FINAL

Baseline Monitoring Document and As-Built Baseline Report

UT to Town Creek Restoration Project – Option A

Stanly County, North Carolina

DMS Project ID No. 94648; NCDEQ Contract No. 003277

SAW-2013-01280; DWR# 14-1024

Yadkin Pee-Dee River Basin: 03040105060040

Prepared for:

NC Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

Data Collection Period – February – June 2016

Submission Date – Nov 2016

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1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc., (Baker) restored 5,554 linear feet (LF) and enhanced 791 LF (447 LF of Enhancement I and 344 LF of Enhancement II) of perennial and intermittent stream along an Unnamed Tributary (UT) to Town Creek and three additional unnamed tributaries. Also as part of this Project, Baker restored, created, and enhanced 5.12 acres of riparian wetlands and constructed two stormwater wetland best management practices (BMPs) upstream of the mitigation areas. In addition, Baker planted 25.1 acres of native riparian vegetation within the recorded conservation easement. Both BMPs are included in the conservation easement. Though no mitigation credit is being sought for wetland enhancement, additional stream mitigation credit is being sought for the inclusion of the proposed stormwater BMPs and the extended riparian buffer width within the conservation easement.

UT to Town Creek Restoration Project – Option A (Site) is located in Stanly County, approximately 1.7 miles west of the Town of New London, within cataloging unit 03040105 of the Yadkin Pee-Dee River Basin (see Figure 1). The Site is located in a North Carolina Division of Mitigation Services (NCDMS) - Targeted Local Watershed (03040105060040). The Project involved stream restoration and enhancement, as well as wetland restoration, creation, and enhancement along UT to Town Creek and several of its tributaries, which had been impaired due to historical pasture conversion and cattle grazing.

Based on both the River Basin Restoration Priorities (RBRP) document for the Lower Yadkin – Pee Dee River Basin (NCEEP, 2009) and the Yadkin-Pee Dee River Basinwide Water Quality Plan (NCDENR, 2008), many streams in the Rocky River Watershed (03040105) are documented as impaired or impacted due to habitat degradation. Stressors identified in the plan include impervious surfaces, sedimentation and erosion from construction, general agriculture, and other land disturbing activities. As stated in the Yadkin-Pee Dee River Basinwide Water Quality Plan, the project watershed naturally consists of erodible soils; therefore, increasing the system's vulnerability to the aforementioned stressors.

The primary goals of the Project were to improve aquatic habitat degradation by improving ecologic functions and reducing non-points source loads from agricultural run-off to the impaired areas as described in the Lower Yadkin – Pee Dee RBRP and as identified below:

- Improve aquatic and terrestrial habitat through increasing dissolved oxygen concentrations, reduction in nutrient and sediment loading, improving substrate and in-stream cover, and reduction of in-stream water temperature;
- Improve both aquatic and riparian aesthetics;
- Create geomorphically stable conditions along UT to Town Creek and its tributaries through the Project area;
- Prevent cattle from accessing the Project area thereby protecting riparian and wetland vegetation and reducing excessive bank erosion;
- Restore historical wetlands, create new wetlands, and enhance/preserve existing wetlands to improve terrestrial habitat and reduce sediment and nutrient loading to UT to Town Creek and the Little Long Creek Watershed.

To accomplish these goals, the following objectives were identified:

- Restore, enhance, create, and protect riparian wetlands and buffers to reduce nutrient and pollutant loading by particle settling, vegetation filtering and nutrient uptake;

- Construct wetland BMPs on the upstream extent of Reaches 4 and 7 to improve water quality by capturing and retaining stormwater run-off from the adjacent cattle pastures to allow for the biological removal of nutrient pollutant loads and for sediment to settle out of the water column;
- Restore existing incised, eroding, and channelized streams by creating stable channels with access to their geomorphic floodplains;
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools and areas of water re-aeration, and reducing bank erosion;
- Control invasive species vegetation within the Project reaches;
- Establish native stream bank, riparian floodplain, and wetland vegetation, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve bank stability, shade the stream to decrease water temperature, and provide improved wildlife habitat quality.

This report documents the completion of the restoration construction activities and presents as-built monitoring data for the post-construction monitoring period. Table 1 summarizes the project components and mitigation credit assets and is located in Appendix A.

2.0 PROJECT GOALS, BACKGROUND AND ATTRIBUTES

2.1 Project Location and Description

The Site is located in Stanly County, NC, approximately 1.7 miles west of the Town of New London, as shown on the Vicinity Map (Figure 1). The Project is located within the Yadkin-Pee Dee River Basin and the North Carolina Division of Mitigation Services (NCDMS) - Targeted Local Watershed 03040105060040. The Project is located in the Piedmont physiographic region within the Carolina Slate Belt and includes an Unnamed Tributary (UT) to Town Creek, three of its headwater unnamed tributaries, and seven riparian wetlands. The four UTs were divided into seven individual Reaches (R1, R2, R3, R4, R5, R6, and R7) as shown in Figure 2.

The United States Geologic Survey (USGS) topographic quadrangle maps (Richfield and New London) depict UT to Town Creek (Reaches R1, R2, and R3) as solid blue-line stream, along its entire length within the project limits. Though the topographic quadrangle maps do not depict UT to Town Creek's smaller tributaries (Reaches R4, R5, R6, and R7) with either a solid or a dashed blue line, the topographic crenulations depicted on the quadrangle maps clearly define the hydrologic watercourse of each reach. Preliminary field investigations determined that Reaches R1, R2, and R3 are perennial streams, while Reaches R4, R5, R6, and R7 are intermittent channels. On-site field investigations were confirmed during an on-site jurisdictional determination field review with the United States Army Corps of Engineers (USACE). The jurisdictional determination was approved on July 17, 2013.

Based on both the RBRP document for the Lower Yadkin – Pee Dee River Basin (NCEEP, 2009) and the Yadkin-Pee Dee River Basinwide Water Quality Plan (NCDENR, 2008), many streams in the Rocky River Watershed (03040105) are documented as impaired or impacted due to habitat degradation. Stressors identified in the plan include impervious surfaces, sedimentation and erosion from construction, general agriculture, and other land disturbing activities.

2.2 Site Directions

To access the Site from Raleigh, take I-40 West toward Sanford/Wake Forest. Take Exit 293 (I-440/US-64 W/US-1) toward Sanford/Wake Forest. Keep left at the fork toward US-1 S/US-64 W. Take Exit 293A for US-1 S/US-64 W toward Sanford/Asheboro. Keep left at the fork toward US-1 S/US-64 W. Continue on US-1 S/US-64 W towards Apex/Sanford/Asheboro. Take exit 98B to merge onto US-64 W towards Pittsboro/Asheboro. After 62 miles, turn left onto Connector Rd. Turn right onto NC 49 S. After 28.4 miles, take a slight left onto N Main St. After 1.1 miles, turn left onto Old Salisbury Rd. Follow Old Salisbury Rd. for approximately 2.0 miles to its intersection with Misenheimer Rd. / Steakhouse Rd. Go through the intersection and continue on Old Salisbury Rd. for approximately 0.4 miles and the Site is on the right accessed via a dirt farm road.

2.3 Project Goals and Objectives

The primary goals of the Project are to improve aquatic habitat degradation by improving ecologic functions and reducing non-points source loads from agricultural run-off to the impaired areas as described in the Lower Yadkin – Pee Dee RBRP and as identified below:

- Improve aquatic and terrestrial habitat through increasing dissolved oxygen concentrations, reduction in nutrient and sediment loading, improving substrate and in-stream cover, and reduction of in-stream water temperature;
- Improve both aquatic and riparian aesthetics;

- Create geomorphically stable conditions along UT to Town Creek and its tributaries through the Project area;
- Prevent cattle from accessing the project area thereby protecting riparian and wetland vegetation and reducing excessive bank erosion;
- Restore historical wetlands, create new wetlands, and enhance/preserve existing wetlands to improve terrestrial habitat and reduce sediment and nutrient loading to UT to Town Creek and the Little Long Creek Watershed.

To accomplish these goals, the Project incorporated the following objectives:

- Restore, enhance, create, and protect riparian wetlands and buffers to reduce nutrient and pollutant loading by particle settling, vegetation filtering and nutrient uptake;
- Construct wetland BMPs on the upstream extent of Reaches 4 and 7 to improve water quality by capturing and retaining stormwater run-off from the adjacent cattle pastures to allow for the biological removal of nutrient pollutant loads and for sediment to settle out of the water column;
- Restore existing incised, eroding, and channelized streams by creating stable channels with access to their geomorphic floodplains;
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools and areas of water re-aeration, and reducing bank erosion;
- Control invasive species vegetation within the project reaches;
- Establish native stream bank, riparian floodplain, and wetland vegetation, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve bank stability, shade the stream to decrease water temperature, and provide improved wildlife habitat quality.

3.0 PROJECT STRUCTURE, RESTORATION TYPE AND APPROACH

3.1 Project Components

The Project area consists of the restoration and enhancement of an UT to Town Creek and three of its headwater tributaries and the restoration, enhancement, and creation of 5.12 acres riparian wetlands. The Project is located in the Carolina Slate Belt Level IV Ecoregion of the Piedmont physiographic region. For assessment and design purposes, the four UTs were divided into seven individual Reaches (R1, R2, R3, R4, R5, R6, and R7). Two stormwater wetland BMPs were constructed upstream of the mitigation areas and native species riparian buffer vegetation was established and/or protected at least 50 feet from the top of both bank along all project reaches and at least 30 feet from the top of bank of each BMP. Lastly, cattle were excluded along all project reaches, headwater wetlands, and BMPs located within the conservation easement with the installation of permanent fencing. The reach designations have remained in the same order to be consistent throughout the document.

3.2 Restoration Approach

Based on the post-construction as-built survey, the Project consisted of the following: 1,204 LF of Priority I Restoration on R1, 1,782 LF of Priority I Restoration on R2, 829 LF of Priority I Restoration on R3, 447 LF of Enhancement I on R4, 344 LF of Enhancement II on R5, 1,340 LF of Priority I Restoration on Reach R6, and 399 LF of Priority I Restoration on R7. A recorded conservation easement consisting of 25.1 acres protects and preserves all stream reaches, wetland areas, BMPs, and riparian buffers in perpetuity.

The Project involved the restoration and enhancement of a Rural Piedmont Stream System (NC WAM 2010, Schafale 2012) which had been impaired due to past agricultural conversion and cattle grazing. Restoration practices involved raising the existing streambed and reconnecting the stream to the relic floodplain, and restoring natural flows to areas previously drained by ditching activities. The existing channels abandoned within the restoration areas were partially to completely filled to decrease surface and subsurface drainage and raise the local water table. Permanent cattle exclusion fencing was provided around all proposed reaches, wetland areas, and riparian buffers.

The vegetative components of this Project included stream bank, floodplain, wetland, and transitional upland planting and described as the riparian buffer zone. The Site was planted with native species riparian buffer vegetation as shown in Table 8 and Table 9 (Appendix C) and now protected through a permanent conservation easement. Table 1 and Figure 2 (Appendix A) provide a summary of the Project components.

3.2.1 Reach 1 Restoration

A Priority Level I restoration approach was implemented along R1 to provide floodplain reconnection and promote long-term channel stability. In its existing condition, the reach was incised and eroding. The channel improvements began at Station 10+00 and tied into an existing 84-inch corrugated metal pipe (CMP) at Misenheimer Road. From there a new off-line 'C4' stream type was constructed to restore floodplain connectivity, provide stream bed and bank stability, improve transport of sediment and water quality, improve existing wetland hydrology, provide hydrology to restored wetlands and provide habitat and bedform diversity. In-stream structures included constructed riffles for grade control and aquatic habitat, log vanes, rock j-hooks, and bio-engineering practices (vegetated geo-lifts) for stream bed/bank stability, and habitat diversity.

At the downstream end of the reach, approximately Station 21+12, the restored channel ties into existing bedrock at proposed grade and transitions back on-line with the existing alignment, at Station 21+50. Bedrock along the channel bed continues throughout the remainder of the reach to its terminus with R2. Though no grade control or habitat type structures were implemented within this section of

the reach, contractors were able to use construction equipment to chisel out sections of rock and create streambed variability to grade throughout the section.

Channel banks were graded to stable slopes throughout the entire reach. Floodplain benches were implemented along the upstream extent of the reach to promote stability in areas where the channel lies close to the toe of slope and to provide a floodplain along the reach while the stream is being transitioned up to the historic floodplain.

The existing, unstable channel was partially to completely filled along its length using fill material excavated from construction of the restored channel.

Riparian buffers in excess of 50 feet were restored along all of R1. No stream crossing or breaks in the easement were implemented along this reach; however, permanent fencing was installed outside the conservation easement to exclude cattle access to the creek.

3.2.2 Reach 2 Restoration

Work along Reach 2 involved Priority Level I Restoration throughout its entirety from its inception at the confluence of Reach 7 (Station 22+04) and termination at the confluence of R6 (Station 40+46). Bedrock along the channel bed continues from Reach 1 to Station 27+75 of Reach 2.

R2 was constructed from its upstream extent to Station 24+75 along the existing alignment throughout a large meander to Station 24+75. Downstream of Station 24+75, the floodplain widens and flattens, which allowed for the stream to transition off-line and into a 'C4' stream type throughout the remainder of the reach. Restoration activities throughout the reach restored floodplain connectivity, provided stream bed and bank stability, improved transport of sediment and water quality, improved existing wetland hydrology, provided hydrology to restored and created wetlands and provided habitat and bedform diversity. In-stream structures included constructed riffles for grade control and aquatic habitat, log vanes, log weirs, rock j-hooks, and vegetated geo-lifts for stream bed/bank stability and habitat diversity. Channel banks were graded to stable slopes throughout the entire reach.

To allow for farm access from Old Salisbury Road, Reach 2 is divided by a sixty-foot existing farm road crossing located between Station 34+05 and 34+65. Based on hydraulic analysis, the existing 42-inch CMP at this crossing was undersized; therefore, to meet capacity requirements and ensure the integrity of the crossing, the culvert was replaced with two 48-inch reinforced concrete pipes (RCPs) and a 42-inch bankfull RCP.

The existing, unstable channel was partially to completely backfilled along its length in areas where the constructed channel transitioned off-line. Backfill was comprised of material excavated from construction of the restored channel.

Invasive species vegetation such as parrotfeather (*Myiophyllum aquaticum*) and multi-flora rose (*Rosa multiflora)* were removed and/or treated within the conservation easement along R2. As previously noted, one 60-foot stream crossing, as well as an easement break, were included approximately mid-way along R2. Permanent fencing and crossing gates were installed outside the conservation easement to exclude cattle access to the creek.

3.2.3 Reach R3 Restoration

Reach 3 begins at the confluence of Reaches 2 and 6. Work within this reach consisted of Rosgen Priority Levels I and II Restoration approaches. A new off-line, 'C4' stream type was constructed to allow the channel to meander across the valley and reconnect to its original floodplain. Channel banks were graded to stable slopes throughout the entire reach. Floodplain grading was implemented towards the lower end of Reach 3, where the channel must transition down to the existing bed elevation (Shallow Rosgen Priority Level II approach).

In addition to restoring floodplain connectivity and hydrology throughout the reach, restoration activities provided stream bed and bank stability, improved transport of sediment and water quality, and provided habitat and bedform diversity. In-stream structures included constructed riffles for grade control and aquatic habitat, log vanes, log weirs, rock j-hooks, and vegetated geo-lifts for stream bed/bank stability and habitat diversity.

The existing, unstable channel was partially to completely backfilled along its length in areas where the constructed channel transitioned off-line. Backfill was comprised of material excavated from construction of the restored channel.

Riparian buffers in excess of 50-feet were restored along all of Reach 3. No stream crossings or breaks in the easement were implemented along this reach. As in R2, fencing was installed outside of the conservation easement to exclude cattle from entering the restored streams.

3.2.4 Reach 4 Enhancement

Reach 4 begins at the outlet of a constructed wetland and continues to its confluence with Reach 5 (the beginning of Reach 6). A 'B4' stream type was constructed to restore the appropriate dimension and profile. Reach 4 was constructed on-line with minimal pattern changes; however, due to intermittent flows and the abundance of available on-site rock material, the on-site Construction Engineer decided to use rock in lieu of logs for the grade control structures along this reach. Therefore, in-stream structures, such as constructed riffles, grade-control rock j-hooks, rock step-pools, and boulder sills were placed in key locations to aid in dissipating stream flow energy, control grade, enhance pool-to-pool spacing, and improve the quality of pool habitat present and bedform diversity. Floodplain benches were installed and integrated with local topography where feasible along the reach.

Riparian buffers in excess of 50-feet were restored or protected along all of R4. Invasive species vegetation such as Chinese privet (*Ligustrum sinese*) and multi-flora rose (*Rosa multiflora)* were removed and/or treated along the reach in areas where existing riparian vegetation was left undisturbed. No stream crossing or breaks in the easement were implemented along this reach; however, permanent fencing was installed outside the conservation easement to exclude cattle access to the creek as well as the upstream water quality constructed wetland.

3.2.5 Reach 5 Enhancement

Reach 5 is a small intermittent tributary that originates northwest of Reach 6 and terminates at its confluence with Reach 4. Reach 5 was vertically stable upstream of a large headcut located just below a bedrock knickpoint at Station 11+90; however, the bedform diversity and bank stability along the entire reach was highly degraded do to cattle access to the channel. Therefore, Enhancement Level II practices were implemented along Reach 5. Boulder steps were installed to hold grade, dissipate flow energies, and improve the quality of pool habitat, and eroding banks were stabilized.

No stream crossing or breaks in the easement were implemented along this reach; however, permanent fencing was installed along the conservation easement to permanently restrict cattle access to the restored stream. Invasive species vegetation was treated and the riparian buffer was planted with native vegetation.

3.2.6 Reach 6 Restoration

Reach 6 begins at the confluence of Reaches 4 and 5. A Rosgen Priority Level I Restoration approach was implemented on this reach. The majority of the channel was constructed as a 'C4' type channel and in-line with the existing alignment. However at Station 25+50, the channel slope drops as it approaches the wider and flatter floodplain of the mainstem; therefore, the channel was constructed off-line for this section of the reach. This allowed the channel to meander across the valley as it reconnects to its floodplain. Channel banks were graded to stable slopes throughout the entire reach.

Multiple areas of bedrock along the channel bed and outcrops were present along Reach 6, making the installation of some grade control structures unnecessary and some habitat structures difficult. Therefore, in-stream structures, were installed where needed and feasible with instruction from the on-site Construction Engineer. As in Reach 4, the Construction Engineer opted to use boulder structures in lieu of logs, because of the intermittent nature of the stream's base flow and the abundance of available on-site rock.

Restoration activities used throughout the reach were implemented to maintain channel grade and sediment transport functions while increasing habitat through bedform diversity. In-stream structures consisted of constructed riffles, boulder sills, and rock j-hooks for grade control and aquatic habitat, and vegetated geo-lifts for stream bed/bank stability and habitat diversity.

To accommodate Natural Resources Conservation Service (NRCS) water system requirements for cattle management, pasture rotation, and large farm equipment access, a culverted crossing (48-inch RCP) was installed along Reach 6. The crossing is located at Station 20+30 and allows cattle to move from pastures on opposite sides of the conservation easement, thus reducing the distances traveled to other areas of the farm. The culverted crossing on Reach 6 has been removed from the as-built restoration length and the associated SMU adjustment has been accounted for in the stream credit calculations as shown in Table 1.

Riparian buffers in excess of 50-feet were restored or protected along all of R6. Invasive species vegetation such as Chinese privet (*Ligustrum sinese*) and multi-flora rose (*Rosa multiflora)* were removed and/or treated along the reach in areas where existing riparian vegetation was left undisturbed. Permanent fencing was installed outside the conservation easement to exclude cattle access to the creek as well as the upstream water quality constructed wetland. Gates were installed at the cattle crossing to prevent cattle access when the crossing is not in use.

3.2.7 Reach 7 Restoration

Reach 7 begins at the outlet of a constructed wetland and continues to its confluence with Reach 1. A Rosgen Priority Level I Restoration approach was implemented along this reach. A 'B4' type channel was constructed keeping mostly in-line with its existing alignment, while restoring channel dimension and profile. In-stream structures were placed in key locations to maintain channel grade and sediment transport functions, aid in dissipating stream flow energy, enhance pool-to-pool spacing, and improve the quality of pool habitat present. Channel dimensions were adjusted to create an appropriately sized bankfull channel, while eroding banks were stabilized.

Non-native, invasive species vegetation were removed and/or treated, while riparian buffer vegetation was restored along all of R7 from the planting of native vegetation and the implementation of a conservation easement. No stream crossings or breaks in the easement were implemented along this reach; however, permanent fencing was installed outside the conservation easement to exclude cattle access to the creek as well as the upstream water quality constructed wetland.

3.3 Wetland Restoration and Creation Approach

Wetland restoration and creation areas were based upon the type of soil unit identified in the *Hydric Soil Investigation Report*, hydrologic results, and the soil borings, located in the Project's Mitigation Plan. Vertical adjustment of the channel's profile from Priority I Restoration restored floodplain hydrology and raised the surrounding groundwater elevation, while minor floodplain grading, 12-inches or less for restoration areas and greater than 12-inches for creation areas (NCIRT, 2013), removed excess floodplain fill; therefore, improving surface hydrologic inputs to wetlands. Non-native, invasive species vegetation were removed and/or treated. Planting of native wetland species vegetation and permanent cattle exclusion was also implemented throughout the wetland restoration, creation, and enhancement areas. These areas are included within the Project's conservation easement and will be protected in perpetuity.

3.4 Constructed Stormwater Wetland BMPs

Constructed stormwater wetland BMPs located at the upstream extent of Reaches 4 and 7 were installed to treat stormwater runoff from their contributing watersheds. These watersheds are likely contributing high nutrient and fecal coliform loads to UT to Town Creek. BMPs were constructed to detain 1-inch of stormwater runoff for approximately 48-hours to help remove these pollutants.

Design features include V-Notch weirs, wetland and littoral shelf vegetation plantings, and an emergency spillway. Both constructed wetlands are included in the Project's conservation easement and fencing encompasses their perimeters to exclude cattle access.

3.5 Project History, Contacts, and Attribute Data

Baker implemented the Project under a full delivery contract with NCDMS to provide stream and wetland mitigation credits in the Yadkin – Pee Dee River Basin. The chronology of the Project is presented in Table 2. The contact information for all designers, contractors, and relevant suppliers is presented in Table 3. Relevant project background information is presented in Table 4. Tables 2, 3, and 4 are located in Appendix A of this report. As-built stationing is outlined in the Construction Summary, below, and in Table 1 in Appendix A.

3.5.1 Construction Summary

In accordance with the approved Mitigation Plan and regulatory permits (i.e., 401/404, Sedimentation and Erosion Control), construction activities began in July 2015 with site preparation, installation of sedimentation and erosion control measures, and the establishment of staging areas, haul roads, and stockpile areas. The construction contractor was Wright Contracting, LLC. (Wright). Materials were stockpiled as needed for the initial stages of construction. Suitable channel fill material and alluvium was harvested on-site from existing spoil piles and within the existing streambed. The floodplain was graded to promote the re-establishment of hydrologic connectivity to the floodplain and riparian wetlands, before tying into existing grades, where necessary. Construction equipment was equipped with Topcon GPS units to allow for the quick layout of the design plan for channel work and floodplain grading; however, survey grade stakes were also set along the extents of the floodplain and limits of disturbance to aid the grading activities. Since construction activities began during the growing season of the NC Piedmont, vegetation installation of vegetated geo-lifts, live stakes, and bare root areas were delayed until after the onset of the dormant season (November 15).

Actual in-stream structure location, placement, and type varied slightly from the design plans in various sections due to exposed bedrock, as well as to promote bedform diversity, increase vertical stability, and maintain structure integrity. Additional rock lined channels and matted grass swales, not shown on the Mitigation Plan, were incorporated within the floodplain of Reach 1, Reach 2, and Reach 6. Originally, it wasn't anticipated that discharges from natural and stormwater drainages into the project floodplain would lead to stream bank instability; however, after multiple large rain events, it was determined that these measures were necessary to maintain the restored channel's integrity.

Construction began on the upstream portion of Reach 1 at Station 10+00 by tying into an existing 84-inch CMP at Misenheimer Road and proceeded downstream towards the confluence of Reach 7 and the beginning of Reach 2. The work involved the construction of a defined single thread channel that was built mostly offline, using a pump around operation, to Station 21+12 where the channel ties into existing bedrock at proposed grade and transitions back on-line with the existing alignment. Bedrock along the channel bed continues throughout the remainder of the reach to its terminus with R2. Though no grade control or habitat type structures were implemented within this section of the reach, contractors were able to use construction equipment to chisel out sections of rock and create streambed variability to grade throughout the section.

A floodplain bench was incorporated along the right stream bank from Station 10+25 to 11+25 to increase floodplain relief due to the channel's proximity to the toe of slope. Reach 1 was built with channel meanders and riffle-pool sequences, as well as a series of small grade drops to accommodate for existing constraints along the stream bed and within the floodplain such as: Steep topography, adjacent wetlands, mature hardwood trees, and existing bedrock outcrops. The existing degraded channel was filled and graded to match the design topography in the floodplain.

The new channel was reconnected with its floodplain using a Priority Level I approach and the floodplain was graded, to promote the re-establishment of hydrologic connectivity to the floodplain and riparian wetlands, while allowing higher flow energies to dissipate. Upon completion of new channel segments, in-stream structures, coir fiber matting, and permanent seeding, were installed before moving to the next section. As stated previously, vegetation planting of bio-engineered structures and stream banks were delayed until after the onset of the dormant season. The as-built length of Reach 1 is 1,204 LF.

As in Reach 1, work along Reach 2 involves Priority Level I Restoration. Bedrock along the channel bed continues from Reach 1 into Reach 2 to Station 27+75. Channel alignment from Station 22+04 to 24+75 remained on-line and followed the existing alignment throughout a large meander. As in Reach 1, no grade control or habitat type structures were implemented within this section of the reach; however, contractors were able to use construction equipment to chisel out sections of rock and create streambed variability to grade. In-stream structures were incorporated into the design around Station 27+75, where the floodplain begins to widen and flatten. Construction activities continued downstream along the Mainstem towards the culverted stream crossing on Reach 2. An undersized culverted farm crossing on Reach 2 at Station 34+05 was replaced with the installation of two 48-inch RCPs and one 42-inch RCP, designed to provide bankfull flood relief and ensure the integrity of the crossing.

Downstream of the crossing, Priority I Level design was continued throughout the remainder of Reach 2 and into Reach 3. The downstream segment of Reach 3 transitions from a Priority Level I approach to a Priority Level II. This allows the channel to step back down to its existing grade and tie into the existing channel at the project boundary.

As in Reach 1, the existing degraded channel along Reach 2 and Reach 3 was filled and graded to match the design topography and promote the re-establishment of hydrologic connectivity to the floodplain and riparian wetlands, while minimizing the disturbance of the wetland areas and mature hardwoods. Upon completion of new channel segments along Reach 2 and Reach 3, in-stream structures, coir fiber matting, and permanent seeding were installed before moving to the next section. Again, vegetation planting of bioengineered structures and stream banks were delayed until after the onset of the dormant season. The as-built length of Reach 2 and Reach 3 is 1,782 LF and 829 LF, respectively.

While construction was being completed along Reach 2 and Reach 3, contractors brought another construction crew to begin work on Reach 7 and its upstream constructed wetland. Prior to the excavation of the BMP, the contractor created and matted a small diversion ditch to carry "clean" water run-off around the area set aside for the BMP work. Work then began on the excavation of the BMP.

The BMP was constructed off-line from Reach 7 to act as its own sediment trap. Next the BMP's permanent pool and littoral shelf were graded to design elevations and the concrete weir was formed and poured. After the concrete had cured, the on-site Engineer verified its grade, and a riprap spillway was installed. Prior to completion, the contractor redirected the diversion ditch from around the BMP into its inlet, so it would be able to carry pollutant-laden run-off from an existing drainage swale within the surrounding pasture and outside the easement to the constructed wetland for treatment. After the construction of the BMP was completed, the contractor stabilized the area with temporary and permanent riparian seed and mulch and began work on Reach 7 at Station 10+00. Vegetative plantings were installed during the dormant season, and herbaceous plugs were installed in late May.

Construction activities continued downstream on Reach 7 to its confluence with the Mainstem at the Reach 1 and Reach 2 break. Work along Reach 7 implemented a 'B4a' stream type through Priority Level I Restoration. Due to the nature of the stream type and the narrow channel corridor, a majority of this channel was kept in its existing location, while the channel dimension and profile were restored. Grade control structures were used to maintain channel grade and sediment transport functions while increasing habitat and bedform diversity. Upon completion of new channel segments, in-stream structures, coir fiber matting, and permanent seeding, were installed before moving to Reach 5. The as-built length of Reach 7 is 399 LF. As stated previously, live stake planting were delayed until after the onset of the dormant season. Both Reach 7 and its upstream constructed wetland are included in the conservation easement and were permanently fenced from cattle access.

After completing the construction along the Mainstem through Reach 3, the construction crew moved to the upstream extent of Reach 4 to begin work on the upstream constructed wetland. Prior to the excavation of the BMP, the contractor created and matted a small diversion ditch to carry "clean" water run-off around the area set aside for the BMP work. Work then began on the excavation of the BMP.

The BMP was constructed off-line from Reach 4 to act as its own sediment trap. During construction of the BMP, contractors exposed large amounts of very rocky soils and bedrock along the bed and side slopes of the wetland. Though difficult, the majority of the permanent pool and littoral shelf were excavated to grade, with on minor inflections of +/- 1-foot along the bottom. Grading, though challenging, was met in areas were rock was exposed along the side slopes. After excavation of the BMP was completed, the concrete weir was formed. Due to excessive rainfall, pouring of the weir was delayed slightly; therefore, the riprap spillway was installed first, then the concrete weir was poured, allowed to cure, and the on-site Engineer verified its grade.

Prior to completion, the contractor redirected the diversion ditch from around the BMP into its inlet, so it would be able to carry pollutant-laden run-off from an existing drainage swale within the surrounding pasture and outside the easement to the constructed wetland for treatment. After the construction of the BMP was completed, the contractor stabilized the area with temporary and permanent riparian seed and mulch and began work on Reach 4 at Station 10+00. Vegetative plantings were installed during the dormant season, and herbaceous plugs were installed in late March.

Construction activities continued downstream on Reach 4 to its terminus at Station 14+47 where Reach 5 discharges into the channel, and Reach 6 begins. Work along Reach 4 was kept on-line and consisted of Enhancement Level I activities to restore the channel to the appropriate dimension and profile of a 'B4' type stream. Floodplain benching was used increase floodplain relief in areas where the floodplain is pinched due to steep topography. Structure type and placement followed the design plans; however, structures using logs were changed to boulders.

The contractor did not disturb vegetation within the Enhancement area, unless it was necessary to remove existing invasive species vegetation or trees that were damaged or stressed due to significant bank erosion. Upon completion of new channel segment and the installation of in-stream structures, coir fiber matting and permanent seeding were installed before moving to Reach 6. As stated previously, live stake and riparian plantings were delayed until after the onset of the dormant season. Both Reach 4 and its upstream constructed wetland are included in the conservation easement and were permanently fenced from cattle access. The as-built length of Reach 4 is 447 LF.

While construction was being completed by a crew on Reach 4, the construction crew previously working on Reach 7 moved to Reach 5. Work began on the upstream portion (Station 10+00) of Reach 5 and progressed downstream to its confluence at the reach break of Reach 4 and Reach 6. Work along Reach 5 implemented an Enhancement Level II approach. Banks were graded to stabilize eroding slopes. Boulder sills were placed in the downstream portion of the reach to control grade, enhance pool-to-pool spacing, and improve the quality of pool habitat present. Invasive species were either removed or treated and mature native trees were left intact where feasible. After construction was

complete on Reach 5 and the channel was stabilized with temporary and riparian seed, the supplemental construction crew demobilized from the Site, leaving the primary crew to work on Reach 6. The as-built length of Reach 5 after construction is 344 LF. Planting of the riparian buffer occurred during the dormant season.

