Snowbird Creek Tributaries Restoration Plan
Graham County, North Carolina
EEP No. 000613

November 13, 2009

Final

Prepared For

NCDENR-EEP
1652 Mail Service Center
Raleigh, North Carolina 27699-1652
Phone: 919-715-0476
Fax: 919-715-2219

This document was printed using 100% recycled paper.

Snowbird Creek Tributaries Restoration Plan (Draft)
Graham County, North Carolina

Report Prepared and Submitted by Michael Baker Engineering, Inc.

Baker

Michael Baker Engineering, Inc.
797 Haywood Road
Suite 201
Asheville, North Carolina 28806
Phone: 828.350.1408
Fax: 828.350.1409

Jake McLean, PE
Project Manager

Micky Clemmons
Office Principal

EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) proposes to restore, enhance, and preserve nearly 8,134 linear feet (LF) of stream on three distinct unnamed tributaries (UTs) to Snowbird Creek. The project site is located in Graham County, approximately one and a half miles southwest of Robbinsville. Members of the Griffin family currently occupy the site and have held ownership of the property for many years. With the exception of the restoration reach on UT3, the project area is overwhelmingly forested. Two reaches have been identified for restoration and enhancement, however, the majority of the acquired easement will be conserved to preserve the near-complete natural recovery of the systems from prior logging impacts. These valleys are narrow and steep; any development will have to occur high in these watersheds and the terrain will be a limiting factor for feasible density.

The three unnamed tributaries that comprise the project area are first and second order high gradient, colluvial systems with occasional bedrock outcroppings. The tributaries lie in Type II valleys and do not converge within the easement boundaries. These tributaries are headwater systems located within the larger Little Tennessee River Basin within North Carolina Division of Water Quality (NCDWQ) sub-basin 04-04-04 and USGS hydrologic unit 06010204020010. In-stream habitat is primarily composed of woody debris and a gravel/cobble substrate.

Debris from prior logging in portions of Reach 2 of UT2 has created minor instability issues; logging is also responsible for the invasive species present. On Reach 2 of UT3, channelization and vegetation removal have had noticeable impacts. UT3 has been moved from the low part of the valley to its present location, where it is perched against the valley wall. The narrowing of the channel by construction of a berm to constrain it against the valley wall has had a destabilizing effect. The physical symptoms of instability are incision, eroding banks, widened and degraded channel segments, and a fining of the stream substrate. These physical impacts are affecting stream habitat and stream functions. Also of concern is the presence of invasive species in these reaches and habitat impacts include loss of stream shading.

These reaches will be treated with the appropriate level of site work to restore functions that have been compromised. In UT2, this will consist of hand work with chainsaws and other hand tools to remove debris from the channel. Some planting and invasive species treatment will be coupled with this effort on a total length of 171 LF of UT 2. UT3 will undergo channel restoration on the 466-foot long Reach 2. This reach of UT3 will also be planted with native riparian species within the entire conservation easement.

The remaining reaches will all be preserved (7,497 LF). Despite prior impacts, these areas have largely recovered. The remaining evidence of local instability is not of system-wide concern and mostly reflects local perturbations that are consistent with natural impacts found in reference streams. Any minor improvements that could be made would not be justified given the level of disturbance that would be created to access these steep and densely wooded areas.

The goals (italicized) and means for accomplishing the same for this restoration project are as follows:

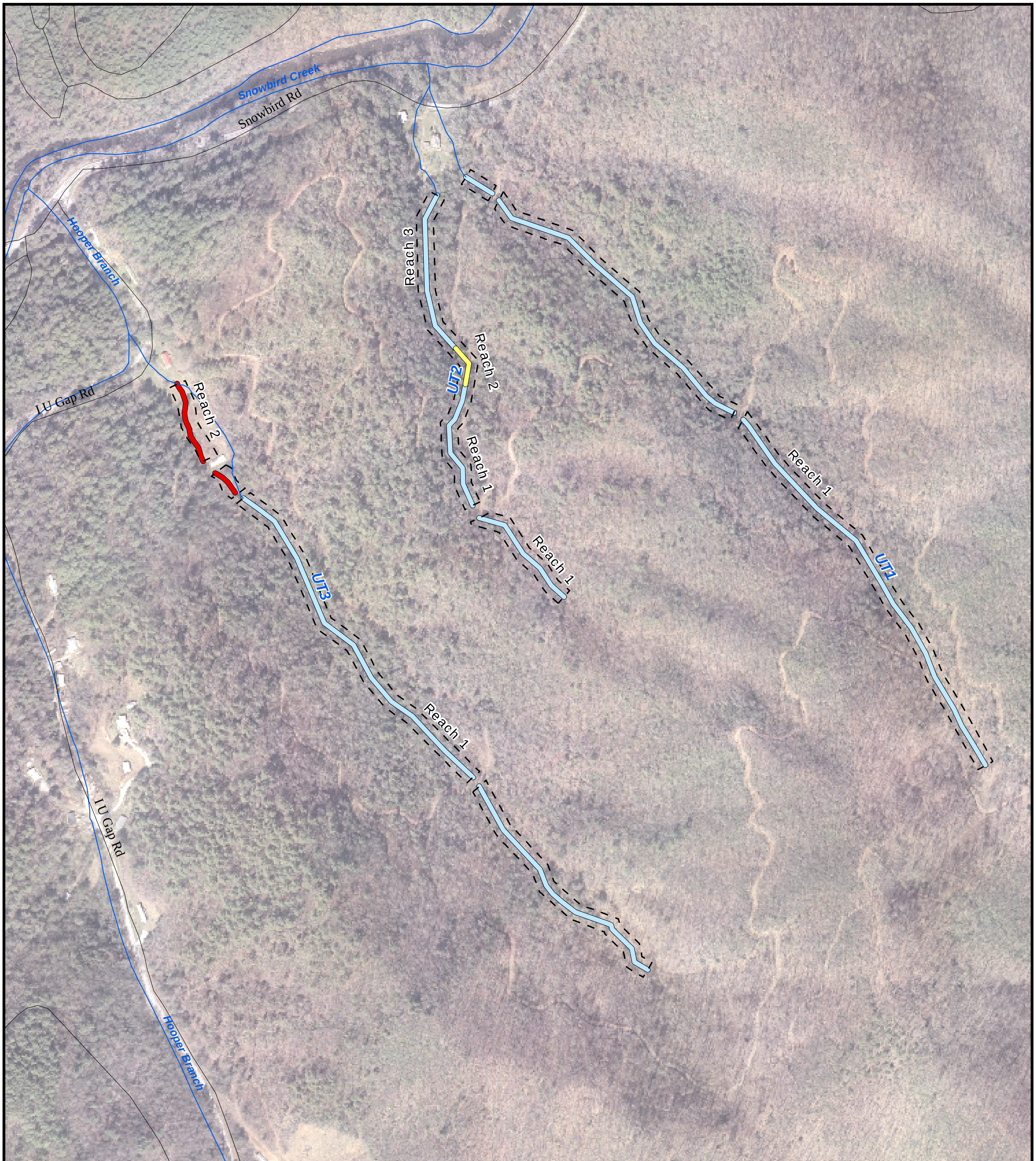
- *Promote and recreate geomorphically stable conditions*: Restoration and enhancement activities on UT3 (Reach 2) and UT2 (Reach 2), respectively, will restore a stable dimension, pattern, and profile to these reaches. The primary physical modifications are restoring a step-pool morphology to UT3 while relocating it to the low point in the valley, and removal of logging debris from UT2. The vegetation enhancement activities will complement these efforts to restore physical stability. Preserved reaches are near full recovery from prior logging impacts - the designation of a permanent buffer on these reaches will prevent future disturbance and allow for a permanent natural stream corridor with all of the benefits that a buffer provides.

- *Reduce sediment and nutrient inputs, decrease fine sediment loading:* Establish and preserve native stream bank and floodplain vegetation to increase storm water runoff filtering capacity, improve bank stability by creating appropriate dimensions to halt bank erosion and promote natural transport processes and through planting of the banks with woody vegetation.
- *Improve aquatic and terrestrial habitat:* Existing high quality coldwater habitat will be protected and degraded habitat will be improved with physical restoration or enhancement, water temperature, dissolved oxygen, and physical habitat will be positively impacted by improving streamside vegetative cover, and wildlife habitat will be protected through the development of conservation easements and enhanced through the removal of invasive species and planting of natives.

Table ES.1 Snowbird Creek Tributaries - Project Overview
Snowbird Creek Tributaries Restoration Plan- Project #000613

Project Feature	Existing Condition (Linear Feet or Acres)	Design Condition (Linear Feet or Acres)	Approach
UT1	3,213 LF	3,213 LF	Preservation
UT2 Reach 1	1,033 LF	1,033 LF	Preservation
UT2 Reach 2	171 LF	171 LF	Enhancement
UT2 Reach 3	675 LF	675 LF	Preservation
UT3 Reach 1	2,576 LF	2,576 LF	Preservation
UT3 Reach 2	543 LF	466 LF	Restoration

The work will include 7,497 LF of stream preservation, 171 LF of stream enhancement level II, and 466 LF of stream restoration. This approach should yield 2,033 stream mitigation units (SMUs), which is greater than the proposed amount (1,938 SMU) for contract under this proposal. The additional credits developed from the site will be available to the NCEEP as part of the proposed project. The proposed total for stream mitigation is presented in Table 1.1 and the components are mapped in Figure ES.1.



LEGEND:

Proposed Project Components
Preservation
Enhancement II
Restoration (Priority 1)

Proposed Easement Boundary
Streams

0 200 400 800 Feet

Figure ES.1 Project Components and Structure Map

Snowbird Creek Tributaries Project
Graham County, NC

TABLE OF CONTENTS

LIST OF TABLES

List of Figures

List of Appendices

1.0 PROJECT SITE IDENTIFICATION AND LOCATION

1.1 Project Description and Directions to Project Site

Baker proposes to restore, enhance, and preserve a combined total of 8,134 linear feet (LF) of stream on three unnamed tributaries (UTs) to Snowbird Creek in Graham County, North Carolina. The area to be preserved within the conservation easement totals 13.1 acres. The project component attributes are summarized in Table 1.1. Project reach UT1 flows northwest from its source to approximately 3,213 LF downstream, just above the Griffin residence on Snowbird Road. UT2 also flows northwest from its source and continues downstream approximately 1,879 LF to the Griffin residence. Downstream of the project site, both UT1 and UT2 cross under NC Highway 143 and converge before entering Snowbird Creek. The project reach on UT3 begins approximately 3,300 LF upstream of its confluence with Hooper Branch and ends about 200 LF short of this confluence. The excluded 200 LF reach flows through a residential yard. Hooper Branch then empties into Snowbird Creek less than a half mile below the project reach. Each site is accessible from private driveways off of Highway 143 (Snowbird Road) and IU Gap Road south of Robbinsville.

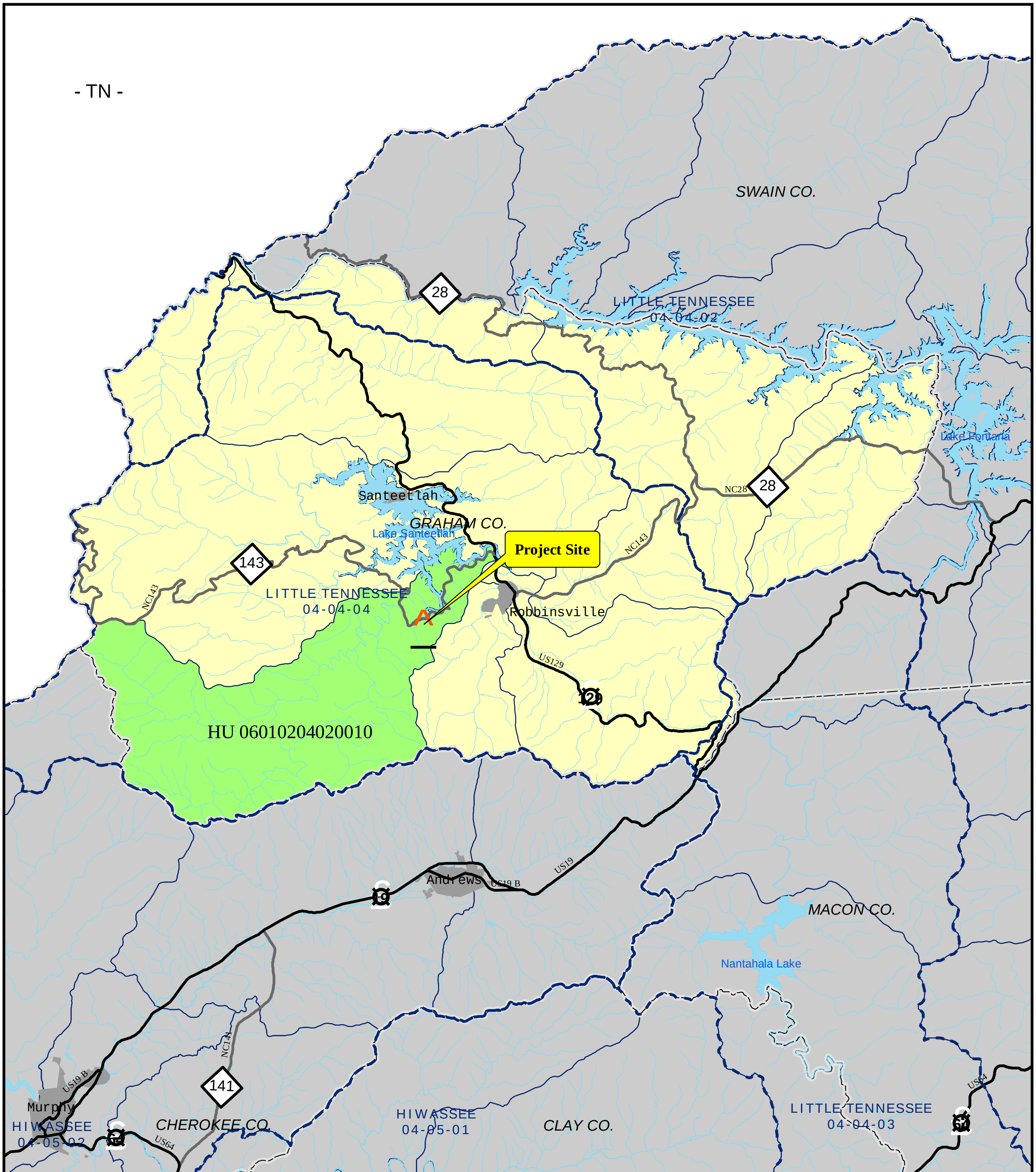
With the exception of short reaches on UT2 and UT3, land cover on the Griffin property is overwhelmingly forested. UT2 has been impacted by prior logging and UT3 has been channelized and moved out of the low point of the valley for a short reach; it is presently situated adjacent to a small mowed field. The riparian buffers in the vicinity of the mowed and logged reaches are impaired and invasive plant species are present. The most recent timber harvesting has occurred within the last 15 years. Much of the property shows evidence of selective harvesting activities within the last 50 years, but land cover on most reaches has returned to a natural state.

The Snowbird Creek Tributaries enhancement site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina, as shown on the Project Location Map (Figure 1.1). To reach the project site from the intersection of NC Highways 143 and 129, turn south onto N.C. Highway 129. At the first stop light past the Microtel, turn right onto East Main Street, continue for approximately 0.3 miles, and turn left onto Atoah Street. Atoah Street becomes Snowbird Road (both are NC Highway 143). Snowbird Road (NC 143) will come to parallel Santeetlah Reservoir (an inundated portion of Snowbird Creek). At the intersection of IU Gap Road and Snowbird Road, the property will be situated to the east. The last house on the left before you get to this intersection is the property owner and just before you get to this house there is a dirt road that leads to UT1 and UT2. To get to UT3, turn left on IU Gap Rd, as the road bends to the right, the UT3 property is on the left and the access drive is on the left just past a small rented farm house.

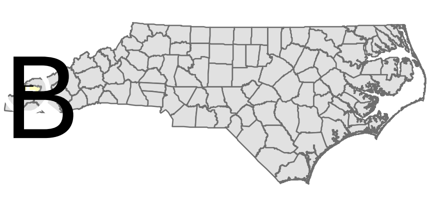
1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

The Snowbird Creek watershed lies in the Little Tennessee River Basin, within North Carolina Division of Water Quality (NCDWQ) sub-basin 04-04-04 and USGS local watershed unit 06010204020010.

The three unnamed tributaries to Snowbird Creek in this project area are identified as “blue-line” streams, on the USGS topographic quadrangle (Robbinsville) for the site. After referencing USGS topographic quadrangle map to determine stream order, a field evaluation using the North Carolina Division of Water Quality (NCDWQ) stream assessment protocol was conducted. Field observations noted on the NCDWQ Stream Identification Forms confirm that each of the project tributaries is perennial within the project area. NCDWQ Stream Identification Forms for the project area are provided in Appendix A. The total current length of stream within the project is 8,211LF.



Map Inset



LEGEND:
- NCDWQ Sub-basin
- Counties
- USGS Hydrologic Unit
- Project Hydrologic Unit
- Graham County

0 1 2 4 Miles

Figure 1.1 Project Location Map

Snowbird Creek Tributaries Project
Graham County, NC

Ecosystem Enhancement PROGRAM

Baker

1.3 Project Components and Structure

Distinct project reaches are summarized in Table 1.0 below and are depicted in the Project Components figure in the Executive Summary (ES.1). A table (1.1.) summarizing project component attributes is also provided.

Table 1.0 Snowbird Creek Tributaries Project Components
Snowbird Creek Tributaries Restoration Plan- Project #000613

Project Component or Reach ID	**Existing Feet (LF)**	**Restoration Level**	**Approach**	**Proposed Feet**	**Proposed Stationing (LF)**	**Buffer Acres**	**Comment**
UT1	3,213	-	P	3,213	0+00 to 32+13	4.43	643 SMU for Preservation
UT2 Reach 1	1,033	-	P	1,033	0+00 to 10+33	1.42	229 SMU for Preservation
UT2 Reach 2	171	II	E	171	0+00 to 1+71	0.23	68 SMU for Enhancement
UT2 Reach 3	675	-	P	675	0+00 to 6+75	0.93	112 SMU for Preservation
UT3Reach 1	2,576	-	P	2,576	0+00 to 25+76	3.55	515 SMU for Preservation
UT3 Reach 2	543	-	R	466	0+00 to 5+31	0.64	466 SMU for Restoration

Component Summations

Restoration Level	Stream (LF)	Buffer (Ac)	SMU	Ratios
Restoration	466	.64	466	1:1
Enhancement I	0	0	0	1:1.5
Enhancement II	171	.23	68	1:2.5
Preservation	7,497	10.33	1,499	1:5
Totals	**8,134**	**11.2**	2,033	

Table 1.1 Project Attribute Table Snowbird Creek Tributaries Restoration Plan- Project #000613						
Project County	Graham					
Physiographic Region	Blue Ridge					
Ecoregion	Blue Ridge Mountains-Metasedimentary Mountains					
Project River Basin	Little Tennessee River					
USGS HUC for Project	06010204020010					
NCDWQ Sub-basin for Project	04-04-04					
Planning Area	No targeted or local watershed plans currently available					
WRC Class	Cold					
% of Project Easement Fenced or Demarcated	0%					
Beaver Activity Observed During Design Phase	No					
Restoration, Enhancement and Preservation Component Attribute Table (continued)						
	UT1	UT2			UT3	
	Reach 1	Reach 1	Reach 2	Reach 3	Reach 1	Reach 2
Drainage Area	.13	.05	.06	.08	.15	.18
Stream Order	1st	1st	1st	1st	1st	1st
Restored Length (feet)	3,213	1,033	171	675	2,576	466
Perennial or Intermittent	P	P	P	P	P	P
Watershed Type	Rural					
Watershed LULC Distribution* (Cumulative acreage)						
Developed Open Space	< 1%					
Deciduous Forest	80.15%					
Evergreen Forest	8.68%					
Mixed Forest	11.16%					
Watershed Impervious Cover (%)	<25%					
NCDWQ AU/Index Number	2-190-9(15.5)					
NCDWQ Classification	C; Tr	C; Tr	-	-	-	-
303d Listed	No	No	No	No	No	No
Upstream of 303d Listed Segment	No	No	No	No	No	No
Reasons for 303d Listing or Stressor	N/A	N/A	N/A	N/A	N/A	N/A
Total Acreage of Easement (Cumulative)	13.1					
Total Vegetated Acreage Within the Easement	~4.43	~1.42	~.23	~0.93	~3.55	~0.64
Total Planted Acreage As Part of the Restoration	.86 Acres					
Rosgen Classification of Pre-existing	B3					
Rosgen Classification of As-built (Design)	B3					

Valley Type	II	II	II	II	II	II
Valley Slope	.094					
Valley Side Slope Range	U	U	U	U	U	U
Valley Toe Slope Range	U	U	U	U	U	U
Cowardin Classification	N/A	N/A	N/A	N/A	N/A	N/A
Trout Waters Designation	Snowbird Creek is classified as "Trout Waters". The tributaries within the project area do not have a listed designation, but are most likely treated as "Trout Waters".					
Species of Concern, Endangered, etc.	No	No	No	No	No	No
Dominant Soil Series and Characteristics						
Series	ScF/ SvD	ScF/ SbE	ScF	ScF/ SvD	SvD/ SvC	ThB
Depth (inches)	80	80/>60	80	80	80	>60
Clay %	5-18/ 5-24	5-18	5-18	5-18/ 5-24	5-24	5-25
K	.10-.17/ .02-.10	.10-.17/ .10	.10-.17	.10-.17/ .02-.10	.02-.10/ .03-.10	.17-.24
T	2/3	5	5	5	5	5
Notes: USDA Soil Abbreviations are as follows: SvC and SvD (Spivey-Whiteoak Complex), ScF (Soco-Stecoah Complex), SbE (Snowbird Loam) and ThB (Thurmont-Dillard Complex).						

2.0 WATERSHED CHARACTERIZATION

2.1 Watershed Delineation and Project Area Measurement

The Snowbird Creek Tributaries project site is located in the Little Tennessee River Basin as illustrated in Figure 1.1. Watersheds for each of the three tributaries are delineated in Figure 2.1. The drainage areas for each of the tributaries are as follows: UT1- 83.2 acres (0.13 sq. mi.), UT2- 48.8 acres (0.076 sq. mi.), and UT3- 116.6 acres (0.18 sq. mi.). The total proposed easement area is 13.07 acres.

2.2 Surface Water Classification/ Water Quality

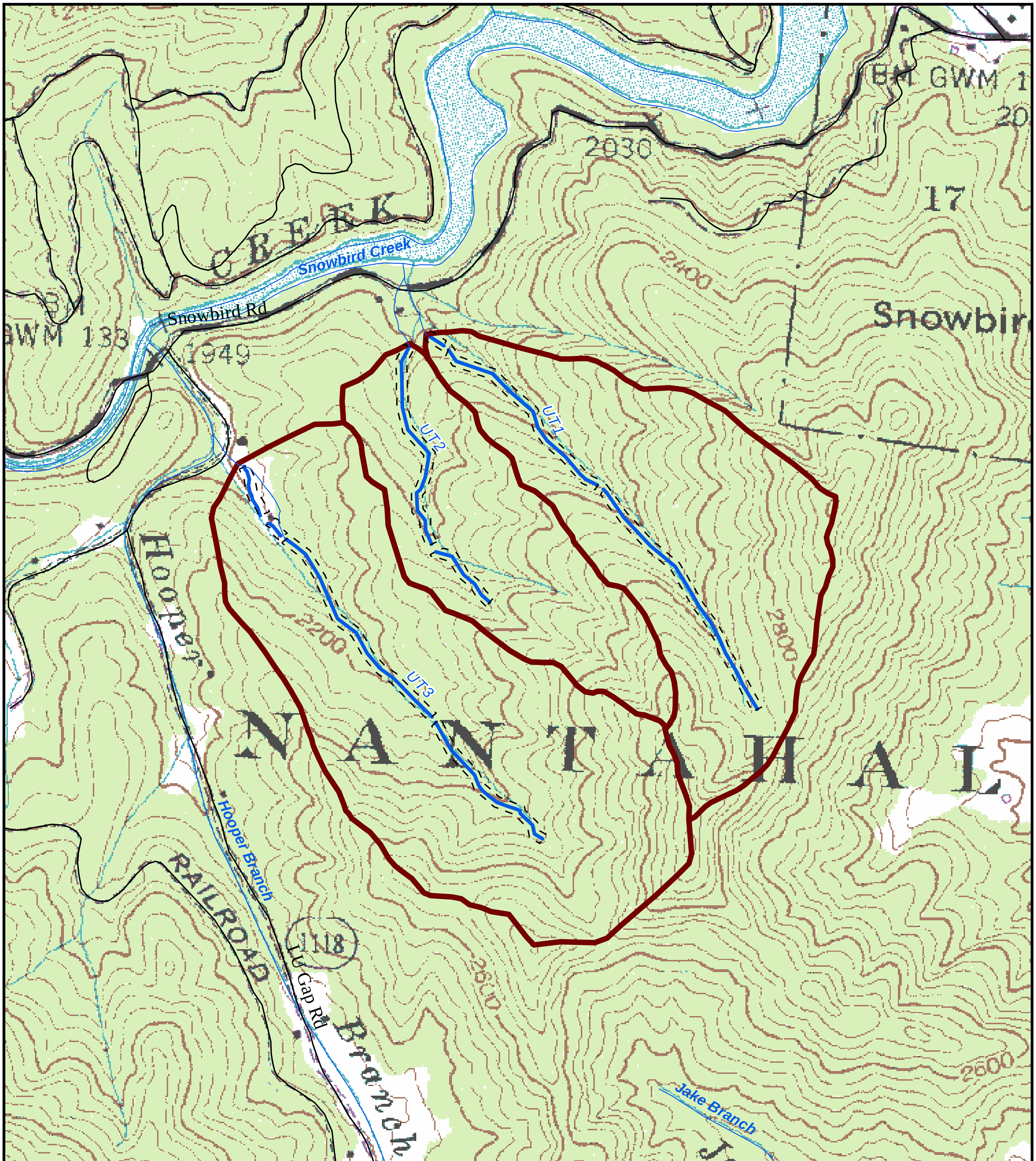
NCDWQ designates surface water classifications for water bodies such as streams, rivers, and lakes. Classifications define the best uses for these waters (e.g., swimming, fishing, and drinking water supply). These classifications are associated with a set of water quality standards to protect their uses. All surface waters in North Carolina must at least meet the standards for Class C (fishable/swimmable) waters. Other primary classifications provide additional levels of protection for primary water contact recreation (Class B) and drinking water supplies (WS). In addition to these primary classifications, supplemental classifications are sometimes assigned to water bodies to protect special uses or values. The project area encompasses three headwater tributaries to Snowbird Creek, a Class C water with a supplemental “Tr” classification. The “Tr” or “Trout Waters” supplemental classification is intended to protect freshwaters for natural trout propagation and survival of stocked trout. Restoring, enhancing and preserving streams with this high quality designation will provide improved habitat, including better passage for aquatic life as well as improved water quality of these important ecosystems, which supports the existing management designation.

2.3 Physiography, Geology and Soils

The project site lies within the Blue Ridge physiographic province of western North Carolina. According to the 1985 North Carolina Geological Survey Map and a 1° x 2° geologic map of the Knoxville Quadrangle prepared by the USGS (Hadley, and Nelson, 1971, Map I-654), the project site is underlain by an undivided, medium to thick bedded, largely feldspathic metasandstone with interbeds of quartz-mica schist or gray phyllite common to the Great Smoky Group of the Ocoee Supergroup. The origin of the Ocoee Supergroup is placed in the Late Proterozoic during continental rifting episodes (USGS Bulletin 1979). The metasedimentary rocks of the Great Smoky Group also include local beds of quartz-feldspar pebble conglomerate, graphitic and sulfidic mica schist, kyanite- or sillimanite bearing garnet-mica schist, and rare thin interbeds of garnet-hornblende-quartz-feldspar granofels.

This rock unit along with other rock types of the geographic area weather to form both fine and coarse grained loams within the Hapludults and Dystrudepts Great Groups. Soils described as the Soco-Stecoah complex are weathered from coarse grained metasandstone, slate and phyllite. Some soils within the Spivey-Whiteoak complex are formed from the weathering of slate, siltstone and phyllite. Additional soil characteristics of the site were determined using the Natural Resources Conservation Service (NRCS) Soil Survey data for Graham County, and site evaluation for hydric soils. A map depicting the boundaries of each soil type is presented in Figure 2.2. There are four general soil types found within the project boundaries. A discussion of each soil type and its locations given by the NRCS is presented in Table 2.1. Table 2.2 identifies characteristics of each soil series located on the project site and will be referenced in conjunction with the soils descriptions to select appropriate seeding mixes and other vegetative cover.

Soils found within the site are primarily mapped as the Spivey-Whiteoak complex, Soco-Stecoah Complex, and the Thurmont-Dillard Complex according to the NRCS Soil Survey for Graham County. The Spivey-Whiteoak complex is found in drainageways and on benches and toe slopes in the lower valley of the



LEGEND:

Project Reach

Proposed Easement Boundary

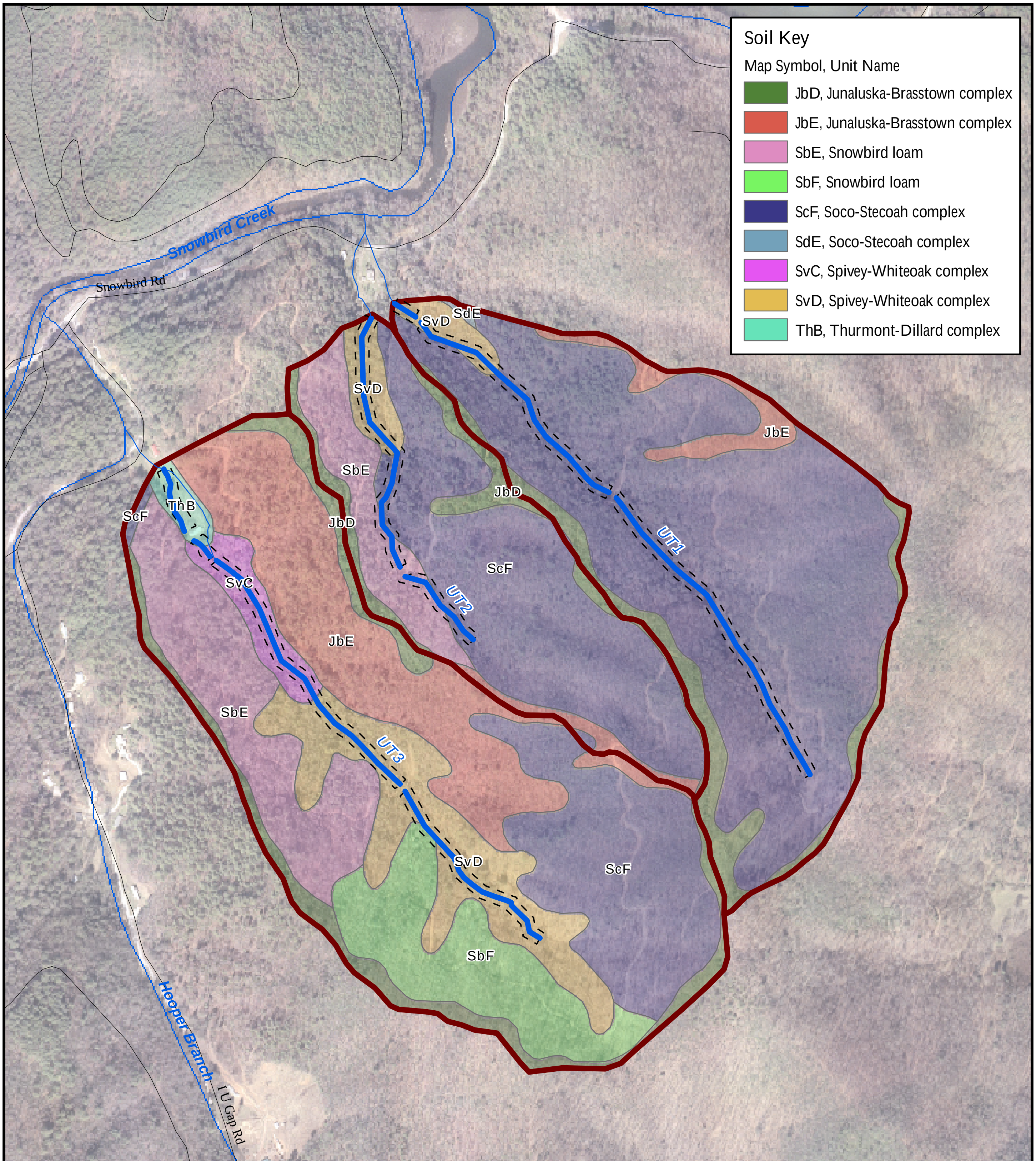
Streams

Watershed Boundary

0 200 400 800 Feet

Figure 2.1 USGS Topographic Map (Robbinsville Quadrangle)

Snowbird Creek Tributaries Project Graham County, NC



LEGEND:

- Project Reach
- Proposed Easement Boundary
- Streams
- Watershed Boundary

0 200 400 800 Feet

Figure 2.2 Project Soil Types

Snowbird Creek Tributaries Project
Graham County, NC

Ecosystem Enhancement Program

Baker

Snowbird Creek project site. The Soco-Stecoah complex extends from ridgelines and side slopes to toe slopes of the project area, and is especially dominant within the upper reaches of the project.

Thurmont-Dillard soils are located in the lower reach of UT3 and are generally moderately to well drained. However this soil complex is known to have hydric inclusions of Hemphill soils in a small (5%) percentage of land coverage. Bedrock was observed in a few isolated locations of the unnamed tributaries. In areas where shallow bedrock is encountered, the restoration plan will incorporate this bedrock as in-situ grade control.

