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EXECUTIVE SUMMARY

For this project, the restoration goal is to restore the physical and biological integrity beyond current stream conditions. Current conditions consist of modified or impaired stream channels. Restoration of the streams will provide the desired habitat and stability features necessary to improve the quality of the stream. Objectives to meet that goal of restoring these stream channels are listed below.

1. Provide a stable stream channels with features inherent of a biologically diverse environment.
2. Restore the connection between the bankfull width and floodprone width of the channels by restoring the floodplain area.
3. Stabilize eroding banks.
4. Provide a functional, native vegetated riparian floodplain corridor, where deficient, and preserve existing forested corridors.
5. Improve physical aquatic habitat features.
6. Minimize land development impacts to the streams.
7. Provide long-term protection of the stream corridors.

The restoration techniques proposed for Thompsons Fork mainstem and the Unnamed Tributary stream will provide the attributes described above by incorporating a variety of features recognized to support the stability and biological diversity that are essential to ecosystem enhancement. Presently, these features are non-existent or diminished within the project stream reaches.

The restoration of the Thompsons Fork mainstem and the Unnamed Tributary stream includes assessing and quantifying stable geomorphologic reference reach conditions that will become the foundation for the design and construction of stable natural channels. Considerations that have been applied to the design of this project are listed below.

- A channel designed with appropriate bankfull dimensions, cross-sectional area and slope to convey anticipated bankfull flows and to entrain bedload readily available to the stream.
- A channel pattern extrapolated from data measured from a stable reference reach within the Thompsons Fork watershed.
- Grade control and bank stabilization structures to enhance the environmental and ecological attributes of the stream channel though the use of natural materials and indigenous, native revetment.
- In-stream habitat features, such as sand/gravel bars, pool/riffle complexes and re-establishment of the appropriate substrate material will be applied consistently. Rock vanes, cross-vanes, J-hook vanes, log vanes, root wad bank stabilization structures, step-pools, or combinations thereof, will also be utilized where necessary to relieve near bank stress.
- Reconnection of the stream channels to functional floodplains by making improvements to the stream channel and riparian zone that restores dimension, pattern and profile based on reference reach conditions.
- Indigenous instream, overbank and riparian corridor herbaceous ground cover, shrub, understory and canopy species will be planted throughout the project reaches.

Proven natural stream geometry relationships, as described by Newbury, Leopold, Wolman, Miller, Rosgen and others, are the basis for designing a stable, self-maintaining channel. These empirical relationships between channel pattern, profile and dimension and stream flow form the foundation for the restoration of the physical and biological functions of streams. The restoration work focuses

on the mainstem channel of Thompsons Fork and an associated Unnamed Tributary. Preservation, enhancement and priority level one restoration is proposed for the Unnamed Tributary. A priority level one restoration approach is proposed for Thompsons Fork's mainstem. Approximately 2,799 linear feet of channel will be restored on the mainstem, and approximately 2,382 feet on the Unnamed Tributary. Approximately 356 linear feet of stream will be preservation at the top of the reach, followed by 400 linear feet of Enhancement Level II and approximately 1,982 linear feet of Priority Level I restoration is proposed from the bottom of the enhancement reach to the Unnamed Tributary's confluence with Thompsons Fork mainstem. The sum of the total stream lengths designated in the restoration plan, including the preservation reach on the Unnamed Tributary is approximately 5,537 linear feet. Pre-existing and proposed stream lengths and restoration approach are summarized in the following table, including proposed Stream Mitigation Units (SMUs):

Thompsons Fork and Unnamed Tributary Restoration Summary
Project Number D05016-1 (Thompsons Fork and Unnamed Tributary)

Reach/Approach	Existing Length	Proposed Length	Credit Ratio	SMUs
Mainstem Priority Level I Restoration	2,530 ft	2,784 ft	1	2,784
UT Preservation	356 ft	356 ft	5	71
UT Enhancement Level II	400 ft	390 ft	1.5	260
UT Priority Level I Restoration	1,598 ft	1,982 ft	1	1,982
Totals	**4,884 ft**	**5,512 ft**		**5,097**

The stream restoration project will be monitored for a period of five consecutive years or until the required success criteria has been met as determined by the North Carolina Division of Water Quality (DWQ) and the U.S. Army Corps of Engineers (COE), Wilmington District. Parameters that will be documented during annual stream monitoring, to ensure the success of the stream restoration project, will include stream channel surveys (longitudinal profiles and cross-sections), particle distributions, photographs, and vegetation surveys along the streams and riparian buffer zones.

1.0 PROJECT SITE IDENTIFICATION AND LOCATION

1.1 Directions to Project Site

The proposed project is located near the intersection of Watson Road and South Creek Road on the north side of Interstate 40, approximately 7 miles east of the City of Marion, in Nebo Township, McDowell County, North Carolina as shown on the site vicinity map presented on **Figure 1**. The project spans properties owned by Zeb B. Lowdermilk and wife Francis M. Lowdermilk (Tract 1), Francis McNeely Lowdermilk (Life Estate), Susan Delene Lowdermilk, Don Lance Lowdermilk, and Dane Scott Lowdermilk (Tract 2) and Zeb B. Lowdermilk and daughter Susan Lowdermilk Walker Icard (Tracts 3 and 4).

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

The Thompsons Fork watershed is located within the Upper Catawba River Basin. The project stream reaches are mapped on North Carolina Department of Transportation Light Detection and Ranging (LiDAR) coverage and are located within USGS Catalog Unit Number 03050101 (Upper Catawba River Basin) and Local Targeted Watershed 14-digit basin 03050101040010 (North Muddy Creek), as shown on **Figure 2**. The lower extent of the Thompsons Fork restoration project is located in a wide, Rosgen Valley Type VIII, approximately 800 feet upstream from the confluence of Thompsons Fork with North Muddy Creek.

2.0 WATERSHED CHARACTERIZATION

2.1 Drainage Area

The drainage area tributary to the downstream limits of the project on Thompsons Fork mainstem is 7.57 square miles or 4,847 acres. The associated Unnamed Tributary has a contribution drainage area of 0.16 square miles or 104 acres. These watershed areas are shown on **Figure 3**. Drainage areas for the project site are summarized in **Table 1**.

TABLE 1
Drainage Areas
Project Number D05016-1 (Thompsons Fork and Unnamed Tributary)

Reach	Drainage Area (Acres)
Reference Reach – Thompsons Fork*	3566
Thompsons Fork Mainstem (downstream project limits)	4847
Unnamed Tributary to Thompsons Fork*	104
Total	4847

*The reference reach and Unnamed Tributary drainage areas are included in the total drainage area for the Thompsons Fork Mainstem (See **Figure 3**).

2.2 Surface Water Classification/Water Quality

The majority of land in the North Muddy Creek watershed is forested, with an abundance of cleared land along the riparian corridor. The City of Marion, North Carolina lies in the northwestern region of the watershed, with I-40 nearly bisecting the catchment. The most degraded water quality in this local watershed is Corpening Creek, flowing from Marion to North Muddy Creek in the center of the basin. Corpening Creek (4.7 miles) is on the 2000 303(d) List (not yet EPA approved) due to nonpoint source pollution and urban impacts. The North Muddy Creek catchment contains Bobs Creek Pocket Wilderness, a Significant Natural Heritage area. Sampling performed by the Division of Water Quality indicates sedimentation and turbidity as problem parameters, with agriculture a potential source of water quality degradation. (Watershed Restoration Plan for the Catawba River Basin, 2001).

Along the altered project stream reaches of Thompsons Fork within the North Muddy Creek subbasin, the mainstem reach has undergone extreme downcutting and streambank erosion, resulting in a deeply incised stream channel disconnected from its floodplain. Degradational processes dominate streambed features. Vertical to undercut stream banks, up to 15 feet in height near the bottom of the reach, contribute large volumes of sediment and increased turbidity to receiving waters downstream. This project will restore the connection between the mainstem channel and its floodplain using a Priority Level I approach. Pattern, profile and dimension will be restored through a combination of off-line meander restoration and stabilization, utilizing instream structures to stabilize streambank and bedform features, with the goal of restoring and enhancing presently degraded aquatic and riparian habitat functions.

2.3 Physiography, Geology, and Soils

The Thompsons Fork watershed is located in the Eastern Blue Ridge Foothills on the boundary between the Southern Inner Piedmont and Blue Ridge Mountains Physiographic Provinces of Western North Carolina. Soils are developed over metamorphic and intrusive igneous rocks associated with the Inner Piedmont, Chauga Belt, Smith River Allochthon and Sauratown Mountains Anticlinorium, uplifted and thrust fault-emplaced over younger sequences of sedimentary bedrock during tectonic continental plate collision during the Alleghenian Orogeny about 356 million years (my) ago (Fullager and Odom, 1973).

Metamorphic rocks that outcrop within the Thompsons Fork watershed include biotite gneiss and schist, mica schist, amphibolite, megacrystic biotite gneiss, and inequigranular biotite gneiss. The intrusive igneous rock formation that underlies portions of the stream restoration project along the Thompsons Fork mainstem and the Unnamed Tributary includes the Henderson Gneiss (monzonitic to granodicritic, inequigranular, granitic to quartz dioritic, biotite gneiss and amphibolite common) radioactive dated to approximately 524 my. Exposed rock is equigranular to megacrystic, foliated to massive and includes the Toluca Granite (Fullager and Odom, 1973). The site geology map is presented on **Figure 4** (excerpted from the Geologic Map of North Carolina, 1985).

The soils along the mainstem of Thompsons Fork and its associated Unnamed Tributary have been derived from and developed over these metamorphic and intrusive igneous rock formations include the Colvard Series. The Colvard Series consists of very deep, well drained soils that have formed on floodplains in the southern Appalachian Mountains. The mean annual temperature ranges from 46 to 57 degrees Fahrenheit. The mean annual precipitation ranges from 38 to 65 inches. Slopes range from 0 to 4 percent. The pedon contains loamy sediments ranging from 40 to 60 inches or more in thickness over deposits of stratified sandy, loamy gravelly to cobbly sediments. Rock fragments range from 0 to 15 percent to a depth of 40 inches, and from 0 to 80 percent below 40 inches. The soil ranges from strongly acid to mildly alkaline. Flakes of mica range from few to common (USDA NRCS, January 3, 2006).

Soils mapping and taxonomic descriptions are from the NRCS Soil Survey of McDowell County, North Carolina (USDA NRCS, September 1995). **Figure 5** shows the boundaries of mapped soil units within the project site and vicinity.

Valley Type VIII (Rosgen, 1996) is most readily identified landform along the mainstem corridor, with the presence of river terraces positioned laterally along the broad valley with gentle, down-valley elevation relief in the project vicinity. Alluvial terraces and floodplains are the predominant depositional features in this fluvial geomorphologic system and produce a high sediment supply.

First- and second-order, Rosgen Type I v-shaped valleys and Type II narrow colluvial valleys, with their associated A and B stream types, respectively, dominate the headwater reaches of the watershed. The Thompsons Fork mainstem project reach is a third-order stream within the watershed. The landform is attributed to alluvial riverine depositional processes where Rosgen Type VIII valleys and classic E4 to E5 channel types are the stable endpoints of landform evolution. Elevations within the watershed range from 2,020 feet above mean sea level (MSL) at the headwaters to the west to below 1,085 feet MSL at the downstream limits of the stream restoration project. The resulting relief is 935 feet, from the headwaters to the downstream limits of the project, located approximately 4.5 miles downstream (east) from the watershed divide. The confluence of Thompsons Fork with North Muddy Creek is located approximately 200 feet south of the outlet of the 3-chamber box culvert that carries Thompsons Fork under I-40.

2.4 Historical Land Use and Development Trends

Within the watershed boundaries of the project, land use is predominantly agricultural, including row crop production and pasture/hay land with wooded and cleared hillsides. Land use in the vicinity of the project is not expected to change in the foreseeable future. **Table 2** presents a breakdown of land use within the local watershed and is based upon USGS National Land Cover Dataset (NLCD, 2001) as presented on **Figure 6**.

TABLE 2
Thompsons Fork Watershed Land Use Summary
Project Number D066030-A (Thompsons Fork and Unnamed Tributary)

Description	Count	Sq Meters	Acres	Sq Mi	Percent
Open water	38	34200	8.5	0.013	0.17
Developed, open space	2296	2066400	510.6	0.798	10.54
Developed, low intensity	357	321300	79.4	0.124	1.64
Developed, medium intensity	14	12600	3.1	0.005	0.06
Developed, high intensity	7	6300	1.6	0.002	0.03
Barren land (rock/sand/clay)	29	26100	6.4	0.010	0.13
Deciduous Forest	13686	12317400	3043.7	4.756	62.81
Evergreen Forest	648	583200	144.1	0.225	2.97
Shrub/Scrub	1001	900900	222.6	0.348	4.59
Grassland/Herbaceous	995	895500	221.3	0.346	4.57
Pasture/Hay	2487	2238300	553.1	0.864	11.41
Cultivated Crops	184	165600	40.9	0.064	0.84
Woody Wetlands	46	41400	10.2	0.016	0.21
	Totals	**19,609,200**	**4,847**	**7.57**	**100.00**

2.5 Endangered/ Threatened Species

The species listed in **Table 3** are Federally-listed Threatened or Endangered Species in McDowell County, North Carolina according to the U.S. Fish and Wildlife Service (FWS) website (http://nc-es.fws.gov/es/countyfr.html):

TABLE 3
Federal Threatened and Endangered Species in McDowell County
Project Number D06030-A (Thompsons Fork and Unnamed Tributary)

Common Name	Scientific Name	Federal Status	Known Occurrences
Bald Eagle	*Halieeatus leucocephalus*	Threatened	Current
Carolina Northern Flying Squirrel	*Glauconys sabrinus coloratus*	Endangered	Current
Bog Turtle	*Clemmys muhlenbergii*	Threatened	Current
Mountain Golden Heather	*Hudsonia montana*	Threatened	Current
Small-whorled pogonia	*Isotria medeoloides*	Threatened	Current

The "Known Occurrences" column refers to the last time the species was observed in a particular county, according to the species distribution maps from the North Carolina Natural Heritage Program dataset. "Current" means that the species was seen in the county within the last 20 years, and "Historical" means that the species was last observed in the county more than 20 years ago.

A request for a site-specific search of the North Carolina Natural Heritage Program Database was made to the North Carolina Department of Environment and Natural Resources (NCDENR). The search results returned on February 22, 2006 revealed one record of a rare species within a mile of the project area. *Caecidotea carolinensis* (Bennett's Mill Cave water slater) is a significantly rare species in North Carolina and a Federal species of concern found at Bennett's Mill Cave on the bank of Muddy Creek. This is the only known record of this species, which has only been found in McDowell County in North Carolina. An additional vague record for *Myotis septentrionalis* (Northern Long Eared Myotis) was noted as collected in McDowell County. *Myotis septentrionalis* is listed as a North Carolina Special Concern Species. No records were located within the project area.

Based on a review of available information, including a site visit, no habitat for any of the listed species is apparent on the site. Due to a lack of available habitat, the Thompsons Fork project is not likely to have an adverse effect on any Federally-listed threatened or endangered species. This information was presented in the Categorical Exclusion report submitted to and accepted by the Federal Highway Administration and State of North Carolina on September 18, 2006.

2.6 Cultural Resources

A scoping letter was submitted to the North Carolina Department of Cultural Resources, State Historic Preservation Office (SHPO) for review. In correspondence dated August 3, 2006, the SHPO recommended that the project area be surveyed for the presence of prehistoric and historic archeological sites. Phase I Cultural Resources Management investigations were conducted by the Archeological Department of EMH&T, Inc., for the project area during the month of August 2006. No National Register historic buildings or structures were identified in the area of potential effect. Documentation of the survey methods and findings were provided to SHPO for review. EMH&T recommended no further archaeological investigation be conducted for the project site. In correspondence dated October 19, 2006, Mr. Peter Sandbeck, the SHPO Administrator, concurred with this determination.

2.7 Potential Constraints

There are no constraints that have potential to adversely impact or limit improvements associated with the Restoration Plan for Thompsons Fork and its associated Unnamed Tributary.

2.7.1 Property Ownership History and Boundary

The project site lies entirely within four tracts of land. Tract 1 is owned by Zeb B. Lowdermilk and wife Francis M. Lowdermilk (Deed Reference: Book 171 Page 129). Tract 2 is owned by Frances McNeely Lowdermilk (Life Estate), Susan Delene Lowdermilk, Don Lance Lowdermilk, and Dane Scott Lowdermilk (Deed Reference: Book 210 Page 542). Two tracts (Tracts 3 and 4) are owned Zeb B. Lowdermilk and daughter Susan Lowdermilk Walker Icard (Deed References: Book 558 Page 109 and Book 558 Page 111, respectively). The project, in its entirety, is located in Nebo Township, McDowell County, North Carolina.

2.7.2 Site Access

Access to the site is provided from South Creek Road as shown on **Figure 1**. The publicly dedicated right-of-way of South Creek Road provides direct access to the Conservation Easements for both Thompsons Fork and the Unnamed Tributary. No independent ingress/egress is provided as part of the Conservation Easement.

2.7.3 Utilities

To the best of our knowledge, there is only one utility located within the project corridor. An overhead electric line, owned by Duke Power, is present across Thompsons Fork mainstem. The project will not disturb the existing utility, nor will the electric line hinder the construction of the project. The location and designation of this utility is shown on the Restoration Plan design sheets presented in **Appendix 1**.

3.0 PROJECT SITE STREAMS

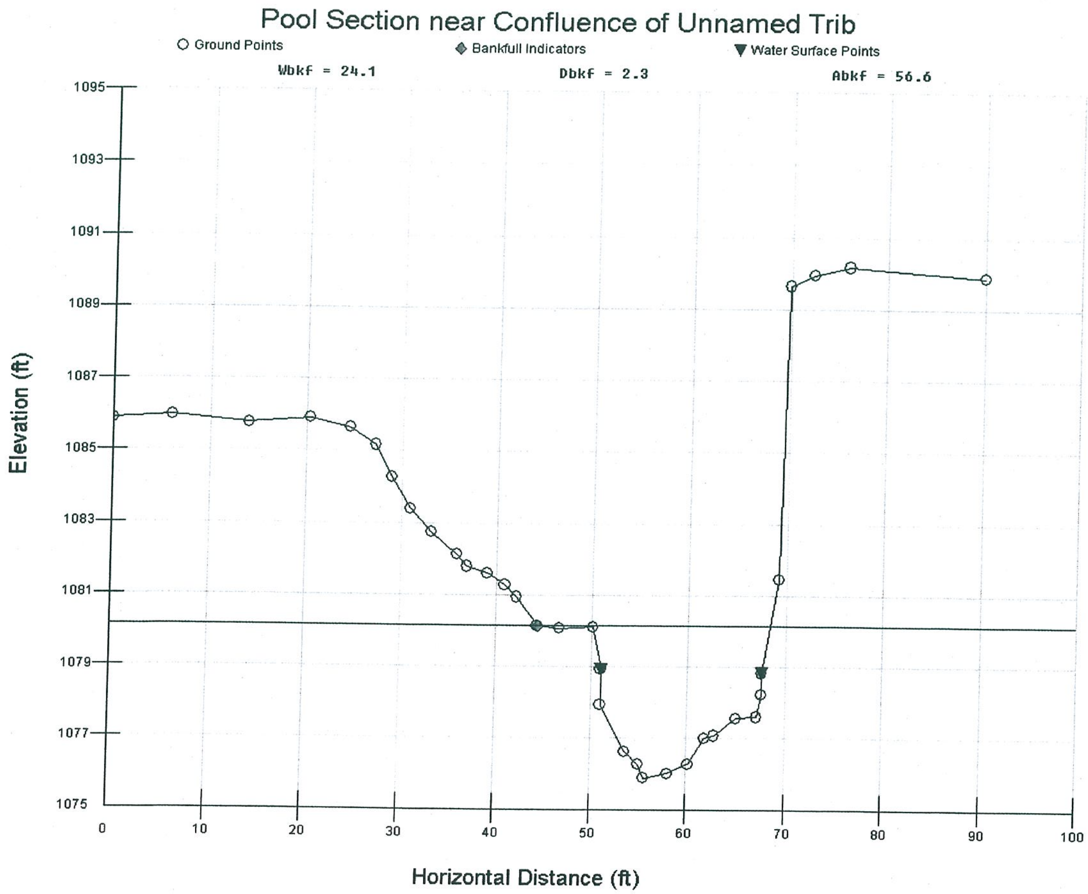
3.1 Channel Classification

Thompsons Fork Mainstem

North Carolina Division of Water Quality (DWQ) Stream Classification Form was completed for the Thompsons Fork mainstem and is included in **Appendix 2**. The mainstem received a score of 41, classifying it as a perennial channel. The stable, natural channel form for Thompsons Fork mainstem is a Rosgen E4 stream type, based on detailed, quantitative analysis of a stable reference reach located approximately 2,800 feet upstream from the top of the altered mainstem reach within the Thompsons Fork watershed.

A number of anthropogenic factors have impacted the channel along the altered mainstem reach, resulting in its present unstable G4/G5 stream type. The incised nature of the channel is attributed to aggressive vegetative management of the riparian corridor, cattle intrusion, and clear water discharge of "sediment hungry" water from Muddy Creek Flood Control Dam Number 8, located approximately 6,000 feet upstream from the top of the altered mainstem reach. This maximum capacity, 925 acre-feet embankment type flood control dam, constructed in 1964 and maintained by the McDowell County Soil and Water Conservation District, regulates flows from two-thirds of the 4,847 acres (7.57 square miles) watershed and captures two-thirds of the sediment budget for the Thompsons Fork watershed. The drainage area tributary to Muddy Creek Flood Control Dam Number 8 is 3,192 acres or 4.99 square miles. The area within the Thompsons Fork watershed downstream from the impoundment and not regulated by Muddy Creek Flood Control Dam Number 8 is 1,655 acres or 2.59 square miles.

Additionally, a shift in stream base level occurred when the 3-chamber box culvert, carrying Thompsons Fork under I-40, was set approximately 15 feet lower in elevation than the pre-disturbed channel and floodplain during the 1960's. This shift in stream base level has resulted in severe incision of the channel, abandonment of its floodplain, and lowering of the water table as the streambed continues to cut headward to re-establish profile equilibrium. At the bottom of the impaired mainstem reach, the channel has cut 15 feet vertically into the floodplain to meet the invert elevation at the 3-chamber box culvert carrying Thompsons Fork under I-40. A pool cross-section, surveyed in the field on February 7, 2006, and located immediately upstream from the confluence of the Unnamed Tributary on the mainstem, graphically depicts the deeply incised, G4/G5 features of the existing channel:



Thompsons Fork Mainstem Pool Cross-Section from left to right looking downstream.

Photograph at Thompsons Fork Mainstem Pool Cross-Section looking upstream. The confluence of the Unnamed Tributary with Thompsons Fork is the small gravel fan deposit shown in the lower right corner of the photograph.

The restoration plan for Thompsons Fork utilizes proven geomorphological approaches developed by understanding and implementing stable channel dimension, pattern and profile, based on data extrapolated from reference reach boundary conditions and superimposing the stable dimension, pattern and profile on the unstable form. The Priority Level I, off-line restoration approach for the altered mainstem reach entails reconnection with the existing floodplain with appropriate elevation, width, valley slope and channel dimensions, extrapolated from stable geomorphologic and hydraulic parameters measured and quantified from reference reach boundary conditions upstream from the project in the Thompsons Fork watershed. The proposed channel will be an E4 stream type designed with stable dimension, pattern and profile to entrain its bedload without either aggrading or degrading at bankfull stage. In-stream structures will be utilized to reduce shear stress in the near bank region. Grade control structures will be required to prevent the clear water discharge from the upstream flood control dam from eroding the channel bed and banks.

Additionally, bank reinforcement materials will be used in high-stress regions (e.g., along outside meander bends). Reinforcement materials will consist of a combination of rock toe, coir logs, jute coir matting, live stakes and aggressive revetment of streambanks and the riparian corridor.

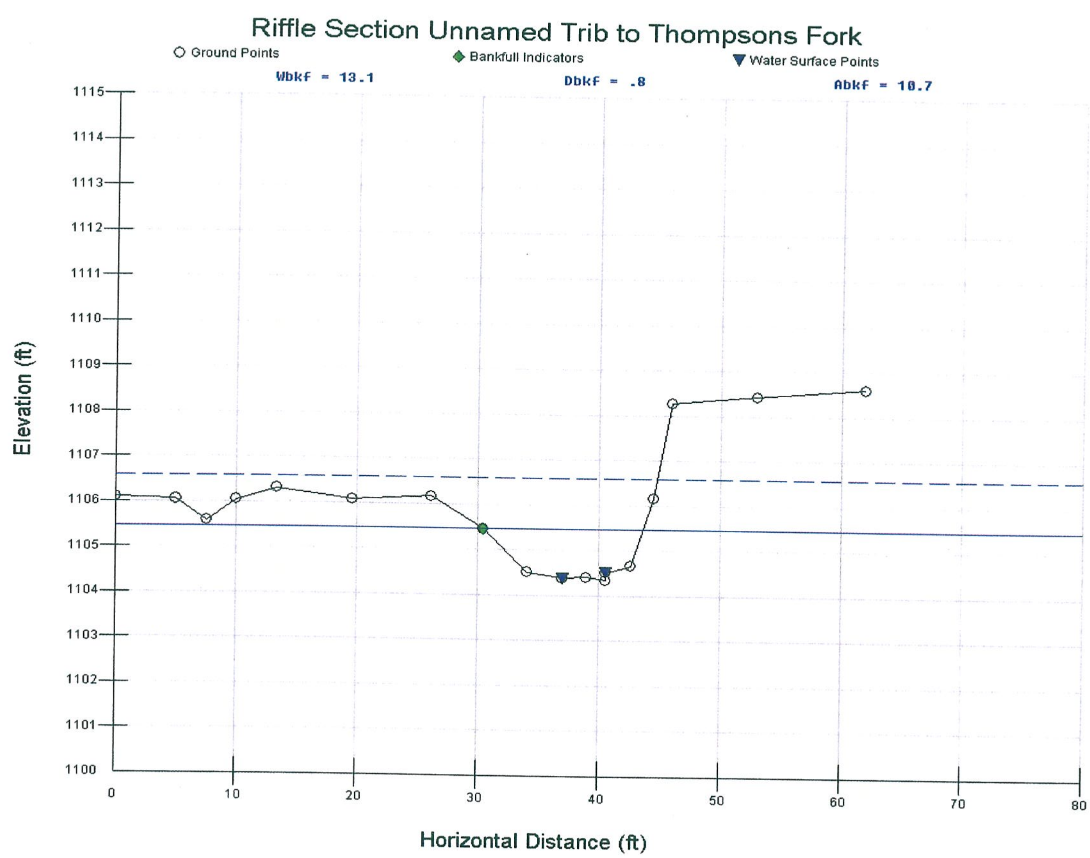
Unnamed Tributary to Thompsons Fork

The North Carolina DWQ Stream Classification Form was completed for the Unnamed Tributary to Thompsons Fork and is included in **Appendix 2**. The Unnamed Tributary received a score of 30, classifying it as a perennial channel.
The Unnamed Tributary stream emerges from a granite bedrock spring at its headwaters, located above the top of the proposed Enhancement Level II restoration reach. From its headwaters the channel form is a classic Type I valley-confined, A1 stream type with bedrock control transitioning to a B3 stream type within the project reach. The streambanks are stable along the A1 reach, located

within a second- to third-growth deciduous hardwood forested riparian corridor. Preservation is proposed along this reach of the project stream corridor.

At the point where the Unnamed Tributary emerges from its forested canopy into a narrow mowed meadow is the location where the profile gradient flattens to less than four percent and the stream channel transitions to a B3 stream type. Vegetative management (mowing to the top of bank for hay production) combined with a relatively steep profile gradient of approximately 3.1 percent (0.0308 ft/ft) combined with a low sinuosity (1.12) characteristic of colluvial valley (Valley Type II, Rosgen 1996) B stream type has destabilized streambanks along the right bank. The left bank is characterized by a narrow floodplain along the toe of a steep hillside. An Enhancement Level II approach is proposed along this reach of the Unnamed Tributary to Thompsons Fork.

Continuing downstream from the proposed Enhancement Level II reach the existing laterally confined channel has developed a slightly wider floodplain on the left bank as shown in the following cross-section, surveyed in the field on February 9, 2006:



Thompsons Fork Unnamed Tributary Riffle Cross-Section, from left to right looking downstream.

Thompsons Fork Unnamed Tributary Riffle Cross-Section, photograph taken from left to right looking upstream.

From this location to just upstream from the 30-inch diameter corrugated metal pipe (CMP) that carries the Unnamed Tributary under South Creek Road, the floodprone width is approximately 45 feet and the channel geometry and dominant substrate material (small cobble) exhibits Rosgen C3 cross-sectional geometry. The existing width to depth ratio along this reach is approximately 16 with a mean depth of 0.82 feet, bankfull width of 13.1 feet, bankfull cross-sectional area of 10.7 square feet with a mean bankfull discharge of 54.9 cubic feet per second (cfs), based on profile gradient and riffle bed particle distribution.

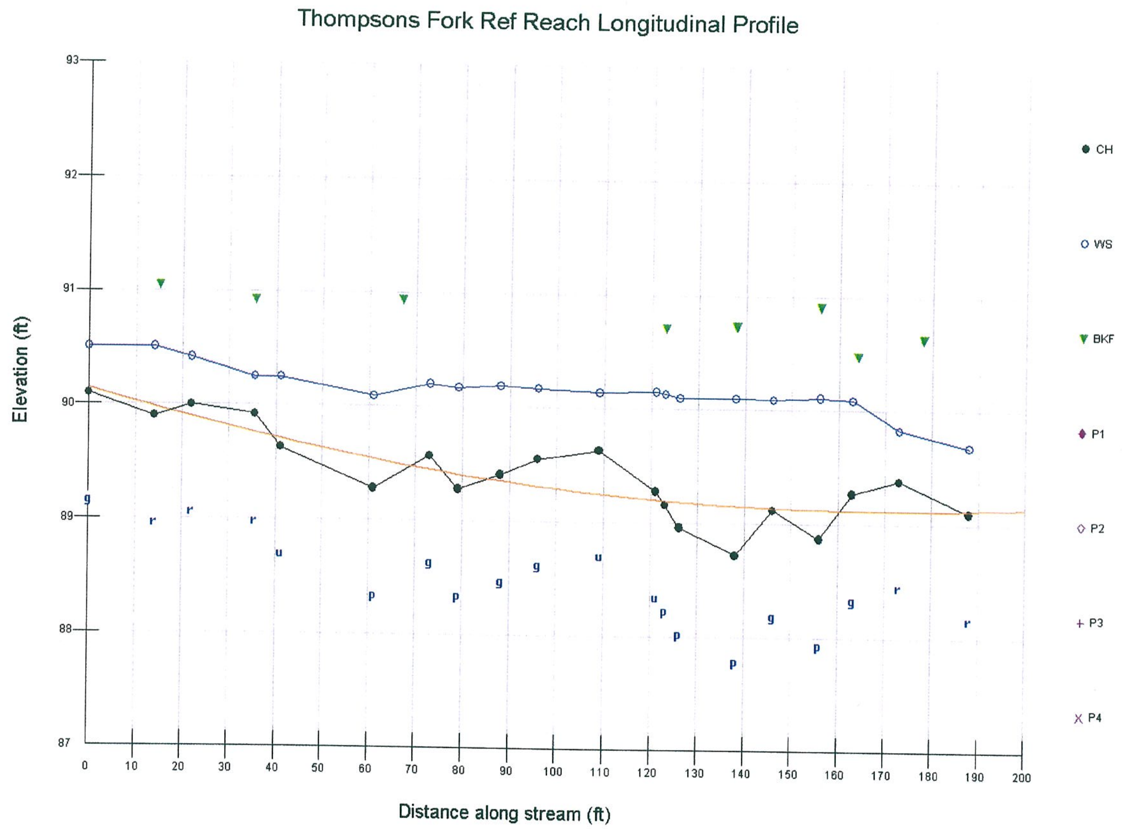
The near vertical right bank and adjacent, mowed meadow laterally confines this reach of the Unnamed Tributary, preventing the stream from establishing stable pattern, profile and dimension to dissipate energy without eroding its banks (note slumped bank downstream from the survey rod in the photograph above). The Priority Level I restoration approach along this reach is to size and construct a stable, natural C3b (profile gradient greater than 0.02 ft/ft) channel by increasing the belt width to the extent that a restored reach average sinuosity of 1.38 can be achieved. This pattern will allow re-establishment of riffle, run, pool and glide sequences that will enable the channel to entrain its bedload without neither aggrading nor degrading while maintaining its dimension, pattern and profile at bankfull stage. Proposed belt width along the Priority Level I reach will range between 45 to 85 feet and will reconnect the channel to its floodplain by restoring the floodprone width. Step-pools, constructed riffles and pool sequences, bank reinforcement, and combinations thereof, will be utilized to reduce shear stress in the near bank region to prevent stream channel degradation and streambank erosion.

As noted, bank reinforcement materials will be used in high stress regions (e.g., along outside meander bends). Reinforcement materials will consist of a combination of rock toe, coir logs, jute coir matting, live stakes and aggressive revetment of streambanks and the riparian corridor. Revetment of the new floodplain and riparian corridor with native herbaceous, shrub, understory and canopy plant species will be completed as set forth in Sections 5.5 and 6.3 of this restoration plan.

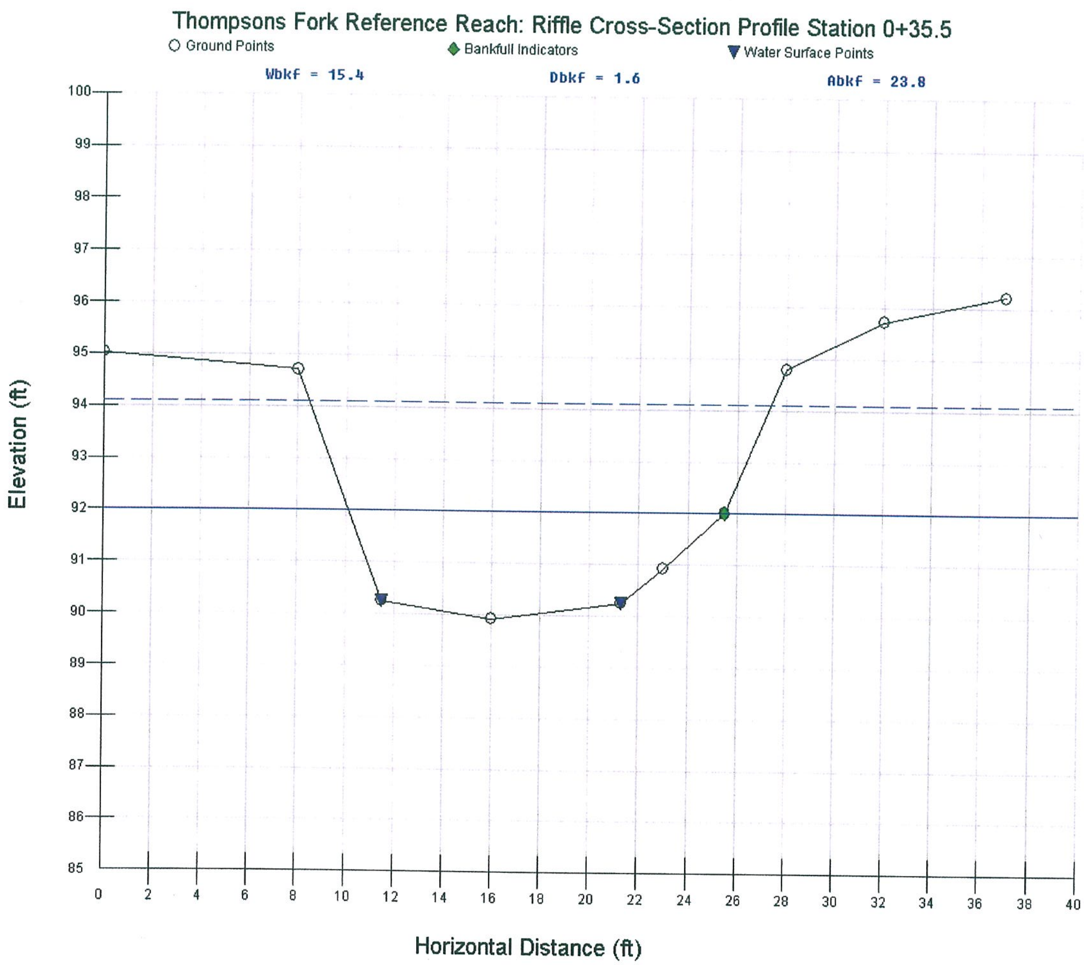
3.2 Discharge

Thompsons Fork Mainstem

For Thompsons Fork, bankfull discharge was determined through a quantitative assessment and analysis of reference reach boundary conditions and comparison of predicted bankfull discharge through a stable riffle section located approximately 2,800 feet upstream from the top of the altered mainstem reach. The reference reach is a Rosgen E4 stream type that has lost connection with its adjacent healthy, deciduous hardwood forested riparian corridor and floodplain. Muddy Creek Flood Control Dam No. 8, constructed in 1964 and located approximately 3,000 feet upstream from the top of the reference reach, regulates peak flows in the mainstem channel below the dam. Additionally, clear water "sediment hungry" discharge from the dam has resulted in a concave profile along the reference reach, as determined by a Rosgen Level III assessment and analysis of the reference reach conditions during August 2006. The longitudinal profile that follows, analyzed using RiverMorph® version 4.0.1a, clearly shows the concave trend of the streambed on the longitudinal profile that follows:

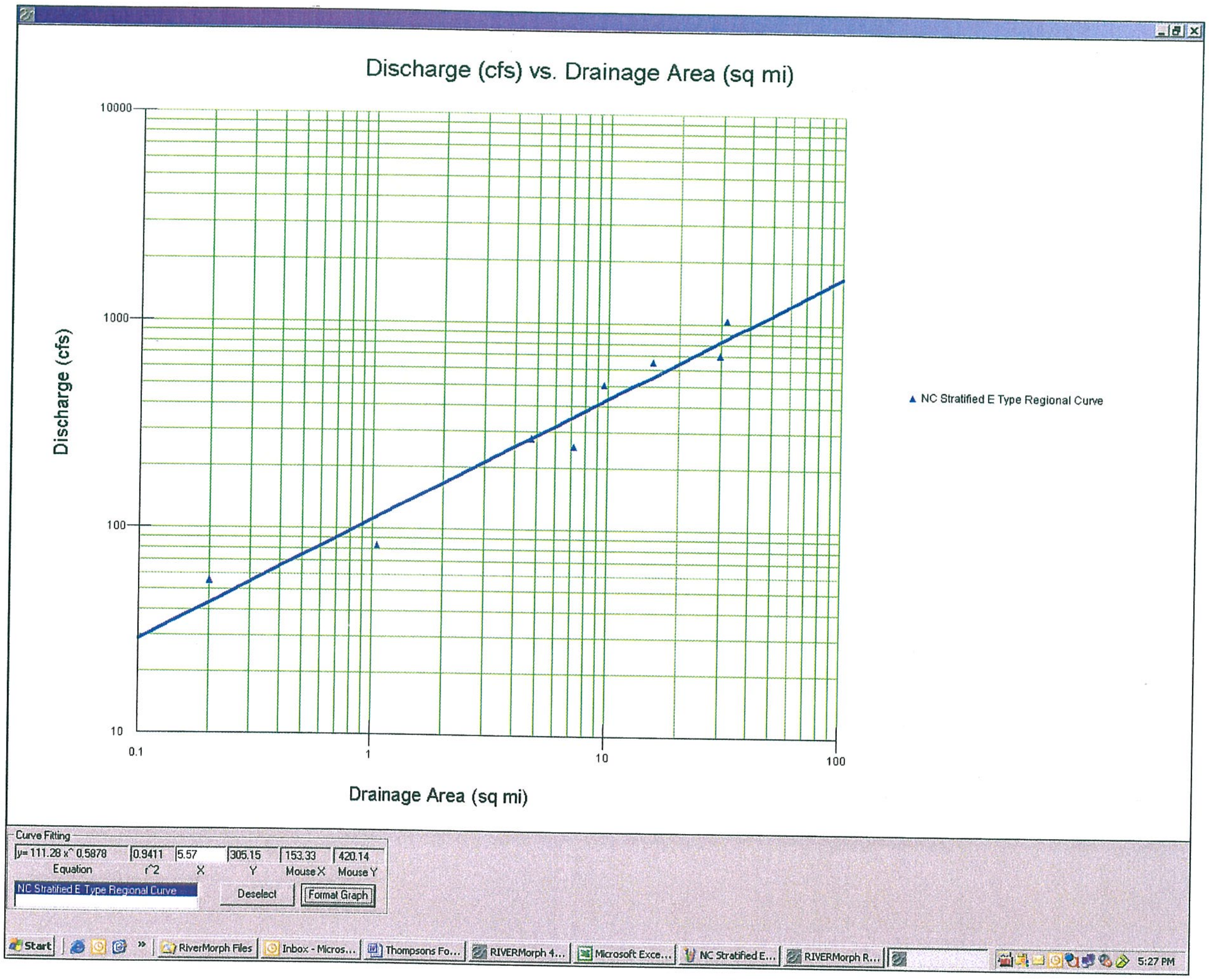


The healthy root mass along the reference reach streambanks is resistant to bank erosion. The sediment deprived, clear water discharge from the upstream dam is scouring the streambed. Streambed substrate materials are imbedded as a result. This condition has visibly impaired the diversity of aquatic habitat along the reference reach. The rising and falling limbs of stream hydrographs below dams are less steep and peak flow durations are longer due to available storage behind the dam that regulates flows from the outfall structure (in this case, a 30-inch diameter reinforced concrete pipe at the toe of the dam's embankment). The reference reach riffle cross-section shows a "dominant flow" inner berm that represents the "new" bankfull condition, 43 years post construction of the dam. It is also note worthy to point out there have been no flows through the emergency spillway at the crest stage of the dam in response to greater than 100-year frequency, Type III distribution storms (i.e., tropical depressions associated with hurricanes) since the dam was constructed in 1964 (based on personal communication with Mr. Sam Bingham, Rutherford and McDowell County Soil and Water Conservation District on August 2, 2006):

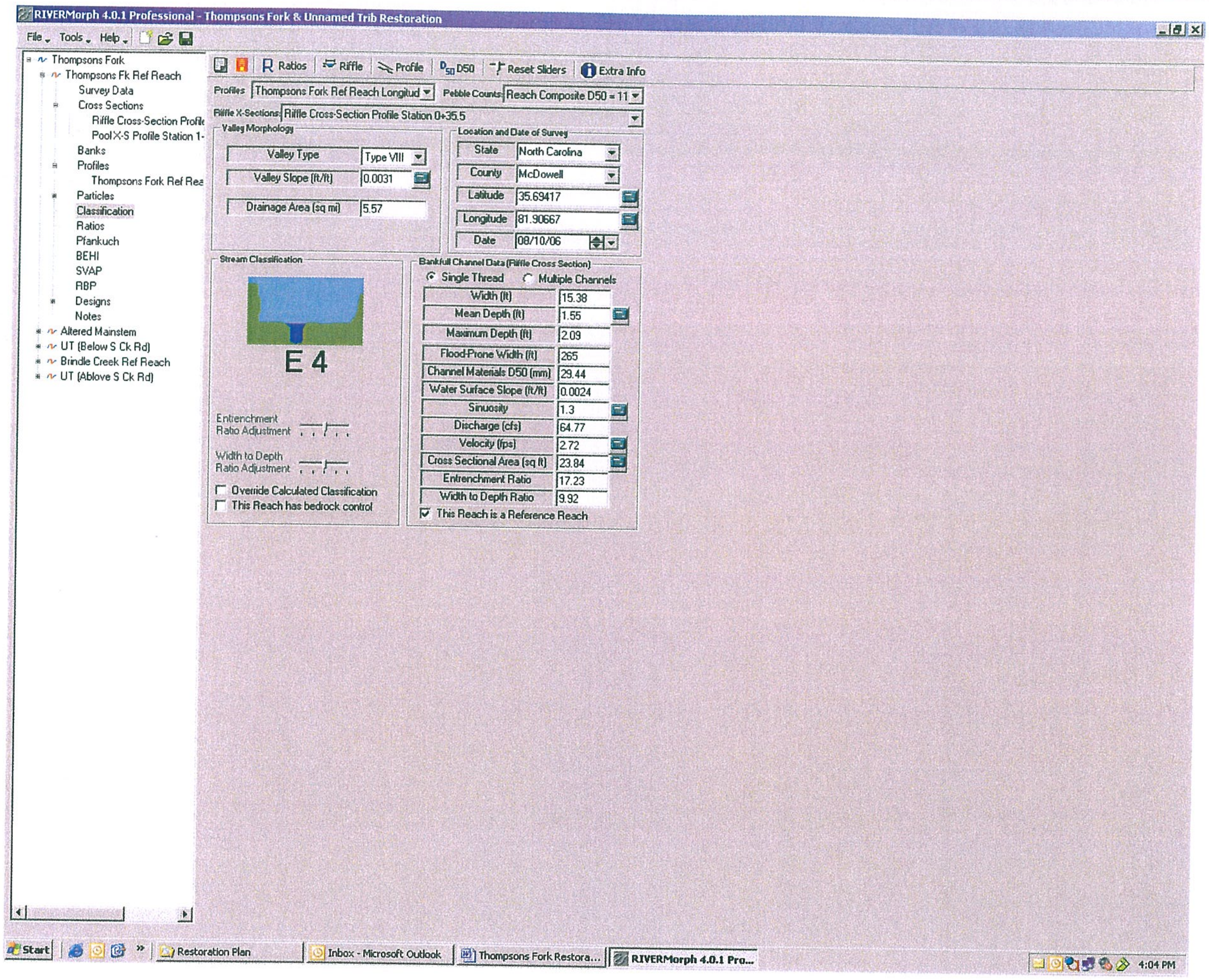


The dashed line represents the floodprone elevation (i.e., two times the bankfull maximum depth). Visual assessment of streambanks and the adjacent riparian corridor show no indication of overbank flows in the recent past.

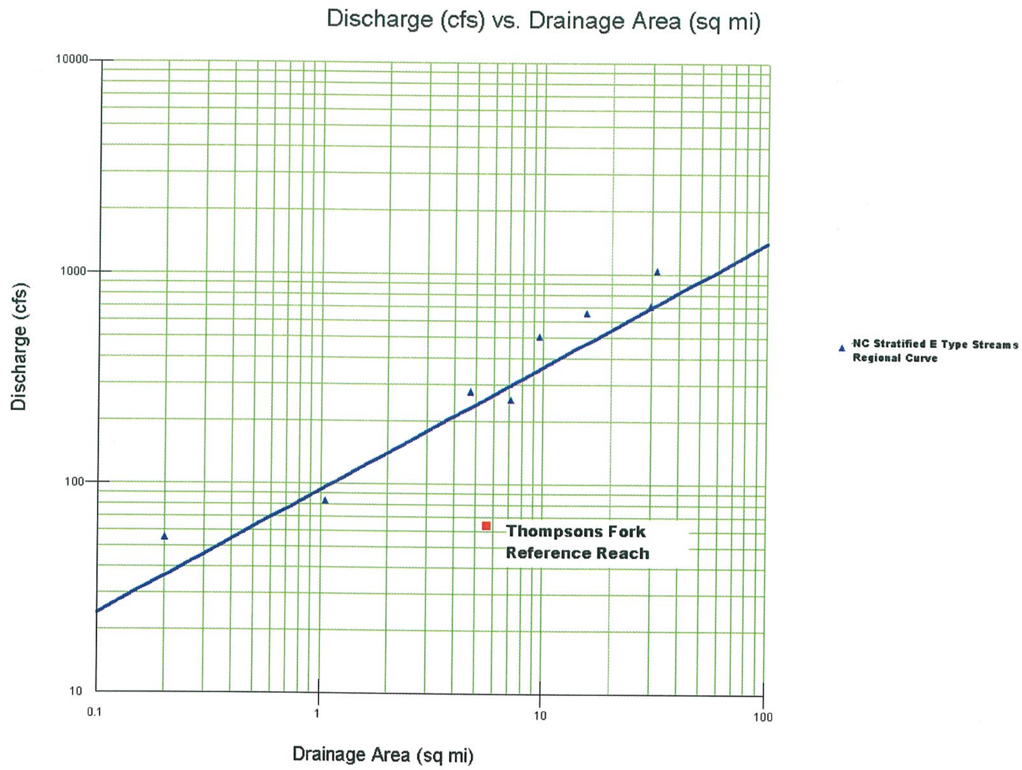
The North Carolina Piedmont and Mountains Regional Curve datasets (North Carolina Stream Mitigation Guidelines, April 2003), stratified by E type streams, grossly overestimates the bankfull discharge characteristics, channel geomorphology and hydraulic relationships for the drainage area tributary to the reference reach, and the mainstem altered reach, due to the 925 acre-feet of storage available at crest stage of the upstream flood control dam. The total drainage area tributary to the reference reach is 3565.5 acres or 5.57 square miles, with 4.99 square miles of that drainage area above the dam. The empirical relationship between bankfull discharge from the stratified E type stream regional curve dataset, and the contribution drainage area tributary to the reference reach predicts a bankfull width, depth, cross-sectional area at a stable riffle, and bankfull discharge at this position in the watershed is 24.9 feet, 2.8 feet, 70 square feet and 305 cubic feet per second (cfs), respectively.



Calculated bankfull discharge for the surveyed reference reach riffle cross-section, based on hydraulic radius, wetted perimeter, channel slope and a roughness coefficient derived from particle distribution collected from the reference reach riffle bed materials is quantified to be 64.8 cfs. This analyses, compared to the stratified E-type streams regional curve dataset provides a very poor match with respect to drainage area versus discharge from the stratified dataset (i.e., 64.8 cfs calculated versus 305 cfs predicted from stratified E-type streams regional curve dataset at a stable reference reach riffle cross-section). The following screen shot from RiverMorph® shows the boundary conditions and calculated bankfull discharge and mean flow velocity (using Manning's Equation) through the reference reach riffle cross-section:



The following drainage area verses discharge plot shows the North Carolina Piedmont and Mountain stratified E-type stream regional curve dataset, and includes the Thompsons Fork reference reach drainage area and computed discharge at a stable riffle cross-section (plotted as a red square). The logarithmic plot graphically shows the poor correlation of drainage area verses discharge relationship for the Thompsons Fork reference reach in comparison to the stratified regional curve dataset, due to the 925 acre-feet of storage provided by Muddy Creek Flood Control Dam Number 8, located approximately 3,000 feet upstream.

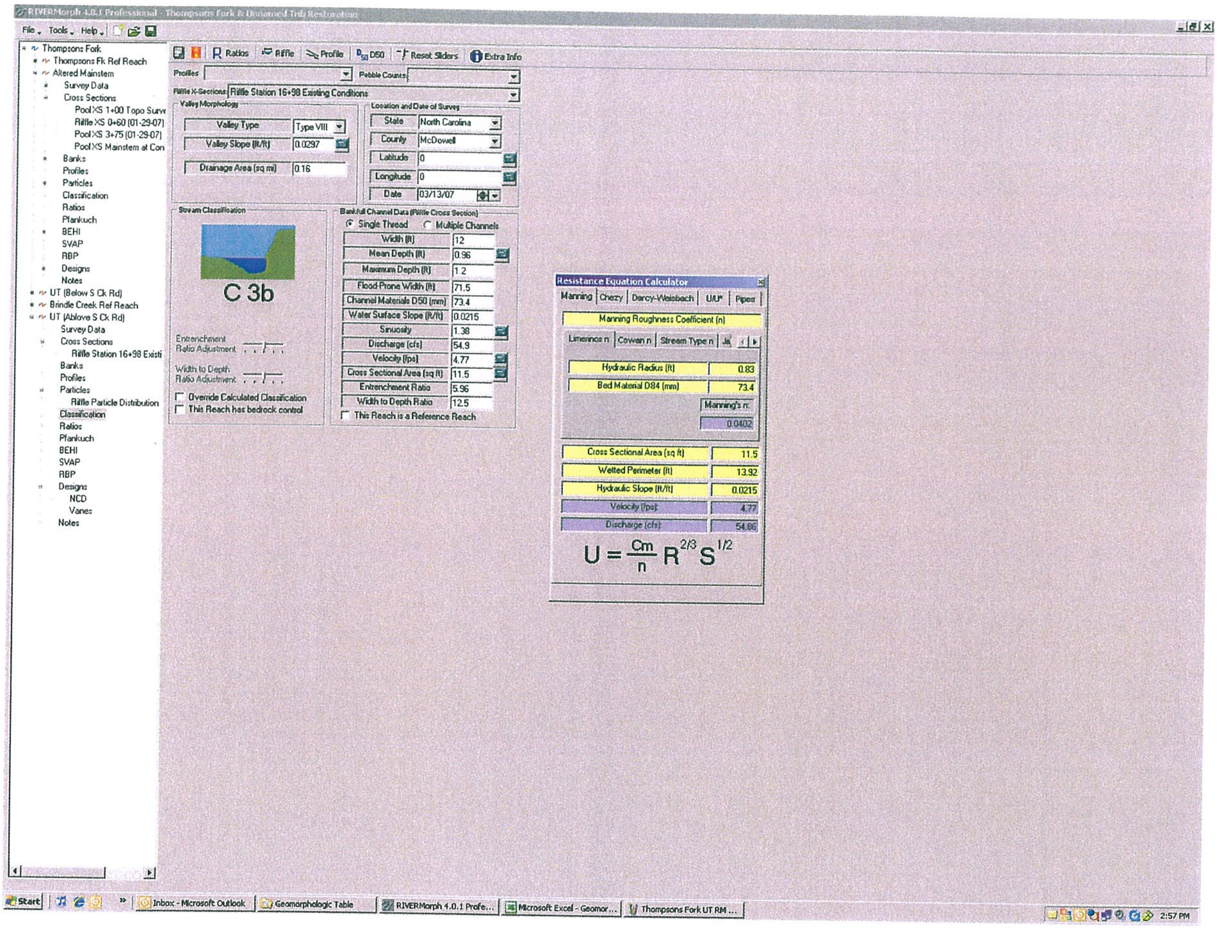


Given the poor regional curve fit, and since the flow from the dam's primary outfall structure is not gaged, it became necessary to use runoff curves and regression equations to estimate bankfull discharge for areas in the Thompsons Fork catchment uncontrolled by the dam. (USGS Water Resources Investigations Report 01-4207, Estimating the Magnitude and Frequency of Floods in Rural Basins of North Carolina (Revised), Benjamin F. Pope, Gary D. Tasker and Jeanne C. Robins, 2001). A 1.8-year flow rate of 285 cfs for the altered mainstem, downstream from the reference reach is based on an interpolated peak flow of 250 cfs from the uncontrolled area below the dam (drainage area = 2.59 square miles), using the regression equations, plus an estimated 35 cfs maximum outflow from the dam during a 2-year event return frequency flow, using the TR-20 watershed model. The Thompsons Fork Watershed Hydraulic Assessment is estimated in **Appendix 3**.

Unnamed Tributary

Bankfull discharge for the Unnamed Tributary was quantified from reference reach boundary conditions and compared to empirical relationships using regression equations published with the *Bankfull Regional Curves for North Carolina Mountain Streams*. The mountain streams regional curves dataset does not include data for streams with drainage areas less than one square mile. Therefore the regression equations developed from the regional curve dataset were used to extrapolate beyond the lower limits of verified bankfull dimensions, discharge and drainage area relationships. The area of a surveyed riffle cross-section near the bottom of the Unnamed Tributary reach, however, approximates the empirical relationship between drainage area and bankfull cross-sectional area extrapolated from the published regional curve data for North Carolina Mountain and

Piedmont streams. The predicted bankfull discharge based on existing channel geometry, channel slope, wetted perimeter, hydraulic radius, bed roughness, and channel slope is 54.9 cfs.



3.3 Channel Morphology

As previously noted, existing morphology along the Thompsons Fork altered mainstem reach is Rosgen Valley Type VIII. The pre-restoration channel is a deeply incised G4/G5 Rosgen stream type. The restoration goal is to reconnect the channel to it's abandoned floodplain and re-establish a stable pattern, profile and dimension consistent with the E4 stream type reference reach boundary conditions. **Table 4** summarizes the geomorphologic and hydraulic data for Thompsons Fork mainstem, its associated Unnamed Tributary and reference reach data collected for the project.

3.4 Channel Stability Assessment

Thompsons Fork Mainstem

In its present state, the stream channel's unstable width to depth ratio, entrenchment ratio (flood prone width/bankfull width = 1.33), relatively flat profile slope (0.0039 ft/ft) and poorly defined active streambed has resulted in a deeply incised, unstable channel disconnected from its floodplain. Mid-channel, lateral, and transverse sand and gravel bar deposits are present at locations throughout the reach, demonstrating the stream lacks stable pattern, profile, dimension, capacity and competency

Table 4: Thompsons Fork and Unnamed Tributary
Geomorphologic and Hydraulic Summary Table
Project Number D06603-A

Variables	Thompsons Fk Ref Reach	Existing Mainstem	Proposed Mainstem	Brindle Ck Ref Reach	Existing UT	Proposed UT
1. Stream Type	E4	G4	E4	C4	C3	C3b
2. Drainage Area, mi^2 (DA)	5.57	7.57	7.57	1.16	0.16	0.16
3. Mean Riffle Depth, ft (d_{bkf})	1.55	2.7	2.4	1.28	0.82	0.96
4. Riffle Width, ft (W_{bkf})	Mean: 15.38 Range:	Mean: 20.9 Range:	Mean: 21.5 Range:	Mean: 24.02 Range:	Mean: 13.1 Range:	Mean: 12.0 Range:
5. Width/Depth Ratio (W_{bkf}/d_{bkf})	Mean: 9.92 Range:	Mean: 7.70 Range:	Mean: 8.96 Range:	Mean: 18.77 Range:	Mean: 16.0 Range:	Mean: 12.5 Range:
6. Riffle Cross-Sectional Area, ft^2 (A_{bkf})	Mean: 23.8 Range:	Mean: 56.5 Range:	Mean: 52.0 Range:	Mean: 30.8 Range:	Mean: 10.7 Range:	Mean: 11.5 Range:
7. Max Riffle Depth (d_{mbkf})	Max: 2.09 Range: 1.09-2.09	Mean: 5.05 Range:	Mean: 3.0 Range:	Mean: 2.41 Range:	Mean: 1.12 Range:	Mean: 1.2 Range:
8. Max Riffle Depth/Mean Riffle Depth (d_{mbkf}/d_{bkf})	Mean: 1.35 Range:	Mean: 1.86 Range:	Mean: 1.25 Range:	Mean: 1.72 Range: 1.62-1.86	Mean: 1.37 Range:	Mean: 1.25 Range:
9. Mean Pool Depth (d_{bkfp})	Mean: 1.85 Range: 1.59-2.72	Mean: 2.35 Range:	Mean: 2.9 Range: 2.5-4.2	Mean: 2.33 Range:	Mean: Range:	Mean: 1.08 Range:
10. Mean Pool Depth/Mean Riffle Depth	Mean: 1.19 Range: 1.02-1.75	Mean: 0.87 Range:	Mean: 1.19 Range: 1.02-1.75	Mean: 1.82 Range:	Mean: Range:	Mean: 1.82 Range:
11. Pool Width (W_{bkfp})	Mean: 17.38 Range:	Mean: 24.1 Range:	Mean: 24.3 Range:	Mean: 26.90 Range:	Mean: Range:	Mean: 13.4 Range:
12. Pool Width/Riffle Width	Mean: 1.13 Range:	Mean: 1.15 Range:	Mean: 1.13 Range:	Mean: 1.12 Range:	Mean: Range:	Mean: 1.12 Range:
13. Pool Cross-Sectional Area, ft^2 (A_{bkfp})	Mean: 32.1 Range:	Mean: 56.6 Range:	Mean: 69.6 Range:	Mean: 62.77 Range:	Mean: Range:	Mean: 23.5 Range:
14. Pool Area/Riffle Area	Mean: 1.35 Range:	Mean: 1.00 Range:	Mean: 1.34 Range:	Mean: 2.04 Range:	Mean: Range:	Mean: 2.04 Range:
15. Max Pool Depth (d_{maxp})	Max: 2.72 Range: 1.59-2.72	Mean: 4.25 Range:	Mean: 4.2 Range:	Mean: 3.06 Range:	Mean: Range:	Mean: 2.30 Range:
16. Max Pool Depth/Mean Riffle Depth (d_{maxp}/d_{bkf})	Mean: 1.75 Range:	Mean: 1.86 Range:	Mean: 1.75 Range:	Mean: 2.39 Range:	Mean: Range:	Mean: 2.39 Range:
17. Max Run Depth (d_{run})	Mean: 1.41 Range: 1.34-1.48	Mean: Range:	Mean: 3.2 Range:	Mean: 2.3 Range: 1.87-2.56	Mean: Range:	Mean: 1.7 Range: 1.0-1.9
18. Ratio Max Run Depth/Bankfull Mean Depth (d_{run}/d_{bkf})	Mean: 1.07 Range:	Mean: Range:	Mean: 1.07 Range:	Mean: 1.80 Range: 1.08-2.00	Mean: Range:	Mean: 1.80 Range: 1.08-2.00
19. Max Glide Depth, ft (d_g)	Mean: 1.43 Range: 0.84-1.80	Mean: Range:	Max: 3.48 Range:	Mean: 2.21 Range: 1.64-2.70	Mean: Range:	Mean: 1.7 Range: 1.6-2.6
20. Ratio Max Glide Depth/Bankfull Mean Depth (d_g/d_{bkf})	Mean: 0.923 Range: 0.542-1.161	Mean: Range:	Max: 1.16	Mean: 1.73 Range: 1.28-2.11	Mean: Range:	Mean: 1.73 Range: 1.28-2.11
21: Lowest Bank Height (LBH)	Mean: 1.14 Range: 1.01-1.26	Mean: 10.02 Range:	Mean: 2.4 Range:	Mean: 2.41 Range:	Mean: 1.82 Range:	Mean: 1.2 Range:
22. Bank Height Ratio, BHR (LBH/d_{mbkf})	Mean: 0.63 Range: 0.60-0.65	Mean: 2.36 Range:	Mean: 1.0 Range:	Mean: 1.0 Range: 0.94-1.08	Mean: 1.63 Range:	Mean: 1.0 Range:
23. Width Floodprone Area, ft (W_{fpa})	Mean: 18.89 Range:	Mean: 32 Range:	Median: 90 Range: 39-100	Mean: 232.0 Range:	Mean: 44.8 Range:	Mean: 71.5 Range: 45.0-85.0
24. Entrenchment Ratio (W_{fpa}/W_{bkf})	Mean: 1.23 Range:	Mean: 2.45 Range:	Mean: 4.19 Range:	Mean: 9.66 Range:	Mean: 3.42 Range:	Mean: 5.96 Range: 3.75-7.08
25. Point Bar Slope (ft/ft)	Mean: N/A Range:	Mean: N/A Range:	Mean: N/A Range:	Mean: 0.01 Range:	Mean: Range:	Mean: 0.01 Range:
26. Bankfull Mean Velocity, ft/s (U_{bkf})	3.1	6.8	3.5	3.19	5.13	4.77
27. Bankfull Discharge, ft^3/s (Q_{bkf})	64.8	285	285	98.2	54.9	54.9
28. Wetted Perimeter, ft (WP)	18.5	24.77	26.3	25.41	14.74	13.92
29. Hydraulic Radius, ft ('R)	1.29	2.28	1.98	1.21	0.73	0.83
30. Meander Length, ft (L_m)	Mean: 104.3 Range: 49.5-119.4	Mean: Range:	Median: 110.4 Range: 89.2-119.9	Mean: 104.8 Range: 88.2-115.7	Mean: Range:	Median: 100.0 Range: 64.2-124.0
31. Meander Length Ratio (L_m/W_{bkf})	Mean: 6.78 Range: 3.22-7.76	Mean: Range:	Median: 5.13 Range: 4.15-5.58	Mean: 4.36 Range: 3.67-4.82	Mean: Range:	Median: 8.33 Range: 5.35-10.33
32. Radius of Curvature, ft (R_c)	Mean: 25.4 Range: 9.7-48.9	Mean: Range:	Median: 28.3 Range: 18.7-48.9	Mean: 13.89 Range: 13.0-24.5	Mean: Range:	Median: 22.6 Range: 14.4-40.9
33. Ratio of Radius of Curvature to Bankfull Width (R_c/W_{bkf})	Mean: 1.65 Range: 0.63-3.18	Mean: Range:	Median: 1.32 Range: 0.87-2.27	Mean: 0.74 Range: 0.54-1.02	Mean: Range:	Median: 1.88 Range: 1.20-3.41
34. Belt Width, ft (W_{blt})	Mean: 36.4 Range: 16.3-56	Mean: Range:	Median: 90 Range: 39-100	Mean: 45.2 Range: 44.2-46-6	Mean: Range:	Median: 71.5 Range: 45.0-85.0
35. Meander Width Ratio (W_{blt}/W_{bkf})	Mean: 2.37 Range: 1.06-3.64	Mean: Range:	Median: 4.19 Range: 1.81-4.65	Mean: 1.88 Range: 1.84-1.94	Mean: Range:	Median: 5.96 Range: 3.75-7.08
36. Individual Riffle Length, ft (L_{rif})	Mean: 18.3 Range: 15.0-21.6	Mean: Range:	Median: 21.8 Range: 14.3-39.4	Mean: 25.7 Range: 19.0-31.0	Mean: Range:	Median: 36.40 Range: 22.6-46.6
37. Riffle Length/Riffle Width	Mean: 1.2 Range: 0.98-1.4	Mean: Range:	Median: 1.01 Range: 0.67-1.83	Mean: 1.07 Range: 0.79-1.29	Mean: Range:	Median: 3.03 Range: 1.88-3.88
38. Riffle-Riffle Spacing, ft (r-r)	Mean: 157.4 Range:	Mean: Range:	Median: 58.1 Range: 44.2-79.8	Mean: 106.2 Range: 91.0-130.2	Mean: Range:	Median: 79.00 Range: 55.0-125.0
39. Ratio of r-r Spacing to Bankfull Width (r-r/W_{bkf})	Mean: 10.2 Range:	Mean: Range:	Median: 2.70 Range: 2.06-3.71	Mean: 4.42 Range: 3.78-5.42	Mean: Range:	Median: 6.58 Range: 4.58-10.42
40. Individual Pool Length, ft	Mean: 24.27 Range: 16.98-32.05	Mean: Range:	Median: 42.6 Range: 28.6-105.0	Mean: 17.4 Range: 11.0-31.6	Mean: Range:	Median: 27.60 Range: 18.4-43.0
41. Pool Length/Riffle Width	Mean: 1.58 Range: 1.10-2.08	Mean: Range:	Median: 1.98 Range: 1.33-4.88	Mean: 0.73 Range: 0.46-1.31	Mean: Range:	Median: 2.30 Range: 1.53-3.58
42. Pool-Pool Spacing, ft (p-p)	Mean: 75.1 Range: 73.1-77.1	Mean: Range:	Median: 61.5 Range: 42.6-83.2	Mean: 71.4 Range: 67.6-77.5	Mean: Range:	Median: 78.40 Range: 63.4-112.0
43. Ratio of p-p Spacing to Bankfull Width (p-p/W_{bkf})	Mean: 4.88 Range: 4.75-5.01	Mean: Range:	Median: 2.86 Range: 1.98-3.87	Mean: 2.97 Range: 2.81-3.23	Mean: Range:	Median: 6.53 Range: 5.28-9.33
44. Individual Run Length, ft	Mean: 8.75 Range: 5.5-12.0	Mean: Range:	Mean: 12.2 Range: 7.7-16.8	Mean: 10.50 Range: 5.0-17.1	Mean: Range:	Mean: 5.3 Range: 2.5-8.5
45. Run Length/Riffle Width	Mean: 0.57 Range: 0.36-0.78	Mean: Range:	Mean: 0.57 Range: 0.36-0.78	Mean: 0.44 Range: 0.21-0.71	Mean: Range:	Mean: 0.44 Range: 0.21-0.71
46. Individual Glide Length, ft	Mean: 6.5 Range: 4.4-8.0	Mean: Range:	Mean: 9.1 Range: 6.2-11.2	Mean: 9.6 Range: 8.3-11.0	Mean: Range:	Mean: 4.8 Range: 4.2-5.5
47. Glide Length/Riffle Width	Mean: 0.42 Range: 0.29-0.52	Mean: Range:	Mean: 0.42 Range: 0.29-0.52	Mean: 0.40 Range: 0.35-0.46	Mean: Range:	Mean: 0.40 Range: 0.35-0.46
48. Stream Length (SL)	578.39	2530	2799	353	2354	2738
49. Valley Length (VL)	431.29	2261	2296	261	2125	2099
50. Valley Slope (VS)	0.0031	0.0044	0.0031	0.0156	0.0353	0.0354
51. Average Water Surface Slope (S_{ws})	0.0024	0.0039	0.0024	0.01154	0.0318	0.0271
52. Sinuosity (k)	SL/VL: 1.34 VS/S: 1.29	SL/VL: 1.12 VS/S: 1.13	SL/VL: 1.22 VS/S: 1.29	SL/VL: 1.35 VS/S: 1.35	SL/VL: 1.11 VS/S: 1.1	SL/VL: 1.3 VS/S: 1.3
53. Riffle Slope (water surface facet slope), ft/ft (S_{rif})	Mean: 0.01129 Range: 0.0099-0.00127	Mean: Range:	Mean: 0.01129 Range: 099-0.00127	Mean: 0.0246 Range: 0.0172-0.0346	Mean: Range:	Mean: 0.0578 Range: 0.0603-0.1215
54. Ratio of Riffle Slope/Average Water Surface Slope (Srif/S)	Mean: 4.70 Range: 4.13-5.29	Mean: Range:	Mean: 4.70 Range: 4.13-5.29	Mean: 2.13 Range: 1.49-3.00	Mean: Range:	Mean: 2.13 Range: 1.49-3.00
55. Run Slope (water surface facet slope), ft/ft (S_{run})	Mean: 0.0043 Range: 0.0024-0.0063	Mean: Range:	Mean: 0.0043 Range: 0024-0.0063	Mean: 0.0211 Range: 0.0125-0.0362	Mean: Range:	Mean: 0.0496 Range: 0.0437-0.1272
56. Ratio Run Slope/Average Water Surface Slope (Srun/S)	Mean: 1.80 Range: 0.98-2.61	Mean: Range:	Mean: 1.80 Range: 0.98-2.61	Mean: 1.83 Range: 1.08-3.14	Mean: Range:	Mean: 1.83 Range: 1.08-3.14
57. Pool Slope (water surface facet slope), ft/ft (S_p)	Mean: 0.0013 Range: 0.0003-0.0020	Mean: Range:	Mean: 0.0013 Range: 0003-0.0020	Mean: 0.0043 Range: 0.001-0.0095	Mean: Range:	Mean: 0.0101 Range: 0.0036-0.0332
58. Ratio Pool Slope/Average Water Surface Slope (S_p/S)	Mean: 0.533 Range: 0.121-0.842	Mean: Range:	Mean: 0.533 Range: 0.121-0.842	Mean: 0.37 Range: 0.09-0.82	Mean: Range:	Mean: 0.37 Range: 0.09-0.82
59. Glide Slope (water surface facet slope), ft/ft (S_g)	Mean: 0.0028 Range: 0.0012-0.0049	Mean: Range:	Mean: 0.0028 Range: 0012-0.0049	Mean: 0.0053 Range: 0.002-0.0075	Mean: Range:	Mean: 0.0124 Range: 0.0069-0.0263
60. Ratio Glide Slope/Average Water Surface Slope (S_g/S)	Mean: 1.175 Range: 0.517-2.046	Mean: Range:	Mean: 1.175 Range: 0.517-2.046	Mean: 0.46 Range: 0.17-0.65	Mean: Range:	Mean: 0.46 Range: 0.17-0.65
61. Particle Size Distribution - Channel Materials (active bed)						
D16 (mm)	3.1			0.84		
D35 (mm)	7.2			18.6		
D50 (mm)	12.0			27.7		
D84 (mm)	38.8			58.3		
D95 (mm)	57.7			87.1		
D100 (mm)	128.0			180.0		
62. Particle Size Distribution of Riffle Material (mm)						
D16 (mm)	14.8	2.1	2.1	20.0	25.5	25.5
D35 (mm)	21.9	9.0	9.0	29.7	31.5	31.5
D50 (mm)	29.4	13.7	13.7	38.5	37.5	37.5
D84 (mm)	50.1	26.2	26.2	60.2	73.4	73.4
D95 (mm)	64.0	36.8	36.8	77.0	84.8	84.8
D100 (mm)	128.0	44.0	44.0	90.0	90.0	90.0

to entrain its bedload. The locations of these depositional features in the near bank region deflects flows from the center of the channel toward the incised vertical to undercut banks, accelerating streambank erosion. Near bank stress at a critical riffle cross-section, is approximately 2.24 lbs/square foot, based on design calculations. The near vertical, denuded streambanks at this location are typical of the existing impaired stream reach throughout the mainstem project corridor. Utilizing the near bank stress method algorithm included in RiverMorph® v.4.0.1a, it is estimated 2,076 cubic yards per year (or 2,700 tons per year) of sediment is being eroded from the unstable, vertical to undercut streambanks along the mainstem. Bank Erosion Hazard Index (BEHI) and sediment export, bank erosion rate estimates, together with bank stability evaluation, or Bank Height Ratio (BHR) calculations, with RiverMorph® model inputs and results are presented in **Appendix 4**.

