Snowbird Creek Tributaries Mitigation Project

Year 3 Monitoring Report - Final
Graham County, North Carolina

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

Monitoring Firm POC: Matthew Reid

Prepared for: North Carolina Ecosystem Enhancement Program (NCEEP)

NCEEP Project Manager: Paul Wiesner

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

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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 3 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^2) (10m x 10m) in size was used to predict the survival of the woody vegetation planted on-site. The Year 3 monitoring of vegetation indicated an average survival of 769 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.

The design implemented at the Snowbird Creek Tributaries mitigation project site involved Priority Level 1 Restoration, and Enhancement Level II approaches, as well as Preservation. Channels were built to be consistent with, or evolve to, a 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. At least three bankfull events have now been documented (in three separate years) over the course of the first three monitoring periods thereby satisfying the hydrologic success criteria. 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 and hydrologic data presented in Appendix D and E, this Site is currently on track to meet the stream and hydrologic success criteria specified in the Snowbird Creek Tributaries Mitigation Plan.

Summary information/data related to potential threats to restoration values, such as encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. The only area of concern observed in Year 3 is a small strip of impacted buffer paralleling the upstream limits of UT3-Reach 2. This buffer impact is approximately 30 feet wide by 130 feet long and is located within the left floodplain; it is caused by local residents encroaching on a portion of the easement in order to gain vehicle access to existing logging roads (trails) that continue on the property further upstream of the project reach/easement limits. Vegetation within this impacted swath of buffer is

sparse from the driving over and flattening by vehicles to the extent that a defined path has become apparent. Baker is coordinating with a contractor and the land owner to correct this situation by relocating the easement encroached portion of the vehicle access to outside of and adjacent to the easement to avoid further encroachment. The impacted buffer within the easement will be reseeded and replanted after construction of the relocated vehicle access. This is scheduled to be completed by the end of 2014 and will be documented within the Year 4 monitoring report. Supplemental information can be found in Appendix F which includes a planview figure, photos, and a summary table.

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.

NCEEP received Monitoring Year 2 report comments from NCDWR on February 21, 2014. NCDWR requested the installation and monitoring of three additional vegetation plots, for a total of two plots within the UT2 enhancement reach easement and two plots within the UT3 restoration reach easement. When vegetation monitoring was established at this site Baker implemented the monitoring guidance that was required for this project (CVS-EEP protocol dated 11/06/06). The CVS-EEP protocol was followed to determine the number of vegetation plots needed for the project. This established protocol determined that this site should have the one site that Baker established and has been monitoring each year. This protocol was used to establish the budget for this project and to vary from the established approach at this point, especially to the degree the NCDWR is requesting, will be costly and inconclusive since it will be impossible to distinguish planted from volunteer trees. Baker will agree to conduct one random temporary vegetation plot to document the number of live woody stems and include the results in the Year 4 & Year 5 Monitoring Report. During the Year 2 Monitoring period, Baker attempted to establish a vegetation plot on Reach 2 of UT2. As documented in the Year 2 Monitoring Report, this plot was not able to be installed due to terrain, rhododendron growth and difficulty to distinguish planted stems from volunteers. In lieu of the vegetation plot, two additional photograph stations were installed to visually document changes in the riparian corridor over the course of the monitoring period. Based on observations, woody vegetation is becoming reestablished where the riparian area was disturbed on Reach 2 of UT2.

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, but 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 the restoration of 543 linear feet (LF) of UT3 (Reach 2) and the enhancement of 171 LF of UT2 (Reach 2). In addition, 7,497 LF of UT1, UT2 and UT3 were preserved with a conservation easement deed. The restoration, enhancement, and preservation of 8,211LF of stream within this project site will generated 2,035 stream mitigation units (SMUs). Other general information about the project is located in Tables 1-4 of Appendix A.

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 current condition plan view 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.

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 2014 to document stream dimension for Monitoring Year 3. 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. Minor changes in the bottom depth appear to be due to the movement of cobble in and out of the transect. At this time, cross-sectional measurements do not indicate any streambank or channel stability issues.

2.1.1.2 Pattern and Longitudinal Profile

As-built profile monitoring data for stream stability was collected in February 2011. The longitudinal profile for Year 3 was re-surveyed during February 2014; 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 characterized as having 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 3 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 piping around the second drop of a boulder step structure near station 0+95. At this time, the structure is not considered to be an area of concern. Baker will continue to monitor this structure and make any adjustments that are needed. No other stream problem areas were

observed during Monitoring Year 3. There were no signs of bank or channel instability observed during the Monitoring Year 3 survey.

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 3 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 IRT will decide how to proceed.

2.1.2.1.1 Results

The site was found to have at least one bankfull event over the duration of the Year 3 monitoring period based on crest gauge readings. A cumulative total of at least three bankfull events have now been documented onsite within the first three monitoring periods/years (with at least one event documented per monitoring period). These three bankfull events were documented to have occurred in three separate years (between Spring 2011/Winter 2012, Winter 2012/Winter 2013 and Winter 2013/Winter 2014 respectively), and thus fulfills the hydrology success criteria for this stream mitigation project site. However, Baker will continue to monitor and report subsequent bankfull events using the crest gauges throughout the course of the remaining monitoring periods through year five. Information on these events is provided in Table E10 (Appendix E).

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 3 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.

2.1.3.2.1 Results

Photographs of the restoration project were taken in January 2014. The photographs illustrate stable conditions across the project site. Vegetative growth along the streambanks and riparian buffers has become dense and improved since construction was completed in 2011. Structures are functioning as designed.

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 the restored area (Reach 2 of UT3). The Year 3 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. 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. No stream problem areas were identified during MY3.

Quantitative reference reach and design data used to determine the restoration approach, as well as the Year 3 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.

Proposed Bare-Root and Live Stake Species (may also include seed or container species)				
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	*Platanus occidentalis*	8	54	FACW-
River Birch	*Betula nigra*	7	48	FACW
White Oak	*Quercus alba*	5	34	FACU
Red Maple	*Acer rubrum*	5	34	FAC
Tulip Poplar	*Liriodendron tulipifera*	5	34	FAC
Yellow Birch	*Betula alleghaniensis (lutea)*	5	34	FACU+
Black (Sweet) Birch	*Betula lenta*	5	34	FACU
Northern Red Oak	*Quercus rubra*	5	34	FACU
Yellow Buckeye	*Aesculus octandra*	5	34	N/A
Mockernut Hickory	*Carya alba (tomentosa)*	3	20	N/A
Scarlet Oak	*Quercus coccinea*	2	14	N/A
Trees Understory				
Highland Doghobble	*Leucothoe fontanesiana (axilarris var. editorum)*	5	34	N/A
Mountain Laurel	*Kalmia latifolia*	5	34	FACU

Proposed Bare-Root and Live Stake Species (may also include seed or container species)				
Snowbird Creek Tributaries Mitigation Plan-NCEEP Project #92764				
Common Name	**Scientific Name**	**% Planted by Species**	**Planting Density**	**Wetness Tolerance**
Flame Azalea	*Rhododendron calendulaceum*	5	34	N/A
Black Willow	*Salix nigra*	2	14	OBL
Ironwood	*Carpinus caroliniana*	3	20	FAC
Witch Hazel	*Hamamelis virginiana*	2	14	FACU
Sourwood	*Oxydendrum arboreum*	5	34	FACU
Flowering Dogwood	*Cornus florida*	5	34	FACU
Rhododendron	*Rhododendron maximum*	3	20	FAC-
Tag Alder	*Alnus serrulata*	5	34	FACW+ or OBL
Redbud	*Cercis canadensis*	5	34	FACU
Shrubs				
Rivercane (giant cane)	*Arundinaria gigantea*	15	102	FACW
Spicebush	*Lindera benzoin*	15	102	FACW
Deerberry	*Vaccinium stamineum*	15	102	FACU
Eastern Sweetshrub, Sweetshrub	*Calycanthus floridus, Calycanthus spp.*	10	68	FACU
Sweetpepperbush	*Clethra spp.*	15	102	N/A
Winterberry	*Ilex verticillata*	10	68	FACW
Virginia Sweetspire	*Itea virginica*	15	102	FACW+
Chokeberry	*Photinia*	5	34	N/A
Alternate Species				
Blight-resistant American Chestnut	*Castanea dentata*	Not Used	Not Used	
American Hazelnut	*Corylus americana*	Not Used	Not Used	FACU
Blue Ridge Blueberry	*Vaccinium pallidum*	Not Used	Not Used	
Riparian Livestake Plantings				
Ninebark	*Physocarpus opulifolius*	15	102	FAC-
Elderberry	*Sambucus canadensis*	20	136	FACW-
Buttonbush	*Cephalanthus occidentalis*	15	102	OBL
Silky Willow	*Salix sericea*	25	170	OBL
Silky Dogwood	*Cornus amomum*	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.

2.2.1.1.1 Results

Tables 5 through 7b in Appendix C present information on vegetation success criteria, vegetation metadata, and stem counts for the vegetation monitoring plot. Vegetation data was collected in October 2013. Data from the Year 3 monitoring event indicates that approximately 82% of the stems surveyed were in fair to excellent condition and 94% of the stems in the plot showed no signs of damage. The average density of planted bare root stems, based on data collected from the monitoring plot during Year 3 monitoring, is 769 stems per acre or 19 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, between the Baseline and Year 3 monitoring periods, a mortality of six stems have been observed. This accounts for the difference or decrease between the original planted stem count (1,012 stems) from Baseline monitoring and the total stem count (769) from Year 3 monitoring. An average density of 769 stems per acre indicates that the Site is meeting the minimum interim success criteria of 320 trees per acre by the end of Year 3. The site is on course to meet 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 Current Condition Plan View.

The area on Reach 2 of UT3 that was identified during as-built surveys as having sparse groundcover was found to have rebounded and is no longer considered to be a vegetation problem area; 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.

