Elk Branch Restoration Project

Baseline Monitoring Document and As-built Baseline Report

Mitchell County, North Carolina

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EXECUTIVE SUMMARY

The Elk Branch 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 base-line, as-built monitoring data for the five-year monitoring period. The goals for the restoration project were as follows:

- Restoration or enhance headwater tributaries to Cane Creek and the French Broad Basin;
- Reduce sediment and nutrient loading through restoration of riparian areas and streambanks;
- Improve and restore hydrologic connections between the project streams and the floodplain;
- Create geomorphically stable conditions on the Elk Branch project site; and
- Improve aquatic and terrestrial habitat along the project corridor.

To accomplish these goals, the following objectives were implemented:

- Restore the existing trampled, straightened and relocated streams by creating stable channels with adequate grade control and access to the floodplain;
- Establish buffers for nutrient removal from runoff and stabilization of streambanks to reduce bank erosion;
- Improve in-stream habitat by reducing fine sediment loading from the watershed, provide a more diverse bedform with riffles and pools, create deeper pools, develop areas that increase oxygenation, provide woody debris for habitat, and reduce bank erosion; and
- Improve terrestrial habitat by planting riparian areas with native vegetation and protect these areas with a permanent conservation easement and fencing, 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.

Elk Branch and its tributaries (UT1 and UT2), were impaired by historical and recent land management practices, which included timber harvesting, channelization, livestock grazing, and pasture land for horses. During development of the land for agricultural use, most woody riparian vegetation was removed. Prior to the restoration project, livestock had open access to parts of all of the project streams (Elk Branch and its tributaries UT2 and UT1). Over time, these land disturbances have contributed sediment and nutrient loading to Cane Creek and the North Toe River.

This Baseline Monitoring Document presents data on stream geometry, crest gauge installation and stem count data from vegetation monitoring stations. Project construction was completed in June 2011, with most baseline monitoring occurring in July 2011. Baseline vegetation monitoring was completed in January 2012 after woody stems were planted on-site. Subsequent monitoring reports will relate any deviances to these baseline measurements and will use comparative analyses to assess and predict project success using established success monitoring criteria.

The design proposed for the Elk Branch mitigation project involved Restoration (Priority 1 & 2) and Enhancement approaches. Restoration and Enhancement work were completed in accordance with the approved design approach provided in the mitigation plan for this site. The project should ultimately result in stable Cb and Eb-type channels for Elk Branch, UT1 and UT2. Based on data collected and presented in this report, this Site is currently on track to meet the stream geometry, hydrologic, and planting success criteria specified in the Elk Branch Mitigation Plan with the caveat discussed below.

Preliminary vegetation data suggests a lower-than-desired stem density in some portions of the project area. Our assessment is that the contractor has planted at a density of approximately 537 stems per acre (9x9’ spacing), which is acceptable, but less than intended (8x8’ spacing). During processing of the data, it was determined that the shape and orientation of vegetation monitoring plots misrepresent the true planting density. During Monitoring Year 1, Baker proposes to conduct additional stem count studies in the easement area where existing plot data suggests low density. If unacceptably low stem densities are measured, all deficient areas will be planted with additional bare roots using the planting list for this project.

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Tables and Exhibits **Appendix**

1.0 PROJECT GOALS, BACKGROUND, AND ATTRIBUTES

The Elk Branch mitigation site is situated in the French Broad River Basin, within North Carolina Division of Water Quality (NCDWQ) sub-basin 04-03-06 and United States Geologic Survey (USGS) hydrologic unit 06010108040010. The watershed in which the Elk Branch mitigation project is located is dominated by forested land use, but also contains pasture and residences. Slightly less than two-thirds of the watershed is in forested cover, leaving about one-third of the drainage in some form of pasture land or other agricultural or residential use. Elk Branch and its tributaries have been impaired by historical and recent land management practices that include timber harvesting, pasture conversion, channelization, and livestock grazing. Prior to restoration, stream channelization and channel dredging were evident through much of the project site as was the impacts of open stream access by cattle and horses. A significant loss of woody streambank vegetation also occurred during the development of the land for agricultural use. Over time, these practices have contributed excessive sediment and nutrient loading to Elk Branch, Cane Creek and ultimately to the North Toe River, home to the endangered Appalachian elktoe mussel.

The project involved restoration or enhancement of 2,228 linear feet (LF) primarily along three on-site streams: Elk Branch and two unnamed tributaries (UT1 and UT2). In addition, a third tributary (UT3) segment was also restored by day-lighting the tributary and the easement boundary and restoring it to its confluence with Elk Branch. Elk Branch is shown as a solid blue-line stream while spring-fed tributaries UT1 and UT2 are apparent from the topography, but are not displayed on the USGS topographic quadrangle map for the site. All three streams were confirmed as being perennial based on field evaluations using the NCDWQ stream assessment protocol.

1.1 Restoration Summary

1.1.1 Location and Setting

The Elk Branch project site is located about one mile northeast of Bakersville in Mitchell County, North Carolina (Figure 1 in Appendix A). To reach the project site, follow I-26 North from Asheville for approximately 20 miles and take U.S. Highway 19N Exit 9, towards Burnsville and Spruce Pine. Continue along U.S. Highway 19 (which becomes 19-E), for 25 miles. Turn left onto N.C. Highway 226 and continue until you reach the Town of Bakersville. Once in Bakersville, turn right (northeast) onto North Mitchell Avenue and after approximately a half mile, North Mitchell Avenue turns into Cane Creek Road. Continue another 0.7 miles, then turn left off of Cane Creek Road onto Nora Lane (SR 1219). The project site begins just below a spring head at the head of the valley, approximately 1,500 feet beyond the end of Nora Road (paved).

1.1.2 Project Goals and Objectives

The goals for the Elk Branch restoration project are as follows:

- Restore or enhance headwater tributaries to Cane Creek and the French Broad Basin;
- Reduce sediment and nutrient loading through restoration of riparian areas and streambanks;
- Improve and restore hydrologic connections between the creek and floodplain;
- Create geomorphically stable conditions on the Elk Branch project site; and
- Improve aquatic and terrestrial habitat along the project corridor.

To accomplish these goals, the following objectives were fulfilled:

- Restore the existing trampled, straightened and relocated streams by creating stable channels with adequate grade control and access to the floodplain;
- Establish buffers for nutrient removal from runoff and stabilization of streambanks to reduce bank erosion;

- Improve in-stream habitat by reducing fine sediment loading from the watershed, provide a more diverse bedform with riffles and pools, create deeper pools, develop areas that increase oxygenation, provide woody debris for habitat, and reduce bank erosion; and
- Improve terrestrial habitat by planting riparian areas with native vegetation and protect these areas with a permanent conservation easement and fencing, 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.

1.1.3 Project Structure, Restoration Type, and Approach

1.1.3.1 Project Structure

Please refer to Table 1 in Appendix A for a summarization of the project structure of Elk Branch. Figure 2, also in Appendix A, illustrates restoration approaches by project reach.

1.1.3.2 Restoration Type and Approach

Elk Branch (Reach 1)

The channel elevation was raised using a Priority 1 Restoration approach on Reach 1 of Elk Branch to eliminate high bank height ratios, reroute the channel away from erosional areas and create a stable step-pool channel appropriate to the valley. Vertical and lateral stability was achieved by constructing step-pool sequences with a series of grade control structures. These structures dissipate energy vertically, decreasing pool spacing while improving the overall quality of pool habitat. During the course of reconstruction, headcuts propagating up the channel were remedied, floodplain connectivity was restored and channel dimension was altered to stabilize vertical and eroding banks, and the existing channel alignment was altered to move the channel off of the toe of the valley wall.

Elk Branch (Reach A)

An Enhancement Level I approach was used to continue the stable step-pool channel downstream of Reach 1, through Reach A and the remainder of the project reaches, on Elk Branch. Because the channel moves away from the valley wall in this reach, pattern was not as much of a concern as was achieving vertical and lateral channel stability by restoring access to the floodplain, improving bank stability through modification of channel dimension and using grade control structures to dissipate the energy of the stream vertically while improving bedform. Fencing was installed to prohibit livestock access. The riparian buffer that establishes should provide runoff and pollutant reduction from adjacent grazed areas.

Elk Branch (Reach B)

A Priority 1 Restoration approach was used on Reach B of Elk Branch. Like Reach 1, pattern adjustments were warranted to remove the stream away from the valley wall. Dimension and profile adjustments were implemented in a manner similar to the upstream restoration and enhancement reaches. This reach was previously being mowed up to the stream's edge and will now be left to grow up and increase the shading and buffering capacity of the riparian vegetation.

Elk Branch (Reach 2)

An Enhancement Level I approach was used to implement dimension and profile modifications; pattern was not considered as big of an issue as the channel is well away from the valley wall at this point in the project area. In this valley, the channel type was such that pattern was not a driving design element. Channel profile and dimension continued to be the primary focus of restoration efforts given the presence of headcuts, unstable streambanks and poor bedform in Reach 2. Floodplain connectivity and bank stability were restored in this

reach through a modified channel dimension; grade control structures were used to prevent future headcuts while improving riffle and pool habitat. This reach was previously being mowed up to the stream's edge and will now be left to grow up and increase the shading and buffering capacity of the riparian vegetation.

UT 1

UT1 confluences with Elk Branch downstream of the restoration and enhancement efforts on the branch. UT1 had been severely impacted by channelization and livestock, including on-going horse and goat access. Using a Priority 1 Restoration approach, a steep valley headwater channel (Cb-type) was constructed to restore a step-pool morphology appropriate to this steep headwater valley. The tributary was near absent of bedform diversity and was experiencing widespread erosion, and also segments of aggradation, and subsequent channel invasion by exotic grasses. Step-pool structures were used to help dissipate energy vertically, promote a diverse bedform with increased habitat diversity. Bank stability and floodplain access were improved by restoring adequate channel dimension. Fencing was installed to prohibit livestock access. The riparian buffer that establishes should provide runoff and pollutant reduction from adjacent grazed areas.

UT2

A Priority 1 Restoration approach was used to bring UT2 back to the surface as it previously flowed underground as a result of human disturbance. The new Cb-type channel (based in part on a less disturbed reach of this channel upstream), was constructed with a stable dimension, pattern and profile. Grade control structures like those used throughout the remainder of the project area were implemented to help restore the channel which now has access to the floodplain. Fencing was installed to prohibit livestock access. The riparian buffer that establishes should provide runoff and pollutant reduction from adjacent grazed areas.

UT3

A Priority 1 Restoration approach was used to day-light UT3 at the easement boundary and use bank grading, matting, and structure installation to reestablish the tributary as an open-water resources within the easement. Efforts on UT3 are shown below as they are not represented in the photo points or geomorphic plots.

Exotic invasive removal and re-planting with native vegetation was conducted on all project reaches to restore or enhance existing buffer widths with woody and herbaceous vegetation native to the ecoregion.

Some modifications in the restoration approach were made during construction. The primary modifications are described in Table 1 below. Changes were implemented in order to minimize

impacts to existing resources and adapt to unmapped or changed field conditions including micro-topography, vegetation, and existing in-stream grade control. Changes that were made to the construction sequence, beyond weather-related scheduling modifications, are documented in the summary table below. The final as-built stream length for the project, as indicated in Table A1, is 3,159 LF (Appendix A).

Table 1. Project Construction Modifications
Elk Branch Mitigation Project-NCEEP Project #92665

Nature of Modification	Stationing	Comment
Elk Mainstem-Profile adjustment	8+00-9+00	Increased drop over structures to maintain overall channel slope desired.
Elk Mainstem-Pattern adjustment	17+50-18+00	Minor pattern adjustment to avoid large, mature trees
UT1- Structure addition	6+00-6+83	Addition of two drop structures to adjust profile to tie in with existing, incised channel on property of landowner who dropped out of project.
UT2-Profile adjustment	2+00-2+50	Raised channel profile to match top of bank with existing ground.
UT3	0+00-0+36	Day-lighted stream that was in pipe, not shown on plans

1.1.4 Project History, Contacts and Attribute Data

The general area in which the project is located is rural in character, and is not likely to change significantly in the foreseeable future. The project area primarily drains forested and some agricultural land. The largest percentage of land in the watershed is currently forest and shrub (63%), which serves as cover for wildlife as well as providing for timber production. Agricultural lands make up 33% of the watershed with these lands supporting hay production, Christmas tree farming, grazing lands and row crops. The project watershed also supports a low density of residential sites (4%).

Anthropogenic land use alteration, such as deforestation, channelization of streams for agricultural purposes, and prolonged open stream access to livestock has resulted in various stream corridor impairments. Stream channel incision, bank destabilization and erosion, loss of in-stream and riparian habitat, and loss of shading and buffering capacity functions were present throughout the project area.

In accordance with the approved mitigation plan for the site, construction activities began in May 2011. Project activity on Elk Branch Reach 1, Reach B, UT1, UT2, and UT3 consisted of making adjustments to channel dimension, pattern, and profile typically using a Priority 1 Restoration approach. A Level I Enhancement approach was used on Elk Branch Reaches A and 2 to re-establish adequate channel dimension for bank stability and floodplain access, while recreating a stable channel profile and bedform using a step-pool restoration approach that features grade control structures and constructed riffles.

Stream dimensions were adjusted to eliminate vertical banks and erosion resulting from excessive shear stress and lack of floodplain relief. Streambanks were stabilized using a combination of erosion control matting, bare-root planting, transplants, and live staking. Transplants will provide living root mass quickly to increase streambank stability and create shaded holding areas for fish and aquatic biota. Where feasible, plan form adjustments were made to correct prior channelization by making slight adjustments to channel pattern (step-pool channels have a low sinuosity, so stream pattern is not a critical component of stream stability). These modifications will allow flows larger than bankfull to spread onto the restored floodplain, dissipating flow energies and reducing streambank stress. Native vegetation was planted across the site, and the entire mitigation site is protected through a permanent conservation easement.

The creation of a step-pool channel profile was used to achieve vertical stability and eliminate self-propagating headcuts previously found within the site. This was a primary means to promote improved stability, water quality, and habitat goals. In-stream structures (constructed riffles, boulder steps, log vanes, log drops, and log rollers) were used to control streambed grade, reduce stresses on streambanks, and promote diversity of bedform and habitat. Structures were spaced at a distance that resulted in the downstream header protecting the upstream footer to create a redundancy that will ensure long term vertical stability.

Appendix A provides the following required information: The chronology of the Elk Branch mitigation project (Table A2), the contact information for designers, contractors and plant material suppliers (Table A3), and the relevant project background information (Table A4). Total as-built stream length across the project is 3,159 LF.

2.0 SUCCESS CRITERIA

The five-year monitoring plan for the Elk Branch mitigation project includes criteria to evaluate the success of the vegetation and stream components of the project. The specific locations of vegetation plots, permanent cross-sections, reference photo stations and crest gauges are shown on the as-built plan sheets.

2.1.1 Morphologic Parameters and Channel Stability

Geomorphic monitoring of restored stream reaches will be conducted over the next five years to evaluate the effectiveness of the restoration practices installed. Monitored stream parameters include bankfull flows, stream dimension, profile, pattern (to a lesser degree for reasons noted below), and photographic documentation. The methods used and any related success criteria are described below for each parameter. For monitoring stream success criteria, eleven permanent cross-sections, six longitudinal profile sections and two crest gauges were installed.

2.1.1.1 Dimension

Eleven permanent cross-sections were installed to help evaluate the success of the mitigation project and measured data are provided in Appendix B. Permanent cross-sections were established throughout the project site as follows: five cross-sections were located on Elk Branch, four cross-sections were located on UT1 and two cross-sections were located on UT2. Cross-sections selected for monitoring were located in representative riffle and pool reaches, and each cross-section was marked on both banks with permanent pins to establish the exact transect used. A common horizontal and vertical reference will be used for cross-sections and consistently referenced to facilitate comparison of year-to-year data. The cross-sectional surveys will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections are classified using the Rosgen Stream Classification System.

Although minor changes are not uncommon, there should not be any significant changes in the as-built cross-sections. If changes do take place, they will be evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). At this time, cross-sectional measurements do not indicate any streambank or channel stability issues.

2.1.1.2 Pattern and Longitudinal Profile

A longitudinal profile was completed for the entire project length of Elk Branch, UT1 and UT2 to provide a baseline for evaluating changes in channel bed conditions over time. Longitudinal profiles will be replicated annually during the five year monitoring period. Longitudinal profile data are provided in Appendix B.

Measurements taken during longitudinal profiles include thalweg, water surface, and the left and right tops of 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 reflect stable channel bedform and a diverse range of riffle and pool complexes.

All measurements will be taken at the head of each feature (e.g., riffle, run, pool, or glide) and at the maximum pool depth. Elevations of grade control structures will also be included in longitudinal profiles surveyed. Surveys will be tied to permanent horizontal and vertical control. The longitudinal profiles show that the bed features are stable. Where the channel slopes are steeper, closely-spaced grade control structures should help maintain the overall profile desired and there was no notable bank erosion observed as a result of the channel profile adjustments.

Although pattern adjustments were made, Elk Branch and its tributaries are primarily Cb-type streams characterized by step-pool sequences, and increased sinuosity is not a design goal, nor a typical characteristic of this channel type. Pattern information is not provided in Appendix B, as is information is generally only provided for meandering, alluvial channels. Nevertheless, as the site is monitored, reaches will be evaluated for significant changes in pattern and any changes warranting repair work will be discussed in future monitoring reports.

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 gradation that occur over time as the stream adjusts to upstream sediment loads. Significant changes in sediment gradation will be evaluated with respect to stream stability and watershed changes. As-built surveys do not reveal any significant areas of aggradation or degradation within the project area at this time. Pebble count data is in Appendix B.

2.1.2 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. In order to determine if the criteria are achieved, six vegetation monitoring quadrants were installed across the restoration site. The size of individual quadrants vary from 100 square meters for tree species to 1 square meter for herbaceous vegetation. Vegetation monitoring will occur in spring, after leaf-out has occurred, or in the fall prior to leaf fall. Individual quadrant data will be provided and will include diameter, height, density, and coverage quantities. Relative values will be calculated, and importance values will be determined. Individual seedlings will be marked to ensure that they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

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

The interim measure of vegetative success for the site will be the survival of at least 320, planted trees per acre at the end of Year 3 of the monitoring period. The final vegetative success criteria will be the survival of 260, planted trees per acre at the end of Year 5. If the measurement of vegetative density proves to be inadequate for assessing plant community health, additional plant community indices may be incorporated into the vegetation monitoring plan as requested by EEP.

Temporary seeding applied to streambanks beneath the erosion matting sprouted within two weeks of application and has provided good ground coverage. Live stakes and bare root trees planted are also providing streambank stability. Bare-root trees were planted throughout the conservation easement with the exception of the preservation reach. A minimum 60-foot-wide conservation easement was established along the project streams during initial design (this is in addition to the stream width). After final design, a buffer width of 30 feet on either side of the stream was achieved in most areas. In some areas, regulatory comments or ultimate field design changes resulted in a varying buffer widths. In general, bare-root vegetation was planted at a target density of 537 stems per acre, in a 9-foot by 9-foot grid pattern. Planting of bare-root trees was completed in January 2012. Species planted are listed below.

