

# Snowbird Creek Tributaries Mitigation Project

## Year 1 Monitoring Report - Final

### Graham County, North Carolina

---



Monitoring Firm: Michael Baker Engineering, Inc. (Baker)

Monitoring Firm POC: Carmen McIntyre

Prepared for: North Carolina Ecosystem Enhancement Program (NCEEP)

NCEEP Project Manager: Paul Wiesner



NCEEP Contract Number: 000613 NCEEP Project Number: 92764

Project Construction: 2010

Year 1 Data Collection: 2011-2012

Report Submitted: 2012

Report Prepared By:

Michael Baker Engineering, Inc.  
NC Engineering License F-1084  
797 Haywood Road, Suite 201  
Asheville, NC 28806

---

# Snowbird Creek Tributaries Mitigation Project

## Graham County, North Carolina

---

Report Prepared and Submitted by Michael Baker Engineering, Inc.

NC Professional Engineering License # F-1048



**Michael Baker Engineering, Inc.**

797 Haywood Road

Suite 201

Asheville, North Carolina 28806

Phone: 828.350.1408

Fax: 828.350.1409

(STAMP & SEAL)

---

Jake McLean, P.E.  
Project Manager

---

Micky Clemmons  
Office Principal

# Table of Contents

<b>EXECUTIVE SUMMARY</b> .....	<b>V</b>
<b>1.0 PROJECT BACKGROUND AND ATTRIBUTES</b> .....	<b>1</b>
1.1 LOCATION AND SETTING .....	1
<b>2.0 METHODOLOGY AND RESULTS</b> .....	<b>2</b>
2.1 STREAM ASSESSMENT .....	2
2.1.1 <i>Morphologic Parameters and Channel Stability</i> .....	2
2.1.2 <i>Hydrology</i> .....	4
2.1.3 <i>Photographic Documentation of Site</i> .....	4
2.1.4 <i>Stream Stability Assessment</i> .....	5
2.2 VEGETATION ASSESSMENT .....	5
2.2.1 <i>Vegetation</i> .....	5
2.3 AREAS OF CONCERN.....	8
<b>3.0 REFERENCES</b> .....	<b>8</b>

## Tables and Exhibits

## Appendix

<b>Figure</b>	<b>1</b>	Project Location Map.....	<b>A</b>
<b>Table</b>	<b>A1</b>	Project Components .....	<b>A</b>
<b>Table</b>	<b>A2</b>	Project Activity and Reporting History .....	<b>A</b>
<b>Table</b>	<b>A3</b>	Project Contacts Table .....	<b>A</b>
<b>Table</b>	<b>A4</b>	Project Attribute Table.....	<b>A</b>
<b>Figure</b>	<b>2</b>	Restoration Summary Map .....	<b>B</b>
<b>Exhibit</b>	<b>1</b>	Reference Station Photologs .....	<b>B</b>
<b>Exhibit</b>	<b>2</b>	Vegetation Plot Photolog .....	<b>B</b>
<b>Table</b>	<b>C5</b>	Vegetation Plot Criteria Attainment - Year 1 .....	<b>C</b>
<b>Table</b>	<b>C6</b>	Vegetation Metadata - Year 1 .....	<b>C</b>
<b>Table</b>	<b>C7</b>	Stem Count Arranged by Plot - Year 1 .....	<b>C</b>
<b>Exhibit</b>	<b>3</b>	Year 1 Cross-Sections with Annual Overlays .....	<b>D</b>
<b>Exhibit</b>	<b>4</b>	Year 1 Longitudinal Profile with Annual Overlay .....	<b>D</b>
<b>Exhibit</b>	<b>5</b>	Riffle Pebble Count Size Class Distribution (UT3) .....	<b>D</b>
<b>Table</b>	<b>D8</b>	Cross-Section Morphology Data Table .....	<b>D</b>
<b>Table</b>	<b>D9</b>	Stream Reach Morphology Data Table .....	<b>D</b>
<b>Table</b>	<b>E10</b>	Verification of Bankfull or Greater than Bankfull Events .....	<b>E</b>
<b>Figure</b>	<b>3</b>	Stream Problem Areas .....	<b>F</b>
<b>Figure</b>	<b>4</b>	Vegetation Problem Areas .....	<b>F</b>
<b>Table</b>	<b>F11</b>	Visual Morphological Stability Assessment Table .....	<b>F</b>

**Table F12** Stream Problem Areas Table ..... F  
**Table F13** Vegetation Problem Areas Table ..... F

## EXECUTIVE SUMMARY

The Snowbird Creek Tributaries site was restored through a full delivery contract with the North Carolina Ecosystem Enhancement Program (NCEEP). This report documents the completion of the project and presents Year 1 monitoring data for the five-year monitoring period. The goals for the restoration project were as follows:

- Promote and recreate geomorphically stable conditions at the Snowbird Creek Tributaries project site;
- The reduction of sediment and nutrient inputs through restoration of riparian areas and stream banks; and
- To improve aquatic and terrestrial habitat along the project corridor.

To accomplish these goals, the following objectives were implemented:

- Restoration of an incised, channelized, and eroding stream by creating a stable channel that has access to its floodplain; enhancement of a previously disturbed stream reach by replanting the riparian corridor with native woody vegetation;
- Improve water quality by establishing buffers for nutrient removal from runoff;
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools, developing areas that increase oxygenation, providing woody debris for habitat, and reducing bank erosion; and
- Improve terrestrial habitat by removing invasive species, planting riparian areas with native vegetation and protecting these areas with a permanent conservation easement so that the riparian area will increase storm water runoff filtering capacity, improve bank stability, provide shading to decrease water temperature and improve wildlife habitat.

One vegetation monitoring plot 100 square meters (m<sup>2</sup>) (10m x 10m) in size was used to predict survivability of the woody vegetation planted on-site. The Year 1 monitoring of vegetation indicated an average survival of 850 stems per acre. The data shows that the Site is on track to meet both the interim stem survival criteria for Year 3 (320 stems per acre) and the final success criteria of 260 trees per acre by the end of Year 5. Per comments received by the EEP during the submittal of the baseline report for this project, a smaller vegetation plot was to be established on UT2 to monitor the success of stems planted in the Enhancement II reach. However, it was discovered that the planting contractor neglected to set out stems after removing the debris from the reach. As a result, Baker is coordinating with the planting contractor to replant the Enhancement II area prior to a plot being established. Despite the lack of stems, the Enhancement II area did not appear to be unstable and debris that was formerly in the channel was removed. Figure 4 and Table 13 in Appendix F both document the lack of stems reported along the entire length of Reach 2 of UT2.

The design implemented at the Snowbird Creek Tributaries mitigation project site involved Priority Level 1 Restoration, and Enhancement Level II approaches. Channels were built to be consistent with, or evolve to, stable B3-type channel for Reach 2 of UT3 and a B4-type channel for the section of UT2 that was enhanced. Restoration and enhancement work were completed in accordance with the approved design approach provided in the mitigation plan for the tributaries. Longitudinal profile and cross-section data indicate that the project streams have remained stable since baseline monitoring data were collected in February 2011. During the time of the as-built surveys, vegetation was sparse on a section of UT3-Reach 2; however, by the time Year 1 monitoring activities began in November 2011, a dense layer of herbaceous vegetation covered the site. Photo logs included in this report confirm the herbaceous cover at the project site is flourishing, and in conjunction with other erosion control measures like matting, is promoting bank stability on-site while planted, woody vegetation becomes more established. Based on geomorphic data presented in Appendix D, this Site is currently on track to meet the hydrologic and stream success criteria specified in the Snowbird Creek Tributaries Mitigation Plan.

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

## **1.0 PROJECT BACKGROUND AND ATTRIBUTES**

The Snowbird Creek Tributaries mitigation site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina (Figure 1, Appendix A). The project site is situated in the Little Tennessee River Basin, within North Carolina Division of Water Quality (NCDWQ) sub-basin 04-04-04 and United States Geologic Survey (USGS) hydrologic unit 06010204020010. The Snowbird Creek Tributaries mitigation project is located in a watershed that is predominantly forested that also contains a small number of residences near the tributaries and Hooper Branch. The vast majority of the watershed is in forested cover, with less than one percent of land being in agricultural use. Over the past 100 years, various parcels within the project area have been impacted by logging activities as well as residential and agricultural land use within the valley bottom.

Anthropogenic land use alteration and channelization of streams in the Snowbird Creek Tributaries project watersheds have resulted in various stream corridor impairments. Incision, bank erosion, and other ongoing stream processes typical of adjusting streams were found in various reaches of UT3 and other tributaries within the project area. However, it was determined that the benefits of stream and riparian enhancement further upslope in the watershed would not be significant enough to justify further disturbance of the watershed which continues to revert to a more natural state in the absence of intensive logging activities.

In accordance with the approved mitigation plan for the site, construction activities were conducted in August 2010. Project activity on UT2 consisted of improving bank stability and riparian conditions along a small section of UT2 that had been degraded by previous logging activities. An Enhancement II approach was used to stabilize this reach; efforts included replacing native woody vegetation in an area previously disturbed during logging activities and removal of debris from the channel that was contributing to channel disturbance. Re-vegetation of the riparian corridor will improve shading and provide high quality biomass to the stream in addition to other habitat improvements.

A Priority I Restoration approach was used on Reach 2 of UT3 to address prior manipulation and relocation of the reach by restoring a channel with step-pool morphology in the low part of the valley. The restoration of this reach of UT3 eliminated the bank erosion, aggradation of fines, and lack of native riparian vegetation and rootmass that characterized the former location of Reach 2 on UT3. The new channel has improved connectivity to its floodplain and channel bedform was improved by constructing a series of step-pool and riffle-pool sequences using grade control structures. These grade control structures will aid in dissipating streamflow energy, decrease pool-to-pool spacing and improve the quality of in-stream habitat present. Given the steepness of the project area, creating a step-pool channel system was critical in achieving a more stable profile and preventing self-propagating headcuts. A vegetated riparian buffer was also planted which will support streambank stability along the new reach while serving a variety of terrestrial and aquatic habitat functions.

The project involved restoration or enhancement of 714 linear feet (LF) of two streams: Reach 2 of UT3 and Reach 2 of UT2. In addition, 7,497 LF of UT1, UT2 and UT3 were preserved with conservation easements. The restoration, enhancement, and preservation of 8,211 LF of stream within this project site has generated 2,035 stream mitigation units (SMUs).

### **1.1 Location and Setting**

The Snowbird Creek Tributaries mitigation site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina. 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 gated dirt road that leads to UT1 and UT2. To get to UT3, turn left on IU Gap Rd., go .15 miles, the UT3 property is on the left and the access drive is on the left just past a small rental farm house.

## **2.0 METHODOLOGY AND RESULTS**

The five-year monitoring plan for the Snowbird Creek Tributaries mitigation project includes criteria to evaluate the success of the geomorphic, vegetative and hydrologic components of the project. The specific locations of the cross-sections, sediment sampling location, vegetation plot, crest gauge installation and permanent reference photo stations, are shown on the as-built plans submitted with this report.

### **2.1 Stream Assessment**

#### **2.1.1 Morphologic Parameters and Channel Stability**

Geomorphic monitoring of restored stream reaches is being conducted over a five year period to evaluate the effectiveness of the restoration practices installed. Monitored stream parameters include channel dimension (cross-sections), profile (longitudinal survey), pattern (to a lesser degree for reasons noted below), bed composition, bank stability, bankfull flows, and stability of reference sites documented by photographs. Crest gauges, as well as high flow marks, will be used to document the occurrence of bankfull events. The methods used and any related success criteria are described below for each parameter. Detailed channel morphology was surveyed with a total station by Baker under the direction of Will Kent, PLS; survey data is georeferenced.

##### **2.1.1.1 Dimension**

Four permanent cross-sections were installed in representative riffle and pool reaches on UT3 to help evaluate the success of the mitigation project. Each cross-section was established by installing permanent pins on each bank to establish a consistent and repeatable transect from year-to-year. The cross-sectional surveys capture points at all breaks in slope and includes typical features such as top of bank, bankfull (if different from top of bank), inner berm, edge of water, and thalweg. Cross-sections are provided in Exhibit 3 of Appendix D and are depicted with an orientation looking downstream. Riffle cross-sections are classified using the Rosgen Stream Classification System. The project was built with a larger-than-typical entrenchment ratio for B-type channels, however Baker has determined that the B classification is still most appropriate based on other channel characteristics, namely width-depth ratio, sinuosity, and slope.

From year-to-year, change in cross-section dimensions should typically be limited to steepening of the banks from a gentler side-slope that they are typically constructed at, to a steeper slope that is sustainable once complementary vegetation establishes. This vegetation of the banks and floodplain may promote further bank deposition and channel narrowing based on the resulting increase in roughness that accompanies dense vegetation establishment. These, and any other changes, will be evaluated to determine their root cause and whether they represent movement toward a more unstable condition (e.g., down-cutting or erosion) or movement toward increased stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio).



#### **2.1.1.1.1 Results**

As-built cross-section monitoring data for stream stability was collected in February 2011. The four permanent cross-sections along UT3 were re-surveyed in January 2012 to document stream dimension for Monitoring Year 1. Cross-sectional data is presented in Table 8 (Appendix D) and the location of cross-sections is shown on the plan sheets submitted with this report.

