Prepared for:

North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program Raleigh, North Carolina

Stream and Wetland Mitigation Plan Report for Five-Mile Branch

Iredell County, North Carolina

December 2009

Stream and Wetland Mitigation Plan Report

Five-Mile Branch

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NCDENR-NCEEP

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Executive Summary

This document is consistent with the requirements of the federal rule for compensatory mitigation project sites as described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.8 paragraphs (c)(2) through (c)(14). Specifically the document addresses the following requirements of the federal rule:

(2) *Objectives*. A description of the resource type(s) and amounts(s) that will be provided, the method of compensation (i.e. restoration, establishment, enhancement, and/or preservation), and the manner in which the resource functions of the compensatory mitigation project will address the needs of the watershed, ecoregion, physiographic province, or other geographic area of interest.

(3) *Site selection*. A description of the factors considered during the site selection process. This should include consideration of watershed needs, onsite alternatives where applicable, and the practicability of accomplishing ecologically self-sustaining aquatic resource restoration, establishment, enhancement, and/or preservation at the compensatory mitigation project site. (See § 332.3(d).)

(4) *Site protection instrument*. A description of the legal arrangements and instrument, including site ownership, that will be used to ensure the long-term protection of the compensatory mitigation project site (See § 332.3(d).)

(5) *Baseline information*. A description of the ecological characteristics of the proposed compensatory mitigation project site and, in the case of an application for a DA permit, the impact site. This may include descriptions of historic and existing plant communities, historic and existing hydrology, soil conditions, a map showing the locations of the impact and mitigation sites(s) of the geographic coordinates for those site(s), and other site characteristics appropriate to the type of resource proposed as compensation. The baseline information should also include a delineation of waters of the United States on the proposed compensatory mitigation project site. A prospective permittee planning to secure credits from and approved mitigation bank or in-lieu fee program only needs to provide baseline information about the impact site, not the mitigation bank or in-lieu fee project site.

(6) *Determination of credits*. A description of the number of credits to be provided, including a brief explanation of the rationale for this determination. (See § 332.3(f).)

(7) *Mitigation work plan*. Detailed written specifications and work descriptions for the compensatory mitigation project; construction methods, timing, and sequence;

source(s) of water, including connections to existing waters and uplands; methods for establishing the desired plant community; plans to control invasive plant species; the proposed grading plan, including elevations and slopes of the substrate; soil management; and erosion control measures. For stream compensatory mitigation projects, the mitigation work plan may also include other relevant information, such as plan form geometry, channel form (e.g. typical channel cross-sections), watershed size, design discharge, and riparian area plantings.

(8) *Maintenance plan*. A description and schedule of maintenance requirements to ensure the continued viability of the resource once initial construction is completed.

(9) *Performance standards*. Ecologically-based standards that will be used to determine whether the compensatory mitigation project is achieving its objectives. (See § 332.5.)

(10) Monitoring requirements. A description of parameters to be monitored in order to determine if the compensatory mitigation project is on track to meet performance standards and if adaptive management is needed. A schedule for monitoring and reporting on monitoring results to the district engineer must be included. (See § 332.6.)

(11) Long-term management plan. A description of how the compensatory mitigation project will be managed after performance standards have been achieved to ensure the long-term sustainability of the resource, including long-term financing mechanisms and the party responsible for long-term management. (See § 332.7(d).)

(12) Adaptive management plan. A management strategy to address unforeseen changes in site conditions or other components of the compensatory mitigation project, including the party or parties responsible for implementing adaptive management measures. The adaptive management plan will guide decisions for revising compensatory mitigation plans and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect compensatory mitigation success. (See § 332.7(c).)

(13) Financial assurances. A description of financial assurances that will be provided and how they are sufficient to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with its performance standards. (See § 332.3(n)).

The Five Mile Branch Site (site) is east of Statesville in Iredell County, southeast of Interstate 40 (I-40) and northwest of US Route 64. The site is in the Township of Cool Springs on the Statesville East, NC, 7.5-minute U.S. Geological Survey (USGS)

topographic quadrangle. The Site comprises 12 adjacent parcels totaling approximately 229 acres (92.67 ha). It is bordered to the north by I-40 and to the south, east, and west by various forested, pasture, and residential properties. Swann Road (SR 2167), running north and south, bisects the site. Chimney Lane dead-ends on the site west of Swann Road. The study area consists primarily of currently fallow agricultural fields previously planted in row crops.

All water resources at the site are part of the Yadkin-Pee Dee River Basin. According to the Yadkin-Pee Dee Basinwide Water Quality Plan (North Carolina Department of Environment and Natural Resources [NCDENR] 2008), Fifth and Beaver Creeks are in USGS 8-digit Hydrologic Unit 03040102, 14-digit Hydrologic Unit 03040102010100, and North Carolina Division of Water Quality (NCDWQ) Sub-basin 03-07-06. According to NCDENR Basinwide Information Management System (BIMS), Fifth Creek from its source to the South Yadkin River and Beaver Creek from its source to Fifth Creek are denoted as Class C waters. Class C waters are suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. The NCDENR gave both Beaver Creek and Fifth Creek the support rating “Supporting.”

The Five Mile Branch site is not included as part of a Targeted Local Watershed or a Local Watershed Plan area. The Upper Yadkin-Pee Dee River Basin Restoration Priorities was updated in February 2009 and provides restoration goals for the upper Yadkin- River Basin. While goals for the Five Mile Branch site (CU 03040102) are not specifically identified in the Upper Yadkin-Pee Dee River Basin Restoration Priorities, primary watershed restoration goals are and they include the following:

Restoration of water quality and aquatic habitat in impaired stream segments;

Protection of high-resource value waters, including HQW, ORW and WSW designated waters, and those containing large numbers of rare and endangered aquatic species (NHEOs);

Continuation of existing watershed restoration and protection initiatives and projects, including efforts funded by Clean Water Management Trust Fund (CWMTF), DWQ's 319 Program, NCEEP, Ag Cost Share (ACSP) and Community Conservation Assistance Program (CCAP);

Collaborative efforts with local resource agencies, land trusts and willing landowners to implement new stream, riparian buffer and wetland restoration, enhancement and preservation projects in priority sub-watersheds within TLWs;

Improved management of stormwater runoff (including the implementation of stormwater BMP projects), especially in urban and suburban areas contributing to downstream degradation of stream habitat and impairment ofwater quality; and

Implementation of agricultural BMPs within high-priority rural sub-watersheds, especially with respect to limiting inputs of sediment, nutrients and fecal coli form to streams from active farming operations

The North Carolina Division of Water Quality's Basinwide Plan identifies increasing nutrient enrichment, urbanization, and wastewater as the primary impacts to water quality in the basin. Most of the stream impairments are based on poor biological integrity measured by aquatic macroinvertebrates and fish communities, followed by turbidity measurements. The Five Mile Branch Project will increase bank stability, reduce erosion, and re-establish a natural riparian buffer. These measures will improve aquatic habitat within this CU and reduce sedimentation within the watershed.

Project Goals:

- Increase bank stability, nutrient filtration and aquatic habitat
- Reduce soil disturbance and nutrient inputs to stream
- Improve soil physical and chemical properties in the near term
- Improve hydrologic connectivity with floodplain
- Attenuate site impacts of storm flows
- Restore ground water hydrology to pre-agricultural levels
- Restore wetland and riparian habitat

Project Objectives:

- Establish a minimum 50-foot buffer consisting of a mix of native species representative of piedmont/mountain bottomland hardwood forest
- Grade stream banks, install in-stream structures, and remove berm to reconnect streams with floodplain
- Eliminate past agricultural land uses, fill existing drainage ditches and excavate flood plain pools.
- Rip floodplain soil prior to planting

The Five Mile Branch Mitigation site was selected for several reasons. The first being the need for mitigation credits within the hydrologic unit at the time the site was first identified. The number of credits needed in the unit has since decreased but the need is still there. The site is also an optimum restoration site. Beaver and Fifth Creeks flowed through agricultural fields that were planted seasonally. The fields have drainage ditches bisecting them to facilitate crop production. Soil piles adjacent

to the streams provide evidence that the streams have been maintained in the past. This maintenance reduced the aquatic habitat diversity within the streams. All these factors contributed to the selection of the site.

The majority of the 229-acre site is owned by the North Carolina Department of Transportation (NCDOT). The NCDOT purchased conservation easements on portions of two parcels at the downstream end of the project.

The Five Mile Branch Restoration site is within the western Piedmont physiographic province. This province lies between the Coastal Plain and the Blue Ridge Mountain provinces and covers the central portion of the state, occupying approximately 45 percent of the area of the state. Gently rolling, well-rounded hills, and long, low ridges with moderate elevation changes between the hills and valleys characterize the Piedmont.

Fifth and Beaver creeks flow through a broad, flat valley. The valley is bordered to the southeast by steep hillsides. To the northwest, gently sloping and rolling hills bound the valley. Elevations in the valley range from 740 feet (225.55 m) above mean sea level (ft msl) at the upstream end of the Five Mile Branch project area to 720 ft msl (219.46 m) at the downstream end. The highest adjacent elevations to the southeast and northwest are approximately 850 ft msl (259.09 m) and 800 ft msl (243.84 m), respectively.

This portion of the Piedmont of North Carolina is known for its deep, well-drained, dark-red, clay soils. Agriculture has been a major factor in the development, or rather the loss of, soil in the Piedmont. Under natural conditions, soils in this region contain a brownish loam surface layer 6 to 10 inches (12.2 to 25.4 centimeters [cm]) thick. The surface horizons have generally been lost due to the constant agricultural use of the land for the past 200 years. The Five Mile Branch Restoration site is no exception. The site differs from the surrounding area by containing a significant amount of hydric or nearly hydric soils. Land within this region of North Carolina that held water for an extended period of time was historically ditched and drained for agricultural utilization. This has resulted in a hydrologic change that has significantly modified many of the properties of the soils, resulting primarily from dry conditions.

Research indicates that the site was in agricultural use for more than 50 years. Aerial photography from 1956 shows the site as being very similar to its condition prior to the NCDOT acquisition of the property. The fields, drainage ditch, and streams are in relatively the same locations now that they were then. The major exception is that I-40 was not present in 1956. Based on field observation, it also appears that Beaver Creek and Fifth Creek have been straightened. Old spoil piles have created a berm

along the banks of Beaver and Fifth Creek that are adjacent to the old agricultural fields. In the past, the drainage ditches were better maintained, with the vegetation mowed or sprayed with herbicide. However, since NCDOT has purchased the parcels containing the ditches, vegetation has grown considerably.

Restoration activities are expected to result in 12,270 linear feet (lf) of enhancement level II (6,220 lf on Beaver Creek and 6,050 lf on Fifth Creek), 890 lf of stream preservation (188 lf on UT to Beaver Creek, 102 lf on UT at Chimney Lane, 495 lf on the UT at Swann Road, and 105 lf on the Smiley UT), 58.6 acres of Piedmont/ Mountain Bottomland Hardwood Forest restoration and 1.9 acres of Piedmont/ Mountain Bottomland Hardwood Forest preservation. The current alignment of the streams will be maintained. This method of restoration was selected based on conversations with NCEEP and NCDOT. All interested parties decided this was the most cost effective way to proceed while still providing a substantial ecological uplift.

Concerns from NCDOT over hydrologic trespass of the I-40 right of way, and discussions with NCEEP regarding risk of the original design and value driven uplift have resulted in a new restoration design for the Five Mile Branch project. The current design involves grading selected stream banks to less than vertical and excavating a floodplain/bankfull bench or removing an earthen berm on the left (north) bank, to reconnect the channel to its historic floodplain at the bankfull elevation. The prior straightening and the resulting excess stream power combined with a low width to depth ratio, lack of a significant amount of mature woody vegetation on the left bank, multiple debris jams and a clay layer that is preventing further incision are the factors that lead to ARCADIS's confidence that without intervention accelerated erosion will continue.

While there will be improvements to the project's profile that will be meaningful, they will be geared more towards localized measures of bank protection, grade control and provision of habitat at needed locations as opposed to producing a discernable and systemic shift of the profile towards reference distributions. Given this, the project reaches will yield an Enhancement II level of restoration according to the 2003 stream guideline definitions (USACE, 2003), however, due to the near systemic nature of the improvement to the channel cross-section and the localized improvements to the profile/in-stream habitat, NCEEP will be seeking a credit ratio of 2.0:1 as opposed the lower limit of 2.5:1 within the Enhancement II credit range of 2.5:1 to 1.5:1.Site construction will begin at the upstream end of Beaver Creek and proceed downstream (easterly). The material excavated from shaping the stream banks will be used to fill the existing drainage ditches. The ditches will be cleared and grubbed prior to filling. Vegetation will be salvaged from the ditches and transplanted onsite. The floodplain

pools will be excavated as work progress easterly. Access to the site will remain the same, Chimney lane and Swann Road.

The site will be monitored annually following the NCEEP guidelines. This monitoring will identify the sites progress toward compliance with the established success criteria. If during the monitoring period any of the success criteria are not met, the noncompliant item will be discussed with NCEEP and corrective action plan developed.

The following items will be monitored to determine if the site is meeting the established goals:

- Bank Height Ratio
- Proportion of downcutting or aggradation within the profile
- Integrity of in-stream structures
- Maintenance of pools associated with in-stream structures
- Bankfull area distributions
- Substrate distributions
- Proportions of active bank erosion
- Channel width distributions
- Entrenchment ratio distributions
- Bankfull frequency
- Woody stem density
- Diversity of woody stems
- Presence of invasive species
- Wetland hydrology

Upon completion of site construction the NCEEP shall monitor the project in keeping with the monitoring plan. Post-construction monitoring activities will be conducted to evaluate site performance, to identify maintenance and\or repair concerns, and to maintain the integrity of the project boundaries. If during the post-construction monitoring period it is determined project compliance is jeopardized the NCEEP shall take the necessary action to resolve the project concerns and bring the project back into compliance. At the conclusion of the post-construction monitoring period the project shall be presented to the regulatory authority for project acceptance and close-out. Upon close-out the project shall be transferred to the NCDENR Division of Natural

Resource Planning and Conservation Stewardship Program for long-term management and stewardship.

1. Project Site Identification and Location

The Five Mile Branch Site (site) is east of Statesville in Iredell County, southeast of Interstate 40 (I-40) and northwest of US Route 64. The site is in the Township of Cool Springs on the Statesville East, NC, 7.5-minute U.S. Geological Survey (USGS) topographic quadrangle (Figure 1). The Site comprises 12 adjacent parcels totaling approximately 229 acres (92.67 ha). It is bordered to the north by I-40 and to the south, east, and west by various forested, pasture, and residential properties. Swann Road (SR 2167), running north and south, bisects the site. Chimney Lane dead-ends on the site west of Swann Road. The study area consists primarily of currently fallow agricultural fields previously planted in row crops.

Directions: Take I-40 west out of Raleigh to US 64 west (exit 162) toward Cool Springs. Turn left onto US 64. Turn right onto Swann Road. Swann Road crosses the Site just before I-40.

All water resources at the site are part of the Yadkin-Pee Dee River Basin. The Yadkin-Pee Dee basin is the second-largest river basin in the state, covering approximately 7,213 square miles (mi^2) (18,681.58 hectares [ha]). The basin is situated primarily in the Piedmont physiographic region, but also drains portions of the Mountain and Coastal Plain regions of North Carolina. According to the Yadkin-Pee Dee Basinwide Water Quality Plan (North Carolina Department of Environment and Natural Resources [NCDENR] 2008), Fifth and Beaver Creeks are in USGS 8-digit Hydrologic Unit 03040102, 14-digit Hydrologic Unit 03040102010100, and North Carolina Division of Water Quality (NCDWQ) Sub-basin 03-07-06.

Restoration activities are expected to result in 12,270 linear feet (lf) of enhancement level II (6,220 lf on Beaver Creek and 6,050 lf on Fifth Creek), 890 lf of stream preservation (188 lf on UT to Beaver Creek, 102 lf on UT at Chimney Lane, 495 lf on the UT at Swann Road, and 105 lf on the Smiley UT), 58.6 acres of Piedmont/Mountain Bottomland Hardwood Forest restoration and 1.9 acres of Piedmont/Mountain Bottomland Hardwood Forest preservation (Table 1). The State owns only the north bank on the last 912 lf of Fifth Creek. No mitigation credit is being sought for this reach.

2. Watershed Characterization

2.1 Drainage Area

There are two main streams (Beaver Creek and Fifth Creek) and five unnamed tributaries located on the site. Beaver Creek runs about 6,120 lf (1,865.4 meters [m]) across the site before converging with Fifth Creek. Fifth Creek runs approximately 6,960 lf (2,121.4 m) from I-40 to the terminus of the project. Beaver Creek, upstream of the confluence with Fifth Creek, has a drainage area of approximately 10.7 mi^2 (2,771.29 ha). Fifth Creek upstream of the confluence with Beaver Creek drains approximately 13.9 mi^2 (3,600.08 ha). Fifth Creek at the downstream limit of the project has a drainage area of approximately 26 mi^2 (6,733.97 ha). The five unnamed tributaries are identified (from west to east) as UT to Beaver Creek, UT at Chimney Lane, UT to Fifth Creek, UT at Swann Road, and UT at Smiley.

The project area is approximately 229.11 acres (92.71 ha), comprised of 12 separate parcels. The State of North Carolina owns approximately 227.12 acres (91.91 ha), 10 parcels, fee simple. The remaining 1.99 acres (0.81 ha), portions of two parcels, are in a conservation easement held by the State of North Carolina.

2.2 Surface Water Classification

All surface waters in North Carolina are assigned a primary water classification by NCDENR. Supplemental classifications may also be assigned, as applicable. These classifications are assigned to protect uses of the waters, such as swimming, aquatic life propagation, or water supplies. For each classification, a set of water-quality standards must be met to protect the uses. According to NCDENR Basinwide Information Management System (BIMS), Fifth Creek from its source to the South Yadkin River and Beaver Creek from its source to Fifth Creek are denoted as Class C waters. Class C waters are suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. The NCDENR gave both Beaver Creek and Fifth Creek the support rating “Supporting.” Supporting waters are waters that are sufficient to support the uses for which the state has classified the water body. The NCDWQ has assigned stream index numbers of 12-108-13 for Fifth Creek and 12-108-13-1 for Beaver Creek.

The NCDOT conducted fish and benthic macroinvertebrate surveys on the site in June 2004. A total of 13 fish species (10 from Beaver Creek,8 in Fifth Creek upstream of Beaver Creek, and 9 in Fifth Creek downstream of Beaver Creek) were collected, with

the bluehead chub (*Nocomis leptocephalus*) and creek chub (*Semotilus atromaculatus*) being the most abundant (Medlin 2004). A total of 63 macroinvertebrate species were collected and identified in Beaver and Fifth creeks (49 in Beaver Creek, 30 in Fifth Creek upstream of Beaver Creek, and 37 in Fifth Creek downstream of Beaver Creek) (Herring 2005). The results of these studies seem to indicate that water quality and in-stream habitat are better on Beaver Creek, followed by Fifth Creek downstream of Beaver Creek, and then Fifth Creek upstream of Beaver Creek.

2.3 Physiography, Geology, and Soils

2.3.1 Physiography

The Five Mile Branch Restoration site is within the western Piedmont physiographic province. This province lies between the Coastal Plain and the Blue Ridge Mountain provinces and covers the central portion of the state, occupying approximately 45 percent of the area of the state. Gently rolling, well-rounded hills, and long, low ridges with moderate elevation changes between the hills and valleys characterize the Piedmont.

Fifth and Beaver creeks flow through a broad, flat valley. The valley is bordered to the southeast by steep hillsides. To the northwest, gently sloping and rolling hills bound the valley. Elevations in the valley range from 740 feet (225.55 m) above mean sea level (ft msl) at the upstream end of the Five Mile Branch project area to 720 ft msl (219.46 m) at the downstream end. The highest adjacent elevations to the southeast and northwest are approximately 850 ft msl (259.09 m) and 800 ft msl (243.84 m), respectively.

2.3.2 Geology

According to the Geologic Map of North Carolina (North Carolina Division of Land Resources [NCDLR] 1985), the site lies within an outcropping of metamorphic rock associated with the Charlotte and Milton belts. This formation of biotite gneiss and schist is noted for its abundant potassic feldspar, garnet, mica schist, and amphibolite with inter-layered calc-silicate rock. Additionally, small masses of granitic rock are often present throughout the formation. This formation occurs throughout the upper Piedmont of North Carolina.

2.3.3 Soils

This portion of the Piedmont of North Carolina is known for its deep, well-drained, dark-red, clay soils. Agriculture has been a major factor in the development, or rather the loss of, soil in the Piedmont. Under natural conditions, soils in this region contain a brownish loam surface layer 6 to 10 inches (12.2 to 25.4 centimeters [cm]) thick. The surface horizons have generally been lost due to the constant agricultural use of the land for the past 200 years. The Five Mile Branch Restoration site is no exception. The site differs from the surrounding area by containing a significant amount of hydric or nearly hydric soils. Land within this region of North Carolina that held water for an extended period of time was historically ditched and drained for agricultural utilization. This has resulted in a hydrologic change that has significantly modified many of the properties of the soils, resulting primarily from dry conditions.

ARCADIS conducted soil profiling on the File Mile Branch site in March and April of 2003 to validate the soil mapping performed by the Iredell County office of the Natural Resources Conservation Service (NRCS) in 1960. Because the original soil mapping was conducted after the system of ditches was established on the site, much of it remains accurate. There are, however, locations on the site in which the soil mapping differs from what the updated profiles found. These differences involve inclusions that would be expected within the mapped series, or upland series, and that are within the same soil taxonomic family and differ little. In addition, ARCADIS has changed the mixed-alluvial-land map unit. The soils within this map unit have been divided into Chewacla and Wehadkee soils, with Chewacla soils representing more than 75 percent of the unit. Thirteen mapping units are located on the NRCS map (Figure 3), with eight soil series represented.

ARCADIS also conducted deep soil cores between February and May 2003 in an attempt to locate relic stream channels on site. Identifying the relic stream channels would provide insight to the site's history and determine Beaver Creek's and Fifth Creek's original substrate. The soil cores were investigated to a depth of approximately 8 feet (2.4 m) along three transects. One of the soil cores located approximately 20 feet (6.1 m) north of Beaver Creek contained unweathered gravel at a depth of 41 inches (104 cm). This may be due to natural lateral migration of the channel sometime in the past or may be the result of human intervention. However, none of the other soils cores investigated contained enough unweathered gravel to suggest the relocation of either of the channels. Therefore, it cannot be confirmed if either of the creek channels has been relocated.