Work along the entire length of Reach 6 consisted of Priority Level I Restoration. Construction started in the upstream extent and progressed downstream to a culverted stream crossing at Station 20+30. Work along this portion of the reach was conducted on-line allowing for pattern variations that incorporate slight meanders and riffle-step-pool sequences appropriate for a 'B4' stream type. A drainage feature located in the left floodplain at Station 19+50 was graded into trapezoidal swale and matted to stabilize the side slopes and prevent post-construction erosion or headcutting. As in Reach 4, structure material containing the use of logs was changed to boulders. Structure placement varied slightly and an additional boulder sill was added in the upstream extent of Reach 6 in order to provide better grade control.

A culverted crossing (48-inch RCP) was installed along Reach 6 at Station 20+30. The majority of the crossing lies outside of the conservation easement; however, due to crossing stability issues, the culvert extends approximately six feet into the easement on the downstream portion of Reach 6. This minor easement encroachment has been removed from the as-built restoration length on Reach 6 and the associated SMUs have been adjusted accordingly. The installation of the crossing in conjunction with easement fencing along Reach 6 restricts cattle access to the restored stream, while still allowing for pasture rotation and farm equipment passage. Upon completion of the crossing, side slopes were stabilized and work progressed downstream.

Work conducted downstream of the crossing on Reach 6 from Station 20+50 to 25+50 was similar to that of the upstream section; however, in this portion of Reach 6, bedrock was present along the stream bed in multiple locations. Therefore, grade control structures were only implemented along this section of the reach where bedrock was not present. However, the presence of bedrock did not impede the implementation of bio-engineered structures as designed.

Stream work at Station 25+50, transitioned from a 'B4' type channel to a 'C4' type channel. Work in this section was conducted mostly off-line allowing the channel to meander across a wider and flatter floodplain to its confluence with the Mainstem. Grade control and habitat structures were implemented in the form of vegetated geo-lifts, rock j-hooks, and constructed riffles.

Mature wooded areas were left undisturbed along Reach 6, except for areas where the removal and/or treatment of invasive species was needed. Stream banks and vegetated geo-lifts were stabilized with temporary and permanent seed and mulch. Bare root vegetation and live stakes were planted during the dormant season. The as-built length of Reach 6 after construction is 1,346 LF.

All excess fill material generated during construction of all reaches was wasted and stabilized on-site in the locations and as noted in the Erosion and Sediment Control plans. Minimal Site modifications involved the location and selection of some in-stream structures and bank stabilization practices. Substitutions and/or relocations were made based on existing field conditions and best professional judgment. All riparian buffer areas within the project boundaries are a minimum of 50-feet along both stream banks and are protected in perpetuity by a recorded conservation easement that totals 25.1 acres. Permanent cattle exclusion fencing (woven wire) was installed outside the conservation easement boundary along all reaches that border pastureland. Access gates were installed near the stream crossings and at strategic locations for post-construction monitoring activities and maintenance access, if needed. In addition, permanent watering systems were tied to an existing on-site well and were installed in pasture areas as directed by the property owner.

The As-built plan sheets/record drawings depict actual surveyed areas within the project area and depict any deviations from the final design plans to what was implemented on-site during construction. The

as-built plan sheets/record drawings are located in Appendix D. The as-built results for the Project totaled 6,351 LF of stream and are outlined in Table 1.

After construction was complete, multiple large rain events in November and December 2015 exposed multiple unstable floodplain drainage features along Reach 1 and Reach 2, as well as, a small headcut on Reach 7 at Station 12+00. Therefore, prior to the removal of sediment and control measures and permanent demobilization and the onset of easement planting, Baker and Wright met on-site on January 14, 2016 to generate a punch-list of final items for completion and to discuss a strategy to best address the areas of instability while limiting re-disturbance.

Work to repair areas of instability and to address outstanding punch list items, began on January 18, 2016. Work began in the left floodplain of the upstream portion of Reach 1. Two drainage swales, one rock lined channel and one matted channel, were constructed to outlet stormwater through the floodplain and converge into a single rock lined swale before out-falling into Reach 1 at Station 10+75. Construction work then progressed downstream to Station 13+05. Drainage from an existing wetland feature was causing erosion at the top of the left stream bank. The area was lightly graded and lined with rock to its outfall with the Mainstem.

From there repair work moved downstream to Station 17+50, where a small gully was discovered during construction. The erosional feature began at a roadside storm drainage outfall along Old Salisbury Road and continued perpendicularly across the left floodplain to the toe of slope. Previous attempts were made during the construction of this section of Reach 1 to stabilize the area, but were deemed insufficient. Therefore, a rock lined step-pool channel was implemented down slope to its tie-in with Reach 1.

After completion of the step-pool channel, the construction crew split up to simultaneously repair the two remaining instability issues. Repair work on Reach 2 at Station 25+25 consisted of implementing a rock lined channel in the left floodplain that will intercept discharges from a ground water seep and roadside drainage. Repair work on Reach 7 at Station 12+00, included the addition of a boulder sill to control grade, and the repair of the riffle-pool complex upstream of the structure.

Repair work and punch list items were complete on January 20, 2016. Upon final approval from Baker, sedimentation and erosion control measures such as temporary construction entrances, rock check dams, and silt fence were removed, and all disturbed areas were stabilized with temporary and permanent seed and mulch before de-mobilizing from the Site. Baker met with NCDMS on-site on February 2, 2016 for the final construction Site walk. NCDMS approved the construction work during the visit. The planting of bare-root trees and shrubs, live stakes, vegetated geo-lifts were completed and approved on March 11, 2016. The planting of herbaceous wetland plugs were completed in late May 2016. Herbaceous plantings were approved by Baker on June 1, 2016. NCDMS approved the Site plantings and monitoring device installations on June 20, 2016.

4.0 PERFORMANCE STANDARDS

Baker has obtained regulatory approval for numerous stream mitigation plans involving NCDMS Full-delivery Projects. The success criteria for the Site will follow the mitigation plans developed for these projects, as well as the *Stream Mitigation Guidelines* (SMG) issued in April 2003 (USACE).

Channel stability, vegetation survival, and viability of wetland functions will be monitored on the Project Site. Post-restoration monitoring will be conducted for a minimum of five years or until the success criteria are met following the completion of construction to document project success. Different monitoring approaches are proposed throughout the project area and are based on the design approach to be used. Reaches 1, 2, 3, 4, 6, and 7 involve the Restoration and/or Enhancement I of the historic flow patterns as a single-thread channel, success criteria will follow those recommended by the Stream Mitigation Guidelines (USACE, et.al, 2003). Reach 5 will implement Enhancement Level II type success criteria, which will focus primarily on visual assessments and vegetation success.

The monitoring parameters shall be consistent with the requirements described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.5 paragraphs (a) and (b). Specific success criteria components and evaluation methods are described in Section 5.0 and report documentation will follow the NCDMS Baseline Monitoring Document template and guidance (v 1.0, 2009b).

5.0 MONITORING PLAN AND SUCCESS CRITERIA

5.1 Stream Monitoring

Geomorphic monitoring of the restoration reaches will be conducted once a year for a minimum of five years following the completion of construction to evaluate the effectiveness of the restoration practices. Monitored stream parameters include stream dimension (cross-sections), profile (longitudinal profile), pattern (planimetric survey), and visual observation with photographic documentation. The success criteria for the proposed Enhancement Level II reaches/sections will follow the methods described in sections 5.1.6 and 5.2. The methods used and related success criteria are described below for each parameter.

5.1.1 Bankfull Events and Flooding Functions

The occurrence of bankfull events within the monitoring period will be documented by the use of a crest gauge and photographs. The crest gauge was installed in the floodplain within ten feet (horizontal) of the restored channel. The crest gauge will record the highest watermark between site visits, and the gauge 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 events must be documented within the 5-year monitoring period. The bankfull events must occur in separate years; otherwise, the monitoring will continue until two floodplain events have been documented in separate years.

5.1.2 Flow Documentation

Monitoring of flow will be conducted to demonstrate that the restored stream systems classified as intermittent exhibit base flow for some portion of the year during a year with normal rainfall conditions. In order to determine if rainfall amounts are normal for the given year, rainfall gauge data will be obtained from the nearest Stanly County weather station (CRONOS Database, NEWL – North Stanly Middle School, if available) and compared to the average monthly rainfall amounts from the Stanly Count WETS Table (NRCS, 2002). If a normal year of precipitation does not occur during the first five years of monitoring, flow conditions will continue to be monitored on the site until it documents that the intermittent streams have been flowing during the appropriate times of the year.

The proposed monitoring of the restored intermittent reaches will include a combination of photographic documentation and the installation of two in-stream pressure transducers within the thalweg of the channel, one in the upstream portion and one in the downstream portion of Reaches 6 and 7. A regular and continuous series of remote photos over time will be used to subjectively evaluate channel flow conditions throughout the year. More specifically, the longitudinal photos should indicate the presence of flow within the channel in order to discern water levels within the pools and riffles. The photographs will be taken from a height of approximately five to six feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map. The visual monitoring effort, including the photo locations with descriptions, will be included with the annual monitoring reports. The devices will be inspected on a quarterly/semi-annual basis to document surface hydrology and provide a basis for evaluating general flow response to rainfall events and surface runoff during various water tables levels throughout the monitoring period.

5.1.3 Cross-sections

Permanent cross-sections will be installed at an approximate rate of one cross-section per twenty bankfull widths or an average distance interval (not to exceed 500 LF) of restored stream, with approximately twelve (12) cross-sections located at riffles, and seven (7) located at pools. Each cross-section will be marked on both stream banks with permanent monuments of rebar set in place to establish the exact transect used. A common benchmark will be used for cross-sections to facilitate easy comparison of year-to-year data. The cross-section surveys will occur annually and must include measurements of Bank Height Ratio (BHR) and Entrenchment Ratio (ER). The monitoring survey will include points measured at all breaks in slope, including top of stream banks, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen Stream Classification System.

There should be little change from the as-built cross-sections. If changes do take place, they will be documented in the survey data and 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 stream banks, or decrease in width/depth ratio). Using the Rosgen Stream Classification System, all monitored riffle cross-sections should fall within the quantitative parameters (i.e. BHR no more than 1.2, an ER no less than 2.2 for 'C' stream types and an ER between 1.4 and 2.2 for 'B' stream types) defined for channels of the design stream type. Given the smaller channel sizes and meander geometry of the proposed steams, bank pins will not be installed unless monitoring results indicate active lateral erosion.

Reference photo transects will be taken at each permanent cross-section. Lateral photos should not indicate excessive erosion or continuing degradation of the stream banks. Photographs will be taken of both stream banks at each cross-section. The survey tape will be centered in the photographs of the stream banks. The water line will be located in the lower edge of the frame, and as much of the stream bank as possible will be included in each photo. Photographers should make an effort to consistently maintain the same area in each photo over time.

5.1.4 Pattern

The plan view measurements such as sinuosity, radius of curvature, meander width ratio will be taken on newly constructed meanders during baseline (Year 0) only. Subsequent visual monitoring will be conducted twice a year, at least five months apart, to document any changes or excessive lateral movement in the plan view of the restored channel.

5.1.5 Longitudinal Profile

A longitudinal profile will be completed immediately after construction and annually thereafter for the duration of the five-year monitoring period. The as-built survey will be used as the baseline for subsequent surveys. The profile will be conducted for a total of 3,000 LF of the restored channels. Measurements will include thalweg, water surface, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature (e.g., riffle, run, pool, and glide) and the maximum pool depth. The survey will be tied to a permanent benchmark.

5.1.6 Bed Material Analysis

After construction, there should be minimal change in the pebble count data over time given the current watershed conditions and sediment supply regime. Reachwide pebble counts shall be conducted annually for Reaches 1, 2, 3, and 6. Pebble counts shall be conducted immediately after construction and annually thereafter at the time the cross-section and longitudinal surveys are performed during the five-year monitoring period. These samples will reveal any changes in sediment gradation that occur over time as the stream adjusts to upstream sediment loads. Significant changes in sediment gradation shall be evaluated with respect to stream stability and watershed changes.

5.1.7 Visual Assessment

Qualified personnel, annually for a minimum of five years following construction, will conduct visual monitoring assessments of all stream sections. Photographs will be used to document success visually. Reference photos were taken from a height of approximately five to six feet. To ensure that the same locations are monitored, photograph locations have been marked in the field and documented in the As-built Plan Set. When modifications to photo position must be made due to obstructions or other reasons, the position will be noted along with any landmarks and the same position will be geographically located using a sub-meter GPS unit for use in subsequent monitoring years. Photographs will be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures subjectively.

Reference photos include photos taken of structures along the restored streams. Photographers will make every effort to consistently document the same area in each photo point over time. All photo directions and locations have been documented in the As-built Plan Set. Locations and directions of photos will continue to be documented throughout the monitoring period. Points will be close enough together to provide an overall view of the reach.

5.2 Vegetation Monitoring

Successful restoration of the vegetation on a site is dependent upon hydrologic restoration, planting of preferred canopy species, and volunteer regeneration of the native plant community. In order to determine if the criteria are achieved, vegetation-monitoring quadrants were installed and will be monitored across the site in accordance with the CVS- NCEEP Protocol for Recording Vegetation, Level 1-2 Plot Sampling, Version 4.2 (2008). Based on the CVS-EEP Entry Tool Database version 2.2.7 (Lee, 2007), twenty permanent monitoring quadrants were established within the floodplain areas throughout the conservation easement. The size of each quadrant is 100 square meters for woody species.

Construction of the Site was completed in March 2016 including all buffer vegetation planting. The approved contract with NCDMS requires that all vegetation must be planted at least six months (180 days) before Baseline (Year 0) monitoring activities are conducted at the end of the first full growing season. Since the Site was planted in March 2016, Baseline (Year 0) and Year 1 Monitoring will be initiated in the fall, prior to the loss of leaves. Individual quadrant data will follow the guidelines established per CVS-NCEEP Protocol for Recording Vegetation, Level 1-2 Plot Sampling, Version 4.2 (2008).

At the end of the first growing season, species composition, diameter, height, density, and survival will be evaluated for each subsequent year during a period of five years or until the final success criteria are achieved (Lee, et al., 2008). Individual seedlings will be marked to ensure that they can be found in subsequent 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.

The restored Site will be evaluated between September and November. While measuring species density and height is the current accepted methodology for evaluating vegetation success on mitigation projects, species density and height alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of additional plant community indices, native volunteer species, and the presence of invasive species vegetation to assess overall vegetative success.

The interim measure of vegetative success for the Site will be the survival of at least 320, 3-year old, planted woody stems (trees and shrubs) per acre at the end of year three of the monitoring period. The final vegetative success criteria will be the survival of 260, 5-year old, planted woody stems (trees and shrubs) per acre at the end of year five of the monitoring period. Vegetation monitoring will be conducted for five years post-construction or until vegetative success criteria are met.

Baker will provide any required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species, beaver management/dam removal, or removing undesirable/invasive species vegetation, and continue to monitor vegetation performance until the corrective actions demonstrate that the Site is trending towards or meeting the success criteria.

Additionally, herbaceous vegetation, primarily native grasses and forbs, was seeded/planted throughout the Site. During and immediately following construction activities, all ground cover at the project Site was in compliance with the NC Erosion and Sedimentation Control requirements.

5.3 Wetland Monitoring

Wetland restoration and creation will be monitored after construction by groundwater wells and periodic visual inspections. Post-construction groundwater monitoring stations were installed across the Project Site in areas similar to those from pre-construction monitoring. Installation and monitoring of the groundwater stations will follow the USACE standard methods outlined in the *ERDC TN-WRAP-05-2* (USACE, 2005). Water levels will be collected and analyzed in the same manner as the pre-construction monitoring period.

Groundwater and surface water levels (overbank events) will be compared to pre-restoration conditions and onsite reference stations; however, success criteria for wetland hydrology will be met when each wetland site is saturated within 12 inches of the soil surface for 9 percent of the growing season (NCIRT, 2013). To document the hydrologic conditions of the restored site, each groundwater monitoring station will be monitored for seven years post-construction or until wetland success criteria are met. As stated in the May 13, 2013 letter from NCEEP to the IRT, "In the fourth year of monitoring, EEP will decide if the specific site may qualify to close out after five successful monitoring years. For those, EEP will submit to the IRT for early closure. For any … site that EEP does not think meet early closeout criteria, EEP will contact out to complete the final two years" of monitoring (NCEEP, 2013). A copy of the letter has been included in Appendix F for reference.

In order to determine if the rainfall is normal for the given year, rainfall amounts will be tallied using data obtained from the Stanly County WETS Station (NRCS, 2002) and from the automated weather station at the North Stanly Middle School (NEWL) in New London, approximately 1.5 miles southeast of the Project Site on Old Salisbury Rd. Data from the NEWL station can be obtained from the CRONOS Database located on the State Climate Office of North Carolina's website (2011). Therefore, a rain gauge will not be installed on-site.

Visual inspection of proposed wetland areas will be conducted to document any visual indicators that would be typical of jurisdictional wetlands. This could include, but is not limited to, vegetation types present, surface flow patterns, stained leaves, and ponded water. Wetland plants will be documented along with other visual indicators noted above. Proposed wetland restoration and creation areas that exhibit all three wetland indicators (the presence of hydric soils, wetland hydrology, and wetland vegetation) after construction and through the monitoring period will validate wetland restoration and creation success.

5.4 Stormwater Management Monitoring

Implementation of stormwater wetland BMPs located at the upstream extent of Reaches 4 and 7 will be visually monitored for vegetative survivability and permanent pool storage capacity using photo documentation during the 5-Year monitoring period. Maintenance measures will be implemented during the 5-Year monitoring period to replace dead vegetative material and to remove excess sedimentation from permanent pools, as needed.

6.0 AS-BUILT DATA DOCUMENTATION

To evaluate project success, post-construction monitoring will be conducted for a minimum of five years for both the stream and vegetation components of the project and for a minimum of seven years for the wetland components of the project or until the success criteria are met. The specific locations for the vegetation plots, flow/crest gauges, groundwater monitoring wells, and cross-sections are shown on the as-built plan sheets.

6.1 Stream Data

For monitoring stream success criteria, nineteen (19) permanent cross-sections were installed along Restoration and Enhancement I reaches throughout the Site. The permanent cross-sections will be used to monitor channel dimension and bank stability over time. One crest gauge was installed along Reach 3. The crest gauge will be used to document the occurrence of bankfull events. To provide a baseline for evaluating changes in bed conditions over time, a longitudinal survey was completed for each of the following stream reaches upon which Restoration and/or Enhancement I Mitigation was conducted: Reach 1, Reach 2, Reach 3, Reach 4, Reach 6, and Reach 7. The as-built permanent cross-sections (with photos) and the as-built longitudinal data, as well as the quantitative pre-construction, reference reach, and design data used to determine restoration approach are provided in Appendix B. In addition, the as-built reachwide bed material sampling data for Reach1, Reach 2, Reach 3, and Reach 6 are included in Appendix B. As-built data will be used for comparison to post-construction monitoring data. The locations of the permanent cross-sections and the crest gauge are shown on the as-built plan sheets in Appendix D. Representative photographs from selected portions of each project reach are provided in Appendix E.

6.2 Vegetation Data

Bare-root trees and shrubs were planted within restoration and enhancement areas of the conservation easement. A minimum 50-foot buffer was established and/or protected along both banks of all stream reaches. Planting of bare-root trees and shrubs, live stakes, and herbaceous plugs began in March of 2016. Bare-root and live stake planting were completed on March 11, 2016 and the installation of herbaceous plugs was completed in May of 2016.

The Mitigation Plan for the Site specifies that the number of quadrants required shall be based on the CVS-NCEEP monitoring guidance (2007). The total number of quadrants was calculated using the CVS-NCEEP Entry Tool Database version 2.2.7 (CVS-NCEEP, 2007). The sizes of individual quadrants are 100 square meters. Twenty (20) vegetation plots were installed throughout the Project Site. The initial planted density of each species and within each vegetation monitoring plot is provided in Table 8 and Table 9, respectively. The average density of planted bare root stems, based on the data from the twenty vegetation monitoring plots, is 730 stems per acre. The locations of the vegetation plots are shown on the as-built plan sheets in Appendix D.

6.3 Wetlands Data

After construction was complete, eight (8) groundwater monitoring wells were reinstalled within wetland restoration and creation areas throughout the Project Site. In addition, one well was reinstalled in each of the reference wetlands (Monitoring Wells 1 and 6); therefore, totaling ten (10) in all. Groundwater monitoring well installation was complete by mid-March 2016. Groundwater monitoring well data will document water table hydrology throughout the monitoring period and will be compared to pre-restoration and reference conditions. Each ground water monitoring well will record the groundwater level depth below ground surface in inches, twice per day and at 12-hour intervals throughout the monitoring period.

Post-construction groundwater monitoring wells were installed in the same locations as pre-construction where feasible. However, due to the following, location modifications for some of the post-construction monitoring wells from their pre-construction was necessary.

- Pre-construction locations of monitoring wells 4, 5, 8, and 10 were located within or too close to the restored channel alignment,
- Well installation in or near the pre-construction locations of monitoring wells 2, 3, 4, 5, 8, and 10 was not feasible due to auger refusal through the rocky soil substrate, and
- Pre-construction location of monitoring well 9 was located at the head of Reach 4 to monitor the ground water hydrology of the proposed constructed wetland; therefore, monitoring well 9 was moved to monitor ground water hydrology of an unrepresented wetland creation area along Reach 2.

The pre- and post-construction location of monitoring wells are depicted in Figures 4a and 4b of Appendix A. In addition, monitoring well locations are shown on the As-Built Plan Set that is located in Appendix D.

6.4 Flow Documentation Data

After construction was complete, two in-stream pressure transducers (flow gauge) were installed within the thalweg of Reach 6 and Reach 7 to document intermittent base flow conditions during the monitoring period exhibiting normal rainfall conditions. One transducer was installed in the upstream portion of each reach, and one transducer was installed in the downstream portion of each reach. In addition, one remote wireless camera was installed, at the height of five to six feet, alongside the downstream flow data logger in Reach 6 and Reach 7 to subjectively evaluate channel flow conditions throughout the year. Installation of the flow gauge and the photo logger was complete in May 2016. Each flow gauge will record base flow data four times per day at 6-hour intervals throughout the monitoring period, while the photo logger will take a picture once a day throughout the monitoring period.

Locations for the flow gauges are shown on the as-built plan sheets in Appendix D.

6.5 Areas of Concern

Per observations made during the NCDMS Site visit on February 2, 2016, invasive species, which are prevalent in areas outside of the conservation easement, may try to reestablish within the easement if not properly maintained. No other areas of concern were noted for the time of this report.

Section 7.3 describes a specific corrective action plan that will be implemented for areas of concern.

7.0 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 bank erosion than cohesive soils or soils with high gravel and cobble content.
- Alluvial valley channels with access to their floodplain are less vulnerable to erosion than channels that have been disconnected from their floodplain.
- 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 vegetation species can affect the extent to which a native species vegetation buffer can be established.
- The presence of beaver can affect vegetation survivability and stream function.

The Site will be monitored on a regular basis and as well as a physical inspection of the Site at least once a year throughout the post-construction monitoring period. These site inspections may identify site components and features that require routine maintenance. Maintenance issues and recommended remediation measures will be detailed and documented in the post-construction monitoring reports. Factors that may have caused any maintenance needs, including any of the conditions listed above, shall be discussed. Routine maintenance will be most likely in the first two years following site construction and may include the following components as described below.

7.1 Streams

Routine channel maintenance and repair activities may include modifying in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the project reaches. Areas of concentrated stormwater and floodplain flows that intercept the channel may also require maintenance to prevent stream bank failures and head-cutting until vegetation becomes established.

7.2 Wetland

Routine wetland maintenance and repair activities may include supplemental installations of target vegetation within the wetland or installation and maintenance of groundwater wells. Areas of concentrated stormwater and floodplain flows that intercept the wetland may also require maintenance to prevent scour.

7.3 Vegetation

Vegetation will be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, and fertilizing. Baker will provide required remedial action on a case-by-case basis and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement.

Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table that may negatively affect existing forest cover or favorable buffer vegetation. Additionally, herbaceous vegetation, primarily native grasses, will be seeded/planted throughout the site as necessary. Exotic invasive plant species will be controlled by mechanical and/or chemical methods. Any invasive plant species control requiring herbicide application will be performed in accordance with NC Department of Agriculture and Consumer Services (NCDA&CS) rules and regulations.

7.4 Site Boundary

Site boundaries have been demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries can be identified by fence, marker, bollard, post, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.

7.5 Farm Road Crossing

The farm road crossings within the Site may be maintained only as allowed by the recorded Conservation Easement, deed restrictions, rights of way, or corridor agreements.

7.6 Beaver Management

Routine maintenance and repair activities caused by beaver activity may include supplemental planting, pruning, and dam breeching/dewatering and/or removal. Beaver management will be performed in accordance with US Department of Agriculture (USDA) rules and regulations using accepted trapping and removal techniques only within the project boundary.

8.0 REFERENCES

Carolina Vegetation Survey (CVS) and NC Ecosystem Enhancement Program (NCEEP). 2007. CVS-NCEEP Data Entry Tool v. 2.2.7. University of North Carolina, Raleigh, NC.

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_____. 2003. Stream Mitigation Guidelines. Prepared with cooperation from US Environmental Protection Agency, NC Wildlife Resources Commission, and the NC Division of Water Quality. www.saw.usace.army.mil/wetlands/Mitigation/stream_mitigation.html

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APPENDIX A

Figures 1 – 4b
Tables 1 – 4

DIRECTIONS TO SITE FROM RALEIGH, NC:
Take I-40 West toward Sanford/Wake Forest. Take Exit 293 (I-440/US-64 W/US-1) toward Sanford/Wake Forest. Keep left at the fork toward US-1 S/US-64 W. Take Exit 293A for US-1 S/US-64 W toward Sanford/Asheboro. Keep left at the fork toward US-1 S/US-64 W. Continue on US-1 S/US-64 W towards Apex/Sanford/Asheboro. Take exit 98B to merge onto US-64 W towards Pittsboro/Asheboro. After 62 miles, turn left onto Connector Rd. Turn right onto NC 49 S. After 28.4 miles, take a slight left onto N Main St. After 1.1 miles, turn left onto Old Salisbury Rd. Follow Old Salisbury Rd. for approximately 2.0 miles to its intersection with Misenheimer Rd. / Steakhouse Rd. Go through the intersection and continue on Old Salisbury Rd. for approximately 0.4 miles and the Project site is on the right accessed via a dirt farm road.

The subject project site is an environmental restoration site of the NCDEQ Division of Mitigation Services (DMS) 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 DMS.

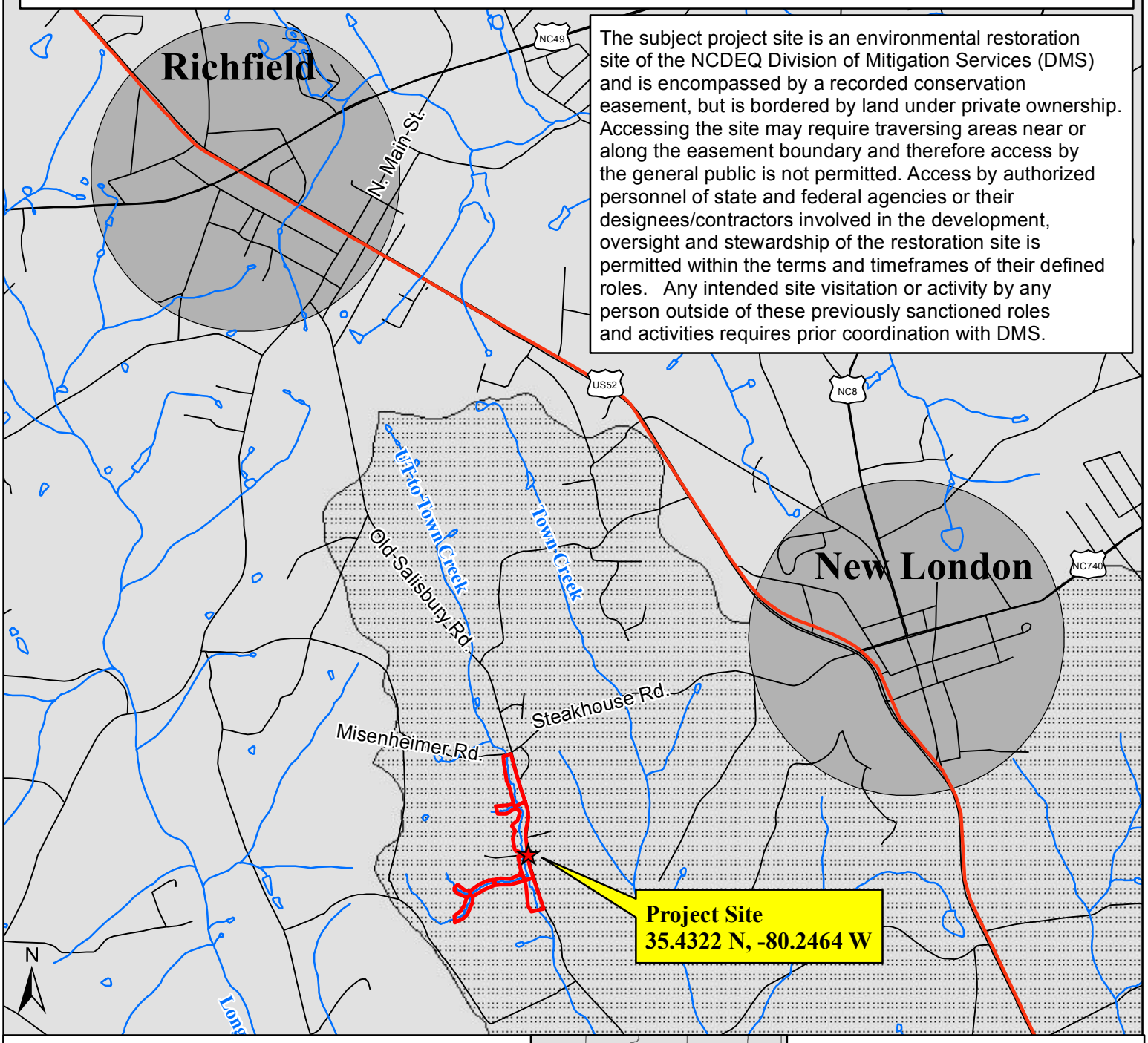


Figure 1. Vicinity Map

UT to Town Creek Restoration Project - Option A

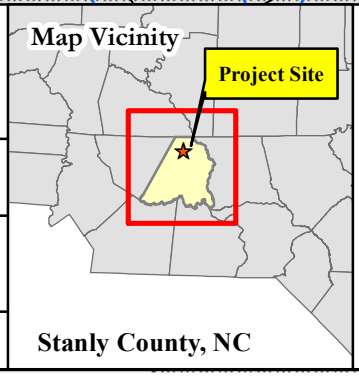
Stanly County, NC

Reference: NCDOT 02 & NC One Map

NC DMS Project No. 94648
NCDEQ Contract No. 003277

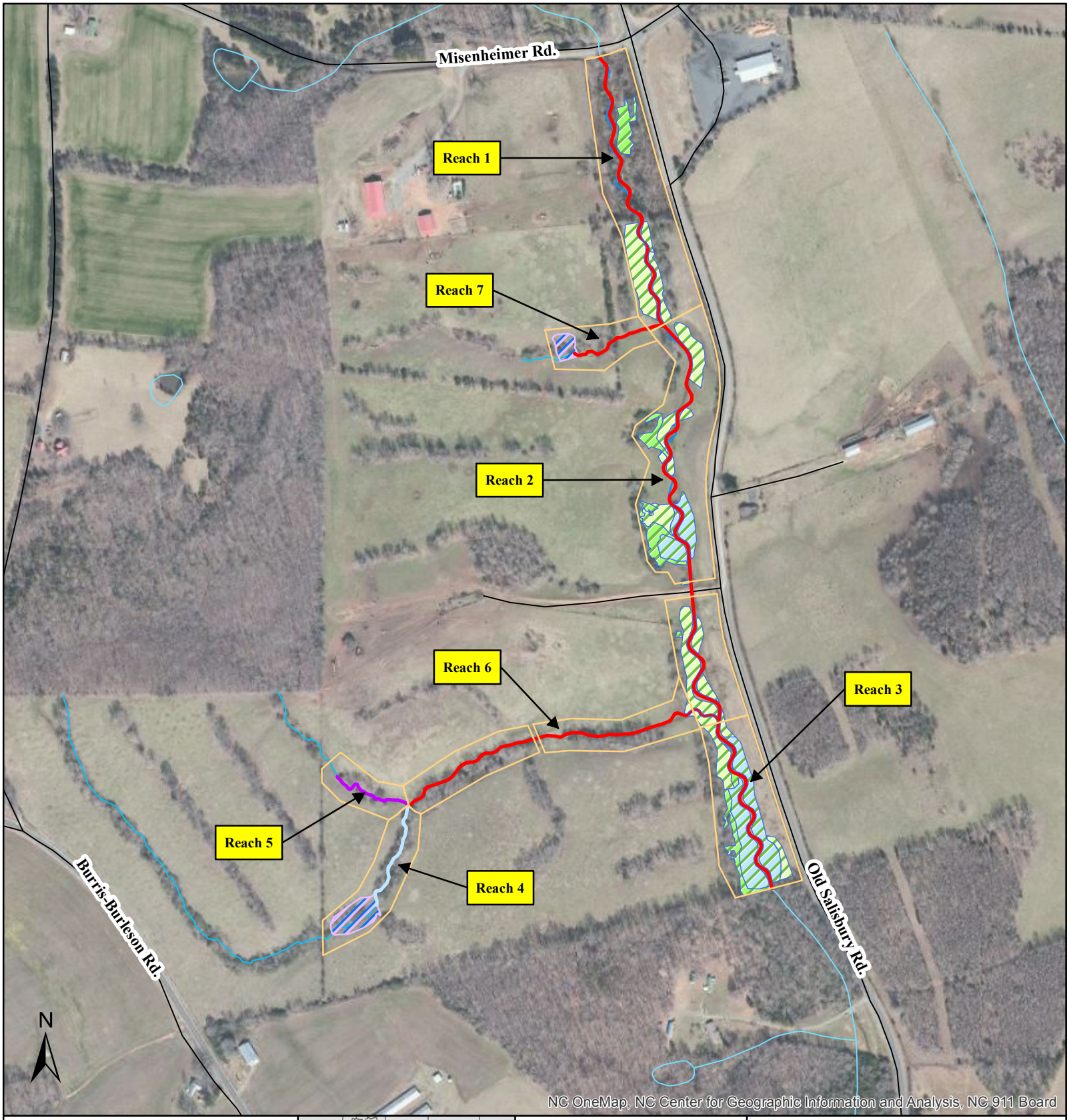
Nov 2016

0 1,500 3,000 Feet 1" = 3000'