During the Year 2 monitoring period, Baker had planned to install a smaller vegetation plot 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. The Planting Contractor has confirmed that the Enhancement II reach was planted. However, when Baker attempted to establish a plot, it was extremely difficult to distinguish planted stems from volunteers. Rather than establish a smaller vegetation plot as originally planned, 2 additional photograph stations, 3a and 3b, were set out in this section of the Enhancement II reach. Photographs for these stations are displayed in Exhibit 1 of Appendix B and their locations are georeferenced in Figures 2. Photographs will be taken on an annual basis to visually document changes in the riparian corridor over the course of the monitoring period. Based on observations during Monitoring Year 3, woody vegetation is becoming re-established where the riparian area was disturbed, and there are no vegetation concerns at this time.

Only one vegetation problem area was identified during the Year 3 monitoring period. It is a small strip of impacted buffer paralleling the upstream limits of UT3-Reach 2. This buffer impact is approximately 30 feet wide by 130 (from station 0+10 to 1+40) feet long and is located within the left floodplain; it is caused by local residents encroaching on a portion of the easement in order to gain 4-wheeler vehicle access to the existing logging roads (trails) that continue on the property further upstream of the project reach/easement limits. Vegetation within this impacted path through the buffer is mashed from being driven on, to the extent that a defined path has become apparent. Baker is coordinating with a contractor and the land owner to correct this situation by relocating the path for vehicle access outside of, and adjacent to, the easement, to avoid further encroachment. The impacted buffer within the easement will be reseeded and replanted after construction of the relocated vehicle access. This is scheduled to be completed in the spring of 2014 and will be documented within the Year 4 monitoring report. Supplemental information can be found in Appendix F which includes a planview figure, photos, and a summary table.

2.3 Areas of Concern

The easement encroachment and associated impacts to the vegetated buffer occurring within the left floodplain of UT3-Reach 2, between stations 0+10 and 1+40 is the only area of concern identified for the Year 3 monitoring period. As previously mentioned, Baker is coordinating with a contractor and the land owner to create an alternate vehicle access, located outside the easement, to avoid further encroachment. The impacted buffer within the easement will be replanted after construction of the alternate vehicle access. This is scheduled to be completed in the spring of 2014 and will be documented within the Year 4 monitoring report.

3.0 REFERENCES

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

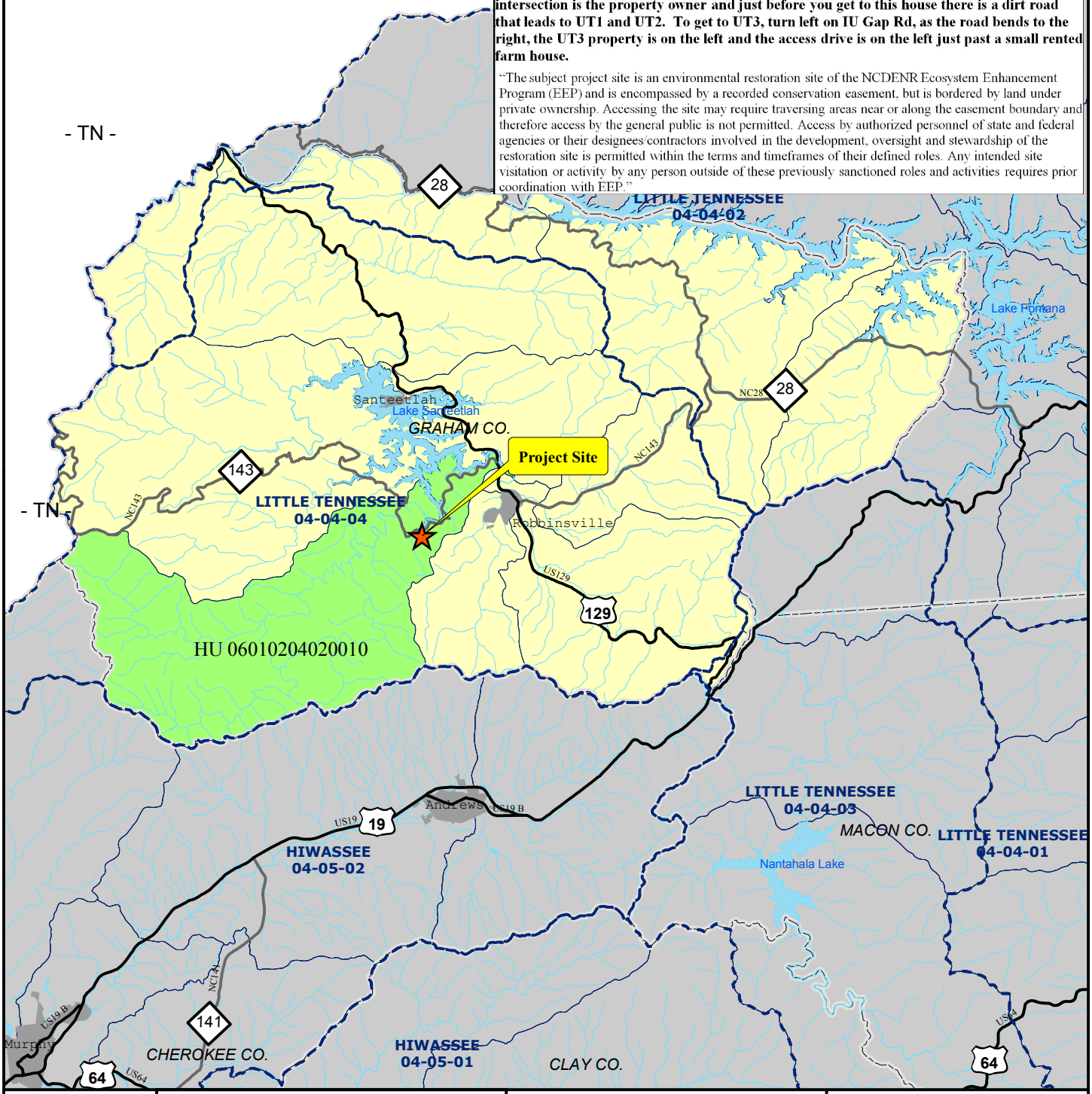
Peet, R.K., T.R. Wentworth and P.S. White. 1998. "A flexible, multipurpose method for recording vegetation composition and structure." Castanea 63:262-274.

APPENDIX A
FIGURE & GENERAL TABLES

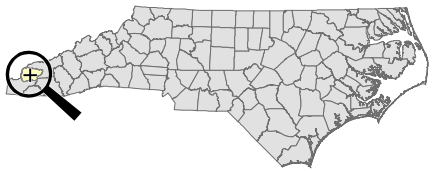
LOCATION MAP
TABLES 1-4

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."



Map Inset



Graham County, NC

LEGEND:

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

0 1 2 4 Miles

Figure 1. Project Vicinity Map

Snowbird Creek Tributaries Project
Graham County, NC

Ecosystem Enhancement PROGRAM

Baker

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.

Table 1. Project Components
Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764

Project Segment or Reach ID	Existing Feet/ Acres	Mitigation Type	Approach	Target Stream Type	Footage or Acreage	Mitigation Ratio	Mitigation Units	Stationing	Comment
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.

Mitigation Unit Summations

Stream (LF)	Riparian Wetland (Ac)	Nonriparian Wetland (Ac)	Total Wetland (Ac)	Buffer (Ac)	Comment
8,135	NA	NA	NA	13.1	
Total MUs	2,035				
Notes:					

Table 2. Project Activity and Reporting History
Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764

Activity or Report	Data Collection Complete	Completion or Delivery
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	February 2013	March 2013
Year 3 Monitoring	January 2014	March 2014
Year 4 Monitoring		
Year 5 Monitoring		

Table 3. Project Contacts Table **Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764**	
Designer	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201, Asheville, NC 28806 Contact: Micky Clemmons, Tel. 828.350.1408 x2002
Construction Contractor	
River Works, Inc.	8000 Regency Parkway, Suite 200, Cary, NC 27511 Contact: Bill Wright, Tel. 919.818.6686
Planting & Seeding Contractor	
River Works, Inc.	8000 Regency Parkway, Suite 200, Cary, NC 27511 Contact: George Morris, Tel. 919.459.9001
Seed Mix Sources	Green Resources
Nursery Stock Suppliers	Arborgen and Hillis Nursery
Monitoring	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201, Asheville, NC 28806 Contact: Matthew Reid, Tel. 828.350.1408 x2006