Table 2. Riparian Buffer Plantings
Elk Branch Mitigation Project- NCEEP Project #92665

Common Name	Scientific Name	% Planted by Species	Planting Density
Acer rubrum	Red Maple	10%	200
Betula nigra	River Birch	5%	100
Carpinus caroliniaun	Ironwood	5%	100
Carya ovata	Shagbark Hickory	5%	100
Cornus florida	Flowering Dogwood	5%	100
Diospyros virginiana	Persimmon	5%	100
Lindera benzoin	Spicebush	5%	100
Liriodendron tulipfera	Tulip Poplar	5%	100
Nyssa sylvatica	Blackgum	5%	100
Platanus occidentalis	Sycamore	10%	200
Quercus alba	White Oak	5%	100
Quercus rubra	Red Oak	5%	100
Understory/Shrub Species			
Alnus serrulata	Tag Alder	14%	300
Calycanthus floridus	Sweetshrub	14%	300
Sambucus canadensis	Elderberry	5%	100
Riparian Livestake Plantings			
Cornus amomum	Silky Dogwood	40%	1000
Salix sericea	Silky Willow	30%	750
Salix nigra	Black Willow	10%	250
Sambucus canadensis	Elderberry	20%	500

The restoration plan for the Elk Branch Site specifies that the number of 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. A total of six vegetation plots, each 5 by 20 meters or 10 by 10 meters in size, were established across the restored site. The initial planted density within each of the vegetation monitoring plots is given in Table C7, Appendix C. The average density of planted bare root stems (based on the data from the six monitoring plots), is 432 stems per acre which indicates that the Site is on track for meeting the minimum success interim 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. Based on the plot data collected, one plot is not currently meeting the success criteria. The lower density recorded is likely attributable to the orientation in which bare roots were planted in relation to the layout of this 5x20' vegetation plot, and the measurement of stem offsets (9'x 9' for this project). As noted in the Executive Summary, Baker proposes to conduct additional stem count studies in the easement area where existing plot data suggests low density during Monitoring Year 1. If stem density also appears low in the unofficial plots, the area will be planted with additional bare roots; tree selection will be based on the planting list for this project. The locations of the vegetation plots are shown on the as-built plan sheets.

2.1.3 Hydrology

2.1.3.1 Streams

The occurrence of bankfull events within the monitoring period will be documented by the use of crest gauges and photographs. Crest gauges were installed on the floodplain at bankfull elevation. One crest gauge was placed near the end of Reach 2 of Elk Branch while another gauge was set up near the end of the project area on UT1 to Elk Branch. The crest gauges 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 each 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.

2.1.4 Photographic Documentation of Site

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

2.1.4.1 Lateral Reference Photos

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

2.1.4.2 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.

Photographs will be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, structure function and stability, and effectiveness of erosion control measures subjectively. 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.

2.2 Areas of Concern

At this time, there are no areas of concern. As noted in Section 2.1.2 and the Executive Summary, supplemental planting of the site will occur during Monitoring Year 1 if additional vegetation studies indicate stem density is insufficient to meet the vegetation success criteria set forth in this report across the entire site.

3.0 MAINTENANCE AND CONTINGENCY PLANS

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

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

Maintenance issues and recommended remediation measures will be detailed and documented in this and future monitoring reports. Factors that may have caused any maintenance needs, including any of the conditions listed above, shall be discussed. NCEEP approval will be obtained prior to any remedial action.

APPENDIX A
GENERAL TABLES AND FIGURES

LOCATION MAP AND PROJECT COMPONENT MAP
TABLES 1-4

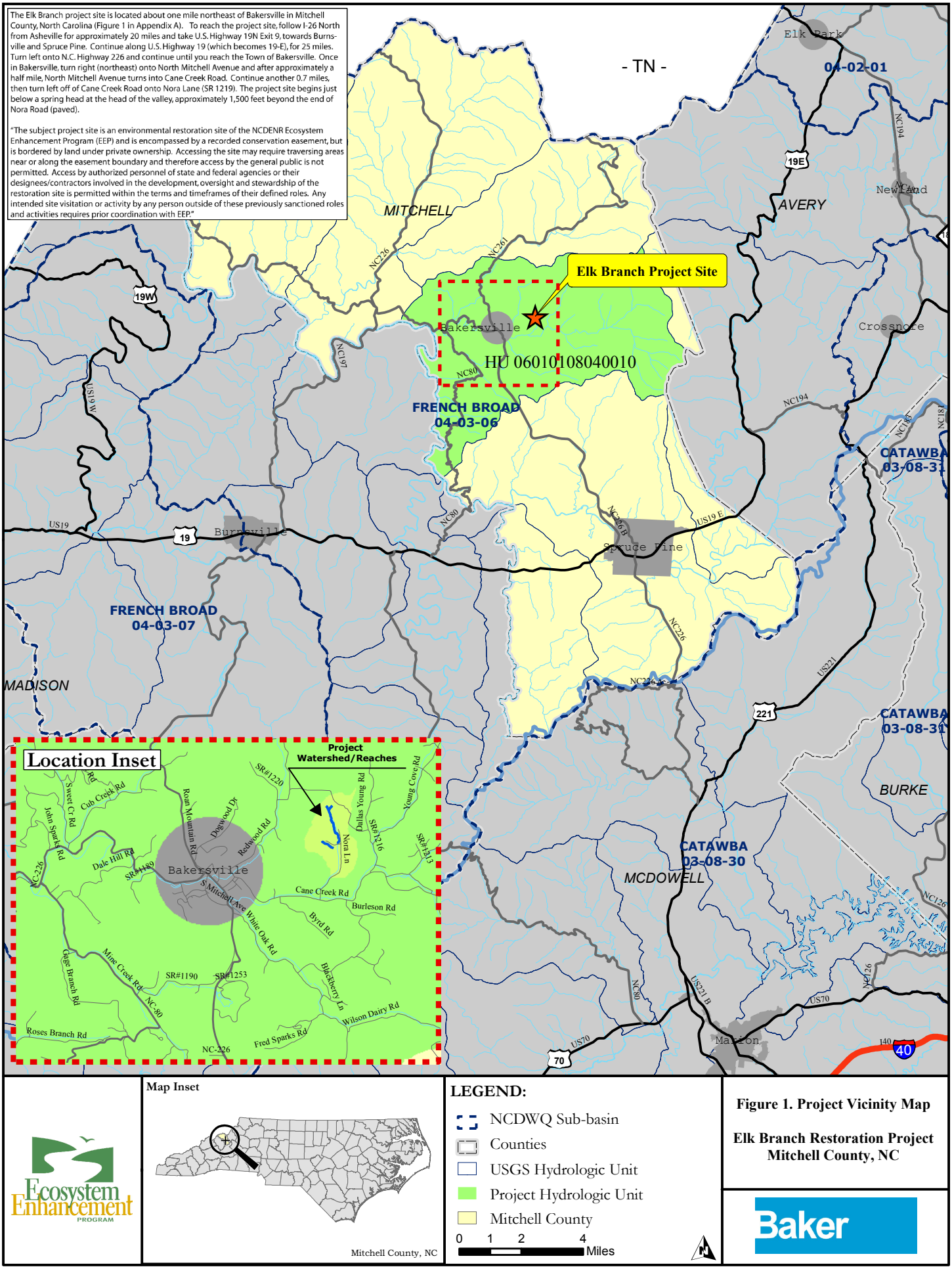


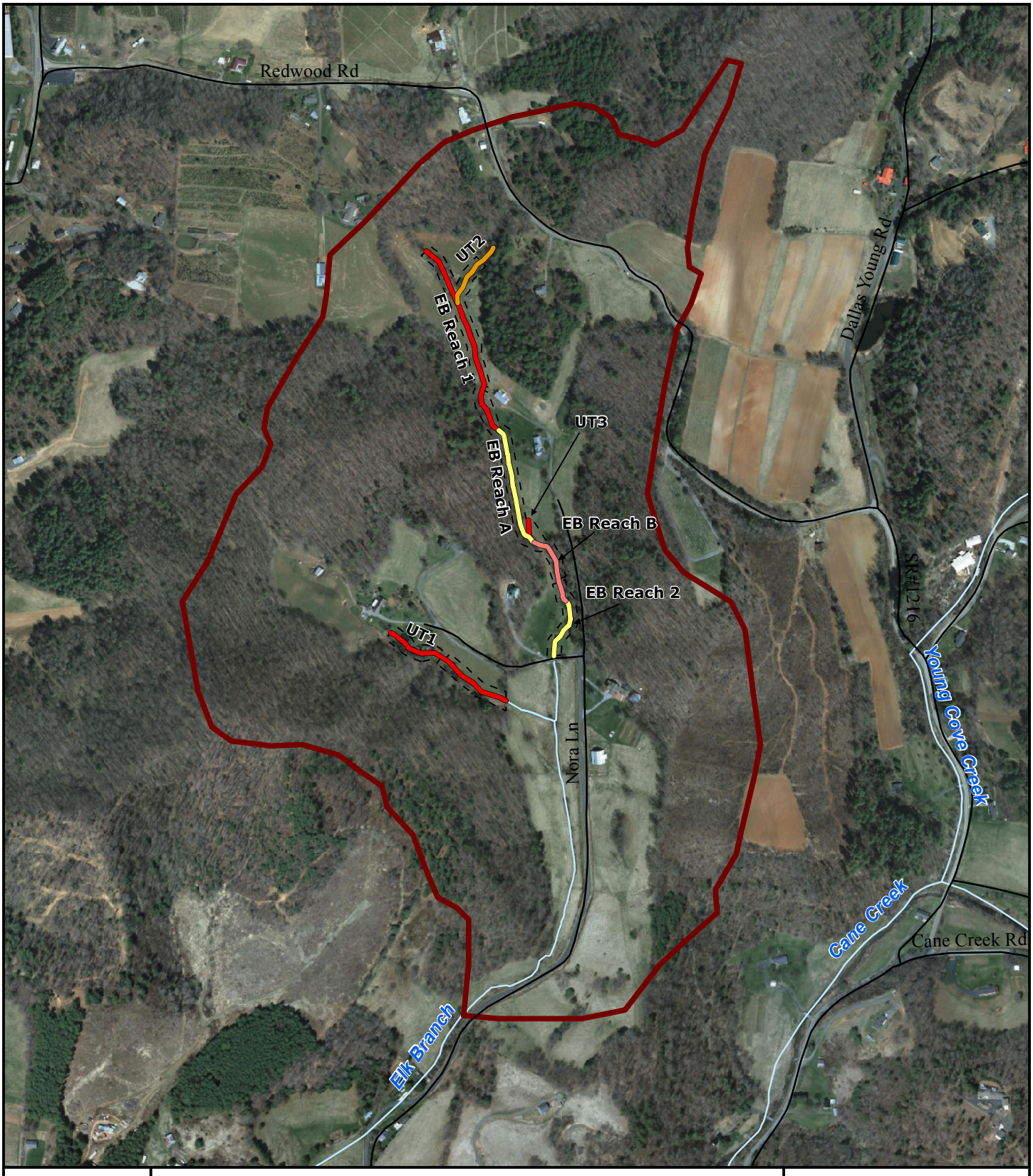
Figure 1. Project Vicinity Map

Elk Branch Restoration Project
Mitchell County, NC

Figure 1. Notes

The Elk Branch project site is located about one mile northeast of Bakersville in Mitchell County, North Carolina, North Carolina. To reach the project site, follow I-26 north from Asheville for approximately 20 miles and take U.S. Highway 19N Exit 9, towards Burnsville and Spruce Pine. Continue along U.S. Highway 19 (which becomes 19-E), for 25 miles. Turn left onto N.C. Highway 226 and continue until you reach the Town of Bakersville. Once in Bakersville, turn right (northeast) onto North Mitchell Avenue and after approximately a half mile, North Mitchell Avenue turns into Cane Creek Road. Continue another 0.7 miles, then turn left, off of Cane Creek Road onto Nora Lane (SR 1219). The project site begins just below a spring head at the head of the valley, approximately 1,500 feet beyond the end of Nora Lane (paved).

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.



LEGEND:

Proposed Project Component
- Enhancement 1
- Priority 1 Restoration
- Priority 2 Restoration
- Priority I & 2 Restoration

- Proposed Easement Boundary
- Streams
- Watershed Boundary

0 200 400 800 Feet

Ecosystem Enhancement Program

Figure 2. As-built Project Components

Elk Branch Restoration Project
Mitchell County, NC

Baker

Table A1. Project Components
Elk Branch Mitigation Project-NCEEP Project #92665

Project Segment or Reach ID	Existing Feet/ Acres	Mitigation Type	Approach	Target Stream Type	Footage or Acreage	Mitigation Ratio	Mitigation Units	Stationing	Comment
Elk Branch									
Reach 1	2,020 LF	R	P1	Cb4	951 LF	1.0:1	951	0+76-10+50	Adjust pattern, improve dimension by removal of vertical banks and increased floodplain connectivity, and restore step-pool channel via grade control and constructed riffles.
Reach A		E	LI		592 LF	1.5:1	395	10+50-16+42	Restore stable dimension to halt erosion and add grade control to improve pools. Grade control structures will provide long-term channel stability and improve instream habitat.
Reach B		R	P1/2		403 LF	1.0:1	403	16+42-20+60	Adjust pattern, improve dimension by removal of vertical banks and increased floodplain connectivity, and restore step-pool channel via grade control and constructed riffles.
Reach 2	279 LF	E	LI		279 LF	1.5:1	186	20+60-23+39	Restore stable dimension to halt erosion and add grade control to improve pools. Grade control structures will provide long-term channel stability and improve instream habitat.
UT1									
Reach 1	685 LF	R	P1	Cb4	656 LF	1.0:1	656	0+06-6+83	Restore channel-floodplain connectivity of previously channelized tributary. Adjustments also made to pattern and profile to eliminate eroding streambanks and improve habitat diversity. Invasive vegetation also removed; riparian buffer restored.
UT 2									
Reach 1	185* LF	R	P1	Eb4	242 LF	1.0:1	242	0+92-3+34	Excavate previously buried section of UT2. New channel constructed with stable dimension, pattern, and profile. Priority 1 approach also applied to existing segment of UT2 to improve channel and bank stability, as well as increased access to the floodplain. Trash and debris were removed. *buried portion not included in existing length
UT 3 (New component, not in restoration plan)									
Reach 1	0 LF	R	P1	Cb4	36 LF	1.0:1	36	0+00-0+36	Daylight previously piped section of UT3 at the easement boundary and run into Elk Branch Reach B with bank sloping and matting and structure for grade control.

Mitigation Unit Summations

Stream (LF)	Riparian Wetland (Ac)	Nonriparian Wetland (Ac)	Total Wetland (Ac)	Buffer (Ac)	Comment
2,869	NA	NA	NA		

Notes: Elk Branch Reach 1 was broken out into smaller reaches subsequent to the submittal and approval of the restoration plan.

Table A2. Project Activity and Reporting History **Elk Branch Mitigation Project-NCEEP Project #92665**		
Activity or Report	**Data Collection Complete**	**Completion or Delivery**
Restoration Plan		December 2009
Final Design-90%		December 2009
Construction		June 2011
Temporary S&E mix applied to entire project area		June 2011
Permanent seed mix applied to project site		June 2011
Installation of crest gauges		July 2011
Plantings set out	January 2012	January 2012
Mitigation Plan / As-built (Year 0 Monitoring – baseline)	July 2011/January 2012	April 2012 (Draft)
Year 1 Monitoring		
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		

Table A3. Project Contacts Table **Elk Branch Mitigation Project-NCEEP Project #92665**	
Principal-In-Charge	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201, Asheville, NC 28806 Contact: Micky Clemmons, Tel. 828.350.1408 x2002
Designer	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201, Asheville, NC 28806 Contact: Jake McLean, Tel. 828.350.1408 x2007
Construction Contractor	
River Works, Inc.	8000 Regency Parkway, Suite 200, Cary, NC 27511 Contact: Will Pedersen, Tel. 919.459.9001
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: Carmen McIntyre, Tel. 828.350.1408 x2010

Table A4. Project Attribute Table Elk Branch Mitigation Project-NCEEP Project #92665	
Project County	Mitchell County, NC
Physiograhic Region	Blue Ridge
Ecoregion	Blue Ridge Mountains-Southern Crystalline Ridges and Mountains
Project River Basin	French Broad
USGS HUC for Project	6010108040010
NCDWQ Sub-basin for Project	04-03-06
Within extent of EEP Watershed Plan?	In a TLW (French Broad River Basin Priorities Report-2009)
WRC Class	Cold
% of Project Easement Fenced or Demarcated	100% (~60% fenced, 40% demarcated)
Beaver Activity Observed During Design Phase?	No
Drainage Area (Square Miles)	
Elk Branch Reach 1	.07 mi^2
Reach A	
Reach B	
Elk Branch Reach 2	.14 mi^2
UT1	.06 mi^2
UT2	.01 mi^2
Stream Order	Elk Branch- 1st UT1-Zero, UT2-Zero
Restored Length	
Elk Branch Reach 1	951 LF
Reach A	592 LF
Reach B	403 LF
Elk Branch Reach 2	279 LF
UT1	656 LF
UT2	242 LF
UT3	36 LF
Perennial or Intermittent	Perennial
Watershed Type	Rural (Predominantly Forested)
Watershed LULC Distribution (Percent area)	
Forest	57%
Shrub	6%
Pasture/Crops	33%
Developed Open Space	4%
Drainage Impervious Cover Estimate (%)	<10%
NCDWQ AU/Index #	7-2-59-8
303d Listed	No
Upstream of 303d Listed Segment	No

Table A4. Project Attribute Table **Elk Branch Mitigation Project-NCEEP Project #92665**				
Reasons for 303d Listing or Stressor	-			
Total Acreage of Easement	9.46			
Total Vegetated Acreage w/in Easement	Easement vegetated with exception of stream channel and a ford crossings within an easement breaks			
Total Planted Acreage within the Easement	~4 Acres (remainder already forested)			
Rosgen Classification (Pre-existing)				
Elk Branch	Cb/B/G/Eb			
UT1	Fb			
UT2	B			
UT3	Piped			
Rosgen Classification of As-built				
Elk Branch-Reach 1	Cb4			
Reach A	Cb4			
Reach B	Cb4			
Elk Branch-Reach 2	Cb4			
UT1	Cb4			
UT2	Eb4			
UT3	Cb4			
Valley Type	II			
Valley Slope	.03 (Elk Branch), .04 (UT1), .04 (UT2)			
Valley Side Slope Range	n/a			
Valley Toe Slope Range	n/a			
Trout Waters Designation	Yes (Elk Branch is a tributary to designated trout waters)			
Species of Concern	No			
Dominant Soil Series and Characteristics	Bandana/ Fannin/Saunook-Thunder/Saunook			
	Depth (in.)	% Clay	K Factor	T Factor
Elk Branch Reach 1	>60”	7-20/12-27, 5-35	.24/.05, .32	5
Reach A	>60”	7-20/12-27, 5-35	.24/.05, .32	5
Reach B	>60”	7-20/12-27, 5-35	.24/.05, .32	5
Elk Branch Reach 2	>60”	7-20/12-27, 10-20	.24/.05, .2	5,4
UT1	>60”	7-20/12-27	.24/.05	5
UT2	>60”	7-20/12-27, 12-35	.24/.05, .15-.32	5

APPENDIX B
MORPHOLOGICAL SUMMARY DATA AND PLOTS, AND REFERENCE PHOTOGRAPHS

TABLES 1-2
EXHIBIT 1: LONGITUDINAL PROFILE AND CROSS-SECTION PLOTS
FIGURE 1: PEBBLE COUNT
EXHIBIT 2: REFERENCE PHOTOGRAPHS