LEGEND

- Project Area
- Streams
- US Highways
- Roads
- Major Waterways
- Municipalities
- Yadkin (HUC 03040105060-040)

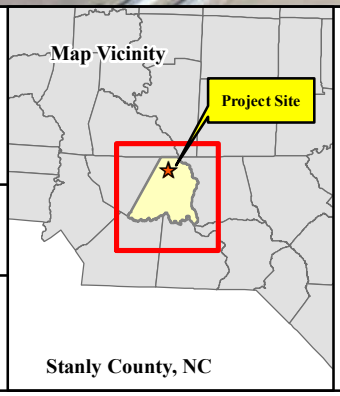


Michael Baker INTERNATIONAL

Nov 2016

0 250 500 Feet

1" = 500'



LEGEND

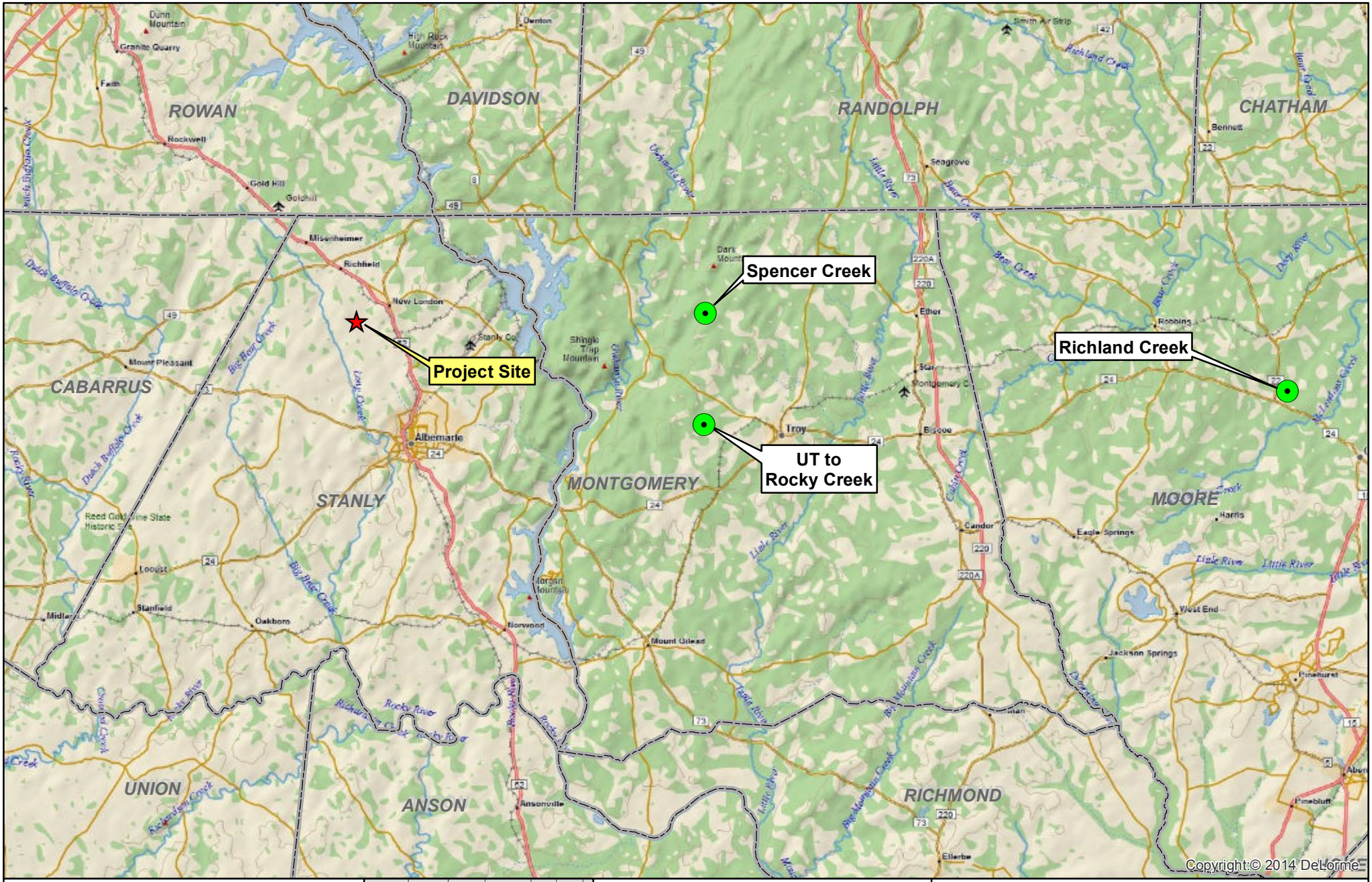
- Conservation Easement
- Wetland Creation
- Wetland Restoration
- Restoration
- Enhancement I
- Enhancement II
- Jurisdictional Wetlands
- Wetland BMPs

Figure 2. Mitigation Summary

UT to Town Creek
Restoration Project - Option A

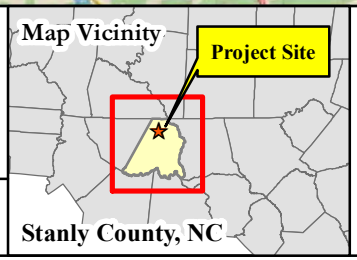
Stanly County, NC

NC DMS Project No. 94648
NCDEQ Contract No. 003277



Michael Baker
INTERNATIONAL

October 2016



LEGEND

- Reference Reach Locations
- Project Site

N

0 3 6 Miles

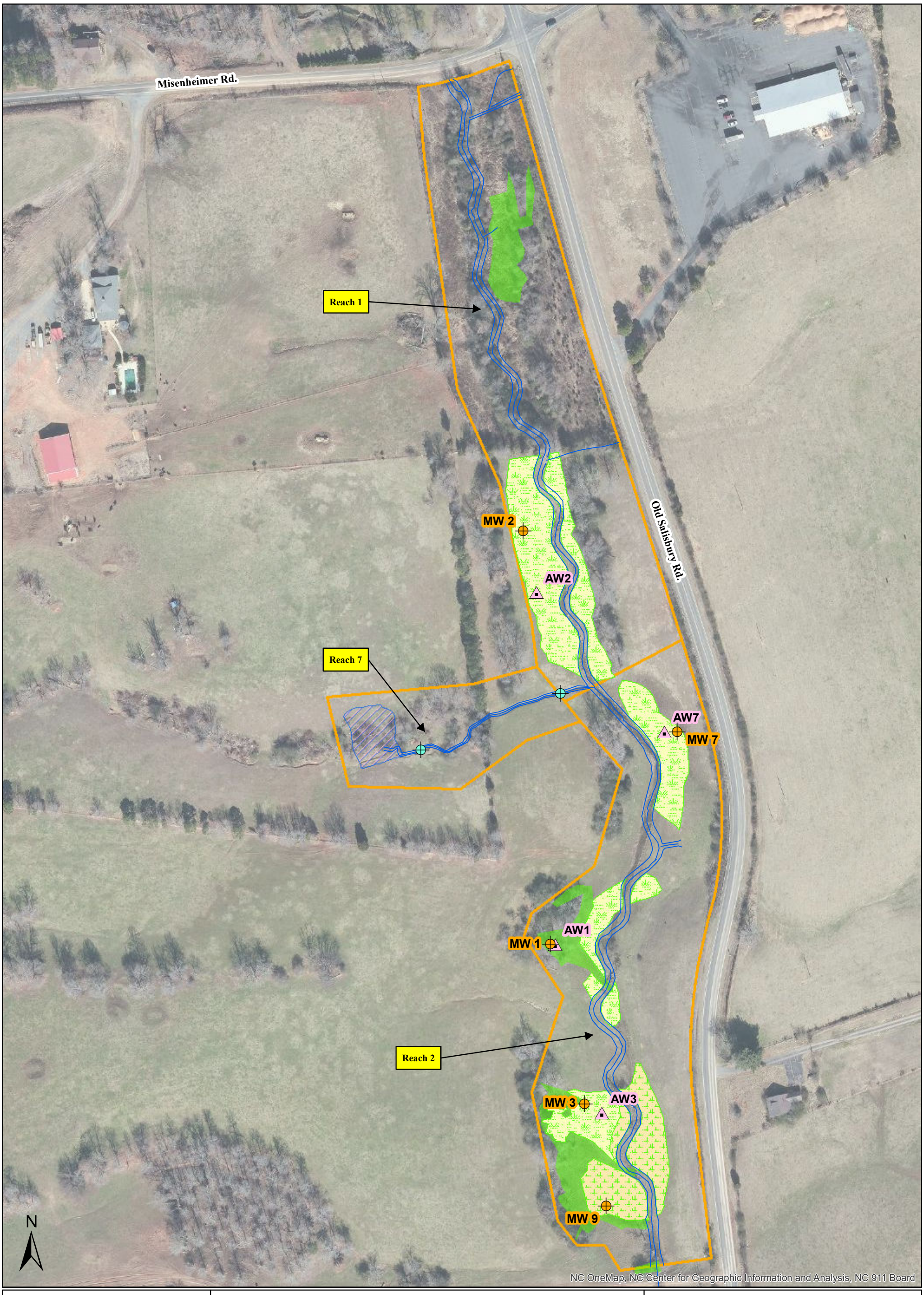
1" = 6 Miles

Figure 3. Reference Site Locations Map

UT to Town Creek Restoration Project - Option A

Stanly County, NC

NC DMS Project No. 94648
NCDEQ Contract No. 003277



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Nov 2016

NC DMS Project No. 94648
NC DEQ Contract No. 003277

LEGEND

- Groundwater Monitoring Well (As-Built)
- Flow Transducer (As-built)
- Groundwater Auto Well (Existing)
- Wetland Creation
- Wetland Restoration
- Existing Wetlands
- Wetland BMPs
- Conservation Easement

0 75 150 Feet
1" = 150'

Figure 4a. Monitoring Well Locations (As-Built & Existing)

UT to Town Creek
Restoration Project - Option A
Stanly County, NC

Station 10+00 - 34+00 - Reaches 1 & 2
Station 10+00 - 14+00 - Reach 7

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Nov 2016

NC DMS Project No. 94648
NC DEQ Contract No. 003277

LEGEND

- Monitoring Wells (As-Built)
- Crest Gauge (As-Built)
- Flow Transducer (As-Built)
- Groundwater Auto Well (Existing)
- Wetland Creation
- Wetland Restoration
- Existing Wetlands
- Wetland BMPs
- Conservation Easement

0 75 150 Feet
1" = 150'

Figure 4b. Monitoring Well Locations (As-Built & Existing)

UT to Town Creek
Restoration Project - Option A
Stanly County, NC

Station 33+00 - 47+75 - Reaches 2 & 3
Station 10+00 - 47+47 - Reach 4
Station 10+00 - 13+44 - Reach 5
Station 14+47 - 28+13 - Reach 6

Table 1. Project Mitigation Components
UT to Town Creek Restoration Project - Option A: DMS Project No ID. 94648

Project Component (reach ID, etc.)	Wetland Position and Hydro Type	Existing Footage or Acreage	Stationing	Restored Footage, Acreage, or SF	Creditable Footage, Acreage, or SF	Restoration Level	Approach		Mitigation Credits	Notes/Comments
							Priority Level	Mitigation Ratio (X:1)		
Reach 1		1181	10+00 - 22+04	1,204	1,204	R	PI	1:1.0668	1284	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, and Permanent Conservation Easement. Mitigation ratio of 1:1.0668 for buffer widths in excess of 50-ft.
Reach 2		1672	22+04 - 40+46	1,842	1,782	R	PI	1:1.08	1925	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement, and a 60-ft culverted farm road crossing. Mitigation ratio of 1:1.07 for buffer widths in excess of 50-ft.
Reach 3		721	40+46 - 48+75	829	829	R	PI	1:1.10	912	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, and Permanent Conservation Easement. Mitigation ratio of 1:1.1 for buffer widths in excess of 50-ft.
Reach 4		404	10+00 - 14+47	447	447	EI	PIII	1:1	447	Dimension and Profile modified in keeping with reference, Planted Buffer, Livestock Exclusion, Permanent Conservation Easement, and Headwater Constructed Wetland. Mitigation Ratio of 1:1 as result of water quality benefits from the implementation of headwater constructed wetland.
Reach 5		324	10+00 - 13+44	344	344	EII	PIV	2.5:1	138	Dimension modified and structure implementation in keeping with reference, Planted Buffer, Livestock Exclusion, and Permanent Conservation Easement.
Reach 6		1349	14+47 - 28+13	1,366	1,340	R	P1	1:1	1340	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement, and a 26-ft culverted farm road crossing.
Reach 7		386	10+00 - 13+99	399	399	R	P1	1:1	399	Headwater Constructed Wetland, Full Channel Restoration, Planted Buffer, Livestock Exclusion, and Permanent Conservation Easement.
Wetland Group 1 (WG1)	RNR	0		2.56	2.56	R		1:1	2.56	Minor floodplain grading, of 12-inches or less, to restore floodplain hydrolgy and remediate compaction, based on hydric soil investigation. Planted, Excluded Livestock and Permanent Conservation Easement.
Wetland Group 2 (WG2)	RNR	0		1.56	1.56	C		3:1	0.52	Floodplain grading, of 12-inches or greater, to restore relic floodplain hydrolgy and remediate compaction, based on hydric soil investigation. Planted, Excluded Livestock and Permanent Conservation Easement.
Buffer Group 1 (BG1)										
Buffer Group 2 (BG2)										
Buffer Group 3 (BG3)										

Length and Area Summations by Mitigation Category

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Credited Buffer (square feet)
		Riverine	Non-Riverine		
Restoration	5554	2.56			
Enhancement					
Enhancement I	447				
Enhancement II	344				
Creation		1.56			
Preservation					
High Quality Pres					

Overall Assets Summary

Asset Category	Overall Credits
Stream	**6445***
RP Wetland	**3.08**

General Note - The above component table is intended to be a close complement to the asset map. Each entry in the above table should have clear distinction and appropriate symbology in the asset map.

1 - **Wetland Groups** represent pooled wetland polygons in the map with the same wetland type and restoration level. If some of the wetland polygons within a group are in meaningfully different landscape positions, soil types or have different community targets (as examples), then further segmentation in the table may be warranted. **Buffer groups** represent pooled buffer polygons with common restoration levels.

2 - **Wetland Position and Hydro Type** - Indicates Riparian Riverine, (RR) , riparinan non-riverine (RNR) or Non-Riverine (NR)

3- **Restored** Footage, Acreage or Square Feet (SF)

4 - **Creditible Footage**, Acreage or Square feet - creditible anounts after exclusion and reductions are accounted for,

* Stream assests are based on the stream length from the As-Built survey. Since the As-Built survey stream lengths exceeded the anticipated design lengths, the stream assets exceeded that of the proposed assest range listed in the Mitigation Plan.

Table 2. Project Activity and Reporting History			
UT to Town Creek Restoration Project - Option A: DMS Project No ID. 94648			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Mitigation Plan Prepared	N/A	N/A	Apr-14
Mitigation Plan Amended	N/A	N/A	Dec-14
Mitigation Plan Approved	N/A	N/A	Dec-14
Final Design – (at least 90% complete)	N/A	N/A	Jan-15
Construction Begins	N/A	N/A	Jul-15
Temporary S&E mix applied to entire project area	N/A	N/A	Jan-16
Permanent seed mix applied to entire project area	N/A	N/A	Jan-16
Planting of live stakes	Feb-16	N/A	Mar-16
Planting of bare root trees	Feb-16	N/A	Mar-16
Planting of herbaceous plugs	Jun-16	N/A	May-16
End of Construction	Dec-16	N/A	Jan-16
Survey of As-built conditions (Year 0 Monitoring-baseline)	Apr-16	May-16	Jun-16
Baseline Monitoring Report	May-16	Jun-16	Nov-16
Year 1 Monitoring	Nov-16	N/A	N/A
Year 2 Monitoring	Nov-17	N/A	N/A
Year 3 Monitoring	Nov-18	N/A	N/A
Year 4 Monitoring	Nov-19	N/A	N/A
Year 5 Monitoring	Nov-20	N/A	N/A
Year 6 Wetland Monitoring	Nov-21	N/A	N/A
Year 7 Wetland Monitoring	Nov-22	N/A	N/A

Table 3. Project Contacts	
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648	
Designer	
Michael Baker Engineering, Inc.	797 Haywood Road, Suite 201 Asheville, NC 28806 Contact: Jacob Byers, PE, Tel. 828-412-6101
Construction Contractor	
Wright Contracting, LLC.	160 Walker Road Lawndale, NC 28090 Contact: Joe Wright, Tel. 919-663-0810
Planting Contractor	
H.J. Forest Service	P.O. Box 458 Holly Ridge, NC 28445 Contact: Matt Hitch, Tel. 910-512-1743
Seeding Contractor	
Wright Contracting, LLC.	160 Walker Road Lawndale, NC 28090 Contact: Joe Wright, Tel. 919-663-0810
Seed Mix Sources	Green Resources, Tel. 336-855-6363 Mellow Marsh Farm, Tel. 919-742-1200
Nursery Stock Suppliers	Mellow Marsh Farm, Tel. 919-742-1200 Foggy Mountain Nursery, Tel. 336-384-5323 ArborGen, Tel. 843-528-3203
Monitoring Performers	
Michael Baker Engineering, Inc.	9716-B Rea Road #56 Charlotte, NC 28277
	Contact:
Stream Monitoring Point of Contact	Kristi Suggs, Tel. 704-579-4828
Vegetation Monitoring Point of Contact	Kristi Suggs, Tel. 704-579-4828

Table 4. Project Attributes							
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648							
Project County	Stanly						
Physiographic Region	Piedmont						
Ecoregion	Carolina Slate Belt						
Project River Basin	Yadkin - Pee Dee						
USGS HUC for Project (14 digit)	03040105060040						
NCDWQ Sub-basin for Project	03-07-13						
Within Extent of DMS Watershed Plan	Lower Yadkin RBRP, 2009						
WRC Class (Warm Cool Cold)	Warm						
% Project Easement Fenced/Demarcated	100%						
Beaver activity observed during design phase	No activity observed						
Restoration Component Attribute Table							
	Reach 1	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**	**Reach 6**	**Reach 7**
Drainage Area (ac.)	532.1	616.6	766.7	53.7	48.9	127.8	29.2
Stream Order	2	2	3	1	1	2	1
Restored Length (LF)	1,204	1,782	829	447	344	1,340	399
Perennial (P)/Intermittent (I)	P	P	P	I	I	I	I
Watershed Type (Rural, Urban, etc.)	R	R	R	R	R	R	R
Watershed LULC Distribution							
Rural Residential	6%	1%	0%	1%	2%	0%	0%
Ag-Row Crop	8%	0%	0%	14%	4%	0%	10%
Ag-Livestock	57%	85%	70%	59%	17%	88%	64%
Forested	8%	0%	0%	17%	62%	0%	21%
Other/Open Area	8%	0%	0%	0%	9%	0%	0%
Commercial	10%	0%	0%	0%	0%	0%	0%
Roadway	3%	4%	2%	3%	<1%	0%	0%
Wooded-Livestock	0%	10%	28%	6%	4%	12%	5%
Open Water	0%	0%	0%	0%	<1%	0%	0%
Watershed Impervious Cover (%)	19%	5%	2%	4%	<4%	<1%	<1%
NCDWR AU/Index#	13-17-31-1-1						
NCDWQ Classification	C						
303(d) Listed	No						
303 (d) Listing Stressor	N/A						
Total Acreage of Easement	5.35	8.01	3.79	1.97	1.06	3.55	1.36
Total Vegetated Easement Acreage	4.81	6.97	3.48	1.63	0.94	3.22	1.26
Total Planted Acreage for Restoration	4.81	6.97	3.48	1.63	0.94	3.22	1.26
	Reach 1	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**	**Reach 6**	**Reach 7**
Rosgen Classification (existing)	E4	E4	E4	B4	B4	B4	B4a
Rosgen Classification (as-built)	C4	C4	C4	B4	B4	C4b	B4a
Valley Type	VIII	VIII	VIII	II	II	II	II
Valley Slope	0.0092	0.0092	0.0089	0.023	0.0447	0.0243	0.0495
Trout Waters Designation	No						
Species of Concern, edangered etc. (Y/N)	No*, Yes**						
Dominant Soil Series and Characteristics							
Series	OaA	OaA	OaA	GoF	GoF	GoF	BaD
Depth	46”	46”	46”	36”	36”	36”	40”
Clay %	10-35%	10-35%	10-35%	5-27%	5-27%	5-27%	Oct-55
K	0.28	0.28	0.28	0.05	0.05	0.05	0.15-0.24
T	4	4	4	4	4	4	3

* Bald Eagle (*Haliaeetus leucocephalus*) a BGEPA species is listed as occurring in Stanly County; however, suitable habitat is not located within the Project area or within two miles of the Project site.

** Schweinitz’s Sunflower (*Helianthus schweinitzii*) A federally endangered species is listed as occurring within Stanly County and though suitable habitat is present, a field study was conducted and no species were located within the Project area. NCNHP database indicated there are no known populations of these species within two miles of the study area.

(NRCS, 2010a; NCDENR, 2007 & 2008; USFWS, 2012; NCNHP, 2012)

APPENDIX B

Morphological Summary Data
Tables 5 and 6
Cross-section Data and Photos
Longitudinal Profile
Reachwide Pebble Count Data

Table 5. Baseline Stream Summary
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648
Reach 1 (1,204 LF)

Parameter	Design						As-built					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle												
BF Width (ft)	-----	13.5	-----	-----	-----	-----	11.8	-----	-----	14.4	-----	3
Floodprone Width (ft)	45	-----	-----	63	-----	-----	33.1	-----	-----	91.8	-----	3
BF Mean Depth (ft)	-----	1	-----	-----	-----	-----	0.8	-----	-----	1.0	-----	3
BF Max Depth (ft)	-----	1.4	-----	-----	-----	-----	1.2	-----	-----	1.4	-----	3
BF Cross-sectional Area (ft^2)	-----	13.8	-----	-----	-----	-----	9.1	-----	-----	13.9	-----	3
Width/Depth Ratio	-----	13.2	-----	-----	-----	-----	14.4	-----	-----	15.2	-----	3
Entrenchment Ratio	3.3	-----	-----	4.7	-----	-----	2.8	-----	-----	6.4	-----	3
Bank Height Ratio	-----	1	-----	-----	-----	-----	1.0	-----	-----	1.0	-----	3
d50 (mm)	-----	50	-----	-----	-----	-----	-----	31.2	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	42.0	51.6	-----	72.9	-----	18
Rc:Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	2.6	-----	-----	-----	15
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	16.9	33.0	34.2	42.0	-----	7
Riffle Slope (ft/ft)	0.01	-----	-----	0.017	-----	-----	0.011	0.017	0.016	0.024	-----	7
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	20.3	-----	-----	67.5	-----	-----	46.0	62.0	64.0	75.0	-----	10
Pool Max Depth (ft)	2.1	-----	-----	3.6	-----	-----	2.50	-----	-----	2.52	-----	2
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
d16 / d35 / d50 / d84 / d95			11.3 / 33.0 / 50.0 / 128.0 / >2048						4.0 / 18.4 / 31.2 / 96.6 / >2048 / >2048			
Reach Shear Stress (competency) lb/f^2	-----	0.41	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	26.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	0.830	-----	-----	-----	0.83	-----	-----	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	C4	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----
BF Velocity (fps)	-----	3.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	13.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	1,082	-----	-----	-----	-----
Channel length $(ft)^2$	-----	1,192	-----	-----	-----	-----	-----	1,206	-----	-----	-----	-----
Sinuosity	-----	1.10	-----	-----	-----	-----	-----	1.11	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0094	-----	-----	-----	-----	-----	0.0096	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0107	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

Table 5. Baseline Stream Summary (continued)
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648
Reach 2 (1,782 LF)

Parameter	Design						As-built					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle												
BF Width (ft)	-----	14.0	-----	-----	-----	-----	15.4	-----	-----	15.6	-----	3
Floodprone Width (ft)	83	-----	-----	104.0	-----	-----	74.9	-----	-----	102.7	-----	3
BF Mean Depth (ft)	-----	1.1	-----	-----	-----	-----	1.0	-----	-----	1.1	-----	3
BF Max Depth (ft)	-----	1.4	-----	-----	-----	-----	1.3	-----	-----	1.8	-----	3
BF Cross-sectional Area (ft^2)	-----	14.7	-----	-----	-----	-----	14.8	-----	-----	17.0	-----	3
Width/Depth Ratio	-----	13.3	-----	-----	-----	-----	14.2	-----	-----	16.5	-----	3
Entrenchment Ratio	5.9	-----	-----	7.4	-----	-----	4.8	-----	-----	6.7	-----	3
Bank Height Ratio	-----	1.0	-----	-----	-----	-----	1.0	-----	-----	1.0	-----	3
d50 (mm)	-----	50	-----	-----	-----	-----	-----	20.9	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	48.6	54.7	-----	65.6	-----	7
Rc:Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	3.0	-----	-----	-----	8
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	10.1	20.0	21.8	28.0	-----	4.0
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	0.012	0.017	0.014	0.026	-----	4.0
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	21	-----	-----	70	-----	-----	46.0	69.0	70.0	85.0	-----	10
Pool Max Depth (ft)	2.1	-----	-----	3.7	-----	-----	2.5	-----	-----	2.9	-----	2
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
d16 / d35 / d50 / d84 / d95			11.3 / 33.0 / 50.0 / 128.0 / >2048						<0.063 / 12.2 / 20.9 / 68.5 / 151.8 / >2048			
Reach Shear Stress (competency) lb/f^2	-----	0.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	35.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	0.96	-----	-----	-----	-----	-----	0.96	-----	-----	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	C4	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----
BF Velocity (fps)	-----	3.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	55	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	1,549	-----	-----	-----	-----
Channel length $(ft)^2$	-----	1,833	-----	-----	-----	-----	-----	1,842	-----	-----	-----	-----
Sinuosity	-----	1.07	-----	-----	-----	-----	-----	1.19	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0127	-----	-----	-----	-----	-----	0.0077	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0091	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S.