Table 2.1 Project Soil Types and Descriptions
Snowbird Creek Tributaries Restoration Plan- Project #000613

Soil Name	Taxonomic Identification	Location	Description
Spivey-Whiteoak Complex, (SvC and SvD)	Loamy-skeletal, isotic, mesic, Humic Dystrudepts / Fine-loamy, isotic, mesic, Typic Dystrudepts	Drainageways, benches, fans and coves / toe slopes, benches, fans	The Spivey-Whiteoak complex consists of well drained, moderately rapid permeable soils on fans, coves and drainageways of mountain slopes in the Great Smoky Mountains. These soils formed in stony colluvium made up of phyllite, slate, metasandstone and/or other metasedimentary rock. Located on slopes ranging from 8-15% in project area. The Spivey-Whiteoak complex also extends to slopes on-site that range from 15-30%. These areas are labeled “SvD” on county soil resource maps.
Soco-Stecoah Complex (SvF)	Coarse-loamy, mixed, active, mesic, Typic Dystrudepts	Ridges, side slopes	The Soco-Stecoah complex consists of well drained soils and occurs on steep mountain slopes ranging from 50-95%. This soil type was formed in residuum, and is affected by soil creep in the upper solum. Parent rock includes weathered metasandstone and thinly bedded phyllite.
Thurmont-Dillard Complex (ThB)	Fine-loamy, mixed, semi-active, mesic Aquic Hapludults / Fine-loamy, mixed, active, mesic Oxyaquic Hapludults	Footslopes, colluvial fans, benches and stream terraces/ toeslopes, stream terraces	Thurmont soils formed from alluvium and/or colluvium on footslopes, colluvial fans, benches, and stream terraces, are well drained and have a moderate permeability. Dillard soils formed from alluvium on stream terraces, are well drained and have a moderately slow permeability. This complex is located in the project area on slopes ranging from 2-8%.
Snowbird Fine Sandy Loam (SbE)	Fine-loamy, mixed, active, mesic Humic Hapludults	Cool, north/ east facing mountain slopes	The Snowbird soil series consists of well drained, moderately permeable soils. Like the Soco-Stecoah complex, this soil was formed in residuum from metasedimentary rocks and is affected by soil creep in the upper solum.

Note: USDA, NRCS. Official Soil Series Descriptions. (http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi)
USDA, NRCS Soil Data Mart database. (http://soildatamart.nrcs.usda.gov)

Table 2.2 Project Soil Type Characteristics Snowbird Creek Tributaries Restoration Plan- Project #000613					
Series	**Max Depth (in)**	**% Clay on Surface**	**Erosion Factor K**	**Erosion Factor T**	**OM %**
Spivey-Whiteoak Complex (SvC)	80”	5-20 / 15-24	.03 / .10	5	5-15 / 3-10
Spivey-Whiteoak Complex (SvD)	80”	5-20 / 15-24	.02 / .10	5	5-15 / 3-10
Soco-Stecoah Complex (SvF)	80”	5-18	.10 / .17	2 / 3	2-6
Thurmont-Dillard Complex (ThB)	>60”	5-18 / 10-25	.17 / .24	5	2-8 / .5-5
Snowbird Fine Sandy Loam (SbE)	>60”	5-18	.10	5	5-10
Source: **NRCS, USDA. Official Soil Series Descriptions** (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx) (http://soildatamart.nrcs.usda.gov)					

2.4 Historical Land Use and Development Trends

Except for low density residential development, logging roads and remnants of a small, recent logging operation, the Snowbird Creek tributaries are in a watershed that is primarily deciduous forest as shown in Table 2.3.

Table 2.3 Snowbird Creek Tributaries Watershed Land Use/ Land Cover Snowbird Creek Tributaries Restoration Plan- Project #000613		
Land Use Category	**Area (acres)**	**Percent Area**
Developed Open Space	0.003	0.001%
Deciduous Forest	199.23	80.15%
Evergreen Forest	21.58	8.68%
Mixed Forest	27.75	11.16%
Note: The above was gathered from 2001 U.S. Geological Survey land cover data. *Source: http://seamless.usgs.gov/*		

2.4.1 Watershed Trajectory and Stream Design

2.4.1.1 State of Watershed

The majority of the project site is forested. A non-forested area is being proposed for restoration and a forested, but recently logged reach will be enhanced. Prior timber harvesting has occurred on the property, with the most recent activities involving selective harvesting of portions of the property within the last 15 years. Much of the property shows evidence of selective harvesting activities within the last 50 years, but land cover in the upper reaches has now returned to a more natural state. Invasive plant species and debris associated with the most recent logging activities have impacted an isolated reach of UT2. The downstream end of UT3 has been moved and flows along the edge of a pasture where the left bank is mowed.

2.4.1.2 Types and Likelihood of Change

Low density residential development and logging of uplands are the potential threats to these watersheds. Although the project site is less than five miles away from the town of Robbinsville, the watershed in which the project is located is not close to any major population centers. Land use within the watershed is rural in character and is unlikely to change significantly in the near future. The landowner is considering developing parts of the watershed as a campground or as some other "low impact" development that will provide income.

The small, narrow valley bottoms are unlikely candidates for development or future logging due to the conservation easement constricting the flat land available for use. In addition, easily developable land is already in residential or agricultural use. Even the lower slopes of the watershed above the residential sites are steep enough so as to discourage intensive development.

2.4.1.3 Channel Evolution

Despite the evidence of logging in the watershed, the majority of the stream segments have recovered or are in the process of recovering, to a stable condition. The potential impact from working on these stream segments would not justify the benefits. Instead, the majority of these stream segments will be preserved in their existing condition. The segments that will be enhanced or restored have been subject to a higher degree of disturbance. Rather than watershed scale disturbance, they have been subjected to reach scale disturbance- including removal of riparian vegetation and in the case of UT3, channel relocation and straightening). The enhancement section of UT 2 and the restoration section of UT 3 are either in a stage of channel degradation or in an early stage of recovery where the opportunity exists to eliminate the undesirable impacts from natural channel evolution by repairing and restoring these areas to a stable condition once again.

2.5 Watershed Planning

The Snowbird Creek Tributaries project site does not lie within a targeted or local watershed planning area. According to the latest basin plan for the Little Tennessee River, the Snowbird Creek drainage, a predominantly forested watershed, contains numerous miles of streams that have been designated by the state as being high quality waters. Although the project tributaries empty into a reach of Snowbird Creek that is not listed as high quality waters, this reach of Snowbird Creek does support native trout populations and is thus subject to trout buffer rules managed by the N.C. Division of Land Resources.

To promote water quality and habitat protection, the Snowbird Tributaries project will buffer the streams from existing and future land use with a forested riparian zone that will filter pollutants and reduce impacts from overland runoff. A permanent conservation easement will also be established which guarantees that approximately 13 acres of stream riparian zones will be protected from encroachment by any future land use practices.

2.6 Endangered/Threatened Species

Some populations of plants and animals are declining as a result of various natural forces including competition with humans for resources. According to the North Carolina Natural Heritage Program (NHP) and United States Fish and Wildlife Service (USFWS) lists of rare and protected animal and plant species, seven federally protected species are known to exist in Graham County as of January 12, 2009 (USFWS 2008 and NHP 2009).

Legal protection for federally listed species, Threatened (T) or Endangered (E) status, is conferred by the Endangered Species Act of 1973, (as amended 16 U.S.C. 1531-1534). This act makes illegal the killing, harming, harassing, or removing of any federally listed animal species from the wild; plants are similarly protected but only on federal lands. Section 7 of this act requires federal agencies to ensure that actions they fund or authorize do not jeopardize any federally listed species.

Organisms that are listed as Endangered (E), Threatened (T), or Special Concern (SC) on the NHP list of Rare Plant and Animal Species are afforded state protection under the State Endangered Species Act and the North Carolina Plant Protection and Conservation Act of 1979.

Species lists that the USFWS and NHP prepared for Graham County were last updated January 31, 2008 and January 9, 2009, respectively. A brief description of the characteristics and habitat requirements of the species under federal protection follows in Table 2.4, along with a conclusion regarding potential project impact. Information on candidate species or species under federal protection through other legislation that occur in Graham County is also provided.

Table 2.4 Species Under Federal Protection in Graham County
Snowbird Creek Tributaries Restoration Plan- Project #000613

Family	Scientific Name	Common Name	Federal Status	State Status	Habitat Present / Biological Conclusion
Vertebrates					
Accipitridae	*Haliaeetus leucocephalus*	Bald Eagle	BGPA	T	No/No effect
Emydidae	*Clemmys muhlenbergii*	Bog Turtle	T(S/A)	T	No/No effect
Vespertilionidae	*Myotis sodalis*	Indiana Myotis (bat)	E	E	No/No effect
Sciuridae	*Glaucomys sabrinus coloratus*	Carolina Northern Flying Squirrel	E	E	No/No effect
Invertebrates					
Unionidae	*Alasmidonta raveneliana*	Appalachian Elktoe	E	E	No/No effect
Plants					
Rosaceae	*Spiraea virginiana*	Virginia Spiraea	T	E	No/No effect
Lichen					
Cladoniaceae	*Gymnoderma lineare*	Rock Gnome Lichen	E	T	No/ No effect

Notes:

BGPA: Bald and Golden Eagle Protection Act. As of August 8, 2007, the Bald and Golden Eagle Protection Act (Eagle Act) (16 U.S.C. 668-668d) is the primary law protecting bald and golden eagles. The Eagle Act prohibits take of bald and golden eagles and provides a statutory definition of "take" that includes "disturb".

E: An Endangered species is one whose continued existence as a viable component of the state's flora or fauna is determined to be in jeopardy.

T: Threatened

T(S/A): Threatened due to similarity of appearance. A species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.

The U.S. Fish and Wildlife Service (USFWS) was most recently contacted March 13, 2008 regarding protected species on the project site. To date, no response has been received from the USFWS regarding potential project impacts to federally listed species located in Graham County. As a precautionary measure, Baker will consider the effects of construction activities on species listed in Table 2.4 and take reasonable measures to avoid direct and indirect impacts during the project. Correspondence submitted to the USFWS is included in Appendix B.

2.6.1 Federally Protected Vertebrates

2.6.1.1 *Haliaeetus leucocephalus* (Bald Eagle)

Bald eagles are large raptors, 32 to 43 inches long, with a white head, white tail, yellow bill, yellow eyes, and yellow feet. The lower section of the leg has no feathers. Wingspread is about seven feet. The characteristic plumage of adults is white and dark brown to black with young birds being completely dark brown. Juveniles have a dark bill, pale markings on the belly, tail, and under the wings and do not develop the white head and tail until five to six years old.

According to the NHP species account, bald eagles in the Southeast frequently build their nests in the transition zone between forest and marsh or open water. Nests are cone-shaped, six to eight feet from top to bottom, and six feet or more in diameter. They are typically constructed of sticks lined with a combination of leaves, grasses, and Spanish moss. Nests are built in dominant live pines or cypress trees that provide a good view and clear flight path, usually less than 0.5 miles from open water. Winter roosts are usually in dominant trees, similar to nesting trees, but may be somewhat farther from water. In North Carolina, nest building takes place in December and January, with egg laying (clutch of one to three eggs) in February and hatching in March. Bald eagles are opportunistic feeders consuming a variety of living prey and carrion. Up to 80 percent of their diet is fish, which is self caught, scavenged, or robbed from ospreys. They may also take various small mammals and birds, especially those weakened by injury or disease.

(Henson 1990, Potter et al. 1980, USFWS 1992a)

Biological Conclusion: No Effect

Bald eagles have been sighted in Graham County, which is not unusual given the large open waters of Santeetlah and Fontana Reservoirs. According to information posted on the NC Natural Heritage Program website (http://149.168.1.196/nhp/), an occurrence of the bald eagle has been recorded within 2 miles of the project area, probably over the reservoir. However, the project area consists of headwater streams with small drainage areas, and for the most part, forest cover that does not allow predation by large birds of prey. These streams do not hold prey-sized fish that could support a bald eagle.

This project involves riparian enhancement and channel restoration that impacts a very small percentage of the total project stream length. Improvements made through this project will not adversely impact any bald eagle populations or habitat. Canopy improvements made to the riparian zone within the project area could actually support bald eagles in the long term should any of the planted trees become dominant canopy trees. Stream enhancement activities will result in channel stability and improved water quality through a reduction in sediment loading and colder water by the addition of shading vegetation. These activities are likely to benefit fish populations, which could in turn benefit predators such as eagles rather than adversely impact them.

2.6.1.2 *Clemmys muhlenbergii* (Bog Turtle)

The bog turtle is among the smallest turtles of North America at only 3-4.5 inches in length with an average weight of 4 ounces. Its shell is light brown to ebony in color and it has a notable bright orange, yellow or red blotch on each side of its head. The bog turtle's preferred habitat in the southern Appalachians includes sphagnum bogs, drained swamps, and mucky, slow moving spring-fed streams in meadows and pastures that are typically less than 4 acres in size (USFWS 1997a).

Biological Conclusion: No Effect

The Snowbird Tributaries Site is heavily forested and does not have shallow spring-fed fens, sphagnaceous bogs or marshy meadows and pasture. Non-forested areas within the project reaches also do not feature habitat favored by bog turtles. Streams on-site are fairly fast flowing, steep, and have a bed of sand, gravel and cobble without areas of mud or silt. There should be no effects from construction of this project because the project will have no direct impacts to a population or to habitat for this species.

2.6.1.3 *Myotis sodalis* (Indiana Myotis)

The Indiana bat is 3.5 inches long, with mouse-like ears, plain nose, dull, grayish fur on the back, and lighter, cinnamon-brown fur on the belly. Its “wingspread” ranges from 9.5 to 10.5 inches. From early October until late March and April, Indiana bats hibernate in large clusters of hundreds or even thousands in limestone caves and abandoned mines, usually near water. During summer, females establish maternity colonies of two dozen to several hundred under the loose bark of dead and dying trees or shaggy-barked live trees, such as the shagbark hickory. Hollows in live or dead trees are also used. Most roost trees are usually exposed to the sun and are near water. Males and non-reproductive females typically roost singly or in small groups. Roost trees can be found within riparian areas, bottomland hardwoods, and upland hardwoods (Adams 1987, USFWS 1992a).

Biological Conclusion: No Effect

No foraging or nesting habitat was found for the Indiana bat in the lower project reaches due to the level of disturbance to the riparian area. Riparian areas in the headwaters of the project area will not be disturbed. Any potential habitat that may exist in the upper reaches will be left in its current condition. Because no potential habitat will be impacted by this project “no effect” determination was made.

2.6.1.4 *Glaucomys sabrinus coloratus* (Carolina Northern Flying Squirrel)

The Carolina northern flying squirrel is a small nocturnal gliding mammal some 260 to 305 millimeters (10 to 12 inches) in total length and 95-140 grams (3-5 ounces) in weight. It possesses a long, broad, flattened tail (80 percent of head and body length), prominent eyes, and dense, silky fur. The broad tail and folds of skin between the wrist and ankle form the aerodynamic surface used for gliding. Adults are gray with a brownish, tan, or reddish wash on the back, and grayish white or buffy white ventrally. Juveniles have uniform dark, slate-gray backs, and off-white undersides. The northern flying squirrel can be distinguished from the southern flying squirrel by its larger size; the gray base of its ventral hairs as opposed to a white base in the southern species; the relatively longer upper tooth row; and the short, stout baculum (penis bone) of the males.

(Cooper et al. 1977, Murdock pers. comm., Terwilliger et al. 1995, USFWS 1992a, Weigl 1987)

Biological Conclusion: No effect

The Carolina northern flying squirrel prefers the ecotone between coniferous and mature northern hardwood forests usually above 4,500 feet or narrow, north-facing valleys above 4,000 feet. There is no habitat of this kind at the project site. The land disturbing activities will take place on a floodplain and a timber clearing with maximum elevations below 2,200’ ASL, well below what would be expected for this animal. There should be no effect on this species or its habitat.

2.6.2 Federally Protected Invertebrates

2.6.2.1 *Alasmidonta raveneliana* (Appalachian Elktoe)

The Appalachian elktoe has a thin, but not fragile, kidney-shaped shell, reaching up to about 3.2 inches in length, 1.4 inches in height, and one inch in width (Clarke 1981). Like other freshwater mussels, the Appalachian elktoe feeds by filtering food particles from the water column. The specific food habits of the species are unknown, but other freshwater mussels have been documented to feed on detritus, diatoms, phytoplankton, and zooplankton (Churchill and Lewis 1924). The species has been found in relatively shallow, medium-sized creeks and rivers with cool, clean, well-oxygenated, moderate- to fast-flowing water. The species is most often found in riffles, runs, and shallow flowing pools with stable, relatively silt-free, coarse sand and gravel substrate associated with cobble, boulders, and/or bedrock. Stability of the substrate appears to be critical to the Appalachian elktoe, and the species is seldom found in stream reaches with accumulations of silt or shifting sand, gravel, or cobble. Individuals that have been encountered in these areas are believed to have been scoured out of upstream areas during periods of heavy rain, and have not been found on subsequent surveys (USFWS Webpage; C. McGrath, pers. comm. 1996; J.A. Fridell, pers. observation 1995, 1996, 1999).

Biological Conclusion: No Effect

The USFWS has designated a portion of the Cheoah River system within Graham County as critical habitat for the Appalachian elktoe. According to the September 27, 2002 Federal Register, 67:61016-61040, critical habitat for the Appalachian elktoe exists in the Cheoah River below the Santeetlah Dam to its confluence with the Little Tennessee River. However, the project site is not located in the critical habitat area for the Appalachian elktoe. The described habitat does not exist within the project reach and no individual animals were observed. Unnamed Tributaries 1 and 2 converge before entering Snowbird Creek within the normally impounded area of Santeelah Reservoir. Unnamed Tributary 3 flows into Hooper Branch which then meets Snowbird Creek also within the impoundment. Snowbird Creek is a tributary to the Santeetlah Reservoir which was created when the Cheoah River was dammed. According to state natural heritage element occurrence data for 2007, the closest recorded occurrence of Appalachian elktoe to the project area is approximately 10 miles away, below the Dam. Therefore, any potential, temporary increases in stream turbidity levels caused by enhancement or restoration activities or other unforeseeable impacts will not affect Appalachian elktoe mussel populations downstream of the dam. Project erosion control measures will further ensure that impacts to any potential habitat downstream of the project area are minimized or avoided.

2.6.3 Federally Protected Plants

2.6.3.1 *Spiraea virginiana* (Virginia Spiraea)

Preferred habitat of the Virginia spiraea ranges from flood-scoured, high-gradient rocky riverbanks, gorges, and canyons to braided areas of stream reaches. Virginia spiraea have also been observed in disturbed rights-of-way. Virginia spiraea prefer sunlight and moist, acidic soils (primarily sandstones). This plant grows in thickets, and is commonly associated with a variety of grape species (Vitis spp.) and royal fern (Osmunda regalis), though it may still be located in thickets where these other plants are not present. Habitat conditions for the Virginia spiraea must be present in some combination in order for the spiraea to flourish. Due to the specificity of site conditions needed, the Virginia spiraea is limited to a specific ecological niche (Radford et al. 1964, USFWS 1992a.).

Biological Conclusion:

The project streams are very small with bankfull widths of 10 to 15 feet, and are located on moderate to steep gradients. Some habitat features favored by the Virginia spiraea do exist within the project limits for Virginia spiraea. Favorable habitat features consisted of sections of braided channel, previously disturbed banks and access routes that are highly exposed to sunlight, and minor scour associated with prior channelization of the stream.

Subsequent field surveys have been conducted and potential habitat features were found to be less significant due to a lack of overall habitat suitability. Sections of braided channel were located in moderate to steep relief. Dominant vegetation on steeper slopes consisted of dense rhododendron and doghobble, hemlock, poplar, and maple. Braided channel features on more moderate slopes consisted of multiflora rose, chinese privet, poplar, dogwood and a variety of ferns and mosses. The enhancement reach on UT 3 is located on a moderate slope and is adjacent to a residence. One bank is bordered by a forested slope; the opposite bank is bordered by a field that is mowed to the top of bank of the stream. Braiding and minor scour was observed along sections of the proposed enhancement reach on UT3 where the previously channelized tributary is attempting to move back toward the center of the valley. Vegetation present is as described above for braided channels on moderate slopes. Site conditions at the enhancement reach on UT 2 consist of an area previously opened by timber harvesting conducted within the last 10 years. Logging debris has been left within the enhancement reach on UT 2. Although the enhancement reach on UT 2 currently receives ample sunlight, other habitat features required, including scoured, rocky streambanks are not present and the area has been overtaken by multiflora rose. Recent on-site observations made May 8, 2008 confirm that Virginia spiraea is not present in portions of the project site where land disturbing activity will occur (including staging areas and access routes). Therefore, no impacts to the species from this project are anticipated.

2.6.4 Federally Protected Lichen

2.6.4.1 *Gymnoderma lineare* (Rock Gnome Lichen)

Rock Gnome Lichen grows in dense colonies of narrow straps (squamules) that appear a bluish-grey on the surface and a shiny white on the lower surface. The squamules are about 1 millimeter across near the tip, tapering to the blackened base, sparingly and subdichotomously branched, and generally about 1 to 2 centimeters (.39 to .79 inches) long, although they can vary somewhat in length, depending upon environmental factors. Flowering occurs between July to September; fruiting bodies are located at the tips of the squamules and are also black. The squamules are nearly parallel to the rock surface, with the tips curling away from the rock, in a near perpendicular orientation to the rock surface.

The rock gnome lichen is endemic to the southern Appalachian Mountains of North Carolina and Tennessee, where it is limited to 32 populations. Only seven of the remaining 32 populations cover an area larger than 2 square meters (2.4 square yards). Most populations are 1 meter (3.3 feet) or less in size (USFWS, 1997b).

Rock gnome lichen habitat is located around humid, high elevation rock outcrops or vertical cliff faces or in rock outcrops in humid gorges at lower elevations. Most populations occur above an elevation of (5,000 feet) (USFWS, 1997b).

Biological Conclusion:

The project area lacks habitat characteristics favored by the rock gnome lichen. Enhancement activities which are located at elevations less than 2,800 feet and in less steep portions of the project area make it unlikely that any habitat exists for the rock gnome lichen. There are no deep river gorges or high elevation rock outcrops or cliffs within the enhancement reach of this project. This project will have no direct impacts to a population or its habitat.

2.7 Cultural Resources

A letter was sent to the North Carolina State Historic Preservation Office (SHPO) and Eastern Band of Cherokee Indians' Tribal Historic Preservation Office (THPO), January 25, 2008, requesting a review and comment for the potential of cultural resources in the vicinity of the Snowbird Tributaries restoration site. A response was received on March 13, 2008, from the SHPO stating they were unaware of any historic resources which would be affected by the project. Consequently, a Phase I Archaeological Survey was not requested by the SHPO. The THPO has not submitted comments on this project to date. A copy of the SHPO and THPO correspondence is included in Appendix B.

2.8 Potential Constraints

Baker assessed the Snowbird Creek tributaries project site in regards to potential site constraints. No fatal flaws have been identified during development of the project design.

2.8.1 Property Ownership and Boundary

Baker has obtained a conservation easement from Mary Griffin, property owner, for the Snowbird Creek tributaries project area. The easement has been approved by the N. C. State Property Office (SPO) and recorded at the Graham County Courthouse. Final copies of the easement and plat have been provided to SPO and to EEP. The easement will allow Baker to proceed with the project and restricts the land use in perpetuity. Breaks in the conservation easement have been recorded on the plat and these areas will be used for stream crossings; these areas are removed from the stream length used to calculate mitigation credits.

2.8.2 Site Access

The site can be accessed for construction and post-restoration monitoring. Construction access and staging areas have been identified and are shown on the attached project plan sheets.

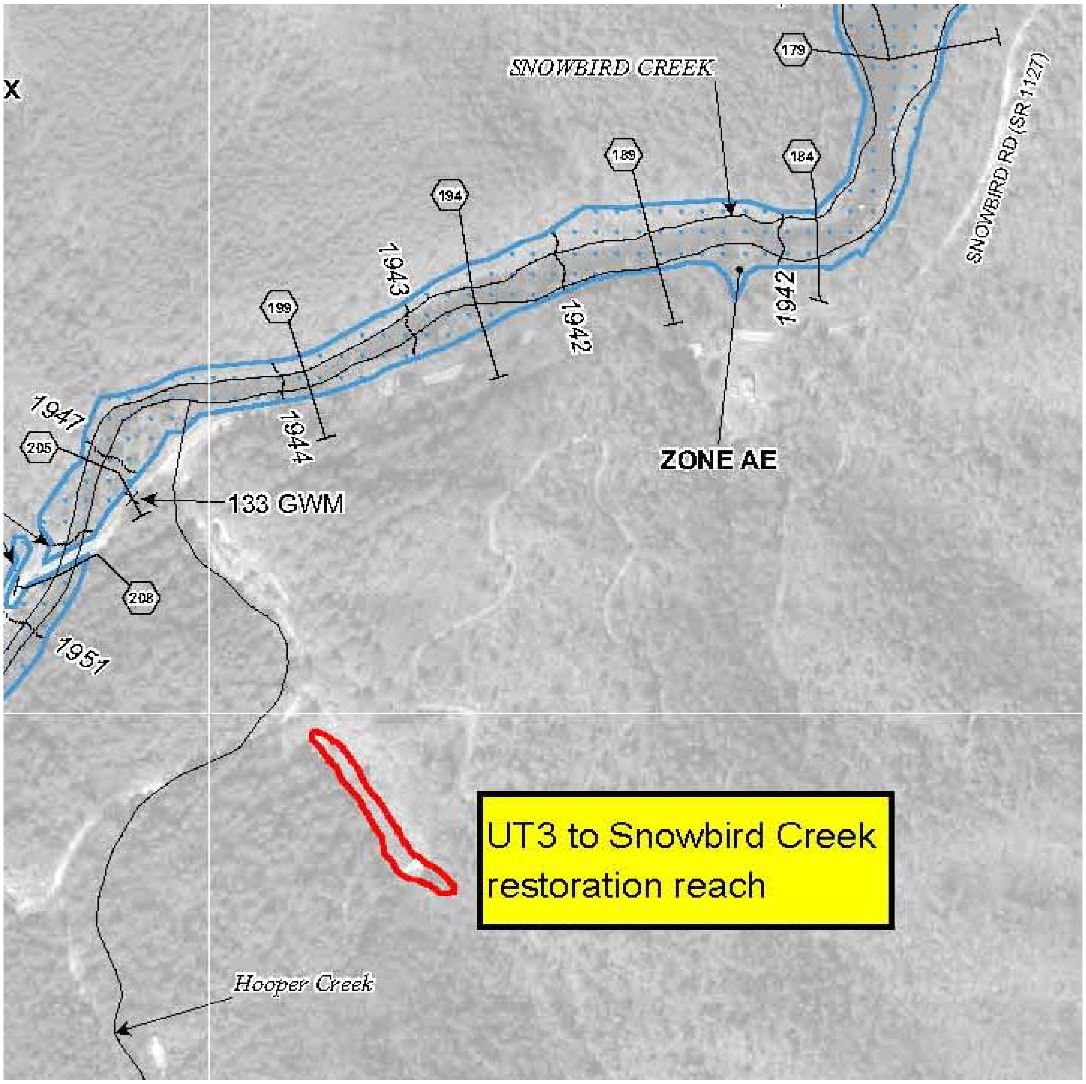
2.8.3 Utilities

No utility easements are present within the conservation easement. An existing waterline from a spring house upstream of the restoration reach to residences downstream of the project will run beside the easement and cross the channel at the stream crossing.

2.8.4 Hydrologic Trespass and Floodplain Characterization

The Effective FEMA Flood Insurance Rate Map (FIRM) for Graham County, NC, (Map Number 3700565000J) indicates that the project is located within an unregulated unshaded Zone X (Figure 2.3 (NCFMP, 2009). There is no local floodplain authority for Graham County; therefore Baker will submit the Floodplain Requirements Checklist to the state as required by the EEP. No further study is expected to be required as part of this project.

Figure 2.3 FEMA Floodplain Map from FIRM 3700565000J, Effective Date 2/18/09



Approximate Scale: 1”:500’

(http://www.ncfloodmaps.com/)

2.9 Potentially Hazardous Environmental Sites

An EDR Transaction Screen Map Report that identifies and maps real or potential hazardous environmental sites within the distance required by the American Society of Testing and Materials (ASTM) Transaction Screening Process (E 1528) was prepared for the site January 3, 2008. A copy of the report with an overview map is included in Appendix C. The overall environmental risk for the Snowbird Tributaries project site was determined to be low. Environmental sites including Superfund (National Priorities List, NPL); hazardous waste treatment, storage, or disposal facilities; the Comprehensive Environmental Response, Compensation, and Liability Act Information System (CERCLIS); suspect state hazardous waste, solid waste or landfill facilities; or leaking underground storage tanks were not identified by the report to me in the proposed project area. During field data collection, there was no evidence that these types of sites may be in the proposed project vicinity, and conversations with the landowner did not reveal any further knowledge of hazardous environmental sites or conditions in the area.

3.0 PROJECT SITE STREAMS (EXISTING CONDITIONS)

3.1 Existing Conditions Survey

For each tributary in the project area, Baker collected representative cross-section and profile survey data of the existing streams to assess the current condition and overall stability of the channel. Figure 3.1 illustrates the locations of cross-section surveys on the project reaches. The survey included four cross sections on UT3, two cross-sections on UT2 and one cross-section on UT1. Baker also collected substrate samples to characterize stream sediments. The following sections of this report summarize the survey results for the restoration reach. No other detailed discussion of the preservation reaches has been included, however, all of the surveyed cross sections and profiles are provided in Appendix D. A photo log that depicts the existing conditions at the Snowbird Tributaries project site is provided in Appendix E. Results of sediment sampling and analyses are included in Appendix F.

The existing conditions of designated project reaches are described below with Table 3.1 summarizing the representative geomorphic conditions currently present at the Snowbird Creek Tributaries project site. The table also provides regional curve data for comparison based on the drainage area of each reach. This data has limited applicability given the small sizes and steep slopes present within the project. A more detailed discussion of the assessment conducted to determine channel stability and channel forming discharge for project streams is included in Sections 3.5 through 3.7.

3.2 Channel Geomorphic Characterization and Classification

The plan for the Snowbird Tributaries Project involves the preservation of 7,497 LF of stream channel, the enhancement of approximately 171 LF of stream channel, and the restoration of 466 LF of stream channel. The preservation streams have been logged within the last 50 years but are now returning to a more natural state. The stream reaches on which enhancement and restoration are proposed have been impacted by logging, clearing, invasive species, and other land disturbing activities. Based on the current conditions, the stream stability and buffer quality will take a long time to naturally restore without intervention. Baker assessed the stream and valley types present and considered their evolutionary stage and likely endpoint in order to develop a basis for the proposed restoration plan. The project is dominated by narrow, colluvial valleys that contain a moderate range of slopes. Stream types located within the project consist of B4a and A4a+- type channels. All streams within the project reach have been altered to some degree by timber harvesting activities or relocation due to land use practices.

Preservation is proposed on 7,497 LF of stream on this site (UT1, UT2 Reaches 1 and 3, and UT3 Reach 1). Preserving riparian buffers around all of these streams will protect the habitat and hydrology by protecting bank stability, filtering runoff, maintaining aquatic and terrestrial habitat, and providing shade.

The enhancement reach (UT 2 - Reach 2) is where a logging road approaches the stream and debris from logging activities has been left in the stream. The banks have degraded and invasive plant species are present in the riparian buffer. Along with debris and invasive plant removal, buffer planting will be performed.

The restoration reach (UT 3 – Reach 2) is at the downstream end of UT3. There is a limited riparian buffer along this reach with invasive plant species present in the existing corridor and in the proposed relocation corridor. In addition to an off-line channel restoration along the historical channel path, invasive plant removal and buffer planting will be performed.

LEGEND:

Project Reaches

- UT1, Reach 1
- UT2, Reach 1
- UT2, Reach 2
- UT2, Reach 3
- UT3, Reach 1
- UT3, Reach 2
- Cross-sections
- Proposed Easement Boundary
- Streams

0 200 400 800 Feet

Figure 3.1 Project Reaches and Surveyed Cross-Section Locations

Snowbird Creek Tributaries Project
Graham County, NC

Ecosystem Enhancement PROGRAM

Baker

3.3 Valley Classification

All of the tributary valleys are Type II, moderately steep colluvial valleys with gentle sloping side slopes. They are fed at the top and along their sides by steep V-shaped ephemeral stream valleys (Type I). This is typical and characteristic of headwaters in the mountain region. In the same way, B type streams are characteristic of these same colluvial valleys with some A type steams where the stream is able to incise. B streams tend to be stable in Type II valleys and contribute only small quantities of sediment during runoff events. The slope of the valley through the restoration reach is 0.094 ft/ft.

3.4 Project Reach Characterization

Members of the Griffin family have held ownership of the property for many years. The lands along the streams and in the surrounding area are overwhelmingly forested. The majority of the streams and accompanying acquired easements will be simply conserved to allow for the continued natural recovery of the systems, which is already well underway. Some stream reaches have been altered or impacted by prior activities and are slated for enhancement or restoration. A description of each stream within the project area is provided below.

3.4.1 Unnamed Tributary (UT) 1 (Preservation)

Unnamed Tributary 1 drains approximately 83.2 acres at the downstream property boundary, is in good condition and will be preserved as is under the project conservation easement. This particular stream flows 3,213 LF through deciduous riparian forest. The reach has stable banks and a bankfull channel that allows floodplain access at bankfull flows.

Unnamed Tributary 1 is a 1st order headwater A4a+ type stream in a steep (V or Bowl-shaped) valley. Despite prior impacts, this stream has largely recovered. The remaining evidence of local instability is not of system-wide concern and mostly reflects local perturbations that are consistent with natural impacts found in reference streams. Any minor improvements that could be made would not be justified given the level of disturbance that would be required to access these steep and densely wooded areas

3.4.2 Unnamed Tributary (UT) 2

3.4.2.1 UT2 Reach 1 (Preservation)

Reach 1 of UT2 drains approximately 34.7 acres at its downstream junction with Reach 2, is in good condition and will be preserved under the project conservation easement. Reach 1 of UT2 flows 1,146 LF through a deciduous riparian forest. The reach has stable banks and a bankfull channel that allows floodplain access at bankfull flows. Unnamed tributary 2 is a 1st order, B4a type stream. It is also located in a steep valley much like other tributaries in the greater Snowbird Creek drainage. The typical stream type in the reach is B. As is the case with the preservation reaches on UT1 and UT3, UT2 exhibits localized sections of channel instability that are causing neither aggradation nor degradation on a scale large enough to disrupt the stream on a system wide scale. As noted earlier, any minor improvements that could be made would not be justified given the level of disturbance that would be required to access these steep and densely wooded areas.

3.4.2.2 UT2 Reach 2 (Enhancement)

The enhancement reach (UT2 - Reach 2) is where a logging road approaches the stream and debris from logging activities has been left in the stream. The banks have degraded and invasive plant species are present in the riparian buffer. Along with logging debris and invasive plant removal, buffer planting will be performed.

Geomorphic survey information from the reach has been provided in Table 3.1 with substrate data provided in Table 3.2. This short 171-foot reach reflects a profile of debris jams, over-widening and aggradation punctuated by short, steep drops at the downstream ends of the debris jams. The banks are eroding due to this unstable pattern.