Thompsons Fork is a vertically incised stream that has abandoned its floodplain due to a lowering of stream base level and is characterized by up to 15 feet high, near vertical to undercut streambanks. The consequence of channelization, cattle intrusion, confinement (lateral containment), major floods, changes in sediment regime, loss of riparian vegetation and shift in stream base level at the invert of the 3-chamber box culvert carrying Thompsons Fork under I-40, constructed in the 1960's, are attributed causes and effects for existing conditions along the altered mainstem reach. The effects of these anthropogenic changes are accelerated streambank erosion, channel incision, land loss, aquatic habitat loss, lowering of the water table, land productivity reduction and in-stream and downstream sedimentation.

Unnamed Tributary to Thompsons Fork

The Unnamed Tributary channel, from the headwater granite bedrock spring from where it emerges is a classic Rosgen Type I valley confined, A1-A2 stream type transitioning to a Type II colluvial valley, B3 stream type at the point where the stream emerges from its deciduous hardwood forested corridor into an open meadow at the top of the impaired reach. The forested segment of the reach exhibits some bedrock control, in-stream boulders with negligible instream woody debris accumulation. The indigenous, well established, healthy riparian vegetative communities in the channel and in the overbank regions provide extremely stable channel conditions. Preservation is proposed for this reach as the aquatic habitat that exist in the streambed substrate may serve as a source population to repopulate degraded aquatic habit features along the Enhancement Level II and Priority Level I reaches of the Unnamed Tributary and the restored mainstem.

Agricultural land use (hayland meadow) adjacent to the stream corridor together with aggressive vegetative management (mowing to the top of the right streambank) has resulted in steep to undercut streambanks, accelerated streambank erosion and channel incision. The unstable streambanks are contributing large volumes of suspended sediment and bedload material to the larger Thompsons Fork mainstem. Utilizing the near bank stress method, adjusted for channel pattern and depositional features algorithm included in RiverMorph® v.4.0.1a, it is estimated 291 cubic yards per year (or 378 tons per year) of sediment is being eroded from streambanks along the Unnamed Tributary under existing conditions. BEHI sediment export and bank erosion rate estimates together with bank stability evaluation, or BHR calculations, with RiverMorph® model inputs and results are presented in **Appendix 4**. Representative photographs of the Unnamed Tributary are presented in **Appendix 5**.

3.5 Bankfull Verification

Thompsons Fork Mainstem

As noted in Section 3.2, for Thompsons Fork mainstem, bankfull discharge was determined through quantitative analysis of stable reference reach data and comparison of predicted bankfull discharge through a stable riffle section located approximately 2,000 feet upstream from the top of the impaired reach (project area). Discharge area versus drainage relationships for the reference reach riffle section were compared to stratified E-type streams data merged from *Bankfull Regional Curves for North Carolina Piedmont and Mountain Streams* datasets. The calculated discharge using quantified reference reach data provided a very poor match to the discharge extrapolated from the stratified data regional curve set due to the 950,000 acre-feet of storage available to regulate peak flows in response to rainfall events. Bankfull discharge at the top of the impaired reach, just below the confluence of Thompsons Fork and Hemphill Creek, with a total contribution drainage area of 7.57 square miles was extrapolated from the from stable reference reach boundary conditions, with a calculated bankfull discharge of 285 cfs utilizing the TR-20 watershed model to estimate flows of the dam, runoff curves and regression equations, to take into account flows from areas of the watershed (2.59 square miles) uncontrolled by Muddy Creek Flood Control Dam No. 8 as presented in Section 3.2.

Considering only the uncontrolled drainage area below the dam tributary to the project (2.59 square miles), and adding 35 cfs contribution discharge from the dam during a bankfull flow event, the regression equations published with *North Carolina Mountains Regional Curve Dataset* predict a bankfull discharge of 267 cfs. This is consistent with the TR-20 watershed model output for drainage areas within the watershed controlled by Muddy Creek Flood Control Dam No. 8 (i.e., predicted bankfull discharge or 285 cfs). The difference between the two discharge estimates is only 18 cfs, so the more conservative (i.e., the larger bankfull discharge estimate) TR-20 watershed model results together with USGS 2001 regression equations have been carried forward into the design for the mainstem altered reach.

The *North Carolina Mountains Regional Curve Dataset* power function regression equation for bankfull discharge is:

$Q_{bkf} = 115.7A_w^{0.73}$, with a coefficient of determination (R^2) = 0.88, where Q_{bkf} = bankfull discharge (cfs) and A_w = watershed drainage area (mi^2), and

$Q_{bkf} = 115.7 \times 2.59^{0.73} = 232 \text{ cfs} + 35 \text{ cfs} = 267 \text{ cfs}$

As previously noted, the more conservative bankfull discharge estimate (285 cfs) using the USGS regression equations for drainage areas uncontrolled by Muddy Creek Flood Control Dam No. 8, and TR-20 watershed model analysis for contribution discharge from the dam's primary outfall has been carried forward into the mainstem design.

Unnamed Tributary

Bankfull characteristics for the Unnamed Tributary were interpreted directly from regression equations published with the *Bankfull Regional Curves for North Carolina Mountain Streams*. The mountain streams regional curve dataset does not include data for A, B and C stream types with drainage areas less than one square mile. Therefore the regression equations developed from the regional curves dataset were used to extrapolate beyond the lower limits of verified bankfull discharge, dimension and drainage area empirical relationships. The area of a surveyed riffle cross-section at altered profile station approximately 400 feet north of South Creek Road on Unnamed Tributary reach, however, approximates the empirical relationship between drainage area and bankfull cross-sectional area extrapolated from the regression equations published regional curve data for North Carolina mountain streams. The surveyed bankfull cross-sectional area (A_{bkf}) is 10.7 ft^2. The A_{bkf} derived from the published power function regression equation, $A_{bkf} = 22.1A_w^{0.67}$, where A_w is the watershed area in square miles (for the Unnamed Tributary, the drainage area is 0.16 square miles or 104 acres), yields a bankfull cross-sectional area of 6.5 ft^2. The survey verification of the cross-sectional area needed to carry the calculated bankfull discharge of 54.9 cfs, taking into account drainage area, average bankfull slope, streambed roughness, wetted perimeter and hydraulic radius has therefore been carried forward into the design for the impaired Unnamed Tributary reach, with minor modifications to maintain a width to depth ratio greater than 12.

3.6 Vegetation

The existing riparian corridor along Thompsons Fork is extremely thin (5 to 10 feet wide) within the project area, widening for only a short distance at the downstream end near the box culvert under Interstate 40. The stream banks are highly degraded and denuded in several areas. Where present, the corridor contains few woody species, including *Alnus rugosa* (tag alder), *Platanus occidentalis* (Eastern sycamore), and *Cornus amomum* (silky dogwood), as well as some *Carex scoparia* (broomsedge). Cattle pasturelands are present immediately adjacent to the corridor. Photographs of the Thompsons Fork corridor are included within **Appendix 4**.

A very narrow forested corridor is present along the majority of the right bank of the Unnamed Tributary. Typical species observed along this bank include *Cornus amomum, Bignonia capreolata* (crossvine), *Ilex* opaca (American holly), *Aeschynomene* species (jointed vetch), and the invasive species *Ligustrum sinense* (Chinese privet) and *Lonicera japonica* (Japanese honeysuckle). Cattle pastureland is present outside of the riparian corridor along the right bank of the tributary. The left bank of the tributary consists of a fully vegetated hill slope, consisting predominately of the following species: *Abies* species (fir), *Pinus taeda* (loblolly pine), *Pinus elliottii* (slash pine), *Ostrya virginiana* (Eastern hophornbeam), *Diospyros virginiana* (persimmon), *Kalmia latifolia* (mountain laurel), and *Plantanus occidentalis*. Along the upper limits of the Unnamed Tributary (where the forest has not been cleared for pastureland), the right bank also remains fully vegetated. **Appendix 5** presents photographs of the Unnamed Tributary.

4.0 REFERENCE STREAMS

4.1 Watershed Characterization

Thompsons Fork Mainstem

A stable reference reach was selected using aerial orthophotography (1998) and NCDOT LiDAR contour data coverages for the drainage area tributary to the restoration project in the Thompsons Fork watershed.

The location of the reference reach in relation to the mainstem altered reach is shown on **Figure 3**. The top of the reference reach begins at 35.69417° North Latitude and 81.90667° West Longitude. The drainage area tributary to the reference reach is 5.57 square miles. Muddy Creek Flood Control Dam No. 8 regulates flows from 4.99 square miles of the watershed area and regulates 89.6 percent of the runoff and sediment budget available to the reference reach.

Dimension, pattern, profile and substrate data were collected along the reference reach and quantitatively evaluated using RiverMorph® v.4.0.1a software application. Two complete meander wavelengths along the reference reach were evaluated using accepted stream assessment methodologies and procedures (D.L. Rosgen, 1994). Reference reach geomorphologic summary reports, dimensionless ratios, longitudinal profile, cross-sections, including photographs taken at stable riffle and pool cross-section locations, are included in **Appendix 5**. **Figure 7A** presents pattern summary for the reference reach. **Figure 7B** presents pattern summary for a relatively stable reach along Thompsons Fork immediately upstream from the top of altered mainstem project reach.

Thompsons Fork Unnamed Tributary

The Brindle Creek reference reach, located near the headwaters in the Silver Creek catchment (Targeted Watershed 50050, Subbasin 31), begins at 35°37'07" North Latitude and 81°48'58" West Longitude (NAD 83, UTM Zone 17 Coordinates 691,930.87 N, 1,163,198.35 E GPS Reference Point), was selected as a reference reach for the Thompsons Fork Unnamed Tributary. The drainage area tributary to the reference reach is 1.16 square miles. The location of the reference reach is shown on **Figure 3A**.

Dimension, pattern, profile and substrate data were collected along the reference reach on January 13, 2005 and were quantitatively evaluated using RiverMorph® v.4.0.1.a software application. Reference reach geomorphologic summary reports, dimensionless ratios, longitudinal profile, cross-sections, including photos taken at stable riffle and pool cross-section locations, are included in **Appendix 6**.

4.2 Channel Classification

Thompsons Fork Mainstem

The reference reach is located approximately 2,800 feet upstream from the altered mainstem reach on Thompsons Fork. The reference reach is a Rosgen E4 stream type that has lost connection to its adjacent healthy, deciduous hardwood forested riparian corridor and floodplain. Muddy Creek Flood Control Dam No. 8, constructed in 1964 and located approximately 3,000 feet upstream from the top of the reference reach, regulates peak flows on the mainstem channel below the dam. Additionally, clear water "sediment hungry" discharge from the dam has resulted in a concave profile along the reference reach, as determined by a Rosgen Level III assessment and analysis of the reference conditions during August 2006.

Unnamed Tributary to Thompsons Fork

Brindle Creek is a stable, Rosgen C4 stream type with excellent connection to its healthy, deciduous hardwood forested floodplain. Calculated discharge for a stable reference reach riffle cross-section was compared to stratified C Type streams data from *Bankfull Regional Curves for North Carolina Mountain Streams* dataset. The calculated discharge using quantified reference reach data is a very close match to the stratified data's empirical relationships.

4.3 Discharge

Thompsons Fork Mainstem

The calculated bankfull discharge, using quantified reference reach data collected at a stable riffle cross-section 2,800 feet upstream from the altered mainstem reach is 64.8 cfs, as discussed in detail in Section 3.2. Calculated discharge at the reference reach riffle cross-section was compared to stratified E Type streams data from *Bankfull Regional Curves for North Carolina Piedmont and Mountain Streams* dataset. The calculated discharge using quantified reference reach data provides a poor match in comparison to the stratified data's empirical relationships between discharge versus drainage area. Reference reach analytical data summaries and photographs are presented in **Appendix 6**.

Thompsons Fork Unnamed Tributary

The Brindle Creek calculated bankfull discharge, using quantified and verified reference reach data collected at a stable riffle cross-section is 96.1 cfs. The calculations are included in the information within **Appendix 6**.

4.4 Channel Morphology

Thompsons Fork Mainstem

The reference reach channel morphology summary report is presented in **Appendix 6**. Stream channel morphology data for the reference reach, the Thompsons Fork mainsteam, and the Unnamed Tributary is presented in tabular format in **Table 4**.

Thompsons Fork Unnamed Tributary

The Brindle Creek reference reach channel morphology summary report is presented in **Appendix 6**. Stream channel morphology data for the reference reach and the Unnamed Tributary to Thompsons Fork is presented in tabular format in **Table 4**.

4.5 Channel Stability Assessment

Thompsons Fork Mainstem

As shown on the photographs in **Appendix 6**, the plant community exists over the streambanks into the active channel along the reference reach. High root densities and depths were observed at both stable riffle and pool locations throughout the reference reach, with healthy communities of canopy, understory, shrub and herbaceous species present. Best-fit trend lines drawn through the bankfull indicator points, water surface and thalweg points, respectively, on the longitudinal profile are essentially parallel. There is no indication of head cutting, downcutting, aggradation or degradation. As noted in Section 3.2, when a best fit curve is plotted through the reference reach thalweg points, the bedform exhibits a concave profile. This is attributed to moderate streambed scouring resulting from the clear water discharge from Muddy Creek Flood Control Dam No. 8, located approximately 3,000 feet upstream from the top of the reference reach. Otherwise, the reference reach is a stable, third-order E4 stream channel, with a large gravel to small cobble streambed substrate, based on quantitative analysis of reference reach boundary conditions measured in the field.

Thompsons Fork Unnamed Tributary

As shown on the photographs in **Appendix 6**, the plant community exists over the streambanks into the active channel along the Brindle Creek reference reach. High root densities and depths were observed at both stable riffle and pool locations throughout the reference reach, with healthy communities of canopy, understory, shrub and herbaceous species present. Best-fit trend lines drawn through the bankfull indicator points, water surface and thalweg points, respectively, on the longitudinal profile are essentially parallel. There is no indication of head cutting, downcutting, aggradation or degradation. The reference reach is an extremely stable, second-order C4 stream channel, with a large gravel to small cobble streambed substrate, based on quantitative analysis of reference reach boundary conditions measured in the field.

4.6 Bankfull Verification

Thompsons Fork Mainstem

See Section 3.2 and 4.3 for reference reach bankfull verification details and supporting documentation in **Appendix 6**.

Thompsons Fork Unnamed Tributary

The Brindle Creek reference reach is a stable, Rosgen C4 stream type with excellent connection to its healthy, deciduous hardwood forested floodplain. Calculated discharge for a stable reference reach riffle cross-section (98.2 cfs) was compared to stratified C Type streams data from *Bankfull Regional*

Curve for North Carolina Mountain Streams dataset. The calculated discharge using quantified reference reach data provides a very close match to the stratified data's empirical relationships.

4.7 Vegetation

Thompsons Fork Mainstem

The reference reach exists within a second- to third-growth, forested floodplain containing herbaceous ground cover, shrubs, understory and mature upper canopy trees. Tree species observed along the reference reach include *Pinus taeda*, *Platanus occidentalis*, *Ostrya virginiana,* and *Alnus serrulata*. *Quercus species* (oak) were also observed further out from the stream within the forested valley. Invasive *Ligustrim sinense* was the dominant shrub adjacent to the stream in this area, and a few *Cornus florida* (flowering dogwood) shrubs were also noted. Vegetative cover along the reference reach is much more intact than along the Thompsons Fork altered mainstem reach. The reference reach flows through a wide forested area, rather than a sparsely vegetated and disconnected riparian corridor, typical of the mainstem altered reach. Vegetation along the reference reach is largely undisturbed, and tree roots along the channel are providing bank stability along the reach. Photographs of the reference reach are provided within **Appendix 6**.

Thompsons Fork Unnamed Tributary

The Brindle Creek reference reach flows through a second-growth, forested floodplain containing mature trees, understory saplings, shrubs and herbaceous ground cover. Tree species observed along the reference reach include *Pinus taeda*, *Platanus occidentalis*, *Quercus rubra* (red oak), and *Fagus grandifolia* (American beech). Scattered *Symplocos tinctoria* (common sweetleaf) shrubs were also present. Vegetative cover along the reference reach is more diverse, dense and intact than along Enhancement Level II and Priority I altered reaches on the Thompsons Fork Unnamed Tributary. The reference reach flows through a healthy deciduous hardwood forest, rather than a narrow mowed riparian corridor. Vegetation along the reference reach is undisturbed, and tree roots along the streambanks are providing lateral stability along the reach. Photographs of the Brindle Creek reference reach are provided within **Appendix 6**.

5.0 PROJECT SITE RESTORATION PLAN

5.1 Restoration Project Goals and Objectives

Thompsons Fork Mainstem

The primary goal and objective for this project reach is to restore stable pattern, profile and dimension along the mainstem of Thompsons Fork. This will be accomplished using an off-line, Priority I approach to reconnect the laterally confined and incised existing channel to its abandoned floodplain. Grade control structures will be used to reduce critical shear stress in the near bank region while maintaining flow velocities and critical depths required to entrain coarse gravel (D84 particle size = 26.2 mm), based on analysis of riffle bed particle distributions collected from both the stable reference reach and the altered mainstem reach riffle conditions.

The restoration plan for Thompsons Fork utilizes proven geomorphologic approaches developed by understanding and implementing stable channel dimension, pattern and profile, based on data extrapolated from reference reach boundary conditions and superimposing the stable dimension, pattern and profile on the unstable form. The Priority I, off-line restoration approach for the altered mainstem reach entails reconnecting the realigned channel to its adjacent floodplain with appropriate elevation, width, valley slope and channel dimensions, extrapolated from stable geomorphologic and hydraulic parameters measured and quantified from reference reach boundary conditions upstream from the project.

The proposed channel will be an E4 stream type designed with stable dimension, pattern and profile to entrain its bedload without aggrading or degrading at bankfull stage. In-stream structures will be utilized to reduce shear stress in the near bank region. Grade control structures will be required to prevent the clear water discharge from the upstream flood control dam from eroding the channel bed and banks.

A combination of in-stream structures such as cross-vanes, J-hook vanes, rock vanes, log vanes, constructed riffles, and streambank reinforcement consisting of boulder toe, coir roll, live stakes and live branches, combined with heavy coir fabric jute matting, held in place with hardwood stakes and soil nails, as shown on the restoration plan detail sheet RP-14/21, will be constructed at appropriate locations throughout the reach to reduce near bank stress and prevent streambank erosion. In-stream stabilization structures will be utilized, where needed, to maintain entrainment velocities required to move coarse gravel-size particles, readily available to the stream, during bankfull flow conditions while maintaining competency to mobilize sand size particles at normal stage. The in-stream structures have the added benefit of creating aquatic habitat and preventing the development of deleterious mid-channel sand and gravel bars that increase flow velocities and shear stress in the near bank region. The plan sheets and design details for the Thompsons Fork mainstem are presented in **Appendix 1**.

In addition, a vegetated riparian corridor will be established along the realigned Thompsons Fork mainstem reach to enhance streambank stability, provide sediment and nutrient storage, create and enhance terrestrial and aquatic habitat. The stream corridor plantings will be protected by the installation of livestock exclusion fencing along the left bank at the edge of the conservation easement boundary.

Unnamed Tributary to Thompsons Fork

The primary goal for the Unnamed Tributary is to restore stable pattern, profile, dimension, and floodprone width, together with revetment of plant communities the riparian corridor with indigenous instream, stream side, overbank and floodplain.

The near vertical right bank and adjacent, mowed meadow laterally confines this segment of the Unnamed Tributary, preventing the stream from establishing stable pattern, profile and dimension to dissipate energy without eroding its banks. The restoration approach along this reach is to size and construct a stable, natural C3b (profile gradient greater than 0.02 ft/ft) channel by increasing the belt width to the extent that a sinuosity of approximately 1.38 can be achieved along the Priority Level I reach. This pattern will allow re-establishment of riffle, run, pool and glide sequences that will enable the channel to entrain its bedload without neither aggrading nor degrading while maintaining channel dimension, pattern and profile at bankfull stage.

Proposed belt width along the Priority Level I reach will range between 45 to 85 feet and will reconnect the channel to its floodplain by restoring the floodprone width. Step-pools, constructed riffle, run, pool and glide sequences will be utilized to reduce shear stress in the near bank region and alleviate streambank erosion. Aggressive revetment of the new floodplain and riparian corridor with native herbaceous, shrub, understory and canopy plant species will be completed as set forth in Sections 5.5 and 6.3 of this restoration plan.

Step-pools will be constructed at appropriate spacings and locations to dissipate energy during bankfull flows. The plan and profile sheets presenting the design for the Unnamed Tributary stream are provided on sheets RP-09/21 through RP-13/21 in **Appendix 1**. Design specification and in-stream structure details for the Unnamed Tributary are presented on restoration plan sheets RP-14/21 through RP-16/21 in **Appendix 1**.

5.1.1 Designed Channel Classification

The designed mainstem channel is a stable E4 channel, with restored pattern, profile and dimension to entrain its bedload. The designed Unnamed Tributary stream will be restored to a stable C3b stream type. Table 5 summarizes the restoration structure and objectives for Thompsons Fork Mainstem and the Unnamed Tributary.

TABLE 5
Thompsons Fork and Unnamed Tributary Restoration Structure and Objectives
Project Number D05016-1 (Thompsons Fork and Unnamed Tributary)

Reach/Approach	Existing Length	Proposed Length	Stationing	Comment
Mainstem Priority Level I Restoration	2,530 lf	2,784 lf	0+00 – 27+54	Restore stable channel pattern, profile, dimension, substrate, reconnection to abandoned floodplain, riparian revetment, livestock exclusion fencing (left bank only)
UT Preservation	356 lf	356 lf	Upstream Property Line to top of Enhancement Level II Reach	Perpetual conservation easement with livestock exclusion fencing (right bank only)
UT Enhancement Level II	400 lf	390 lf	0+00 – 4+00	Step-pool bank stabilization and profile restoration, livestock exclusion fencing (right bank only)
UT Priority Level I Restoration	1,598 lf	1,982 lf	4+00 – 23+82	Restore stable channel pattern, profile, dimension, substrate, floodprone area, riparian revetment, livestock exclusion fencing

5.1.2 Target Buffer Communities

The target buffer community for both the Thompsons Fork mainstem and the Unnamed Tributary is of the Piedmont/Low Mountian Alluvial Forest community type, as described in *Classification of the Natural Communities of North Carolina* (Schafale and Weakley, 1990). According to the Schafale and Weakley publication, hydrology of these areas is palustrine, seasonally or intermittently flooded on various alluvial soils. Important characteristics regarding the Piedmont/Low Mountain Alluvial forest Community according to Schafale and Weakley, 1990 include the following:

- *Flood carried sediment provides nutrient input to these communities, as well as serving as a natural disturbance factor.*

- *Variation is probably most related to frequency and recentness of destructive flooding. Sites may vary due to different alluvial material and its effect on soil fertility but almost all alluvial sites are more fertile than surrounding uplands.*

- *Piedmont/Low Mountain alluvial forests may be distinguished from mesic communities by location in a floodplain and by the presence of alluvial species such as Platanus occidentalis, Betula nigra, and Acer negundo.*

- *Piedmont Alluvial Forests may be distinguished from Montane Alluvial Forests by the presence of low elevation alluvial species such as Liquidambar styraciflua, Acer negundo, Fraxinus pennsylvanica, Ulmus americana, and Ulmus alata.*

5.2 Sediment Transport Analysis

5.2.1 Methodology

The modified Shields Equation was used to calculate the largest entrainable particle size, based on site-specific stable and altered boundary conditions for the Thompsons Fork mainstem and the Unnamed Tributary. (Rosgen, 1994; Williams and Rosgen, 1989; Andrews, 1984).

5.2.2 Calculations and Discussion

Shields (1936) described shear stress as:

$$\tau = \gamma RS$$

where:

τ = shear stress (lbs/sq. ft.)
γ = specific weight of water (62.4 lbs/cu. ft.)
R = hydraulic radius (ft.), and
S = channel slope (ft./ft.).

To test the relationship between shear stress and mean stream velocity at multiple flow levels, Rosgen (1994) used an aggregate data set for six stream types. By plotting discharge (cfs) vs. bedload (lbs/sec) it was demonstrated a significant relationship was not found for the aggregate data set. Rosgen found, however, there is a significant empirical relationship when the same data set was stratified by stream type and shear stress (lbs/sq. ft.) was plotted vs. mean velocity (ft/sec) on a log-log scale.

The bankfull shear stress required to entrain the design particle diameter ($D50_{BED}$) of 13.7 millimeters is 0.172 lbs/sq. ft. with a required hydraulic radius of 1.97 feet, bankfull mean depth of 2.24 feet, and a mean bankfull velocity of 5.48 ft/sec.

The associated critical dimensionless shear stress (τ_{ci}*) was calculated based on the D50 particle distribution collected at altered mainstem riffle section 0+60 and composite D50 particle distribution from the bar sample collected at the confluence of the Thompsons Fork mainstem and the Unnamed Tributary reference reach is 0.0183.

The critical dimensionless shear stress, returned from RiverMorph®, is calculated using the following equation (Williams & Rosgen, 1989):

$$\tau_{ci}^* = 0.0834(D50_{BED}/D50_{BAR})^{-0.872}$$

The following equation is used to predict the depth and slope needed to move the largest size of sediment available to the channel:

$$d = \frac{(\tau_{ci}^*)(\gamma_S)(D50_{BAR})}{S}$$

Where:

γ_S = submerged specific weight of sediment
$D50_{BAR}$ = median diameter of bar sample
d = mean depth
S = mean water surface slope at bankfull

The required bankfull water surface slope, based on boundary conditions as noted, is 0.0024 ft/ft. To maintain stable geomorphic geometry relationships, streambed structures, constructed using strategically placed bank stabilization structures will be utilized, where needed, to increase entrainment velocities needed to entrain sand-size particles through the system at normal stage, while maintaining entrainment velocities and critical depths required to move the D50 design particle through the system at bankfull discharge. The streambed structures have the added benefit of creating additional aquatic habitat and will prevent the development of deleterious depositional sand and gravel bars features within the active streambed. Entrainment calculations are included in the RiverMorph design summary reports in **Appendix 4**.

5.3 HEC-RAS Analysis

A comprehensive floodplain study has been prepared in support of a request for a floodplain use permit from McDowell County Planning Department for the proposed stream restoration on Thompsons Fork. The HEC-RAS analyses and McDowell County floodplain use permit application are presented in **Appendix 7**.

5.4 Stormwater Best Management Practices

5.4.1 Site-Specific Stormwater Concerns

Properly installed and well maintained Best Management Practices (BMP) applications shall adequately mitigate the impact of sediment laden stormwater flows within the project corridors. The stormwater BMP erosion and sediment control narrative, practices, schedule, contractor responsibilities, inspection, maintenance and soil stabilization measures are presented on restoration plan sheet RP-17/21 in **Appendix 1**. All BMP applications as shown on restoration plan sheets RP-18/21 through RP-21/20 will be inspected and maintained throughout the construction process and until the site is stabilized per the planting plan shown on sheet RP-21/21 in **Appendix 1** and as described in Section 5.5 which follows.

5.5 Natural Plant Community Restoration

5.5.1 Plant Community Restoration Plan

The proposed riparian planting plan was developed by integrating the native plant species observed on site along with selected species known to inhabit the Piedmont/Low Mountain alluvial forest community type as described in *Classification of the Natural Communities of North Carolina* (Schafale and Weakley, 1990) to institute species diversity. According to the Schafale and Weakley publication, hydrology of these areas is palustrine, seasonally or intermittently flooded on various alluvial soils. Important characteristics regarding the Piedmont/Low Mountain alluvial forest community according to Schafale and Weakley, 1990 include the following:

- *Flood carried sediment provides nutrient input to these communities, as well as serving as a natural disturbance factor.*

- *Variation is probably most related to frequency and recentness of destructive flooding. Sites may vary due to different alluvial material and its effect on soil fertility but almost all alluvial sites are more fertile than surrounding uplands.*

- *Piedmont/Low Mountain alluvial forests may be distinguished from mesic communities by location in a floodplain and by the presence of alluvial species such as Platanus occidentalis, Betula nigra, and Acer negundo.*

- *Piedmont Alluvial Forests may be distinguished from Montane Alluvial Forests by the presence of low elevation alluvial species such as Liquidambar styraciflua, Acer negundo, Fraxinus pennsylvanica, Ulmus americana, and Ulmus alata...*

Thompsons Fork Mainstem

Along the mainstem of Thompsons Fork, the majority of the restored riparian zone will be located within the created bankfull bench and toe slope areas. The sparse amount of vegetation currently along the stream will likely be cleared during restoration construction. The restored stream will be fully replanted with the appropriate native species in the form of live stakes or bare-root material, along with some larger specimens (1 gallon container size). Planting zones have been designated for Thompsons Fork as described in the tables below. The bare root seedlings will be planted during the later summer or fall, as soon as possible after the completion of the earthwork associated with constructing the new stream channels. During the following spring, supplemental shrub and tree species will be planted if survival rates of previously planted seedlings are below target densities as determined in late summer (August-September). Final species selection will be based upon availability. In addition to planting described below, temporary and permanent seeding will occur in Zones 2, 3 & 4. The planting plan is presented in the schematic engineering drawings, included on design sheet RP-17/19 in Appendix 1.

Proposed Thompsons Fork Plantings

- Zone 1 – Stream Edge

Live Branches, 3x3' centers

Common Name	Scientific Name
Silky dogwood	*Cornus amomum*
Southern arrowwood viburnum	*Viburnum dentatum*
Elderberry	*Sambucus canadensis*
Black willow	*Salix nigra*

- Zone 2 – Streamside Shrubs and Trees

Shrubs, Bareroot Material - 4x4' centers

Common Name	Scientific Name
Painted buckeye	*Aesculus sylvatica*
Silky dogwood	*Cornus amomum*
Tag alder	*Alnus serrulata*
Black willow	*Salix nigra*
Elderberry	*Sambucus canadensis*
Southern arrowwood viburnum	*Viburnum dentatum*

Zone 2 – Streamside Shrubs and Trees (cont.)

American hazelnut	*Corylus americana*
American holly	*Ilex opaca*
Persimmon	*Diospyros virginiana*

Trees, 1 Gallon Containers - 100 foot spacing

Common Name	Scientific Name
Box elder	*Acer negundo*
River birch	*Betula nigra*
Sycamore	*Platanus occidentalis*
Sweet gum	*Liquidambar styraciflua*
Green ash	*Fraxinus pennsylvanica*
Tulip poplar	*Liriodendron tulipifera*
American elm	*Ulmus americana*
Bitternut hickory	*Carya cordiformis*

- Zone 3 – Floodplain

Bareroot Material - 8x8' centers

Common Name	Scientific Name
Box elder	*Acer negundo*

River birch	*Betula nigra*
Sycamore	*Platanus occidentalis*
Sweet gum	*Liquidambar styraciflua*
Green ash	*Fraxinus pennsylvanica*
Tulip poplar	*Liriodendron tulipifera*
American elm	*Ulmus americana*
Bitternut hickory	*Carya cordiformis*
Persimmon	*Diospyros virginiana*

- Zone 4 – 30' Riparian Buffer

  Bareroot Material - 10x10' centers

Common Name	Scientific Name
White ash	*Fraxinus americana*
Black walnut	*Juglans nigra*
Tulip poplar	*Liriodendron tulipifera*
Black gum	*Nyssa sylvatica*
Black cherry	*Prunus serotina*
White oak	*Quercus alba*
Eastern hophornbeam	*Ostrya virginiana*
Mountain laurel	*Kalmia latifolia*
Strawberry bush	*Euonymus americanus*

Unnamed Tributary to Thompsons Fork

Presently, the majority of the right bank along the Unnamed Tributary has only a thin corridor of shrubs and trees and is in some areas denuded. Invasive *Lonicera japonica* and *Ligustrum sinense* were identified within this corridor. What little corridor is present will be cleared for restoration purposes along the right bank, including the invasive species. A full replanting of the right bank of the Unnamed Tributary will occur, following the 'zone' methodology prescribed for the mainstem of Thompsons Fork. The left bank of the tributary is currently a fully vegetated hill slope, which will be preserved during the restoration. Any incidental clearing along the left bank necessary for restoration construction will be replanted accordingly following the specifications for Zone 1 plantings. Planting along meander bends will also follow Zone 1 specifications.

5.5.2 On-Site Invasive Species Management

This project proposes to treat and eradicate exotic woody vegetation by appropriate means. This will help meet one of the overall goals of the restoration project by enhancing buffers and creating habitat for birds and animals. By eradicating non-native vegetation, native vegetation will be allowed to colonize and provide a better food source for the local fauna.

Before treatment, a vegetation assessment would be performed to determine extent of invasive vegetation. The most appropriate treatment options will be determined after the assessment. Invasive Japanese honeysuckle and Chinese privet have already been identified along the Unnamed Tributary and will be removed during construction.

Possible treatments for invasive exotic vegetation include application of appropriate herbicides either through stem cut and spray or spraying of the actively photosynthesizing leaves. This work would most likely be done in the fall or winter, during the dormant season of most native vegetation. The initial treatment would likely take a week to complete. Follow up and maintenance is critical in order to eradicate any root sprouts that may occur in the following seasons.

6.0 PERFORMANCE CRITERIA

6.1 Streams

As discussed in the original proposal, the restoration goal for the stream is to restore the physical and biological integrity beyond current stream conditions. Current conditions consist of modified or impaired stream channels. Objectives to meet that goal of restoring these stream channels include the following:

1. Provide a stable stream channel with features characteristic of a biologically diverse environment.
2. Restore the connection between the bankfull width and floodprone width of the channels by restoring the floodplain area.
3. Stabilize eroding streambanks.
4. Provide a functional, native riparian floodplain corridor where deficient, and preserve any existing forested corridor.
5. Improve the physical aquatic habitat features.
6. Minimize land development impacts to the streams.
7. Provide long-term protection of the stream corridors.

Restoration of the streams will provide desired habitat and stability features necessary to improve the quality of the stream. There are many long-term benefits derived from the efforts to restore the streams, such as:

- reversing the effects of channel incision
- stabilizing eroding streambanks
- development of instream habitat features
- re-vegetation of the riparian corridor with native, wildlife friendly plants
- construction of a floodplain with the accompanying benefits of sediment and nutrient storage

The restoration techniques proposed for the Unnamed Tributary stream will provide the attributes described above by incorporating a variety of features recognized to support the stability and biological diversity that are essential to restoration and ecosystem enhancement. Presently, these features are diminished within Thompsons Fork and the associated Unnamed Tributary.

The restoration of the streams includes assessing and predicting the morphological features that will become the foundation for the construction of a stable natural channels. Considerations that have been applied to the design of this project are listed below.

- Bankfull channels designed with the appropriate dimension and cross-sectional area to convey anticipated bankfull flows and to entrain bedload material.

- Stable channel pattern (sinuosity) extrapolated from stable reference reaches boundary conditions.
- Grade control and bank stabilization structures to enhance the environmental and ecological attributes of the stream channels though the use of natural materials and native plantings.
- In-stream habitat features, such as sand/gravel bars, pool/riffle complexes, rock vanes, cross-vanes, J-hook vanes, log vanes, bank stabilization structures, step-pools (where appropriate) and re-establishment of the appropriate substrate material.
- Reconnection of the stream channels to functional floodplains, to be accomplished using a combination of Priority Level I (raising the stream channel) restoration.
- Installation of extensive woody riparian plantings.

Proven natural stream geometry relationships as described by Newbury, Leopold, Wolman, Miller, Rosgen and others, is the basis for designing a stable, self-maintaining channel. These empirical relationships between channel pattern, profile and dimension and stream flow form the foundation for the restoration of the physical and biological functions of the stream.

6.2 Stormwater Management Devices

Properly installed and well maintained Best Management Practices (BMP) applications shall adequately mitigate the impact of sediment laden stormwater flows within the project corridors. The stormwater BMP erosion and sediment control narrative, practices, schedule, contractor responsibilities, inspection, maintenance and soil stabilization measures are presented on restoration plan sheet RP-17/21 in **Appendix 1**. All BMP applications as shown on restoration plan sheets RP-18/21 through RP-21/20 will be inspected and maintained throughout the construction process and until the site is stabilized per the planting plan shown on sheet RP-21/21 in **Appendix 1**.

6.3 Vegetation

The target density for the riparian buffer is to establish a minimum of 320 stems per acre after 3 years, with a minimum of 260 stems per acre at the end of the 5-year monitoring period. This would represent a minimum survival rate of 80% of the plantings.

6.4 Monitoring Schedule and Reporting

The restoration site will be monitored for five consecutive years or until the required success criteria have been met as determined by the EEP, NC DWQ, and USACE. Monitoring activities will begin immediately following completion of the stream construction in order to alleviate any potential problems as they occur. Planting will occur during the late summer/fall of 2007; therefore, the riparian buffer restoration will be monitored the following growing season projected to be late summer/fall of 2008. Monitoring activities will follow the guidelines presented in the request for proposal for this project.

Parameters that will be included in the annual stream monitoring to ensure the success of the restoration activities will include stream channel surveys (longitudinal and cross-sectional profiles), pebble counts, photographs, and vegetation surveys.

Following the submittal of the monitoring reports to the appropriate agency representatives, the recipients of the report will be contacted for the purpose of discussing the monitoring data, required success criteria and whether or not the site is functioning as expected. If the site is not functioning as expected, a site visit will be scheduled with the review agencies so that consideration can be given to whether a remediation plan should be created and implemented. The remediation plans, if required, will directly reflect the requested alterations as discussed with the regulatory agencies, if it is determined that such alterations will correct any identified deficiencies.

Stream Channels

Stream channel stability will be physically monitored by establishing permanent cross-sections located approximately every 500 feet along the restored channels (or no more than 2 per thousand feet). Each cross-section will be monumented for future identity and survey. All of these cross-sectional surveys will also be utilized as photographic points. Cross-section locations to be monitored will be established immediately following construction during the completion of the "as-built" survey. A longitudinal profile survey will be conducted along the entire restoration reach of the Thompsons Fork mainstem as well as the entire Unnamed Tributary. The "as-built" mitigation plan will include the constructed stream channel dimension, pattern, and longitudinal profile. This data will be utilized as baseline to compare future monitoring surveys and subsequently to determine channel stability and transition. Other data collected will include at least six pebble counts for the project, stream pattern data, and stream side plant conditions. Annual inspection of in-stream structures will also occur to verify proper function and channel stability. Stream channel monitoring surveys will be completed annually for five consecutive years, starting on Year 1 after completion of the project.

The performance standards for the restoration project are those mandated in the multi-agency *Stream Mitigation Guidelines* (USACE Wilmington District, et al., April 2003). Performance goals for the site are:

- Minimal or negligible development of instream bar deposits.
- Minimal or negligible change in channel pattern, profile and dimension in comparison to As-Built conditions. Adjustments may occur and some may be indicative of stability, for example moderate reductions in width/depth ratios as a result of slight channel narrowing, natural sorting and shaping of bed materials and features, respectively.
- Maintenance of floodplain connectivity (only reductions or very small increases will be considered acceptable).
- Target density of 320 stems per acre after 3 years and 260 stems per acre after 5 years for planted woody vegetation (represents 80% survival after 5 years).

Subsequent monitoring reports will address the attainment of performance goals. If goals are not be attained, then the monitoring reports will document any remedial actions taken during the monitoring period and the success of these actions.

Riparian Buffers

Vegetation within the restored riparian buffer will be monitored for five consecutive years. A total of 8 ten by ten meter square plots will be permanently established following completion of the planting phase and at least two opposing corners will be permanently installed and surveyed for future use.

Approximately 3.2% of the project area will be monitored following the CVS-EEP Level 1 Protocol for Recording Vegetation, Version 4.0 (Lee et al., 2006). A stem count of planted species will be performed within each monitoring plot. The species, location, size, density, survival rates, and cause of mortality if identifiable will be reported for each planted species in each plot. Vegetation plots will be sampled annually and reported every year along with the data collected during the physical monitoring of the channel. The primary focus of the vegetative monitoring will be on the planted individuals in the tree and shrub strata. Vegetation monitoring will occur between the months of August and October.

Monitoring reports and discussions of remedial actions will take place with EEP. EEP will review the monitoring documents and make them available to the agencies after the review period. Decision making regarding remediation will be between EEP and WRC and its agents or representatives. Agency interaction will take place through permit requests for maintenance should they become necessary. Agency interaction will take place at the end of the monitoring period.

7.0 REFERENCES

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8.0 FIGURES

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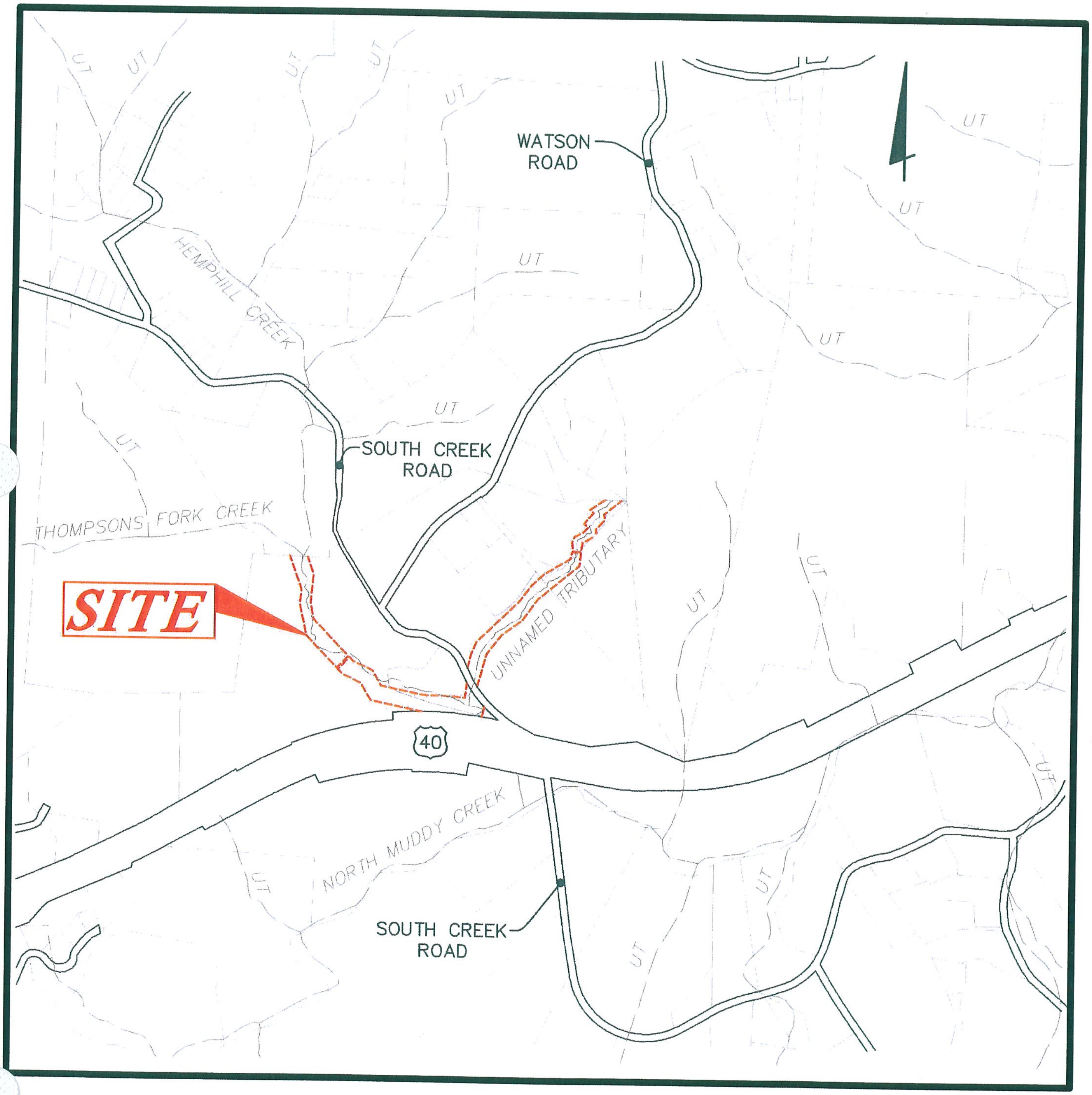
MCDOWELL COUNTY, NORTH CAROLINA

THOMPSONS FORK CREEK

STREAM RESTORATION PROJECT

FIGURE 1

Date: January, 2007	Job No. 2006-1398	Scale: 1" = 1200'



\\CMHDATA2\ENVIRON\PROJECT\20061398\DWG\FIGURES\FIGURE 1 - LOCATION MAP.DWG<FIGURE 1> - NO XREFS - SAVED BY JCRAMER (1/25/2007 11:16:57 AM) - PLOTTED BY JCRAMER (1/25/2007 11:17:09 AM)

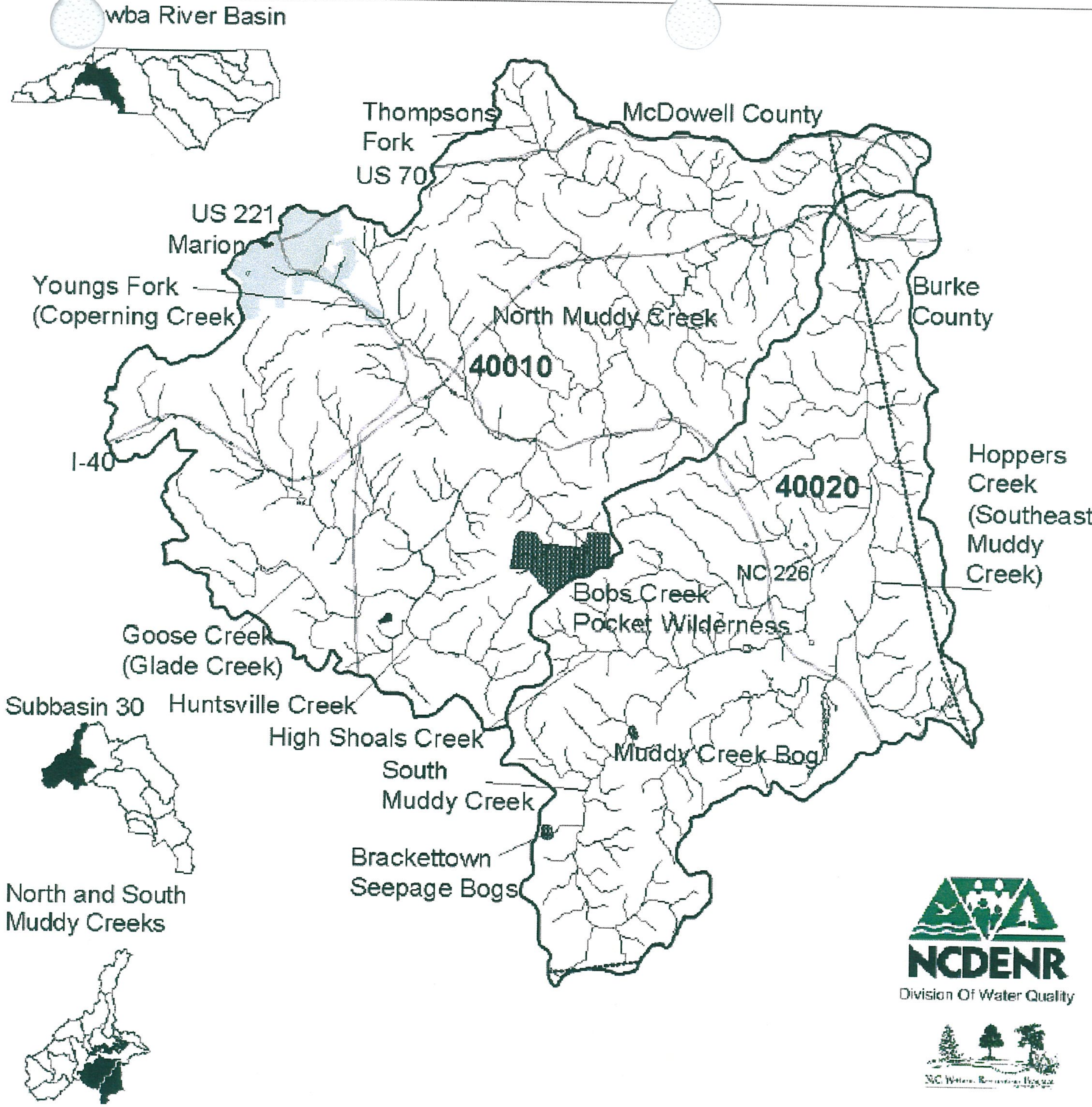


Figure 2
Catawba River Subbasin 30 Targeted Local Watersheds 40010 and 40020 North and South Muddy Creeks

This map was produced on January 27, 2001 by the North Carolina Division Of Water Quality Wetlands Restoration Program. Geographic information was provided by North Carolina Center for Geographic Information and Analysis
This map was based on:
Projection: Stateplane zone 4901
Datum: NAD83
Spheroid: GRS 1980
Units: Meters

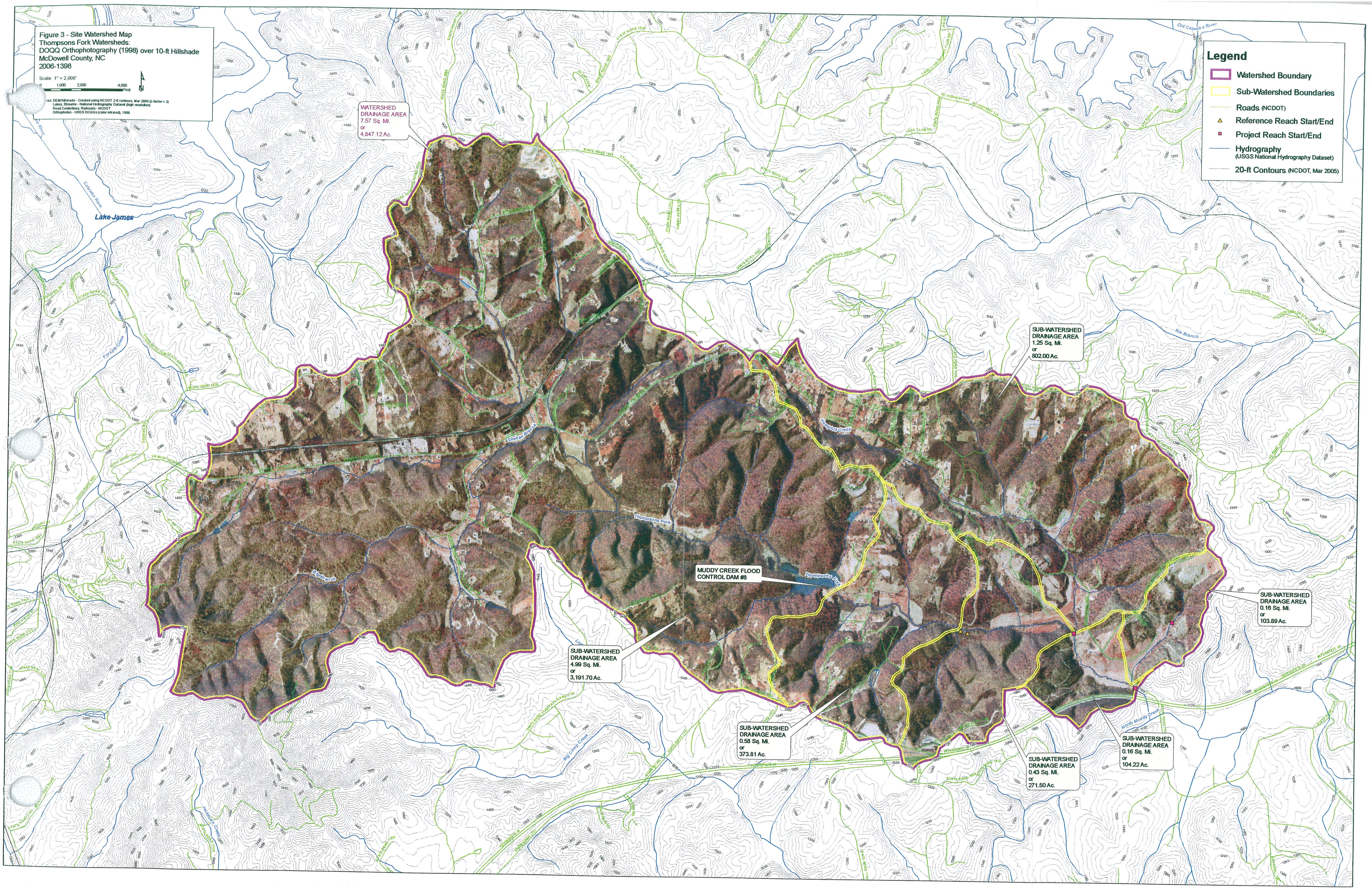
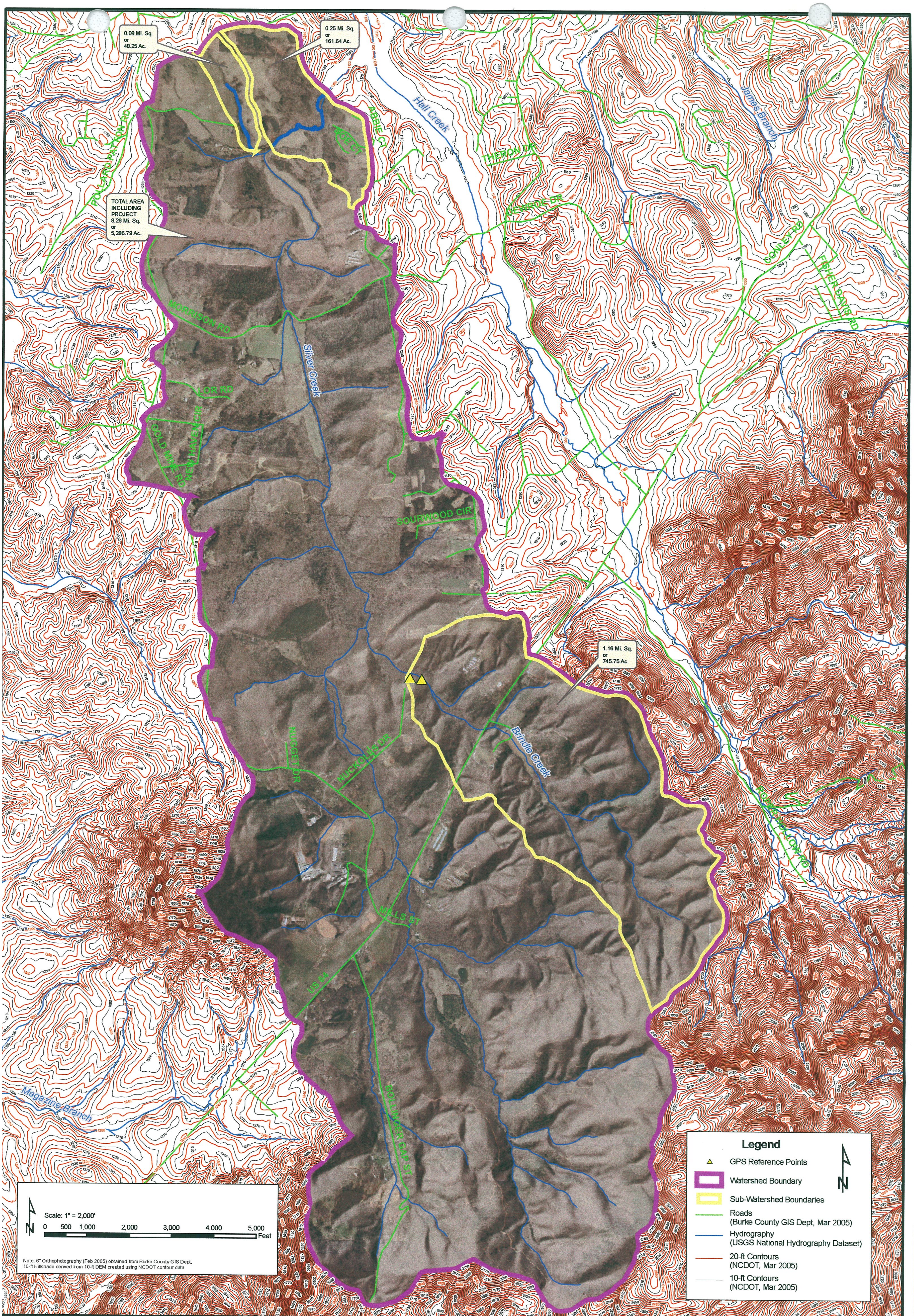


Figure 3 - Site Watershed Map
Thompsons Fork Watersheds:
DOQQ Orthophotography (1998) over 10-ft Hillshade
McDowell County, NC
2006-1398



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BURKE COUNTY, NORTH CAROLINA

SILVER CREEK WATERSHEDS
6" Orthophotography (Feb 2005) over 10-ft Hillshade
FIGURE 3A