Table 5. Baseline Stream Summary (continued)
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648
Reach 3 (829 LF)

Parameter	Design						As-built					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle												
BF Width (ft)	-----	15.5	-----	-----	-----	-----	14.9	-----	-----	17.1	-----	3
Floodprone Width (ft)	104	-----	-----	218.0	-----	-----	99.3	-----	-----	99.8	-----	3
BF Mean Depth (ft)	-----	1.2	-----	-----	-----	-----	1.1	-----	-----	1.3	-----	3
BF Max Depth (ft)	-----	1.6	-----	-----	-----	-----	1.6	-----	-----	1.8	-----	3
BF Cross-sectional Area (ft^2)	-----	18.2	-----	-----	-----	-----	16.3	-----	-----	21.5	-----	3
Width/Depth Ratio	-----	13.2	-----	-----	-----	-----	13.5	-----	-----	14.0	-----	3
Entrenchment Ratio	6.7	-----	-----	14.1	-----	-----	5.8	-----	-----	6.7	-----	3
Bank Height Ratio	-----	1.0	-----	-----	-----	-----	1.0	-----	-----	1.0	-----	3
d50 (mm)	-----	15	-----	-----	-----	-----	-----	21.8	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	31.0	-----	-----	47.0	-----	-----	54.5	63.2	-----	71.8	-----	9
Rc:Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	3.5	-----	-----	8.0	-----	-----	-----	3.2	-----	-----	-----	7
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	23.1	38.0	35.0	60.0	-----	5
Riffle Slope (ft/ft)	0.005	-----	-----	0.006	-----	-----	0.003	0.010	0.013	0.014	-----	5
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	62	-----	-----	109	-----	-----	64	78	77	91	-----	9
Pool Max Depth (ft)	2.4	-----	-----	4.11	-----	-----	3.2	-----	-----	3.2	-----	1
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
d16 / d35 / d50 / d84 / d95			1.0 / 11.0 / 15.0 / 64.0 / 150.0						2.0 / 12.6 / 21.8 / 74.1 / 128.0 / 128 - 180			
Reach Shear Stress (competency) lb/f^2	-----	0.23	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	12.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	1.2	-----	-----	-----	-----	-----	1.2	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	C4	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----
BF Velocity (fps)	-----	3.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	65.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	695	-----	-----	-----	-----
Channel length $(ft)^2$	-----	803	-----	-----	-----	-----	-----	823	-----	-----	-----	-----
Sinuosity	-----	1.16	-----	-----	-----	-----	-----	1.18	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0032	-----	-----	-----	-----	-----	0.0062	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0075	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

Table 5. Baseline Stream Summary (continued)
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648
Reach 6 (1,340 LF)

Parameter	Design						As-built					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle												
BF Width (ft)	-----	10.0	-----	-----	-----	-----	8.5	-----	-----	10.5	-----	-----
Floodprone Width (ft)	19	-----	-----	87.0	-----	-----	33.1	-----	-----	55.4	-----	-----
BF Mean Depth (ft)	-----	0.6	-----	-----	-----	-----	0.6	-----	-----	0.9	-----	-----
BF Max Depth (ft)	-----	0.9	-----	-----	-----	-----	1.2	-----	-----	1.5	-----	-----
BF Cross-sectional Area (ft^2)	-----	6.3	-----	-----	-----	-----	5.3	-----	-----	9.8	-----	-----
Width/Depth Ratio	-----	15.9	-----	-----	-----	-----	11.4	-----	-----	15.1	-----	-----
Entrenchment Ratio	1.9	-----	-----	8.7	-----	-----	3.1	-----	-----	5.7	-----	-----
Bank Height Ratio	-----	1.0	-----	-----	-----	-----	1.0	-----	-----	1.0	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	-----	-----	28.3	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc:Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	9.1	25.0	22.7	60.0	-----	12
Riffle Slope (ft/ft)	0.025	-----	-----	0.041	-----	-----	-----	0.002	-----	0.027	-----	12
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	-----	50.0	-----	-----	-----	-----	27.0	37.0	31.0	75.0	-----	8
Pool Max Depth (ft)	1.3	-----	-----	2.2	-----	-----	1.4	-----	-----	1.8	-----	2
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
d16 / d35 / d50 / d84 / d95			11.3 / 22.6 / 32.0 / 90.0 / 150.0						8.7 / 21.5 / 28.3 / 73.4 / 160.7 / >2048			
Reach Shear Stress (competency) lb/f^2	-----	0.67	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	32.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	0.2	-----	-----	-----	-----	-----	0.2	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	C4b	-----	-----	-----	-----	-----	C4b	-----	-----	-----	-----
BF Velocity (fps)	-----	2.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	14	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	1259	-----	-----	-----	-----
Channel length $(ft)^2$	-----	1,370	-----	-----	-----	-----	-----	1366	-----	-----	-----	-----
Sinuosity	-----	1.04	-----	-----	-----	-----	-----	1.08	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0226	-----	-----	-----	-----	-----	0.0226	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0244	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

Table 5. Baseline Stream Summary (continued)
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648
Reach 7 (399 LF)

Parameter	Design						As-built					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle												
BF Width (ft)	-----	5.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Floodprone Width (ft)	10	-----	-----	38.0	-----	-----	-----	-----	-----	-----	-----	-----
BF Mean Depth (ft)	-----	0.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Max Depth (ft)	-----	0.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	1.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Width/Depth Ratio	-----	15.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Entrenchment Ratio	2	-----	-----	7.6	-----	-----	-----	-----	-----	-----	-----	-----
Bank Height Ratio	-----	1.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc:Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	10.3	22.0	18.9	43.0	-----	7
Riffle Slope (ft/ft)	0.045	-----	-----	0.073	-----	-----	-----	-----	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	8.0	-----	-----	25.0	-----	-----	24.0	33.0	32.0	43.0	-----	8
Pool Max Depth (ft)	0.6	-----	-----	1.1	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
d16 / d35 / d50 / d84 / d95				-----						-----		
Reach Shear Stress (competency) lb/f^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	0.0	-----	-----	-----	-----	-----	-----	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	B4a	-----	-----	-----	-----	-----	B4a	-----	-----	-----	-----
BF Velocity (fps)	-----	3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	4.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	382.26	-----	-----	-----	-----
Channel length $(ft)^2$	-----	399	-----	-----	-----	-----	-----	412.53	-----	-----	-----	-----
Sinuosity	-----	1.04	-----	-----	-----	-----	-----	1.08	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0407	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

Table 6. Morphology and Hydraulic Monitoring Summary
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648
Reach 1 (1,204 LF)

	Cross-section X-1 (Riffle)							Cross-section X-2 (Pool)							Cross-section X-3 (Pool)							Cross-section X-4 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	11.77							22.22							16.38							14.44						
BF Mean Depth (ft)	0.77							1.23							1.41							0.96						
Width/Depth Ratio	15.23							18.03							11.59							15.04						
BF Cross-sectional Area (ft²)	9.1							27.4							23.2							13.9						
BF Max Depth (ft)	1.11							2.5							2.52							1.35						
Width of Floodprone Area (ft)	33.14							70.59							77.09							91.83						
Entrenchment Ratio	2.8							3.2							4.7							6.4						
Bank Height Ratio	1							1							1							1						
Wetted Perimeter (ft)	13.3							24.7							19.2							16.4						
Hydraulic Radius (ft)	0.7							1.1							1.2							0.8						
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft²)	-							-																				
d50 (mm)	-							-																				

	Cross-section X-5 (Riffle)																											
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	12.1																											
BF Mean Depth (ft)	0.8																											
Width/Depth Ratio	14.4																											
BF Cross-sectional Area (ft²)	10.1																											
BF Max Depth (ft)	1.2																											
Width of Floodprone Area (ft)	71.2																											
Entrenchment Ratio	5.9																											
Bank Height Ratio	1.0																											
Wetted Perimeter (ft)	13.7																											
Hydraulic Radius (ft)	0.7																											
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft²)	-							-							-							-						
d50 (mm)	-							-							-							-						

Table 6. Morphology and Hydraulic Monitoring Summary
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648
Reach 2 (1,782 LF)

	Cross-section X-6 (Riffle)							Cross-section X-7 (Pool)							Cross-section X-8 (Riffle)							Cross-section X-9 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	15.6							16.3							15.4							24.3						
BF Mean Depth (ft)	0.95							1.4							1.1							1.4						
Width/Depth Ratio	16.5							11.5							14.5							17.9						
BF Cross-sectional Area (ft²)	14.8							23.2							16.5							33.1						
BF Max Depth (ft)	1.3							2.5							1.7							2.9						
Width of Floodprone Area (ft)	74.9							75.8							102.7							95.4						
Entrenchment Ratio	4.8							4.6							6.7							3.9						
Bank Height Ratio	1.0							1.0							1.0							1.0						
Wetted Perimeter (ft)	17.5							19.2							17.6							27.1						
Hydraulic Radius (ft)	0.8							1.2							0.9							1.2						
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft²)	-							-																				
d50 (mm)	-							-																				

	Cross-section X-10 (Riffle)							Cross-section X-7 (Pool)							Cross-section X-8 (Riffle)							Cross-section X-9 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	15.5																											
BF Mean Depth (ft)	1.1																											
Width/Depth Ratio	14.2																											
BF Cross-sectional Area (ft²)	17.0																											
BF Max Depth (ft)	1.8																											
Width of Floodprone Area (ft)	100.0																											
Entrenchment Ratio	6.4																											
Bank Height Ratio	1.0																											
Wetted Perimeter (ft)	17.7																											
Hydraulic Radius (ft)	1.0																											
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft²)	-							-							-							-						
d50 (mm)	-							-							-							-						

Table 6. Morphology and Hydraulic Monitoring Summary
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648
Reach 3 (829 LF)

	Cross-section X-11 (Riffle)							Cross-section X-12 (Riffle)							Cross-section X-13 (Riffle)							Cross-section X-14 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	14.9							17.1							16.0							21.3						
BF Mean Depth (ft)	1.1							1.3							1.2							1.8						
Width/Depth Ratio	13.5							13.7							14.0							11.7						
BF Cross-sectional Area (ft²)	16.3							21.5							18.3							39.0						
BF Max Depth (ft)	1.6							1.8							1.6							3.2						
Width of Floodprone Area (ft)	99.8							99.7							98.3							98.7						
Entrenchment Ratio	6.7							5.8							6.1							4.6						
Bank Height Ratio	1.0							1.0							1.0							1.0						
Wetted Perimeter (ft)	17.1							19.6							18.3							25.0						
Hydraulic Radius (ft)	1.0							1.1							1.0							1.6						
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft²)	-							-																				
d50 (mm)	-							-																				

Reach 6 (1,340 LF)

	Cross-section X-15 (Pool)							Cross-section X-16 (Riffle)							Cross-section X-17 (Riffle)							Cross-section X-18 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	11.0							9.7							10.5							8.5						
BF Mean Depth (ft)	1.0							0.6							0.9							0.6						
Width/Depth Ratio	10.9							15.1							11.4							13.5						
BF Cross-sectional Area (ft²)	11.1							6.2							9.8							5.3						
BF Max Depth (ft)	1.8							1.2							1.5							1.2						
Width of Floodprone Area (ft)	60.3							55.4							33.1							37.3						
Entrenchment Ratio	5.5							5.7							3.1							4.4						
Bank Height Ratio	1.0							1.0							1.0							1.0						
Wetted Perimeter (ft)	13.0							11.0							12.4							9.7						
Hydraulic Radius (ft)	0.9							0.6							0.8							0.5						
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft²)	-							-																				
d50 (mm)	-							-																				

	Cross-section X-19 (Pool)																											
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	10.8																											
BF Mean Depth (ft)	0.8																											
Width/Depth Ratio	13.7																											
BF Cross-sectional Area (ft²)	8.4																											
BF Max Depth (ft)	1.4																											
Width of Floodprone Area (ft)	41.4																											
Entrenchment Ratio	3.8																											
Bank Height Ratio	1.0																											
Wetted Perimeter (ft)	12.3																											
Hydraulic Radius (ft)	0.7																											
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft²)	-							-							-							-						
d50 (mm)	-							-							-							-						

Permanent Cross-section

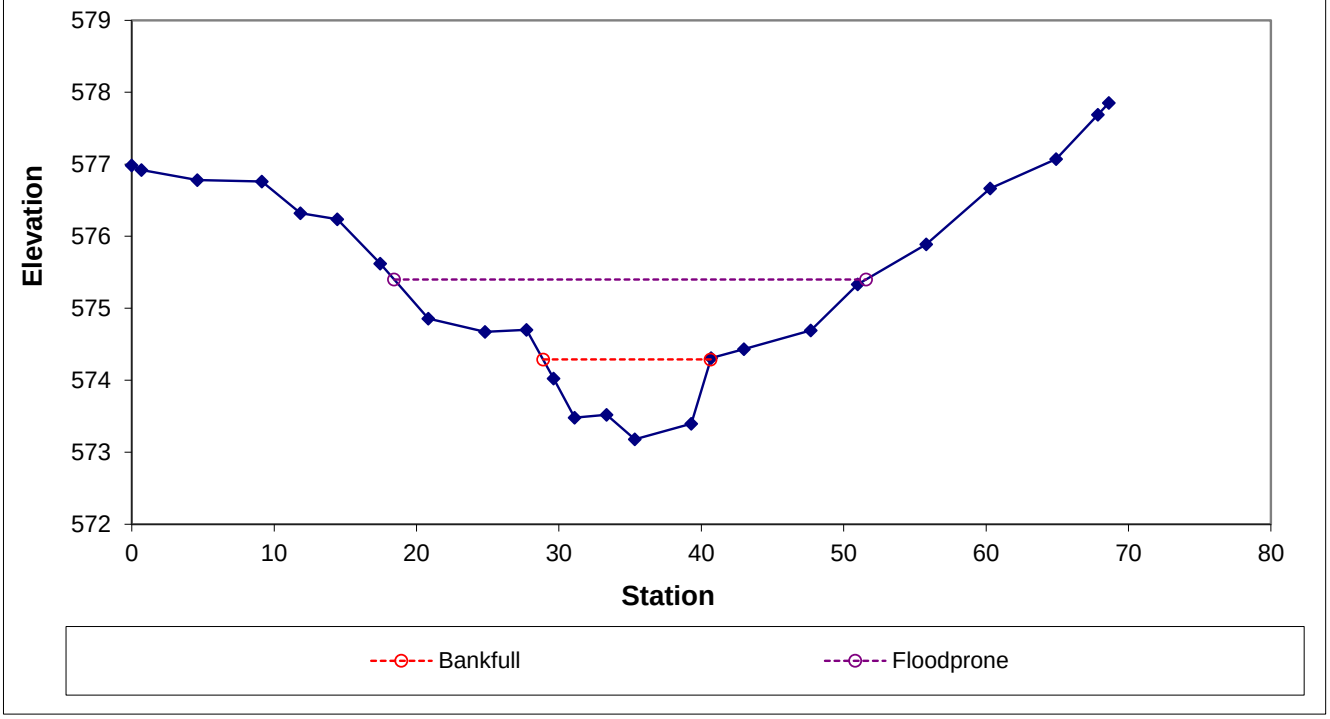
X1 - Reach 1

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	9.1	11.77	0.77	1.11	15.23	1	2.8	574.29	574.31	33.14



Permanent Cross-section

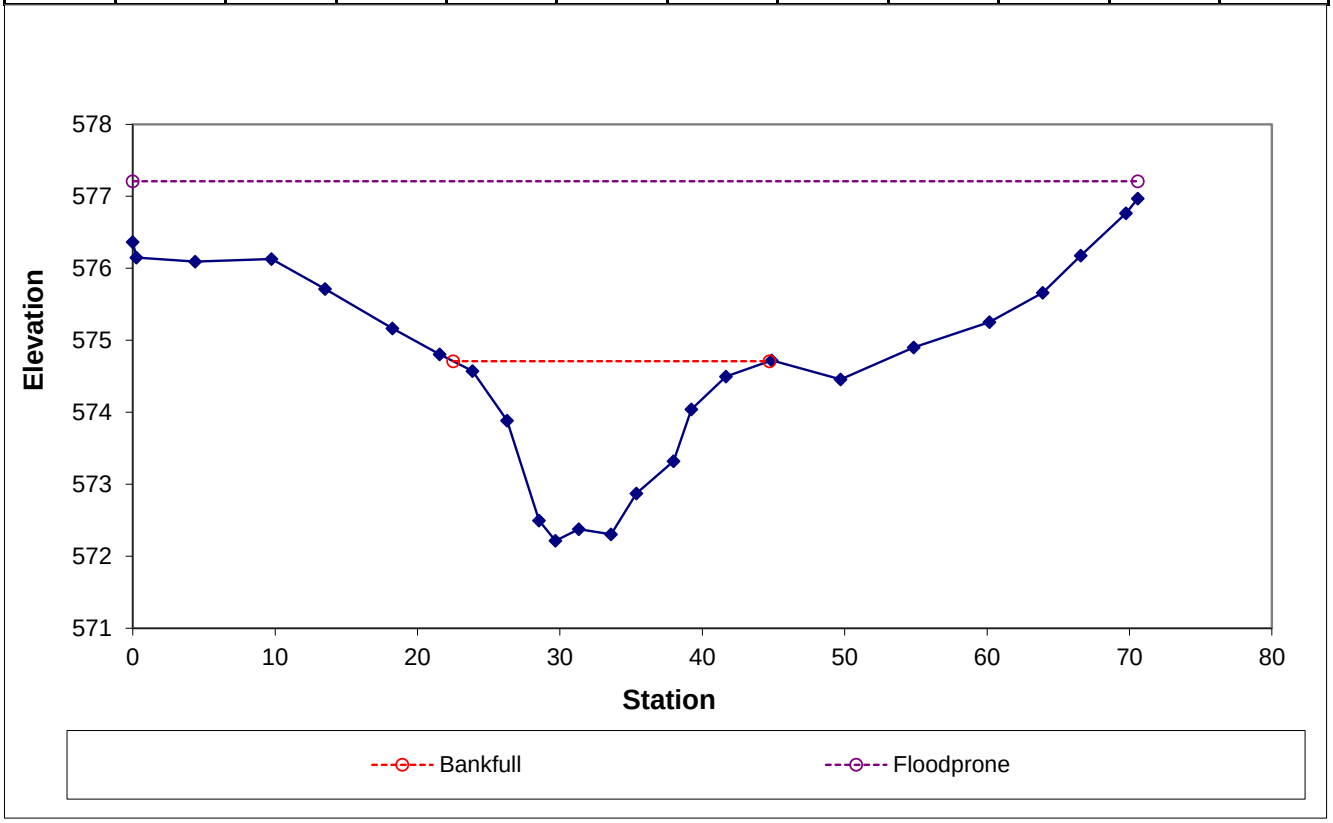
X2 - Reach 1

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Pool		27.4	22.22	1.23	2.5	18.03	1	3.2	574.71	574.72	70.59



Permanent Cross-section

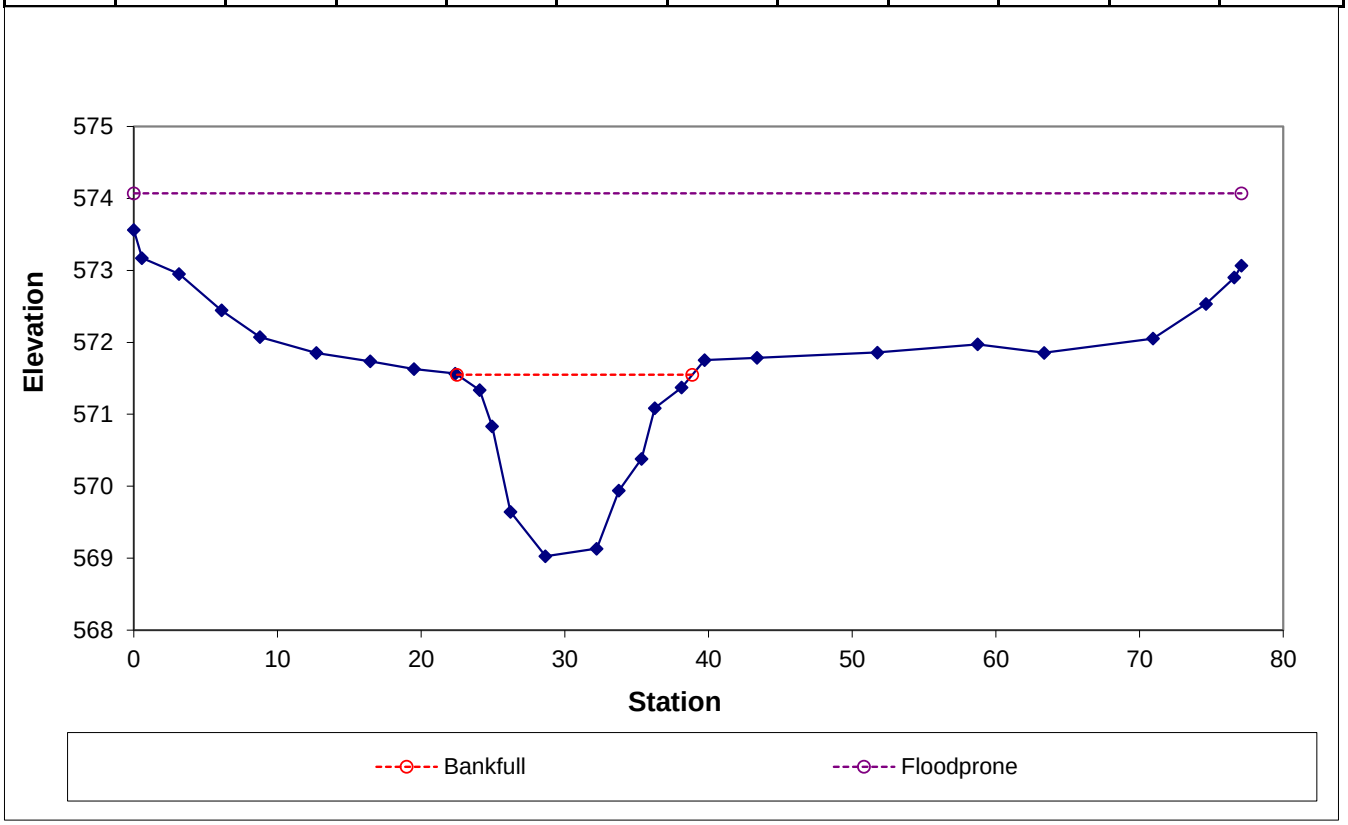
X3 - Reach 1

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Pool		23.2	16.38	1.41	2.52	11.59	1	4.7	571.55	571.57	77.09



Permanent Cross-section

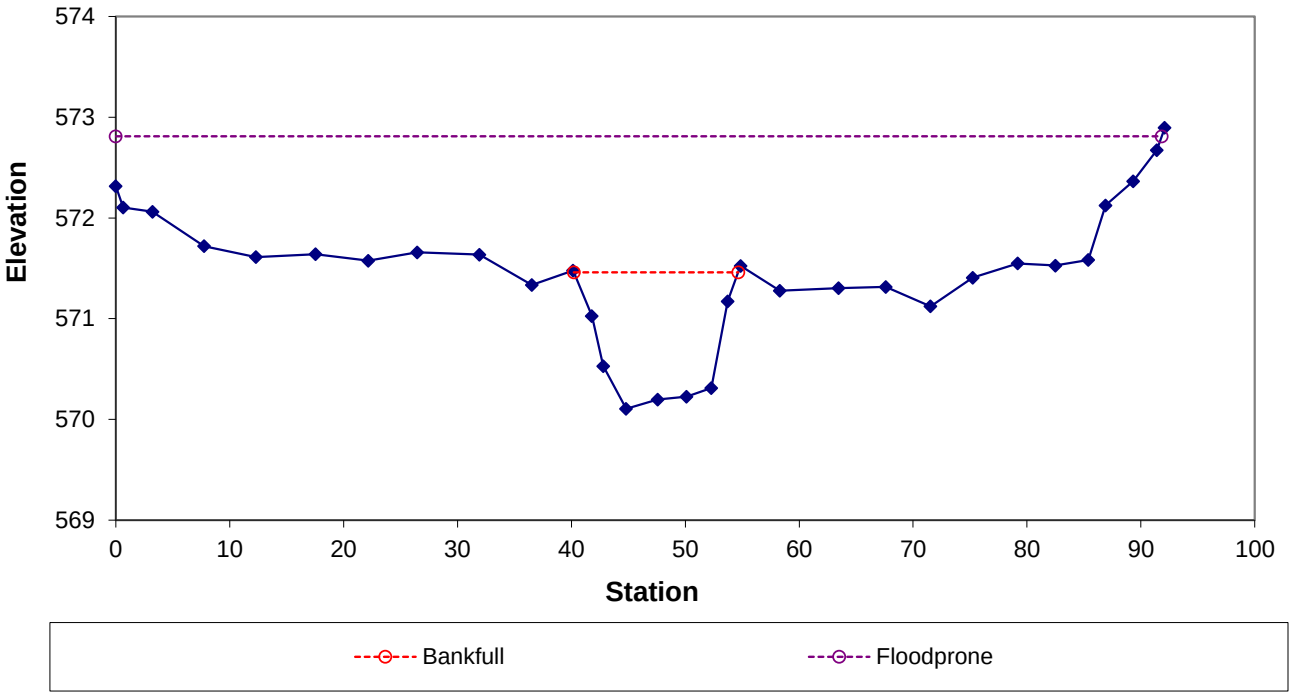
X4 - Reach 1

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	13.9	14.44	0.96	1.35	15.04	1	6.4	571.46	571.48	91.83



Permanent Cross-section

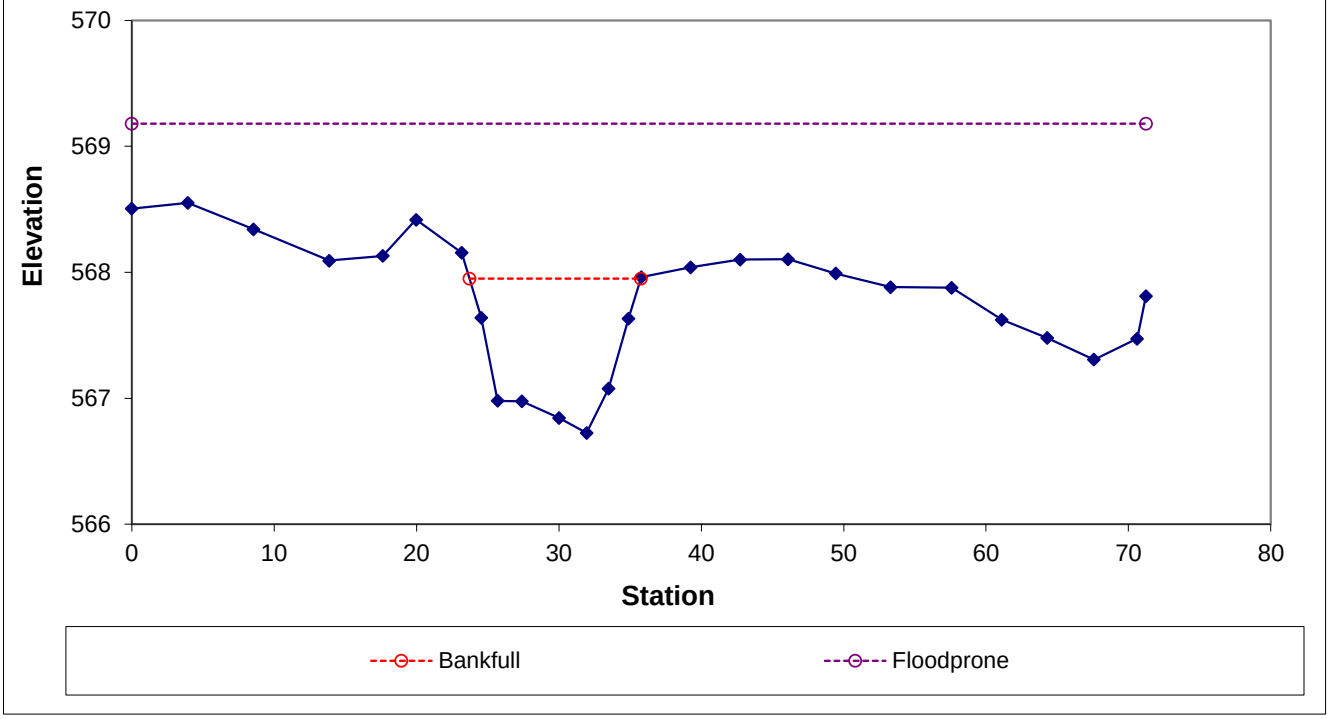
X5 - Reach 1

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	10.1	12.05	0.84	1.23	14.4	1	5.9	567.95	567.96	71.23



Permanent Cross-section

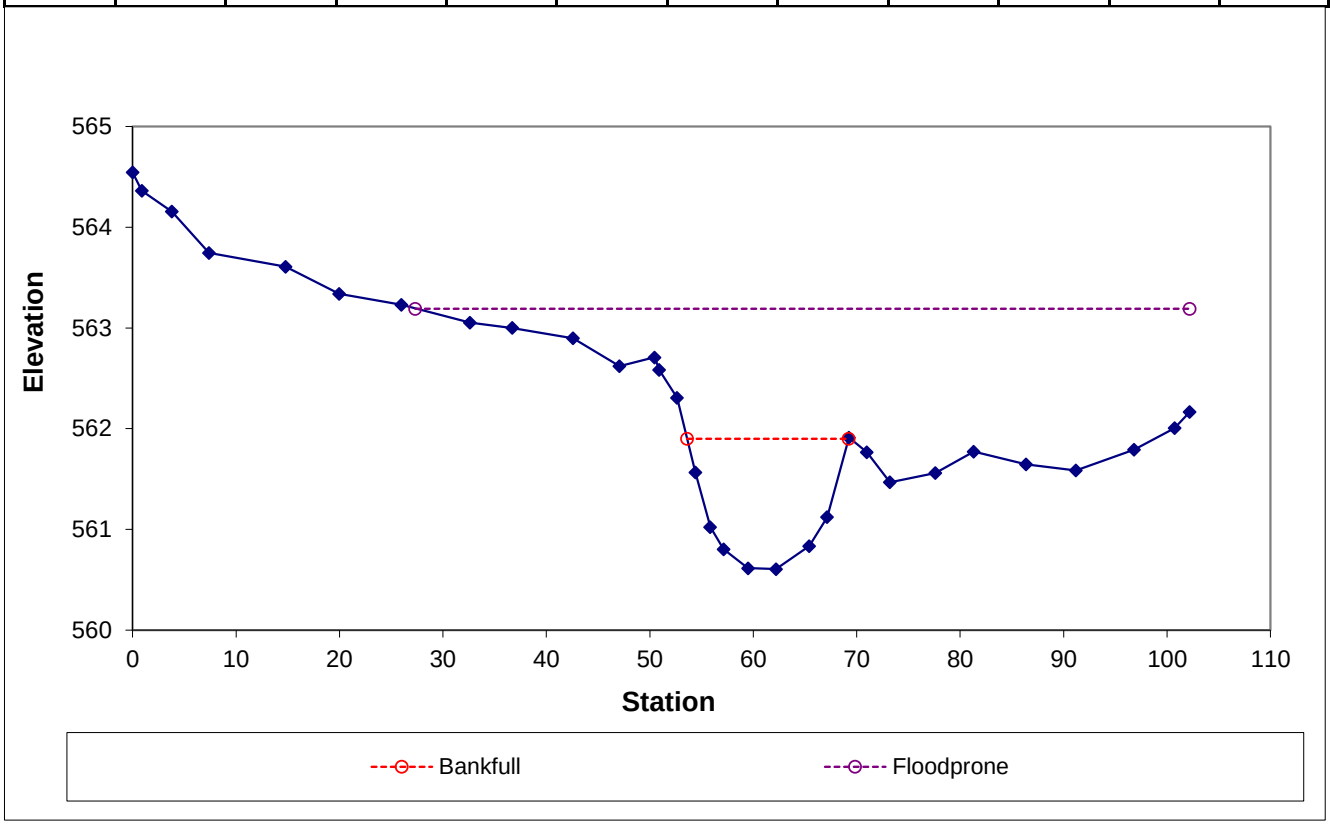
X6 - Reach 2

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	14.8	15.61	0.95	1.29	16.52	1	4.8	561.9	561.91	74.86



Permanent Cross-section

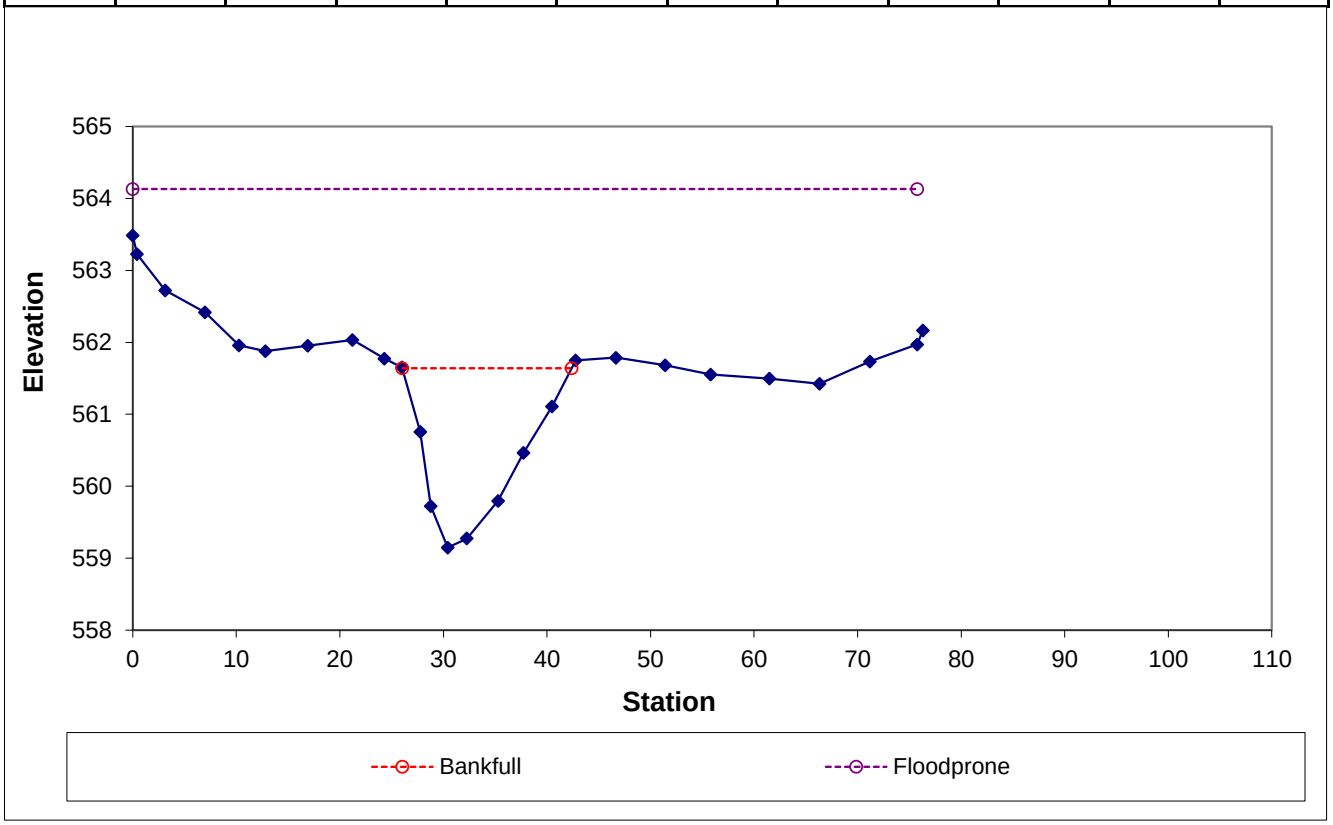
X7 - Reach 2

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Pool		23.2	16.34	1.42	2.49	11.52	1	4.6	561.64	561.65	75.75