2.4 Historical Land Use and Development Trends

Research indicates that the site was in agricultural use for more than 50 years. Aerial photography from 1956 shows the site as being very similar to its condition prior to the NCDOT acquisition of the property. The fields, drainage ditch, and streams are in relatively the same locations now that they were then. The major exception is that I-40 was not present in 1956. Based on field observation, it also appears that Beaver Creek and Fifth Creek have been straightened. Old spoil piles have created a berm along the banks of Beaver and Fifth Creek that are adjacent to the old agricultural fields. In the past, the drainage ditches were better maintained, with the vegetation mowed or sprayed with herbicide. However, since NCDOT has purchased the parcels containing the ditches, vegetation has grown considerably.

The majority of the watershed is undeveloped, consisting of agricultural land (pasture, hayfields and row crops) and forested areas. The remaining areas are comprised of rural residential developments, a small amount of industrial development (and associated parking lots), and roadways. There are only a few housing developments located in the watershed, most of which are located in Fifth Creek's upper watershed around the US 21 and Interstate 77 interchange just north of Statesville. This is also the location of the majority of the industrial development as well. However, as with most rural areas in close proximity to a larger city, residential and industrial development is expected to continue within the watershed. This continued development could result in the following changes:

- Stream flows reach high stages quicker (i.e., flashier flows)
- Total runoff increases
- Dry-season base flows are reduced
- Loss of native vegetation and wildlife habitat
- Channel becomes unstable or continues to degrade

If proper stormwater controls are installed during the development process, most of these changes can be reduced or eliminated. ARCADIS has no control over the land use management within the watershed and therefore must consider the possibility of these changes during the design process. One of the best ways to moderate most of the stream changes associated with development in the watershed is to restore native

vegetation along the stream banks. Vegetation increases roughness along the stream bank and reduces erosion. In addition, it is important to design the stream with a width to depth ratio that results in adequate stream power to transport the anticipated sediment load through the system. The restoration design proposed for Beaver and Fifth Creek will improve vegetation along the stream bank and floodplain and produce a stream power that will sufficiently transport the current and anticipated future sediment loads, given implementation of proper stormwater controls within the watershed.

2.5 Watershed Planning

NCEEP develops River Basin Restoration Priorities (RBRP) to guide its restoration activities within each of the state's 54 Cataloging Units (CU). The Upper Yadkin-Pee Dee River Basin Restoration Priorities was updated in February 2009 and provides restoration goals for the Upper Yadkin-Pee Dee River Basin (USGS Catalog Units 03040101 and 03040102). The Five Mile Branch Project is located in the 03040102 CU. This CU is characterized by relatively equal portions of agriculture and forest, 42 percent and 43 percent, respectively. Only 10 percent of this CU is characterized as urban. Approximately 53 percent of the monitored streams within this CU are impaired (NCDWQ 2008). Habitat degradation is the leading cause of impairment. Turbidity and fecal coliform bacteria also contribute to impairment of streams within the CU. The Five Mile Branch Project will increase bank stability, reduce erosion, and re-establish a natural riparian buffer. These measures will improve aquatic habitat within this CU and reduce sedimentation within the watershed. According to David Currier, Director of Planning and Zoning for the City of Statesville, Statesville does not have a local watershed plan in place at this time (telephone interview, June 12 2009).

2.6 Endangered Species

A review of North Carolina Natural Heritage Program (NCNHP) records was conducted to identify known occurrences of federally protected species on or near the proposed restoration site. No records of federally listed species exist within two miles of the site (ARCADIS 1999). A list of special-status species for Iredell County was obtained from the NCNHP Web page. There are 27 special-status species listed in Iredell County, of which three are federal species of special concern and one is a federally threaten species. The bog turtle (*Clemmy muhlenbergii*) is a federally threatened species. It is listed as threatened due to similarity of appearance. It is not biologically endangered or threatened itself and is not subject to Section 7 consultation under the federal Endangered Species Act.

The Allegheny wood rat (*Neotoma magister*), tall larkspur (*Delphinium exalatum*), and Carolina birdfoot-trefoil (*Lotus helleri*) are listed as federal species of special concern. Habitat for the Allegheny wood rat, tall larkspur, Carolina birdfoot-trefoil, and bog turtle are not present on the site (ARCADIS 1999).

2.7 Cultural Resources

Reviews were conducted at the North Carolina Office of State Archaeology and the State Historic Preservation Office (SHPO) in Raleigh, North Carolina. Two National Register properties are located approximately 2 miles (3.2 km) to the west of the site (ARCADIS 1999). Due to their distance from the site, they would not be adversely affected by the project. SHPO Survey and Planning and the Office of State Archaeology signed a concurrence letter on 11 November 2002 that recommends construction activities be monitored by an NCDOT archaeologist.

2.8 Potential Constraints

Potential on-site constraints were evaluated to determine if any would result in a fatal flaw.

2.8.1 Property Ownership and Boundary

NCDOT either owns or holds a conservation easement on all the properties within the project area. Property ownership or boundaries will not impact the construction of the proposed project.

2.8.2 Site Access

The site will continue to be accessed from the same location. Chimney Lane enters the site upstream of the Beaver Creek\Fifth Creek confluence. This road will provide access to all of Beaver Creek and Fifth Creek upstream of Beaver Creek.

An earthen access road enters the site from Swann Road just downstream of the Beaver Creek\Fifth Creek confluence. This access road will require improvements to adequately handle construction equipment and will provide access to all of Fifth Creek. Site access will not impact the construction of the proposed project.

2.8.3 Utilities

There are no utilities located within the project area.

2.8.4 FEMA / Hydrologic Trespass

NCDOT voiced concerns about the original design and the possibility it had of creating wetlands within their right of way (ROW) along I-40. ARCADIS conducted a field evaluation of the entire right-of-way boundary adjacent to the project site and noted areas of potential concern. Following the field evaluation, ARCADIS plotted profiles of the ditches on-site and compared them with elevations at the right-of-way boundary. In order to alleviate NCDOT's concerns, the current design proposes to leave the ditches, flowing directly adjacent to the right-of-way, unfilled. As these ditches diverge from the right-of-way, fill will be placed to an elevation not to exceed the lowest elevation within the right-of-way. This will allow the hydrologic patterns within the right-of-way to remain unaltered.

The results of the HEC-RAS model indicate that the proposed project will not create any increase (0.0 foot or greater) to the 100-year flood elevations, floodway elevations, or floodway widths on Beaver Creek or Fifth Creek. See Section 7.3.4 for a more detailed Discussions with NCDOT revealed the presence on "underdrains" beneath I-40. Underdrains were installed by the contractor during the construction of I-40 in wet areas not shown on the design sheets but requiring additional drainage. The underdrains are not shown on the I-40 as built drawing and none were located during several field surveys of the I-40 ROW. The presence of the underdrains and their undocumented locations was another reason the I-40 ROW was avoided in the redesign.

3. Project Site Streams

3.1 Existing Conditions Survey

Entering the site, Beaver Creek is a fourth-order stream and Fifth Creek a third-order stream. Exiting the study area, Fifth Creek is a fourth-order stream. Three perennial streams enter the site from the south and two from the north. Several agricultural drainage ditches throughout the site help to transport surface runoff to Beaver and Fifth creeks (Figure 4). The site has been left fallow for several years, and young woody vegetation has begun to establish. Several areas at the site exhibit more mature woody vegetation, apparently due to those areas being too wet to plant when the site was in crop production. Three of these areas potentially qualify as jurisdictional wetlands. A jurisdictional determination by the United States Army Corps of Engineers (USACE) has not been requested.

Beaver Creek is a slightly incised, sand-dominated stream with a very low width-to-depth ratio and very low sinuosity. Beaver Creek is classified as an E5 Rosgen stream type. It flows adjacent to and south of the old agriculture cropland. Past vegetation-management practices have inhibited the establishment of woody vegetation on the northern bank. To the south is a well-developed, mature forested area. Apparent dredge-spoil piles are located on the top of the north bank. However, there is no evidence of a relic stream channel on the site. Beaver Creek has near-vertical banks, with evidence of bank failure at several locations. Several out of bank events have occurred over the past few years. These events have caused severe bank “blow-outs” on Beaver Creek, mainly near the upstream end of the project.

Fifth Creek is very similar to Beaver Creek in dimension. Fifth Creek also is classified as an E5 channel. Upstream (west) of Swann Road, Fifth Creek flows through the old agricultural field. The stream banks are nearly vertical and have moderate amounts of woody vegetation. The vegetation has only recently established itself due to the lack of vegetation maintenance. Apparent dredge-spoil piles are absent from Fifth Creek stream banks upstream of Swann Road. The dredged material from when the stream was straightened was more than likely used to fill the old channel and was spread throughout the agricultural fields. Downstream of Swann Road, Fifth Creek flows on the southern side of the old agricultural fields. The southern stream bank has sparse woody vegetation. This is caused by the fact that the area is maintained and has been used as cattle pasture. Woody vegetation is also sparse on the northern stream bank due to past vegetation management practices. Apparent dredge-spoil piles are also present on the northern stream bank. Out of bank events have had the same effect on Fifth Creek as on Beaver Creek. There is severe scouring around the Swann Road

bridge support piers. Immediately downstream of Swann Road the out of bank events have severely eroded a 40-foot section of the north bank.

UT to Beaver Creek enters Beaver Creek from the south approximately 2,600 feet (692.48 m) upstream of Chimney Lane. UT to Beaver Creek has a drainage area of 0.2 mi^2 (51.8 ha), and approximately 200 lf (60.96 m) exists within the state's property. UT to Beaver Creek flows through a mature forest and appears to be stable, with low bank heights, an exception being the 30-foot (9.1-m) reach upstream of the confluence with Beaver Creek. It appears that this reach has adjusted its bed in response to the straightening and deepening of Beaver Creek, resulting in a head cut. Tree roots have prevented the head cut from migrating farther upstream.

UT at Chimney Lane enters Beaver Creek from the south immediately upstream of Chimney Lane and is very similar to UT to Beaver Creek except that a portion of it flows through a sparsely vegetated floodplain previously used as cattle pasture. Tree roots are also protecting UT at Chimney Lane from a head cut migrating upstream of its confluence with Beaver Creek.

UT to Fifth Creek is not located on the site. It actually enters Fifth Creek between the two lanes of I-40. USGS maps and Figure 2 show it entering on the site. It appears that it was realigned during the construction of I-40.

UT at Swann Road enters Fifth Creek from the north immediately west of Swann Road. UT at Swann Road flows through the old agriculture field in an excavated drainage ditch and under an earthen access road in a 24 -inch (0.6-m) reinforced-concrete pipe, then discharges into Fifth Creek.

UT at Smiley enters Fifth Creek from the south approximately 1,000 feet (304.8 m) upstream of the terminus of the project. UT at Smiley is very similar to UT at Chimney Lane in that it flows through a maintained area previously used for cattle pasture. UT at Smiley is slightly incised due to the stream bed's adjusting to the straightening of Fifth Creek.

3.2 Channel Classification

Beaver Creek and Fifth Creek are classified as E5 Rosgen stream types. E5 stream types are meandering, sand bed streams with low width-to-depth ratios and gentle to moderate channel gradients. The unnamed tributaries were not classified. No work is proposed on the tributaries.

3.3 Valley Classification

The restoration site is located within a Valley Type VIII. This valley type has multiple river terraces positioned along broad valleys with gentle slopes (Rosgen 1996). Soils in this valley type are developed over alluvium from riverine processes. Stream types "C" and "E" are typically found within this valley type.

3.4 Discharge

Stream discharge was determined by using the revised North Carolina regional curves developed by Surry County NRCS (draft 3/16/2009), and the Manning's "n" equation. Bankfull discharge as extrapolated from the regional curves for Beaver Creek, Fifth Creek upstream of Beaver Creek and Fifth Creek downstream of Beaver Creek are 377.5, 465.9 and 770.9 cubic feet per second (cfs), respectively. Manning "n" calculations resulted in a discharge of 427.3 cfs for Beaver Creek, 407.0 cfs for Fifth Creek upstream of Beaver Creek and 615.4 cfs for Fifth Creek downstream of Beaver Creek. These are average velocities. Actual values ranged approximately 100 cfs greater and less than the average for each reach.

3.5 Channel Morphology

Beaver Creek and Fifth Creek have very low sinuosity, likely due to past dredging operations. Beaver Creek has an average width-to-depth ratio of 5.3 and an average bank height ratio of 1.2. The average pool-to-pool spacing ratio (8.1), meander length ratio (63.3), and belt width ratio (10.8) are not representative of a stable E5 stream. Most of the pools have formed as a result of obstructions in the channel. Fifth Creek, up stream of Beaver Creek, has an average width-to-depth ratio of 5.8 and an average bank height ratio of 1.2. Downstream of Beaver Creek, it has an average width-to-depth ratio of 6.7 and an average bank height ratio of 1.5. Pattern and profile parameters are similar to those of Beaver Creek and are not representative of a stable E5 stream. Morphological parameters for on-site streams are provided in Table 4.

3.6 Channel Evolution

Beaver Creek and Fifth Creek are currently unstable E5 streams. Based on field observation, ARCADIS believes Beaver Creek and Fifth Creek were ditched/dredged when the site was in agricultural use. These practices have altered the natural state of the channel by reducing sinuosity and inhibiting the establishment of woody vegetation along the stream banks. In response, Beaver Creek and Fifth Creek have incised to a clay layer, which is acting somewhat as grade control, and the streams are now

eroding laterally in an attempt to reduce stream power. If left untouched, it is unlikely these streams would ever incise to the point of a G5 stream type because of the dense clay layer in the stream bed. The more likely scenario is that both streams would continue to erode laterally in an attempt to regain sinuosity and exist for many more years as unstable E5 streams. Eventually the streams will create a new floodplain at a lower elevation and vegetation will have time to establish on the stream banks. However, it could be several years before the streams reach their equilibrium point and in the process, tons of sediment will enter the watershed due to stream bank erosion.

The first detailed stream survey was conducted in spring of 2003. A more recent evaluation was conducted in February 2009. Several debris jams resulting from recent tree falls, associated with trees being undermined by the stream, were identified during each survey. Several of the debris jams present during the 2003 survey are no longer present. Additionally, several new debris jams now occur within the streams.

3.7 Channel Stability Assessment

A Bank Erosion Hazard Index (BEHI) analysis was conducted for Beaver Creek and Fifth Creek, upstream and downstream of its confluence with Beaver Creek. Approximately 1,000 feet (304.8 m) along the left bank of each reach was studied for the purposes of calculating sediment export estimates. The left bank was chosen because field observations suggested the majority of sediment was being contributed from the left bank due to vegetation removal and control during past agricultural practices. Beaver Creek and the downstream portion of Fifth Creek exhibited very similar erosion rates (0.38 and 0.34 tons/yr/ft, respectively), due to the lack of woody vegetation along the left bank. The upstream portion of Fifth Creek contained several areas where woody vegetation was well established on the stream bank, resulting in lower sediment export estimates (0.14 tons/yr/ft). Near Bank Stress (NBS) ranged from low to moderate throughout all reaches, with the exception of areas where log jams were creating a disproportionate distribution of energy in the near bank region. Several debris jams associated with recent tree falls were identified during the February 2009 stream assessment. The tree falls are a result of bank erosion undermining the trees. The total sediment contribution from the 3,000 feet of stream bank studied was approximately 860 tons/year. Extrapolated for the entire site, Beaver Creek and Fifth Creek are contributing over 3,500 tons of sediment per year to the watershed from erosion along the left bank alone. A summary of the BEHI analysis and sediment export estimates is presented in Table 5.

3.8 Bankfull Verification

In order to confirm the correct bankfull determinations were made at the restoration site, a USGS Gage station (gauge # 0214340 on Jacobs Fork in Burke County) was surveyed. The reason a gage station is used is that the return interval for any flow can be determined. It is necessary to calculate the return interval because the return interval for bankfull flows is between 1 and 2 years. The gage has more than 40 years of data. Several gages nearer the project site were investigated, but they were determined to be unsuitable for several reasons, including unstable channel, lack of a consistent bankfull indicator, or lack of data. An abbreviated survey was conducted at the gage station. The survey consisted of a riffle cross-section and a longitudinal profile. The same bankfull indicator at the gauge station was used at the restoration site. The return interval for the bankfull flow at this indicator was determined to be one year. Therefore, it is expected that the correct bankfull indicator was identified.

The bankfull channel cross sectional area was compared to the revised North Carolina rural regional curves developed by Haywood County NRCS. The average bankfull cross sectional area measured in the field was 90.0 ft^2 (8.4 m^2) for Beaver Creek, 112.9 ft^2 (10.5 m^2) for Fifth Creek upstream of Beaver Creek, and 202.5 ft^2 (18.8 m^2) for Fifth Creek downstream of the confluence of Beaver Creek. The cross sectional areas as determined by the regional curves for Beaver Creek, Fifth Creek upstream of Beaver Creek and Fifth Creek downstream of Beaver Creek are 92.5, 112.3 and 178.9 ft^2 (8.6, 10.4, and 16.6 m^2), respectively.

3.9 Vegetation Community Types Descriptions and Disturbance History

Vegetative communities present at the site were categorized using Classification of the Natural Communities of North Carolina, Third Approximation (Schafale and Weakley 1990). Natural communities are defined as “distinct and re-occurring assemblages of populations of plants, animals, bacteria, and fungi naturally associated with each other and their physical environment.” These communities are in a constant state of transition based on current and previous land uses. Some of the community names have been modified to better reflect field observations. Based on field surveys, two natural communities are present at the Five Mile Branch site: Piedmont/Mountain Bottomland Forest and Early Successional Piedmont/Mountain Bottomland Forest.

3.9.1 Piedmont/Mountain Bottomland Forest

Piedmont/Mountain Bottomland Forest communities can be found in a wide variety of alluvial landscapes within the Piedmont. Most are on floodplain ridges and terraces,

adjacent to streams and rivers, and not within the active levee or floodplain. Since these communities are associated with riverine systems, they are occasionally flooded, which provides a significant portion of the nutrients in the community. The velocity of floodwaters has usually dissipated as they reach the bottomland forest areas, and the flowing water does not inhibit vegetation growth in the bottomland system. However, long-term flooding can cause mortality for many of the vegetation species found in these communities. There is a broad range of wetness, related to the height of ridges or terraces above normal ground water level. Soils are a range of alluvial types associated with deposition and saturation conditions. This type of forest system may be a climax community, with an uneven-aged mix of vegetation that is regenerated whenever gaps occur in the canopy (Shafale and Weakley 1990). This Piedmont/ Mountain Bottomland Forest community is present along the southern side of the Five Mile Branch site, at the far southwestern end, and in a number of small, wooded areas within the agricultural fields. This community along with the description in Shafale and Weakley (1990) was used as the reference community which the planting plan was based.

The canopy is dominated by species such as sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), yellow-poplar (*Liriodendron tulipfera*), and loblolly pine (*Pinus taeda*). Trees present in the understory include swamp chestnut oak (*Quercus michauxii*), black cherry (*Prunus serotina*), river birch (*Betula nigra*), white oak (*Quercus alba*), northern red oak (*Q. rubra*), ironwood (*Carpinus caroliniana*), and American holly (*Ilex opaca*). The shrub layer is somewhat thick in locales and includes possumhaw (*Viburnum nudum*), silky dogwood (*Cornus ammomum*), tag alder (*Alnus serrulata*), black willow (*Salix nigra*), flowering dogwood (*C. florida*), deerberry (*Vaccinium stamineum*), elderberry (*Sambucus canadensis*), strawberry bush (*Euonymus americanus*), multiflora rose (*Rosa multiflora*), spicebush (*Lindera benzoin*), and Chinese privet (*Ligustrum sinense*). The herbaceous and vine strata include yellowroot (*Xanthorhiza simplicissima*), blackberry (*Rubus* spp.), Japanese honeysuckle (*Lonicera japonica*), greenbrier (*Smilax* spp.), poison ivy (*Toxicodendron radicans*), goldenrod (*Solidago* spp.), jewelweed (*Impatiens capensis*), Christmas fern (*Polystichum acrostichoides*), and smartweed (*Polygonum* spp.).

3.9.2 Early Successional Piedmont/Mountain Bottomland Forest

This community occurs in the old agricultural areas on site. On-site crop production ceased in 2005 when the State of North Carolina purchased the property. Prior to this, the fields were plowed and planted annually. The ditches were maintained during this time by mechanically cutting the vegetation and clearing debris from the ditches. The

lack of regular maintenance in these areas has resulted in the establishment of an early successional community. There is currently no canopy layer, but young canopy trees found throughout this community include sycamore, green ash, sweetgum, loblolly pine, and red maple (*Acer rubrum*). Other shrub and tree species scattered throughout this community include black willow, tree of heaven (*Ailanthus altissima*), elderberry, boxelder (*Acer negundo*), and eastern red cedar (*Juniperus virginiana*). The herbaceous layer is dense throughout this community and dominated by golden rod, blackberry, milkweed (*Asclepias* sp.), bluestem (*Andropogon* sp.), and rush (*Juncus effusus*).

Tree-of heaven (*Ailanthus altissima*) and Chinese privet (*Ligustrum sinense*) occur in both communities. Tree of heaven is randomly scattered throughout the old agricultural fields and along the northern stream bank of Beaver and Fifth Creeks. Privet occurs in the older communities on site, mainly the bottomland forest to the south of the creeks. Japanese honeysuckle (*Lonicera japonica*) also occurs randomly throughout the site.

4. Reference Stream

One specific reference stream was not used for the restoration design. The project consists of Enhancement Level II. Stream banks will be reshaped, bankfull benches will be excavated and stream profile will be modified using in-stream structures. The structures will provide bank protection, grade control, and habitat diversity within the stream channel. ARCADIS used equations provided by Dave Rosgen to determine structure length and spacing (Rosgen, 2006). Ratios from several reference reaches (E stream types) and regional curves were used to establish the appropriate bankfull width, depth and other design parameters. Pattern ratios were not used because the streams will remain on existing alignment to reduce construction costs. ARCADIS evaluated reference reach data from the ARCADIS inventory and the NCDOT database. ARCADIS also compared reference reach data to the ranges Dave Rosgen established for E type streams (Rosgen 1996).

5. Project Site Wetlands

5.1 Jurisdictional Wetlands

Sections 404 and 401 of the Clean Water Act (CWA) regulate discharges into waters of the United States. The United States Environmental Protection Agency (USEPA) is the principal administrative agency of the CWA; however, the USACE has the responsibility for implementation, permitting, and enforcement of the provisions of the CWA related to dredging and placement of fill. The USACE regulatory program is defined in 33 CFR 320-330. NCDWQ is the principal administrative agency of the Section 401 Surface Water and Wetland Standards and is defined in NC Administration Code 15A NCAC 02B .0100 & .0200.

Water bodies – including lakes, rivers, streams, and wetlands – are identified as waters of the United States and are subject to jurisdictional consideration under the Section 404 program. Wetlands, defined in 33 CFR 328.3, are those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Any action that proposes to place fill into these areas falls under the jurisdiction of the USACE under Section 404 of the CWA (33 USC 1344).