Date: May, 2006

Ecosystem Enhancement PROGRAM

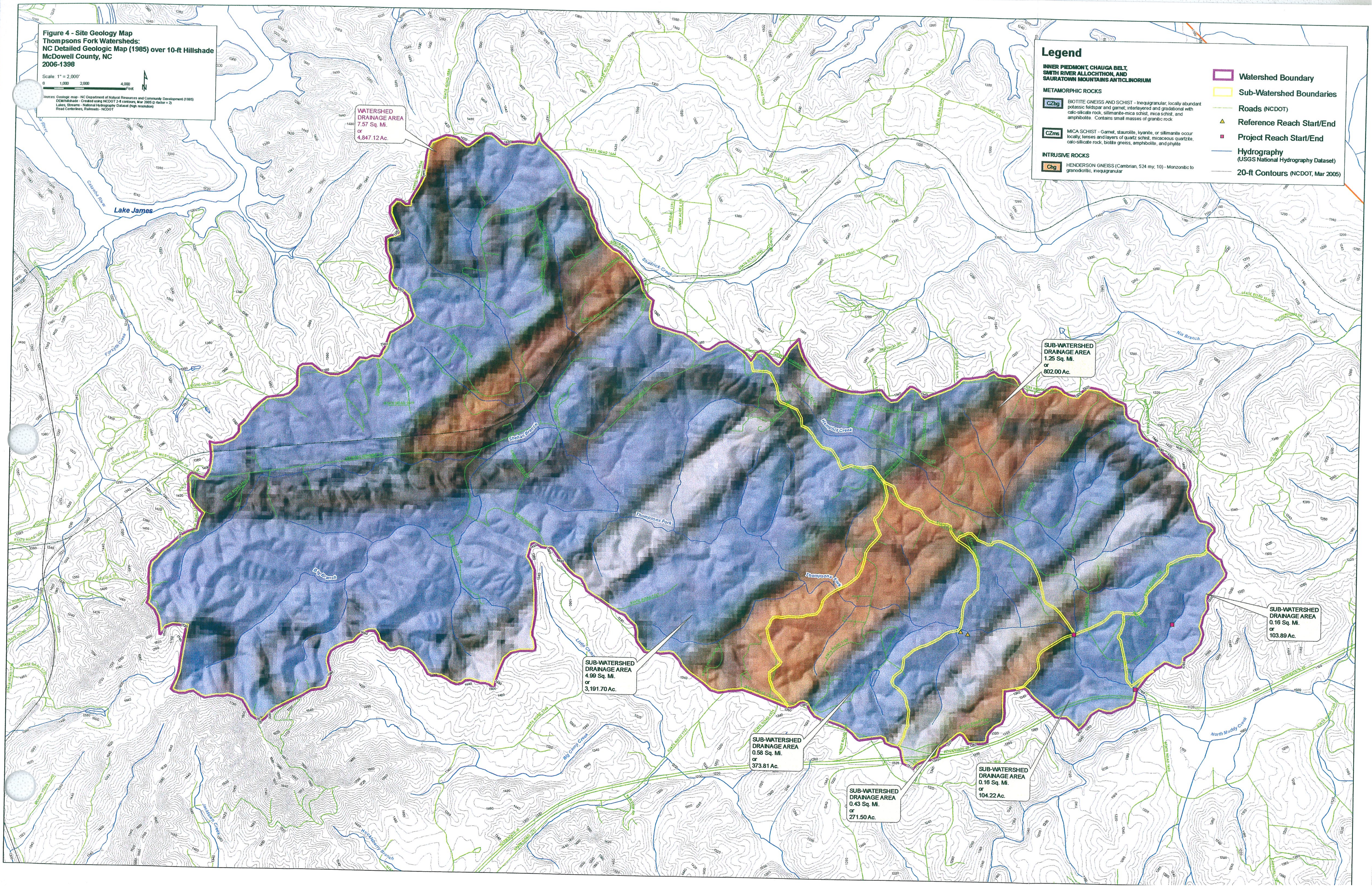
Figure 4 - Site Geology Map
Thompsons Fork Watersheds:
NC Detailed Geologic Map (1985) over 10-ft Hillshade
McDowell County, NC
2006-1398
Scale: 1" = 2,000'
0 1,000 2,000 4,000 Feet
N
Sources: Geologic map - NC Department of Natural Resources and Community Development (1985)
DEM/hillshade - Created using NCDOT 2-ft contours, Mar 2005 (z-factor = 2)
Lakes, Streams - National Hydrography Dataset (high resolution)
Road Centerlines, Railroads - NCDOT
Legend
INNER PIEDMONT, CHAUGA BELT, SMITH RIVER ALLOCHTHON, AND SAURATOWN MOUNTAINS ANTICLINORIUM
METAMORPHIC ROCKS
CZbg
BIOTITE GNEISS AND SCHIST - Inequigranular, locally abundant potassic feldspar and garnet; interlayered and gradational with calc-silicate rock, sillimanite-mica schist, mica schist, and amphibolite. Contains small masses of granitic rock
CZms
MICA SCHIST - Garnet, staurolite, kyanite, or sillimanite occur locally; lenses and layers of quartz schist, micaceous quartzite, calc-sillicate rock, biotite gneiss, amphibolite, and phylite
INTRUSIVE ROCKS
Chg
HENDERSON GNEISS (Cambrian, 524 my; 10) - Monzonitic to granodicritic, inequigranular
Watershed Boundary
Sub-Watershed Boundaries
Roads (NCDOT)
Reference Reach Start/End
Project Reach Start/End
Hydrography
(USGS National Hydrography Dataset)
20-ft Contours (NCDOT, Mar 2005)
WATERSHED DRAINAGE AREA 7.57 Sq. Mi. or 4,847.12 Ac.
SUB-WATERSHED DRAINAGE AREA 1.25 Sq. Mi. or 802.00 Ac.
SUB-WATERSHED DRAINAGE AREA 0.16 Sq. Mi. or 103.89 Ac.
SUB-WATERSHED DRAINAGE AREA 4.99 Sq. Mi. or 3,191.70 Ac.
SUB-WATERSHED DRAINAGE AREA 0.58 Sq. Mi. or 373.81 Ac.
SUB-WATERSHED DRAINAGE AREA 0.43 Sq. Mi. or 271.50 Ac.
SUB-WATERSHED DRAINAGE AREA 0.16 Sq. Mi. or 104.22 Ac.
Lake James
Thompsons Fork
Shadrick Creek
Nix Branch
North Muddy Creek

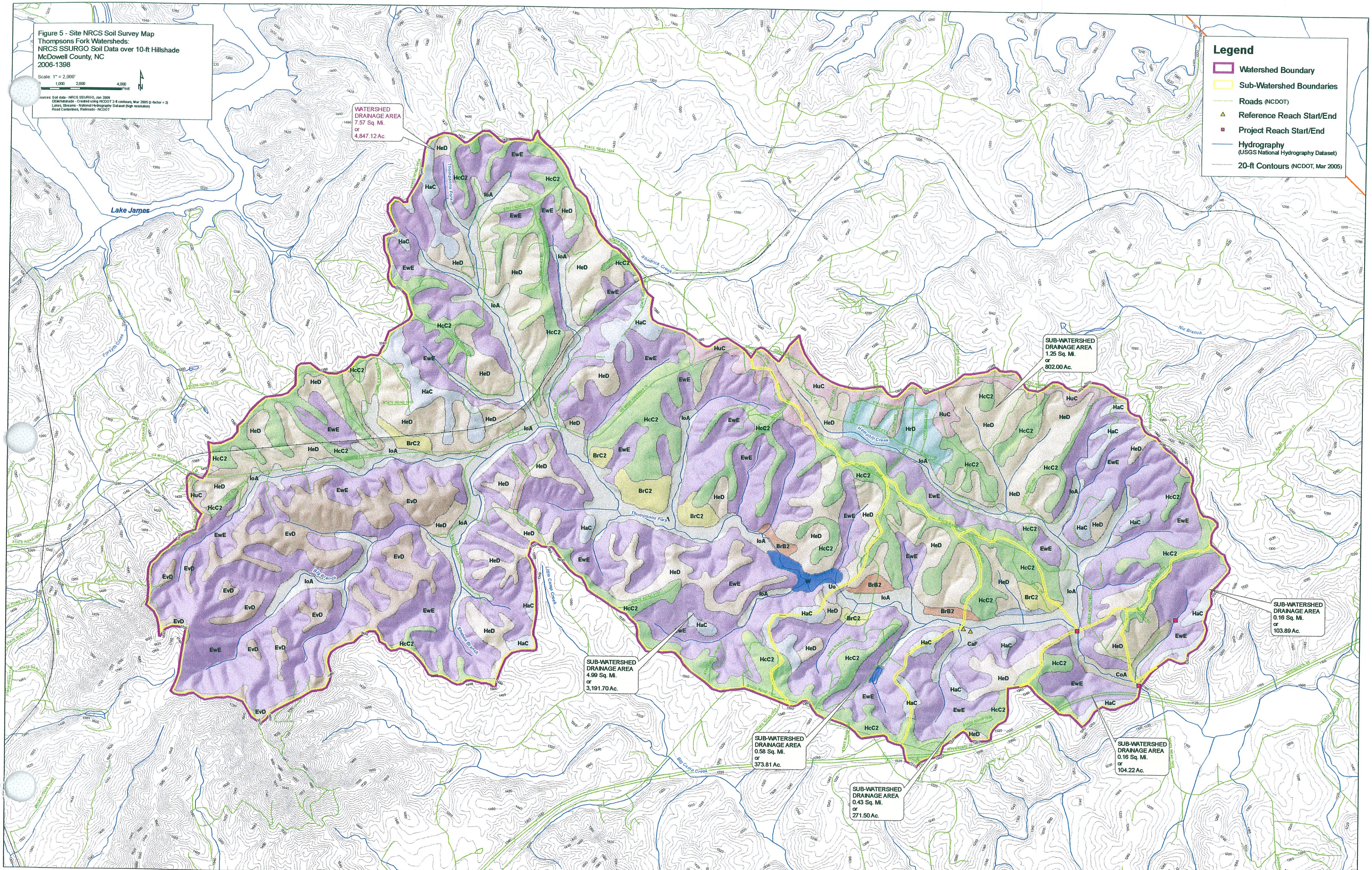

Figure 5 - Site NRCS Soil Survey Map
Thompsons Fork Watersheds:
NRCS SSURGO Soil Data over 10-ft Hillshade
McDowell County, NC
2006-1398

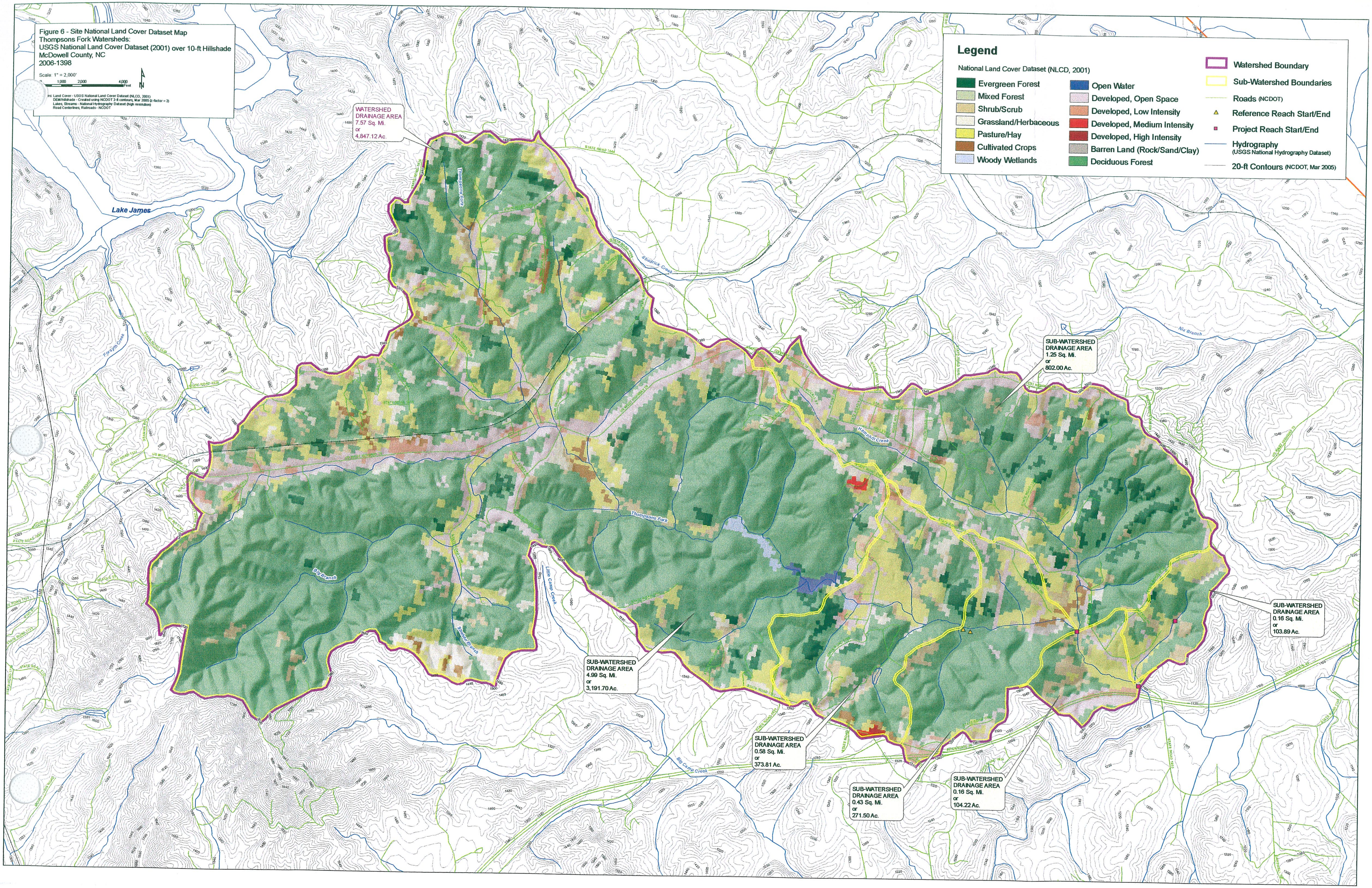
Figure 6 - Site National Land Cover Dataset Map
Thompsons Fork Watersheds:
USGS National Land Cover Dataset (2001) over 10-ft Hillshade
McDowell County, NC
2006-1398
Scale: 1" = 2,000'
1,000 2,000 4,000 Feet
N
es: Land Cover - USGS National Land Cover Dataset (NLCD, 2001)
DEM/hillshade - Created using NCDOT 2-ft contours, Mar 2005 (z-factor = 2)
Lakes, Streams - National Hydrography Dataset (high resolution)
Road Centerlines, Railroads - NCDOT
Legend
National Land Cover Dataset (NLCD, 2001)
Evergreen Forest
Mixed Forest
Shrub/Scrub
Grassland/Herbaceous
Pasture/Hay
Cultivated Crops
Woody Wetlands
Open Water
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land (Rock/Sand/Clay)
Deciduous Forest
Watershed Boundary
Sub-Watershed Boundaries
Roads (NCDOT)
Reference Reach Start/End
Project Reach Start/End
Hydrography
(USGS National Hydrography Dataset)
20-ft Contours (NCDOT, Mar 2005)
WATERSHED DRAINAGE AREA 7.57 Sq. Mi. or 4,847.12 Ac.
Lake James
Thompsons Fork
Little Camp Creek
Big Branch
SUB-WATERSHED DRAINAGE AREA 1.25 Sq. Mi. or 802.00 Ac.
SUB-WATERSHED DRAINAGE AREA 0.16 Sq. Mi. or 103.89 Ac.
SUB-WATERSHED DRAINAGE AREA 4.99 Sq. Mi. or 3,191.70 Ac.
SUB-WATERSHED DRAINAGE AREA 0.58 Sq. Mi. or 373.81 Ac.
SUB-WATERSHED DRAINAGE AREA 0.43 Sq. Mi. or 271.50 Ac.
SUB-WATERSHED DRAINAGE AREA 0.16 Sq. Mi. or 104.22 Ac.
Nix Branch
Big Camp Creek

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MCDOWELL COUNTY, NORTH CAROLINA

THOMPSONS FORK RESTORATION

REFERENCE REACH - PATTERN SUMMARY EXHIBIT
FIGURE 7A

Date:	January, 2007
Scale:	1" = 50'
Job No:	2006-1398
Sheet:	1 of 2

Thompsons Fork Pattern Summary

Sinuosity (K) = Stream Length/Valley Length Reach 1

Reach 1	
SL	VL
578.39'	431.29'
K = 1.3	

Meander Length (Lm) Mean, Min and Max

Mean	Min	Max
104.3'	49.5'	119.4'

Radius of Curvature (Rc) Mean, Min and Max

Mean	Min	Max
25.4'	9.7'	48.9'

Belt Width (Wblt) Mean, Min and Max

Mean	Min	Max
36.4'	16.3'	56.0'

Thompsons Fork Reference Reach

Reference Reach GPS Data Points

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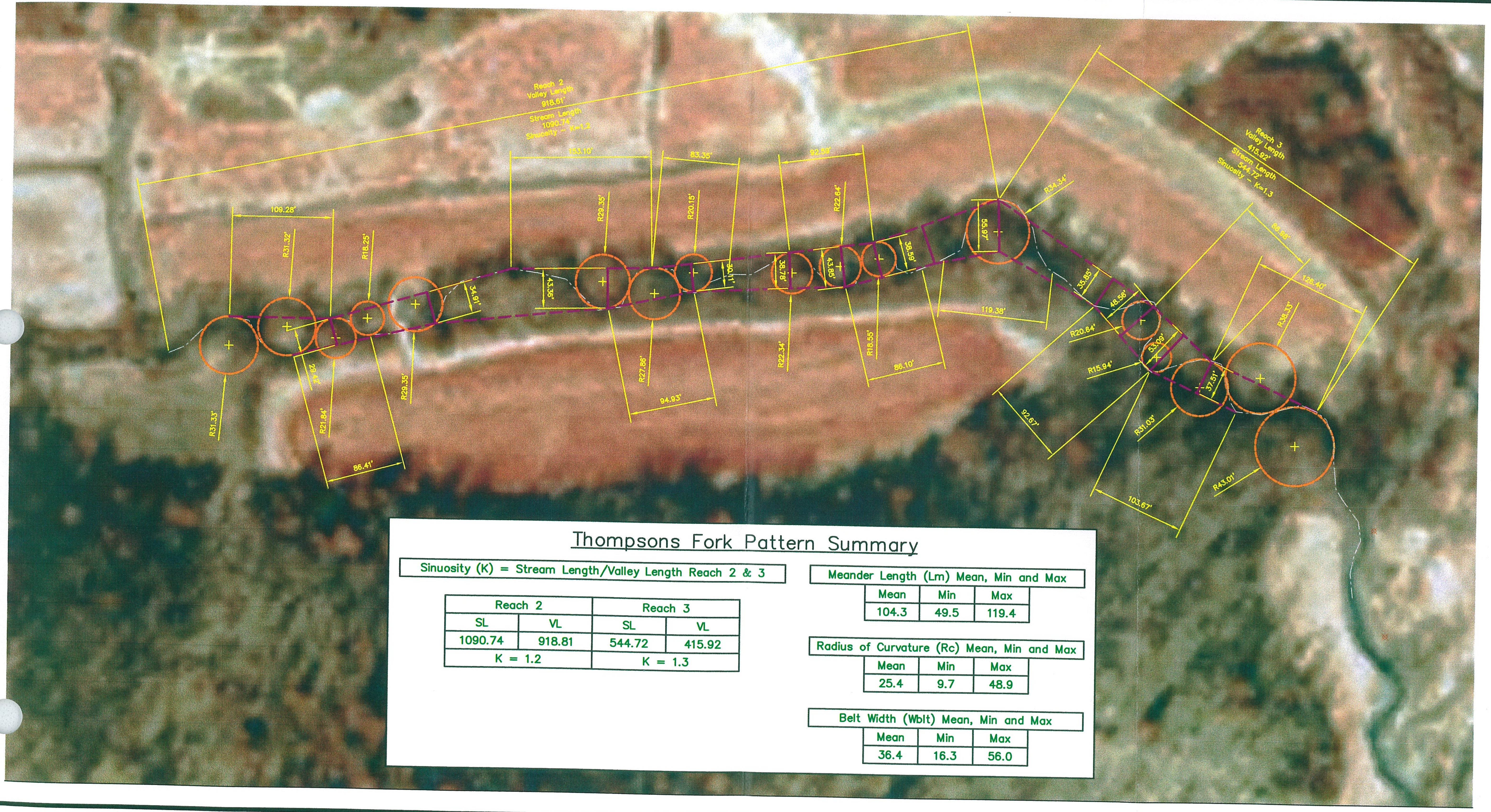
THOMPSONS FORK RESTORATION

REFERENCE REACH - PATTERN SUMMARY EXHIBIT

FIGURE 7B

Date:	January, 2007
Scale:	1" = 50'
Job No:	2006-1398
Sheet:	2 of 2



Thompsons Fork Pattern Summary

Sinuosity (K) = Stream Length/Valley Length Reach 2 & 3

Reach 2		Reach 3	
SL	VL	SL	VL
1090.74	918.81	544.72	415.92
K = 1.2		K = 1.3	

Meander Length (Lm) Mean, Min and Max

Mean	Min	Max
104.3	49.5	119.4

Radius of Curvature (Rc) Mean, Min and Max

Mean	Min	Max
25.4	9.7	48.9

Belt Width (Wblt) Mean, Min and Max

Mean	Min	Max
36.4	16.3	56.0

9.0 APPENDICES

APPENDIX 1

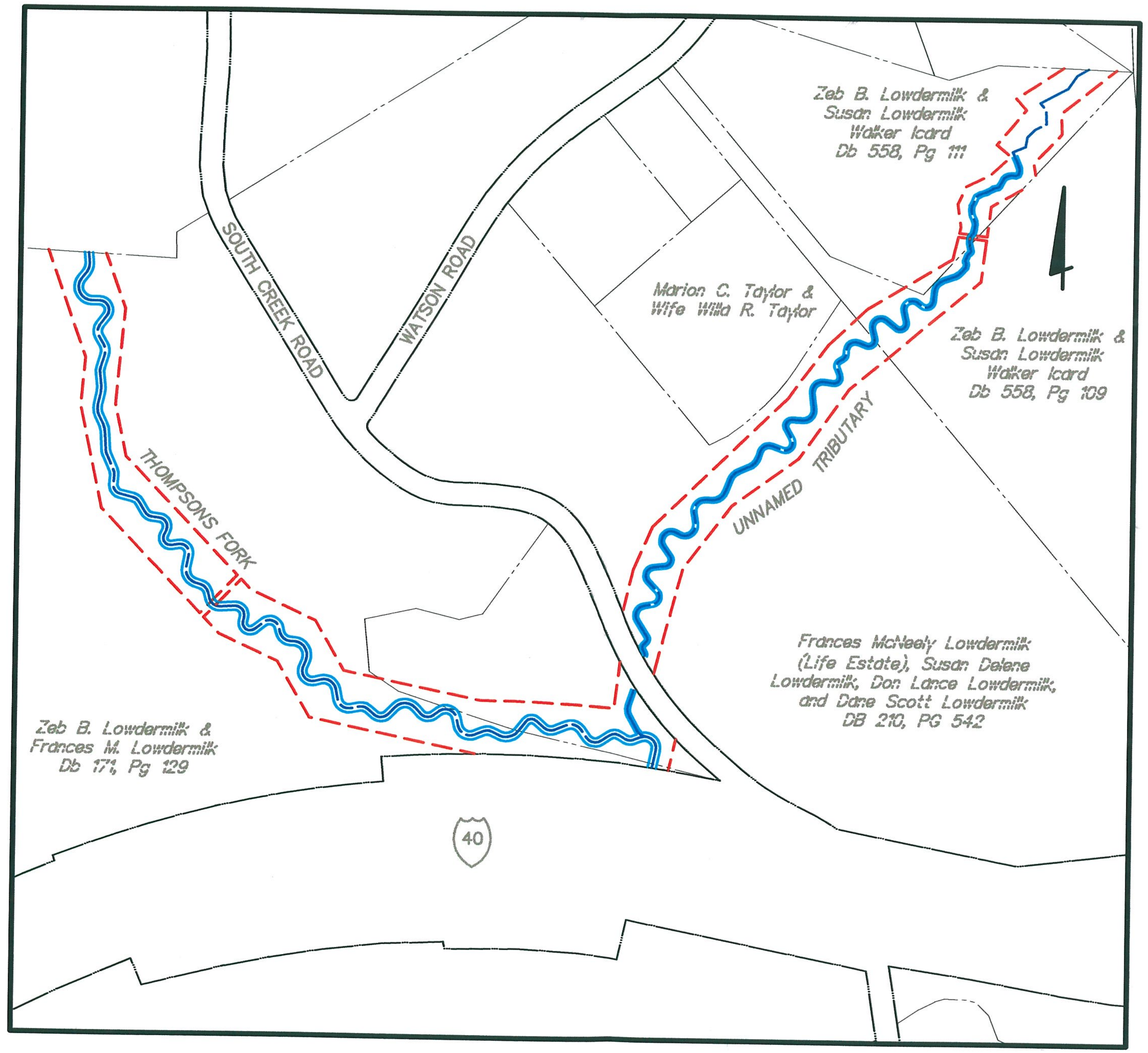
Restoration Plan Design Sheets

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
2007

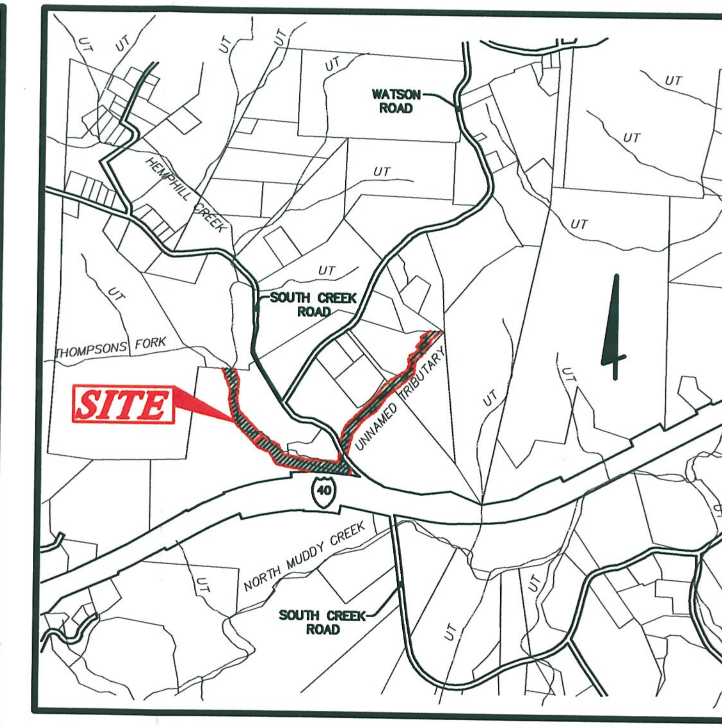
INDEX OF SHEETS

STREAM DESIGN STATISTICS

Parameters	Thompson Fork	Unnamed Tributary
Watershed Area at Downstream End	7.57 Sq. Mi.	0.16 Sq. Mi.
Average Sinuosity	1.22	1.32
Average Meander Length	110'	100'
Bankfull Width	21.5'	12'
Bankfull Depth	24.3'	13.4'
W/D Ratio	8.96	12.5
Floodprone Width	39' – 100'	45' – 85'
Entrenchment Ratio	4.19	5.96
Bankfull Discharge at Downstream End	285 cfs	42 cfs
Bankfull Velocity at Downstream End	3.5 ft/s	3.9 ft/s



LOCATION MAP
Scale: 1"=400'



VICINITY MAP
Not To Scale

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
STREAM RESTORATION PROJECT
TITLE SHEET

Job No. 2006-1398
Date May, 2007
Scale As Noted
Sheet RP-01/21

Ecosystem Enhancement PROGRAM

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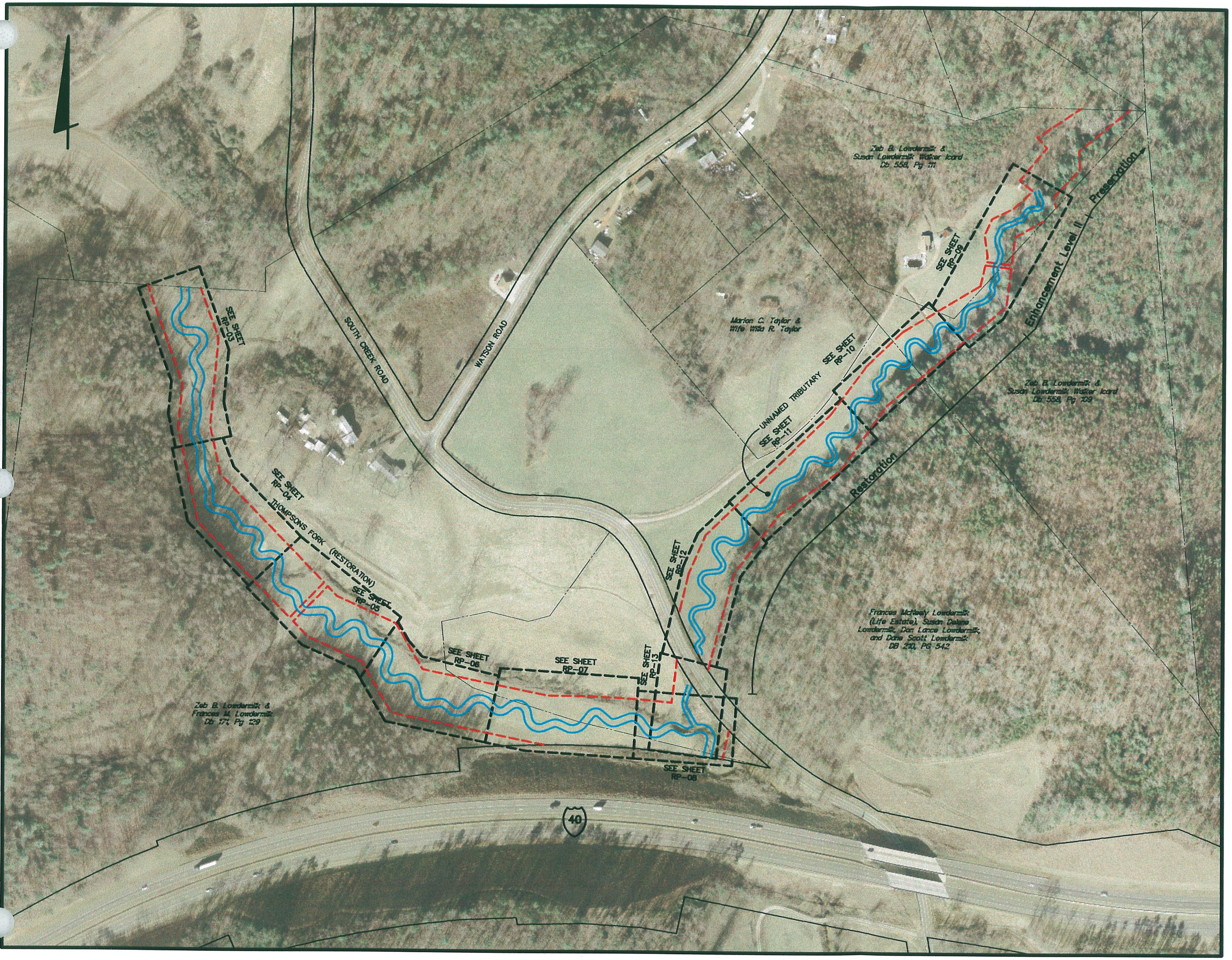
REVISIONS
MARK | DATE | DESCRIPTION

PRELIMINARY
NOT FOR CONSTRUCTION



INDEX MAP
Scale: 1" = 300'

LEGEND

- EX. UTILITY POLE
- EX. TREE
- EX. TREE LINE
- EX. 1 FOOT CONTOURS
- EX. 5 FOOT CONTOURS
- EX. FENCE
- EX. PROPERTY LINE
- EX. RIGHT OF WAY
- EX. STREAM
- PROP. THALWEG
- PROP. BANKFULL
- PROP. BELTWIDTH
- PROP. CONSERVATION EASEMENT
- TEMPORARY SEDIMENT FENCE
- TEMPORARY DIVERSION CHANNEL
- TEMPORARY DIVERSION CHANNEL (RUNOFF CONTROL)
- PROP. WIRE FENCE (LIVESTOCK EXCLUSION)
- TEMPORARY STREAM CROSSING
- TEMPORARY EARTHEN PLUG
- TEMPORARY ROCK FILTER OUTLET
- PROP. CONSTRUCTED POINT BAR
- PROP. STEP POOL
- PROP. RIFFLE
- PROP. POOL
- PROP. CROSS VANE
- PROP. STEP RIFFLE
- PROP. J-HOOK
- PROP. BANK REINFORCEMENT

Job No.	Sheet
2006-1398	RP-02/21

Date	Scale
May, 2007	As Noted

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
STREAM RESTORATION PROJECT
INDEX SHEET

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MARK	DATE	DESCRIPTION

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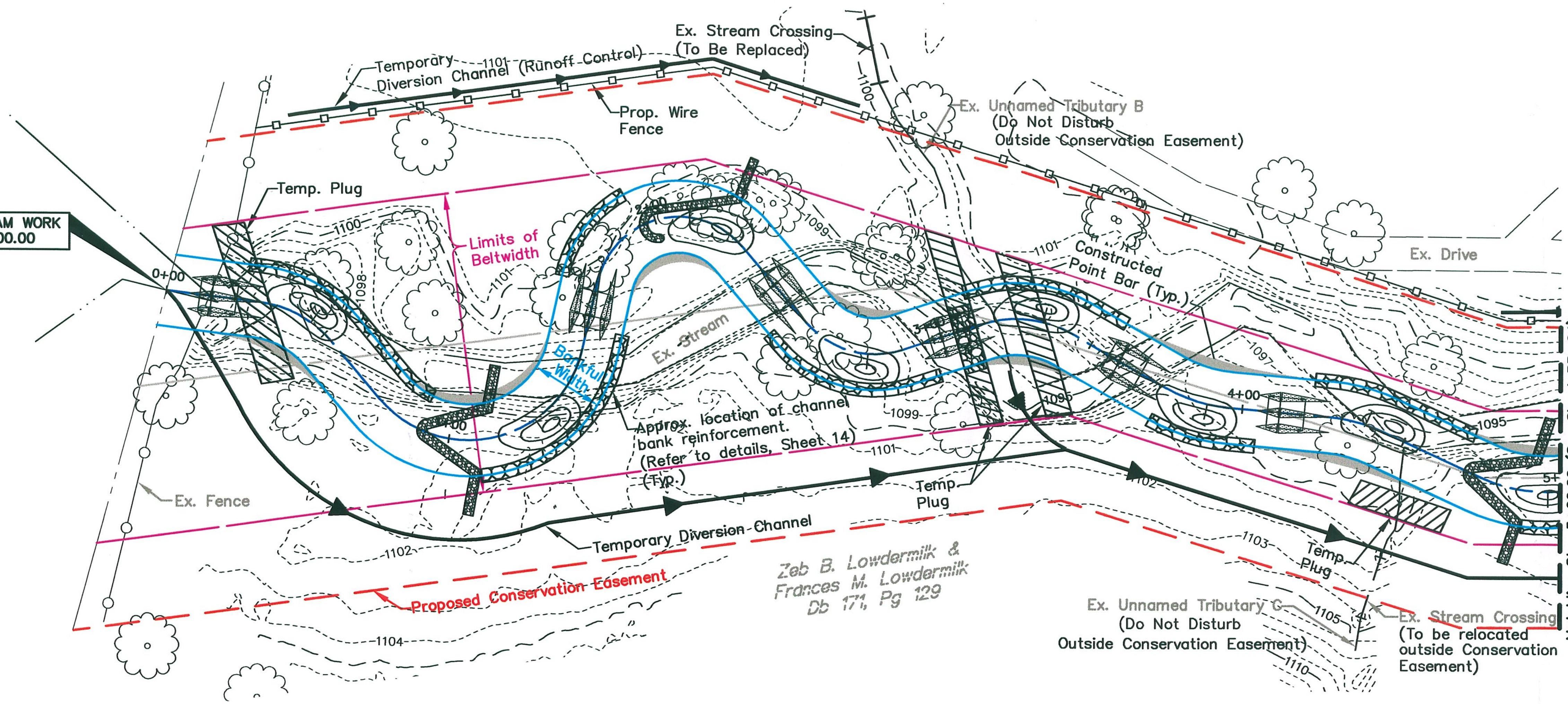
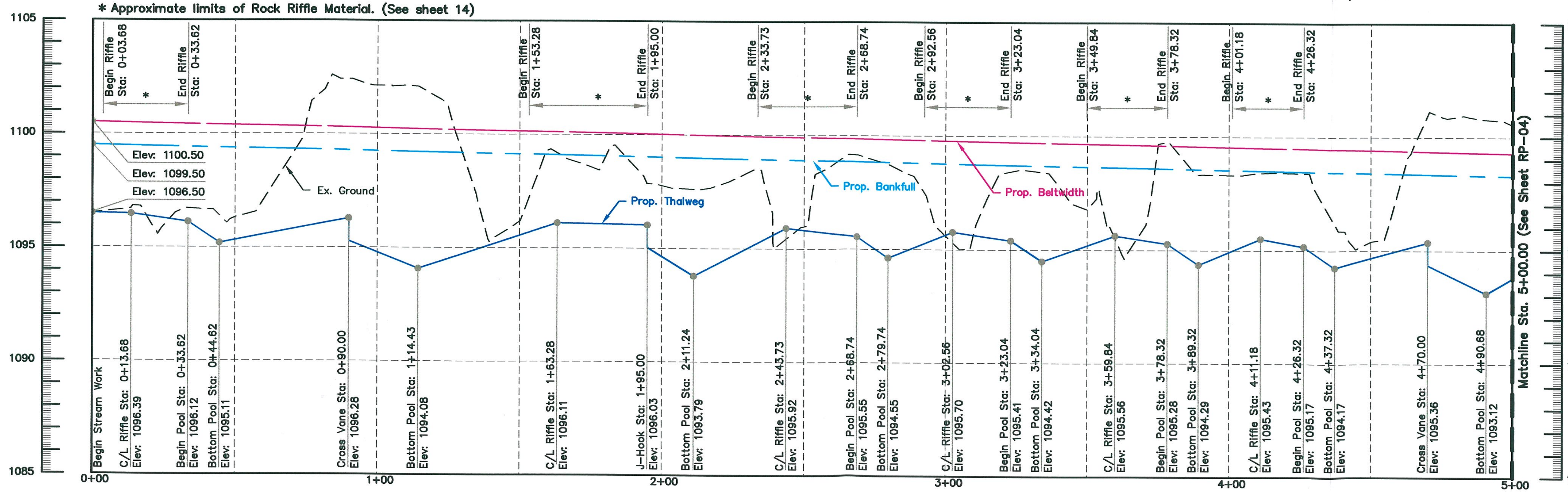


Notes:
See sheets 14–16 for In–Stream Stuctures details.

See sheets 17–20 for Erosion Control notes, plan and details.

** Channel Reinforcement shall begin 5 feet above the end of the upstream riffle and extend 3 feet below the beginning of the downstream riffle: Refer to riffle stations on profile.

* Approximate limits of Rock Riffle Material. (See sheet 14)



Job No. 2006-1398
Sheet RP-03/21
Date May, 2007
Scale Hor: 1" = 40' Ver: 1" = 5'

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK
AND UNNAMED TRIBUTARY
THOMPSONS FORK CREEK
PLAN & PROFILE

Ecosystem Enhancement PROGRAM

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REVISIONS
MARK DATE DESCRIPTION

PRELIMINARY
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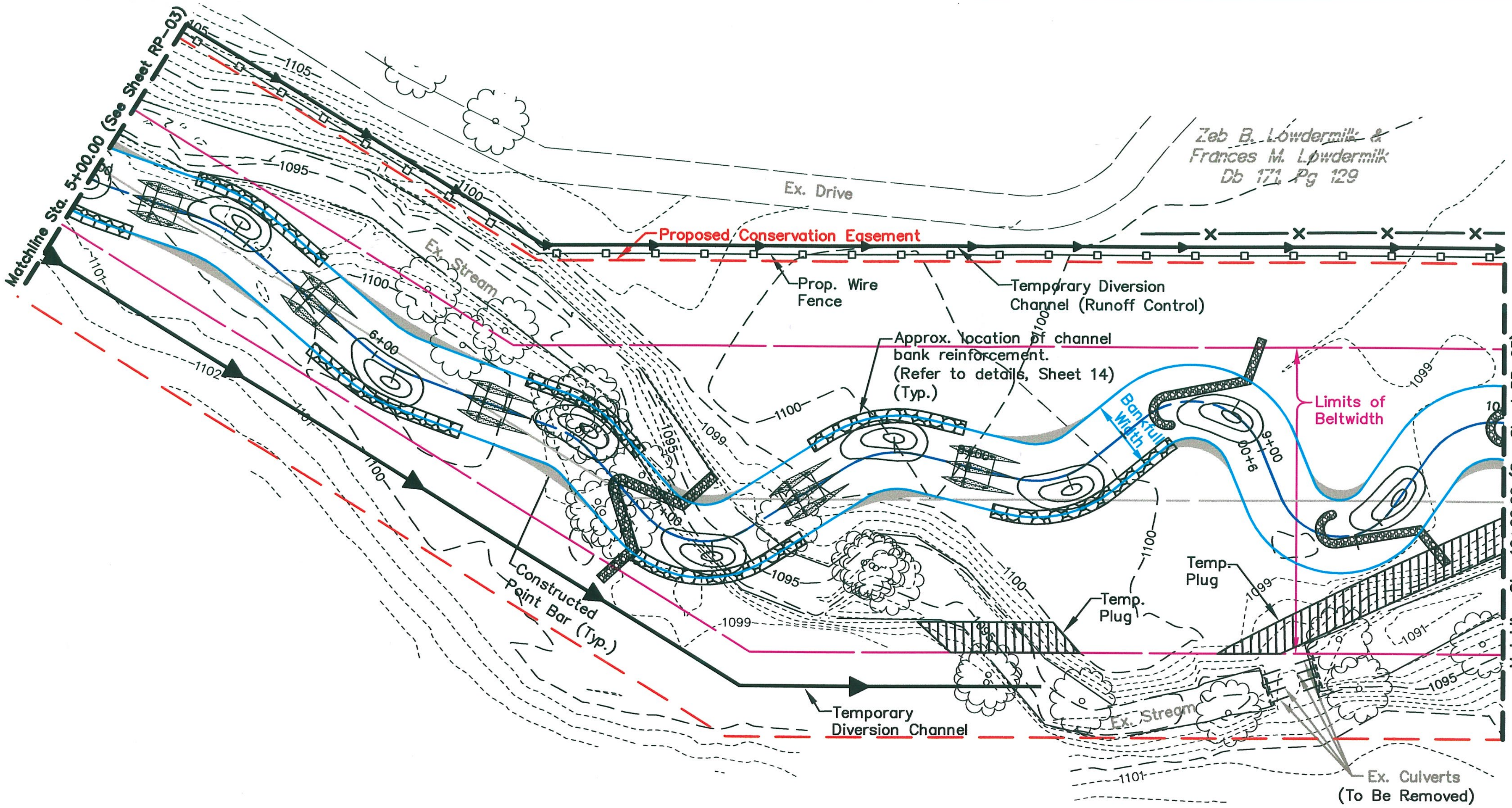

Notes:
See sheets 14–16 for In–Stream Stuctures details.

See sheets 17–20 for Erosion Control notes, plan and details.

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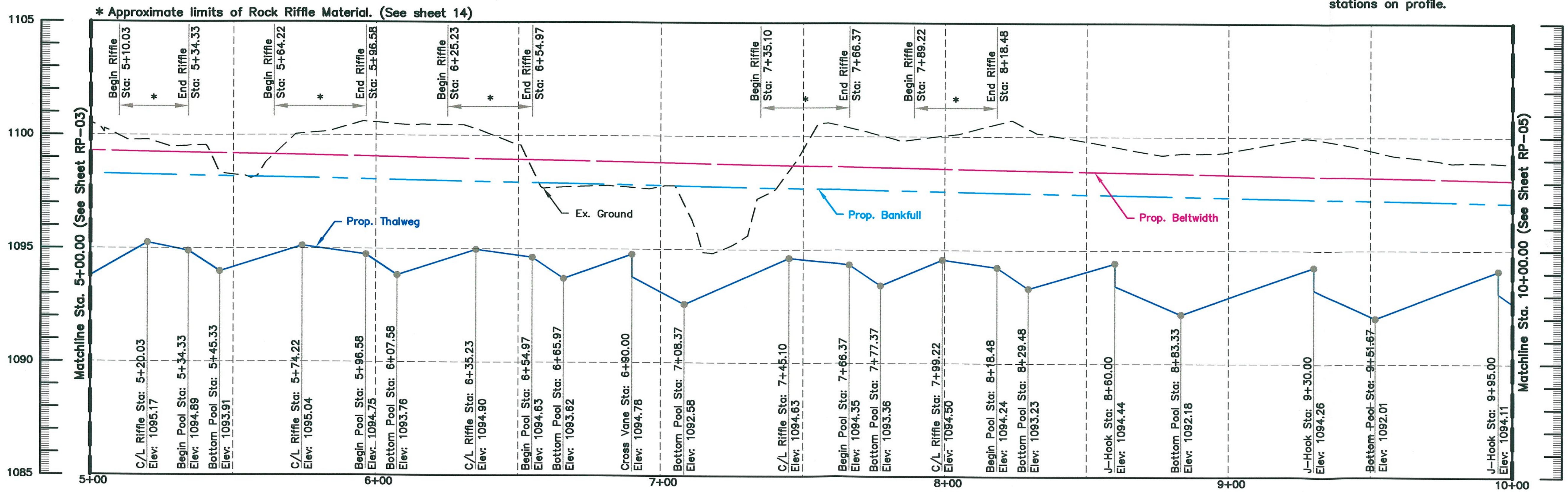

Job No.	2006-1398
Sheet	RP-04/21
Date	May, 2007
Scale	Hor: 1" = 40' Ver: 1" = 5'

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
THOMPSONS FORK CREEK
PLAN & PROFILE

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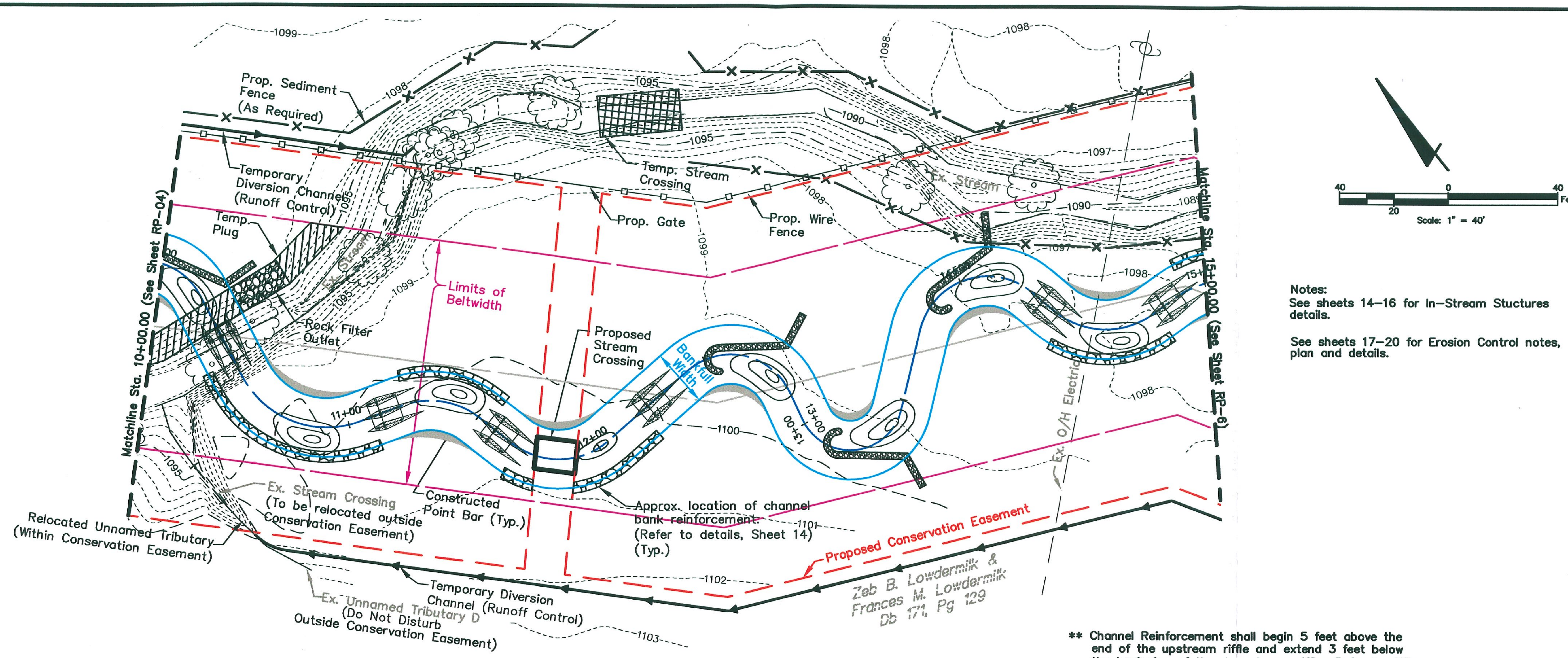
PRELIMINARY NOT FOR CONSTRUCTION

MARK	DATE	DESCRIPTION

REVISIONS

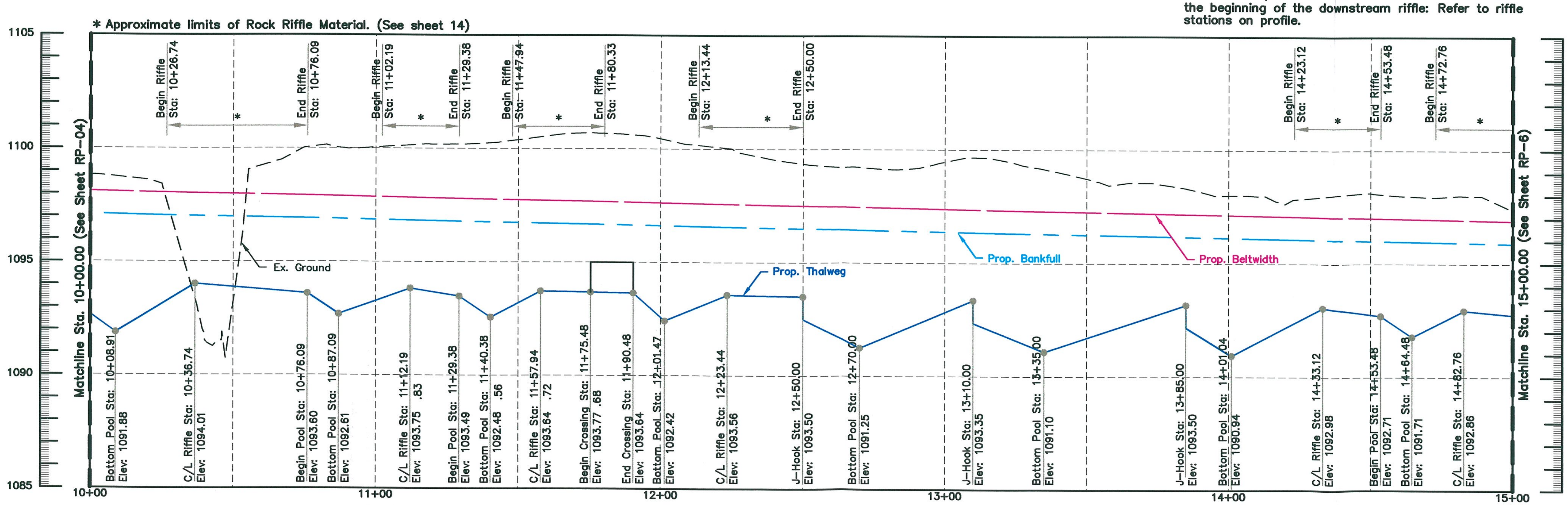


Notes:
See sheets 14–16 for In-Stream Stuctures details.

See sheets 17–20 for Erosion Control notes, plan and details.

** Channel Reinforcement shall begin 5 feet above the end of the upstream riffle and extend 3 feet below the beginning of the downstream riffle: Refer to riffle stations on profile.

* Approximate limits of Rock Riffle Material. (See sheet 14)



Job No.	Sheet
2006-1398	RP-05/21

Date	Scale
May, 2007	Hor: 1" = 40' Ver: 1" = 5'

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
THOMPSONS FORK CREEK
PLAN & PROFILE

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REVISIONS		

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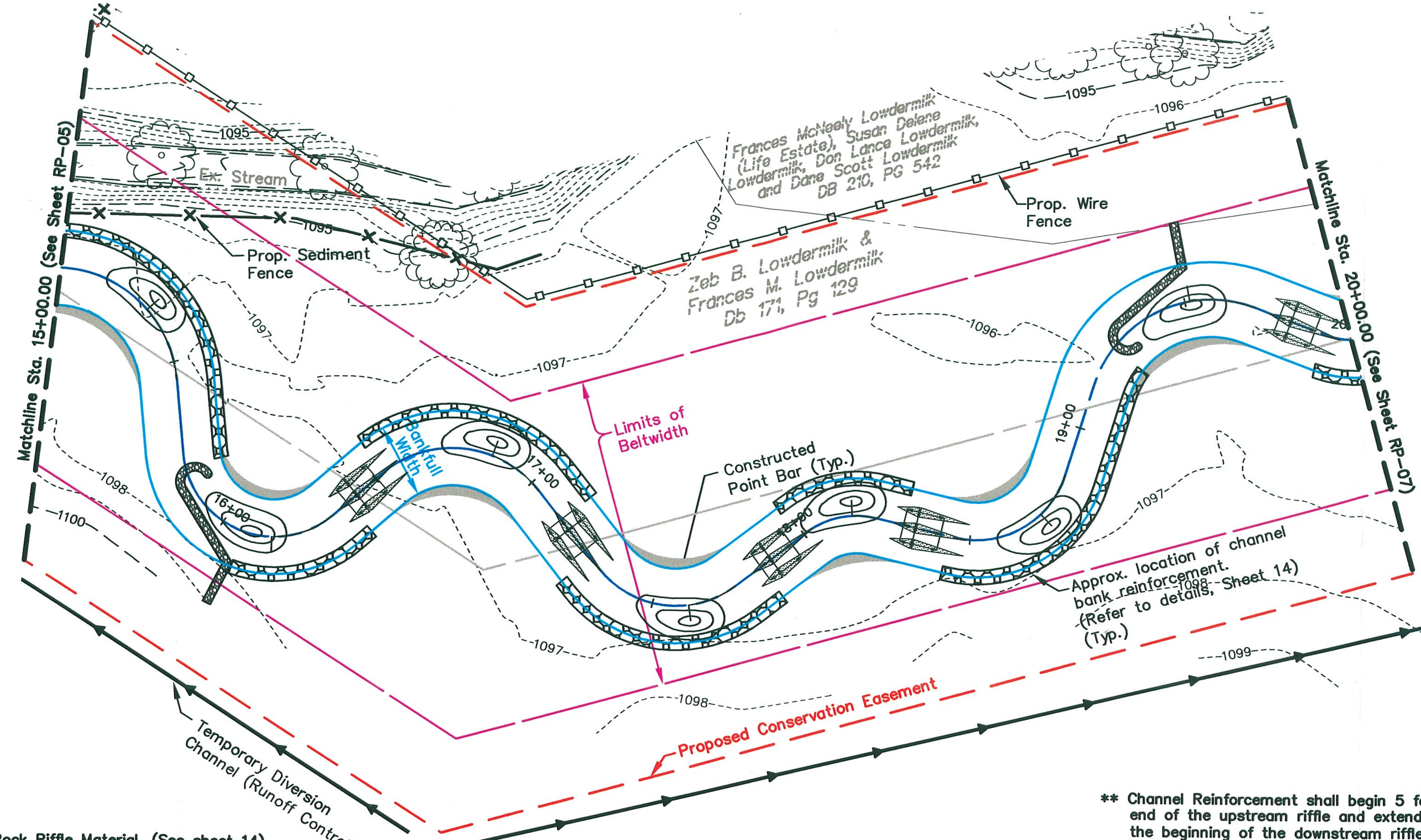


40 0 20 40 Feet

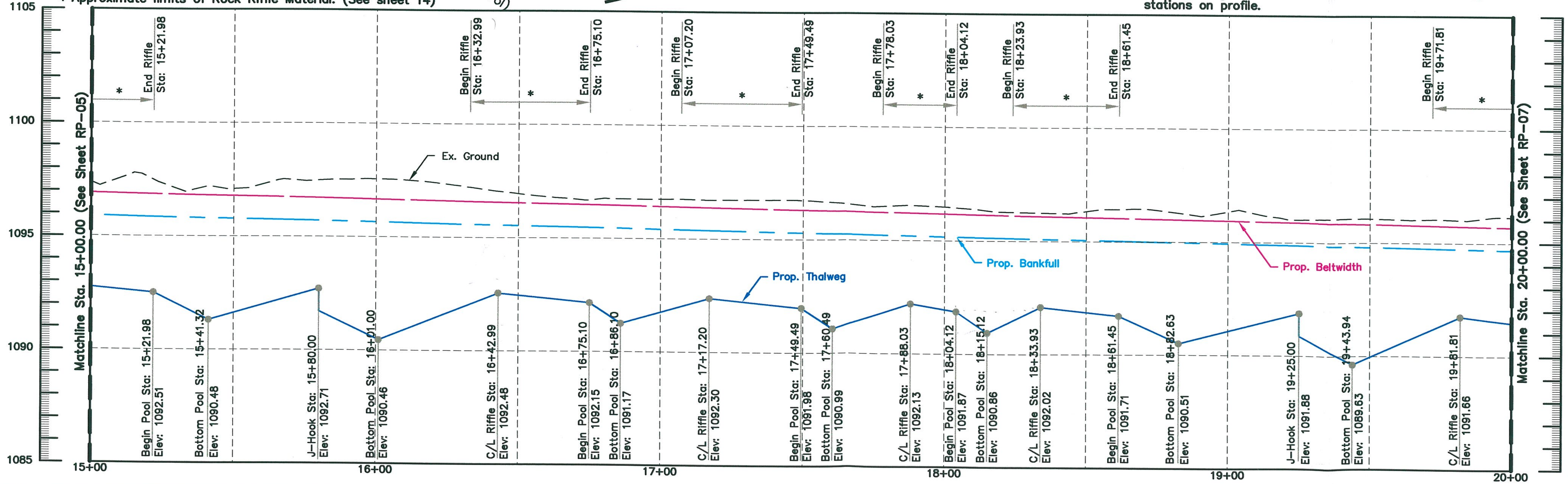
Scale: 1" = 40'

Notes:
See sheets 14–16 for In-Stream Stuctures details.

See sheets 17–20 for Erosion Control notes, plan and details.

** Channel Reinforcement shall begin 5 feet above the end of the upstream riffle and extend 3 feet below the beginning of the downstream riffle: Refer to riffle stations on profile.

* Approximate limits of Rock Riffle Material. (See sheet 14)



MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
THOMPSONS FORK CREEK
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Date: May, 2007	Job No.: 2006-1398
Scale: Hor: 1" = 40' Ver: 1" = 5'	Sheet: RP-06/21

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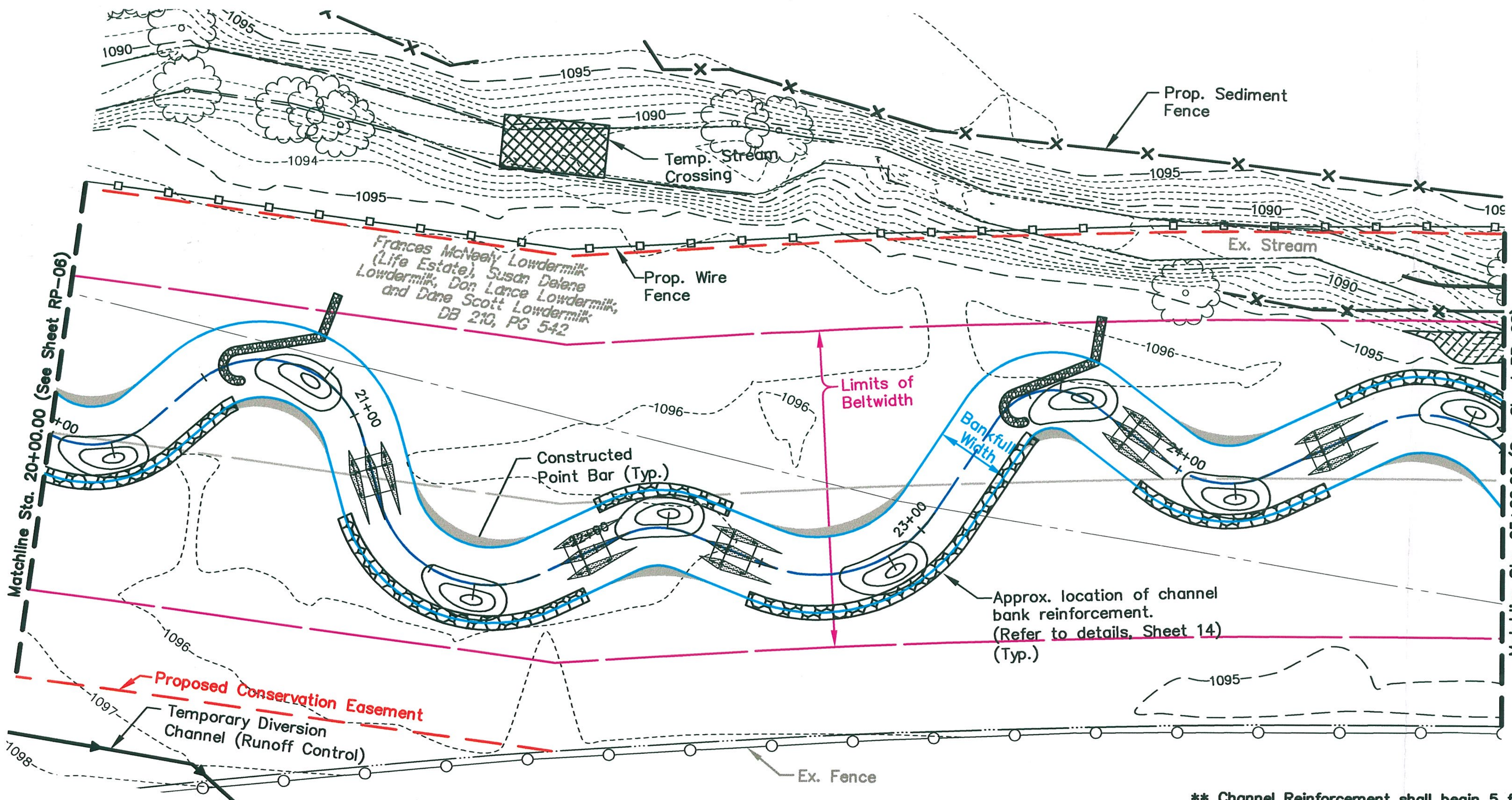
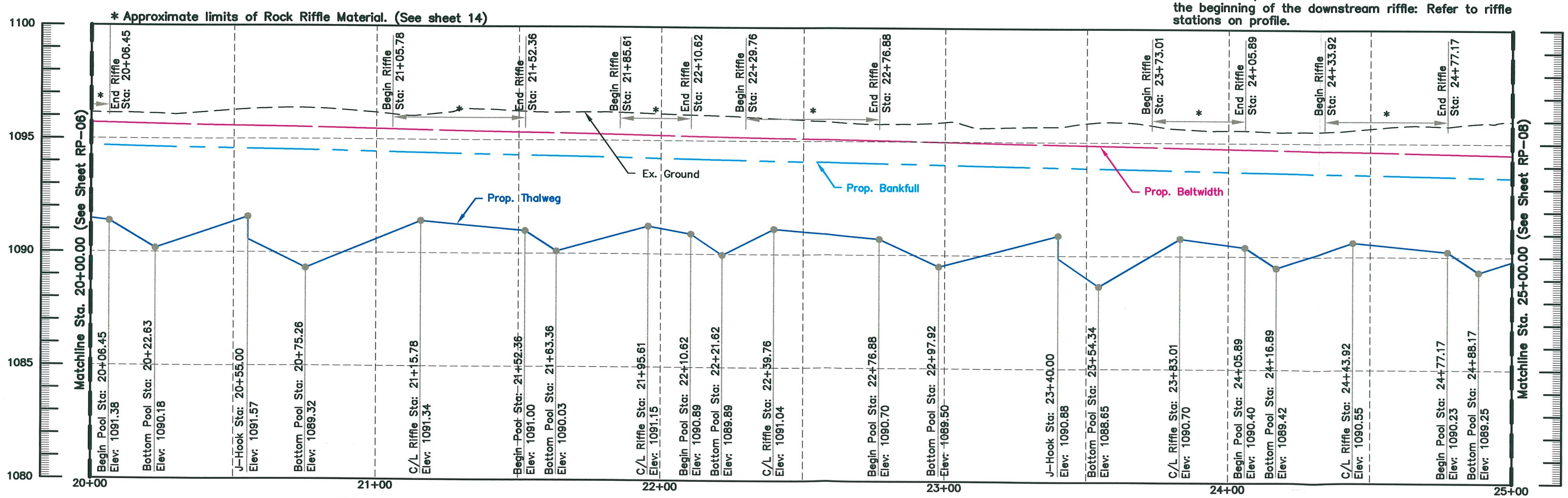


Notes:
See sheets 14–16 for In-Stream Structures details.

See sheets 17–20 for Erosion Control notes, plan and details.

** Channel Reinforcement shall begin 5 feet above the end of the upstream riffle and extend 3 feet below the beginning of the downstream riffle: Refer to riffle stations on profile.