Table B1. Morphology and Hydraulic Monitoring Summary - Baseline Monitoring
Elk Branch Mitigation Project #92665

	Elk Branch - Reach 1						Elk Branch - Reach A											
Parameter	Cross Section 1 Riffle						Cross Section 2 Pool						Cross Section 3 Riffle					
	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
Dimension																		
BF Width (ft)	4.4						3.3						5.3					
Floodprone Width (ft)	6.1						6.0						10.6					
BF Cross Sectional Area (ft2)	1.7						2.9						1.5					
BF Mean Depth (ft)	0.38						0.87						0.28					
BF Max Depth (ft)	0.49						1.08						0.41					
Width/Depth Ratio	11.5						3.8						19.0					
Entrenchment Ratio	1.4						1.8						2.0					
Wetted Perimeter (ft)	5.1						5.0						5.8					
Hydraulic Radius (ft)	0.32						0.57						0.25					
Substrate																		
d50 (mm)																		
d84 (mm)																		

	Elk Branch - Reach B					
Parameter	Cross Section 4 Riffle					
	AB	MY1	MY2	MY3	MY4	MY5
Dimension						
BF Width (ft)	6.3					
Floodprone Width (ft)	31.2					
BF Cross Sectional Area (ft2)	2.2					
BF Mean Depth (ft)	0.35					
BF Max Depth (ft)	0.48					
Width/Depth Ratio	18.2					
Entrenchment Ratio	5.0					
Wetted Perimeter (ft)	7.0					
Hydraulic Radius (ft)	0.31					

Parameter	AB (2011)			MY-1 (2012)			MY-2 (2013)			MY-3 (2014)			MY-4 (2015)			MY-5 (2016)		
	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)	5	64	36															
Riffle Slope (ft/ft)	0.010	0.045	0.025															
Pool Length (ft)	3	14	7															
Pool Spacing (ft)	10	57	44															
Substrate																		
d50 (mm)	----																	
d84 (mm)	----																	
Additional Reach Parameters																		
Valley Length (ft)	2121																	
Channel Length (ft)	1946																	
Sinuosity	1.09																	
Water Surface Slope (ft/ft)	0.027																	
BF Slope (ft/ft)	0.021	0.033	0.027															
Rosgen Classification	B4																	

Table B1. Morphology and Hydraulic Monitoring Summary - Baseline Monitoring
Elk Branch Mitigation Project #D06125-B

Parameter	Elk Branch - Reach 2 Cross Section 5 Riffle					
	AB	MY1	MY2	MY3	MY4	MY5
Dimension						
BF Width (ft)	4.4					
Floodprone Width (ft)	9.2					
BF Cross Sectional Area (ft2)	2.2					
BF Mean Depth (ft)	0.49					
BF Max Depth (ft)	1.01					
Width/Depth Ratio	9.1					
Entrenchment Ratio	2.1					
Wetted Perimeter (ft)	5.4					
Hydraulic Radius (ft)	0.4					
Substrate						
d50 (mm)						
d84 (mm)						

Parameter	AB (2011)			MY-1 (2012)			MY-2 (2013)			MY-3 (2014)			MY-4 (2015)			MY-5 (2016)		
	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)	19	40	31															
Riffle Slope (ft/ft)	0.021	0.039	0.026															
Pool Length (ft)	7	11	9															
Pool Spacing (ft)	31	48	40															
Substrate																		
d50 (mm)	17																	
d84 (mm)	38																	
Additional Reach Parameters																		
Valley Length (ft)	304																	
Channel Length (ft)	279																	
Sinuosity	1.09																	
Water Surface Slope (ft/ft)	0.027																	
BF Slope (ft/ft)	0.017	0.024	0.021															
Rosgen Classification	B4/Eb4																	

Table B1. Morphology and Hydraulic Monitoring Summary - Baseline Monitoring
Elk Branch Mitigation Project #D06125-B

UT1

Parameter	Cross Section 1 Riffle						Cross Section 2 Riffle						Cross Section 3 Riffle						Cross Section 4 Pool					
	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)	6.7						6.5						7.3						9.4					
Floodprone Width (ft)	35.7						37.6						34.8						45.2					
BF Cross Sectional Area (ft2)	3.1						3.8						3.6						11.9					
BF Mean Depth (ft)	0.46						0.59						0.5						1.26					
BF Max Depth (ft)	0.68						0.8						0.71						2.17					
Width/Depth Ratio	14.7						11.0						14.5						7.5					
Entrenchment Ratio	5.3						5.8						4.8						4.8					
Wetted Perimeter (ft)	7.7						7.7						8.3						11.9					
Hydraulic Radius (ft)	0.41						0.50						0.44						1.00					
Substrate																								
d50 (mm)																								
d84 (mm)																								

Parameter	AB (2011)			MY-1 (2012)			MY-2 (2013)			MY-3 (2014)			MY-4 (2015)			MY-5 (2016)		
	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)	11	24	15															
Riffle Slope (ft/ft)	0.018	0.104	0.080															
Pool Length (ft)	2	6	4															
Pool Spacing (ft)	31	26	23															
Substrate																		
d50 (mm)	----																	
d84 (mm)	----																	
Additional Reach Parameters																		
Valley Length (ft)	662.00																	
Channel Length (ft)	683.00																	
Sinuosity		1.04																
Water Surface Slope (ft/ft)		0.049																
BF Slope (ft/ft)	0.046																	
Rosgen Classification	B																	

Table B1. Morphology and Hydraulic Monitoring Summary - Baseline Monitoring
Elk Branch Mitigation Project #D06125-B

UT2

Parameter	Cross Section 1 Riffle						Cross Section 2 Pool					
	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
Dimension												
BF Width (ft)	3.6						4.1					
Floodprone Width (ft)	5.4						9.5					
BF Cross Sectional Area (ft2)	0.9						2.0					
BF Mean Depth (ft)	0.25						0.49					
BF Max Depth (ft)	0.43						0.75					
Width/Depth Ratio	14.5						8.4					
Entrenchment Ratio	1.5						2.3					
Wetted Perimeter (ft)	4.1						5.1					
Hydraulic Radius (ft)	0.22						0.39					
Substrate												
d50 (mm)												
d84 (mm)												

Parameter	AB (2011)			MY-1 (2012)			MY-2 (2013)			MY-3 (2014)			MY-4 (2015)			MY-5 (2016)		
	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)	9	14	13															
Riffle Slope (ft/ft)	0.026	0.080	0.047															
Pool Length (ft)	3	11	5															
Pool Spacing (ft)	15	27	23															
Substrate																		
d50 (mm)		----			----			----			----			----			----	
d84 (mm)		----			----			----			----			----			----	
Additional Reach Parameters																		
Valley Length (ft)		320																
Channel Length (ft)		241																
Sinuosity	----	1.04	----															
Water Surface Slope (ft/ft)	----	0.038	----															
BF Slope (ft/ft)	0.04	0.05	0.04															
Rosgen Classification		B4																

Notes:

Table B2. Baseline Stream Summary - Baseline Monitoring

Elk Branch Mitigation Project #92665

Baseline Stream Summary
UT2

Parameter	Regional Curve Equation	Pre-Existing Condition			Reference Reach(es) Data			Design			As-Built			Monitoring Year 1			Monitoring Year 2			Monitoring Year 3		
Dimension - Riffle	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	3.70	3.5	7.7	11.9	11.7	19.7	27.6	3.0	5.7	8.4	----	3.6	----									
Floodprone Width (ft)	-----	6.8	29.4	52.0	20.0	30.5	41.0	9.0	17.0	25.0	----	5.4	----									
Bankfull Mean Depth (ft)	0.28	0.34	0.53	0.72	0.60	0.85	1.10	0.30	0.45	0.60	----	0.25	----									
Bankfull Max Depth (ft)	-----	0.90	1.30	1.70	0.90	1.70	2.50	0.40	0.70	1.00	----	0.43	----									
Bankfull Cross Sectional Area (ft2)	1.50	5.5	7.7	9.9	10.2	21.6	33.0	3.0	4.5	6.0	----	0.9	----									
Width/Depth Ratio	-----	2.1	5.1	8.1	10.7	18.9	27.0	10.0	12.0	14.0	----	14.5	----									
Entrenchment Ratio	-----	1.9	4.8	7.7	1.3	2.3	3.2	-----	3.0	-----	----	1.5	----									
Bank Height Ratio	-----	1.0	1.5	1.9	1.0	1.0	1.0	1.0	1.1	1.1	----	2.0	----									
Bankfull Velocity (fps)	-----	-----	-----	-----	-----	-----	-----	2.0	4.0	6.0	----	6.7	----									
Pattern																						
Channel Beltwidth (ft)	-----	-----	-----	-----	16	36	55	-----	-----	-----	-----	-----	-----									
Radius of Curvature (ft)	-----	-----	-----	-----	28	38	47	-----	-----	-----	-----	-----	-----									
Meander Wavelength (ft)	-----	-----	-----	-----	70	165	260	-----	-----	-----	-----	-----	-----									
Meander Width Ratio	-----	-----	-----	-----	1.1	2.6	4.1	-----	-----	-----	-----	-----	-----									
Profile																						
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	9	12	14									
Riffle Slope (ft/ft)	-----	-----	-----	-----	0.190	0.475	0.760	0.023	0.042	0.061	0.026	0.050	0.080									
Pool Length (ft)	-----	-----	-----	-----	13	15	16	-----	-----	-----	3	7	11									
Pool Spacing (ft)	----	-----	-----	-----	42	137	231	9	26	42	15	22	27									
Substrate and Transport Parameters																						
d16 / d35 / d50 / d84 / d95	-----		----		1-6/14/31-39/51-88/110				---			---										
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.47	-----									
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	3.17	-----									
Additional Reach Parameters																						
Channel length (ft)	-----	-----	185	-----	-----	-----	-----	-----	244	-----	-----	241	-----									
Drainage Area (SM)	-----	-----	0.01	-----	0.45	1.025	1.60	-----	0.01	-----	-----	0.01	-----									
Rosgen Classification	-----	-----	B4/G	-----	-----	B4	-----	-----	B4	-----	-----	B4	-----									
Bankfull Discharge (cfs)	2-3	-----	-----	-----	----	-----	----	-----	6	-----	-----	6	-----									
Sinuosity	-----	1.02	1.06	1.10	1.10	1.15	1.19	-----	1.04	-----	-----	1.04	-----									
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.039	-----									
Notes:																						

Table B2. Baseline Stream Summary - Baseline Monitoring

Elk Branch Mitigation Project #92665

Baseline Stream Summary: UT1

Parameter	Regional Curve Equation	Pre-Existing Condition			Reference Reach(es) Data			Design			As-Built			Monitoring Year 1			Monitoring Year 2			Monitoring Year 3		
Dimension - Riffle	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Mean
Bankfull Width (ft)	6.90	3.5	7.7	11.9	11.7	19.7	27.6	3.0	6.9	8.4	6.49	6.9	7.25									
Floodprone Width (ft)	-----	6.8	29.4	52.0	20.0	30.5	41.0	9.0	17.0	25.0	34.82	36.3	37.86									
Bankfull Mean Depth (ft)	0.47	0.34	0.53	0.72	0.60	0.85	1.10	0.30	0.45	0.60	0.46	0.5	0.59									
Bankfull Max Depth (ft)	-----	0.90	1.30	1.70	0.90	1.70	2.50	0.40	0.70	1.00	0.68	0.7	0.80									
Bankfull Cross Sectional Area (ft2)	4.10	5.5	7.7	9.9	10.2	21.6	33.0	3.0	4.5	6.0	3.10	3.5	3.80									
Width/Depth Ratio	-----	2.1	5.1	8.1	10.7	18.9	27.0	10.0	12.0	14.0	11.04	12.8	14.52									
Entrenchment Ratio	-----	1.9	4.8	7.7	1.3	2.3	3.2	-----	3.0	-----	4.80	5.3	5.80									
Bank Height Ratio	-----	1.0	1.5	1.9	1.0	1.0	1.0	1.0	1.1	1.1	1.00	1.0	1.00									
Bankfull Velocity (fps)	-----	-----	-----	-----	-----	-----	-----	2.0	4.0	6.0	2.63	2.9	3.23									
Pattern																						
Channel Beltwidth (ft)	-----	-----	-----	-----	16	36	55	-----	-----	-----	-----	-----	-----									
Radius of Curvature (ft)	-----	-----	-----	-----	28	38	47	-----	-----	-----	-----	-----	-----									
Meander Wavelength (ft)	-----	-----	-----	-----	70	165	260	-----	-----	-----	-----	-----	-----									
Meander Width Ratio	-----	-----	-----	-----	1.10	2.60	4.10	-----	-----	-----	-----	-----	-----									
Profile																						
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	11	17	24									
Riffle Slope (ft/ft)	-----	0.022	0.030	0.038	0.200	0.138	0.076	0.023	0.042	0.061	0.018	0.066	0.104									
Pool Length (ft)	-----	-----	-----	-----	13	15	16	-----	-----	-----	2	4	6									
Pool Spacing (ft)	-----	-----	-----	-----	42	137	231	9	13	17	20	23	26									
Substrate and Transport Parameters																						
d16 / d35 / d50 / d84 / d95	-----		----		-6/14/31-39/51-88/110-21(				----			---										
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.53	-----									
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.54	-----									
Additional Reach Parameters																						
Channel length (ft)	-----	-----	685	-----	-----	-----	-----	-----	654	-----	-----	656	-----									
Drainage Area (SM)	-----	-----	0.06	-----	-----	0.06	-----	-----	0.06	-----	-----	0.06	-----									
Rosgen Classification	-----	-----	B4/G	-----	-----	B4	-----	-----	B4	-----	-----	B4	-----									
Bankfull Discharge (cfs)	10-12	-----	-----	-----	----	----	----	3	7	10	-----	10	-----									
Sinuosity	-----	1.02	1.06	1.10	1.10	1.15	1.19	----	1.04	----	-----	1.04	-----									
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.046	-----									

Table B2. Baseline Stream Summary - Baseline Monitoring

Elk Branch Mitigation Project #92665

Baseline Stream Summary
Elk Branch: Reach 2

Parameter	Regional Curve Equation	Pre-Existing Condition			Reference Reach(es) Data			Design			(As-Built)			Monitoring Year 1			Monitoring Year 2			Monitoring Year 3		
Dimension - Riffle	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	9.30	3.9	5.9	7.8	11.7	19.7	27.6	4.0	7.3	10.5	----	4.4	----									
Floodprone Width (ft)	-----	5.2	30.1	55.0	20.0	-----	41.0	9.0	44.5	80.0	----	9.2	----									
Bankfull Mean Depth (ft)	0.61	0.48	0.80	1.12	0.60	0.85	1.10	0.40	0.58	0.75	----	0.49	----									
Bankfull Max Depth (ft)	-----	0.90	1.30	1.70	0.90	1.70	2.50	0.50	0.75	1.00	----	1.01	----									
Bankfull Cross Sectional Area (ft2)	6.80	2.9	8.7	14.5	10.2	21.6	33.0	3.0	5.0	7.0	----	2.2	----									
Width/Depth Ratio	-----	5.0	9.5	14.0	10.7	18.9	27.0	10.0	12.0	14.0	----	9.1	----									
Entrenchment Ratio	-----	1.6	4.3	7.0	1.3	2.3	3.2	3.0	5.3	7.6	----	2.1	----									
Bank Height Ratio	-----	1.4	2.3	3.1	1.0	1.0	1.0	1.0	1.1	1.1	----	2.0	----									
Bankfull Velocity (fps)	-----	-----	-----	-----	-----	-----	-----	2.0	4.0	6.0	-----	4.9	-----									
Pattern																						
Channel Beltwidth (ft)	-----	2	3	4	16	36	55	11	45	80	-----	-----	-----									
Radius of Curvature (ft)	-----	2	4	7	28	38	47	5	15	25	-----	-----	-----									
Meander Wavelength (ft)	-----	9	23	38	70	165	260	21	52	82	-----	-----	-----									
Meander Width Ratio	-----	0.40	0.60	0.80	1.10	2.60	4.10	3.50	5.75	8.00	-----	-----	-----									
Profile																						
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	19	30	40									
Riffle Slope (ft/ft)	-----	0.02	0.03	0.03	0.200	0.480	0.760	0.022	0.037	0.051	0.021	0.028	0.039									
Pool Length (ft)	-----	-----	-----	-----	13	15	16	-----	-----	-----	7	9	11									
Pool Spacing (ft)	-----	42	-----	157	42	137	231	9	30	50	31	39	48									
Substrate and Transport Parameters																						
d16 / d35 / d50 / d84 / d95	-----	1.2/6.6/13/65/130			1-6/14/31-39/51-88/110-210			.6-1.5/2-7/6.2-19/19-65/26-130			---											
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.67	-----									
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	3.28	-----									
Additional Reach Parameters																						
Channel length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	279	-----	-----	279	-----									
Drainage Area (SM)	-----	0.07	-----	0.14	0.45	1.03	1.60	0.07	0.11	0.14	0.05	0.10	0.14									
Rosgen Classification	-----	-----	Cb/B/G /Eb4	-----	-----	B4	-----	-----	B4	-----	-----	B4	-----									
Bankfull Discharge (cfs)	13-23	-----	-----	-----	----	----	----	7	11	14	7	11	14									
Sinuosity	-----	1.02	1.06	1.10	1.10	1.15	1.19	-----	1.09	-----	-----	1.09	-----									
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.024	-----									

Table B2. Baseline Stream Summary - Baseline Monitoring

Elk Branch Mitigation Project #92665

Baseline Stream Summary
Elk Branch: Reach B

Parameter	Regional Curve Equation	Pre-Existing Condition			Reference Reach(es) Data			Design			(As-Built)			Monitoring Year 1			Monitoring Year 2			Monitoring Year 3		
Dimension - Riffle	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	6.3-9.3	3.9	5.9	7.8	11.7	19.7	27.6	4.0	7.3	10.5	----	6.3	----									
Floodprone Width (ft)	-----	5.2	30.1	55.0	20.0	-----	41.0	9.0	44.5	80.0	----	31.2	----									
Bankfull Mean Depth (ft)	.44-.61	0.48	0.80	1.12	0.60	0.85	1.10	0.40	0.58	0.75	----	0.35	----									
Bankfull Max Depth (ft)	-----	0.90	1.30	1.70	0.90	1.70	2.50	0.50	0.75	1.00	----	0.48	----									
Bankfull Cross Sectional Area (ft2)	3.6-6.8	2.9	8.7	14.5	10.2	21.6	33.0	3.0	5.0	7.0	----	2.2	----									
Width/Depth Ratio	-----	5.0	9.5	14.0	10.7	18.9	27.0	10.0	12.0	14.0	----	18.2	----									
Entrenchment Ratio	-----	1.6	4.3	7.0	1.3	2.3	3.2	3.0	5.3	7.6	----	5.0	----									
Bank Height Ratio	-----	1.4	2.3	3.1	1.0	1.0	1.0	1.0	1.1	1.1	----	2.0	----									
Bankfull Velocity (fps)	-----	-----	-----	-----	-----	-----	-----	2.0	4.0	6.0	-----	4.8	-----									
Pattern																						
Channel Beltwidth (ft)	-----	2	3	4	16	36	55	11	45	80	-----	-----	-----									
Radius of Curvature (ft)	-----	2	4	7	28	38	47	5	15	25	-----	-----	-----									
Meander Wavelength (ft)	-----	9	23	38	70	165	260	21	52	82	-----	-----	-----									
Meander Width Ratio	-----	0.40	0.60	0.80	1.10	2.60	4.10	3.50	5.75	8.00	-----	-----	-----									
Profile																						
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5	23	42									
Riffle Slope (ft/ft)	-----	0.02	0.03	0.03	0.200	0.480	0.760	0.022	0.037	0.051	0.018	0.025	0.039									
Pool Length (ft)	-----	-----	-----	-----	13	15	16	-----	-----	-----	4	8	14									
Pool Spacing (ft)	-----	42	-----	157	42	137	231	9	30	50	10	29	50									
Substrate and Transport Parameters																						
d16 / d35 / d50 / d84 / d95	-----	1.2/6.6/13/65/130			-6/14/31-39/51-88/110-21			.6-1.5/2-7/6.2-19/19-65/26-130			---											
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.51	-----									
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.43	-----									
Additional Reach Parameters																						
Channel length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	403	-----	-----	403	-----									
Drainage Area (SM)	-----	-----	.03-.07	-----	0.45	1.03	1.60	0.05	0.10	0.14	0.05	0.10	0.14									
Rosgen Classification	-----	-----	Cb/B/G/Eb4	-----	-----	B4	-----	-----	B4	-----	-----	B4	-----									
Bankfull Discharge (cfs)	7-13	-----	-----	-----	----	----	----	7	11	14	7	11	14									
Sinuosity	-----	1.02	1.06	1.10	1.10	1.15	1.19	-----	1.09	-----	-----	1.09	-----									
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.021	-----									