Three wetlands are located on the Five Mile Branch site. The locations of all wetland boundaries were flagged in the field during November 2002. All delineations were based on the USACE Wetlands Delineation Manual (1987). The wetland areas were incorporated into a survey performed in April 2003. Based upon the results of the survey, there are 1.9 acres (0.77 ha) of wetlands on the Five Mile Branch site. NWI mapping identifies none of these wetlands. Appendix 2 includes the wetland data forms. The wetlands are discussed in more detail in Section 5.4.

5.2 Hydrological Characterization

In order to facilitate agricultural uses of the surrounding land, the stream channels of Beaver and Fifth Creeks appear to have been straightened, channelized or relocated. Typically, streams in broad, flat valleys meander throughout the valley. Both streams are uncharacteristically straight.

A series of drainage ditches bisects the site to facilitate crop production. The flow pattern of the streams and ditches is typically west to east across the site. The

surface-water flow patterns are detailed in the Wetland and Stream Mitigation Feasibility Study (ARCADIS 1999).

Eighteen shallow monitoring gauges are located within the study area. These gauges have collected daily water levels since April 2000. Of the 18 gauges, 7 are in drainage ditches, 4 are within possible wetlands, 3 are in the field, 3 are adjacent to the ditches, and 1 is in a sycamore stand. In general, data from the gauges are strongly correlated with surface-water inputs of precipitation, overbank flow, and surface-water outputs of evapotranspiration and runoff. Water levels are higher in the winter and spring, when there are higher precipitation rates and lower evapotranspiration rates. In the growing season, the ditches are often dry, and water levels in the open-field near to the ditches and streams are often 40 inches (101.6 cm) below the soil surface. Three of the four gauges located within possible wetlands have water within 12 inches (30.5 cm) of the surface for 38 percent of the growing season. Gauges located over 20 feet (6.1 m) from the ditches or streams have water within 12 to 24 inches (30.5 to 61 cm) of the surface during the growing season. Gauges adjacent to the ditches have water within 12 to 30 inches (30.5 to 76 cm) of the surface during the growing season. This shows that the ground water level is further below the soil surface closer to a ditch or stream.

A variety of hydrologic conditions have occurred during the monitoring period. Below-normal precipitation occurred in 2000, 2001, and 2002, whereas above-normal precipitation occurred in 2003 and 2004. Because crop production ceased in 2004, it is expected that the amount of water lost through evapotranspiration in the summer months will be reduced until early successional vegetation has time to establish. Preliminary data indicate the hydrology of the floodplain is controlled by the elevation of the ditches. Therefore, restoring the hydrologic conductivity of the wetlands is feasible through restoration efforts.

5.2.1 Hydrologic Budget for Restoration Site

Hydrologic inputs to the site are precipitation, surface water inflow and groundwater inflow. Hydrologic outputs are evapotranspiration, surface and ground water out flow. Surface water inflow is provided by two major sources, overbank events from Beaver and Fifth Creeks and more regularly runoff from the surrounding area. I-40 is the main contributor of surface runoff to the site. Approximately 20 acres (8.1 ha) of impervious surface area drain directly to the site via roadway ditches, culverts and the ditches discussed above. Currently these ditches transport the roadway runoff directly to Beaver and Fifth Creeks. The ditches that are not directly adjacent to the NCDOT right-of-way will be filled. Filling the ditches will not only raise the groundwater

elevation, it will also increase the onsite retention time of roadway runoff; therefore, increasing the amount of surface water available for wetland restoration. The increased retention time is expected to improve water quality. However, water quality is not being evaluated and mitigation credits not sought.

5.3 Soil Characterization

5.3.1 Taxonomic Classification (including series)

The majority of the site is comprised of Chewacla and Wehadkee soils. Chewacla soils are classified as fine-loamy, mixed, active, thermic Fluvaquentic Dystrudepts. Wehadkee soils are classified as fine-loamy, mixed, active, nonacid, thermic Fluvaquentic Endoaquepts. Most soils mapped as Chewacla also contain Wehadkee inclusions. Chewacla and Wehadkee soils are in the order Inceptisols. Inceptisols have weakly developed diagnostic features. Soils on site are weakly developed due to alluvial deposition from Beaver Creek and Fifth Creek.

5.3.2 Profile Description

On-site profile of Chewacla loam:

Ap -- 0 to 12 inches (0 to 30.5 cm); brown (7.5YR 4/4) silty clay loam; few, fine, faint strong brown (7.5YR 5/8) soft masses of iron accumulation; many fine roots

B1 -- 12 to 24 inches (30.5 to 61.0 cm); dark yellowish-brown (10YR 4/4) silty clay loam; many, medium, prominent yellowish red (5YR 5/8) soft masses of iron accumulation; few, fine, prominent reddish-yellow (7.5YR 6/8) soft masses of iron accumulation; water table at 18 inches; black organic concentrations

Bg -- 24 to 34 inches (61.0 to 86.4 cm); grayish-brown (10YR 5/2) clay loam; many, medium, prominent yellowish-red (5YR 5/6) soft masses of iron accumulation; fine roots, oxidized root channels

Bg2 -- 34 to 36 inches (86.4 to 91.4 cm); very dark gray (10YR 3/1) clay loam; many, fine, prominent red (2.5YR 4/6) and yellowish-red (5YR 5/8) soft masses of iron accumulation; oxidized root channels

On-site profile of Wehadkee loam:

A -- 0 to 3 inches (0 to 7.6 cm); strong brown (7.5YR 4/6) clay loam; common, fine, distinct yellowish-red (5YR 4/6) soft masses of iron accumulation; many roots; organic matter present

Bg1 -- 3 to 12 inches (7.6 to 30.5 cm); dark grayish-brown (10YR 4/2) clay loam; many, medium, prominent strong brown (7.5YR 5/8) soft masses of iron accumulation; water table at 8 inches; many medium roots

Bg2 -- 12 to 24 inches (30.5 to 61.0 cm); gray (10YR 6/1) silty clay loam; common medium prominent strong brown (7.5YR 5/8) soft masses of iron accumulation; oxidized root channels, fine roots, small black organic concentrations

5.4 Vegetation Community Types Descriptions and Disturbance History

Wetland A is a depressional wetland located east of Swann Road and immediately south of I-40. The wetland probably formed in a borrow area used during the construction of or improvements to Interstate-40. Wetland A, the largest wetland at 1.44 acres (0.59 ha), contains vegetation consistent with a Piedmont/Mountain Bottomland Hardwood Forest as described by Schafale and Weakley (1990). The canopy is dominated by red maple, sweetgum, and American elm. The understory consists of blackgum and black willow with an herbaceous/vine layer containing blackberry, giant cane, greenbrier, common grape, various sedges, Japanese honeysuckle, and a few Chinese privet. Water was within 6 inches (15.2 cm) of the surface, and there were sediment deposits and obvious drainage patterns throughout the wetland during the field visit.

Wetland B is a 0.09-acre (0.36-ha) wetland located at the toe of a slope southeast of Wetland A. This wetland appears to be collecting water that travels through the subsurface to Fifth Creek. Wetland B contains vegetation consistent with a Piedmont/Mountain Bottomland Hardwood Forest as described by Schafale and Weakley (1990). The canopy is dominated by sycamore, red maple, sweetgum, and American elm. The soil was saturated within 8 inches of the surface, and sediment deposits and water-stained leaves were evident throughout the wetland. The understory consists mostly of younger canopy species with an herbaceous/vine layer containing blackberry, giant cane, greenbrier, common grape, and various rushes and sedges.

Wetland C is near the downstream terminus of the project area, located between steep slopes and a ditch. Wetland C is approximately 0.32 acre (0.13 ha) in size and contains vegetation consistent with a Piedmont/Mountain Bottomland Hardwood Forest as described by Schafale and Weakley (1990). The canopy is dominated by sweetgum, red maple, and American elm. The understory consists mostly of younger canopy species with an herbaceous/vine layer containing blackberry, giant cane, greenbrier, common grape, Japanese honeysuckle, and various sedges.

6. Reference Wetland

A reference wetland site optimally is a functioning climax wetland community with characteristics that are to be mimicked at the restoration site, and that is located near the project area. The reference site characteristics should include soils, vegetation, and hydrology similar to the proposed restoration site. Although there are three wetlands within the study area, none is appropriate to use as a reference because they have all been significantly altered in the past. Their former uses have included agriculture, pasture, and borrow sites.

In order to design the bottomland restoration area for a climax community representing the natural steady state for a palustrine forested wetland community, property exhibiting mature vegetation was located and used as an off-site reference wetland. Discussions with Iredell County NRCS agents assisted in identifying the appropriate off-site reference wetland. This jurisdictional wetland is approximately 5 miles south-southwest of the project area within land owned by the City of Statesville (Figure 7). The City of Statesville utilizes the majority of the land on the property for a wastewater treatment facility. No equipment used for the treatment of wastewater is in the reference wetland, and no effluent is discharged there.

6.1 Hydrological Characterization

A Memorandum of Agreement (MOA) between NCEEP and the City of Statesville allowing access to the site for the installation and monitoring of groundwater monitoring gauges was agreed to March 14, 2005. Two Telelog ® groundwater monitoring gauges were installed April 14, 2005 (Figure 8). These gauges were downloaded concurrently with the restoration site gauges. Gauge downloading ceased in December 2005. The existing reference gauges were replaced with NCEEP-provided Ecotone® gauges in February 2009.

There is no stream within this approximately 6.5-acre (2.63-ha) wetland. Water enters the site from rainfall, a small, ephemeral channel at the southwestern corner of the site or flooding of Fourth Creek. These factors have created a basin with a minimal surface outfall.

6.1.1 Gauge Data Summary

For the purpose of this report, groundwater elevations were monitored at the reference site between April 13, 2005, and December 14, 2005, using two Telelog ® gauges.

During the 244-day monitoring period, the ground water elevation was greater than 12 inches (30.5 cm) below ground surface a total of 30 days and 46 days. The bulk of these were during September and October when there was no significant rainfall for 48 days. The maximum consecutive days the groundwater elevation was greater than 12 inches (30.5 cm) below ground surface was 72 days (June 27 through September 7) and 20 days (April 14 through May 4).

6.2 Soil Characterization

The NRCS maps soils at the reference site as Wehadkee, a listed Hydric A soil for Iredell County. Soil profiling performed by ARCADIS confirmed this soil mapping.

6.2.1 Taxonomic Classification (including series)

Wehadkee soils are classified as fine-loamy, mixed, active, nonacid, thermic Fluvaquentic Endoaquepts. Wehadkee soils are in the order Inceptisols. Inceptisols have weakly developed diagnostic features which are usually the result of steep gradients or depositional processes.

6.2.2 Profile Description

Reference site profile of Wehadkee silt loam:

A – 0 to 3 inches (0 to 7.6 cm); reddish-brown (5YR 5/3) silty clay loam;

B – 3 to 16 inches (7.6 to 40.6 cm); gray (2.5Y 6/1) silty clay loam; common, fine, prominent brownish-yellow (10YR 6/6) and light yellowish-brown (10YR 6/4) soft masses of iron accumulation

Bh – 16 to 20 inches (40.6 to 50.8 cm); gray (2.5Y 5/1) sandy loam;

6.3 Vegetation Community Types Descriptions and Disturbance History

6.3.1 Community Descriptions

The National Wetlands Inventory (NWI) has mapped the existing bottomland hardwood forest at the reference wetland site as Palustrine Forested (PFO1A). Steep slopes border the site to the south, and a well-developed natural stream levee associated with Fourth Creek has developed to the north. Vegetation in the reference wetland is

consistent with a Piedmont/Mountain Bottomland Forest as described by Schafale and Weakley (1990). The canopy is dominated by swamp chestnut oak, southern red oak, sweetgum, sycamore, and red maple. The understory/shrub layer is sparse and consists of silky dogwood, blackgum, and southern arrowwood. The herbaceous/vine layer contains soft rush, cinnamon fern, and greenbrier. Detailed information concerning the wetland is included in the wetland data form in Appendix 5.

7. Project Site Restoration Plan

7.1 Overarching Goals and Applications of Restoration Plan

In striving to maximize ecological benefit, while minimizing costs, ARCADIS has developed the following restoration plan for the Five Mile Branch site. For several years, agricultural practices have acted as the primary stressor to the streams on site. The removal and control of stream bank vegetation has produced highly erodible banks and increased sediment load within the watershed. The streams also appear to have been straightened in the past. These practices have contributed to a loss of in-stream habitat and function. In addition, the floodplain was cleared of native riparian vegetation and ditched to suit agricultural land use. This lowered the water table in the area, eliminated natural riparian habitat, and depleted the nutrient reduction capabilities of the floodplain. ARCADIS evaluated the site to determine the level of restoration that would be necessary to correct the problems caused by the past land use practices. Originally, ARCADIS intended to realign Beaver and Fifth Creeks to restore proper dimension, pattern, and profile consistent with a stable C5 stream type. The amount of grading and in-stream structures proposed in the original design made it unfeasible to construct based on project budget. ARCADIS reevaluated the project and determined that reducing bank slope, reducing bank height ratios, and reestablishing woody vegetation on the stream banks would provide the most ecological uplift for the streams while staying within the project budget. In addition, ARCADIS proposes to reestablish ground water levels and riparian vegetation to pre-agricultural conditions by filling the ditches (except those located directly adjacent to NCDOT right-of-way) and replanting the floodplain with native vegetation. Table 2 details the linkages between project stressors and proposed restoration activities, and outlines assessment criteria and monitoring parameters. The goals and objectives of this project are outlined in section 7.2.

7.2 Restoration Project Goals and Objectives

The restoration site is included in NCEEP's Upper Yadkin River Basin Restoration Priorities. .NCDWQ's 2008 Yadkin-Pee Dee River Basin Plan (Basin Plan). The Basin Plan identifies "increasing nutrient enrichment, urbanization, and wastewater as the primary impacts to water quality in the basin" (NCDWQ 2008). Most of the stream impairments are based on poor biological integrity measured by aquatic macroinvertebrates and fish communities, followed by turbidity measurements (NCDWQ 2008). Restoration goals for the project include:

- Increase bank stability, nutrient filtration and aquatic habitat
- Reduce soil disturbance and nutrient inputs to stream
- Improve soil physical and chemical properties in the near term
- Improve hydrologic connectivity with floodplain
- Attenuate site impacts of storm flows
- Restore ground water hydrology to pre-agricultural levels
- Restore wetland and riparian habitat

The project objectives include:

- Establish a minimum 50-foot buffer consisting of a mix of native species representative of piedmont/mountain bottomland hardwood forest
- Grade stream banks, install in-stream structures, and remove berm to reconnect streams with floodplain
- Eliminate past agricultural land uses, fill existing drainage ditches and excavate flood plain pools.
- Rip floodplain soil prior to planting

7.2.1 Designed Channel Classification and Wetland Type

A low sinuosity E5 stream type will be constructed. The existing streams currently classify as an E5 stream type. However, they have very low width to depth ratios. The width to depth ratio will be increased slightly by grading banks. The channel slope will be reduced through the use of grade control structures. Boulder vanes and root wads will be used to establish in-stream habitat diversity. A piedmont/mountain bottomland hardwood forest buffer will be established adjacent to the streams. Floodplain pools will be randomly intermixed within the buffer.

7.2.2 Target Wetland Communities/Buffer Communities

7.2.2.1 Bottomland Hardwood Forest

Most of the area surrounding the proposed stream restoration will be replanted and restored as a bottomland hardwood forest. Floodplain pools will be constructed at various locations throughout this vegetative community. This bottomland hardwood forest restoration will also enhance the existing wetland areas on site by establishing a continuous area rather than the highly fragmented communities that currently exist. The existing bottomland hardwood communities within the study area will be used as a reference, such that the natural system, including the plants and topography, appear and function similarly to the existing reference. Details concerning vegetation within this community are discussed in the Section 3 of this report. When possible, transplant species will be identified and salvaged to retain species diversity. Bottomland hardwood forests are found on highly fertile soils, so the soil will be amended and properly prepared prior to planting. Topography will allow for periodical flooding. Alluvial deposition will increase important plant nutrients and introduce additional seed material to promote species diversity.

7.2.2.2 Floodplain Pools

Floodplain pools or vernal ponds are seasonally flooded wetlands. They are located in depressions with no permanent aboveground outlet. Floodplain pools provide valuable habitat for various amphibian and insect species. The restoration plan includes the construction of floodplain pools within the bottomland hardwood forest, and they will range in size depending on the volume of earthwork. In order to reduce construction costs, the design will try to have a balance of earthwork on the site. The source of water for floodplain pools is precipitation, groundwater or overland flow. Woody debris will be incorporated into the pools to the extent feasible. Since, these wetlands periodically dry up, they do not contain fish. Drying may occur annually or only in drought years. In general, they dry most often in late summer or early fall (Biebighauser, no date). The floodplain pools will vary in depth (1 to 3 feet [.3 to .9 m]) in order to vary the duration of standing water within them. The floodplain pools will not be planted with aquatic vegetation after construction. It is anticipated that vegetation will establish naturally.

7.3 Stream Project and Design Justification

The following section was developed through several discussions between ARCADIS and NCEEP.

Concerns from NCDOT over hydrologic trespass of the I-40 right of way, and discussions with NCEEP regarding risk of the original design and value driven uplift have resulted in a new restoration design for the Five Mile Branch project. The original design provided high uplift at a high cost with a somewhat higher level of risk given its highly sinuous nature. In light of these constraints and considerations, ARCADIS believes a lesser yet substantive level uplift can be sustained at a much lower cost with lesser risk and site impacts, thus increasing the overall value of the project. The current design involves grading selected stream banks to less than vertical and excavating a floodplain/bankfull bench or removing an earthen berm on the left (north) bank, to reconnect the channel to its historic floodplain at the bankfull elevation. This restoration most closely resembles Priority II restoration given that the existing channel is only moderately incised in most locations. The result is a proportionally modest change to the cross-section of these slightly to moderately incised E channels and a significant increase in access to the floodplain at the bankfull elevation. ARCADIS is highly confident through its observation, 2003 assessment, 2003 analysis of the project site, and 2009 abbreviated assessment, that intervention is necessary to reduce, non-reference rates of erosion and that the proposed level of enhancement will result in substantive and sustainable reduction in bank erosion. The prior straightening and the resulting excess stream power combined with a low width to depth ratio, lack of a significant amount of mature woody vegetation on the left bank, multiple debris jams and a clay layer that is preventing further incision are the factors that lead to ARCADIS's confidence that without intervention accelerated erosion will continue.

A few mature trees are intermittently spaced at the top of the left bank which provide moderate shading to the channel. Their roots are not providing sufficient bank protection. Many roots are exposed and being undermined and ARCADIS has observed what appears to be a high rate of localized bank retreat. The trees that appear to be providing bank protection will be worked around during construction, saving the maximum number possible.

As stated, ARCADIS is highly confident that the measures proposed (the level of intervention) will reduce bank erosion and associated sedimentation. The changes to the channel cross-section and extent of floodplain grading may seem proportionally small. However, they are longitudinally extensive (nearly systemic) and proportional in

terms of what is necessary to provide a meaningful and sustainable deceleration of erosion/evolution (uplift), even considering the trade-off loss of some mature trees.

While there will be improvements to the project's profile that will be meaningful, they will be geared more towards localized measures of bank protection, grade control and provision of habitat at needed locations as opposed to producing a discernable and systemic shift of the profile towards reference distributions. Given this, the project reaches will yield an Enhancement II level of restoration according to the 2003 stream guideline definitions (USACE, 2003), however, due to the near systemic nature of the improvement to the channel cross-section and the localized improvements to the profile/in-stream habitat, NCEEP will be seeking a credit ratio of 2.0:1 as opposed the lower limit of 2.5:1 within the Enhancement II credit range of 2.5:1 to 1.5:1.

7.3.1 Sediment Transport Analysis

Sediment transport analysis is used to predict if the designed channel will be able to move the bedload that is supplied to the channel. It compares the proposed channel morphological parameters to the bed load material in the channel and determines if the proposed channel is capable of moving the material. For a stream to be stable, it must be able to consistently transport its sediment load (Rosgen 1996). If the stream is not moving its sediment load, the stream channel aggrades, often resulting in a braided system. If the stream is capable of moving more than the supplied sediment load, the stream usually degrades, resulting in an incised stream system. Incorrect estimation of sediment transport is the apparent cause of failure in many stream restoration projects.

Based on visual observation since the first feasibility studies, it appears that Fifth Creek and Beaver Creek are no longer incising. Bed stability (possibly temporary) has resulted from beaver dams or an erosion-resistant subpavement material. The beaver dams appear to provide temporary grade control. Several old, washed-out dams were identified on the site. However, portions of the dams remained in the streambed. These portions of the dams appear to be providing grade control and temporary bed stability. However, evidence of beaver dams was not identified during the 2009 stream survey. Another possibility is that the streambed itself is not easily erodible. Pavement and sub-pavement samples revealed that only a thin layer of sand (less than 2 feet [0.6 m]) exists over a clay bed. The sand moves during high flows, but the highly cohesive clay does not.

7.3.2 Methodology

Sediment transport analysis was conducted by calculating the proposed channel shear stress then comparing it to the Shields curve (Leopold, Wolman and Miller 1964). The Shields curve estimates the largest size particle capable of moving at a given shear stress. This size particle is then compared to the particle size within the stream bed. If the Shields curve particle size estimated is significantly higher than the actual particle size in the stream, then the stream is degrading. If the Shields particle size estimate is significantly smaller than the particle size in the stream, then the stream is aggrading. If the Shields particle size is near the same size as the particle in the channel, then the stream is stable.

7.3.3 Calculation and Discussion

The shear stresses for the proposed section of stream were calculated and the particle size moveable at these shear stresses according to the Shields curve determined. The calculations follow.

$\tau = \gamma RS$ Where τ = bankfull shear stress (lb/ft^2)
γ = specific weight of water (lbs/ft^3)
R = hydraulic radius of bankfull channel (ft)
S = average water surface slope (ft/ft)

Beaver Creek

$\tau = 62.4\ lbs/ft^3 \times 3.52\ ft \times 0.0016\ ft/ft$
$= 0.35\ lb/ft^2$

Particle size (mm) movable = 20 mm Pavement D50 = 12 mm D84 = 24 mm

Fifth Creek upstream of Beaver

$\tau = 62.4\ lbs/ft^3 \times 3.70\ ft \times 0.0013\ ft/ft$
$= 0.30\ lb/ft^2$

Particle size (mm) movable = 17 mm Pavement D50 = 10 mm D84 = 27 mm

Fifth Creek downstream of Beaver

$\tau = 62.4\ lbs/ft^3 \times 4.28\ ft \times 0.0013\ ft/ft$
$= 0.35\ lb/ft^2$

Particle size (mm) movable = 20 mm Pavement D50 = 18 mm D84 = 43 mm

Given the particle size predicted to move at the proposed shear stress and the size of the pavement D50 and D84, the channels are expected to be able to transport the sediment supplied to the channel.