Job No. 2006-1398
Sheet RP-07/21
Date May, 2007
Scale Hor: 1" = 40' Ver: 1" = 5'

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STREAM RESTORATION PLAN
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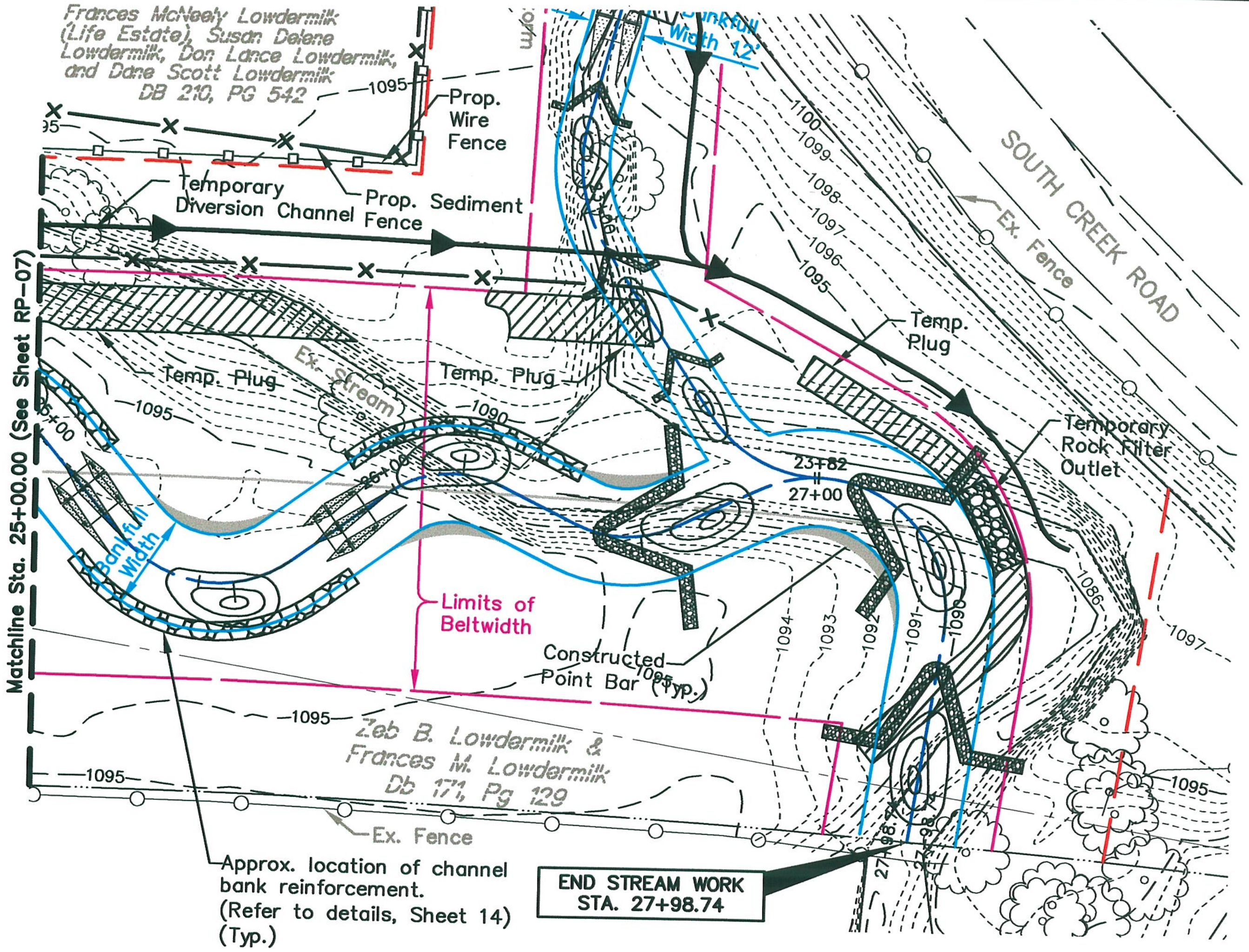
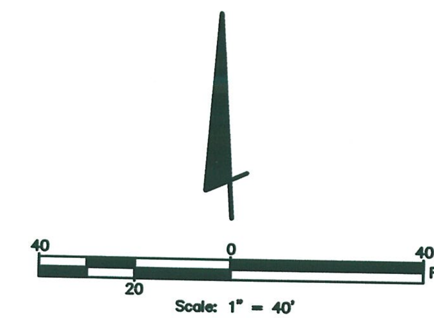
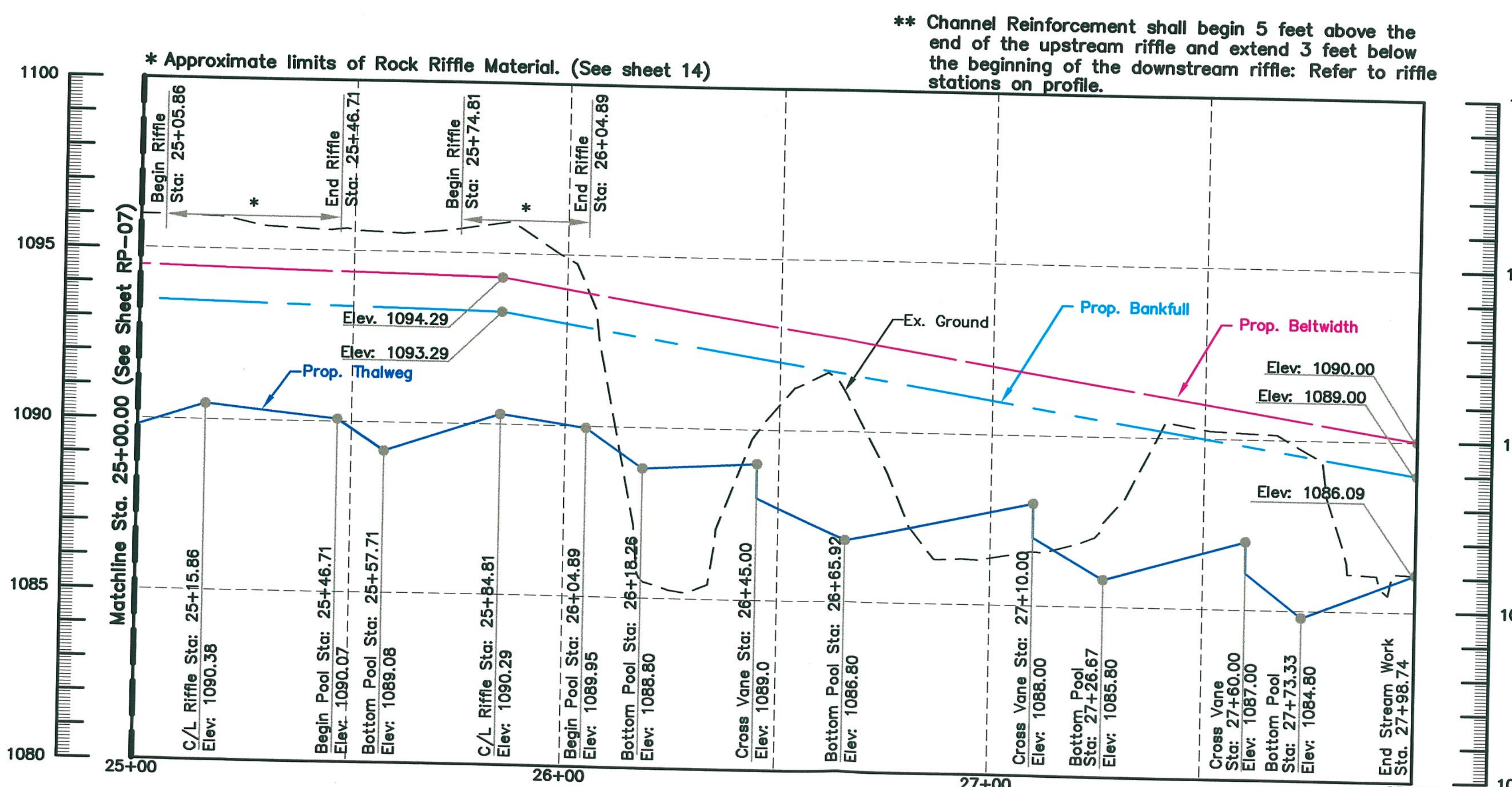




Notes:
See sheets 14–16 for In-Stream Stuctures details.

See sheets 17–20 for Erosion Control notes, plan and details.



MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
THOMPSONS FORK CREEK
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Job No. 2006-1388
Date May, 2007
Scale Hor: 1" = 40' Ver: 1" = 5'
Sheet RP-08/21

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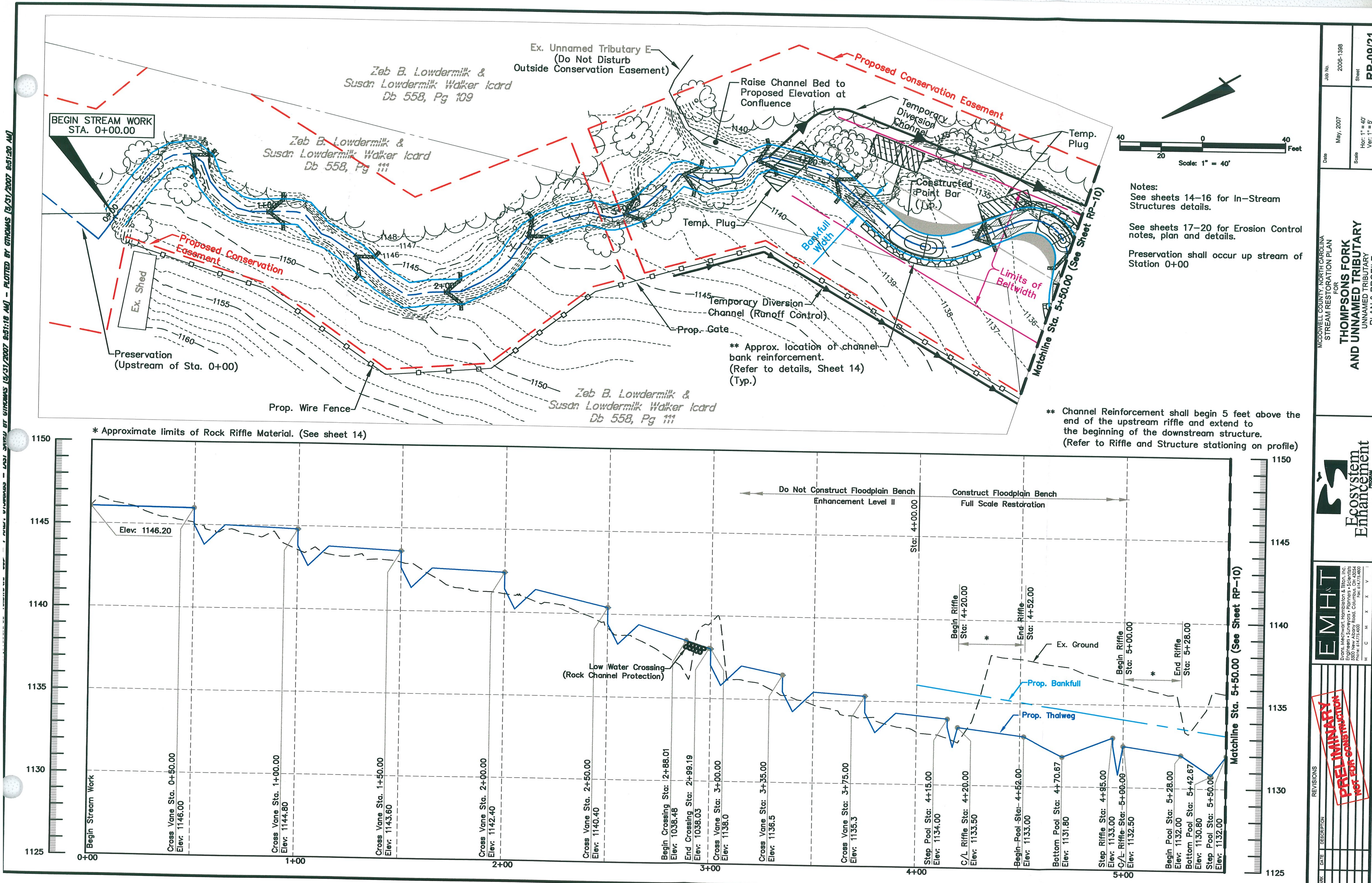
BEGIN STREAM WORK STA. 0+00.00
Zeb B. Lowdermilk & Susan Lowdermilk Walker Icard Db 558, Pg 109
Zeb B. Lowdermilk & Susan Lowdermilk Walker Icard Db 558, Pg 111
Zeb B. Lowdermilk & Susan Lowdermilk Walker Icard Db 558, Pg 111
Ex. Unnamed Tributary E (Do Not Disturb Outside Conservation Easement)
Raise Channel Bed to Proposed Elevation at Confluence
Proposed Conservation Easement
Temporary Diversion Channel
Temp. Plug
Constructed Point Bar (Typ.)
Bankfull Width
Limits of Beltwidth
Temp. Plug
Ex. Shed
Proposed Conservation Easement
Temporary Diversion Channel (Runoff Control)
Prop. Gate
** Approx. location of channel bank reinforcement. (Refer to details, Sheet 14) (Typ.)
Preservation (Upstream of Sta. 0+00)
Prop. Wire Fence
Matchline Sta. 5+50.00 (See Sheet RP-10)
Scale: 1" = 40'
Feet
Notes:
See sheets 14-16 for In-Stream Structures details.
See sheets 17-20 for Erosion Control notes, plan and details.
Preservation shall occur up stream of Station 0+00
** Channel Reinforcement shall begin 5 feet above the end of the upstream riffle and extend to the beginning of the downstream structure. (Refer to Riffle and Structure stationing on profile)
* Approximate limits of Rock Riffle Material. (See sheet 14)
Elev: 1146.20
Do Not Construct Floodplain Bench Enhancement Level II
Construct Floodplain Bench Full Scale Restoration
Sta: 4+00.00
Begin Riffle Sta: 4+20.00
End Riffle Sta: 4+52.00
Begin Riffle Sta: 5+00.00
End Riffle Sta: 5+28.00
Ex. Ground
Prop. Bankfull
Prop. Thalweg
Low Water Crossing (Rock Channel Protection)
Begin Stream Work
Cross Vane Sta. 0+50.00 Elev: 1146.00
Cross Vane Sta. 1+00.00 Elev: 1144.80
Cross Vane Sta. 1+50.00 Elev: 1143.60
Cross Vane Sta. 2+00.00 Elev: 1142.40
Cross Vane Sta. 2+50.00 Elev: 1140.40
Begin Crossing Sta: 2+88.01 Elev: 1038.48
End Crossing Sta: 2+99.19 Elev: 1038.03
Cross Vane Sta: 3+00.00 Elev: 1138.0
Cross Vane Sta: 3+35.00 Elev: 1136.5
Cross Vane Sta: 3+75.00 Elev: 1135.3
Step Pool Sta: 4+15.00 Elev: 1134.00
C/L Riffle Sta: 4+20.00 Elev: 1133.50
Begin Pool Sta: 4+52.00 Elev: 1133.00
Bottom Pool Sta: 4+70.67 Elev: 1131.80
Step Riffle Sta: 4+95.00 Elev: 1133.00
C/L Riffle Sta: 5+00.00 Elev: 1132.50
Begin Pool Sta: 5+28.00 Elev: 1132.00
Bottom Pool Sta: 5+42.67 Elev: 1130.80
Step Pool Sta: 5+50.00 Elev: 1132.00
Matchline Sta. 5+50.00 (See Sheet RP-10)
1150 1145 1140 1135 1130 1125
0+00 1+00 2+00 3+00 4+00 5+00
Job No. 2006-1398
Sheet RP-09/21
Date May, 2007
Scale Hor: 1" = 40' Ver: 1" = 5'
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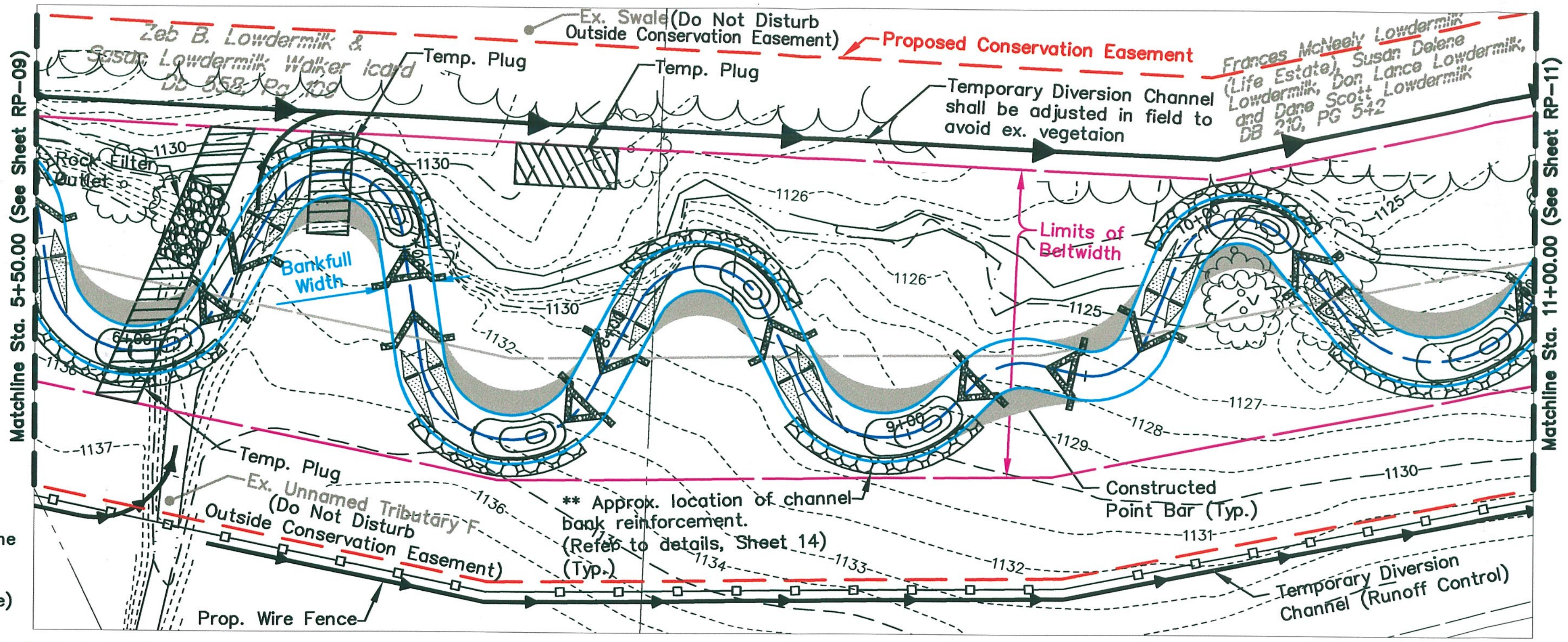
** Channel Reinforcement shall begin 5 feet above the end of the upstream riffle and extend to the beginning of the downstream structure.
(Refer to Riffle and Structure stationing on profile)

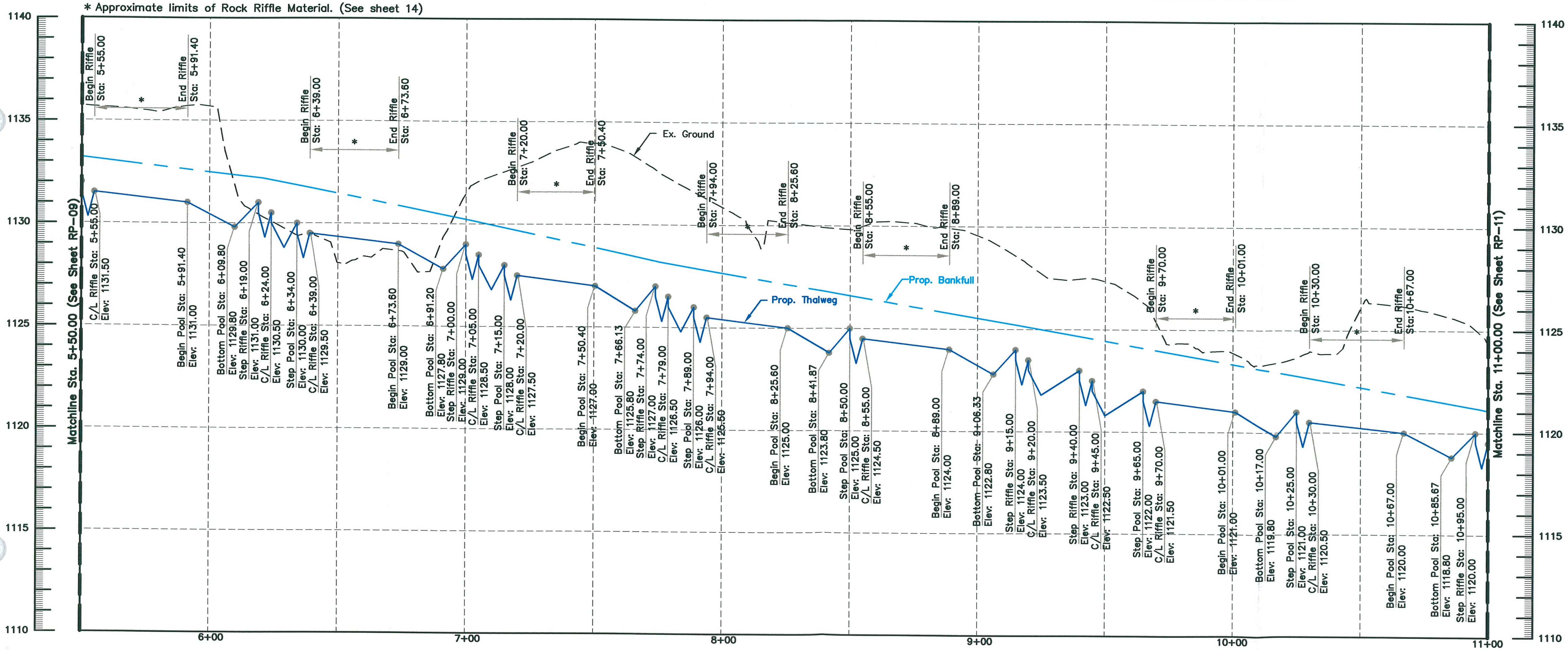


Scale: 1" = 40'

Notes:
See sheets 14–16 for In-Stream Structures details.

See sheets 17–20 for Erosion Control notes, plan and details.

* Approximate limits of Rock Riffle Material. (See sheet 14)



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STREAM RESTORATION PLAN
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UNNAMED TRIBUTARY
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Date	Scale	Job No.	Sheet
May, 2007	Hor: 1" = 40' Ver: 1" = 5'	2006-1398	RP-10/21

REVISIONS

MARK	DATE	DESCRIPTION

PRELIMINARY
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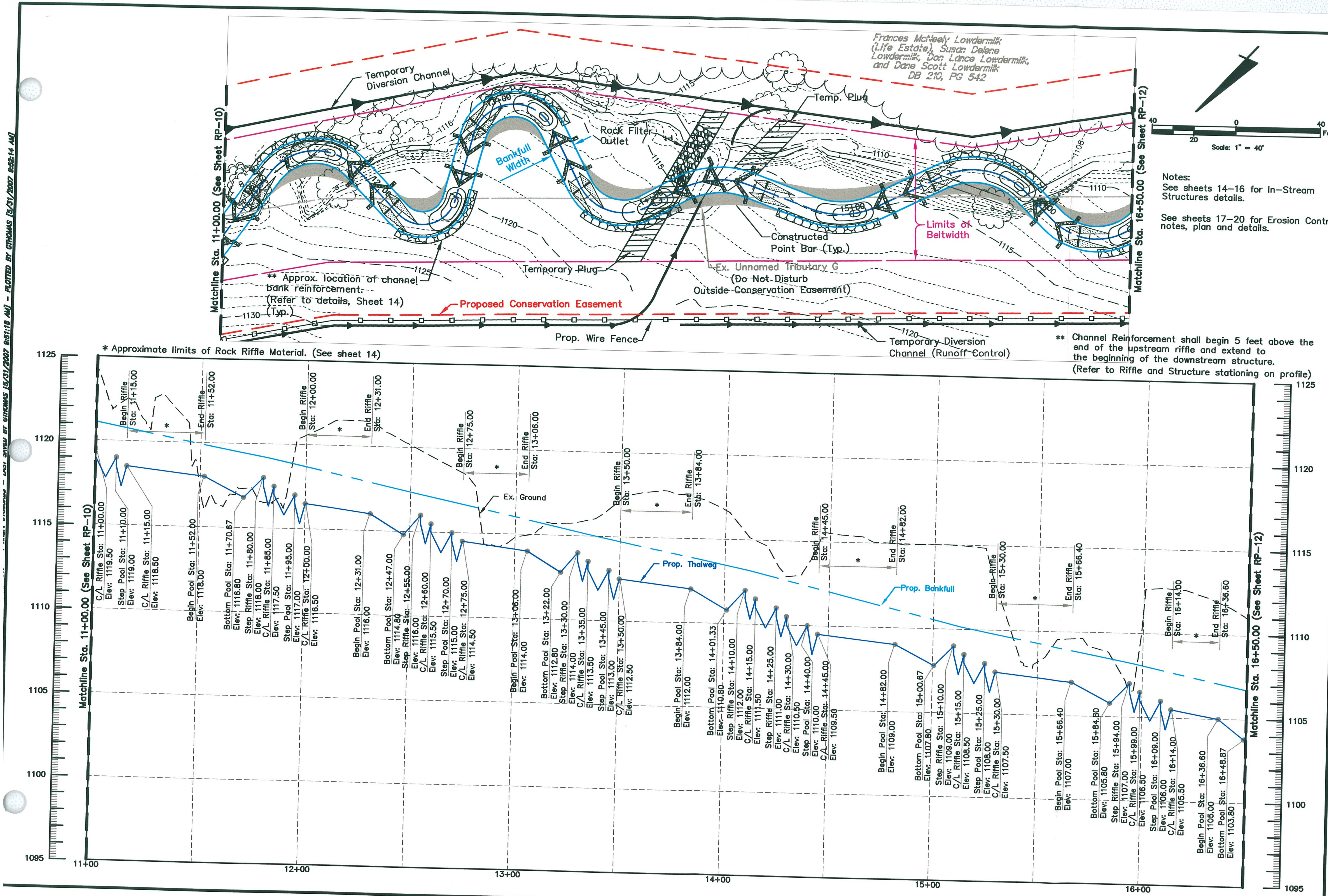

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
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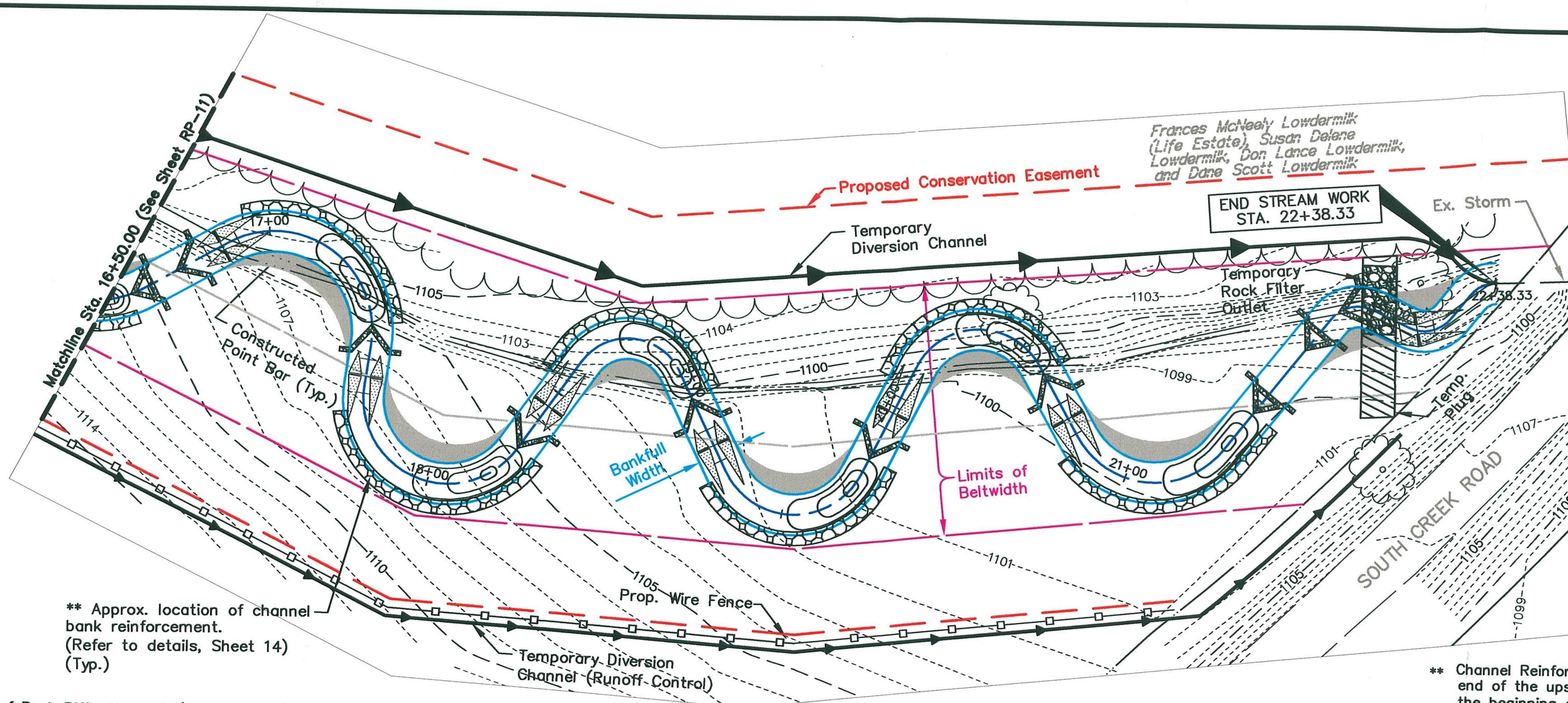
Job No.	Sheet
2006-1398	RP-11/21

Date	Scale
May, 2007	Hor: 1" = 40' Ver: 1" = 5'

REVISIONS

MK	DATE	DESCRIPTION

PRELIMINARY NOT FOR CONSTRUCTION

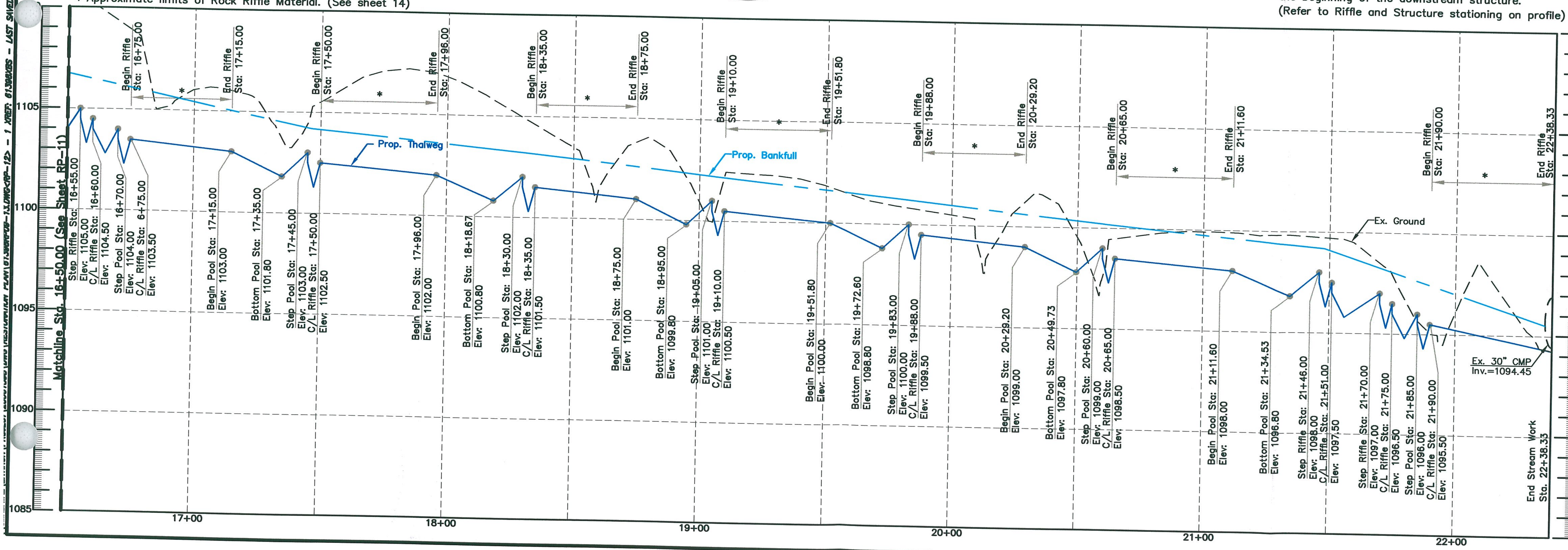


Notes:
See sheets 14–16 for In-Stream Structures details.

See sheets 17–20 for Erosion Control notes, plan and details.

** Channel Reinforcement shall begin 5 feet above the end of the upstream riffle and extend to the beginning of the downstream structure. (Refer to Riffle and Structure stationing on profile)

* Approximate limits of Rock Riffle Material. (See sheet 14)



Job No. 2006-1398
Sheet RP-12/21
Date May, 2007
Scale Hor: 1" = 40' Ver: 1" = 5'

MCDOWELL COUNTY, NORTH CAROLINA
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MARK DATE DESCRIPTION

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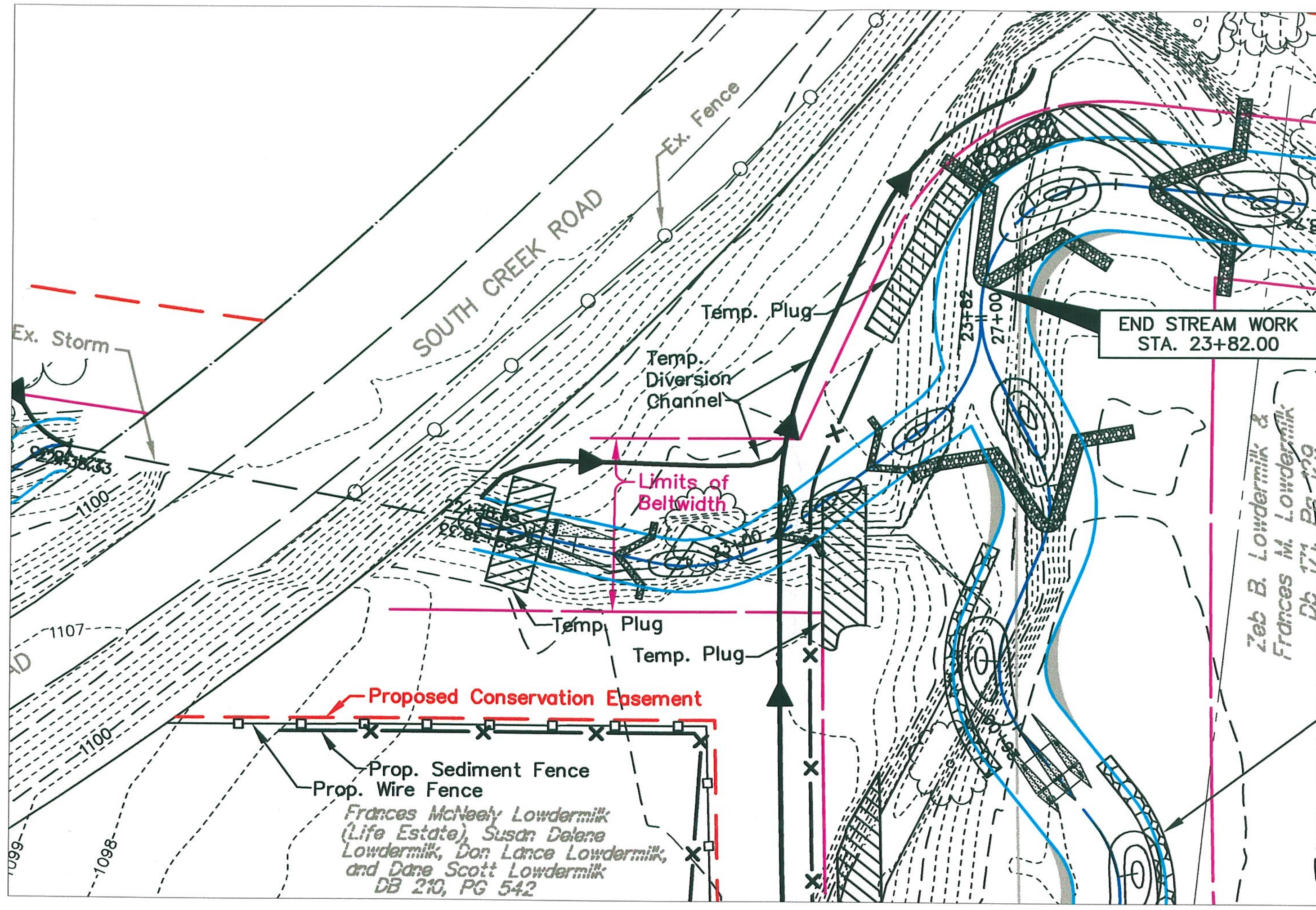


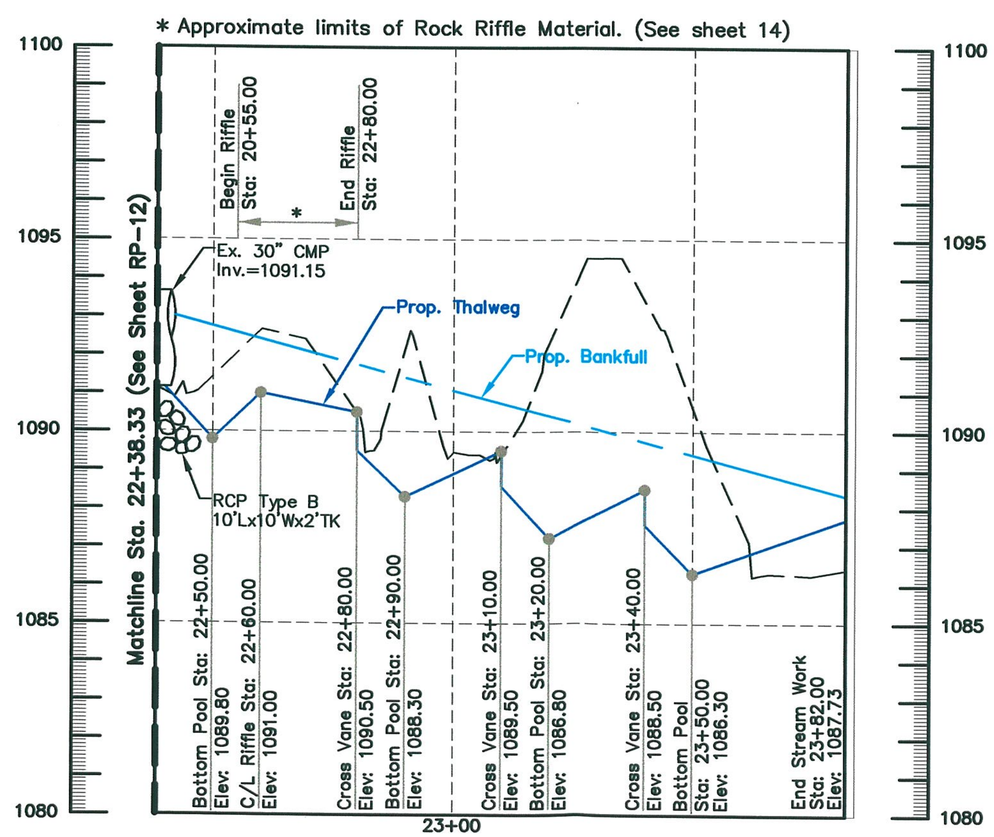
Scale: 1" = 40'

Notes:
See sheets 14–16 for In-Stream Structures details.

See sheets 17–20 for Erosion Control notes, plan and details.

** Approx. location of channel bank reinforcement. (Refer to details, Sheet 14) (Typ.)

** Channel Reinforcement shall begin 5 feet above the end of the upstream riffle and extend to the beginning of the downstream structure. (Refer to Riffle and Structure stationing on profile)



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STREAM RESTORATION PLAN FOR
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Job No.	2006-1398
Date	May, 2007
Scale	Hor: 1" = 40' Ver: 1" = 5'
Sheet	RP-13/21

MARK	DATE	DESCRIPTION

REVISIONS

ROCK RIFFLES:

Only imbedded (not visible) support and crest stone may be quarried limestone material. No construction rubble is permissible. All other material used to construct the rock riffle (all visible rock) shall be river rock, consisting of rounded stone with natural hues. The Contractor shall review samples of this material with the Engineer for approval prior to installation. See Riffle Materials Table for descriptions and sizes of materials.

1.0 CREST STONE

The crest height is determined in the field by measuring the elevation of the toe of the proceeding upstream riffle. The crest elevation must pool water back to the base of the upstream riffle/run.

Installation:
The crest height must be determined and the center weir stone installed first. Trench into the stream bed approximately 1.5 feet and place the stone(s) so that the center weir stone reaches the crest elevation. Trench and install the remaining crest stones across the stream, elevating them into the banks the specified distance.

2.0 SUPPORT STONE
Installation:
Support stone must be placed tightly on both sides of the crest stone paying close attention to fit on the downstream side. Proper elevation of the support stone must be maintained and must be as high as the crest stone. Ten (10) feet downstream of the crest stone the support stone will be laid more loosely to create turbulence of flow across the riffle. At this point, the stone should start to become trenched into the streambed. At the end of the riffle, the support stone will be trenched fully into the stream bed to a depth of approximately 1.5 feet. Finished elevations of the support stone must concentrate flows across the riffle and create non-laminar (turbulent) flow. Support stones will continue up the banks to the final elevation. Support stone will be trenched into the banks to support the crest stone.

3.0 FILL STONE
Installation:
After the installation of the larger crest and support stones, fill all voids with fill stone materials and compact with an excavator bucket. Final grading and transition with the upper bank area can be accomplished using this stone size.

4.0 PAYMENT
The cost of all labor and materials associated with the construction of rock riffles as shown on this plan, including fill stone, shall be included in the price bid for Item, Spec., Rock Riffle, As Per Plan.

BOULDER TOE:

1.0 Material:
The boulder toe material may consist of quarried limestone (no construction rubble is permissible). The Contractor shall review samples of this material with the Engineer for approval prior to installation. The size of this material shall be consistent with the gradation of Type 'B' rock channel protection.

2.0 Installation:
The boulder toe material shall be imbedded into the channel bottom and channel bank to the minimum depths shown on Detail 'C'. Filter fabric material, shall be included in the construction of the boulder toe reinforcement, as demonstrated on Detail 'C'. Over-excavation of the channel bank to install the boulder toe reinforcement shall be back-filled with compactable material that is placed in lifts and graded to conform to the designed channel bank, and reinforced with the geotextile material specified by this plan.

3.0 Payment:
The cost of all labor and materials associated with the placement of Boulder Toe, including filter fabric, shall be included in the price bid for Item, Spec., Boulder Toe, As Per Plan.

COIR ROLL: ***

1.0 Material:
Rolls shall consist of biodegradable material 12-inches in diameter with a density of 7 lbs./cu.ft. The coir roll outer netting shall consist of a biodegradable twine 0.24 inches in diameter with the breaking strength of 90 lbs. Hardwood stakes to anchor the coir rolls shall be 2"x2"x36" in size. The specified length is a minimum and may need to be adjusted to allow for sufficient anchoring.

The Contractor may contact RoLanka Products at 800-760-3215 (fax: 770-506-0391) as a supplier of the specified coir roll material.

2.0 Installation:
Refer to Detail 'A' for a schematic of the location of the coir roll material along the channel and Detail 'C' for a schematic of the location of the coir rolls with respect to the other bank reinforcement materials.

The coir rolls shall be installed after the boulder toe is in place. The upstream and downstream ends of the coir roll installation shall be bent back into the channel bank to prevent stream flow from cutting behind the Rolls. The ends of abutting coir rolls shall be tied together with twine. Hardwood stakes shall be driven into the native, undisturbed soil behind the Rolls. The Rolls shall be tied to the stakes with twine. Stakes shall be placed at the beginning and end of each Roll and at a maximum spacing of 2 feet.

*** Coir Rolls may be eliminated and replaced with additional Boulder Toe material.

3.0 Payment:
The cost of all labor and materials associated with the installation of the coir rolls and stakes shall be included in the price bid for Item, Spec., coir roll, complete.

LIVE BRANCHES:

1.0 Material:
Live branch material shall be dormant and gathered locally (within or in proximity to the project site) or purchased from a reputable commercial supplier. The contractor may contact Ernst Conservation Seeds at 814-336-5191 (fax: 800-873-3321) as a supplier of live branch material. This material shall be planted only during its natural dormancy period, extending from late fall through early spring.

Branches shall be 1/2 to 2-inches in diameter, 2 to 3 feet in length, and living based on the presence of young buds and green bark. Prior to installation, the branches shall be cut so that they are angled on the bottom and flush on the top.

All harvested or purchased live branch material shall be preserved in a cool, moist environment until installation. Plant material that has been allowed to dry out or is not preserved in a dormant state prior to installation shall be discarded.

See Sheet 21 for Plant Material List.

2.0 Installation:
Refer to Detail 'A' for a schematic of the location of the live branches along the channel and Detail 'C' for a schematic of the location of the live branches with respect to the other bank reinforcement materials.

Live branches shall be installed in two rows, with 2.0 foot spacing, between the stakes. Three-fourths of the stake is to be imbedded within the channel bank. The angle of the imbedded branch to the channel bank shall be between 30 and 60 degrees. When installed, at least two (2) buds should remain above the ground surface and those buds shall be oriented upwards.

Live branches that split or become bent or broken during installation shall be removed from the channel bank and discarded

3.0 Payment:
The cost of all labor and materials associated with the installation of live branches shall be included in the price bid for Item, Spec., Live Branches, as per plan.

STOCKPILE COBBLE MATERIAL:

Remove and stockpile any available cobble stream bed material through the reach of the existing stream channel to be excavated/relocated. Stockpiled material shall be replaced within excavated /relocated stream bed upon completion. Cost of this work to be included in the price bid for the various related items.

GEOTEXTILES:

The specified geotextile shall meet the specifications identified on this plan, unless otherwise approved by the Engineer.

Geotextile shall be placed in accordance with manufacturer's recommendations.

The geotextile Rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each Roll shall be labeled or tagged to provide product identification sufficient for field inventory and quality control purposes. Rolls shall be stored in a manner which provides identification, as well as protection from the elements. If stored outdoors, the Rolls shall be elevated and protected with a waterproof cover.

INSTALLATION:

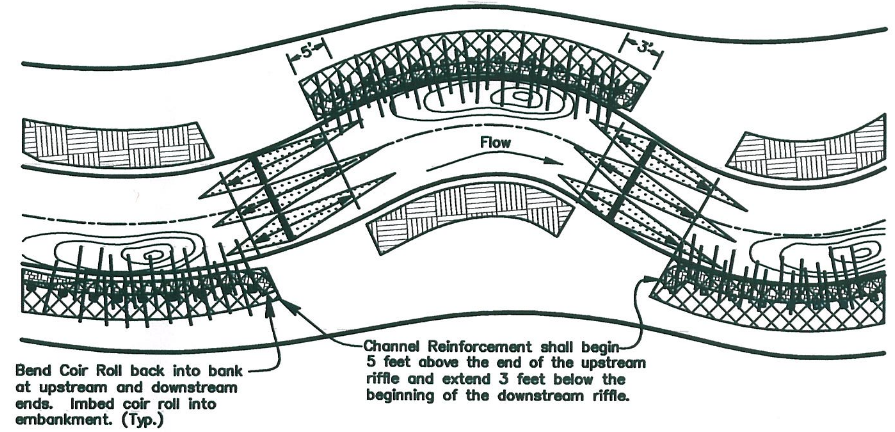
- Over-excavation of the channel bank may be necessary to accomplish the installation of the rock toe protection. The rock toe protection shall be imbedded into the bottom of the channel to the depth specified on this detail.
- The live branches shall be placed on top of the imbedded boulder toe material protruding into the native, undisturbed soil of the channel bank.
- Soil material, including the specified top soil, shall be placed to backfill the over-excavted channel bank.
- The specified seeding shall be applied to the disturbed/restored soil material.
- The first (lowest) row of the geotextile material shall be anchored to the restored soil material.
- The coir roll material shall be installed and secured with the hardwood stakes protruding into the native, undisturbed soil of the channel bank.
- Any remaining rows of geotextile material shall be installed and anchored to the channel bank, with the last (highest) row "trenched" in to the bank.

CHANNEL DIMENSION TABLE

	THOMPSONS FORK	UNNAMED TRIBUTARY
Bankfull depth - Riffle	3.0'	1.2'
Bankfull depth - Pool	4.2'	2.4'
Bankfull width - Riffle	21.5'	12.0'
Bankfull width - Pool	24.3'	13.4'

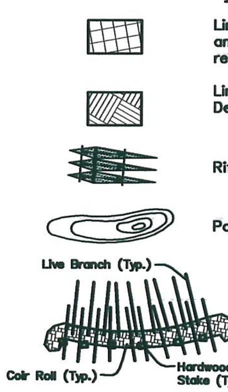
RIFFLE MATERIAL TABLE

I.D.	DESCRIPTION	SIZE	% OF RIFFLE VOLUME
Crest Stone	Crest stone should be angular in shape.	Rock Channel Protection, Type C. Type C shall consist of sizes such that at least 85 percent of the total material by weight shall be larger than 6 inch but less than an 18 inch square opening. At least 50 percent of the total material by weight shall be larger than 12 inch square opening.	30%
Support Stone	Angular stone that supports the crest stone.	Support Stone shall have a gradation of sizes such that at least 85% of the material by weight shall be between 4" and 8" in diameter, 50% of which shall be larger than 6" in diameter.	50%
Fill Stone	Stone that fills the voids between the larger stone: Cobble- rounded river rock	Fill stone shall have a gradation of sizes such that at least 85% of the material by weight shall be between 3/4" and 2" in diameter, 50% of which shall be larger than 1" in diameter.	20%



TYPICAL GEOTEXTILE LOCATION PLAN- DETAIL 'A'
Not to Scale

LEGEND



Limits of boulder toe, coir roll, and geotextile reinforcement*; refer to Detail "C", (This Sheet).

Limits of geotextile*; refer to Detail "C", (This Sheet).

Riffle-Run Complex

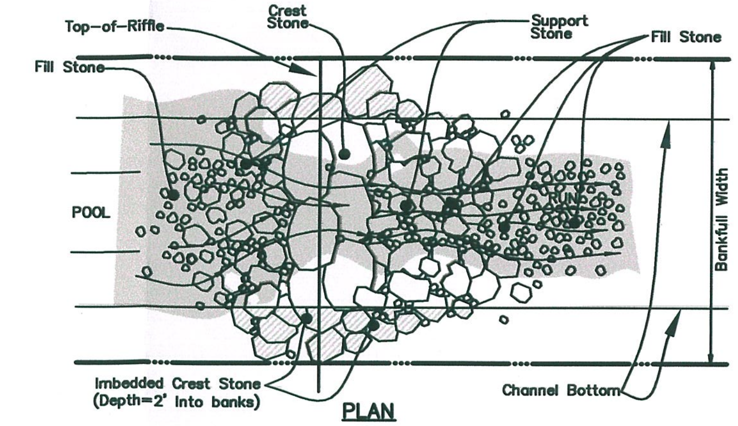
Pool

Limits of boulder toe, coir roll & live branches.

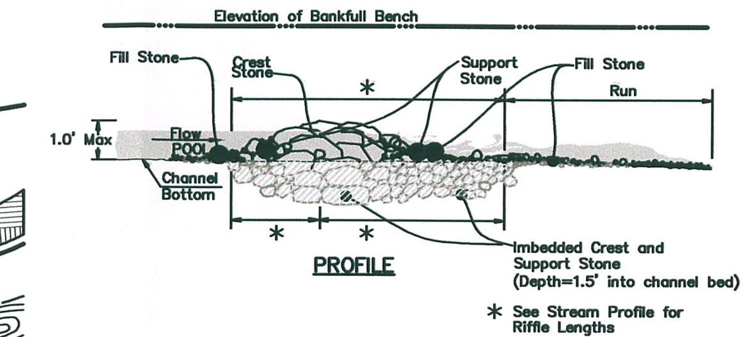
NOTES

* Geotextile shall be an Erosion Control Mat.

- 70% Straw/30% Cocunut Fiber
- Photodegradable Polypropylene Netting

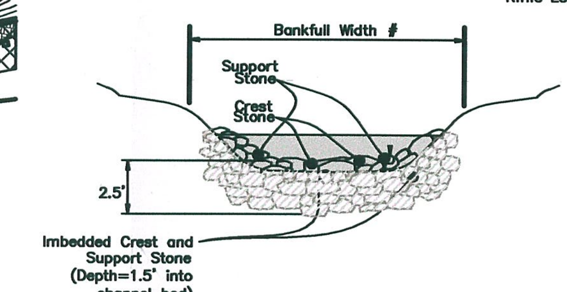


PLAN



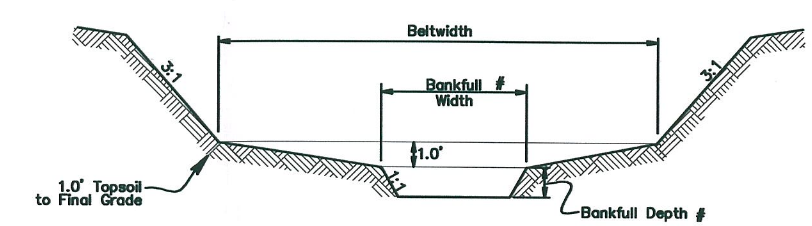
PROFILE

* See Stream Profile for Riffle Lengths

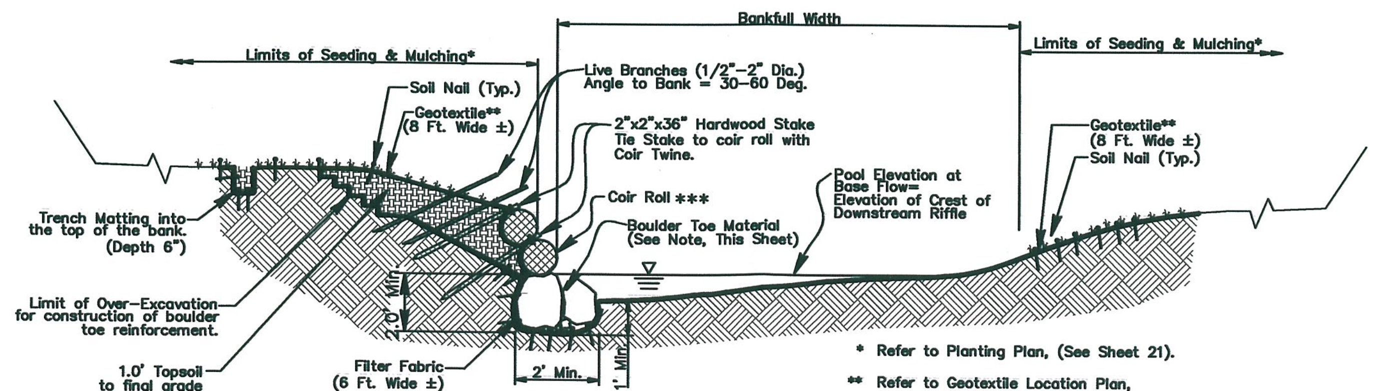


SECTION

ROCK RIFFLE DETAIL - DETAIL 'B'
Not to Scale



TYPICAL RIFFLE SECTION (See Detail 'B')
Not to Scale

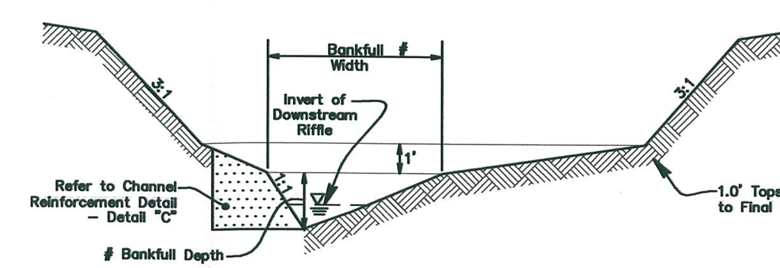


* Refer to Planting Plan, (See Sheet 21).

** Refer to Geotextile Location Plan, (See Detail "A", This Sheet).

*** Coir Rolls may be eliminated and replaced with additional Boulder Toe material.

CHANNEL REINFORCEMENT DETAIL - DETAIL 'C'
Not to Scale



TYPICAL POOL SECTION (See Detail 'C')
Not to Scale

-See Channel Dimension Table (This Sheet)

MARK	DATE	DESCRIPTION

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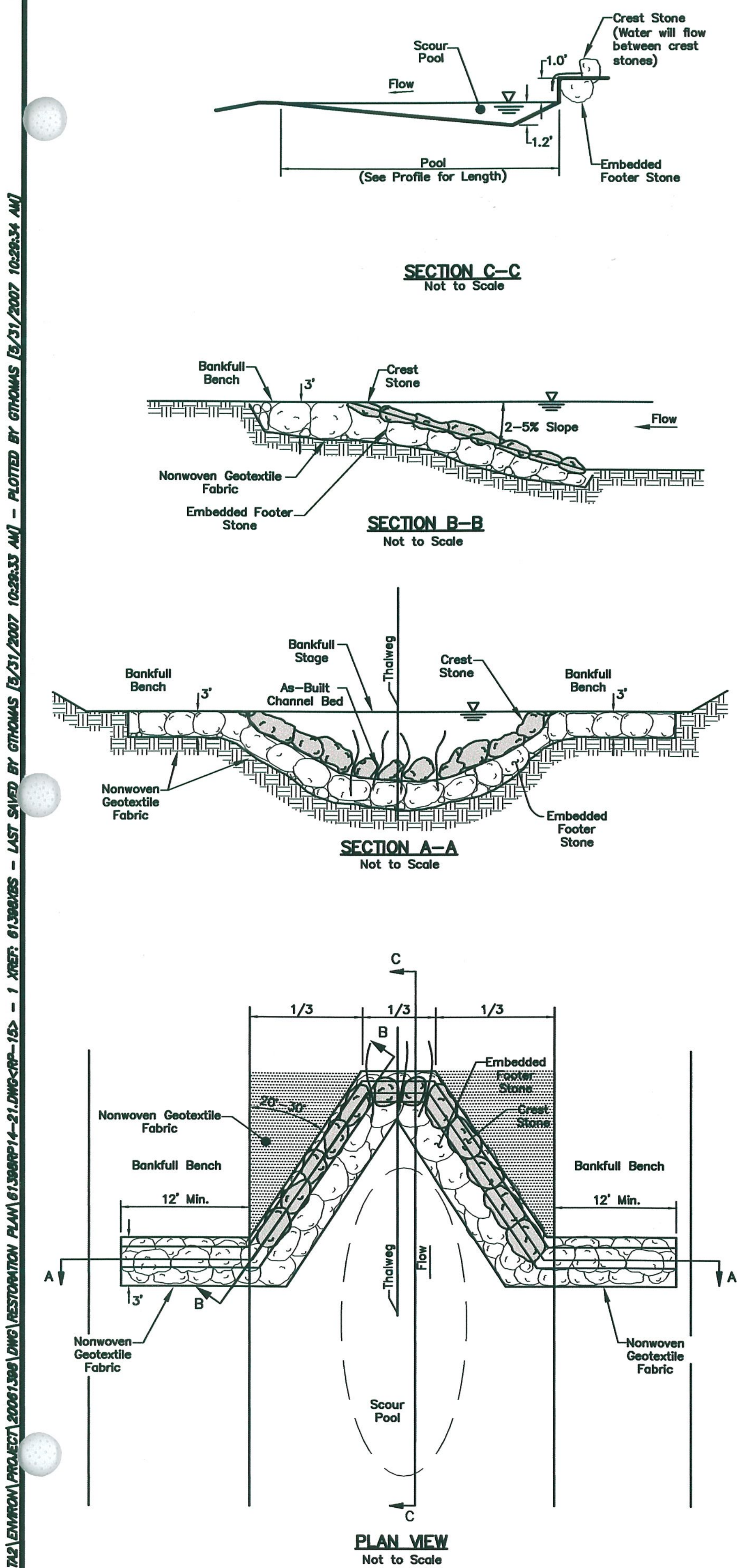
Ecosystem Enhancement PROGRAM

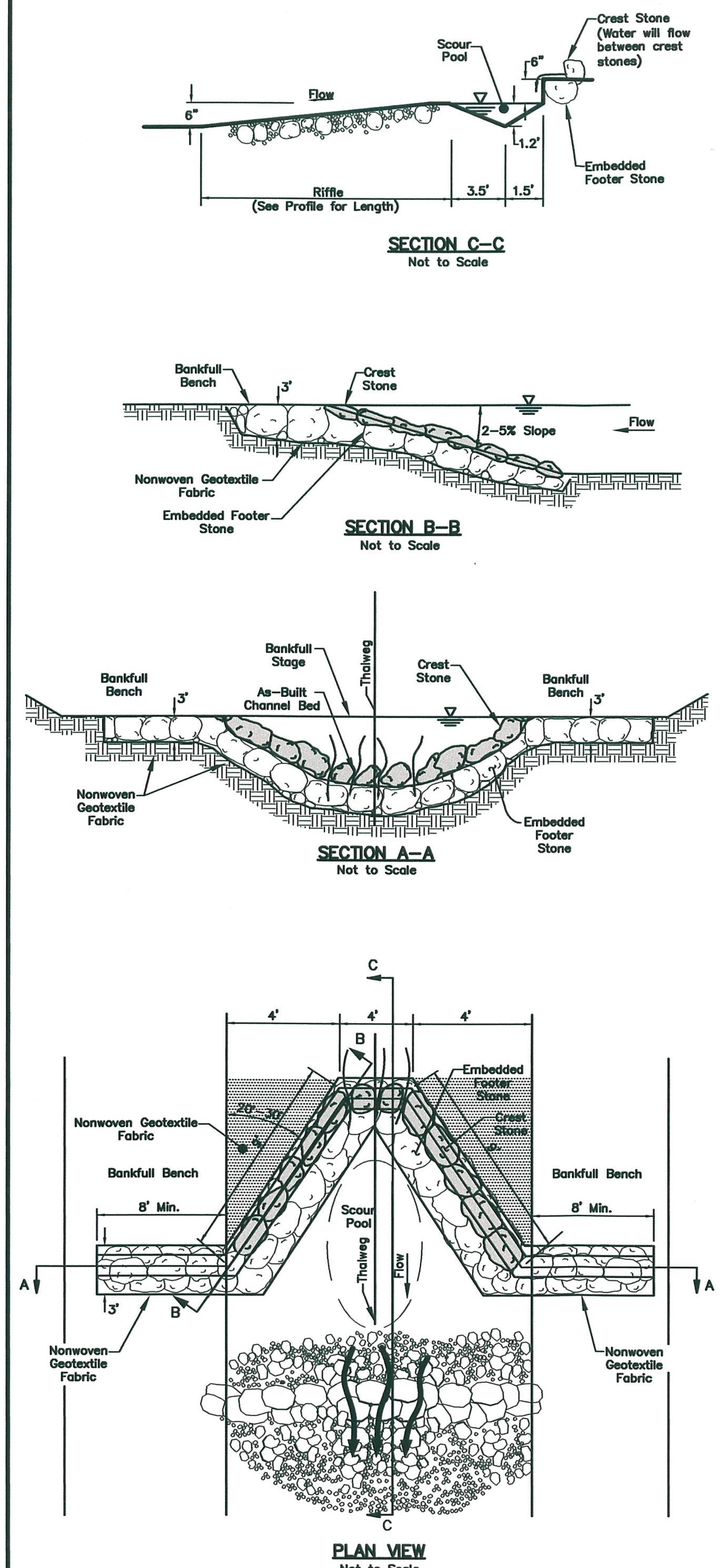
MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
STREAM RESTORATION PROJECT
STRUCTURE DETAILS

Date: May, 2007
Scale: 1" = 200'
Job No.: 2006-1398
Sheet: RP-14/21

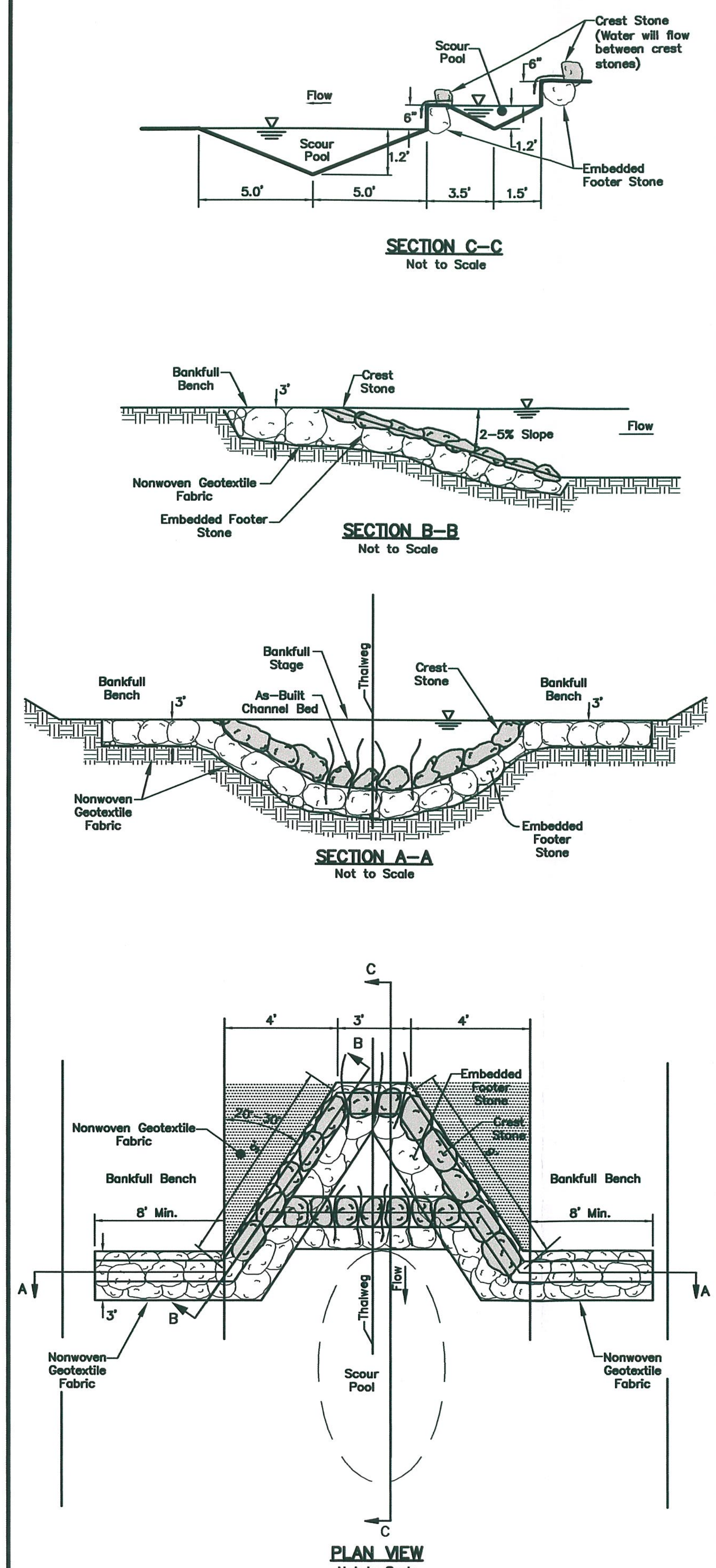
CAPDATA2\ENVIRON\PROJECT\20061398\DWG\RESTORATION PLAN\61398RP14-21.DWG<RP-14> - 1 XREF: 61398XBS - LAST SAVED BY GTHOMAS [5/31/2007 9:32:48 AM] - PLOTTED BY GTHOMAS [5/31/2007 10:22:29 AM]



CROSS VANE DETAIL –THOMPSONS FORK AND UNNAMED TRIBUTARY
Not to Scale



STEP RIFFLE DETAIL – UNNAMED TRIBUTARY
Not to Scale



STEP POOL DETAIL – UNNAMED TRIBUTARY

In–Stream Structure Specifications:

1. Final location, extent, and nature of in stream bed features to be determined during construction with consultation of designer.
2. Final placement of rocks In–Stream Structure to be determined by stream restoration specialist in the field.
3. Dimension slopes and deflection angles of structures may be adjusted by designer based on field conditions during construction.
4. Footer stone and crest stone shall be native stone or shot rock, cubical or rectangular in shape with a minimum diameter of 2.3' feet for Thompsons Fork and 2.5' feet for the Unnamed Tributary.
5. Gaps between boulders shall be minimized by tightly fitting stones together and chinking between structure stones using No. 2 sized rock.
6. Slope of vane from arms shall be 2–7%.
7. Crest stones in the center 1\3 of the channel shall have gaps between the stones. Gaps shall be 7" to 10" for Thompsons Fork and the Unnamed Tributary.
8. A 4 oz. non–woven geotextile fabric shall be placed on the upstream side of the structure vane arms to prevent piping of water through the structure. Fabric shall extend from the top of the footer stone, down to the invert of the trench, and back up to the bankfull bench. Fabric shall be placed along the entire length of the vane arms, as shown on the details.
9. A 4oz. non–woven geotextile shall be placed under all embedded footer stone, as shown on the details.
10. Logs can be substituted for the vane arms, or sills as approved by the design Engineer.
11. Log Sills can be subsituted for the step pools, as approved by the design Engineer.