The enhancement section is either in a stage of channel degradation or in an early stage of recovery. There is local instability and bank erosion due to the extensive debris jams from the earlier logging. The channel will continue to headcut below the debris jams, and locally evolve toward a "G" stream without enhancement. Debris removal should return it to the path of a recovering B4a type stream.

3.4.2.3 UT2 Reach 3 (Preservation)

The downstream reach of UT2, Reach 3, drains approximately 48.8 acres at the downstream property boundary, is in good condition and will be preserved under the project conservation easement. Reach 3 of UT2 flows 562 LF through deciduous riparian forest. The reach has stable banks and a bankfull channel that allows floodplain access at bankfull flows. The reach is a 1st order headwater stream in a steep (V or Bowl-shaped) valley. The typical stream type in the reach is A4a+. Despite prior impacts, these areas have largely recovered. The remaining evidence of local instability is not a system-wide concern and mostly reflects local perturbations that are consistent with natural impacts found in reference streams. Any minor improvements that could be made would not be justified given the level of disturbance that would be required to access these steep and densely wooded areas.

3.4.3 Unnamed Tributary (UT) 3

UT3 is a first order, high gradient, colluvial system with occasional bedrock outcroppings. Table 3.1 summarizes the geomorphic parameters of UT3. In general, the bedform diversity of UT3 is fair with some step pool habitat in existing cascades and around woody debris. Most pools are scour features associated with woody debris laying over or in the channel and debris buried in the substrate. Most of the stream bed is shallow and is best described as a steep riffle with a few runs. Low velocity areas of the channel are primarily composed of large sand particles and small gravel. Higher velocity pools and runs have small cobble and gravel. The project reach can be described as a cobble bed stream based on stream bed sampling of UT 3. Table 3.2 lists substrate data.

3.4.3.1 UT3 Reach 1 (Preservation)

The upstream reach of UT3, Reach1, drains approximately 97.5 acres at its junction with Reach 2, is in good condition and will be preserved as is under the project conservation easement. Reach 1 of UT3 flows 2,576 LF through deciduous riparian forest. The reach has stable banks and a bankfull channel that allows frequent floodplain access during bankfull flows. The reach is a 1st order headwater stream in a steep (V or Bowl-shaped) valley. The typical stream type in the reach is B4a. Despite prior impacts, this reach of UT3 is relatively stable. Any isolated improvements that could be made would not be justified given the level of disturbance that would be created to access these steep and densely wooded areas.

3.4.3.2 UT3 Reach 2 (Restoration)

Reach 2 of UT3 drains 116.6 acres before entering Hooper Branch downstream of the project area. The restoration reach of UT3 presently flows for 543 LF perched up against the valley wall. A grassy field separates the stream from the low point in the valley. Below the restoration reach, it passes a residence and flows under IU Gap Road. A B3a-type stream in this reach, UT3 continues to be a 1st order headwater stream. As Reach 2 of UT3 nears Hooper Branch, its valley transitions to a less confined, bowl-shaped type valley.

In talking with the landowner, it was discovered that this reach of UT3 was previously on the opposite side of the valley near a gravel road leading to a large shed on-site. Relocation and channelization of the channel has resulted in bank erosion that has been compounded by a lack of riparian vegetation.

By constructing a channel with floodplain access at bankfull, a channel with lower shear stress can be created that will allow for equilibrium with the in situ colluvium. This new B- type stream in the steep Type II valley (9.4%) will have a bankfull depth of 0.9 feet to limit the maximum shear stress and thereby reduce particle mobility of the coarsest fraction of the bed.

The design will incorporate on-site boulders and potentially bedrock (if present during construction) as grade control features. These will be used in construction and will assist in armoring and maintaining the new stream bed. Some of the on-site boulders appear to be a product of the original stream processes before the channel was relocated.

The restored channel will also use vegetation as a critical component of stream stability. The existing left stream bank is void of vegetation through much of the reach. Native vegetation will be planted in the form of live stakes, cuttings, and bare root trees in order to help stabilize the banks with live rootmass.

Table 3.1 Representative Geomorphic Data for Snowbird Creek Tributaries
Snowbird Creek Tributaries Restoration Plan- Project #000613

Parameter	Values				Units
	UT2-R2, XS1	UT3-R2, XS1 Sta. 1+82	UT3-R2, XS2 Sta. 0+83	UT3-R2, XS3 Sta. 0+48	
Feature Type	Riffle	Riffle	Pool	Riffle	
Bankfull Width (W_{bkf})	8.23	5.21	6.52	6.78	Feet
Bankfull Mean Depth (d_{bkf})	0.54	0.55	0.65	0.63	Feet
Cross-Sectional Area (A_{bkf})	4.42	2.88	4.2	4.3	Sq. ft.
Width/Depth Ratio (W/D ratio)	15.3	9.5	10.1	10.7	
Bankfull Max Depth (d_{mbkf})	0.87	0.68	1.13	1.06	Feet
Floodprone Area Width (W_{fpa})	>15	7.3	11.6	15.6	Feet
Entrenchment Ratio (ER)	>1.8	1.4	1.8	2.4	
Bank Height Ratio (BHR)	1.5	2.3	2.0	2.3	
Water Surface Slope (S)	0.166	0.087	NA	0.087	Feet/foot
Channel Sinuosity (K)	<1.2	1.1	1.1	1.1	
Rosgen Stream Type	B4a	B4a	NA	B4a	

Table 3.2 Particle Size Distribution from Bed Sediment Sample of UT2 & UT 3 Reach 2
Snowbird Creek Tributaries Restoration Plan- Project #000613

Particle Size (mm)	Channel materials		
	Pebble Count: UT2	Pebble Count: UT3-Reach 2	Bed Bulk Sample: UT3-Reach 2
D16 =	0.5 mm	4.8 mm	7.6mm
D35 =	4.0 mm	45 mm	22.6mm
D50 =	16 mm	58 mm	90mm
D84 =	180 mm	100 mm	90mm
D95 =	256 mm	160 mm	128mm
D100 =	362 mm	256 mm	128mm

Table 3.3 Snowbird Creek UT3 Reach 2 Description Snowbird Creek Tributaries Restoration Plan- Project #000613			
Reach	**Station Location**	**Reach Length * (LF)**	**Watershed Size at Downstream End of Reach (square miles)**
UT3 Reach 2	Sta. 0+00 to 5+31	543	0.18
Total Existing Reach Length		543	0.18

3.5 Channel Morphology, Evolution and Stability Assessment

A common sequence of physical adjustments has been observed in many streams following disturbance. This adjustment process is often referred to as channel evolution. Disturbance can result from channelization, increase in runoff due to build-out in the watershed, removal of streamside vegetation, and other changes that negatively affect stream stability. All of these disturbances occur in both urban and rural environments. Several models have been used to describe this process of physical adjustment for a stream. The Simon (1989) Channel Evolution Model characterizes evolution in six steps, including:

1. Sinuous, pre-modified
2. Channelized
3. Degradation
4. Degradation and widening
5. Aggradation and widening
6. Quasi-equilibrium.

The channel evolution process is initiated once a stable, well-vegetated stream that interacts frequently with its floodplain is disturbed. Disturbance commonly results in an increase in stream power that causes degradation, often referred to as channel incision (Lane, 1955). Incision eventually leads to over-steepening of the banks and, when critical bank heights are exceeded, the banks begin to fail and mass wasting of soil and rock leads to channel widening. Incision and widening continue moving upstream in the form of a head-cut. Eventually the mass wasting slows, and the stream begins to aggrade. A new, low-flow channel begins to form in the sediment deposits. By the end of the evolutionary process, a stable stream with dimension, pattern, and profile similar to those of the earlier undisturbed channel forms in the deposited alluvium. The new channel is at a lower elevation than its original form, with a new floodplain constructed of alluvial material (FISRWG, 1998).

The tributaries within the project area are perennial streams with sections that appear to have been channelized in the past. Other sections of the stream flow through forest areas that were probably clear cut in the past, allowing thick stands of pioneering rhododendron to become established and to limit the density of other woody species. The total project has a number of reaches within the forested sections that are impacted by debris jams that have caused erosion and channel over-widening. The straightened sections are eroding banks in order to reestablish a stable pattern. Some stable cross-sections within the project reach indicate that when deeply rooted vegetation is allowed to grow along the banks, the stream takes on characteristics of a B channel.

Streams within the project area are primarily controlled by bedrock or colluvial boulders and cobbles and dissipate energy vertically rather than horizontally like an alluvial system. Because of this, they are moderately entrenched and in some areas, moderately wide relative to their depths. Their profiles are steep to very steep, tending to erode during low return interval storm events resulting in local changes in bed configuration but not in evolution to a new channel state. The slope of the valley through the restoration reach is 0.094 ft/ft. The low sinuosity of the restoration conforms to the historical alignment and has a width of 9.9 ft. at a bankfull depth of 0.9 ft. The width/depth ratio is approximately 15.

UT3-Reach 2 is a second order high gradient, colluvial system with occasional bedrock outcroppings. It has been moved from the low part of the valley to its present location against the valley wall. A man-made berm was constructed to constrain it to its relocated alignment but had the effect of narrowing the channel, increasing the bank height ratio (BHR) and reducing the entrenchment ratio (ER). During some high runoff events, it jumped the berm and formed its current straighter, steeper channel cutting off a portion of the relocated channel.

At its current narrowed and perched location, UT3-Reach 2 is incised as a result of manmade levy installation. The D50 in the current channel is a coarse gravel based on a bulk sample taken from the stream bed. The higher shear stress in the narrowed relocated channel was able to move that bed material and begin to incise. At the cross-sections that were surveyed, the BHR was 2.3 and the ER was as low as 1.4.

Once incision begins to cut off the bankfull (channel forming) flow from the adjacent floodplain, degradation accelerates. It will continue to degrade at its current incised location as long as it is hydrologically cut off from a floodplain and erode until it reaches bedrock or boulder material. At that point, it would seek to widen and restabilize itself.

Within the project limits, UT3-Reach 2 of Snowbird Creek is predominately classified as a Rosgen stream type B4a which is moderately to highly entrenched and incised. If it were to headcut and flatten its slope, it could evolve to an unstable "G" type stream. The earlier moving and narrowing of the stream have caused a shift away from a stable channel.

Table 3.4 summarizes the geomorphic parameters related to channel stability.

Table 3.4 Stability Indicators: Snowbird Creek UT 3 – Reach 2
Snowbird Creek Tributaries Restoration Plan- Project #000613

Parameter	**Reach 2 (XS1)**	**Reach 2 (XS2)**	**Reach 2 (XS3)**
Stream Type	B	NA (Pool)	B
Riparian Vegetation	Wide buffer of mature rhododendron with some mature trees scattered within the stand on the right bank. The left bank has fescue grass and this is mowed. There are a few small scattered trees on the left bank.	Wide buffer of mature rhododendron with some mature trees scattered within the stand on the right bank. The left bank has fescue grass and this is mowed. There are a few small scattered trees on the left bank.	Wide buffer of mature rhododendron with some mature trees scattered within the stand on the right bank. The left bank has fescue grass and this is mowed. There are a few small scattered trees on the left bank.
Channel Dimension			
Bankfull Area (SF)	2.88	4.2	4.3
Width/Depth Ratio	9.5	10.1	10.7
Channel Pattern			
Meander Width Ratio	NA	NA	NA
Sinuosity	1.1	1.1	1.1
Vertical Stability			
Bank Height Ratio (BHR)	2.3	2.0	2.3
Entrenchment Ratio (ER)	1.4	1.8	2.4
Evolution Scenario			
Existing Evolution Stage[2]			
Notes: 1. NA: Meander Width Ratio not measured due to channel type. 2. Simon Channel Evolution			

Table 3.4 (cont.) Stability Indicators: Snowbird Creek –Enhancement and Preservation Reaches Snowbird Creek Tributaries Restoration Plan- Project #000613				
Parameter	**UT1**	**UT2**		**UT3**
	Reach 1 (XS7)	**Reach 2 (XS6)**	**Reaches 1 & 3 (XS5)**	**Reach 1 (XS4)**
Stream Type	A4a+	B4a	B4a	A4a+
Riparian Vegetation	Banks vegetated with rhododendron, ferns, solomon's seal, and other ground cover. The forest canopy varies somewhat by elevation, but is generally dominated by oaks and tulip poplar. Red maple and sourwood are also abundant in areas.	Banks exhibit dense vegetative cover by rhododendron. The forest floor is lined with ferns, violets and forest litter. The forest canopy includes tulip poplar, maples, and a mix of other hardwoods.	Banks vegetated with rhododendron, ferns, solomon's seal, and other ground cover. The forest canopy varies somewhat by elevation, but is generally dominated by oaks and tulip poplar. Red maple and sourwood are also abundant in areas.	Banks vegetated with rhododendron, ferns, solomon's seal, and other ground cover. The forest canopy varies somewhat by elevation, but is generally dominated by oaks and tulip poplar. Red maple and sourwood are also abundant in areas.
Channel Dimension				
Bankfull Area (SF)	6	5.8	3.7	6.8
Width/Depth Ratio	11.35	11.46	12.76	10.66
Channel Pattern				
Meander Width Ratio	NA	NA	NA	NA
Sinuosity	NA	NA	NA	NA
Vertical Stability				
Bank Height Ratio (BHR)	1.8	4.1	1.6	3.6
Entrenchment Ratio (ER)	1.5	1.3	2.1	2.7
Evolution Scenario	A→A	B→G→Fb→B	B→G→Fb→B	A→A
Existing Evolution Stage[2]	I	I	I	I
Notes: 1. NA: Meander Width Ratio not measured due to channel type. 2. Simon Channel Evolution				

A naturally stable stream must be able to transport the sediment load supplied by its watershed while maintaining dimension, pattern, and profile over time so that it does not degrade or aggrade (Rosgen, 1994). Stable streams migrate across alluvial landscapes slowly, over long periods of time, while maintaining their form and function. Instability occurs when scouring causes the channel to incise (degrade) or excessive deposition causes the channel bed to rise (aggrade). A generalized relationship of stream stability was proposed by Lane (1955) that states the product of sediment load and sediment size is proportional to the product of stream slope and discharge, or stream power. A change in any one of these variables causes a rapid physical adjustment in the stream channel.

UT 3, reach 2 is either in a stage of channel degradation or in an early stage of recovery where the opportunity exists to eliminate the undesirable impacts from natural channel evolution by repairing and restoring it to a stable condition once again.

At its current narrowed and perched location, UT3-Reach 2 has become reasonably incised. Once incision begins to cut off the bankfull (stream forming) flow from the adjacent floodplain, degradation accelerates. It will continue to degrade at its current incised location as long as it is hydraulically cut off from a floodplain. A Priority 1 restoration approach which returns the stream to its original route as much as possible is deemed the best outcome versus, trying to stabilize it in place.

By hydraulically reconnecting Reach 2 of UT 3 with its floodplain at bankfull discharge, constructing in-stream structures to provide grade control, reducing shear stress by widening the channel section, restoring the stream to the historical location and sinuosity at the lowest point in the valley, and selecting a channel lining which is appropriately stable, the restoration reach should remain relatively stable over time. The restored channel should have stream power that is similar to that of the historical channel since the overall slope is not changing and discharge is returning to historical levels as the watershed continues to recover from the previous logging. Since it is a colluvial system, channel stability will be more dependent on the shear stress placed on the channel lining than the transport of a sediment load through the reach.

3.6 Discharge/Bankfull Verification

Baker engaged physical, analytical, and empirical methods to verify the bankfull stage and discharge of the project restoration reach (Reach 2) on UT3. These methods were each given weight, with physical field measurements having a slightly higher weight due to their site-specific nature. Subsequent methods were used to interpret and sometimes adjust field observations.

The bankfull stage for Reach 2 of UT3 was determined using standard methods available for this determination. There is no gage data available for the site; therefore, methods used to verify bankfull stage included a regional curve assessment, USGS regression equations, and Manning's equation.

In stable systems, the "bankfull" or main channel top-of-bank discharge represents the channel-forming discharge. It is widely accepted that the bankfull discharge has a recurrence interval in the range of 1 to 2 years (1.5 years is a commonly used average). The end result of the methods employed is a best estimate of the channel-forming discharge given the unavailability of gauge data.

In summary, the following steps were taken:

1. Identified and surveyed representative cross-sections with physical bankfull indicators.
2. Compared the surveyed cross-sections with each other to ensure consistency.
3. Compared values to regional empirical data (regional curves).
4. Used Manning's equation to estimate design discharge through cross-sections.
5. Finally, considered all results and determined dimensions and flow that corresponds to bankfull.

3.6.1 Physical Field Measurement

Field-identified physical indicators were collected during the topographic survey. Physical bankfull indicators surveyed during the existing conditions analysis were typically depositional bars, defined breaks in slope at a consistent elevation relative to the water surface or transitions in bank vegetation where vegetation exists. These indicators were used in conjunction with hydraulic modeling and discharge information from regional curve data and the USGS rural regression equations to evaluate bankfull estimates for consistency and accuracy. These verification methods are described below.

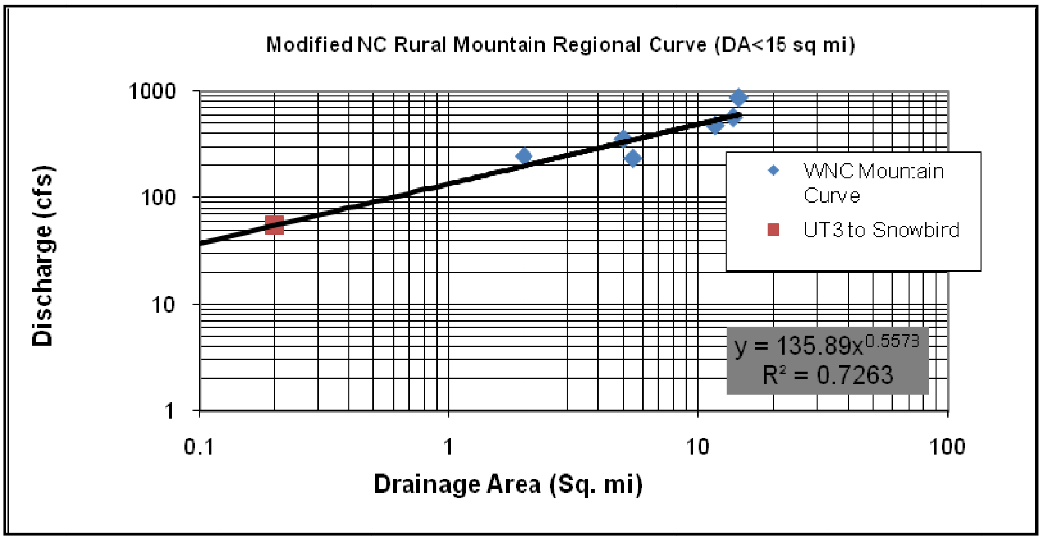
3.6.2 Regional Curve Equations

Publicly available and in-house bankfull regional curves are available for a range of stream types and physiographic provinces. The North Carolina Mountain Regional Curve (Harman et al., 2000) (Harman et al., 1999) was used for comparison to other more site-specific means of estimating bankfull discharge. The Snowbird restoration site (UT3-Reach 2) is a headwater system with a drainage area of 0.18 square miles; drainage areas of this size are not adequately represented in the regional curve data. Because they are not well represented, design information based primarily on the regional curve is likely to vary significantly from the hydraulic regime of the site.

Despite this short-coming, NC mountain data points with drainage areas less than 15 square miles were used to develop a best-fit power curve for bankfull flow. This equation yielded a bankfull mean stage estimate of 0.7 ft for the project site drainage area of 0.18 square miles.

Bankfull indicators were identified in the field; indicators include a break in slope, an intermittent flat depositional feature, and a consistent scour line. Depth and area measurements of stable cross-sections with bankfull indicators were compared to regional curve data to verify the quality of the indicators. Surveyed cross sections with bankfull indicators were plotted on the regional curve. UT3 data points plotted near the North Carolina Mountain Regional Curve (Harman et al, 2000), indicating that the bankfull stage selected in the field was comparable with that of other Mountain streams of similar drainage area. The resulting extension and adjustment of the best fit line did not significantly alter the results or the design mean bankfull stage of 0.66 ft.

Figure 3.2 NC Mountain Regional Curve for Discharge ($Q_{,UT3} \approx$ 55 cfs)



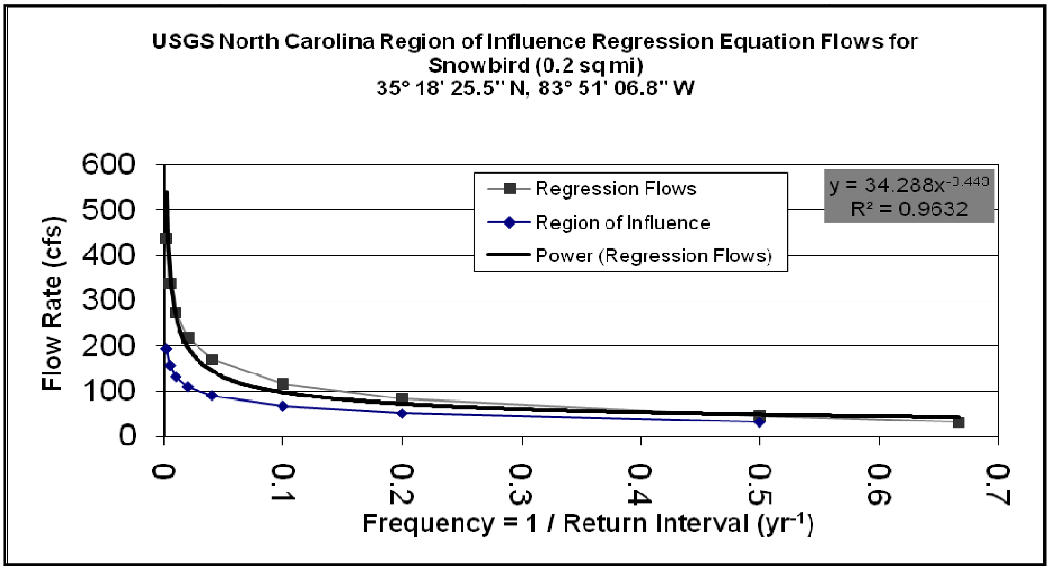
3.6.3 USGS Regression Equations

North Carolina USGS Regionalized (Region of Influence) Regression Equations (Pope et al. 2001) incorporate latitude, longitude, and drainage area information when used to calculate flood estimates based on data from USGS gauges. These regression equations were used to calculate the estimates for the 2-, 5-, 10-, and 25-year floods. The regression equation flows for the mountain and piedmont were plotted for comparison.

The data for UT3-Reach 3 (drainage area = 0.18 square miles) is plotted in Figure 3.3 below, with the supplemented regional curve flow for this project at the far right (assumed return interval of 1.5 or 0.66 frequency for plotting purposes). These regression equation flows were used as comparative estimates of different flow frequencies.

The plot predicts a flow rate of approximately 41 cfs for the 1.5-year return interval event.

Figure 3.3 USGS Regional Regression Equation Flood Events



3.6.4 Manning's Equation

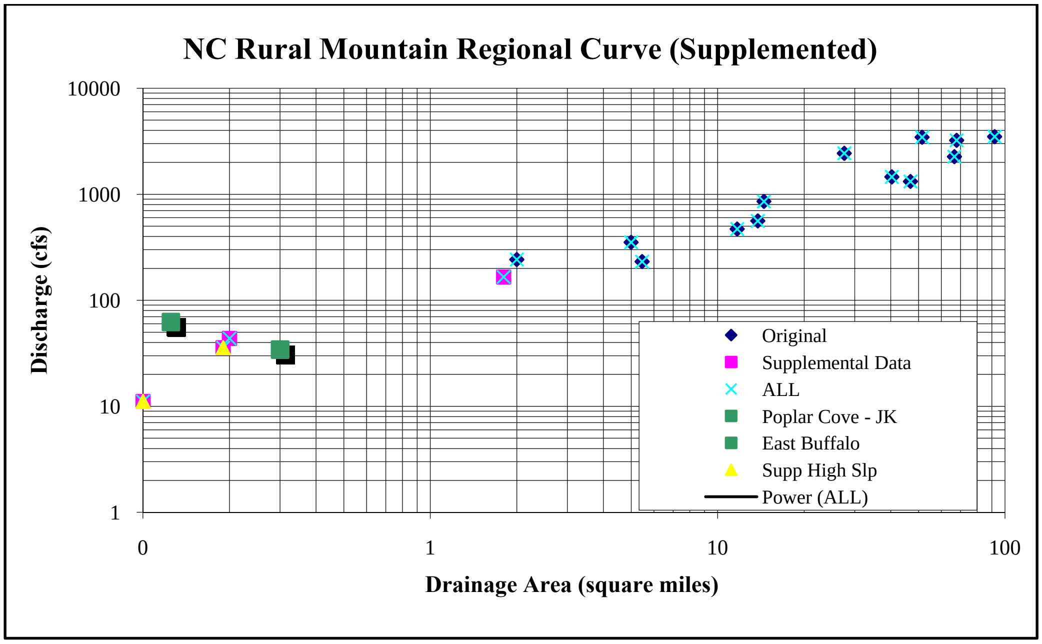
The existing conditions cross-sections were analyzed using Manning's Equation. Once bankfull stage was confidently estimated, channel parameter values including bankfull area and hydraulic radius were known and could be used with other channel parameter values including stream slope and roughness. The selection of Manning's "n" was difficult and is very influential in the results obtained.

A Manning's roughness coefficient was selected based on the factors including channel bed material and the presence and type of vegetation in the channel and on the banks. Calculated discharge was based on average channel slope and bankfull channel parameters including channel area and hydraulic radius calculated from surveyed channel cross-sections with identified physical bankfull indicators. The discharge calculated for the cross sections varied from 20-33 for a Manning's "n" value of 0.04.

3.7 Conclusions for Channel Forming Discharge

The design discharge was estimated using existing conditions, field identified bankfull indicators, and the Manning's discharge estimation method. However, the estimates developed from published regional methods (curves, USGS equations) were high in comparison with estimates developed with Manning's equations for the existing channel – somewhat contrary to expectations for incised channels. The selection of Manning's "n" is difficult for steep channels with coarse bed material. Ultimately, design channel dimensions were based off cross-sectional geometry data from a variety of sources (existing conditions, upstream and nearby references, regional curve and project supplemented curve-shown below). The supplemented curve includes points from other local projects (discharges are also heavily dependent on slope and Manning's "n") and other steep streams in the region. This curve supports that the bankfull discharge should be in the range of 25-50 cfs.

Figure 3.4 Supplemented Project Curve for Bankfull Discharge



All of the sources mentioned provided information for selecting the design discharge, as summarized in Table 3.5. The design discharge was ultimately calculated based on the channel dimensions selected and a Manning's "n" estimate of 0.05. This served as a check of the compiled geometry data against reasonable estimates of discharge prepared in the table below. As mentioned earlier, reference reach geometries and step-pool design guidance were given more weight for ultimate design decisions than was the selected discharge. The design discharge calculation supports the proposed channel geometry.

Table 3.5 Summary of Design Discharge for UT3 Reach 2

Snowbird Creek Tributaries Restoration Plan- Project #000613

Stream	Reach	DA (square miles)	Q, Supplemented Mountain Regional Curve (cfs)	Q, USGS Regression Equation (cfs)	Q, 1-D Manning's Formula, n=0.04 (cfs)	Design Q* (cfs)
				1.5 year		
UT3	2	0.18	45	41	20-33	43

* Design Q is based on Manning's Equation for the design riffle cross-section and an assumed n-value of n=0.05 due to the increase in form and channel roughness expected as a result of the project.

3.8 Vegetation and Habitat Descriptions and Disturbance History

The habitat within and adjacent to the proposed project area consists of Dry Mesic Oak (-Hickory) Forest, Dry Mesic Mixed Forest, and Appalachian Cove Forest as described by Schafale and Weakley (1990) below (http://www.discoverlifeinamerica.org/atbi/grsmnp_habitats/forest/deciduous/CEGL007710.shtml). The riparian areas ranged from relatively disturbed to very disturbed. A general description of each community follows.

3.8.1 Dry Mesic Oak (-Hickory) Forest

This ecological community covers mid slopes and upland forest areas within the preservation reaches. The dominant canopy species of the dry mesic oak forest area includes white oak (*Quercus alba*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), mockernut hickory (*Carya alba* (*tomentosa*)), red hickory (*Carya ovalis*), and pignut hickory (*Caryus glabra*). Yellow poplar (*Liriodendron tulipifera*) are also present on-site. Understory species in this forest community typically include red maple (*Acer rubrum*), flowering dogwood (*Cornus florida),* sourwood *(Oxydendrum arborem),* and american holly *(Ilex opaca).* Shrubs include downy arrowwood (*Viburnum rafinesquianum),*deerberry *(Vaccinium stamineum),*Blue Ridge blueberry *(Vaccinium pallidum (vacillans)),* and strawberry bush *(Evonymus americana).* Herbs are fairly sparse, with *Hexastylis spp.,* downy rattlesnake plantain, striped prince's pine *(Chimaphila maculata),* nakedflower ticktrefoil *(Desmodium nudiflorum)*, and rattlesnakeweed common.

3.8.2 Dry Mesic Mixed Forest

This ecological community is located on low ridges, upland flats and in transition zones with dry mesic oak-hickory forests within the project area. This community type is similar to the Dry Mesic Oak-Hickory Forest community type with one exception. This forest type is dominated less by white oak and more by northern red oak (*Quercus rubra*), tulip poplar (*Liriodendron tulipifera*), and American Beech (*Fagus grandifolia*).

3.8.3 Agricultural/Hay/Pasture Land

The bottom reach of UT3 is classified as agricultural area where the stream is bordered by an open field. The plant species in the adjacent field are composed primarily of mosses, grasses and other groundcover that includes fescue (*Fescue* spp.), golden rod (*Solidago* spp.), jewelweed (*Impatiens capensis*), poison ivy *(Toxicodendron (Rhus) radicans),* christmas fern (*Polystichum acrostichoides*), woodfern (*Dryopteris* spp.), stinging nettle (*Urtica dioica*), and soft rush (*Juncus effusus*).

3.8.4 Appalachian Cove Forest (Typic Montane)

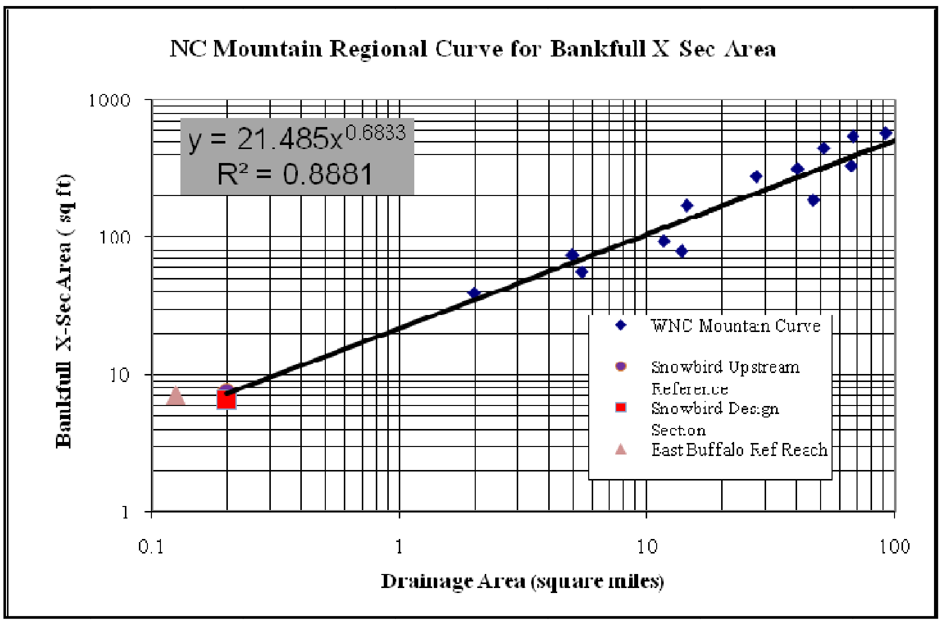
Similar to other plant communities present, the Appalachian Cove Forest (Typic Montane) is also a type of deciduous forest. It is located within the project area at the middle to lower elevations. The dominant canopy species present include a yellow buckeye (*Aesculus flava*), white ash (*Fraxinus americana*), white basswood (*Tilia americana var. heterophylla*), and the cucumbertree (*Magnolia acuminata*). Also present are tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), Eastern hemlock (*Tsuga canadensis*), and sweet birch (*Betula lenta*). The shrub layer is generally sparse to moderate and varies in composition from site to site depending on canopy cover. Common species located in the shrub stratum include sweetshrub (*Calycanthus floridus*) and rhododendron (*Rhododendron maximum*) which dominates the preservation and enhancement reaches of the project area. Herbaceous cover was sparse to moderate depending on the level of previous disturbance and density of the shrub layer. Common species include a variety of sedges (*Carex spp.- Carex austrocaroliniana, Carex pensylvanica, Carex virescens*), fragrant bedstraw (*Galium triflorum*), star chickweed (*Stellaria pubera*), and violet (*Viola spp.-Viola rotundifolia, Viola pubescens, Viola canadensis*, etc.).

4.0 REFERENCE STREAMS

In an effort to determine suitable reference reaches for the design we reviewed data from prior projects in the mountains, internal and publicly available reference reach data, on-site data from upstream of the project reach, and reference condition data at another Baker EEP project preservation site. This data was reviewed and through familiarity with the sources, the most comprehensive references have been provided in Table 4.1 of this report. Design ratios for pattern and profile were based on evaluating dimensionless ratios from these data sources. Design ratios used by Baker that have been successful at many similar sites were also referenced in the same table.

In the process, applicable geomorphic data for watersheds of comparable drainage area to the project site and located within the same or similar physiographic regions were utilized to extend the NC Mountain Regional Curve. By acquiring data points on the low end of the curve, beyond the range of the published data, Baker was able to develop modified regional curve power functions for use in the design decision making process. The regional curve results were used as part of the design decision making process. Values derived from these new power functions are summarized in Section 7 where design criteria are presented in numeric form. Figure 4.1 depicts the bankfull cross sectional area from the Regional Curve at 6.66 sq ft for a watershed of 0.18 square miles vs. a design x-sectional area of 6.5 sq ft.

Figure 4.1 NC Mountain Regional Curve for Bankfull X-Sec Area ($A_{,UT3} \approx 6.66$ sf)



The primary reference reaches chosen for tabular site design based on reference reach ratios were Craig Creek (Pisgah National Forest site evaluated by NC State) and a UT to East Buffalo Creek (UT6), another Baker EEP full-delivery project presently underway within miles of the Snowbird Creek tributaries site. The specific design parameters are described in detail in Section 7. On-site data, restoration project design data, and reference reach data were used in this design and these data are described below and summarized in Table 4.1. Surveyed cross-sections and profile data from the Snowbird Creek tributaries project tributaries are included in Appendix D.

