48	1.54	1.44	1.55		1.56		1.65	1.90
Riffle Slope Ratio, Srif./Schan	1.8	1.7			1.7	2.5			2.2	2.2	
Pool length/Wbkf	0.9				2.3	1.4					
Min. Pool Length/Wbkf	0.915		1.1		2.3	1.4					
Max. Pool Length/Wbkr	4.248		0.5		2.5						
Pool Depth/Dbkf	1.1		1.3	1.4	1.0	2.5					
Max. pool Depth/Dbkf	2.082	2.446	2.476	2.123	1.845	3.100					
Pool-Pool spacing/Wbkf	6.4	6.5	9.1	3.1	6.2	1.1			11.8	11.8	11.8
Pool Slope Ratio, Spool/Schan	0.36	0.28			0.36	6.03			0.38	0.38	
Min Pool Spacing Ratio, Lps/Wbkf	2.5	2.7	8.2		5.6	6.7			6.6	6.6	6.6
Max Pool Spacing Ratio, Lps/Wbk	15.8	10.4	10.1		6.7	10.1			17.0	17.0	17.0
Pool width/Wbkf	1.0		1.5	0.8	1.1	1.0					
Pool Area/Abkf	1.09	1.31	1.60	0.85	1.03	1.03					
Min Rc Ratio, Rc/Wbkf		0.5	1.3		2.2	1.8			5.5	5.5	5.5
Max Rc Ratio, Rc/Wbkf		1.0	2.1		2.8	2.4			7.955	7.955	7.955
Meander Len Ratio, Lm/Wbkf		3.1	10.5		9.8	9.1					
Min. Meander Length Ratio, MinLm (ft)/Wbkf		1.9			8.1	7.4					7.3
Max. Meander Length Ratio, MinLm (ft)/Wbkf		5.4			11.6	10.9			13.6	13.6	13.6
Min MW Ratio, Wblt/Wbkf (ft)		3.3	1.8		2.8	1.8					
Max MW Ratio, Wblt/Wbkf (ft)		3.4	2.3		3.3	2.8					4.5

Appendix 4


SR 1535 Walker Branch Road
68537 ± SQ. FT.
1.527 ± ACRES
149859 ± SQ. FT.
3.440 ± ACRES
66815 ± SQ. FT.
1.534 ± ACRES
Wills Branch
Walker Branch
McKinney Branch
24' Maintained Right of Way
Beech Glen Road SR 1540
Middle and Lower Pasture on Big Warrior Creek showing the locations of structural improvements made along the stream channel.
Root-wad
Cross-vane
J-hook vane
Fencing
Ford Crossing
Channel Narrowing



Appendix 4. Project modifications along Middle Fork Creek and unnamed tributaries at the Phillips/Willis Site.

Survey of Conservation Easement Acquired by North Carolina Department of Transportation for North Carolina Wildlife Resources Commission		North Carolina Department of Transportation Location and Surveys Unit 81 Dogwood Road Asheville, NC 28806 828-667-9616
Township: Number 4	County: Madison	Survey Date: 1-10-03 through 2-13-03
State: North Carolina	TIP NO. A0010WM	Scale: 1"=100'
Tax Parcels: 9767-25-4639 9767-14-1202, 9767-24-4539, 9767-05-5358		Mattern & Craig

Appendix 5. The following series of photos shows various spots along the channel at different points in time. In general the photos start at the downstream end of the project and move upstream and then show two sites on McKinney Branch. The photos show the same general location prior to construction, just after the end of construction, and one year later. Individual photos show there file name and the location of the file.

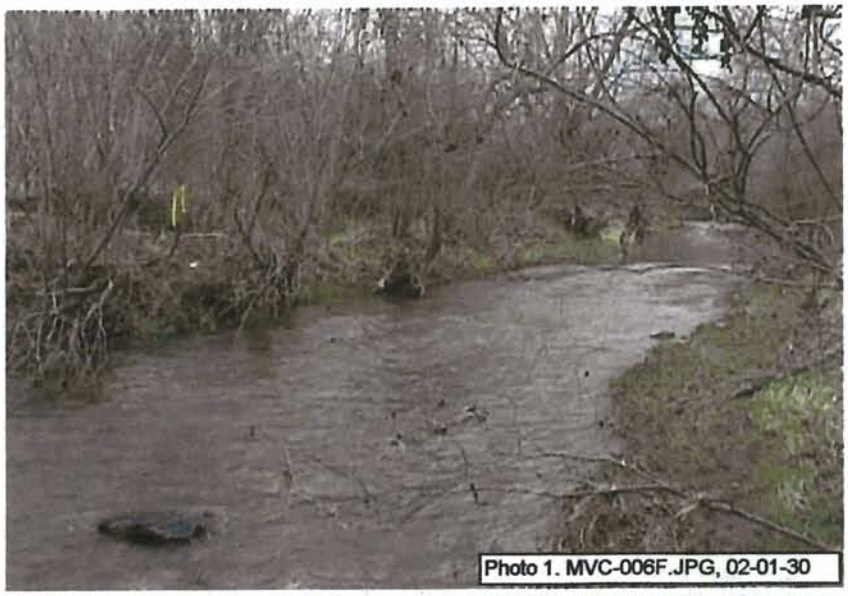


Photo 1. MVC-006F.JPG, 02-01-30

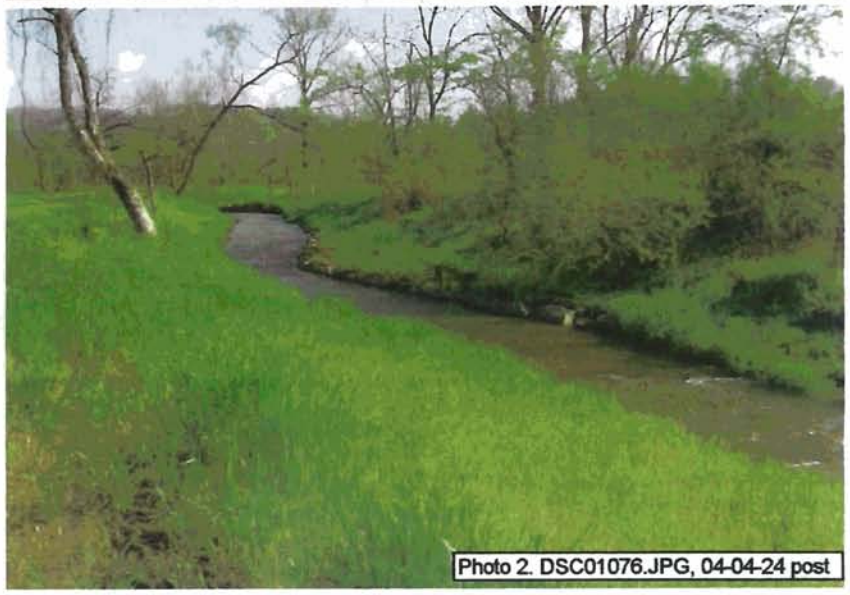


Photo 2. DSC01076.JPG, 04-04-24 post

Photo 3. DSC01203.JPG, 04-07-29 post

Series 1. These photos show the area between the McKinney Branch confluence and the ford. Photo 1 shows preconstruction conditions in this reach, photo 2 shows the narrowed channel and cover crop, and photo 3 shows area one year later with perenial seed mix starting to come up.

Photo 1. MV-004F.JPG, 02-04-15

Photo 2. XS3-UStoDS1.JPG, 04-01 As-built

Photo 3. DSC01205.JPG, 04-7-29 post const

Series 2. These photos show the area at the lower end of the S-curve where properties meet. Photo 1 shows preconstruction conditions in this area, photo 2 shows the modified channel moved off vertical bank and rootwads installed, and photo 3 shows area one year later.

Photo 1. MVC-011F.JPG, 02-01-30

Photo 2. DSC01085.JPG, 04-04-27

Photo 3. DSC01209.JPG, 04-07-29

Series 3. These photos show the area at the lower end of the S-curve where properties meet. Photo 1 shows preconstruction conditions in this area, photo 2 shows the modified channel moved off vertical bank and rootwads installed, and photo 3 shows area one year later.

Photo 1. MV-011F.JPG, 02-4-15 preconst

Photo 2. XS5-UStoDS2.JPG, 04-01 As-built

Photo 3. DSC01211.JPG,04-7-29 post const

Series 4. These photos show the area at the upper end of the S-curve just below the confluence with Willis Branch. Photo 1 shows preconstruction conditions, photo 2 shows entire area with both meanders and vanes, and photo 3 shows the upper meander and upper vane just below confluence.

Photo 1. MVC-009a.JPG, 02-04-15 trib

Photo 2. zTXS2-UStoDS.JPG, 04-01 As-built

Series 5. These photos show the area within the barn yard just upstream of Middle Fork Road. Photo 1 shows preconstruction conditions where livestock had access to the channel and photo 2 shows the same area after livestock were excluded and the channel defined using coir logs. The tape on XS-2MB is shown.

Photo 1. MVC-001a.JPG, 02-04-15 trib

Photo 2. zTXS5-DStoUS.JPG, 04-01 As-built

Series 6. These photos show the upstream most reach on McKinney Branch in the upper pasture. Photo 1 shows preconstruction conditions where livestock had access to the channel and photo 2 shows the same area after livestock were excluded and the right bank (left in the photo) has been lowered to develop a floodplain. The tape on XS-5MB is shown.

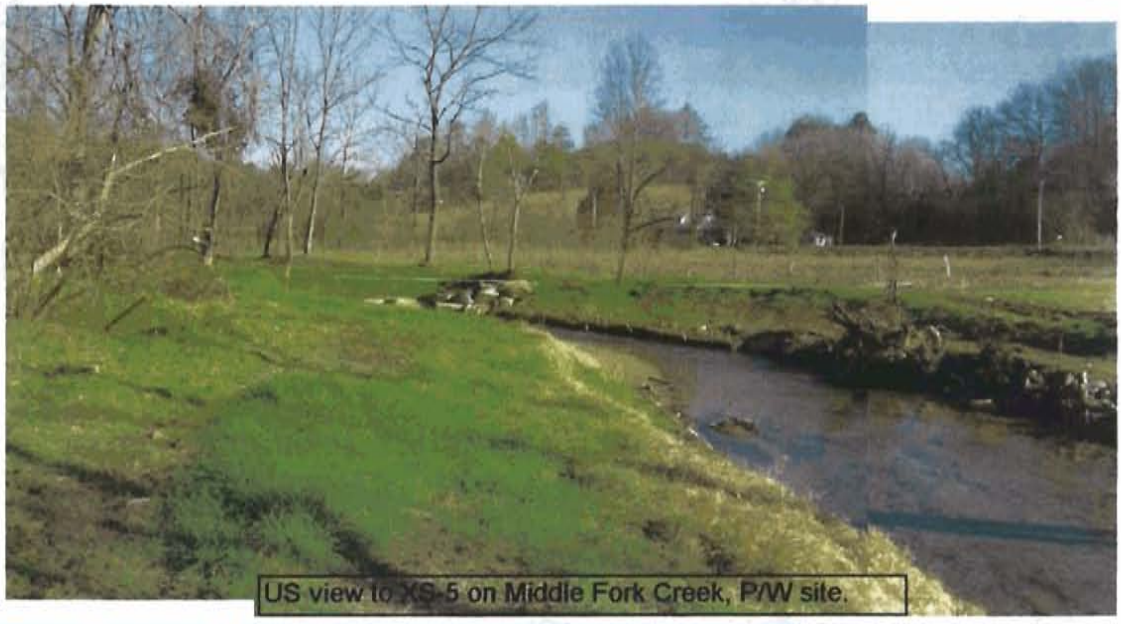
Appendix 6. The following series of panoramic photos show the various cross-sections and final morphology of the as-built channel. These photos were made by connecting 2 or 3 photos together. Individual photos indicate the orientation relative to stream flow and the cross-section being shown. Location of these photos can be determined by referencing the cross-section location map.

DS view to XS-2 on Middle Fork Creek, P/W site.

US view to XS-2 on Middle Fork Creek, P/W site.

DS view to XS-3 on Middle Fork Creek, P/W site.

DS view to XS-4 on Middle Fork Creek, P/W site.



US view to XS-5 on Middle Fork Creek, P/W site.

US view to XS-6 on Middle Fork Creek, P/W site.

DS view to XS-6 on Middle Fork Creek, P/W site.

US view to XS-7 on Middle Fork Creek, P/W site.

DS view to XS-7 on Middle Fork Creek, P/W site.

US view to XS-8 on Middle Fork Creek P/W site.