7.3.4 HEC-RAS Analysis

For the hydraulic analysis, HEC-RAS version 4.0.0 was used to perform steady-state backwater calculations under a subcritical flow regime within the studied reach. The models obtained from the North Carolina Floodplain Mapping Program (NCFMP) were run in HEC-RAS 4.0.0 and the results of the Flood Insurance Study (FIS) duplicated within 0.1-foot to form the Duplicate Effective model as required by FEMA.

The Duplicate Effective Model was then modified by replacing effective cross-sections along the project reach with more recent and detailed survey information to form the Corrected Effective/Existing Conditions model. The Corrected Effective/Existing Conditions model is utilized in this analysis to support conclusions about the actual impacts of the project associated with the proposed conditions model.

The Proposed Conditions model was developed by modifying the Corrected Effective/Existing Conditions model to account for proposed grading of the channel and floodplain along the project reach. In addition, minor adjustments to Manning's n were made at a limited number of cross-sections to account for proposed plantings along the channel banks and riparian corridor. The proposed project does not include changes to the meander pattern of the channel. Therefore, reach lengths in the Proposed Conditions model remain the same as in the Corrected Effective/Existing Conditions model.

In comparing the Proposed Conditions model to the Corrected Effective/Existing Conditions model, the results indicate that the proposed project will not create any increase (0.0 foot or greater) to the 100-year flood elevations, floodway elevations, or floodway widths on Beaver Creek or Fifth Creek at published sections in the FIS for Iredell County, North Carolina, data March 18, 2008, and will not create any increase in the 100-year flood elevations, floodway elevations, or floodway widths at unpublished cross sections in the vicinity of the project.

7.3.4.1 No-rise. LOMR, CLOMR

The HEC-RAS analysis for the proposed project indicated that there will not be a rise in the water surface elevation of the 100-year flood event. Therefore, a Letter or Map Revision (LOMR) or a conditional letter of map revision (CLOMR) is not required.

7.3.4.2 Hydrologic Trespass

The potential for hydrologic trespass into the NCDOT right-of-way is being eliminated by not filling the ditches adjacent to their right-of-way. . The remaining ditches will be filled to the lowest elevation of the roadway ditches at the point where they enter the site. This will allow the roadway ditched to continue to route water away from I-40 and onto the site

NCDOT owns the majority of the property to the south of the streams to just beyond the toe of slope. Grading activities will not take place south of the streams. Therefore, restoration activities will not affect groundwater levels beyond the toe of slope. The two parcels that NCDOT owns a conservation easement are at the downstream limits of the project and immediately adjacent to Fifth Creek. No grading will take place within these parcels. Therefore, the project will not result in hydrologic trespass on these parcels.

The results of the HEC-RAS model indicate that the proposed project will not create any increase (0.0 foot or greater) to the 100-year flood elevations, floodway elevations, or floodway widths on Beaver Creek or Fifth Creek. See Section 7.3.4 for a more detailed discussion.

7.4 Site Construction

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

7.4.1.1 Narrative

Access to the site will continue to be from Chimney Lane and Swann Road. Site construction will begin at the upstream end of Beaver Creek and proceed downstream (easterly). The material excavated from shaping the stream banks will be used to fill the existing drainage ditches. The ditches will be cleared and grubbed prior to filling. Vegetation will be salvaged from the ditches and transplanted onsite. The floodplain pools will be excavated as work progress easterly. Invasive species will be treated or

removed prior to all grading activities. This will reduce the probability of their spread across the site.

In areas where work in the existing stream bed is required, the section of stream will be dewatered prior to any excavation activities. In areas that only call for regrading of stream banks, the channel will not be dewatered. Work will be performed from the bank being grading and care will be taken to prevent material from entering the channel.

The ditch south of I-40 and east Swann Road will not be filled. Some type of drainage structure is located adjacent to the I-40 right of way. The structure appears to be associated with I-40, although a review of I-40 design files did not identify it. Currently, it was decided to maintain existing drainage patterns in this area by not filling the ditches.

7.4.1.2 Scaled Schematic of Grading

All design aspects are shown on the design sheets.

7.4.1.3 In-stream Structure and other construction elements

In-stream structures will include boulder cross vanes, boulder vanes, log vanes, root wads, and boulder and log toe protection. Boulder vanes will be used for grade control, bank stabilization and in stream habitat improvement. Boulder and log vanes, root wads, and boulder and log toe protection will provide the same functions with the exception of grade control. Vegetation transplants will be utilized and installed around the in-stream structures.

7.4.2 Native Plant Community Restoration

A piedmont/mountain bottomland forest buffer will be established on site. Trees and shrubs will be planted within the floodplain at a spacing of 8 feet by 8 feet (2.4 m by 2.4 m), resulting in a density of approximately 680 stems per acre. The initial density will exceed the establish success criteria. Species composition is discussed above in Section 3.

7.4.2.1 Soil Preparation and Amendments

Prior to the installation of plants and seeds, soil testing will be performed on site. Soil amendments will be used based on the results of the soil test. All planting areas will be ripped and raked prior to planting. Topsoil will be stockpiled during grading activities and reapplied throughout disturbed areas prior to planting.

7.4.2.2 Narrative of plant community restoration that correlates with the Planting Plan as depicted on the Restoration Plan Design Sheets

Piedmont/mountain bottomland forest will be established adjacent to the streams. Buffer width is expected to be 50 feet. Within the buffer, floodplain pools will be excavated. The size and location of the floodplain pools have not been determined. This will depend on the final earthwork calculation.

7.4.2.3 Narrative of invasive species management

Small areas of tree of heaven (*Ailanthus altissima*) and Chinese privet are located throughout the site. Removal method depends on the location of the trees. Trees located within an excavation area will be removed by excavating the tree roots and all, without compromising the integrity of the stream restoration. Trees outside of excavation will be cut and the stumps treated with an appropriate herbicide. Trees removed will be disposed of appropriately.

If beaver are identified as concern during construction, NCEEP will have the USDA (APHIS) remove the beaver.

8. Performance Criteria

In order to determine if the restoration site is performing as designed, performance criteria to monitor the development of the site are required. Monitoring provides quantitative data and documentation of changes occurring at the site. The criteria include monitoring stream stability, vegetation development, changes in groundwater elevations and soil profile analysis. All post-construction monitoring data will be compared to the pre-construction data and all previous years' data. This comparison will show whether the site is progressing towards the desired outcome. Table 2 provides a detailed description of assessment criteria.

8.1 Streams

Stream monitoring will follow the guidelines established in the USACE, Wilmington District, April 2003, Stream Mitigation Guidelines, monitoring level I. Benthic monitoring is not included at this time. Stream dimension pattern and profile will be monitored, as well as substrate. The performance criteria are linked to the assessment criteria and monitored parameters outline in Table 2 Functional Needs, Goals and Objectives.

At least two bankfull events must occur during the five-year monitoring period. The bankfull events must occur in separate years. Monitoring will continue until two bankfull events in separate years occur. A water-level data-logger or crest stage gauges will be installed on site to document bankfull events.

Stream dimension will be monitored by establishing permanent cross sections at an average frequency of approximately 1 per 20 bankfull widths. An equal number of riffle and pool cross sections will be established and monitored. It is possible, based on conditions after construction that the establishment of permanent cross sections will differ slightly than what is proposed. The actual location of permanent cross sections will be discussed with the NCEEP monitoring specialist (Greg Melia) prior to field surveys. Each cross section will be compared with the baseline survey and the previous years' survey to identify any trends. Any changes in the channel dimension should be minor, no more than 25 percent. Bank height ratios should not exceed 1.4. If a significant change from the baseline survey is observed, the change will be assessed to determine if it is a shift toward stability or instability. All cross sections will be classified using the Rosgen stream classification system.

A longitudinal profile survey of the stream will be conducted each year of monitoring. The profile will identify the same features as the baseline profile survey. The longitudinal profiles will show changes, if any, in the location of stream features. The change in bed elevation will be less than 20 percent on the maximum riffle depth. A segment exceeding 25 percent of the total reach threatened by down cutting due to structure failure would result in corrective actions.

Photographs of the site will provide valuable visual information to complement the figures and narrative material that will be included in the monitoring reports. Photo documentation will be conducted twice a year (summer and winter) during the monitoring period. Permanent photo reference points will be established during the baseline survey. The locations will be permanently marked and shown on the baseline survey. Photo reference points will include a representative number of in-stream structures, all permanent cross-section locations, all permanent vegetation-monitoring plots and any other areas of special interest identified during the baseline survey.

8.2 Wetlands

Data from all monitoring gauges will be recorded on a daily basis and periodically during the entire growing season. The groundwater data will be compared with monthly precipitation data in order to estimate the return cycle for water inputs.

Groundwater gauges will be installed at representative locations throughout the site. Gauges are currently located in the reference wetland. The data collected from the restoration site gauges will be used to determine the hydrologic success of the restoration. The reference area is located off site. However, it exhibits the same hydrology as the restoration site, the main source being ground water, roadway runoff and stream over bank events. Therefore, the groundwater levels within the restoration areas should be similar to those in the reference areas. If groundwater levels within the restored areas do not meet the criteria of within 12 inches (30.5 cm) of surface for 5 percent of the growing season, then the levels will be compared to those in the adjacent reference areas. If there is a significant difference in groundwater levels, remedial actions will be coordinated with NCEEP.

During Years 3 and 5, soil samples will be taken in the vicinity of the vegetation monitoring plots to determine if the soils are exhibiting hydric soil conditions.

8.3 Vegetation

The success of vegetation is based on the total number of surviving stems at a specific time period. The success criteria established by the USACE is 320 surviving stems after 3 years, 288 stems after 4 years and ultimately 260 stems after 5 years. Successful vegetation establishment for this project will be based on 288 stems after 5 years. The intermediate criteria will be used as guidance to warn NCEEP that the vegetation maybe trending towards non-compliance.

Invasive vegetation will be will be visually monitoring during the monitoring period. If the establishment of invasive vegetation appears to threaten the success of the restoration site, corrective actions will be taken. The necessity of corrective actions will be discussed with NCEEP monitoring specialist (Greg Melia) prior to implementation.

8.4 Beaver Management

On-site beaver activity may affect the success of the site. Beaver may build dams on the restored stream, affecting sediment transport and bank stability. Beaver may also forage on planted vegetation. Beaver activity will be documented during the monitoring period. If beaver activity appears to be affecting the performance of the restoration, corrective actions will be taken. Corrective actions would more than likely consist of relocating the beaver. Corrective actions will be discussed with NCEEP monitoring specialist (Greg Melia) prior to implementation. NCEEP will have the USDA (APHIS) remove the beaver

8.5 Schedule / Reporting

Stream monitoring will occur mid to late summer. Vegetation monitoring will follow protocol outlined in the NCEEP-CVS guidelines. Wetlands vegetation monitoring will be conducted concurrently as the buffer vegetation monitoring. Groundwater monitoring gauges will be downloaded periodically during the Iredell County growing season.

The draft monitoring report will be submitted to NCEEP no later than November of the monitoring year. The draft report will be made final based on NCEEP comments and submitted to the regulatory agencies no later than January of the following year.

9. Preliminary Monitoring

Site monitoring and reporting will follow the guidelines established by NCEEP in the Mitigation Plan Document Format, Data Requirements, and Content Guidance , Version 2.0, 03/27/2008. Vegetation will be monitoring following NCEEP-CVS methodology and be conducted at the appropriate time of the year. Assessment criteria and monitoring parameters identified in Table 2 will be monitored.

10. Site Protection and Adaptive Management Strategy

The majority of the site is currently owned fee simple by the NCDOT. NCDOT purchased two small conservation easements near the downstream terminus of the project. The property owner was not willing to sell the property fee simple.

Upon completion of site construction the NCEEP shall monitor the project in keeping with the monitoring plan. Post-construction monitoring activities will be conducted to evaluate site performance, to identify maintenance and\or repair concerns, and to maintain the integrity of the project boundaries. If during the post-construction monitoring period it is determined project compliance is jeopardized, the NCEEP shall take the necessary action to resolve the project concerns and bring the project back into compliance. At the conclusion of the post-construction monitoring period, the project shall be presented to the regulatory authority for project acceptance and close-out. Upon close-out the project shall be transferred to the NCDENR Division of Natural Resource Planning and Conservation Stewardship Program for long-term management and stewardship.

11. References

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Tables

Table 1. Project Components Five Mile Branch Stream Restoration, Iredell County, SCO # 040607901							
Project Component or Reach ID	Existing Feet	Restoration Level	Approach	Footage or Acreage	Stationing	Buffer Acres	Comments
Beaver Creek	6,220	E2	P3	6,220 LF	10+00 BVR – 72+20 BVR	-	Maintaining existing alignment. Modifying dimension and profile.
Fifth Creek u/s Beaver	1,590	E2	P3	1,590 LF	10+00 FTH – 25+90 FTH	-	Maintaining existing alignment. Modifying dimension and profile.
Fifth Creek d/s Beaver	5,372	E2	P3	4,460 LF	25+90 FTH – 79+62 FTH	-	State owns north side of downstream terminus of Beaver Creek. This area not included in assets.
UT to Beaver Creek	188	P	P	188 LF	10+00 – 11+88	-	Located on State owned property.
UT at Chimney Lane	102	P	P	102 LF	10+00 – 11+02	-	Located on State owned property.
UT at Swann Road	495	P	P	495 LF	10+00 – 14+95	-	Located on State owned property.
UT at Smiley	105	P	P	105 LF	10+00 – 11+05	-	Located on State owned easement.
Riverine Wetland	1.9	R	R	65.7 ac	-	-	Bottomland hardwoods. Floodplain pools included in calculation.
Riverine Wetland	1.9	P	P	1.9 ac	-	-	

Component Summations							
Restoration Level	Stream (lf)	Riparian Wetland (Ac)		Non-Riparian Wetland (Ac)	Upland (Ac)	Buffer (Ac)	BMP
		Riverine	Non-Riverine				
Restoration	-	65.7	-	-	-	-	-
Enhancement	-	-	-	-	-	-	-
Enhancement I	-	-	-	-	-	-	-
Enhancement II	12,270	-	-	-	-	-	-
Creation	-	-	-	-	-	-	-
Preservation	890	1.9	-	-		-	
HQ Preservation	-	-	-	-	-	-	-
Total	13,160	67.6	-	-	-	-	-

Table 2. Functional Needs, Goals and Objectives
Five Mile Branch Stream Restoration, Iredell County, SCO # 040607901

		Effects	Responses	Remedies	Assessment Criteria*	Monitored Parameters**
Stressors	**Channel Straightening**	• Increased stream power • Increased bank erosion • Lost connection with floodplain • Reduced in-stream habitat	• Improve stream bed and bank stability • Restore in-stream habitat • Improve hydrologic connectivity with floodplain	• Grade stream banks • Install in-stream structures • Remove berm to connect with existing floodplain	1 – 10	1, 2, 3, 4, 7, 9
	Removal of Streambank and Riparian Vegetation	• Loss of riparian and in-stream habitat/shading • Loss of organic matter inputs • Loss of streambank protection • Loss of floodplain roughness/filtration of runoff	• Restore riparian and in-stream habitat/shading • Improve bank stability • Attenuate site impacts of storm flows	• Replant stream banks and floodplain with native vegetation • Install vegetation transplants in strategic locations throughout site	11, 12, 13	1, 2, 3, 5, 6, 9
	Ditching of Floodplain	• Lowered ground water level • Loss of wetland habitat • Reduced nutrient filtration	• Restore ground water hydrology to pre-agricultural levels • Restore wetland habitat and function/nutrient filtration	• Fill ditches • Plant hydrophytic vegetation in wetland restoration areas • Install floodplain pools	11, 12, 13, 14	5, 6, 8, 9, 10
	Agricultural Practices	• Increased nutrient input to streams • Compaction of floodplain soils	• Reduce nutrient inputs • Improve physical properties of soil in the near term	• Eliminate agricultural practices • Implement property ownership or conservation easement on-site • Rip floodplain soils prior to planting	None proposed	None proposed

*Assessment Criteria: 1 – bank height ratio (<1.4), 2 – proportion of downcutting or aggradation within the profile, 3 – integrity of in-stream structures, 4 – maintenance of pools associated with in-stream structures, 5 – bankfull area distributions, 6 – substrate distributions, 7 - proportions of active bank erosion, 8 – channel width distributions, 9 – entrenchment ratio distributions, 10 – bankfull frequency, 11 – woody stem density, 12 – diversity of woody stems, 13 – presence of invasive species, 14 – wetland hydrology

**Monitored Parameters: 1 – longitudinal profile, 2 – cross sections, 3 – Visual assessment/inventory of stream features and channel structures, 4 – substrate analysis, 5 – Visual assessment/inventory of the riparian zone, 6 – vegetation plots, stem counts, and vegetation assessments, 7 – stream gauge for stream hydrology, 8 – groundwater wells for wetland hydrology, 9 – Photographs, 10 – Soil Profiles

Assessment Criteria Defined

1 – Bank Height Ratio – Mean bank height ratios should not exceed 1.4

2 – Proportion of downcutting or aggradation within the profile – Profile should exhibit stable patterns of variation. Occurrences of change in bed elevation over the monitoring period should be vertically small (generally <20% of max riffle depths), localized, and vary year to year in their position along the profile. This guidance criteria may be exceeded if there was an initial adjustment in response to a rare storm event shortly after construction and subsequently the reach does not exhibit additional degradation when challenged by additional events >bankfull.

3 – Integrity of in-stream structures – Grade control structures should not demonstrate multiple sequential grade control failures with any frequency. Should the reach demonstrate continuous segments (i.e. one or two segments totaling 20-25% of the reach) threatened by future downcut risk or blowouts around a structure, this would constitute a barrier to final success determination without remediation. Loss of grade control constitutes physical deconstruction of the structure, significant piping and/or evidence of actual grade loss in the bed upstream of the structure.

4 – Maintenance of pools associated with in-stream structures – Pools associated with in-stream structures should maintain pool depth to bankfull depth ratios within the ranges set forth in the design parameters. Pool depths that increase over time and outside of the design range, will not constitute failure unless the structure is compromised as a result.

5 – Bankfull area distributions – The mean riffle areas for the reach should be maintained or decrease. The bankfull channel may exhibit some increases in area (no more than 25%) as long as there is evidence any systematic adjustment has arrested through challenge by subsequent events greater than bankfull.

6 – Substrate distributions – Five Mile Branch is a sand bed system and is expected to remain a sand bed system after construction. However, if substrate coarsens as a result of the restoration effort, and the stream maintains stability, the substrate variation will not be considered a failure.

7 – Proportions of active bank erosion – The cumulative occurrence of erosion and mass wasting should not exceed 15% of the project bank footage as a criterion or the proportions should represent a clear improvement over pre-restoration rates. The 15% guidance criteria may be exceeded slightly if there is evidence that prior instances of bank instability have arrested and are stabilizing.

8 – Channel width distributions – Maintenance or reductions of bankfull width (without concomitant increase in mean riffle bankfull depths) represent success related to this stability parameter. The bankfull channel may exhibit mean width increases (no higher than 20%) as long as there is evidence any systematic adjustment has arrested through challenge by subsequent events > bankfull. Increases of width at the bankfull elevation should also be carefully viewed in the context of narrowing below that elevation such as via development of an inner berm feature. This can leave the impression of widening when these width values are examined independent of cross-sectional area and cross-section plots.

9 – Entrenchment ratio distributions – Values should be ≥ 2.5 for stable C/E floodplain stream types. Values should not exhibit reductions > 25% compared to as-built values unless the reduction was the result of constructive floodplain deposition processes.

10 – Bankfull frequency – Stream should access its floodplain at least twice during the five year monitoring period. Stream crest gage will be used to monitor bankfull events.

11 – Woody stem density – Regulatory guidance indicates a stem density of 260 stems/acre at year 5.

12 – Diversity of woody stems – The majority of the species identified within the planting plan should be present on site and represent a mixture of early and late successional species.

13 – Presence of invasive species – Only trace amounts of high threat invasive species such as kudzu, knotweed, and other climbing species that represent a physical threat to the buffer as a whole should be present at any given time.

14 – Wetland hydrology – Hydrology data should indicate saturation within 12 inches of the soil surface for the hydro-period dictated by the project reference or 5% of the growing season, whichever is less.