Note: Dimension information based on pool cross-section

Table B2. Baseline Stream Summary - Baseline Monitoring

Elk Branch Mitigation Project #92665

Baseline Stream Summary
Elk Branch: Reach A

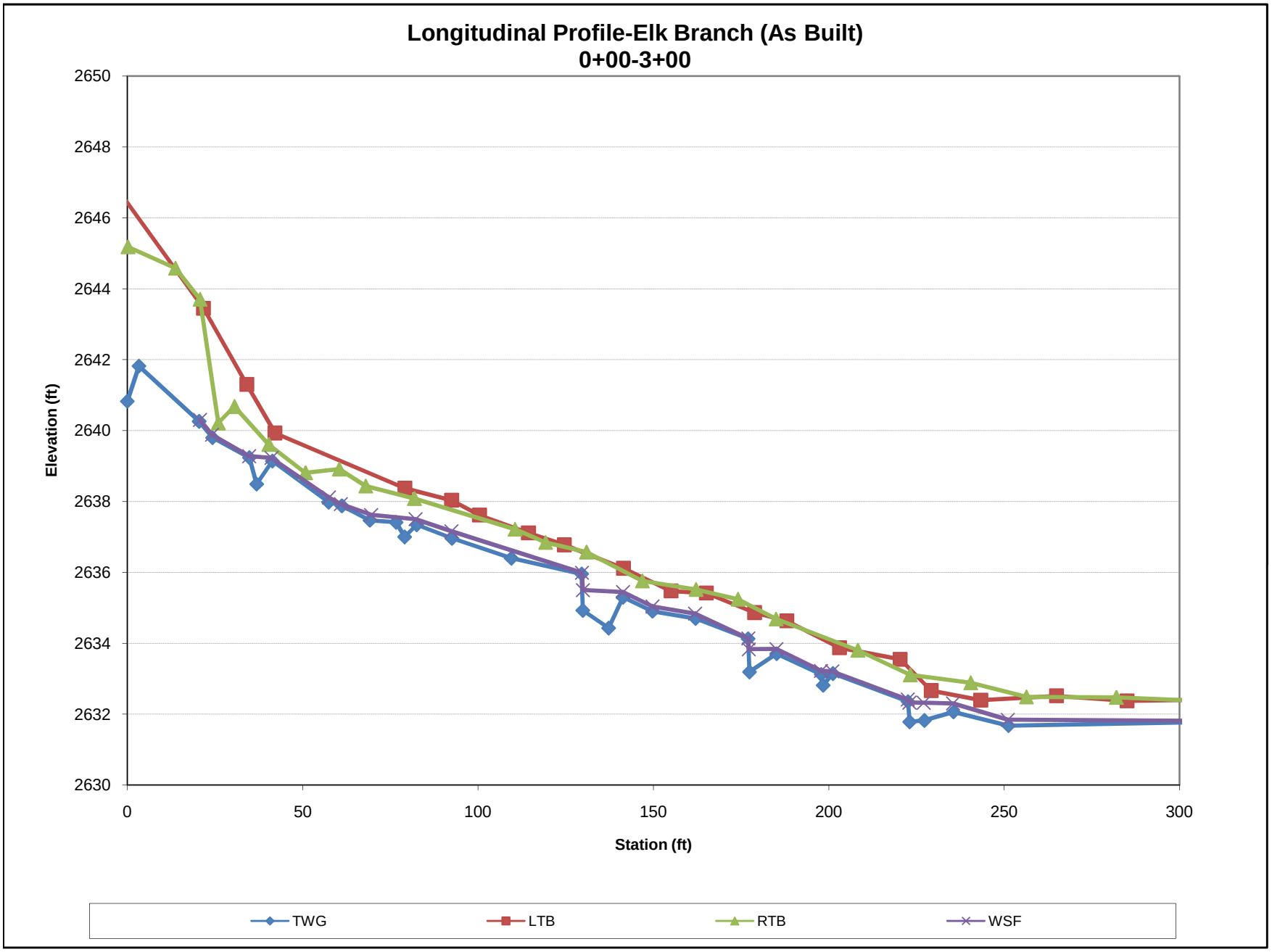
Parameter	Regional Curve Equation	Pre-Existing Condition			Reference Reach(es) Data			Design			(As-Built)			Monitoring Year 1			Monitoring Year 2			Monitoring Year 3		
Dimension - Riffle	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	6.3-9.3	3.9	5.9	7.8	11.7	19.7	27.6	4.0	7.3	10.5	----	5.3	----									
Floodprone Width (ft)	-----	5.2	30.1	55.0	20.0	-----	41.0	9.0	44.5	80.0	----	10.6	----									
Bankfull Mean Depth (ft)	.44-.61	0.48	0.80	1.12	0.60	0.85	1.10	0.40	0.58	0.75	----	0.28	----									
Bankfull Max Depth (ft)	-----	0.90	1.30	1.70	0.90	1.70	2.50	0.50	0.75	1.00	----	0.41	----									
Bankfull Cross Sectional Area (ft2)	3.6-6.8	2.9	8.7	14.5	10.2	21.6	33.0	3.0	5.0	7.0	----	1.5	----									
Width/Depth Ratio	-----	5.0	9.5	14.0	10.7	18.9	27.0	10.0	12.0	14.0	----	19.0	----									
Entrenchment Ratio	-----	1.6	4.3	7.0	1.3	2.3	3.2	3.0	5.3	7.6	----	2.0	----									
Bank Height Ratio	-----	1.4	2.3	3.1	1.0	1.0	1.0	1.0	1.1	1.1	----	2.0	----									
Bankfull Velocity (fps)	-----	-----	-----	-----	-----	-----	-----	2.0	4.0	6.0	----	7.2	----									
Pattern																						
Channel Beltwidth (ft)	-----	2	3	4	16	36	55	11	45	80	-----	-----	-----									
Radius of Curvature (ft)	-----	2	4	7	28	38	47	5	15	25	-----	-----	-----									
Meander Wavelength (ft)	-----	9	23	38	70	165	260	21	52	82	-----	-----	-----									
Meander Width Ratio	-----	0.40	0.60	0.80	1.10	2.60	4.10	3.50	5.75	8.00	-----	-----	-----									
Profile																						
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	34	45	64									
Riffle Slope (ft/ft)	-----	0.02	0.03	0.03	0.200	0.480	0.760	0.022	0.037	0.051	0.010	0.025	0.040									
Pool Length (ft)	-----	-----	-----	-----	13	15	16	-----	-----	-----	4	5	6									
Pool Spacing (ft)	-----	42	-----	157	42	137	231	9	30	50	22	43	57									
Substrate and Transport Parameters																						
d16 / d35 / d50 / d84 / d95	-----	1.2/6.6/13/65/130			-6/14/31-39/51-88/110-21			.6-1.5/2-7/6.2-19/19-65/26-			---											
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.34	-----									
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.44	-----									
Additional Reach Parameters																						
Channel length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	642	-----	-----	642	-----									
Drainage Area (SM)	-----	-----	.03-.07	-----	0.45	1.03	1.60	0.05	0.10	0.14	0.05	0.10	0.14									
Rosgen Classification	-----	-----	Cb/B/G /Eb4	-----	-----	B4	-----	-----	B4	-----	-----	B4	-----									
Bankfull Discharge (cfs)	7-13	-----	-----	-----	-----	-----	-----	7	11	14	7	11	14									
Sinuosity	-----	1.02	1.06	1.10	1.10	1.15	1.19	-----	1.09	-----	-----	1.09	-----									
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.027	-----									