Permanent Cross-section

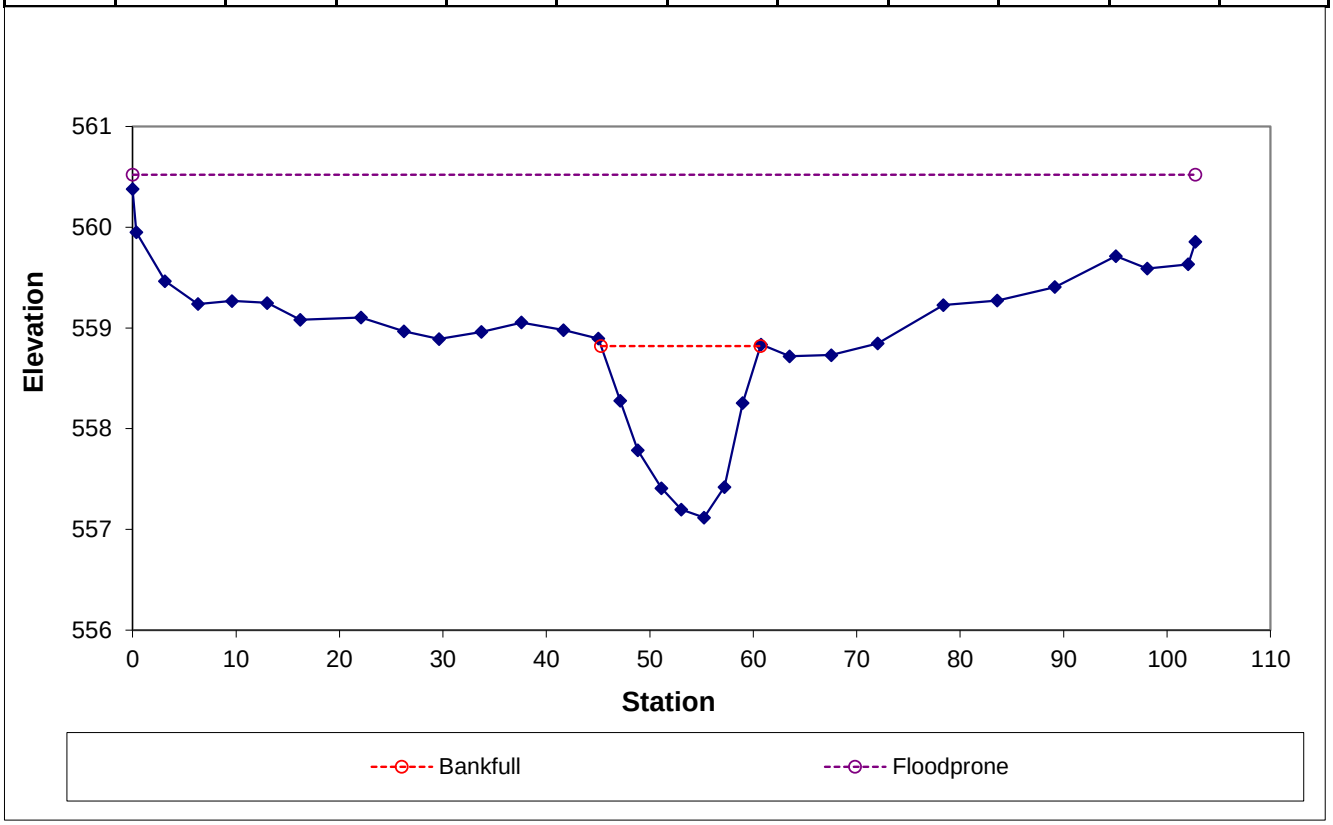
X8 - Reach 2

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	16.5	15.44	1.07	1.7	14.47	1	6.7	558.82	558.84	102.74



Permanent Cross-section

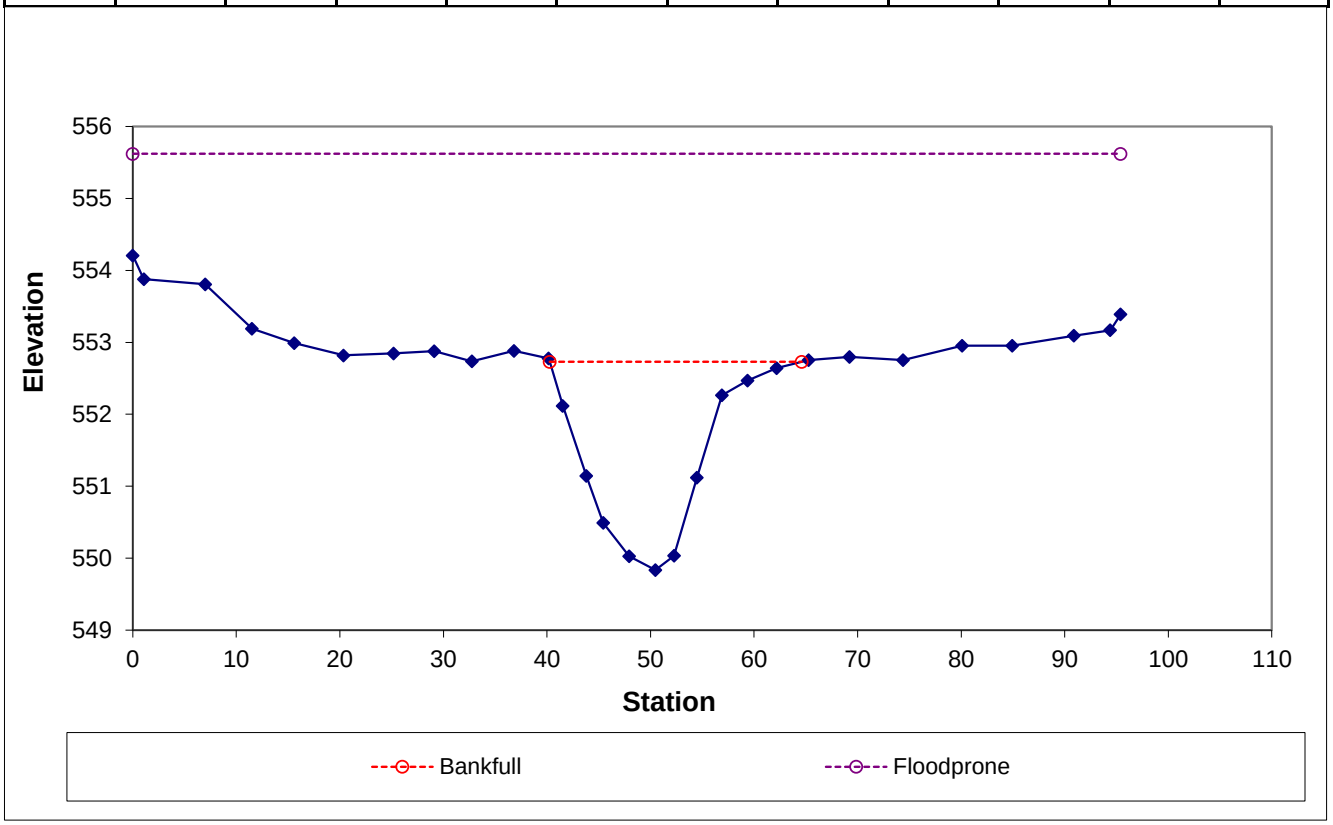
X9 - Reach 2

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Pool		33.1	24.33	1.36	2.89	17.9	1	3.9	552.73	552.76	95.4



Permanent Cross-section

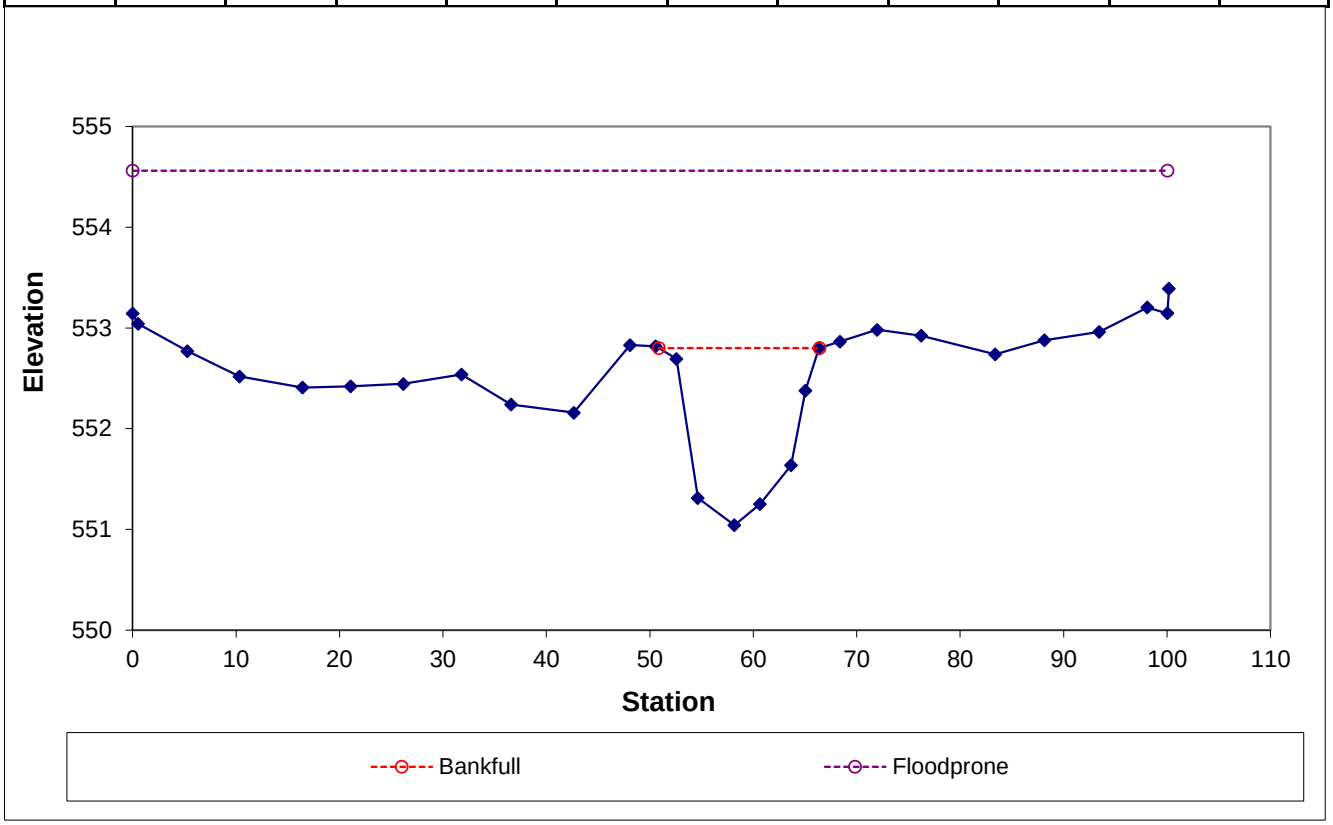
X10 - Reach 2

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	17	15.54	1.1	1.76	14.19	1	6.4	552.8	552.8	100.03



Permanent Cross-section

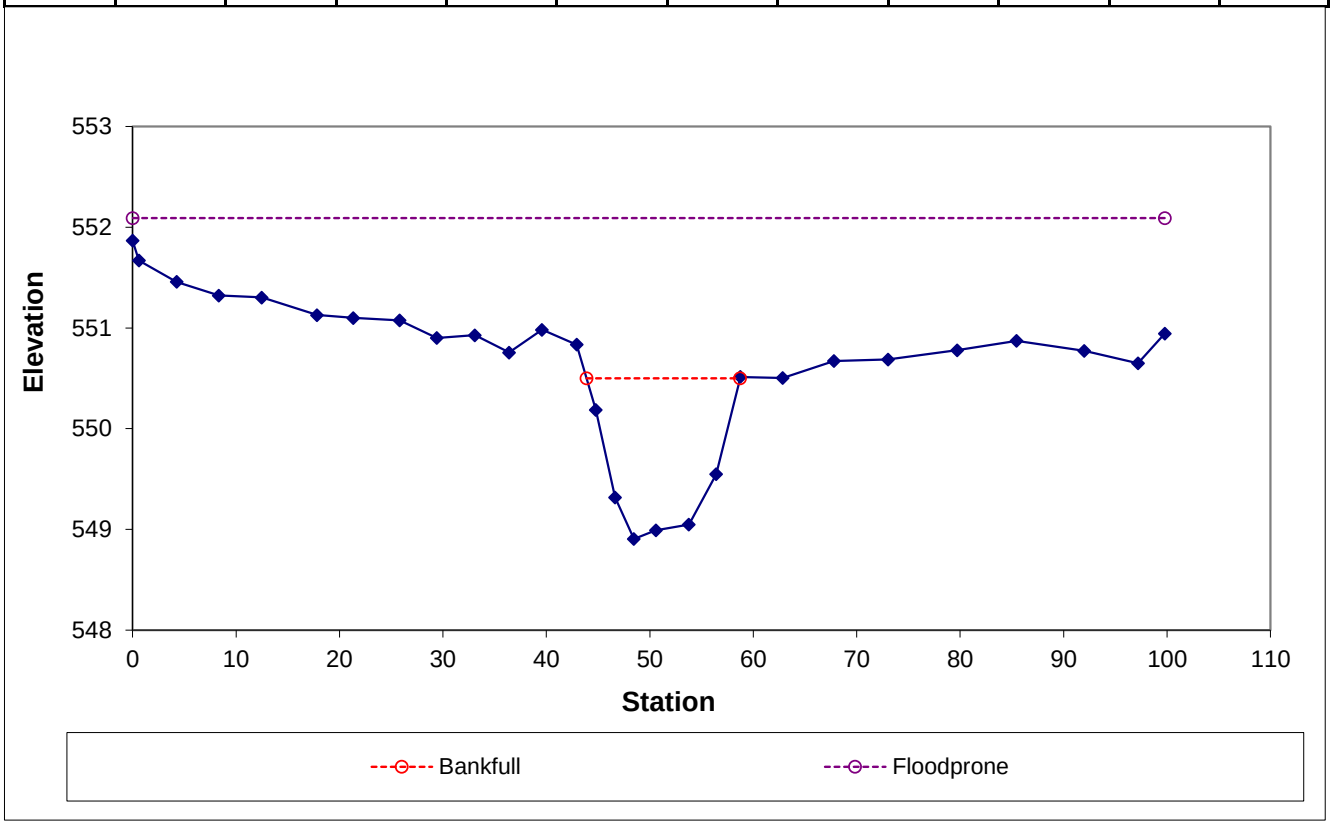
X11 - Reach 3

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	16.3	14.85	1.1	1.59	13.49	1	6.7	550.5	550.51	99.8



Permanent Cross-section

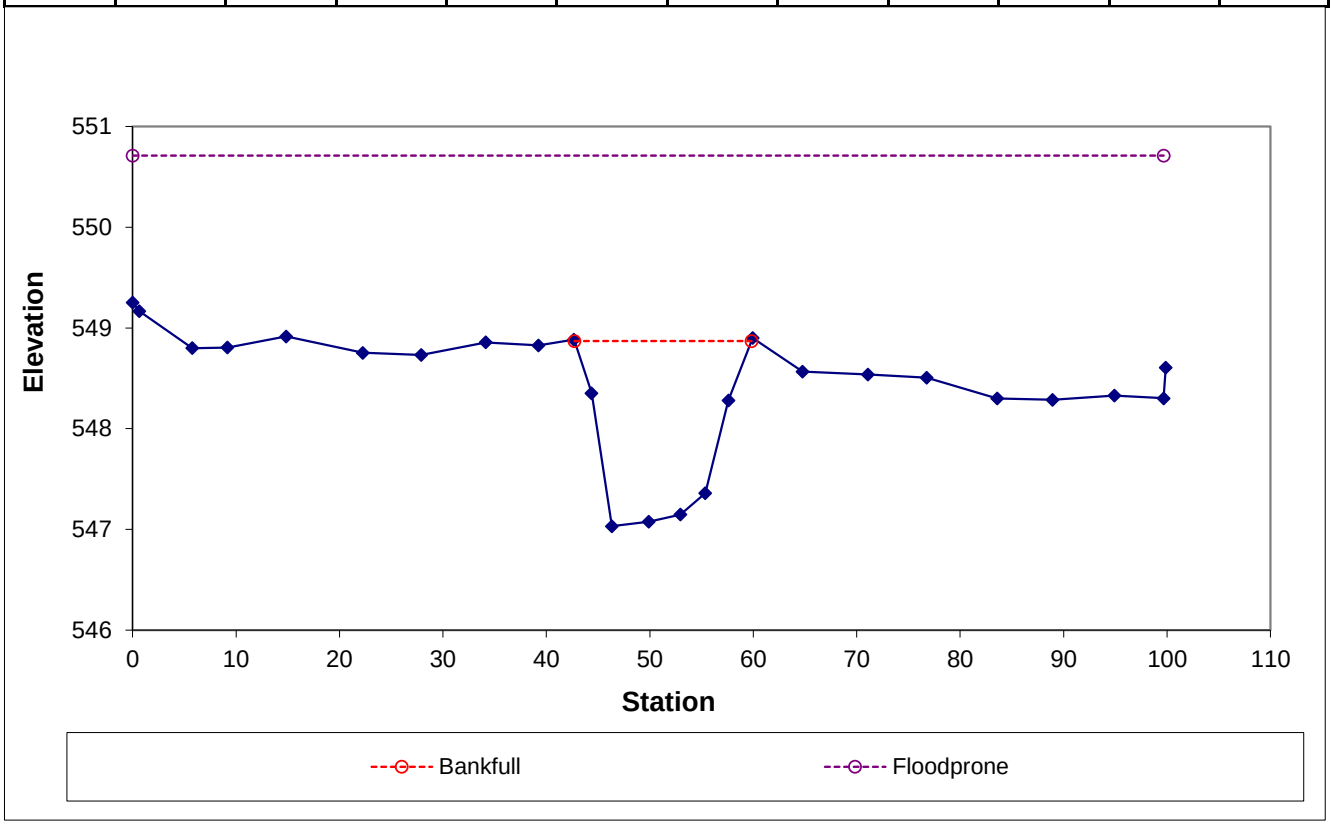
X12 - Reach 3

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	21.5	17.12	1.25	1.84	13.66	1	5.8	548.87	548.88	99.67



Permanent Cross-section

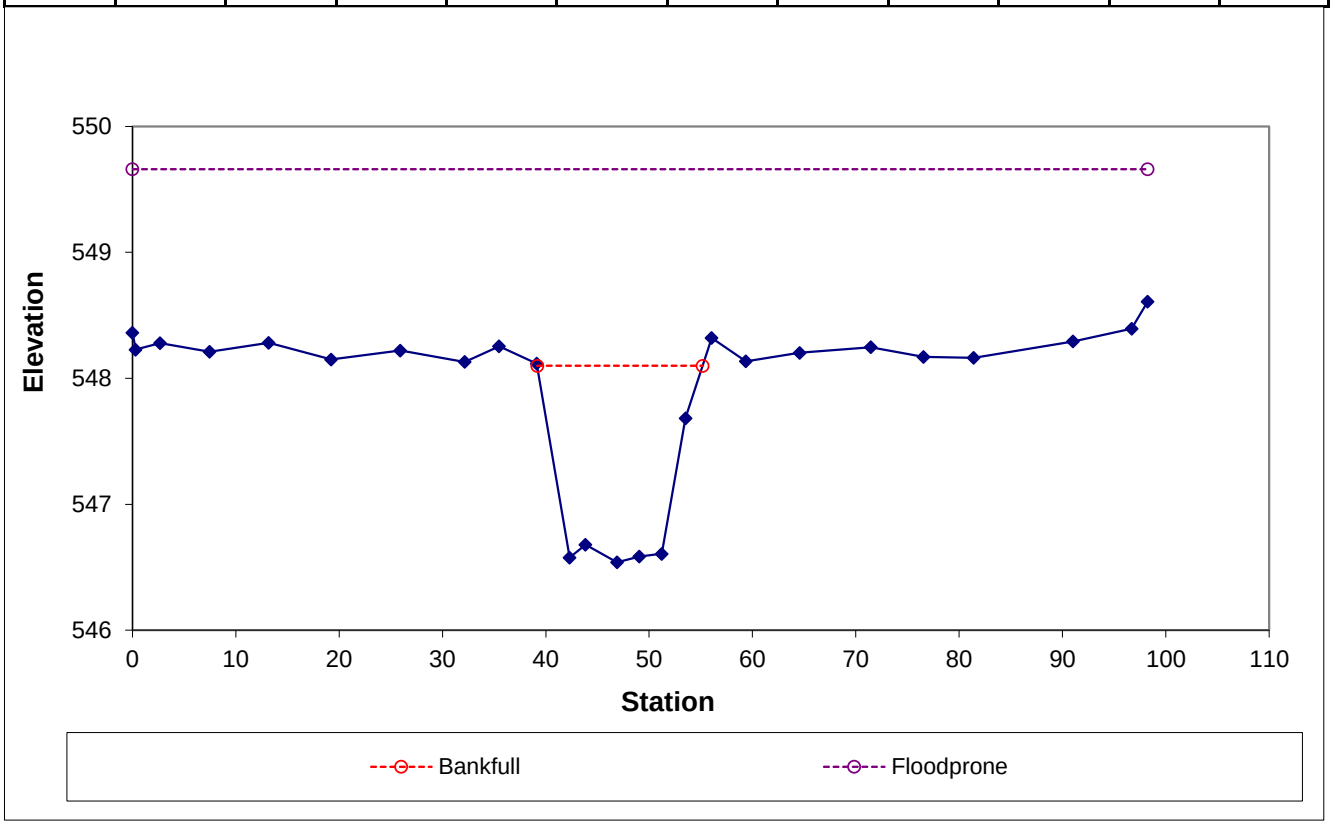
X13 - Reach 3

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	18.3	16	1.15	1.56	13.96	1	6.1	548.1	548.12	98.25



Permanent Cross-section

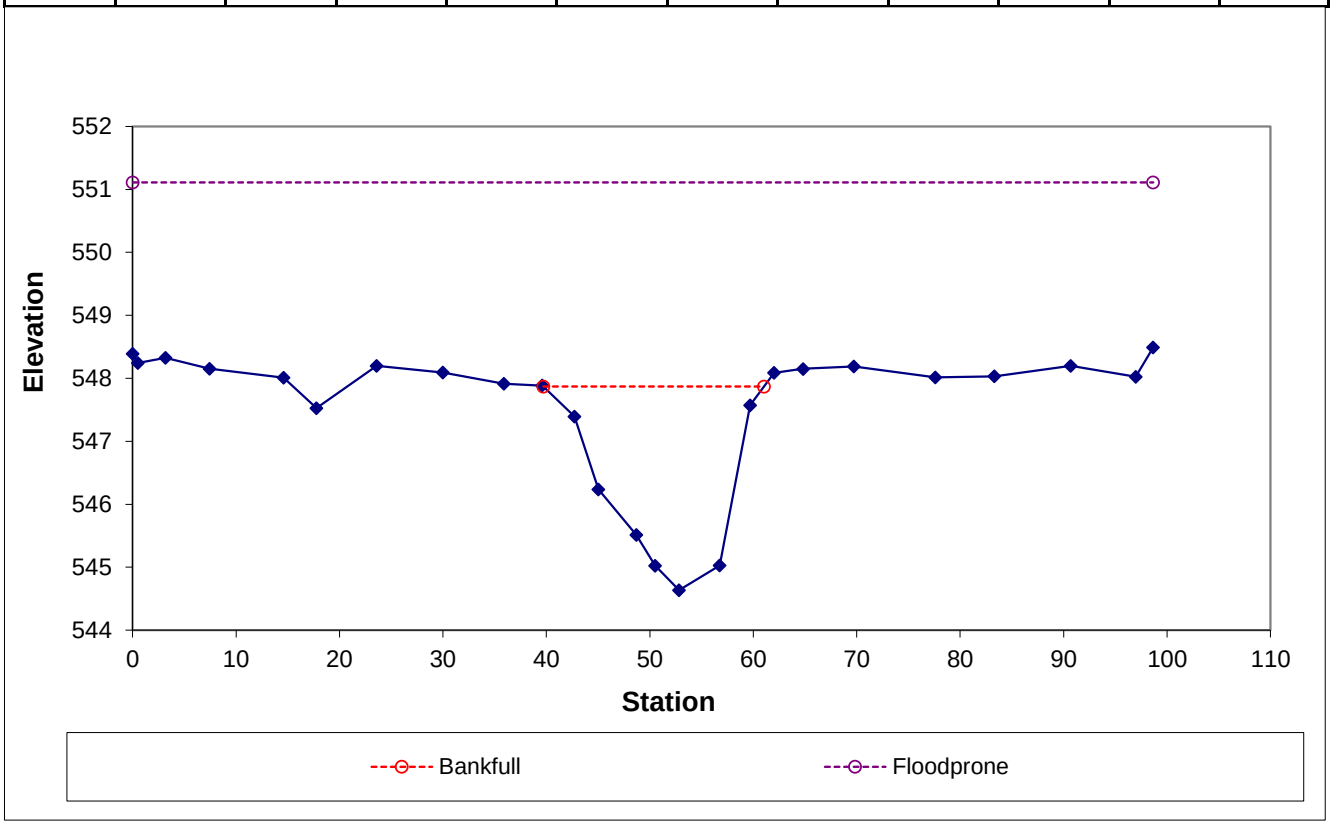
X14 - Reach 3

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Pool		39	21.33	1.83	3.24	11.67	1	4.6	547.87	547.89	98.66



Permanent Cross-section

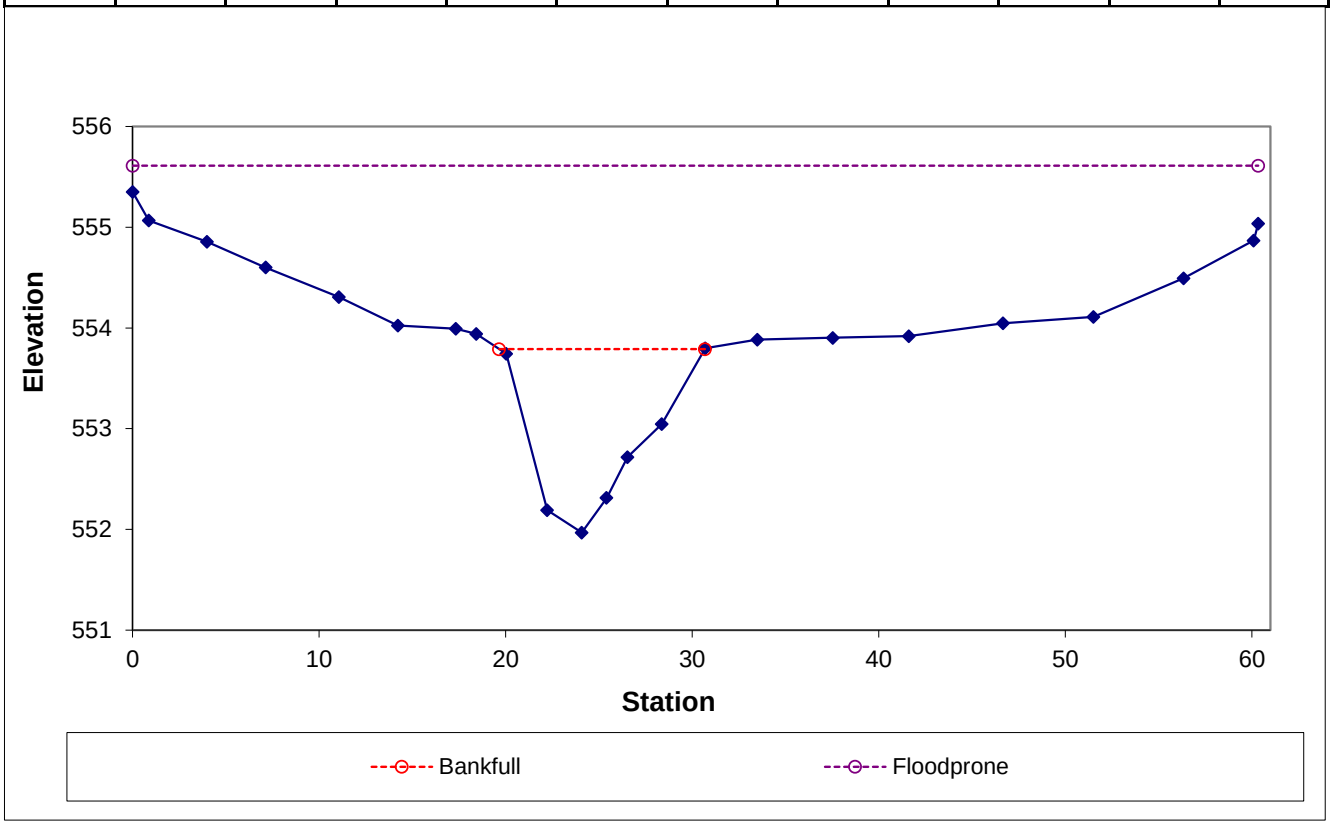
X15 - Reach 6

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Pool		11.1	11.02	1.01	1.82	10.91	1	5.5	553.79	553.8	60.34