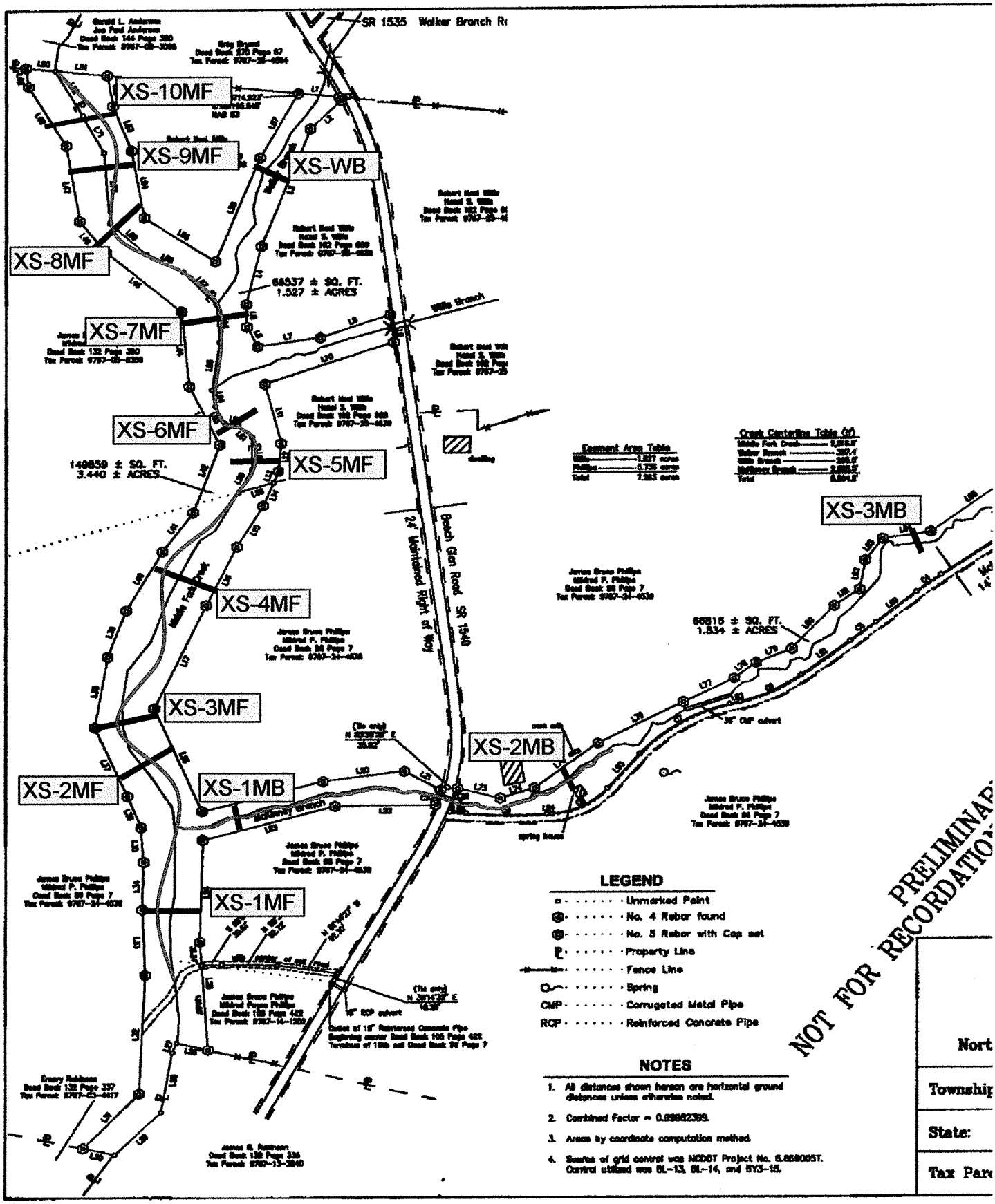
DS view to XS-8 on Middle Fork Creek, P/W site.

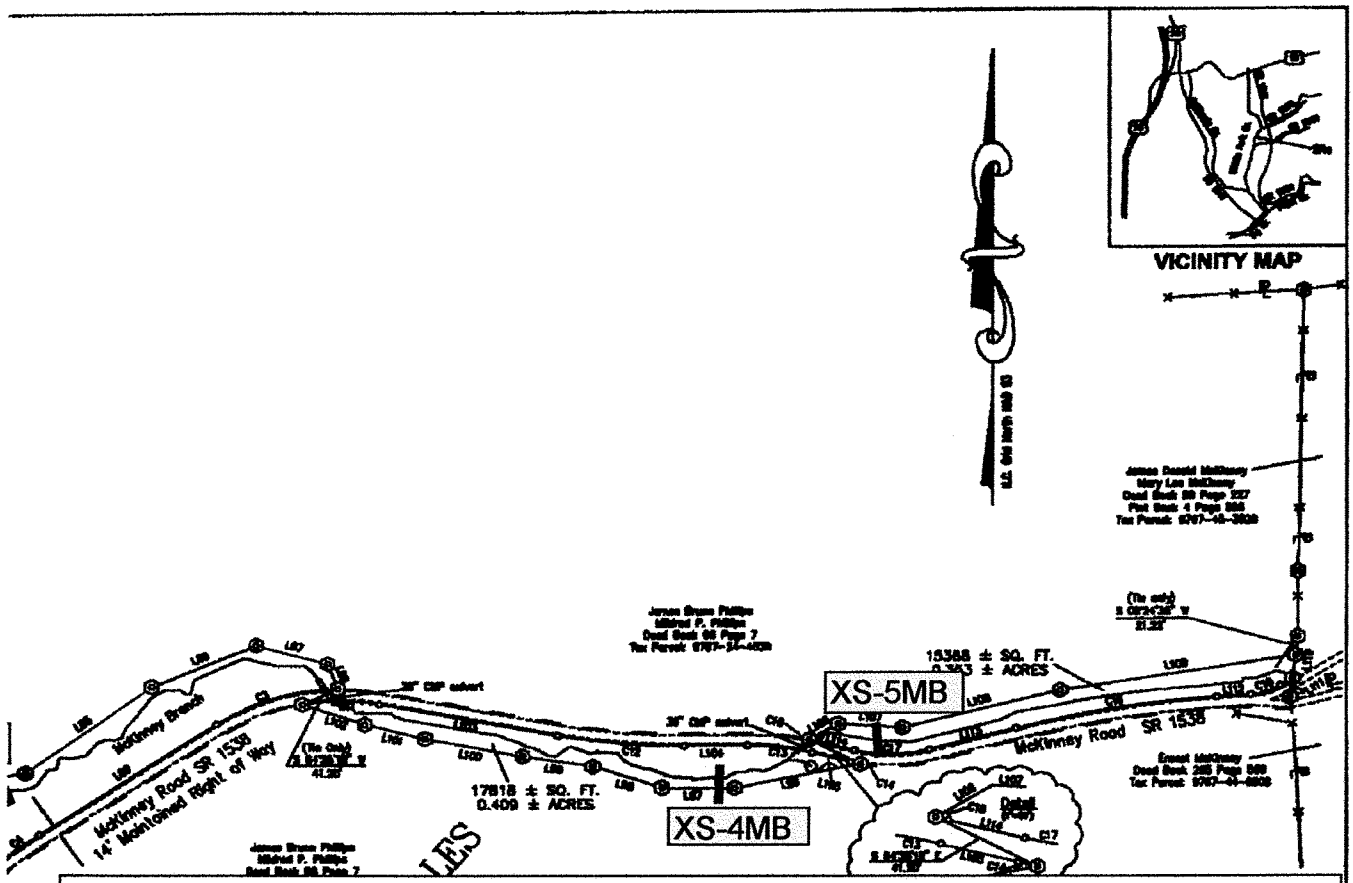
DS view to XS-9 on Middle Fork Creek, P/W site.

US view to XS-10 on Middle Fork Creek, P/W site.

DS view to XS-10 on Middle Fork Creek, P/W site.

Appendix 7


SR 1535 Walker Branch Rd
XS-10MF
XS-9MF
XS-WB
XS-8MF
XS-7MF
XS-6MF
XS-5MF
XS-4MF
XS-3MF
XS-2MF
XS-1MB
XS-1MF
XS-2MB
XS-3MB
66537 ± SQ. FT.
1.527 ± ACRES
149859 ± SQ. FT.
3.440 ± ACRES
66815 ± SQ. FT.
1.534 ± ACRES
Easement Area Table
Creek Centerline Table (ft)
24' Maintained Right of Way
Beech Glen Road SR 1540
Walker Branch
Middle Fork Creek
spring house
30" CMP culvert
18" RCP culvert
LEGEND
Unmarked Point
No. 4 Rebar found
No. 5 Rebar with Cap set
Property Line
Fence Line
Spring
CMP - Corrugated Metal Pipe
RCP - Reinforced Concrete Pipe
NOTES
1. All distances shown hereon are horizontal ground distances unless otherwise noted.
2. Combined Factor = 0.99982389.
3. Areas by coordinate computation method.
4. Source of grid control was NCDOT Project No. 8.6580057. Control utilized was BL-13, BL-14, and BY3-15.
PRELIMINARY
NOT FOR RECORDATION
Nort
Township
State:
Tax Par



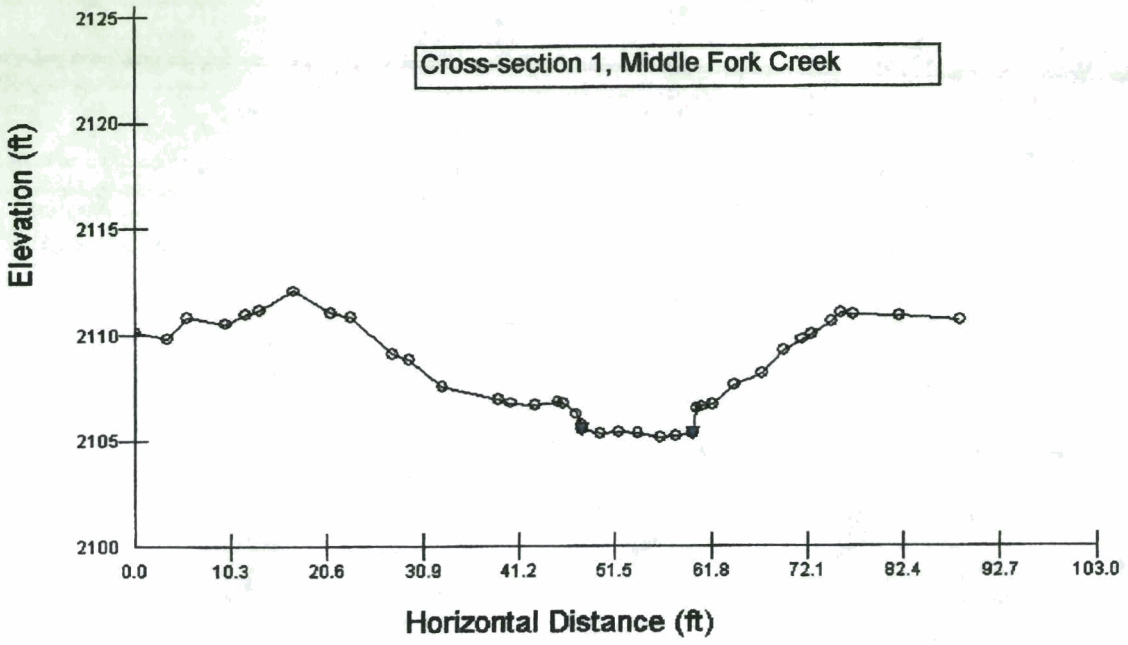
Cross-section and Longitudinal Profile Information

The location of cross-sections on Middle Fork Creek (MF), Walker Branch (WB), and the unnamed tributary we are calling McKinney Branch (MB), are shown. Blue segments indicate that reach of stream that was included in the longitudinal profile. Points along the survey line are referenced by the number of the survey line which that point begins. For example L18 is line 18 and begins and ends on surveyed points. We have referred to the first point on this line as MFC18 and the second point as MFC 19.