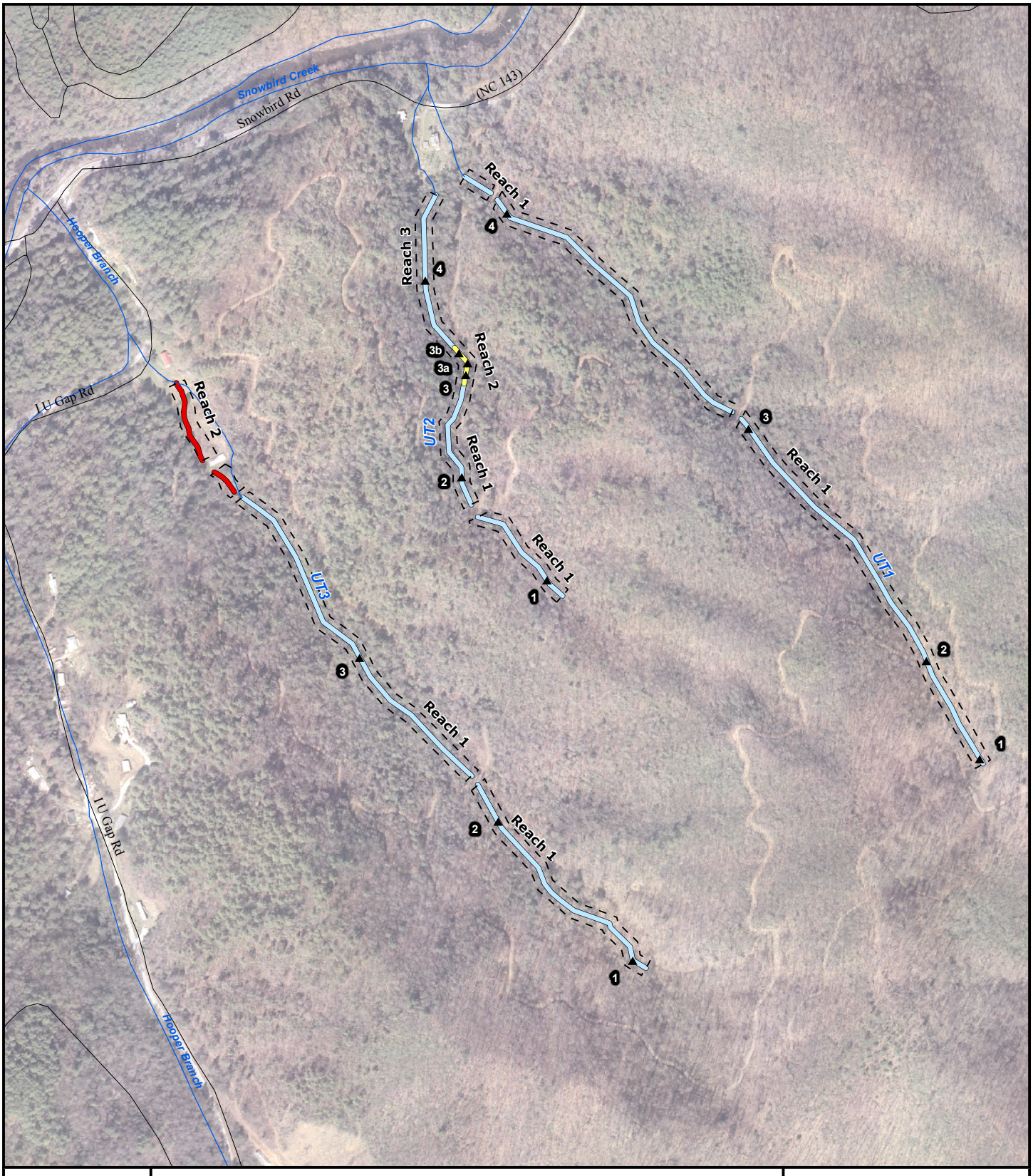
Table 4. Project Attribute Table **Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764**	
Project County	Graham County, NC
Physiograhic Region	Blue Ridge
Ecoregion	Blue Ridge Mountains-Southern Metasedimentary Mountains
Project River Basin	Little Tennessee
USGS HUC for Project	06010204020010
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^2
UT2	
Reach 1	.05 mi^2

Table 4. Project Attribute Table **Snowbird Creek Tributaries Mitigation Project-NCEEP Project #92764**	
Reach 2	.06 mi^2
Reach 3	.08 mi^2
UT3	
Reach 1	.15 mi^2
Reach 2	.18 mi^2
Stream Order	
UT1	1st (Perennial)
UT2	
Reach 1	1st (Perennial)
Reach 2	1st (Perennial)
Reach 3	1st (Perennial)
UT3	
Reach 1	1st (Perennial)
Reach 2	1st (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 4. 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	$Aa^{+/}Aa^{+}$			
UT2				
Reach 1	B3a/ B3a			
Reach 2	B3a/ B3a			
Reach 3	B3a/ B3a			
UT3				
Reach 1	$A4a^{+}/A4a^{+}$			
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-Stecoah/ 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:

Project Components
- Preservation
- Enhancement II
- Restoration (Priority 1)

- Easement Boundary
- Streams
- 3▲ Photo Points (EII & Preservation Reaches)*

0 200 400 800 Feet

* Photo Points for the restored reach, UT3 Reach 2, can be found on the CCPV, Figure 3 of Appendix F.

Ecosystem Enhancement PROGRAM

Figure 2. Restoration Summary Map

Snowbird Creek Tributaries Project
Graham County, NC

Baker

Snowbird Creek
Photo Log - Reference Photo Points

Notes: Photos for Snowbird Creek were taken January 2014.

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 February 2014.

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 February 2014.

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, 3a, and 3b are 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 3a: looking down valley along right bank

Photo Point 3a: looking up valley along right bank

Photo Point 3b: looking down valley along right bank

Photo Point 3b: looking up valley along right bank

Photo Point 4: looking downstream

Photo Point 4: looking upstream

UT3 (Preservation)
Photo Log - Reference Photo Points

Notes: Photos were taken February 2014.

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 October 2013.

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 5-7b

Table 5. Vegetation Plot Criteria Attainment Snowbird Creek Mitigation Project-#92764	
Vegetation Plot ID	Vegetation Survival Threshold Met?
1	Y

Table 6. Vegetation Metadata East Buffalo Creek Mitigation Project-#92763	
Report Prepared By	Matthew Reid
Date Prepared	10/30/2013 9:46
database name	cvs-eep-entrytool-v2.3.1.mdb
database location	C:\Users\mdreid\Desktop
computer name	ASHEWSGREGORY1
file size	48185344
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data
CVS Stem Count Total and Planted by Plot and Species	Displays Plot and Stem Count Mertrics as well as Stems Planted Per Acre
PROJECT SUMMARY----------	
Project Code	92764
project Name	Snowbird Tributaries
Description	Restoration: 466 LF, Enhancement II:171 LF, Preservation: 7,497 LF
River Basin	Little Tennessee
length(ft)	466
stream-to-edge width (ft)	30
area (sq m)	2597.31
Required Plots (calculated)	1
Sampled Plots	2

Table 7. Stem Count Arranged by Plot
Snowbird Creek Tributaries Mitigation Project-#92764

Tree Species	Common Name	Species Type	Plot 1	As-built Totals	MY 1 Totals	MY 2 Totals	MY 4 Totals	MY 5 Totals	Survival %	Probable Cause
Acer rubrum	Red Maple	Tree	1	1	2	2			100%	
Alnus serrulata	Tag Alder	Tree	3	3	3	3			100%	
Betula lenta	Sweet Birch	Tree	3	4	4	4			75%	
Betula nigra	River Birch	Tree	0	2	0	0			0%	
Carya alba	Mockernut Hickory	Tree	3	3	3	3			100%	
Platanus occidentalis	Sycamore	Tree	6	7	6	7			86%	
Quercus rubra	Red Oak	Tree	2	3	2	2			67%	
Shrub Species										
Cercis canadensis	Redbud	Tree	0	1	0	0			0%	
Hamamelis virginiana	Witch Hazel	Shrub	1	1	1	1			100%	
Stems/plot			19	25	21	22			19	
Stems/acre			769	1012	850	890			769	

Note: Volunteer species were not identified in year 3 monitoring. Volunteers will be identified for year 4 monitoring report.

Table 7b. Stem Count Arranged by Plot
Snowbird Creek Tributaries Mitigation Project-#92764

Scientific Name	Common Name	Species Type	Current Plot Data (MY3 2013)			Annual Means								
			E92764-01-0001			MY3 (2013)			MY2 (2012)			MY1 (2011)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree	1	1	1	1	1	1	2	2	2	2	2	2
Alnus serrulata	hazel alder	Tree	3	3	3	3	3	3	3	3	3	3	3	3
Betula lenta	sweet birch	Tree	3	3	3	3	3	3	4	4	4	4	4	4
Carya alba	mockernut hickory	Tree	3	3	3	3	3	3	3	3	3	3	3	3
Hamamelis virginiana	American witchhazel	Tree	1	1	1	1	1	1	1	1	1	1	1	1
Platanus occidentalis	American sycamore	Tree	6	6	6	6	6	6	7	7	7	6	6	6
Quercus rubra	northern red oak	Tree	2	2	2	2	2	2	2	2	2	2	2	2
		Stem count	19	19	19	19	19	19	22	22	22	21	21	21
		size (ares)	1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02		
		Species count	7	7	7	7	7	7	7	7	7	7	7	7
		Stems per ACRE	769	769	769	769	769	769	890	890	890	850	850	850

Note: Volunteer species were not identified in year 3 monitoring. Volunteers will be identified for year 4 monitoring report.

APPENDIX D

MORPHOLOGICAL SUMMARY DATA

EXHIBIT 3 – CROSS-SECTIONS (WITH ANNUAL OVERLAYS)

EXHIBIT 4 – LONGITUDINAL PROFILE (WITH ANNUAL OVERLAYS)

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	4.3	8.43	0.51	0.93	16.4	1	5.3	2045.35	2045.35

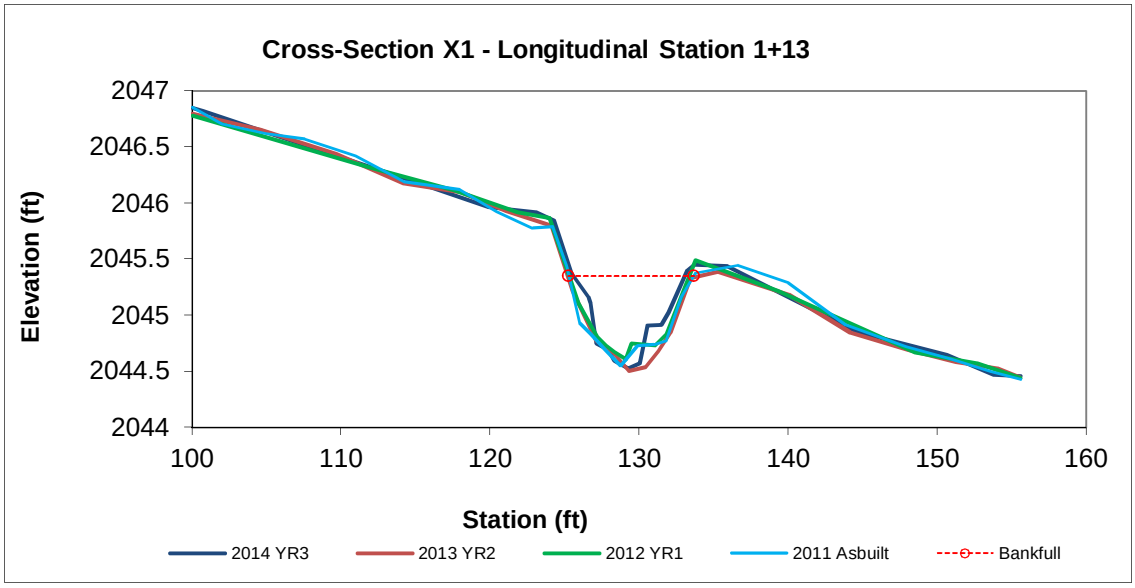


Photo 1: XS-1 facing right bank

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	9.8	15.73	0.62	1.47	25.24	1	3.2	2030.14	2030.21