Note:
See Sheet 16 for J–Hook Detail.

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK
AND UNNAMED TRIBUTARY
STRUCTURE DETAILS

Job No. 2006-1398
Date May, 2007
Scale As Noted
Sheet RP-15/21

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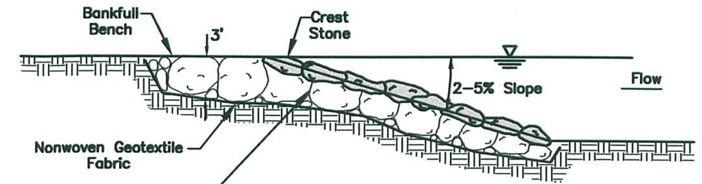
Notes:
See sheets 15 for In-Stream Stuctures specifications.



SECTION B-B
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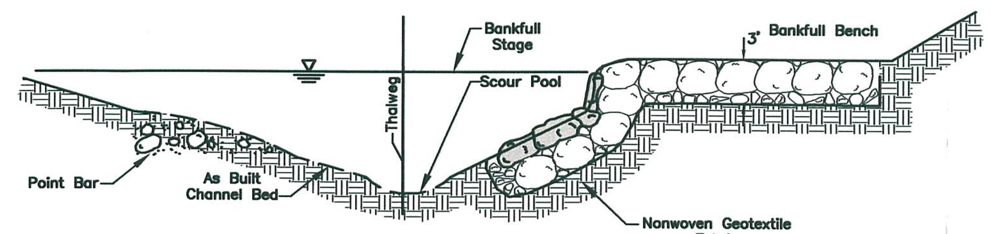

SECTION A-A
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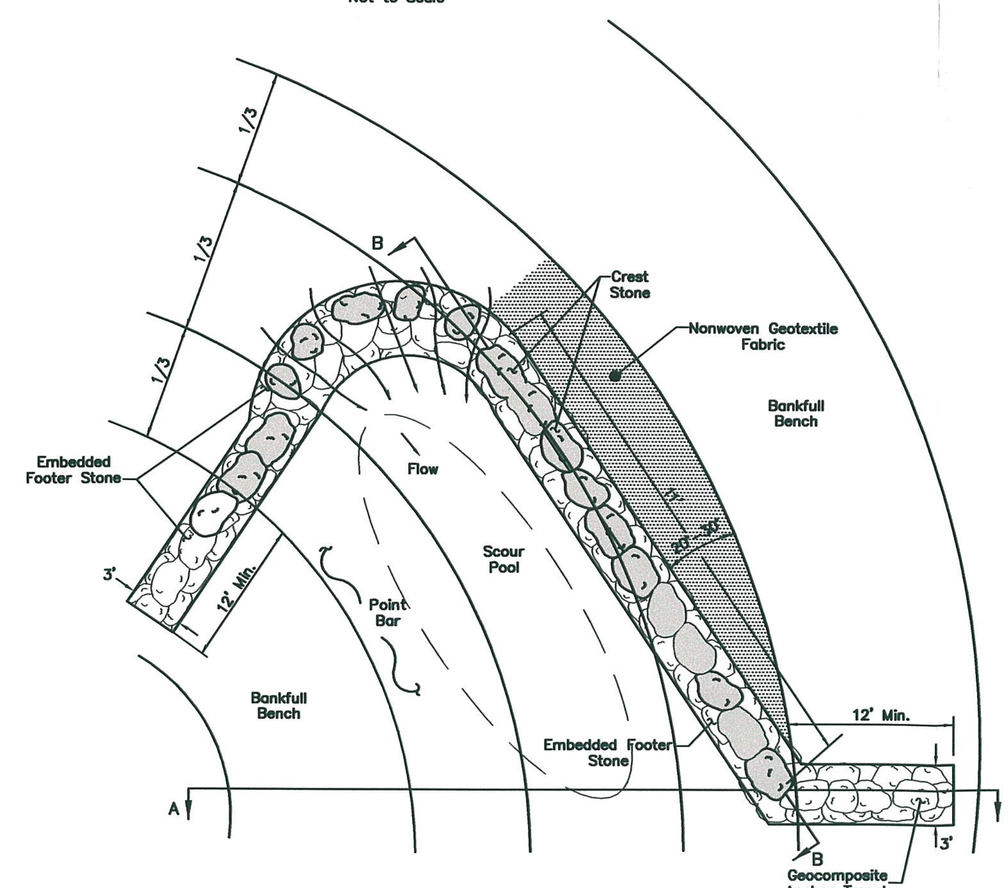

PLAN VIEW
Not to Scale

J-HOOK DETAIL - THOMPSONS FORK
Not to Scale

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
STRUCTURE DETAILS

Date	Job No.
May, 2007	2006-1398
Scale: As Noted	Sheet: RP-16/21

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MARK	DATE	DESCRIPTION

\\CMHDATA2\ENVIRON\PROJECT\20061398\DWG\RESTORATION PLAN\61398RP14-21.DWG<RP-16> - 1 XREF: 61398XBS - LAST SAVED BY GTHOMAS [5/31/2007 10:53:48 AM] - PLOTTED BY GTHOMAS [5/31/2007 10:53:51 AM]

EROSION AND SEDIMENT CONTROL NARRATIVE

PLAN DESIGNER:
Evans, Mechwart, Hambleton, & Tilton, Inc.
5500 New Albany Road
Columbus, Ohio 43054
Phone: (614)775-4500 Fax: (614)775-4800

PROJECT OWNER:
Cal Miller
Wetlands Resource Center
3970 Bowen Rd
Canal Winchester, OH 43110
(614) 327-7034

SITE CONTACT:
Bob Koone
South Mountain Forestry
6624 Roper Hollow Road
Morganton, NC 28655
(828) 432-7759

PROJECT LOCATION:
The project is located within McDowell County, north of Interstate 40.

PROJECT DESCRIPTION:
The project consists of the restoration and stabilization of stream channels, indicated as Thompsons Fork and Unnamed tributary on the restoration plan. The existing eroded stream banks of the stream buffer corridors of the watercourse shall be planted with a variety of trees, shrubs and seedings as indicated on the planting plan.

AREA OF PROJECT SITE & AREAS OF DISTURBANCE:
Project Area: 12.21 Acres
Estimated Area of Disturbance: 24 Acres

EXISTING SITE CONDITIONS:
The Thompson Fork corridor predominantly consists of a narrow riparian buffer with adjoining pasture and wooded hillsides.

The unnamed tributary contains a wooded hillside south the stream and a mowed field north of the stream. Impact to existing wooded areas will be minimized.

ADJACENT AREAS:
The adjacent areas are predominately pasture or wooded hillsides.

DESCRIPTION OF SOILS:
Colvard Series (CvA) Colvard soils are on flood plains of mountain valleys in the southern Appalachian Mountains. Slopes range from 0 to 4 percent. The soils consist of in loamy and sandy sediments.
Below 40 inches are sandy or loamy sediments contain 0 to 80 percent gravel to cobble size rock fragments.

RECEIVING STREAM/SURFACE WATER:
Thompsons Fork

EROSION AND SEDIMENT CONTROL PRACTICES

Runoff Diversion Channel
Diversion channels will be constructed above the 3:1 cut slopes, outside the beltwidth, on Thompsons Fork and the Unnamed Tributary. These diversions will divert clean runoff from the surrounding hillside to the small unnamed tribs. These small tribs will carry the flow to Thompsons Fork and the Unnamed Tributary. Construction of these diversions should take place before any construction activities begin for the proposed stream excavation. See detail on sheet 19.

Temporary Diversion Channel
Temporary Diversion channels will be constructed near the beltwidth, for Thompsons Fork and the Unnamed Tributary. These diversions will divert clean water around the project site. Construction of these diversions should take place before any construction activities begin for the proposed stream excavation. Temporary check dams and pump arounds can be used instead of the temporary diversion channel for the upstream portion of Thompsons Fork, if needed. See detail on sheet 19.

Temporary Sediment Traps
Temporary sediment traps will be utilized within the proposed stream corridor. These traps will be formed when the proposed valley is constructed and temporary plugs are constructed or left in place. Sediment laden runoff from the channel/valley construction will accumulate in the temporary traps. The traps will contain a stabilized rock filter outlet structure to treat the sediment laden runoff. Any accumulated sediment will be removed before the temporary plugs are removed. See detail on sheet 20.

Temporary Rock Filter Outlet
Temporary Rock Filter Outlets will be constructed at for the outlet of the temporary sediment traps. Sediment laden runoff from the channel/valley construction will accumulate in the temporary traps. The rock filter outlet will treat and sediment laden flow before allowing it to enter the existing stream or temporary diversions. Any accumulated sediment will be removed before the temporary plugs and rock outlets are removed. See detail on sheet 20.

Sediment Fence
Sediment fence will be placed along stream buffers before each phase of construction begins to prevent sediment from entering the unnamed tributaries or Thompsons Fork. Sediment Fence will also be placed along the north side of the new stream after the original channel is filled.

Aggregate Check Dam
Aggregate Check Dams can be used instead of temporary diversion channels during construction of the upstream portion of Thompsons Fork. The dams will be placed at the upstream and downstream end of each section of the work. The upstream dam will be used to plug the channel so clean water can be pumped around the work area. The downstream dam will be used to trap sediment laden water and pump it to a dewatering sediment trap. See detail on sheet 19.

Dewatering Sediment Trap
Dewatering Sediment traps can be used instead of temporary diversions during construction of the upstream portion of Thompsons Fork. Sediment laden water within the work area will be trapped by an aggregate check dam and pumped into the dewatering sediment trap. The trap should be located so that filtered water flows through existing vegetation before re-entering the unnamed tributary downstream of the work area. These sediment traps will be abandoned once the work area is stabilized. Any accumulated sediment will be removed or stabilized in-place. Filter fabric sediment bags can be used instead of sediment traps, if needed. See detail on sheet 19.

EROSION CONTROL SCHEDULE
Thompsons Fork

Phase A – Construct Diversion Channel (Optional)
1. Construct the temporary stream crossings across existing Thompsons Fork.
2. Construct the temporary diversion channel, crossings, earthen plugs and begin diverting Thompsons Fork to the diversion channel. Start this process at the downstream end of the project and work toward the upstream end, diverting Thompsons Fork as the diversion/plugs are constructed.
3. Construct the temporary earthen plugs and diversions to maintain drainage from the small tribs to the diversion channel.
4. Construct rock filter outlets into the earthen plugs to create a temporary sediment basin for any water that enters the proposed stream during construction.
5. Stabilize the earthen plugs with seed, fertilize, mulch and matting.

Phase B – Small Unnamed Tributary Construction (not the Unnamed Tributary)
6. Relocate and/or construct stream crossings on the small unnamed tribs.
7. Install sediment fence on each side of the small unnamed tribs.
8. Stabilize any disturbed areas on the banks of the small unnamed tribs with seed, fertilize, mulch and matting.

Phase C – Runoff and Sediment Control Features
9. Construct runoff diversion channels along Thompsons Fork.
10. Stabilize the runoff diversion channels with seed, fertilize, mulch and matting.
11. Install sediment fence along the north side of Thompsons Fork to prevent sediment laden runoff from the stockpile area from entering the existing stream.

Phase D – Valley/Channel Construction
12. Excavate the valley and channel to the appropriate elevations.
13. The temporary plugs and rock filter outlets shall be left in place to act as temporary sediment basins. (optional)
14. Spoil from the excavation shall be stockpiled in the valley north of the stream.
15. Construct the permanent stream crossing.
16. Construct the in-stream structures such as pools, riffles, and cross vanes.
17. Stabilize the valley with seed, fertilize, mulch and matting per the seeding table and stabilization details.

Phase E – Divert Flow to New Channel
18. Remove sediment within the new channel that has accumulated behind the temporary sediment traps. Place this material in the spoil area.
19. Remove the downstream earthen plug and rock filter outlet.
20. Remove the earthen plugs that were used to divert flow from the unnamed tribs to the diversion channel. Start this process at the downstream end of the project and work upstream.
21. Divert the small unnamed tributaries into the new channel and plug the connection between the diversion channel and new channel.
22. Construct any in-stream structures that could not be constructed because of the temporary earthen plugs.
23. Remove the upstream earthen plug, divert the flow into the new channel, and plug the connection to the diversion channel.
24. Construct any in-stream structures that could not be constructed because of the temporary earthen plug.
25. Stabilize any disturbed areas along the valley with seed, fertilize, mulch and matting per the seeding table and stabilization detail.

Phase F – Fill Original Stream and Diversion Channel.
26. Remove the temporary stream crossings that were placed in the original stream or diversion channel.
27. Remove the sediment fence along the original stream and install sediment fence along the top of the new valley.
28. Fill the existing stream and diversion channel with soil stockpiled in the spoil area. The grading shall be completed so that the valley will drain to the new channel. Fill shall be placed and compacted in lifts not to exceed 9".
29. Remove any temporary plugs that were constructed between the new channel and the diversion channel, re-grade the proposed valley slope.
30. Evenly grade any spoils left in the stockpile area so the valley will drain to the new channel.
31. Stabilize any disturbed areas along the valley with seed, fertilize, mulch and matting per the seeding table and stabilization detail.
32. Stabilize the original stream, diversion channel and stockpile area with seed, fertilize and mulch.

Phase G – Removal of Runoff and Sediment Control Features
33. After the entire site has been stabilized and vegetation is established the sediment fence can be removed.
34. Stabilize any areas disturbed during removal of the sediment fence.

The construction sequence letters listed above are also identified on the channel stabilization detail shown on sheet 20.

Each of the items listed above is shown on sheet 18.

The following construction methods are also acceptable if the sequence listed above cannot be used due to site constraints in the upstream portion of the project:

Thompsons Fork can be constructed in the dry using a series of pump arounds and aggregate check dams or earthen plugs. This method should only be used if there is not enough room to construct the diversion channel in addition to the proposed valley. With this method clean water shall be pumped around the construction area and turbid water shall be pumped to a sediment trap or filter bag. If this pump around method is used the project should be constructed in sections small enough that the entire section can be completed and stabilized daily.

Thompsons Fork can be constructed online instead of utilizing temporary diversion channels for the upstream portion of the site. This method should only be used if there is not enough room to construct the diversion channel in addition to the proposed valley. If this online method is used the project should be constructed in sections small enough that the entire section can be completed and stabilized daily.

EROSION CONTROL SCHEDULE
Unnamed Tributary

Phase A – Construct Diversion Channel (Optional)
1. Construct the temporary stream crossings across the existing Unnamed Trib.
2. Construct the temporary diversion channel, crossings, earthen plugs and begin diverting the Unnamed Trib to the diversion channel. Start this process at the downstream end of the project and work toward the upstream end, diverting flow as the diversion/plugs are constructed.
3. Construct the temporary earthen plugs and diversions to maintain drainage from the smaller unnamed tribs to the diversion channel.
4. Construct rock filter outlets into the earthen plugs to create a temporary sediment basin for any water that enters the proposed stream during construction.
5. Stabilize the earthen plugs with seed, fertilize, mulch and matting.

Phase B – Small Unnamed Tributary Construction (not the Unnamed Trib)
6. Relocate and/or construct stream crossings on the small unnamed tribs.
7. Install sediment fence on each side of the small unnamed tribs.
8. Stabilize any disturbed areas on the banks of the small unnamed tribs with seed, fertilize, mulch and matting.

Phase C – Runoff and Sediment Control Features
9. Construct runoff diversion channels on the north side of the Unnamed Trib.
10. Stabilize the runoff diversion channels with seed, fertilize, mulch and matting.

Phase D – Valley/Channel Construction
11. Excavate the valley and channel to the appropriate elevations.
12. The temporary plugs and rock filter outlets shall be left in place to act as temporary sediment basins.
13. Spoil from the excavation shall be stockpiled in the spoil area north of Thompsons Fork.
14. Construct the permanent stream crossing.
15. Construct the in-stream structures such as pools, riffles, and step pools.
16. Stabilize the valley with seed, fertilize, mulch and matting per the seeding table and stabilization details.

Phase E – Divert Flow to New Channel
17. Remove sediment within the new channel that has accumulated behind the temporary sediment traps. Place this material in the spoil area north of Thompsons Fork.
18. Remove the downstream earthen plug and rock filter outlet.
19. Remove the earthen plugs that were used to divert flow from the small unnamed tribs to the diversion channel. Start this process at the downstream end of the project and work upstream.
20. Divert the small unnamed tributaries into the new channel and plug the connection between the diversion channel and new channel.
21. Construct any in-stream structures that could not be constructed because of the temporary earthen plugs.
22. Remove the upstream earthen plug, divert the flow into the new channel, and plug the connection to the diversion channel.
23. Construct any in-stream structures that could not be constructed because of the temporary earthen plug.
24. Stabilize any disturbed areas along the valley with seed, fertilize, mulch and matting per the seeding table and stabilization detail.

Phase F – Fill Original Stream and Diversion Channel.
25. Remove the temporary stream crossings that were placed in the original stream or diversion channel.
26. Fill the existing stream and diversion channel with soil stockpiled in the spoil area. The grading shall be completed so that the valley will drain to the new channel. Fill shall be placed and compacted in lifts not to exceed 9".
27. Remove any temporary plugs that were constructed between the new channel and the diversion channel, re-grade the proposed valley slope.
28. Evenly grade any spoils left in the stockpile area so the valley will drain to Thompsons Fork.
29. Stabilize any disturbed areas along the valley with seed, fertilize, mulch and matting per the seeding table and stabilization detail.
30. Stabilize the original stream, diversion channel and stockpile area with seed, fertilize and mulch.

Phase G – Removal of Runoff and Sediment Control Features
31. After the entire site has been stabilized and vegetation is established the runoff diversion channels can be filled.
32. Stabilize any areas disturbed during removal of the channels

The construction sequence letters listed above are also identified on the channel stabilization detail shown on sheet 20.

Each of the items listed above is shown on sheet 18.

The following construction methods are also acceptable if the sequence listed above cannot be used due to site constraints along portions of the project:

The Unnamed Tributary can be constructed in the dry using a series of pump arounds and aggregate check dams or earthen plugs. This method should only be used if there is not enough room to construct the diversion channel in addition to the proposed valley. With this method clean water shall be pumped around the construction area and turbid water shall be pumped to a sediment trap or filter bag. If this pump around method is used the project should be constructed in sections small enough that the entire section can be completed and stabilized daily.

The Unnamed Tributary can be constructed online instead of utilizing temporary diversion channels. This method should only be used if there is not enough room to construct the diversion channel in addition to the proposed valley. If this online method is used the project should be constructed in sections small enough that the entire section can be completed and stabilized daily.

CONTRACTOR RESPONSIBILITIES
Details have been provided on this plan in an effort to help the Contractor provide erosion and sedimentation control. The details shown on the plan shall be considered a minimum. Erosion and sediment control features indicated on the relocation plan shall be installed per the State of North Carolina Department of Transportation details. The Contractor shall be solely responsibility for providing necessary and adequate measures for proper control of erosion and sediment runoff from the site along with proper maintenance and inspection in compliance with with the North Carolina Department of Environmental, and Natural Resources erosion and sediment control regulations.

The Contractor shall provide a schedule of operations to the Owner. The schedule should include a sequence of the placement of the sedimentation and erosion control measures that provides for continual protection of the site throughout the earth moving activities.

Prior to Construction Operations in a particular area, all sedimentation and erosion control features shall be in place. Field adjustments with respect to locations and dimensions may be made by the Engineer.

It may become necessary to remove portions of sedimentation controls during construction to facilitate the grading operations in certain areas. However, the controls shall be replaced upon completion of grading or during any inclement weather.

The Contractor shall be responsible to have the current Erosion Control Plan immediately available or posted on site.

The Contractor shall be responsible to ensure that off-site tracking of sediments by vehicles and equipment is minimized. All such off-site sediment shall be cleaned up daily.

The Contractor shall be responsible to ensure that no solid or liquid waste is discharged into the stream tributaries. Untreated sediment-laden runoff shall not flow off of site without being directed through a sediment control practice.

INSPECTIONS
The Owner/Contractor holder provide qualified personnel to conduct site inspections ensuring proper functionality of the erosion and sedimentation controls. All erosion and sedimentation controls are to be inspected once every seven (7) calendar days or within 24 hours of a 1/2 inch storm event or greater. Records of the site inspections shall be kept and made available to jurisdictional agencies if requested.

MAINTENANCE
It is the Contractor's responsibility to maintain the sedimentation and erosion control features on this project. Any sediment or debris that has reduced the efficiency of a control shall be removed immediately. Upon conducting an erosion control inspection, the Contractor shall repair or replace structures if it is determined that the structure is damaged and/or overwhelmed with sediment.

SOIL STABILIZATION
The Contractor shall stabilize disturbed slopes within 21 calendar days following completion of any phase of grading, permanent ground cover shall be established for all disturbed areas within 15 working days or 90 calendar days (whichever is shorter) following completion of construction.

Disturbed slopes shall be stabilized per the stream channel bank stabilization details and the planting plan.

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
UNNAMED TRIBUTARY
EROSION CONTROL GENERAL NOTES

Job No.	Date	Scale	Sheet
2006-1398	May, 2007	As Noted	RP-17/21

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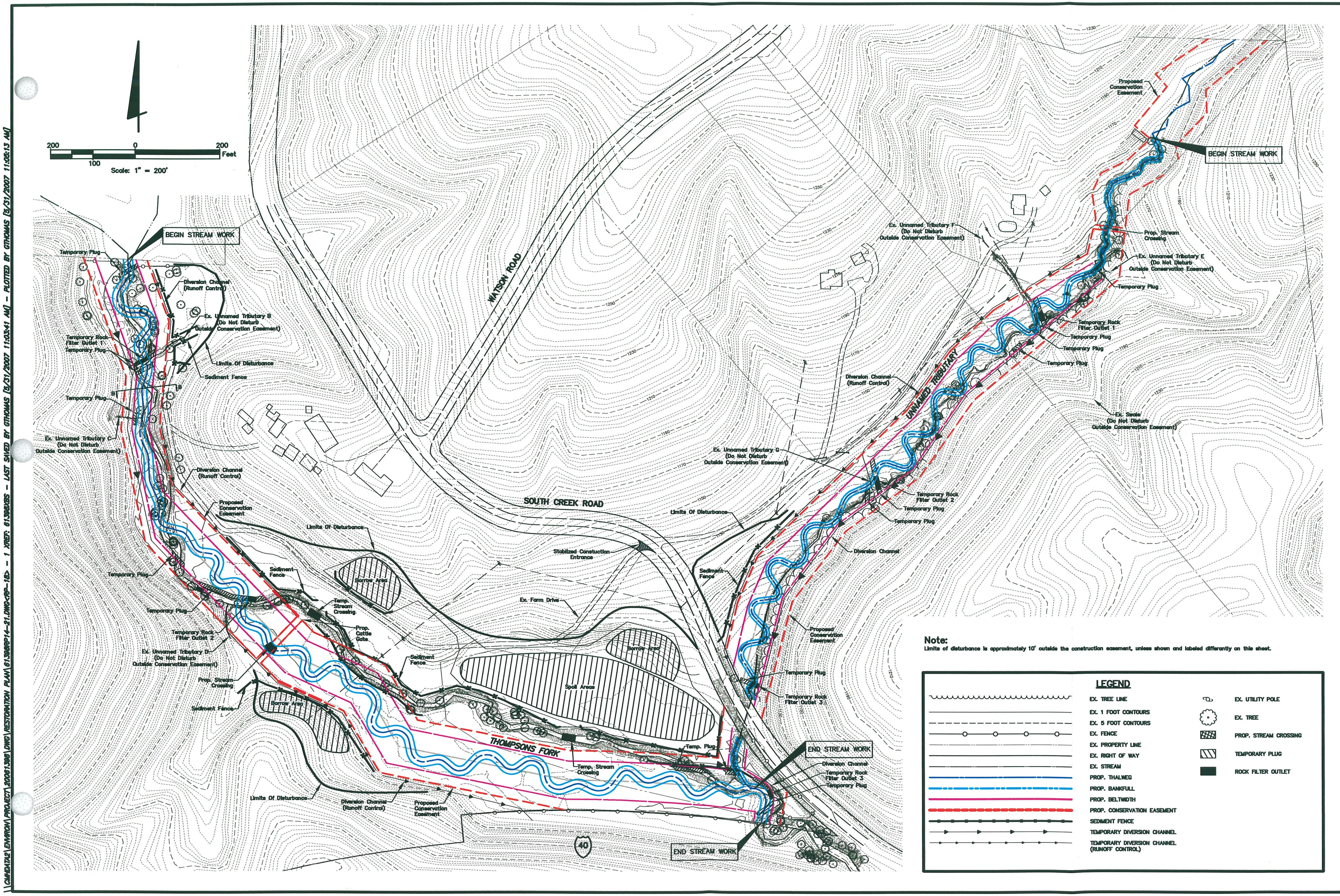

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY

EROSION CONTROL SITE PLAN

Date	Job No.
May, 2007	2006-1398
Scale	Sheet
1" = 200'	RP-18/21

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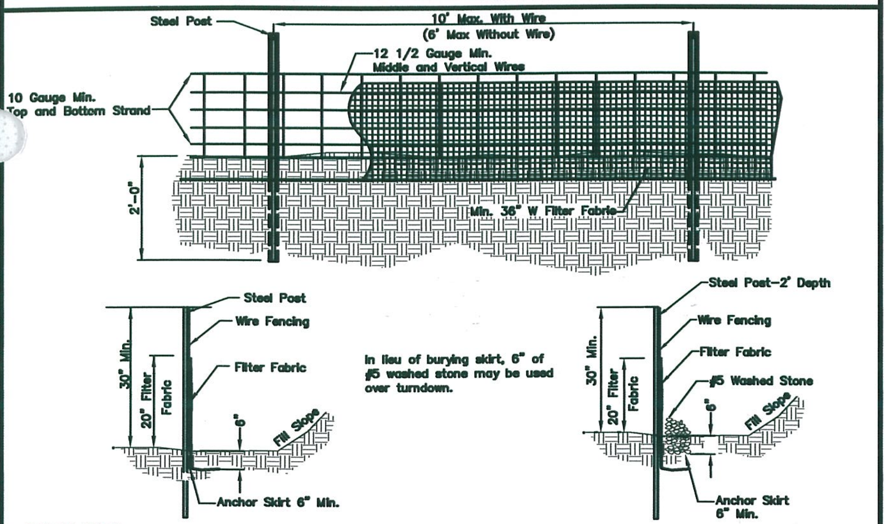
TEMPORARY SEDIMENT FENCE DETAIL



GENERAL NOTES:

Filter fabric fence shall be a minimum of 36" in width and shall be fastened adequately as directed by the Engineer.

Woven filter fabric be should used where silt fence is to remain for a period of more than 30 days.

Steel posts shall be 5'-0" in height and be of the self-fastener angle steel type.

Wire fencing shall be at least #10 gauge with a minimum of 6 line wires with 12" stay spacing.

Turn silt fence up slope at ends.

Wire mesh shall be min. 13 gauge with maximum 12" openings.

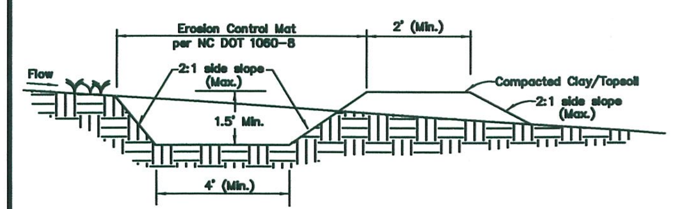
MAINTENANCE NOTES:

Filter barriers shall be inspected by the financially responsible party or his agent immediately after each rainfall and at least daily during prolonged rainfall. Any repairs needed shall be made immediately.

Should the fabric decompose or become ineffective prior to the end of the expected usable life and the barrier still is necessary, the fabric shall be replaced promptly. Sediment deposits should be removed when deposits reach approx. half the height of the barrier.

Any sediment deposits remaining in place after the silt fence is removed shall be dressed to conform to the existing grade, prepared and seeded.

DIVERSION CHANNEL DETAIL (RUNOFF CONTROL)



CONSTRUCTION SPECIFICATIONS:

Remove and properly dispose of all trees, brush, stumps, and other objectionable material.

Provide sufficient room around diversion to permit machine regrading and cleanout.

Vegetate the ridge immediately after construction, unless it will remain in place less than 30 working days.

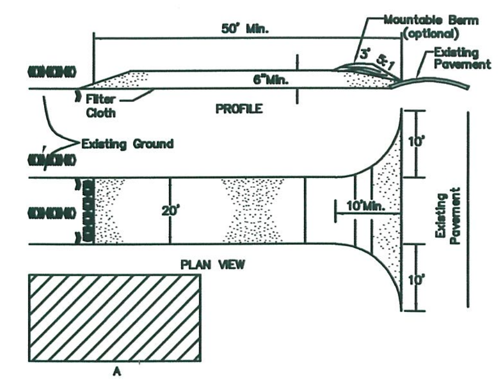
MAINTENANCE:

Inspect temporary diversions once a week and after every rainfall. Immediately remove sediment from the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the area protected is permanently stabilized, remove the ridge and the channel to blend with the natural ground level and appropriately stabilize it.

SEEDING TABLE OUTSIDE STREAM CORRIDOR

TYPE		APPLICATION RATES	APPLICATION DATES
TEMPORARY SEED:			
Rye (Grain)	*(Secale cereale)*	120 lbs/acre	June–August
PERMANENT SEED:			
Big Bluestem	*(Andropogon gerardii)*	15 lbs/acre of mixture	September – May
Tall Fescue	*(Festuca arundinacea)*		
Kentucky Bluegrass	*(Poa pratensis)*		
Korean Lespedeza	*(Lespedeza stipulacea)*		
Sericea Lespedeza	*(Lespedeza cuneata)*		
Redtop	*(Agrostis gigantea)*		
Indiangrass	*(Sorghastrum nutans)*		

STABILIZED CONSTRUCTION ENTRANCE



A: Contractor Laydown Area (Dumpster, Cement Truck Washout, Vehicle Fueling) Location to be determined in the field by Contractor.

Stone Size – Use 2" stone, or reclaimed or recycled concrete equivalent.

Length – As required.

Thickness – Not less than six (6) inches.

Width – Twenty (20) foot minimum, but not less than the full width at points where ingress or egress occurs.

Filter Cloth – will be placed over the entire area prior to placing of stone.

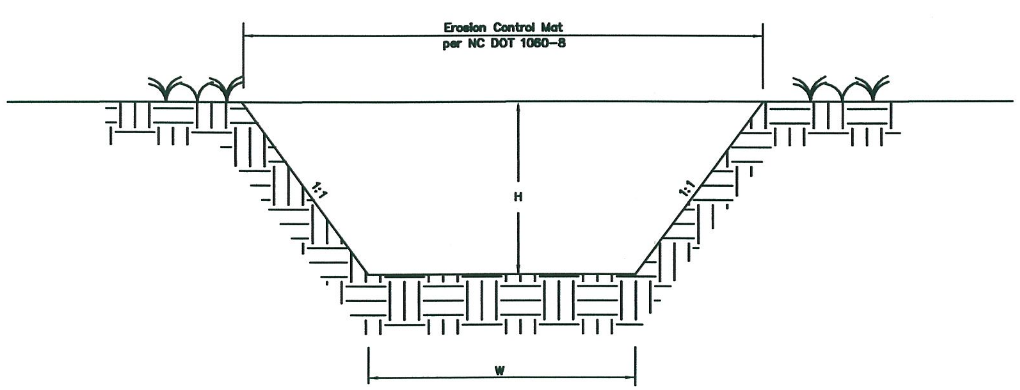
Surface Water – All surface water flowing or diverted toward construction entrances shall be piped across the entrance. If piping is impractical, a mountable berm with 5:1 slopes will be permitted.

Maintenance – The entrance shall be maintained in a condition which will prevent tracking or flowing of sediment onto public right-of-way. This may require periodic top dressing with additional stone as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spilled, dropped, washed or tracked onto public rights-of-way must be removed immediately.

Washing – Wheels shall be cleaned to remove sediment prior to entrance onto public right-of-ways. When washing is required, it shall be done on an area stabilized with stone and which drains into an approved sediment trapping device.

Periodic inspection and needed maintenance shall be provided after each rain.

TEMPORARY DIVERSION CHANNEL DETAIL



CONSTRUCTION SPECIFICATIONS:

Remove and properly dispose of all trees, brush, stumps, and other objectionable material.

Provide sufficient room around diversion to permit machine regrading and cleanout.

Vegetate the ridge immediately after construction, unless it will remain in place less than 30 working days.

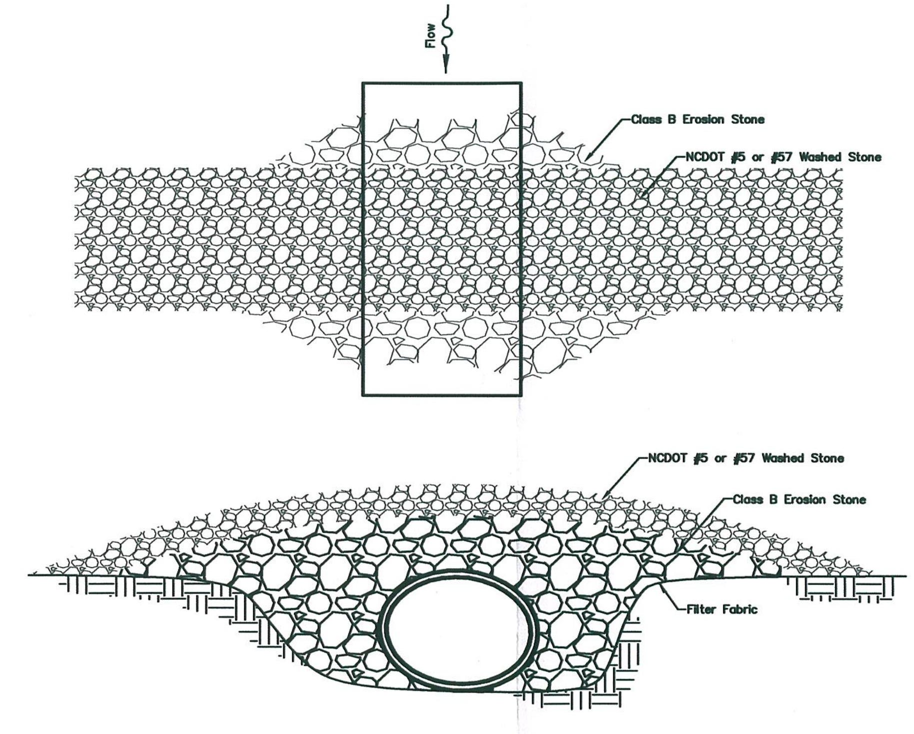
MAINTENANCE:

Inspect temporary diversions once a week and after every rainfall. Immediately remove sediment from the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the proposed stream is permanently stabilized, fill in the channel to blend with the natural ground level and appropriately stabilize it.

DIVERSION CHANNEL DIMENSION TABLE

	Width	Height
Thompsons Fork	7.0'	6.0'
Unnamed Tributary	3.0'	2.0'

TEMPORARY STREAM CROSSING DETAIL



TEMPORARY STREAM CROSSING DETAIL
Not To Scale

Construction Specifications

Keep clearing and excavation of the stream banks and bed approach sections to a minimum.

Keep stream crossings at right angles to the stream flow.

Stablize all disturbed areas subject to flowing water with riprap or other suitable means.

Remove temporary stream crossings immediatley when they are no longer needed. Restore the stream channel to it's original cross-section, smooth and stablize all disturbed areas.

Maintenance

Inspect temporary stream crossings after runoff-producing rains to check for blockage in channel, erosion of abutments, channel scour, riprap displacement, or piping. Make all repairs immediately to prevent further damage to the installation.

PRELIMINARY NOT FOR CONSTRUCTION

REVISIONS

MARK	DATE	DESCRIPTION

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists
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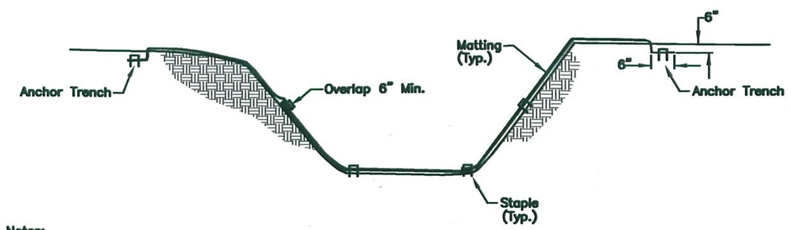
Ecosystem Enhancement PROGRAM

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
UNNAMED TRIBUTARY
EROSION CONTROL DETAILS

Date: May, 2007	Job No.: 2006-1398
Scale: Not To Scale	Sheet: RP-19/21

MATTING INSTALLATION DETAIL



Notes:
Do not stretch blankets/matting tight. Allow the rolls to conform to any irregularities in the soil.

Fertilize, seed and mulch before matting installation. Planting of shrubs, trees, etc. should occur after installation.

Staple the beginning/end and edge of each roll every 18". All other staples should be placed on 3' centers.

MAINTENANCE:
Inspect Rolled Erosion Control Products at least weekly and after each significant (½ inch or greater) rainfall event repair immediately.

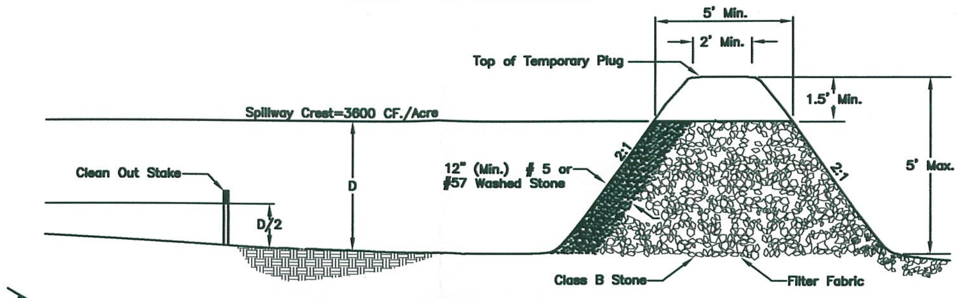
Good contact with the ground must be maintained, and erosion must not occur beneath the matting.

Any areas of the matting that are damaged or not in close contact with the ground shall be repaired and stapled.

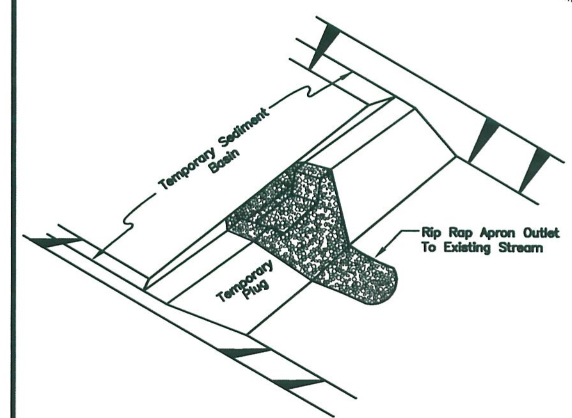
If erosion occurs due to poorly controlled drainage, the problem shall be fixed and the eroded area protected.

Monitor and repair the matting as necessary until ground cover is established.

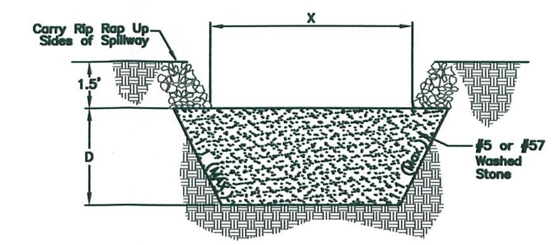
TEMPORARY SEDIMENT TRAP AND ROCK FILTER OUTLET DETAIL



SECTION THROUGH TRAP AND OUTLET



OBLIQUE PLAN



ELEVATION OF OUTLET

MAINTENANCE:
Inspect temporary sediment traps at least weekly and after each significant (½ inch or greater) rainfall event and repair immediately. Remove sediment, and restore the trap to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment that is removed in the designated disposal area, and replace the part of the gravel facing that is impaired by sediment.

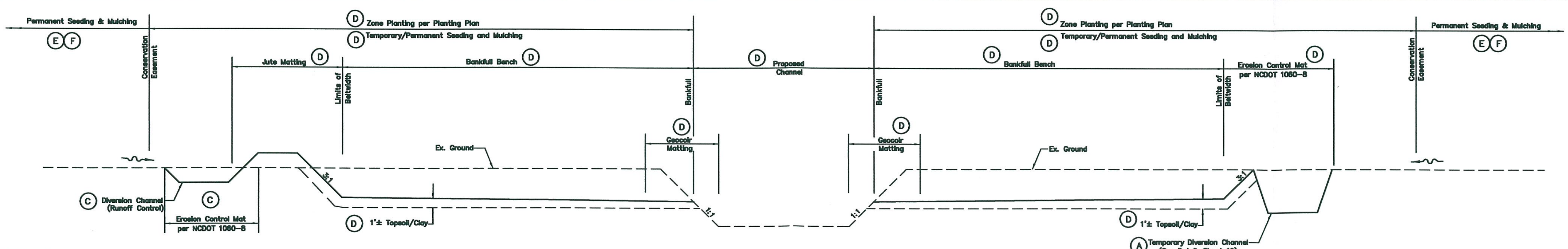
Check the structure for damage from erosion of piping. Periodically check the depth of the spillway to ensure it is a minimum of 1.5 feet below the low point of the embankment. Immediately fill any settlement of the embankment to slightly above design grade. Any riprap displaced from the spillway must be replaced immediately.

After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. smooth the area to blend with adjoining areas, and stabilize property.

TEMPORARY SEDIMENT TRAP AND ROCK FILTER OUTLET TABLE

TRAP	DRAINAGE AREA (ACRES)	DENUDED AREA (ACRES)	TRAP SURFACE AREA REQUIRED (SQ. FT.)	TRAP SURFACE AREA PROVIDED (SQ. FT.)	TRAP VOLUME REQUIRED (CUBIC FT.)	TRAP VOLUME PROVIDED (CUBIC FT.)	CLEANOUT DEPTH (FT.) D/2	D (FEET)	X (FEET)
Thompsons Fork									
1	0.6	0.6	739	Ok	2,160	Ok	1.0'	2.0'	4'
2	1.3	1.3	1,601	Ok	4,680	Ok	1.0'	2.0'	6'
3	4.5	4.5	5,544	Ok	16,200	Ok	1.0'	2.0'	12'
Unnamed Tributary									
1	0.4	0.4	493	Ok	1,440	Ok	1.0'	2.0'	4'
2	1.3	1.3	1,601	Ok	4,680	Ok	1.0'	2.0'	6'
3	1.2	1.2	1,478	Ok	4,320	Ok	1.0'	2.0'	6'

CHANNEL STABILIZATION DETAIL – SECTION B–B



Notes:
- –Typical Section is from left to right looking downstream.
- –Bankfull Bench shall be over-excavated approxiamatly 1' and restored with clay and topsoil.
- –Geocoir Matting shall extend from the invert of the existing channel onto the bankfull bench.
- –Jute Matting shall extend from the bankfull bench to the invert of the diversion channel.
- –Diversion channels shall be constructed with a combination of topsoil and compacted clay.
- –See sheet 17 for a detailed erosion control schedule.
- –See plan view for location of each erosion control feature (Sheet 18).
- –Matting shall be installed per NCDOT Item 1631.3 and detail, this sheet.
- –Site stabilization includes placing fertilizer, seeding, mulching, and matting.
- –Runoff shall be controlled by diversion channels. The clean runoff shall be diverted to a small Unnamed Tributary
- –See sheet 18 for location of section B–B.
- –Straw mulch shall be applied at a ratio 1–2 tons per acre, and shall be anchored using a mulch anchoring tool or other approved method.

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MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
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AND UNNAMED TRIBUTARY
UNNAMED TRIBUTARY
EROSION CONTROL DETAILS

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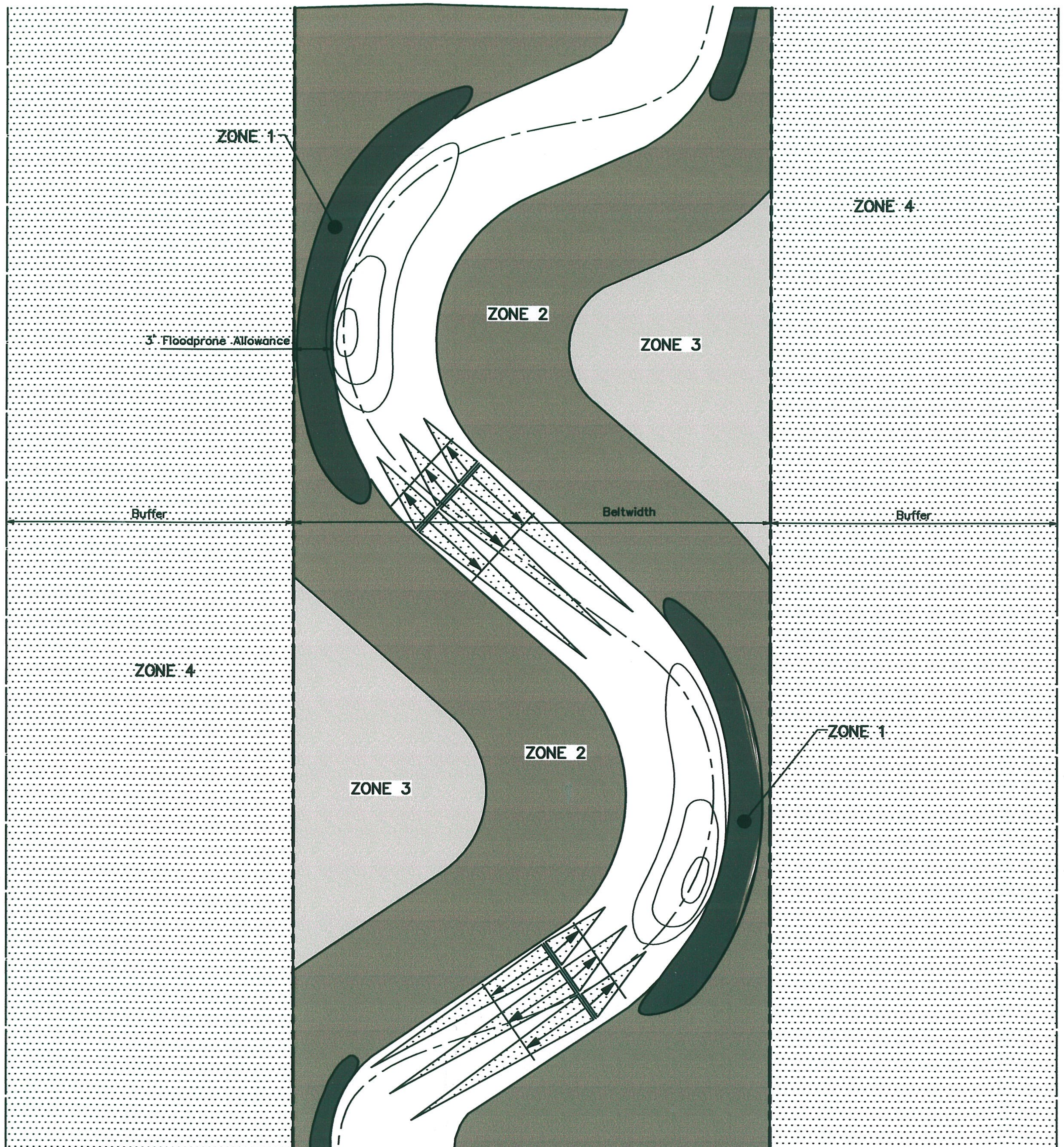

PLANTING ZONES
Not to Scale

PLANTING ZONES

- Zone 1 - Stream Edge

Live Branches, 3x3' centers

Common Name	Scientific Name
Silky dogwood	*Cornus amomum*
Southern arrowwood viburnum	*Viburnum dentatum*
Elderberry	*Sambucus canadensis*
Black willow	*Salix nigra*

- Zone 2 - Streamside Shrubs and Trees

Shrubs
Bareroot Material - 4x4' centers

Common Name	Scientific Name
Painted buckeye	*Aesculus sylvatica*
Silky dogwood	*Cornus amomum*
Tag alder	*Alnus serrulata*
Black willow	*Salix nigra*
Elderberry	*Sambucus canadensis*
Southern arrowwood viburnum	*Viburnum dentatum*
American hazelnut	*Corylus americana*
American holly	*Ilex opaca*
Persimmon	*Diospyros virginiana*

Trees
1 Gallon Containers - 100 foot spacing

Common Name	Scientific Name
Box elder	*Acer negundo*
River birch	*Betula nigra*
Sycamore	*Platanus occidentalis*
Sweet gum	*Liquidambar styraciflua*
Green ash	*Fraxinus pennsylvanica*
Tulip poplar	*Liriodendron tulipifera*
American elm	*Ulmus americana*
Bitternut hickory	*Carya cordiformis*

- Zone 3 - Floodplain

Bareroot Material - 8x8' centers

Common Name	Scientific Name
Box elder	*Acer negundo*
River birch	*Betula nigra*
Sycamore	*Platanus occidentalis*
Sweet gum	*Liquidambar styraciflua*
Green ash	*Fraxinus pennsylvanica*
Tulip poplar	*Liriodendron tulipifera*
American elm	*Ulmus americana*
Bitternut hickory	*Carya cordiformis*
Persimmon	*Diospyros virginiana*

- Zone 4 - 30' Riparian Buffer

Bareroot Material - 10x10' centers

Common Name	Scientific Name
White ash	*Fraxinus americana*
Black walnut	*Juglans nigra*
Tulip poplar	*Liriodendron tulipifera*
Black gum	*Nyssa sylvatica*
Black cherry	*Prunus serotina*
White oak	*Quercus alba*
Eastern hophornbeam	*Ostrya virginiana*
Mountain laurel	*Kalmia latifolia*
Strawberry bush	*Euonymus americanus*

Notes

- Final species selection will be based upon availability
- Temporary and permanent seeding to occur in Zones 1, 2, 3 & 4 — See Table Below
- Planting zones are for Thomsons Fork and the Unnamed Tributary.
- Full planting will occur along the right bank of the Unnamed Tributary.
- The left bank of the Unnamed Tributary will only contain planting zones 1 and 2.

STREAM CORRIDOR SEEDING TABLE

TYPE	APPLICATION RATES	APPLICATION DATES
TEMPORARY SEED: Rye (Grain) *(Secale cereale)*	40 lbs/acre	June–August
PERMANENT SEED: Big Bluestem *(Andropogon gerardii)* Broomsedge *(Andropogon virginicus)* Deertongue *(Panicum clandestinum)* Little Bluestem *(Schizachyrium scoparium)* Indiangrass *(Sorghastrum nutans)*	15 lbs/acre of mixture	September – May
OVERSEED: Pearl Millet *(Pennisetum glaucum)*	15 lbs/acre	June–August

MCDOWELL COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
THOMPSONS FORK AND UNNAMED TRIBUTARY
STREAM RESTORATION PROJECT
PLANTING PLAN

Job No. 2006-1398
Sheet RP-21/21
Date May, 2007
Scale Not To Scale

Ecosystem Enhancement PROGRAM

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APPENDIX 2

Project Site NCDWQ Stream Classification Forms

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 2/7/06	Project: Thompsons Fork	Latitude:
Evaluator: Peffer, Darby	Site: Mainstem	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 41	County: McDowell	Other *e.g. Quad Name:* Marion East

A. Geomorphology (Subtotal = 23.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	**(3)**
2. Sinuosity	0	1	**(2)**	3
3. In-channel structure: riffle-pool sequence	0	1	**(2)**	3
4. Soil texture or stream substrate sorting	0	1	2	**(3)**
5. Active/relic floodplain	0	1	2	**(3)**
6. Depositional bars or benches	0	1	**(2)**	3
7. Braided channel	**(0)**	1	2	3
8. Recent alluvial deposits	0	1	2	**(3)**
9[a] Natural levees	**(0)**	1	2	3
10. Headcuts	**(0)**	1	2	3
11. Grade controls	0	0.5	**(1)**	1.5
12. Natural valley or drainageway	0	0.5	1	**(1.5)**
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		**(Yes = 3)**	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8)				
14. Groundwater flow/discharge	0	1	2	**(3)**
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	2	**(3)**
16. Leaflitter	**(1.5)**	1	0.5	0
17. Sediment on plants or debris	**(0)**	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	**(0.5)**	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		**(Yes = 1.5)**	

C. Biology (Subtotal = 9.5)				
20[b]. Fibrous roots in channel	**(3)**	2	1	0
21[b]. Rooted plants in channel	**(3)**	2	1	0
22. Crayfish	0	0.5	**(1)**	1.5
23. Bivalves	**(0)**	1	2	3
24. Fish	0	0.5	**(1)**	1.5
25. Amphibians	0	0.5	**(1)**	1.5
26. Macrobenthos (note diversity and abundance)	0	**(0.5)**	1	1.5
27. Filamentous algae; periphyton	**(0)**	1	2	3
28. Iron oxidizing bacteria/fungus.	**(0)**	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			N/A

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Highly entrenched reach. Perennial stream.

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 2/7/06	Project: Thompsons Fork-Tributary	Latitude:
Evaluator: Peffer, Darby	Site: Tributary	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 30	County: McDowell	Other *e.g. Quad Name:* Marion East

A. Geomorphology (Subtotal = 18.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	1	2	(3)
3. In-channel structure: riffle-pool sequence	0	1	2	(3)
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	(2)	3
6. Depositional bars or benches	0	(1)	2	3
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	(1)	2	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	(0)	1	2	3
11. Grade controls	0	0.5	(1)	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 5.5)				
14. Groundwater flow/discharge	0	(1)	2	3
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	(2)	3
16. Leaflitter	1.5	1	(0.5)	0
17. Sediment on plants or debris	0	(0.5)	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	(1.5)
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal = 6)				
20[b]. Fibrous roots in channel	3	2	(1)	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	(0.5)	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	0	(0.5)	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	(1)	1.5
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			N/A

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Perennial Stream

Sketch:

APPENDIX 3

Thompsons Fork Watershed Hydraulic Assessment

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers, Surveyors, Planners, Scientists

MEMO

Date: November 30, 2006

To: File

From: Bob Davis

Re: Thompson Fork hydraulic study of existing condition stream

EMH&T, Inc. Job No. 2006-1398

A preliminary hydraulic analysis of the existing condition stream has been completed, utilizing the HEC-RAS computer program, and flows derived from the regression equation analysis. The hydraulic model contains mostly valley sections, but does include a low-water driveway bridge crossing near the middle point of the study reach. The HEC-RAS file can be found from my machine on the following path … Y:\PROJECT\20061398\HEC-RAS\TF.prj. Assumptions for the analysis include:

- Cross-section Station/Elevation data was derived from a combination of field-surveyed spot elevations and elevation contour data provided on an aerial mosaic of the study area. See the aerial map for the locations of the cross sections used in the analysis.
- Flow rates for the 1.8-year and 100-year storms were utilized in the HEC-RAS model. The **1.8-year flow rate of 285 cfs** was based on an interpolated peak flow of 250 cfs from the uncontrolled area below the dam, using the regression equations, plus 35 cfs maximum outflow from the dam during a 2-year event, as estimated from my TR-20 watershed model results. The **100-year flow rate of 1473 cfs** was based on the calculated peak flow of 1353 cfs for the uncontrolled area below the dam, using the regression equations, plus 120 cfs outflow from the dam during the 100-year event, as estimated from my TR-20 watershed model results.
- The starting water surface elevations at the first cross section in the analysis were estimated by slope-area method … the slope was determined by plotting selected channel bottom points along the stream reach, and then drawing a best-fit, constant slope through the given points. The resulting slope of 0.0030 was then used as the starting slope for the flood profiles.
- Generalized Manning's "n" values for the stream reach were estimated from the aerial photo mapping and ground photos provided to me. While there are numerous ground photos of the study reach, I was not able to relate the ground photos to specific locations in the stream reach. Therefore, I assumed Manning's "n" values for channel and overbank areas based on average condition for the bulk of the stream length. In establishing these "n" values, I did consider the effect of the rather severe meandering of the stream, and also the likelihood of major floods occurring during the summer vegetative season, as historical floods in the region are generally associated with tropical storm events.

Results of the analysis appear reasonable, with the 1.8-year storm staying within the banks at most sections, and the 100-year storm occupying the floodplain areas of the stream. The most difficult portion of the stream to model is located in the general area of the low-flow driveway bridge crossing.

The stream slope increases significantly from just downstream of this crossing to a point about 100 feet upstream of the crossing, which causes critical depth problems in this local reach. There may well be supercritical flow in the stream within this short reach. Based on the results of the HEC-RAS analysis, the average maximum flow depth in the existing stream during the 100-year storm event is about 8-9 feet. Detailed flood elevations for the 1.8-year and 100-year storm events are summarized in the following table.

Section Number	Distance upstream from Section 1.0	Stream invert elevation	1.8-year flood elevation	100-year flood elevation
	(feet)	(Ft.)	(Ft.)	(Ft.)
1.0	0	1085.4	1089.82	1094.83
2.0	130	1085.5	1090.27	1095.33
4.0	550	1087.4	1091.85	1096.46
6.0	870	1087.2	1092.85	1097.29
8.0	1150	1089.7	1093.71	1097.84
10.0	1460	1089.6	1094.81	1098.65
12.0	1880	1091.7	1095.69	1100.04
12.2 (just downstream of driveway bridge)	1900	1093.7	1096.33	1100.46
12.6 (just upstream of driveway bridge)	1920	1094.2	1098.87	1100.73
12.8	1965	1093.2	1098.97	1101.27
13.0	2020	1094.6	1099.30	1102.23
14.0	2160	1094.1	1099.57	1102.55
15.0	2290	1094.9	1099.93	1103.02
16.0	2420	1095.2	1100.22	1103.48
18.5	2645	1095.3	1100.57	1104.02
19.5	2780	1095.6	1100.81	1104.15

MEMO

Date: November 10, 2006

To: File

From: Bob Davis, Senior Hydrologist

Re: Thompsons Fork hydrologic analysis of watershed

EMH&T, Inc. Job No. 2006-1398

I have completed a preliminary analysis of the Thompsons Fork watershed to a point just upstream of the I-40 bridge crossing. The analysis includes the influence of a flood control dam located on Thompsons Fork, approximately 1.5 miles upstream of the I-40 bridge crossing. USGS quadrangle mapping has been utilized for purposes of establishing drainage area boundaries, stream lengths, time of concentration flow paths, and land uses for the hydrologic analysis. I have utilized construction plans and other pertinent design information provided from a variety of sources to determine the flood storage and outlet rating for the existing flood control dam (identified/known as "Muddy Creek Dam #8"), for use in the hydrologic analyses. I have calculated preliminary peak flow rates for the stream utilizing two different methodologies … (1) regression equations, and (2) SCS/NRCS.

For the regression analysis, I have used formulas published in USGS Water-Resources Investigations Report 01-4207, Estimating the Magnitude and Frequency of Floods in Rural Basins of North Carolina (Revised), by Benjamin F. Pope, Gary D. Tasker and Jeanne C. Robbins. Flow rates are calculated at two different locations … at the upstream end of the flood control dam on Thompsons Fork, and just upstream of the I-40 bridge crossing. The first location at the upstream side of the dam represents all flow entering the flood control structure, before being routed through the outlet appurtenances. The second location, just upstream of the I-40 crossing, represents flow rates associated with only the uncontrolled drainage area downstream of the flood control structure, as the regression equations do not account for flows that are controlled within a watershed. In order to obtain a reasonable estimate of total peak flow rates at the I-40 crossing, including the controlled areas, an estimated outflow must be added to the calculated flow rate associated with the uncontrolled area. Based on timing of peak flow rates from the uncontrolled and controlled areas, it appears that the maximum contribution of peak flow from the flood control structure to I-40 will be approximately 45 cfs, during the 100-year storm event. So basically the drainage area and flows from upstream of the flood control dam can be pretty much ignored in the calculation of peak flow rates at the I-40 crossing, for storms up to and including the 100-year event. (Sam Bingham of the Rutherford-McDowell Counties SWCD indicates that tropical storms larger than the 100-year event have been passed through the existing flood control structure without emergency spillway flow, so outflow is controlled solely by a 30-inch diameter pipe). Table 1 shows the peak flow rates obtained at the upstream side of the existing dam, and just upstream of the I-40 crossing.

Table 1
Summary of Peak Flows on Thompson Fork using Regression Formulas

Storm Recurrence Interval	Peak Flows Entering Existing Flood Control Structure (Muddy Creek Dam #8) [Drainage Area = 5.0196 sq.mi.]	Peak Flows Just Upstream of I-40 Bridge Crossing (Reflecting Uncontrolled Area Downstream of Dam Only) [Drainage Area = 2.5988 sq.mi.]
	(cfs)	(cfs)
1-year	-	-
2-year	419	264*
5-year	721	462*
10-year	972	629*
25-year	1,348	881*
50-year	1,677	1,104*
100-year	2,042	1,353*

* Need to add a small amount of outflow (< 45 cfs) from the existing flood control dam to obtain true total peak flow.

For the SCS/NRCS analysis, I subdivided the total watershed into 7 different subareas; 3 upstream of the flood control dam, and 4 downstream of the dam, to reflect flow rates at significant stream confluences, and to insure that no single subarea exceeded the 2000 acre size limit recommended by the methodology. (See the drainage area map with delineated watershed boundaries). For the first trial, no channel routings were included in the TR-20 hydrologic model. Flood storage at the existing dam was assumed to increase linearly from zero at normal pool elevation 1143.5 feet to 250 acre-feet at flood pool elevation 1166 feet, per the information provided. An outflow rating for the 30-inch pipe and outlet structure at the existing dam was developed based on information provided on furnished as-built plans. Details of the outlet structure were somewhat vague on the one detail sheet provided, in particular, at the top of the riser structure. It was assumed that water would be able to pour into a fully open riser section once the pool exceeded the top of riser elevation. The computed outlet rating was then used to route the various frequency storm event runoff hydrographs through the reservoir. It should also be noted that I could not find any soils information for the general area … checking online at NRCS, I found that there is a soils survey report available for McDowell County, North Carolina, but it is not available for viewing online. Therefore, I just had to guess at the soil group that would exist in the watershed … since the topography appeared rugged, I assumed that there probably would be rock outcroppings, which would be best mimicked by a "D" soil. For rainfall amounts associated with the various frequency storm events, I found information for the general McDowell County area in NOAA Atlas 14 for North Carolina.

The results of the first trial produced peak flow rates that far exceeded the peak flow rates calculated with the regression equations. I then began a process of trying to calibrate the model to try and match the regression equation flows by adjusting the runoff curve number, since the drainage areas and times of concentration seemed to be less negotiable. It was necessary to lower the runoff curve number to about 40-45 to get some of the flows in the ballpark of the regression equation flows … but there were two remaining problems. One was that the entire range of flows by frequency could not be brought into line with the regression equation flows … if the 100-year flow rates were in the ballpark, the more frequent storm events were way low. And conversely, if the more frequent events were calibrated, the larger event flows would become way too high. The other problem was that the reservoir routings in the model were predicting overflow into the emergency spillway for the larger storm events, even when the TR-20 flows were near or below the regression equation flows … when information we received specifically pointed out that the reservoir had passed several 100-year events associated with tropical storms without spillway discharge.