Table B2. Baseline Stream Summary - Baseline Monitoring

Elk Branch Mitigation Project #92665

Baseline Stream Summary
Elk Branch: Reach 1

Parameter	Regional Curve Equation	Pre-Existing Condition			Reference Reach(es) Data			Design			(As-Built)			Monitoring Year 1			Monitoring Year 2			Monitoring Year 3		
Dimension - Riffle	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	6.3-9.3	3.9	5.9	7.8	11.7	19.7	27.6	4.0	7.3	10.5	----	4.4	----									
Floodprone Width (ft)	-----	5.2	30.1	55.0	20.0	-----	41.0	9.0	44.5	80.0	----	6.1	----									
Bankfull Mean Depth (ft)	.44-.61	0.48	0.80	1.12	0.60	0.85	1.10	0.40	0.58	0.75	----	0.38	----									
Bankfull Max Depth (ft)	-----	0.90	1.30	1.70	0.90	1.70	2.50	0.50	0.75	1.00	----	0.49	----									
Bankfull Cross Sectional Area (ft2)	3.6-6.8	2.9	8.7	14.5	10.2	21.6	33.0	3.0	5.0	7.0	----	1.7	----									
Width/Depth Ratio	-----	5.0	9.5	14.0	10.7	18.9	27.0	10.0	12.0	14.0	----	11.5	----									
Entrenchment Ratio	-----	1.6	4.3	7.0	1.3	2.3	3.2	3.0	5.3	7.6	----	1.4	----									
Bank Height Ratio	-----	1.4	2.3	3.1	1.0	1.0	1.0	1.0	1.1	1.1	----	2.0	----									
Bankfull Velocity (fps)	-----	-----	-----	-----	-----	-----	-----	2.0	4.0	6.0	----	6.4	----									
Pattern																						
Channel Beltwidth (ft)	-----	2	3	4	16	36	55	11	45	80	-----	-----	-----									
Radius of Curvature (ft)	-----	2	4	7	28	38	47	5	15	25	-----	-----	-----									
Meander Wavelength (ft)	-----	9	23	38	70	165	260	21	52	82	-----	-----	-----									
Meander Width Ratio	-----	0.4	0.6	0.8	1.1	2.6	4.1	3.5	5.8	8.0	-----	-----	-----									
Profile																						
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	18	34	51									
Riffle Slope (ft/ft)	-----	0.02	0.03	0.03	0.200	0.480	0.760	0.022	0.037	0.051	0.021	0.029	0.045									
Pool Length (ft)	-----	-----	-----	-----	13	15	16	-----	-----	-----	3	6	9									
Pool Spacing (ft)	-----	42	-----	157	42	137	231	9	30	50	17	40	55									
Substrate and Transport Parameters																						
d16 / d35 / d50 / d84 / d95	-----	1.2/6.6/13/65/130			1-6/14/31-39/51-88/110-210			.6-1.5/2-7/6.2-19/19-65/ 26-130			---											
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.5	-----									
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	3.2	-----									
Additional Reach Parameters																						
Channel length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	901	-----	-----	901	-----									
Drainage Area (SM)	-----	0.03	0.05	0.07	0.45	1.03	1.60	0.05	0.10	0.14	0.05	0.10	0.14									
Rosgen Classification	-----	-----	Cb/B/G /Eb4	-----	-----	B4	-----	-----	B4	-----	-----	B4	-----									
Bankfull Discharge (cfs)	7-13	-----	-----	-----	-----	-----	-----	7	11	14	7	11	14									
Sinuosity	-----	1.02	1.06	1.10	1.10	1.15	1.19	1.02	1.07	1.11	-----	1.09	-----									
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.033	-----									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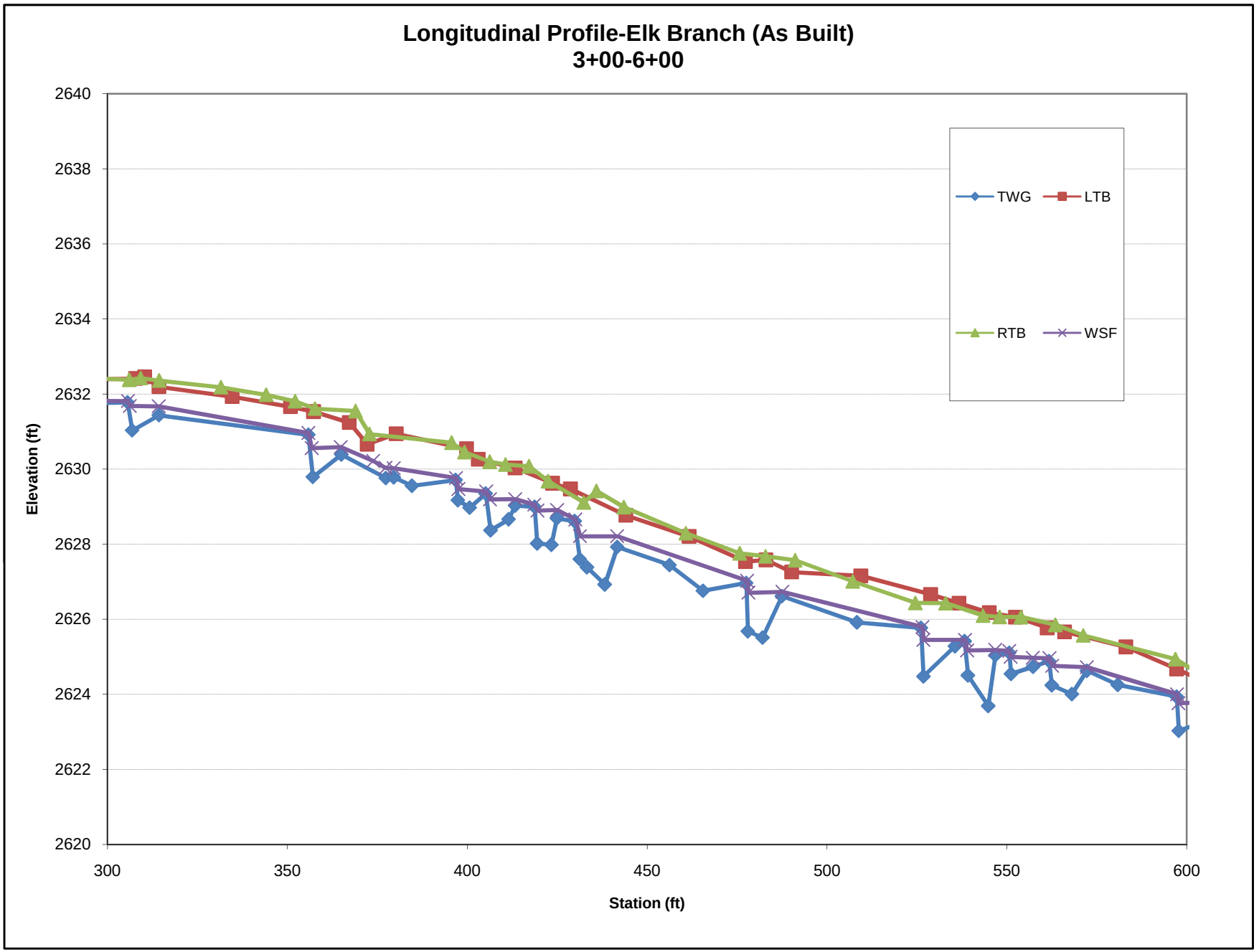
2646
2644
2642
2640
2638
2636
2634
2632
2630
0
50
100
150
200
250
300
Station (ft)
TWG
LTB
RTB
WSF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3+00-6+00
Elevation (ft)
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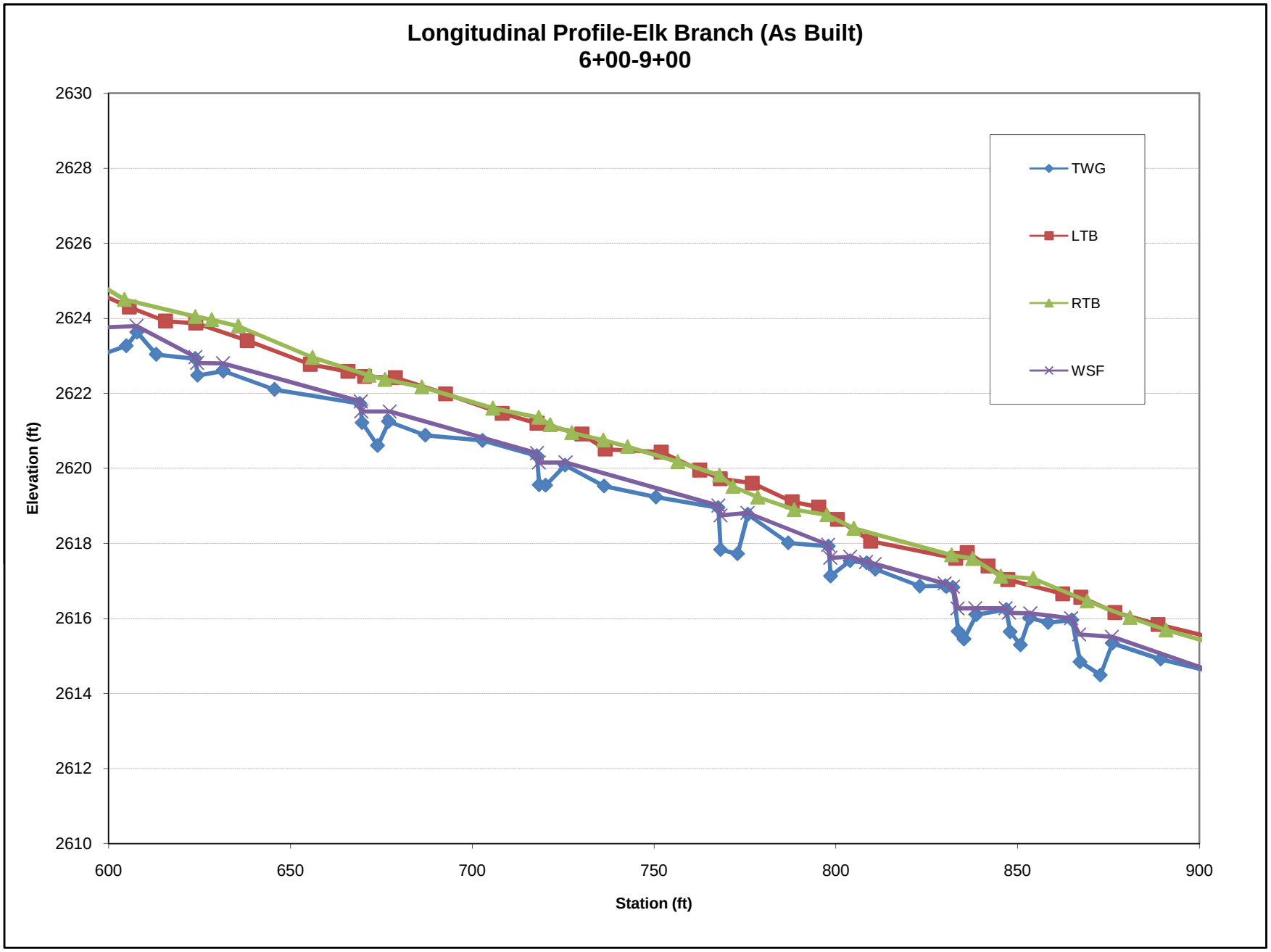
2638
2636
2634
2632
2630
2628
2626
2624
2622
2620
300
350
400
450
500
550
600
Station (ft)
TWG
LTB
RTB
WSF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6+00-9+00
Elevation (ft)
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2628
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2624
2622
2620
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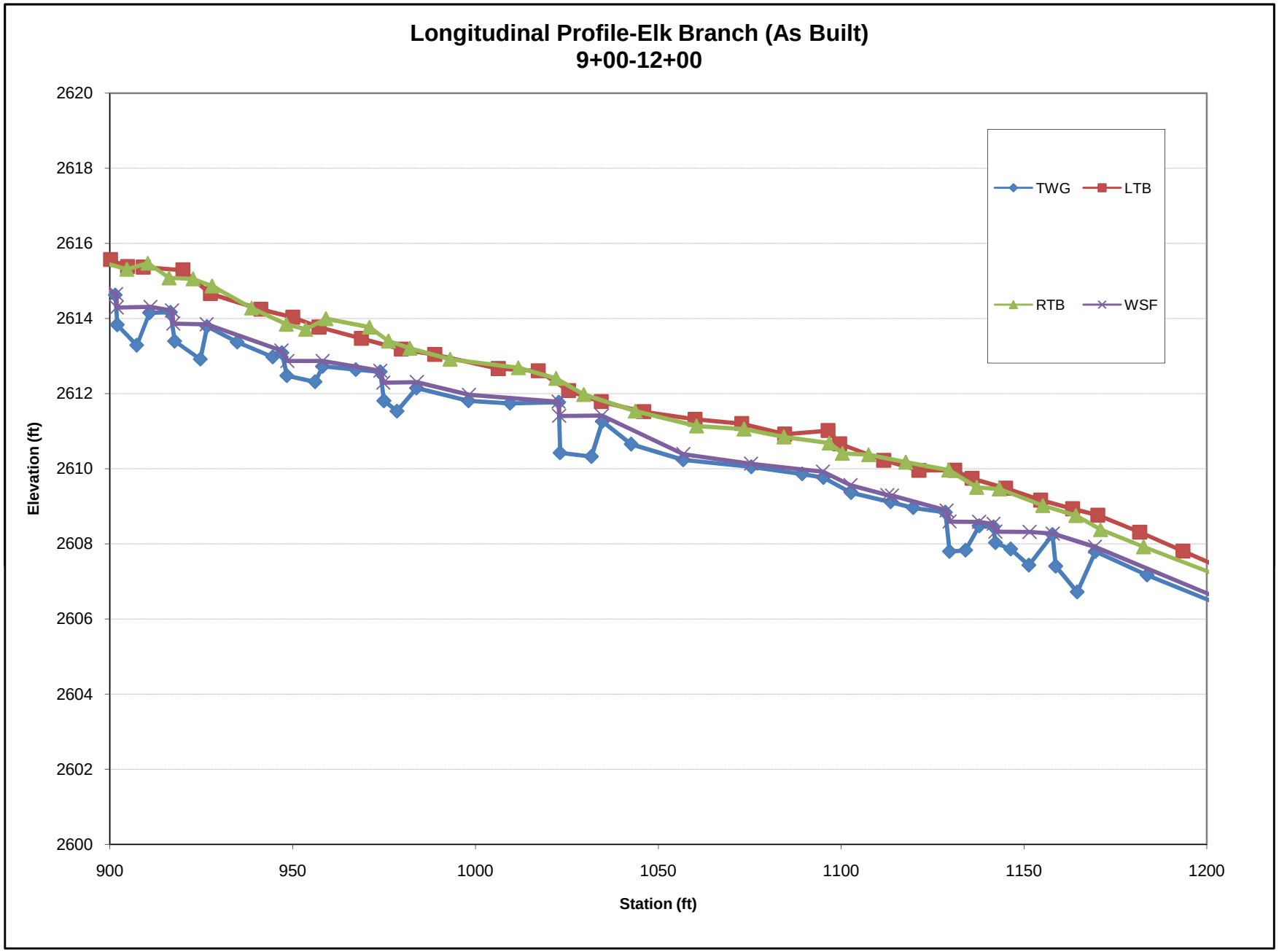
2610
600
650
700
750
800
850
900
Station (ft)
TWG
LTB
RTB
WSF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Elevation (ft)
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2618
2616
2614
2612
2610
2608
2606
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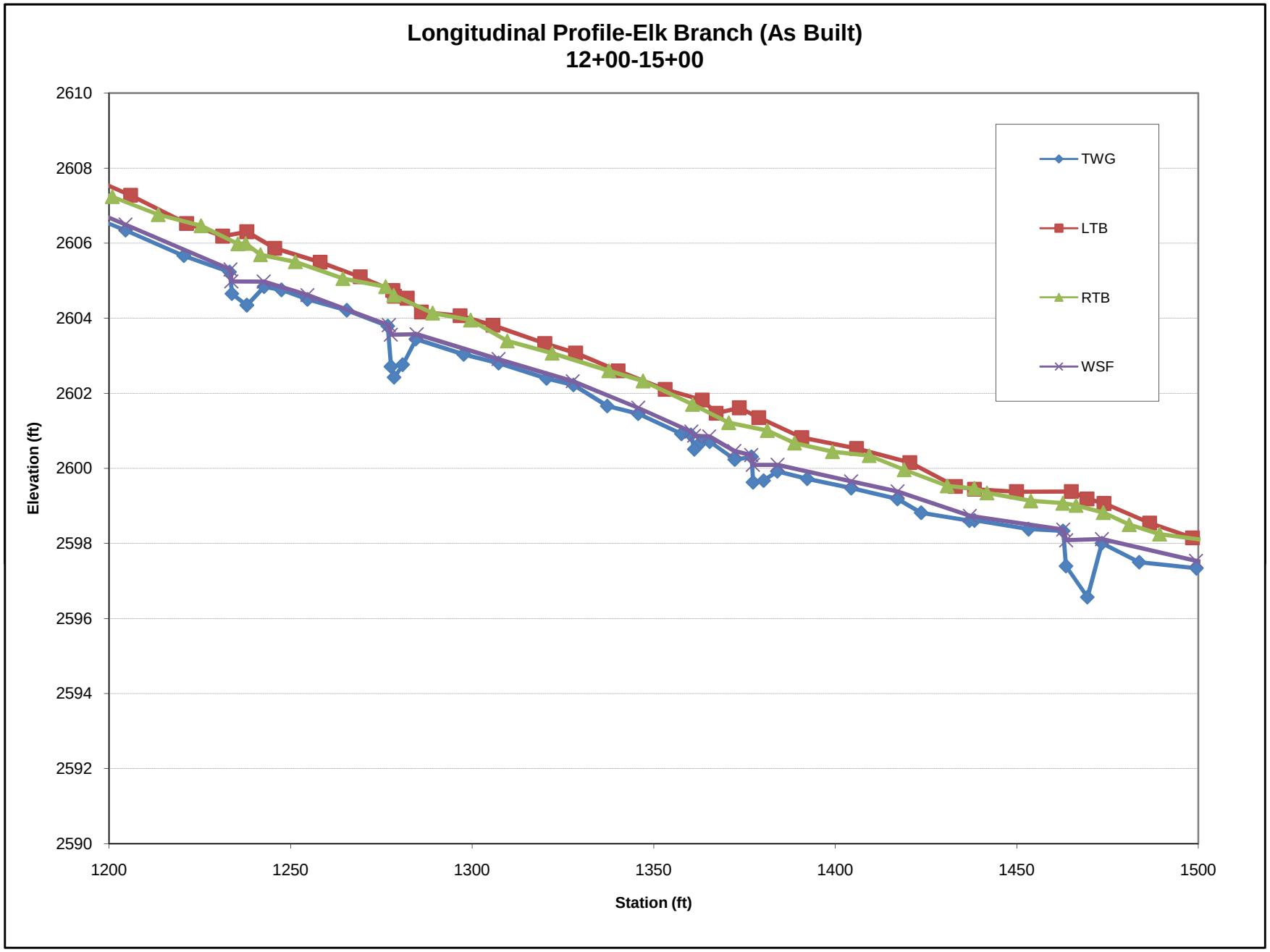
2602
2600
900
950
1000
1050
1100
1150
1200
Station (ft)
TWG
LTB
RTB
WSF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Elevation (ft)
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2606
2604
2602
2600
2598
2596
2594
2592
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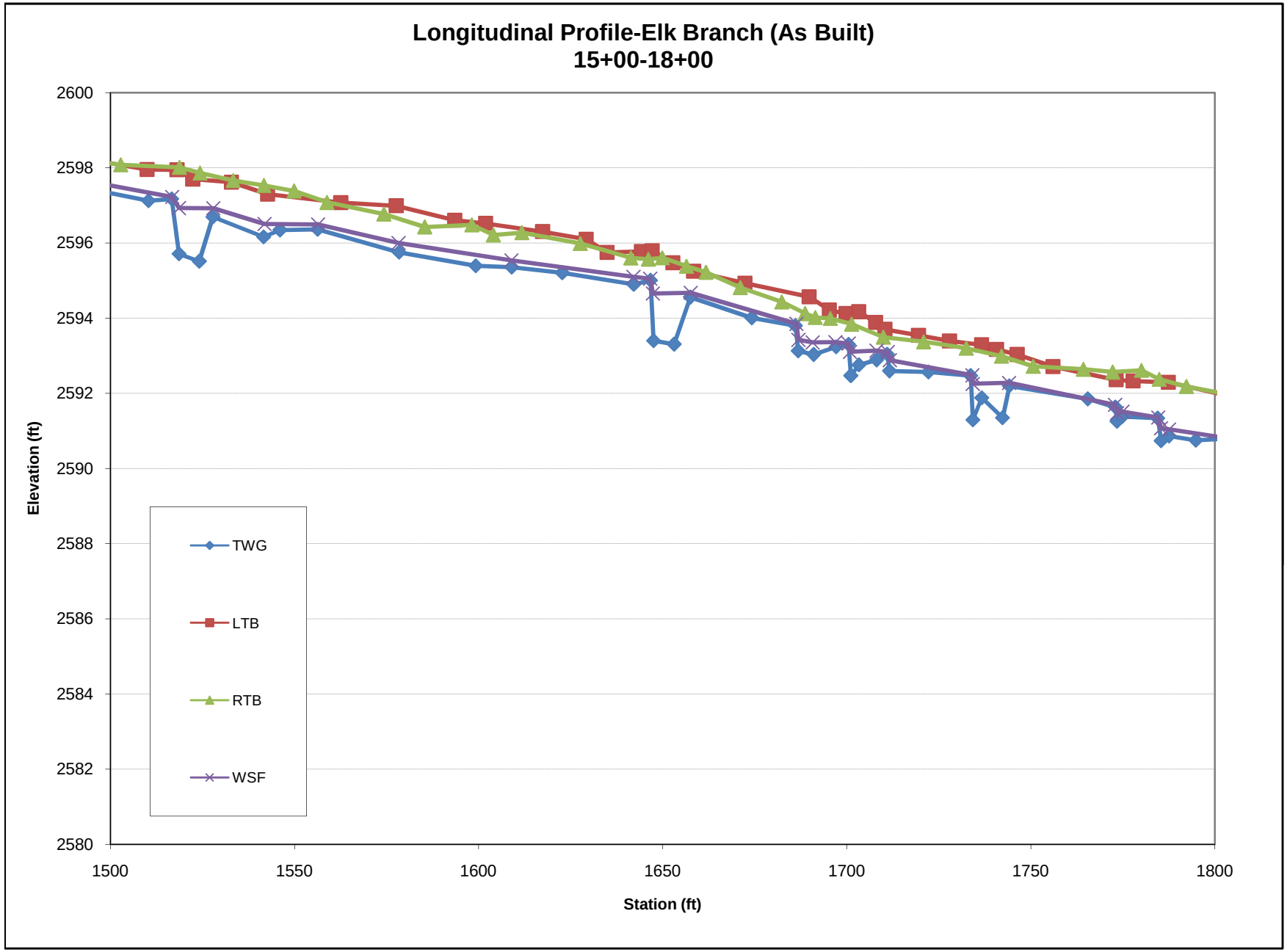
1200
1250
1300
1350
1400
1450
1500
Station (ft)
TWG
LTB
RTB
WSF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15+00-18+00
Elevation (ft)
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2598
2596
2594
2592
2590
2588
2586
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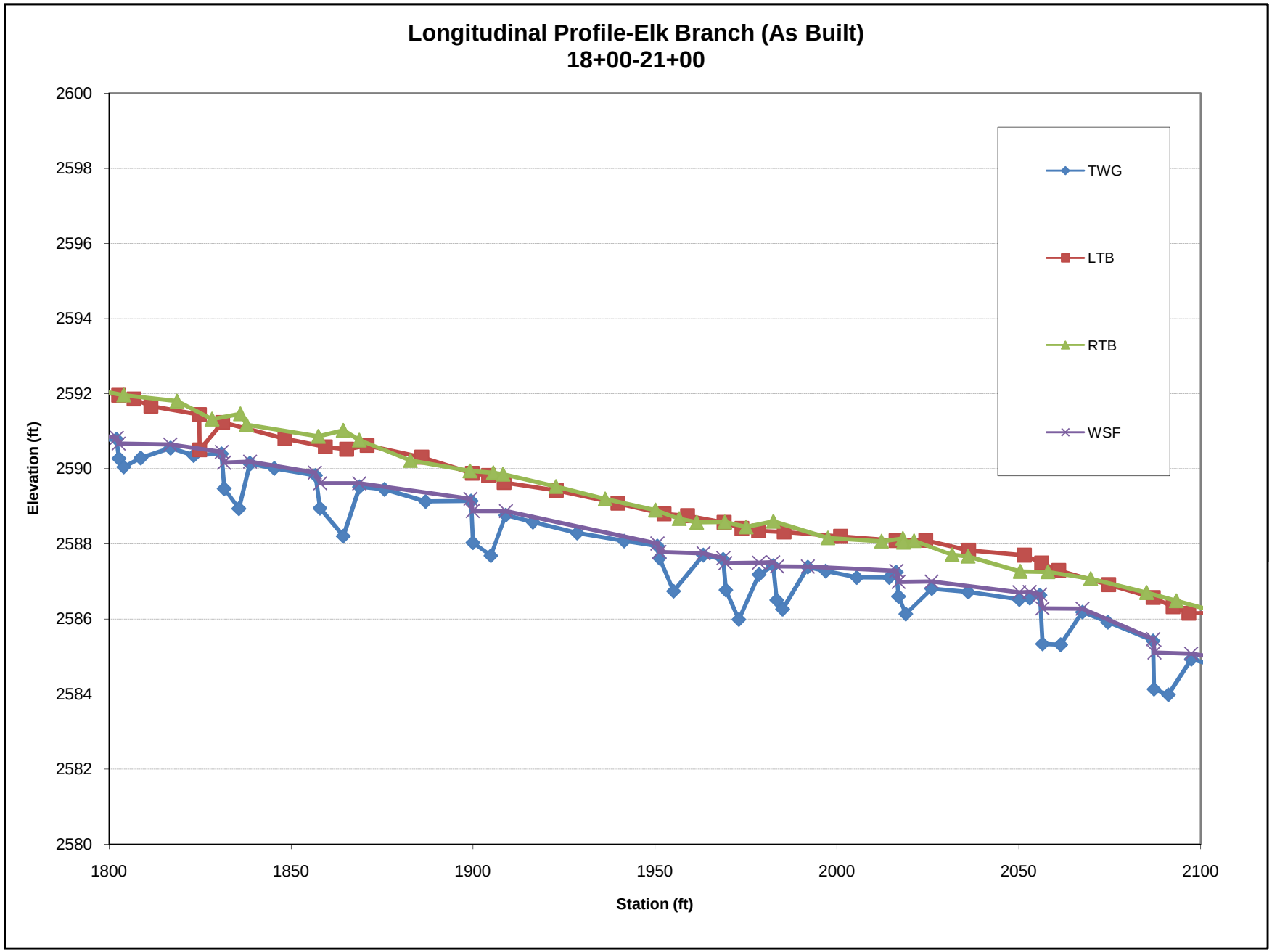
2582
2580
1500
1550
1600
1650
1700
1750
1800
Station (ft)
TWG
LTB
RTB
WSF


Longitudinal Profile-Elk Branch (As Built)
18+00-21+00
Elevation (ft)
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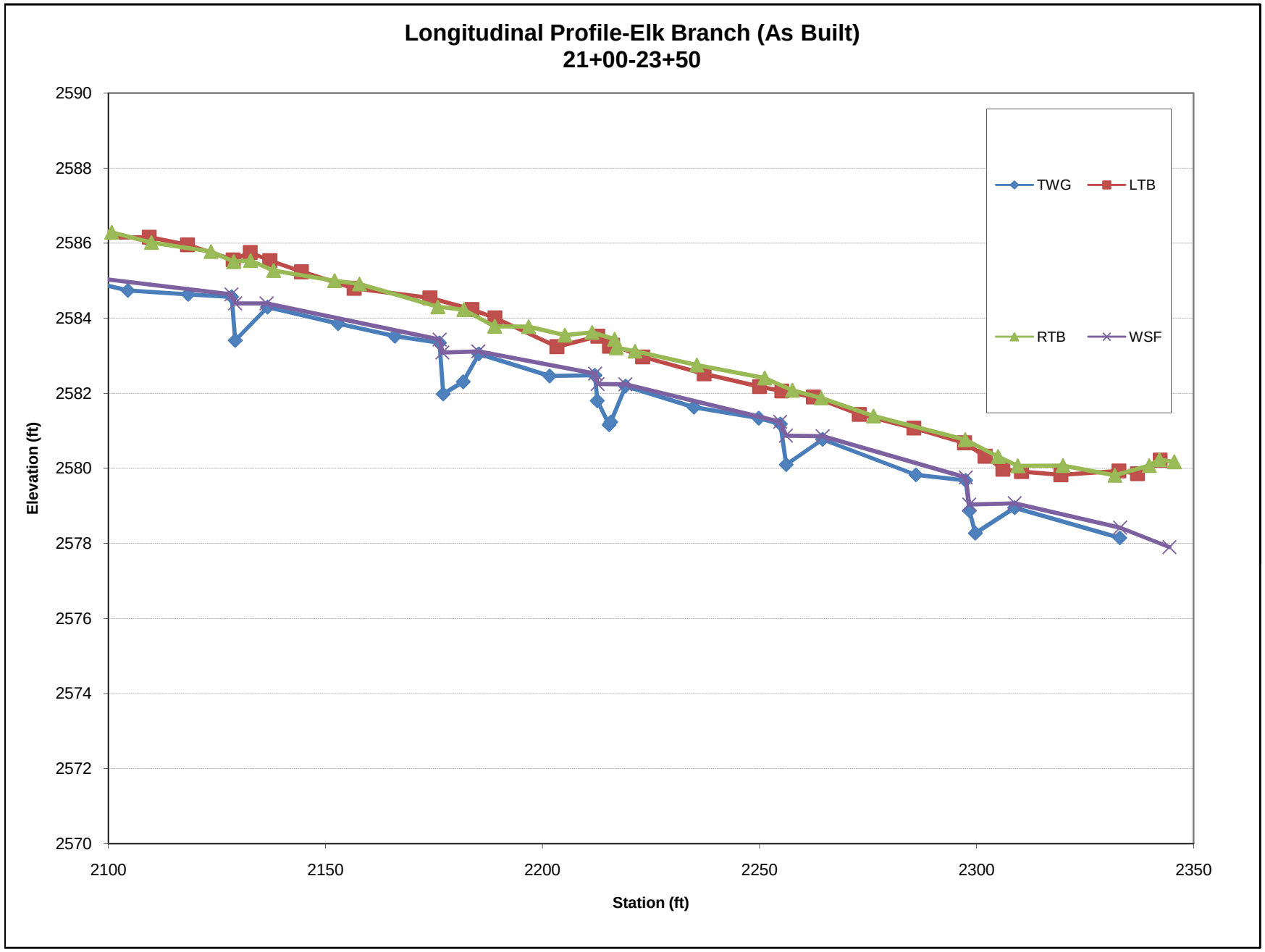
2598
2596
2594
2592
2590
2588
2586
2584
2582
2580
1800
1850
1900
1950
2000
2050
2100
Station (ft)
TWG
LTB
RTB
WSF