Craig Creek is located in the Pisgah National Forest and was evaluated by NC State University as part of a thesis research project evaluating morphology relationships in reference streams. The stream is an example of a B4 stream type with a small drainage area, similar to the project reaches.

UT6 to East Buffalo Creek is a geomorphically stable reach on a nearby Baker EEP full-delivery project site. The stream is an example of an A3a+ stream type sharing a comparable drainage area, dimension, slope, and hydrologic character to the project reach.

Table 4.1 Geomorphic Design Parameters Snowbird Creek Tributaries Restoration Plan-Project #000613	**Snowbird Design**		**Snowbird Existing Conditions**		**UT6 to East Buffalo Reference Reach**		**Craig Creek Reference Reach**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
1. Stream Type	B		B3		A3a+		B4	
2. Drainage Area – square miles	.18	.18	.18	.18	.13	.13	1.6	1.6
3. Bankfull Width (w_{bkf}) – feet	9.9	9.9	5.21	6.78	7.38	8.04	27.6	27.6
4. Bankfull Mean Depth (d_{bkf}) – feet	.66	.66	.55	.63	.87	.98	1	1.1
5. Width/Depth Ratio (w/d ratio)	15.1	15.1	9.5	10.7	7.57	9.22	25	27
6. Cross-sectional Area (A_{bkf}) – SF	6.5	6.5	2.9	4.3	7.02	7.2	26	33
7. Bankfull Mean Velocity (v_{bkf}) – fps	3.1	6.2	-------	-------	-------	--------	-------	-------
8. Bankfull Discharge (Q_{bkf}) – cfs	20	40	-------	-------	-------	--------	-------	-------
9. Bankfull Max Depth (d_{mbkf}) – feet	.9	.9	.68	1.06	1.09	1.36	1.6	1.6
10. d_{mbkf} / d_{bkf} ratio	1.21	1.36	1.24	1.68	1.25	1.39	1.6	1.6
11. Low Bank Height to d_{mbkf} Ratio	1.21	1.36						
12. Bank Height Ratio dlow/dmax	1	1	2.3	2.3	1.05	1.22		
13. Floodprone Area Width (w_{fpa}) – feet	20	50	7.3	15.6	12.15	15.73	36	38.6
14. Entrenchment Ratio (ER)	2	5	1.4	2.4	1.65	1.96	1.3	1.4
15. Meander length (L_m) – feet								
16. Meander length to bankfull width (L_m/w_{bkf})								
17. Radius of curvature (R_c) – feet								
18. Radius of curvature to bankfull width (R_c / w_{bkf})								
19. Belt width (w_{blt}) – feet								
20. Meander Width Ratio (w_{blt}/W_{bkf})								
21. Sinuosity (K) Stream Length/ Valley Distance	1.1	1.1	1.1	1.1	1.08	1.08	1.1	1.1
22. Valley Slope – feet per foot	.094	.094	.094	.094	.136	.136	.0364	.0364
23. Channel Slope ($s_{channel}$) – feet per foot	.089	.089	.087	.087	.121	.121	.0331	.0331
24. Pool Slope (s_{pool}) – feet per foot							0	0
25. Pool Slope to Average Slope (s_{pool} / $s_{channel}$)							0	0
26. Maximum Pool Depth (d_{pool}) – feet							2.1	2.1
27. Pool Depth to Average Bankfull Depth (d_{pool}/d_{bkf})							2.1	
28. Pool Width (w_{pool}) – feet							26	26
29. Pool Width to Bankfull Width (w_{pool} / w_{bkf})							.9	.9
30. Pool Area (A_{pool}) – square feet							37.1	37.1
31. Pool Area to Bankfull Area (A_{pool}/A_{bkf})							1.1	1.4
32. Pool-to-Pool Spacing – feet	5	48					42	156.5
33. Pool-to-Pool Spacing to Bankfull Width ($p\text{-}p/w_{bkf}$)	.5	4.8					1.5	6.7
34. Riffle Slope (4((s_{riffle}) – feet per foot	.048	.153					1.9	7.6
35. Riffle Slope to Average Slope (s_{riffle}/ s_{bkf})	.54	1.72					1.9	7.6
36. Pool Length, Lp								
37. Pool Length Ratio Lp/Wbkf								
38. Particle Size Distribution of Riffle Material								
Material (d_{50})			Small Cobble		Medium Gravel		Very Coarse Sand	
d_{16} – mm			7.6		5.6		5	5.6
d_{35} – mm			22.6		9.5		14.3	
d_{50} – mm			90		11		30.8	
d_{84} – mm			90		100		88.4	
d_{95} – mm			128		200		110	
- : data not available								

5.0 PROJECT SITE WETLANDS (EXISTING CONDITIONS)

5.1 Jurisdictional Wetlands

The proposed project area was reviewed for the presence of wetlands and waters of the United States in accordance with the provisions on Executive Order 11990, the Clean Water Act, and subsequent federal regulations. Wetlands have been identified by the USACE as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR 328.3(b) and 40 CFR 230.3 (t)).

Following an in-office review of the National Wetland Inventory (NWI) map, NRCS soil survey, and USGS quadrangle map, a field survey of the project area was conducted to delineate wetlands and waters of the U. S. The project area was examined utilizing the jurisdictional definition detailed in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory, 1987). Supplementary information to further support wetland determinations was found in the *National List of Plant Species that Occur in Wetlands: Southeast (Region 2)* (Reed, 1988).

There are no areas located within the project boundary that display true wetland characteristics. Therefore, no wetland restoration or enhancement activities are proposed under the Snowbird Creek Tributaries restoration project.

5.2 Reference Wetlands

No wetland restoration or enhancement activities are proposed under the Snowbird Creek tributaries restoration project. Therefore, no reference wetland data is required.

6.0 PROJECT SITE RESTORATION PLAN

This section discusses the design objectives selected for the stream restoration, enhancement, and preservation of three unnamed tributaries to Snowbird Creek that are encompassed within the project area. Preservation is proposed on UT1, UT2 Reaches 1 and 3, and UT3 Reach 1. The costs and risk benefits were weighed qualitatively in determining which reaches to preserve and which to enhance or restore. Despite prior impacts, the preservation areas have largely recovered. The remaining evidence for local instability is not of system-wide concern and mostly reflects local perturbations that are consistent with natural impacts found in reference streams. Any minor improvements that could be made to them would not be justified given the level of disturbance that would be required to access these steep and densely wooded areas.

The other reaches will be treated with the appropriate level of site work to generate a sustainable functional lift for the functions that have been compromised. UT 3 - Reach 2 will be restored. The proposed stream restoration design will consist of a Rosgen Priority Level 1 approach. The Priority Level 1 approach involves the reconstruction of a channel along the location of the previously abandoned historical stream channel.

Priority Level 1 restoration efforts on Reach 2 of UT3 are justifiable for the following reasons:

1. Albeit on a small scale due to the size of the stream, there is evidence of incision and bank erosion due to past straightening activities and buffer impacts;
2. The stream would benefit significantly by being returnedto its original location, and pattern; and creating better riffle and step/pool sequences;
3. Moving the stream away from the valley wall will reduce erosion, improve floodplain connectivity, and improve floodplain hydrology;
4. The recommended Priority 1 restoration efforts are likely to raise the water table in the valley and result in improved hydrology;

Enhancement Level II measures are proposed for UT 2 – Reach 2. The design will focus on removing debris and invasive species and establishing native riparian buffers. This stream is currently close to the low point of the valley; pattern adjustment would be inappropriate for the valley type. The restored and enhanced streams will be Rosgen B type streams with design dimensions based on reference reaches, sediment transport modeling and successful application in past projects. Where abandoned, the old stream channel will be backfilled using fill material generated by the grading of the new channel. Any excess fill material that is generated during construction will be disposed of on-site in designated disposal areas.

The restoration design and enhancement improvements will allow stream flows larger than bankfull flows to spread onto the floodplain, dissipating flow energies and reducing the stress on streambanks. In-stream structures will be used to control streambed grade, reduce stresses on streambanks, and promote bedform sequences and habitat diversity for Reach 2 of UT 3. In-stream structures may consist of root wads, constructed riffle/cascades, rock/log vanes, and boulder steps. Reach-wide grade control will be provided by the aforementioned in-stream structures. Where possible, both wood and rock will be incorporated into the structures to promote a diversity of habitat features. Streambanks will be stabilized with a combination of bioengineering measures, erosion control matting, bare-root plantings, and live staking.

This section discusses the design criteria selected for stream restoration on Reach 2 of UT 3 to Hooper Branch.

6.1 Restoration Project Goals and Objectives

The goals (italicized) and means for accomplishing the same for this restoration project are as follows:

Promote and recreate geomorphically stable conditions: Restoration and enhancement activities on UT3 (Reach 2) and UT2 (Reach 2), respectively, will restore a stable dimension, pattern, and profile to these reaches. The primary physical modifications are restoring step-pool morphology to UT3 while relocating it to the low point in the valley, and removal of logging debris from UT2. The vegetation enhancement activities will complement these efforts to restore physical stability. Preserved reaches are near full recovery from prior logging impacts- the designation of a permanent buffer on these reaches will prevent future disturbance and allow for a permanent natural stream corridor with all of the benefits that a buffer provides.

Reduce sediment and nutrients inputs, decrease fine sediment loading: Establish and preserve native stream bank and floodplain vegetation to increase storm water runoff filtering capacity and improve bank stability by creating appropriate dimensions to halt bank erosion and promote natural transport processes and to increase bank stability with the rootmass of planted vegetation.

Improve aquatic and terrestrial habitat: Existing coldwater habitat will be protected and degraded habitat will be addressed with physical restoration or enhancement. Water temperature, dissolved oxygen and other habitat components will be positively impacted by improving streamside vegetation cover, and wildlife habitat will be protected through the development of conservation easements and enhanced through the removal of invasive plant species and the planting of native vegetation.

This project reach is an appropriate candidate for restoration as the channel is perched on one side of the valley and is locked in this location by manmade berms. The stream has not been able to reach a stable state and the hydrology of the valley will not be the same until the channel is returned to the low point in the valley. Bank erosion and a lack of riparian buffer are problematic. Restoration and enhancement measures will create a stable stream at the appropriate location in the valley and significantly diminish bank erosion and improve habitat value.

The accompanying plans depict the proposed restoration measures. The application of these measures are described below for the project restoration reach:

<u>UT3 to Hooper Branch (Reach 2)</u>

Priority I restoration of Reach 2 of UT3 will address prior manipulation and relocation of the reach by recreating a channel with step-pool morphology in the low part of the valley. The reconstruction of the stream will facilitate the elimination of existing problems which include bank erosion, aggradation of fines, and lack of riparian vegetation and rootmass. The new channel will be connected to floodplain in the appropriate hydrologic location in the valley. Vertical and lateral stability will be achieved with riffle-pool sequences achieved with a series of small grade drops. Grade control structures will aid in dissipating streamflow energy, decrease pool-to-pool spacing and improve the quality of pool habitat present. A vegetated riparian buffer will also be restored. These efforts will restore grade control, lateral stability, and habitat features to the reach improving both its health and function, as well as that of receiving waters.

6.2 Design Criteria Selection for Stream Restoration

A number of analyses and data were incorporated in the development of the site-specific natural channel design approach for restoration efforts on Reach 2 of UT3. Among these are hydraulic and sediment analyses, existing site conditions data collection, incorporation of reference reach databases, regime equations, and evaluation of results from past projects.

Design criteria are dependent on the general restoration approach determined to be a best fit for the Snowbird Creek tributaries restoration site (Table 6.1). The approach was based on the reach's potential for restoration, as determined during the site assessment. After selection of the general restoration approach, specific design criteria were developed so that the plan view layout, cross-section dimensions, and profile could be described for the purpose of developing construction documents. The design philosophy at the Snowbird Creek tributaries site is to use average values for the selected stream type when designing dimension and profile and to work within the ranges expected for the selected stream type with regards to pattern and in-stream structures used. This approach should allow for maximum diversity of pattern and habitat while maintaining stable pools and riffles. Variation in form will develop over long periods of time under the processes of flooding, re-colonization of vegetation, and geologic influences.

After examining the existing conditions, recognizing the potential for restoration, and reviewing reference reach data, design criteria were developed. Assigning an appropriate stream type for the corresponding valley that will accommodate the existing and future hydrologic and sediment contributions was considered conceptually prior to selecting reference reach streams. Design criteria for the proposed stream were selected based on the range of the reference data and the desired performance of the proposed channel.

Following initial application of the design criteria, detail refinements were made to accommodate the existing valley morphology, to avoid encroachment into the access road embankment, to minimize unnecessary disturbance, and to promote natural channel adjustment following construction. The construction documents have been tailored to produce a cost and resource efficient design that is constructible, using a level of detail that corresponds to the tools of construction. The design also reflects a philosophy that the stream will adapt to the inherent uniformity of the restoration project and be allowed to adjust over long periods of time under the processes of flooding, re-colonization of vegetation, and local topographic influences.

Table 6.1 Project Design Stream Types and Rationale
Snowbird Creek Tributaries Restoration Plan- Project #000613

Reach	Proposed Stream Type	Rationale
UT 2 Reach 2	NA	An Enhancement II approach will be used to remove woody debris, leftover from logging, from the channel and to stabilize the channel and banks through the reach. Vegetation will be planted to provide bank stabilization, shading and vegetative diversity.
UT 3 Reach 2	B	A Restoration approach will be used to establish a stable, step/pool channel with greater pool habitat at the historical stream location at the lowest point in the valley. The constructed channel will provide connectivity to floodplain. Bank stability will be improved by eliminating nonnative vegetation and planting diverse tree, shrub and herbaceous species.

6.3 Stream Project Design & Justification

The primary objective of the restoration design is to construct a stream with a stable dimension, pattern, and profile that has access to its floodplain at bankfull flows while enhancing riparian and aquatic habitat. The philosophy applied by Baker through the restoration reach on UT3 consisted of creating a high width-depth ratio B type channel with the expectation that it may naturally narrow over time as the riparian buffers become more established.

Data for design guidance was developed using a survey of the existing conditions both upstream and within the design reach, selecting applicable reference reach data to survey and use in the development of dimensionless geomorphic design ratios, selecting data to enhance and extend the data range of published regional curves, and based on a consideration of constructability and equipment limitations. Lines of converging evidence provided confidence in the approach and design targets. The proposed design parameters for the Snowbird Creek tributaries project are detailed in Table 6.2. The design rationale and design parameters are presented below.

Dimension

Through the proposed design, the cross-section dimensions were adjusted to reduce velocities and near-bank shear stress during storm flows. Channel width was designed to maintain velocities that could move small grain particles through the reach and avoid aggradation. A low bank height ratio (BHR) of 1.0 was designed so the channel has access to the floodplain during events having flows in excess of bankfull. Typical cross sections are shown on the attached plan sheets.

Pattern

The proposed channel alignment on Reach 2 will decrease the stream length by 12 LF and thus sinuosity slightly. This reduction in stream length represents a return of the channel to the original location at the lowest point of the valley. Plan views of the channel are shown on the attached plan sheets.

The pattern for the proposed step-pool channel is based on typical natural sinuosity for steep headwater streams in natural settings. A sinuosity of 1.1-1.2 is typical of these streams and is appropriate for the new design channel. These channels do not dissipate energy in meanders but rather through vertical drops. The pattern has been laid out so as not to create high shear stresses with sharp bends that would be atypical to this type of stream system. The overall length of restored and enhanced channel will decrease slightly from 714 to 702 LF due to the lateral distance that the channel was previously moved to put it against the valley wall. Plan views of the main channel are shown on the plan sheets.

Profile/Bedform

Although moderately functional and somewhat stable, the channel profile of the existing stream is lacking sufficient overall bedform diversity. During construction of the proposed channel, cross section dimensions will be achieved first, followed by structure placement and facet development to mimic characteristics of the reference conditions. The profile along the proposed restoration channel alignment calls for alternating steps, pools, and steep riffles (or cascades). This step-pool morphology is typical of steep headwater mountain streams which are both hydraulically diverse and stable. With an overall valley slope of approximately 9.4%, the steps, pools, and cascades will provide adequate energy dissipation and prohibit bed degradation and excessive material transport. Riffle slopes and the magnitude of drops are limited to sustainable values observed to be stable from prior project experience. The average channel slope for the total reach is .089 which is a minor increase from the existing reach-wide slope of .087. Riffles or cascades throughout the design reaches are between .5 and 2.0 times the average slope of the channel. Structural modifications to the existing profile will be done primarily with rock structures.

A stable cross-section will be achieved by widening the channel and increasing the width/depth ratio. Stability will be enhanced by achieving a cross-section with banks that are low sloping to bankfull. Grade control at the bed is a major concern at this site due to the steep slope of the valley. A variety of in-stream structures will be used to enhance stability and improve habitat. These structures include boulder steps, log J-hook structures and embedded logs. Bioengineering and in-stream structures will be used (including root wads, vegetated geo-lifts and log vanes) to promote additional bank stability and improve habitat.

Reach 2 of UT 3, a 466-LF reach, is designed as a Rosgen B stream type, having a steep slope and minimal meandering. A variety of in-stream structures will be installed in this reach that will serve to provide grade control, center the thalweg, and improve habitat quality.

Table 6.2 presents the proposed stream restoration design criteria applied through the project reach.

Table 6.2 Design Parameters and Proposed Geomorphic Characteristics
Snowbird Creek Tributaries Restoration Plan-Project #000613

	Design Reaches	
1. Stream Type	B	
2. Drainage Area – square miles	0.2	
3. Bankfull Width (w_{bkf}) – feet	9.9	
4. Bankfull Mean Depth (d_{bkf}) – feet	0.66	
5. Width/Depth Ratio (w/d ratio)	15.1	
6. Cross-sectional Area (A_{bkf}) – SF	6.5	
7. Bankfull Mean Velocity (v_{bkf}) – fps	4.3	
8. Bankfull Discharge (Q_{bkf}) – cfs	30	
9. Bankfull Max Depth (d_{mbkf}) – feet	0.9	
10. d_{mbkf} / d_{bkf} ratio	1.37	
11. Low Bank Height to d_{mbkf} Ratio	1	
12. Floodprone Area Width (w_{fpa}) – feet	20+	
13. Entrenchment Ratio (ER)	2.0+	
14. Meander length (L_m) – feet	NA	NA
15. Meander length to bankfull width (L_m/w_{bkf})	NA	NA
16. Radius of curvature (R_c) – feet	NA	NA
17. Radius of curvature to bankfull width (R_c / w_{bkf})	NA	NA
18. Belt width (w_{blt}) – feet	NA	NA
19. Meander Width Ratio (w_{blt}/W_{bkf})	NA	NA
20. Sinuosity (K) Stream Length/ Valley Distance	1.1	
21. Valley Slope – feet per foot	0.094	
22. Channel Slope ($s_{channel}$) – feet per foot	0.089	
23. Pool Slope (s_{pool}) – feet per foot	0.000	
24. Maximum Pool Depth (d_{pool}) – feet	0.5	
25. Pool Depth to Average Bankfull Depth (d_{pool}/d_{bkf})	0.56	
26. Pool Width (w_{pool}) – feet	NA	
27. Pool Width to Bankfull Width (w_{pool} / w_{bkf})	NA	
28. Pool Area (A_{pool}) – square feet	NA	
29. Pool Area to Bankfull Area (A_{pool}/A_{bkf})	NA	
30. Pool-to-Pool Spacing – feet	5	48
31. Pool-to-Pool Spacing to Bankfull Width (p-p/w_{bkf})	0.5	5
32. Riffle Slope (4((s_{riffle}) – feet per foot	0.048	.15
33. Riffle Slope to Average Slope (s_{riffle}/ s_{bkf})	0.6	1.9

6.3.1 UT2-Reach 2 Target Buffer Communities

UT 2- Reach 2 is an appropriate candidate for enhancement because significantly more erosion will occur before the channel is able to achieve a stable, quasi-equilibrium state. Most of the project enhancement reach appears to have one of two problems: over-widening from debris and aggradation or erosion and channel braiding due to a lack of vegetation and prior logging. These two instability problems are contributing excessive sediment to the areas downstream of the project site. Enhancement can help to stabilize the channel, halt over-widening, establish proper pattern and significantly diminish bank erosion.

To restore functions that have been compromised, enhancement efforts will also include hand work with chainsaws and other hand tools to remove debris and enhance the function of vegetation in maintaining stream stability. In places, rhododendron branches have fallen in or entire plants have been washed out of the bank or the rhododendron plants are so thick that they have limited germination of tree species.

Vegetation along all reaches will be modified to increase diversity by reducing the density of rhododendron and planting a mix of species that root deeply and provide higher quality biomass to the stream to support aquatic food chains. Invasive vegetative species removal efforts and reforestation of the riparian buffer with native species will complement the debris removal.

6.3.2 Sediment Transport Methodology

The purpose of a sediment transport analysis is typically to ensure that the stream restoration design creates a stable channel that does not aggrade or degrade over time. Being naturally degradational, steep headwater streams should primarily be designed to have limited particle mobility.

Sediment transport competency is a measure of force over an area (lbs/ft2) that refers to the stream's ability to move a given particle size. Quantitative assessments include shear stress, tractive force, and critical dimensionless shear stress. Since these assessments help determine a size class that is mobile under certain flow conditions, they are most important in gravel bed studies in which the bed material ranges in size from sand to cobble (of which only a fraction are mobile during bankfull conditions).

Comparing the design shear stress values for a project reach to those for the existing conditions in a system allows a quantitative determination of reduction of erosive forces.

The primary consideration in terms of the design, aside from the channel geometry, is the sizing of the bed material such that it will be immobile during the channel forming or bankfull flow. To assist in determining what bed material is needed, a bulk sample was taken from the existing bed (pavement and sub-pavement) of the stream reach to be restored. The results are presented in Table 3.2. The bulk sample reveals an existing stream bed lining dominated by small cobbles (over half the sample by dry weight, in fact). Fine sand, silt, and clay particles accounted for only 2% of the sample and may be remnants from prior logging in the watershed.

The design will incorporate boulders that exceed what the maximum shear stress can move with a factor of safety. Cascades and steep riffles will be constructed with a mix of the colluvium from the existing channel and larger material brought on-site to create a coarse and mostly non-mobile bed. The coarsest fractions of the sediment load may only move during the largest flood events.

6.3.2.1 Sediment Transport Calculations and Discussion

Existing channel form and sediment composition data, design data, hydraulic and sediment transport models, design spreadsheets, and best judgment were used to perform sediment transport analyses for Snowbird Creek. For reasons mentioned, sediment competency was the only type of analysis deemed appropriate for the valley and stream type.

A bulk sample (taken with shovel) was used to determine the sediment distributions for sediment transport (Table 3.2). Appendix F contains the raw data and cumulative frequency graphs for this sample and the other pebble count samples considered as part of the sediment transport analyses. The existing channel reach has a median particle size range of small cobbles. Design sediment sizes used in transport capacity analyses were D_{16} = 7.6mm, D_{50} = 90mm, and D_{84} = 90mm.

Critical shear stress calculations were performed based on the typical riffle and pool cross sections. The typical riffle and an energy grade line slope of 0,09 were used to estimate the average channel shear stress to be approximately 3.5 lb/ft^2. Based on this value, multiple methods were used to assess the maximum competent particle. Among the methods used were Lane's diagram (1953) as described in *Hydraulics of Sediment Transport* (Graf, 1971), the method “Shields Diagram for Direct Determination of Critical Shear” as described in *Open Channel Hydraulics* (Sturm 2001), a critical shear stress versus subpavement graph provided in Rosgen’s training documents, and Figure 10.3 from Raudkivi’s (1967) *Loose Boundary Hydraulics*. In addition, the riprap sizing plots referencing the Isbesh curve were consulted. The results varied within less than an order of magnitude, with good agreement between Lane, Shields, and Raudkivi. These methods yielded a maximum mobile particle size of 100-220 mm for bankfull flows in the typical riffle section. The Isbesh curve suggested that a smaller particle would be immobile and the Rosgen curve suggested that the mobile particle size would be larger. Based on the limitations of the methods, it is sufficient for this analysis to assume that particles below 100 mm have a much higher likelihood of movement under the right conditions at bankfull flow and that particles up to 200-500 mm may be mobile under extremely high flow conditions.

The existing channel has a D50 of 90 mm; this is also the size of the D84 particle size (based on the shovel bulk sample). The assessment of the surface layer (pavement) conducted by performing a 100-count pebble count analysis yielded a D50 of 58 mm and a D84 of 100 mm. It is reasonable to assume that the D84 particle size is mobile under high flow events and this validates the critical particle size (competency) analysis method results. Structures will be built using boulders of a much larger particle size that are protected and interlocked with other boulders; this will significantly reduce the risk of structure failure in the “step-pool” design channel. Riffle/cascade material brought onsite to introduce into the project will consist of particles within the range of the existing channel with some particles in the high end of the 100-220 mm range in order to increase the vertical stability of riffles. Riffles and cascades will be constructed to have a moderate to high degree of interlocking (graded) particles in order to reduce sediment transport at lower flows.

It is believed that in high gradient, low order streams, large events (on the order of 20 to 50-year return intervals) define the overall character of the channel and the spacing of energy dissipating drops (Grant et al., 1990). At these locations, the largest particles create boulder and debris jams that serve as grade control and create hydraulic diversity. The stream channel design will build a spacing based on reference data that will provide a comparable physical structure to a natural stream reach in this setting with comparable (or slightly less mobile) stone sizes.

6.3.3 Preliminary Modeling and Hydrologic Trespass

UT3-Reach 2 is a low order tributary to Hooper Branch. It is not necessary to conduct a flood study based on the following information: according to the FEMA Flood Insurance Rate Map (FIRM) for Graham County, NC, (Map Number 3700565000J) the entire project area is in an unregulated area mapped Zone X (Figure 2.3). Flood modeling is not required for non-regulatory floodplains. Furthermore, any change in the 100-year water surface is expected to be minimal and to be contained within the conservation easement.

The County does not have a Local Floodplain Administrator so Baker will be consulting with the state to ensure that there are no other requirements. The FEMA floodplain checklist has been completed and is in Appendix B.

6.4 Site Construction

6.4.1 Site Grading, Structure Installation, and Other Project Related Construction

6.4.1.1 Narrative

A construction sequence is provided below and can be found within the accompanying restoration plan set for the Snowbird Creek tributaries project.

1. Any utility locations shown on these plans are approximate. The contractor shall have all underground utilities within the project limits located and marked prior to beginning construction.
2. Access to the site shall be from the existing drive on IU Gap Road; any impact to these roads or associated erosion control practices shall be addressed immediately. All damage or impacts from use of existing access roads will be repaired immediately if it poses a risk to water quality or prior to demobilization or at the request of the project engineer.
3. The construction entrance shall be maintained to the specifications of the detail. Excessively muddy stone shall be replaced. All public roads shall be kept free of mud and debris. Entrances shall be returned to their pre-existing condition prior to demobilization.
4. First, erosion and sediment control will be installed. Staging areas will be established. Equipment and materials will be mobilized to these locations. Boulders can be staged adjacent to structure installation locations. Boulders can be staged adjacent to structure installation locations. All ground disturbed from stone trucks shall be mulched at the end of each day.
5. Temporary soil stockpile & extra fill area are denoted on the plans and will be outfitted with silt fence to protect adjacent areas from sediment runoff. Silt fence shall remain in place until temporary or permanent vegetation has been established. The clearing and grubbing required within the grading limits shall be performed so as to limit sediment migration off-site. Logs and root wads from trees larger than 10 inches in diameter shall be stockpiled for use as in-stream structures. Salvageable native vegetation (doghobble, rhododendron, yellowroot, etc.), mats or individual plants will be harvested for transplanting. These mats will be excavated and moved to the banks of the new channel sections.
6. Activities will involve both enhancement to the existing channel at the tie-in points and creation of new Priority 1 offline channel. Earthwork shall be staged such that no more channel will be disturbed than can be stabilized by the end of the work day or before flow is diverted into the new channel segment. Mulch will be applied to all disturbed areas and bare soil at the end of each day.
7. Dewatering of off-line channel sections is expected to be minor. Any water pumped during dewatering operations in the off-line sections will be diverted through a sediment filter before being discharged into the downstream reach. The pumping detail outlines this procedure and the use of temporary sand bag coffer dams in order to divert the flow with a pump and piping.
8. All structures will be installed. The new channel will be dug and stabilized with seed, mulch, and matting. During this process, the cut material from the new channel will be systematically moved to the stockpile or fill areas (and contained with silt fence). Any sediment against silt fences will be removed when sediment has accumulated above one third of the height of the silt barrier and/or it has failed. This excess material will be hauled outside the conservation easement or used to backfill abandoned channel before demobilization.

9. A pump around will be set up for the existing channel- see the pump around detail on sheet 13 for a more detailed explanation of flow diversion.
10. Once the channel is dewatered, the contractor will plug the lower end of the old channel and move gravel and cobble bed material from the old channel into the new channel as specified in the typical cross section. Matting shall already be in place at this point so that the gravel helps reinforce the toe of the matting.
11. Any material needed to fill in the old channel will be borrowed from the stockpile area. Upon filling the old channel, all bare areas shall be seeded and mulched. The silt socks shall be reused and rearranged with extra silt sock to protect the new channel where possible.
12. Where the downstream tie in is located, the root wad and single log vanes will be installed. Then, the upstream channel plug will be built from a non-sandy material and the downstream and upstream tie ins constructed in the dry. Upon stabilization of the tie ins, the pump around will be removed and the water released into the new channel.
13. During this process, sediment from the stockpile (except channel gravel) will be moved to the fill area to balance the site. Any material in excess of the maximum fill area dimensions shall be spread and subsequently covered with mulch. Finish all fine grading, and finish seeding and mulching all bare areas. Staging areas will be seeded and mulched upon completion.

* Bank and floodplain vegetation, including brush materials and live stakes, will be installed during dormant season (November to April).
* Silt fences will be removed once planting is complete or once they are no longer needed.
* Construction entrances and site access will be repaired to initial conditions prior to demobilization.

6.4.1.2 In-stream Structures and Other Construction Elements

A variety of in-stream structures are proposed for the Snowbird Creek site. Structures such as root wads, boulder steps, embedded logs and log vanes will be used to stabilize the newly-restored stream. This project will primarily utilize those structures which provide grade control and enhance pool habitat as “A” and “B” type streams make up the project site. Wood structures will be incorporated into the site because of the observed role of this material in the existing system. Table 6.3 summarizes the use of in-stream structures at the site.

Table 6.3 Proposed In-Stream Structure Types and Locations
Snowbird Creek Tributaries Restoration Plan-Project #000613

Structure Type	Location
Root Wad	Outside bank of bends for stability and habitat.
Boulder Steps	Straight sections to provide grade control, center thalweg, and improve habitat.
Embedded Logs	Primarily located in riffles to improve habitat diversity and below crossings to provide grade control.
Log Vane	Riffles to turn water off of the stream bank and provide convergence for habitat improvement.

Root Wad

Root wads are large in-tact root masses placed at the toe of the stream bank in high stress areas to absorb energy, increase flow roughness and provide a physical barrier to the erosion of vulnerable stream banks. In the process, they can help induce scour-pool formation and serve as habitat for organisms favoring wood or cover. In addition to stream bank protection, they provide structural support to the stream bank and habitat for fish and other aquatic animals. They also increase substrate surface area for aquatic insects and other benthic organisms. Root wads include the root mass or root ball of a tree plus a portion of the trunk which is driven or buried into the bank. Root wads will be used in the restoration reach.

Boulder Step Structure

Boulder step structures consist of boulders placed in the channel in a U-shape constructed similarly to a cross-vane. These structures provide grade control in steep channels, direct high velocity flows to the center of the channel, and promote diverse habitat through the creation of plunge pools immediately downstream of the structure. These projects will be used extensively on the restoration reach.

Embedded Logs

Embedded logs consist of a series of logs placed can be placed in a series of opposing angles and slopes or in a perpendicular fashion to the channel banks. These structures are used to create micro-pool habitat that is common to mountain streams. Embedded logs can also function as grade control and are particularly useful below stream crossings.

Rock or Log Vane

A rock or log vane is used to protect the stream bank. The length of a single-vane structure can span one-half to two-thirds the bankfull channel width. Vanes in this project typically are intended to function as flow directional devices reducing near bank shear stress and alignment maintenance and secondarily as grade control features. Logs and or boulders may be used to construct vanes.

Typically, cross vane applications in the project reach will be replaced with boulder steps due to the low width of the proposed cross-section. In either case, the purpose is to keep the thalweg in the center of the channel, promote channel narrowing and protect the stream bank. Any cross vanes built for this project will come to more of a point due to the requirement that the vane allow for a triangular flow “ramp” on either margin of the channel.

6.4.2 Natural Plant Community Restoration

Native riparian vegetation will be established in the restored stream buffer. In the proposal it was stated that tree and shrub species planted along the enhancement and restoration reaches would include a mixture of no less than five of the following species: hemlock (*Tsuga canadensis*), yellow buckeye (*Aesculus octandra*), spicebush (*Lindera benzoin*), flame azalea (*Rhododendron calendulaceum*), mountain laurel (*Kalmia latifolia*), and highland doghobble (*Luecothoe fontanesiana*). Hemlock has been removed from consideration due to its susceptibility to mortality from wooly adelgid. A number of other species will be considered for planting as specified in Table 6.4 below. Invasive species such as multiflora rose (*Rosa multiflora*) and Japanese honeysuckle (*Lonicera japonica*) will be removed so as not to threaten the newly established native plants within the conservation easement. Known invasive species to be treated include multiflora rose (*Rosa multiflora*) and Japanese honeysuckle (*Lonicera japonica*).

6.4.2.1 Soil Preparation and Amendments

To promote vegetation growth, organic soil amendments will be prepared according to the nutrient requirements of the Snowbird tributaries. Application of soil amendments will occur as site stabilization measures are implemented and during installation of permanent vegetation.

6.4.2.2 Stream Buffer Vegetation

Bare-root trees, live stakes, and permanent seeding will be planted within designated areas of the conservation easement. A 30-foot buffer measured from the top of banks will be established along all jurisdictional stream reaches. Bare-root vegetation will be planted at a target density of 680 stems per acre. The proposed species to be planted are listed in Table 6.4. Planting of bare-root trees and live stakes will be conducted during the first dormant season following construction. If construction activities are completed in summer/fall of a given year, all vegetation will be installed prior to the start of the growing season of the following calendar year.