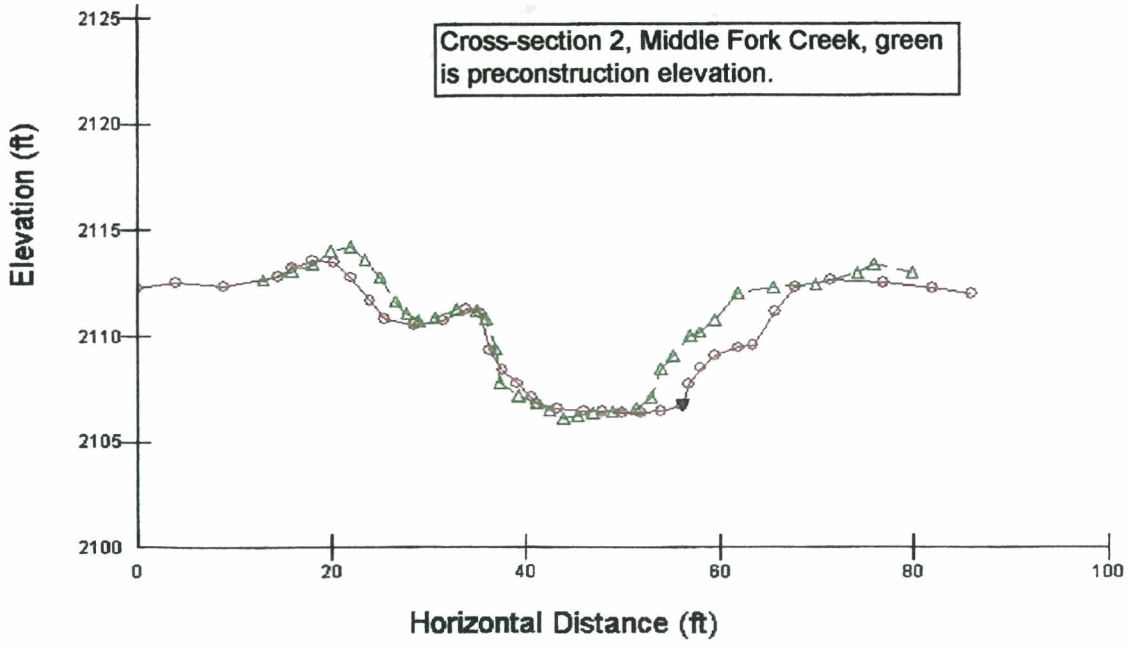
The following elevations are all based on a DOT supplied BM (2126.38) set on the DS, left side of the concrete head wall on Walker Branch. Elevations are for the top of the metal pin set in concrete (CMP) on each cross-section.

CMP elevation at XS-1MF = 2110.85
CMP elevation at XS-2MF = 2112.78
CMP elevation at XS-3MF = 2113.19
CMP elevation at XS-4MF = 2114.26
CMP elevation at XS-5MF = 2114.94
CMP elevation at XS-6MF = 2116.90
CMP elevation at XS-7MF = 2117.30
CMP elevation at XS-8MF = 2117.89
CMP elevation at XS-9MF = 2120.39
CMP elevation at XS-10MF = 2121.73

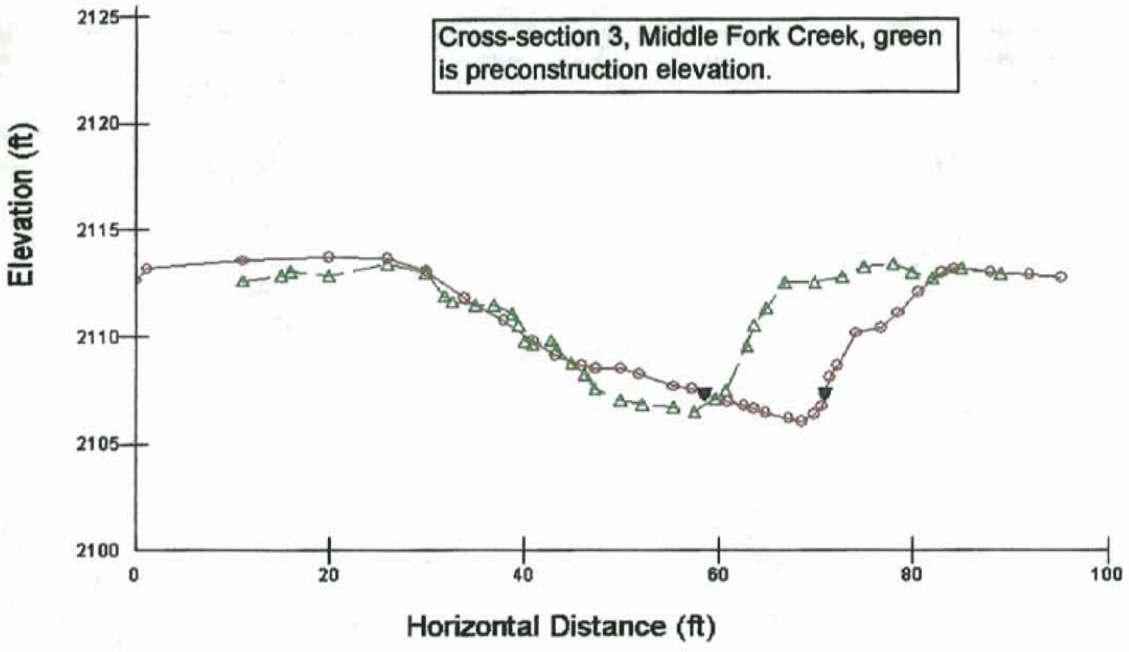
CMP elevation at XS-WB = 2119.83
CMP elevation at XS-1MB = 2113.52
CMP elevation at XS-2MB = 2131.92
CMP elevation at XS-3MB = 2162.77
CMP elevation at XS-4MB = 2203.66
CMP elevation at XS-5MB = 2211.62



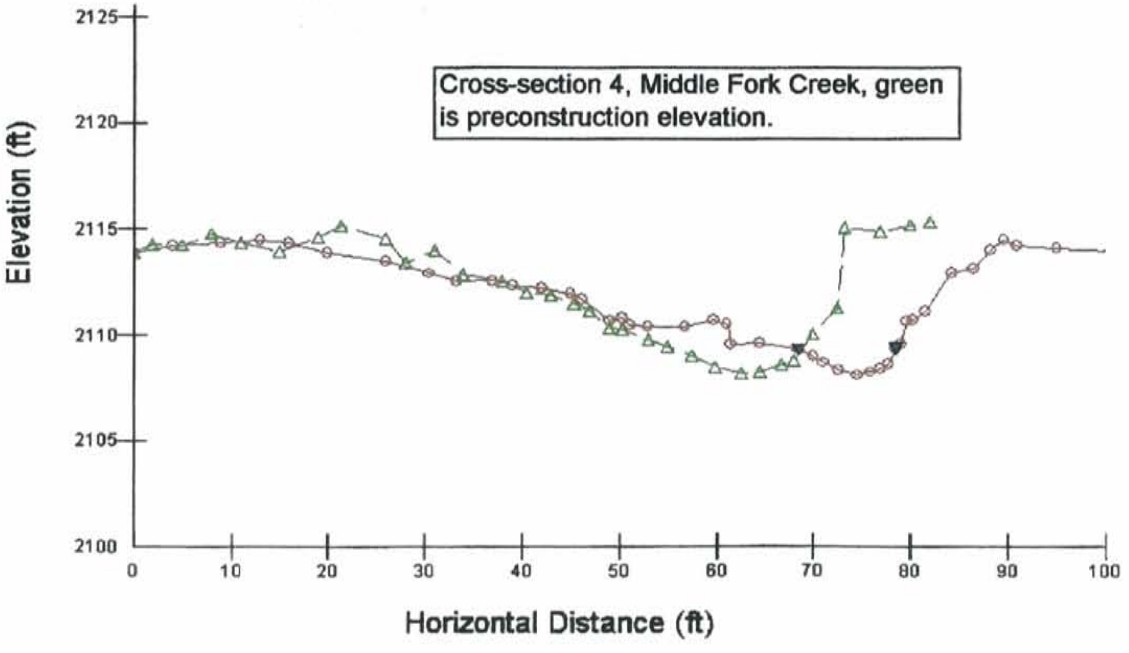
Cross-section 1, Middle Fork Creek; Location: is upstream of the ford, above the rootwads with LBpin is 43' US of MF25, RBpin is on easement line 1.26' US of MF34. XS crosses the LB rebar monument pin at station 16.5 and on the RB it crosses the concrete monument at station 77.05'.



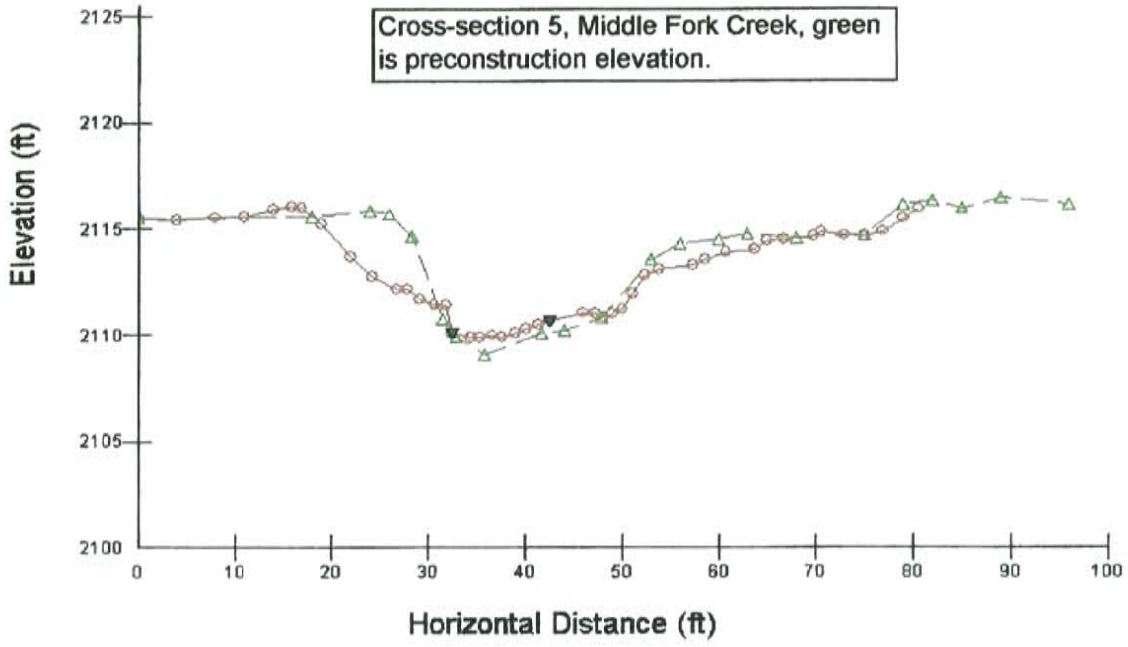
Cross-section 2, Middle Fork Creek, Location: is upstream of McKinney Branch, Both end pins are app. on easement line. LBpin is 82.6' DS of MF18, RBpin is 21.1' US of MF37. XS crosses LB rebar monument pin at station 18.02 and crosses RB concrete monument at station 70.68'.



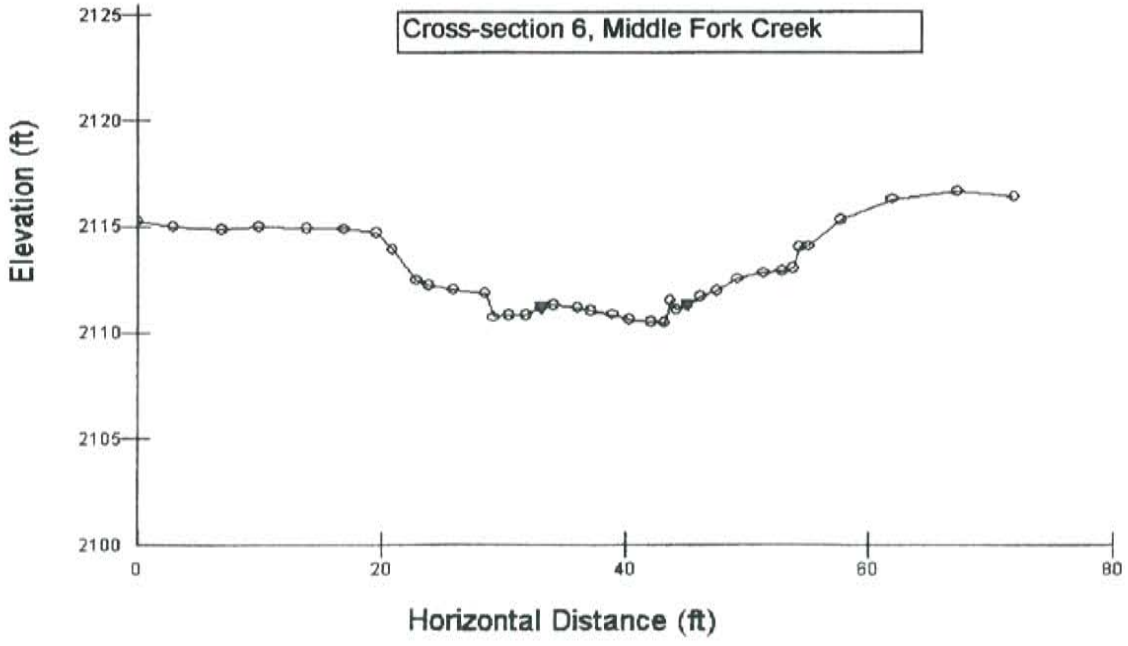
Cross-section 3, Middle Fork Creek, Location: is in meander upstream of McKinney Branch confluence. LBpin is 8.8' DS of MF18, RBpin is 10 inches US of MF38. XS crosses LB rebar monument pin at station 7.4' and crosses RB concrete monument at station 84.31'.