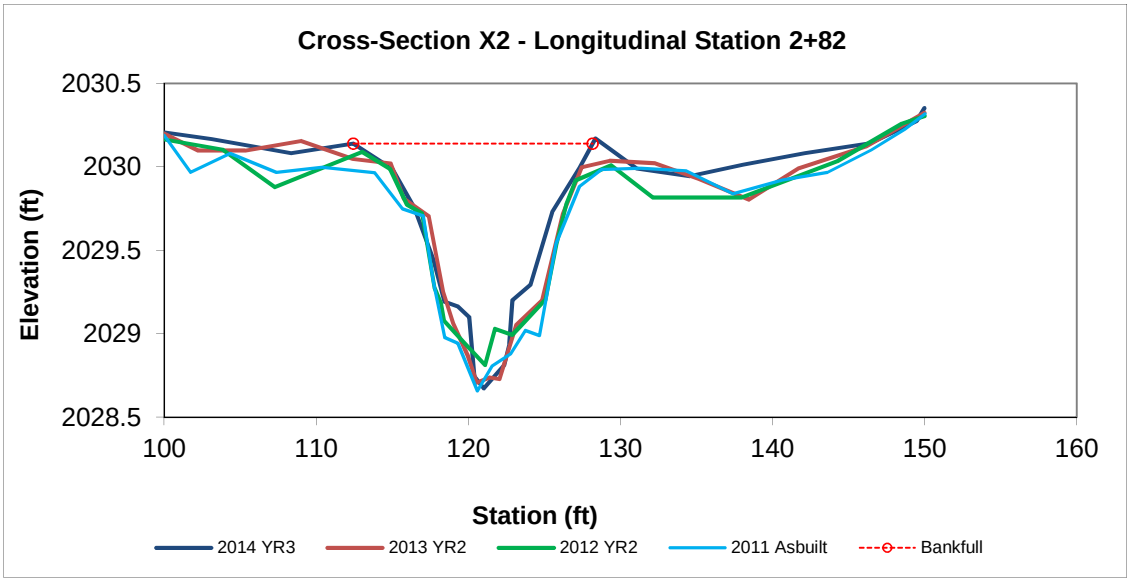


Photo 1: XS-2 facing right bank

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	9.8	12.58	0.78	1.7	16.07	2	4.5	2021.13	2022.83

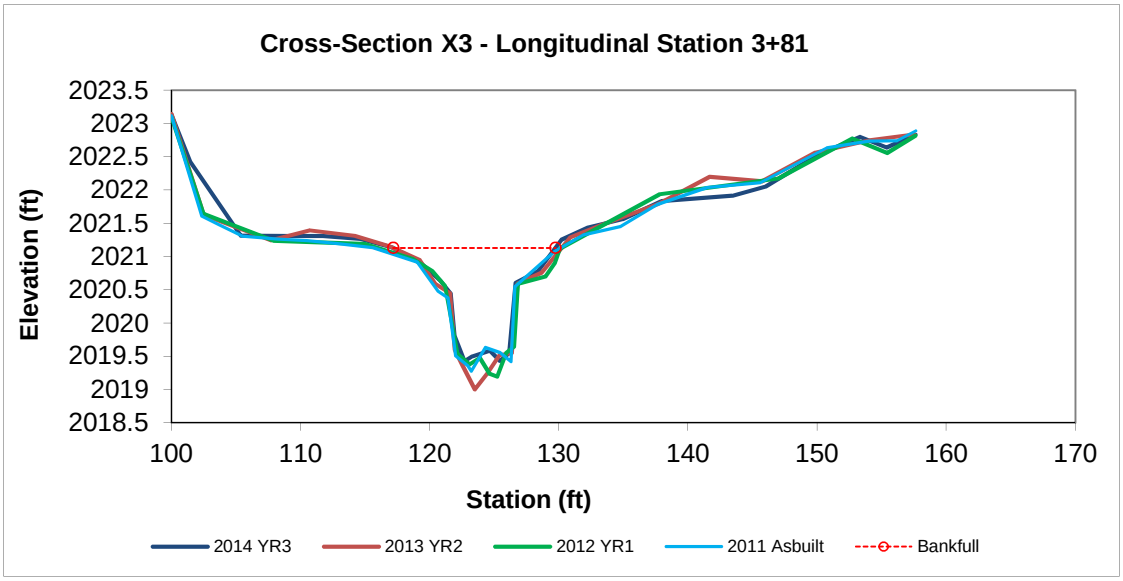


Photo 1: XS-3 facing right bank

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	8.1	12.31	0.66	1.16	18.69	2.1	4.6	2015.06	2016.29

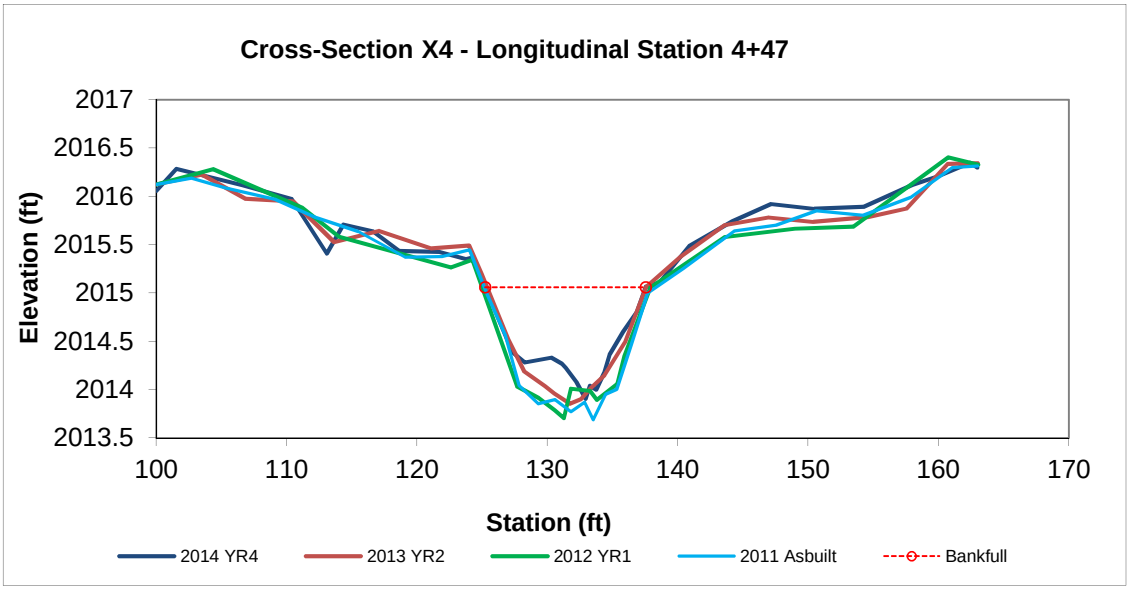
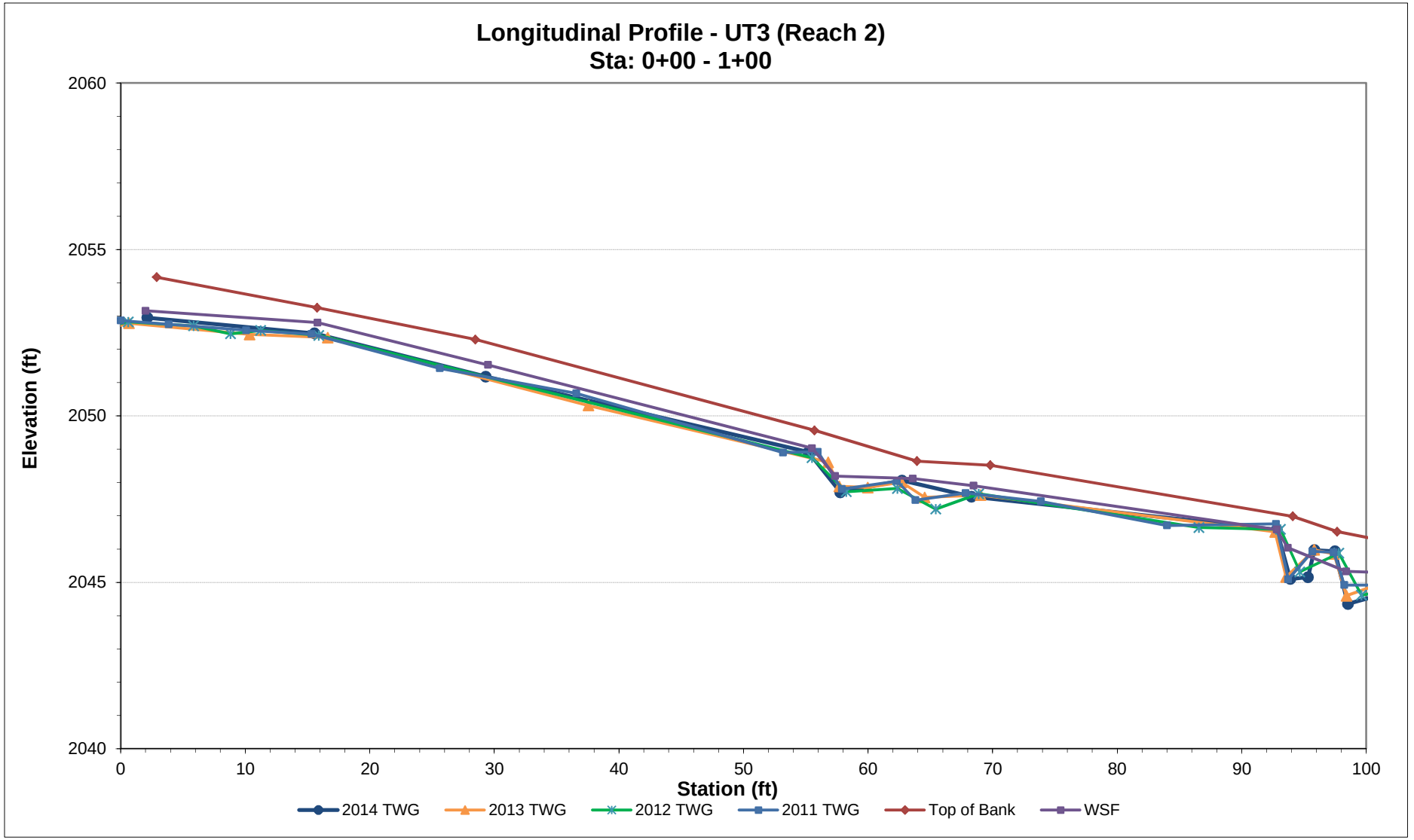