Species selection for re-vegetation of the site will generally follow those suggested by Schafale and Weakley (1990) and tolerances cited in the USACE Wetland Research Program (WRP) Technical Note VN-RS-4.1 (1997). Tree species selected for stream restoration areas will generally be weakly tolerant to tolerant of flooding. Weakly tolerant species are able to survive and grow in areas where the soil is saturated or flooded for relatively short periods of time. Moderately tolerant species are able to survive in soils that are saturated or flooded for several months during the growing season. Flood tolerant species are able to survive on sites in which the soil is saturated or flooded for extended periods during the growing season (WRP, 1997).

Observations will be made during construction regarding the relative wetness of areas to be planted. Planting zones will be determined based on these observations, and planted species will be matched according to their wetness tolerance and the anticipated wetness of the planting area.

Live stakes will be installed two to three feet apart using triangular spacing or at a density of 160 to 360 stakes per 1,000 square feet along the stream banks just above and just below the bankfull elevation.

Permanent seed mixtures of native species will be applied to all disturbed areas of the project site. Table 6.5 lists the species, mixtures, and application rates that will be used. A mixture is provided for floodplain wetland and floodplain non-wetland areas. Mixtures will also include temporary seeding (rye grain during cold season or browntop millet during warm season). The permanent seed mixture specified for floodplain areas will be applied to all disturbed areas outside the banks of the restored stream channel and is intended to provide rapid growth of herbaceous ground cover and improvements to biological habitat value. The species provided are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability.

Temporary seeding will be applied to all disturbed areas. These areas include constructed stream banks, access roads, side slopes, and spoil piles. If temporary seeding is applied from November through April, rye grain will be used and applied at a rate of 130 pounds per acre. If applied from May through October, temporary seeding will consist of browntop millet, applied at a rate of 45 pounds per acre.

Table 6.4 Proposed Bare-Root and Live Stake Species (may also include seed or container species) Snowbird Creek Tributaries Restoration Plan-Project #000613			
Common Name	Scientific Name	% Planted by Species	Wetness Tolerance
Riparian Buffer Plantings			
Trees Overstory			
Sycamore	*Platanus occidentalis*	8	FACW-
River Birch	*Betula nigra*	7	FACW
White Oak	*Quercus alba*	5	FACU
Red Maple	*Acer rubrum*	5	FAC
Tulip Poplar	*Liriodendron tulipifera*	5	FAC
Yellow Birch	*Betula alleghaniensis (lutea)*	5	FACU+
Black (Sweet) Birch	*Betula lenta*	5	FACU
Northern Red Oak	*Quercus rubra*	5	FACU
Yellow Buckeye	*Aesculus octandra*	5	N/A
Mockernut Hickory	*Carya alba (tomentosa)*	3	N/A
Scarlet Oak	*Quercus coccinea*	2	N/A
Trees Understory			
Highland Doghobble	*Leucothoe fontanesiana (axilarris var. editorum)*	5	N/A
Mountain Laurel	*Kalmia latifolia*	5	FACU
Flame Azalea	*Rhododendron calendulaceum*	5	N/A
Black Willow	*Salix nigra*	2	OBL
Ironwood	*Carpinus caroliniana*	3	FAC
Witch Hazel	*Hamamelis virginiana*	2	FACU
Sourwood	*Oxydendrum arboreum*	5	FACU
Flowering Dogwood	*Cornus florida*	5	FACU
Rhododendron	*Rhododendron maximum*	3	FAC-
Tag Alder	*Alnus serrulata*	5	FACW+ or OBL
Redbud	*Cercis canadensis*	5	FACU
Shrubs			
Rivercane (giant cane)	*Arundinaria gigantea*	15	FACW
Spicebush	*Lindera benzoin*	15	FACW
Deerberry	*Vaccinium stamineum*	15	FACU
Eastern Sweetshrub, Sweetshrub	*Calycanthus floridus, Calycanthus spp.*	10	FACU
Sweetpepperbush	*Clethra spp.*	15	N/A
Winterberry	*Ilex verticillata*	10	FACW
Virginia Sweetspire	*Itea virginica*	15	FACW+
Chokeberry	*Photinia*	5	N/A
Alternate Species			

Blight-resistant American Chestnut	*Castanea dentata*	N/A	N/A
American Hazelnut	*Corylus americana*	N/A	FACU
Blue Ridge Blueberry	*Vaccinium pallidum*	N/A	N/A
Riparian Livestake Plantings			
Ninebark	*Physocarpus opulifolius*	15	FAC-
Elderberry	*Sambucus canadensis*	20	FACW-
Buttonbush	*Cephalanthus occidentalis*	15	OBL
Silky Willow	*Salix sericea*	25	OBL
Silky Dogwood	*Cornus amomum*	25	FACW+
Note: Species selection may change due to refinement or availability at the time of planting.			

Table 6.5 Proposed Permanent Seed Mixture
Snowbird Creek Tributaries Restoration Plan-Project #000613

Common Name	Scientific Name	% Planted by Species	Density (lbs/ac)	Wetness Tolerance
Creeping Bentgrass	*Agrostis stolonifera*	10%	1.5	FACW
Big Bluestem	*Andropogon gerardii*	2%	0.3	N/A
Devil's Beggartick	*Bidens frondosa (or aristosa)*	3%	0.45	FACW
Northern Long Sedge	*Carex folliculata*	2%	0.3	N/A
Nodding Sedge	*Carex gynandra*	5%	0.75	N/A
Upright Sedge	*Carex stricta*	2%	0.3	OBL
Lance-leaved Tick Seed	*Coreopsis lanceolata*	3%	0.45	N/A
Virginia Wildrye	*Elymus virginicus*	15%	2.25	FAC
Soft Rush	*Juncus effusus*	2%	0.3	FACW+
Tioga Deer Tongue	*Panicum clandestinum*	10%	1.5	FACW
Switch Grass	*Panicum virgatum*	15%	2.25	FAC+
Pennsylvania Smartweed	*Polygonum pensylvanicum*	5%	0.75	FACW
Broadleaf Arrowhead	*Sagittaria latifolia var. pubescens*	1%	0.15	OBL
Little Bluestem	*Schizachyrium scoparium*	5%	0.75	FACU
Roundleaf Goldenrod	*Solidago patula*	3%	0.45	OBL
Indian Grass	*Sorghastrum nutans*	10%	1.5	FACU
Eastern Gamma Grass	*Tripsacum dactyloides*	5%	0.75	FAC+
Joe Pye Weed	*Eupatorium fistulosum*	2%	0.3	N/A
	Total	100	15	
Note: Species selection may change due to refinement or availability at the time of planting.				

6.4.2.1 On-site Invasive Species Management

The restoration and enhancement reaches of the site contain some infestation of multiflora rose (Rosa multiflora) and Japanese honeysuckle (Lonicera japonica). These areas will be treated and monitored so that the invasive species do not threaten the newly-planted riparian vegetation.

The most appropriate means of treating invasive grasses growing in the creek and on the margins of the channel will be assessed and implemented prior to vegetation removal. The long-term development of a forested creek will shade out fescue and other invasive grasses present. These areas will also be monitored so that the invasive species do not threaten the newly-planted riparian vegetation.

7.0 PERFORMANCE CRITERIA

The Baker team has been involved in obtaining recent approvals from the regulatory agencies for a series of mitigation and restoration plans for wetland and stream projects. The stream restoration success criteria for the project site will follow accepted and approved success criteria presented in recent restoration and mitigation plans developed for numerous NCEEP full delivery projects, as well as the Stream Mitigation Guidelines issued in April 2003. Specific success criteria components are presented below.

7.1 Stream Monitoring

Channel stability and vegetation survival will be monitored on the project site. Post-restoration monitoring will be conducted for five years following the completion of construction to document project success. Monitored stream parameters include stream dimension (cross sections), pattern (longitudinal survey), profile (profile survey), and photographic documentation. The methods used and any related success criteria are described below for each parameter.

7.1.1 Bankfull Events

The occurrence of bankfull events within the monitoring period will be documented by the use of a crest gauge and photographs. The crest gauge will be installed on the floodplain within 10 feet of the restored channel. The crest gauge will record the highest watermark between site visits, and the gauge will be checked each time there is a site visit to determine if a bankfull event has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits.

Two bankfull flow events in separate years must be documented within the 5-year monitoring period. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years.

7.1.2 Cross Sections

For the Snowbird Creek tributaries project, four cross-sections will be installed for the restoration reach on UT3. Each cross-section will be marked on both banks with permanent pins to establish the exact transect used. A common benchmark will be used for cross sections and consistently used to facilitate easy comparison of year-to-year data. The annual cross-section survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross sections will be classified using the Rosgen Stream Classification System.

There should be little change in reference cross sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross sections will be classified using the Rosgen Stream Classification System, and all monitored cross sections should fall within the quantitative parameters defined for channels of the design stream type.

7.1.3 Longitudinal Profile

A longitudinal profile will be surveyed immediately after construction and once every year thereafter for the duration of the five-year monitoring period. The as-built survey will be used as the baseline for the Year One Monitoring Report. Per the monitoring report guidelines, the longitudinal profile will extend the entire length of restoration and enhancement reaches on UT2 and UT3. Measurements will include thalweg, water surface, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The survey will be tied to a permanent benchmark.

The longitudinal profiles should show that the bedform features are remaining stable; i.e., they are not aggrading or degrading. The pools should remain deep, with flat water surface slopes, and the riffles should remain steeper and shallower than the pools. Bedforms observed should be consistent with those observed for channels of the design stream type.

7.1.4 Bed Material Analyses

Pebble counts will be conducted to help monitor changes in the particle transport competencies for the stream reaches within the project area. Two 100-pebble count samples will be collected at two cross-section sites immediately after construction and every year thereafter at the time the longitudinal surveys are performed for the five year monitoring period. These samples will reveal any changes in sediment gradation that occur over time as the stream adjusts to upstream sediment loads. Significant changes in sediment gradation will be evaluated with respect to stream stability and watershed changes.

7.1.5 Photo Reference Sites

Photographs will be used to visually document restoration success. Photographic reference stations will be established on restoration, enhancement and preservation reaches. Reference stations will be photographed before construction and continued annually for at least five years following construction. Photographs will be taken from a height of approximately five to six feet. Permanent markers will be established to ensure that the same locations (and view directions) on the site are monitored in each monitoring period.

Lateral reference photos. Reference photo transects will be taken at each permanent cross-section. Photographs will be taken of both banks at each cross-section. The survey tape will be centered in the photographs of the bank. The water line will be located in the lower edge of the frame, and as much of the bank as possible will be included in each photo. Photographers should make an effort to consistently maintain the same area in each photo over time.

Structure photos. Photographs will be taken at grade control structures along the restored stream, and should be limited to cross-veins and weir structures. Photographers should make every effort to consistently maintain the same area in each photo over time.

Photographs will be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures subjectively. Lateral photos should not indicate excessive erosion or continuing degradation of the banks. A series of photos over time should indicate successive maturation of riparian vegetation.

7.2 Vegetation Monitoring

Successful restoration of the vegetation on a site is dependent upon hydrologic restoration, active planting of preferred canopy species, and volunteer regeneration of the native plant community. In order to determine if the criteria are achieved, vegetation monitoring quadrants will be installed across the restoration site. The number of quadrants required will be based on the species/area curve method, with a minimum of three quadrants. The size of individual quadrants will vary from 100 square meters for tree species to 1 square meter for herbaceous vegetation. Vegetation monitoring will occur in spring, after leaf-out has occurred. Individual quadrant data will be provided and will include diameter, height, density, and coverage quantities. Relative values will be calculated, and importance values will be determined. Individual seedlings will be marked to ensure that they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

At the end of the first growing season, species composition, density, and survival will be evaluated. For each subsequent year, until the final success criteria are achieved, the restored site will be evaluated between July and November.

Specific and measurable success criteria for plant density on the project site will be based on the recommendations found in the WRP Technical Note and past project experience.

The interim measure of vegetative success for the site will be the survival of at least 320, 3-year old, planted trees per acre at the end of year three of the monitoring period. The final vegetative success criteria will be the survival of 260, 5-year old, planted trees per acre at the end of year five of the monitoring period. While measuring species density is the current accepted methodology for evaluating vegetation success on restoration projects, species density alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of additional plant community indices to assess overall vegetative success.

7.3 Schedule/Reporting

Annual monitoring reports containing the information defined herein will be submitted to NCEEP by December 31 of the year during which the monitoring was conducted. Project success criteria must be met by the fifth monitoring year, or monitoring will continue until all success criteria are met.

8.0 PRELIMINARY MONITORING

Once construction is complete, geomorphic data collected during the design phase will be compared to post-construction survey data to evaluate the success of restoration measures implemented. Post-construction data will be summarized in a mitigation plan which will also include Baker's monitoring approach for evaluating the success of the Snowbird Creek tributaries site for five years following the collection of As-built data. Preliminary monitoring of the site included the collection of longitudinal profile data as well as cross-sectional data to assess existing channel dimension and hydraulic function. Other data collected during the preliminary monitoring phase included sediment transport data and vegetative data including an evaluation of invasive vegetation present.

9.0 SITE PROTECTION AND ADAPTIVE MANAGEMENT STRATEGY

The Snowbird Creek tributaries project area will be protected by a permanent conservation easement that will be held by the state. Baker will monitor the project site for a minimum of five years following construction. Post-construction monitoring activities will be conducted to evaluate site performance, to identify maintenance and/or repair concerns, and to maintain the integrity of the project boundaries. If during the post-construction monitoring period it is determined project compliance is jeopardized, Baker shall take the necessary action to resolve the project concerns and bring the project back into compliance. If maintenance or site repairs become necessary, Baker will evaluate the level of response required, secure a contractor to make the repairs and monitor the work performed by the construction contractor.

Maintenance requirements vary from site to site and are generally driven by the following conditions:

- ✓ Projects without established, woody floodplain vegetation are more susceptible to erosion from floods than those with a mature, hardwood forest.
- ✓ Projects with sandy, non-cohesive soils are more prone to short-term bank erosion than cohesive soils or soils with high gravel and cobble content.
- ✓ Alluvial valley channels with wide floodplains are less vulnerable than confined channels.
- ✓ Wet weather during construction can make accurate channel and floodplain excavations difficult.
- ✓ Extreme and/or frequent flooding can cause floodplain and channel erosion.
- ✓ Extreme hot, cold, wet, or dry weather during and after construction can limit vegetation growth, particularly temporary and permanent seed.
- ✓ The presence and aggressiveness of invasive species can affect the extent to which a native buffer can be established.

Maintenance issues and recommended remediation measures will be detailed and documented in the as-built and monitoring reports. The conditions listed above and any other factors that may have necessitated maintenance will be discussed. If more substantial repair work is required Baker will coordinate with the NCEEP and regulatory agencies to determine whether work performed merits an extended monitoring period. At the conclusion of the post-construction monitoring period the project shall be transferred to the NCDENR Division of Natural Resource Planning and Conservation Stewardship Program for long-term management and stewardship.

10.0 REFERENCES

Adams, W.F. 1987. Indiana bat. In: Clark, M.K. (ed.). Endangered, Threatened and Rare Fauna of North Carolina, Part I. A Re-evaluation of the Mammals. Occasional Papers of the North Carolina Biological Survey. North Carolina State Museum of Natural Science, Raleigh.

Churchill, E. P., Jr., and S. I. Lewis. 1924. Food and feeding in freshwater mussels. Bulletin of the Bureau of Fisheries 39:439-471.

Clarke, A. H. 1981. The Tribe Alasmidontini (Unionidae: Anodontinae), Part 1: Pegias, Alasmidonta, and Arcidens. Smithsonian Contributions to Zoology, 326:1-101.

Cooper, J.E., S.S. Robinson, and J.B. Funderburg (eds.). 1977. Endangered and Threatened Plants and Animals of North Carolina. North Carolina State Museum of Natural History, Raleigh.

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. Stream corridor restoration: Principles, processes and practices. National Technical Information Service. Springfield, VA.

Graf, W.H. 1971. Hydraulics of Sediment Transport. New York: McGraw Hill. 513pp.

Grant, G.E., Swanson, F.J., and Wolman, M.G., 1990. Pattern and origin of stepped-bed morphology in high gradient streams, Western Cascades, Oregon. Geological Society of America Bulletin, v. 102, p. 340-352.

Hadley, J.B. and Nelson, A.E., 1971. Geologic map of the Knoxville quadrangle, North Carolina, Tennessee, and South Carolina: U.S. Geological Survey, Miscellaneous Geologic Investigations Map I-654, scale 1:250000. http://ngmdb.usgs.gov/Prodesc/proddesc_9432.htm.

Harman, W.A., D.E. Wise, M.A. Walker, R. Morris, M.A. Cantrell, M. Clemmons, G.D. Jennings, D. Clinton, and J. Patterson. 2000. Bankfull regional curves for North Carolina mountain streams. In Proc. AWRA Conf. Water Resources in Extreme Environments, Anchorage, Alaska, ed. E.L. Kane, pp. 185-190. Middleburg, VA.: American Water Resources Association.

Henson, T.H. 1990. Bald eagle. In: Lee, D.S. and J.F. Parnell (eds.). Endangered, Threatened and Rare Fauna of North Carolina, Part III. A Re-evaluation of the Birds. Occasional Papers of the North Carolina Biological Survey. North Carolina Museum of Natural Sciences, Raleigh.

Lane, E. W. 1955. Design of stable channels. Transactions of the American Society of Civil Engineers. Paper No. 2776: 1234-1279.

McGrath, C. Personal Communication. 1996.

Murdock, N. U.S. Fish and Wildlife Service. Ashville Field Office. Personal communication.

North Carolina Floodplain Mapping Program (NCFMP), FIRM Map Number 3700565000J (Preliminary). 2007. [Online WWW]. Available URL: http://www.ncfloodmaps.com/default_swf.asp.

North Carolina Natural Heritage Program (NHP) Element Occurrence Database (Listing of State and Federally Endangered and Threatened Species of North Carolina). North Carolina Department of Environment and Natural Resources. Raleigh, North Carolina, USA. 2008. [Online WWW]. Available URL: http://149.168.1.196/nhp/.

Potter, E.F., J.F. Parnell, and R.T. Teulings. 1980. Birds of the Carolinas. University of North Carolina Press, Chapel Hill, NC.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1964. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill.

Raudkivi, A.J. 1967. Loose Boundary Hydraulics. Oxford, England: Pergramon Press. 331pp.

Rosgen, D. L. 1994. A classification of natural rivers. *Catena* 22:169-199.

___. 1996. Applied River Morphology. Pagosa Springs, CO: Wildland Hydrology Books.

___. 1997. A geomorphological approach to restoration of incised rivers. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. Wang, S.S.Y, E.J. Langendoen, and F.D. Shields, Jr., eds. 12-22.

___. 1998. The reference reach - A blueprint for natural channel design (draft). ASCE Conference on River Restoration. Denver CO. March, 1998. ASCE. Reston, VA.

___. 2001a. A stream channel stability assessment methodology. Proceedings of the Federal Interagency Sediment Conference. Reno, NV. March, 2001.

___. 2001b. The cross-vane, w-weir and j-hook vane structures…their description, design and application for stream stabilization and river restoration. ASCE conference. Reno, NV. August, 2001.

Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. North Carolina Natural Heritage Program. Division of Parks and Recreation, NCDEHNR. Raleigh, NC.

Simon, A. 1989. A model of channel response in disturbed alluvial channels. *Earth Surface Processes and Landforms* 14(1):11-26.

Sturm, Terry. 2001. Open Channel Hydraulics. New York: McGraw-Hill Science/Engineering/Math. 512pp.

Terwilliger, K., J.R. Tate, and S.L. Woodward (eds.). 1995. A Guide to Endangered and Threatened Species in Virginia. The McDonald & Woodward Publishing Company, Blacksburg, Va.

United States Department of Agriculture, Natural Resources Conservation Service (NRCS). 1996. Field Indicators of Hydric Soils in the United States. G.W. Hurt, Whited, P.M., and Pringle, R.F., eds. Fort Worth, TX.

___. 1997. Part 650, Chapter 19 of the NRCS Engineering Field Handbook: Hydrology Tools for Wetland Determination.

___. 1996. Field Indicators of Hydric Soils in the United States. G.W. Hurt, Whited, P.M., and Pringle, R.F., eds. Fort Worth, TX.

___. Web Soil Survey of Graham County, North Carolina. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

___. Offical Soil Series Descriptions. [Online WWW]. Available URL: (http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi).

___. 2005. HEC-RAS Hydraulic Reference Manual, Version 3.1.0. Davis, CA: U.S. Army Corps of Engineers, Hydrologic Engineering Center.

___. 1997. Corps of Engineers Wetlands Research Program. Technical Note VN-rs-4.1. Environmental Laboratory. US Army Engineer Waterways Experiment Station. Vicksburg, MS.

United States Department of Interior, Fish and Wildlife Service (USFWS). Threatened and Endangered Species in North Carolina, Graham County. 2008. [Online WWW]. Available URL: http://www.fws.gov/nc-es/es/countyfr.html.

___. 1992a. Endangered and Threatened Species of the Southeastern United States (The Red Book).

___. 1997a. Endangered and Threatened Wildlife and Plants: Bog Turtle determined to be a Threatened Species. *Federal Register* 62(213):59605-59623.

___. 1997b. Recovery Plan for the Rock Gnome Lichen *(Gymnoderma lineare)* (Evans). Yoshimura and Sharp. Atlanta, Ga. 30pp.

United States Department of the Interior, U.S. Geological Survey (USGS). 2001. Land Cover Data. [Online WWW]. Available URL: http://seamless.usgs.gov/.

Weigl, P.D. 1987. Northern Flying Squirrel. In: Clark, M.K. (ed.). Endangered, Threatened and Rare Fauna of North Carolina, Part I. A Re-evaluation of the Mammals. Occasional Papers of the North Carolina Biological Survey. North Carolina State Museum of Natural Science, Raleigh.

APPENDIX A. NCDWQ Stream Identification Forms

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

Date:	3/12/07	Project:	Tribs to Snowbird	Latitude:	35°18'32" N
Evaluator:	AB	Site:	Hooper Branch	Longitude:	83°51'13" W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30*	43	County:	Graham	Other *e.g. Quad Name:*	Robbinsville

A. Geomorphology (Subtotal = 29)	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 = 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			

Not observed (items 22–28)

[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.)

Sketch:

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

Date: 3/12/07	Project: Trib to Snowbird	Latitude: 35° 18' 23" N
Evaluator: AB	Site: UT 1	Longitude: 83° 50' 55" W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 35+	County: Graham	Other *e.g. Quad Name:* Robbinsville

A. Geomorphology (Subtotal = 24)	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 = 7)				
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 = 4+)				
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			

Not observed (items 22–28)

[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.)

Sketch:

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

Date: 3/12/07	Project: Tribs to Snowbird	Latitude: 35°18'23" N
Evaluator: AB	Site: UT 2	Longitude: 83°56'53" W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 32.5+	County: Graham	**Other** *e.g. Quad Name*: Robbinsville

A. Geomorphology (Subtotal = 23)	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 = 6.5)				
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 = 3+)				
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			

(Items 22–28: Not observed)

[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.)

Sketch:

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

Date: 3/12/07	Project: Tribs to Snowbird	Latitude: 35°18'9"N
Evaluator: AB	Site: UT 3	Longitude: 83°50'50"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 34.5+	County: Graham	Other *e.g. Quad Name:* Robbinsville

A. Geomorphology (Subtotal = 25)	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 = 6.5)				
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 = 3+)				
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			

Not observed (items 22–28)

[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.)

Sketch:

APPENDIX B. Regulatory Correspondence

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Snowbird Creek Tributaries
Name if stream or feature:	UT3 to Snowbird Creek
County:	Graham
Name of river basin:	Little Tennessee
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Graham County
DFIRM panel number for entire site:	3700565000J
Consultant name:	Michael Baker Engineering, Inc.
Phone number:	828-350-1408 x2007
Address:	797 Haywood Road Suite 201 Asheville, NC 28806

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500".

UT1 and UT2 are conservation reaches. A small portion of UT2 will involve planting. No development work, as defined by FEMA, will be performed on these tributaries. UT3 to Snowbird Creek will be moved from its perched location in the valley into the valley low-point. This work will involve a step-pool natural channel design approach. UT3 is a low order tributary to Snowbird Creek; it is in the Little Tennessee Basin.

Summarize stream reaches or wetland areas according to their restoration priority.

Example

Reach	Length	Priority
UT3	***531***	***One (Restoration)***

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

◯ Yes ◉ No

If project is located in a SFHA, check how it was determined: **Not Applicable**

☐ Redelineation

☐ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation: **Zone X (Unmapped)**

Check if applies:

☐ AE Zone

◯ Floodway

◯ Non-Encroachment

◉ None

☐ A Zone

◯ Local Setbacks Required

◯ No Local Setbacks Required

If local setbacks are required, list how many feet: **Not applicable**

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

☐ Yes ☒ No

Land Acquisition (Check)

☐ State owned (fee simple)

☐ Conservation easment (Design Bid Build)

☑ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

☒ Yes ☐ No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: Edward Curtis, (919) 715-8000 x369)

Name of Local Floodplain Administrator:
Phone Number: **None (per conversation with county planning department 5-27-2009)**

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☑ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision

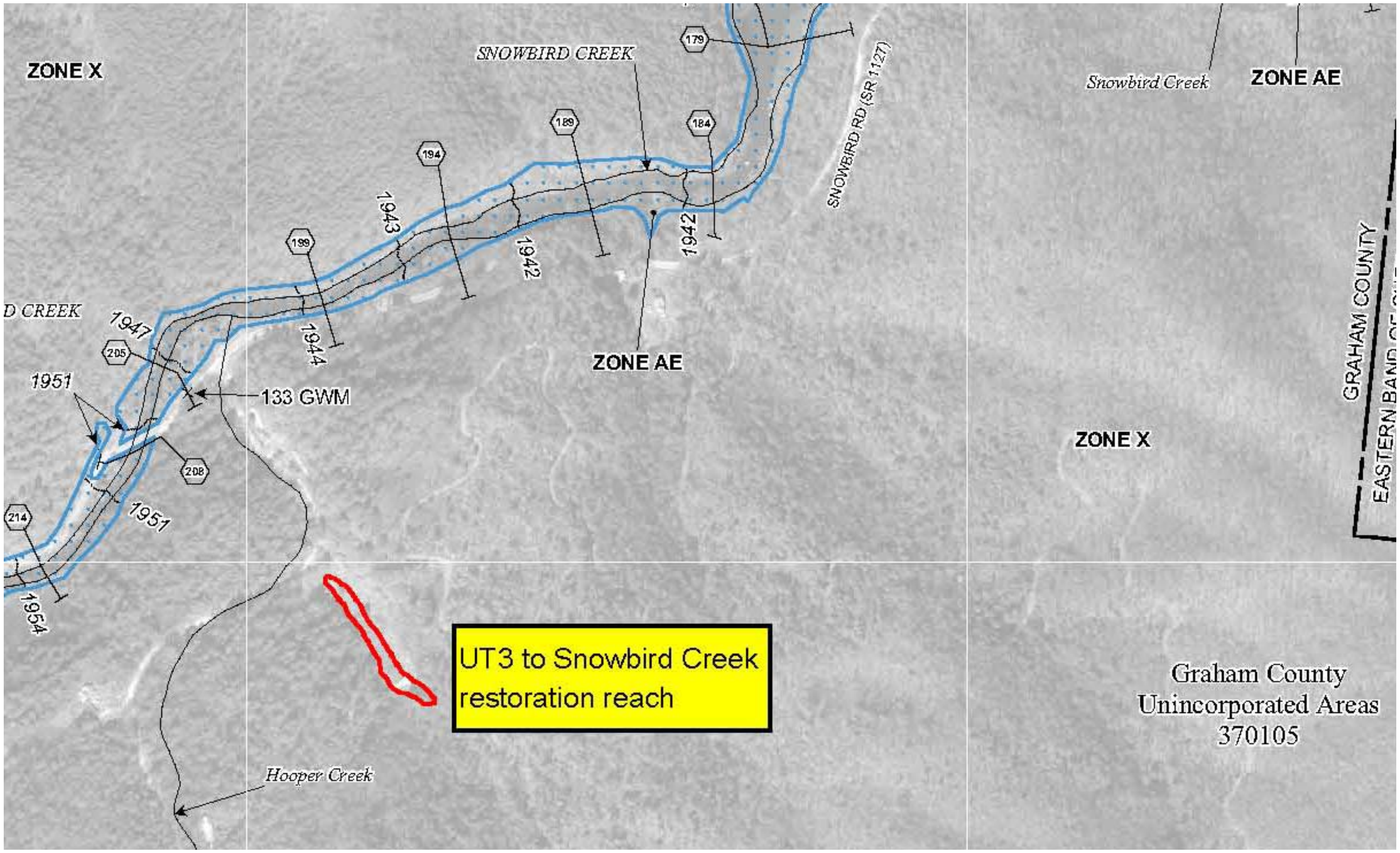
☐ Other Requirements

List other requirements:
Not Applicable

Comments:
The stream is an unmapped Zone X. It does not involve disturbance to more than 5 acres of land. No FEMA requirements apply.

Name: Jake McLean Signature: Jacob O. McLean

Title: Professional Engineer, NC Date: 5/27/2009



1":500' Orthophotographic Map of Approximate Project Development Limits (Scale is +/- 10%)
from FIRM 3700565000J Effective 02/18/2009 (http://www.ncfloodmaps.com/)

Baker

Baker Engineering NY, Inc.
797 Haywood Road
Suite 201
Asheville, North Carolina 28806

828-350-1408
FAX 828-350-1409

January 25, 2008

Ms. Renee Gledhill-Earley
State Historic Preservation Office
4617 Mail Service Center
Raleigh, NC 27699-4617

Subject: NC-EEP stream mitigation project in Graham County.

Dear Ms. Gledhill-Earley,

The North Carolina Ecosystem Enhancement Program (EEP) requests review and comment on any possible issues that might emerge with respect to archaeological or cultural resources associated with a potential stream restoration project area identified on the maps attached (a vicinity map, and USGS site map with areas of potential ground disturbance are enclosed).

The streams identified on the attached maps are tributaries to Snowbird Creek and have been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. The project will involve the enhancement and preservation of tributaries to Snowbird Creek in the Little Tennessee River Basin. Project goals include the enhancement of approximately 810 linear feet and the preservation of an additional 8,070 linear feet of stream.

No architectural structures or archaeological artifacts have been observed or noted during preliminary surveys of the site for restoration purposes. The project area consists of floodplain and forested slopes with maximum elevations of approximately 2,680' ASL. Approximately 80% of the project area is in forested cover, while the remaining 20% is in residential use. Headwaters identified within the upper limits of the project area are in a heavily forested area that borders U.S. Forest Service land. Residential land use is located in the lower section of the project area. As the enclosed aerial photograph shows, the majority of the area within the project limits of the site consists of floodplain, previously disturbed riparian area associated with residential development, and a recently logged section of land adjacent to one of the tributaries.

Minimal ground disturbing activities are proposed for enhancement reaches within the project site. Ground disturbing activities will consist of the planting of additional trees and other vegetation, and the removal of exotic, invasive vegetative species. The removal of logging debris from Unnamed Tributary 2 (UT2) will also occur. Access to enhancement reach sites will be achieved by utilizing previously established access routes on-site. The riparian corridor identified for preservation purposes will not be disturbed.

We ask that you review this site based on the attached information to determine the presence of any historic properties or other objects of cultural significance. Thank you in advance for your timely response and cooperation. Please feel free contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

CARMEN HORNE-MCINTYRE

Carmen Horne-McIntyre
Baker Engineering NY, Inc.
797 Haywood Rd., Suite 201
Asheville, NC 28806
Phone: 828.350.1408, Email: cmcintyre@mbakercorp.com

Cc:
Mr. Guy Pearce
NC Ecosystem Enhancement Program (EEP)
1652 Mail Service Center
Raleigh, NC 27699

Mr. Tyler Howe
Eastern Band of Cherokee Indians
Tribal Historic Preservation Office
P.O. Box 455
Cherokee NC, 28719

North Carolina Department of Cultural Resources

State Historic Preservation Office

Peter B. Sandbeck, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

March 13, 2008

Carmen Horne-McIntyre
Baker Engineering NY, Inc.
797 Haywood Road, Suite 201
Asheville, NC 28806

Re: Tributaries to Snowbird Creek Stream Mitigation, Graham County, ER 08-0450

Dear Ms. Horne-McIntyre:

Thank you for your letter of January 25, 2008, concerning the above project.

We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Peter Sandbeck

cc: Guy Pearce, NCEEP
Tyler Howe, Eastern Band of Cherokee Indians

Baker

Baker Engineering NY, Inc.
797 Haywood Road
Suite 201
Asheville, North Carolina 28806

828-350-1408
FAX 828-350-1409

January 25, 2008

Mr. Tyler Howe
Tribal Historic Preservation Office
P.O. Box 455
Cherokee, NC 28719

Subject: NC-EEP stream mitigation project in Graham County.

Dear Mr. Howe,

The North Carolina Ecosystem Enhancement Program (EEP) requests review and comment on any possible issues that might emerge with respect to archaeological or cultural resources associated with a potential stream restoration project area identified on the maps attached (a vicinity map, and USGS site map with areas of potential ground disturbance are enclosed).

The streams identified on the attached maps are tributaries to Snowbird Creek and have been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. The project will involve the enhancement and preservation of tributaries to Snowbird Creek in the Little Tennessee River Basin. Project goals include the enhancement of approximately 810 linear feet and the preservation of an additional 8,070 linear feet of stream.

No architectural structures or archaeological artifacts have been observed or noted during preliminary surveys of the site for restoration purposes. The project area consists of floodplain and forested slopes with maximum elevations of approximately 2,680' ASL. Approximately 80% of the project area is in forested cover, while the remaining 20% is in residential use. Headwaters identified within the upper limits of the project area are in a heavily forested area that borders U.S. Forest Service land. Residential land use is located in the lower section of the project area. As the enclosed aerial photograph shows, the majority of the area within the project limits of the site consists of floodplain, previously disturbed riparian area associated with residential development, and a recently logged section of land adjacent to one of the tributaries.

Minimal ground disturbing activities are proposed for enhancement reaches within the project site. Ground disturbing activities will consist of the planting of additional trees and other vegetation, and the removal of exotic, invasive vegetative species. The removal of logging debris from Unnamed Tributary 2 (UT2) will also occur. Access to enhancement reach sites will be achieved by utilizing previously established access routes on-site. The riparian corridor identified for preservation purposes will not be disturbed.