Permanent Cross-section

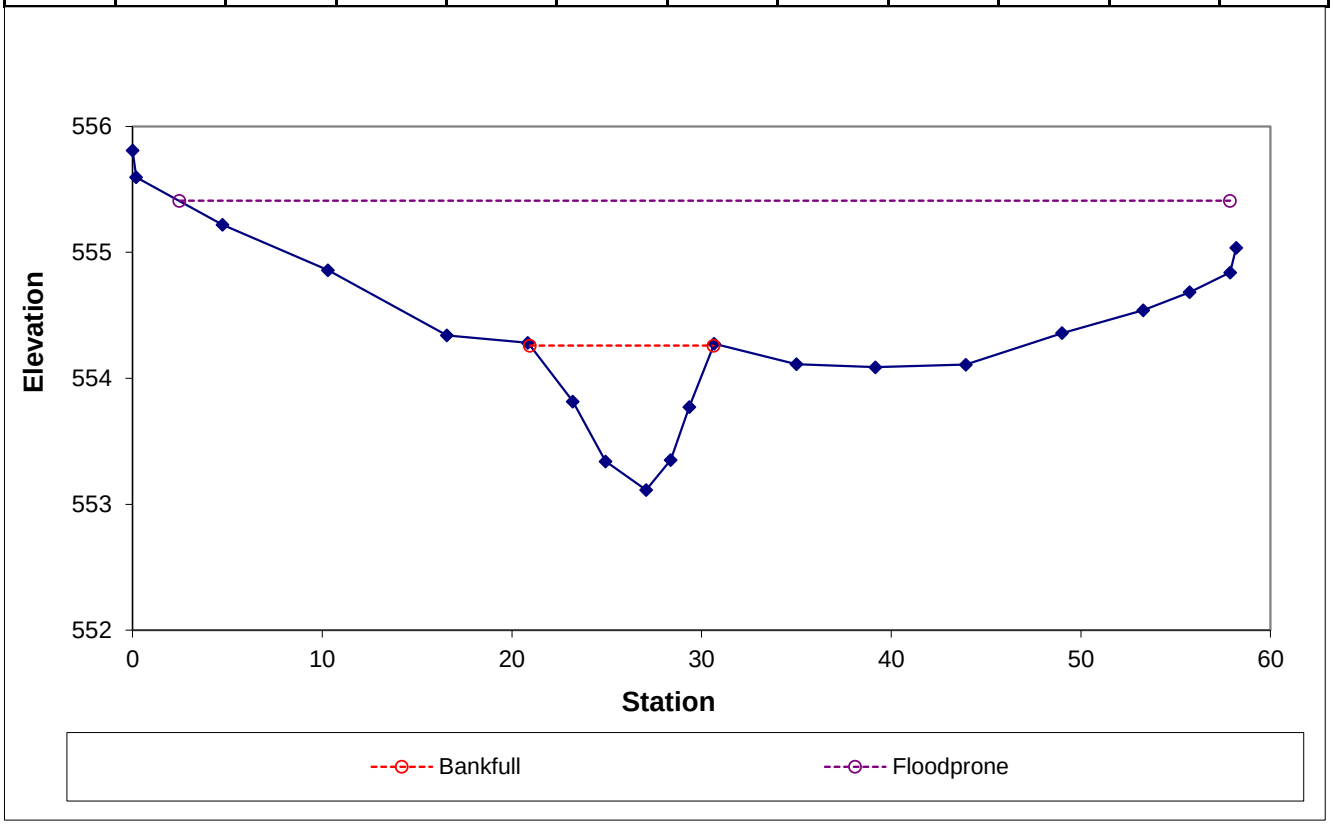
X16 - Reach 6

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	6.2	9.68	0.64	1.15	15.08	1	5.7	554.26	554.27	55.4

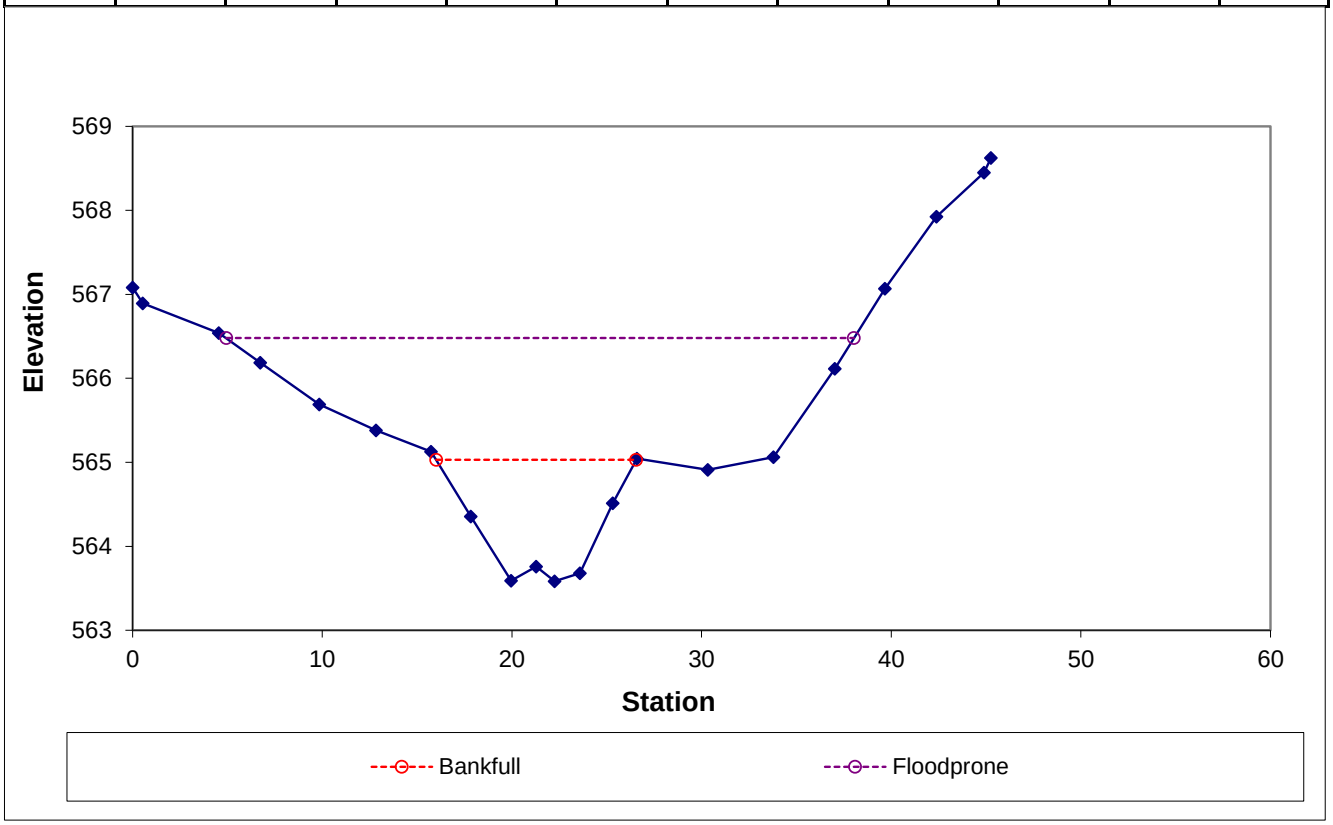


Permanent Cross-section
X17 - Reach 6
(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	9.8	10.54	0.93	1.45	11.37	1	3.1	565.03	565.05	33.09



Permanent Cross-section

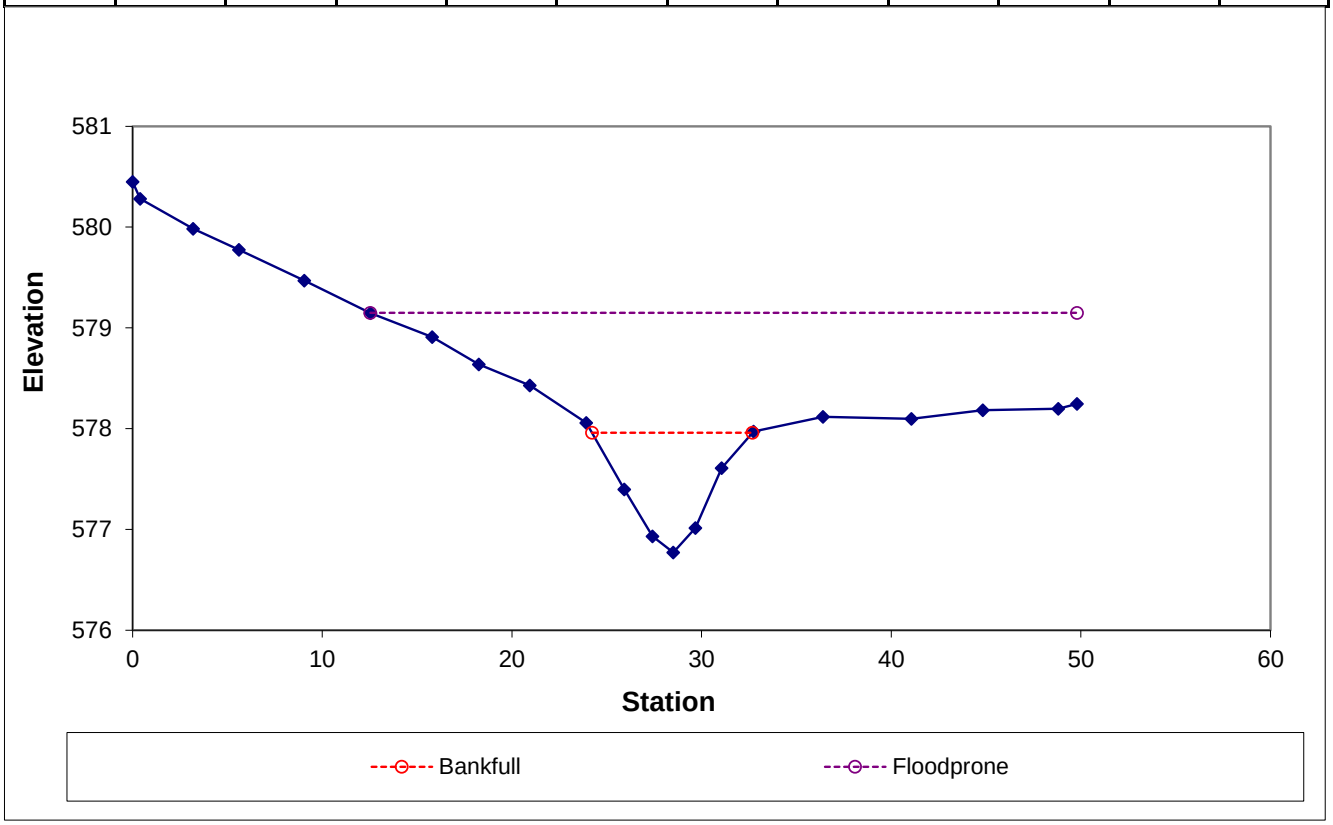
X18 - Reach 6

(As-built Data - Collected April 2016)

LEFT BANK

RIGHT BANK

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Riffle	C	5.3	8.47	0.63	1.19	13.53	1	4.4	577.96	577.97	37.26



Permanent Cross-section

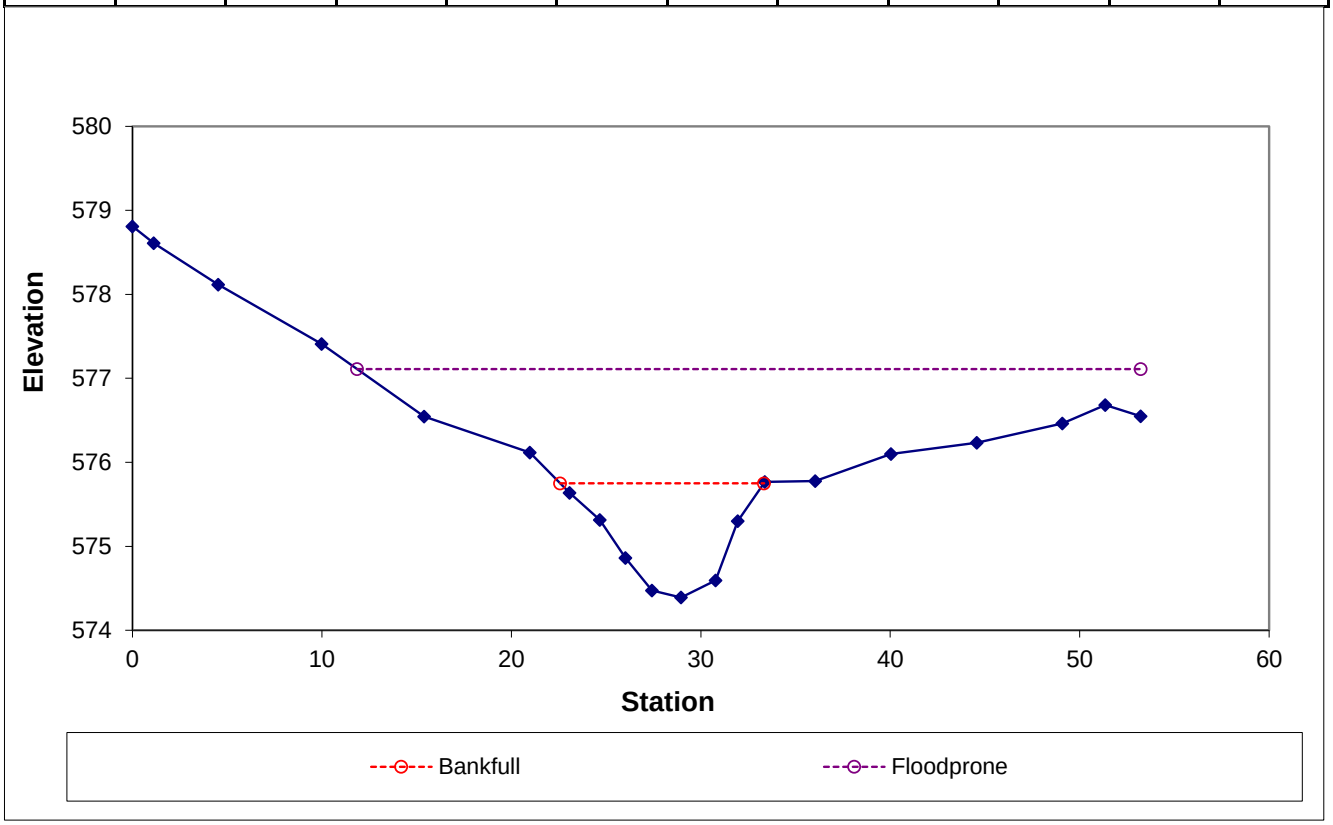
X19 - Reach 6

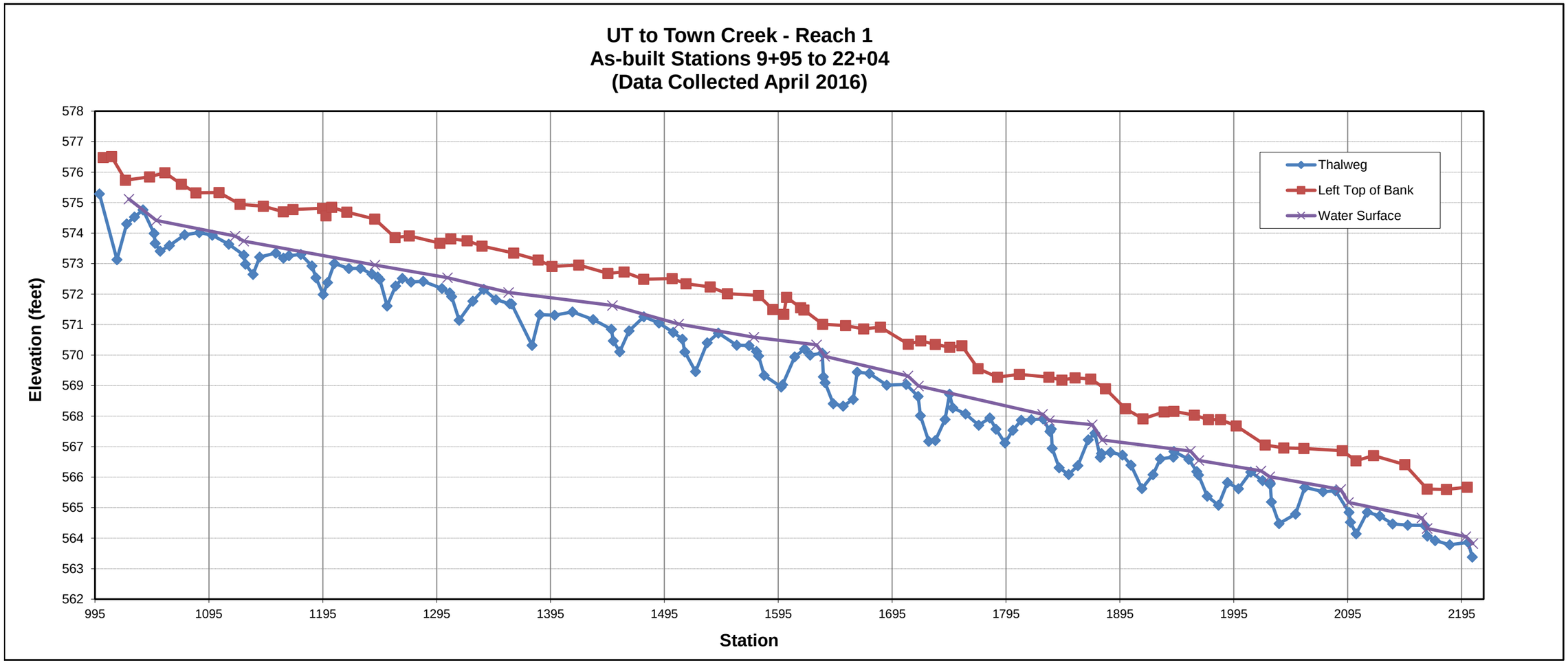
(As-built Data - Collected April 2016)

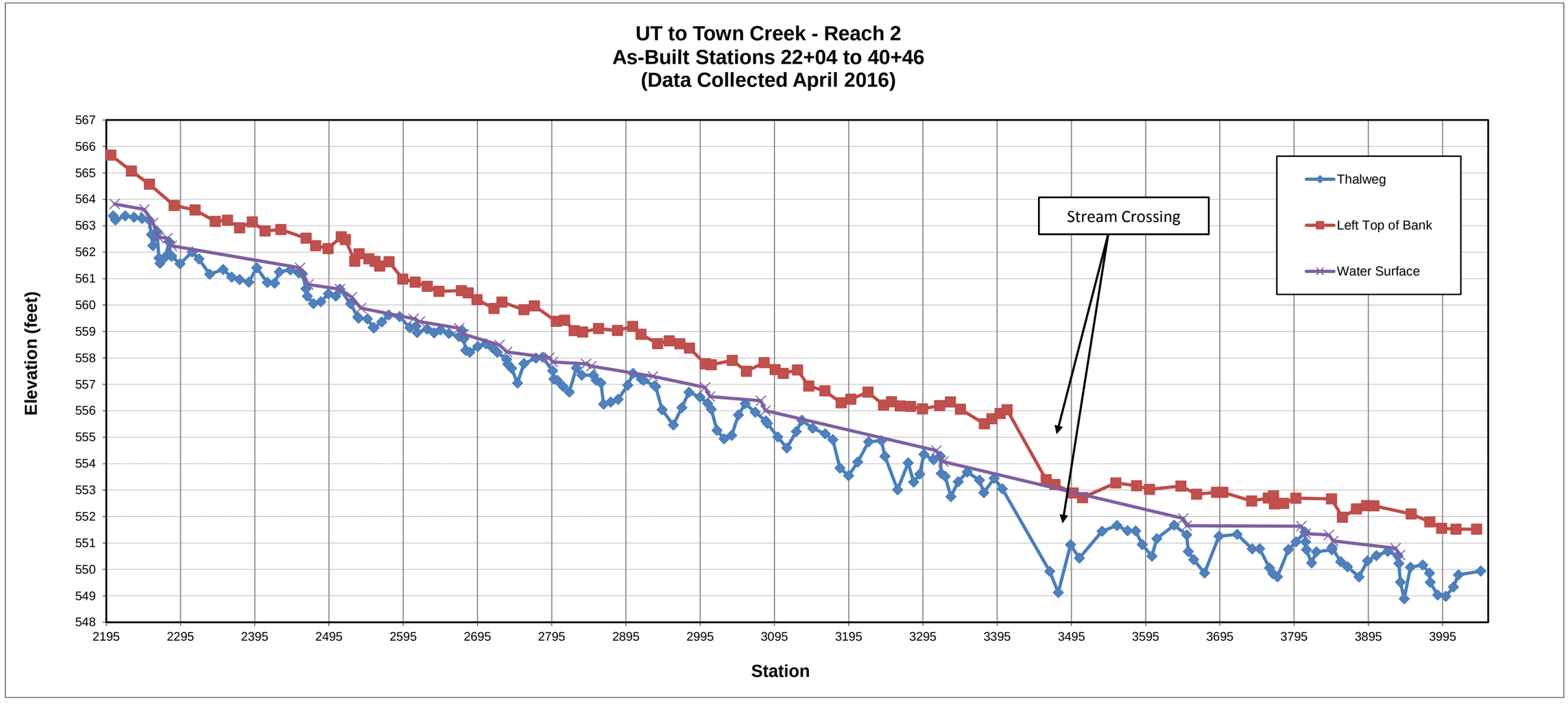
LEFT BANK

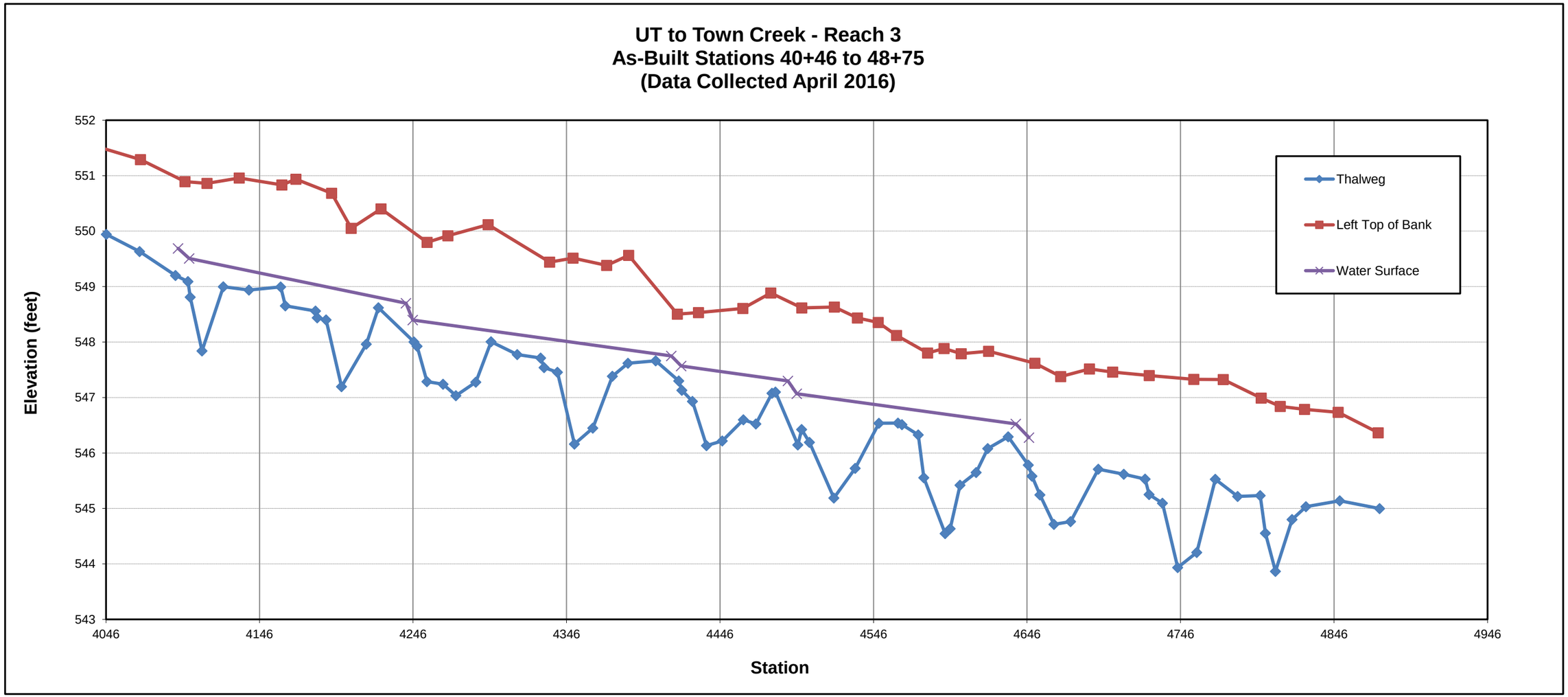
RIGHT BANK

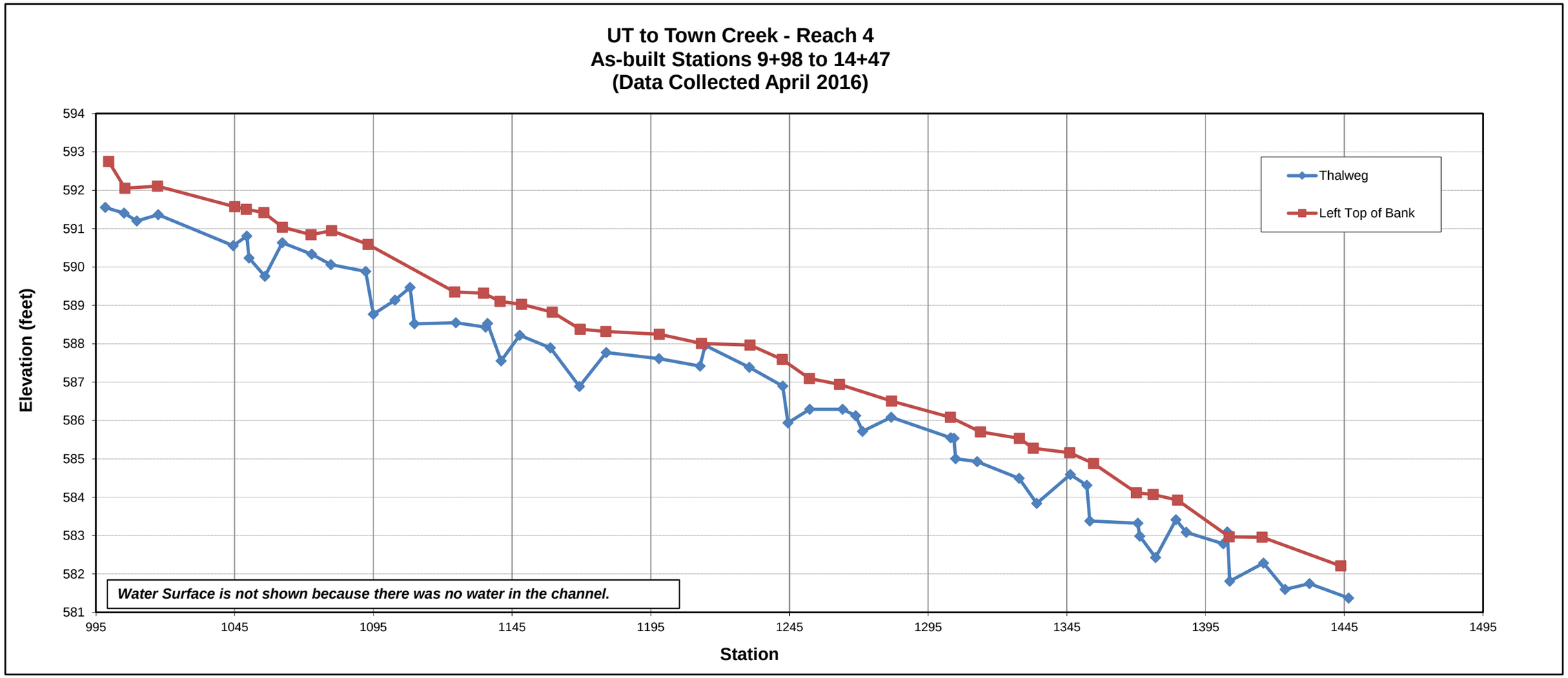
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	WFPA
Pool		8.4	10.76	0.78	1.36	13.73	1	3.8	575.75	575.77	41.36

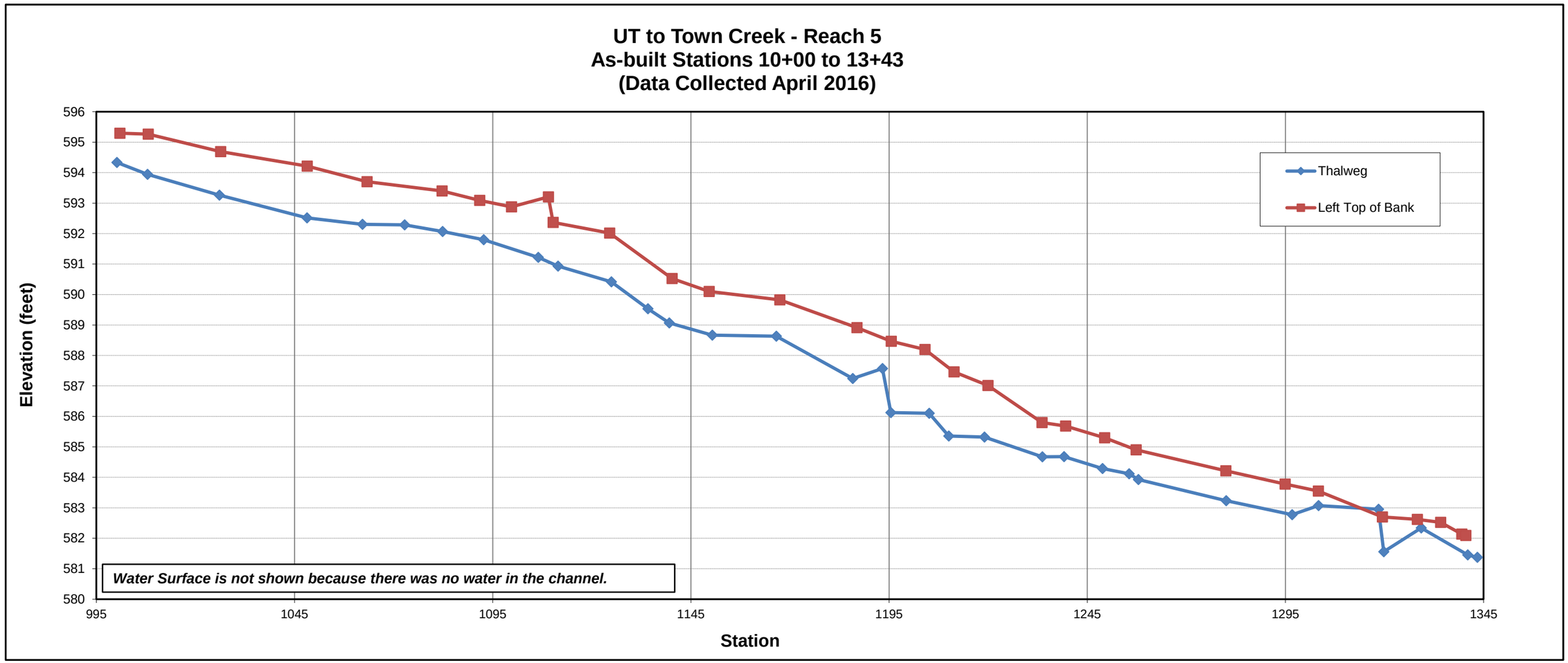


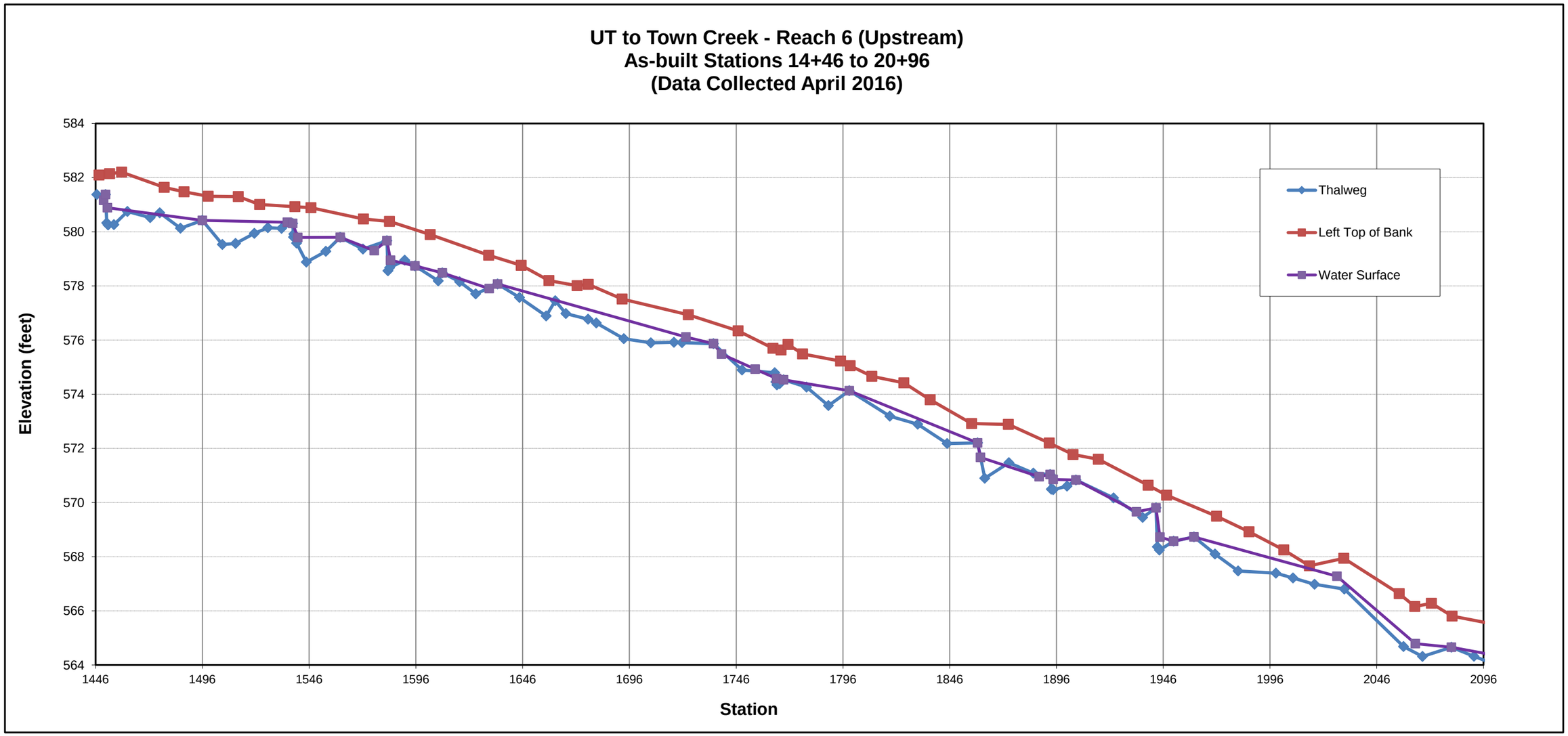

UT to Town Creek - Reach 1
As-built Stations 9+95 to 22+04
(Data Collected April 2016)
Elevation (feet)
578
577
576
575
574
573
572
571
570
569
568
567
566
565
564
563
562
995
1095
1195
1295
1395
1495
1595
1695
1795
1895
1995
2095
2195
Station
Thalweg
Left Top of Bank
Water Surface