At this point, I felt that there must be additional storage being utilized, probably in the main channel, during larger storm events. So I established channel routings for the TR-20 model, with estimated ratings. Since a natural channel typically carries a 1-year to 2-year storm within its banks, I set up arbitrary cross sections, incorporating a natural channel (with 10-foot bottom width) that had the capacity to carry slightly less than a 2-year peak flow (as estimated from the regression equations), and overbanks that were at a generic slope of 2% to produce a floodplain about 400 feet wide, which seemed to be a reasonable amount based on the USGS topo map. Using the estimated natural channel slopes from the USGS map, I inserted these sections into the HEC-2 program to establish the ratings for the channel routings. In addition, the mention of "tropical storm" triggered a long-distant memory of a rainfall distribution that I used years ago on the East Coast … a SCS/NRCS Type 3 rainfall distribution, which is supposed to mimic a typical tropical storm rainfall (more steady heavy rain rather than intense, short-duration thunderstorm-type activity). This would also help to lower peak flow rates in the watershed. I inserted the Type 3 rainfall distribution table into the TR-20 model, to be used as the default rainfall distribution pattern.

The next set of trials produced slightly better results, but the overall curve number for the watershed was still very low, and I was still having problems with spillway overflow during the largest storm events. As I started to study the information provided (250 acre-feet of flood storage at flood pool, it just did not seem reasonable. It became apparent that in order for the reservoir to not overflow its spillway, it would be necessary to have less than 2 inches of runoff from the watershed during a 100-year storm event … while the rainfall was almost 8.6 inches! Not only did this seem improbable, it also seemed unlikely that a flood control dam would be built that would only control 2 inches of runoff from its tributary area. Since I had a rough 5-ft. contour map of the pool area in the materials given to us, I thought I'd better check the storage for the reservoir. Sure enough, when I created my own storage information, I obtained significantly more storage … approximately 925 acre-feet at the spillway crest, instead of 250 acre-feet. With the new storage curve, the revised TR-20 run now produced no spillway overflow, but the peak flows are still somewhat of a problem. I plotted up the regression equation flows and TR-20 comparison flows on semi-log paper for comparison purposes. The TR-20 computed flows are summarized in Table 2, using watershed average curve numbers 50 and 55. I suspect that we still need to do some adjusting of parameters in the TR-20 modeling, but I really need to have better data to justify some of the current assumptions. At this point we need to decide a future course of action, relative to flow rates to be used in the proposed channel redesign project.

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers, Surveyors, Planners, Scientists

Table 2
Summary of TR-20 Results, Relative to Regression Equation Results

Storm Recurrence Interval	TR-20 Peak Flows Entering Existing Flood Control Structure (Muddy Creek Dam #8) RCN = 50 [Drainage Area = 5.0196 sq.mi.]	TR-20 Peak Flows Entering Existing Flood Control Structure (Muddy Creek Dam #8) RCN =55 [Drainage Area = 5.0196 sq.mi.]	Regression Equation Peak Flows Entering Existing Flood Control Structure (Muddy Creek Dam #8) [Drainage Area = 5.0196 sq.mi.]	TR-20 Peak Flows Just Upstream of I-40 Bridge Crossing RCN = 50 [Drainage Area = 7.6184 sq.mi.]	TR-20 Peak Flows Just Upstream of I-40 Bridge Crossing RCN = 55 [Drainage Area = 7.6184 sq.mi.]	Regression Equation Peak Flows* Just Upstream of I-40 Bridge Crossing (Reflecting Uncontrolled Area Downstream of Dam Only) [Drainage Area = 2.5988 sq.mi.]
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
1-year	45	113	-	24	58	-
2-year	132	278	419	68	141	264*
5-year	400	659	721	201	332	462*
10-year	694	1008	972	352	519	629*
25-year	1137	1560	1,348	602	812	881*
50-year	1577	2046	1,677	830	1083	1,104*
100-year	2069	2650	2,042	1097	1384	1,353*

* Need to add a small amount of outflow (< 45 cfs) from the existing flood control dam to obtain true total peak flow.

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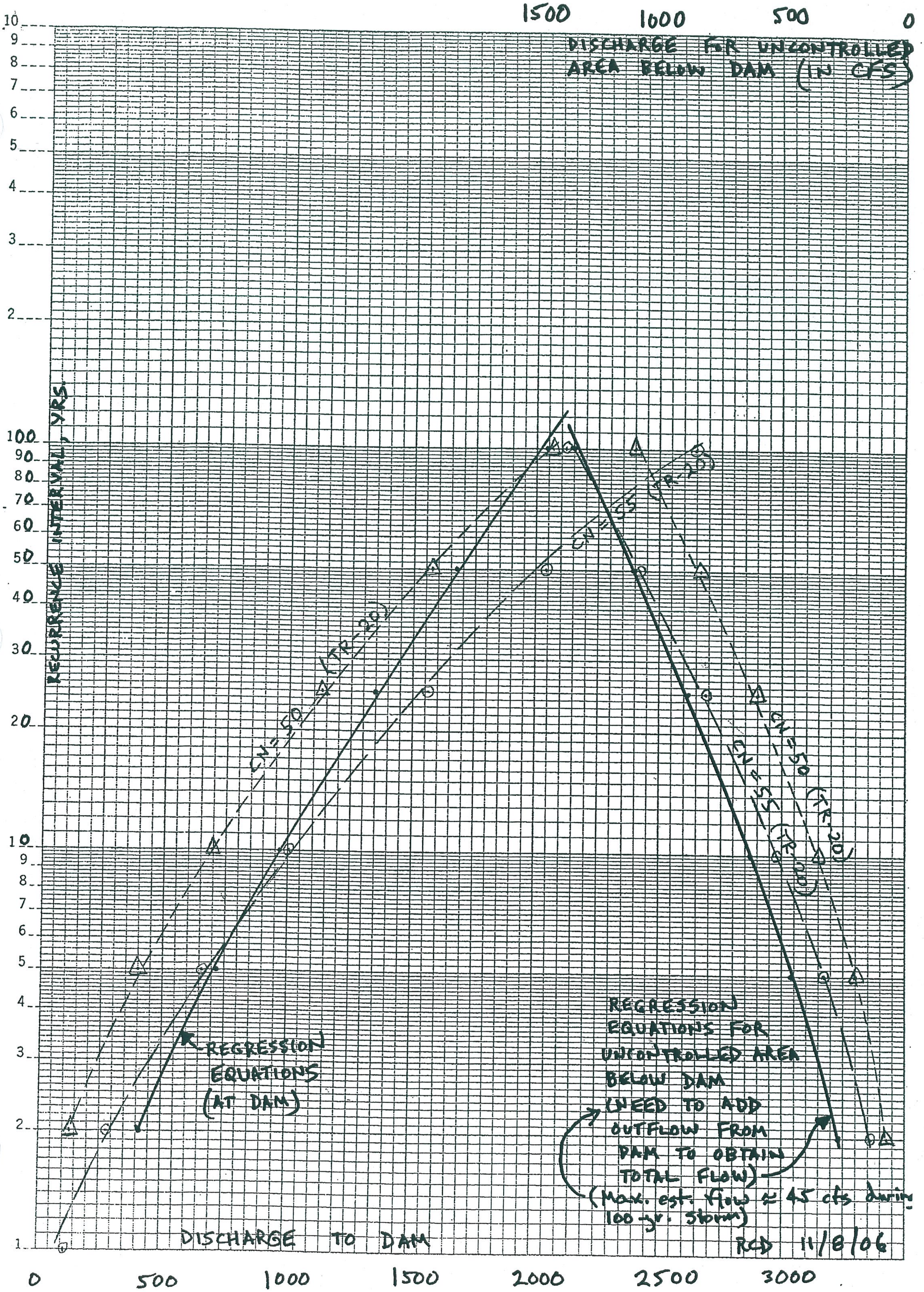


1500
1000
500
0
DISCHARGE FOR UNCONTROLLED AREA BELOW DAM (IN CFS)
RECURRENCE INTERVAL, YRS.
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
CN = 50 (TR-20)
CN = 55 (TR-20)
REGRESSION EQUATIONS (AT DAM)
REGRESSION EQUATIONS FOR UNCONTROLLED AREA BELOW DAM (NEED TO ADD OUTFLOW FROM DAM TO OBTAIN TOTAL FLOW)
(Max. est. flow ≈ 45 cfs during 100 yr. storm)
DISCHARGE TO DAM
RCD 11/8/06
0
500
1000
1500
2000
2500
3000

APPENDIX 4

Project Site Design Calculations, Plots, Photographs and Summary Reports

RIVERMORPH NATURAL CHANNEL DESIGN REPORT

River Name: Thompsons Fork
Reach Name: Proposed Mainstem

--Reference Reach--

Thompsons Fork; Thompsons Fk Ref Reach (E 4)

--Boundary Conditions--

Drainage Area:	7.57 sq mi
Valley Slope:	0.0031 ft/ft
Bankfull Discharge:	285 cfs
Bankfull Cross Sectional Area:	52 sq ft
Mean Depth Calculation Tolerance:	0.2 ft

--Sediment Data--

Riffle Bed Material ID:	Riffle Bed Sample 0+60
Riffle Bed Material D84:	26.19 mm
Riffle Bed Material D50:	13.7 mm

Bar Sample ID:	Bar Sample @ Conf Thompsons Fk & UT
Bar Sample Dmax:	31.5 mm
Bar Sample D50:	7.72 mm

--Entrainment Options--

Shields Entrainment Function Augmented with Rosgen Sediment Transport Data (Provisional)

---------------NCD Results---------------

--Alignment--

Meander Wavelength:	110.40 ft
Channel Length:	370.38 ft
Sinuosity:	1.22
Radius of Curvature:	38.4 ft
Bankfull Slope:	0.0024
Meander Belt Width:	90.00 ft
Meander Width Ratio:	4.19
Deflection Angle:	1.63 rad

--Riffle Cross Sectional Properties--

Width to Depth Ratio:	8.96
Entrenchment Ratio:	4.19
Floodprone Width:	90.00 ft
Bankfull Width:	21.5 ft
Bankfull Mean Depth:	2.42 ft
Bankfull Velocity:	5.48 ft/s
Bankfull Hydraulic Radius:	1.97 ft
Bankfull Shear Stress:	0.172 lbs/sq ft
Required Roughness (n):	0.0159 ft^(1/6)
Entrainable Particle Size:	41.7 mm

--Rosgen Stream Classification--

Reference Reach :	E 4
Proposed Reach :	E 4
Existing Reach :	G 4c (BKF Slope < .02 ft/ft)

--Sediment Transport Competency--

Ratio - Riffle Slope / Bankfull Slope:	4.7
Ratio - Di bar / D50bed:	2.299
Critical Dimensionless Shear Stress (2):	0.0183
Required Mean Depth (2):	2.23 ft

Minimum Required Mean Depth: 2.23 ft

Thompsons Fork Mainstem - Proposed Profile Summary

	Upstream	Downstream
Upstream Invert =	1096.50	1090.29
Downstream Invert =	1090.29	1086.09
Channel Slope =	0.0024	0.0196
Channel Length =	2584.81	213.93

Description	Stationing	Channel Invert	Pool Invert	Bankfull Elevation
Begin Project	0+00.00	1096.50	1095.30	1099.50
CL Riffle	0+13.68	1096.47	1095.27	1099.47
Begin Pool	0+33.62	1096.42	1095.22	1099.42
Bottom Pool	0+44.62	1096.39	1095.19	1099.39
Cross Vane	0+90.00	1096.28	1095.08	1099.28
Bottom Pool	1+14.43	1096.23	1095.03	1099.23
CL Riffle	1+63.28	1096.11	1094.91	1099.11
J-Hook	1+95.00	1096.03	1094.83	1099.03
Bottom Pool	2+11.24	1095.99	1094.79	1098.99
CL Riffle	2+43.73	1095.91	1094.71	1098.91
Begin Pool	2+68.74	1095.85	1094.65	1098.85
Bottom Pool	2+79.74	1095.83	1094.63	1098.83
CL Riffle	3+02.56	1095.77	1094.57	1098.77
Begin Pool	3+23.04	1095.72	1094.52	1098.72
Bottom Pool	3+34.04	1095.70	1094.50	1098.70
CL Riffle	3+59.84	1095.64	1094.44	1098.64
Begin Pool	3+78.32	1095.59	1094.39	1098.59
Bottom Pool	3+89.32	1095.56	1094.36	1098.56
CL Riffle	4+11.18	1095.51	1094.31	1098.51
Begin Pool	4+26.32	1095.48	1094.28	1098.48
Bottom Pool	4+37.32	1095.45	1094.25	1098.45
Cross Vane	4+70.00	1095.37	1094.17	1098.37
Bottom Pool	4+90.68	1095.32	1094.12	1098.32
CL Riffle	5+20.03	1095.25	1094.05	1098.25
Begin Pool	5+34.33	1095.22	1094.02	1098.22
Bottom Pool	5+45.33	1095.19	1093.99	1098.19
CL Riffle	5+74.22	1095.12	1093.92	1098.12
Begin Pool	5+96.58	1095.07	1093.87	1098.07
Bottom Pool	6+07.58	1095.04	1093.84	1098.04
CL Riffle	6+35.23	1094.97	1093.77	1097.97
Begin Pool	6+54.97	1094.93	1093.73	1097.93
Bottom Pool	6+65.97	1094.90	1093.70	1097.90
Cross Vane	6+90.00	1094.84	1093.64	1097.84
Bottom Pool	7+08.37	1094.80	1093.60	1097.80
CL Riffle	7+45.10	1094.71	1093.51	1097.71
Begin Pool	7+66.37	1094.66	1093.46	1097.66
Bottom Pool	7+77.37	1094.63	1093.43	1097.63
CL Riffle	7+99.22	1094.58	1093.38	1097.58
Begin Pool	8+18.48	1094.53	1093.33	1097.53
Bottom Pool	8+29.48	1094.51	1093.31	1097.51
J-Hook	8+60.00	1094.43	1093.23	1097.43
Bottom Pool	8+83.33	1094.38	1093.18	1097.38
J-Hook	9+30.00	1094.27	1093.07	1097.27
Bottom Pool	9+51.67	1094.21	1093.01	1097.21
J-Hook	9+95.00	1094.11	1092.91	1097.11
Bottom Pool	10+08.91	1094.08	1092.88	1097.08
CL Riffle	10+36.74	1094.01	1092.81	1097.01
Begin Pool	10+76.09	1093.91	1092.71	1096.91
Bottom Pool	10+87.09	1093.89	1092.69	1096.89
CL Riffle	11+12.19	1093.83	1092.63	1096.83
Begin Pool	11+29.38	1093.79	1092.59	1096.79
Bottom Pool	11+40.38	1093.76	1092.56	1096.76
CL Riffle	11+57.94	1093.72	1092.52	1096.72
Begin Crossing	11+75.48	1093.68	1092.48	1096.68
End Crossing	11+90.48	1093.64	1092.44	1096.64
Bottom Pool	12+01.47	1093.61	1092.41	1096.61
CL Riffle	12+23.44	1093.56	1092.36	1096.56
J-Hook	12+50.00	1093.50	1092.30	1096.50
Bottom Pool	12+70.00	1093.45	1092.25	1096.45
J-Hook	13+10.00	1093.35	1092.15	1096.35
Bottom Pool	13+35.00	1093.29	1092.09	1096.29
J-Hook	13+85.00	1093.17	1091.97	1096.17
Bottom Pool	14+01.04	1093.13	1091.93	1096.13
CL Riffle	14+33.12	1093.06	1091.86	1096.06
Begin Pool	14+53.48	1093.01	1091.81	1096.01
Bottom Pool	14+64.48	1092.98	1091.78	1095.98
CL Riffle	14+82.76	1092.94	1091.74	1095.94
Begin Pool	15+21.98	1092.84	1091.64	1095.84
Bottom Pool	15+41.32	1092.80	1091.60	1095.80
J-Hook	15+80.00	1092.70	1091.50	1095.70
Bottom Pool	16+01.00	1092.65	1091.45	1095.65
CL Riffle	16+42.99	1092.55	1091.35	1095.55
Begin Pool	16+75.10	1092.48	1091.28	1095.48
Bottom Pool	16+86.10	1092.45	1091.25	1095.45
CL Riffle	17+17.20	1092.37	1091.17	1095.37
Begin Pool	17+49.49	1092.30	1091.10	1095.30
Bottom Pool	17+60.49	1092.27	1091.07	1095.27
CL Riffle	17+88.03	1092.20	1091.00	1095.20
Begin Pool	18+04.12	1092.17	1090.97	1095.17
Bottom Pool	18+15.12	1092.14	1090.94	1095.14
CL Riffle	18+33.93	1092.09	1090.89	1095.09
Begin Pool	18+61.45	1092.03	1090.83	1095.03
Bottom Pool	18+82.63	1091.98	1090.78	1094.98
J-Hook	19+25.00	1091.88	1090.68	1094.88
Bottom Pool	19+43.94	1091.83	1090.63	1094.83
CL Riffle	19+81.81	1091.74	1090.54	1094.74
Begin Pool	20+06.45	1091.68	1090.48	1094.68
Bottom Pool	20+22.63	1091.64	1090.44	1094.64
J-Hook	20+55.00	1091.56	1090.36	1094.56
Bottom Pool	20+75.26	1091.51	1090.31	1094.51
CL Riffle	21+15.78	1091.42	1090.22	1094.42
Begin Pool	21+52.36	1091.33	1090.13	1094.33
Bottom Pool	21+63.36	1091.30	1090.10	1094.30
CL Riffle	21+95.61	1091.23	1090.03	1094.23
Begin Pool	22+10.62	1091.19	1089.99	1094.19
Bottom Pool	22+21.62	1091.16	1089.96	1094.16
CL Riffle	22+39.76	1091.12	1089.92	1094.12
Begin Pool	22+76.88	1091.03	1089.83	1094.03
Bottom Pool	22+97.92	1090.98	1089.78	1093.98
J-Hook	23+40.00	1090.88	1089.68	1093.88
Bottom Pool	23+54.34	1090.84	1089.64	1093.84
CL Riffle	23+83.01	1090.77	1089.57	1093.77
Begin Pool	24+05.89	1090.72	1089.52	1093.72
Bottom Pool	24+16.89	1090.69	1089.49	1093.69
CL Riffle	24+43.92	1090.63	1089.43	1093.63
Begin Pool	24+77.17	1090.55	1089.35	1093.55
Bottom Pool	24+88.17	1090.52	1089.32	1093.52
CL Riffle	25+15.86	1090.46	1089.26	1093.46
Begin Pool	25+46.71	1090.38	1089.18	1093.38
Bottom Pool	25+57.71	1090.36	1089.16	1093.36
CL Riffle/Grade Break	25+84.81	1090.29	1089.09	1093.29
Begin Pool	26+04.89	1089.90	1088.70	1092.90
Bottom Pool	26+18.26	1089.63	1088.43	1092.63
Cross Vane	26+45.00	1089.11	1087.91	1092.11
Bottom Pool	26+65.92	1088.70	1087.50	1091.70
Cross Vane	27+10.00	1087.83	1086.63	1090.83
Bottom Pool	27+26.67	1087.50	1086.30	1090.50
Cross Vane	27+60.00	1086.85	1085.65	1089.85
Bottom Pool	27+73.33	1086.59	1085.39	1089.59
End Project	27+98.74	1086.09	1084.89	1089.09

Riffle Lengths

Lrif	
19.94	1
31.72	1
25.01	1
20.48	1
18.48	1
15.14	1
14.30	1
22.36	1
19.74	1
21.27	1
19.26	1
39.35	1
17.19	1
17.54	1
26.56	1
20.36	1
39.22	1
32.11	1
32.29	1
16.09	1
27.52	1
24.64	1
36.58	1
15.01	1
37.12	1
22.88	1
33.25	1
30.85	1
20.08	1
716.34	29
24.70	

Riffle Spacing

R-R	
80.45	1
58.83	1
57.28	1
51.34	1
54.19	1
61.01	1
54.12	1
75.45	1
45.75	1
47.96	1
49.64	1
74.21	1
70.83	1
45.90	1
79.83	1
44.15	1
60.91	1
71.94	1
68.95	1
1152.74	19
60.67	

Pool Lengths

Lpool	
56.38	1
73.28	1
48.73	1
33.82	1
36.80	1
32.86	1
43.68	1
50.03	1
39.89	1
38.65	1
35.03	1
55.10	1
32.85	1
41.52	1
70.00	1
65.00	1
41.74	1
36.10	1
28.56	1
32.96	1
60.00	1
75.00	1
48.12	1
29.28	1
58.02	1
62.99	1
42.10	1
38.54	1
29.81	1
63.55	1
56.81	1
48.55	1
60.78	1
43.25	1
29.14	1
63.12	1
43.01	1
38.03	1
38.69	1
38.10	1
40.11	1
65.00	1
50.00	1
38.74	1
2053.72	44
46.68	

Pool Spacing

P-P	
69.81	1
96.81	1
68.50	1
54.30	1
55.28	1
48.00	1
53.36	1
54.65	1
62.25	1
58.39	1
42.40	1
69.00	1
52.11	1
53.85	1
68.34	1
57.24	1
78.18	1
53.29	1
61.09	1
68.53	1
65.00	1
66.04	1
63.44	1
76.84	1
59.68	1
85.10	1
74.39	1
54.63	1
67.51	1
61.31	1
78.69	1
52.63	1
88.10	1
58.26	1
76.30	1
56.42	1
62.55	1
71.28	1
69.54	1
60.55	1
47.66	1
60.75	1
46.66	1
2728.71	43
63.46	

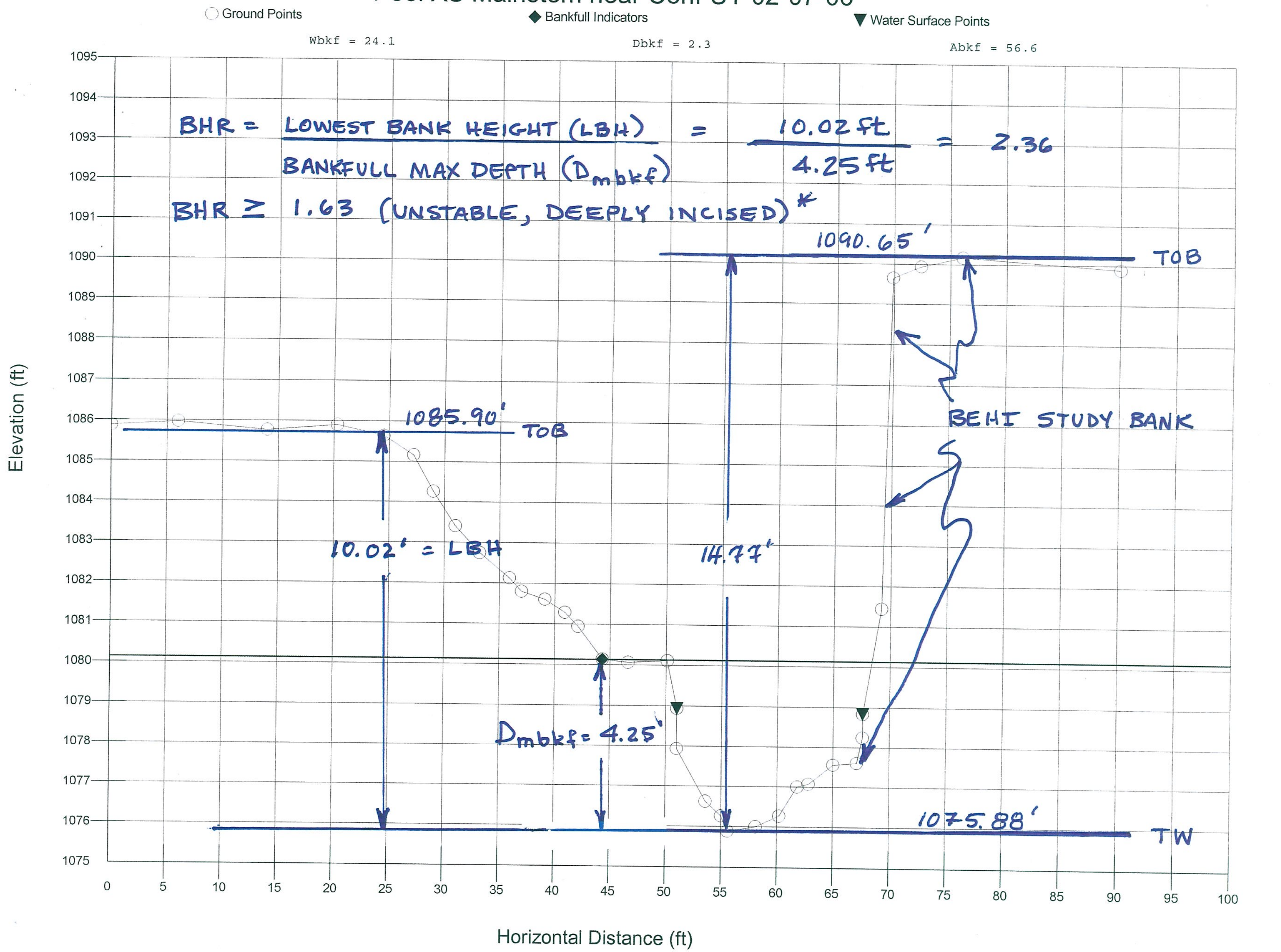
Lrif		R-R		Lpool		P-P	
Mean	24.70	Mean	60.67	Mean	46.68	Mean	63.46
Std Error	1.44	Std Error	2.78	Std Error	1.96	Std Error	1.76
Median	22.36	Median	58.83	Median	42.56	Median	61.31
Mode	#N/A	Mode	#N/A	Mode	65.00	Mode	#N/A
Std Dev	7.73	Std Dev	12.12	Std Dev	12.99	Std Dev	11.56
Variance	59.80	Variance	146.82	Variance	168.75	Variance	133.75
Kurtosis	-0.94	Kurtosis	-1.33	Kurtosis	-0.79	Kurtosis	0.60
Skewness	0.55	Skewness	0.27	Skewness	0.55	Skewness	0.73
Range	25.05	Range	36.30	Range	46.44	Range	54.41
Minimum	14.30	Minimum	44.15	Minimum	28.56	Minimum	42.40
Maximum	39.35	Maximum	80.45	Maximum	75.00	Maximum	96.81
Sum	716.34	Sum	1152.74	Sum	2053.72	Sum	2728.71
Count	29	Count	19	Count	44	Count	43

BANK EROSION HAZARD INDEX (BEHI) STUDY BANK / BANK HEIGHT RATIO (BHR) CALCULATIONS

BANK STABILITY EVALUATION

EXISTING CONDITIONS

Pool XS Mainstem near Conf UT 02-07-06



* D.L. Rosgen, 2001

RIVERMORPH CROSS SECTION SUMMARY

River Name: Thompsons Fork
Reach Name: Altered Mainstem
Cross Section Name: Pool XS Mainstem at Conf UT 02-07-06
Survey Date: 02/07/06

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	8.64	1085.88	FP
6	8.55	1085.97	FP
14	8.75	1085.77	FP
20.3	8.62	1085.9	FP
24.5	8.88	1085.64	LB
27.2	9.36	1085.16	
29	10.26	1084.26	
31	11.12	1083.4	
33.2	11.78	1082.74	
35.9	12.4	1082.12	
37	12.73	1081.79	
39.1	12.92	1081.6	
40.9	13.24	1081.28	
42.1	13.58	1080.94	
44.3	14.39	1080.13	BKF
46.6	14.46	1080.06	PB
50.1	14.41	1080.11	PB
51	15.59	1078.93	LEW
51	16.59	1077.93	
53.6	17.9	1076.62	
55	18.26	1076.26	
55.6	18.64	1075.88	TW
58.1	18.52	1076	
60.2	18.25	1076.27	
61.8	17.52	1077	
62.8	17.45	1077.07	
65	16.97	1077.55	
67.1	16.92	1077.6	
67.6	16.28	1078.24	
67.6	15.69	1078.83	REW
69.2	13.08	1081.44	
69.9	4.87	1089.65	RB
72.4	4.58	1089.94	FP
76.1	4.35	1090.17	FP
90	4.63	1089.89	FP

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1084.38	1084.38	1084.38
Bankfull Elevation (ft)	1080.13	1080.13	1080.13
Floodprone Width (ft)	32	-----	-----
Bankfull Width (ft)	24.1	12.05	12.05
Entrenchment Ratio	1.33	-----	-----

Mean Depth (ft)	2.35	1.58	3.12
Maximum Depth (ft)	4.25	4.25	4.21
Width/Depth Ratio	10.26	7.63	3.86
Bankfull Area (sq ft)	56.56	18.99	37.57
Wetted Perimeter (ft)	28.01	18.32	18.12
Hydraulic Radius (ft)	2.02	1.04	2.07
Begin BKF Station	44.3	44.3	56.35
End BKF Station	68.4	56.35	68.4

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0.0039	0	0
Shear Stress (lb/sq ft)	0.49		
Movable Particle (mm)	90.2		

RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Thompsons Fork
Reach Name: Altered Mainstem
BEHI Name: Thompsons Fk Altered Mainstem
Survey Date: 02/07/06

Bankfull Height: 4.25 ft
Bank Height: 14.77 ft
Root Depth: 0.5 ft
Root Density: 2 %
Bank Angle: 85 Degrees
Surface Protection: 1 %

Bank Material Adjustment: Sand 10

Bank Stratification Adjustment: Yes 3

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 59.8
BEHI Adjective Rating: Extreme
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 2530 ft
Estimated Sediment Loss: 2076.01 Cu Yds per Year
Estimated Sediment Loss: 2698.81 Tons per Year

RIVERMORPH BEHI SUMMARY REPORT

River Name: Thompsons Fork
Reach Name: Altered Mainstem

Table 1. Bank Identification Summary

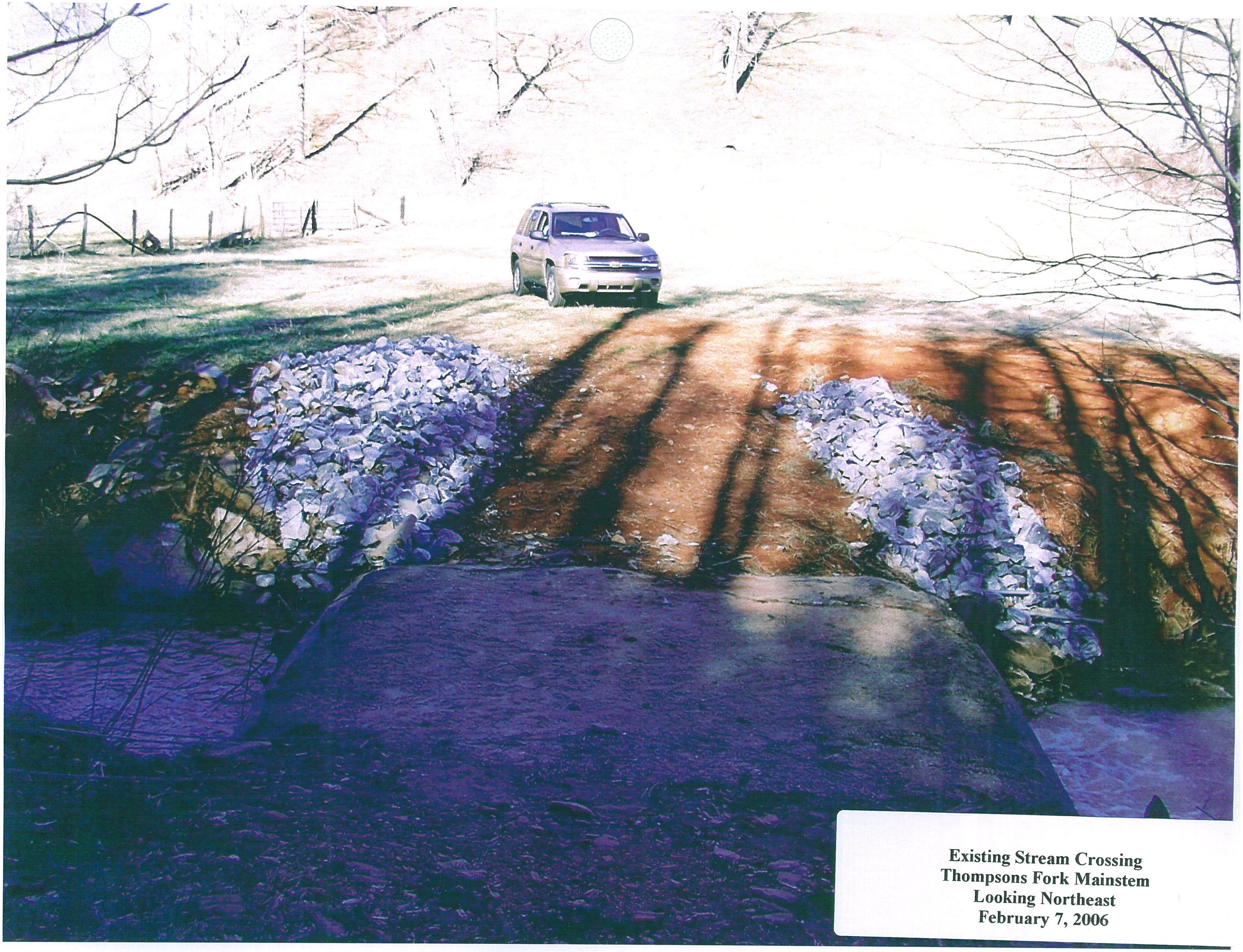
Bank	Name
1	Thompsons Fk Altered Mainstem

Table 2. Predicted Annual Bank Erosion Rates

Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr
1	59.8	Extreme	Very High	2530	2076.01	2698.81
Totals				2530	2076.01	2698.81

Total Reach Ln: 2530   Total Loss (tons/yr) per ft of Reach: 1.0667

Existing Stream Crossing
Thompsons Fork Mainstem
Looking Down Stream
February 7, 2006


Existing Stream Crossing
Thompsons Fork Mainstem
Looking Northeast
February 7, 2006

Existing Stream Crossing
Thompsons Fork Mainstem
Looking Southwest
February 7, 2006

Existing Stream Crossing
Thompsons Fork Mainstem
Looking Upstream
February 7, 2006


Existing Stream Crossing
Thompsons Fork Mainstem
Looking Down Stream
February 7, 2006

Thompsons Fork Mainstem
Existing Conditions
Upstream of Stream Crossing
February 7, 2006

Thompsons Fork Mainstem
Existing Conditions
Downstream of Stream Crossing
February 7, 2006

Thompson Fork Mainstem
Slumped Bank – Mass Wasting
Below Confluence of 1st Order Tributary
Looking Upstream
February 7, 2006

Thompsons Fork Mainstem
Existing Denuded Streambanks
Due to Cattle Intrusion
Upstream Altered Reach
March 30, 2006

Thompsons Fork Mainstem
Sparsely Vegetated Riparian Corridor
Due to Cattle Intrusion
Upstream Altered Reach
March 30, 2006

Thompsons Fork Mainstem
Sparsely Vegetated Riparian Corridor
Due to Cattle Intrusion
Upstream Altered Reach
March 30, 2006

Thompsons Fork Mainstem
Sparsely Vegetated Riparian Corridor
Due to Cattle Intrusion
Upstream Altered Reach
March 30, 2006

Thompsons Fork Mainstem
Denuded Riparian Corridor
East Ephemeral Stream Confluence
Looking Northeast Near Top of Altered Reach
March 30, 2006

Thompsons Fork Mainstem
Denuded Riparian Corridor
West Ephemeral Stream Confluence
Looking North Near Top of Altered Reach
March 30, 2006

Thompsons Fork Mainstem
Bank Failure – Mid Channel Gravel Bar
Altered Conditions Near Project Midpoint
Looking Upstream
December 21, 2006

Confluence of Unnamed Tributary with
Thompsons Fork Mainstem
Confined by South Creek Road and I-40
Existing Incised Channels
March 1, 2007

Thompsons Fork Mainstem
Vertical +14-ft Eroding Left Bank
At Confluence of Unnamed Tributary
Looking South
December 21, 2006

RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name:	Thompsons Fork
Reach Name:	UT (Ablove S Ck Rd) <-- This is not a Reference Reach
Drainage Area:	0.16 sq mi
State:	North Carolina
County:	McDowell
Latitude:	0
Longitude:	0
Survey Date:	03/13/07

Classification Data

Valley Type:	Type VIII
Valley Slope:	0.0297 ft/ft
Number of Channels:	Single
Width:	12 ft
Mean Depth:	0.96 ft
Flood-Prone Width:	71.5 ft
Channel Materials D50:	73.4 mm
Water Surface Slope:	0.0215 ft/ft
Sinuosity:	1.38
Discharge:	54.9 cfs
Velocity:	4.77 fps
Cross Sectional Area:	11.5 sq ft
Entrenchment Ratio:	5.96
Width to Depth Ratio:	12.5
Rosgen Stream Classification:	C 3b

Station - Station		Lrif		Station - Station		Lpool		R-R	P-P
420	452	32	1	452	495	43	1	80	76
500	528	28	1	528	550	22	1	55	63.4
555	591.4	36.4	1	591.4	619	27.6	1	84	82.2
639	673.6	34.6	1	673.6	700	26.4	1	81	76.8
720	750.4	30.4	1	750.4	774	23.6	1	74	75.2
794	825.6	31.6	1	825.6	850	24.4	1	61	63.4
855	889	34	1	889	915	26	1	115	112
970	1001	31	1	1001	1025	24	1	60	66
1030	1067	37	1	1067	1095	28	1	85	85
1115	1152	37	1	1152	1180	28	1	85	79
1200	1231	31	1	1231	1255	24	1	75	75
1275	1306	31	1	1306	1330	24	1	75	78
1350	1384	34	1	1384	1410	26	1	95	98
1445	1482	37	1	1482	1510	28	1	85	84.4
1530	1566.4	36.4	1	1566.4	1594	27.6	1	84	70.2
1614	1636.6	22.6	1	1636.6	1655	18.4	1	61	78.4
1675	1715	40	1	1715	1745	30	1	75	81
1750	1796	46	1	1796	1830	34	1	85	79
1835	1875	40	1	1875	1905	30	1	75	76
1910	1951	41	1	1951	1983	32	1	78	78.73
1988	2029.2	41.2	1	2029.73	2060	30.27	1	77	81.87
2065	2111.6	46.6	1	2111.6	2146	34.4	1	125	
2190	2233.59	43.59	1						
		822.39	23			611.67	22		
		35.76				27.80			

Priority 1 UT Stream Length = 1967

Lrif		Lpool	
Mean	35.76	Mean	27.80
Std Error	1.22	Std Error	1.09
Median	36.40	Median	27.60
Mode	31.00	Mode	24.00
Std Dev	5.84	Std Dev	5.12
Variance	34.15	Variance	26.17
Kurtosis	-0.01	Kurtosis	2.73
Skewness	-0.02	Skewness	1.11
Range	24.00	Range	24.60
Minimum	22.60	Minimum	18.40
Maximum	46.60	Maximum	43.00
Sum	822.39	Sum	611.67
Count	23	Count	22

UT Desired Total Lrif =	1180.20	= 60% Priorty 1 Reach
UT Desired Total Lpool =	786.80	= 40% Priority 1 Reach
Priority 1 UT Stream Length =	1967.00	= Total Restored Length

		Desired Mean Length
Number Riffles =	23	51.31
Number Pools =	22	35.76

R-R		P-P	
Mean	80.45	Mean	79.03
Std Error	3.45	Std Error	2.35
Median	79.00	Median	78.40
Mode	85.00	Mode	76.00
Std Dev	16.18	Std Dev	10.78
Variance	261.88	Variance	116.27
Kurtosis	2.34	Kurtosis	3.83
Skewness	1.14	Skewness	1.43
Range	70.00	Range	48.60
Minimum	55.00	Minimum	63.40
Maximum	125.00	Maximum	112.00
Sum	1770	Sum	1659.60
Count	22	Count	21

RIVERMORPH VANE DESIGN REPORT

River Name: Thompsons Fork
Reach Name: UT (Ablove S Ck Rd)
Vane Name: UT Step-Pool Design

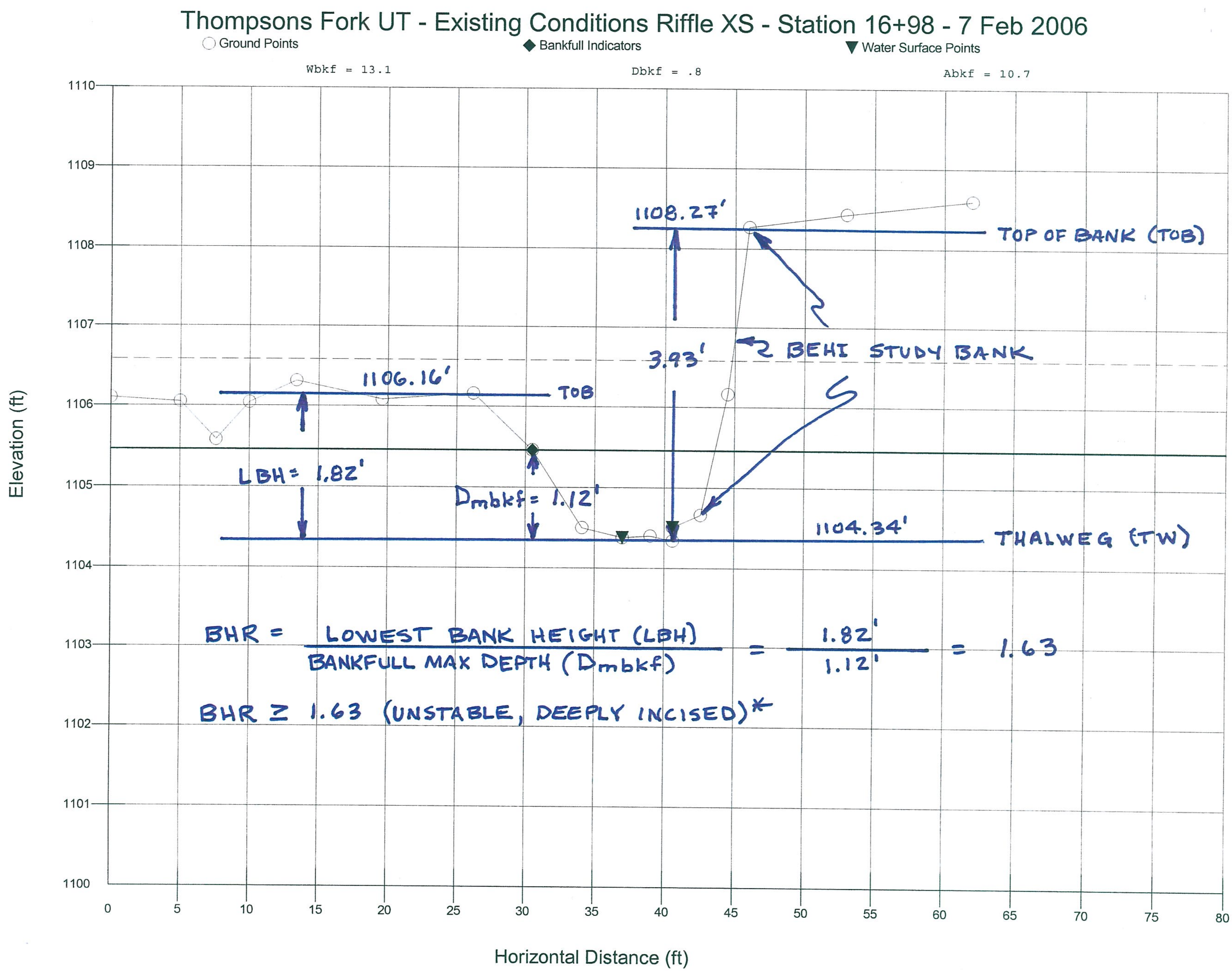
Input Data

Bank Height:	1.2 ft
Bankfull Height:	.75 ft
Shear Stress:	1.5 lbs/sq ft
Near Bank Stress:	1.88 lbs/sq ft
Bankfull Slope:	0.0215 ft/ft
Bankfull Width:	12 ft
Radius of Curvature:	24 ft
Plan View Vane Angle:	20 deg

Results

Ratio - Rc/Wbkf:	2
Vane Spacing:	46.8 ft
Vane Length:	11.0 ft
Minimum Rock Size (Diameter):	2.5 ft
Protrusion Height:	0.08 ft
Footing Depth:	2.4 ft
Layers of Footing Stones:	1
Vane Slope:	6.8 %

BANK EROSION HAZARD INDEX (BEHI) STUDY BANK / BANK STABILITY EVALUATION - BANK HEIGHT RATIO (BHR)



* D.L. Rosgen, 2001

RIVERMORPH CROSS SECTION SUMMARY

River Name: Thompsons Fork
Reach Name: UT (Ablove S Ck Rd)
Cross Section Name: Riffle Station 16+98 Existing Conditions
Survey Date: 02/07/07

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	8.9	1106.1	
5	8.95	1106.05	
7.6	9.42	1105.58	
10	8.96	1106.04	
13.4	8.69	1106.31	
19.6	8.92	1106.08	
26.2	8.84	1106.16	LB
30.5	9.54	1105.46	BKF
34.1	10.5	1104.5	
37	10.54	1104.38	LEW
37	10.62	1104.38	
39	10.6	1104.4	
40.6	10.66	1104.34	TW
40.6	10.49	1104.51	REW
42.6	10.34	1104.66	
44.5	8.84	1106.16	
46	6.73	1108.27	RB
53	6.57	1108.43	
62	6.4	1108.6	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1106.58	1106.58	1106.58
Bankfull Elevation (ft)	1105.46	1105.46	1105.46
Floodprone Width (ft)	44.8	-----	-----
Bankfull Width (ft)	13.11	6.56	6.55
Entrenchment Ratio	3.42	-----	-----
Mean Depth (ft)	0.82	0.72	0.91
Maximum Depth (ft)	1.12	1.08	1.12
Width/Depth Ratio	15.99	9.11	7.2
Bankfull Area (sq ft)	10.73	4.75	5.97
Wetted Perimeter (ft)	13.7	7.77	8.09
Hydraulic Radius (ft)	0.78	0.61	0.74
Begin BKF Station	30.5	30.5	37.06
End BKF Station	43.61	37.06	43.61

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

Channel	Left Side	Right Side

Slope	0.026	0	0
Shear Stress (lb/sq ft)	1.27		
Movable Particle (mm)	180.8		

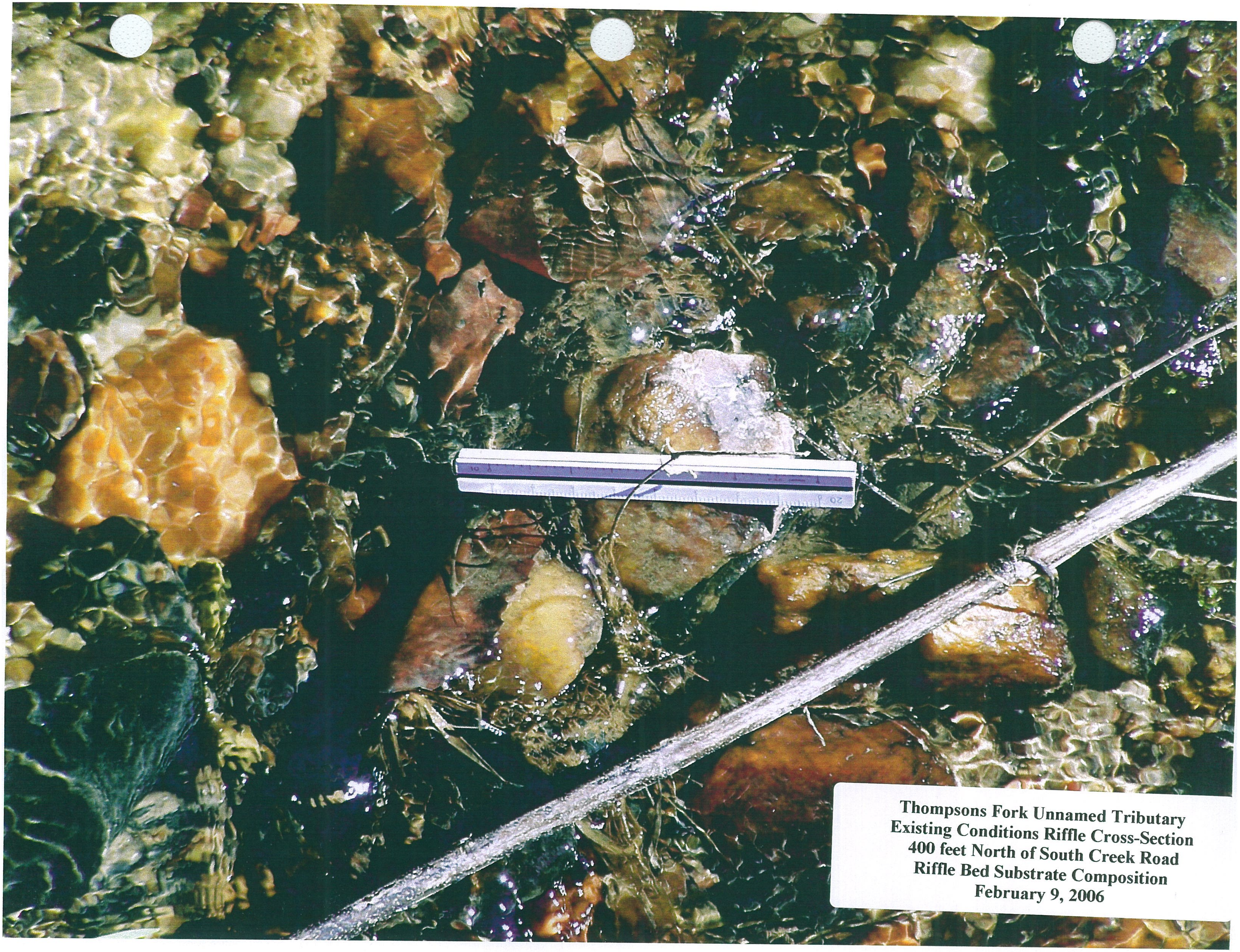
Existing Conditions Riffle XS Dist 020707.txt
RIVERMORPH PARTICLE SUMMARY

River Name: Thompsons Fork
Reach Name: UT (Ablove S Ck Rd)
Sample Name: Riffle Particle Distribution - Existing Conditions XS
Survey Date: 02/07/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	0	0.00	0.00
0.50 - 1.0	0	0.00	0.00
1.0 - 2.0	0	0.00	0.00
2.0 - 4.0	0	0.00	0.00
4.0 - 5.7	0	0.00	0.00
5.7 - 8.0	0	0.00	0.00
8.0 - 11.3	0	0.00	0.00
11.3 - 16.0	0	0.00	0.00
16.0 - 22.6	4	6.67	6.67
22.6 - 32.0	18	30.00	36.67
32 - 45	19	31.67	68.33
45 - 64	4	6.67	75.00
64 - 90	15	25.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	25.52
D35 (mm)	31.48
D50 (mm)	37.47
D84 (mm)	73.36
D95 (mm)	84.8
D100 (mm)	90
Silt/Clay (%)	0
Sand (%)	0
Gravel (%)	75
Cobble (%)	25
Boulder (%)	0
Bedrock (%)	0

Total Particles = 60.



Thompsons Fork Unnamed Tributary
Existing Conditions Riffle Cross-Section
400 feet North of South Creek Road
Riffle Bed Substrate Composition
February 9, 2006

RIVERMORPH PARTICLE SUMMARY

River Name: Thompsons Fork
Reach Name: UT (Ablove S Ck Rd)
Sample Name: Bar Sample @ Conf UT & Thmps Fk
Survey Date: 02/09/06

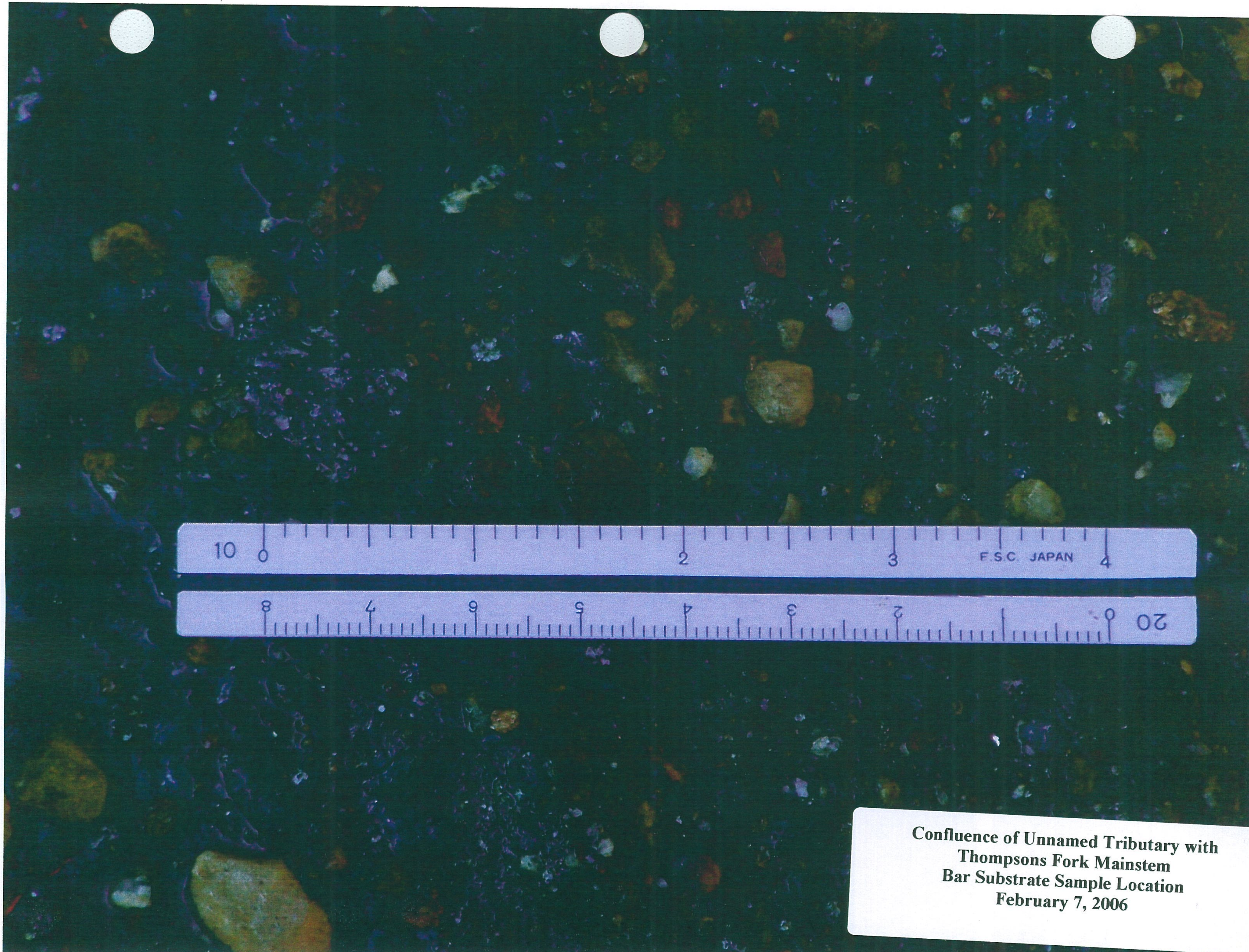
SIEVE (mm)	NET WT
25	66.7
19	54.8
12.5	146.3
9.5	83
4.75	174
2.36	104
1.18	71.4
0.6	55.6
0.425	23
0.075	50.2
0.053	2.8
PAN	0

D16 (mm)	1.2
D35 (mm)	4.39
D50 (mm)	7.72
D84 (mm)	18.49
D95 (mm)	27.45
D100 (mm)	31.5
Silt/Clay (%)	0.15
Sand (%)	22.2
Gravel (%)	77.64
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0

Total Weight = 831.8000.

Largest Surface Particles:

	Size(mm)	Weight
Particle 1:	31.5	
Particle 2:	25	



Confluence of Unnamed Tributary with Thompsons Fork Mainstem Bar Substrate Sample Location February 7, 2006

RIVERMORPH BANK EROSION HARZARD INDEX (BEHI)

River Name: Thompsons Fork
Reach Name: UT (Ablove S Ck Rd)
BEHI Name: Riffle XS Ex Conditions Sta 16+98
Survey Date: 02/07/06

Bankfull Height: 1.12 ft
Bank Height: 3.93 ft
Root Depth: 0.5 ft
Root Density: 12 %
Bank Angle: 88 Degrees
Surface Protection: 0.5 %

Bank Material Adjustment: Sand 10

Bank Stratification Adjustment: None 3

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 58.6
BEHI Adjective Rating: Extreme
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 1998 ft
Estimated Sediment Loss: 290.82 Cu Yds per Year
Estimated Sediment Loss: 378.07 Tons per Year

BEHI Altered UT Erosion Rates tons-yr-ft.txt
RIVERMORPH BEHI SUMMARY REPORT

River Name: Thompsons Fork
Reach Name: UT (Ablove S Ck Rd)

Table 1. Bank Identification Summary

Bank	Name
1	Riffle XS Ex Conditions Sta 16+98

Table 2. Predicted Annual Bank Erosion Rates

Bank	BEHI Numeric Rating	BEHI Adjective Rating	NBS Adjective Rating	Length ft	Loss cu yds/yr	Loss tons/yr
1	58.6	Extreme	Very High	1998	290.82	378.07
Totals				1998	290.82	378.07

Total Reach Ln: 1998   Total Loss (tons/yr) per ft of Reach: 0.1892

Thompsons Fork Unnamed Tributary
Existing Conditions Riffle Cross-Section
400 feet North of South Creek Road
Looking Upstream
February 9, 2006

Thompsons Fork Unnamed Tributary
Existing Conditions Riffle Cross-Section
400 feet North of South Creek Road
Looking Down Stream
February 9, 2006

Thompsons Fork Unnamed Tributary
Existing Conditions
Proposed Priority Level 1 Reach
Lower Section Looking Upstream
February 7, 2006

APPENDIX 5

Unnamed Tributary to Thompsons Fork Photographs


Thompsons Fork Unnamed Tributary
Top of Preservation Reach
Biotite Gneiss Outcrop Spring and Boulders
Extremely Stable A1 Rosgen Stream Type
February 7, 2006

Thompsons Fork Unnamed Tributary
Near Top of Preservation Reach
Stable A1 Transitioning to A2 Stream Type
February 7, 2006

Thompsons Fork Unnamed Tributary
Preservation Reach
Stable A2 Transitioning to B3 Stream Type
February 7, 2006

Thompsons Fork Unnamed Tributary
Preservation Reach
Extremely Stable B3 Stream Type
February 7, 2006

Thompsons Fork Unnamed Tributary
Preservation Reach
Extremely Stable B3 Stream Type
February 7, 2006

Thompsons Fork Unnamed Tributary
Preservation Reach
Extremely Stable B3 Stream Type
February 7, 2006

Thompsons Fork Unnamed Tributary
Preservation Reach
Robust Forested Riparian Corridor
February 7, 2006

Thompsons Fork Unnamed Tributary
Preservation Reach
Robust Forested Riparian Corridor
February 7, 2006

Thompsons Fork Unnamed Tributary
Preservation Reach
Robust Forested Riparian Corridor
February 7, 2006

Thompsons Fork Unnamed Tributary
Preservation Reach
Shed at Bottom of Preservation Reach
February 7, 2006

Thompsons Fork Unnamed Tributary
Top of Enhancement Level II Reach
(Location where stream emerges into meadow)
February 7, 2006

Thompsons Fork Unnamed Tributary
Enhancement Level II Reach
Mowed Meadow Along Right Bank
February 7, 2006

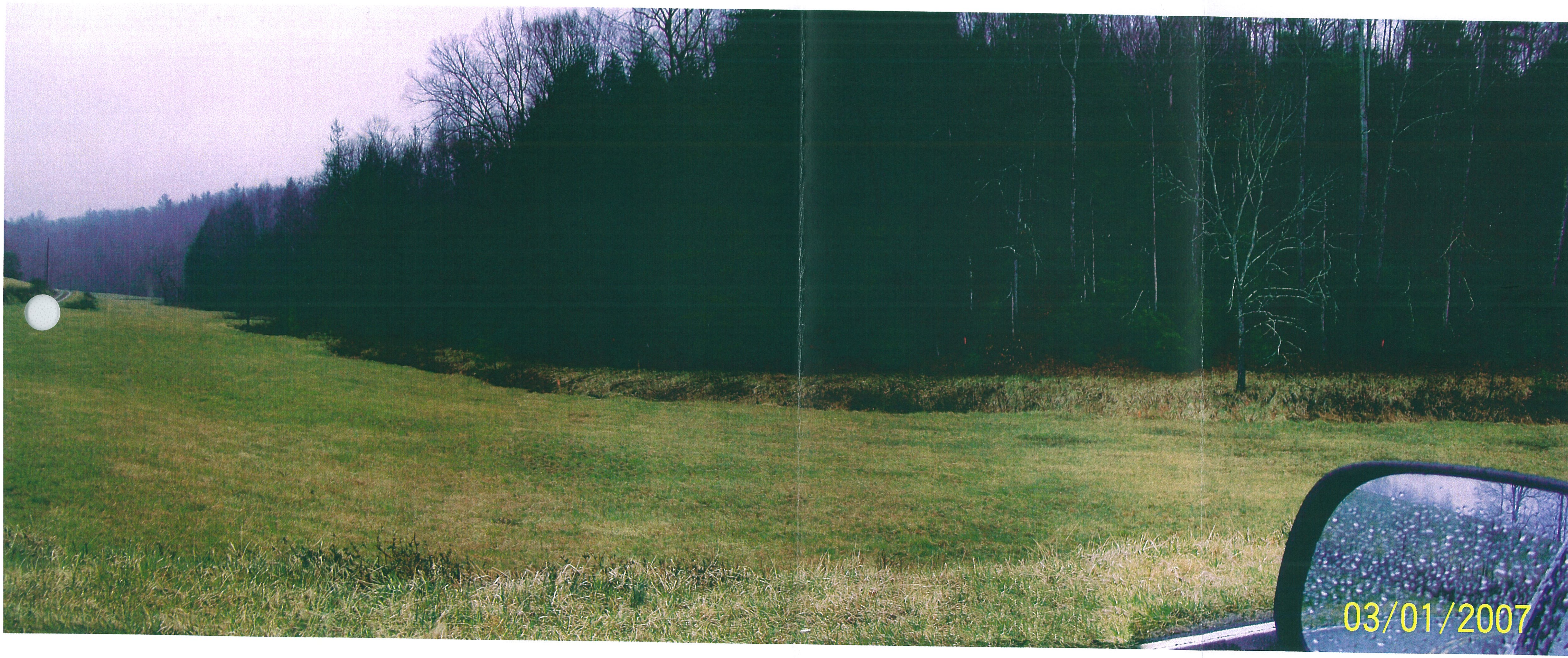
Thompsons Fork Unnamed Tributary
Enhancement Level II Reach
Looking Upstream
February 7, 2006

Thompsons Fork Unnamed Tributary
Enhancement Level II Reach
Miniature Step-Pools Looking Upstream
February 7, 2006

Thompsons Fork Unnamed Tributary
Near Bottom Enhancement Level II Reach
Looking Upstream
February 7, 2006

Thompsons Fork Unnamed Tributary
Priority Level I Restoration Reach
Looking Downstream
Existing Conditions Riffle Cross-Section
February 9, 2006

Thompsons Fork Unnamed Tributary
Priority Level I Restoration Reach
Looking Upstream
Existing Conditions Riffle Cross-Section
February 9, 2006



Thompsons Fork Unnamed Tributary
Priority Level I Restoration Reach
Looking Northeast from South Creek Road
March 1, 2007

Thompsons Fork Unnamed Tributary
Priority Level I Restoration Reach
Looking North from South Creek Road
Just Upstream of 32-inch CMP Inlet
March 1, 2007

Thompsons Fork Unnamed Tributary
Priority Level I Restoration Reach
Collapsed Culvert Headwall on North Side
of South Creek Road
March 30, 2006

Thompsons Fork Unnamed Tributary
Priority Level I Restoration Reach
NCDOT Repaired Culvert Inlet 08/28/06
North Side of South Creek Road
December 21, 2006

Thompsons Fork Unnamed Tributary
Priority Level I Restoration Reach
30-inch CMP Outlet on South Side
of South Creek Road
December 21, 2006

Thompsons Fork Unnamed Tributary
Priority Level I Restoration Reach
To Confluence with Thompsons Fork Mainstem
December 21, 2006

APPENDIX 6

Reference Reach Classification, Photographs and Data Summary Reports

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers, Surveyors, Planners, Scientists

Subject

Date Job No.

Computed by Checked by

Thompsons Fork Reference Reach Data.

Stream Classification Form

Stream Channel Classification (Level II) ...

Stream NAME: Thompsons Fork, Reach - Thompsons Fk Ref Reach

Basin NAME: Catawba River Drainage AREA: 3564.8 acre 5.57 mi^2

Location: Thompsons Fork of N Muddy Creek of Muddy Creek of the Catawba Basin

Twp: ______ Rge: ______ Sec: ______ Qtr: ______ Lat: 35.6942 Long: 81.907

Observers: Warren E. Knotts, PG Date: 8/10/2006

Bankfull WIDTH (W_{bkf}) — 15.38 Feet

WIDTH of the stream channel, at bankfull stage elevation, in a riffle section.

Mean DEPTH (d_{bkf}) — 1.55 Feet

Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section. ($d_{bkf}=A_{bkf}/W_{bkf}$)

Bankfull Cross Section Area (A_{bkf}) — 23.84 $Feet^2$

AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.

WIDTH / DEPTH RATIO (W_{bkf}/d_{bkf}) — 9.92 Ft/Ft

Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.