We ask that you review this site based on the attached information to determine the presence of any historic properties or other objects of cultural significance. Thank you in advance for your timely response and cooperation. Please feel free contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

CARMEN HORNE-MCINTYRE

Carmen Horne-McIntyre
Baker Engineering NY, Inc.
797 Haywood Rd., Suite 201
Asheville, NC 28806
Phone: 828.350.1408, Email: cmcintyre@mbakercorp.com

Cc:

Mr. Guy Pearce
NC Ecosystem Enhancement Program (EEP)
1652 Mail Service Center
Raleigh, NC 27699

Ms. Renee Gledhill-Earley
State Historic Preservation Office
4617 Mail Service Center
Raleigh, NC 27699-4617

Baker

Baker Engineering NY, Inc.
797 Haywood Road
Suite 201
Asheville, North Carolina 28806

828-350-1408
FAX 828-350-1409

March 31, 2008

Eastern Band of Cherokee Indians (EBCI)
Mr. Tyler Howe
Tribal Historic Preservation Office
PO Box 455
Cherokee, NC 28719

RE: Phase I Archaeological Survey Report (ER 08-0014) for stream restoration site on East Buffalo Creek in Graham County, North Carolina.

This letter and the enclosed report are provided to your office at the State Historic Preservation Office's request that Baker Engineering NY, Inc. conduct a comprehensive survey of areas to be impacted during a stream restoration project on East Buffalo Creek.

The enclosed report details the approach that Archaeological Consultants of the Carolinas, Inc. (ACC) used for this survey, as well as research conducted and findings from their field survey. A copy of this report is also being submitted to the State Historic Preservation Office for their review as well.

Based on our understanding of this report, no significant archaeological remains were found within our project area. Two archaeological sites (31GH198 and 31GH199) have been previously identified within 1.6 km of the project area; however neither archaeological site will be impacted by the stream restoration work proposed. We are submitting this information for your review and comment as to the potential for impacting cultural resources.

Additionally, we have received comment back from the State Historic Preservation Office regarding enhancement of tributaries to Snowbird Creek, also located in Graham County, NC. The State Historic Preservation Office has concluded that the project, as proposed, will not result in any potential historic resources being affected. I am enclosing a copy of the previous letter submitted to the THPO which summarizes the extent of work being performed on the Snowbird tributaries within the proposed project area.

Please provide us your comments as soon as possible regarding the projects above so that we can either address further needs or communicate a finding of no significant impact for these projects to the NC Ecosystem Enhancement Program. I can be reached via email at cmcintyre@mbakercorp.com or by phone (828.350.1408 x.2010). Thank-you for your assistance in this matter.

Sincerely,
Carmen Horne-McIntyre
Carmen Horne-McIntyre
Environmental Scientist

Enclosure: Archaeological Survey Report for East Buffalo Creek, Snowbird Tributaries Project Letter

Baker

Baker Engineering NY, Inc.
797 Haywood Road
Suite 201
Asheville, North Carolina 28806

828-350-1408
FAX 828-350-1409

January 15, 2008

U.S. Fish and Wildlife Service
Ms. Marella Buncick
Asheville Field Office
160 Zillicoa St.
Asheville, NC 28801

Subject: NC-EEP Snowbird Creek Tributaries Project in Graham County

Dear Ms. Buncick,

The Ecosystem Enhancement Program (EEP), requests review and comment on any possible issues that might emerge with respect to endangered species as a stream enhancement project is conducted. A vicinity map and a topographic map showing the approximate areas of potential ground disturbance by enhancement activities are enclosed.

The Snowbird Creek Tributaries project site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts in the Little Tennessee River Basin. Sections of channel in two tributaries to Snowbird Creek have been identified as significantly degraded. While the proposed project area is primarily in forested cover, there is a short reach on each tributary that been impacted by logging or residential land use.

We have already obtained a current species list for Graham County from your website (http://nc-es.fws.gov/es/countyfr.html). The threatened or endangered species for this county as identified on the website are: the Carolina Northern Flying Squirrel (*Glaucomys sabrinus coloratus*), Bog Turtle (*Clemmys muhlenbergii*), Indiana Bat (*Myotis sodalis*), Appalachian Elktoe (*Alasmidonta raveneliana*), Virginia Spiraea (*Spiraea virginiana*), and the Rock Gnome Lichen (*Gymnoderma lineare*).

With the exception of the Virginia spiraea, no suitable habitat was located within the limits of disturbance for the property. Potential habitat does exist within the project limits for Virgina spiraea. Its habitat is described as "flood-scoured, high-gradient, rocky riverbanks, braided areas of lower stream reaches, gorges, and canyons, as well as disturbed rights-of-way." Limited debris removal and buffer planting on the enhancement reaches where exotic, invasive vegetation is being removed is not expected to disturb potential habitat and may actually serve to increase habitat. The project in the upper reaches consists solely of preservation. Therefore, no impacts to the species are anticipated.

The Carolina northern flying squirrel prefers the ecotone between coniferous and mature northern hardwoods usually above 4,500' above sea level (ASL). The project area consists of floodplain with maximum elevations below 2,800' ASL. Therefore, a "no effect" determination was made for the Carolina northern flying squirrel due to lack of suitable habitat.

No foraging or nesting habitat was found for the Indiana bat in the lower project reaches due to the level of disturbance to the riparian area. As stated earlier, riparian areas in the headwaters of the project area will not be disturbed. Any potential habitat that may exist in the upper reaches will be left in its current condition; therefore no adverse impacts to the Indiana bat are expected to occur from this project.

Based on the degraded conditions found within the proposed enhancement reaches, a "no effect," determination was made regarding the Appalachian elktoe. The Appalachian elktoe prefers morphologically stable stream segments in silt accumulation or heavily shifting substrate, which does not currently exist on the site as the proposed project is to perform enhancement activities on each tributary so that they become more morphologically stable. Additionally, the project is located outside of the drainage area in Graham County designated as critical habitat.

The project area lacks habitat characteristics favored by the rock gnome lichen which include humid, high elevation rock outcrops, vertical cliff faces or in rock outcrops in humid gorges at lower elevations. Enhancement activities which are located in lower altitude and less steep portions of the project area also make it unlikely that any habitat exists for the rock gnome lichen as most populations occur above an elevation of (5,000 feet). Because this project involves degraded streams and lacks other habitat criteria necessary, this project is not likely to affect the rock gnome lichen.

We are requesting that you please provide any known information for each species in the county. The USFWS will be contacted if suitable habitat for any listed species may be encroached upon or if we determine that the project may affect one or more federally listed species or designated critical habitat area.

Please provide comments on any possible issues that might emerge with respect to endangered species, migratory birds or other trust resources from the construction of a wetland and/or stream restoration project on the subject property. A vicinity map and a USGS map showing the approximate areas of potential ground disturbance are enclosed.

If we have not heard from you in 30 days we will assume that our species list is correct, that you do not have any comments regarding associated laws, and that you do not have any information relevant to this project at the current time.

We thank you in advance for your timely response and cooperation. Please feel free to contact me at cmcintyre@mbakercorp.com or by phone at 828.350.1408 ext. 2007 with any questions you may have concerning the extent of site disturbance associated with this project.

Sincerely,

CARMEN HORNE-MCINTYRE

Carmen Horne-McIntyre
Environmental Scientist
Baker Engineering NY, Inc.
797 Haywood Rd., Suite 201
Asheville, NC 28806

Cc:
Mr. Guy Pearce
NC Ecosystem Enhancement Program (EEP)
1652 Mail Service Center
Raleigh, NC 27699

East Buffalo Creek and Snowbird Tributaries Restoration Projects (NCEEP)

From: Carmen McIntyre
To: Marella_Buncick@fws.gov
Date: 3/13/2008 8:47 AM
Subject: East Buffalo Creek and Snowbird Tributaries Restoration Projects (NCEEP)
Attachments: East Buffalo.pdf; USFWS Letter.pdf; figure_disturbance_limits.pdf; Location Map.pdf; Topo Map.pdf; Snowbird Figures.pdf

Hi Ms. Buncick,
Our office is in the process of finalizing an environmental review for the two projects listed above. We plan to submit our findings to the NCDENR Ecosystem Enhancement Program (NCEEP) by April 4th. Before we finalize the environmental review document, I wanted ensure any concerns held by USFWS about the two projects had been met. If there are any concerns, please contact me at your earliest convenience at 828.350.1408 x. 2010 or Micky Clemmons at 828.350.1408 x. 2002. If we do not hear from you by March 31st, we will assume the USFWS has no concerns regarding federally listed species within the project area. Please see the documents attached which describe the scope of the projects as well as their locations.

Thank-you for your assistance,

Carmen Horne-McIntyre

Carmen Horne-McIntyre
Baker Engineering NY, Inc.
797 Haywood Rd., Suite 201
Asheville, NC 28806
P: 828.350.1408 x. 2010
F: 828.350.1409

Baker

Baker Engineering NY, Inc.
797 Haywood Road
Suite 201
Asheville, North Carolina 28806

828-350-1408
FAX 828-350-1409

January 15, 2008

Ms. Shannon Deaton
North Carolina Wildlife Resource Commission
Division of Inland Fisheries
1721 Mail Service Center
Raleigh, NC 27699

Subject: NC-Ecosystem Enhancement Program: Stream mitigation project in Graham County, NC.

Dear Ms. Deaton,

The purpose of this letter is to request review and comment on any possible issues that might emerge with respect to fish and wildlife issues associated with a potential stream restoration project area identified on the maps attached (vicinity map and USGS site map with approximate areas of potential ground disturbance are enclosed).

The streams identified on the attached maps are tributaries to Snowbird Creek and have been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts within the Little Tennessee River Basin. Project goals include the enhancement of approximately 810 linear feet of significantly degraded stream channel. An additional 8,070 linear feet in the headwaters of the tributaries will be preserved under this project.

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Carmen Horne-McIntyre

Carmen Horne-McIntyre
Baker Engineering NY, Inc.
797 Haywood Rd., Suite 201
Asheville, NC 28806
Phone: 828.350.1408, Email: cmcintyre@mbakercorp.com

Cc:
Mr. Guy Pearce
NC Ecosystem Enhancement Program (EEP)
1652 Mail Service Center
Raleigh, NC 27699

North Carolina Wildlife Resources Commission

January 29, 2008

Carmen Horne-McIntyre
Baker Engineering NY, Inc.
797 Haywood Rd., Suite 201
Asheville, NC 28806

SUBJECT: EEP Stream Mitigation Project in Graham County, Snowbird Creek tributaries

Dear Ms. Horne-McIntyre:

Biologists with the North Carolina Wildlife Resources Commission (Commission) received your letter dated January 15, 2008 regarding the Ecosystem Enhancement Program project on tributaries to Snowbird Creek in Graham County. Comments from the Commission are provided under provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

Graham County is a "trout county" per an agreement between the U.S. Army Corps of Engineers (ACOE) and the Commission. As such, Commission biologists review all Nationwide Permit applications here and make recommendations to minimize the adverse resource effects of some activities, including restoration work. Once a permit application is prepared for this project, a copy must be sent to me in order to solicit Commission concurrence and recommendations for consideration by the ACOE. Rainbow trout have been found in Hooper Branch, which appears downstream of part of the project area.

The Commission does not anticipate any major resource concerns with this project provided sedimentation from construction is minimized. Existing mature vegetation should be preserved as much as possible because it promotes the stability of channel work and provides seed sources for natural regeneration, organic material to the streams, and riparian habitat complexity until planted vegetation matures. The use of balled or container grown trees is recommended in the outside of channel bends to expedite long-term bank stability. Also, any stream channel modifications should create dimensions, patterns, and profiles that mimic stable, reference conditions. Overly and unnaturally sinuous stream channels should be avoided.

Thank you for the opportunity to review and comment on this project. If there are any questions regarding these comments, please contact me at (828) 452-2546 ext. 24.

Sincerely,

D.Mc

Dave McHenry
Mountain Region Coordinator
Habitat Conservation Program

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

Baker

Baker Engineering NY, Inc.
797 Haywood Road
Suite 201
Asheville, North Carolina 28806

828-350-1408
FAX 828-350-1409

February 8, 2008

Mr. Glenn Carson
USDA-NRCS District Conservationist
Graham County
P.O. Box 286
480 Village Shopping Center
Robbinsville, NC 28771

Subject: Prime and Important Farmland Soils RE: NCEEP Full Delivery Project, Snowbird Tributaries Project Site, Graham County, NC

Dear Mr. Carson,

The purpose of this letter is to request your assistance in completing a Farmland Conversion Impact Rating form for the subject site. Enclosed please find a copy of the form, site and location mapping for the Snowbird Tributaries project site. Mapped soils within the project area include the Spivey-Whiteoak complexes (8 to 15% and 15 to 30% slopes, bouldery), the Soco-Stecoah complex (50 to 95% slopes), Snowbird fine sandy loam (30 to 50% slopes), and the Thurmont-Dillard complex which occurs on 2 to 8% slopes. The Spivey-Whiteoak and Soco-Stecoah complexes are the dominant soils complexes in areas adjacent to the streams. These soils are characterized as steep and well drained and lie above the seasonal high water table. Soils data presented in this letter were assembled from the initial dataset of soil mapping updates by the Natural Resources Conservation Service in 2007 for Graham County and from the USDA-NRCS Soil Data Mart website (http://soildatamart.nrcs.usda.gov/Default.aspx).

For this stream restoration and enhancement project, areas where ground disturbing activities are expected to take place are noted on the restoration figure enclosed. Approximately 80% of the project area is in forested cover, while the remaining 20% is in residential use. The majority of the area within the project limits of the site consists of floodplain, previously disturbed riparian area associated with residential development, and a recently logged section of land adjacent to one of the tributaries. Minimal ground disturbing activities are proposed for enhancement reaches within the project site. Ground disturbing activities will consist of the planting of additional trees and other vegetation, and the removal of exotic, invasive vegetative species.

The total area of the project site consists of 13.75 acres. The area of proposed ground disturbing activities includes approximately 1 acre of the Thurmont-Dillard soil complex. Based on our review, this soil is considered to be Prime Farmland. A review of the soil types for the project area indicate there are no soils within or adjacent to the project site that are associated with other farmland of statewide importance.

We ask that you review this site based on the attached information to determine if you know of any other existing resources that we need to know about. We know that you have greater familiarity with farmland issues in this area than we do, and we will be happy to make any changes to the form that you deem appropriate. Please return the form to us with your determinations and we will fill out the rest of the form if needed. In addition, please let us know the level of involvement you may require (if needed); it is anticipated this project will be implemented in the fall of 2008 or spring of 2009. If we have not received a response from you within 30 days, we will assume that you have no comment regarding the project. This letter is intended to satisfy any requirements of the Farmland Protection Policy Act.

If you have any questions, please feel free to contact me at cmcintyre@mbakercorp.com or by phone at 828.350.1408 ext. 2010. Our fax number is 828.350.1409.
Thank-you for your assistance in this matter.

Sincerely,

Carmen Horne-McIntyre

Carmen Horne-McIntyre
Environmental Scientist
Baker Engineering NY, Inc.
797 Haywood Rd., Suite 201
Asheville, NC 28806

Cc:
Mr. Guy Pearce
NC Ecosystem Enhancement Program (EEP)
1652 Mail Service Center
Raleigh, NC 27699

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
589 Raccoon Road, Suite 246
Waynesville, NC 28786
Phone 828 456-6341 ext. 5 FAX 828 452-7031

March 27, 2008

Carmen Horne-McIntyre
Baker Engineering NY, Inc.
797 Haywood Road, Suite 201
Asheville, NC 28806

Re: USDA Farmland Conversion Impact Rating Form (AD-1006)
Snowbird Tributaries Enhancement Project– Graham County, NC

Ms. Horne-McIntyre

Attached you will find two copies of the completed AD-1006. Based on the maps that you provided, and on a soil survey map of the area, it appears that 1.0 acre of prime farmland will be impacted by the proposed project.

If I can be of further assistance, please feel free to contact me.

M. Kent Clary

M. Kent Clary
Area Resource Soil Scientist
USDA-NRCS

cc: Glenn Carson, District Conservationist, USDA-NRCS, Murphy, NC

Baker

Baker Engineering NY, Inc.
797 Haywood Road
Suite 201
Asheville, North Carolina 28806

828-350-1408
FAX 828-350-1409

April 11, 2008

Mr. Kent Clary
USDA-NRCS Area Resource Soil Scientist
589 Raccoon Road, Suite 246
Waynesville, NC 28786

Subject: USDA Farmland Conversion Impact Rating Form (AD-1006): NCEEP Full Delivery Project, Snowbird Tributaries, Graham County, NC

Dear Mr. Clary,

Thank you for your assistance in completing portions of the USDA Farmland Conversion Impact Rating Form (AD-1006) for the project referenced above. Please find enclosed a completed version of the form. Sections VI and VII were estimated in accordance with 7 CFR 658.5(b). If you have any questions or concerns regarding the total points assigned to the farmland assessed, please feel free to contact me at cmcintyre@mbakercorp.com or by phone at 828.350.1408 ext. 2010.

Best regards,

Carmen Horne-McIntyre

Carmen Horne-McIntyre
Environmental Scientist
Baker Engineering NY, Inc.
797 Haywood Rd., Suite 201
Asheville, NC 28806

Cc:
Mr. Guy Pearce
NC Ecosystem Enhancement Program (EEP)
1652 Mail Service Center
Raleigh, NC 27699

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

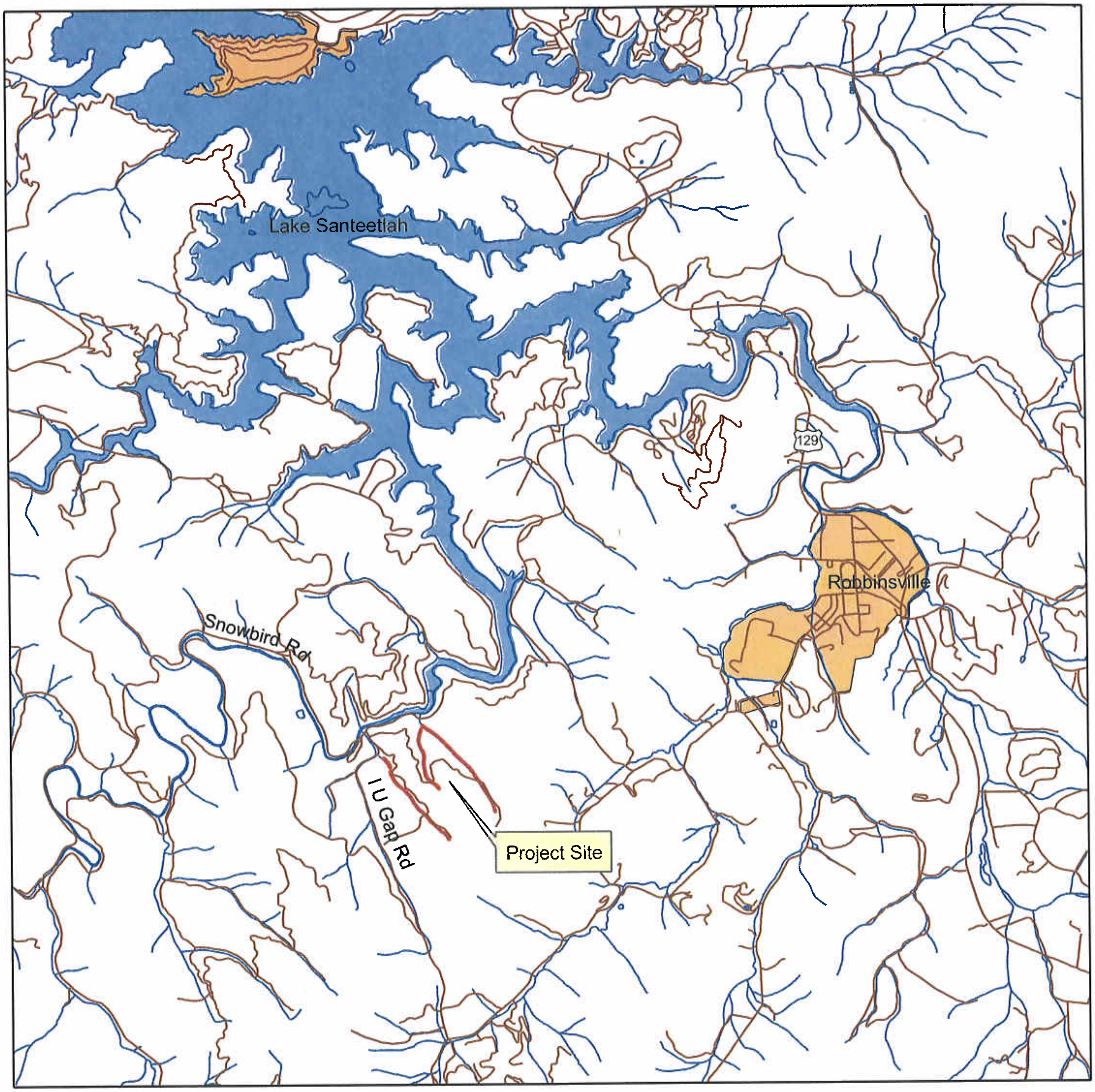
PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 2/8/08
Name Of Project Snowbird Tributaries Enhancement Project	Federal Agency Involved FHWA
Proposed Land Use Stream and Riparian Enhancement	County And State Graham, NC
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 2/8/08

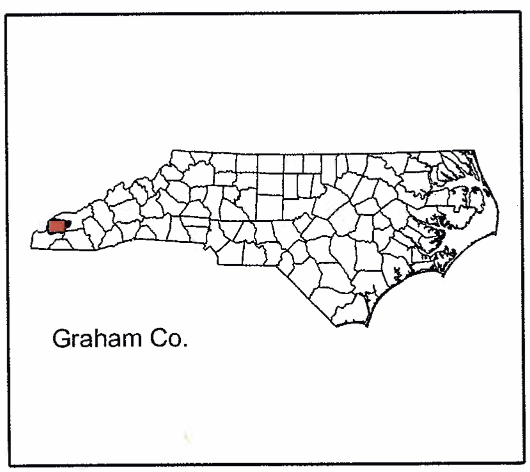
Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply -- do not complete additional parts of this form).*	Yes ☑	No ☐	Acres Irrigated ------	Average Farm Size 56 acres
Major Crop(s) Hay	Farmable Land In Govt. Jurisdiction Acres: 18,430 % 10		Amount Of Farmland As Defined in FPPA Acres: 6,860 % 23	
Name Of Land Evaluation System Used Graham Cales	Name Of Local Site Assessment System		Date Land Evaluation Returned By NRCS 3/27/08	

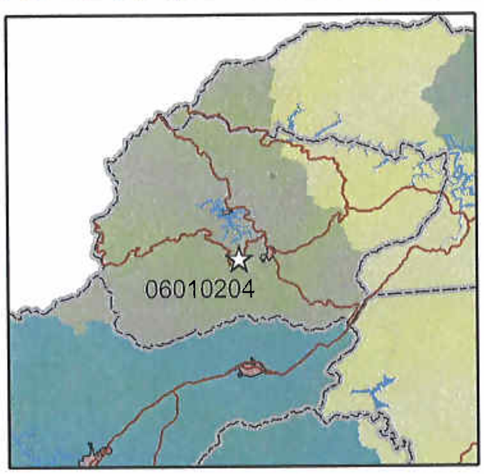
	Maximum Points	Alternative Site Rating Site A	Site B	Site C	Site D
PART III *(To be completed by Federal Agency)*					
A. Total Acres To Be Converted Directly		13.8			
B. Total Acres To Be Converted Indirectly					
C. Total Acres In Site		13.8	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland					
B. Total Acres Statewide And Local Important Farmland		1.0			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted		0.1			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		8.0			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*		73	0	0	0
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use		12			
2. Perimeter In Nonurban Use		8			
3. Percent Of Site Being Farmed		0			
4. Protection Provided By State And Local Government		20			
5. Distance From Urban Builtup Area		10			
6. Distance To Urban Support Services		10			
7. Size Of Present Farm Unit Compared To Average		10			
8. Creation Of Nonfarmable Farmland		0			
9. Availability Of Farm Support Services		3			
10. On-Farm Investments		5			
11. Effects Of Conversion On Farm Support Services		0			
12. Compatibility With Existing Agricultural Use		0			
TOTAL SITE ASSESSMENT POINTS	160	78	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	73	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	78	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	151	0	0	0

Site Selected: A	Date Of Selection 4/8/08	Was A Local Site Assessment Used? Yes ☐ No ■

Reason For Selection: Agreement with NC-Ecosystem Enhancement Program to improve watershed health and obtain mitigation credits within the Little Tennessee River Basin.







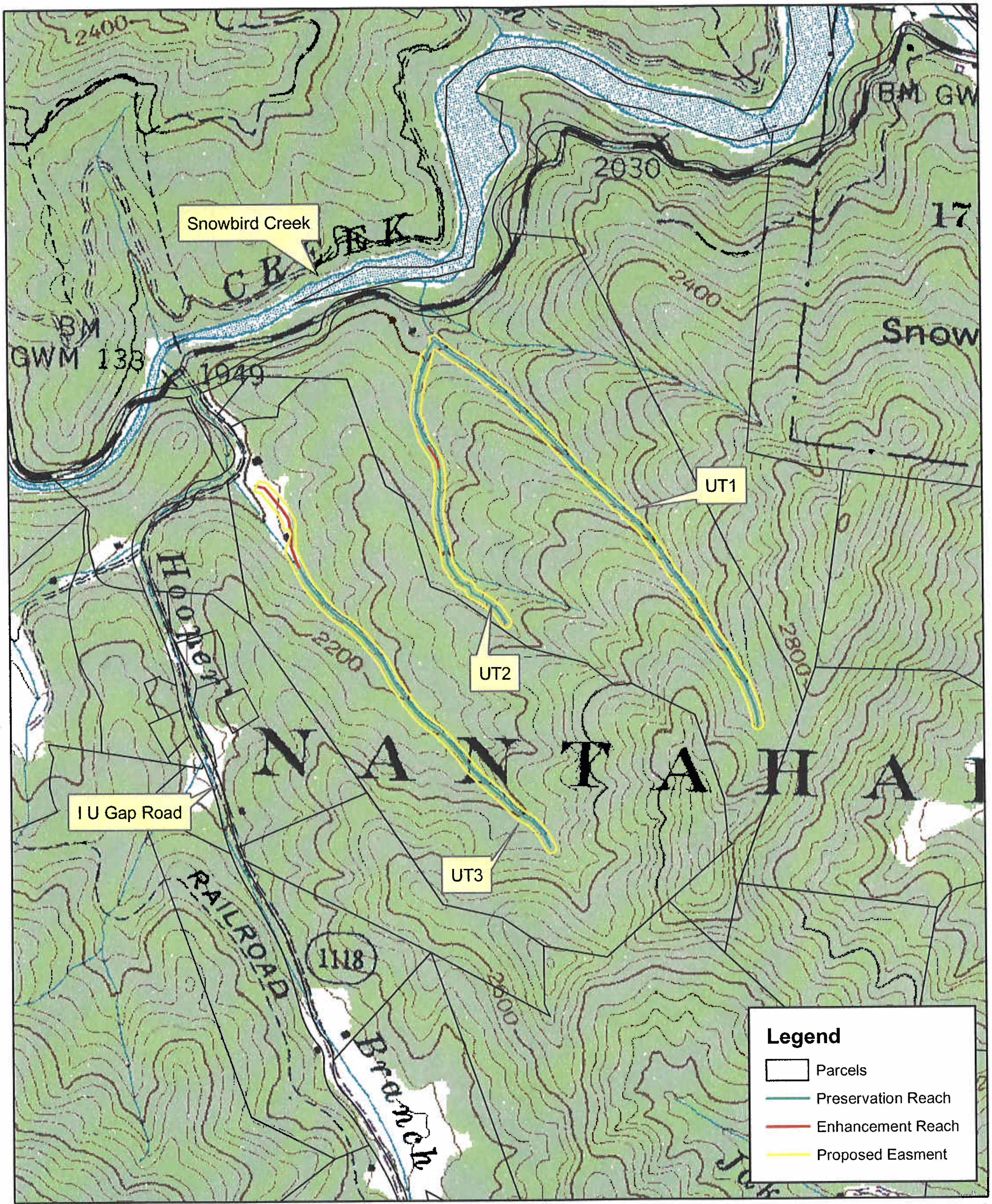
Baker

Figure 1
Project Vicinity Map

Tributaries to Snowbird Creek

0 0.5 1 Miles

N



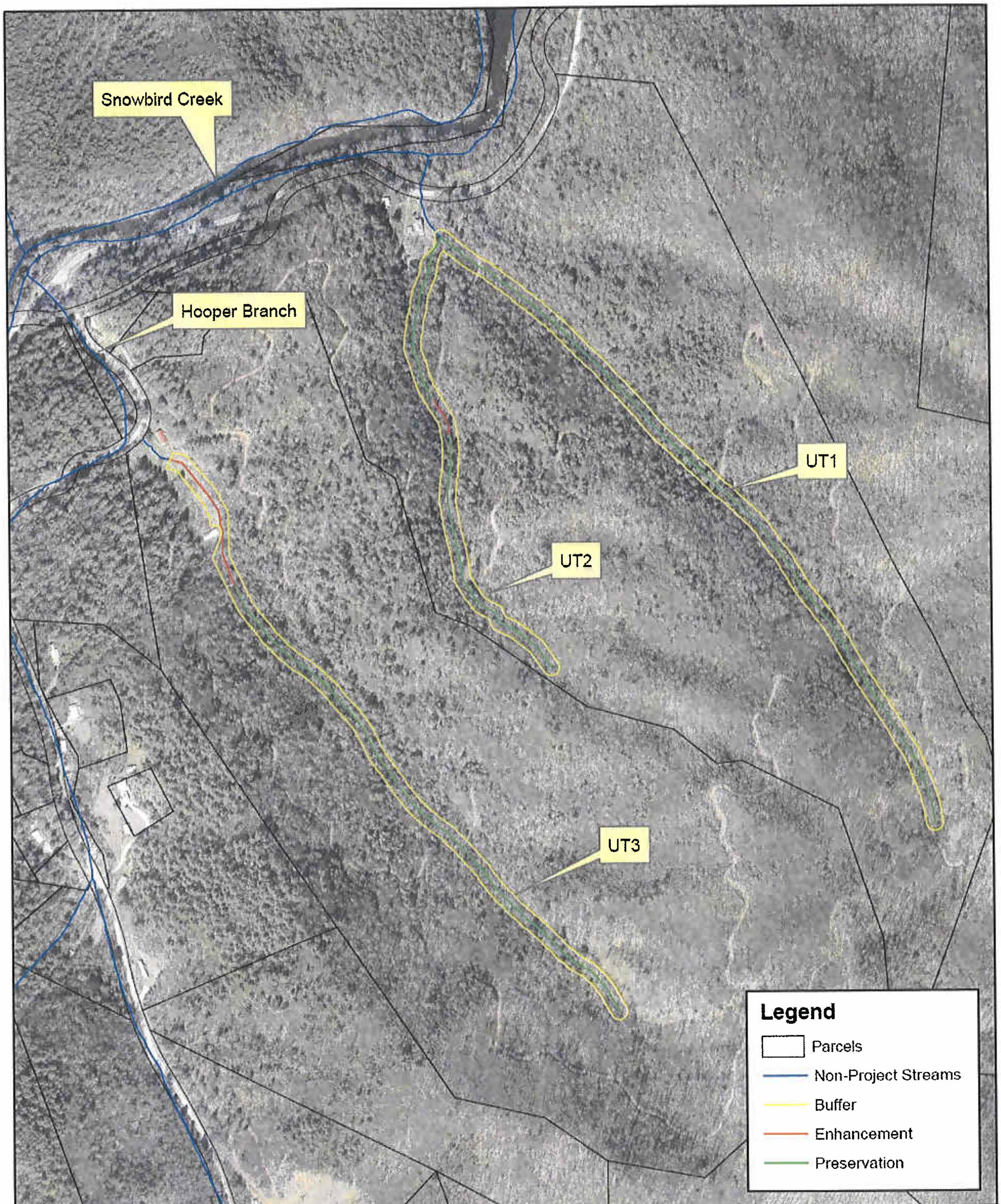
Baker

Figure 2.
Watershed Map

Tributaries to Snowbird Creek

0 200 400 800 1,200 Feet

N



Baker

Figure 3b.
Proposed Restoration Plan

Tributaries to Snowbird Creek

APPENDIX C. EDR Report

The EDR Radius Map
with GeoCheck®

Snowbird Creek Tributaries Project
Snowbird Rd (SR1127)/IU Gap Rd (SR 1118)
Robbinsville, NC 28771

Inquiry Number: 2112222.2s

January 03, 2008

EDR® Environmental Data Resources Inc

The Standard in Environmental Risk Information

440 Wheelers Farms Road
Milford, Connecticut 06461

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com

TABLE OF CONTENTS

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-05) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

SNOWBIRD RD (SR1127)/IU GAP RD (SR 1118)
ROBBINSVILLE, NC 28771

COORDINATES

Latitude (North):	35.310250 - 35˚ 18' 36.9''
Longitude (West):	83.848080 - 83˚ 50' 53.1''
Universal Tranverse Mercator:	Zone 17
UTM X (Meters):	241051.0
UTM Y (Meters):	3910972.8
Elevation:	2069 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	35083-C7 ROBBINSVILLE, NC
Most Recent Revision:	2001

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

FEDERAL RECORDS

NPL - National Priority List
Proposed NPL - Proposed National Priority List Sites
Delisted NPL - National Priority List Deletions
NPL LIENS - Federal Superfund Liens
CERCLIS - Comprehensive Environmental Response, Compensation, and Liability Information System
CERC-NFRAP - CERCLIS No Further Remedial Action Planned
CORRACTS - Corrective Action Report
ERNS - Emergency Response Notification System
HMIRS - Hazardous Materials Information Reporting System
US ENG CONTROLS - Engineering Controls Sites List

EXECUTIVE SUMMARY

US INST CONTROL Sites with Institutional Controls
DOD Department of Defense Sites
FUDS Formerly Used Defense Sites
US BROWNFIELDS A Listing of Brownfields Sites
CONSENT Superfund (CERCLA) Consent Decrees
ROD Records Of Decision
UMTRA Uranium Mill Tailings Sites
ODI Open Dump Inventory
TRIS Toxic Chemical Release Inventory System
TSCA Toxic Substances Control Act
FTTS FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
SSTS Section 7 Tracking Systems
LUCIS Land Use Control Information System
DOT OPS Incident and Accident Data
ICIS Integrated Compliance Information System
RCRA-CESQG RCRA - Conditionally Exempt Small Quantity Generator
RCRA-NonGen RCRA - Non Generators
DEBRIS REGION 9 Torres Martinez Reservation Illegal Dump Site Locations
HIST FTTS FIFRA/TSCA Tracking System Administrative Case Listing
US CDL Clandestine Drug Labs
RADINFO Radiation Information Database
LIENS 2 CERCLA Lien Information
RCRA-TSDF RCRA - Transporters, Storage and Disposal
RCRA-SQG RCRA - Small Quantity Generators
RCRA-LQG RCRA - Large Quantity Generators
PADS PCB Activity Database System
MLTS Material Licensing Tracking System
MINES Mines Master Index File
FINDS Facility Index System/Facility Registry System
RAATS RCRA Administrative Action Tracking System

STATE AND LOCAL RECORDS

SHWS Inactive Hazardous Sites Inventory
NC HSDS Hazardous Substance Disposal Site
IMD Incident Management Database
SWF/LF List of Solid Waste Facilities
OLI Old Landfill Inventory
HIST LF Solid Waste Facility Listing
LUST Regional UST Database
LUST TRUST State Trust Fund Database
UST Petroleum Underground Storage Tank Database
AST AST Database
INST CONTROL No Further Action Sites With Land Use Restrictions Monitoring
VCP Responsible Party Voluntary Action Sites
DRYCLEANERS Drycleaning Sites
BROWNFIELDS Brownfields Projects Inventory
NPDES NPDES Facility Location Listing

TRIBAL RECORDS

INDIAN RESERV Indian Reservations
INDIAN LUST Leaking Underground Storage Tanks on Indian Land
INDIAN UST Underground Storage Tanks on Indian Land

EXECUTIVE SUMMARY

EDR PROPRIETARY RECORDS

Manufactured Gas Plants. . . EDR Proprietary Manufactured Gas Plants

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were not identified.