Table 3. Project Attributes Five Mile Branch Stream Restoration, Iredell County, SCO # 040607901			
Project County	Iredell		
Physiographic Region	Piedmont		
Ecoregion	Southern Outer Piedmont		
Project River basin	Yadkin-Pee Dee		
USGS HUC for Project (14 digit)	03040102010100		
NCDWQ Sub-basin for Project	03-07-06		
Identify Planning Area (LWP, RBRP, other)	Upper Yadkin-Pee Dee River Basin Restoration Priorities, February 2009. Actual site not included in RBRP.		
WRC Classification (Warm, Cool, Cold)	Cool		
% of project easement fenced or demarcated	±50% Property line adjacent to I-40 ROW fenced. Live stock fencing located on parcels containing a state owned easements.		
Beaver activity observed during design phase?	Yes. In drainage ditches.		
Restoration Components Attributes			
	Beaver Creek	Fifth Creek u/s	Fifth Creek d/s
Drainage Area	10.7 sq. mi.	13.9 sq. mi.	26.0 sq. mi.
Stream Order	4th	3rd	4th
Enhancement level II Length (ft)	6,220	1,590	5,372
Perennial or Intermittent	P	P	P
Watershed Type (Rural, Urban(izing), etc.)	Rural/Urbanizing	Rural/Urbanizing	Rural/Urbanizing
Watershed LULC Distribution Residential Agricultural Row Crop Agricultural Livestock Forested	40% 15% 15% 30%		
Watershed Impervious cover %	10%-20%		
NCDWQ AU/Index Number	12-108-13-1	12-108-13	12-108-13
NCDWQ Classification	C	C	C
303d listed?	no	no	no
Upstream of 303d listed Segment?	no	no	no
Reason for 303d listing or stressor	N/A	N/A	N/A
Total acreage of easement	229 for entire site		
Total vegetated acreage within the easement	229 with the exception of Chimney Lane, a small dirt road.		
Total planted acreage as part of the restoration	65.7 Replanting abandoned agriculture field with Bottomland hardwood species.		
Rosgen classification of pre-existing	E5	E5	E5
Rosgen classification of As-built	E5	E5	E5
Valley type	VIII	VIII	VIII
Valley slope %	0.172		

Valley side slope range %	0-10		
Valley toe slope range %	0-10		
Trout waters designation	None	None	None
Species of concern, endangered, etc (Y/N)	N	N	N
Dominant soil series and characteristics			
Series	Chewacla/Wehadkee	Chewacla/Wehadkee	Chewacla/Wehadkee
Depth Class	Very Deep (>80 in.)	Very Deep (>80 in.)	Very Deep (>80 in.)
Clay %	5-35%	5-35%	5-35%
K	Unknown	Unknown	Unknown
T			

TABLE 4A
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL
WITH GAGE STATION
(Adapted from Rosgen, 1996)

Restoration Site: Beaver Creek, Five Mile Branch Site, near Statesville, Iredell County, NC
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel		Proposed Reach		USGS Gage Station	
1. Stream Type	E5		E5		B	
2. Drainage Area (sq. mi)	10.76		10.76		25.7	
3. Bankfull Width (Wbkf) ft	Mean:	26.7	Mean:	27.6	Mean:	51.0
	Range:	20.2 - 35.2	Range:	20.7 - 38.8	Range:	
4. Bankfull Mean Depth (dbkf) ft	Mean:	4.5	Mean:	4.2	Mean:	2.7
	Range:	3.3 - 5.9	Range:	3.3 - 5.0	Range:	
5. Width/Depth Ratio (Wbkf/dbkf)	Mean:	6.0	Mean:	6.6	Mean:	18.8
	Range:	4.4 - 9.1	Range:	5.1 - 9.5	Range:	
6. Bankfull Cross-Sectional Area (Abkf) sq ft	Mean:	119.4	Mean:	115.5	Mean:	139.3
	Range:	79.7 - 176.0	Range:	75.0 - 163.2	Range:	
7. Bankfull Mean Velocity (Vbkf) fps	Mean:	3.8	Mean:	3.7	Mean:	3.9
	Range:	3.3 - 4.0	Range:		Range:	
8. Bankfull Discharge (Qbkf) cfs	Mean:	453.7	Mean:	453.7	Mean:	539.9
	Range:	302.9 - 668.8	Range:	302.9 - 668.8	Range:	
9. Maximum Bankfull Depth (dmax) ft	Mean:	6.9	Mean:	5.9	Mean:	3.3
	Range:	8.1 - 5.0	Range:	4.6 - 7.2	Range:	
10. Ratio of Low Bank Height to Max. Bankfull	Mean:	1.2	Mean:	1.0	Mean:	1.4
	Range:	1.0 - 1.5	Range:		Range:	
11. Width of Flood Prone Area (Wfpa) ft	Mean:	180	Mean:	180.0	Mean:	70.5
	Range:	100.0 - 250.0	Range:	100.0 - 250.0	Range:	
12. Entrenchment Ratio (Wfpa/Wbkf)	Mean:	8.2	Mean:	6.4	Mean:	1.4
	Range:	4.6 - 10.9	Range:	3.6 - 9.0	Range:	
13. Meander Length (Lm) ft	Mean:	1,380.0	Mean:	1380.0	Mean:	
	Range:	575.0 - 2,132.0	Range:	575.0 - 2,132.0	Range:	
14. Ratio of Meander Length to Bankfull Width (Lm/Wbkf)	Mean:	63.3	Mean:	50.0	Mean:	
	Range:	26.3 - 97.8	Range:	20.8 - 77.2	Range:	
15. Raduis of Curvature (Rc) ft	Mean:	3,527.0	Mean:	3527.0	Mean:	
	Range:	60.0 - 14,000.0	Range:	60.0 - 14,000.0	Range:	
16. Ratio of Radius of Curvature to Bankfull Width	Mean:	161.8	Mean:	127.8	Mean:	
	Range:	2.7 - 642.2	Range:	2.2 - 507.2	Range:	
17. Belt Width (Wblt) ft	Mean:	235.0	Mean:	235.0	Mean:	
	Range:	47.0 - 443.0	Range:	47.0 - 443.0	Range:	
18. Meander Width Ratio (Wblt/Wbkf)	Mean:	10.8	Mean:	8.5	Mean:	
	Range:	2.1 - 20.3	Range:	1.7 - 16.0	Range:	
19. Sinuosity (Stream length/valley distance) (k)	Mean:	1.07	Mean:	1.07	Mean:	
	Range:		Range:		Range:	
20. Valley Slope (ft/ft)	Mean:	0.00172	Mean:	0.00172	Mean:	
	Range:		Range:		Range:	
21. Average Water Surface Slope or Bankful Slope for	Mean:	0.0016	Mean:	0.0016	Mean:	0.0032
	Range:		Range:		Range:	
22. Pool Slope (Spool) ft / ft	Mean:	0.0028	Mean:	0.0	Mean:	
	Range:	0.0 - 0.0200	Range:		Range:	
23. Ratio of Pool Slope to Average Slope (Spool/Sbkf)	Mean:	1.7	Mean:	0.0	Mean:	
	Range:	0.0 - 12.5	Range:		Range:	
24. Maximum Pool Depth (dpool) ft	Mean:	6.7	Mean:	6.7	Mean:	
	Range:	4.7 - 7.8	Range:	4.7 - 7.8	Range:	
25. Ratio of Maximum Pool Depth to Bankfull Mean	Mean:	1.6	Mean:	1.6	Mean:	
	Range:	1.1 - 1.9	Range:	1.1 - 1.9	Range:	
26. Pool Width (Wpool) ft	Mean:	20.5	Mean:	20.5	Mean:	
	Range:	14.4 - 24.1	Range:	14.4 - 24.1	Range:	

TABLE 4A
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL
WITH GAGE STATION
(Adapted from Rosgen, 1996)

Restoration Site: Beaver Creek, Five Mile Branch Site, near Statesville, Iredell County, NC
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel		Proposed Reach		USGS Gage Station
27. Ratio of Pool Width to Bankfull Width	Mean:	0.9	Mean:	0.7	Mean:
	Range:	0.7 - 1.1	Range:	0.5 - 0.9	Range:
28. Bankfull Cross-sectional Area at Pool (Apool) sq ft	Mean:	100.6	Mean:	100.6	Mean:
	Range:	80.9 - 119.8	Range:	80.9 - 119.8	Range:
29. Ratio of Pool Area to Bankfull Area (Apool/Abkf)	Mean:	1.1	Mean:	0.9	Mean:
	Range:	0.9 - 1.3	Range:	0.7 - 1.0	Range:
30. Pool to Pool Spacing (p-p) ft	Mean:	176.7	Mean:	176.7	Mean:
	Range:	20.6 - 748.9	Range:	20.6 - 748.9	Range:
31. Ratio of Pool-to-Pool Spacing to Bankfull Width (p-	Mean:	8.1	Mean:	6.4	Mean:
	Range:	0.9 - 34.3	Range:	0.7 - 27.1	Range:
32. Pool Length (Lp) ft	Mean:	25.7	Mean:	25.7	Mean:
	Range:	5.5 - 161.9	Range:	5.5 - 161.9	Range:
33. Ratio of Pool Length to Bankfull Width (Lp/Wbkf)	Mean:	1.2	Mean:	0.9	Mean:
	Range:	0.2 - 7.4	Range:	0.2 - 5.9	Range:
34. Riffle Slope (Sriff) ft / ft	Mean:	0.0020	Mean:	0.0020	Mean:
	Range:	0.0 - 0.0094	Range:	0.0 - 0.0094	Range:
35. Ratio of Riffle Slope to Average Slope (Sriff/Sbkf)	Mean:	1.2	Mean:	1.2	Mean:
	Range:	0.0 - 5.9	Range:	0.0 - 5.9	Range:
36. Maximum Riffle Depth (driff) ft	Mean:	5.7	Mean:	5.9	Mean:
	Range:	3.7 - 7.1	Range:	4.6 - 7.2	Range:
37. Ratio of Riffle Depth to Bankfull Mean Depth	Mean:	1.4	Mean:	1.4	Mean:
	Range:	0.9 - 1.7	Range:	1.1 - 1.7	Range:
38. Run Slope (Srun) ft / ft	Mean:	0.0105	Mean:	0.0105	Mean:
	Range:	0.0 - 0.0269	Range:	0.0 - 0.0269	Range:
39. Ratio of Run Slope to Average Slope (Srun/Sbkf)	Mean:	6.6	Mean:	6.6	Mean:
	Range:	0.0 - 16.8	Range:	0.0 - 16.8	Range:
40. Maximum Run Depth (drun) ft	Mean:	5.6	Mean:	5.6	Mean:
	Range:	5.2 - 6.3	Range:	5.2 - 6.3	Range:
41. Ratio of Run Depth to Bankfull Mean Depth	Mean:	1.4	Mean:	1.3	Mean:
	Range:	1.3 - 1.5	Range:	1.2 - 1.5	Range:
42. Slope of Glide (Sgl) ft / ft	Mean:	0.0042	Mean:	0.0042	Mean:
	Range:	0.0 - 0.0180	Range:	0.0 - 0.0180	Range:
43. Ratio of Glide Slope to Average Water Surface Slope	Mean:	2.6	Mean:	2.6	Mean:
	Range:	0.0 - 11.2	Range:	0.0 - 11.2	Range:
44. Maximum Glide Depth (dgl) ft	Mean:	5.9	Mean:	5.9	Mean:
	Range:	4.8 - 7.2	Range:	4.8 - 7.2	Range:
45. Ratio of Glide Depth to Bankfull Mean Depth	Mean:	1.4	Mean:	1.4	Mean:
	Range:	1.2 - 1.7	Range:	1.1 - 1.7	Range:
46. Step Slope (Sst)	Mean:	0.1629	Mean:	N/A	Mean:
	Range:		Range:		Range:
47. Ratio of Step Slope to Average Water Surface Slope	Mean:	103.7	Mean:	N/A	Mean:
	Range:		Range:		Range:
48. Maximum Step Depth (dst)	Mean:	5.9	Mean:	N/A	Mean:
	Range:		Range:		Range:
49. Ratio of Step Depth to Bankfull Mean Depth	Mean:	1.4	Mean:	N/A	Mean:
	Range:		Range:		Range:

TABLE 4A
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL
WITH GAGE STATION
(Adapted from Rosgen, 1996)

Restoration Site: Beaver Creek, Five Mile Branch Site, near Statesville, Iredell County, NC
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel		Proposed Reach		USGS Gage Station
Materials:					
Particle Size Distribution of Channel Material (mm)					
D16	N/A		Expected to		
D35	0.1		Coarsen		
D50	0.2				
D84	1.0				
D95	7.0				
Particle Size Distribution of Bar Material	P	SP			
D16	N/A	N/A			
D35	5.6	N/A			
D50	10.3	2.2			
D84	22.9	13.1			
D95	28.8	24.1			
Largest Size Particle on Bar					

Sediment Transport:		
Sediment Transport Validation (Based on Bankfull Shear Stress)	**Existing**	**Proposed**
Calculated value (mm) from curve	33	24
Value from Shields Curve (lb/ft2)	0.43	0.35

TABLE 4B
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL
WITH GAGE STATION
(Adapted from Rosgen, 1996)

Restoration Site: Fifth Creek upstream Beaver Creek, Five Mile Branch Site,(near Statesville),Iredell County, NC
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel		Proposed Reach		USGS Gage Station	
1. Stream Type		E5		E5		B
2. Drainage Area (sq. mi)		13.93		13.93		25.7
3. Bankfull Width (Wbkf) ft	Mean:	30.7	Mean:	29.0	Mean:	51
	Range:	23.9 - 40.3	Range:	25.1 - 33.0	Range:	
4. Bankfull Mean Depth (dbkf) ft	Mean:	4.2	Mean:	4.1	Mean:	2.7
	Range:	3.8 - 5.0	Range:	3.8 - 4.6	Range:	
5. Width/Depth Ratio (Wbkf/dbkf)	Mean:	7.0	Mean:	7.0	Mean:	18.8
	Range:	5.3 - 8.4	Range:	5.5 - 8.6	Range:	
6. Bankfull Cross-Sectional Area (Abkf) sq ft	Mean:	130.1	Mean:	119.7	Mean:	139.3
	Range:	94.0 - 176.4	Range:	104.5 - 144.7	Range:	
7. Bankfull Mean Velocity (Vbkf) fps	Mean:	3.4	Mean:	3.4	Mean:	3.9
	Range:		Range:		Range:	
8. Bankfull Discharge (Qbkf) cfs	Mean:	442.3	Mean:	442.3	Mean:	539.9
	Range:	319.6 - 599.8	Range:	319.6 - 599.8	Range:	
9. Maximum Bankfull Depth (dmax) ft	Mean:	7.8	Mean:	7.4	Mean:	3.3
	Range:	6.7 - 9.1	Range:	6.4 - 8.3	Range:	
10. Ratio of Low Bank Height to Max. Bankfull	Mean:	1.1	Mean:	1.0	Mean:	1.4
	Range:	1.1 - 1.2	Range:		Range:	
11. Width of Flood Prone Area (Wfpa) ft	Mean:	200.0	Mean:	200.0	Mean:	70.5
	Range:	200.0	Range:		Range:	
12. Entrenchment Ratio (Wfpa/Wbkf)	Mean:	6.5	Mean:	6.5	Mean:	1.4
	Range:		Range:		Range:	
13. Meander Length (Lm) ft	Mean:	4,618.0	Mean:	4,618.0	Mean:	
	Range:	4,464.0 - 4,771.0	Range:	4,464.0 - 4,771.0	Range:	
14. Ratio of Meander Length to Bankfull Width	Mean:	179.7	Mean:	159.2	Mean:	
	Range:	173.7 - 185.6	Range:	153.9 - 164.5	Range:	
15. Raduis of Curvature (Rc) ft	Mean:	2,693.0	Mean:	2,693.0	Mean:	
	Range:	1,275.0 - 3,800.0	Range:	1,275.0 - 3,800.0	Range:	
16. Ratio of Radius of Curvature to Bankfull Width	Mean:	104.8	Mean:	92.9	Mean:	
	Range:	49.6 - 147.8	Range:	44.0 - 131.0	Range:	
17. Belt Width (Wblt) ft	Mean:	639.0	Mean:	639.0	Mean:	
	Range:	48.0 - 1.566.0	Range:	48.0 - 1,566.0	Range:	
18. Meander Width Ratio (Wblt/Wbkf)	Mean:	24.9	Mean:	22.0	Mean:	
	Range:	1.9 - 60.9	Range:	1.7 - 54.0	Range:	
19. Sinuosity (Stream length/valley distance) (k)	Mean:	1.04	Mean:	1.04	Mean:	
	Range:		Range:		Range:	
20. Valley Slope (ft/ft)	Mean:	0.00167	Mean:	0.00167	Mean:	
	Range:		Range:		Range:	
21. Average Water Surface Slope or Bankful Slope for	Mean:	0.0013	Mean:	0.0013	Mean:	0.0032
	Range:		Range:		Range:	
22. Pool Slope (Spool) ft / ft	Mean:	N/A	Mean:	0.0	Mean:	
	Range:		Range:		Range:	
23. Ratio of Pool Slope to Average Slope (Spool/Sbkf)	Mean:	N/A	Mean:	0.0	Mean:	
	Range:		Range:		Range:	
24. Maximum Pool Depth (dpool) ft	Mean:	N/A	Mean:	7.8	Mean:	
	Range:		Range:	7.5 - 8.0	Range:	
25. Ratio of Maximum Pool Depth to Bankfull Mean	Mean:	N/A	Mean:	3.1	Mean:	
	Range:		Range:	3.0 - 3.2	Range:	
26. Pool Width (Wpool) ft	Mean:	N/A	Mean:	29.0	Mean:	
	Range:		Range:	25.1 - 33.0	Range:	

TABLE 4B
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL
WITH GAGE STATION
(Adapted from Rosgen, 1996)

Restoration Site: Fifth Creek upstream Beaver Creek, Five Mile Branch Site,(near Statesville),Iredell County, NC
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel		Proposed Reach		USGS Gage Station
27. Ratio of Pool Width to Bankfull Width	Mean:	N/A	Mean:	1.0	Mean:
	Range:		Range:	0.9 - 1.1	Range:
28. Bankfull Cross-sectional Area at Pool (Apool) sq ft	Mean:	N/A	Mean:	119.7	Mean:
	Range:		Range:	104.5 - 144.7	Range:
29. Ratio of Pool Area to Bankfull Area (Apool/Abkf)	Mean:	N/A	Mean:	1.0	Mean:
	Range:		Range:	0.9 - 1.2	Range:
30. Pool to Pool Spacing (p-p) ft	Mean:	N/A	Mean:	297.0	Mean:
	Range:		Range:	272.0 - 322.0	Range:
31. Ratio of Pool-to-Pool Spacing to Bankfull Width	Mean:	N/A	Mean:	10.2	Mean:
	Range:		Range:	9.4 - 11.1	Range:
32. Pool Length (Lp) ft	Mean:	N/A	Mean:	112.8	Mean:
	Range:		Range:	81.2 - 144.3	Range:
33. Ratio of Pool Length to Bankfull Width (Lp/Wbkf)	Mean:	N/A	Mean:	3.9	Mean:
	Range:		Range:	2.8 - 5.0	Range:
34. Riffle Slope (Sriff) ft / ft	Mean:	0.001	Mean:	0.001	Mean:
	Range:	0.0009 - 0.0011	Range:	0.0009 - 0.0011	Range:
35. Ratio of Riffle Slope to Average Slope (Sriff/Sbkf)	Mean:	0.8	Mean:	0.8	Mean:
	Range:	0.7 - 0.8	Range:	0.7 - 0.8	Range:
36. Maximum Riffle Depth (driff) ft	Mean:	7.6	Mean:	7.4	Mean:
	Range:	7.4 - 7.8	Range:	6.4 - 8.3	Range:
37. Ratio of Riffle Depth to Bankfull Mean Depth	Mean:	1.7	Mean:	1.8	Mean:
	Range:	1.6 - 1.7	Range:	1.6 - 2.0	Range:
38. Run Slope (Srun) ft / ft	Mean:	N/A	Mean:	0.0043	Mean:
	Range:		Range:	0.0 - 0.0127	Range:
39. Ratio of Run Slope to Average Slope (Srun/Sbkf)	Mean:	N/A	Mean:	2.0	Mean:
	Range:		Range:	0 - 5.9	Range:
40. Maximum Run Depth (drun) ft	Mean:	N/A	Mean:	4.9	Mean:
	Range:		Range:	4.8 - 5.1	Range:
41. Ratio of Run Depth to Bankfull Mean Depth	Mean:	N/A	Mean:	1.2	Mean:
	Range:		Range:		Range:
42. Slope of Glide (Sgl) ft / ft	Mean:	N/A	Mean:	0.0017	Mean:
	Range:		Range:	0.0 - 0.0032	Range:
43. Ratio of Glide Slope to Average Water Surface	Mean:	N/A	Mean:	0.8	Mean:
	Range:		Range:	0.0 - 1.5	Range:
44. Maximum Glide Depth (dgl) ft	Mean:	N/A	Mean:	5.4	Mean:
	Range:		Range:	4.9 - 5.8	Range:
45. Ratio of Glide Depth to Bankfull Mean Depth	Mean:	N/A	Mean:	1.3	Mean:
	Range:		Range:	1.2 - 1.4	Range:
46. Step Slope (Sst)	Mean:	N/A	Mean:	N/A	Mean:
	Range:		Range:		Range:
47. Ratio of Step Slope to Average Water Surface	Mean:	N/A	Mean:	N/A	Mean:
	Range:		Range:		Range:
48. Maximum Step Depth (dst)	Mean:	N/A	Mean:	N/A	Mean:
	Range:		Range:		Range:
49. Ratio of Step Depth to Bankfull Mean Depth	Mean:	N/A	Mean:	N/A	Mean:
	Range:		Range:		Range:

TABLE 4B
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL
WITH GAGE STATION
(Adapted from Rosgen, 1996)

Restoration Site: Fifth Creek upstream Beaver Creek, Five Mile Branch Site,(near Statesville),Iredell County, NC
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel		Proposed Reach		USGS Gage Station
Materials:					
Particle Size Distribution of Channel Material (mm)					
D16	N/A		Expected to		
D35	0.1		Coarsen		
D50	0.2				
D84	1.0				
D95	7.0				
Particle Size Distribution of Bar Material	P	SP			
D16	N/A	N/A			
D35	6.8	N/A			
D50	18	N/A			
D84	42.6	6.1			
D95	56.4	15.1			
Largest Size Particle on Bar	60				

Sediment Transport:		
Sediment Transport Validation (Based on Bankfull Shear Stress)	**Existing**	**Proposed**
Calculated value (mm) from curve	28	17
Value from Shields Curve (lb/ft2)	0.38	0.3

TABLE 4C
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION

(Adapted from Rosgen, 1996)

Restoration Site: Fifth Creek Swann Road to End, Five Mile Branch Site, near Statesville, Iredell County, N
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel	Proposed Reach	USGS Gage Station
1. Stream Type	E5	E5	B
2. Drainage Area (sq. mi)	26.05	26.05	25.7
3. Bankfull Width (Wbkf) ft	Mean: 35.6 Range: 27.9 - 44.1	Mean: 33.4 Range: 26.3 - 40.8	Mean: 51 Range:
4. Bankfull Mean Depth (dbkf) ft	Mean: 5.3 Range: 4.5 - 6.8	Mean: 4.7 Range: 4.0 - 5.7	Mean: 2.7 Range:
5. Width/Depth Ratio (Wbkf/dbkf)	Mean: 6.6 Range: 4.7 - 8.2	Mean: 7.1 Range: 5.2 - 8.8	Mean: 18.8 Range:
6. Bankfull Cross-Sectional Area (Abkf) sq ft	Mean: 202.5 Range: 192.6 - 222.2	Mean: 157.8 Range: 120.3 - 202.7	Mean: 139.3 Range:
7. Bankfull Mean Velocity (Vbkf) fps	Mean: 5.2 Range:	Mean: 3.9 Range:	Mean: 3.9 Range:
8. Bankfull Discharge (Qbkf) cfs	Mean: 1166.3 Range:	Mean: 1166.3 Range:	Mean: 539.9 Range:
9. Maximum Bankfull Depth (dmax) ft	Mean: 7.6 Range: 5.8 - 9.3	Mean: 6.5 Range: 5.1 - 7.8	Mean: 3.3 Range:
10. Ratio of Low Bank Height to Max. Bankfull	Mean: 1.5 Range: 1.3 - 1.7	Mean: 1.0 Range:	Mean: 1.4 Range:
11. Width of Flood Prone Area (Wfpa) ft	Mean: 316.7 Range: 250 - 400.0	Mean: >200 Range:	Mean: 70.5 Range:
12. Entrenchment Ratio (Wfpa/Wbkf)	Mean: 8.6 Range: 7.1 - 10.8	Mean: >6.5 Range:	Mean: 1.4 Range:
13. Meander Length (Lm) ft	Mean: 4618 Range: 4,464.0 - 4,771.0	Mean: 4,618.0 Range: 4,464.0 - 4,771.0	Mean: Range:
14. Ratio of Meander Length to Bankfull Width (Lm/Wbkf)	Mean: 125.8 Range: 121.6 - 130.0	Mean: 138.3 Range: 133.6 - 142.8	Mean: Range:
15. Raduis of Curvature (Rc) ft	Mean: 2693 Range: 1,275.0 - 3,800.0	Mean: 2,693.0 Range: 1,275.0 - 3,800.0	Mean: Range:
16. Ratio of Radius of Curvature to Bankfull Width	Mean: 73.4 Range: 34.7 - 103.5	Mean: 80.6 Range: 38.2 - 113.8	Mean: Range:
17. Belt Width (Wblt) ft	Mean: 639.0 Range: 48.0 - 1,566.0	Mean: 639.0 Range: 48.0 - 1,566.0	Mean: Range:
18. Meander Width Ratio (Wblt/Wbkf)	Mean: 17.4 Range: 1.3 - 42.7	Mean: 19.1 Range: 1.4 - 46.9	Mean: Range:
19. Sinuosity (Stream length/valley distance) (k)	Mean: 1.04 Range:	Mean: 1.04 Range:	Mean: Range:
20. Valley Slope (ft/ft)	Mean: 0.00167 Range:	Mean: 0.00167 Range:	Mean: Range:
21. Average Water Surface Slope or Bankful Slope for	Mean: 0.0016 Range:	Mean: 0.0013 Range:	Mean: 0.0032 Range:
22. Pool Slope (Spool) ft / ft	Mean: 0.0035 Range: 0.0 - 0.0117	Mean: 0.0 Range:	Mean: Range:
23. Ratio of Pool Slope to Average Slope (Spool/Sbkf)	Mean: 2.2 Range: 0.0 - 7.3	Mean: 0.0 Range:	Mean: Range:
24. Maximum Pool Depth (dpool) ft	Mean: 9.5 Range: 8.0 - 11.4	Mean: 7.8 Range: 7.5 - 8.0	Mean: Range:
25. Ratio of Maximum Pool Depth to Bankfull Mean	Mean: 1.7 Range: 1.4 - 2.1	Mean: 1.7 Range: 1.6 - 1.7	Mean: Range:
26. Pool Width (Wpool) ft	Mean: 32.8 Range:	Mean: 32.8 Range:	Mean: Range:

TABLE 4C
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION

(Adapted from Rosgen, 1996)

Restoration Site: Fifth Creek Swann Road to End, Five Mile Branch Site, near Statesville, Iredell County, N
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel		Proposed Reach		USGS Gage Station
27. Ratio of Pool Width to Bankfull Width	Mean:	0.9	Mean:	1.0	Mean:
	Range:		Range:		Range:
28. Bankfull Cross-sectional Area at Pool (Apool) sq ft	Mean:	199.0	Mean:	157.8	Mean:
	Range:		Range:	120.3 - 202.7	Range:
29. Ratio of Pool Area to Bankfull Area (Apool/Abkf)	Mean:	1.0	Mean:	1.0	Mean:
	Range:		Range:	0.8 - 1.3	Range:
30. Max Pool to Max Pool Spacing (p-p) ft	Mean:	256.3	Mean:	297.0	Mean:
	Range:	62.3 - 1,206.3	Range:	272.0 - 322.0	Range:
31. Ratio of Pool-to-Pool Spacing to Bankfull Width (p-	Mean:	7.0	Mean:	8.9	Mean:
	Range:	1.7 - 32.9	Range:	8.1 - 9.6	Range:
32. Pool Length (Lp) ft	Mean:	30.0	Mean:	112.8	Mean:
	Range:	15.2 - 69.8	Range:	81.2 - 144.3	Range:
33. Ratio of Pool Length to Bankfull Width (Lp/Wbkf)	Mean:	0.8	Mean:	3.3	Mean:
	Range:	0.4 - 1.9	Range:	2.4 - 4.3	Range:
34. Riffle Slope (Sriff) ft / ft	Mean:	0.0017	Mean:	0.0026	Mean:
	Range:	0.0 - 0.0043	Range:	0.0022 - 0.0030	Range:
35. Ratio of Riffle Slope to Average Slope (Sriff/Sbkf)	Mean:	1.1	Mean:	1.2	Mean:
	Range:	0.0 - 2.7	Range:	1.0 - 1.4	Range:
36. Maximum Riffle Depth (driff) ft	Mean:	7.1	Mean:	6.5	Mean:
	Range:	5.8 - 9.1	Range:	5.1 - 7.8	Range:
37. Ratio of Riffle Depth to Bankfull Mean Depth	Mean:	1.3	Mean:	1.4	Mean:
	Range:	1.0 - 1.6	Range:	1.1 - 1.7	Range:
38. Run Slope (Srun) ft / ft	Mean:	0.0161	Mean:	0.0043	Mean:
	Range:	0.0035 - 0.0250	Range:	0.0 - 0.0127	Range:
39. Ratio of Run Slope to Average Slope (Srun/Sbkf)	Mean:	10.1	Mean:	2.0	Mean:
	Range:	2.2 - 15.6	Range:	0 - 5.9	Range:
40. Maximum Run Depth (drun) ft	Mean:	6.7	Mean:	4.9	Mean:
	Range:	4.8 - 8.1	Range:	4.8 - 5.1	Range:
41. Ratio of Run Depth to Bankfull Mean Depth	Mean:	1.2	Mean:	1.0	Mean:
	Range:	0.9 - 1.5	Range:	1.0 - 1.1	Range:
42. Slope of Glide (Sgl) ft / ft	Mean:	0.0011	Mean:	0.0017	Mean:
	Range:	0.0 - 0.0062	Range:	0.0 - 0.0032	Range:
43. Ratio of Glide Slope to Average Water Surface Slope	Mean:	0.7	Mean:	0.8	Mean:
	Range:	0.0 - 3.9	Range:	0.0 - 1.5	Range:
44. Maximum Glide Depth (dgl) ft	Mean:	8.0	Mean:	5.4	Mean:
	Range:	6.9 - 10.3	Range:	4.9 - 5.8	Range:
45. Ratio of Glide Depth to Bankfull Mean Depth	Mean:	1.4	Mean:	0.9	Mean:
	Range:	1.2 - 1.9	Range:	1.0 - 1.2	Range:
46. Step Slope (Sst)	Mean:	N/A	Mean:	N/A	Mean:
	Range:		Range:		Range:
47. Ratio of Step Slope to Average Water Surface Slope	Mean:	N/A	Mean:	N/A	Mean:
	Range:		Range:		Range:
48. Maximum Step Depth (dst)	Mean:	N/A	Mean:	N/A	Mean:
	Range:		Range:		Range:
49. Ratio of Step Depth to Bankfull Mean Depth	Mean:	N/A	Mean:	N/A	Mean:
	Range:		Range:		Range:

TABLE 4C
MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION

(Adapted from Rosgen, 1996)

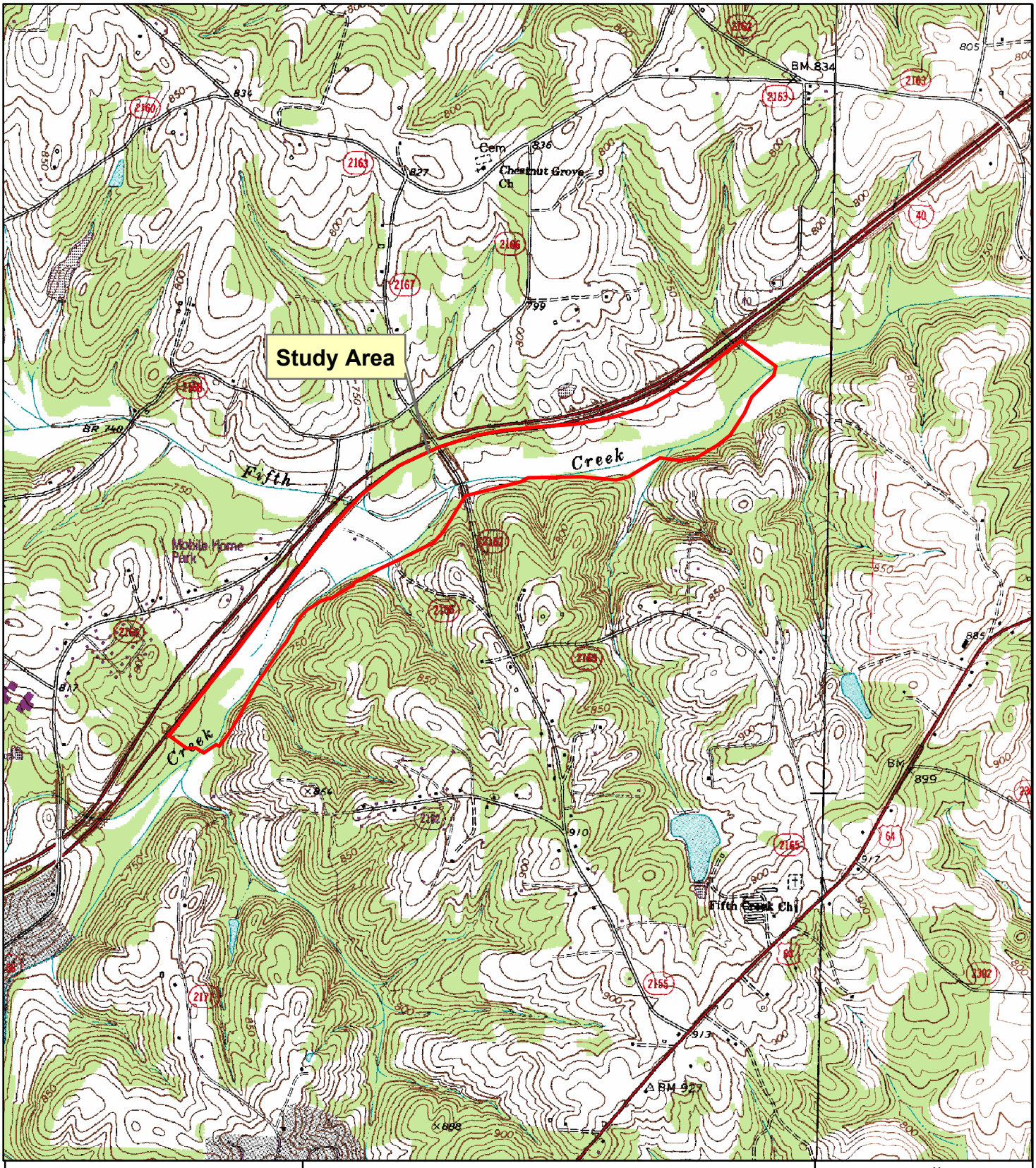
Restoration Site: Fifth Creek Swann Road to End, Five Mile Branch Site, near Statesville, Iredell County, N
USGS Gage Station: #02143040 Jacob Fork, Burke County, NC

Variables	Existing Channel		Proposed Reach		USGS Gage Station
Materials:					
Particle Size Distribution of Channel Material (mm)					
D16	N/A		Expected to		
D35	0.1		Coarsen		
D50	0.2				
D84	1.0				
D95	7.0				
Particle Size Distribution of Bar Material	P	SP			
D16	N/A	N/A			
D35	6.8	N/A			
D50	18	N/A			
D84	42.6	6.1			
D95	56.4	15.1			
Largest Size Particle on Bar					

Sediment Transport:		
Sediment Transport Validation (Based on Bankfull Shear Stress)	**Existing**	**Proposed**
Calculated value (mm) from curve	35	20
Value from Shields Curve (lb/ft2)	0.46	0.35

Table 5. BEHI and Sediment Export Estimates for Project Site Streams															
Five Mile Branch/Project #															
Time Point	**Segment/Reach**	**Linear Footage (left bank)**	**Extreme**		**Very High**		**High**		**Moderate**		**Low**		**Very Low**		**Sediment Export**
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	ton/yr
Preconstruction	Beaver Creek	1000	360.0	36.0	313.0	31.3	327.0	32.7							380.0
	Fifth Creek u/s	1000	100.0	10.0	220.0	22.0	130.0	13.0	150.0	15.0	400.0	40.0			140.0
	Fifth Creek d/s	1000	285.0	28.5	455.0	35.5	260.0	26.0							340.0
	Project Total	3000	745.0	24.9	988.0	32.9	717.0	23.9	150.0	5.0	400.0	13.3			860.0

Figures



0 1,500 3,000 6,000 Feet

SCALE: 1:24,000

Source: USGS Quadrangle Maps Statesville East and Cool Springs, NC

N W E S

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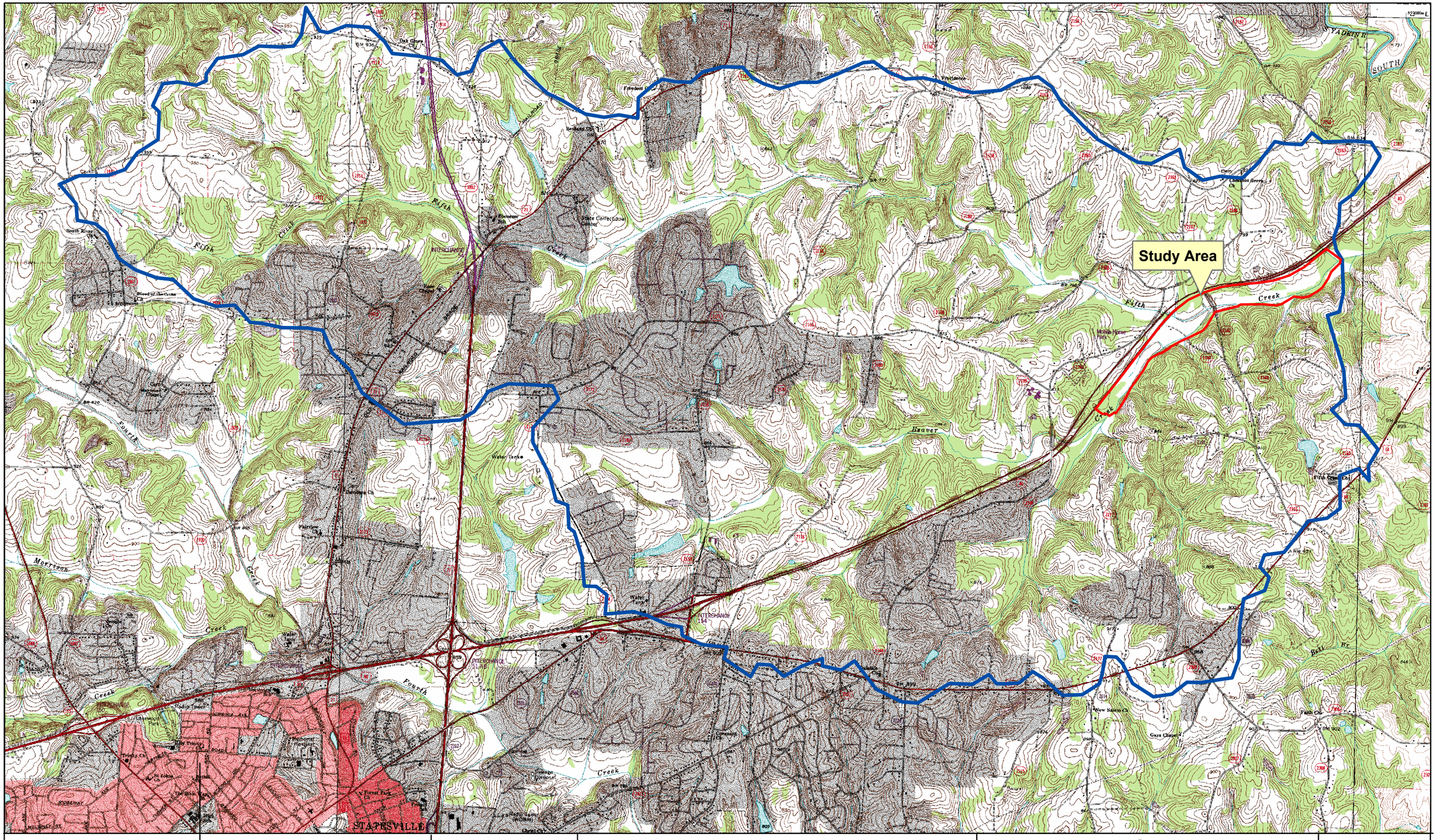
Ecosystem Enhancement Program

VICINITY MAP

Five Mile Branch
Stream and Wetland Restoration Site
Iredell County, North Carolina

Figure No.

1



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N

W E

S

0 1,500 3,000 6,000 Feet

SCALE: 1:39,000

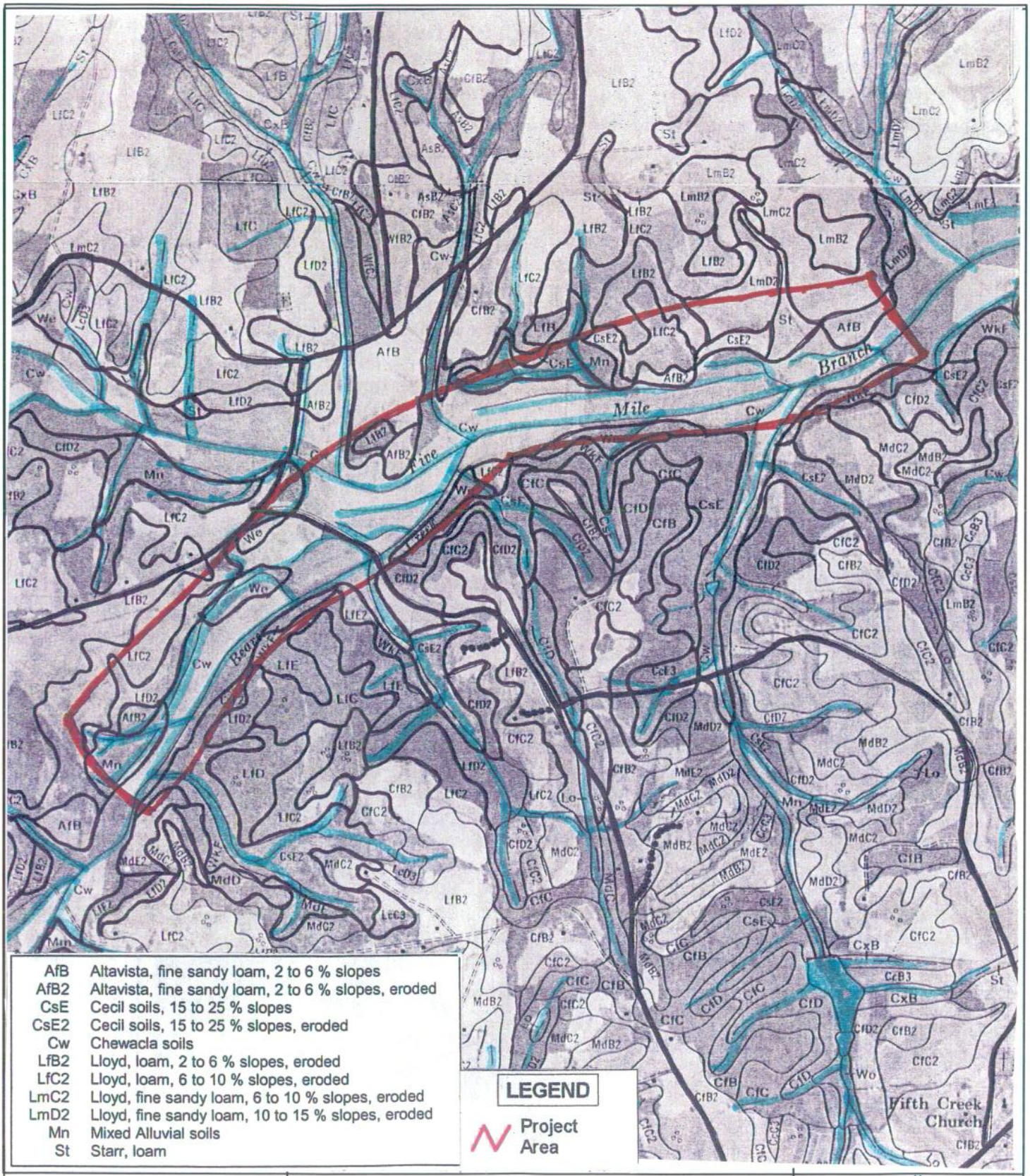
Source: USGS Quadrangle Maps Statesville East and Cool Springs, NC

WATERSHED MAP

Five Mile Branch
Stream and Wetland Restoration Site
Iredell County, North Carolina

Figure No.

2



AfB	Altavista, fine sandy loam, 2 to 6 % slopes
AfB2	Altavista, fine sandy loam, 2 to 6 % slopes, eroded
CsE	Cecil soils, 15 to 25 % slopes
CsE2	Cecil soils, 15 to 25 % slopes, eroded
Cw	Chewacla soils
LfB2	Lloyd, loam, 2 to 6 % slopes, eroded
LfC2	Lloyd, loam, 6 to 10 % slopes, eroded
LmC2	Lloyd, fine sandy loam, 6 to 10 % slopes, eroded
LmD2	Lloyd, fine sandy loam, 10 to 15 % slopes, eroded
Mn	Mixed Alluvial soils
St	Starr, loam

NO SCALE

Source: Soil Survey of Iredell County North Carolina

N
W E
S

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Soil Units

Five Mile Branch
Stream and Wetland Restoration Site
Iredell County, North Carolina

Figure No.