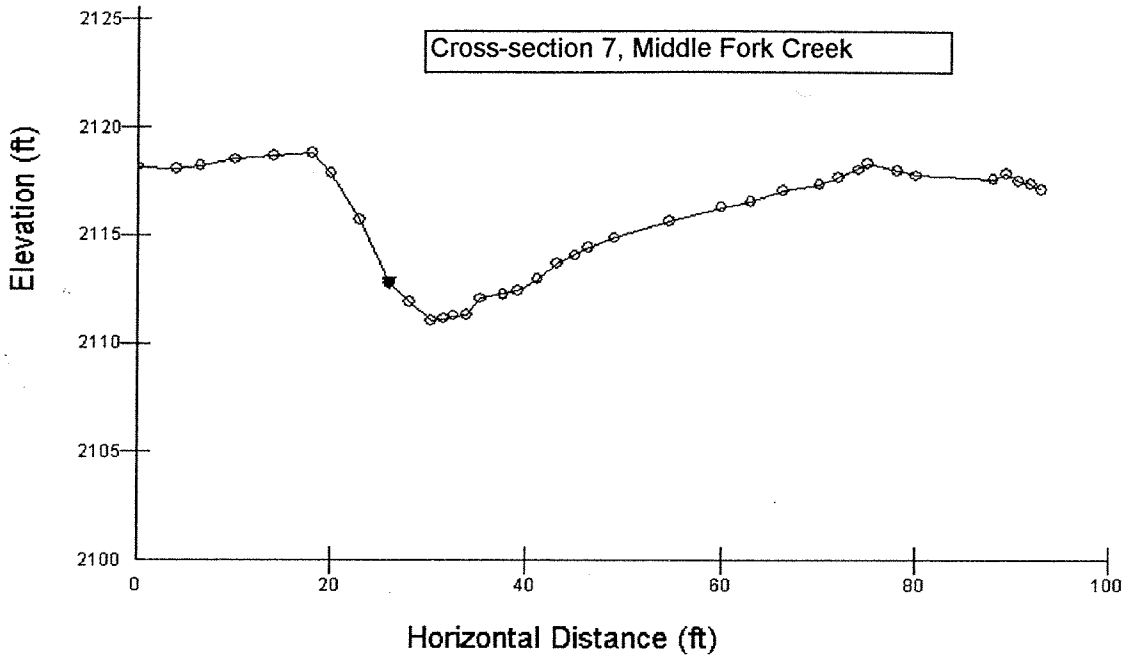
Cross-section 4, Middle Fork Creek, Location:on meander at the US end of the narrow part of the RB field. LBpin is 53' DS of MF16, RBpin is 17' DS of MF41. XS crosses LB rebar monument pin at station 18' and crosses RB concrete monument at station 91.6'.



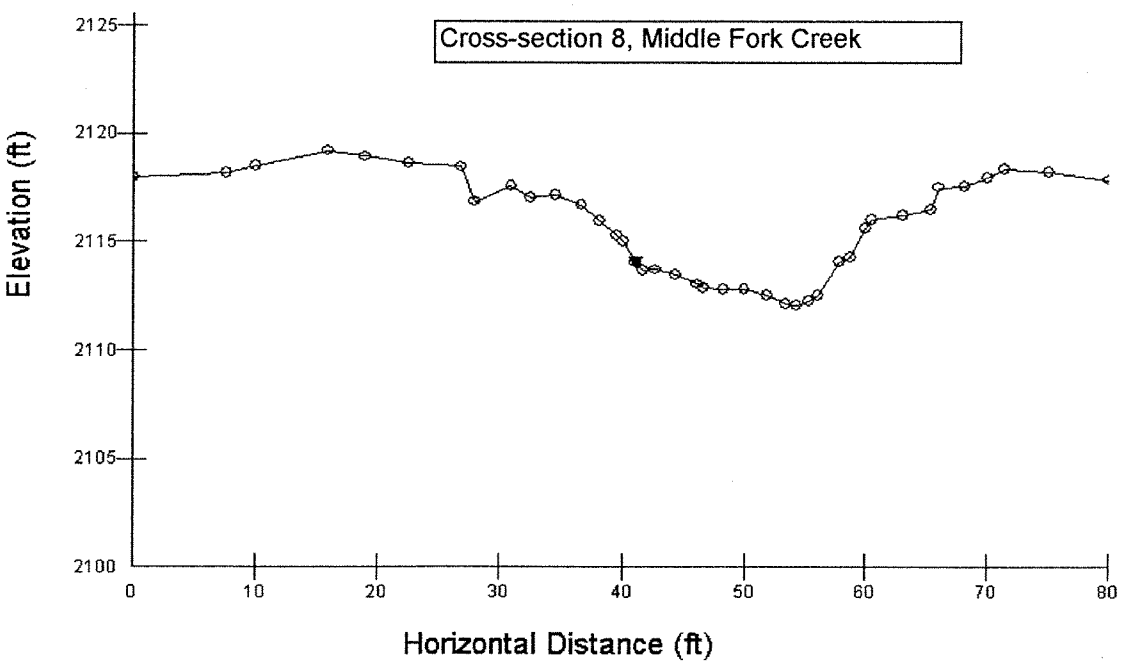
Cross-section 5, Middle Fork Creek, Location: on lower meander of S curve just above where two properties meet. LBpin is 6.6' US of MF13, RBpin is 1.2' stream side of a walnut tree. XS crosses LB rebar monument pin at station 16.05' and crosses RB concrete monument at station 67.5'. Line ends 33.5' short of the easement line due to walnut tree.



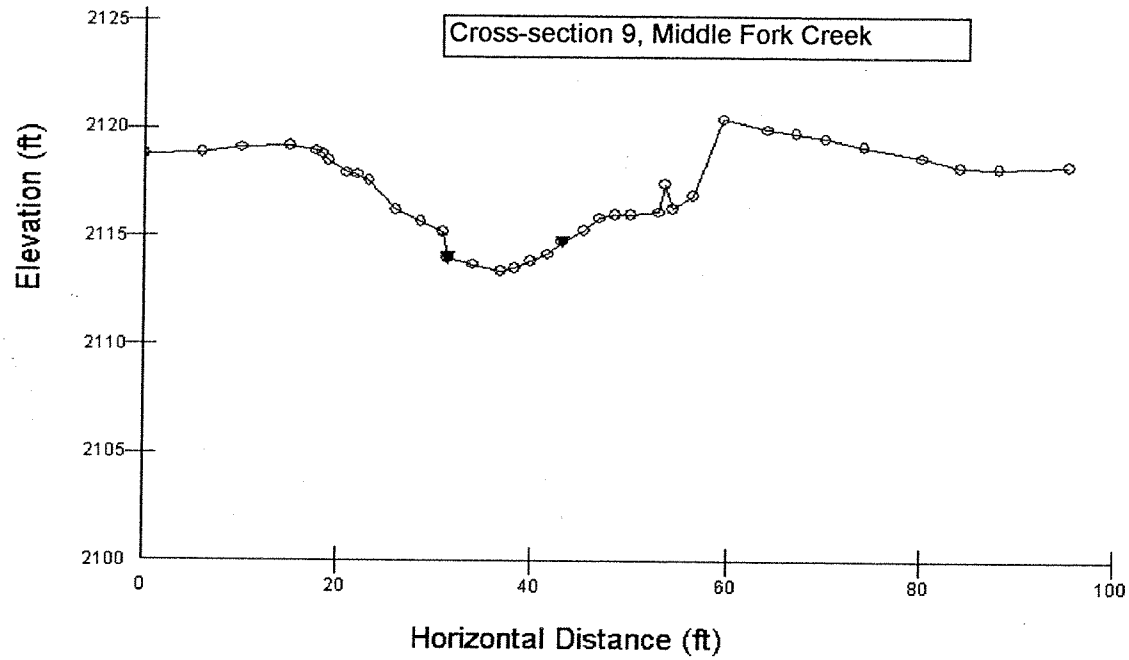
Cross-section 6, Middle Fork Creek, Location: on riffle between meanders of S curve. LBpin is streamside of 3 walnut trees and 2.73' from closest walnut. XS crosses LB rebar monument pin at station 0.5' and crosses RB concrete monument at station 65.37'. Line begins 33.0' short of the LB easement line due to walnut trees.



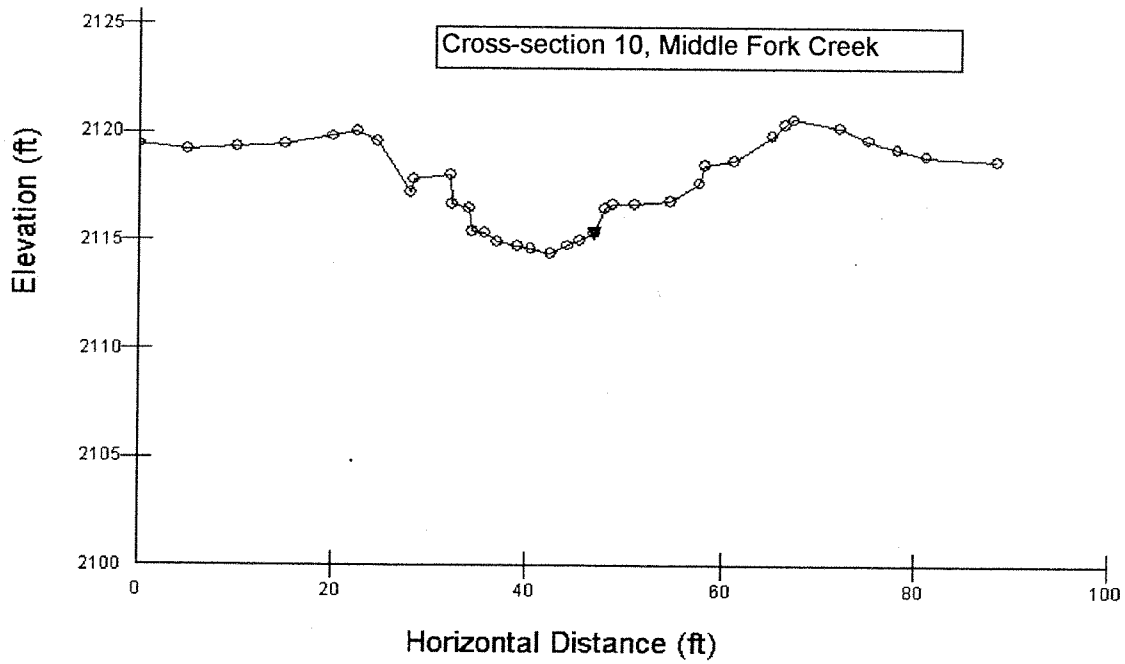
Cross-section 7, Middle Fork Creek, Location:on meander at the confluence of Walker Branch. LBpin is 11.2' DS of MF5, RBpin is 11.6' DS of MF45. XS crosses LB rebar monument pin at station 10.1' and crosses RB concrete monument at station 67.17'.



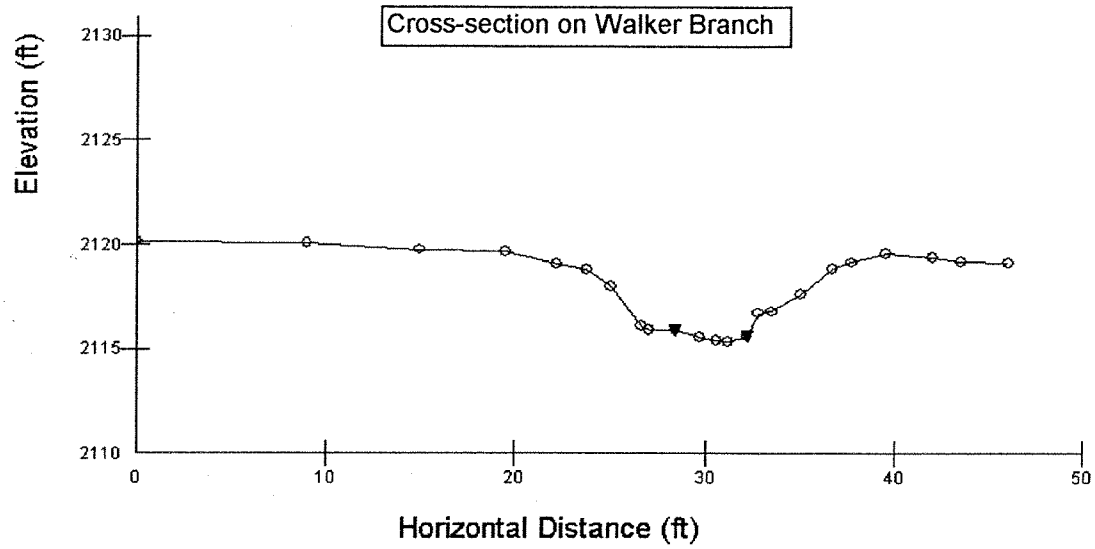
Cross-section 8, Middle Fork Creek, Location:on meander at the bamboo covered point along the upper LB field. LBpin is 11.6' US of MF55, RBpin is 14.8' US of MF46. XS crosses LB rebar monument pin at station 15.8' and crosses RB concrete monument at station 68.53'.