Unmappable (orphan) sites are not considered in the foregoing analysis.

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
GRAHAM COUNTY LANDFILL	SWF/LF, HIST LF
GRAHAM COUNTY TEMPORARY TRANSFER STATION	HIST LF
BURLINGTON FURNITURE	SHWS
GRAHAM COUNTY MUNICIPAL LANDFILL	SHWS
HACKNEY FOOD SHOP #3	LUST, IMD
BEN CRISP CITGO	FINDS, LUST
DOT FACILITY-ROBBINSVILLE	LUST, IMD
CROSSROADS OF TIME	LUST, IMD
HACKNEY FOOD SHOP #3	LUST TRUST
TED NORCROSS RESIDENCE	LUST TRUST
KAY’S FASION & CONVIENIENCE S	UST
ROBINSON’S GROC	UST
ATOAH GROCERY	UST
JOHNNY’S CARB & TUNE & AMOCO	UST
JOANNA’S GROCERY	UST
EVERETT WILLIAMS GROCERY	UST
CHESTER CRISP	UST
WOLFECREEK GROCERY	UST
STECOAH SCHOOL	UST
BEN CRISP CITGO	UST, IMD
STEWARTS GROC.	UST
SANTEETLAH BOAT DOCK	UST
TALLAUFF SERVICE STATION	UST
CHEOAH DAM	UST
CHEOAH HYDROELECTRIC PROJECT	UST
WOLF CREEK GROC.	FINDS
BIG D #27 AST SPILL(RVIL BLK)	IMD
STANLEY FURNITURE-DIESEL SPILL	IMD

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FEDERAL RECORDS								
NPL		1.000	0	0	0	0	NR	0
Proposed NPL		1.000	0	0	0	0	NR	0
Delisted NPL		1.000	0	0	0	0	NR	0
NPL LIENS		TP	NR	NR	NR	NR	NR	0
CERCLIS		0.500	0	0	0	NR	NR	0
CERC-NFRAP		0.500	0	0	0	NR	NR	0
CORRACTS		1.000	0	0	0	0	NR	0
ERNS		TP	NR	NR	NR	NR	NR	0
HMIRS		TP	NR	NR	NR	NR	NR	0
US ENG CONTROLS		0.500	0	0	0	NR	NR	0
US INST CONTROL		0.500	0	0	0	NR	NR	0
DOD		1.000	0	0	0	0	NR	0
FUDS		1.000	0	0	0	0	NR	0
US BROWNFIELDS		0.500	0	0	0	NR	NR	0
CONSENT		1.000	0	0	0	0	NR	0
ROD		1.000	0	0	0	0	NR	0
UMTRA		0.500	0	0	0	NR	NR	0
ODI		0.500	0	0	0	NR	NR	0
TRIS		TP	NR	NR	NR	NR	NR	0
TSCA		TP	NR	NR	NR	NR	NR	0
FTTS		TP	NR	NR	NR	NR	NR	0
SSTS		TP	NR	NR	NR	NR	NR	0
LUCIS		0.500	0	0	0	NR	NR	0
DOT OPS		TP	NR	NR	NR	NR	NR	0
ICIS		TP	NR	NR	NR	NR	NR	0
RCRA-CESQG		0.250	0	0	NR	NR	NR	0
RCRA-NonGen		0.250	0	0	NR	NR	NR	0
DEBRIS REGION 9		0.500	0	0	0	NR	NR	0
HIST FTTS		TP	NR	NR	NR	NR	NR	0
CDL		TP	NR	NR	NR	NR	NR	0
RADINFO		TP	NR	NR	NR	NR	NR	0
LIENS 2		TP	NR	NR	NR	NR	NR	0
RCRA-TSDF		0.500	0	0	0	NR	NR	0
RCRA-SQG		0.250	0	0	NR	NR	NR	0
RCRA-LQG		0.250	0	0	NR	NR	NR	0
PADS		TP	NR	NR	NR	NR	NR	0
MLTS		TP	NR	NR	NR	NR	NR	0
MINES		0.250	0	0	NR	NR	NR	0
FINDS		TP	NR	NR	NR	NR	NR	0
RAATS		TP	NR	NR	NR	NR	NR	0
STATE AND LOCAL RECORDS								
State Haz. Waste		1.000	0	0	0	0	NR	0
NC HSDS		1.000	0	0	0	0	NR	0
IMD		0.500	0	0	0	NR	NR	0
State Landfill		0.500	0	0	0	NR	NR	0
OLI		0.500	0	0	0	NR	NR	0

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
HIST LF		0.500	0	0	0	NR	NR	0
LUST		0.500	0	0	0	NR	NR	0
LUST TRUST		0.500	0	0	0	NR	NR	0
UST		0.250	0	0	NR	NR	NR	0
AST		0.250	0	0	NR	NR	NR	0
INST CONTROL		0.500	0	0	0	NR	NR	0
VCP		0.500	0	0	0	NR	NR	0
DRYCLEANERS		0.250	0	0	NR	NR	NR	0
BROWNFIELDS		0.500	0	0	0	NR	NR	0
NPDES		TP	NR	NR	NR	NR	NR	0
TRIBAL RECORDS								
INDIAN RESERV		1.000	0	0	0	0	NR	0
INDIAN LUST		0.500	0	0	0	NR	NR	0
INDIAN UST		0.250	0	0	NR	NR	NR	0
EDR PROPRIETARY RECORDS								
Manufactured Gas Plants		1.000	0	0	0	0	NR	0

NOTES:

TP = Target Property

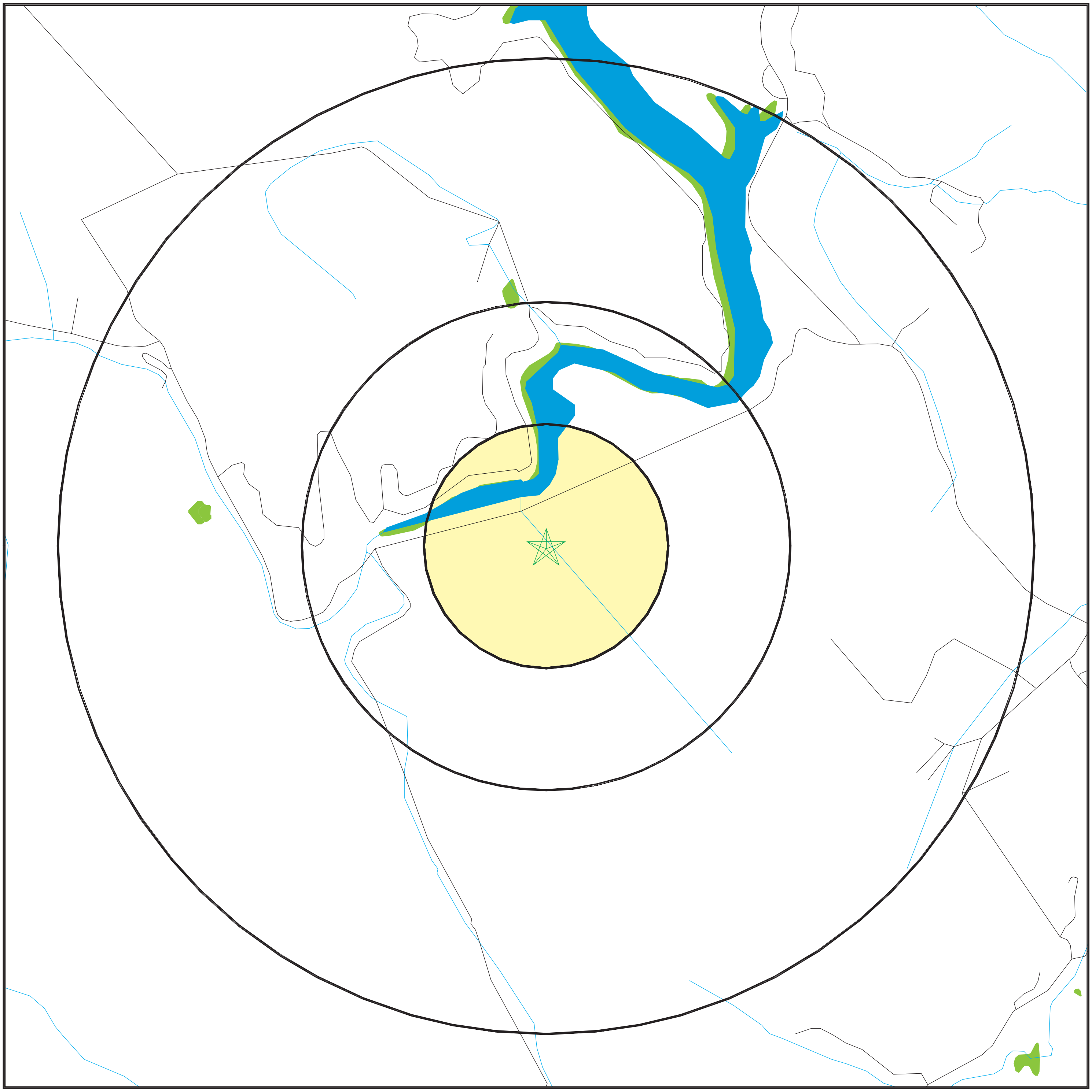
NR = Not Requested at this Search Distance

Sites may be listed in more than one database

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

NO SITES FOUND

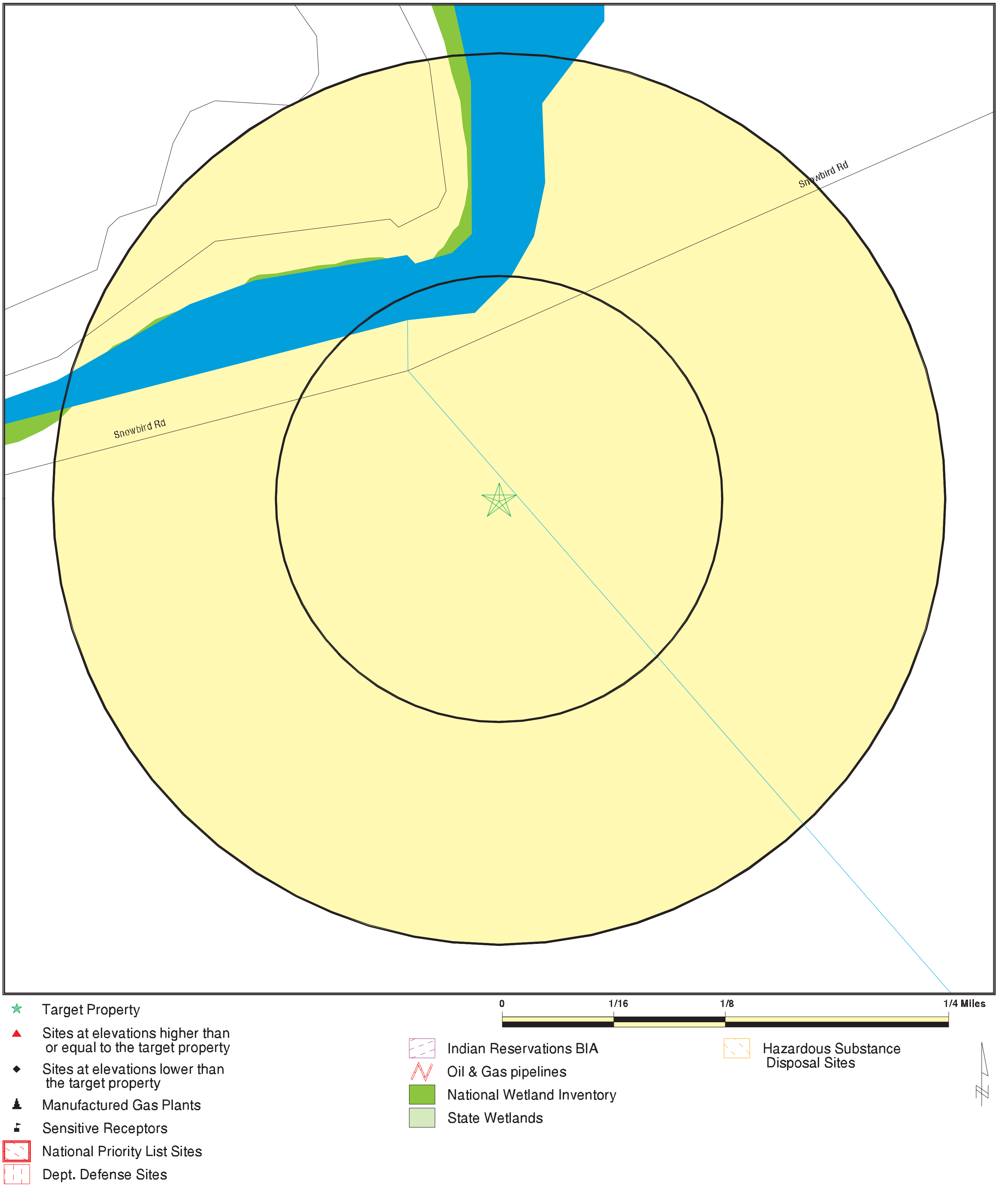
OVERVIEW MAP - 2112222.2s



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Oil & Gas pipelines
- National Wetland Inventory
- State Wetlands
- Hazardous Substance Disposal Sites

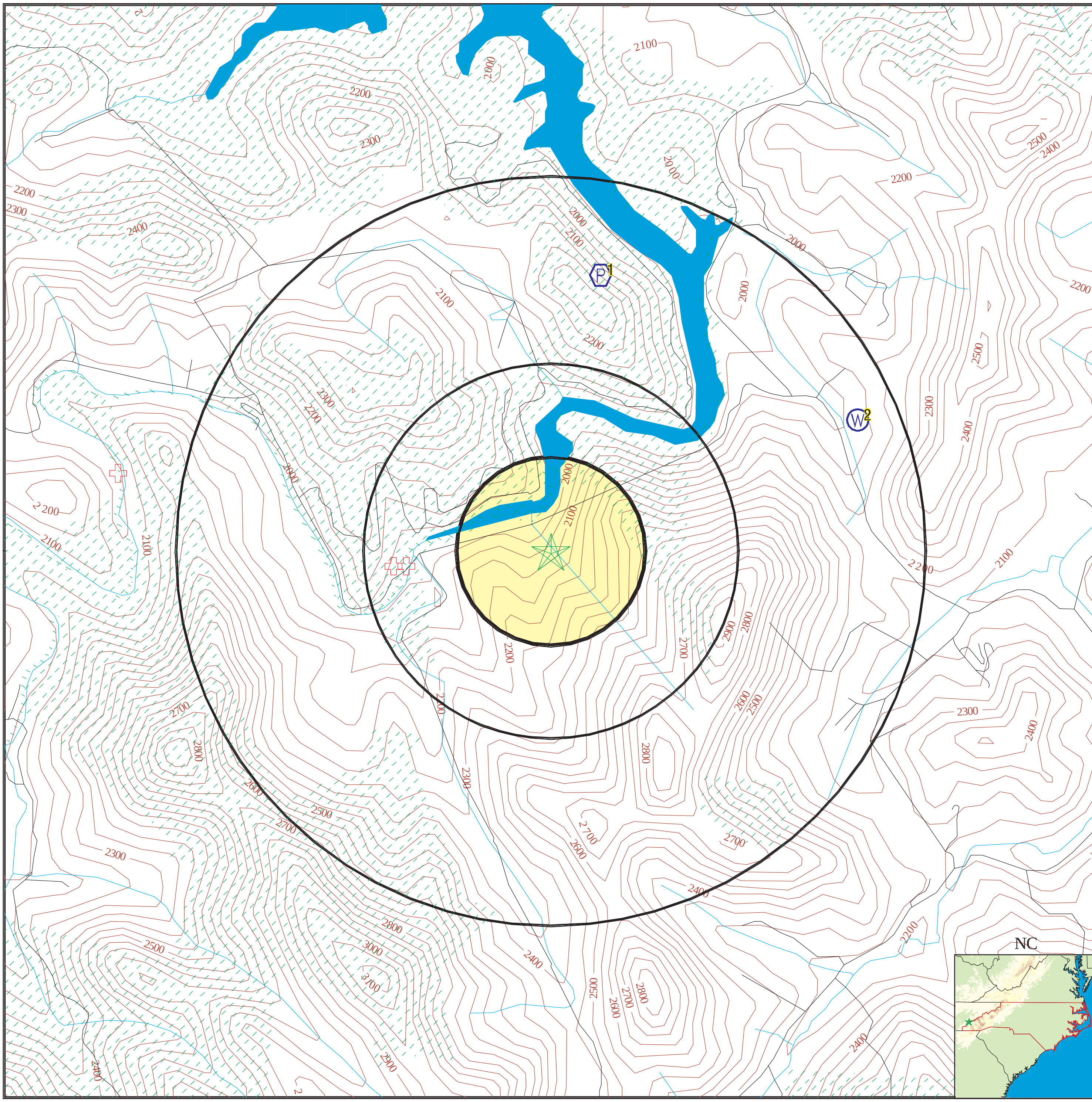
SITE NAME:	Snowbird Creek Tributaries Project	CLIENT:	Baker Engineering
ADDRESS:	Snowbird Rd (SR1127)/IU Gap Rd (SR 1118)	CONTACT:	Carmen Horne-McIntyre
	Robbinsville NC 28771	INQUIRY #:	2112222.2s
LAT/LONG:	35.3103 / 83.8481	DATE:	January 03, 2008 4:39 pm

DETAIL MAP - 2112222.2s



SITE NAME:	Snowbird Creek Tributaries Project	CLIENT:	Baker Engineering
ADDRESS:	Snowbird Rd (SR1127)/IU Gap Rd (SR 1118)	CONTACT:	Carmen Horne-McIntyre
	Robbinsville NC 28771	INQUIRY #:	2112222.2s
LAT/LONG:	35.3103 / 83.8481	DATE:	January 03, 2008 4:39 pm

PHYSICAL SETTING SOURCE MAP - 2112222.2s



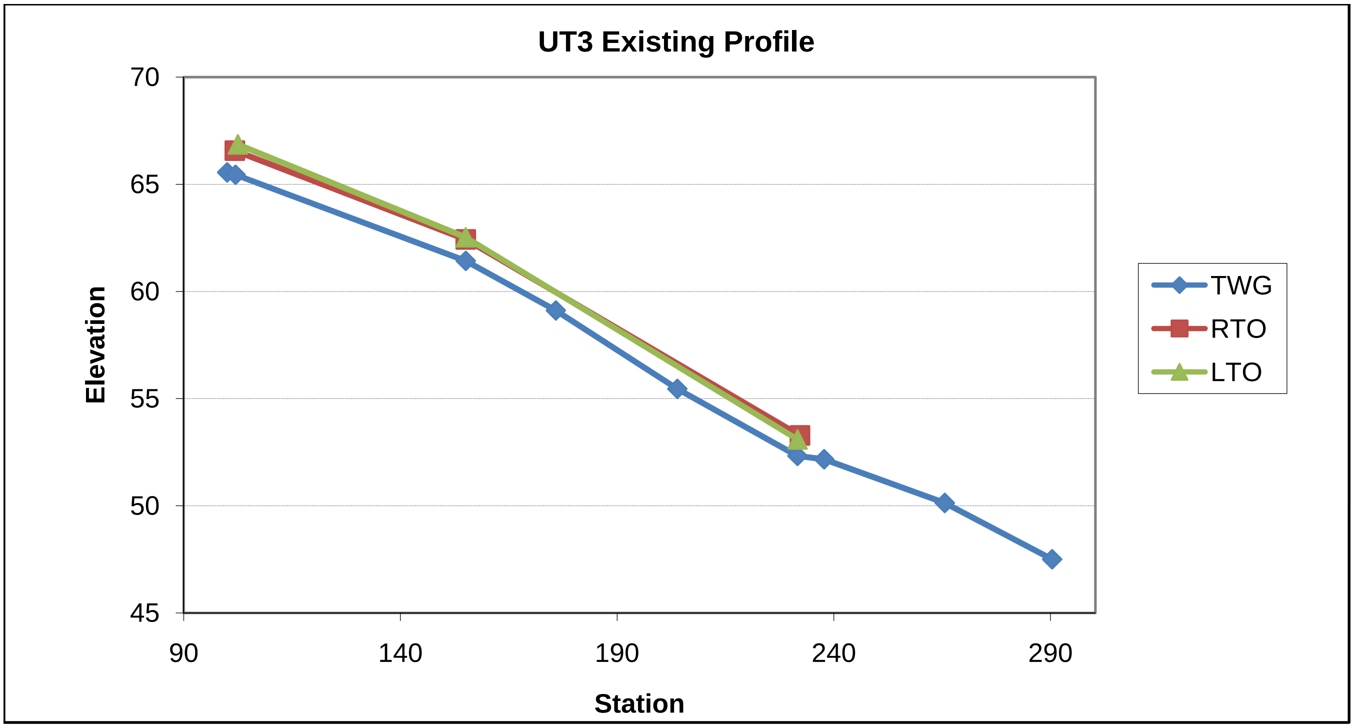
County Boundary
Major Roads
Contour Lines
Earthquake epicenter, Richter 5 or greater
Water Wells
Public Water Supply Wells
Cluster of Multiple Icons

Groundwater Flow Direction
Indeterminate Groundwater Flow at Location
Groundwater Flow Varies at Location

Wildlife Areas
Natural Areas
Rare & Endangered Species

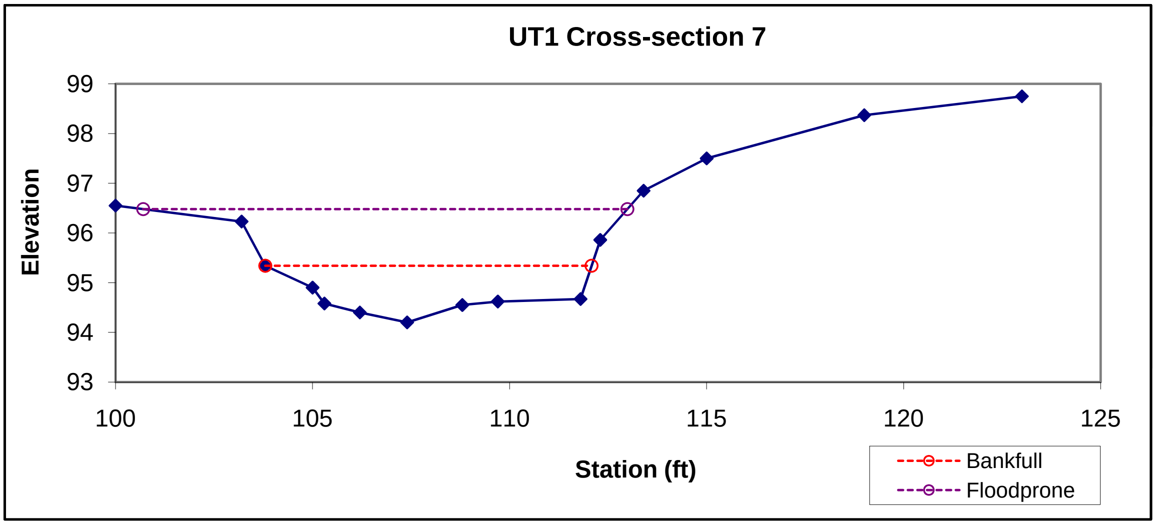
SITE NAME:	Snowbird Creek Tributaries Project	CLIENT:	Baker Engineering
ADDRESS:	Snowbird Rd (SR1127)/IU Gap Rd (SR 1118)	CONTACT:	Carmen Horne-McIntyre
	Robbinsville NC 28771	INQUIRY #:	2112222.2s
LAT/LONG:	35.3103 / 83.8481	DATE:	January 03, 2008 4:39 pm

APPENDIX D. Existing Conditions Geomorphic Data

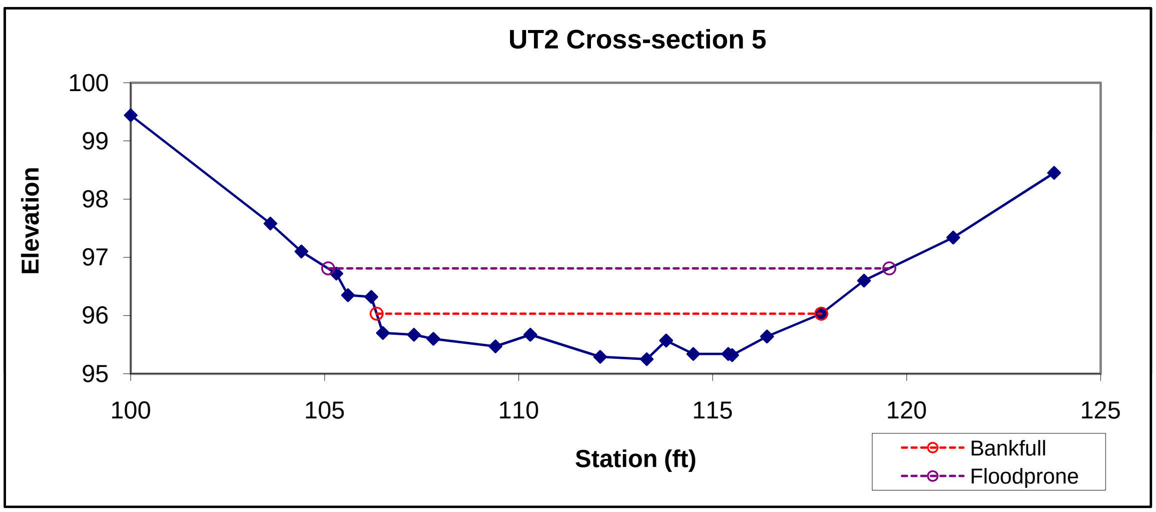


UT3 Existing Profile
Elevation
Station
70
65
60
55
50
45
90
140
190
240
290
TWG
RTO
LTO

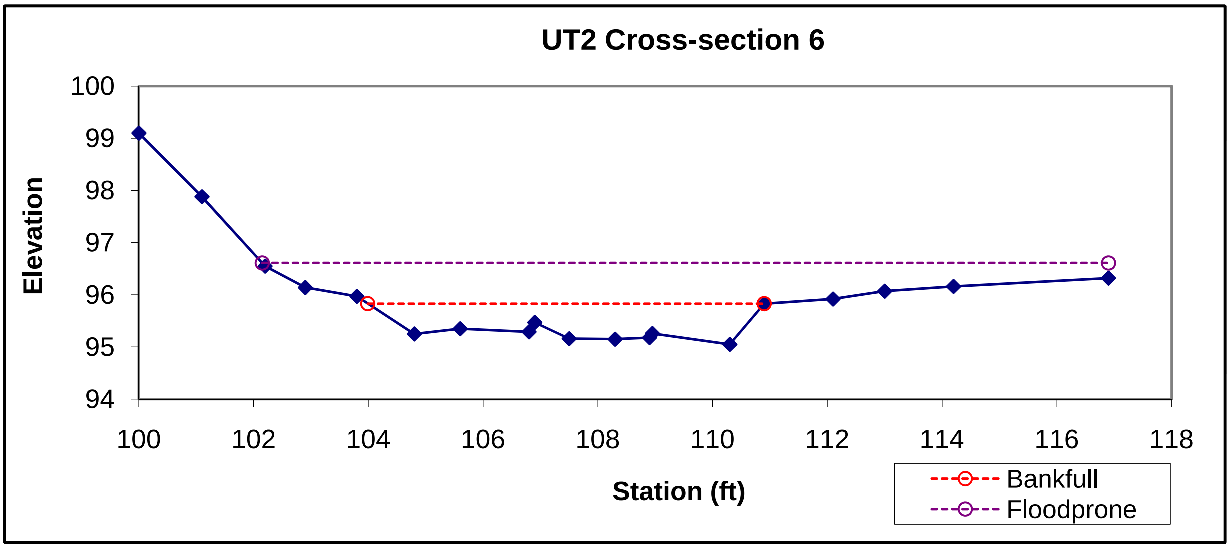
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	A4a+	6	8.28	0.73	1.14	11.35	1.8	1.5	95.34	96.23



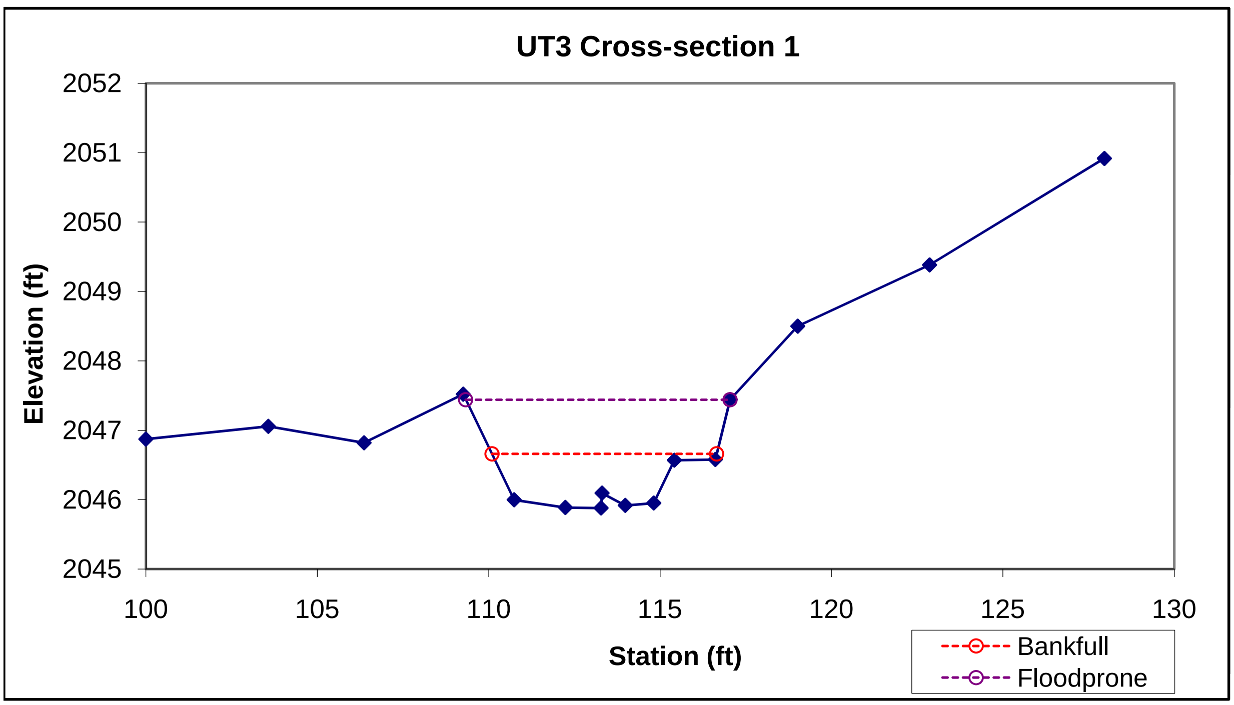
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B4a	5.8	11.46	0.5	0.78	22.72	4.1	1.3	96.03	98.45



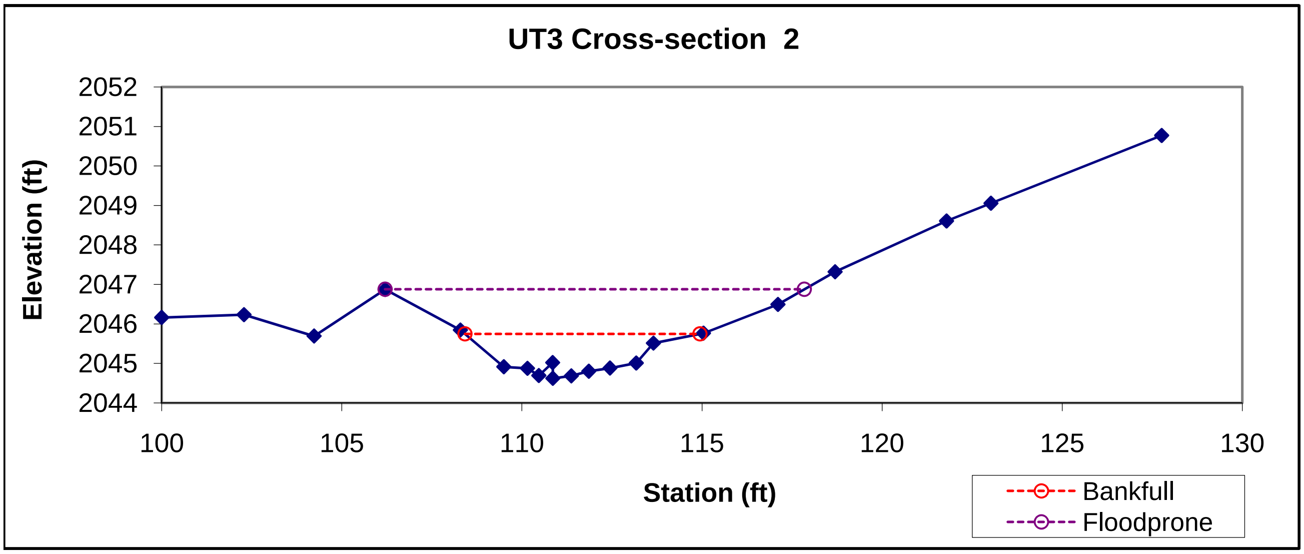
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B4a	3.7	6.91	0.54	0.78	12.76	1.6	2.1	95.83	96.32