3

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Scale: 1:8,500

0 500 1,000 Feet

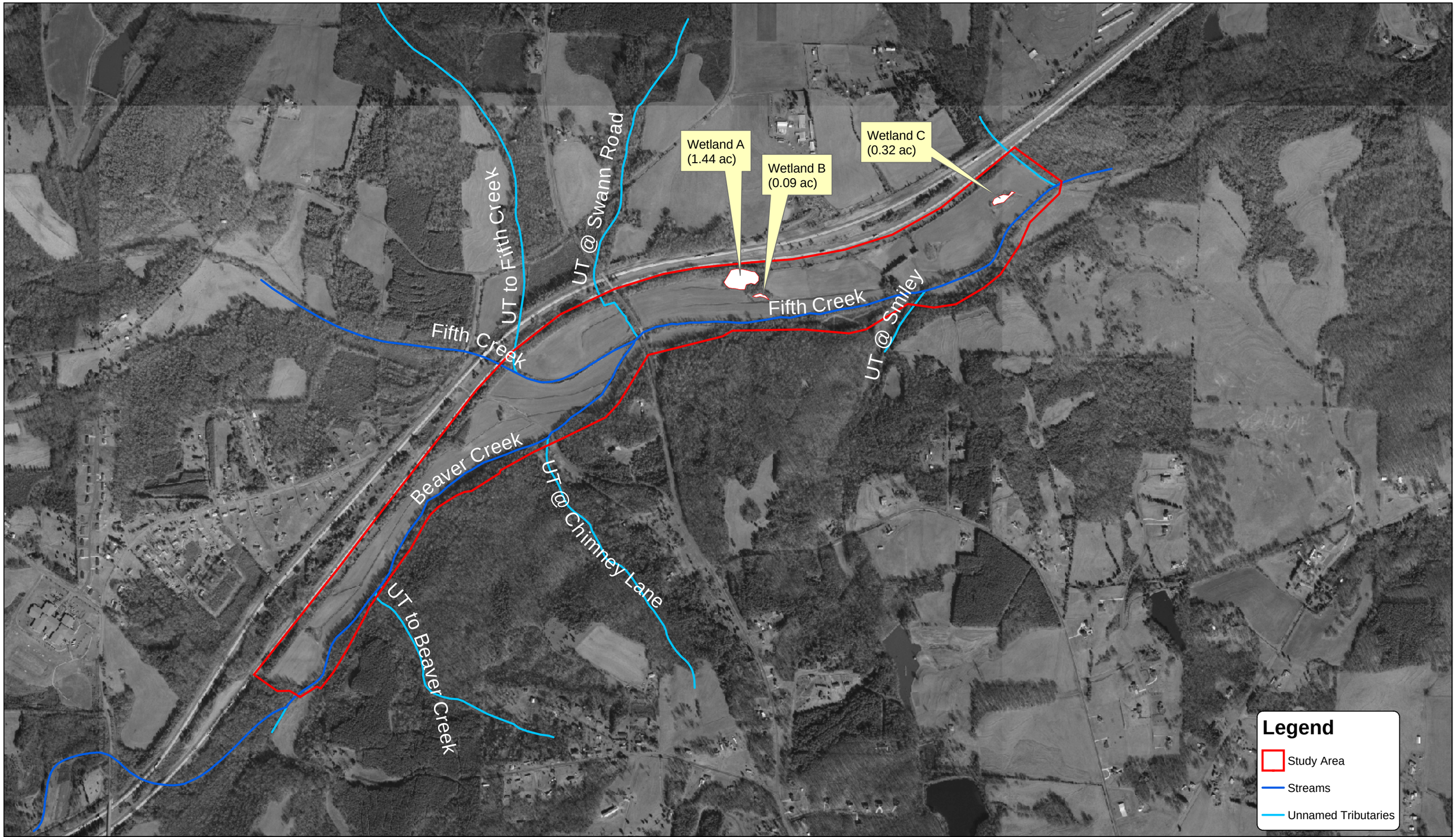
Source: Iredell County GIS (2002)

N
W E
S

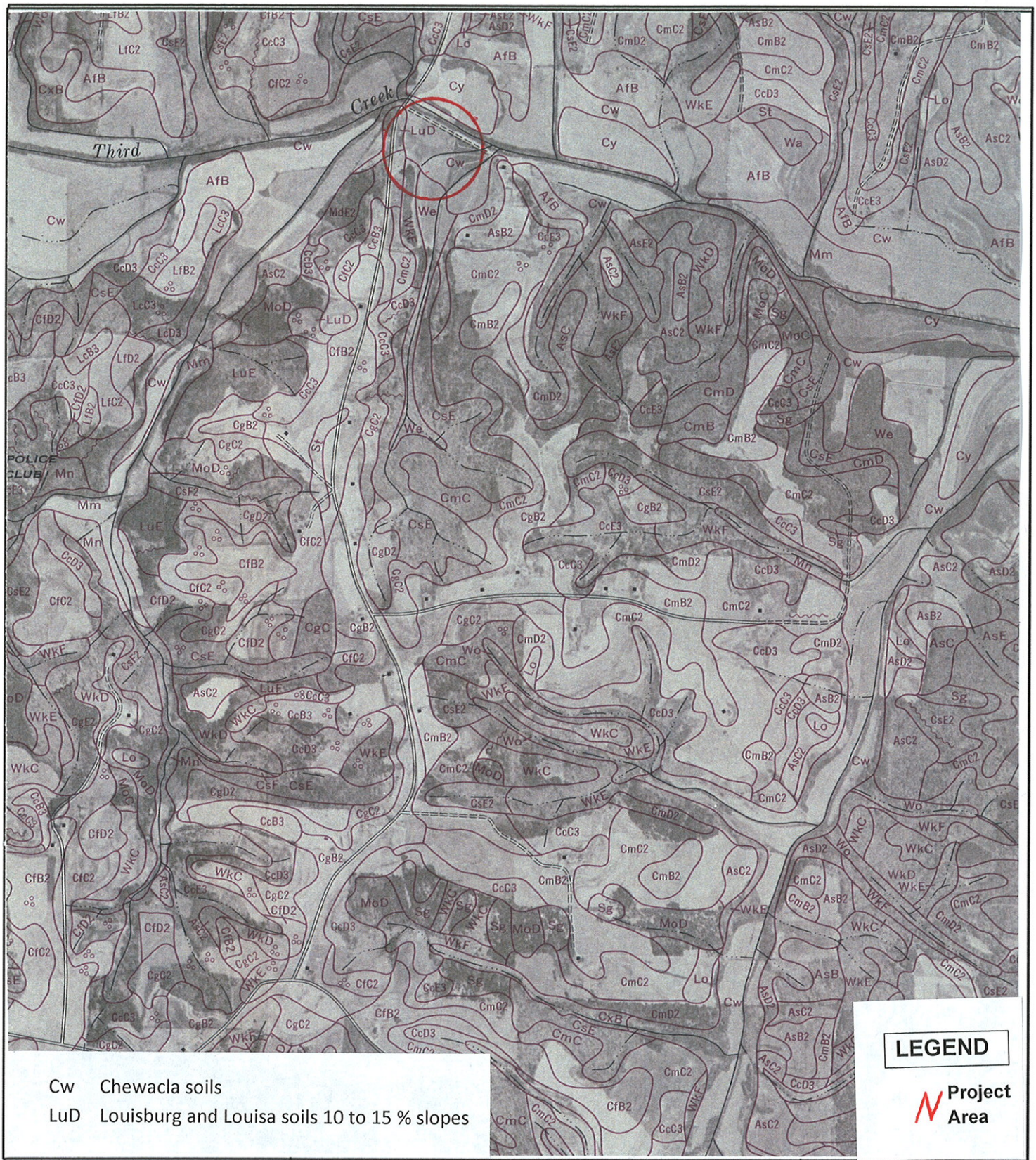
Hydrologic Features and Gauge Locations
Five Mile Branch
Stream and Wetland Restoration Site
Iredell County, North Carolina

Figure No.

4



Prepared For Ecosystem Enhancement Program	Scale: 1:12,000 0 500 1,000 Feet	**Source: Iredell County GIS (2002)**	2	**Project Site Wetland Delineation Map** **Five Mile Branch** **Stream and Wetland Restoration Site** **Iredell County, North Carolina**	**Figure No.** **5**



Cw Chewacla soils

LuD Louisburg and Louisa soils 10 to 15 % slopes

LEGEND

Project Area

SCALE: 1:15,840

Source: Soil Survey of Iredell County North Carolina, June 1964

N W E S

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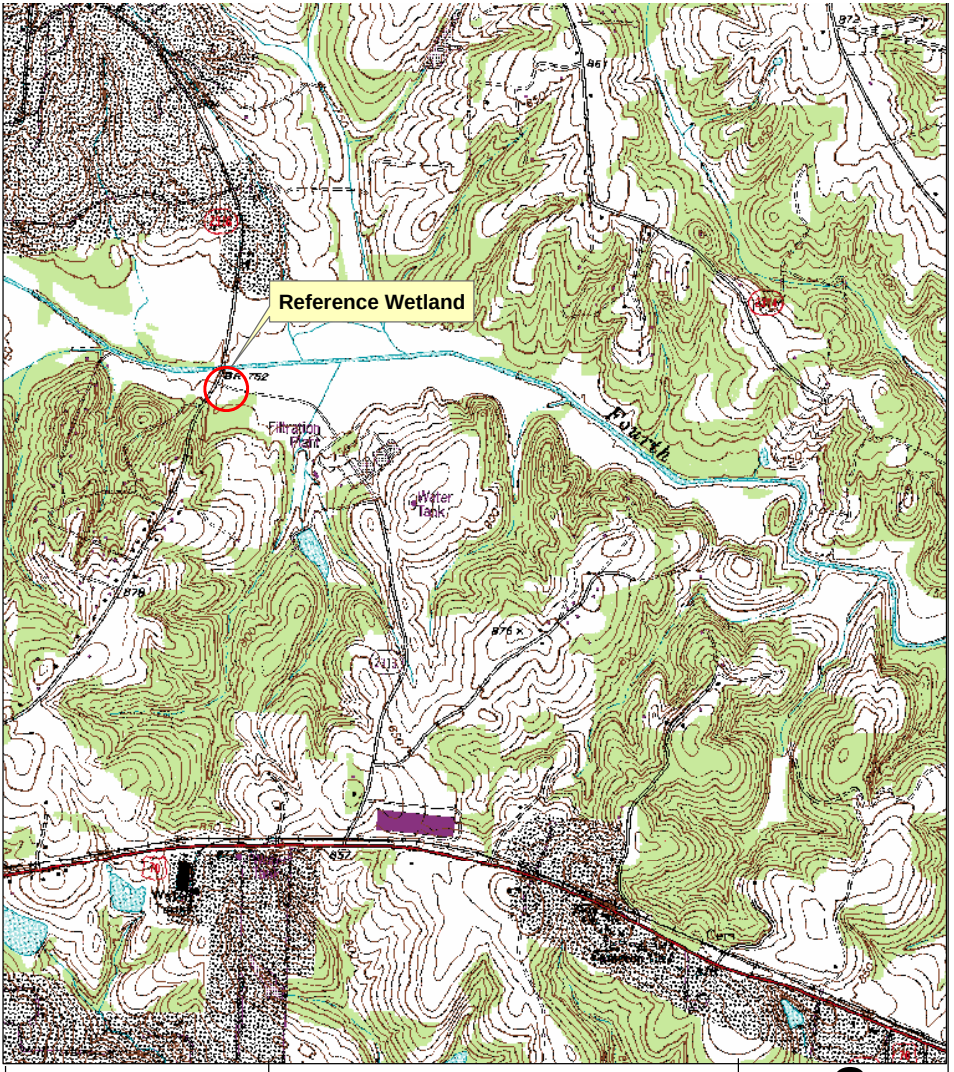
Ecosystem Enhancement Program

Reference Wetland Soils

Five Mile Branch
Stream and Wetland Restoration Site
Iredell County, North Carolina

Figure No.

6



0 1,000 2,000 4,000 Feet

SCALE:1:20,000

Source: USGS Quadrangle Maps Statesville East and Cool Springs, NC

2

Prepared For

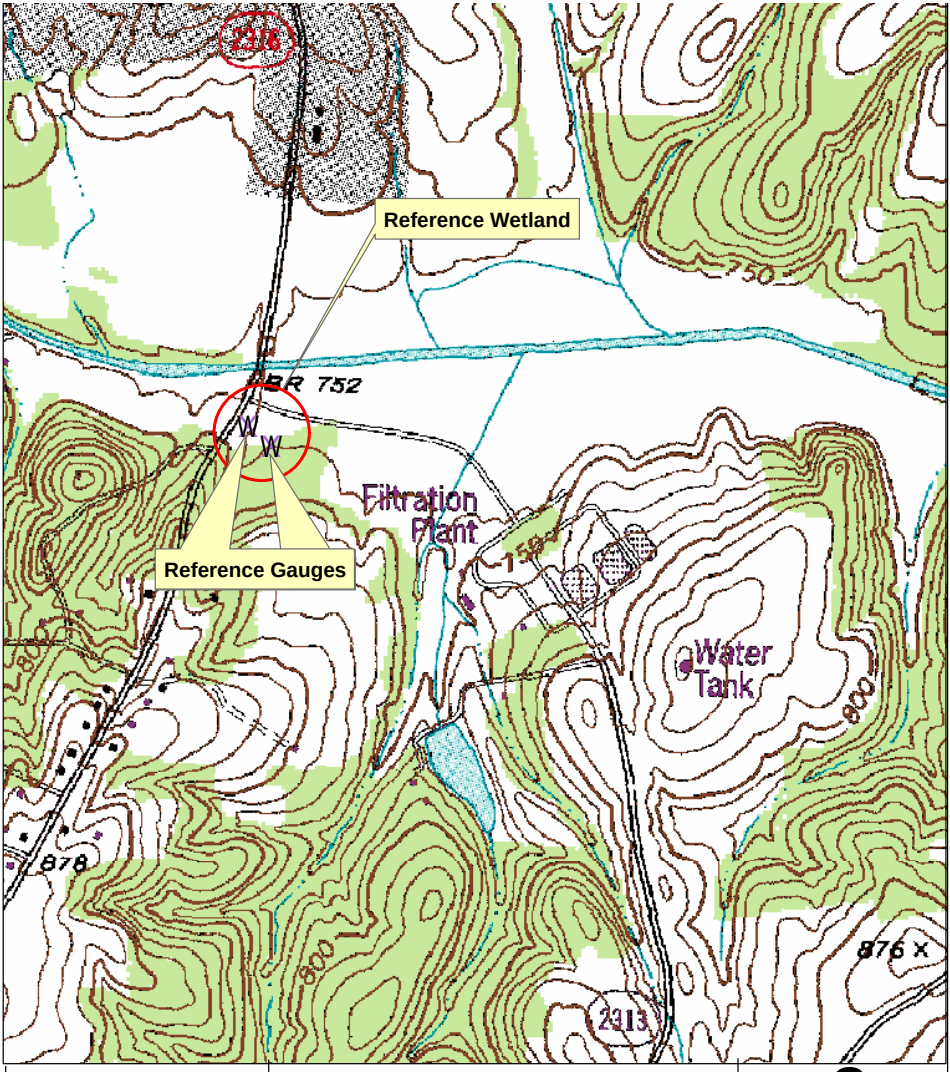
Ecosystem Enhancement Program

Reference Site Vicinity Map

Five Mile Branch
Stream and Wetland Restoration Site
Iredell County, North Carolina

Figure No.

7



0 500 1,000 2,000 Feet

SCALE: 1:9,000

Source: USGS Quadrangle Maps Statesville East and Cool Springs, NC

2

Prepared For

Ecosystem Enhancement Program

Reference Wetland Gauge Locations

Five Mile Branch
Stream and Wetland Restoration Site
Iredell County, North Carolina

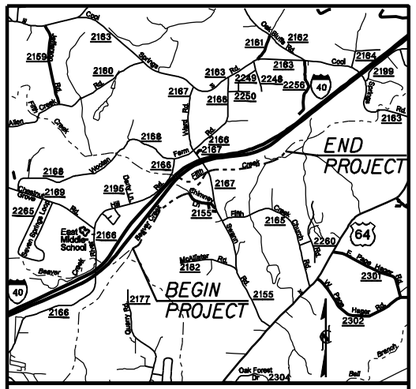
Figure No.

8

Design Sheets

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

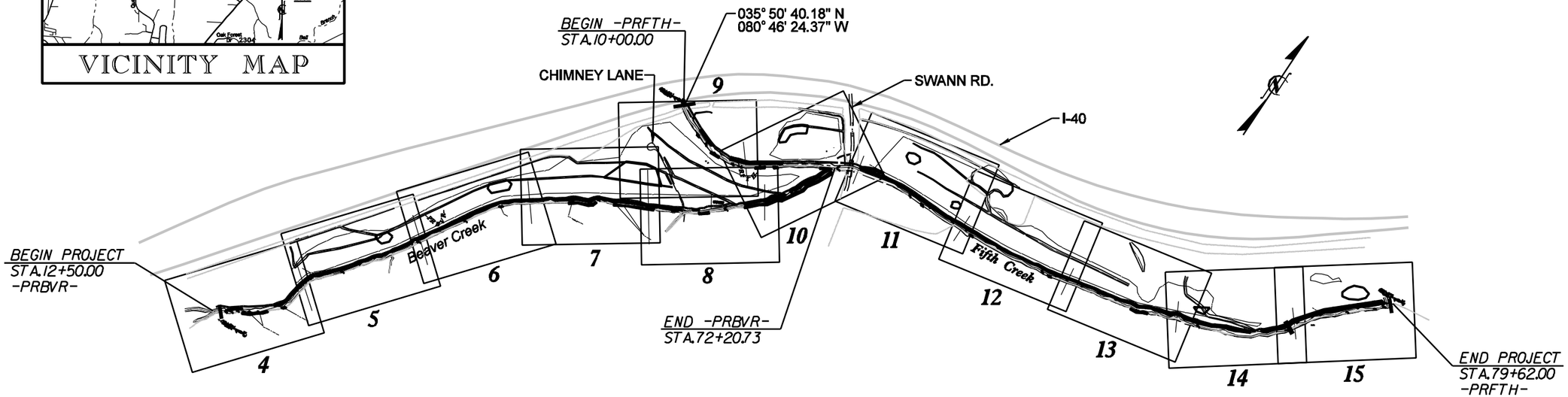
IREDELL COUNTY



VICINITY MAP

LOCATION: FIVE-MILE BRANCH MITIGATION SITE

TYPE OF WORK: NATURAL CHANNEL DESIGN STREAM AND WETLAND RESTORATION
SCO# 040607901



NCEEP PROJECT MANAGER - PAUL WIESNER
NCEEP REVIEW COORDINATOR - LIN XU
ARCADIS PROJECT MANAGER - ROBERT LEPSIC

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

SCO # 040607901

ARCADIS C&M
Date:$DATE$ Time: $TIME$
Filename:$FILE$

GRAPHIC SCALES

40 20 0 40 80
PLANS

40 20 0 40 80
PROFILE (HORIZONTAL)

0
PROFILE (VERTICAL)

DESIGN DATA

SEE SHEET 2-C FOR GEOMORPHOLOGICAL TABLE

PROPOSED STREAM LENGTHS

STREAM PRESERVATION	=	*890'*
BEAVER CREEK (-PRBVR-)	=	*6220' ENHANCEMENT LEVEL I/II*
FIFTH CREEK (-PRFTH-)	=	*6050' ENHANCEMENT LEVEL I/II*
TOTAL LENGTH OF STREAM ENHANCEMENT	=	*12,270'*

PROPOSED WETLAND ACERAGE

BOTTOMLAND HARDWOOD FOREST	*=66.10 ACRES RESTORATION*
	=1.90 ACRES PRESERVATION

Prepared In The Office of:
ARCADIS
G & M of North Carolina, Inc.
WWW.ARCADIS-US.COM
801 Corporate Center Drive, Suite 300
Raleigh, NC 27607-5073
Tel: 919/854-1282 Fax: 919/854-5448

for the North Carolina Department of Environment and Natural Resources

2002 STANDARD SPECIFICATIONS	*ARCADIS CONTACT*
RIGHT OF WAY DATE: N/A	ROBERT LEPSIC *PROJECT BIOLOGIST*
LETTING DATE: N/A	*PROJECT DESIGN ENGINEER*

NATURAL CHANNEL DESIGN ENGINEER

SIGNATURE: *P.E.*

LEGEND

ROADS & RELATED ITEMS

- **Prop. Woven Wire Fence**
- **Prop. Chain Link Fence**
- Prop. Barbed Wire Fence
- Existing Fence
- Exist. Guardrail
- **Prop. Guardrail**
- Equality Symbol

RIGHT OF WAY

- Right of Way Marker
- Exist. Right of Way Line w/Marker
- Prop. Right of Way Line (by others)
- Prop. Right of Way Line (by contract)
- Exist. Control of Access Line
- Prop. Control of Access Line
- Exist. Easement Line
- Prop. Temp. Construction Easement Line
- Prop. Temp. Drainage Easement Line
- Prop. Perm. Drainage Easement Line

BOUNDARIES & PROPERTIES

- Property Line Surveyed
- Property Line Not Surveyed
- Exist. Iron Pin
- Property Corner
- Property Monument
- Property Number
- Parcel Number
- Fence Line
- Silt Fence
- Existing Wetland Boundaries
- Proposed Wetland Boundaries
- Buildings
- Foundations
- Limit of Disturbance

HYDROLOGY

- Stream or Body of Water
- Flow Arrow
- Disappearing Stream
- Spring
- Falls, Rapids

UTILITIES

- Exist. Pole
- Exist. Power Pole
- Exist. Telephone Pole
- Exist. Joint Use Pole
- Deep Soil Proflie
- Monitoring Guage
- Hydrant
- Exist. Water Valve
- Sewer Clean Out
- Power Manhole
- Water Manhole
- Light Pole
- H–Frame Pole
- Power Line Tower
- Pole with Base
- Gas Valve
- Gas Meter
- Telephone Manhole
- Power Transformer
- Guy Wire Anchor
- Sanitary Sewer Manhole
- Storm Sewer Manhole
- Tank; Water, Gas, Oil
- Recorded Water Line
- Sanitary Sewer
- Recorded Sanitary Sewer Force Main
- Recorded Gas Line
- Storm Sewer
- Recorded Power Line
- Recorded Telephone Cable
- Recorded U/G Telephone Conduit
- Unknown Utility
- Recorded Television Cable
- Recorded Fiber Optics Cable
- Exist. Water Meter
- Exist. Overhead Power Line
- Exist. Underground Utilities

STRUCTURES

MAJOR

- Bridge, Tunnel, or Box Culvert
- Bridge Wing Wall, Head Wall and End Wall

MINOR

- Head & End Wall
- Pipe Culvert
- Footbridge
- Drainage Boxes

TOPOGRAPHY

- Loose Surface
- Hard Surface
- Change in Road Surface
- Curb
- Right of Way Symbol
- Guard Post
- Paved Walk
- Bridge
- Box Culvert or Tunnel
- Culvert
- Footbridge
- Trail, Footpath

STREAM IMPROVEMENTS

- Approx. Location of Proposed Boulder Cross Vane (See Detail)
- Approx. Location of Proposed Boulder J–Hook Vane (See Detail)
- Approx. Location of Proposed Boulder Vane (See Detail)
- Approx. Location of Proposed Rootwad (See Detail)
- Approx. Location of Proposed Stream Plug (See Detail)
- Approx. Location of Proposed Boulder Step Pool (See Detail)
- Approx. Location of Proposed Boulder Step Pool Drain
- Approx. Location of Proposed Log Vane (See Detail)
- Approx. Location of Proposed Constructed Riffle (See Detail)
- Proposed Oxbox Pond/Wetland (See Detail)
- Proposed Rock Check Dam

- Approximate limits of Buffer
- Existing Thalweg
- Existing Top of Bank
- Proposed Thalweg
- Proposed Bankfull
- Slope Stake Line
- Vegetation Matting
- Log Toe Protection

VEGETATION

- Existing Woods Line

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Raleigh, NC 27607-5073
Tel: 919/854-1282 Fax: 919/854-5448