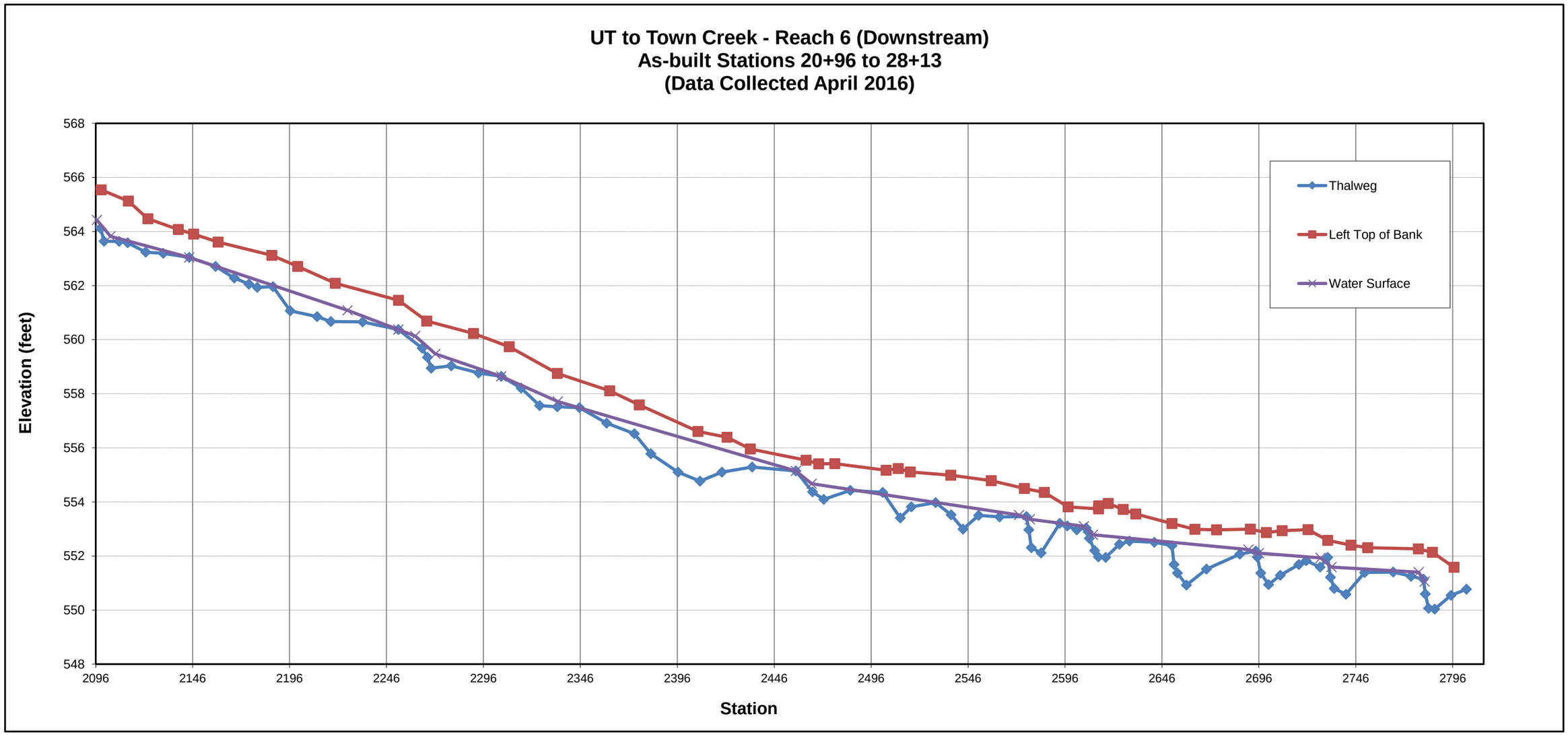

UT to Town Creek - Reach 2
As-Built Stations 22+04 to 40+46
(Data Collected April 2016)
Elevation (feet)
567
566
565
564
563
562
561
560
559
558
557
556
555
554
553
552
551
550
549
548
2195
2295
2395
2495
2595
2695
2795
2895
2995
3095
3195
3295
3395
3495
3595
3695
3795
3895
3995
Station
Stream Crossing
Thalweg
Left Top of Bank
Water Surface

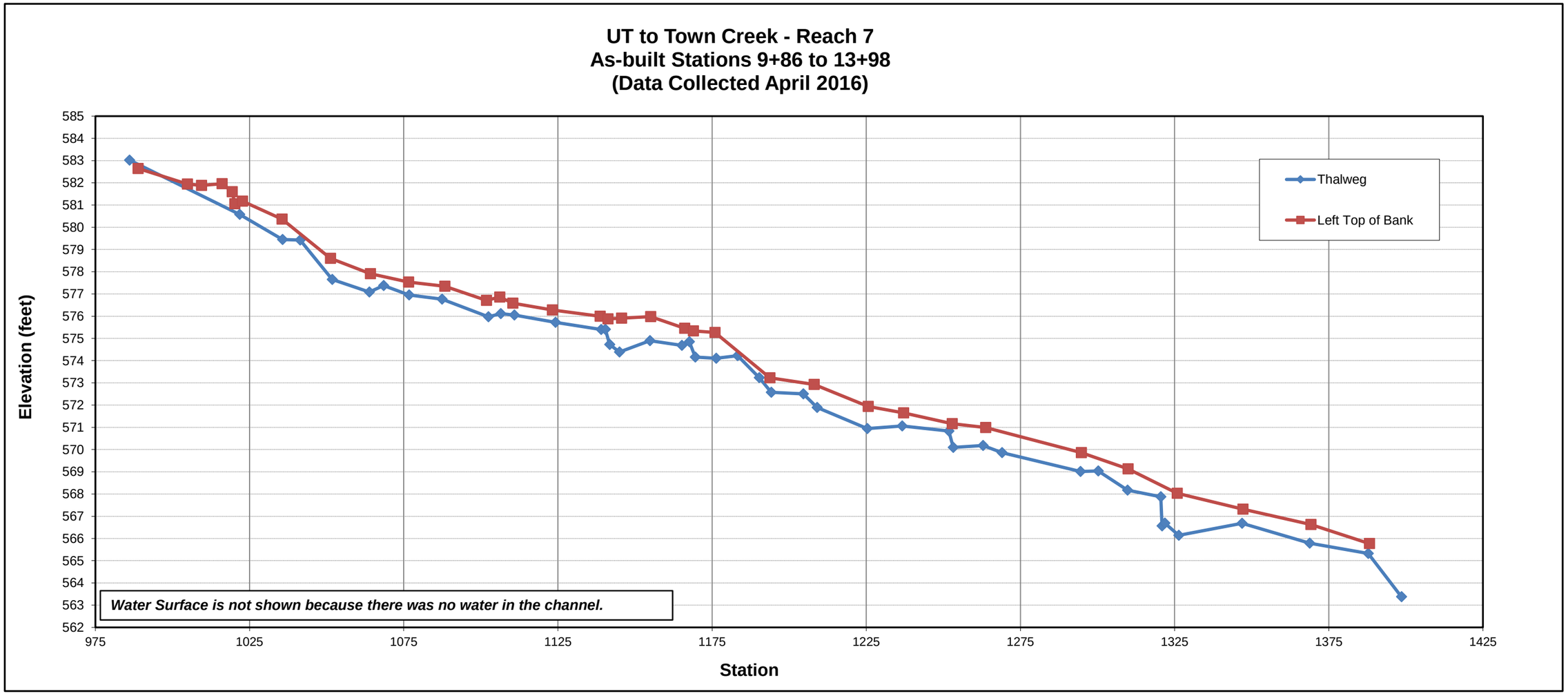

UT to Town Creek - Reach 3
As-Built Stations 40+46 to 48+75
(Data Collected April 2016)
Elevation (feet)
552
551
550
549
548
547
546
545
544
543
4046
4146
4246
4346
4446
4546
4646
4746
4846
4946
Station
Thalweg
Left Top of Bank
Water Surface


UT to Town Creek - Reach 4
As-built Stations 9+98 to 14+47
(Data Collected April 2016)
Elevation (feet)
594
593
592
591
590
589
588
587
586
585
584
583
582
581
995
1045
1095
1145
1195
1245
1295
1345
1395
1445
1495
Station
Thalweg
Left Top of Bank
Water Surface is not shown because there was no water in the channel.


UT to Town Creek - Reach 5
As-built Stations 10+00 to 13+43
(Data Collected April 2016)
Elevation (feet)
596
595
594
593
592
591
590
589
588
587
586
585
584
583
582
581
580
995
1045
1095
1145
1195
1245
1295
1345
Station
Thalweg
Left Top of Bank
Water Surface is not shown because there was no water in the channel.


UT to Town Creek - Reach 6 (Upstream)
As-built Stations 14+46 to 20+96
(Data Collected April 2016)
Elevation (feet)
584
582
580
578
576
574
572
570
568
566
564
1446
1496
1546
1596
1646
1696
1746
1796
1846
1896
1946
1996
2046
2096
Station
Thalweg
Left Top of Bank
Water Surface


UT to Town Creek - Reach 6 (Downstream)
As-built Stations 20+96 to 28+13
(Data Collected April 2016)
Elevation (feet)
568
566
564
562
560
558
556
554
552
550
548
2096
2146
2196
2246
2296
2346
2396
2446
2496
2546
2596
2646
2696
2746
2796
Station
Thalweg
Left Top of Bank
Water Surface


UT to Town Creek - Reach 7
As-built Stations 9+86 to 13+98
(Data Collected April 2016)
Elevation (feet)
585
584
583
582
581
580
579
578
577
576
575
574
573
572
571
570
569
568
567
566
565
564
563
562
975
1025
1075
1125
1175
1225
1275
1325
1375
1425
Station
Thalweg
Left Top of Bank
Water Surface is not shown because there was no water in the channel.

PEBBLE COUNT DATA SHEET: REACH-WIDE COUNT

	BAKER PROJECT NO. 120857
SITE OR PROJECT:	UT To Town Creek - Asbuilt
REACH/LOCATION:	Reach 1 (5 Riffles & 5 Pools)
DATE COLLECTED:	5/11/2016
FIELD COLLECTION BY:	KS & DH
DATA ENTRY BY:	KS

			PARTICLE CLASS WEIGHT (g)			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063		15	15	15%	15%		0%	30%	30%
SAND	Very Fine	.063 - .125					15%		0%		30%
	Fine	.125 - .25					15%		0%		30%
	Medium	.25 - .50					15%		0%		30%
	Coarse	.50 - 1.0					15%		0%		30%
	Very Coarse	1.0 - 2.0					15%		0%		30%
GRAVEL	Very Fine	2.0 - 2.8					15%		0%		30%
	Very Fine	2.8 - 4.0		1			15%		0%	2%	32%
	Fine	4.0 - 5.6		1	1	1%	16%		0%	2%	34%
	Fine	5.6 - 8.0	1	5	6	6%	22%	2%	2%	10%	44%
	Medium	8.0 - 11.0	1	2	3	3%	25%	2%	4%	4%	48%
	Medium	11.0 - 16.0	4	3	7	7%	32%	8%	12%	6%	54%
	Coarse	16.0 - 22.6	5		5	5%	37%	10%	22%		54%
	Coarse	22.6 - 32	8	5	13	13%	51%	16%	38%	10%	64%
	Very Coarse	32 - 45	8	8	16	16%	67%	16%	54%	16%	80%
	Very Coarse	45 - 64	5		5	5%	72%	10%	64%		80%
COBBLE	Small	64 - 90	6	5	11	11%	83%	12%	76%	10%	90%
	Small	90 - 128	5		5	5%	88%	10%	86%		90%
	Large	128 - 180	2	2	4	4%	92%	4%	90%	4%	94%
	Large	180 - 256					92%		90%		94%
BOULDER	Small	256 - 362					92%		90%		94%
	Small	362 - 512					92%		90%		94%
	Medium	512 - 1024					92%		90%		94%
	Large-Very Large	1024 - 2048					92%		90%		94%
BEDROCK	Bedrock	> 2048	5	3	8	8%	100%	10%	100%	6%	100%
		Total	**50**	**50**	**99**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

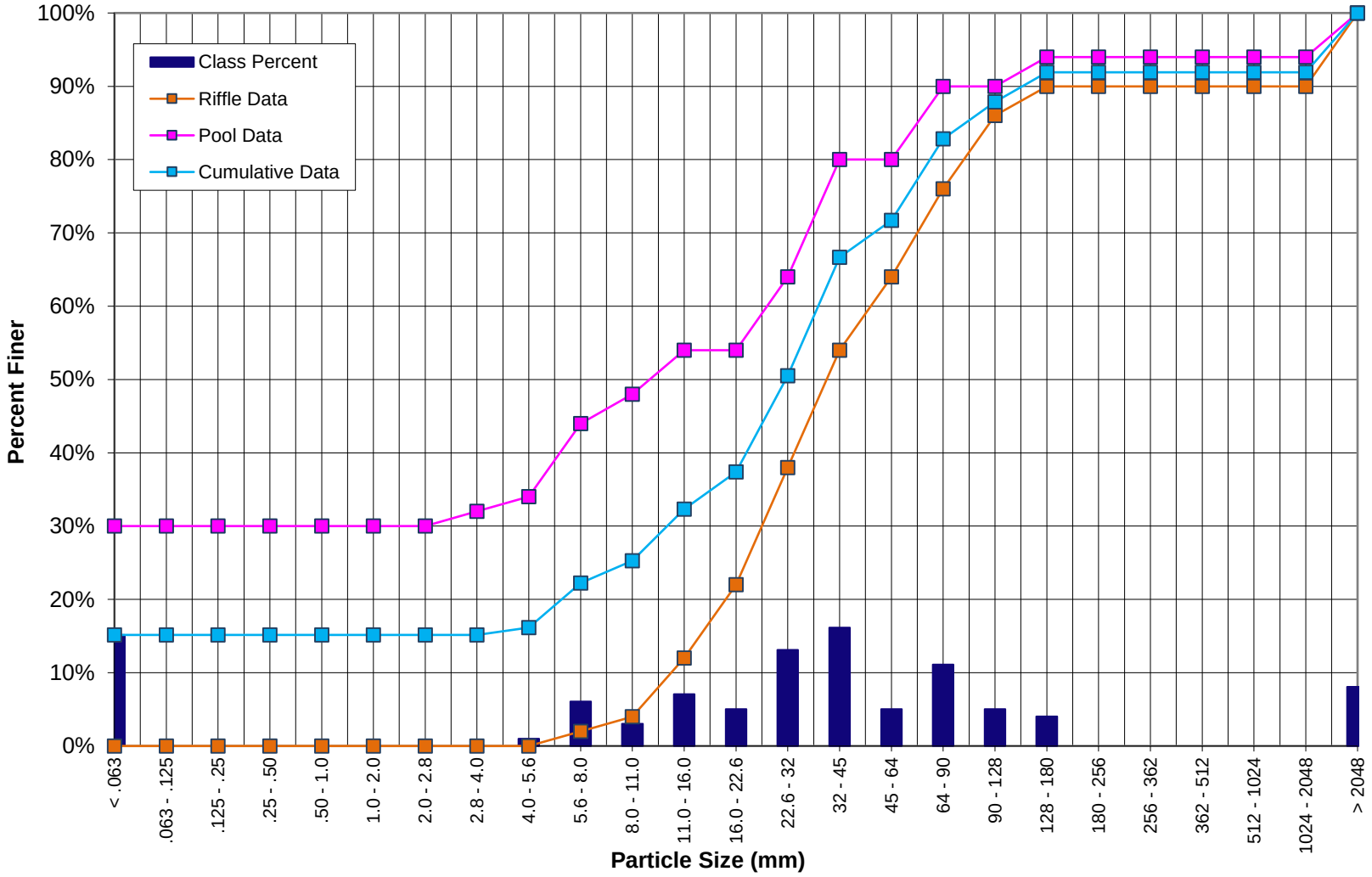
Largest particles: 150.00 **(riffle)** 170.00 **(pool)** **mm**

Cummulative	
Channel materials	
D16 =	4
D35 =	18.37
D50 =	31.16
D84 =	96.57
D95 =	> 2048
D100 =	> 2048

Riffle	
Channel materials	
D16 =	18.37
D35 =	29.98
D50 =	41.32
D84 =	119.29
D95 =	> 2048
D100 =	> 2048

Pool	
Channel materials	
D16 =	<0.063
D35 =	5.80
D50 =	12.46
D84 =	73.35
D95 =	> 2048
D100 =	> 2048

UT to Town Creek - Asbuilt
Sediment Distribution - Active Bed Pebble Count
Reachwide - Reach 1 (5 Riffles & 5 Pools)



PEBBLE COUNT DATA SHEET: REACH-WIDE COUNT

	BAKER PROJECT NO. 120857
SITE OR PROJECT:	UT To Town Creek - Asbuilt
REACH/LOCATION:	Reach 2 (5 Riffles & 5 Pools)
DATE COLLECTED:	5/11/2016
FIELD COLLECTION BY:	KS & DH
DATA ENTRY BY:	KS

			PARTICLE CLASS WEIGHT (g)			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063		22	22	22%	22%		0%	44%	44%
SAND	Very Fine	.063 - .125					22%		0%		44%
	Fine	.125 - .25					22%		0%		44%
	Medium	.25 - .50					22%		0%		44%
	Coarse	.50 - 1.0					22%		0%		44%
	Very Coarse	1.0 - 2.0		1	1	1%	23%		0%	2%	46%
GRAVEL	Very Fine	2.0 - 2.8					23%		0%		46%
	Very Fine	2.8 - 4.0		1			23%		0%	2%	48%
	Fine	4.0 - 5.6	1	1	2	2%	25%	2%	2%	2%	50%
	Fine	5.6 - 8.0	2	2	4	4%	29%	4%	6%	4%	54%
	Medium	8.0 - 11.0		2	2	2%	31%		6%	4%	58%
	Medium	11.0 - 16.0	4	7	11	11%	42%	8%	14%	14%	72%
	Coarse	16.0 - 22.6	6	3	9	9%	52%	12%	26%	6%	78%
	Coarse	22.6 - 32	8	1	9	9%	61%	16%	42%	2%	80%
	Very Coarse	32 - 45	8	5	13	13%	74%	16%	58%	10%	90%
	Very Coarse	45 - 64	8	1	9	9%	83%	16%	74%	2%	92%
COBBLE	Small	64 - 90	4	1	5	5%	88%	8%	82%	2%	94%
	Small	90 - 128	4	1	5	5%	93%	8%	90%	2%	96%
	Large	128 - 180	4		4	4%	97%	8%	98%		96%
	Large	180 - 256					97%		98%		96%
BOULDER	Small	256 - 362					97%		98%		96%
	Small	362 - 512					97%		98%		96%
	Medium	512 - 1024					97%		98%		96%
	Large-Very Large	1024 - 2048					97%		98%		96%
BEDROCK	Bedrock	> 2048	1	2	3	3%	100%	2%	100%	4%	100%
		Total	50	50	99	100%	100%	100%	100%	100%	100%

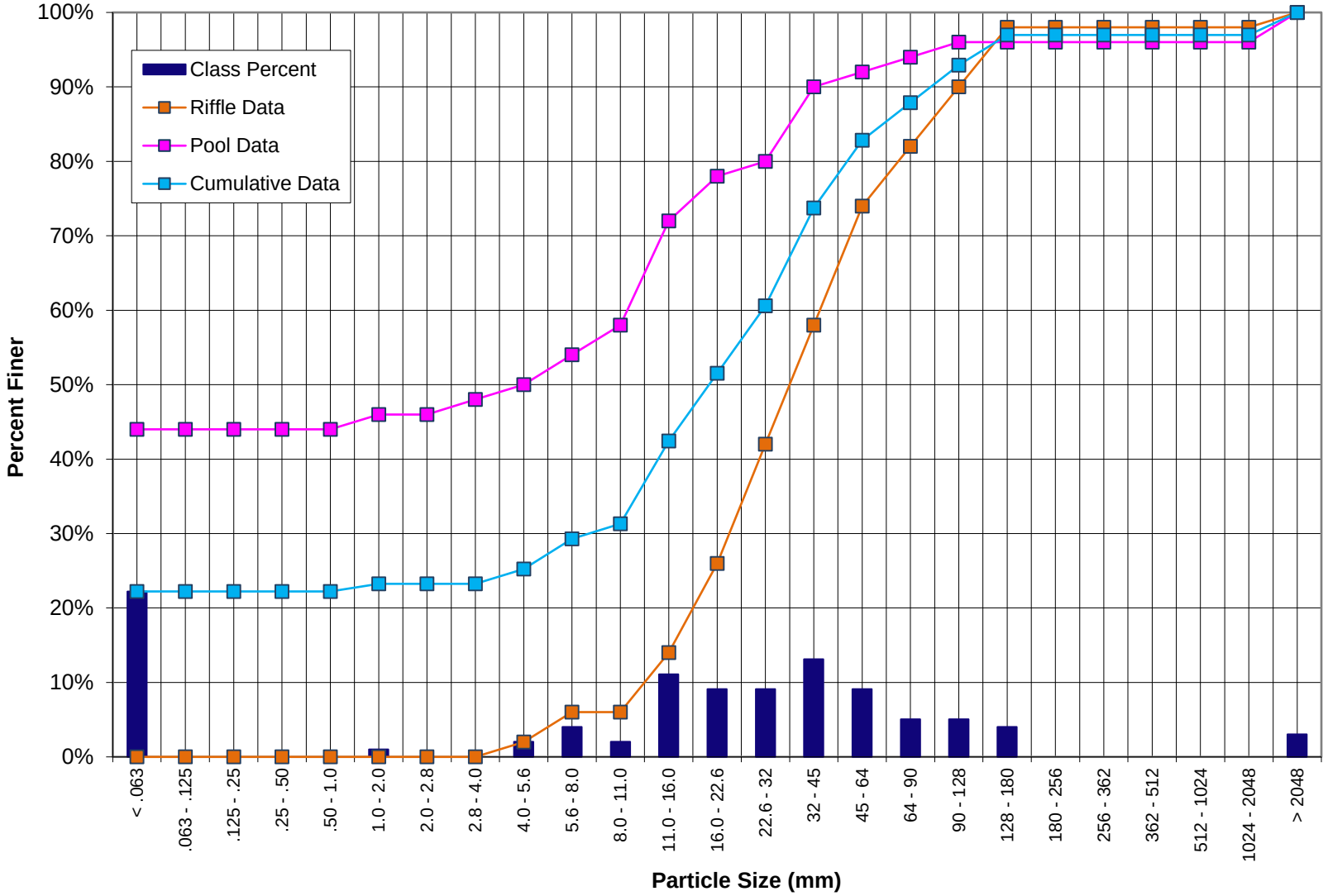
Largest particles: 140.00 (riffle) 110.00 (pool) **mm**

Cummulative	
Channel materials	
D16 =	<0.063
D35 =	12.18
D50 =	20.93
D84 =	68.52
D95 =	151.79
D100 =	> 2048

Riffle	
Channel materials	
D16 =	16.95
D35 =	27.48
D50 =	37.95
D84 =	98.28
D95 =	158.40
D100 =	> 2048

Pool	
Channel materials	
D16 =	<0.063
D35 =	<0.063
D50 =	5.60
D84 =	36.68
D95 =	107.33
D100 =	> 2048

UT to Town Creek - Asbuilt
Sediment Distribution - Active Bed Pebble Count
Reachwide - Reach 2 (5 Riffles & 5 Pools)



PEBBLE COUNT DATA SHEET: REACH-WIDE COUNT

BAKER PROJECT NO.	120857
SITE OR PROJECT:	UT To Town Creek - Asbuilt
REACH/LOCATION:	Reach 3 (5 Riffles & 5 Pools)
DATE COLLECTED:	5/10/2016
FIELD COLLECTION BY:	KS & DH
DATA ENTRY BY:	KS

			PARTICLE CLASS WEIGHT (g)			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063		14	14	14%	14%		0%	28%	28%
SAND	Very Fine	.063 - .125		1	1	1%	15%		0%	2%	30%
	Fine	.125 - .25					15%		0%		30%
	Medium	.25 - .50					15%		0%		30%
	Coarse	.50 - 1.0		1	1	1%	16%		0%	2%	32%
	Very Coarse	1.0 - 2.0					16%		0%		32%
GRAVEL	Very Fine	2.0 - 2.8		1	1	1%	17%		0%	2%	34%
	Very Fine	2.8 - 4.0					17%		0%		34%
	Fine	4.0 - 5.6	1	2	3	3%	20%	2%	2%	4%	38%
	Fine	5.6 - 8.0	1	3	4	4%	24%	2%	4%	6%	44%
	Medium	8.0 - 11.0	3	4	7	7%	31%	6%	10%	8%	52%
	Medium	11.0 - 16.0	7	4	11	11%	42%	14%	24%	8%	60%
	Coarse	16.0 - 22.6	5	4	9	9%	51%	10%	34%	8%	68%
	Coarse	22.6 - 32	6	5	11	11%	62%	12%	46%	10%	78%
	Very Coarse	32 - 45	8	1	9	9%	71%	16%	62%	2%	80%
	Very Coarse	45 - 64	7	3	10	10%	81%	14%	76%	6%	86%
COBBLE	Small	64 - 90	5	2	7	7%	88%	10%	86%	4%	90%
	Small	90 - 128	4	3	7	7%	95%	8%	94%	6%	96%
	Large	128 - 180	3	2	5	5%	100%	6%	100%	4%	100%
	Large	180 - 256					100%		100%		100%
BOULDER	Small	256 - 362					100%		100%		100%
	Small	362 - 512					100%		100%		100%
	Medium	512 - 1024					100%		100%		100%
	Large-Very Large	1024 - 2048					100%		100%		100%
BEDROCK	Bedrock	> 2048					100%		100%		100%
		Total	50	50	100	100%	100%	100%	100%	100%	100%

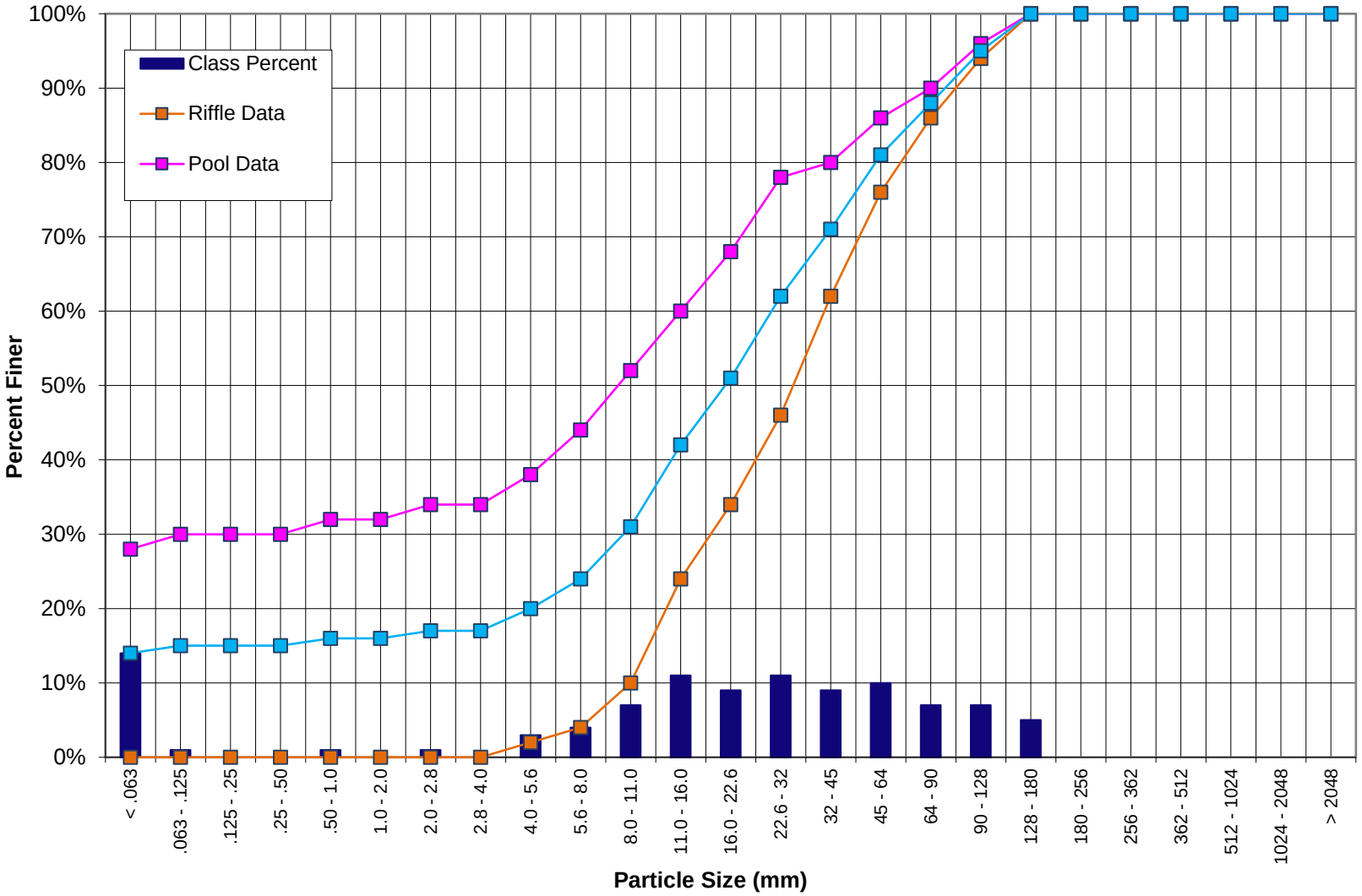
Largest particles: 180.00 (riffle) 150.00 (pool) **mm**