The cross-sections show that there has been little to no adjustment to stream dimension on Reach 2 of UT3 since construction. At this time, cross-sectional measurements do not indicate any streambank or channel stability issues.

#### **2.1.1.2 Pattern and Longitudinal Profile**

The longitudinal profile for Year 1 was surveyed during January 2012; a visualization of the profile is provided in Exhibit 4 of Appendix D. A longitudinal profile was conducted for the entire project length on Reach 2 of UT3. This longitudinal profile will be replicated annually during the five year monitoring period.

Measurements taken along the longitudinal profile include thalweg, water surface, and top of left and right bank. The pools should remain relatively deep with flat water surface slopes, and the riffles should remain steeper and shallower than the pools. Bed form observations should be consistent with those observed for channels of the design stream type. Profile data collected should reflect stable channel bedform and a diverse range of riffle and pool complexes.

All measurements were taken at the head of each feature (e.g., riffle, run, pool, glide) and the maximum pool depth. Elevations of grade control structures were also included in the longitudinal profiles surveyed. Surveys were tied to a permanent benchmark. Although pattern adjustments were made on Reach 2 of UT3 for channel alignment considerations, such as following the low point of the valley, pattern adjustments were not made with the intent to greatly increase sinuosity. Unnamed Tributary 3 is an A/B-type stream primarily characterized by a step-pool morphology. Consequently, pattern information is not provided in Appendix D as the parameters present are generally associated with meandering, riffle-pool channels and not step-pool channels. However, as the site is monitored, reaches will be evaluated for significant changes in pattern. Any changes that occur and warrant repair will be discussed in future monitoring reports.

#### **2.1.1.2.1 Results**

The longitudinal profile shows that the bed features are stable; closely-spaced grade control structures continue to help maintain the overall profile desired. As noted in the Stream Reach Morphology Data Tables in Appendix D (Table 9), riffle and pool characteristics do not appear to have changed much since construction; the riffle slope and pool spacing measurements obtained for Year 1 are acceptable when compared to design data provided for Reach 2 of UT3. Bedform diversity, particularly max pool depths and pool spacing features, appears to have improved with the restoration of the channel; grade control structures will help maintain vertical stability in Reach 2 of UT3 as the channel adjusts to a more natural B-type channel.

There was also little to no change in the profile of Reach 2 of UT3 since construction. There is one structure around station 0+95 where the stream is piping through the structure; however, there was no sign of bank or channel instability observed. At this time, the structure is not considered to be an area of concern. Baker will continue to monitor this structure and repairs will be made should the area become unstable or the area of piping does

not seal itself; Figure 3 and Tables 11 and 12 in Appendix F document the piping of this structure.

### **2.1.1.3 Substrate and Sediment Transport**

Bed material analysis will consist of a pebble count taken in the same constructed riffle during annual geomorphic surveys of the project site. This sample, combined with evidence provided by changes in cross-sectional and profile data will reveal changes in sediment transport and bed gradation that occur over time as the stream adjusts to upstream sediment loads and cross-sections evolve into a more permanent stable dimension. Significant changes in bed load composition will be evaluated with respect to stream stability and watershed changes.

#### **2.1.1.3.1 Results**

For this project, a pebble count was collected on UT3. Visual observations of UT3 and a review of pebble count data collected during Year 1 monitoring did not yield any signs that sediment transport functions have been hampered by the mitigation project; specifically, no significant areas of aggradation or degradation within the project area were observed. The pebble count data (Exhibit 5, Appendix D) indicates that the stream is moving fines through the system and larger pebbles are making up a greater percentage of the bed material.

## **2.1.2 Hydrology**

### **2.1.2.1 Streams**

The occurrence of bankfull events within the monitoring period will be documented by the use of a crest gauge and photographs. A crest gauge was installed on the floodplain of UT3 at the bankfull elevation. The crest gauge will record the highest watermark between site visits and will be checked at each 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 must be documented on the crest gauge within the 5-year monitoring period. The two bankfull events must occur in separate years; otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years or we reach the end of the monitoring period. If we reach the end of the monitoring period without two bankfull events occurring, the MRT will decide how to proceed.

#### **2.1.2.1.1 Results**

At this time, no bankfull events have been recorded (Appendix E). Baker is considering relocating the crest gauge as it has been observed that the current location is prone to holding standing water. If the crest gauge is relocated, the plans accompanying subsequent monitoring reports will be updated to reflect the new location.

## **2.1.3 Photographic Documentation of Site**

Photographs will be used to document restoration success visually. Reference sites were photographed during the as-built survey; photographing these sites will be repeated for at least five years following construction. Reference photos are taken once a year, from a height of approximately five to six feet. Permanent markers will ensure that the same locations (and view) are utilized during each monitoring period. Selected site photographs are shown in Appendix B.

Lateral and structure photographs are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, structure function and stability, and effectiveness of erosion control measures. Lateral photos should not indicate excessive erosion or degradation of the banks. A series of photos over time should indicate successive maturation of

riparian vegetation and consistent structure function. Photo documentation of the site during Year 1 monitoring reflects stable site conditions in restored or enhanced areas.

### **2.1.3.1 Lateral Reference Photos**

Reference photos of transects were taken of the right and left banks at each permanent cross-section. A survey tape was shown in most photographs and represents the cross-section line located perpendicular to the channel flow. The water surface was located in the lower edge of the frame in order to document bank and riparian conditions. Photographers will make an effort to consistently maintain the same area in each photo over time.

### **2.1.3.2 Structure Photos**

Photographs of primary grade control structures (i.e. vanes and weirs), along the restored streams are included within the photographs taken at reference photo stations. Photographers will make every effort to consistently maintain the same area in each photo over time.

## **2.1.4 Stream Stability Assessment**

In-stream structures installed within the restored streams consisted of boulder steps. Table 11 in Appendix F provides a comprehensive visual assessment of morphological stability throughout restored area (Reach 2 of UT3). The Year 1 visual observations of these structures indicate that little or no changes have occurred since the baseline survey was performed; structures are functioning as designed and are holding their elevation and grade. As noted in earlier discussions about channel dimension and profile, a structure around station 0+95 is experiencing piping. However, the channel and banks appear stable in this area; Baker will monitor the structure to see if the piping is corrected by natural processes or if repairs to the structure become warranted. The close spacing of grade control structures on UT3 and favorable bank heights are allowing for both vertical and lateral energy dissipation of the stream during flood events; no structures were found to be in need of repair at this time.

Quantitative reference reach and design data used to determine the restoration approach, as well as the Year 1 data collected during the project's post-construction monitoring period are summarized in Appendix D.

## **2.2 Vegetation Assessment**

### **2.2.1 Vegetation**

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. The restoration plan for the Snowbird Creek Tributaries Site specifies that the number of vegetation monitoring quadrants required will be based on the species/area curve method, as described in NCEEP monitoring guidance documents. The size of individual quadrants is 100 square meters for woody tree species, and 1 square meter for herbaceous vegetation. Level 1 CVS vegetation monitoring will occur in spring, after leaf-out has occurred, or in the fall prior to leaf fall.

At the end of the first growing season during baseline surveys, species composition, density, and survival were evaluated. Individual quadrant data provided during subsequent monitoring events will include diameter, height, density, and coverage quantities. Relative values will be calculated, and importance values will be determined. Individual stems were 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 stems and the current year's living, planted stems.

Photographs are used to visually document vegetation success in sample plots. Reference photos of tree and herbaceous condition within plots are taken at least once per year. Photos of the plots are included in Appendix B of this report.

The interim measure of vegetative success for the site is the survival of at least 320, 3-year old, planted trees per acre at the end of Year 3 of the monitoring period. The final vegetative success criteria is the survival of 260, 5-year old, planted trees per acre at the end of Year 5 of the monitoring period.

Seeding applied to streambanks beneath the erosion matting sprouted within two weeks of application and has provided excellent ground coverage. Live stakes and bare root trees planted are also flourishing and will increasingly contribute to streambank stability and shading. In general, bare-root vegetation was planted at a target density of 680 stems per acre, in an 8-foot by 8-foot grid pattern. Planting of bare-root trees was completed in late March-early April 2011. Species planted are listed below.

<b>Proposed Bare-Root and Live Stake Species (may also include seed or container species)</b>				
Snowbird Creek Tributaries Mitigation Plan-NCEEP Project #92764				
Common Name	Scientific Name	% Planted by Species	Planting Density	Wetness Tolerance
Riparian Buffer Plantings				
Trees Overstory				
Sycamore	<i>Platanus occidentalis</i>	8	54	FACW-
River Birch	<i>Betula nigra</i>	7	48	FACW
White Oak	<i>Quercus alba</i>	5	34	FACU
Red Maple	<i>Acer rubrum</i>	5	34	FAC
Tulip Poplar	<i>Liriodendron tulipifera</i>	5	34	FAC
Yellow Birch	<i>Betula alleghaniensis (lutea)</i>	5	34	FACU+
Black (Sweet) Birch	<i>Betula lenta</i>	5	34	FACU
Northern Red Oak	<i>Quercus rubra</i>	5	34	FACU
Yellow Buckeye	<i>Aesculus octandra</i>	5	34	N/A
Mockernut Hickory	<i>Carya alba (tomentosa)</i>	3	20	N/A
Scarlet Oak	<i>Quercus coccinea</i>	2	14	N/A
Trees Understory				
Highland Doghobble	<i>Leucothoe fontanesiana (axillaris var. editorum)</i>	5	34	N/A
Mountain Laurel	<i>Kalmia latifolia</i>	5	34	FACU
Flame Azalea	<i>Rhododendron calendulaceum</i>	5	34	N/A
Black Willow	<i>Salix nigra</i>	2	14	OBL
Ironwood	<i>Carpinus caroliniana</i>	3	20	FAC
Witch Hazel	<i>Hamamelis virginiana</i>	2	14	FACU
Sourwood	<i>Oxydendrum arboreum</i>	5	34	FACU
Flowering Dogwood	<i>Cornus florida</i>	5	34	FACU

<b>Proposed Bare-Root and Live Stake Species (may also include seed or container species)</b>				
Snowbird Creek Tributaries Mitigation Plan-NCEEP Project #92764				
Common Name	Scientific Name	% Planted by Species	Planting Density	Wetness Tolerance
Rhododendron	<i>Rhododendron maximum</i>	3	20	FAC-
Tag Alder	<i>Alnus serrulata</i>	5	34	FACW+ or OBL
Redbud	<i>Cercis canadensis</i>	5	34	FACU
<b>Shrubs</b>				
Rivercane (giant cane)	<i>Arundinaria gigantea</i>	15	102	FACW
Spicebush	<i>Lindera benzoin</i>	15	102	FACW
Deerberry	<i>Vaccinium stamineum</i>	15	102	FACU
Eastern Sweetshrub, Sweetshrub	<i>Calycanthus floridus</i> , <i>Calycanthus spp.</i>	10	68	FACU
Sweetpepperbush	<i>Clethra spp.</i>	15	102	N/A
Winterberry	<i>Ilex verticillata</i>	10	68	FACW
Virginia Sweetspire	<i>Itea virginica</i>	15	102	FACW+
Chokeberry	<i>Photinia</i>	5	34	N/A
<b>Alternate Species</b>				
Blight-resistant American Chestnut	<i>Castanea dentata</i>	N/A	N/A	N/A
American Hazelnut	<i>Corylus americana</i>	N/A	N/A	FACU
Blue Ridge Blueberry	<i>Vaccinium pallidum</i>	N/A	N/A	N/A
<b>Riparian Livestake Plantings</b>				
Ninebark	<i>Physocarpus opulifolius</i>	15	102	FAC-
Elderberry	<i>Sambucus canadensis</i>	20	136	FACW-
Buttonbush	<i>Cephalanthus occidentalis</i>	15	102	OBL
Silky Willow	<i>Salix sericea</i>	25	170	OBL
Silky Dogwood	<i>Cornus amomum</i>	25	170	FACW+
Note: Species selection may have changed due to refinement or availability at the time of planting.				

In order to determine if the criteria were achieved, one vegetation monitoring quadrant, 10 by 10 meters in size, was installed on Reach 2 of UT3 in April 2011. This plot includes a 1 square meter sub-quadrant for visually documenting the success of herbaceous vegetation. In addition, a smaller vegetation plot will be established in 2012 on Reach 2 of UT2, an Enhancement II Reach to help monitor the stability of the channel and riparian buffer where logging debris was originally removed.

#### 2.2.1.1.1 Results

Tables 5 through 7 in Appendix C present information on vegetation success criteria, vegetation metadata, and stem counts for the vegetation monitoring plot. Vegetation data was collected in November 2011. Data from the Year 1 monitoring event indicates that approximately 88% of the stems surveyed were in good to excellent condition and showed no signs of damage. The average density of planted bare root stems, based on data collected from the monitoring plot during Year 1 monitoring, is 850 stems per acre or 21 stems per plot. The site was originally

planted with approximately 1,102 bare root stems per acre after construction (as cited in the Baseline Monitoring Document), or 25 stems per plot. Therefore, during the last year, between the Baseline and Year 1 monitoring periods, a mortality of 4 stems has been observed that accounts for this difference or decrease between the original planted stem count (1,102 stems) from Baseline monitoring and the total stem count (850) from Year 1 monitoring. However, an average density of 850 stems per acre is still indicative that the Site is on track for meeting the minimum interim success criteria of 320 trees per acre by the end of Year 3, and the final success criteria of 260 trees per acre by the end of Year 5. The location of the vegetation plot is shown on the Year 1 monitoring plans.