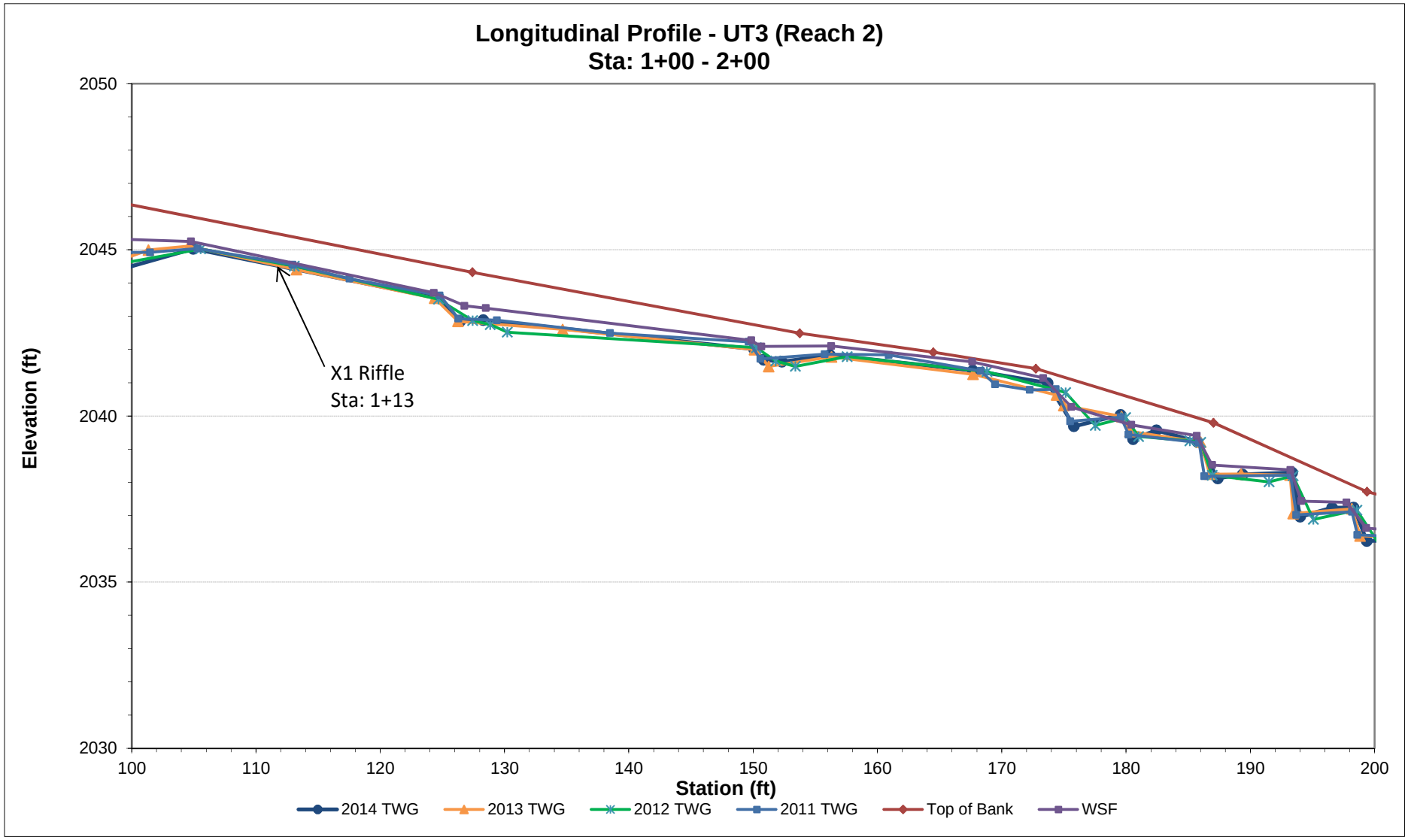
Photo 1: XS-4 facing right bank

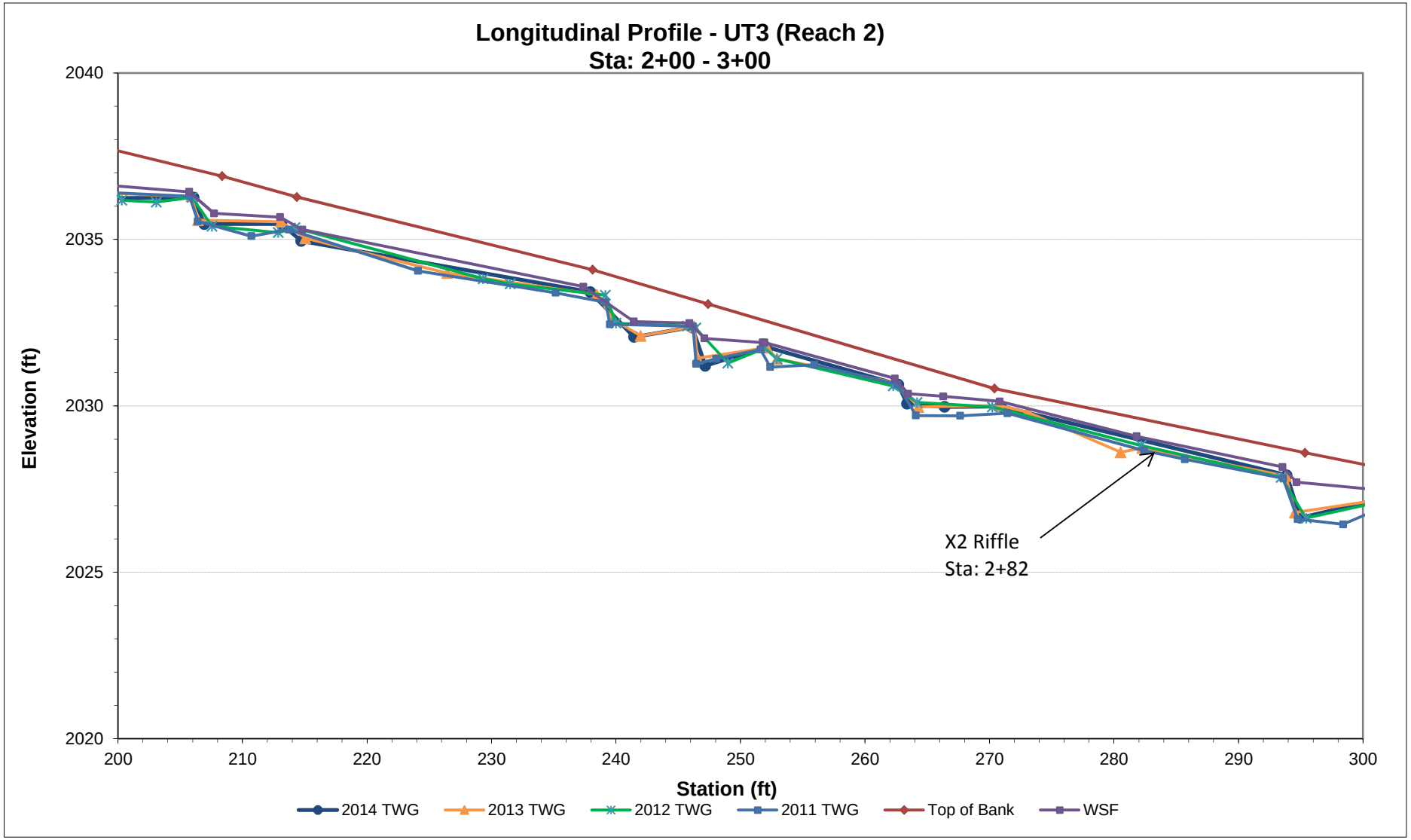
Photo 2: XS-4 facing left bank

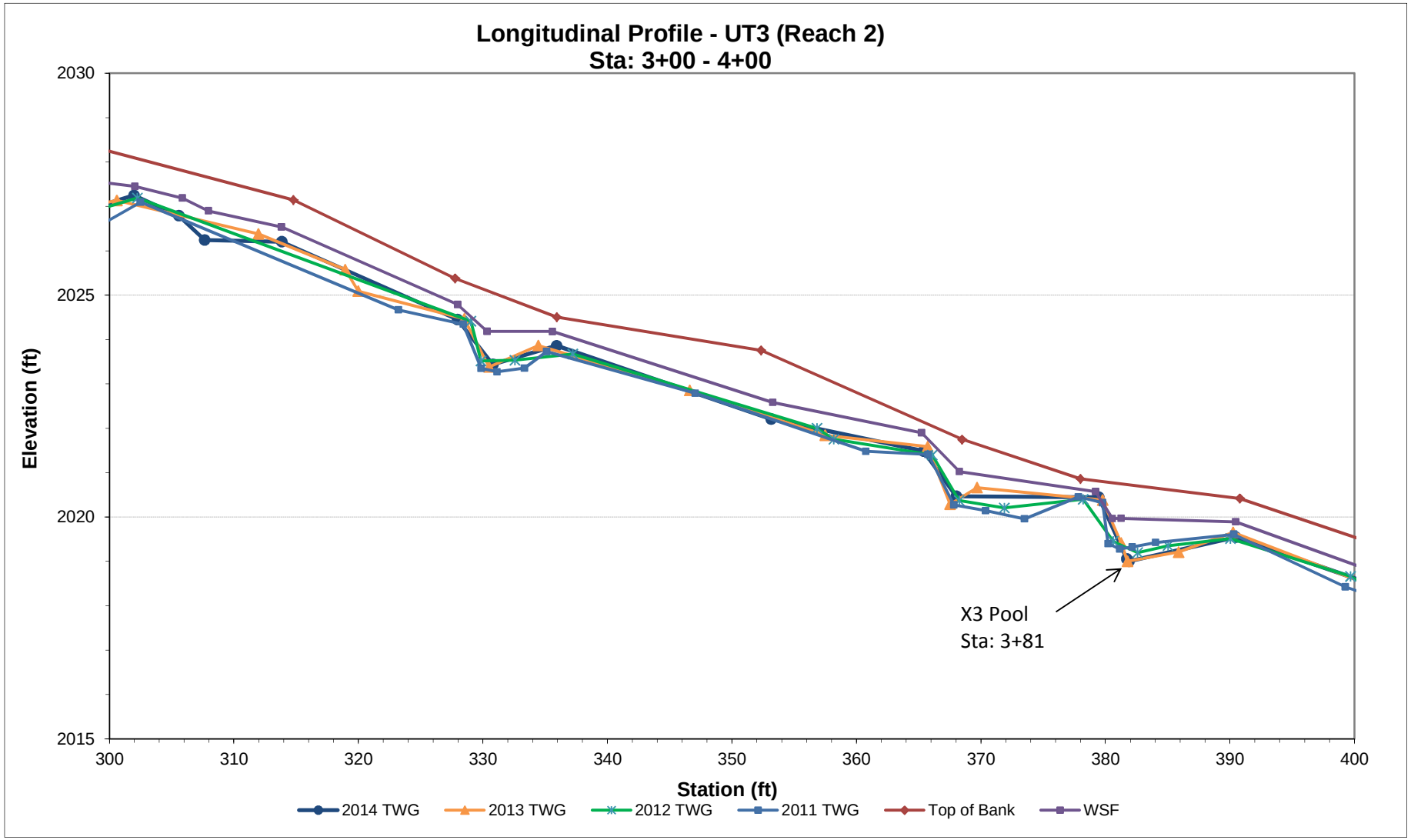
Photo 3: XS-4 facing upstream

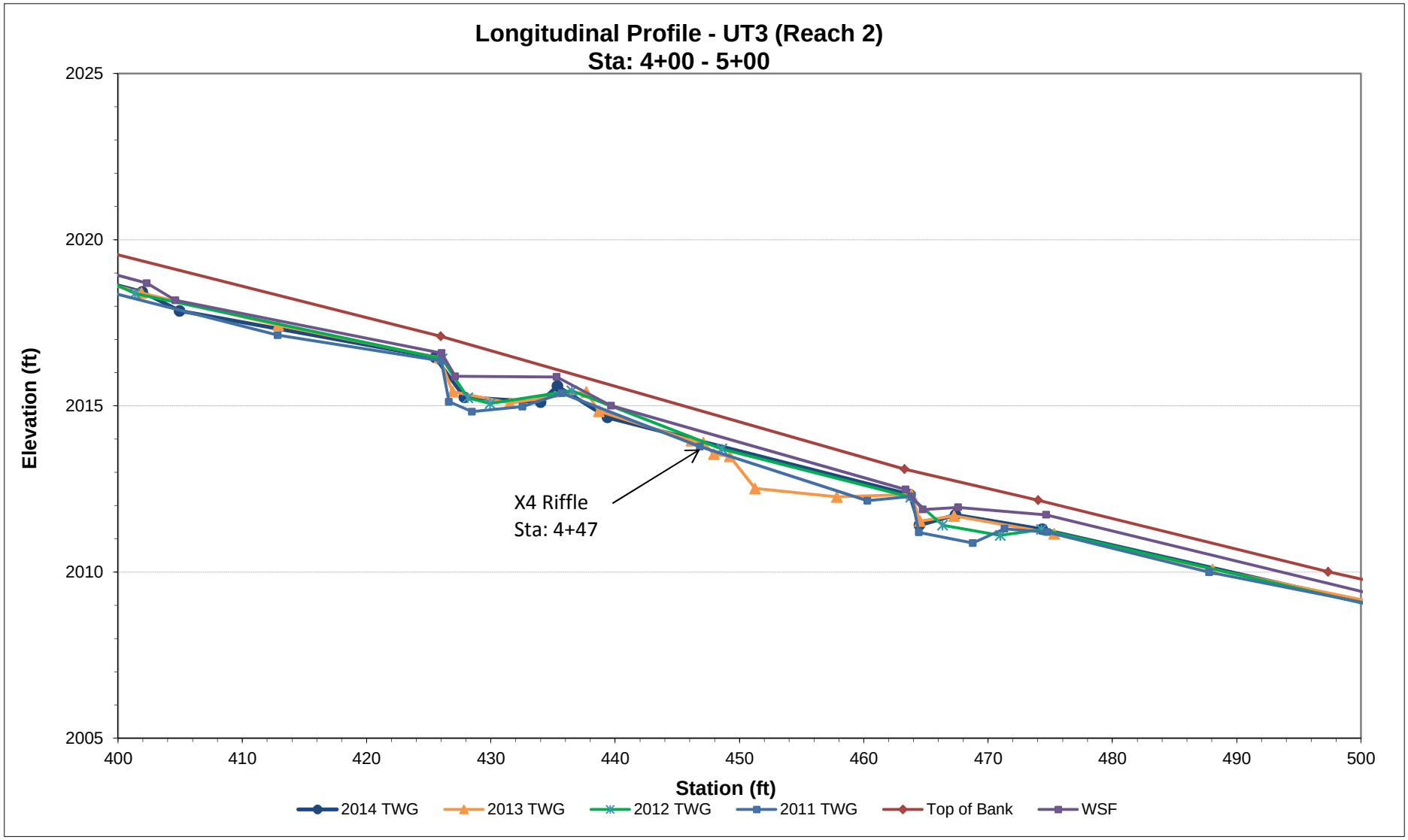
Photo 4: XS-4 facing downstream


Longitudinal Profile - UT3 (Reach 2)
Sta: 0+00 - 1+00
Elevation (ft)
2060
2055
2050
2045
2040
0
10
20
30
40
50
60
70
80
90
100
Station (ft)
2014 TWG
2013 TWG
2012 TWG
2011 TWG
Top of Bank
WSF


Longitudinal Profile - UT3 (Reach 2)
Sta: 1+00 - 2+00
Elevation (ft)
2050
2045
2040
2035
2030
X1 Riffle
Sta: 1+13
100
110
120
130
140
150
160
170
180
190
200
Station (ft)
2014 TWG
2013 TWG
2012 TWG
2011 TWG
Top of Bank
WSF


Longitudinal Profile - UT3 (Reach 2)
Sta: 2+00 - 3+00
Elevation (ft)
2040
2035
2030
2025
2020
200
210
220
230
240
250
260
270
280
290
300
Station (ft)
X2 Riffle
Sta: 2+82
2014 TWG
2013 TWG
2012 TWG
2011 TWG
Top of Bank
WSF


Longitudinal Profile - UT3 (Reach 2)
Sta: 3+00 - 4+00
Elevation (ft)
2030
2025
2020
2015
300
310
320
330
340
350
360
370
380
390
400
Station (ft)
X3 Pool
Sta: 3+81
2014 TWG
2013 TWG
2012 TWG
2011 TWG
Top of Bank
WSF


Longitudinal Profile - UT3 (Reach 2)
Sta: 4+00 - 5+00
Elevation (ft)
2025
2020
2015
2010
2005
400
410
420
430
440
450
460
470
480
490
500
Station (ft)
X4 Riffle
Sta: 4+47
2014 TWG
2013 TWG
2012 TWG
2011 TWG
Top of Bank
WSF