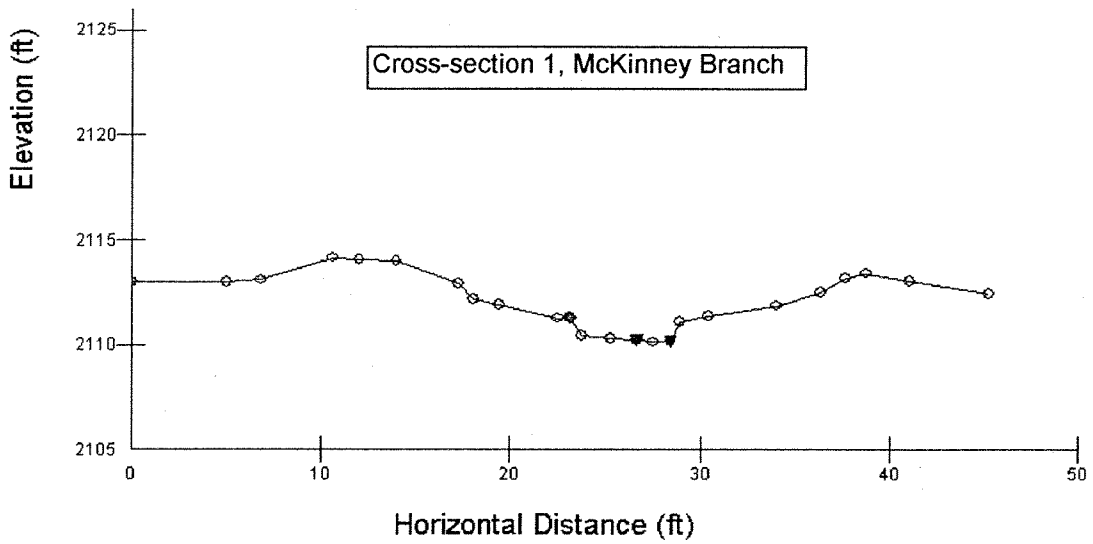
Cross-section 9, Middle Fork Creek, Location:at upper end of project at point of second vane LBpin is 13.6' DS of MF54, RBpin is 24.8' DS of MF48. XS crosses LB rebar monument pin at station 15.07' and crosses RB concrete monument at station 60.72'.



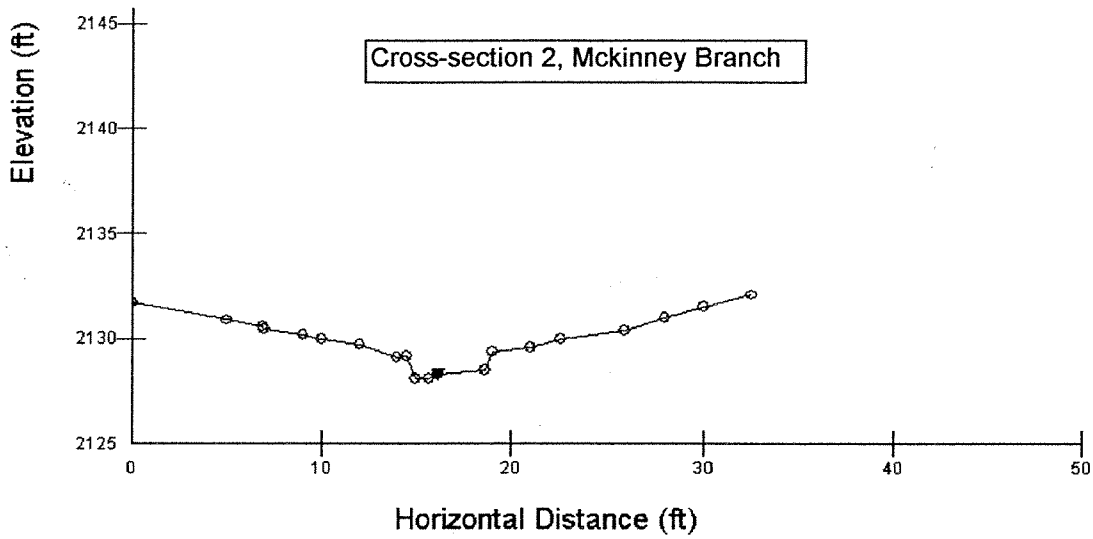
Cross-section 10, Middle Fork Creek, Location: at upper end of project across first vane. LBpin is 5.4' DS of MF53, RBpin is 20.9' US of MF48. XS crosses LB rebar monument pin at station 22.45' and crosses RB concrete monument at station 69.58'.



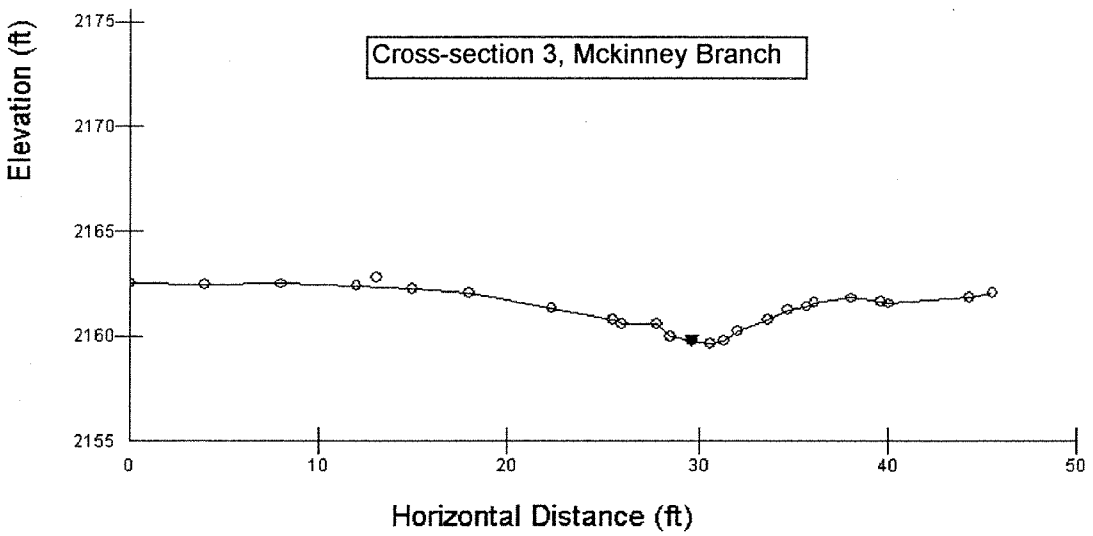
Cross-section on Walker Branch located in the middle of the upper field at repair site. LBpin is 97.6' DS of MF3, RBpin is 25.3' DS of MF57. XS crosses the LB rebar monument pin at station 10' and on the RB it crosses the concrete monument at station 43.5'.



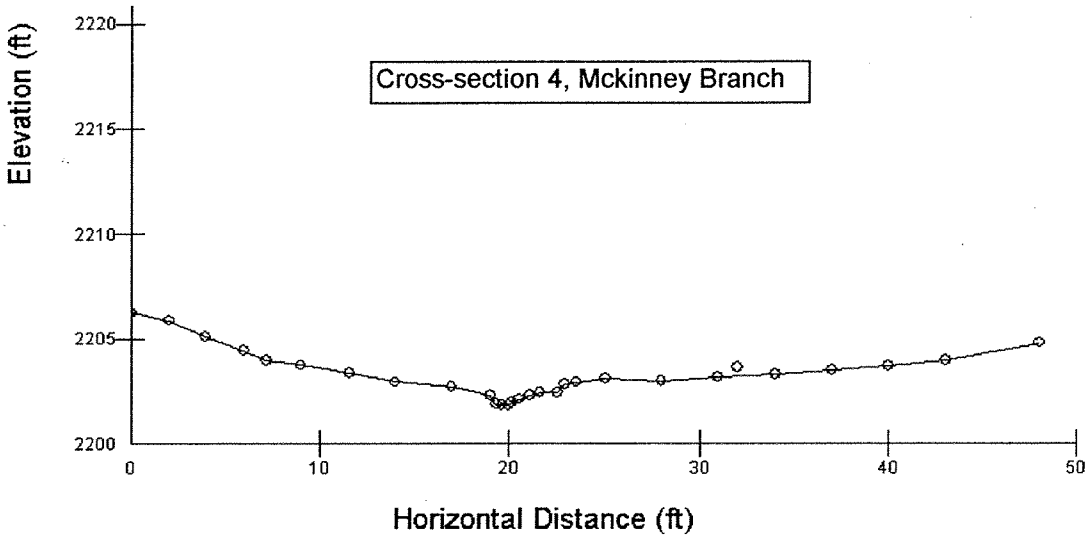
Cross-section 1, McKinney Branch; Location: is just upstream of the confluence. LBpin is 86.4' US of MF24, RBpin is on easement line 75.9' US of MF19. XS crosses the LB rebar monument pin at station 11.93 and on the RB it crosses the concrete monument at station 39.15'.



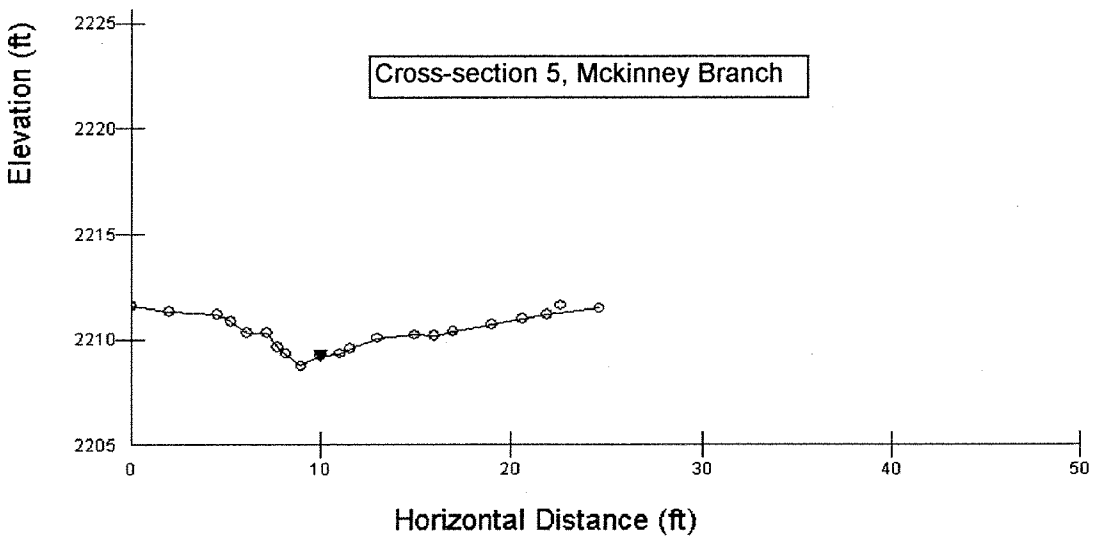
Cross-section 2, McKinney Branch; Location: In the Barn Yard, 4.8' from corner of spring house. RBpin is on fence line 46.2' US of MKB75. XS crosses the LB concrete monument at station 3.0' and on the RB it crosses rebar monument pin at station 21.7'.



Cross-section 3, McKinney Branch; Location: In the Apple Tree Field just upstream of big meander. RBpin is on fence line 41.2' DS of MKB85. XS crosses the LB concrete monument at station 13.1' and on the RB it crosses rebar monument pin at station 40.8'.