The area on Reach 2 of UT3 that was identified during as-built surveys as having sparse groundcover was found to have rebounded; the groundcover is now dense and appears very healthy. Survival rates of planted woody stems in the vegetation plot indicates that plantings in the restored area of UT3 are of sufficient density to meet regulatory requirements, as well as the site stabilization and habitat enhancement goals originally set forth in the mitigation plan.

As noted in the Executive Summary, a smaller vegetation plot is to be established in the Enhancement II Reach on UT2. The plot, which will be 5m<sup>2</sup> in size, will be used to collect tree survival data from a subsampling of the vegetation planted. The plot will be installed once the planting contractor replants the Enhancement II reach, whereupon Baker will annually record the number of stems within the plot and the height of each stem. The plot will also be photographed to visually document changes in the riparian corridor over the course of the monitoring period. Figure 4 and Table 13 in Appendix F document this area that are in need of planted stems along Reach 2 of UT2.

## **2.3 Areas of Concern**

At this time, there are no areas of concern. Baker will monitor the structure where piping is occurring and will repair the structure if the bank or channel becomes unstable; a small vegetation plot will be established on UT2-Reach 2 prior to the next report, the survival of stems within the plot will be monitored annually to document riparian conditions in the Enhancement II reach.

## **3.0 REFERENCES**

Leopold, L.B., M. Wolman, and J. Miller, 1964. "Fluvial Processes in Geomorphology." W.H. Freeman, San Francisco, CA.

Peet, R.K., T.R. Wentworth and P.S. White. 1998. "A flexible, multipurpose method for recording vegetation composition and structure." *Castanea* 63:262-274.

**APPENDIX A**  
**FIGURE & GENERAL TABLES**

**LOCATION MAP**  
**TABLES 1-4**

The Snowbird Creek Tributaries mitigation site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina. 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.

"The subject project site is an environmental restoration site of the NCDENR Ecosystem Enhancement Program (EEP) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with EEP."

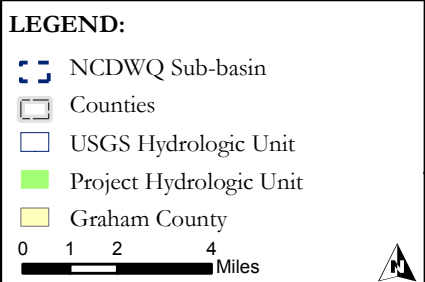
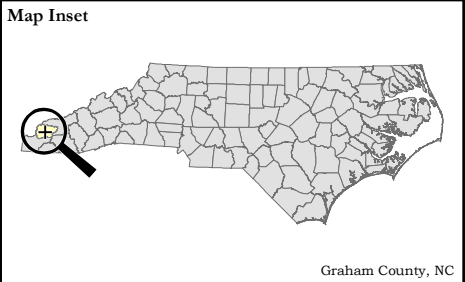
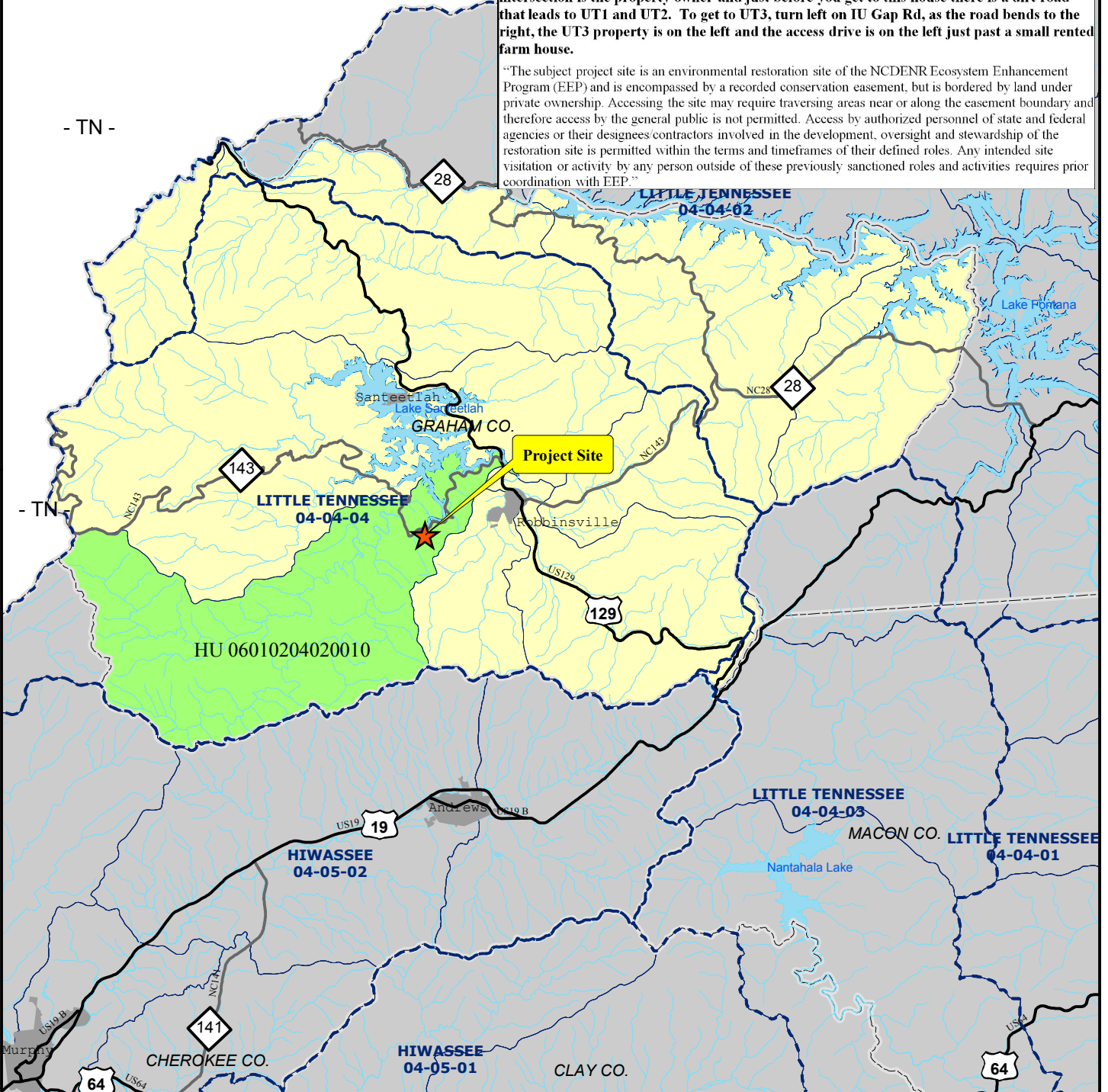


Figure 1. Project Vicinity Map  
Snowbird Creek Tributaries Project  
Graham County, NC



## Figure 1. Notes

The Snowbird Creek Tributaries mitigation site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina. To reach the project site from the intersection of N.C. Highways 143 and 129 in Robbinsville, turn south onto N.C. Highway 129. At the first stop light past the Microtel, turn right onto East Main Street, continue for approximately .3 miles, and turn left onto Atoah Street. Atoah Street becomes Snowbird Road (both are N.C. Highway 143). Snowbird Road (N.C. Highway 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 Road; 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.

The subject project site is an environmental restoration site of the NCDENR Ecosystem Enhancement Program (EEP) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with EEP.

<b>Table A1. Project Components Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764</b>									
<b>Project Segment or Reach ID</b>	<b>Existing Feet/ Acres</b>	<b>Mitigation Type</b>	<b>Approach</b>	<b>Target Stream Type</b>	<b>Footage or Acreage</b>	<b>Mitigation Ratio</b>	<b>Mitigation Units</b>	<b>Stationing</b>	<b>Comment</b>
UT1	3,213LF	P	-	-	3,213 LF	5:1	643	-	No channel alteration (preservation).
UT2									
Reach 1	1,033 LF	P	-	-	1,033 LF	5:1	207	-	No channel alteration (preservation).
Reach 2	171 LF	EII	-	B3a	171 LF	2.5:1	68	-	Removal of woody debris; stabilize streambanks; replanting with native vegetation.
Reach 3	675 LF	P	-		675 LF	5:1	135	-	No channel alteration (preservation).
UT3									
Reach 1	2,576LF	P	-	-	2,576LF	5:1	515	-	No channel alteration (preservation).
Reach 2	543 LF	R	PII	Aa+	467 LF	1:1	467	-	Relocate channel in lowest point of the valley; establish a step-pool channel with stable banks and floodplain connectivity.
<b>Mitigation Unit Summations</b>									
Stream (LF)	Riparian Wetland (Ac)		Nonriparian Wetland (Ac)		Total Wetland (Ac)		Buffer (Ac)	Comment	
2,035	NA		NA		NA		13.1		
Total MUs	2,035								
Notes:									

<b>Table A2. Project Activity and Reporting History Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764</b>		
<b>Activity or Report</b>	<b>Data Collection Complete</b>	<b>Completion or Delivery</b>
Restoration Plan	-	October 2009
Final Design-90%	-	November 2009
Construction	-	August 2010
Temporary S&E mix applied to entire project area	-	August 2010
Permanent seed mix applied to project site	-	August 2010; February 2011
Containerized and B&B plantings set out	-	March 2011
Installation of crest gauges	-	March 2011
Mitigation Plan / As-built (Year 0 Monitoring – baseline)	April 2011	November 2011 (last of plantings completed in March)
Year 1 Monitoring	January 2012	March 2012
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		

<b>Table A3. Project Contacts Table Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764</b>	
<b>Designer</b>	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201, Asheville, NC 28806 <u>Contact:</u> Micky Clemmons, Tel. 828.350.1408 x2002
<b>Construction Contractor</b>	
River Works, Inc.	8000 Regency Parkway, Suite 200, Cary, NC 27511 <u>Contact:</u> Will Pedersen, Tel. 919.459.9001
<b>Planting &amp; Seeding Contractor</b>	
River Works, Inc.	8000 Regency Parkway, Suite 200, Cary, NC 27511 <u>Contact:</u> George Morris, Tel. 919.459.9001
Seed Mix Sources	Green Resources
Nursery Stock Suppliers	Arborgen and Hillis Nursery
<b>Monitoring</b>	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201, Asheville, NC 28806 <u>Contact:</u> Carmen McIntyre, Tel. 828.350.1408 x2010

<b>Table A4. Project Attribute Table Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764</b>	
Project County	Graham County, NC
Physiographic Region	Blue Ridge
Ecoregion	Blue Ridge Mountains-Southern Metasedimentary Mountains
Project River Basin	Little Tennessee
USGS HUC for Project	06010204020010
NCDWQ Sub-basin for Project	04-04-04
Within extent of EEP Watershed Plan?	No local or targeted watershed plans currently available
WRC Class	Cold
% of Project Easement Fenced or Demarcated	0% (post-construction)
Beaver Activity Observed During Design Phase?	No
Drainage Area (Square Miles)	
	UT1 .13 mi <sup>2</sup>
	UT2
	Reach 1 .05 mi <sup>2</sup>