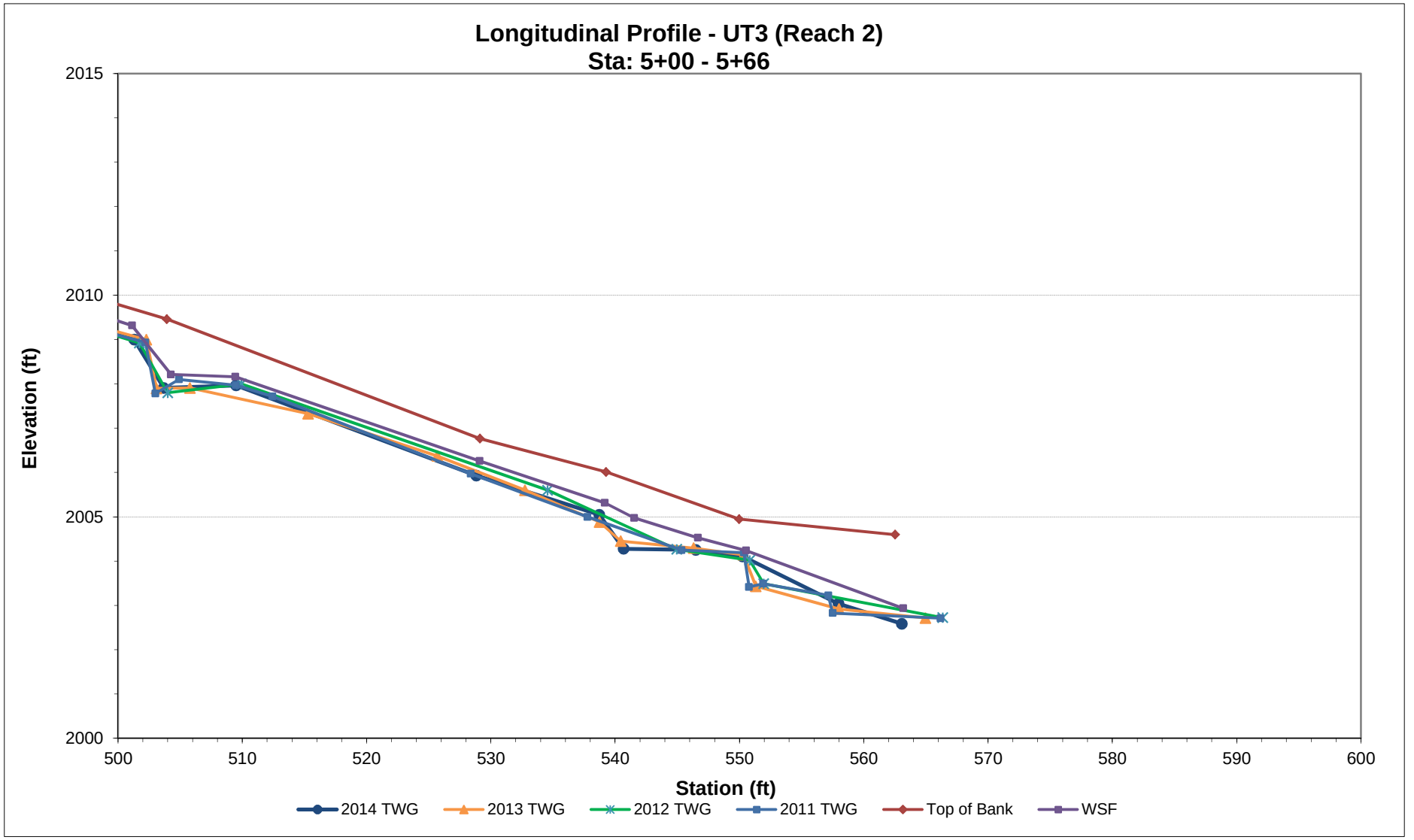
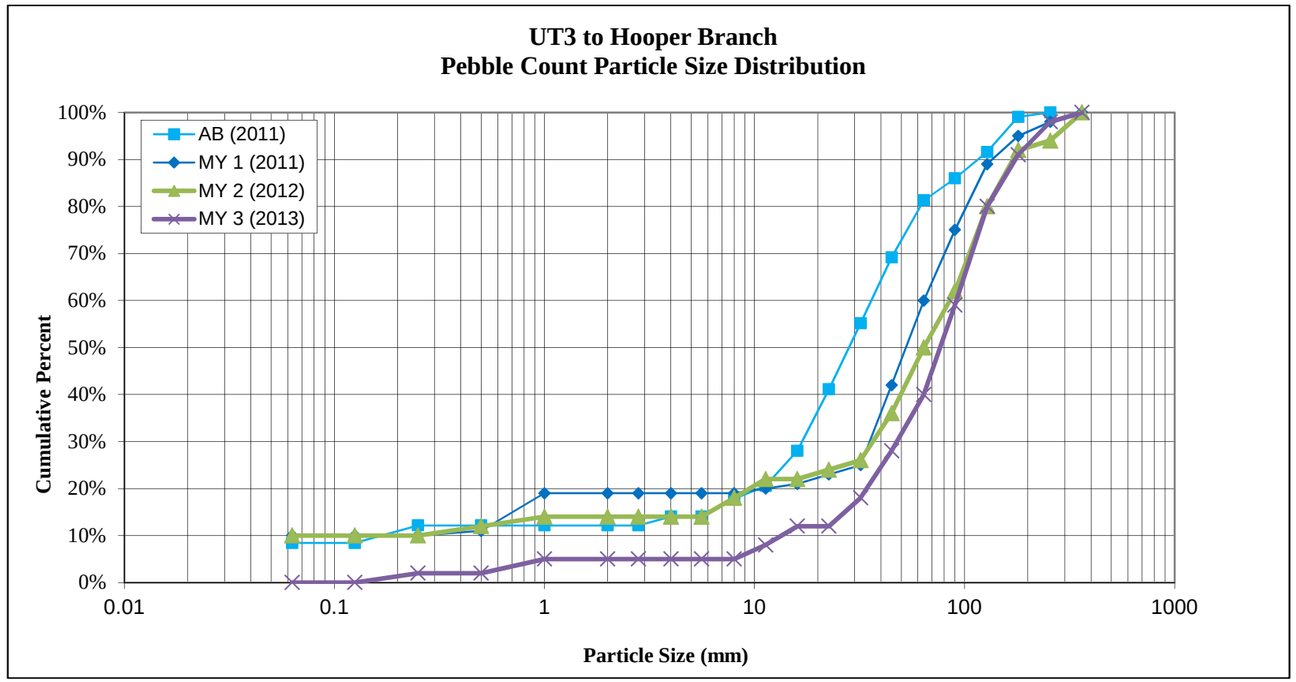

Longitudinal Profile - UT3 (Reach 2)
Sta: 5+00 - 5+66
Elevation (ft)
2015
2010
2005
2000
500
510
520
530
540
550
560
570
580
590
600
Station (ft)
2014 TWG
2013 TWG
2012 TWG
2011 TWG
Top of Bank
WSF

Exhibit 5. 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 2 (2012)					
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Total**	**Class %**	**% Cum**
Silt/Clay	Silt / Clay	< .063		10.00	10.00
Sand	Very Fine	.063 - .125			10.00
	Fine	.125 - .25	2		10.00
	Medium	.25 - .50		2.00	12.00
	Coarse	.50 - 1.0	3	2.00	14.00
	Very Coarse	1.0 - 2.0			14.00
Gravel	Very Fine	2.0 - 2.8			14.00
	Very Fine	2.8 - 4.0			14.00
	Fine	4.0 - 5.6			14.00
	Fine	5.6 - 8.0		4.00	18.00
	Medium	8.0 - 11.0	3	4.00	22.00
	Medium	11.0 - 16.0	4		22.00
	Coarse	16 - 22.6		2.00	24.00
	Coarse	22.6 - 32	6	2.00	26.00
	Very Coarse	32 - 45	10	10.00	36.00
	Very Coarse	45 - 64	12	14.00	50.00
Cobble	Small	64 - 90	19	12.00	62.00
	Small	90 - 128	21	18.00	80.00
	Large	128 - 180	11	12.00	92.00
	Large	180 - 256	7	2.00	94.00
Boulder	Small	256 - 362	2	6.00	100.00
	Small	362 - 512			100.00
	Medium	512 - 1024			100.00
	Large-Very Large	1024 - 2048			100.00
Bedrock	Bedrock	> 2048			100.00
Total % of whole count			100	100	100%