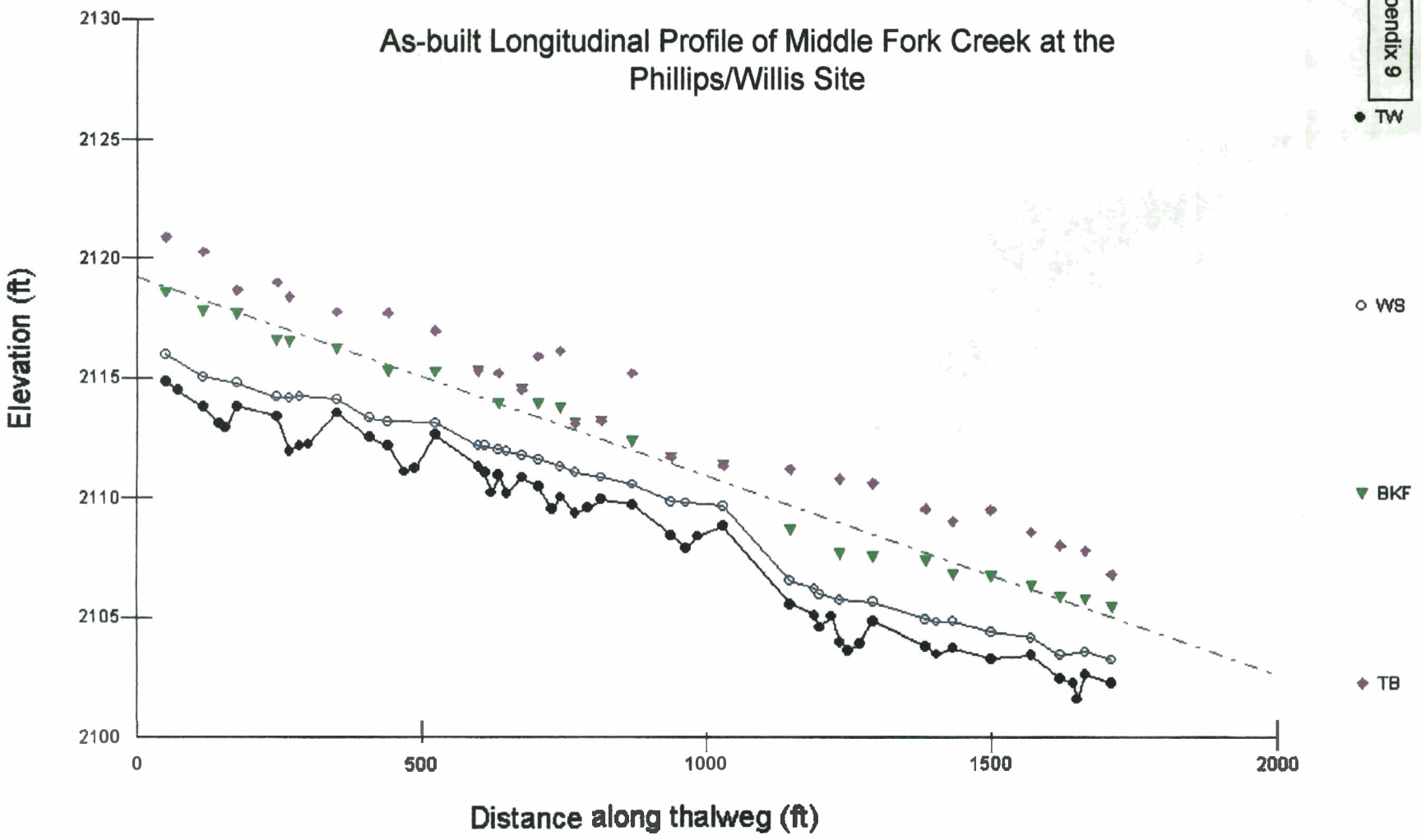


Cross-section 4, McKinney Branch; Location: In the second field from the top on left side of rode. LBpin is on fence line 87.5' US of MKB98. LB rebar monument pin at station 9.3' and on the RB it crosses the concrete monument at station 32'.

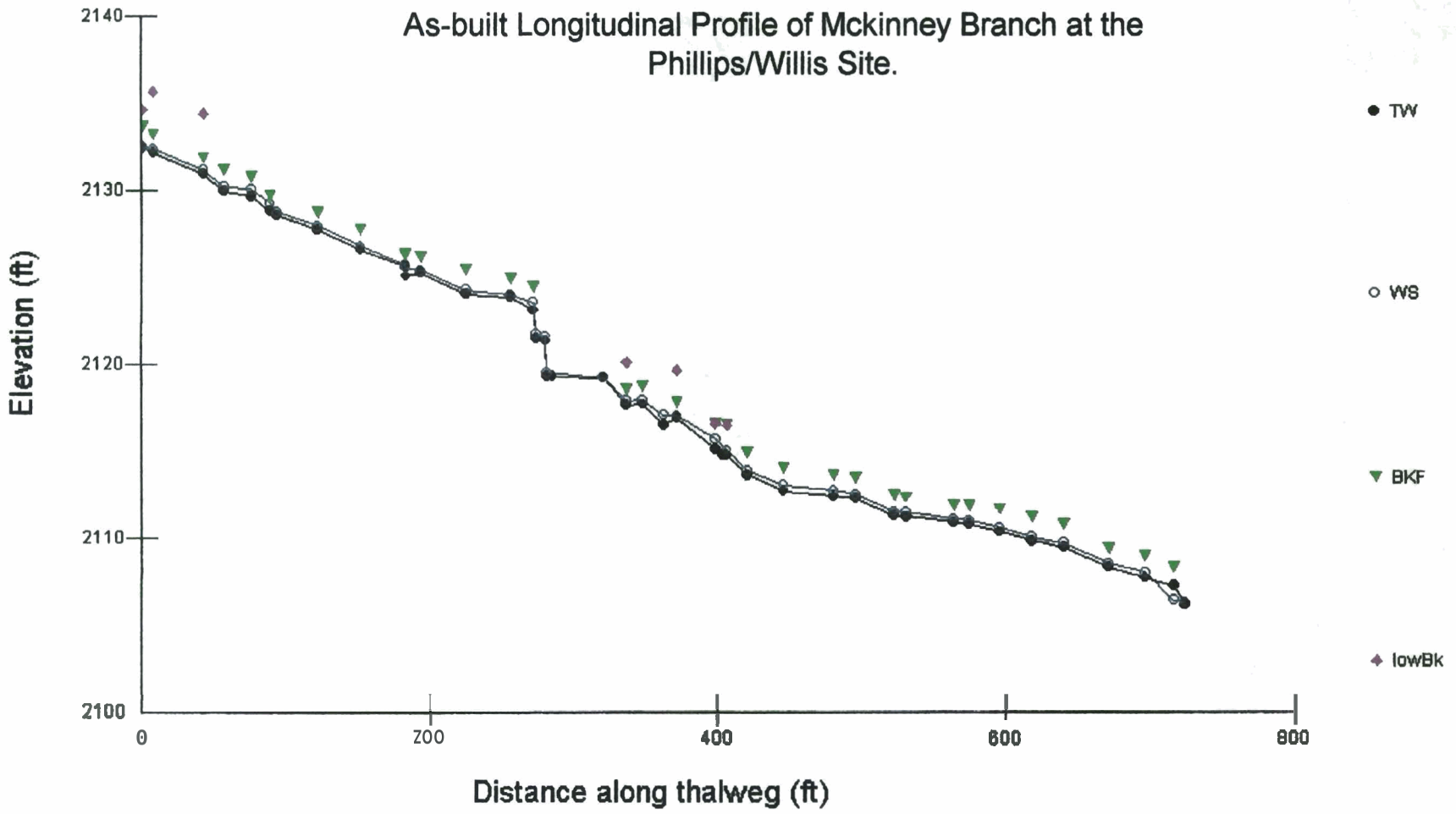


Cross-section 5, McKinney Branch; Location: In the upper field, just upstream of culvert. RBpin is on fence line, 17.3' DS of MKB108. LB rebar monument pin at station 3.4' and on the RB it crosses the concrete monument at station 22.6'.

Appendix 9



The longitudinal profile shows elevations for this reference reach, which starts on or near the property line at the base of a large sycamore tree and runs downstream to the upper side of the ford. The site is shown in blue on the map of cross-sections and profiles.



The longitudinal profile shows elevations for this reference reach, which starts in the upper barn yard area and runs downstream to the confluence with Middle Fork. The site is shown in blue on the map of cross-sections and profiles.

Appendix 9

Appendix 10. The following data and figures show bedload data collected on Middle Fork Creek and McKinney Branch. This is not as-built data but data collected prior to the project. Bedload data was not collected when the as-built data was collected because it would reflect construction impacts and not bedload sorting due to the improved morphology. Monitoring data collected in the future should be compared to this bedload data for assessment of project benefits.

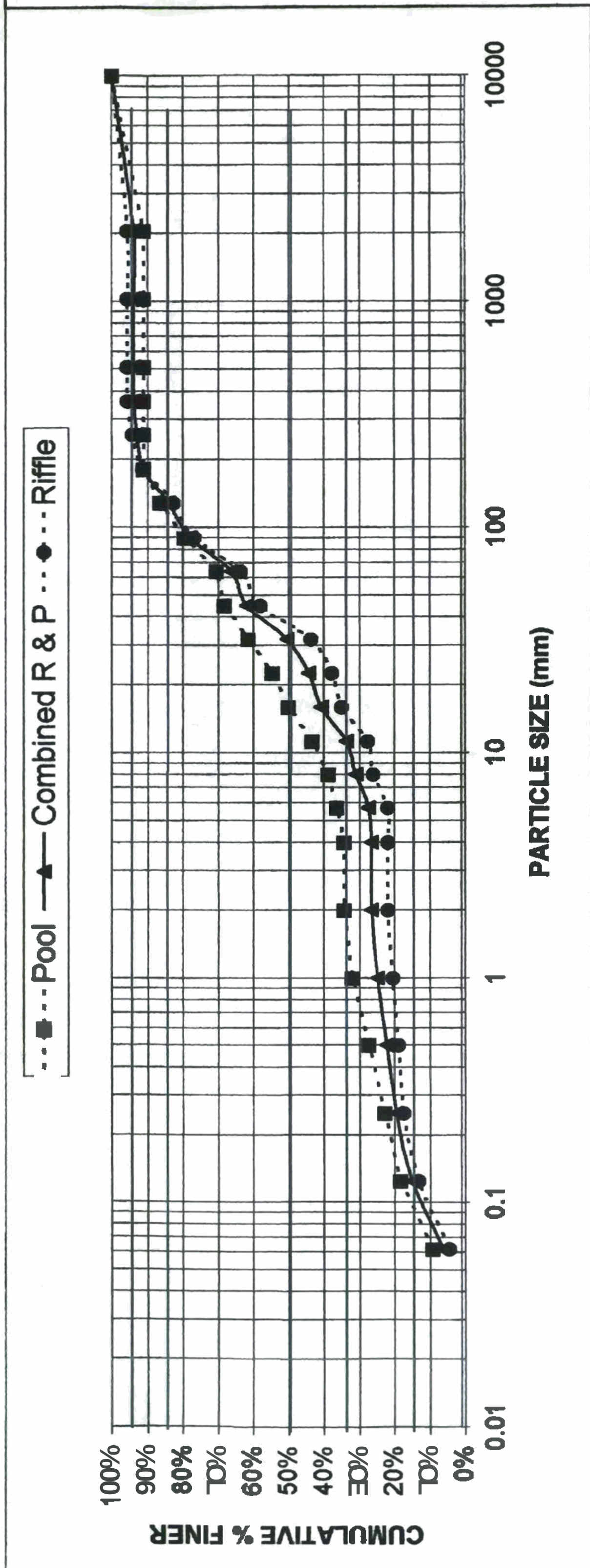
Appendix 10

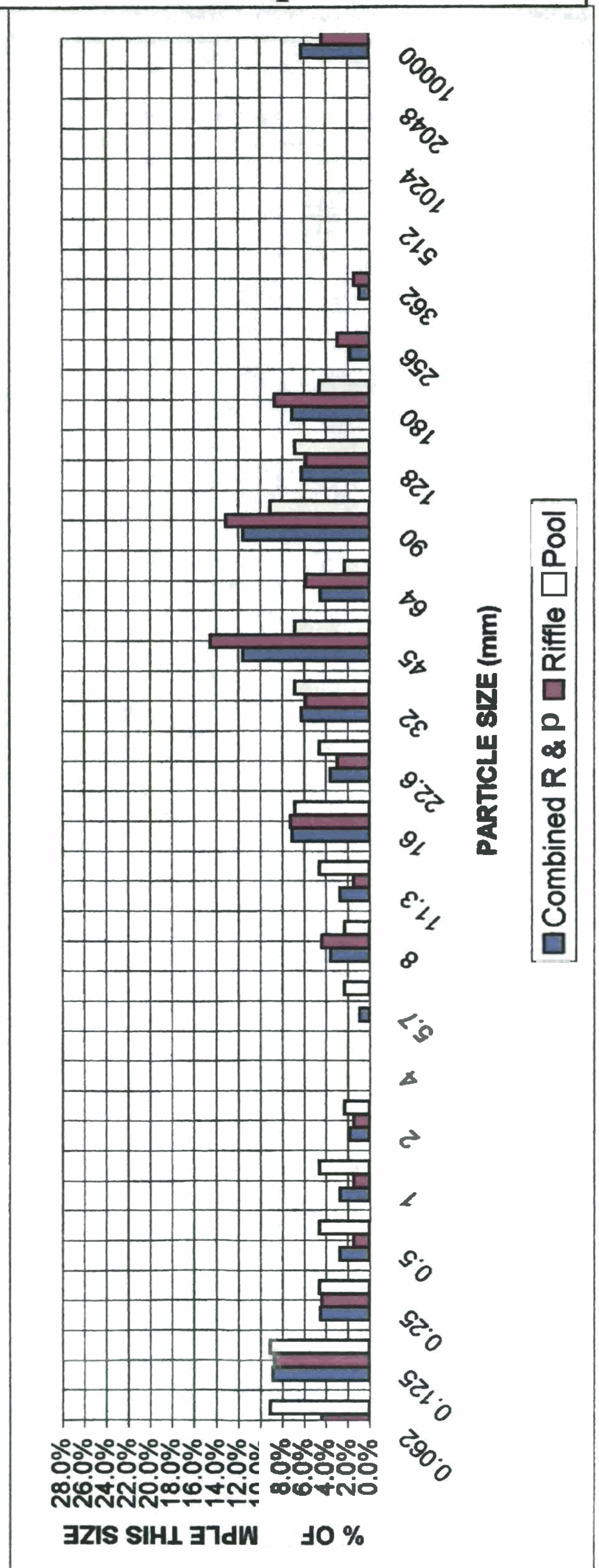
Pebble Count Information for the Phillips/Willis Site, Middle Fork Creek