**Table A4. Project Attribute Table  
Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764**

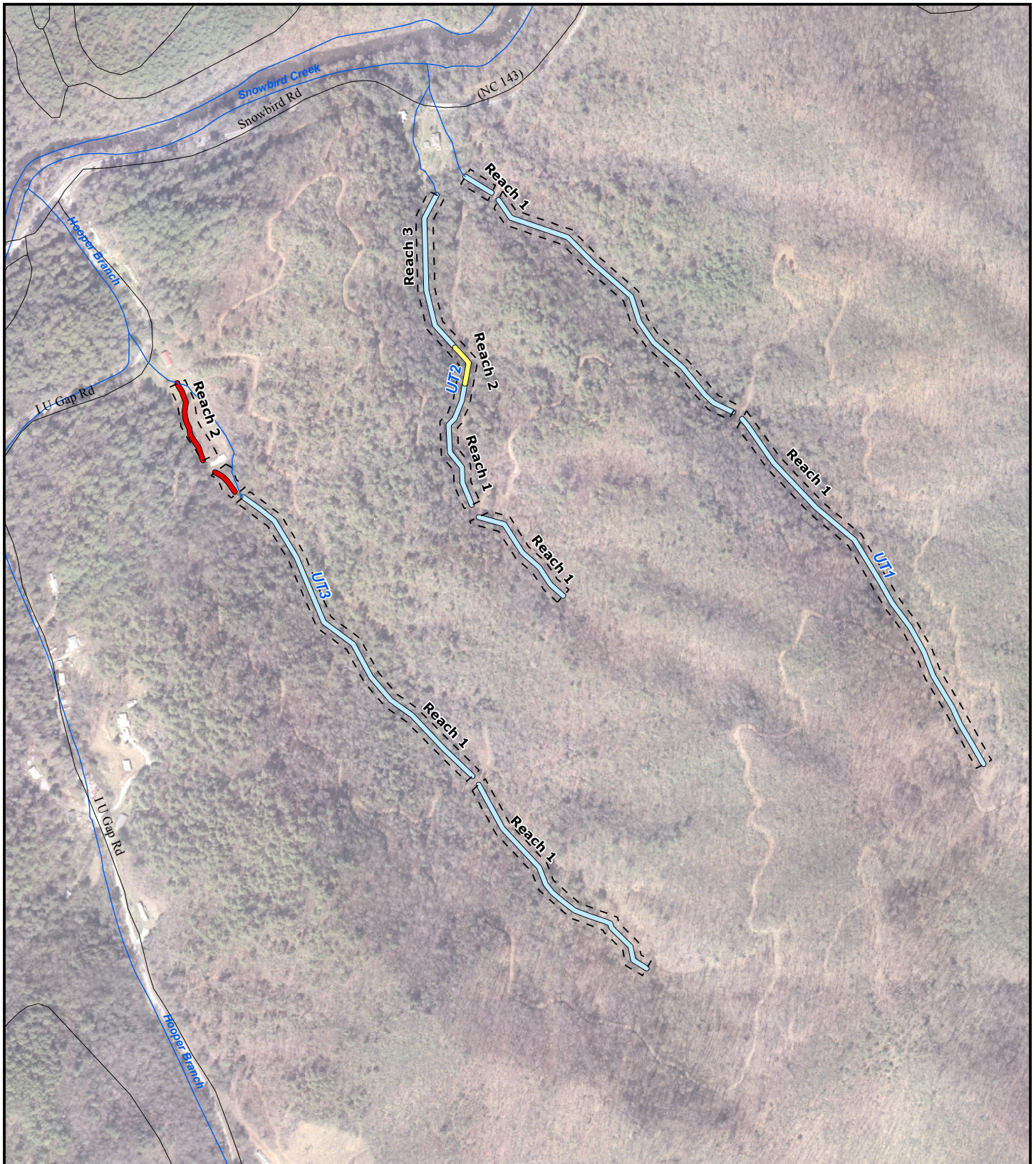
	Reach 2	.06 mi <sup>2</sup>
	Reach 3	.08 mi <sup>2</sup>
	UT3	
	Reach 1	.15 mi <sup>2</sup>
	Reach 2	.18 mi <sup>2</sup>
Stream Order		
	UT1	1 <sup>st</sup> (Perennial)
	UT2	
	Reach 1	1 <sup>st</sup> (Perennial)
	Reach 2	1 <sup>st</sup> (Perennial)
	Reach 3	1 <sup>st</sup> (Perennial)
	UT3	
	Reach 1	1 <sup>st</sup> (Perennial)
	Reach 2	1 <sup>st</sup> (Perennial)
Restored Length		
	UT 1	3,212 LF
	UT2	
	Reach 1	1,033 LF
	Reach 2	171 LF
	Reach 3	675 LF
	UT3	
	Reach 1	2,576 LF
	Reach 2	467 LF
Watershed Type		Rural (Predominantly Forested)
Watershed LULC Distribution (Percent area)		
Deciduous Forest		80.15%
Evergreen Forest		8.68%
Mixed Forest		11.16%
Developed Open Space		<1%
Drainage Impervious Cover Estimate (%)		<25%
NCDWQ AU/Index #		2-190-9(15.5)
303d Listed		No
Upstream of 303d Listed Segment		No
Reasons for 303d Listing or Stressor		-

**Table A4. Project Attribute Table  
Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764**

Total Acreage of Easement	13.1			
Total Vegetated Acreage w/in Easement	n/a (Easement vegetated with exception of stream channel)			
Total Planted Acreage within the Easement	~.86 Acres			
Rosgen Classification (Pre-existing)/As-Built				
UT1	Aa <sup>+</sup> /Aa <sup>+</sup>			
UT2				
Reach 1	B3a/ B3a			
Reach 2	B3a/ B3a			
Reach 3	B3a/ B3a			
UT3				
Reach 1	A4a <sup>+</sup> /A4a <sup>+</sup>			
Reach 2	B/B3			
Valley Type	II			
Valley Slope	.094 (UT3)			
Valley Side Slope Range	n/a			
Valley Toe Slope Range	n/a			
Trout Waters Designation	No			
Species of Concern	No			
Dominant Soil Series and Characteristics	Snowbird loam/ Thurmont-Dillard/ Soco-Ste-coah/ Spivey-Whiteoak			
	Depth (in.)	% Clay	K Factor	T Factor
UT1	>80"	5-18/ 5-24	.10-.17/ .02-.1	2/3
UT2				
Reach 1	~80/>60"	5-18	.10-.17/.1	5
Reach 2	>80"	5-18	.10-.17	5
Reach 3	>80"	5-18/ 5-24	.10-.17/ .02-.1	5
UT3				
Reach 1	>80"	5-24	.02-.1/ .03-.1	5
Reach 2	>60"	5-25	.17-.24	5


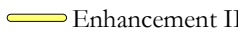
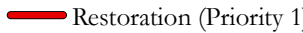
**APPENDIX B**  
**PROJECT REACH FIGURE AND**  
**REFERENCE PHOTOGRAPHS**


**FIGURE 2 PROJECT COMPONENT MAP**  
**EXHIBIT 1-2 REFERENCE STATION AND**  
**VEGETATION PLOT PHOTOLOGS**




**LEGEND:**

Proposed Project Components

-  Preservation
-  Enhancement II
-  Restoration (Priority 1)

 Proposed Easement Boundary

 Streams

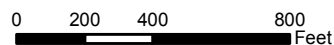


Figure 2. Restoration Summary Map

Snowbird Creek Tributaries Project  
Graham County, NC



# Snowbird Creek

## Photo Log - Reference Photo Points

**Notes:** Photos for Snowbird Creek were taken December 2011.

1. Photo point locations are shown on the plan views in the actual location the picture was taken.
2. All points are marked with a wooden stake and flagging. For channel points, the stake is set up on an adjacent bank.



Photo Point 1: looking downstream



Photo Point 2: looking downstream



Photo Point 2: looking upstream



Photo Point 3: looking downstream





Photo Point 3: looking upstream



Photo Point 4: looking downstream



Photo Point 4: looking upstream



Photo Point 5: looking downstream



Photo Point 5: looking upstream



Photo Point 6: looking downstream



Photo Point 6: looking upstream

## UT1 Reach 1 (Preservation) Photo Log - Reference Photo Points

**Notes:** Photos were taken January 2012.

1. Photo point locations are shown on the plan sheets in the actual location the picture was taken.
2. All points are marked with flagging tape and recorded with GPS points. For channel points, the flagging is tied on an adjacent bank.



Photo Point 1: looking downstream



Photo Point 1: looking upstream



Photo Point 2: looking downstream



Photo Point 2: looking upstream



Photo Point 3: looking downstream



Photo Point 3: looking upstream



Photo Point 4: looking downstream



Photo Point 4: looking upstream

## UT2 (Preservation & Enhancement II) Photo Log - Reference Photo Points

**Notes:** Photos were taken January 2012.

1. Photo point locations are shown on the plan sheets in the actual location the picture was taken.
2. All points are marked with flagging tape and recorded with GPS points. For channel points, the flagging is tied on an adjacent bank.
3. Photo point 3 is located in the Enhancement II Reach.



Photo Point 1: looking downstream



Photo Point 1: looking upstream



Photo Point 2: looking downstream



Photo Point 2: looking upstream



Photo Point 3: looking downstream



Photo Point 3: looking upstream



Photo Point 4: looking downstream



Photo Point 4: looking upstream

## UT3 (Preservation) Photo Log - Reference Photo Points

**Notes:** Photos were taken January 2012.

1. Photo point locations are shown on the plan sheets in the actual location the picture was taken.
2. All points are marked with flagging tape and recorded with GPS points. For channel points, the flagging is tied on an adjacent bank.



Photo Point 1: looking downstream



Photo Point 1: looking upstream



Photo Point 2: looking downstream



Photo Point 2: looking upstream



Photo Point 3: looking downstream



Photo Point 3: looking upstream



# Snowbird Creek Tributaries Mitigation Project

## Photo Log - Vegetation Plot Photos

**Notes:** Photos for Vegetation Plots were taken December 2011.

1. Vegetation plots marked by t-posts at corners; herbaceous plot marked by stake within larger plot.
2. Planted vegetation flagged and tagged for future identification.



Photo 1: Veg Plot 1



Photo 2: Veg Plot 1-Herbaceous Plot

**APPENDIX C**  
**VEGETATION SUMMARY DATA**  
**TABLES 5-7**

<b>Table C5. Vegetation Plot Criteria Attainment-Year 1</b>	
<b>Snowbird Creek Tributaries Mitigation Project-#92764</b>	
Vegetation Plot ID	Vegetation Survival Threshold Met?
1	Y

<b>Table C6. Vegetation Metadata- Year 1</b>	
<b>Snowbird Creek Tributaries Mitigation Project-#92764</b>	
<b>Report Prepared By</b>	Carmen Horne-McIntyre
<b>Date Prepared</b>	12/1/2011 13:30
<b>database name</b>	cvs-eep-entrytool-v2.2.7_Dec 2011.mdb
<b>database location</b>	L:\Monitoring\Monitoring Guidance\Vegetation\CVS EEP Entrytool V2.2.7
<b>computer name</b>	ASHEWCMCINTYR
<b>file size</b>	89882624
<b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b>	
<b>Metadata</b>	Description of database file, the report worksheets, and a summary of project(s) and project data.
<b>CVS Stem Count Total and Planted by Plot and Species</b>	Displays Plot and Stem Count Metrics as well as Stems Planted Per Acre
<b>PROJECT SUMMARY-----</b> 92764	
<b>Project Code</b>	Snowbird Tributaries
<b>project Name</b>	Restoration: 466 LF, Enhancement II:171 LF, Preservation: 7,497 LF
<b>Description</b>	Little Tennessee
<b>River Basin</b>	466
<b>length(ft)</b>	30
<b>stream-to-edge width (ft)</b>	2597.31
<b>area (sq m)</b>	1
<b>Required Plots (calculated)</b>	1
<b>Sampled Plots</b>	1



**APPENDIX D**  
**MORPHOLOGICAL SUMMARY DATA**

- EXHIBIT 3-CROSS-SECTIONS (WITH ANNUAL OVERLAYS)**  
**EXHIBIT 4- LONGITUDINAL PROFILE (WITH ANNUAL OVERLAY)**  
**EXHIBIT 5-RIFFLE PEBBLE COUNT SIZE CLASS DISTRIBUTION**  
**TABLE 8- CROSS-SECTION MORPHOLOGY DATA TABLE**  
**TABLE 9- STREAM REACH MORPHOLOGY DATA TABLE**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B3	5.1	8.8	0.58	0.89	15.4	1	5.1	2045.39	2045.39

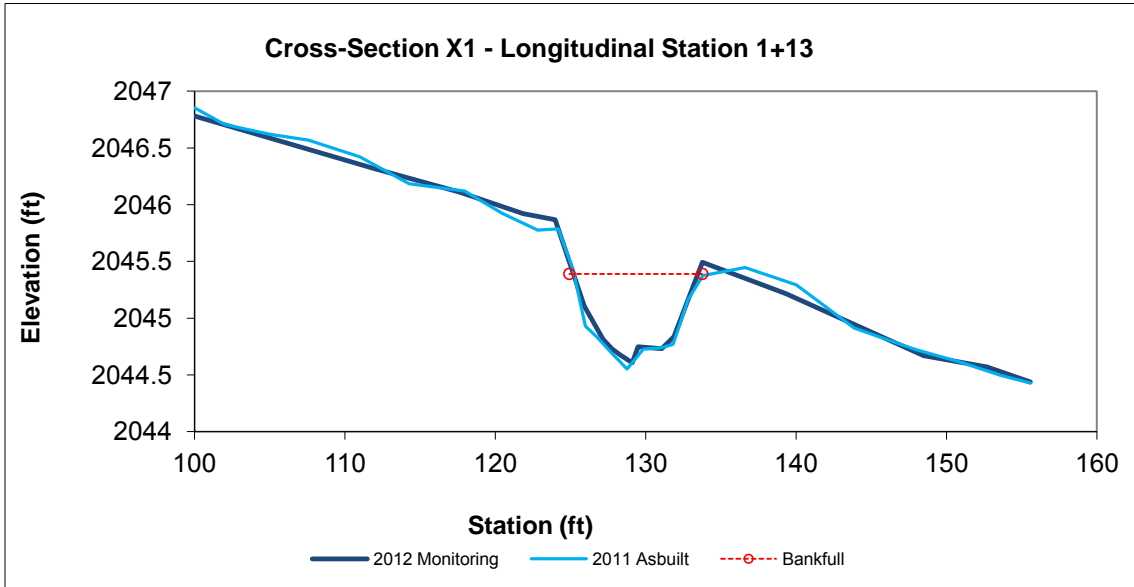


Photo 1: XS-1 facing right bank



Photo 2: XS-1 facing left bank



Photo 3: XS-1 facing upstream



Photo 4: XS-1 facing downstream

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B3	7.7	11.8	0.65	1.11	18.1	1	4.2	2029.92	2029.92