Longitudinal Profile-Elk Branch (As Built)
21+00-23+50
Elevation (ft)
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2588
2586
2584
2582
2580
2578
2576
2574
2572
2570
2100
2150
2200
2250
2300
2350
Station (ft)
TWG
LTB
RTB
WSF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Eb	4.1	6.08	0.67	0.98	9.04	1	5.1	2620.51	2620.51

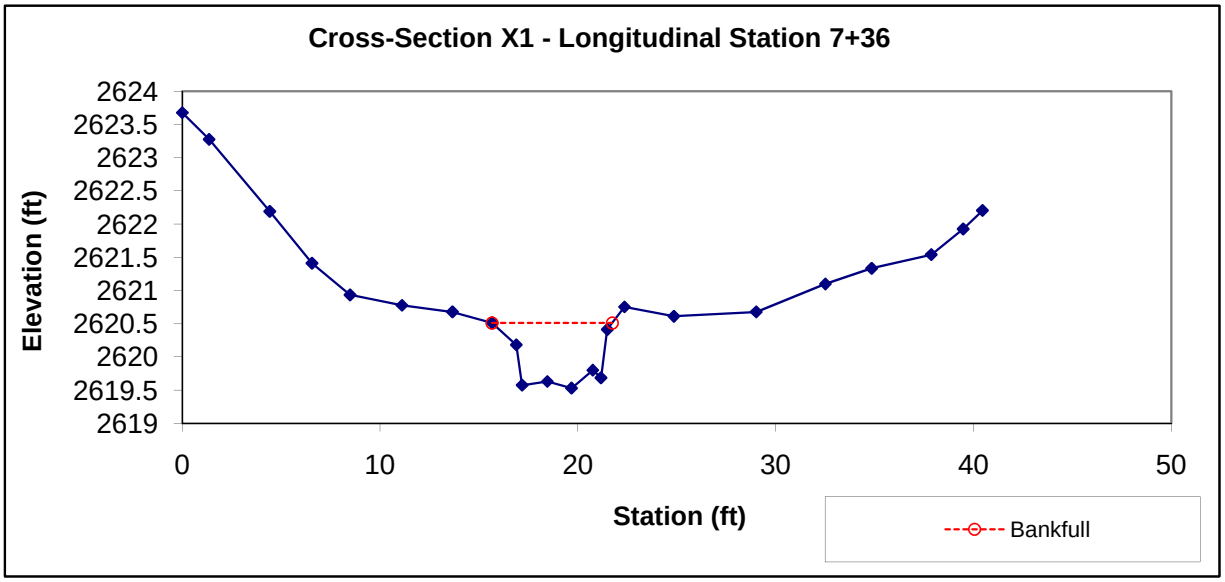


Photo 1: XS-1 facing right bank

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
Pool	-	7.3	6.01	1.22	2.16	4.93	1	5.4	2604.59	2604.59

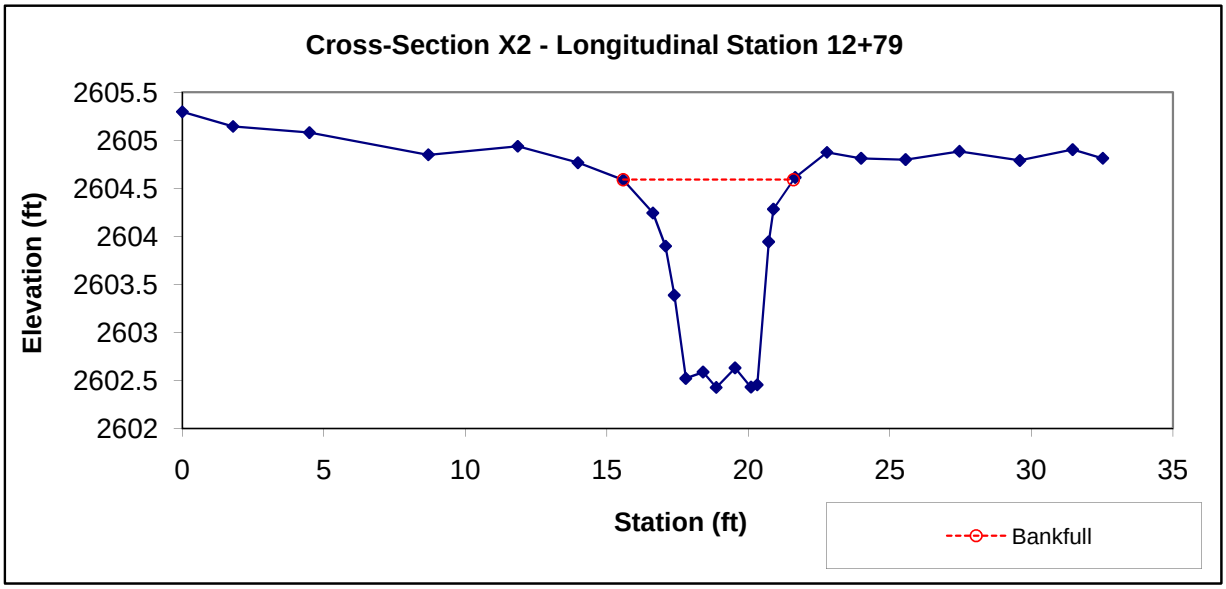


Photo 5: XS-2 facing right bank

Photo 6: XS-2 facing left bank

Photo 7: XS-2 facing upstream

Photo 8: 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
Riffle	Cb	4.2	8.12	0.51	0.83	15.81	1	4.3	2599.44	2599.44

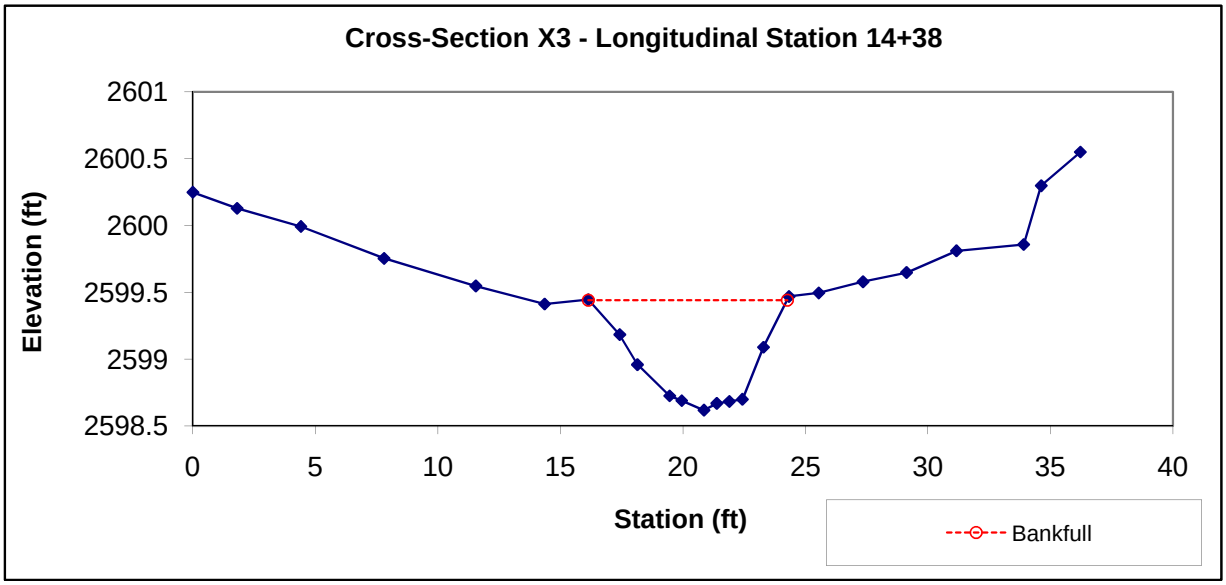


Photo 9: XS-3 facing right bank

Photo 10: XS-3 facing left bank

Photo 11: XS-3 facing upstream

Photo 12: 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	Cb	5.7	8.73	0.65	0.95	13.33	1	5.2	2587.67	2587.67

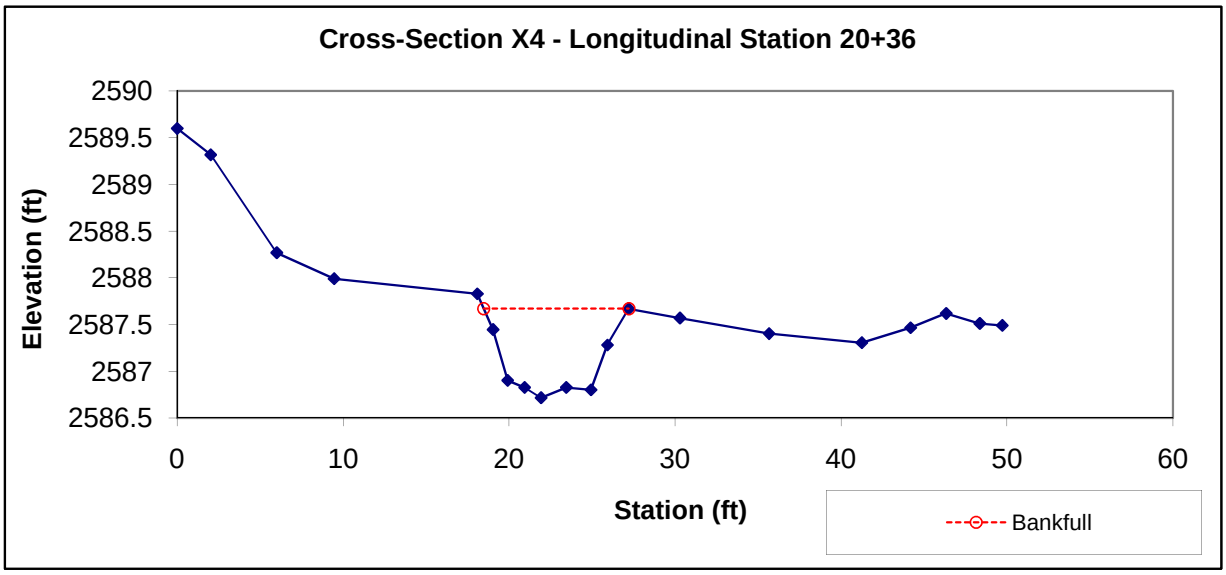


Photo 13: XS-4 facing right bank

Photo 14: XS-4 facing left bank

Photo 15: XS-4 facing upstream

Photo 16: XS-4 facing downstream

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	9	9.15	0.98	2.02	9.31	1	4.8	2583.26	2583.26

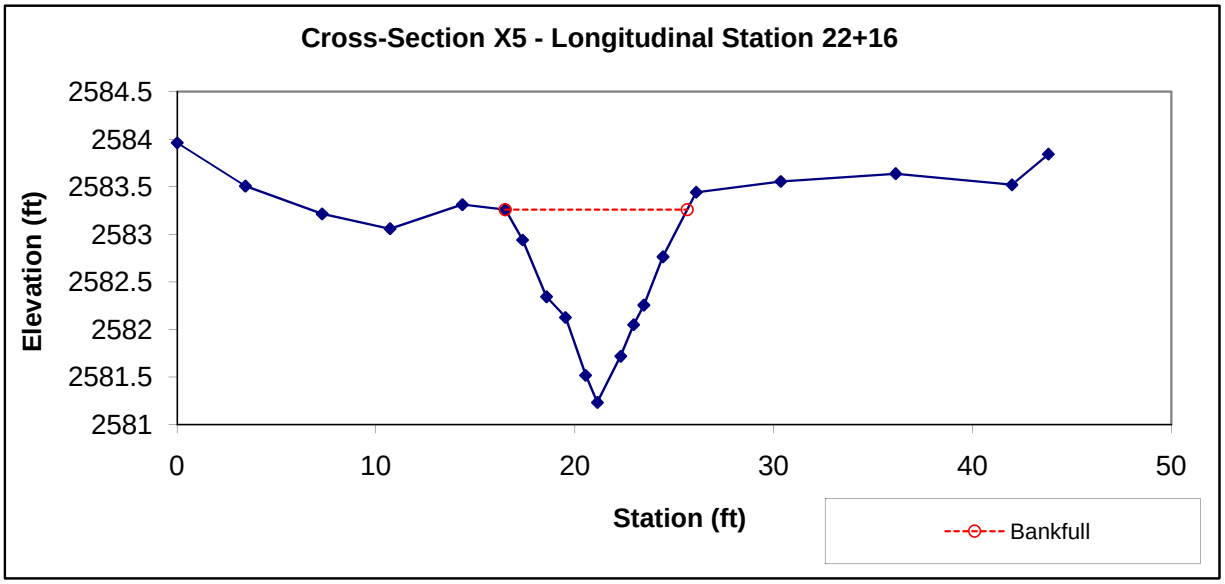
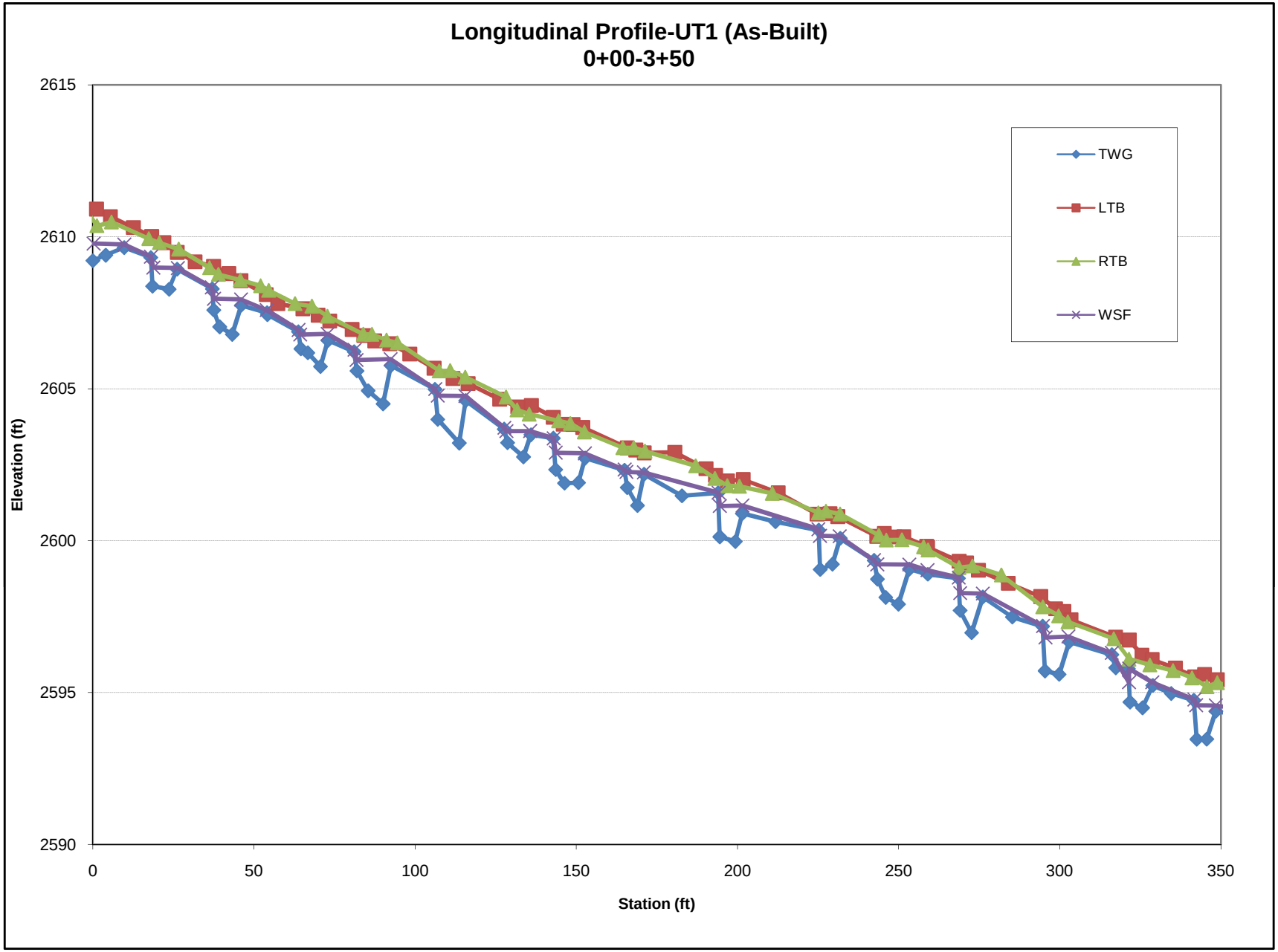