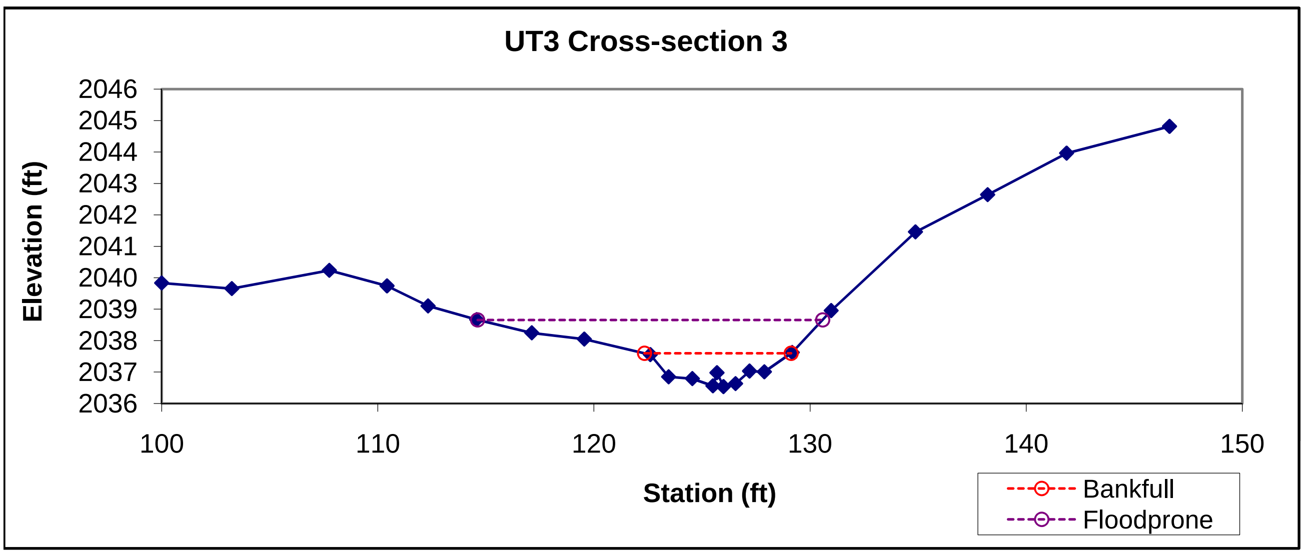
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	F	3.5	6.56	0.54	0.78	12.24	2	1.2	2046.7	2047.4



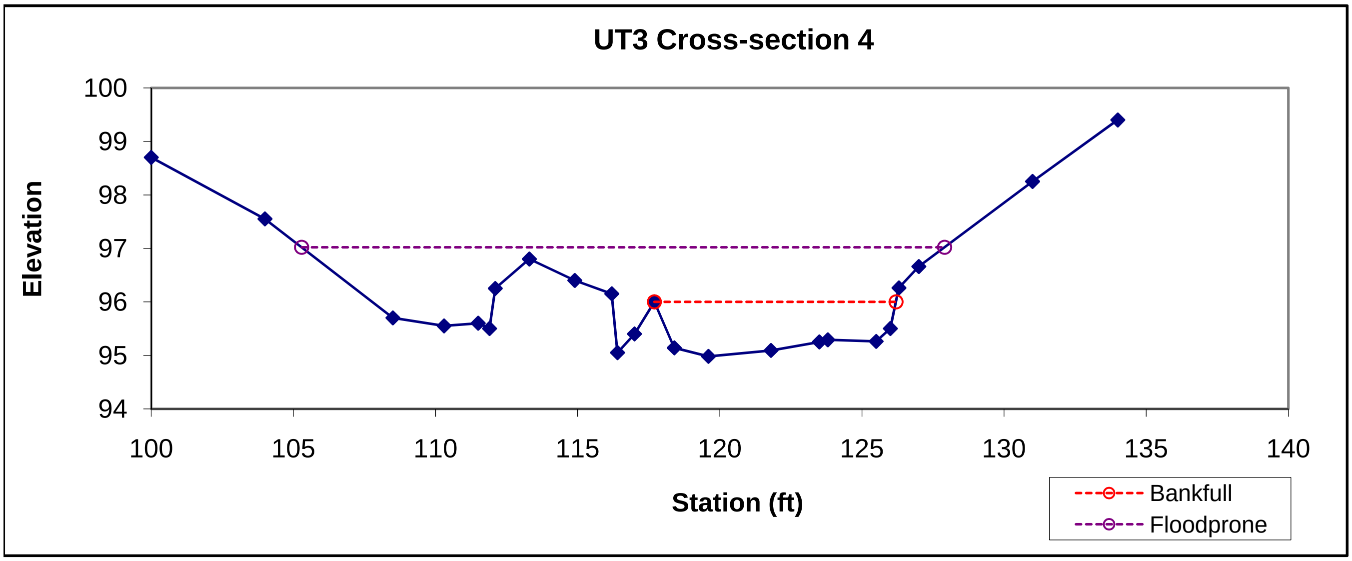
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	E	4.2	6.52	0.65	1.13	10.11	2.0	1.8	2045.75	2046.88



Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	4.3	6.78	0.63	1.06	10.68	2.3	2.4	2037.6	2038.96



Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	A4a+	6.8	8.5	0.8	1.02	10.66	3.6	2.7	96	98.7



APPENDIX E. Existing Conditions Photo Log

Unnamed Tributary 1: (Preservation)

UT1 against a valley wall.

As evidenced in previous photo and photo above, UT1 is characterized by a semi-cascading profile on moderate to steep slopes

Cross section location on UT1

Riffle-pool section of UT 1

Unnamed Tributary 2: Reaches 1 & 3 (Preservation)

Step-pool profile on UT2

Rhododendron prevalent along UT2; particularly where there are breaks in the forest canopy

Typical substrate in preservation reaches

Step-pool features typical on UT2

Unnamed Tributary 2: Reach 2 (Enhancement)

Upper extent of UT2 enhancement area facing downstream

Area where debris left discarded in UT2

Cross section location on UT2

UT2 channel widens in areas where bedrock is exposed and where slope changes

Unnamed Tributary 3: Reach 1 (Preservation)

Typical dimension of UT3 on more moderate
to gentle slopes

Rhododendron lines much of the riparian zone
along UT3

UT3 also features step-pool features similar to
that of UT1 and UT2

Unnamed Tributary 3: Reach 2 (Restoration)

UT3 channel conditions near zone between preservation and restoration reaches

UT3 adjacent to field clearing; previous grading resulted in UT3 having less access to its floodplain

Existing location of UT3 in valley

New alignment of UT3 would begin in the vicinity of location shown

UT3 would be restored in the lowest part of the valley located in the left portion of this photo.

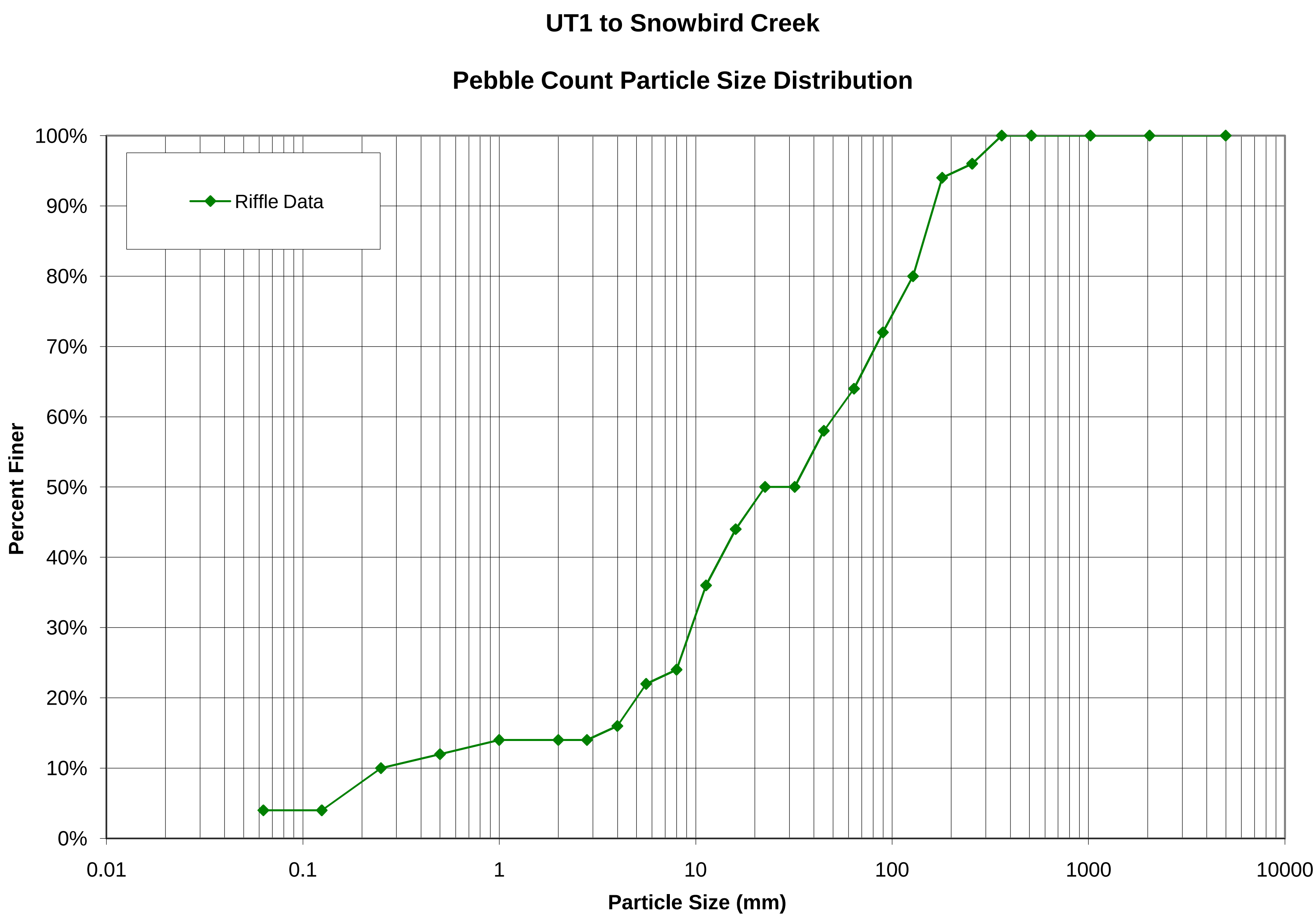
APPENDIX F. Sediment Sampling Analyses

PEBBLE COUNT DATA SHEET: RIFFLE 100-COUNT

BAKER PROJECT NO.	113112
SITE OR PROJECT:	SNOWBIRD TRIBUTARIES
REACH/LOCATION:	UT1 - LOWER ROAD CROSSING
DATE COLLECTED:	5/29/2009
FIELD COLLECTION BY:	SEG
DATA ENTRY BY:	CDM

			PARTICLE CLASS COUNT	Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	4	4%	4%
SAND	Very Fine	.063 - .125			4%
	Fine	.125 - .25	6	6%	10%
	Medium	.25 - .50	2	2%	12%
	Coarse	.50 - 1.0	2	2%	14%
	Very Coarse	1.0 - 2.0			14%
GRAVEL	Very Fine	2.0 - 2.8			14%
	Very Fine	2.8 - 4.0	2		16%
	Fine	4.0 - 5.6	6	6%	22%
	Fine	5.6 - 8.0	2	2%	24%
	Medium	8.0 - 11.0	12	12%	36%
	Medium	11.0 - 16.0	8	8%	44%
	Coarse	16.0 - 22.6	6	6%	50%
	Coarse	22.6 - 32			50%
	Very Coarse	32 - 45	8	8%	58%
	Very Coarse	45 - 64	6	6%	64%
COBBLE	Small	64 - 90	8	8%	72%
	Small	90 - 128	8	8%	80%
	Large	128 - 180	14	14%	94%
	Large	180 - 256	2	2%	96%
BOULDER	Small	256 - 362	4	4%	100%
	Small	362 - 512			100%
	Medium	512 - 1024			100%
	Large-Very Large	1024 - 2048			100%
BEDROCK	Bedrock	> 2048			100%
		Total	**100**	**98%**	

Largest particles: 290.00 **(riffle)**



L:\projects\113112 Snowbird Cr. FD\Design\Empirical Data\PebbleCounts\UT1 SNOWBIRD, Riffle Dist

7/2/2009

PEBBLE COUNT DATA SHEET: RIFFLE 100-COUNT

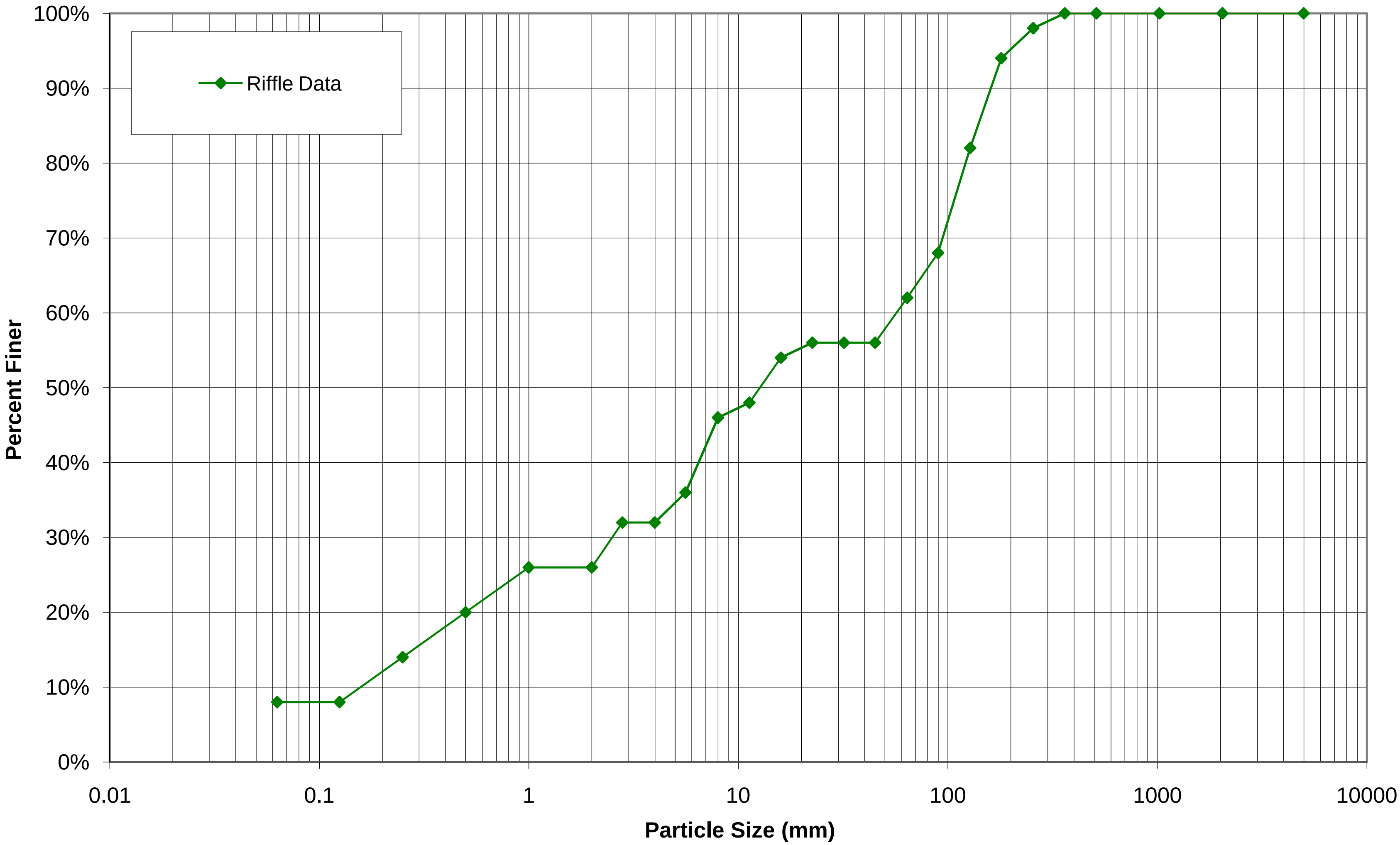
BAKER PROJECT NO.	113112
SITE OR PROJECT:	SNOWBIRD TRIBUTARIES
REACH/LOCATION:	UT2 - REACH 1
DATE COLLECTED:	5/29/2009
FIELD COLLECTION BY:	SEG
DATA ENTRY BY:	CDM

			PARTICLE CLASS COUNT	Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	8	8%	8%
SAND	Very Fine	.063 - .125			8%
	Fine	.125 - .25	6	6%	14%
	Medium	.25 - .50	6	6%	20%
	Coarse	.50 - 1.0	6	6%	26%
	Very Coarse	1.0 - 2.0			26%
GRAVEL	Very Fine	2.0 - 2.8	6	6%	32%
	Very Fine	2.8 - 4.0			32%
	Fine	4.0 - 5.6	4	4%	36%
	Fine	5.6 - 8.0	10	10%	46%
	Medium	8.0 - 11.0	2	2%	48%
	Medium	11.0 - 16.0	6	6%	54%
	Coarse	16.0 - 22.6	2	2%	56%
	Coarse	22.6 - 32			56%
	Very Coarse	32 - 45			56%
	Very Coarse	45 - 64	6	6%	62%
COBBLE	Small	64 - 90	6	6%	68%
	Small	90 - 128	14	14%	82%
	Large	128 - 180	12	12%	94%
	Large	180 - 256	4	4%	98%
BOULDER	Small	256 - 362	2	2%	100%
	Small	362 - 512			100%
	Medium	512 - 1024			100%
	Large-Very Large	1024 - 2048			100%
BEDROCK	Bedrock	> 2048			100%
		Total	**100**	**100%**	

Largest particles: 280.00 **(riffle)**

UT2 to Snowbird Creek

Pebble Count Particle Size Distribution



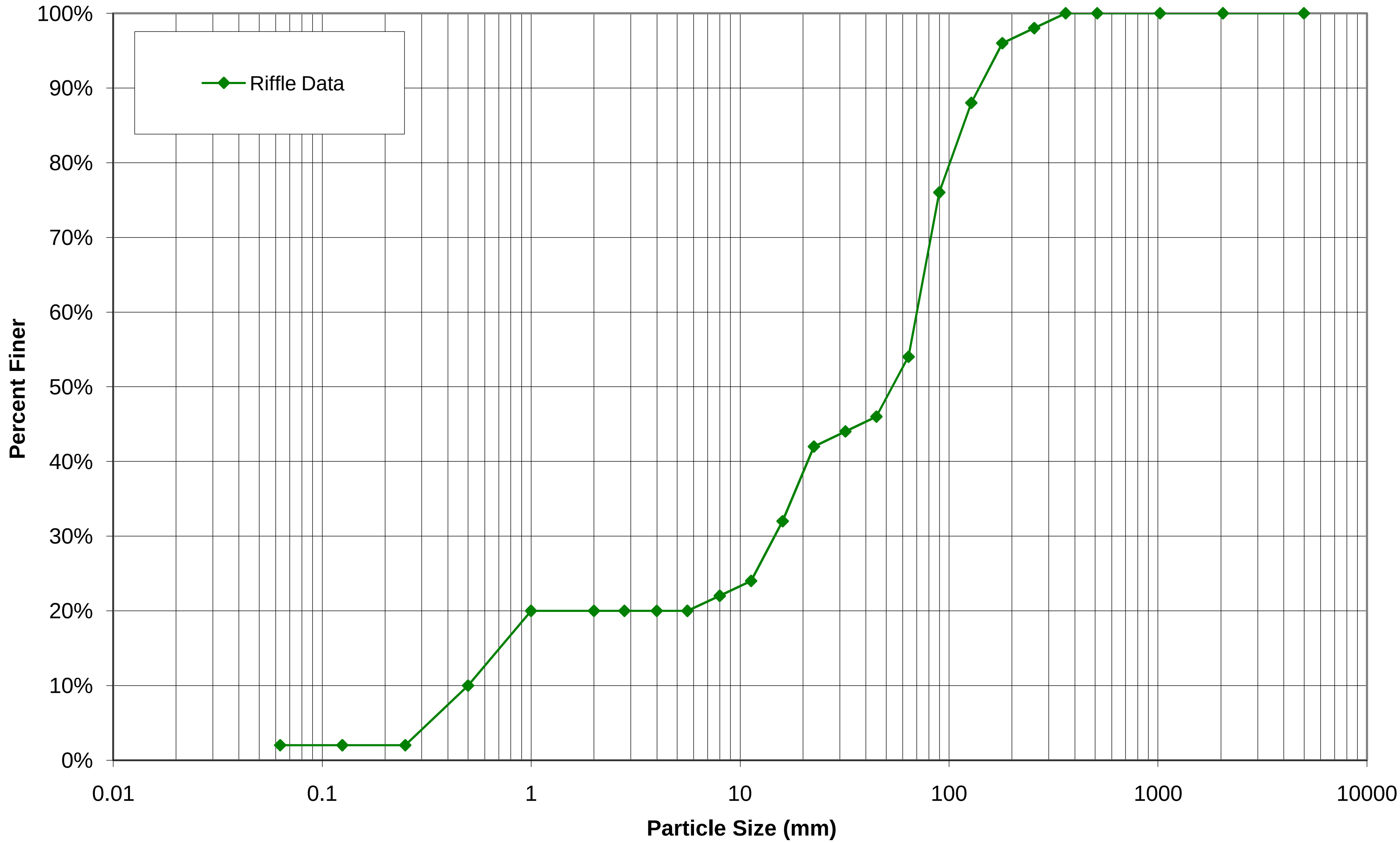
PEBBLE COUNT DATA SHEET: RIFFLE 100-COUNT

BAKER PROJECT NO.	113112
SITE OR PROJECT:	SNOWBIRD TRIBUTARIES
REACH/LOCATION:	UT3 - REACH 1
DATE COLLECTED:	5/28/2009
FIELD COLLECTION BY:	SEG
DATA ENTRY BY:	CDM

			PARTICLE CLASS COUNT	Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	2	2%	2%
SAND	Very Fine	.063 - .125			2%
	Fine	.125 - .25			2%
	Medium	.25 - .50	8	8%	10%
	Coarse	.50 - 1.0	10	10%	20%
	Very Coarse	1.0 - 2.0			20%
GRAVEL	Very Fine	2.0 - 2.8			20%
	Very Fine	2.8 - 4.0			20%
	Fine	4.0 - 5.6			20%
	Fine	5.6 - 8.0	2	2%	22%
	Medium	8.0 - 11.0	2	2%	24%
	Medium	11.0 - 16.0	8	8%	32%
	Coarse	16.0 - 22.6	10	10%	42%
	Coarse	22.6 - 32	2	2%	44%
	Very Coarse	32 - 45	2	2%	46%
	Very Coarse	45 - 64	8	8%	54%
COBBLE	Small	64 - 90	22	22%	76%
	Small	90 - 128	12	12%	88%
	Large	128 - 180	8	8%	96%
	Large	180 - 256	2	2%	98%
BOULDER	Small	256 - 362	2	2%	100%
	Small	362 - 512			100%
	Medium	512 - 1024			100%
	Large-Very Large	1024 - 2048			100%
BEDROCK	Bedrock	> 2048			100%
		Total	**100**	**100%**	

Largest particles: 330.00 **(riffle)**

UT3 to Snowbird Creek
Reach 1
Pebble Count Particle Size Distribution

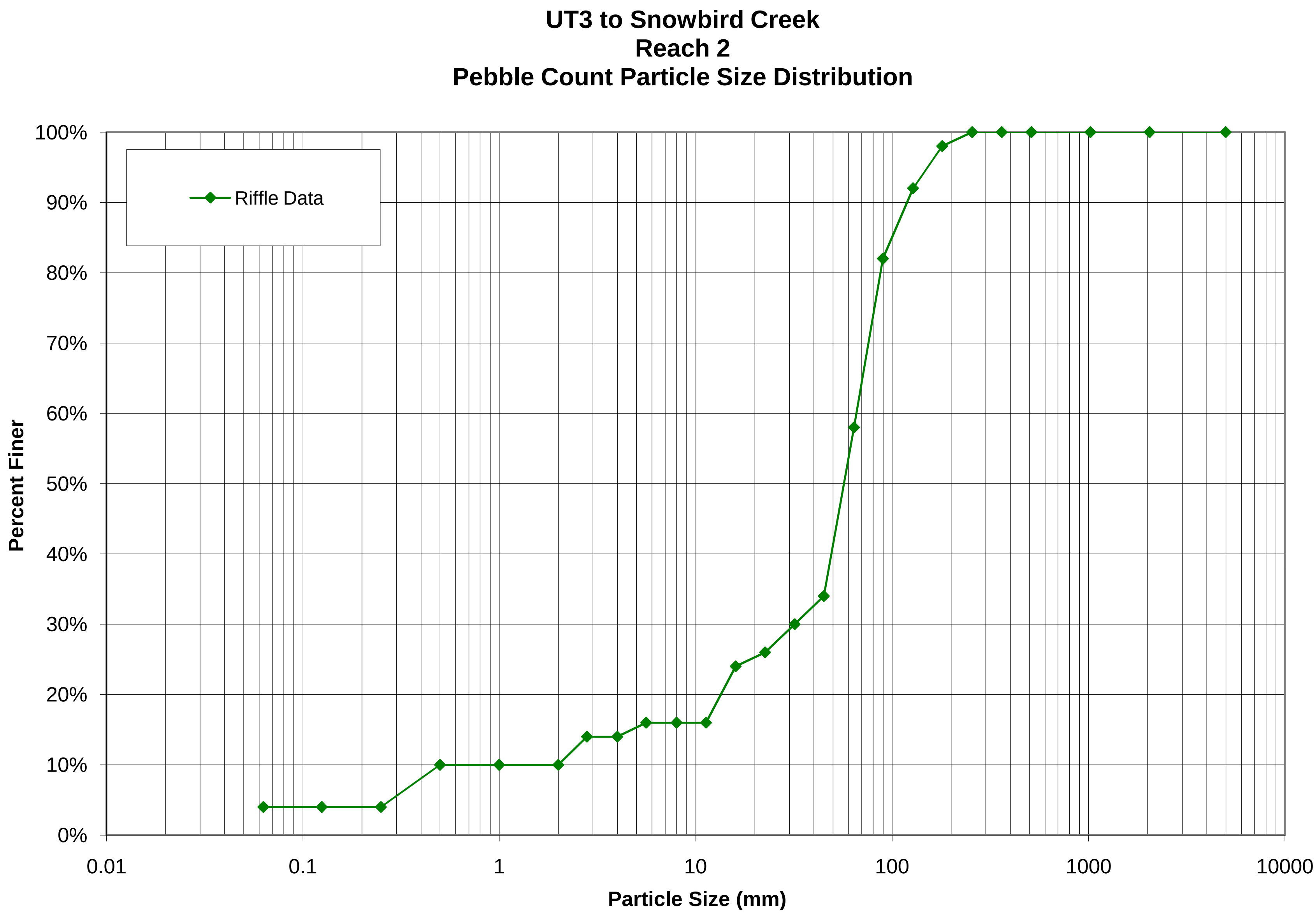


PEBBLE COUNT DATA SHEET: RIFFLE 100-COUNT

BAKER PROJECT NO.	113112
SITE OR PROJECT:	SNOWBIRD TRIBUTARIES
REACH/LOCATION:	UT3 - REACH 2
DATE COLLECTED:	5/29/2009
FIELD COLLECTION BY:	SEG
DATA ENTRY BY:	CDM

			PARTICLE CLASS COUNT	Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	4	4%	4%
SAND	Very Fine	.063 - .125			4%
	Fine	.125 - .25			4%
	Medium	.25 - .50	6	6%	10%
	Coarse	.50 - 1.0			10%
	Very Coarse	1.0 - 2.0			10%
GRAVEL	Very Fine	2.0 - 2.8	4	4%	14%
	Very Fine	2.8 - 4.0			14%
	Fine	4.0 - 5.6	2	2%	16%
	Fine	5.6 - 8.0			16%
	Medium	8.0 - 11.0			16%
	Medium	11.0 - 16.0	8	8%	24%
	Coarse	16.0 - 22.6	2	2%	26%
	Coarse	22.6 - 32	4	4%	30%
	Very Coarse	32 - 45	4	4%	34%
	Very Coarse	45 - 64	24	24%	58%
COBBLE	Small	64 - 90	24	24%	82%
	Small	90 - 128	10	10%	92%
	Large	128 - 180	6	6%	98%
	Large	180 - 256	2	2%	100%
BOULDER	Small	256 - 362			100%
	Small	362 - 512			100%
	Medium	512 - 1024			100%
	Large-Very Large	1024 - 2048			100%
BEDROCK	Bedrock	> 2048			100%
		Total	**100**	**100%**	

Largest particles: 190.00 **(riffle)**



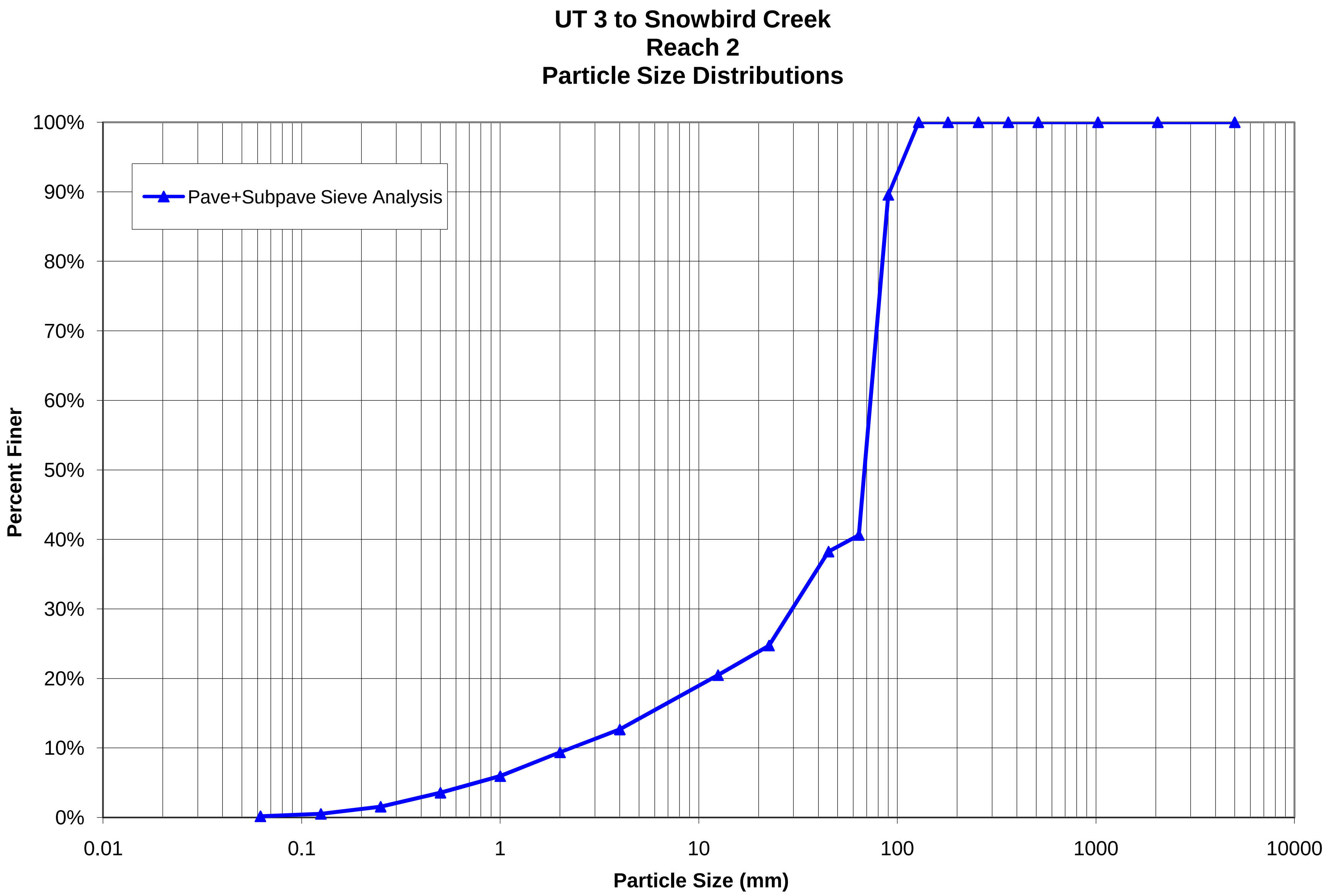
UT3 to Snowbird Creek
Reach 2
Pebble Count Particle Size Distribution
Riffle Data
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Finer
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)

PAVEMENT / SUBPAVEMENT ANALYSIS

BAKER PROJECT NO.	113112
SITE OR PROJECT:	Snowbird
REACH/LOCATION:	UT 3 - Reach 2 (Shovel Sample-includes both surface (pavement) and subsurface particles (subpavement))
DATE COLLECTED:	4/30/2009
FIELD COLLECTION BY:	MC/SG
LAB ANALYSIS BY:	DH

LARGEST PARTICLE: 90-128 mm

			SIEVE ANALYSIS			Summary	
MATERIAL	PARTICLE	SIZE (mm)	RAW	TARE	NET	Class %	% Cum
SILT/CLAY	Silt / Clay	< .062	13.9		13.9	0%	0%
SAND	Very Fine	.062 - .125	27.4		27.4	0%	1%
	Fine	.125 - .25	83.6		83.6	1%	2%
	Medium	.25 - .50	162.2		162.2	2%	4%
	Coarse	.50 - 1.0	190.4		190.4	2%	6%
	Very Coarse	1.0 - 2.0	275.2		275.2	3%	9%
GRAVEL	Very Fine	2.0 - 4.00	265.1		265.1	3%	13%
	Fine - Medium	4.00 - 12.5	628.0		628.0	8%	20%
	Medium- Coarse	12.5 - 22.6	341.8		341.8	4%	25%
	Coarse	22.6 - 45	1087.0		1087.0	14%	38%
	Very Coarse	45 - 64	191.0		191.0	2%	41%
COBBLE	Small	64 - 90	3932.7		3932.7	49%	90%
	Small	90-128	841.0		841.0	10%	100%
	Large	128 - 180					
	Large	180 - 256					
BOULDER	Small	256 - 362					
	Small	362 - 512					
	Medium	512 - 1024					
	Large - Very Large	1024 - 2048					
BEDROCK	Bedrock	> 2048					
		Total			8039.3		


UT 3 to Snowbird Creek
Reach 2
Particle Size Distributions
Pave+Subpave Sieve Analysis
Percent Finer
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)