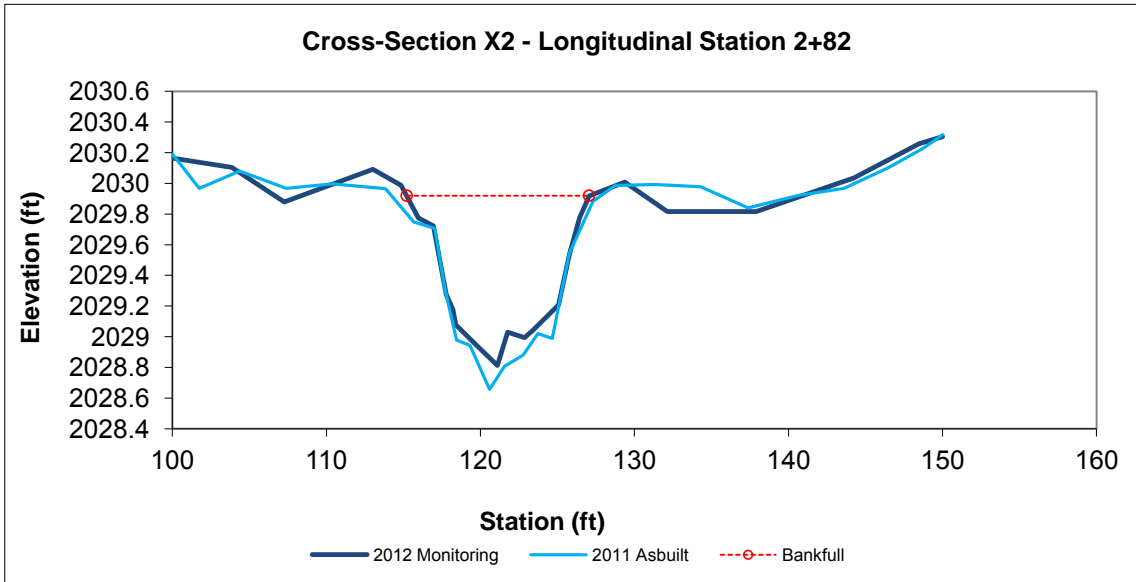


Photo 1: XS-2 facing right bank



Photo 2: XS-2 facing left bank



Photo 3: XS-2 facing upstream



Photo 4: XS-2 facing downstream

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	B3	8.5	10.5	0.81	1.71	12.9	1	4.8	2020.9	2020.9

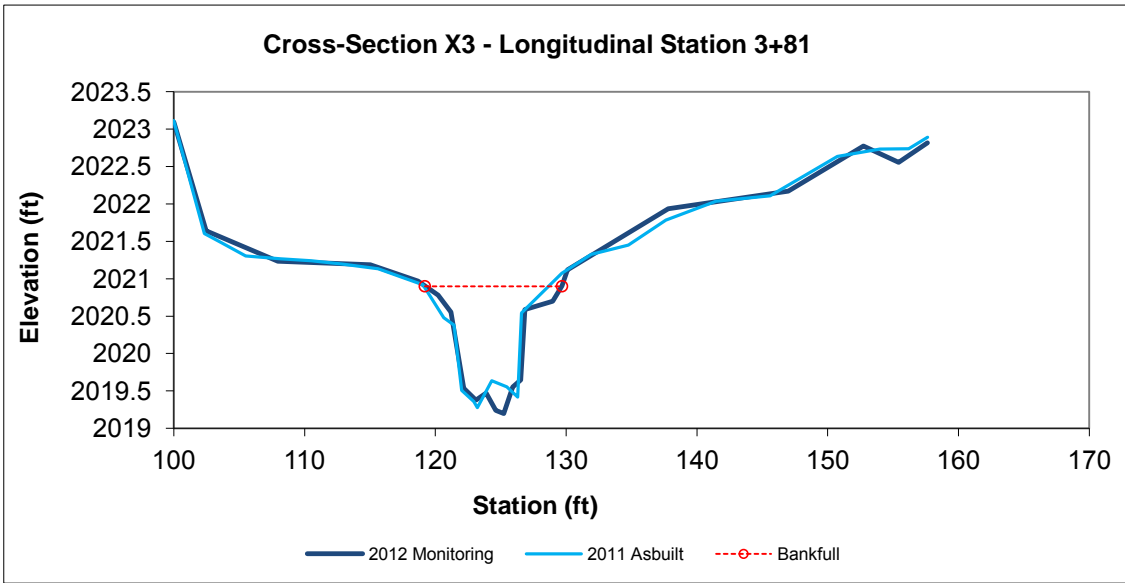


Photo 1: XS-3 facing right bank



Photo 2: XS-3 facing left bank



Photo 3: XS-3 facing upstream



Photo 4: XS-3 facing downstream



Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B3	11.2	12.9	0.87	1.35	14.8	1	4.9	2015.06	2015.06