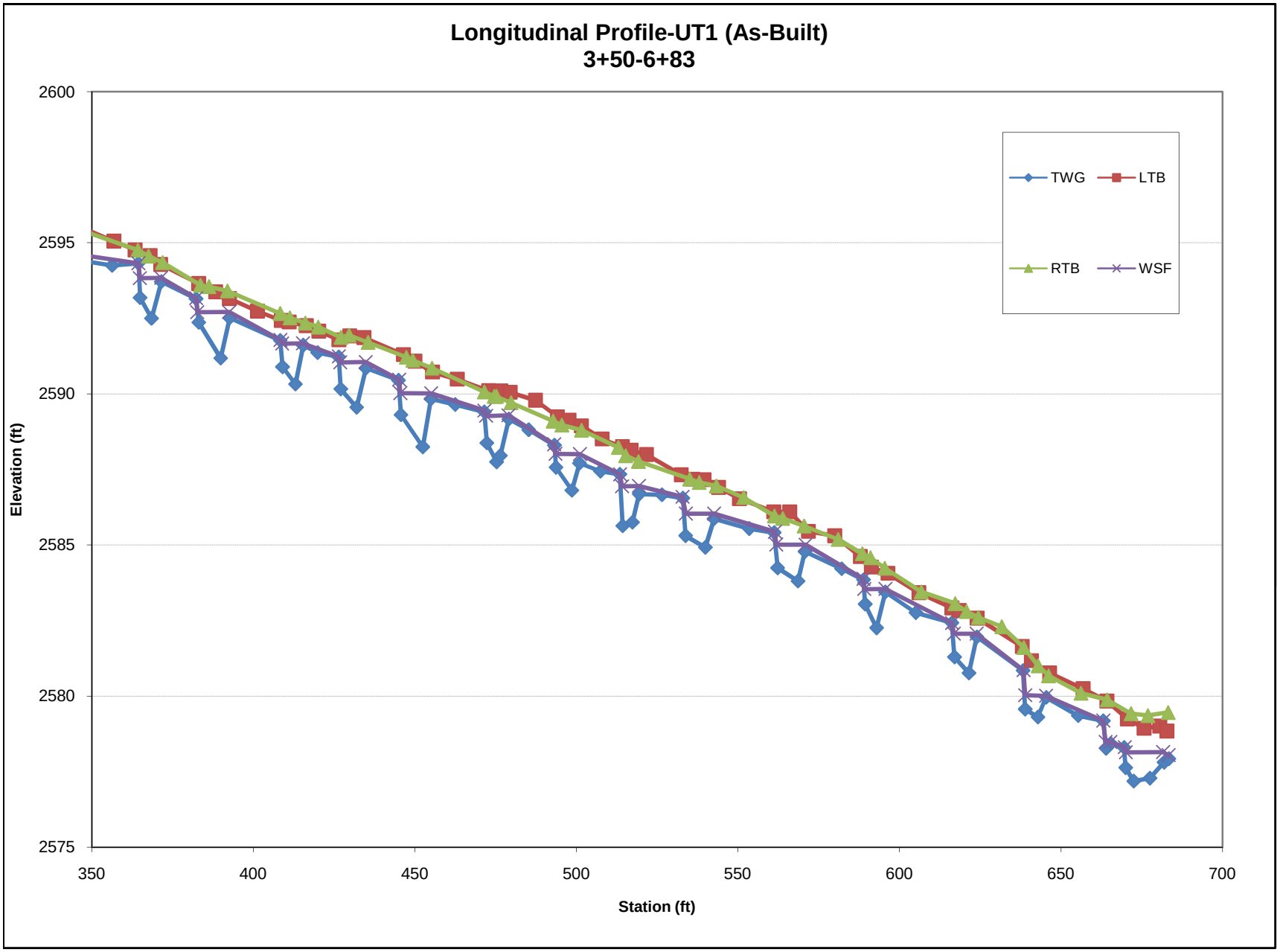
Photo 17: XS-5 facing right bank

Photo 18: XS-5 facing left bank

Photo 19: XS-5 facing upstream

Photo 20: XS-5 facing downstream


Longitudinal Profile-UT1 (As-Built)
0+00-3+50
2615
2610
2605
2600
2595
2590
Elevation (ft)
0
50
100
150
200
250
300
350
Station (ft)
TWG
LTB
RTB
WSF


Longitudinal Profile-UT1 (As-Built)
3+50-6+83
2600
2595
2590
2585
2580
2575
Elevation (ft)
350
400
450
500
550
600
650
700
Station (ft)
TWG
LTB
RTB
WSF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Cb	3.1	6.73	0.46	0.68	14.71	1	5.3	2608.1	2608.1

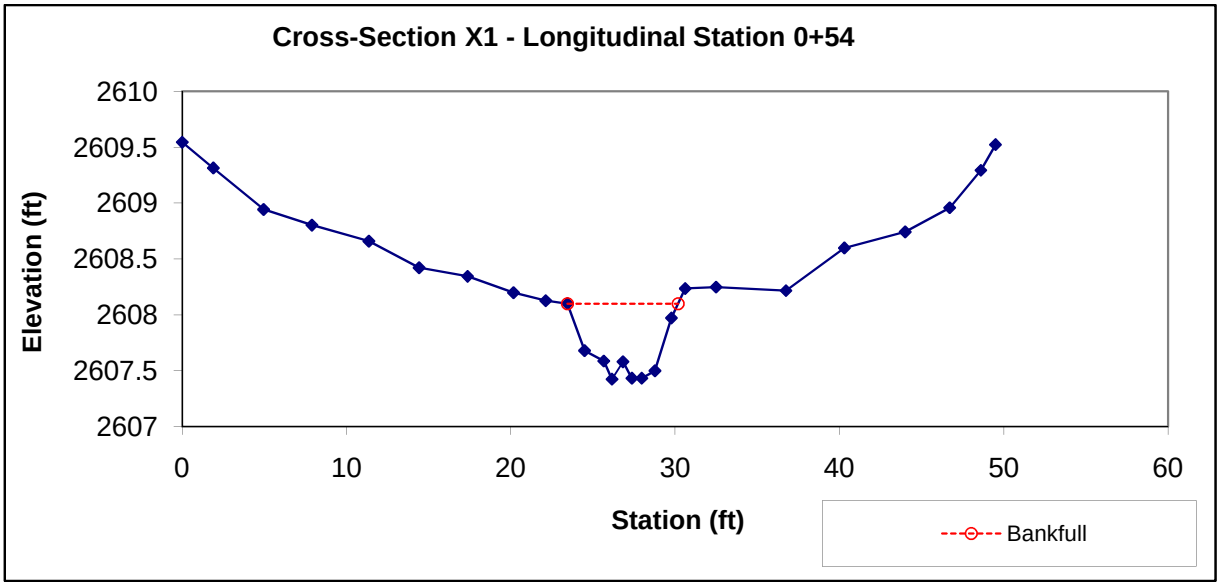


Photo 1: XS-1 facing right bank

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	Eb	3.8	6.49	0.59	0.8	11.04	1	5.8	2599.69	2599.69

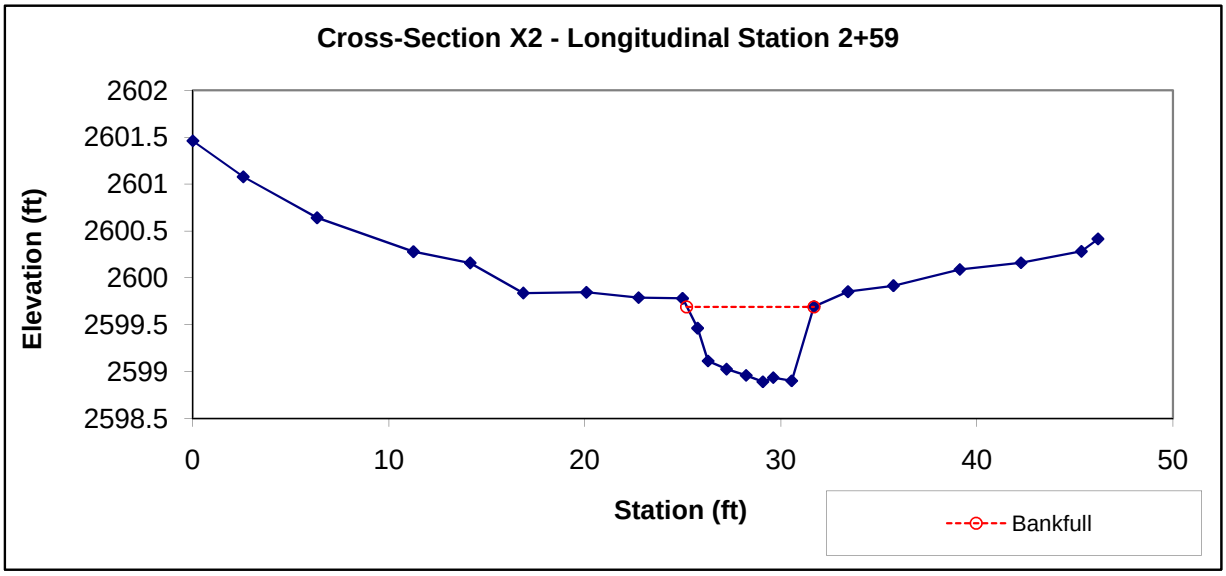


Photo 5: XS-2 facing right bank

Photo 6: XS-2 facing left bank

Photo 7: XS-2 facing upstream

Photo 8: 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
Riffle	Cb	3.6	7.25	0.5	0.71	14.52	1	4.8	2592.08	2592.08

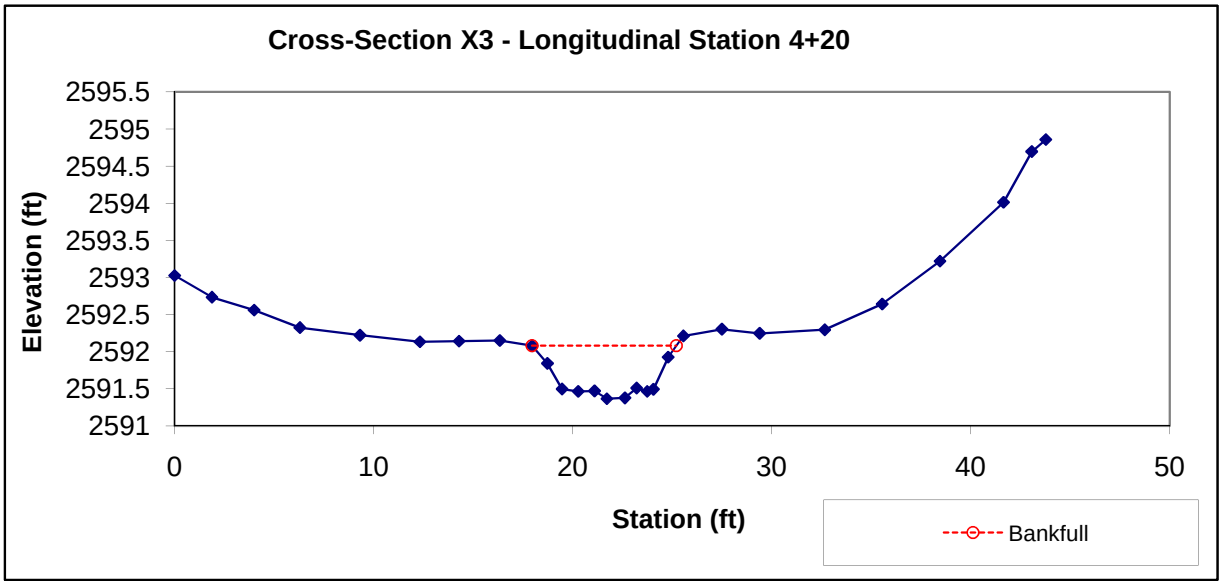


Photo 9: XS-3 facing right bank

Photo 10: XS-3 facing left bank

Photo 11: XS-3 facing upstream

Photo 12: 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
Pool	-	11.9	9.41	1.26	2.17	7.45	1	4.8	2589.92	2589.92

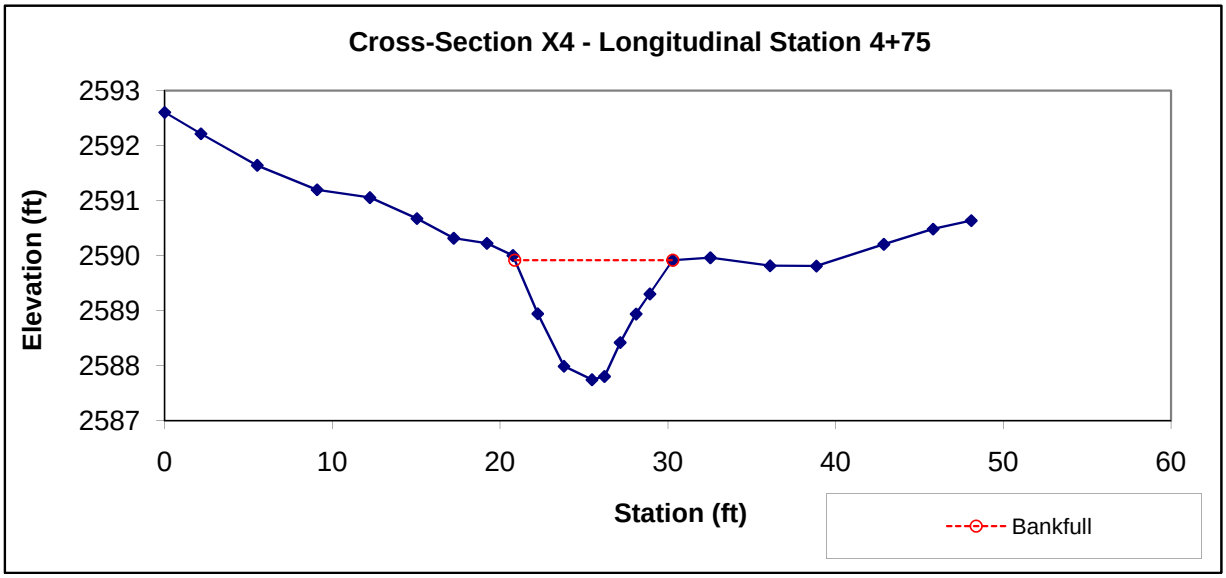
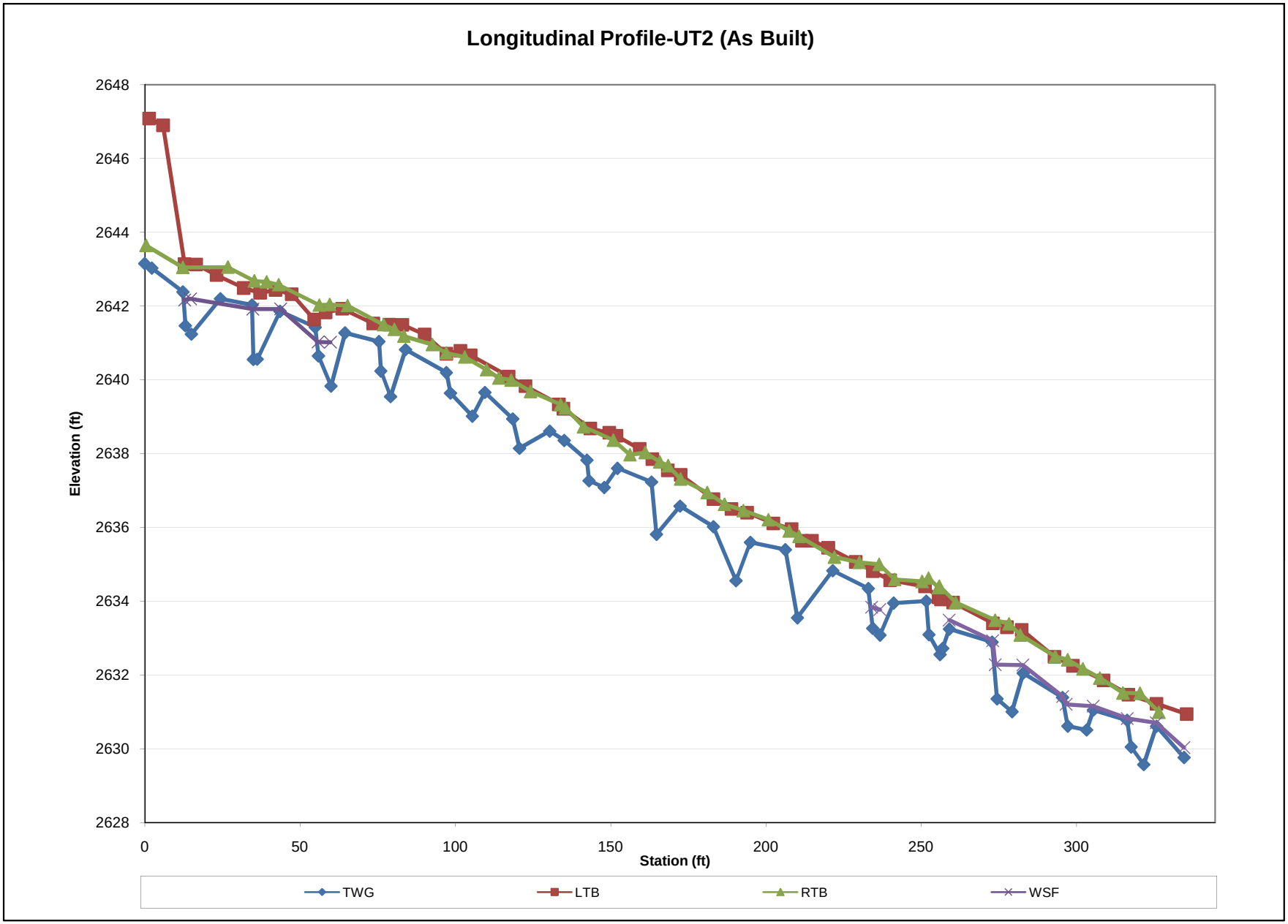


Photo 13: XS-4 facing right bank

Photo 14: XS-4 facing left bank

Photo 15: XS-4 facing upstream

Photo 16: XS-4 facing downstream


Longitudinal Profile-UT2 (As Built)
Elevation (ft)
2648
2646
2644
2642
2640
2638
2636
2634
2632
2630
2628
0
50
100
150
200
250
300
Station (ft)
TWG
LTB
RTB
WSF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Eb	2.8	5.4	0.52	0.86	10.32	1	7.2	2639.22	2639.22

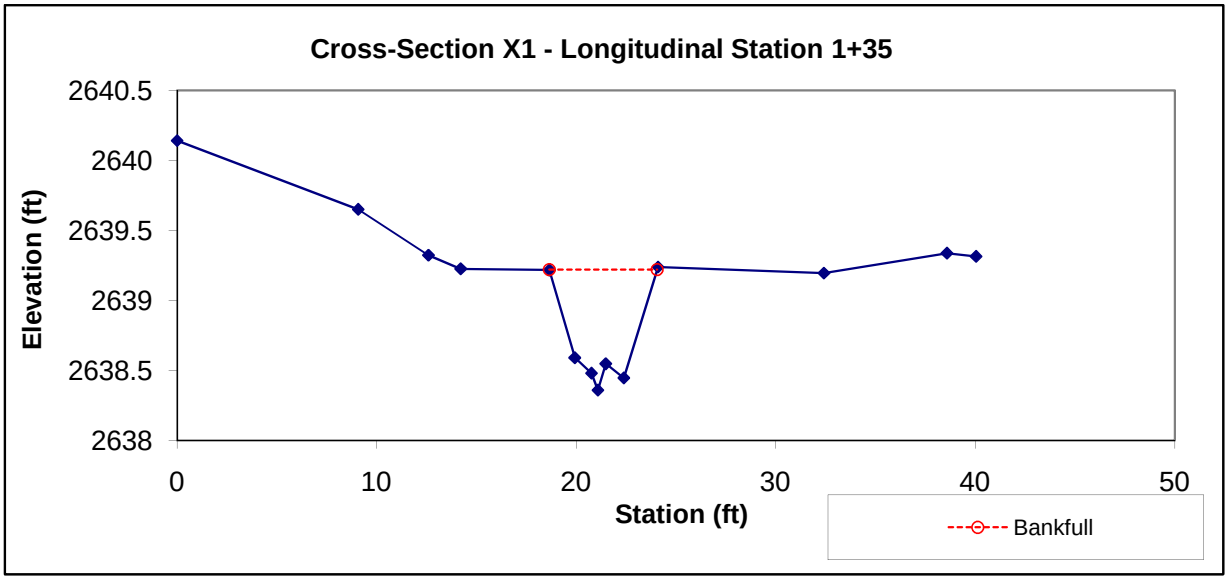


Photo 1: XS-1 facing right bank

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
Pool	-	6.6	7.92	0.83	1.49	9.54	1	4.3	2634.04	2634.04