Maximum DEPTH (d_{mrif}) — 2.09 Feet

Maximum depth of the bankfull channel cross-section, or elevation between the bankfull stage and thalweg in a riffle section.

Flood-Prone Area WIDTH (W_{fpa}) — 265 Feet

The stage/elevation at which flood-prone area WIDTH is determined in a riffle section at twice maximum DEPTH, or ($2 \times d_{mrif}$)

Entrenchment RATIO (ER) — 17.23 Ft/Ft

The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa}/W_{bkf}) in a riffle section.

Channel Materials (Particle Size Index) D50 — 11.97 mm

The 50th percentile, or less than, from a pebble count frequency distribution of channel particles representing the median or dominant particle size.

Water Surface SLOPE (S) — 0.0024 Ft/Ft

Average water surface slope as measured between the same position of bed features in the profile over two meander wave lengths. This is similar to average bankfull slope.

Channel SINUOSITY (K) — 1.3

Sinuosity: an index of channel pattern, determined from stream length / valley length, i.e. (SL/VL); or estimated from a ratio of valley slope divided by channel slope (VS/ S).

Stream Type → **E 4** ← *For Reference, see page 5-5, 5-6: Rosgen, 1996. Applied River Morphology.*

Reference Reach Summary Data Form

... and Reference Reach Summary Data

Channel Dimension

Mean Riffle Depth (d_{bkf})	1.55	feet	Mean Riffle Width (W_{bkf})	15.38	feet	Mean Riffle Area (A_{bkf})	23.84	feet^2
Mean Pool Depth (d_{bkfp})	1.85	feet	Mean Pool Width (W_{bkfp})	17.38	feet	Mean Pool Area (A_{bkfp})	32.1	feet^2
Ratio Mean Pool Depth/Mean Riffle Depth	1.194	d_{bkfp}/ d_{bkf}	Ratio Pool Width/Riffle Width	1.130	W_{bkfp}/ W_{bkf}	Ratio Pool Area/ Riffle Area	1.346	A_{bkfp}/ A_{bkf}
Max Riffle Depth (d_{mrif})	2.09	feet	Max Pool Depth (d_{mpool})	2.72	feet	Max riffle depth/Mean riffle depth	1.348	
Max pool depth/Mean riffle depth	1.755					Point Bar Slope	0	
Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})				2.72	ft/s	Estimation Method	U/U*	
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})				64.77	cfs	Drainage Area	5.57	mi^2

Channel Pattern

Geometry	Ave	Min	Max		Dimensionless Geometry Ratios	Ave	Min	Max
Meander Length (Lm)	104.3	49.5	119.4	feet	Meander Length Ratio (Lm/W_{bkf})	6.782	3.218	7.763
Radius of Curvature (Rc)	25.4	9.7	48.9	feet	Radius of Curvature/Riffle Width (Rc/W_{bkf})	1.651	0.631	3.179
Belt Width (W_{blt})	36.4	16.3	56	feet	Meander Width Ratio (W_{blt}/W_{bkf})	2.367	1.060	3.641
Individual Pool Length	24.27	16.98	32.05	feet	Pool Length/Riffle Width	1.578	1.104	2.084
Pool to Pool Spacing	75.08	73.11	77.05	feet	Pool to Pool Spacing/Riffle Width	4.882	4.754	5.010

Channel Profile

Valley Slope (VS)	0.0031	ft/ft	Average Water Surface Slope (S)	0.0024	ft/ft	Sinuosity (VS/S)	1.3
Stream Length (SL)	578.39	feet	Valley Length (VL)	431.29	feet	Sinuosity (SL/VL)	1.341

Low Bank Height (LBH)	start	1.01	feet	Max Riffle Depth	start	1.01	feet	Bank Height Ratio (LBH/Max Riffle Depth)	start	1
	end	1.26	feet		end	1.26	feet		end	1

Facet Slopes	Ave	Min	Max		Dimensionless Slope Ratios	Ave	Min	Max
Riffle Slope (S_{rif})	0.0113	0.0099	0.0127	ft/ft	Riffle Slope/Average Water Surface Slope (S_{rif}/S)	4.704	4.125	5.283
Run Slope (S_{run})	0.0043	0.0024	0.0063	ft/ft	Run Slope/Average Water Surface Slope (S_{run}/S)	1.796	0.983	2.608
Pool Slope (S_p)	0.0013	0.0003	0.0020	ft/ft	Pool Slope/Average Water Surface Slope (S_p/S)	0.533	0.121	0.842
Glide Slope (S_g)	0.0028	0.0012	0.0049	ft/ft	Glide Slope/Average Water Surface Slope (S_g/S)	1.175	0.517	2.046

Feature Midpoint [a]	Ave	Min	Max		Dimensionless Depth Ratios	Ave	Min	Max
Riffle Depth (d_{mrif})	2.090	2.090	2.090	feet	Riffle Max Depth/Riffle Mean Depth (d_{mrif}/d_{bkf})	1.348	1.348	1.348
Run Depth (d_{mrun})	0.000	0.000	0.000	feet	Run Max Depth/Riffle Mean Depth (d_{mrun}/d_{bkf})	0.000	0.000	0.000
Pool Depth (d_{mp})	2.720	2.720	2.720	feet	Pool Max Depth/Riffle Mean Depth (d_{mp}/d_{bkf})	1.755	1.755	1.755
Glide Depth (d_{mg})	0.000	0.000	0.000	feet	Glide Max Depth/Riffle Mean Depth (d_{mg}/d_{bkf})	0.000	0.000	0.000

Channel Materials

Catagories	Reach[b]	Riffle[c]	Bar
% Silt/Clay	0	0	0.15
% Sand	10	0	22.2
% Gravel	87.5	95	77.64
% Cobble	2.5	5	0
% Boulder	0	0	0
% Bedrock	0	0	0

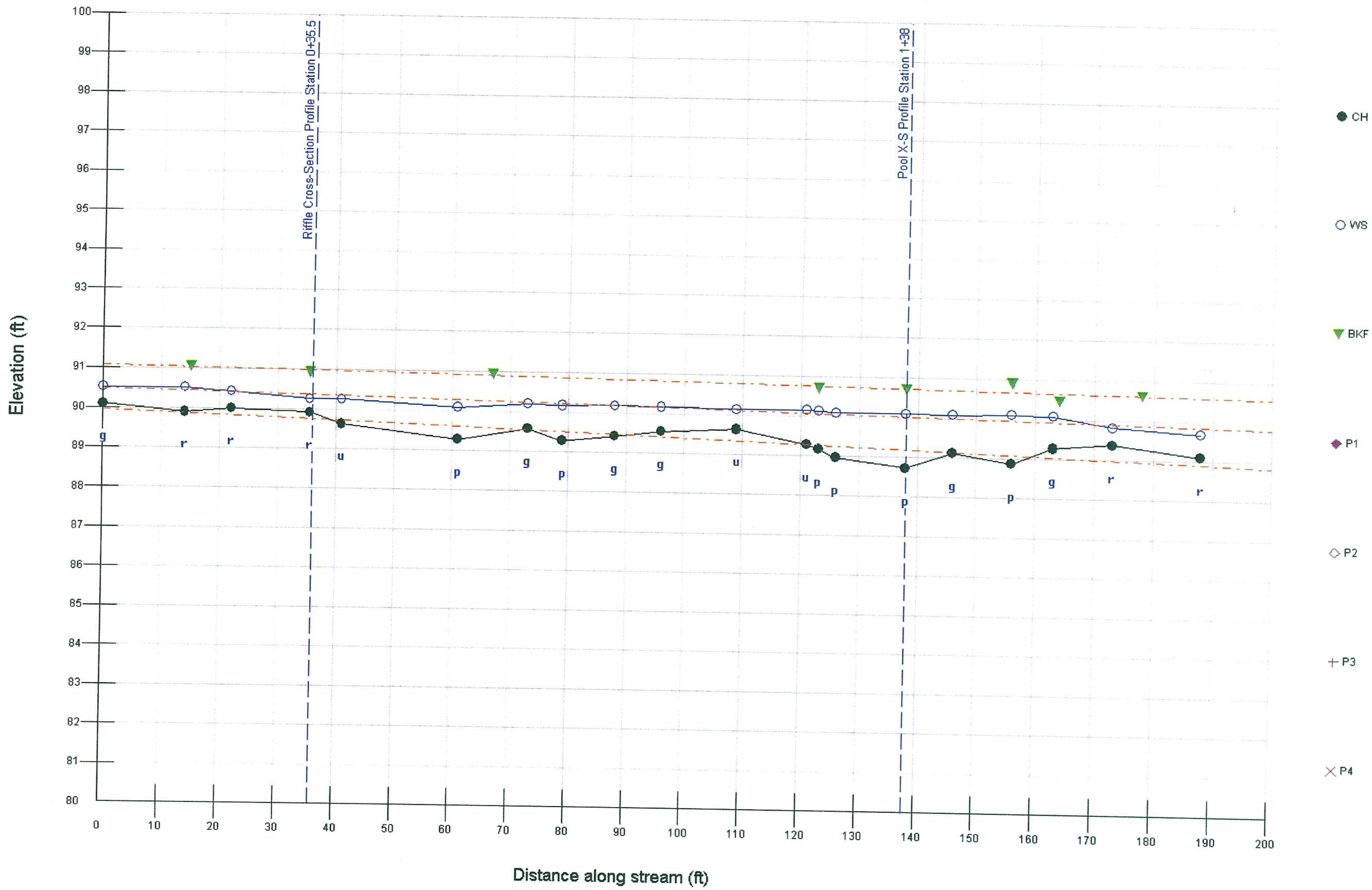
Indices	Reach[b]	Riffle[c]	Bar	
D16	3.11	14.75	1.2	mm
D35	7.23	21.94	4.39	mm
D50	11.97	29.44	7.72	mm
D84	38.76	50.07	18.49	mm
D95	57.67	64	27.45	mm
D100	128	128	31.5	mm

a. The range of "feature" mid-point maximum bankfull depths, including the minimum, maximum and average values. (Pool depths are obtained from the deepest portion of the feature.)

b. A composite sample of materials from riffle and pool featutes taken within the designated reach.

c. Sample obtained within the "active" bed of a riffle feature at the location of the cross section.

Thompsons Fork Reference Reach Longitudinal Profile



RIVERMORPH PROFILE SUMMARY

River Name: Thompsons Fork
Reach Name: Thompsons Fk Ref Reach
Profile Name: Thompsons Fork Ref Reach Longitudinal Profile
Survey Date: 08/15/06

Survey Data

DIST	CH	WS	BKF	P1	P2	P3	P4
0	90.1	90.51					
14	89.9	90.51					
15			91.05				
22	90	90.42					
35.5	89.92	90.25	90.93				
41	89.63	90.25					
61	89.28	90.09					
67			90.94				
73	89.57	90.2					
79	89.28	90.17					
88	89.41	90.19					
96	89.55	90.17					
109	89.63	90.14					
121	89.28	90.15					
123	89.16	90.13	90.71				
126	88.96	90.1					
138	88.72	90.1	90.73				
146	89.12	90.09					
156	88.87	90.11	90.91				
163	89.27	90.09					
164			90.48				
173	89.38	89.83					
178			90.63				
188	89.1	89.68					

Cross Section / Bank Profile Locations

Name	Type	Profile Station
Riffle Cross-Section Profile Station 0+35.5	Riffle XS	35.5
Pool X-S Profile Station 1+38	Pool XS	138

Measurements from Graph

Bankfull Slope: 0.0024

Variable	Min	Avg	Max
S riffle	0.0099	0.01129	0.01268
S pool	0.00029	0.00128	0.00202
S run	0.00236	0.00431	0.00626
S glide	0.00124	0.00282	0.00491
P - P	73.11	75.08	77.05
P length	16.98	24.27	32.05
Dmax riffle	1.09	1.24	1.38
Dmax pool	1.59	1.76	2.01
Dmax run	1.34	1.41	1.48

Dmax glide	0.84	1.43	1.8
Low Bank Ht	1.01	1.14	1.26

Length and depth measurements in feet, slopes in ft/ft.

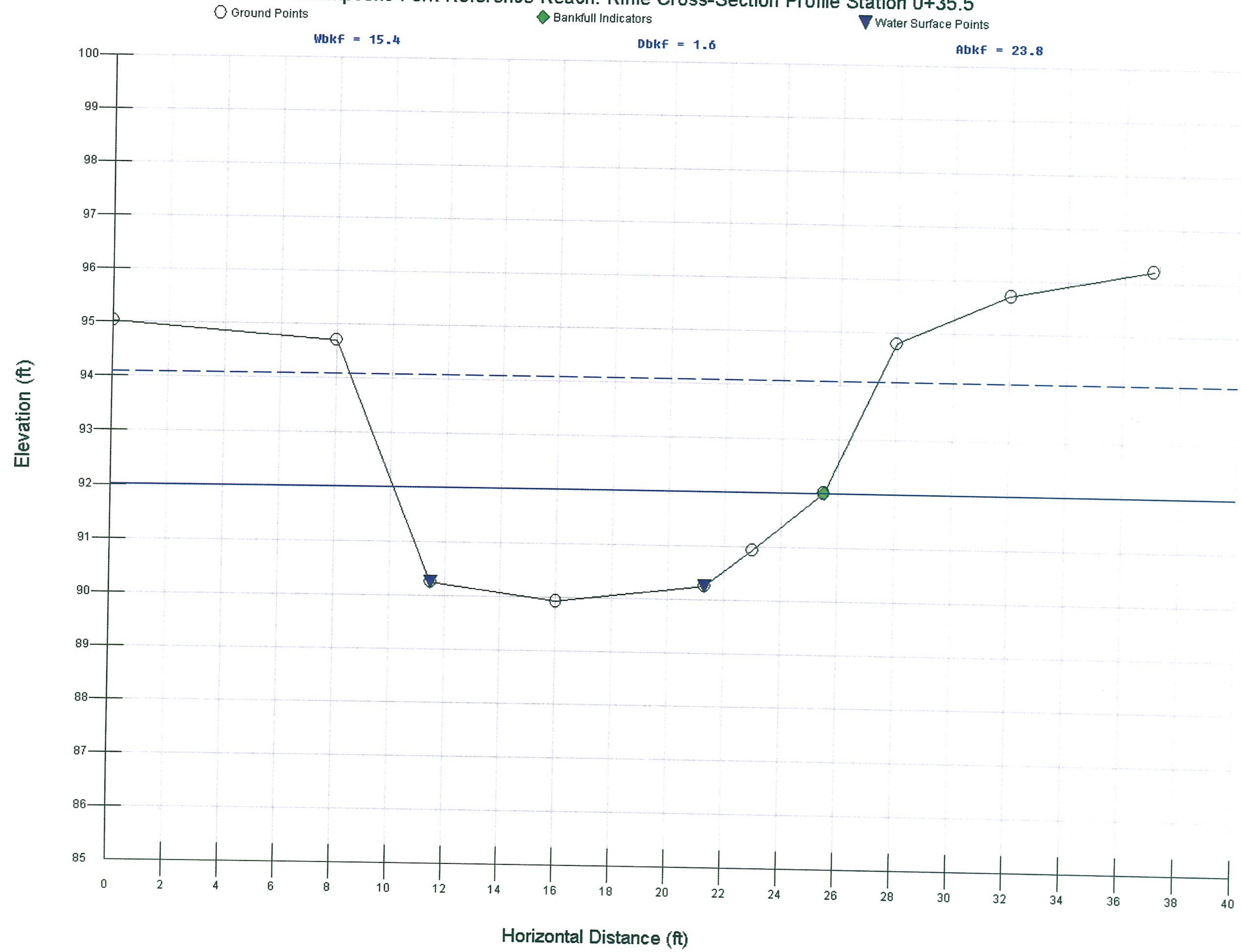
RIVERMORPH PROFILE SUMMARY

Notes

River Name: Thompsons Fork
Reach Name: Thompsons Fk Ref Reach
Profile Name: Thompsons Fork Ref Reach Longitudinal Profile
Survey Date: 08/15/06

DIST	Note
0	Glide
14	Riffle
15	BKF Indicator
22	Riffle
35.5	Riffle at point of X-S
41	Run
61	Pool Top
67	BKF Indicator
73	Glide
79	Pool
88	Glide
96	Glide
109	Run
121	Run
123	Pool
126	Pool
138	Pool at point of X-S
146	Glide
156	Pool
163	Glide
164	BKF Indicator
173	Riffle
178	BKF Indicator
188	Riffle

Thompsons Fork Reference Reach: Riffle Cross-Section Profile Station 0+35.5



RIVERMORPH CROSS SECTION SUMMARY

River Name: Thompsons Fork
Reach Name: Thompsons Fk Ref Reach
Cross Section Name: Riffle Cross-Section Profile Station 0+35.5
Survey Date: 08/15/06

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
37	0	96.22	FP
32	0	95.72	FP
28	0	94.8	RB
25.5	0	92.01	BKF
23	0	90.93	BOT RB
21.3	0	90.25	REW
16	0	89.92	TW
11.5	0	90.25	LEW
8	0	94.71	LB
0	0	95.03	FP

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	94.1	-----	-----
Bankfull Elevation (ft)	92.01	-----	-----
Floodprone Width (ft)	265	-----	-----
Bankfull Width (ft)	15.38	-----	-----
Entrenchment Ratio	17.23	-----	-----
Mean Depth (ft)	1.55	-----	-----
Maximum Depth (ft)	2.09	-----	-----
Width/Depth Ratio	9.92	-----	-----
Bankfull Area (sq ft)	23.84	-----	-----
Wetted Perimeter (ft)	16.61	-----	-----
Hydraulic Radius (ft)	1.44	-----	-----
Begin BKF Station	25.5	-----	-----
End BKF Station	10.12	-----	-----

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0.0024	0	0
Shear Stress (lb/sq ft)	0.22		
Movable Particle (mm)	49.2		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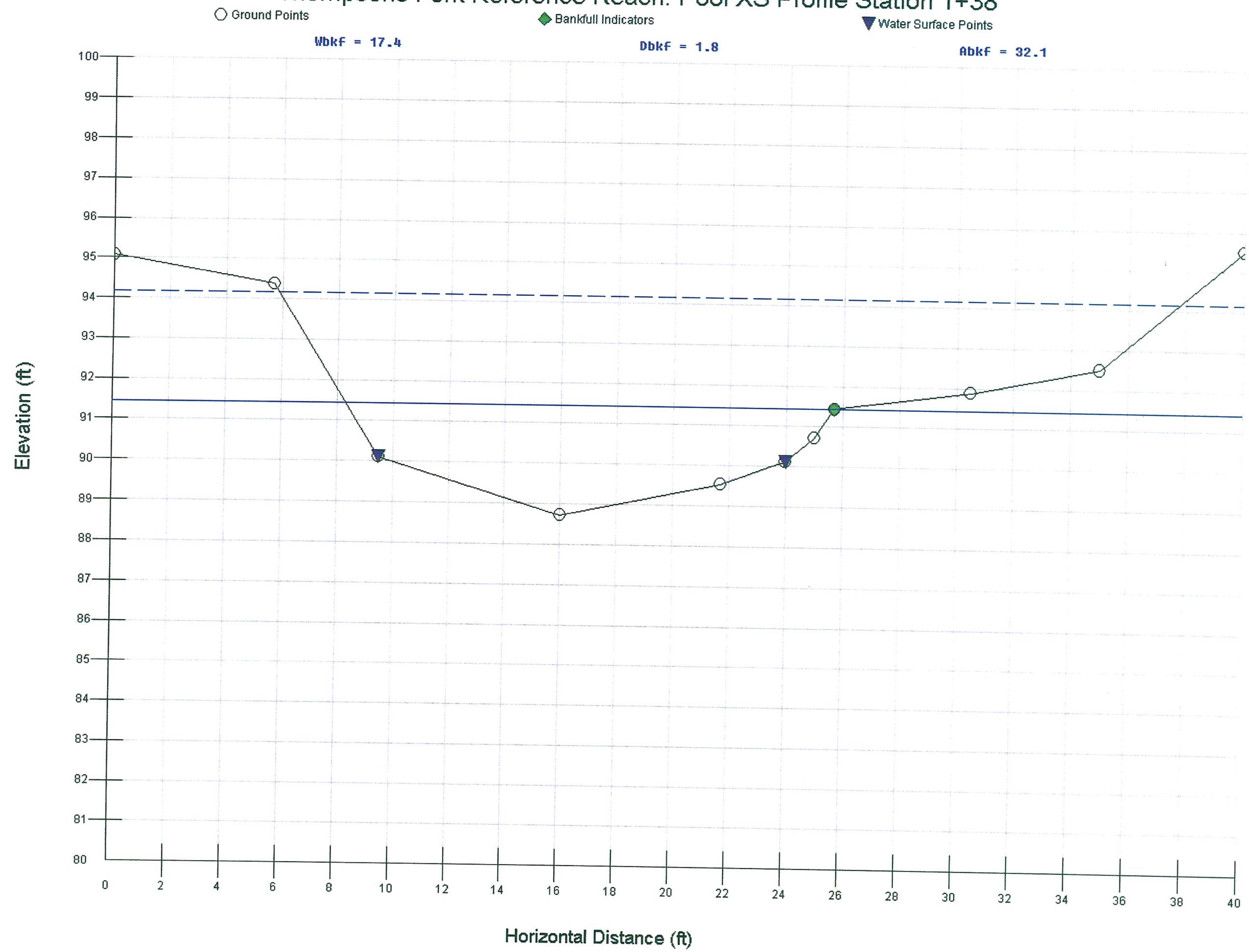
Thompsons Fork Reference Reach: Pool XS Profile Station 1+38



RIVERMORPH CROSS SECTION SUMMARY

River Name: Thompsons Fork
Reach Name: Thompsons Fk Ref Reach
Cross Section Name: Pool X-S Profile Station 1+38
Survey Date: 08/10/06

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	95.07	FP
5.7	0	94.38	
9.5	0	90.11	LEW
16	0	88.72	TW
21.7	0	89.54	SB
24	0	90.12	REW
25	0	90.71	ON RB
25.7	0	91.44	BKF
30.5	0	91.88	ON RB
35	0	92.5	
40	0	95.5	RB

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	94.16	94.16	94.16
Bankfull Elevation (ft)	91.44	91.44	91.44
Floodprone Width (ft)	265	-----	-----
Bankfull Width (ft)	17.38	8.66	8.72
Entrenchment Ratio	15.24	-----	-----
Mean Depth (ft)	1.85	1.91	1.78
Maximum Depth (ft)	2.72	2.72	2.58
Width/Depth Ratio	9.39	4.53	4.9
Bankfull Area (sq ft)	32.1	16.55	15.55
Wetted Perimeter (ft)	18.73	12	11.89
Hydraulic Radius (ft)	1.71	1.38	1.31
Begin BKF Station	8.32	8.32	16.98
End BKF Station	25.7	16.98	25.7

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0.0024	0	0
Shear Stress (lb/sq ft)	0.26		
Movable Particle (mm)	55.8		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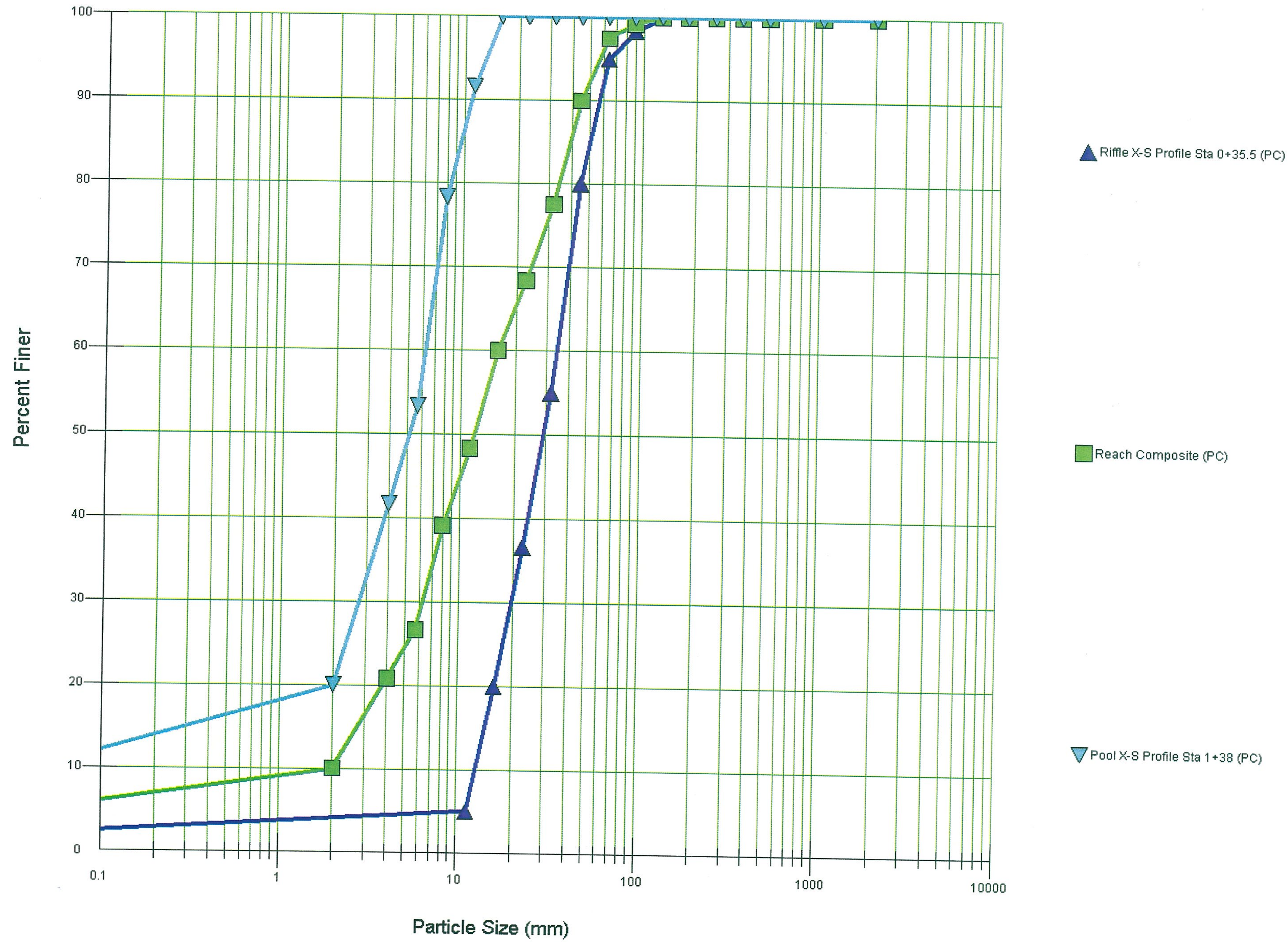
Thompsons Fork Reference Reach Particle Distributions



RIVERMORPH PARTICLE SUMMARY

River Name: Thompsons Fork
Reach Name: Thompsons Fk Ref Reach
Sample Name: Riffle X-S Profile Sta 0+35.5
Survey Date: 08/17/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	0	0.00	0.00
0.50 - 1.0	0	0.00	0.00
1.0 - 2.0	0	0.00	0.00
2.0 - 4.0	0	0.00	0.00
4.0 - 5.7	0	0.00	0.00
5.7 - 8.0	0	0.00	0.00
8.0 - 11.3	3	5.00	5.00
11.3 - 16.0	9	15.00	20.00
16.0 - 22.6	10	16.67	36.67
22.6 - 32.0	11	18.33	55.00
32 - 45	15	25.00	80.00
45 - 64	9	15.00	95.00
64 - 90	2	3.33	98.33
90 - 128	1	1.67	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	14.75
D35 (mm)	21.94
D50 (mm)	29.44
D84 (mm)	50.07
D95 (mm)	64
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	0
Gravel (%)	95
Cobble (%)	5
Boulder (%)	0
Bedrock (%)	0

Total Particles = 60.

RIVERMORPH PARTICLE SUMMARY

River Name: Thompsons Fork
Reach Name: Thompsons Fk Ref Reach
Sample Name: Pool X-S Profile Sta 1+38
Survey Date: 08/17/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	0	0.00	0.00
0.50 - 1.0	0	0.00	0.00
1.0 - 2.0	12	20.00	20.00
2.0 - 4.0	13	21.67	41.67
4.0 - 5.7	7	11.67	53.33
5.7 - 8.0	15	25.00	78.33
8.0 - 11.3	8	13.33	91.67
11.3 - 16.0	5	8.33	100.00
16.0 - 22.6	0	0.00	100.00
22.6 - 32.0	0	0.00	100.00
32 - 45	0	0.00	100.00
45 - 64	0	0.00	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	1.8
D35 (mm)	3.38
D50 (mm)	5.21
D84 (mm)	9.4
D95 (mm)	13.18
D100 (mm)	16
Silt/Clay (%)	0
Sand (%)	20
Gravel (%)	80
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0

Total Particles = 60.

RIVERMORPH PARTICLE SUMMARY

River Name: Thompsons Fork
Reach Name: Thompsons Fk Ref Reach
Sample Name: Reach Composite
Survey Date: 08/10/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	0	0.00	0.00
0.50 - 1.0	0	0.00	0.00
1.0 - 2.0	12	10.00	10.00
2.0 - 4.0	13	10.83	20.83
4.0 - 5.7	7	5.83	26.67
5.7 - 8.0	15	12.50	39.17
8.0 - 11.3	11	9.17	48.33
11.3 - 16.0	14	11.67	60.00
16.0 - 22.6	10	8.33	68.33
22.6 - 32.0	11	9.17	77.50
32 - 45	15	12.50	90.00
45 - 64	9	7.50	97.50
64 - 90	2	1.67	99.17
90 - 128	1	0.83	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	3.11
D35 (mm)	7.23
D50 (mm)	11.97
D84 (mm)	38.76
D95 (mm)	57.67
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	10
Gravel (%)	87.5
Cobble (%)	2.5
Boulder (%)	0
Bedrock (%)	0

Total Particles = 120.

RIVERMORPH STREAM VISUAL ASSESSMENT PROTOCOL SUMMARY

River Name: Thompsons Fork
Reach Name: Reference Reach
Survey Date: 09/14/06

Channel Condition:	9
Hydrologic Alteration:	6
Riparian Zone:	10
Bank Stability:	9
Water Appearance:	10
Nutrient Enrichment:	10
Barriers to Fish Movement:	10
Instream Fish Cover:	10
Pools:	10
Invertebrate Habitat:	8
Canopy Cover:	8
Manure Presence:	
Salinity:	
Riffle Embeddedness:	2
Macroinvertebrates:	9

Warmwater Fishery

Rating Criteria:
 Poor < 6.0
 Fair 6.1-7.4
 Good 7.5-8.9
 Excellent > 9.0

Overall Score (total divided by number scored) = 8.54

Suspected Cause of Observed Problems:
 Riffle embeddedness attributed to clear water d/c from Muddy Ck Flood Control Dam 8, 2900 ft u/s.

Recommendations:
 Quick establishment of veg is essential in stabilizing banks along altered mainstem reach. Grade control will be required.

RIVERMORPH RAPID BIOASSESSMENT PROTOCOL SUMMARY

River Name: Thompsons Fork
Reach Name: Reference Reach

Epifaunal Substrate/Avail Cover:	18
Pool Substrate:	18
Pool Variability:	18
Sediment Deposition:	20
Channel Flow Status:	20
Channel Alteration:	20
Channel Sinuosity:	6
Bank Stability (LB):	9
Bank Stability (RB):	9
Vegetative Protection (LB):	10
Vegetative Protection (RB):	10
Riparian Veg. Zone Width (LB):	9
Riparian Veg. Zone Width (RB):	9

Low Gradient Stream
Rating Criteria:
0-50 Poor
51-100 Marginal
101-150 Suboptimal
151-200 Optimal

Score - 176

RIVERMORPH PFANKUCH SUMMARY

River Name: Thompsons Fork
Reach Name: Reference Reach
Survey Date: 08/10/06

Upper Bank

Landform Slope:	1
Mass Wasting:	4
Debris Jam Potential:	1
Vegetative Protection:	2

Lower Bank

Channel Capacity:	1
Bank Rock Content:	3
Obstructions to Flow:	1
Cutting:	7
Deposition:	3

Channel Bottom

Rock Angularity:	1
Brightness:	1
Consolidation of Particles:	1
Bottom Size Distribution:	3
Scouring and Deposition:	5
Aquatic Vegetation:	

Channel Stability Evaluation

Sediment Supply:	Low
Stream Bed Stability:	Degrading
W/D Condition:	Normal
Stream Type:	E4

Rating - 34
Condition - Good

Lm	Rc	Wblt	K = SL/VL
83.89	34.53	42.87	1.3
117.58	16.5	35.02	1.2
87.88	23.4	33.13	1.3
59.93	48.93	35.62	
109.3	23.4	33.57	
97.29	18.45	21.27	
80.58	9.65	16.29	
109.28	16.06	20.86	
86.41	11.22	29.42	
153.1	23.83	34.91	
94.93	31.33	43.36	
83.35	31.32	30.11	
92.59	21.84	38.78	
92.67	18.25	43.85	
103.67	29.35	38.59	
86.98	29.35	55.97	
128.4	27.86	35.85	
86.1	20.15	48.56	
119.38	22.34	53.09	
49.48	22.64	37.51	
58.31	18.55		
	34.34		
	20.64		
	15.94		
	31.03		
	38.33		
	43.01		
	30.19		
	24.96		

Sinuosity (K) = Stream Length/Valley Length Reach 1, 2 & 3

Reach 1		Reach 2		Reach 3	
SL	VL	SL	VL	SL	VL
578.39	431.29	1090.74	918.81	544.72	415.92
K = 1.3		K = 1.2		K = 1.3	

Meander Lenth (Lm) Mean, Min and Max

Mean	Min	Max
104.3	49.5	119.4

Radius of Curvature (Rc) Mean, Min and Max

Mean	Min	Max
25.4	9.7	48.9

Belt Width (Wblt) Mean, Min and Max

Mean	Min	Max
36.4	16.3	56.0

Summary Statistics

Lm		*Rc*		*Wblt*	
Mean	94.34	Mean	25.43	Mean	36.43
Std Error	5.23	Std Error	1.68	Std Error	2.27
Median	92.59	Median	23.40	Median	35.74
Mode	#N/A	Mode	23.40	Mode	#N/A
Std Dev	23.95	Std Dev	9.06	Std Dev	10.14
Samp Var	573.48	Samp Var	82.08	Samp Var	102.83
Kurtosis	0.86	Kurtosis	0.46	Kurtosis	0.09
Skewness	0.38	Skewness	0.63	Skewness	-0.07
Range	103.62	Range	39.28	Range	39.68
Minimum	49.48	Minimum	9.65	Minimum	16.29
Maximum	153.10	Maximum	48.93	Maximum	55.97
Sum	1981.10	Sum	737.39	Sum	728.63
Count	21	Count	29	Count	20

Subject

Date Job No.

Computed by Checked by

Brindle Creek Reference Reach
Data.

Stream Classification Form

Stream Channel Classification (Level II) ...

Stream NAME: Silver Creek & Trib Restoration, Reach - Reach 1 (Reference Reach)

Basin NAME: CATAWBA RIVER BASIN Drainage AREA: 742.4 acre 1.16 mi^2

Location: BRINDLE CREEK, TRIBUTARY TO SILVER CREEK, BURKE CO., NC

Twp: ______ Rge: ______ Sec: ______ Qtr: ______ Lat: 35.6186 Long: 81.817

Observers: MILES F. HEBERT, P.E & WARREN E. KNOTTS, P.G. Date: 1/13/2006

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel, at bankfull stage elevation, in a riffle section.	**24.02** Feet
Mean DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section. ($d_{bkf}=A_{bkf}/W_{bkf}$)	**1.28** Feet
Bankfull Cross Section Area (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**30.77** $Feet^2$
WIDTH / DEPTH RATIO (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**18.77** Ft/Ft
Maximum DEPTH (d_{mrif}) Maximum depth of the bankfull channel cross-section, or elevation between the bankfull stage and thalweg in a riffle section.	**1.72** Feet
Flood-Prone Area WIDTH (W_{fpa}) The stage/elevation at which flood-prone area WIDTH is determined in a riffle section at twice maximum DEPTH, or ($2 \times d_{mrif}$)	**232** Feet
Entrenchment RATIO (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa}/W_{bkf}) in a riffle section.	**9.66** Ft/Ft
Channel Materials (Particle Size Index) D50 The 50th percentile, or less than, from a pebble count frequency distribution of channel particles representing the median or dominant particle size.	**38.5** mm
Water Surface SLOPE (S) Average water surface slope as measured between the same position of bed features in the profile over two meander wave lengths. This is similar to average bankfull slope.	**0.01149** Ft/Ft
Channel SINUOSITY (K) Sinuosity: an index of channel pattern, determined from stream length / valley length, i.e. (SL/VL); or estimated from a ratio of valley slope divided by channel slope (VS/ S).	**1.2**

Stream Type → **C 4** ← *For Reference, see page 5-5, 5-6: Rosgen, 1996. Applied River Morphology.*

Reference Reach Summary Data Form

... and Reference Reach Summary Data

Channel Dimension

Mean Riffle Depth (d_{bkf})	1.28	feet	Mean Riffle Width (W_{bkf})	24.02	feet	Mean Riffle Area (A_{bkf})	30.77	feet^2
Mean Pool Depth (d_{bkfp})	2.33	feet	Mean Pool Width (W_{bkfp})	26.97	feet	Mean Pool Area (A_{bkfp})	62.77	feet^2
Ratio Mean Pool Depth/Mean Riffle Depth	1.820	d_{bkfp}/d_{bkf}	Ratio Pool Width/Riffle Width	1.123	W_{bkfp}/W_{bkf}	Ratio Pool Area/ Riffle Area	2.040	A_{bkfp}/A_{bkf}
Max Riffle Depth (d_{mrif})	2.41	feet	Max Pool Depth (d_{mpool})	3.76	feet	Max riffle depth/Mean riffle depth	1.883	
Max pool depth/Mean riffle depth	2.938					Point Bar Slope	0	
Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	3.19	ft/s				Estimation Method		
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	98.16	cfs				Drainage Area	1.16	mi^2

Channel Pattern

Geometry	Ave	Min	Max		Dimensionless Geometry Ratios	Ave	Min	Max
Meander Length (Lm)	104.8	88.23	115.7	feet	Meander Length Ratio (Lm/W_{bkf})	4.361	3.673	4.816
Radius of Curvature (Rc)	17.67	12.97	24.44	feet	Radius of Curvature/Riffle Width (Rc/W_{bkf})	0.736	0.540	1.017
Belt Width (W_{blt})	45.22	44.17	46.5	feet	Meander Width Ratio (W_{blt}/W_{bkf})	1.883	1.839	1.936
Individual Pool Length	17.42	11.01	31.56	feet	Pool Length/Riffle Width	0.725	0.458	1.314
Pool to Pool Spacing	71.36	67.6	77.5	feet	Pool to Pool Spacing/Riffle Width	2.971	2.814	3.226

Channel Profile

Valley Slope (VS)	0.0097	ft/ft	Average Water Surface Slope (S)	0.01149	ft/ft	Sinuosity (VS/S)	1.2
Stream Length (SL)	0	feet	Valley Length (VL)	0	feet	Sinuosity (SL/VL)	#####

Low Bank Height (LBH)	start	0 feet	Max Riffle Depth	start	0 feet	Bank Height Ratio (LBH/Max Riffle Depth)	start	#####
	end	0 feet		end	0 feet		end	#####

Facet Slopes	Ave	Min	Max		Dimensionless Slope Ratios	Ave	Min	Max
Riffle Slope (S_{rif})	0.0246	0.0172	0.0346	ft/ft	Riffle Slope/Average Water Surface Slope (S_{rif}/S)	2.144	1.500	3.008
Run Slope (S_{run})	0.0211	0.0125	0.0362	ft/ft	Run Slope/Average Water Surface Slope (S_{run}/S)	1.838	1.088	3.150
Pool Slope (S_p)	0.0043	0.0010	0.0095	ft/ft	Pool Slope/Average Water Surface Slope (S_p/S)	0.372	0.086	0.824
Glide Slope (S_g)	0.0053	0.0020	0.0075	ft/ft	Glide Slope/Average Water Surface Slope (S_g/S)	0.460	0.173	0.655

Feature Midpoint [a]	Ave	Min	Max		Dimensionless Depth Ratios	Ave	Min	Max
Riffle Depth (d_{mrif})	2.410	2.410	2.410	feet	Riffle Max Depth/Riffle Mean Depth (d_{mrif}/d_{bkf})	1.883	1.883	1.883
Run Depth (d_{mrun})	2.300	1.870	2.560	feet	Run Max Depth/Riffle Mean Depth (d_{mrun}/d_{bkf})	1.797	1.461	2.000
Pool Depth (d_{mp})	3.760	3.760	3.760	feet	Pool Max Depth/Riffle Mean Depth (d_{mp}/d_{bkf})	2.938	2.938	2.938
Glide Depth (d_{mg})	2.470	1.640	3.280	feet	Glide Max Depth/Riffle Mean Depth (d_{mg}/d_{bkf})	1.930	1.281	2.563

Channel Materials

Catagories	Reach[b]	Riffle[c]	Bar
% Silt/Clay	0	0	
% Sand	0	0	
% Gravel	0	0	
% Cobble	0	0	
% Boulder	0	0	
% Bedrock	0	0	

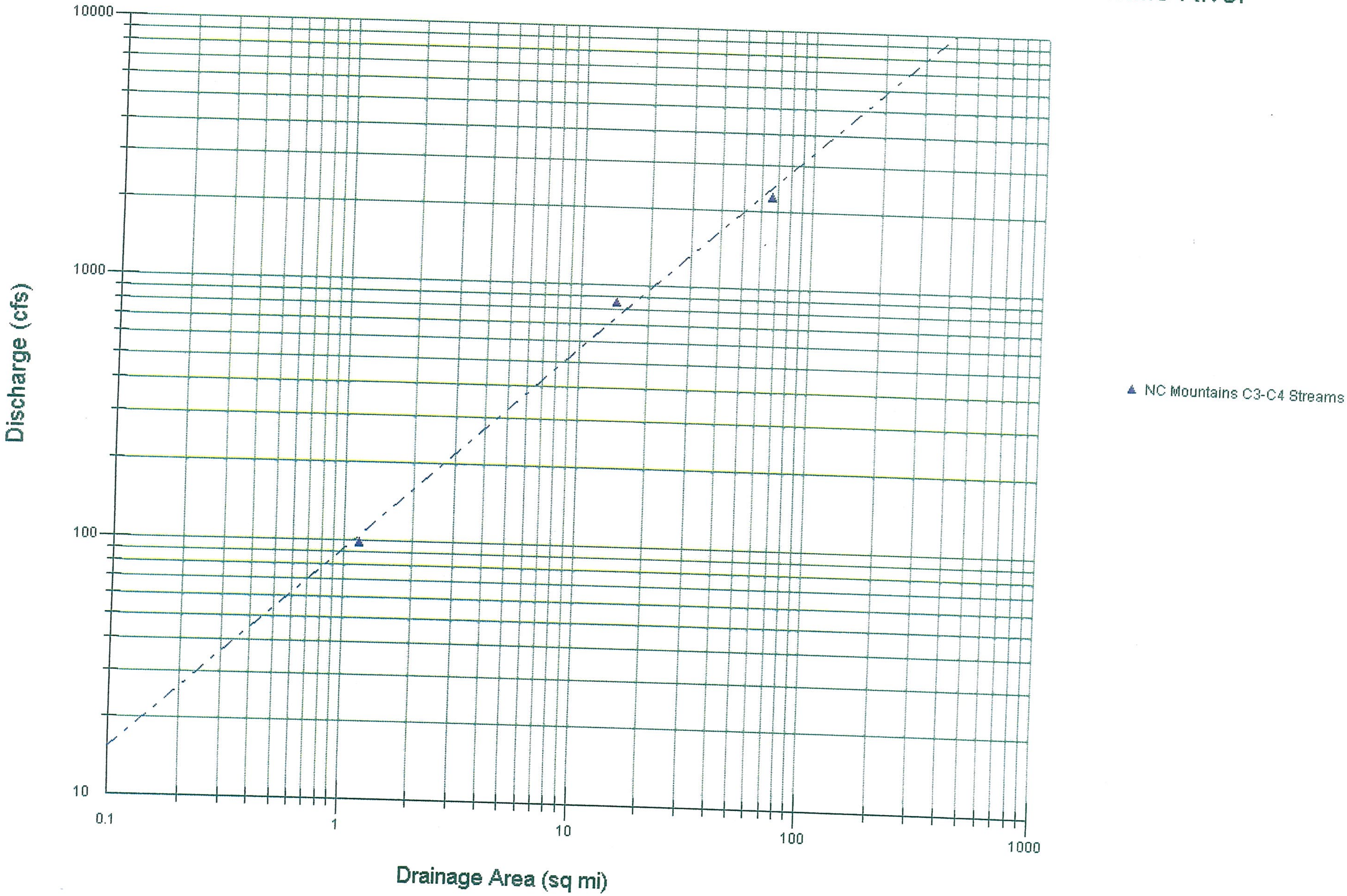
Indices	Reach[b]	Riffle[c]	Bar	
D16	0	0		mm
D35	0	0		mm
D50	27.73	38.5		mm
D84	58.3	60.2		mm
D95	0	0		mm
D100	0	0		mm

a. The range of "feature" mid-point maximum bankfull depths, including the minimum, maximum and average values. (Pool depths are obtained from the deepest portion of the feature.)

b. A composite sample of materials from riffle and pool featutes taken within the designated reach.

c. Sample obtained within the "active" bed of a riffle feature at the location of the cross section.

NC Mountains C3-C4 Regional Curve - Silver Ck, N Fork Swannanoa & Mills River



RIVERMORPH REACH SUMMARY

River Name: Silver Creek & Trib Restoration
Reach Name: Reach 1 (Reference Reach)

Stream Type	Valley Type	D50(mm)	Val Slope	BKF Q(cfs)	DA(sq mi)
C 4	VIII	38.5	0.0097	98.16	1.16

Dimension Summary

Database based on the following Cross Sections:
Riffle Section 0+22
Pool Section 3+20

Variable	Min	Avg	Max
Floodprone Width (ft)	232.0	232.0	232.0
Riffle Area (Sq ft)	30.77	30.77	30.77
Max Riffle Depth (ft)	2.41	2.41	2.41
Mean Riffle Depth (ft)	1.28	1.28	1.28
Riffle Width (ft)	24.02	24.02	24.02
Pool Area (Sq ft)	62.77	62.77	62.77
Max Pool Depth (ft)	3.76	3.76	3.76
Mean Pool Depth (ft)	2.33	2.33	2.33
Pool Width (ft)	26.97	26.97	26.97
Run Area (Sq ft)	0	0	0
Max Run Depth (ft)	1.87	2.3	2.56
Mean Run Depth (ft)	0	0	0
Run Width (ft)	0	0	0
Glide Area (Sq ft)	0	0	0
Max Glide Depth (ft)	1.64	2.47	3.28
Mean Glide Depth (ft)	0	0	0
Glide Width (ft)	0	0	0

Pattern Summary

Variable	Min	Avg	Max
Sinuosity		1.2	
Meander Wavelength (ft)	88.23	104.76	115.67
Radius of Curvature (ft)	12.97	17.67	24.44
Belt Width (ft)	44.17	45.22	46.5

Profile Summary

Data Based on the following:

Variable	Min	Avg	Max
S riffle (ft/ft)	0.01723	0.02464	0.03456
S pool (ft/ft)	0.00099	0.00427	0.00947
S run (ft/ft)	0.0125	0.02112	0.03619
S glide (ft/ft)	0.00199	0.00529	0.00753
- P (ft)	67.6	71.36	77.5
length (ft)	11.01	17.42	31.56
Dmax riffle (ft)	2.41	2.41	2.41
Dmax pool (ft)	3.76	3.76	3.76
Dmax run (ft)	1.87	2.3	2.56
Dmax glide (ft)	1.64	2.47	3.28
Low Bank Ht (ft)	0	0	0

0.01149

Hydraulic Summary

Variable	Min	Avg	Max
Discharge (cfs)		98.16	
Velocity (fps)		3.19	
Hyd Radius (ft)	1.21	1.21	1.21
Bkf Shear (lb/ sq ft)	0.87	0.87	0.87

River Name: Silver Creek & Trib Restoration
Reach Name: Reach 1 (Reference Reach)

Stream Type	Valley Type	D50(mm)	Val Slope	BKF Q(cfs)	DA(sq mi)
C 4	VIII	38.5	0.0097	98.16	1.16

Dimension Summary (DIMESIONLESS RATIOS)

Database based on the following Cross Sections:
Riffle Section 0+22
Pool Section 3+20

Variable	Min	Avg	Max
Wfpa / Wbkf	9.66	9.65862	9.65862
Abkf	30.77	30.77	30.77
Dmbkf	2.41	2.41	2.41
Dbkf	1.28	1.28	1.28
Wbkf	24.02	24.02	24.02
Pool Area / Abkf	2.03997	2.03997	2.03997
Max Pool Depth / Dbkf	2.9375	2.9375	2.9375
Mean Pool Depth / Dbkf	1.82031	1.82031	1.82031
Pool Width / Wbkf	1.12281	1.12281	1.12281
Run Area / Abkf	0	0	0
Max Run Depth / Dbkf	1.46094	1.79687	2
Mean Run Depth / Dbkf	0	0	0
Run Width / Wbkf	0	0	0
Glide Area / Abkf	0	0	0
Max Glide Depth / Dbkf	1.28125	1.92969	2.5625
Mean Glide Depth /Dbkf	0	0	0
Glide Width / Wbkf	0	0	0

Pattern Summary

Variable	Min	Avg	Max
Sinuosity		1.2	
Lm / W bkf	3.67319	4.36137	4.81557
Rc / W bkf	0.53997	0.73564	1.01749
Wblt / Wbkf (MWR)	1.83888	1.8826	1.93589

Profile Summary

Data Based on the following:

Variable	Min	Avg	Max
S riffle / S bkf (ft/ft)	1.49956	2.14447	3.00783
S pool / S bkf (ft/ft)	0.08616	0.37163	0.82419
S run / S bkf (ft/ft)	1.0879	1.83812	3.1497
S glide / S bkf (ft/ft)	0.17319	0.4604	0.65535
- P / W bkf (ft)	2.81432	2.97086	3.22648
length / W bkf (ft)	0.45837	0.72523	1.31391
Dmax riffle / D bkf (ft)	1.88281	1.88281	1.88281
Dmax pool / D bkf (ft)	2.9375	2.9375	2.9375
Dmax run / D bkf (ft)	1.46094	1.79687	2
Dmax glide / D bkf (ft)	1.28125	1.92969	2.5625
Low Bank Ht / Dmax riff (ft)	0	0	0

0.01149

Hydraulic Summary

Variable	Min	Avg	Max
Q bkf		98.16	
V bkf (fps)		3.19	
HR / D bkf (ft)	0.94531	0.94531	0.94531
Bkf Shear (lb/ sq ft)	0.87	0.87	0.87

River Name: Silver Creek & Trib Restoration
Reach Name: Reach 1 (Reference Reach)
Survey Date: 01/13/06

Upper Bank

Landform Slope:	1
Mass Wasting:	2
Debris Jam Potential:	1
Vegetative Protection:	2

Lower Bank

Channel Capacity:	0
Bank Rock Content:	1
Obstructions to Flow:	1
Cutting:	3
Deposition:	3

Channel Bottom

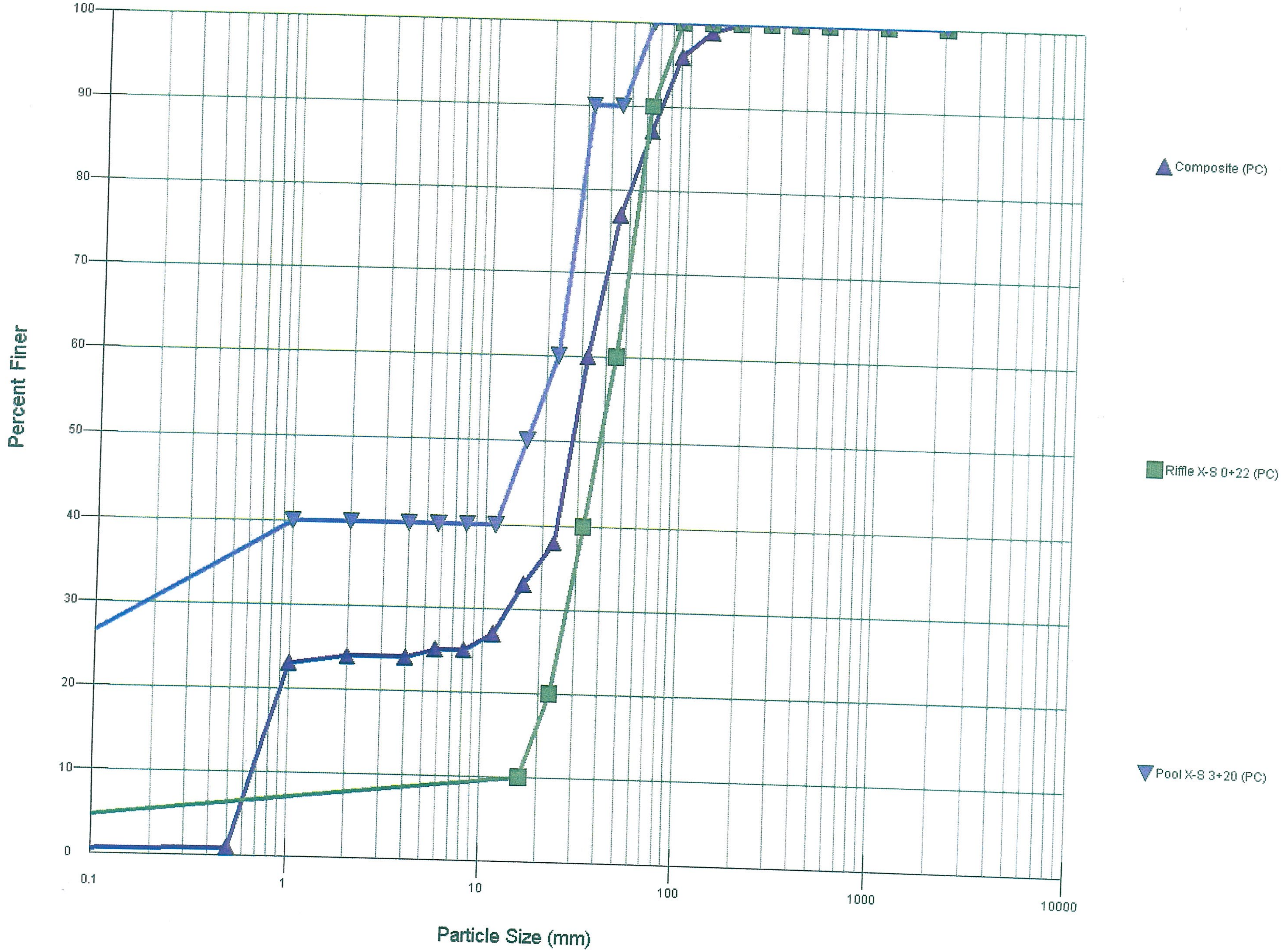
Rock Angularity:	0
Brightness:	0
Consolidation of Particles:	1
Bottom Size Distribution:	3
Scouring and Deposition:	5
Aquatic Vegetation:	1

Channel Stability Evaluation

Sediment Supply:	Moderate
Stream Bed Stability:	Stable
W/D Condition:	Normal
Stream Type:	C4

Rating - 24
Condition - Good

Reference Reach (Brindle ek) Particle Distribution




01/13/2006

RIVERMORPH PARTICLE SUMMARY

River Name: Silver Creek & Trib Restoration
Reach Name: Reach 1 (Reference Reach)
Sample Name: Composite
Survey Date: 01/13/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	1	1.00	1.00
0.50 - 1.0	22	22.00	23.00
1.0 - 2.0	1	1.00	24.00
2.0 - 4.0	0	0.00	24.00
4.0 - 5.7	1	1.00	25.00
5.7 - 8.0	0	0.00	25.00
8.0 - 11.3	2	2.00	27.00
11.3 - 16.0	6	6.00	33.00
16.0 - 22.6	5	5.00	38.00
22.6 - 32.0	22	22.00	60.00
32 - 45	17	17.00	77.00
45 - 64	10	10.00	87.00
64 - 90	9	9.00	96.00
90 - 128	3	3.00	99.00
128 - 180	1	1.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.84
D35 (mm)	18.64
D50 (mm)	27.73
D84 (mm)	58.3
D95 (mm)	87.11
D100 (mm)	179.99
Silt/Clay (%)	0
Sand (%)	24
Gravel (%)	63
Cobble (%)	13
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.

...DWQ Stream Classification Form

Reference Reach
Brindle Creek

Project Name: Silver Creek & UT Restoration Plan | River Basin: Catawba | County: Burke | Evaluator: WARREN KNOTTS, F

DWQ Project Number: D05016-1 | Nearest Named Stream: Silver Creek | Latitude: 35°37'07"N | Signature: Warren Knotts

01/13/2006 | USGS QUAD: Glen Alpine | Longitude: 81°48'48"W | Location/Directions: GOLDMINER TO KNUCKOLLS DR.

PLEASE NOTE: ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used****

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Riffle-Pool Sequence?	0	1	2	**3**
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	**0**	1	2	3
3) Are Natural Levees Present?	**0**	1	2	3
4) Is The Channel Sinuous?	0	1	**2**	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	**3**
6) Is The Channel Braided?	**0**	1	2	3
7) Are Recent Alluvial Deposits Present?	**0**	1	2	3
8) Is There A Bankfull Bench Present?	0	1	2	**3**
9) Is A Continuous Bed & Bank Present?	0	1	2	**3**

NOTE: *If Bed & Bank Caused By Ditching And* ***WITHOUT*** *Sinuosity Then Score=0*)*

10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map ***And/Or*** In Field) Present? *Yes*=**3** *No*=0

PRIMARY GEOMORPHOLOGY INDICATOR POINTS: 17

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	**3**

PRIMARY HYDROLOGY INDICATOR POINTS: 3

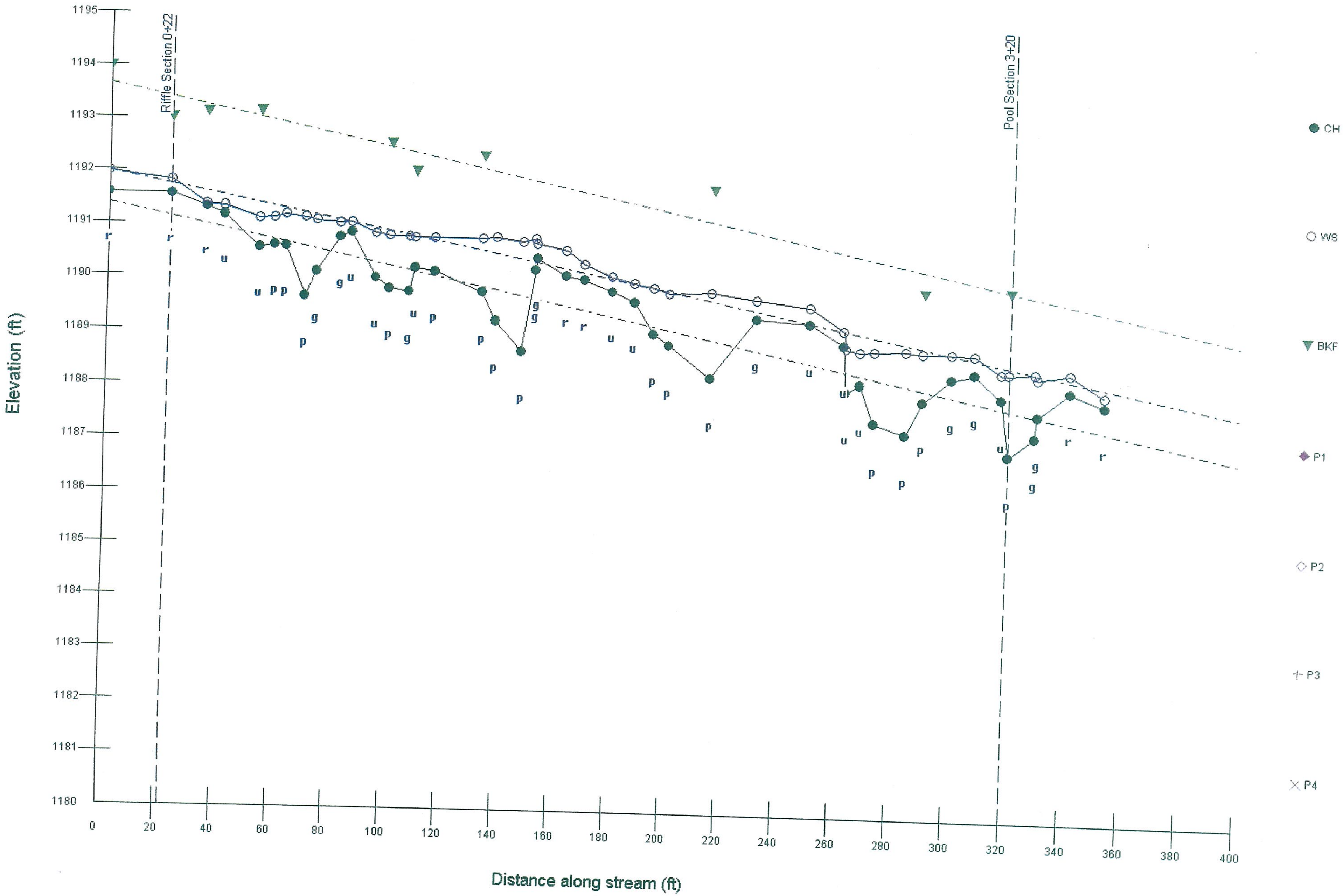
III. Biology	Absent	Weak	Moderate	Strong
1) Are Fibrous Roots Present In Streambed?	**3**	2	1	0
2) Are Rooted Plants Present In Streambed?	**3**	2	1	0
3) Is Periphyton Present?	**0**	1	2	3
4) Are Bivalves Present?	**0**	1	2	3

PRIMARY BIOLOGY INDICATOR POINTS: 6

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Head Cut Present In Channel?	**0**	.5	1	1.5

Silver Creek Reference Reach (Brindle Creek) Longitudnal Profile



RIVERMORPH PROFILE SUMMARY

River Name: Silver Creek & Trib Restoration
Reach Name: Reach 1 (Reference Reach)
Profile Name: Ref Reach Long Pro
Survey Date: 01/13/06

Survey Data

STA	CH	WS	BKF	P1	P2	P3	P4
0	8.43	8.02	6.02				
22	8.44	8.16	6.98				
34.6	8.67	8.62	6.86				
41	8.82	8.65					
53.5	9.44	8.88	6.84				
59	9.38	8.86					
63	9.4	8.8					
70	10.35	8.85					
74	9.88	8.9					
82.3	9.22	8.95					
86.3	9.12	8.93					
95	9.98	9.13					
100	10.18	9.17	7.4				
107	10.24	9.18					
109	9.78	9.2	7.94				
116	9.84	9.2					
133	10.22	9.2	7.62				
138	10.75	9.17					
147.5	11.31	9.25					
152	9.78	9.18					
152.5	9.56	9.28					
163	9.88	9.4					
169.6	9.95	9.66					
179.5	10.16	9.88					
187.5	10.35	10					
194.5	10.94	10.08					
200	11.15	10.18					
215	10.98	9.39	7.43				
231	9.86	9.51					
250	9.93	9.62					
262	10.32	10.05					
263	11.19	10.38					
268	11.04	10.44					
273	11.76	10.42					
284	11.96	10.4					
290	11.33	10.44	9.3				
300	10.9	10.44					
308	10.8	10.45					
317.5	11.26	10.78					
320	12.32	10.78	9.25				
329	11.96	10.76					
330	11.56	10.86					
341	11.1	10.76					
353	11.35	11.17					

Cross Section / Bank Profile Locations

Name	Type	Profile Station

Riffle Section 0+22		Riffle XS	22
Pool Section 3+20		Pool XS	320

Measurements from Graph

Bankfull Slope: 0.01149

Variable	Min	Avg	Max
S riffle	0.01723	0.02464	0.03456
S pool	0.00099	0.00427	0.00947
S run	0.0125	0.02112	0.03619
S glide	0.00199	0.00529	0.00753
P - P	67.6	71.36	77.5
P length	11.01	17.42	31.56
Dmax riffle	1.62	1.72	1.86
Dmax pool	2.71	3.06	3.29
Dmax run	1.87	2.3	2.56
Dmax glide	1.64	2.21	2.7
Low Bank Ht	0	0	0

Length and depth measurements in feet, slopes in ft/ft.