PEBBLE COUNT								PEBBLE COUNT			PEBBLE COUNT		
Site:	Middle Fork Creek - Phillips site				Date:								
Party:	MMC & ABB				Reach: Combined R & P			Reach: Riffle			Reach: Pool		
PARTICLE	MILLIMETER			PARTICLE COUNT	TOT #	ITEM %	% CUM	TOT #	ITEM %	% CUM	TOT #	ITEM %	% CUM
Silt/Clay	< .062	0.062	S/C		7	6.2%	6%	3	4%	4%	4	9%	9%
Very Fine	.062 - .125	0.125	S		10	8.8%	15%	6	9%	13%	4	9%	18%
Fine	.125 - .25	0.25	A		5	4.4%	19%	3	4%	17%	2	5%	23%
Medium	.25 - .50	0.5	N		3	2.7%	22%	1	1%	19%	2	5%	27%
Coarse	.50 - 1.0	1	D		3	2.7%	25%	1	1%	20%	2	5%	32%
Very Coarse	1 - 2	2	S		2	1.8%	27%	1	1%	22%	1	2%	34%
Very Fine	2 - 4	4			0	0.0%	27%	0	0%	22%	0	0%	34%
Fine	4 - 5.7	5.7	G		1	0.9%	27%	0	0%	22%	1	2%	36%
Fine	5.7 - 8	8	R		4	3.5%	31%	3	4%	26%	1	2%	39%
Medium	8 - 11.3	11.3	A		3	2.7%	34%	1	1%	28%	2	5%	43%
Medium	11.3 - 16	16	V		8	7.1%	41%	5	7%	35%	3	7%	50%
Coarse	16 - 22.6	22.6	E		4	3.5%	44%	2	3%	38%	2	5%	55%
Coarse	22.6 - 32	32	L		7	6.2%	50%	4	6%	43%	3	7%	61%
Very Coarse	32 - 45	45	S		13	11.5%	62%	10	14%	58%	3	7%	68%
Very Coarse	45 - 64	64			5	4.4%	66%	4	6%	64%	1	2%	70%
Small	64 - 90	90	C		13	11.5%	78%	9	13%	77%	4	9%	80%
Small	90 - 128	128	O		7	6.2%	84%	4	6%	83%	3	7%	86%
Large	128 - 180	180	B		8	7.1%	91%	6	9%	91%	2	5%	91%
Large	180 - 256	256	L		2	1.8%	93%	2	3%	94%	0	0%	91%
Small	256 - 362	362	B		1	0.9%	94%	1	1%	96%	0	0%	91%
Small	362 - 512	512	L		0	0.0%	94%	0	0%	96%	0	0%	91%
Medium	512-1024	1024	D		0	0.0%	94%	0	0%	96%	0	0%	91%
Lrg-Vry Lrg	1024 - 2048	2048	R		0	0.0%	94%	0	0%	96%	0	0%	91%
Bedrock		10000	BEDROCK		7	6.2%	100%	3	4%	100%	4	9%	100%
				TOTALS:	113			69			44		

Appendix 10

Pebble Count Information for the Phillips/Willis Site



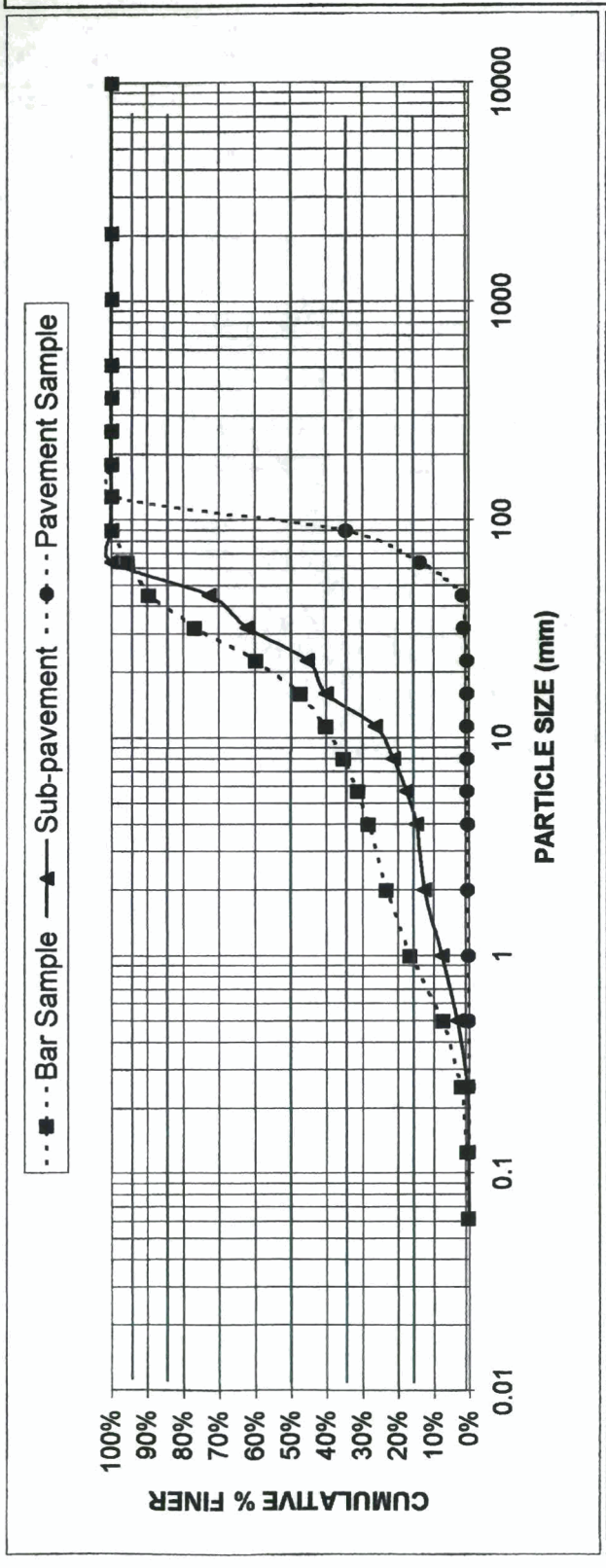


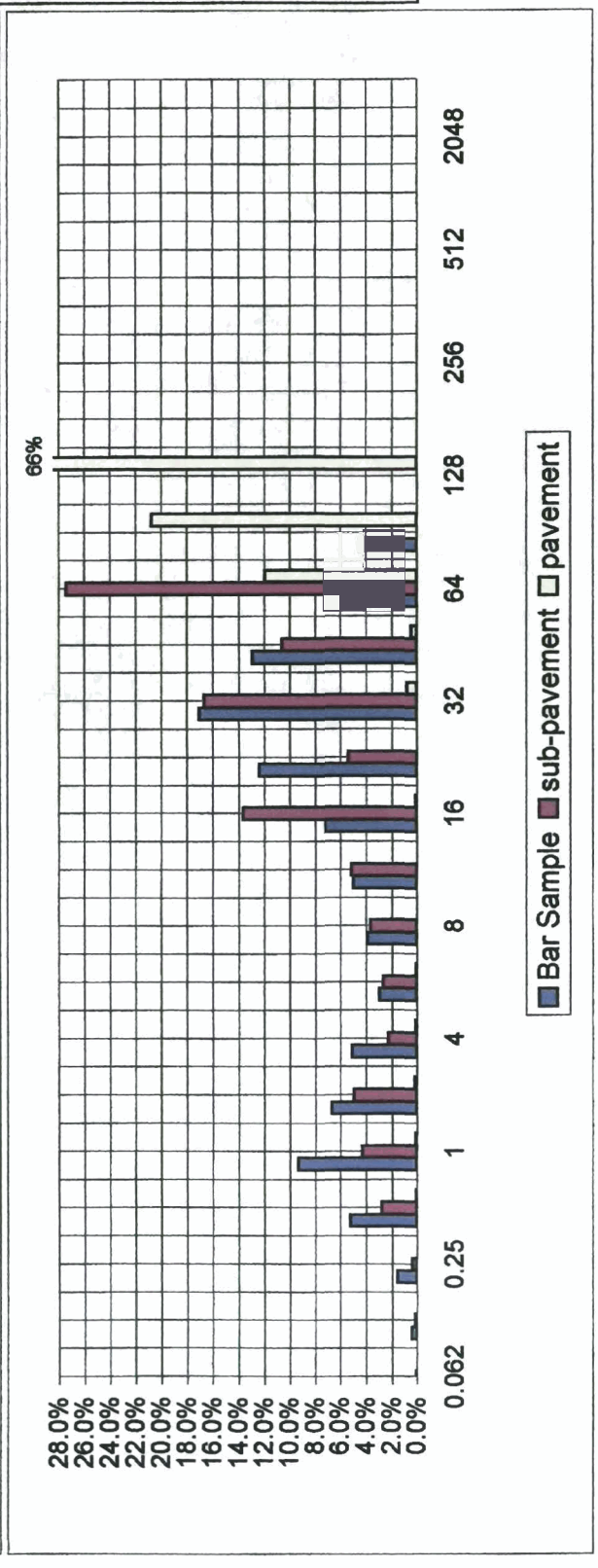
BAR AND PAVEMENT SAMPLE INFORMATION FOR MIDDLE FORK CREEK

					Bar Sample			Sub-pavement			Pavement Sample		
Site:	Middle Fork Creek - Phillips site				Largest Particle: 105 mm			Largest Particle: 105 mm			Largest Particle: 125 mm		
Party:					Reach:			Reach: Riffle			Reach: Riffle		
PARTICLE	MILLIMETER			PARTICLE COUNT	TOT #	ITEM %	% CUM	TOT #	ITEM %	% CUM	TOT #	ITEM %	% CUM
Silt/Clay	< .062	0.062	S/C		17	0.1%	0%	6.5	0%	0%		0%	0%
Very Fine	.062 - .125	0.125	S		46	0.4%	1%	14.5	0%	0%		0%	0%
Fine	.125 - .25	0.25	A		189	1.5%	2%	37.5	0%	1%	0.5	0%	0%
Medium	.25 - .50	0.5	N		638	5.2%	7%	294.5	3%	3%	1.5	0%	0%
Coarse	.50 - 1.0	1	D		1142.5	9.3%	17%	454.5	4%	8%	4.5	0%	0%
Very Coarse	1 - 2	2	S		810.5	6.6%	23%	518	5%	13%	7	0%	0%
Very Fine	2 - 4	4			624	5.1%	28%	243.5	2%	15%	5	0%	0%
Fine	4 - 5.7	5.7	G		365.5	3.0%	31%	282	3%	18%	2	0%	0%
Fine	5.7 - 8	8	R		479	3.9%	35%	386	4%	21%	1	0%	1%
Medium	8 - 11.3	11.3	A		609	5.0%	40%	541.5	5%	26%	0	0%	1%
Medium	11.3 - 16	16	V		880.5	7.2%	47%	1439	14%	40%	4	0%	1%
Coarse	16 - 22.6	22.6	E		1520	12.4%	60%	565	5%	45%	0	0%	1%
Coarse	22.6 - 32	32	L		2093.5	17.0%	77%	1758.5	17%	62%	33.5	1%	1%
Very Coarse	32 - 45	45	S		1582.5	12.9%	90%	1117	11%	73%	18	0%	2%
Very Coarse	45 - 64	64			730	5.9%	96%	2889	27%	100%	511	12%	14%
Small	64 - 90	90	C		552.5	4.5%	100%		0%	100%	887.5	21%	34%
Small	90 - 128	128	O			0.0%	100%		0%	100%	2804.5	66%	100%
Large	128 - 180	180	B			0.0%	100%		0%	100%		0%	100%
Large	180 - 256	256	L			0.0%	100%		0%	100%		0%	100%
Small	256 - 362	362	B			0.0%	100%		0%	100%		0%	100%
Small	362 - 512	512	L			0.0%	100%		0%	100%		0%	100%
Medium	512-1024	1024	D			0.0%	100%		0%	100%		0%	100%
Lrg-Vry Lrg	1024 - 2048	2048	R			0.0%	100%		0%	100%		0%	100%
Bedrock		10000	EDROCK			0.0%	100%		0%	100%		0%	100%
				TOTALS:	12279.5			10547			4280		