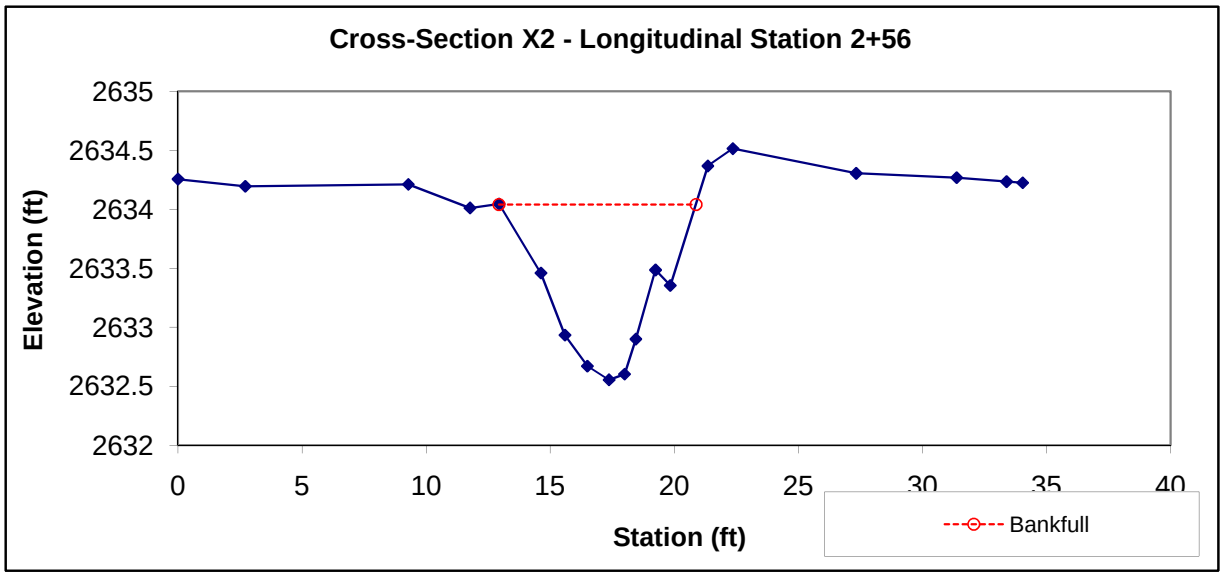


Photo 5: XS-2 facing right bank

Photo 6: XS-2 facing left bank

Photo 7: XS-2 facing upstream

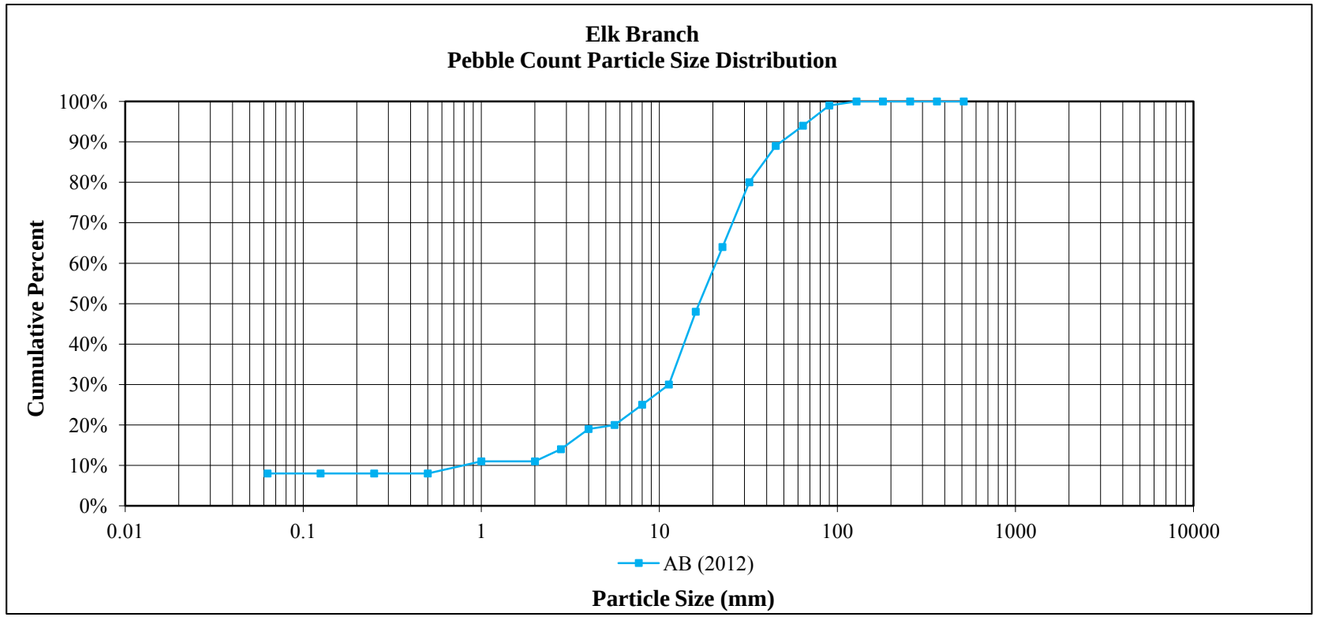
Photo 8: XS-2 facing downstream

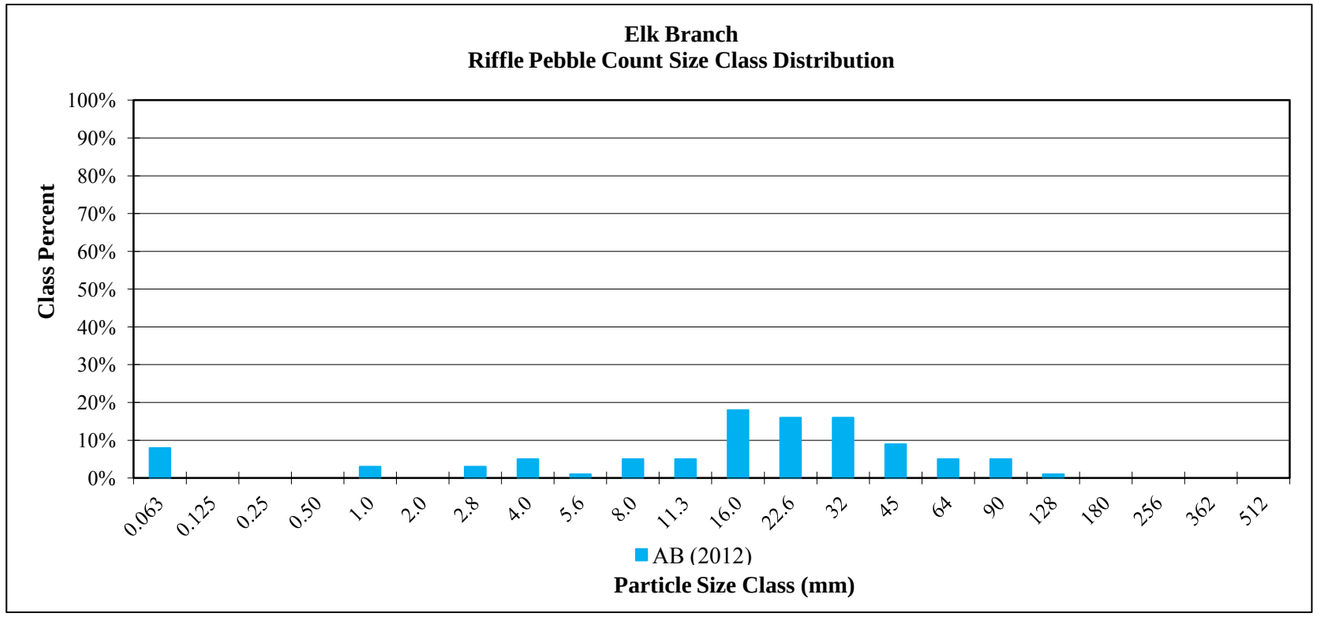
Figure B1. Elk Branch Pebble Count
Elk Branch Mitigation Project, EEP# 92665

SITE OR PROJECT:	Elk Branch
REACH/LOCATION:	Mainstem, Riffle below PPT16
FEATURE:	Riffle

			2012		
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Total**	**Class %**	**% Cum**
Silt / Clay	Silt / Clay	< .063	8	8.00	8.00
Sand	Very Fine	.063 - .125			
	Fine	.125 - .25			
	Medium	.25 - .50			
	Coarse	.50 - 1.0	3	3.00	11.00
	Very Coarse	1.0 - 2.0			
Gravel	Very Fine	2.0 - 2.8	3	3.00	14.00
	Very Fine	2.8 - 4.0	5	5.00	19.00
	Fine	4.0 - 5.6	1	1.00	20.00
	Fine	5.6 - 8.0	5	5.00	25.00
	Medium	8.0 - 11.0	5	5.00	30.00
	Medium	11.0 - 16.0	18	18.00	48.00
	Coarse	16 - 22.6	16	16.00	64.00
	Coarse	22.6 - 32	16	16.00	80.00
	Very Coarse	32 - 45	9	9.00	89.00
	Very Coarse	45 - 64	5	5.00	94.00
Cobble	Small	64 - 90	5	5.00	99.00
	Small	90 - 128	1	1.00	100.00
	Large	128 - 180			
	Large	180 - 256			
Boulder	Small	256 - 362			
	Small	362 - 512			
	Medium	512 - 1024			
	Large-Very Large	1024 - 2048			
Bedrock	Bedrock	> 2048			
Total% of Whole Count			100	100	100

Summary Data	
Channel Materials	
D_{50} =	16.71
D_{84} =	37.24
D_{95} =	68.52





Elk Branch
Photo Log - Reference Photo Points

Notes: Photos for Elk Branch were taken July 2011. Photos points 16 to 20 were taken during intermittent showers.

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 tape. For channel points, the stake is set up on an adjacent bank.

Photo Point 1: looking upstream

Photo Point 1: looking downstream

Photo Point 2: looking upstream

Photo Point 2: looking downstream

Photo Point 3: looking upstream

Photo Point 3: looking downstream

Photo Point 4: looking downstream

Photo Point 5: looking upstream

Photo Point 5: looking downstream

Photo Point 6: looking upstream

Photo Point 6: looking downstream

Photo Point 7: looking upstream

Photo Point 7: looking downstream

Photo Point 8: looking upstream

Photo Point 8: looking downstream

Photo Point 9: looking upstream

Photo Point 10: looking upstream

Photo Point 10: looking downstream

Photo Point 11: looking downstream

Photo Point 12: looking upstream

Photo Point 13: looking upstream

Photo Point 13: looking downstream

Photo Point 14: looking upstream

Photo Point 14: looking downstream

Photo Point 15: looking upstream

Photo Point 15: looking downstream

Photo Point 16: looking upstream

Photo Point 16: looking downstream

Photo Point 17: looking upstream

Photo Point 17: looking downstream

Photo Point 18: looking upstream

Photo Point 18: looking downstream

Photo Point 19: looking upstream

Photo Point 19: looking downstream

Photo Point 20: looking upstream

Photo Point 20: looking downstream

UT2 to Elk Branch
Photo Log - Reference Photo Points

Notes: Photos for UT2 to Elk Branch were taken July 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 tape. For channel points, the stake is set up on an adjacent bank.

Photo Point 1: looking upstream

Photo Point 1: looking downstream

Photo Point 2: looking upstream

Photo Point 2: looking downstream

Photo Point 3: looking upstream

Photo Point 3: looking downstream

Photo Point 4: looking upstream

Photo Point 4: looking downstream

Photo Point 5: looking upstream

UT1 to Elk Branch
Photo Log - Reference Photo Points

Notes: Photos for UT1 to Elk Branch were taken July 2011. Photos points were taken during intermittent showers.

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 tape. For channel points, the stake is set up on an adjacent bank.

Photo Point 1: looking upstream

Photo Point 1: looking downstream

Photo Point 2: looking upstream

Photo Point 2: looking downstream

Photo Point 3: looking upstream

Photo Point 3: looking downstream

Photo Point 4: looking upstream

Photo Point 4: looking downstream

Photo Point 5: looking upstream

APPENDIX C
VEGETATION SUMMARY DATA:
TABLES 1-6
VEGETATION PHOTO LOG

Table C1. Vegetation Metadata
Elk Branch Mitigation Project-#92665

Report Prepared By	Carmen Horne-McIntyre
Date Prepared	1/19/2012 14:03
database name	cvs-eep-entrytool-v2.2.7_Dec 2011.mdb
database location	L:\Monitoring\Monitoring Guidance\Vegetation\CVS EEP Entrytool V2.2.7
computer name	ASHEWCMCINTYR
file size	89882624

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------

Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes and all planted stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.

PROJECT SUMMARY----------

Project Code	92665
project Name	Elk Branch Mitigation Project
Description	Restoration or enhancement of approximately 3,090 lf.
River Basin	French Broad
length(ft)	3090
stream-to-edge width (ft)	30
area (sq m)	17222.48
Required Plots (calculated)	6
Sampled Plots	6

Table C2. Vegetation Vigor by Species
Elk Branch Mitigation Project-#92665

	Species	CommonName	4	3	2	1	0	Missing	Unknown
	Betula nigra	River birch	3						
	Carya ovata	Shagbark hickory	17						
	Corylus americana	American hazelnut	1						
	Diospyros virginiana	Common persimmon	3						
	Vaccinium	Blueberry	1						
	Quercus rubra	Northern red oak	5						
	Lindera benzoin	Northern spicebush	4						
	Liriodendron tulipifera	Tuliptree	4						
	Platanus occidentalis	American sycamore	8						
	Acer rubrum	Red maple	19						
TOT:	**11**	**11**	**65**						

Table C3. Vegetation Damage by Species
Elk Branch Mitigation Project-#92665

	Species	CommonName	Count of Damage Categories	(no damage)
	Acer rubrum	Red maple	0	19
	Betula nigra	River birch	0	3
	Carya ovata	Shagbark hickory	0	17
	Corylus americana	American hazelnut	0	1
	Diospyros virginiana	Common persimmon	0	3
	Lindera benzoin	Northern spicebush	0	4
	Liriodendron tulipifera	Tuliptree	0	4
	Platanus occidentalis	American sycamore	0	8
	Quercus rubra	Northern red oak	0	5
	Vaccinium	Blueberry	0	1
TOT:	**11**	**11**	**0**	**65**

Table C4. Vegetation Damage by Plot
Elk Branch Mitigation Project-92665

	plot	Count of Damage Categories	(no damage)
	92665-CHM/MR-0001	0	17
	92665-CHM/MR-0002	0	9
	92665-CHM/MR-0003	0	7
	92665-CHM/MR-0004	0	10
	92665-CHM/MR-0005	0	9
	92665-CHM/MR-0006	0	13
TOT:	**6**	**0**	**65**

Table C5. Vegetation Damage by Plot and Species
Elk Branch Mitigation Project-92665

	Comment	Species	CommonName	Total Planted Stems	# plots	avg# stems	plot 92665-CHM/MR-0001	plot 92665-CHM/MR-0002	plot 92665-CHM/MR-0003	plot 92665-CHM/MR-0004	plot 92665-CHM/MR-0005	plot 92665-CHM/MR-0006
		Acer rubrum	Red maple	19	5	3.8	6	5	1	1		6
		Betula nigra	River birch	3	2	1.5	2	1				
		Carya ovata	Shagbark hickory	16	6	2.67	6	2	1	3	1	4
		Corylus americana	American hazelnut	1	1	1	1					
		Diospyros virginiana	Common persimmon	3	3	1	1	1			1	
		Lindera benzoin	Northern spicebush	4	3	1.33			1	1	2	
		Liriodendron tulipifera	Tuliptree	4	4	1	1		1	1	1	
		Platanus occidentalis	American sycamore	8	4	2			2	4	1	1
		Quercus rubra	Northern red oak	5	2	2.5					3	2
		Vaccinium	Blueberry	1	1	1			1			
TOT:	**0**	**11**	**11**	**65**	**11**		**17**	**9**	**7**	**10**	**9**	**13**

Table C6. Stem Count Arranged by Plot- Baseline/As-Built Monitoring
Elk Branch Mitigation Site Project #92665

Tree Species	Common Name	Type	Current Data (AB 2012)												Annual Means									
			Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6		Current Mean		MY1 (2012)		MY2 (2013)		MY3 (2014)		MY4 (2015)		MY5 (2016)	
			P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Acer rubrum	Red Maple	Tree	6	6	5	5	1	1	1	1			6	6	3.8	3.8										
Betula nigra	River Birch	Tree	2	2	1	1									1.5	1.5										
Carpinus caroliniaun	Ironwood	Tree																								
Carya ovata	Shagbark Hickory	Tree	6	6	2	2	1	1	3	3	1	1	4	4	2.8	2.8										
Cornus florida	Flowering Dogwood	Tree																								
Corylus amerciana	Hazelnut	Tree	1	1											1.0	1.0										
Diospyros virginiana	Persimmon	Tree	1	1	1	1					1	1			1.0	1.0										
Lindera benzoin	Spicebush	Tree					1	1	1	1	2	2			1.5	1.3										
Liriodendron tulipfera	Tulip Poplar	Tree	1	1			1	1	1	1	1	1			1.0	1.0										
Nyssa sylvatica	Blackgum	Tree																								
Platanus occidentalis	Sycamore	Tree					2	2	4	4	1	1	1	1	2.0	2.0										
Quercus alba	White Oak	Tree																								
Quercus rubra	Red Oak	Tree									3	3	2	2	2.5	2.5										
Shrub Species																										
Alnus serrulata	Tag Alder	Tree																								
Calycanthus floridus	Sweetshrub	Shrub																								
Sambucus canadensis	Elderberry	Tree																								
Vaccnium	Highbush blueberry	Shrub					1	1							1.0	1.0										
P=Planted	Plot area (acres)		0.025		0.025		0.025		0.025		0.025		0.025													
T=Total	Species Count		6	6	4	4	5	5	5	5	6	6	4	4	5.0	5.0										
	Planted Stems/Plot		17	17	9	9	7	7	10	10	9	9	13	13	10.8	10.8										
	Planted Stems Per Acre		688	688	364	364	283	283	405	405	364	364	526	526	432	432										

Elk Branch Mitigation Project
Photo Log - Vegetation Plot Photo Points

Notes:

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.

1/18/2012

Photo 1: Veg Plot 1

1/18/2012

Photo 2: Veg Plot 1: Herbaceous Plot

1/18/2012

Photo 3: Veg Plot 2

1/18/2012

Photo 4: Veg Plot 2: Herbaceous Plot

1/18/2012

Photo 5: Veg Plot 3

1/18/2012

Photo 6: Veg Plot 3: Herbaceous Plot

1/18/2012

Photo 7: Veg Plot 4

1/18/2012

Photo 8: Veg Plot 4: Herbaceous Plot

1/18/2012

Photo 9: Veg Plot 5

1/18/2012

Photo 10: Veg Plot 5: Herbaceous Plot

1/18/2012

Photo 11: Veg Plot 6

1/18/2012

Photo 12: Veg Plot 6: Herbaceous Plot