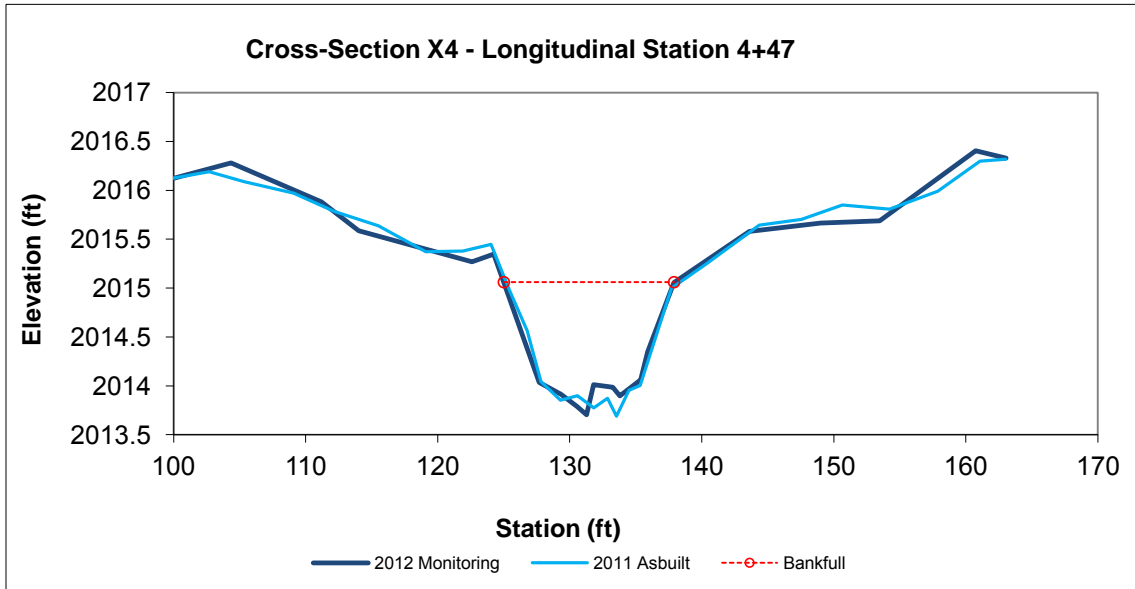


Photo 1: XS-4 facing right bank



Photo 2: XS-4 facing left bank

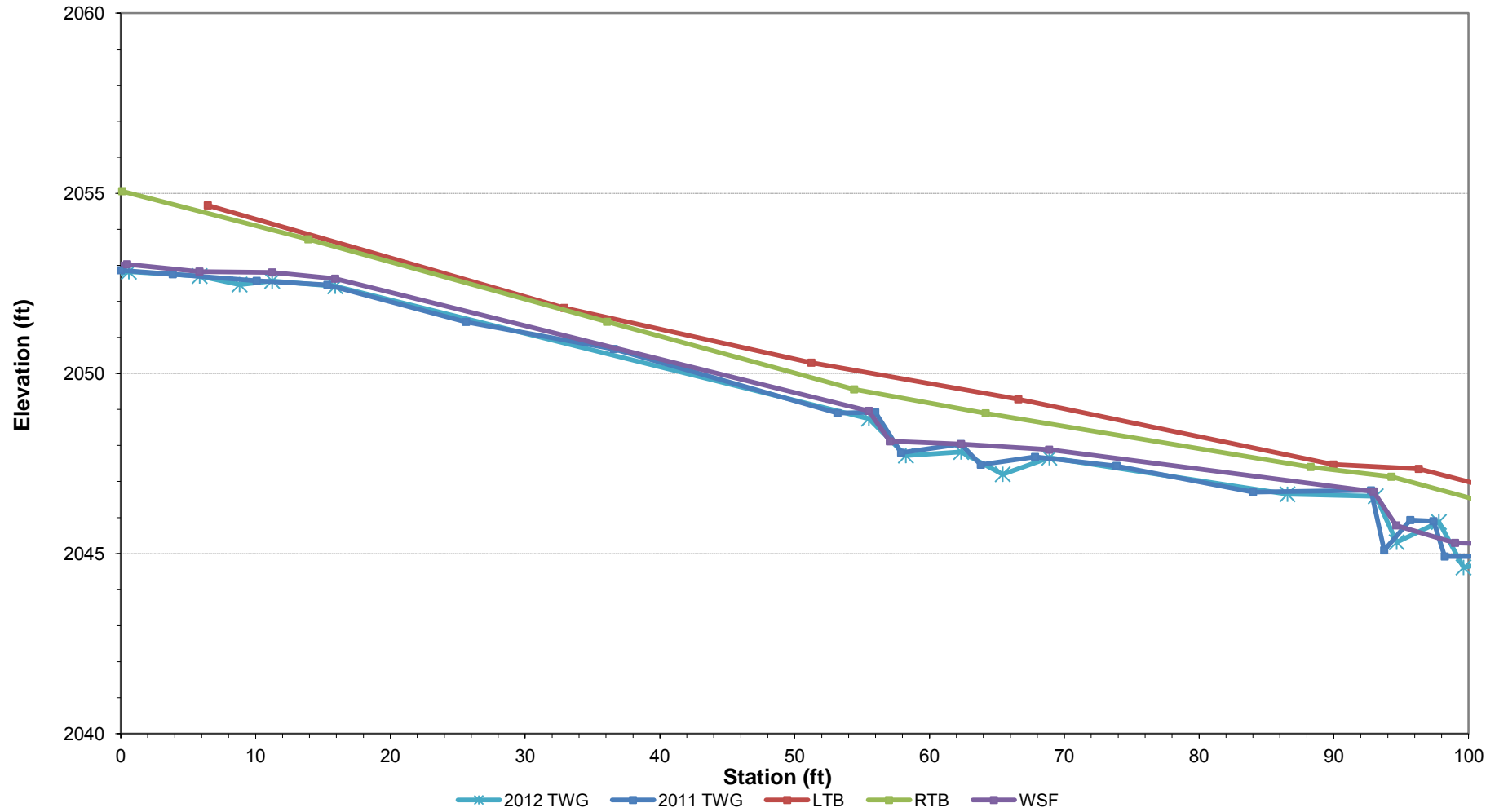


Photo 3: XS-4 facing upstream

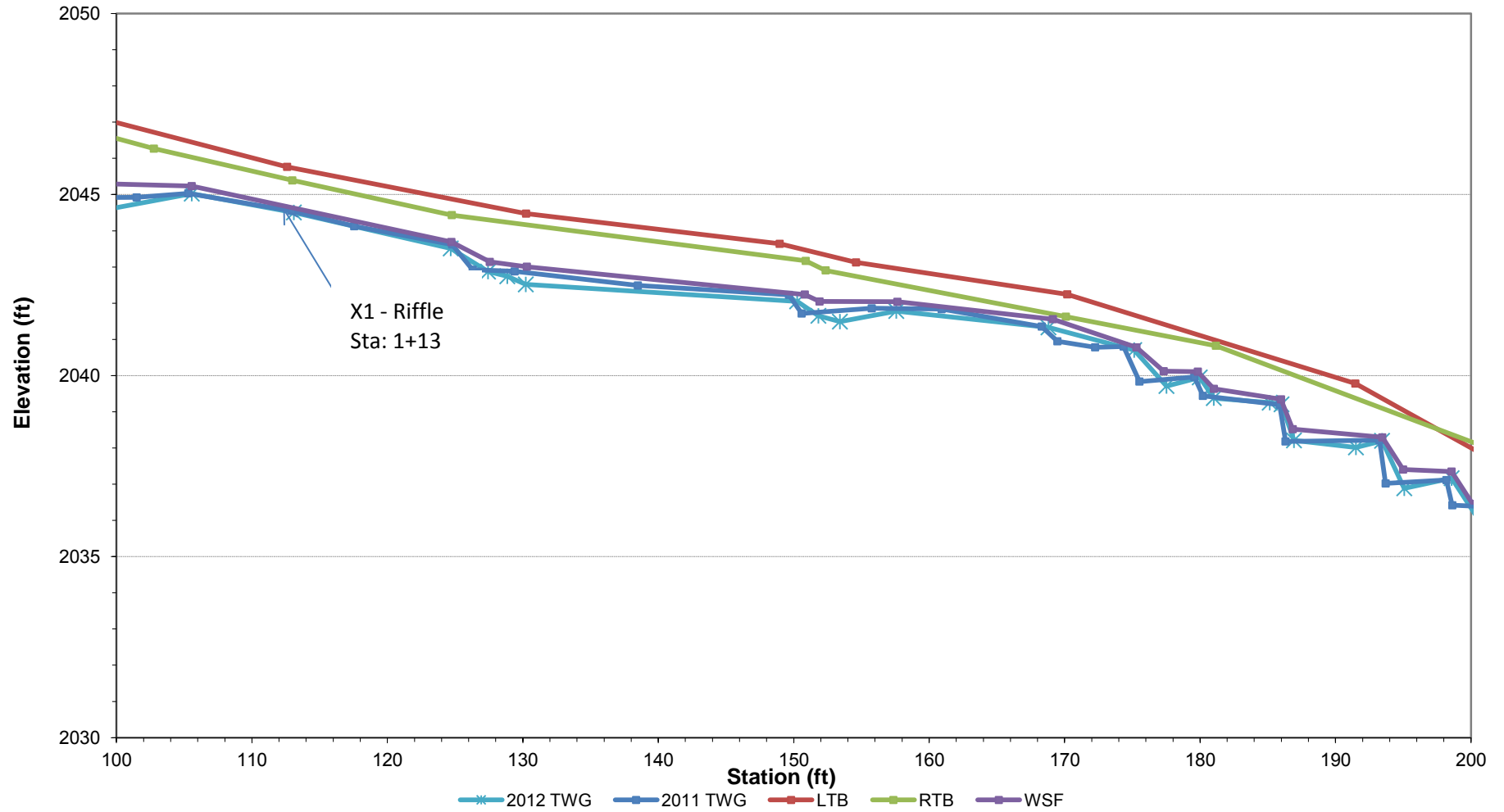


Photo 4: XS-4 facing downstream

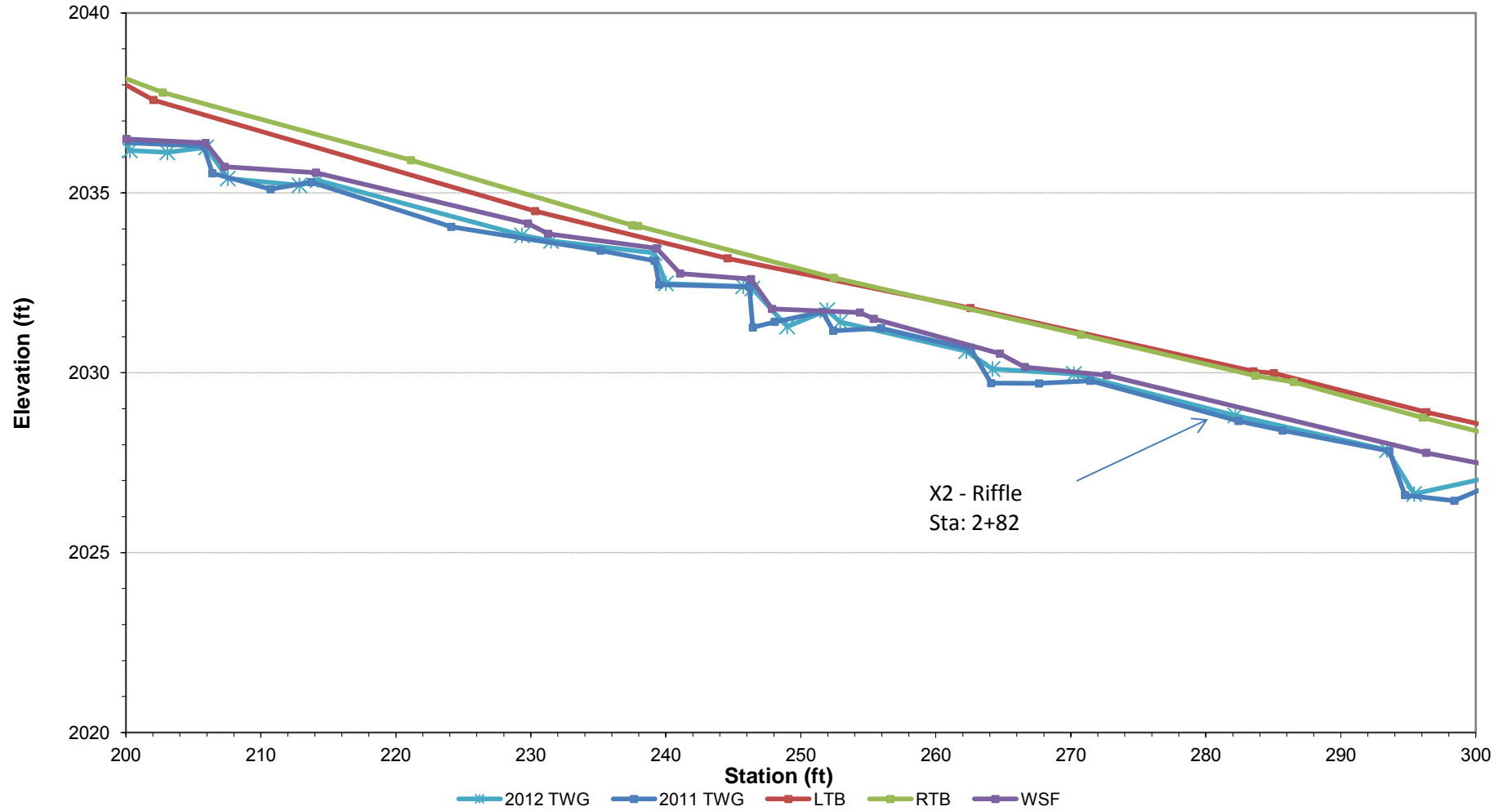
Longitudinal Profile - UT3 (Reach 2)  
Sta: 0+00 - 1+00



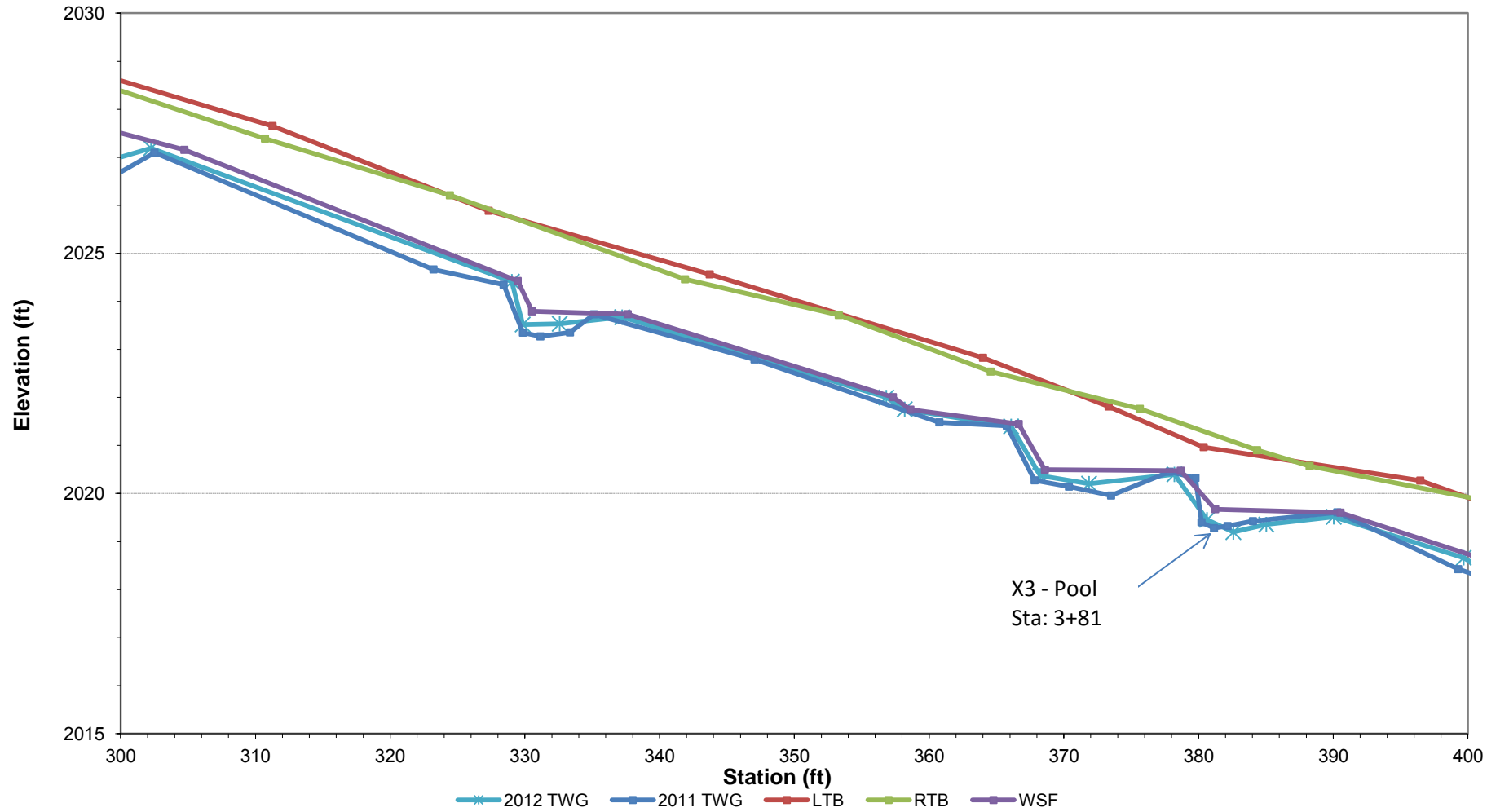
**Longitudinal Profile - UT3 (Reach 2)**  
**Sta: 1+00 - 2+00**



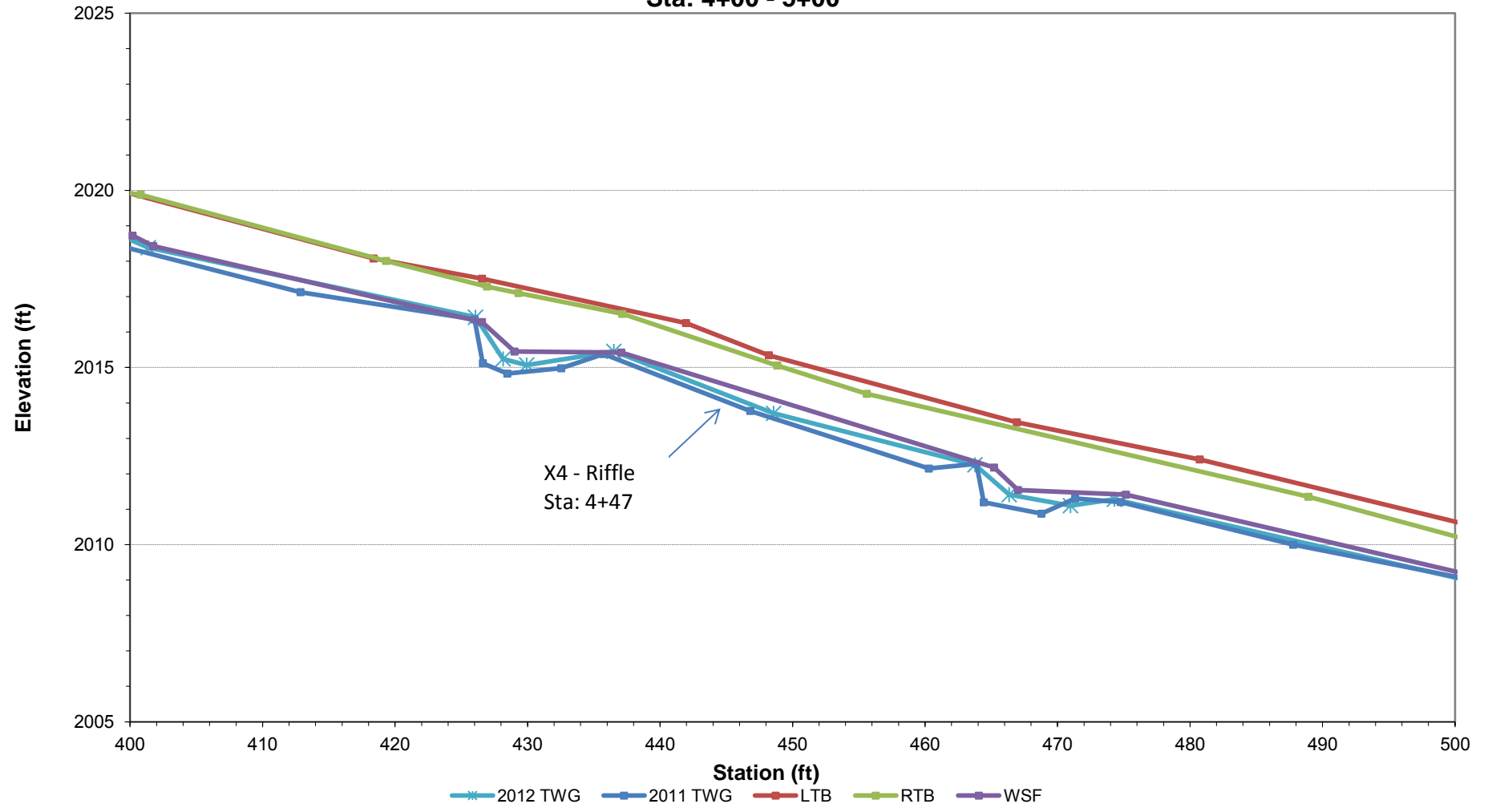
**Longitudinal Profile - UT3 (Reach 2)**  
**Sta: 2+00 - 3+00**