RIVERMORPH PROFILE SUMMARY

Notes

River Name: Silver Creek & Trib Restoration
Reach Name: Reach 1 (Reference Reach)
Profile Name: Ref Reach Long Pro
Survey Date: 01/13/06

STA	Note
0	Riffle Begin
22	Riffle X-S
34.6	Riffle End
41	Run
53.5	Run
59	Pool Top
63	Pool
70	Pool Center
74	Glide
82.3	Glide
86.3	Run
95	Run
100	Pool
107	Glide
109	Run
116	Pool
133	Pool Transition (Compound Pool)
138	Pool Center
147.5	Pool
152	Glide
152.5	Glide
153	Riffle
169.6	Riffle End
179.5	Run
187.5	Run
194.5	Pool
200	Pool Thalweg

231	Glide
250	Run
262	Run
263	Run
268	Run - Top Lat. Log Vane
273	Pool - Bottom Lat. Log Vane
284	Pool
290	Pool
300	Glide
308	Glide
317.5	Run
320	Pool (X-S)
329	Glide
330	Glide
341	Riffle
353	Riffle End

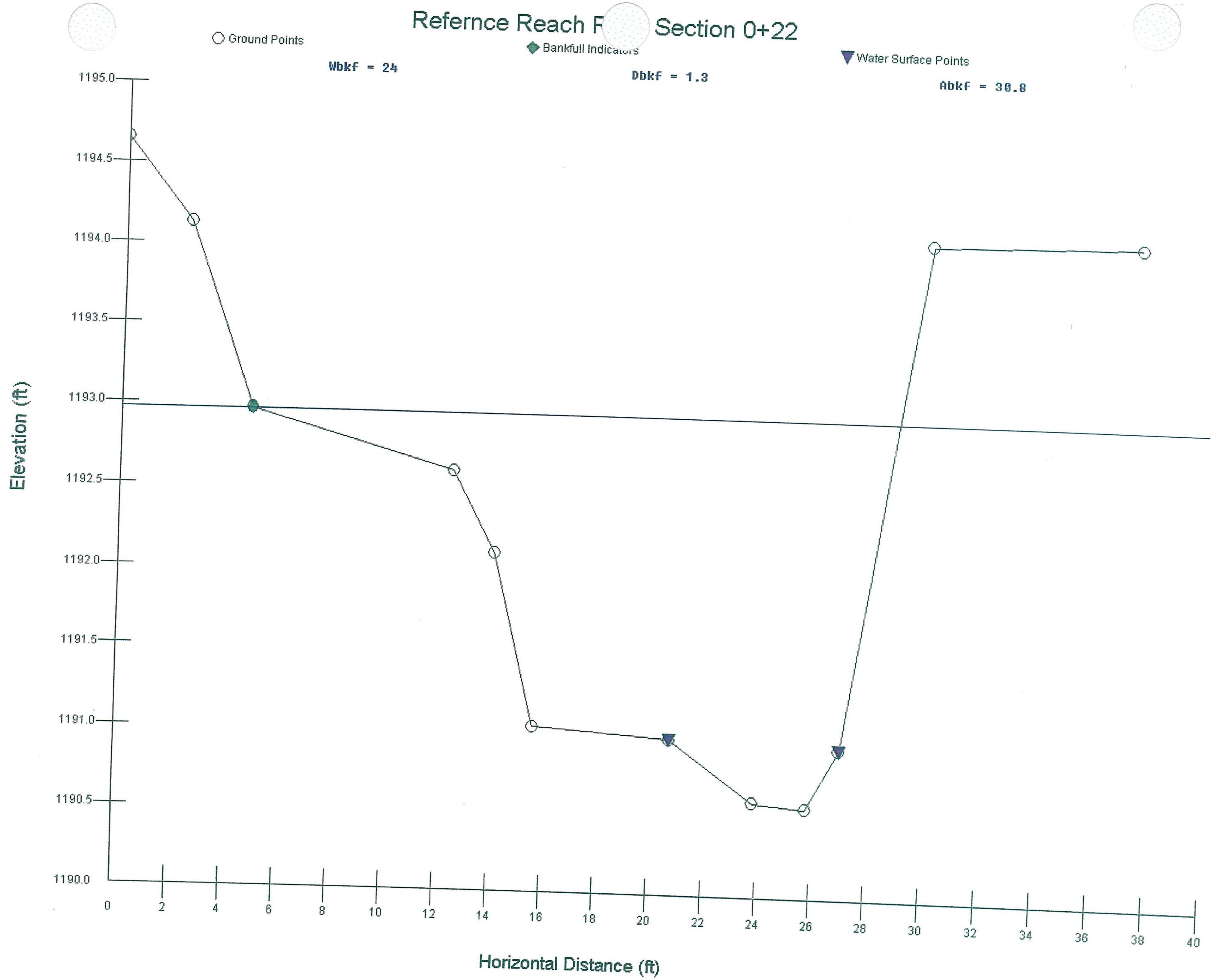
PARTICLE SUMMARY

River Name: Silver Creek & Trib Restoration
Reach Name: Reach 1 (Reference Reach)
Sample Name: Riffle X-S 0+22
Survey Date: 01/19/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	0	0.00	0.00
0.50 - 1.0	0	0.00	0.00
1.0 - 2.0	0	0.00	0.00
2.0 - 4.0	0	0.00	0.00
4.0 - 5.7	0	0.00	0.00
5.7 - 8.0	0	0.00	0.00
8.0 - 11.3	0	0.00	0.00
11.3 - 16.0	1	10.00	10.00
16.0 - 22.6	1	10.00	20.00
22.6 - 32.0	2	20.00	40.00
32 - 45	2	20.00	60.00
45 - 64	3	30.00	90.00
64 - 90	1	10.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

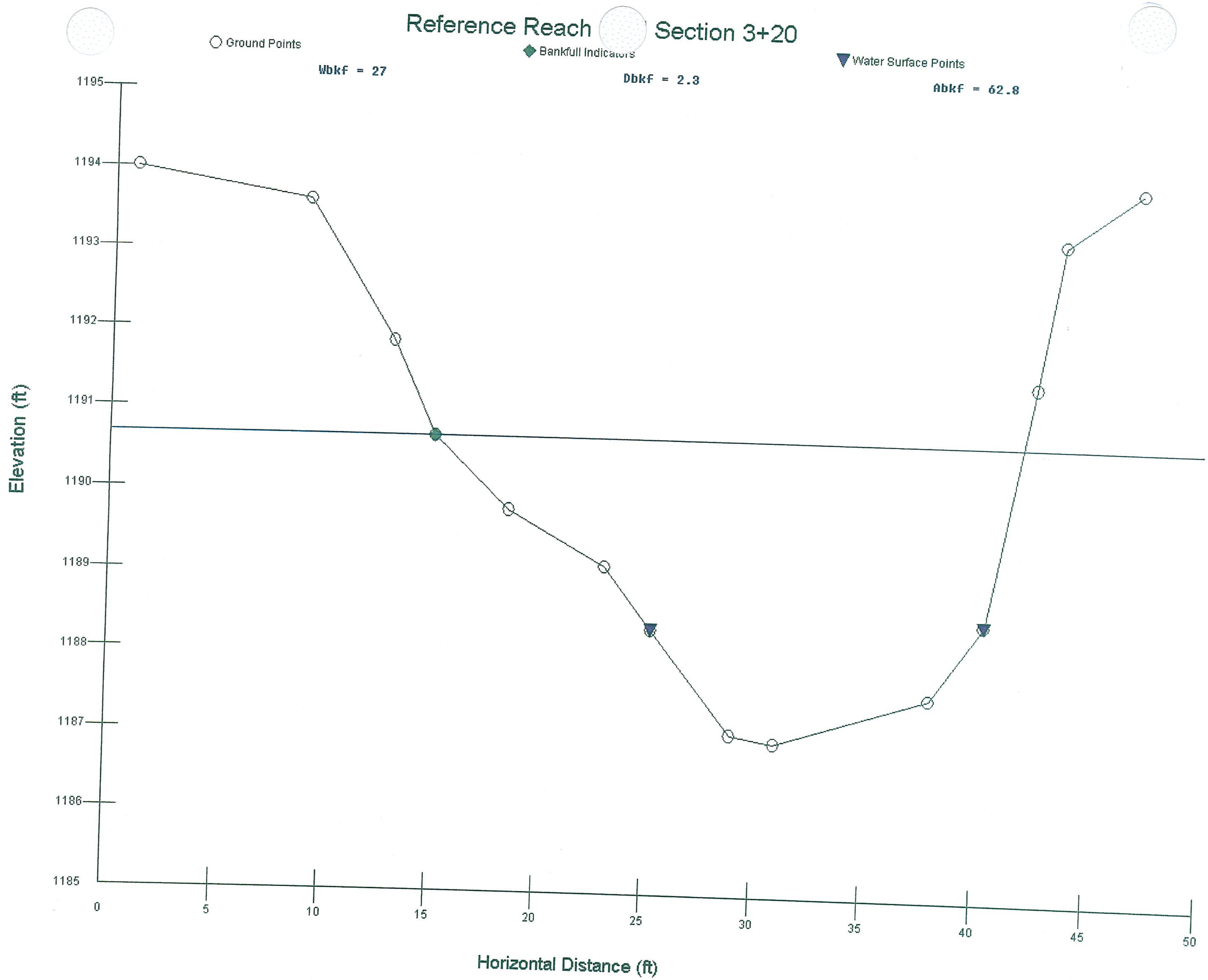
D16 (mm)	19.96
D35 (mm)	29.65
D50 (mm)	38.5
D84 (mm)	60.2
D95 (mm)	77
D100 (mm)	90
Silt/Clay (%)	0
Sand (%)	0
Gravel (%)	90
Cobble (%)	10
Boulder (%)	0
Bedrock (%)	0

Total Particles = 10 (need at least 60).



Refernce Reach F Section 0+22
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 24
Dbkf = 1.3
Abkf = 30.8
1195.0
1194.5
1194.0
1193.5
1193.0
1192.5
1192.0
1191.5
1191.0
1190.5
1190.0
Elevation (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Horizontal Distance (ft)

Reference Reach Riffle Cross-Section
Profile Station 0+22
January 13, 2006


Reference Reach Section 3+20
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 27
Dbkf = 2.3
Abkf = 62.8
Elevation (ft)
1195
1194
1193
1192
1191
1190
1189
1188
1187
1186
1185
0
5
10
15
20
25
30
35
40
45
50
Horizontal Distance (ft)

Reference Reach Pool Cross-Section
Profile Station 3+20
January 13, 2006

Thompsons Fork Mainstem
Existing Conditions Pool Cross-Section
Looking Upstream near
Confluence of Unnamed Tributary
February 7, 2006

Thompsons Fork Mainstem
Existing Conditions Pool Cross-Section
Looking Down Stream near
Confluence of Unnamed Tributary
February 7, 2006

Down Stream Limits of Project
Thompsons Fork Mainstem
15-ft Vertical to Undercut Streambank
February 7, 2006

Thompsons Fork Mainstem
End of Priority Level I Project
Confined by South Creek Road & I-40
Inlet 3-Chamber Box Culvert Under I-40
March 30, 2006

APPENDIX 7

HEC-RAS Analysis

Table of Contents

Overview

This study is prepared in support of a request for a Conditional Letter of Map Revision (CLOMR) from the Federal Emergency Management Agency (FEMA) for the proposed stream restoration and enhancement of Thompsons Fork. The reach of the stream being restudied is shown with an approximate (Zone A) floodplain on the Flood Insurance Rate Map (FIRM) for McDowell County and Incorporated Areas, number 37111C, Panel 0125B, effective July 15, 1988. A portion of the effective FIRM is included as Figure No. 1 that shows the approximate limits of the proposed project.

In August of 2006, the Federal Emergency Management Agency (FEMA), in conjunction with the State of North Carolina issued a Preliminary Flood Insurance Study (FIS) and FIRM for the State. The project area is shown with a detailed (Zone AE) floodplain on the Preliminary FIRM, number 3710, panels 1720 J and 1732 J, with a preliminary date of August 4, 2006 and panels 1740 J and 1742 J with a preliminary date of September 5, 2006. Thompsons Fork is shown with calculated Base Flood Elevations (BFEs) on the Preliminary FIRM, but with no floodway. A portion of the Preliminary FIRM is included as Figure No. 2 that illustrates the approximate limits of the proposed project.

Project Description

The proposed project would affect the alignment, profile and cross-sectional shape of Thompsons Fork from just upstream of Interstate 40 to a point approximately 2,500 feet upstream of I-40. The proposed project is a full-delivery stream restoration under the State of North Carolina's Ecosystem Enhancement Program. The project will restore the stream to a more stable and natural flow pattern while also creating a native vegetated buffer along the channel. Refer to excerpts from the restoration plans for additional details regarding the proposed project, which are located in Appendix C.

Technical Analysis

The information presented below is a general discussion of the technical components of the floodplain study.

Hydrology

The hydrology of Thompsons Fork is identical to that used in the Preliminary FIS and FIRM, dated August 4, 2006. The peak discharge for the 1% annual chance (100-year) event in Thompsons Fork is 3,210 cfs beginning at I-40 and extending to a location approximately 580 feet downstream of the upstream limits of the project. From this point to the upstream limits of the project, the 100-year peak discharge value is 2,760 cfs.

Hydraulics

The U.S. Army Corps of Engineers HEC-RAS hydraulic backwater computer program has been used to perform the study along Thompsons Fork to determine existing flood hazard conditions and determine the impact of the proposed project on those conditions. To demonstrate this impact, the levels of modeling described below were prepared and are included within this report as Appendix A. The Corrected Effective and Project level models begin downstream of I-40 (cross section 51.68) and end 770 feet upstream of the proposed channel relocation (cross section 4280.526). The Duplicate Effective model includes all of the cross sections from the model used to develop the Preliminary FIS (cross section 51.68 to 20794.13)

The locations and alignment of the cross-sections in the described levels of hydraulic modeling are depicted on Exhibit No. 1 in Appendix B. All of the models prepared as part of this study and discussed below are contained on the diskette included at the end of this report. Table No. 1 summarizes the results of the various levels of modeling.

1. Duplicate Effective Model (Project Name: ThompsonsFork, Plan name: ThompsonsFork LDS)
   This level of modeling is a duplication of the model that is summarized in the Preliminary FIS and FIRM, and was provided to EMH&T by the North Carolina Division of Emergency Management Floodplain Mapping Program. The purpose of this level of modeling is to show that the model being used for the analysis duplicates the information presented in the Preliminary FIS.

2. Corrected Effective Model (Project Name: FEMAfieldcombined, Plan name: ThompsonsFork LDS)
   This level of modeling adds additional information to the Duplicate Effective model through the reach of the stream to be relocated. The information includes additional cross sections (750, 950, 1550, 1900, 2000, 2420, 2450, 2500, 2550, 2600, 2750, 3100, 3175, 3300, 3490), and an existing crossing of the stream (cross section 2525). The cross sections and the crossing of the stream were generated from field surveyed information of the project area. The field survey also provided additional information in the vicinity of cross section 1894.128 which resulted in the invert elevation of the cross section being lowered by 0.72 feet. Manning's 'n' values for the additional cross sections were determined utilizing field notes from site visits, as well as a comparison to the Duplicate Effective model values.

3. Project Model (Project Name: FEMAfieldcombined, Plan name: proposed)
   This level of modeling represents the proposed condition of Thompsons Fork. The channel has been relocated, lengthened, and had a change in the profile from cross section 750 to cross section 3508.824. The cross sections for this model were revised from the Corrected Effective model utilizing the typical cross sectional dimensions of the proposed channel (shown on the attached plan excerpts in Appendix C) in combination with the proposed channel profile and the existing topography for the project area. The existing stream crossing is to be removed as part of the project, and this level of modeling represents that as well. The cross sectional area of many of the cross sections has been increased due to the proposed grading activities that are part of the project. Please refer to Appendix C for portions of the restoration plan for additional detail regarding these proposed changes. Manning's 'n' values for the proposed project reach were determined from an assumed fully vegetated condition based on the proposed plantings that will occur once construction of the channel is complete. Fill material that is generated during the construction of the project will be placed within the limits of the floodplain between cross sections 1378.928 and 1900. The model represents this fill as ineffective flow area below an assumed elevation based on a projected amount of fill for the project. The limits of this proposed fill are shown on the attached excerpts from the plan.

Conclusions

The Corrected Effective model results show an increase in water surface elevation at cross section 1378.928 when compared to the Duplicate Effective model. This increase is due to changes in the profile elevations of Thompsons Fork that were created by the inclusion of additional cross sections derived from field survey information obtained as part of the planning for the proposed project. Decreases in elevation between the Corrected and Duplicate Effective models exist at the upstream limits of the project reach.

The proposed channel relocation project raises water surface elevations within the project reach of the stream, specifically, cross sections 1894.128 through 2550. The maximum increase is 0.87 feet when comparing the project level model to the Corrected Effective model, and is located at cross section 2450. The increases are due to the changes in the channel geometry that are proposed as part of this project as well as the fill that will be placed in the overbank area of the proposed channel. All of the increases in water surface elevation are limited to the property that contains the project reach of Thompsons Fork. The project reach of the stream will be contained within a conservation easement that will be deeded to the State of North Carolina, and no structures are located within the floodplain for the project reach of the stream. At the upstream limits of the proposed project, and extending upstream, there are decreases in water surface elevation when comparing the Project Model to either the Corrected Effective or Duplicate Effective model, with a maximum decrease of 2.08 feet at cross section 3508.824. The decreases are in part due to an increase in the cross sectional area of the floodplain that will be created with the grading associated with the project.

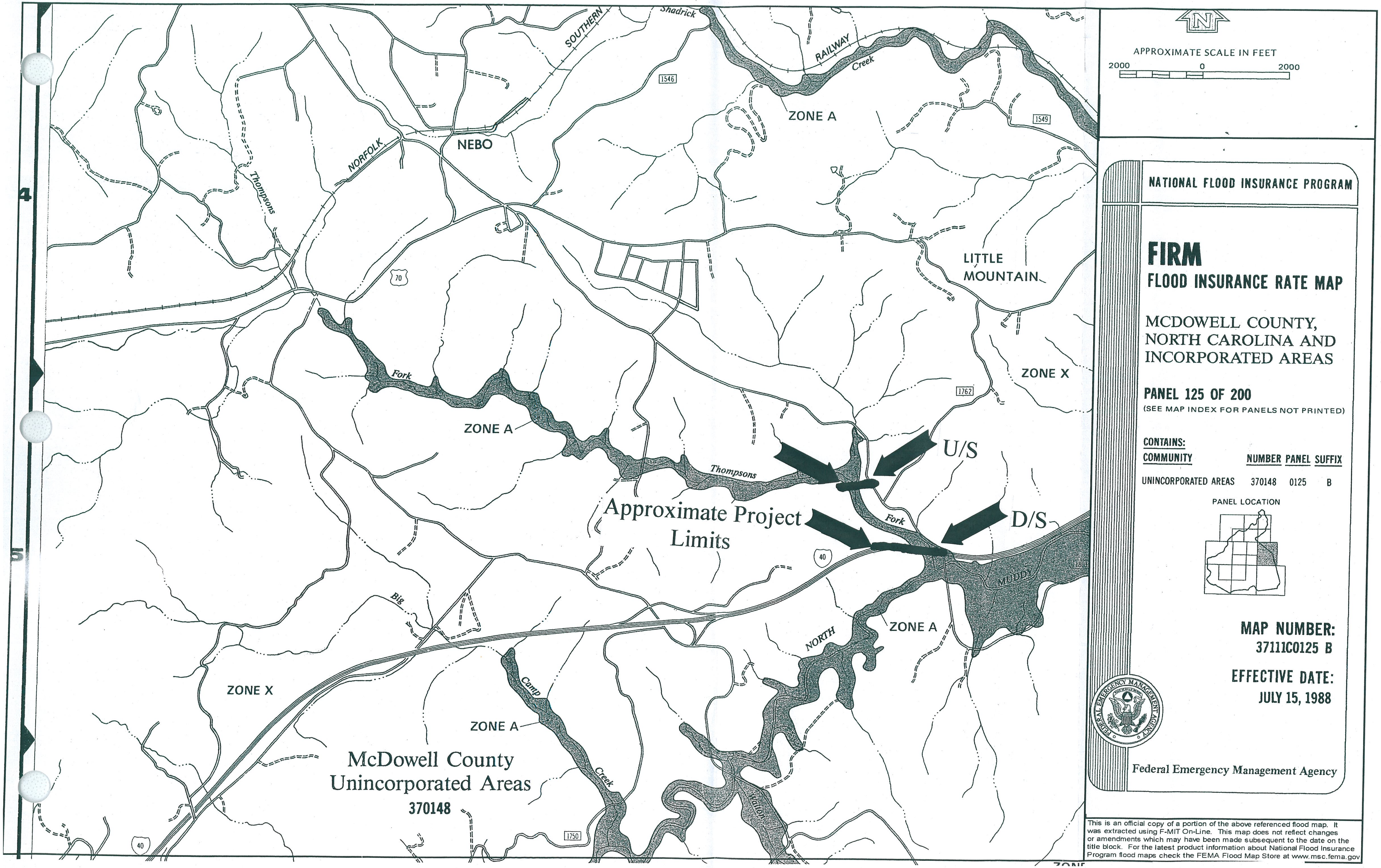
The results of all of the various levels of modeling described above are demonstrated in Table No. 1 and are graphically depicted on Exhibit No. 1 in Appendix B.

Note: All elevations referenced in this report and shown on the enclosed tables and exhibits are with respect to the North American Vertical Datum (NAVD) 1988.

Table No. 1
Calculated Water Surface Elevations

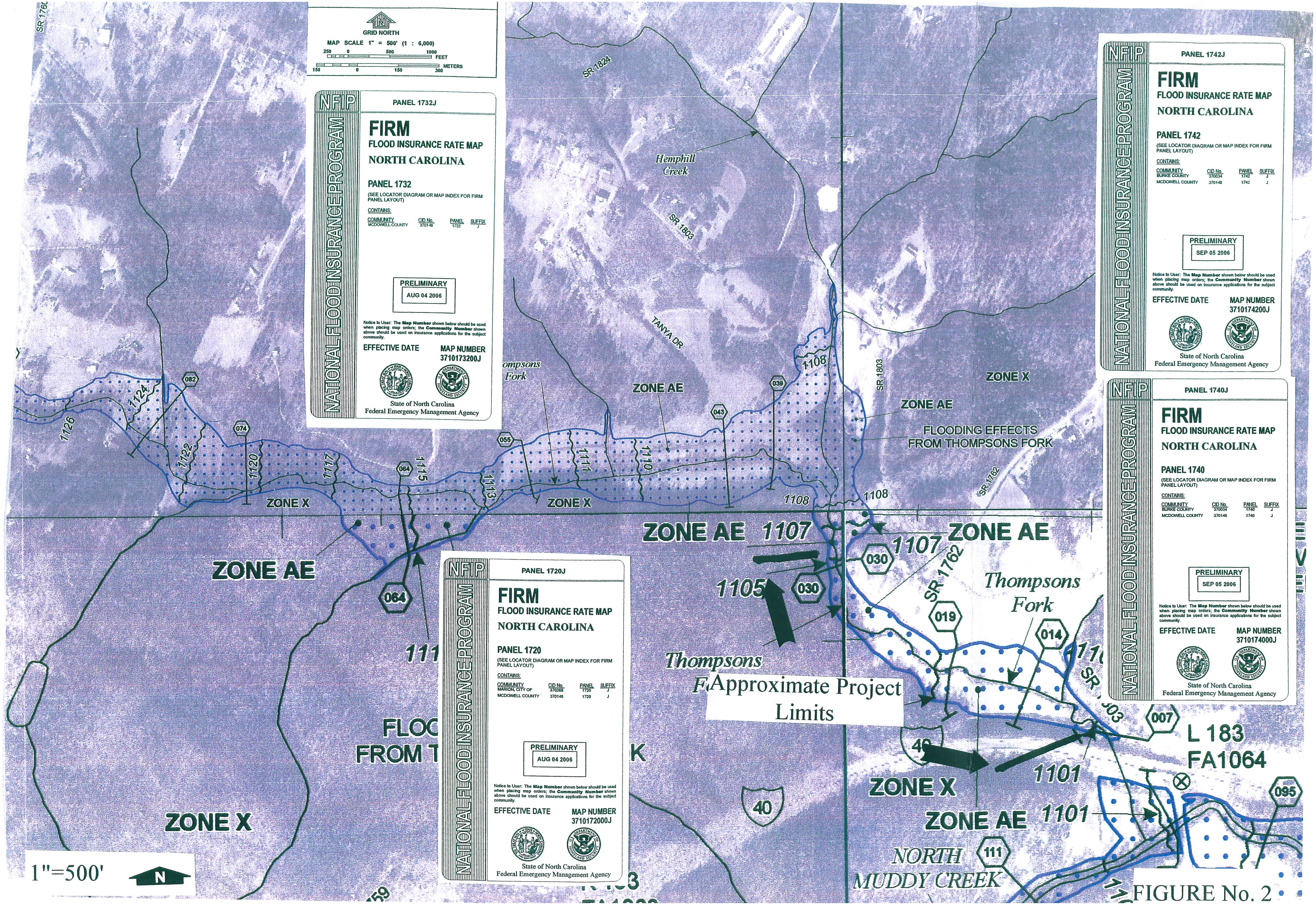
	Cross Section	FEMA Numbered Section	Preliminary FIS	Duplicate Effective	Corrected Effective	Difference from Duplicate	Project	Difference from Corrected	Difference from Duplicate
	51.68	001	1100.6*	1086.92	1086.92	0.00	1086.92	0.00	0.00
	393.811	004	1100.6*	1089.09	1089.09	0.00	1089.09	0.00	0.00
	I-40								
Project Reach	729.076	007	1100.6*	1096.72	1096.72	0.00	1096.72	0.00	0.00
Project Reach	750				1096.80		1096.80	0.00	
Project Reach	950				1099.12		1099.05	-0.07	
Project Reach	1378.928	014	1100.6*	1098.39	1099.29	0.90	1099.23	-0.06	0.84
Project Reach	1550				1099.69		1099.68	-0.01	
Project Reach	1894.128	019	1100.6*	1100.39	1099.99	-0.40	1100.58	0.59	0.19
Project Reach	1900				1100.23		1100.77	0.54	
Project Reach	2000				1100.64		1101.40	0.76	
Project Reach	2420				1101.70		1102.24	0.54	
Project Reach	2450				1101.62		1102.49	0.87	
Project Reach	2500				1102.11		1102.56	0.45	
Project Reach	2550				1102.38		1102.70	0.32	
Project Reach	2600				1103.71		1102.89	-0.82	
Project Reach	2750				1104.15		1103.19	-0.96	
Project Reach	3024.192	030	1104.9	1104.91	1104.18	-0.73	1104.01	-0.17	-0.90
Project Reach	3100				1107.11		1104.23	-2.88	
Project Reach	3175				1107.25		1104.75	-2.50	
Project Reach	3300				1107.62		1105.82	-1.80	
Project Reach	3490				1107.66		1105.90	-1.76	
	3508.824	035	1107.8	1107.99	1107.63	-0.36	1105.91	-1.72	-2.08
	3667.815	037	1108.0	1107.99	1107.84	-0.15	1106.07	-1.77	-1.92
	3942.695	039	1108.2	1108.15	1108.02	-0.13	1106.68	-1.34	-1.47
	4280.526	043	1108.6	1108.57	1108.47	-0.10	1107.78	-0.69	-0.79

* Backwater from North Muddy Creek



APPROXIMATE SCALE IN FEET
2000 0 2000
N
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
MCDOWELL COUNTY, NORTH CAROLINA AND INCORPORATED AREAS
PANEL 125 OF 200
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
UNINCORPORATED AREAS 370148 0125 B
PANEL LOCATION
MAP NUMBER:
37111C0125 B
EFFECTIVE DATE:
JULY 15, 1988
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov
Shadrick
SOUTHERN
RAILWAY
Creek
1546
1549
ZONE A
NEBO
NORFOLK
Thompsons
70
LITTLE MOUNTAIN
ZONE X
1762
Fork
ZONE A
U/S
Thompsons
Approximate Project Limits
Fork
D/S
40
MUDDY
Big
NORTH
ZONE A
ZONE X
Camp
ZONE A
Creek
Walton
McDowell County Unincorporated Areas
370148
1750
40
4
5

FIGURE No. 1


GRID NORTH
MAP SCALE 1" = 500' (1 : 6,000)
FEET
METERS
NFIP
PANEL 1732J
FIRM
FLOOD INSURANCE RATE MAP
NORTH CAROLINA
PANEL 1732
PRELIMINARY
AUG 04 2006
MAP NUMBER
3710173200J
NATIONAL FLOOD INSURANCE PROGRAM
State of North Carolina
Federal Emergency Management Agency
PANEL 1742J
FIRM
FLOOD INSURANCE RATE MAP
NORTH CAROLINA
PANEL 1742
PRELIMINARY
SEP 05 2006
MAP NUMBER
3710174200J
PANEL 1740J
FIRM
FLOOD INSURANCE RATE MAP
NORTH CAROLINA
PANEL 1740
PRELIMINARY
SEP 05 2006
MAP NUMBER
3710174000J
PANEL 1720J
FIRM
FLOOD INSURANCE RATE MAP
NORTH CAROLINA
PANEL 1720
PRELIMINARY
AUG 04 2006
MAP NUMBER
3710172000J
SR 1824
Hemphill Creek
SR 1803
TANYA DR
ZONE AE
ZONE X
FLOODING EFFECTS
FROM THOMPSONS FORK
SR 1762
ZONE AE 1107
1105
Thompsons Fork
Approximate Project Limits
L 183
FA1064
1101
ZONE X
ZONE AE 1101
NORTH MUDDY CREEK
40
1"=500'
N
FIGURE No. 2

Appendix A
HEC-RAS Modeling

Duplicate Effective

DUPLICATE
EFFECTIVE

HEC-RAS Plan: ThompsonsFor River: ThompsonsFork Reach: Main Profile: P100yr

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Prof Delta WS	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Top Wdth Act	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	(ft)	
Main	20794.13	P100yr	2060.00	1173.40	1180.53		1179.92	1181.05	0.006519	7.29	634.56	259.41	259.41	0.56
Main	19571.35	P100yr	2060.00	1166.29	1174.16		1173.43	1174.44	0.004466	6.68	962.61	395.50	395.50	0.49
Main	18994.13	P100yr	2060.00	1164.50	1172.32		1170.71	1172.55	0.002462	5.66	1119.70	413.04	413.04	0.39
Main	18361.54	P100yr	2060.00	1160.08	1171.82		1166.09	1171.91	0.000506	3.23	1922.81	562.23	562.23	0.18
Main	17194.13	P100yr	2300.00	1157.55	1171.59		1163.99	1171.62	0.000157	2.14	2492.54	316.27	316.27	0.11
Main	15950.61	P100yr	2300.00	1152.65	1171.52		1159.31	1171.53	0.000036	1.13	4254.33	339.22	339.22	0.05
Main	14494.13	P100yr	2300.00	1149.39	1171.49		1155.07	1171.49	0.000022	0.97	6575.91	450.10	450.10	0.04
Main	13263.74	P100yr	2300.00	1147.23	1171.46		1151.90	1171.47	0.000022	1.21	5462.52	303.67	303.67	0.04
Main	12694.13	P100yr	2510.00	1145.09	1171.46		1149.49	1171.46	0.000005	0.57	13162.72	719.76	719.76	0.02
Main	11892.4	P100yr	2510.00	1143.87	1171.46		1147.56	1171.46	0.000004	0.53	14411.02	692.04	692.04	0.02
Main	11437.32	P100yr	2510.00	1142.74	1171.45		1146.65	1171.45	0.000011	1.00	7754.01	410.68	410.68	0.03
Main	10752.22	P100yr	2510.00	1142.00	1171.45		1144.81	1171.45	0.000001	0.33	8995.69	403.97	403.97	0.01
Main	10206		Inl Struct											
Main	9904.324	P100yr	2510.00	1123.88	1132.20		1131.89	1133.51	0.008553	10.83	514.32	180.40	180.40	0.68
Main	9392.423	P100yr	2760.00	1122.17	1131.89		1128.94	1131.95	0.000819	3.65	2234.96	565.70	565.70	0.22
Main	9246.419	P100yr	2760.00	1119.60	1131.64		1128.11	1131.80	0.000879	4.72	1833.17	483.13	483.13	0.25
Main	9181.419		Bridge											
Main	9120.498	P100yr	2760.00	1119.60	1128.72		1128.72	1130.90	0.008859	12.52	374.94	141.08	141.08	0.74
Main	8977.797	P100yr	2760.00	1115.52	1126.77		1124.10	1127.96	0.005568	9.40	487.72	151.31	151.31	0.52
Main	8194.128	P100yr	2760.00	1115.00	1123.50		1122.23	1123.90	0.004262	7.08	904.84	424.07	266.94	0.45
Main	7405.452	P100yr	2760.00	1112.22	1120.58		1118.56	1120.83	0.003578	6.57	1251.18	309.02	309.02	0.44
Main	6949.385	P100yr	2760.00	1109.25	1117.56		1116.99	1118.36	0.008569	9.60	769.77	246.85	246.85	0.64
Main	6394.128	P100yr	2760.00	1107.27	1115.25		1113.88	1115.64	0.002924	6.29	1209.50	434.90	434.90	0.42
Main	5494.128	P100yr	2760.00	1104.05	1111.76		1110.74	1112.20	0.005258	8.17	917.96	289.87	289.87	0.55
Main	4280.526	P100yr	2760.00	1099.32	1108.57		1106.62	1108.71	0.001734	5.06	1633.18	456.50	456.50	0.31
Main	3942.695	P100yr	2760.00	1097.71	1108.15		1105.33	1108.23	0.001127	4.13	1834.54	485.03	485.03	0.25
Main	3667.815	P100yr	2760.00	1096.19	1107.99		1104.31	1108.03	0.000457	3.55	3159.39	620.92	620.92	0.18
Main	3508.824	P100yr	2760.00	1095.49	1107.79		1103.59	1107.92	0.000859	4.32	1580.75	250.12	250.12	0.23
Main	3024.192	P100yr	3210.00	1095.07	1104.91		1104.18	1106.65	0.010998	12.25	451.85	101.74	101.74	0.75
Main	1894.128	P100yr	3210.00	1090.42	1100.39		1098.90	1100.63	0.002771	6.17	1169.38	321.67	321.67	0.39
Main	1378.928	P100yr	3210.00	1087.40	1098.39		1097.76	1098.89	0.004104	8.24	1017.93	375.98	375.98	0.49
Main	729.076	P100yr	3210.00	1084.00	1096.72		1090.64	1097.32	0.001570	6.33	596.57	144.31	70.00	0.32
Main	550		Culvert											
Main	393.811	P100yr	3210.00	1082.00	1089.09		1089.09	1092.00	0.018591	13.80	249.95	56.98	49.95	0.94
Main	51.68	P100yr	3210.00	1077.97	1086.92		1083.54	1087.87	0.004059	7.84	411.46	50.43	50.43	0.47

PROJECT (handwritten bracket spanning River Sta 3508.824 to 729.076)

Corrected Effective

CORRECTED EFF.

HEC-RAS Plan: ThompsonsFor River: ThompsonsFork Reach: Main Profile: P100yr

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Prof Delta WS	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Top Wdth Act	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	(ft)	
Main	4280.526	P100yr	2760.00	1099.32	1108.47		1106.62	1108.63	0.001867	5.21	1589.11	454.06	454.06	0.32
Main	3942.695	P100yr	2760.00	1097.71	1108.02		1105.33	1108.10	0.001238	4.28	1768.84	483.81	483.81	0.26
Main	3667.815	P100yr	2760.00	1096.19	1107.84		1104.31	1107.88	0.000498	3.67	3065.80	616.92	616.92	0.19
Main	3508.824	P100yr	2760.00	1095.49	1107.63		1103.59	1107.76	0.000926	4.44	1539.46	249.54	249.54	0.24
Main	3490	P100yr	2760.00	1095.60	1107.66		1103.11	1107.73	0.000420	2.97	1709.80	288.60	288.60	0.17
Main	3300	P100yr	2760.00	1095.30	1107.62		1102.97	1107.68	0.000365	2.65	1832.68	305.96	305.96	0.15
Main	3175	P100yr	2760.00	1095.20	1107.25		1102.20	1107.51	0.000940	4.42	791.01	122.74	122.74	0.25
Main	3100	P100yr	2760.00	1094.90	1107.11		1102.75	1107.36	0.001331	4.73	767.57	111.09	111.09	0.29
Main	3024.192	P100yr	3210.00	1095.07	1104.18		1104.18	1106.54	0.016256	14.01	380.21	95.17	95.17	0.90
Main	2750	P100yr	3210.00	1094.10	1104.15		1102.94	1104.81	0.004998	8.39	634.88	157.29	157.29	0.54
Main	2600	P100yr	3210.00	1094.60	1103.71		1102.16	1104.11	0.002980	6.54	805.98	204.83	204.83	0.43
Main	2550	P100yr	3210.00	1093.20	1102.38		1102.37	1103.62	0.012537	11.44	476.01	173.16	173.16	0.81
Main	2500	P100yr	3210.00	1094.20	1102.11		1101.81	1102.97	0.008567	10.67	577.74	190.31	190.31	0.68
Main	2475		Mult Open	FARM	CROSSING									
Main	2450	P100yr	3210.00	1093.70	1101.62		1101.62	1102.77	0.010748	11.79	524.43	192.22	192.22	0.77
Main	2420	P100yr	3210.00	1091.70	1101.70		1100.48	1102.37	0.003976	7.26	623.35	198.33	198.33	0.48
Main	2000	P100yr	3210.00	1089.60	1100.64		1099.42	1101.19	0.003168	7.09	755.64	220.76	220.76	0.43
Main	1900	P100yr	3210.00	1089.70	1100.23		1098.25	1100.39	0.001340	4.72	1348.42	344.80	344.80	0.28
Main	1894.128	P100yr	3210.00	1089.70	1099.99		1098.87	1100.31	0.003879	6.93	1043.30	318.91	318.91	0.45
Main	1550	P100yr	3210.00	1087.20	1099.69		1097.43	1099.81	0.000889	3.86	1566.86	411.01	411.01	0.23
Main	1378.928	P100yr	3210.00	1087.40	1099.29		1097.76	1099.52	0.001941	6.05	1364.85	393.99	393.99	0.34
Main	950	P100yr	3210.00	1087.40	1099.12		1096.88	1099.34	0.001415	5.04	1160.44	289.61	289.61	0.29
Main	750	P100yr	3210.00	1085.50	1096.80		1094.75	1098.02	0.006176	9.48	424.66	76.75	76.75	0.57
Main	729.076	P100yr	3210.00	1084.00	1096.72		1090.64	1097.32	0.001570	6.33	596.57	144.31	70.00	0.32
I-40 Main	550		Culvert											
Main	393.811	P100yr	3210.00	1082.00	1089.09		1089.09	1092.00	0.018591	13.80	249.95	56.98	49.95	0.94
Main	51.68	P100yr	3210.00	1077.97	1086.92		1083.54	1087.87	0.004059	7.84	411.46	50.43	50.43	0.47

PROJECT

Project Model

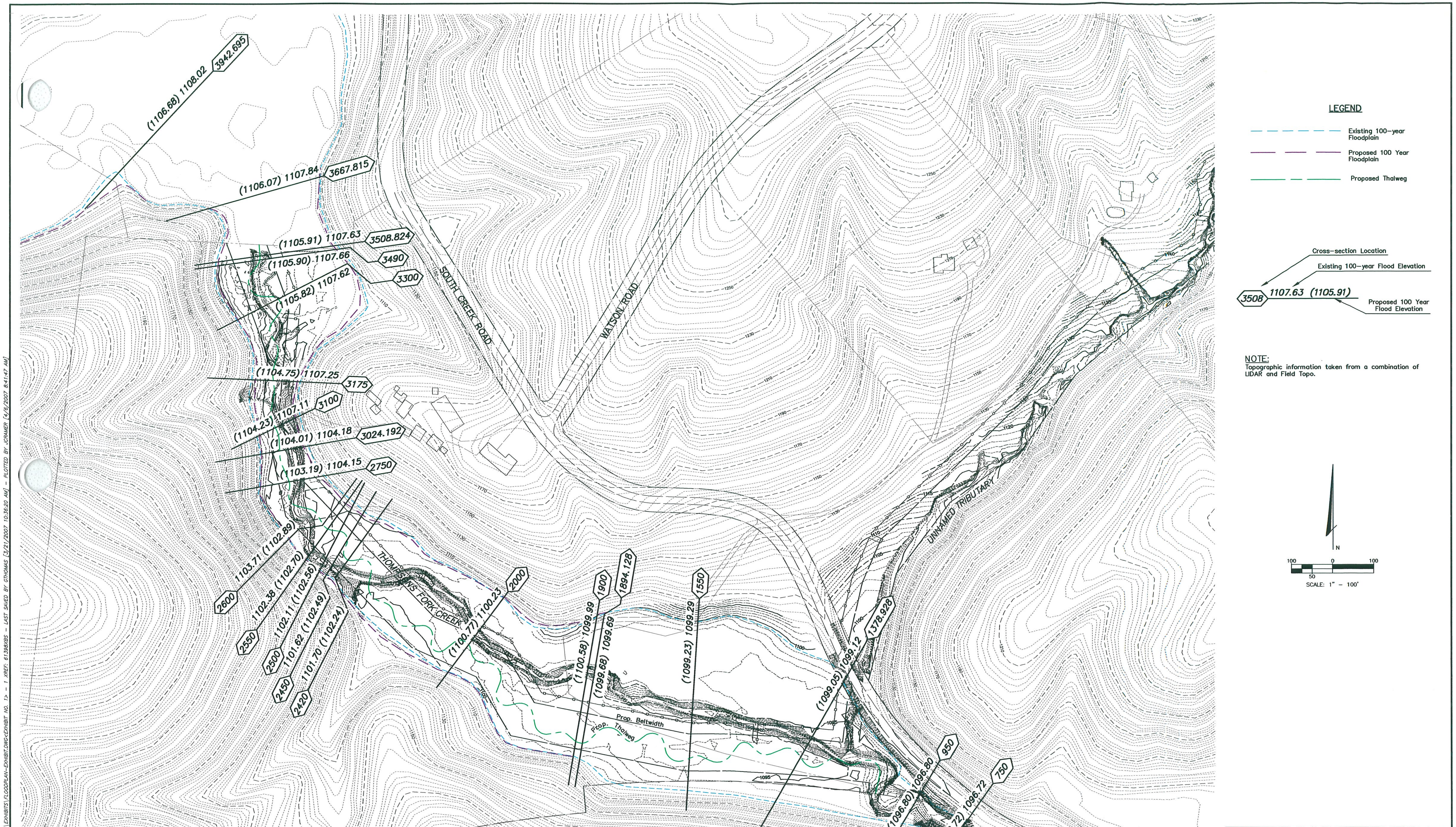
PROPOSED

HEC-RAS Plan: proposed River: ThompsonsFork Reach: Main Profile: P100yr

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Prof Delta WS	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Top Wdth Act	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	(ft)	
Main	4280.526	P100yr	2760.00	1099.32	1107.78		1106.62	1108.04	0.003255	6.49	1284.12	428.94	428.94	0.42
Main	3942.695	P100yr	2760.00	1097.71	1106.68		1105.33	1106.89	0.003497	6.40	1180.51	377.94	377.94	0.43
Main	3667.815	P100yr	2760.00	1096.19	1106.07		1104.31	1106.21	0.001692	6.04	2005.87	584.54	584.54	0.34
Main	3508.824	P100yr	2760.00	1096.50	1105.91		1102.62	1106.01	0.000825	3.83	1225.24	244.90	244.90	0.23
Main	3490	P100yr	2760.00	1096.40	1105.90		1102.78	1106.00	0.000820	3.84	1316.25	276.25	276.25	0.23
Main	3300	P100yr	2760.00	1096.00	1105.82		1102.63	1105.90	0.000686	3.60	1419.39	289.29	289.29	0.21
Main	3175	P100yr	2760.00	1095.50	1104.75		1103.07	1105.54	0.004413	8.74	494.23	104.95	104.95	0.52
Main	3100	P100yr	2760.00	1095.20	1104.23		1102.60	1105.01	0.004534	8.71	486.86	98.06	98.06	0.53
Main	3024.192	P100yr	3210.00	1095.10	1104.01		1101.96	1104.73	0.004559	8.64	550.28	101.58	101.58	0.53
Main	2750	P100yr	3210.00	1095.00	1103.19		1102.74	1104.23	0.007624	10.52	529.42	149.53	149.53	0.67
Main	2600	P100yr	3210.00	1094.50	1102.89		1101.20	1103.27	0.003348	7.09	815.33	198.86	198.86	0.45
Main	2550	P100yr	3210.00	1094.40	1102.70		1101.03	1103.13	0.003711	7.41	755.81	175.64	175.64	0.47
Main	2500	P100yr	3210.00	1094.30	1102.56		1101.05	1102.98	0.003710	7.39	782.50	192.66	192.66	0.47
Main	2450	P100yr	3210.00	1094.30	1102.49		1100.97	1102.89	0.003665	7.29	795.02	196.26	196.26	0.47
Main	2420	P100yr	3210.00	1094.20	1102.24		1100.95	1102.74	0.004542	8.01	730.51	205.52	205.52	0.52
Main	2000	P100yr	3210.00	1093.00	1101.40		1099.41	1101.62	0.002079	5.60	1026.71	238.81	238.81	0.35
Main	1900	P100yr	3210.00	1092.00	1100.77		1098.43	1100.95	0.001828	5.41	1193.79	348.41	348.41	0.33
Main	1894.128	P100yr	3210.00	1091.95	1100.58		1098.67	1100.92	0.003034	6.89	956.99	322.95	322.95	0.43
Main	1550	P100yr	3210.00	1091.20	1099.68		1098.02	1100.03	0.003347	7.15	1016.78	410.27	410.27	0.45
Main	1378.928	P100yr	3210.00	1090.80	1099.23		1097.29	1099.43	0.002080	5.61	1177.73	392.95	392.95	0.35
Main	950	P100yr	3210.00	1090.50	1099.05		1096.72	1099.21	0.001616	5.00	1190.51	288.29	288.29	0.31
Main	750	P100yr	3210.00	1085.50	1096.80		1094.75	1098.02	0.006176	9.48	424.66	76.75	76.75	0.57
Main	729.076	P100yr	3210.00	1084.00	1096.72		1090.64	1097.32	0.001570	6.33	596.57	144.31	70.00	0.32
Main	550		Culvert											
Main	393.811	P100yr	3210.00	1082.00	1089.09		1089.09	1092.00	0.018591	13.80	249.95	56.98	49.95	0.94
Main	51.68	P100yr	3210.00	1077.97	1086.92		1083.54	1087.87	0.004059	7.84	411.46	50.43	50.43	0.47

PROJECT REACH

Appendix B
Exhibits



MCDOWELL COUNTY, NORTH CAROLINA

FLOODPLAIN WORKMAP

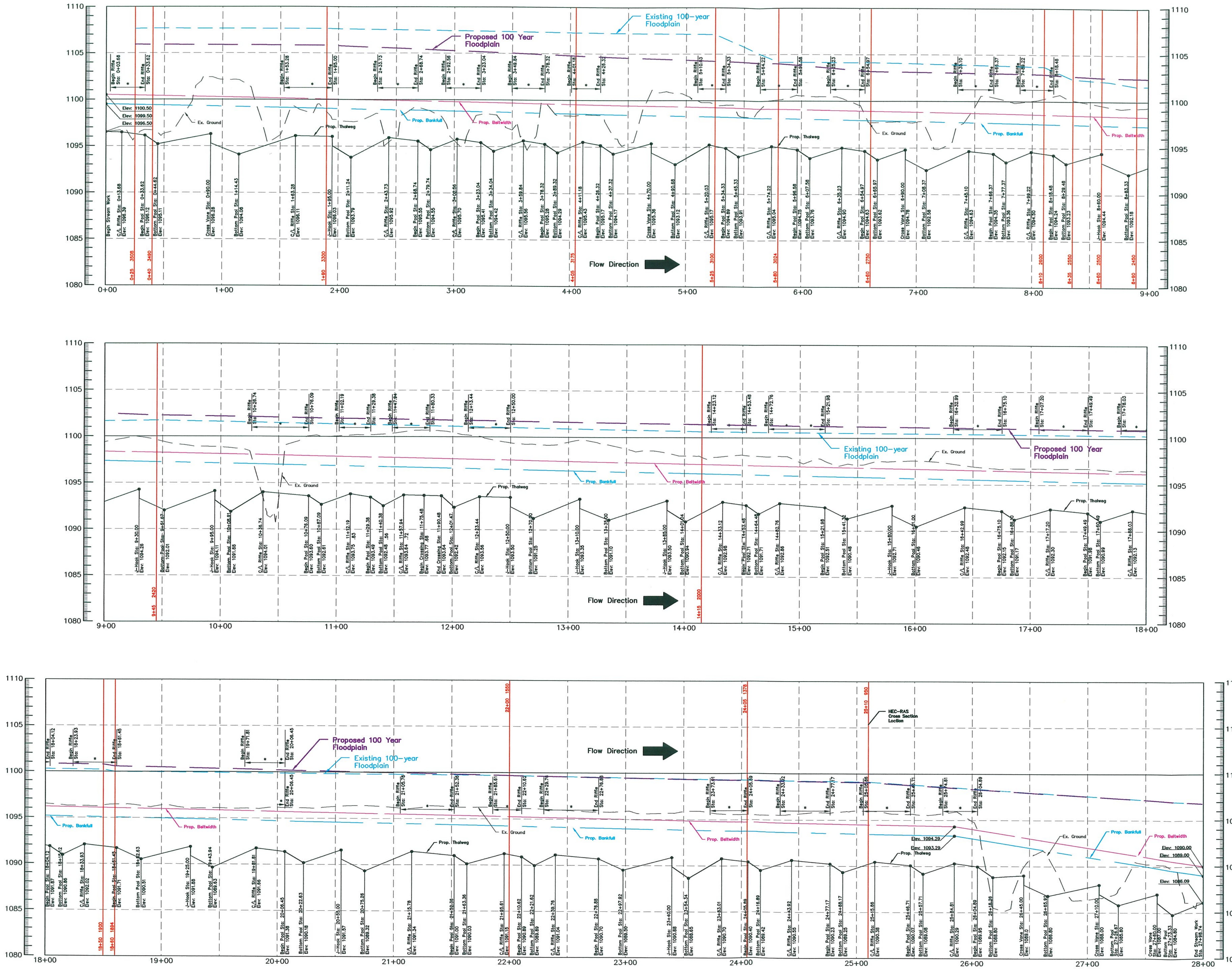
FOR

THOMPSONS FORK CREEK AND UNNAMED TRIBUTARY

EXHIBIT NO. 1

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800
M C M X X V I

Date:	March, 2007
Scale:	1" = 100'
Job No:	2006-1398
Sheet:	1 of 1



40 0 40
20
SCALE: 1" – 40'

MCDOWELL COUNTY, NORTH CAROLINA
FLOODPLAIN WORKMAP
FOR

THOMPSONS FORK CREEK AND UNNAMED TRIBUTARY

EXHIBIT NO. 1A

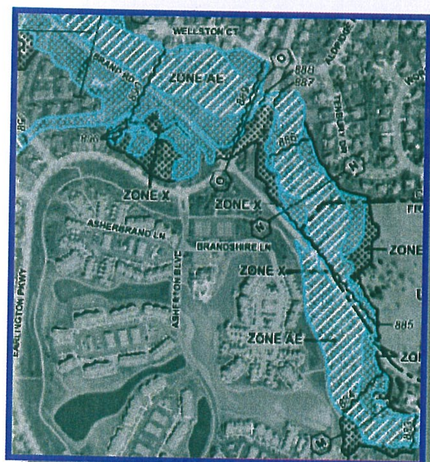
EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800

Date:	March, 2007
Scale:	Hor: 1" = 40' Ver: 1" = 5'
Job No:	2006-1398
Sheet:	1 of 1

Appendix C
Excerpts from Restoration Plan

Appendix D
Application/Certification Forms

EMH&T



Conditional Letter of Map Revision

Prepared For:
Wetland Resource Center

Project:
Thompsons Fork Creek
Stream Restoration
McDowell County, North Carolina

April 2007

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires: August 31, 2007

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☒ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☐ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See Parts 60 & 65 of the NFIP Regulations.)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Ex: 480301 480287	City of Katy Harris County	TX TX	480301 48201C	0005D 0220G	02/08/83 09/28/90
148	McDowell County Unincorporated Areas	NC	37111C	0125B	07/15/88

2. Flooding Source: Thompsons Fork
3. Project Name/Identifier: Thompsons Fork Restoration
4. FEMA zone designations affected: A (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)
5. Basis for Request and Type of Revision:

a. The basis for this revision request is (check all that apply)

☒ Physical Change ☐ Improved Methodology/Data

☐ Regulatory Floodway Revision ☐ Other (Attach Description)

Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following types of flooding and structures (check all that apply)

Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)

☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

Structures: ☐ Channelization ☐ Levee/Floodwall ☐ Bridge/Culvert

☐ Dam ☐ Fill ☐ Other, Attach Description

C. REVIEW FEE

Has the review fee for the appropriate request category been included?	☒ Yes ☐ No, Attach Explanation	Fee amount: $4400

Please see the DHS-FEMA Web site at http://www.fema.gov/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Cal Miller	Company: Wetlands Resource Center	
Mailing Address: 3970 Bowen Rd Canal Winchester Ohio 43110	Daytime Telephone No.: 614 864 7511	Fax No.: 614 866 3691
	E-Mail Address: WetlandsResource@AOL.com	
Signature of Requester (required): [signature]		Date: 4/3/07

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title:		Telephone No.:
Community Name:	Community Official's Signature (required):	Date:

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Joshua A. Reinicke	License No.: Ohio E-67483	Expiration Date: 12/31/07
Company Name: EMH&T	Telephone No.: (614)775-4215	Fax No.: (614)775-4802
Signature: Joshua A. Reinicke		Date: 4/3/07

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	**Required if ...**
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☐ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

STATE OF OHIO
JOSHUA A. REINICKE
E-67483
REGISTERED PROFESSIONAL ENGINEER

Seal (Optional)

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires: August 31, 2007

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3.25 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: Thompsons Fork
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☒ Not revised (skip to section 2) ☐ No existing analysis ☐ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	FIS (cfs)	Revised (cfs)

Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☐ Precipitation/Runoff Model [TR-20, HEC-1, HEC-HMS etc.]
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis. The document, "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by DHS-FEMA. This document can be found at: http://www.fema.gov/fhm/en_modl.shtm.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☐ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Proposed/Revised
Downstream Limit	Interstate 40	729.076	1096.72	1096.72
Upstream Limit	Approx. 2700' U/S I-40	3508.824	1107.99	1105.91

ydraulic Method Used

Hydraulic Analysis HEC-RAS [HEC-2 , HEC-RAS, Other (Attach description)]

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. These tools do not replace engineering judgment. CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. If you disagree with a message, please attach an explanation of why the message is not valid in this case. Review of your submittal and resolution of valid modeling discrepancies will result in reduced review time.

HEC-2/HEC-RAS models reviewed with CHECK-2/CHECK-RAS? ☒ Yes ☐ No

4. Models Submitted ☒ Diskette Submitted

Models Submitted	Natural Run		Floodway Run		Datum
	File Name	Plan Name	File Name	Plan Name	
Duplicate Effective Model*	ThompsonsFork	ThompsonsFork LDS			1988
Corrected Effective Model*	FEMAfieldcombined	ThompsonsFork LDS			1988
Existing or Pre-Project Conditions Model					
Revised or Post-Project Conditions Model	FEMAfieldcombined	proposed			1988
Other - (attach description)					

*Not required for revisions to approximate 1%-annual-chance floodplains (Zone A) – for details, refer to the corresponding section of the instructions.

The document "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by DHS-FEMA. This document can be found at: http://www.fema.gov/fhm/en_modl.shtm.

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

☒ Annotated FIRM and/or FBFM Included ☐ Digital Mapping (GIS/CADD) Data Submitted (Recommended)

D. COMMON REGULATORY REQUIREMENTS*

1. For CLOMR requests, do Base Flood Elevations (BFEs) increase? ☒ Yes ☐ No

   For CLOMR requests, if either of the following is true, please submit evidence of compliance with Section 65.12 of the NFIP regulations:
   - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
   - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR/CLOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

   If Yes, attach evidence of regulatory floodway revision notification. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR/CLOMR requests, does this request have the potential to impact an endangered species? ☐ Yes ☐ No

   If Yes, please submit documentation from the community to show that they have complied with Sections 9 and 10 of the Endangered Species Act (ESA). Section 9 of the ESA prohibits anyone from "taking" or harming an endangered species. If an action might harm an endangered species, a permit is required from U.S. Fish and Wildlife Service or National Marine Fisheries Service under Section 10 of the ESA.

   For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA.

5. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☐ No

   If Yes, please attach proof of property owner notification and acceptance (if available). Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

APPLICATION FOR PERMIT TO DEVELOP IN A FLOOD HAZARD AREA

The undersigned hereby makes application for a permit to develop in a designated flood hazard area. The work to be performed is described below and in attachments hereto. The undersigned agrees that all such work shall be done in accordance with the requirements of the Flood Damage Prevention Ordinance. McDowell County (Community) and with all other applicable local, state and federal regulations necessary required permits/certifications are attached.

Owner's Name: Mr. Cal Miller, Managing Partner, Wetlands Resource Center

Builders's Name: Mr. Bob Koone, President, South Mountain Forestry

Address: 3970 Bowen Road Canal Winchester, Ohio 43110

Address: 6924 Roper Hollow Road Morgantown, NC 28655

Telephone: (614)864-7511

Telephone: (828)432-7729

A. Description of Work (Check appropriate item. Note: All references are in mean sea level):

1. Proposed Development Description:

____ New Construction X Grading
____ Alteration or Repair ____ Dredging
____ Filling ________ Manufactured Home

2. Size and location of proposed development:
Stream Relocation and Restoration

3. Type of Construction
____ New Residential
____ New Non-Residential
____ Addition
____ Improvement to existing structure
____ Accessory Structure
____ Temporary Structure

4. Is the proposed development in an identified floodway? ______ Yes X No

5. If Yes, has a No-Rise Certification been obtained and attached? ______ Yes ______ No

B. Alterations, addition or improvements to an existing structure.

1. What is the estimated market value of the existing structure $________

2. What is the cost of the proposed construction? $________________

3. If the cost of the preposed cnstruction equals or exceeds 50% of the market value of the structure then the substantial improvement requirements apply.

C. Non-Residential Construction

1. Type of flood protection method?

______ Floodproofing ____ Elevation

2. If the structure is floodproofed the required floodproofing elevation is ________ fr. m.s.l.

6. As identified on the (FIRM, FHBM, etc,) what is the zone and panel number in the area of the proposed development?
Zone A, Number 37111C, Panel 0125B, Dated July 15, 1988

7. Base flood elevation at site?_______ feet m.s.l.

8. Required Lowest Floor Elevation (including basement)? ______ ft. m.s.l. developer?

9. Elevation to which all attendant utilities, including all heating and electrical equipments will be installed of floodproofed _______ ft. m.s.l.

10. Will proposed development require alteration of any water course? __X__ Yes _____ No

D. Subdivision

1. Does this subdivision or other development contain 50 lots or 5 acres (which ever is less).
Yes______ No________

2. If yes, has flood elevation date been provided by the

Yes_______ No________

ADMINISTRATIVE

1. Proposed development (Check One)
   ___ a. Must comply with all applicable flood damage prevention standards.
   ___ b. Is exempt from flood damage prevention standards. Attached explanation.

2. Filing Fee $________ Paid:__________________, 20______.

3. Permit issued:_____________, ______________.

4 Work inspected by: __________________________Date: _______________________

5. Certificate of compliance for as-built construction issued: Date____________________

6. As-Built Elevation of lowest floor?______ ft. m.s.l. (Elevation Certificate attached?)

7. As-Built floodproofing elevation? _____________ft. m.s.l (Floodproofing Certificate Attached?)

8. Permit Denied______________________________ Date______________________

   Reasons:

   ____

   ____

   ____

9. Appeals
   a. Appealed on: _____________________________Date __________________________

   b. Appeal heard on:___________________________Date__________________________

   c. Decisions of the Board

   ____

   ____

   ____

Applicant's Signature [signature]__________________ Date 3/30/07________

Local Administrator's Signature______________________________Date__________

APPLICATION FOR PERMIT TO DEVELOP IN A FLOOD HAZARD AREA

The undersigned hereby makes application for a permit to develop in a designated flood hazard area. The work to be performed is described below and in attachments hereto. The undersigned agrees that all such work shall be done in accordance with the requirements of the Flood Damage Prevention Ordinance. McDOWELL COUNTY (Community) and with all other applicable local, state and federal regulations necessary required permits/certifications are attached.

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Builders's Name: Mr. Bob Koone, President, South Mountain Forestry

Address: 3970 Bowen Road, Canal Winchester, OH 43110

Address: 6624 Roper Hollow Road, Morganton, NC 28655

Telephone: (614) 864 - 7511

Telephone: (828) 432-7729

A. Description of Work (Check appropriate item. Note: All references are in mean sea level):

1. Proposed Development Description:

____ New Construction __X__ Grading
____ Alteration or Repair ____ Dredging
____ Filling ________ Manufactured Home

2. Size and location of proposed development:
STREAM RELOCATION AND RESTORATION

3. Type of Construction
____ New Residential
____ New Non-Residential
____ Addition
____ Improvement to existing structure
____ Accessory Structure
____ Temporary Structure

4. Is the proposed development in an identified floodway? ______ Yes __X__ No

5. If Yes, has a No-Rise Certification been obtained and attached? ______ Yes ______ No

B. Alterations, addition or improvements to an existing structure.

1. What is the estimated market value of the existing structure $________

2. What is the cost of the proposed construction? $________________

3. If the cost of the preposed cnstruction equals or exceeds 50% of the market value of the structure then the substantial improvement requirements apply.

C. Non-Residential Construction

1. Type of flood protection method?

______ Floodproofing ____ Elevation

2. If the structure is floodproofed the required floodproofing elevation is ________ fr. m.s.l.

6. As identified on the (FIRM, FHBM, etc,) what is the zone and panel number in the area of the proposed development?
ZONE A, Number 37111C, PANEL 0125B, dated July 15, 1988

7. Base flood elevation at site? — feet m.s.l.

8. Required Lowest Floor Elevation (including basement)? — ft. m.s.l. developer?

9. Elevation to which all attendant utilities, including all heating and electrical equipments will be installed of floodproofed _______ ft. m.s.l.

10. Will proposed development require alteration of any water course? X Yes _____ No

D. Subdivision

1. Does this subdivision or other development contain 50 lots or 5 acres (which ever is less).
Yes______ No________

2. If yes, has flood elevation date been provided by the

Yes_______ No________

ADMINISTRATIVE

1. Proposed development (Check One)
   ___ a. Must comply with all applicable flood damage prevention standards.
   ___ b. Is exempt from flood damage prevention standards. Attached explanation.

2. Filing Fee $________ Paid:__________________, 20______.

3. Permit issued:_____________, ______________.

4 Work inspected by: __________________________ Date: ______________________

5. Certificate of compliance for as-built construction issued: Date____________________

6. As-Built Elevation of lowest floor?______ ft. m.s.l. (Elevation Certificate attached?)

7. As-Built floodproofing elevation? _____________ft. m.s.l (Floodproofing Certificate Attached?)

8. Permit Denied_______________________________ Date______________________

   Reasons:

   ____

   ____

   ____

9. Appeals
   a. Appealed on: _____________________________ Date __________________________

   b. Appeal heard on:___________________________ Date__________________________

   c. Decisions of the Board

   ____

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   ____

Applicant's
Signature_____________________________________ Date____________________

Local Administrator's Signature______________________________ Date__________

APPLICATION FOR PERMIT TO DEVELOP IN A FLOOD HAZARD AREA

The undersigned hereby makes application for a permit to develop in a designated flood hazard area. The work to be performed is described below and in attachments hereto. The undersigned agrees that all such work shall be done in accordance with the requirements of the Flood Damage Prevention Ordinance.____________________________ (Community) and with all other applicable local, state and federal regulations necessary required permits/certifications are attached.

Owner's Name:____________________________ Builders's Name:____________________

Address:____________________________________ Address:__________________________

Telephone:__________________________________ Telephone:________________________

A. Description of Work (Check appropriate item. Note: All references are in mean sea level):

1. Proposed Development Description:

____ New Construction ____Grading

____ Alteration or Repair ____Dredging

____ Filling _________Manufactured Home

2. Size and location of proposed development:

____

____

____

3. Type of Construction

____New Residential

____ New Non-Residential

____Addition

____Improvement to existing structure

____Accessory Structure

____Temporary Structure

4. Is the proposed development in an identified floodway? ______Yes ______ No

5. If Yes, has a No-Rise Certification been obtained and attached? ______Yes ______No

☐ B. Alterations, addition or improvements to an existing structure.

1. What is the estimated market value of the existing structure $________

2. What is the cost of the proposed construction? $________________

3. If the cost of the preposed cnstruction equals or exceeds 50% of the market value of the structure then the substantial improvement requirements apply.

C. Non-Residential Construction

1. Type of flood protection method?

______Floodproofing ____Elevation

2. If the structure is floodproofed the required floodproofing elevation is ________fr. m.s.l.

6. As identified on the (FIRM, FHBM, etc,) what is the zone and panel number in the area of the proposed development?

7. Base flood elevation at site?_______ feet m.s.l.

8.Required Lowest Floor Elevation (including basement)? ______ ft. m.s.l. developer?

9.Elevation to which all attendant utilities, including all heating and electrical equipments will be installed of floodproofed _______ ft. m.s.l.

10.Will proposed development require alteration of any water course? ____Yes _____No

D. Subdivision

1.Does this subdivision or other development contain 50 lots or 5 acres (which ever is less).
Yes______No________

2. If yes, has flood elevation date been provided by the

Yes_______ No________

ADMINISTRATIVE

1. Proposed development (Check One)
   ___ a. Must comply with all applicable flood damage prevention standards.
   ___ b. Is exempt from flood damage prevention standards. Attached explanation.

2. Filing Fee $________ Paid:__________________, 20______.

3. Permit issued:_____________, ______________.

4 Work inspected by: __________________________Date: _______________________

5. Certificate of compliance for as-built construction issued: Date____________________

6. As-Built Elevation of lowest floor?______ ft. m.s.l. (Elevation Certificate attached?)

7. As-Built floodproofing elevation? _____________ft. m.s.l (Floodproofing Certificate Attached?)

8. Permit Denied_______________________________ Date______________________

   Reasons:

   ____

   ____

   ____

9. Appeals
   a. Appealed on: _____________________________Date__________________________

   b. Appeal heard on:___________________________Date__________________________

   c. Decisions of the Board

   ____

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   ____

Applicant's
Signature____________________________________Date____________________

Local Administrator's Signature______________________________Date__________