Cummulative	
Channel materials	
D16 =	2.00
D35 =	12.61
D50 =	21.75
D84 =	74.07
D95 =	128.00
D100 =	128 - 180

Riffle	
Channel materials	
D16 =	12.92
D35 =	23.26
D50 =	34.85
D84 =	84.07
D95 =	135.48
D100 =	128 - 180

Pool	
Channel materials	
D16 =	#N/A
D35 =	4.35
D50 =	10.16
D84 =	56.91
D95 =	120.70
D100 =	128 - 180

UT to Town Creek - Asbuilt
Sediment Distribution - Active Bed Pebble Count
Reachwide - Reach 3 (5 Riffles & 5 Pools)



PEBBLE COUNT DATA SHEET: REACH-WIDE COUNT

BAKER PROJECT NO.	120857
SITE OR PROJECT:	UT To Town Creek - Asbuilt
REACH/LOCATION:	Reach 6 (6 Riffles & 4 Pools)
DATE COLLECTED:	5/11/2016
FIELD COLLECTION BY:	KS & DH
DATA ENTRY BY:	KS

			PARTICLE CLASS WEIGHT (g)			Reach Summary		Riffle Summary		Pool Summary	
MATERIAL	PARTICLE	SIZE (mm)	Riffle	Pool	Total	Class %	% Cum	Class %	% Cum	Class %	% Cum
	Silt / Clay	< .063		7	7	7%	7%		0%	18%	18%
SAND	Very Fine	.063 - .125					7%		0%		18%
	Fine	.125 - .25					7%		0%		18%
	Medium	.25 - .50					7%		0%		18%
	Coarse	.50 - 1.0					7%		0%		18%
	Very Coarse	1.0 - 2.0					7%		0%		18%
GRAVEL	Very Fine	2.0 - 2.8					7%		0%		18%
	Very Fine	2.8 - 4.0		2			7%		0%	5%	23%
	Fine	4.0 - 5.6	1		1	1%	8%	2%	2%		23%
	Fine	5.6 - 8.0	4	1	5	5%	13%	7%	8%	3%	25%
	Medium	8.0 - 11.0	2	2	4	4%	17%	3%	12%	5%	30%
	Medium	11.0 - 16.0	3	1	4	4%	21%	5%	17%	3%	33%
	Coarse	16.0 - 22.6	7	7	14	14%	36%	12%	28%	18%	50%
	Coarse	22.6 - 32	13	7	20	20%	56%	22%	50%	18%	68%
	Very Coarse	32 - 45	8	3	11	11%	67%	13%	63%	8%	75%
	Very Coarse	45 - 64	10	2	12	12%	80%	17%	80%	5%	80%
COBBLE	Small	64 - 90	6	4	10	10%	90%	10%	90%	10%	90%
	Small	90 - 128	1	2	3	3%	93%	2%	92%	5%	95%
	Large	128 - 180	2	1	3	3%	96%	3%	95%	3%	98%
	Large	180 - 256	2		2	2%	98%	3%	98%		98%
BOULDER	Small	256 - 362					98%		98%		98%
	Small	362 - 512					98%		98%		98%
	Medium	512 - 1024					98%		98%		98%
	Large-Very Large	1024 - 2048					98%		98%		98%
BEDROCK	Bedrock	> 2048	1	1	2	2%	100%	2%	100%	3%	100%
		Total	**60**	**40**	**98**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

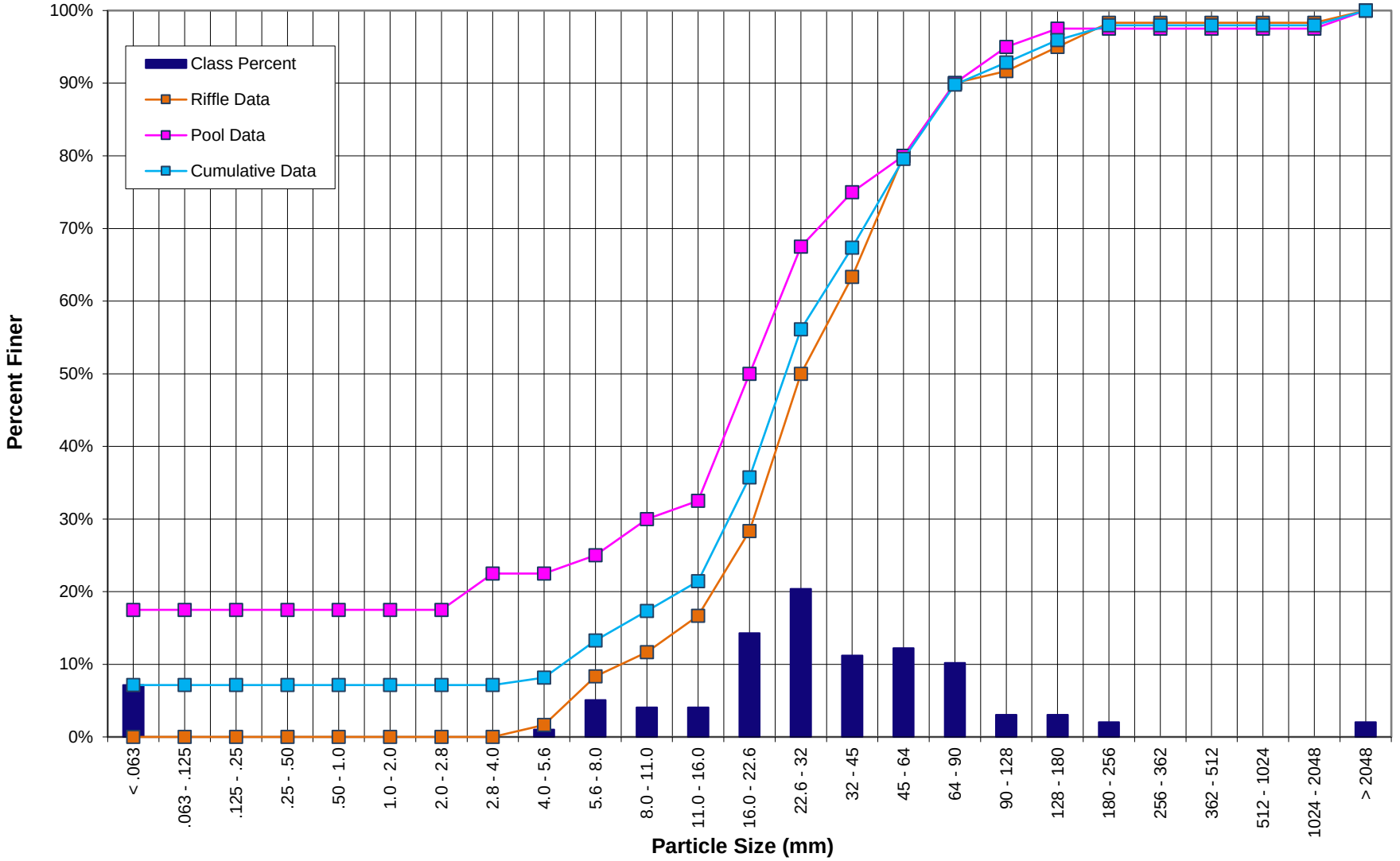
Largest particles: 210.00 **(riffle)** 165.00 **(pool)** **mm**

Cummulative	
Channel materials	
D16 =	8.66
D35 =	21.51
D50 =	28.33
D84 =	73.35
D95 =	160.66
D100 =	> 2048

Riffle	
Channel materials	
D16 =	15.22
D35 =	25.15
D50 =	32.00
D84 =	73.35
D95 =	180.00
D100 =	> 2048

Pool	
Channel materials	
D16 =	<0.063
D35 =	16.81
D50 =	22.60
D84 =	73.35
D95 =	128.00
D100 =	> 2048

UT to Town Creek - Asbuilt
Sediment Distribution - Active Bed Pebble Count
Reachwide - Reach 6 (6 Riffles & 4 Pools)



APPENDIX C

Vegetation Summary Data

Tables 7 – 9

CVS Output Tables

Table 7. Vegetation Plot Attribute Data UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648				
Plot ID	**Community Type***	**Planting Zone ID**	**Reach ID**	**CVS Level**
VP1	Piedmont Alluvial Forest	Upland	Reach 1	I / II
VP2	Piedmont Alluvial Forest	Riparian	Reach 1	I / II
VP3	Piedmont Alluvial Forest	Upland	Reach 1	I / II
VP4	Bottomland Hardwood Forest	Wetland	Reach 1	I / II
VP5	Piedmont Alluvial Forest	Upland	Reach 1	I / II
VP6	Bottomland Hardwood Forest / Piedmont Alluvial Forest	Wetland / Riparian	Reach 2	I / II
VP7	Piedmont Alluvial Forest	Riparian	Reach 2	I / II
VP8	Bottomland Hardwood Forest	Wetland	Reach 2	I / II
VP9	Bottomland Hardwood Forest	Wetland	Reach 2	I / II
VP10	Bottomland Hardwood Forest	Wetland	Reach 2	I / II
VP11	Piedmont Alluvial Forest	Upland / Riparian	Reach 2	I / II
VP12	Bottomland Hardwood Forest	Wetland	Reach 3	I / II
VP13	Piedmont Alluvial Forest	Riparian	Reach 3	I / II
VP14	Bottomland Hardwood Forest	Wetland	Reach 3	I / II
VP15	Piedmont Alluvial Forest	Riparian	Reach 6	I / II
VP16	Piedmont Alluvial Forest	Upland	Reach 6	I / II
VP17	Piedmont Alluvial Forest	Upland / Riparian	Reach 6	I / II
VP18	Piedmont Alluvial Forest	Upland	Reach 4	I / II
VP19	Piedmont Alluvial Forest	Upland	Reach 5	I / II
VP20	Piedmont Alluvial Forest	Upland	Reach 7	I / II
* Community Types are based on (NCWAM, v4.1) and (Schafale, 2012).				

Table 8. Vegetation Species Planted Across the Restoration Site			
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 94648			
Botanical Name	**Common Name**	**% Planted by Species**	**Total Number of Stems**
Riparian Buffer Plantings - Overstory			
Betula nigra	river birch	5%	788
Carpinus caroliniana	ironwood	4%	600
Fraxinus pennsylvanica	green ash	7%	1111
Liriodendron tulipfera	tulip poplar	9%	1452
Nyssa sylvatica	black gum	5%	700
Platanus occidentalis	sycamore	7%	1158
Quercus michauxii	swamp chestnut oak	4%	600
Quercus falcata	Southern red oak	6%	860
Quercus alba	white oak	5%	800
Quercus phellos	willow oak	7%	1170
Quercus lyrata	overcup oak	4%	600
Riparian Buffer Plantings - Understory			
Callicarpa americana	beautyberry	2%	250
Celphalanthus occidentalis	buttonbush	4%	600
Asimina triloba	paw paw	5%	812
Cercis canadensis	redbud	6%	900
Cornus amomum	silky dogwood	7%	1058
Cornus florida	flowering dogwood	5%	800
Diospyros virginiana	persimmon	4%	630
Sambucus nigra	elderberry	4%	600
Riparian Live Stake Plantings			
Cornus amomum	silky dogwood	35%	NA
Salix nigra	black willow	10%	NA
Salix sericea	silky willow	35%	NA
Sambucus nigra	elderberry	20%	NA
Constructed Wetland Zone Plantings			
Juncus effusus	soft rush	30%	-
Carex lurida	Lurid Sedge	25%	-
Scirpus cyperinus	wool grass	20%	-
Acorus calamus	sweetflag	15%	-
Lobelia cardinalis	cardinal flower	5%	-
Hibiscus moscheutos	swamp hibiscus	5%	-

Table 9. Planted and Total Stem Counts (Species by Plot with Annual Means)
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 95026

Tree Species	Common Name	Type	Current Data (AB 2016)																							
			Plot 1			Plot 2			Plot 3			Plot 4			Plot 5			Plot 6			Plot 7			Plot 8		
			PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T
Asimina triloba	paw paw	Tree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Betula nigra	river birch	Tree	1	1	1	0	0	0	4	4	4	3	3	3	3	3	3	4	4	4	0	0	0	0	0	0
Callicarpa americana	American beautyberry	Shrub	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	4	4	4	0	0	0
Carpinus caroliniana	ironwood	Tree	1	1	1	2	2	2	1	1	1	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Cephalanthus occidentalis	common buttonbush	Shrub	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cercis canadensis	redbud	Tree	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5	1	1	1	0	0	0
Cornus amomum	silky dogwood	Shrub	0	0	0	0	0	0	0	0	0	5	5	5	0	0	0	0	0	0	5	5	5	0	0	0
Cornus florida	flowering dogwood	Tree	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	3	3	3	1	1	1
Diospyros virginiana	common persimmon	Tree	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	0	0	0	0	0	0	0	0	0
Fraxinus pennsylvanica	green ash	Tree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lirodendron tulipifera	tulip poplar	Tree	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Nyssa sylvatica	black gum	Tree	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Platanus occidentalis	sycamore	Tree	2	2	2	2	2	2	4	4	4	2	2	2	3	3	3	4	4	4	0	0	0	13	13	13
Quercus sp.	Oak	Tree	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
Quercus alba	white oak	Tree	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	0	0	0
Quercus falcata	southern red oak	Tree	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus lyrata	overcup oak	Tree	1	1	1	0	0	0	0	0	0	0	0	0	2	2	2	1	1	1	0	0	0	0	0	0
Quercus michuaxii	swamp chestnut oak	Tree	6	6	6	4	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3
Quercus phellos	willow oak	Tree	0	0	0	5	5	5	5	5	5	0	0	0	5	5	5	3	3	3	0	0	0	2	2	2
Sambucus nigra	elderberry	Shrub	0	0	0	2	2	2	0	0	0	4	4	4	0	0	0	0	0	0	0	0	0	1	1	1
Unknown	Unknown	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
	Stems Per Plot		17	17	17	18	18	18	17	17	17	18	18	18	17	17	17	20	20	20	17	17	17	21	21	21
	Plot area (ares)		1			1			1			1			1			1			1			1		
	Plot area (acres)		0.025			0.025			0.025			0.025			0.025			0.025			0.025			0.025		
	Species Count		8	8	8	8	8	8	6	6	6	7	7	7	6	6	6	6	6	6	5	5	5	6	6	6
	Stems Per Acre		688	688	688	728	728	728	688	688	688	728	728	728	688	688	688	809	809	809	688	688	688	850	850	850

Notes: CVS Level 1 Survey performed.

PnoL = Planted No Live Stakes
P-all = Planted Including Live Stakes
Total = Total number of Plants

Color for Density

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

Table 9 Cont. Planted and Total Stem Counts (Species by Plot with Annual Means)
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 95026

Tree Species	Common Name	Type	Current Data (AB 2016)																							
			Plot 9			Plot 10			Plot 11			Plot 12			Plot 13			Plot 14			Plot 15			Plot 16		
			PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T
Asimina triloba	paw paw	Tree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	0	0	0
Betula nigra	river birch	Tree	0	0	0	0	0	0	0	0	0	3	3	3	0	0	0	0	0	0	0	0	0	2	2	2
Callicarpa americana	American beautyberry	Shrub	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carpinus caroliniana	ironwood	Tree	3	3	3	1	1	1	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Cephalanthus occidentalis	common buttonbush	Shrub	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Cercis canadensis	redbud	Tree	0	0	0	2	2	2	2	2	2	0	0	0	2	2	2	2	2	2	4	4	4	0	0	0
Cornus amomum	silky dogwood	Shrub	2	2	2	2	2	2	0	0	0	0	0	0	1	1	1	3	3	3	4	4	4	6	6	6
Cornus florida	flowering dogwood	Tree	6	6	6	1	1	1	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1
Diospyros virginiana	common persimmon	Tree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2
Fraxinus pennsylvanica	green ash	Tree	1	1	1	8	8	8	5	5	5	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0
Lirodendron tulipifera	tulip poplar	Tree	0	0	0	0	0	0	2	2	2	4	4	4	0	0	0	2	2	2	0	0	0	1	1	1
Nyssa sylvatica	black gum	Tree	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	6	6	6
Platanus occidentalis	sycamore	Tree	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus sp.	Oak	Tree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus alba	white oak	Tree	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
Quercus falcata	southern red oak	Tree	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0
Quercus lyrata	overcup oak	Tree	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5	3	3	3	2	2	2	2	2	2
Quercus michuaxii	swamp chestnut oak	Tree	4	4	4	1	1	1	2	2	2	1	1	1	3	3	3	0	0	0	1	1	1	1	1	1
Quercus phellos	willow oak	Tree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0
Sambucus nigra	elderberry	Shrub	0	0	0	3	3	3	0	0	0	4	4	4	2	2	2	0	0	0	0	0	0	2	2	2
Unknown	Unknown	Unknown	0	0	0	0	0	0	1	1	1	2	2	2	0	0	0	2	2	2	1	1	1	0	0	0
	Stems Per Plot		16	16	16	19	19	19	19	19	19	20	20	20	16	16	16	17	17	17	19	19	19	24	24	24
	Plot area (ares)		1			1			1			1			1			1			1			1		
	Plot area (acres)		0.025			0.025			0.025			0.025			0.025			0.025			0.025			0.025		
	Species Count		5	5	5	8	8	8	9	9	9	9	9	9	7	7	7	8	8	8	8	8	8	10	10	10
	Stems Per Acre		647	647	647	769	769	769	769	769	769	809	809	809	647	647	647	688	688	688	769	769	769	971	971	971

Notes: CVS Level 1 Survey performed.

PnoL = Planted No Live Stakes
P-all = Planted Including Live Stakes
Total = Total number of Plants

Color for Density
Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

Table 9 Cont. Planted and Total Stem Counts (Species by Plot with Annual Means)
UT to Town Creek Restoration Project - Option A: DMS Project ID No. 95026

Tree Species	Common Name	Type	Current Data (AB 2016)												Annual Means			
			Plot 17			Plot 18			Plot 19			Plot 20			Current Mean		AB (2016)	
			PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	P	T	P	T
Asimina triloba	paw paw	Tree	1	1	1	0	0	0	0	0	0	0	0	0	5	5	5	5
Betula nigra	river birch	Tree	0	0	0	0	0	0	0	0	0	1	1	1	21	21	21	21
Callicarpa americana	American beautyberry	Shrub	0	0	0	0	0	0	0	0	0	0	0	0	7	7	7	7
Carpinus caroliniana	ironwood	Tree	2	2	2	0	0	0	1	1	1	0	0	0	16	16	16	16
Cephalanthus occidentalis	common buttonbush	Shrub	0	0	0	0	0	0	0	0	0	4	4	4	5	5	5	5
Cercis canadensis	redbud	Tree	1	1	1	8	8	8	1	1	1	0	0	0	29	29	29	29
Cornus amomum	silky dogwood	Shrub	1	1	1	1	1	1	1	1	1	0	0	0	31	31	31	31
Cornus florida	flowering dogwood	Tree	0	0	0	2	2	2	1	1	1	1	1	1	21	21	21	21
Diospyros virginiana	common persimmon	Tree	0	0	0	0	0	0	2	2	2	0	0	0	7	7	7	7
Fraxinus pennsylvanica	green ash	Tree	7	7	7	8	8	8	6	6	6	0	0	0	43	43	43	43
Lirodendron tulipifera	tulip poplar	Tree	0	0	0	0	0	0	1	1	1	1	1	1	12	12	12	12
Nyssa sylvatica	black gum	Tree	0	0	0	0	0	0	0	0	0	0	0	0	9	9	9	9
Platanus occidentalis	sycamore	Tree	0	0	0	0	0	0	0	0	0	0	0	0	31	31	31	31
Quercus sp.	Oak	Tree	1	1	1	0	0	0	1	1	1	0	0	0	3	3	3	3
Quercus alba	white oak	Tree	0	0	0	0	0	0	1	1	1	1	1	1	12	12	12	12
Quercus falcata	southern red oak	Tree	1	1	1	1	1	1	1	1	1	5	5	5	15	15	15	15
Quercus lyrata	overcup oak	Tree	0	0	0	0	0	0	0	0	0	0	0	0	16	16	16	16
Quercus michuaxii	swamp chestnut oak	Tree	0	0	0	0	0	0	0	0	0	1	1	1	29	29	29	29
Quercus phellos	willow oak	Tree	2	2	2	0	0	0	0	0	0	3	3	3	27	27	27	27
Sambucus nigra	elderberry	Shrub	1	1	1	0	0	0	0	0	0	0	0	0	19	19	19	19
Unknown	Unknown	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	7	7	7	7
		Stems Per Plot	17	17	17	20	20	20	16	16	16	17	17	17	365	365	365	365
		Plot area (ares)	1			1			1			1			20		20	
		Plot area (acres)	0.025			0.025			0.025			0.025			0.50		0.50	
		Species Count	9	9	9	5	5	5	10	10	10	8	8	8	21	21	21	21
		Stems Per Acre	688	688	688	809	809	809	647	647	647	688	688	688	730	730	730	730

Notes: CVS Level 1 Survey performed.

PnoL = Planted No Live Stakes
P-all = Planted Including Live Stakes
Total = Total number of Plants

Color for Density
Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

APPENDIX E

Photo Log

UT to Town Creek – Reach 1

PID 1: Station 10+50 – Upstream (5/11/16)

PID 2: Station 10+50 – Downstream (2/4/16)

PID 3: Station 10+80 – Left Floodplain (3/11/16)

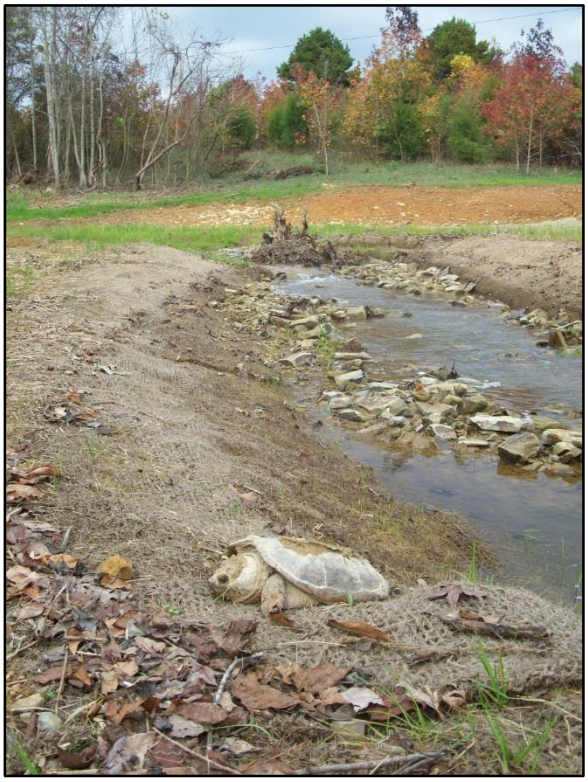
PID 4: Station 11+90 – Downstream (11/5/15)

PID 5: Station 12+85 – Upstream (3/11/16)

UT to Town Creek – Reach 1

PID 6: Station 13+05 – Left Floodplain (2/4/16)

PID 7: Station 15+30 – Upstream (5/11/16)



Snapping Turtle (11/5/15)

PID 8: Station 16+25 – Downstream (11/5/15)

PID 9: Station 17+75 – Left Floodplain (5/11/16)

Caddisfly Casings (3/11/16)

PID 10: Station 18+10 – Downstream (5/11/16)

PID 11: Station 18+10 – Upstream (5/11/16)

PID 12: Station 20+90 – Downstream (5/11/16)

PID 13: Station 21+00 – Upstream (5/11/16)

UT to Town Creek – Reach 2

PID 14: Station 22+75 – Upstream (2/4/16)

PID 15: Station 23+25 – Upstream (2/4/16)

PID 16: Station 23+50 – Downstream (11/5/16)

PID 17: Station 24+60 – Upstream (11/5/15)

PID 18: Station 25+30 – Left Floodplain (5/11/16)

PID 20: Station 26+40 – Downstream (3/11/16)

PID 22: Station 29+35 – Upstream (3/11/16)

PID 19: Station 25+90 – Downstream (11/5/15)

PID 21: Station 28+75 – Downstream (11/5/15)

PID 23: Station 29+50 – Downstream Project View from Floodplain Knoll (5/11/16)

PID 24: Station 30+60 – Upstream (3/11/16)

PID 25: Station 33+10 – Upstream (5/11/16)

PID 26: Station 33+10 – Downstream (5/11/16)

PID 27: Station 35+50 – Upstream (3/1/16)

PID 28: Station 38+30 – Upstream (11/5/15)

UT to Town Creek – Reach 2

PID 29: Station 38+40 – Downstream (11/5/15)

PID 30: Station 39+10 – Downstream (3/11/16)

UT to Town Creek – Reach 3

PID 31: Station 40+25 – Downstream (2/18/16)

PID 32: Station 40+80 – Upstream (11/5/15)

PID 33: Station 41+80 – Upstream (11/5/15)

PID 34: Station 43+00 – Downstream (5/11/16)

PID 35: Station 44+00 – Downstream (3/11/16)

PID 36: Station 44+25 – Upstream (11/5/15)

UT to Town Creek – Reach 3

PID 37: Station 45+50 – Downstream (2/18/16)

PID 38: Station 45+95 – Upstream (11/5/15)

PID 39: Station 46+80 – Upstream (11/5/15)

PID 40: Station 47+75 – Upstream (11/5/15)

PID 41: Station 48+60 – Downstream (5/10/16)

UT to Town Creek – Reach 4

PID 1: Station 09+80 – Upstream (12/11/15)

PID 3: Station 11+20 – Upstream (11/5/15)

PID 2: Station 10+60 – Upstream (11/5/15)

PID 4: Station 11+75 – Upstream (11/5/15)

PID 5: Station 12+95 – Upstream (11/5/15)

PID 6: Station 13+45 – Downstream (11/5/15)

PID 7: Station 13+80 – Upstream (11/5/15)

PID 8: Station 14+ 20 – Upstream (11/5/15)

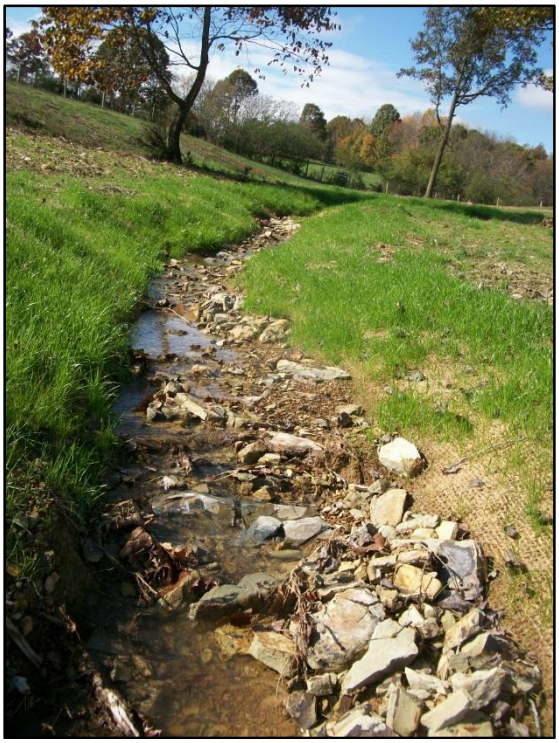
UT to Town Creek – Reach 4

Cows Fenced out of Easement along Reach 4

UT to Town Creek – Reach 5

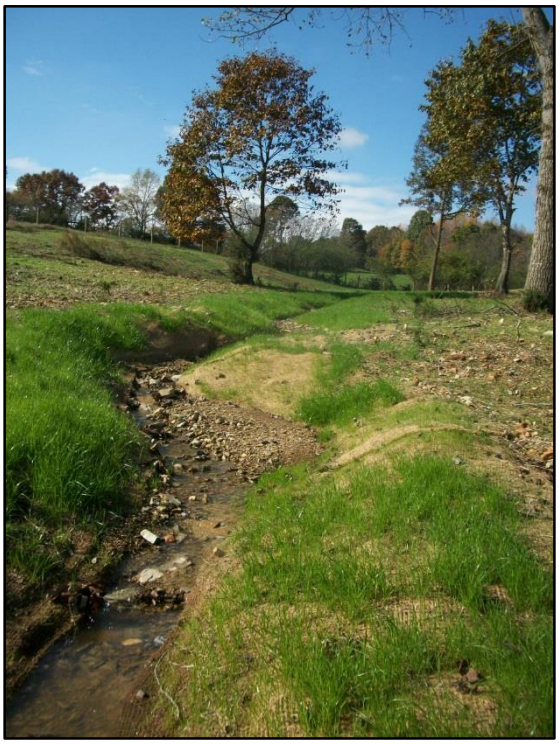
PID 1: Station 10+70 – Upstream (11/5/15)

PID 2: Station 10+75 – Downstream (11-5-15)



PID 3: Station 11+75 – Upstream (11/5/15)

PID 4: Station 12+20 – Upstream (11/5/15)



PID 5: Station 12+65 – Upstream (11/5/15)

PID 6: Station 13+30 – Upstream (11/5/15)

PID 7: Station 13+43 – Upstream (2/18/16)

UT to Town Creek – Reach 6

PID 1: Station14+55 – Upstream (11/5/15)

PID 2: Station 15+30 – Upstream (11/5/15)

PID 3: Station 16+00 – Upstream (11/5/15)

PID 4: Station 16+50 – Upstream (11/5/15)

PID 5: Station 17+25 – Upstream (11/5/15)

PID 6: Station 18+00 – Upstream (11/5/15)

PID 7: Station 18+50 – Upstream (11/5/15)

PID 8: Station 18+90 – Downstream (11/5/15)

UT to Town Creek – Reach 6

PID 9: Station 19+05 – Upstream (11/5/15)

PID 10: Station 19+50 – Left Floodplain (11/5/15)

PID 11: Station 19+75 – Upstream (11/5/15)

PID 12: Station 19+85 – Upstream (11/5/15)

PID 13: Station 20+50 - Upstream (12/11/15)

PID 14: Station 20+50 - Downstream (12/11/15)

PID 15: Station 21+00 – Upstream (11/5/15)

PID 17: Station 23+40 – Upstream (11/5/15)

PID 16: Station 22+75 – Upstream (11/5/15)

PID 18: Station 24+00 – Upstream (3/11/2016)

UT to Town Creek – Reach 6

PID 19: Station 24+50 – Upstream (11/5/15)

PID 20: Station 25+25 – Upstream (2/4/2016)

PID 21: Station 25+80 - Downstream (2/4/16)

PID 22: Station 25+85 – Upstream (11/5/15)

PID 23: Station 26+50 – Upstream (3/11/16)

PID 24: Station 26+75 – Upstream (3/11/16)

PID 25: Station 28+00 – Upstream (3/11/26)

PID 26: Station 28+14 – Upstream (11/5/16)

UT to Town Creek – Reach 7

PID 1: Station 09+40: Upstream (11/5/15)

PID 2: Station 09+90 – Upstream (3/11/16)

PID 3: Station 10+70 – Upstream (11/5/15)

PID 4: Station 10+80 – Downstream (11/5/15)

PID 5: Station 11+75 – Upstream (11/5/15)

PID 6: Station 12+10 – Upstream (11/5/15)

PID 7: Station 12+90 – Upstream (2/2/16)

PID 8: Station 13+40 – Upstream (11/5/15)

PID 9: Station 13+99 – Upstream (11/5/15)