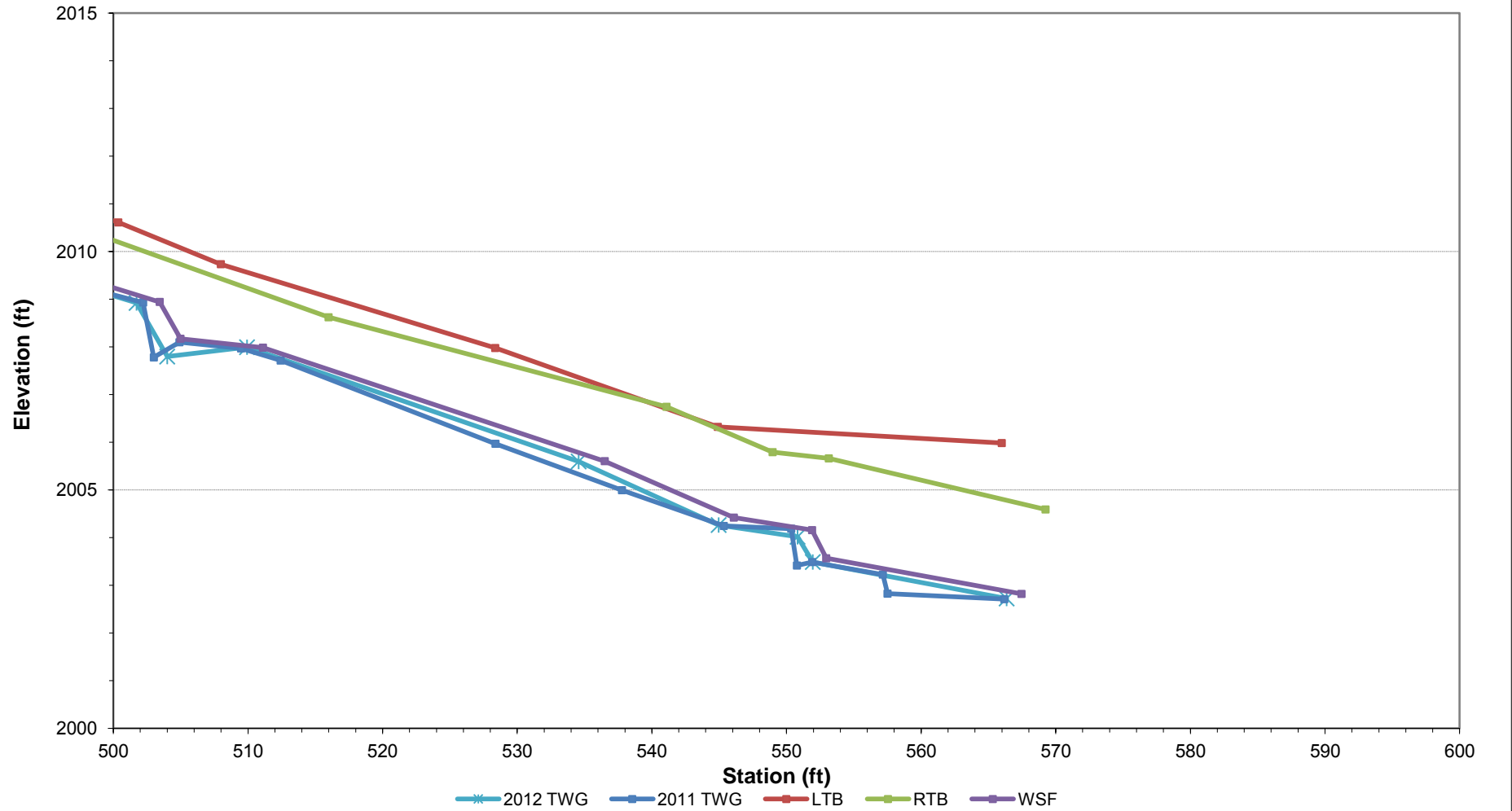
Longitudinal Profile - UT3 (Reach 2)  
Sta: 3+00 - 4+00



**Longitudinal Profile - UT3 (Reach 2)**  
**Sta: 4+00 - 5+00**



Longitudinal Profile - UT3 (Reach 2)  
Sta: 5+00 - 5+66

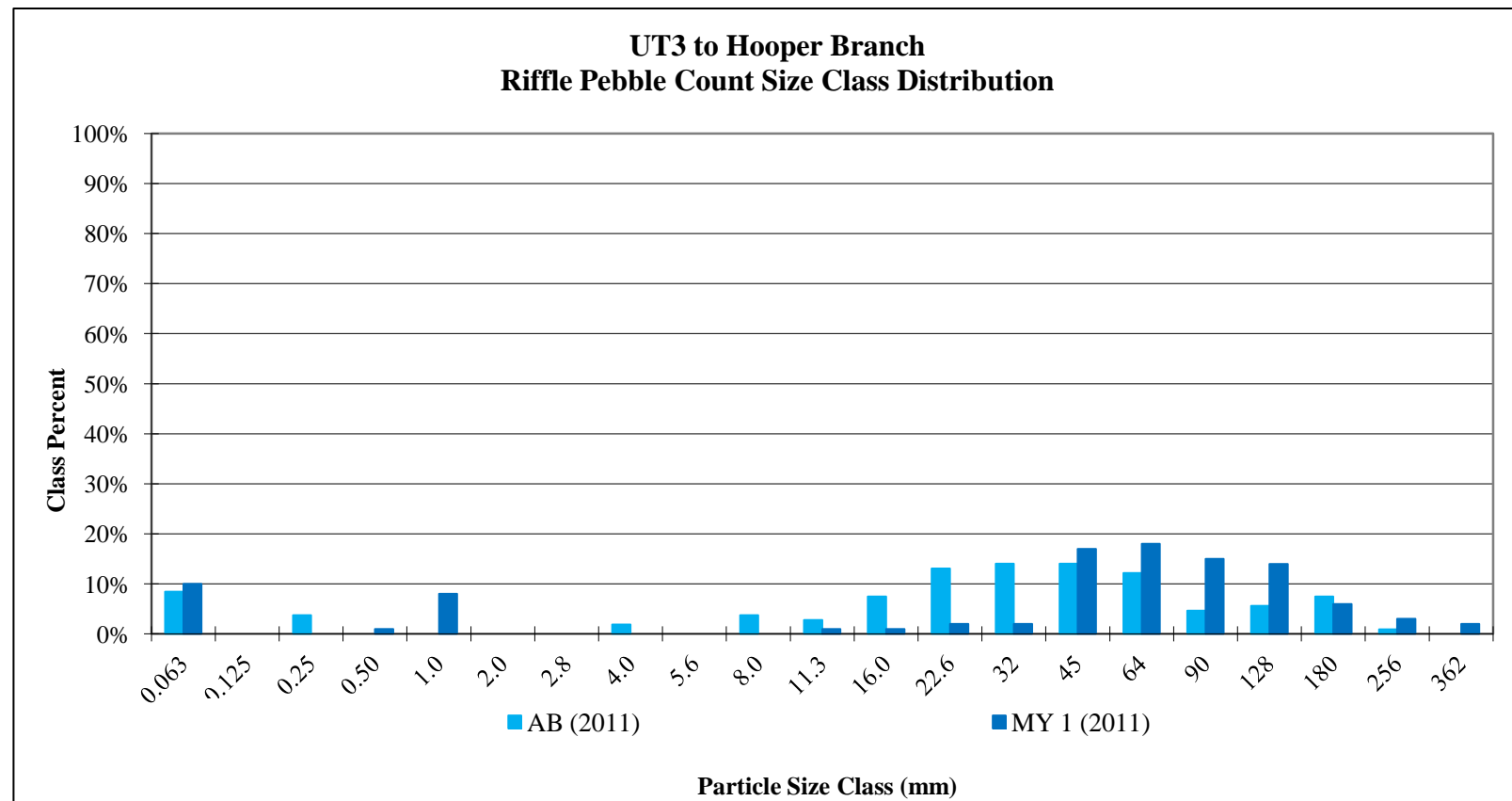
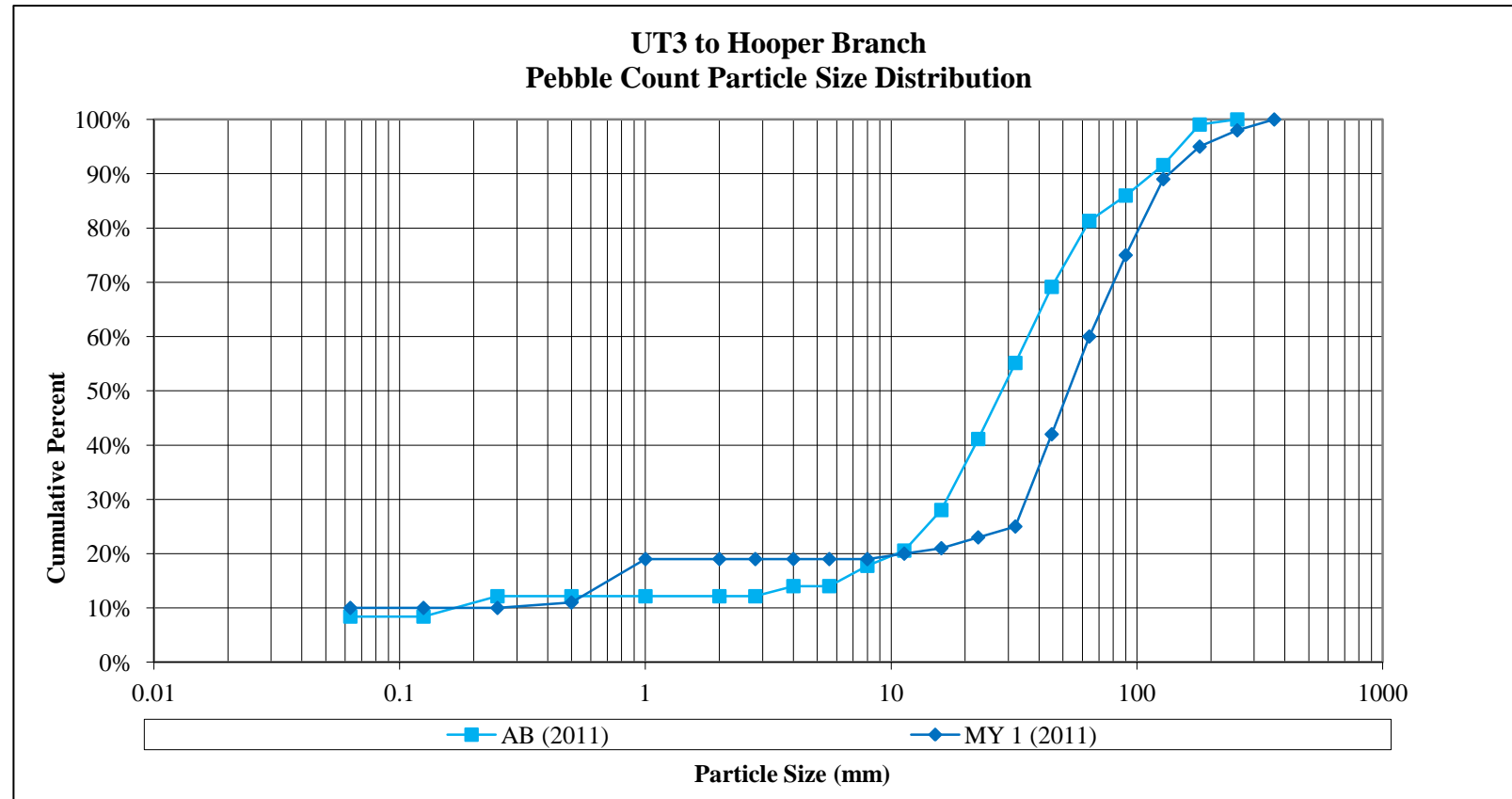


**Figure D5. Cross-Section Pebble Count (UT3 to Hooper Branch)  
Snowbird Creek Tributaries Mitigation Project, EEP# 92764**

SITE OR PROJECT:	Snowbird Creek Tributaries Project
REACH/LOCATION:	UT3 to Hooper Branch (Reach 2)
FEATURE:	Riffle