Summary Data	
Channel materials	
D_{50} =	76.58
D_{84} =	144.89
D_{95} =	220.13



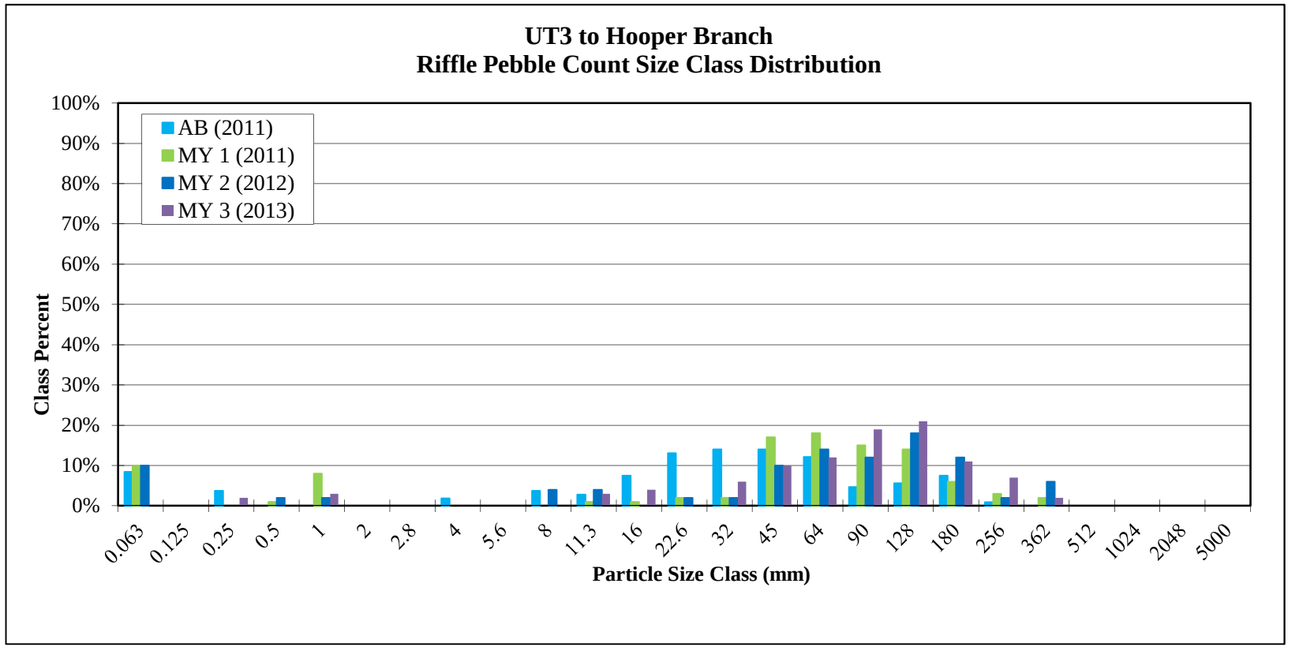


Table D8. Cross-Section Morphology Data Table

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
Dimension																								
BF Width (ft)	8.5	8.8	8.2	8.4			9.5	11.8	12.5	15.7			9.7	10.5	10.2	12.6			12.4	12.9	12.2	12.3		
Floodprone Width (ft)	41.5	45.1	40.7	44.9			50.0	50.0	50.0	50.0			49.1	50.4	57.2	57.0			62.5	63.1	56.7	56.5		
BF Cross Sectional Area (ft2)	4.5	5.1	4.3	4.3			6.3	7.7	8.7	9.8			8.1	8.5	9.1	9.8			10.7	11.2	9.5	8.1		
BF Mean Depth (ft)	0.53	0.58	0.53	0.51			0.66	0.65	0.70	0.62			0.84	0.81	0.89	0.78			0.87	0.87	0.77	0.66		
BF Max Depth (ft)	0.83	0.89	0.83	0.93			1.05	1.11	1.29	1.47			1.64	1.71	1.94	1.70			1.31	1.35	1.21	1.16		
Width/Depth Ratio	16.3	15.4	15.3	16.4			14.3	18.1	17.8	25.2			11.6	12.9	11.5	16.1			14.3	14.8	15.8	18.7		
Entrenchment Ratio	4.9	5.1	5.0	5.3			5.3	4.2	4.0	3.2			5.1	4.8	5.6	4.5			5.1	4.9	4.6	4.6		
Wetted Perimeter (ft)	9.6	10.0	9.2	9.5			10.8	13.1	13.9	17.0			11.4	12.1	12.0	14.1			14.1	14.6	13.8	13.6		
Hydraulic Radius (ft)	0.5	0.5	0.5	0.5			0.6	0.6	0.6	0.6			0.7	0.7	0.8	0.7			0.8	0.8	0.7	0.6		
Substrate																								
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
Pattern																		
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	-						
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	-						
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	-						
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	-						
Profile																		
Riffle length (ft)	24	33	26	23	27	27	23	28	26	23	28	26						
Riffle Slope (ft/ft)	0.058	0.102	0.072	0.044	0.120	0.104	0.047	0.118	0.092	0.041	0.113	0.087						
Pool Length (ft)	3	6	4	3	7	7	4	10	4	5	9	8						
Pool Spacing (ft)	8	41	35	8	47	29	8	55	34	8	52	32						
Substrate																		
d50 (mm)		28			53			64			77							
d84 (mm)		78			113			143			145							
Additional Reach Parameters																		
Valley Length (ft)		445			445			445			445							
Channel Length (ft)		467			467			467			467							
Sinuosity		1.05			1.07			1.05			1.05							
Water Surface Slope (ft/ft)		0.089			0.087			0.088			0.089							
BF Slope (ft/ft)		0.090			0.088			0.092			0.093							
Rosgen Classification		B3a			B3a			B3a			B3a							

Notes:

Table D9. Stream Reach Morphology Data Table

Snowbird Creek Tributaries Mitigation Project #92764

Stream Reach Data Summary
UT3

Parameter	Regional Curve Equation	Reference Reach(es) Data			Design			(As-Built)			Yr 1			Yr 2			Yr 3			Yr 4			Yr 5		
Dimension - Riffle	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	10.1	7.4	17.5	27.6	-----	9.9	-----	8.5	10.1	12.4	8.8	11.2	12.9	8.2	10.9	12.5	8.4	12.2	15.7						
Floodprone Width (ft)	-----	12.2	25.4	38.6	20.0	35.0	50.0	41.5	51.4	62.5	45.1	52.7	63.1	40.7	49.1	56.7	44.9	50.5	56.5						
Bankfull Mean Depth (ft)	0.65	0.87	0.99	1.10	-----	0.66	-----	0.53	0.69	0.87	0.58	0.70	0.87	0.53	0.67	0.77	0.51	0.60	0.66						
Bankfull Max Depth (ft)	-----	1.09	1.35	1.60	-----	0.90	-----	0.83	1.06	1.31	0.9	1.12	1.4	0.83	1.11	1.29	0.83	1.19	1.47						
Bankfull Cross Sectional Area (ft2)	6.7	7.0	20.0	33.0	-----	6.5	-----	4.5	7.1	10.7	5.1	8.0	11.2	4.3	7.5	9.5	4.3	7.4	9.8						
Width/Depth Ratio	-----	7.6	17.3	27.0	-----	15.1	-----	14.3	14.9	16.3	14.8	16.1	18.1	15.3	16.3	17.8	16.4	19.5	25.2						
Entrenchment Ratio	-----	1.3	1.6	2.0	2.0	3.5	5.0	4.9	5.1	5.3	4.2	4.7	5.1	4.0	4.5	5.0	3.2	4.4	5.3						
Bank Height Ratio	-----	1.1	1.1	1.2	-----	1.0	-----	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.4	2.1						
Bankfull Velocity (fps)	-----	-----	-----	-----	-----	4.6	-----	----	3.4	----	----	3.0	----	----	3.2	----	----	3.2	----						
Pattern																									
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----						
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----						
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----						
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----						
Profile																									
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	24	27	33	23	26	27	23	26	28	23	26	28						
Riffle Slope (ft/ft)	-----	0.136	0.152	0.167	0.048	0.101	0.153	0.058	0.075	0.102	0.044	0.094	0.120	0.047	0.086	0.118	0.041	0.087	0.113						
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	3	4	6	3	7	7	4	6	10	5	7	9						
Pool Spacing (ft)	-----	42	99	157	5	27	48	8	27	41	8	26	47	8	29	55	8	28	52						
Substrate and Transport Parameters																									
d16 / d35 / d50 / d84 / d95	-----	5.6/9.5/11/100/200				-----		6.8/19/28/78/150			.7/39/53/113/180			6.7/43/64/143/271			29/55/77/145/220				-----			-----	
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----						
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----						
Additional Reach Parameters																									
Channel length (ft)	-----	-----	-----	-----	-----	466	-----	-----	467	-----	-----	467	-----	-----	467	-----	-----	467	-----						
Drainage Area (SM)	-----	0.13	0.87	1.60	-----	0.18	-----	-----	0.18	-----	-----	0.18	-----	-----	0.18	-----	-----	0.18	-----						
Rosgen Classification	-----	-----	B4a	-----	-----	B3	-----	-----	B3	-----	-----	B3	-----	-----	B3	-----	-----	B3	-----						
Bankfull Discharge (cfs)	27	-----	-----	-----	20	30	40	----	24	----	----	24	----	----	24	----	----	24	----						
Sinuosity	-----	-----	1.10	-----	----	1.10	----	-----	1.05	-----	-----	1.07	-----	-----	1.05	-----	-----	1.05	-----						
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	0.090	-----	-----	0.088	-----	-----	0.092	-----	-----	0.093	-----						

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 (feet above bankfull)
			UT3 (Reach 2)
MY 1 (January 6, 2012	April 8th, 2011 (crest gauge installation for asbuilt) January 6, 2012	Gauge measurement	0.15
MY 2 (February 6, 2013)	January 6, 2012 – February 6, 2013	Gauge measurement	0.22
MY 3 (January 20, 2014)	February 6, 2013-January 20, 2014	Gauge measurement	0.16

APPENDIX F

PROJECT PROBLEM AREAS

FIGURE 3 – VEGETATION PROBLEM AREAS CCPV

TABLE 11 – VISUAL MORPHOLOGICAL STABILITY ASSESSMENT

TABLE 12 – VEGETATION PROBLEM AREAS

EXHIBIT 6 – VEGETATION PROBLEM AREAS PHOTOLOG

LEGEND

- CONSERVATION EASEMENT
- DESIGNED CENTERLINE
- DESIGNED STREAM BANK
- CROSS SECTION
- PHOTO POINT

PROJECT CONDITION

- VEG PLOT CRITERIA MET
- VEG PLOT CRITERIA UNMET (NO PLOTS CURRENTLY MEETING THIS CRITERIA)
- VEGETATION PROBLEM AREA (VPA) (BARE FLOOD PLAIN)
- STREAM PROBLEM AREAS (NO STREAM PROBLEM AREAS)

IMAGE SOURCE: NC STATEWIDE ORTHOIMAGERY, 2010

SNOWBIRD UT3 REACH 2
CURRENT CONDITION
PLAN VIEW
YEAR 3 MONITORING

25 0 25 50

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 3
STREAM PROBLEM AREAS

Ecosystem Enhancement Program

Prepared for:
Ecosystem Enhancement Program
2728 Capitol Blvd, Suite 1H 103
Raleigh, NC 27604
Phone 919-715-0476
Fax: 919-715-2219

EEP Project No.
92764

Baker Project No.
113112

Date:
2/5/2014

DESIGNED: JPM
DRAWN: MDR
APPROVED: MMC

Monitoring Year:
3 of 5

Table 11. 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 Perfomance 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	**100%**
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	**100%**
C. Thalweg[1]	1. Upstream of pool (structure) centering?	36	36	N/A	100	
	2. Downstream of pool (structure) centering?	36	36	N/A	100	**100%**
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	**N/A**
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	**100%**
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	0/0	100	**100%**
G. Rock/Log Drop Structures[2]	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	**99%**
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	**N/A**

[1] 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.

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

Table 12. Vegetation Problem Areas Snowbird Creek Tributaries Mitigation Project: Project No. 92764			
UT2 Reach 2 (171 LF)			
Feature Issue	**Station No.**	**Suspected Cause**	**Photo Number**
Bare Floodplain	0+10 to 1+40 (left floodplain)	Easement encroachment by vehicles accessing existing forest road located further upstream of project reach limits. Baker is coordinating with the contractor and land owner to create an alternate vehicle access located outside the easement to avoid further encroachment. The impacted buffer within the easement will be reseeded and replanted during construction of the alternate vehicle access.	VPA1

EXHIBIT 6 – Vegetation Problem Area (VPA) Photos

VPA1 – Easement encroachment/buffer impact from access road paralleling the upstream limits of UT3-Reach 2 (looking downstream from left floodplain)

VPA1 – Easement encroachment/buffer impact from access road paralleling the upstream limits of UT3-Reach 2 (looking upstream from left floodplain)