BAR & PAVEMENT INFORMATION FOR MIDDLE FORK CREEK

Appendix 10



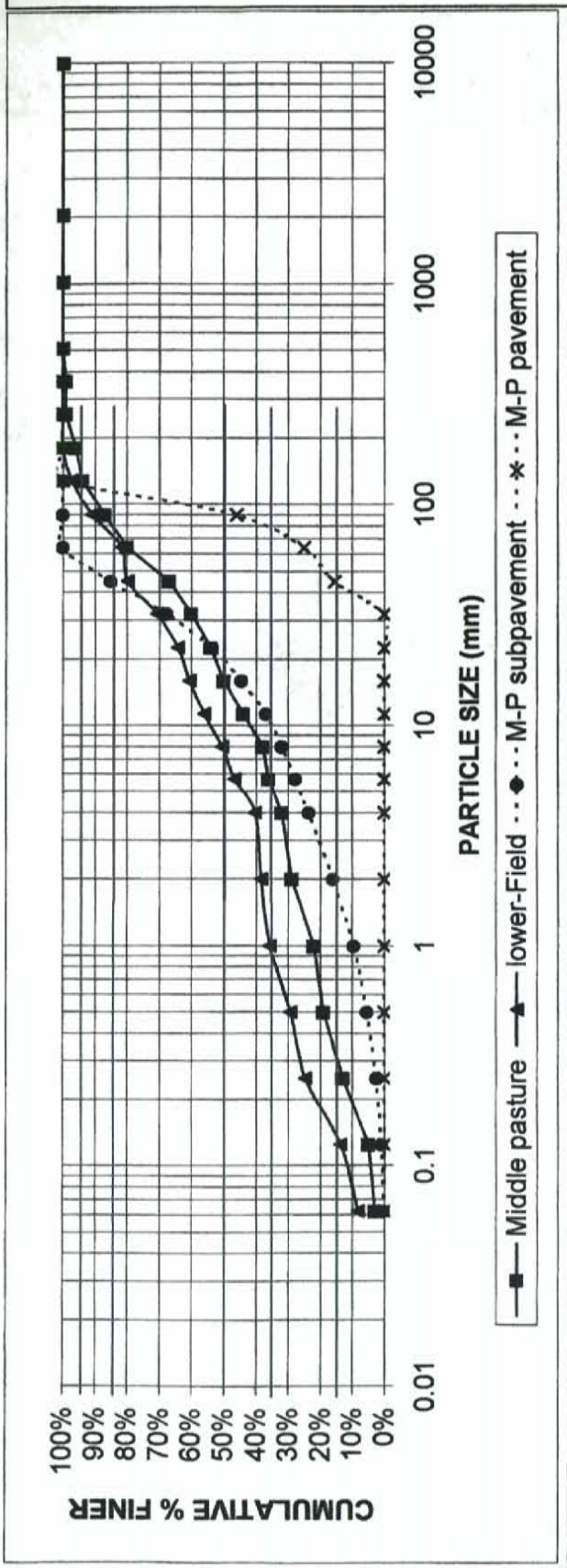


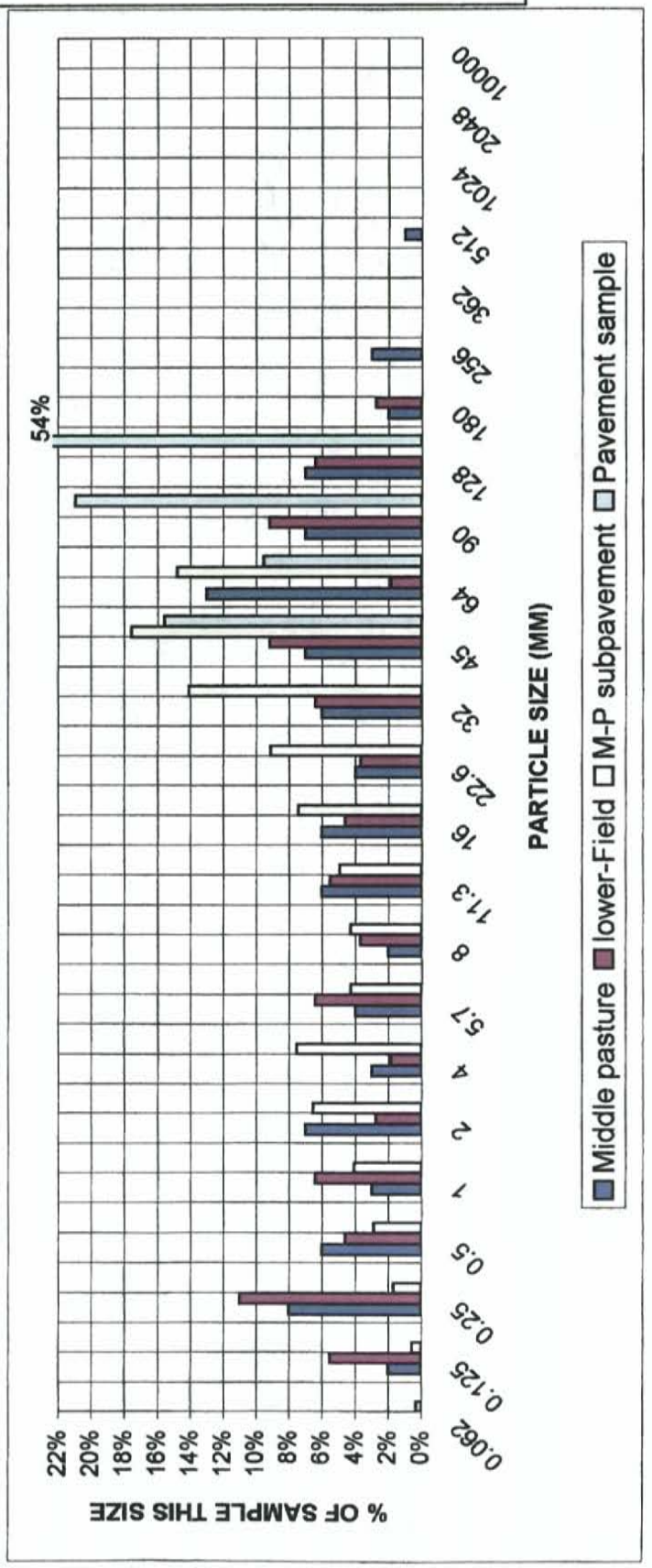
BEDLOAD INFORMATION FOR McKINNEY BRANCH

				PEBBLE COUNT			PEBBLE COUNT			Pavement sample			Subpavement sample		
Site:	Phillips/Willis Site Tributary			Date:											
Party:	ABB			Reach: lower-Field			Reach: Middle pasture			Reach: M-P pavement			Reach: M-P subpavement		
PARTICLE	MILLIMETER			TOT #	ITEM %	% CUM	TOT #	ITEM %	% CUM	TOT #	ITEM %	% CUM	TOT #	ITEM %	% CUM
Silt/Clay	< .062	0.062	S/C	9	8.3%	8%	3	3%	3%		0%	0%	18	0%	0%
Very Fine	.062 - .125	0.125	S	6	5.5%	14%	2	2%	5%		0%	0%	32.5	1%	1%
Fine	.125 - .25	0.25	A	12	11.0%	25%	8	8%	13%		0%	0%	94.5	2%	3%
Medium	.25 - .50	0.5	N	5	4.6%	29%	6	6%	19%		0%	0%	163.5	3%	5%
Coarse	.50 - 1.0	1	D	7	6.4%	36%	3	3%	22%		0%	0%	231.5	4%	9%
Very Coarse	1 - 2	2	S	3	2.8%	39%	7	7%	29%		0%	0%	372.5	7%	16%
Very Fine	2 - 4	4		2	1.8%	40%	3	3%	32%		0%	0%	429.5	8%	24%
Fine	4 - 5.7	5.7	G	7	6.4%	47%	4	4%	36%		0%	0%	243.5	4%	28%
Fine	5.7 - 8	8	R	4	3.7%	50%	2	2%	38%		0%	0%	242.5	4%	32%
Medium	8 - 11.3	11.3	A	6	5.5%	56%	6	6%	44%		0%	0%	281.5	5%	37%
Medium	11.3 - 16	16	V	5	4.6%	61%	6	6%	50%		0%	0%	423.5	7%	45%
Coarse	16 - 22.6	22.6	E	4	3.7%	64%	4	4%	54%		0%	0%	518.5	9%	54%
Coarse	22.6 - 32	32	L	7	6.4%	71%	6	6%	60%		0%	0%	800	14%	68%
Very Coarse	32 - 45	45	S	10	9.2%	80%	7	7%	67%	439	16%	16%	997.5	18%	85%
Very Coarse	45 - 64	64		2	1.8%	82%	13	13%	80%	269	10%	25%	840	15%	100%
Small	64 - 90	90	C	10	9.2%	91%	7	7%	87%	591	21%	46%		0%	100%
Small	90 - 128	128	O	7	6.4%	97%	7	7%	94%	1522.5	54%	100%		0%	100%
Large	128 - 180	180	B	3	2.8%	100%	2	2%	96%		0%	100%		0%	100%
Large	180 - 256	256	L		0.0%	100%	3	3%	99%		0%	100%		0%	100%
Small	256 - 362	362	B		0.0%	100%		0%	99%		0%	100%		0%	100%
Small	362 - 512	512	L		0.0%	100%	1	1%	100%		0%	100%		0%	100%
Medium	512-1024	1024	D		0.0%	100%		0%	100%		0%	100%		0%	100%
Lrg-Vry Lrg	1024 - 2048	2048	R		0.0%	100%		0%	100%		0%	100%		0%	100%
Bedrock		10000	BEDROCK		0.0%	100%		0%	100%		0%	100%		0%	100%
				109			100			2821.5			5689		

Appendix 10

CHART OF BEDLOAD DATA FROM McKINNEY BR.





Appendix 11. Vegetation planted at the Phillips/Willis restoration site.

Native riparian seed mix sewn throughout the easement area.

Common name		Botanical Name
3.00%	Black-eyed susan	*Rudbeckia hirta*
15.00%	Sunburst Switchgrass	*Panicum virgatum*
11.00%	Partridge Pea	*Chamaecrista fasciculate*
6.00%	Pennsylvania smartweed	*Polygonum pennsylvanicum*
6.00%	Lance-leaved Coreopsis	*Coreopsis lanceolata*
6.00%	Slender smartweed	*Polygonum lapathifolium*
6.00%	Smooth Panicgrass	*Panicum dichotomiflorum*
5.00%	Virginia Wild Rye	*Elymus virginicus*
6.00%	Osage Indiangrass	*Sorghastrum nutans*
4.00%	Biannual Evening Primrose	*Oenothera biennis*
4.00%	Bur-Marigold/Showy Tickseed	*Bidens aristosa*
10.00%	Little Bluestem	*Andropogon scoparius*
5.00%	Big Bluestem	*Andropogon gerardii*
3.00%	Silky Dogwood	*Cornus amomum*
3.00%	Ashy Sunflower	*Helianthus mollis*
3.00%	Buttonbush	*Cephalanthus occidentalis*
4.00%	River Oats	*Uniola latifolia*

Bare-rooted trees and live stakes planted along the easement at the Phillips/Willis site.

Common name	Botanical Name
Service Berry	*Amelanchier arborea*
Winterberry	*Ilex verticillata*
Spicebush	*Lindera bensoin*
Tag Alder	*Alnus serrulata*
Ironwood	*Carpinus caroliniana*
Persimmon	*Diospyros virginiana*
River Birch	*Betula nigra*
Crabapple	*Malus angustifolia*
Possum-haw viburnum	*Viburnam nudum*
Silky Dogwood	*Cornus amomum*
Black Willow	*Salix nigra*
Silky Willow	*Salix sericea*
Apple	*Malus domestica*
Sycamore	*Platanus occidentalis*
Shagbark Hickory	*Carya ovata*
N. Red Oak	*Quercus sp.*
White Oak	*Quercus sp.*

Agricultural practices that were constructed to exclude livestock and farming impacts from easement areas on Phillips Property. Map shows the approximate location of proposed fencing, watering system, and stream crossing.

Appendix 12