MY 1 (2011)					
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum
Silt/Clay	Silt / Clay	< .063	10	10%	10%
Sand	Very Fine	.063 - .125			10%
	Fine	.125 - .25			10%
	Medium	.25 - .50	1	1%	11%
	Coarse	.50 - 1.0	8	8%	19%
	Very Coarse	1.0 - 2.0			19%
Gravel	Very Fine	2.0 - 2.8			19%
	Very Fine	2.8 - 4.0			19%
	Fine	4.0 - 5.6			19%
	Fine	5.6 - 8.0			19%
	Medium	8.0 - 11.0	1	1%	20%
	Medium	11.0 - 16.0	1	1%	21%
	Coarse	16 - 22.6	2	2%	23%
	Coarse	22.6 - 32	2	2%	25%
	Very Coarse	32 - 45	17	17%	42%
	Very Coarse	45 - 64	18	18%	60%
Cobble	Small	64 - 90	15	15%	75%
	Small	90 - 128	14	14%	89%
	Large	128 - 180	6	6%	95%
	Large	180 - 256	3	3%	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 % of whole count			100	100%	100%

Summary Data	
Channel materials	
D <sub>50</sub> =	52.63
D <sub>84</sub> =	112.87
D <sub>95</sub> =	180.00





**Table D8. Cross-Section Morphology Data Table**

Snowbird Creek Tributaries Mitigation Project #92764

UT3																								
Parameter	Cross Section 1 Riffle						Cross Section 2 Riffle						Cross Section 3 Pool						Cross Section 4 Riffle					
	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
<b>Dimension</b>																								
BF Width (ft)	8.5	8.8					9.5	11.8					9.7	10.5					12.4	12.9				
Floodprone Width (ft)	41.5	45.1					50.0	50.0					49.1	50.4					62.5	63.1				
BF Cross Sectional Area (ft <sup>2</sup> )	4.5	5.1					6.3	7.7					8.1	8.5					10.7	11.2				
BF Mean Depth (ft)	0.53	0.58					0.66	0.65					0.84	0.81					0.87	0.87				
BF Max Depth (ft)	0.83	0.89					1.05	1.11					1.64	1.71					1.31	1.35				
Width/Depth Ratio	16.3	15.4					14.3	18.1					11.6	12.9					14.3	14.8				
Entrenchment Ratio	4.9	5.1					5.3	4.2					5.1	4.8					5.1	4.9				
Wetted Perimeter (ft)	9.6	10.0					10.8	13.1					11.4	12.1					14.1	14.6				
Hydraulic Radius (ft)	0.5	0.5					0.6	0.6					0.7	0.7					0.8	0.8				
<b>Substrate</b>																								
d50 (mm)																								
d84 (mm)																								
Parameter	AB (2010)			MY-1 (2011)			MY-2 (2012)			MY-3 (2013)			MY-4 (2014)			MY-5 (2015)								
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med						
<b>Pattern</b>																								
Channel Beltwidth (ft)	-	-	-	-	-	-																		
Radius of Curvature (ft)	-	-	-	-	-	-																		
Meander Wavelength (ft)	-	-	-	-	-	-																		
Meander Width Ratio	-	-	-	-	-	-																		
<b>Profile</b>																								
Riffle length (ft)	24	33	26	23	27	27																		
Riffle Slope (ft/ft)	0.058	0.102	0.072	0.044	0.120	0.104																		
Pool Length (ft)	3	6	4	3	7	7																		
Pool Spacing (ft)	8	41	35	8	47	29																		
<b>Substrate</b>																								
d50 (mm)		28			53																			
d84 (mm)		78			113																			
<b>Additional Reach Parameters</b>																								
Valley Length (ft)		445			445																			
Channel Length (ft)		467			467																			
Sinuosity		1.05			1.07																			
Water Surface Slope (ft/ft)		0.089			0.087																			
BF Slope (ft/ft)		0.090			0.088																			
Rosgen Classification		B3a			B3a																			

Notes:



## **APPENDIX E**

### **TABLE 10-VERIFICATION OF BANKFULL EVENTS**

**Table E10. Verification of Bankfull or Greater than Bankfull Events**  
 Snowbird Creek Tributaries Mitigation Project-#92764

Date of Data Collection	Date of Event	Method of Data Collection	Gauge Watermark Height (inches)
			UT3 (Reach 2)
MY 1	---	Gauge measurement	No event recorded
MY 2			

**APPENDIX F**

**PROJECT PROBLEM AREAS**

**FIGURE 3 – STREAM PROBLEM AREAS**

**FIGURE 4 – VEGETATION PROBLEM AREAS**

**TABLE 11 – VISUAL MORPHOLOGICAL STABILITY ASSESSMENT**

**TABLE 12 – STREAM PROBLEM AREAS**

**TABLE 13 VEGETATION PROBLEM AREAS**

# SNOWBIRD UT 3 - REACH 2



## STREAM PROBLEM AREAS YEAR 1 MONITORING

1" = 50'



Michael Baker Engineering Inc.  
 NC Engineering License E-1084  
 797 Haywood Road, Suite 204  
 Asheville, North Carolina 28806  
 Phone: 828.350.1408  
 Fax: 828.350.1409

# Baker

SNOWBIRD CREEK TRIBUTARIES PROJECT  
 GRAHAM COUNTY, NORTH CAROLINA  
**FIGURE 3**  
 STREAM PROBLEM AREAS



Prepared for:  
 Ecosystem Enhancement Program  
 2728 Capitol Blvd., Suite 14 103  
 Raleigh, NC 27604  
 Phone: 919-715-0476  
 Fax: 919-715-2219

ECP Project No.  
 92764

Baker Project No.  
 113112

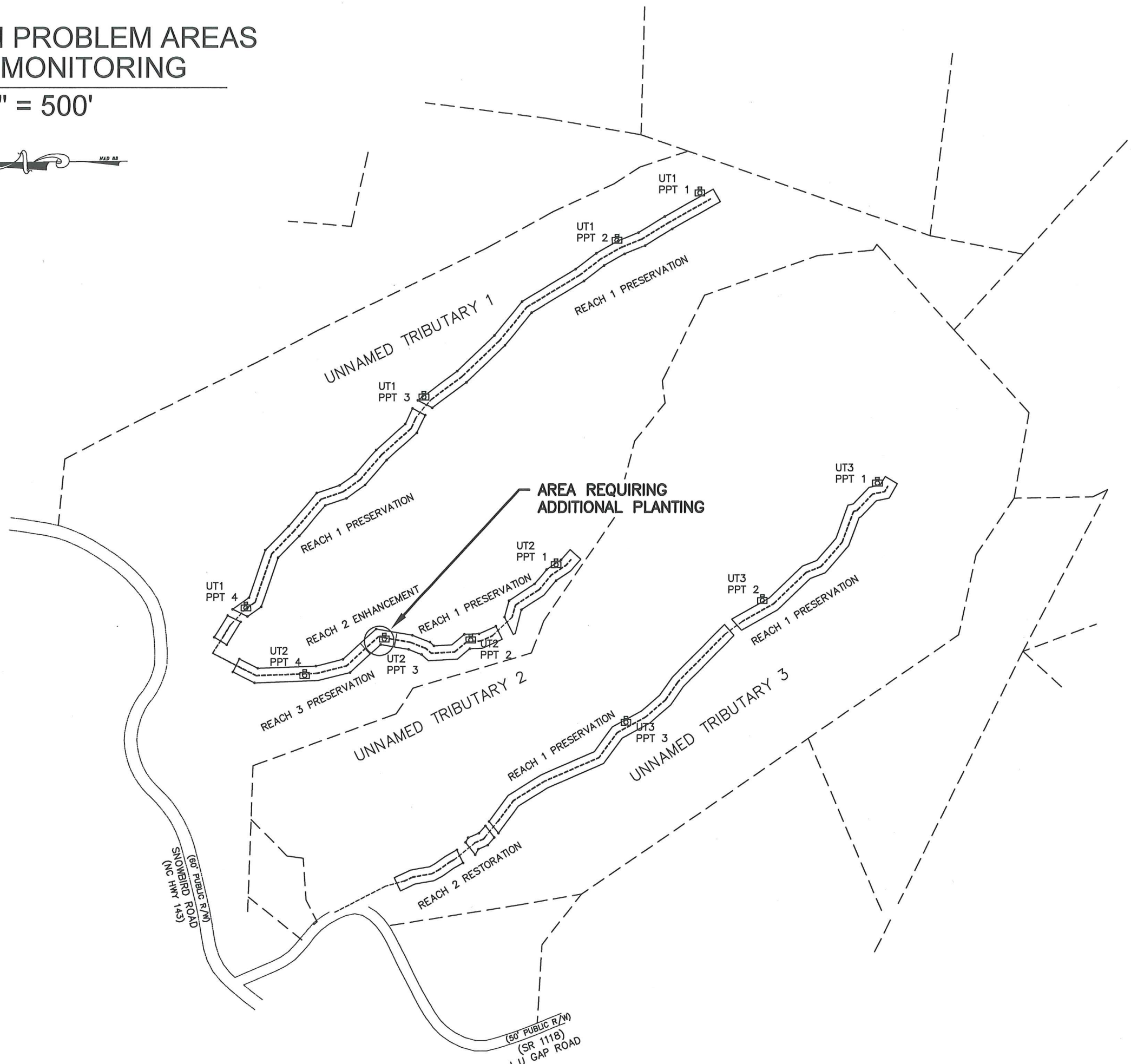
Date:  
 3/27/2012

DESIGNED: JPM  
 DRAWN: MDR  
 APPROVED: MMC

Monitoring Year:  
 1 of 5

# VEGETATION PROBLEM AREAS YEAR 1 MONITORING

1" = 500'



Michael Baker Engineering Inc.  
NC Engineering License F-1084  
797 Haywood Road, Suite 201  
Asheville, North Carolina 28806  
Phone: 828.350.1408  
Fax: 828.350.1409

# Baker

SNOWBIRD CREEK TRIBUTARIES PROJECT  
GRAHAM COUNTY, NORTH CAROLINA  
FIGURE 4  
VEGETATION PROBLEM AREAS



Prepared for:  
Ecosystem Enhancement Program  
2728 Capitol Blvd., Suite 11103  
Raleigh, NC 27604  
Phone: 919-715-0476  
Fax: 919-715-2219

EEP Project No.  
92764

Baker Project No.  
113112

Date:  
3/27/2012

DESIGNED: JPM  
DRAWN: MDR  
APPROVED: MMC

Monitoring Year:  
1 of 5

**Table F11. Stream Problem Areas  
Snowbird Creek Tributaries Mitigation Project: Project No. 92764**

**UT3 Reach 2 (467 LF)**

<b>Feature Issue</b>	<b>Station No.</b>	<b>Suspected Cause</b>	<b>Photo Number</b>
Other	0+95 along left and right bank boulder arm tie-ins	Piping of rock drop structure along left and right bank tie-in boulders suggesting the settling of unconsolidated backfill material over time.	No photo included as piping water around structure is not discernable in the image.



**Table F12. Visual Morphological Stability Assessment  
Snowbird Creek Tributaries Mitigation Project: Project No. 92764**

**UT3 Reach 2 (467 LF)**

Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Performance Mean or Total
A. Riffles	1. Present?	14	14	N/A	100	
	2. Armor stable (e.g. no displacement)?	14	14	N/A	100	
	3. Facet grades appears stable?	14	14	N/A	100	
	4. Minimal evidence of embedding/fining?	14	14	N/A	100	
	5. Length appropriate?	14	14	N/A	100	<b>100%</b>
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	24	24	N/A	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	24	24	N/A	100	
	3. Length appropriate?	24	24	N/A	100	<b>100%</b>
C. Thalweg <sup>1</sup>	1. Upstream of pool (structure) centering?	36	36	N/A	100	
	2. Downstream of pool (structure) centering?	36	36	N/A	100	<b>100%</b>
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	N/A	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	N/A	
	3. Apparent Rc within spec?	N/A	N/A	N/A	N/A	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	N/A	<b>N/A</b>
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	N/A	N/A	0/0	100	<b>100%</b>
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	0/0	100	<b>100%</b>
G. Rock/Log Drop Structures <sup>2</sup>	1. Free of back or arm scour?	24	24	N/A	100	
	2. Height appropriate?	24	24	N/A	100	
	3. Angle and geometry appear appropriate?	24	24	N/A	100	
	4. Free of piping or other structural failures?	23	24	N/A	96	<b>99%</b>
H. Wads/Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	<b>N/A</b>

<sup>1</sup> Thalweg feature is scored according to the centering of the thalweg over inverts of drop structures above pools and through the constructed riffle below pools since this reach is a step-pool channel without meander bends.

<sup>2</sup> Vane feature category was replaced with rock/log drop structures since there are no vanes present on this reach.

**Table F13. Vegetation Problem Areas  
Snowbird Creek Tributaries Mitigation Project: Project No. 92764**

**UT2 Reach 2 (171 LF)**

<b>Feature Issue</b>	<b>Station No.</b>	<b>Suspected Cause</b>	<b>Photo Number</b>
Other	N/A	N/A	N/A
Bare Bank	Left and right bank along the entire 171 LF reach (reach is not stationed).	Both banks need to be planted as a result of the planting contractor neglecting to set out stems after conducting debris removal from the channel. Baker is coordinating with the contractor to plant the area prior to a vegetation plot being established (which will be included in Year 2 monitoring).	UT2 Photo Point 3 in Appendix B
Bare Bench	N/A	N/A	N/A
Bare Flood Plain	N/A	N/A	N/A
Invasive/Exotic Populations	N/A	N/A	N/A