DESIGN ENGINEER

5			
4			
3			
2			
1	DGL	12/04/09	DRAFT RESTORATION PLAN
	BY	DATE	DESCRIPTION OF REVISION

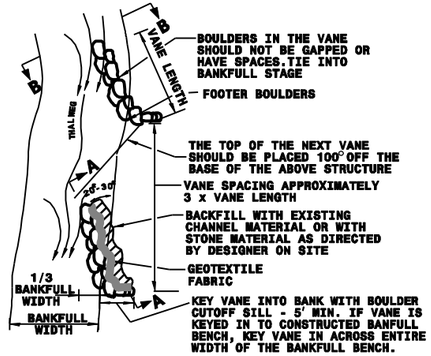
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

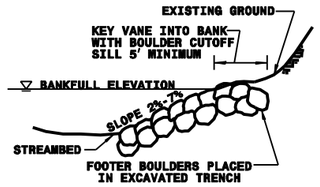
LEGEND SHEET NO. 2

Dorte\DATE\
Filenames\FILE\

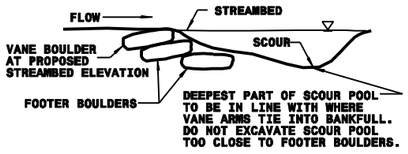
Details – Five Mile Branch



PLAN VIEW



SECTION A-A



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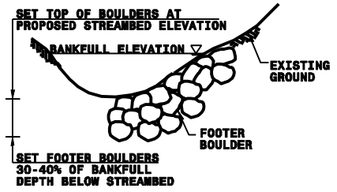
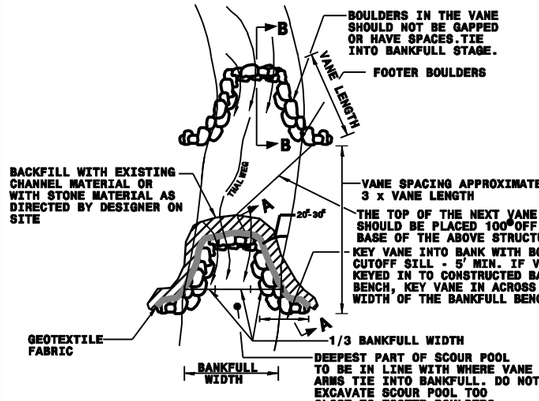


CROSS SECTION VIEW

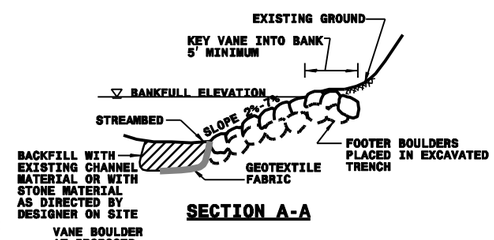
NOTE: MINIMUM BOULDER SIZE FOR IN-STREAM STRUCTURES TO BE AS FOLLOWS:
BEAVER CREEK = 2.2 CUBIC YARDS
FIFTH CREEK = 2.2 CUBIC YARDS
UT @ SWANN ROAD = 2.2 CUBIC YARDS
UT @ SMILEY = 2.2 CUBIC YARDS
UT @ CHIMNEY LANE = 0.9 CUBIC YARDS
ALL BOULDERS SHALL BE ANGULAR, FLAT WITH ONE AXIS 3 TIMES AS LONG AS THE OTHERS TO RESIST ROLLING. BOULDER SHALL BE CLEAN AND FREE OF SEDIMENT

BOULDER VANE WITH GEOTEXTILE FABRIC

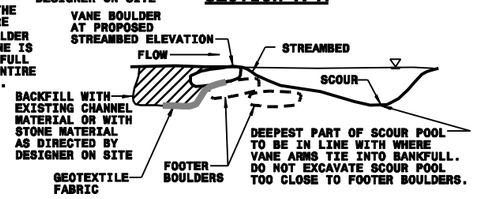
NTS



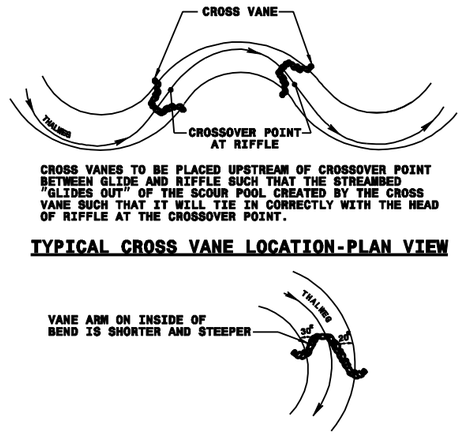
PLAN VIEW



SECTION A-A



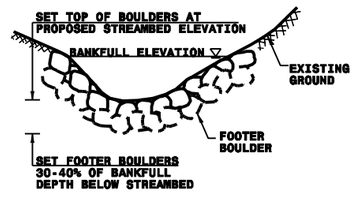
SECTION B-B



CROSS VANES TO BE PLACED UPSTREAM OF CROSSOVER POINT BETWEEN GLIDE AND RIFFLE SUCH THAT THE STREAMBED "GLIDES OUT" OF THE SCOUR POOL CREATED BY THE CROSS VANE SUCH THAT IT WILL TIE IN CORRECTLY WITH THE HEAD OF RIFFLE AT THE CROSSOVER POINT.

TYPICAL CROSS VANE LOCATION-PLAN VIEW

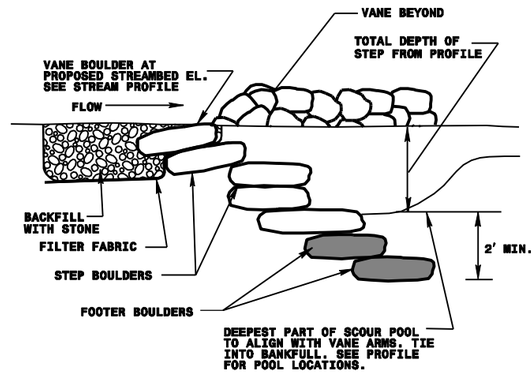
CROSS VANE CONSTRUCTION IN MEANDER-PLAN VIEW



CROSS SECTION VIEW

BOULDER CROSS VANE WITH GEOTEXTILE FABRIC

NTS



SECTION B-B
(FOR CROSS VANE AT STEP)

NOTE: MINIMUM BOULDER SIZE FOR IN-STREAM STRUCTURES TO BE AS FOLLOWS:
BEAVER CREEK = 2.2 CUBIC YARDS
FIFTH CREEK = 2.2 CUBIC YARDS
UT @ SWANN ROAD = 2.2 CUBIC YARDS
UT @ SMILEY = 2.2 CUBIC YARDS
UT @ CHIMNEY LANE = 0.9 CUBIC YARDS
ALL BOULDERS SHALL BE ANGULAR, FLAT WITH ONE AXIS 3 TIMES AS LONG AS THE OTHERS TO RESIST ROLLING. BOULDER SHALL BE CLEAN AND FREE OF SEDIMENT

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	BY	DATE	DESCRIPTION OF REVISION

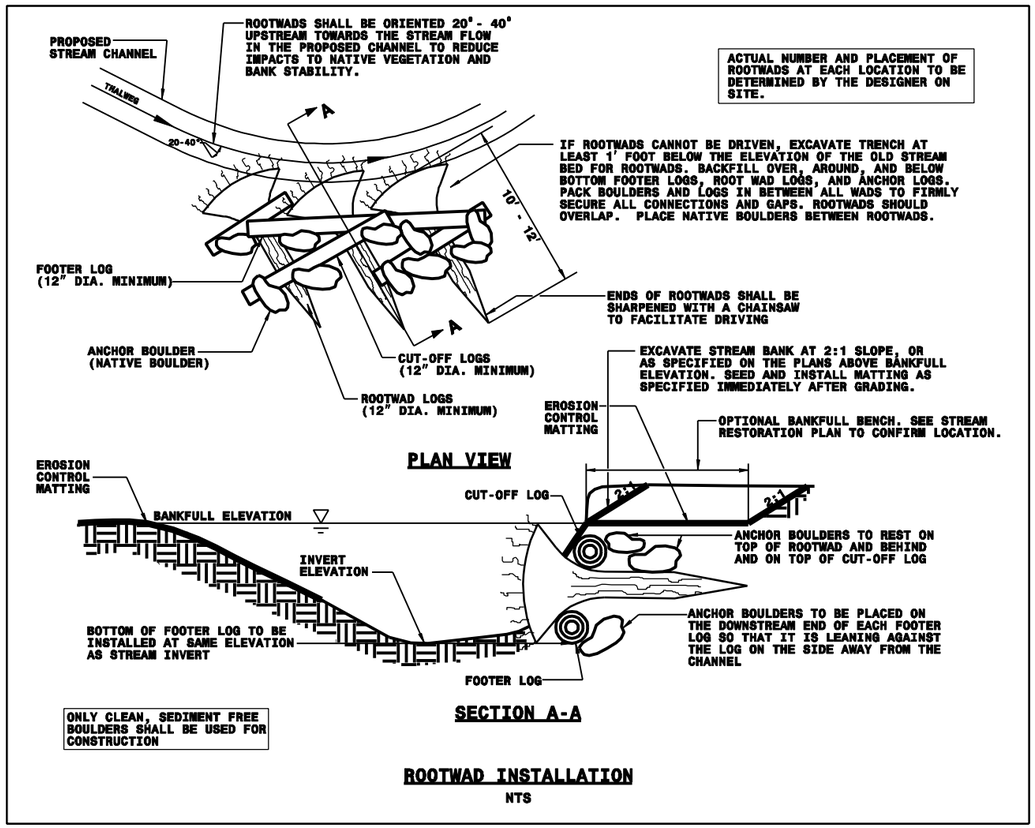
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

DETAILS SHEET NO. D1

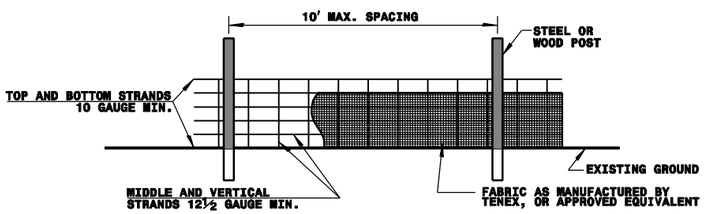
Dotes&DATE&
Filenames#FILE#

Details – Five Mile Branch



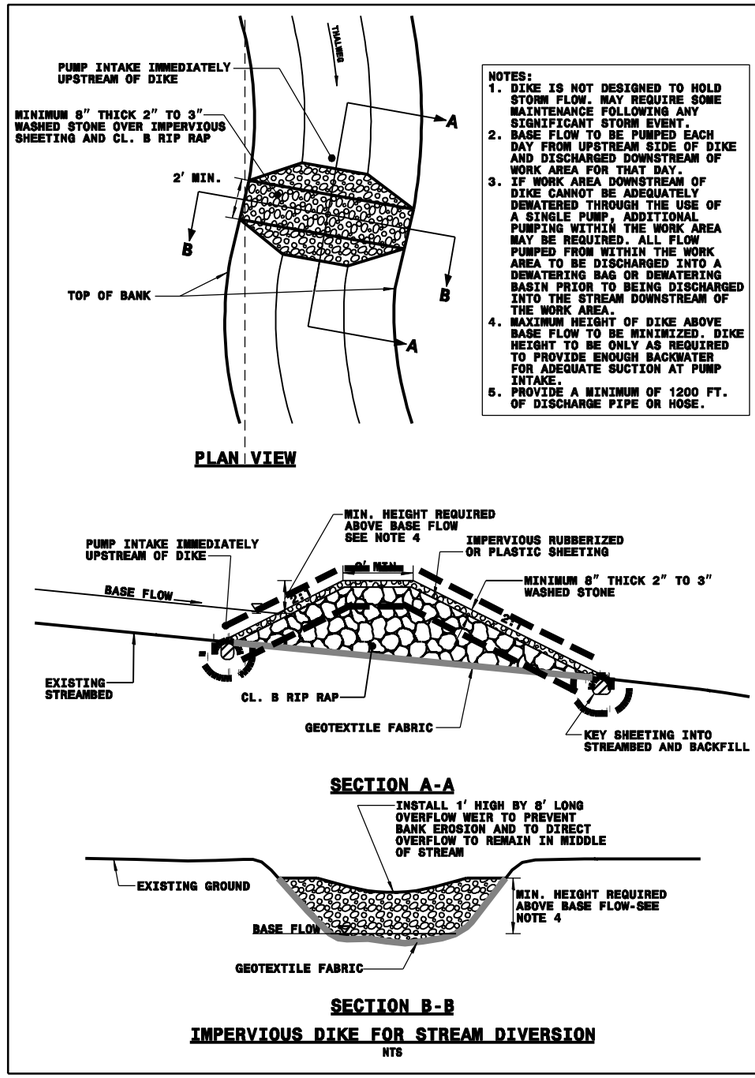
ROOTWAD INSTALLATION

NTS



TREE PROTECTION/CONSTRUCTION LIMITS FENCING

NTS



SECTION B-B

IMPERVIOUS DIKE FOR STREAM DIVERSION

NTS

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NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

DETAILS SHEET NO. D2

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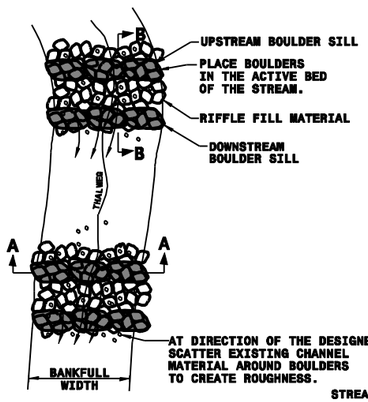
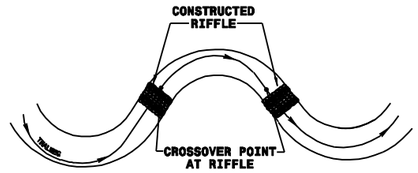
Filename:$FILE$

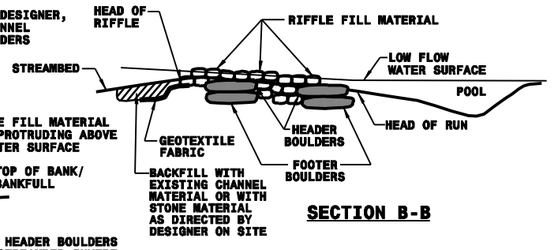


PLAN VIEW

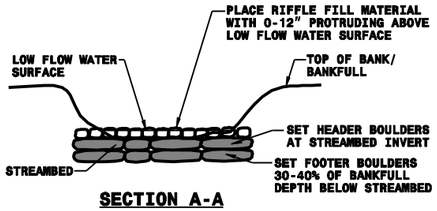


CONSTRUCTED RIFFLE TO BE PLACED AT THE CROSSOVER POINT BETWEEN THE HEAD OF RIFFLE AND HEAD OF RUN

TYPICAL CONSTRUCTED RIFFLE LOCATION PLAN VIEW

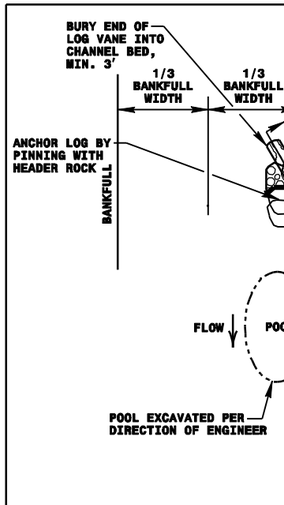


SECTION B-B

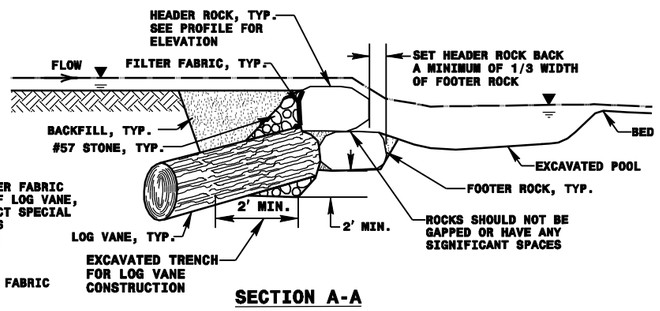


SECTION A-A

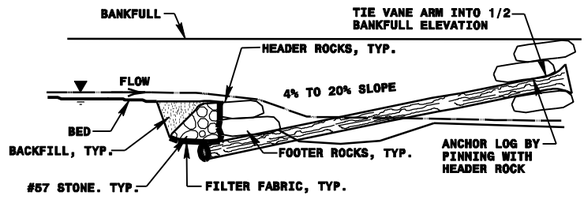
CONSTRUCTED RIFFLE
NTS



PLAN VIEW



SECTION A-A

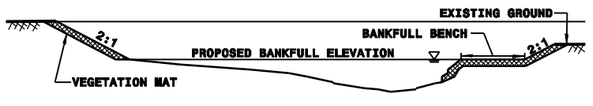


SECTION B-B

NOTES:
1. DEEPEST PART OF POOL TO BE IN LINE WHERE VANE ARM TIES INTO BANKFULL.
2. DO NOT EXCAVATE POOL TOO CLOSE TO FOOTER BOULDERS.
3. CLASS "A" STONE CAN BE USED TO REDUCE VOIDS BETWEEN HEADERS AND FOOTERS.
4. COMPACT BACKFILL TO EXTENT POSSIBLE OR AT THE DIRECTION OF THE ENGINEER.
5. POOL DEPTH SHOULD BE 2 TO 3 TIMES BANKFULL DEPTH.

LOG VANE DETAIL
NTS

TYPICAL RIFFLE

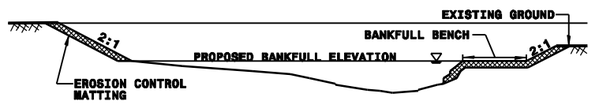


TYPICAL POOL

NOTES:
1. SHAPE CHANNEL AS DESIGNED.
2. EXCAVATE AREAS WHERE VEGETATION MATS ARE TO BE INSTALLED.
3 VEGETATION MATS ARE TO BE HARVESTED FROM EXISTING DRAINAGE DITCHES, AND INSTALLED IMMEDIATELY AFTER HARVESTING.
4. INSTALL VEGETATION MATS TO DESIGNED ELEVATIONS.
5. THOROUGHLY WATER VEGETATION MATS.

TYPICAL VEGETATION MAT PLACEMENT
NTS

TYPICAL RIFFLE



TYPICAL POOL

NOTES:
1. EROSION CONTROL MATTING TO BE PLACED ON CONSTRUCTED BANKFULL BENCHES AND SLOPES.
2. MATTING TO BE PROPERLY INSTALLED, KEYED IN, AND SECURED PER MANUFACTURERS RECOMMENDATIONS.
3. TEMPORARY AND PERMANENT SEED MIXTURES, LIME, AND FERTILIZER TO BE SPREAD PER THE PROJECT SPECIFICATIONS ON CONSTRUCTED BANKFULL BENCHES AND SLOPES IMMEDIATELY PRIOR TO THE PLACEMENT OF EROSION CONTROL MATTING.

TYPICAL EROSION CONTROL MATTING PLACEMENT
NTS

EROSION CONTROL MATTING PROPERTIES

1. BLANKET, BROWN IN COLOR, CONSISTING OF 100% COCONUT FIBER ENCLOSED IN 100% BIO-DEGRADABLE NETTING AND THREAD.
2. COVERED ON THE TOP AND BOTTOM WITH 100% JUTE FIBER SCRIM CLOTH AND BIO-DEGRADABLE FIBER NETTING WITH LENO WEAVE CONSTRUCTION WOVEN INTO AN APPROXIMATE 0.75 INCH BY 0.75 INCH MESH.
3. SEWN TOGETHER WITH BIODEGRADABLE 100% COTTON THREAD ON 2 INCH CENTERS.
4. THE WEIGHT SHALL BE 0.70 LBS/SQUARE YARD.
5. MAXIMUM ALLOWABLE SHEER STRESS IS 3.13 LB/S.F.

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

DETAILS SHEET NO. D3

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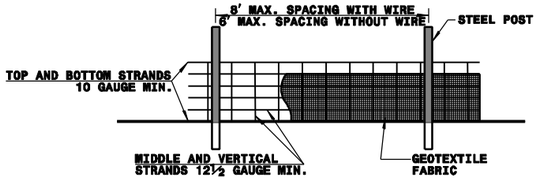
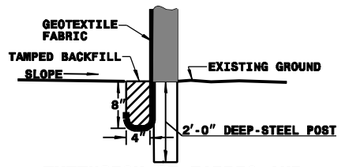
Details – Five Mile Branch



POST SPACING

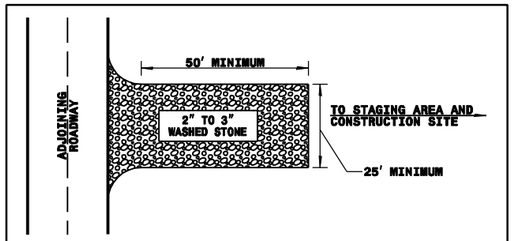
NOTES:
1. WIRE SHALL BE MINIMUM OF 32" WIDE AND SHALL HAVE A MINIMUM OF 6 STRANDS WITH 12" STAY SPACING.
2. GEOTEXTILE FABRIC SHALL BE MINIMUM OF 36" WIDE AND SHALL BE FASTENED ADEQUATELY TO THE WIRE AS DIRECTED BY DESIGNER.
3. STEEL POSTS SHALL BE 5' HIGH AND BE OF THE SELF-FASTENER ANGLE STEEL TYPE.



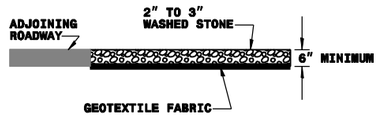
EXTENSION OF FABRIC AND WIRE INTO TRENCH

TEMPORARY SILT FENCE

NTS



PLAN VIEW

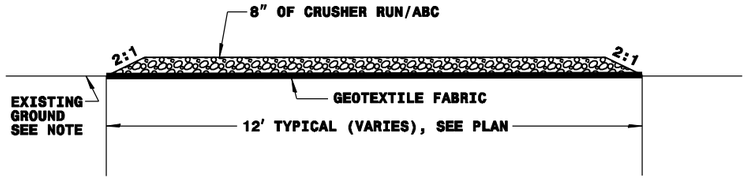


PROFILE VIEW

NOTES:
1. PUT SILT FENCE OR TREE PROTECTION FENCE UP TO DIVERT ALL EQUIPMENT TRAFFIC IN ORDER TO ENSURE CONSTRUCTION ENTRANCE IS USED.
2. TURNING RADIUS SUFFICIENT TO ACCOMODATE LARGE TRUCKS IS TO BE PROVIDED.
3. ENTRANCE(S) SHOULD BE LOCATED TO PROVIDE FOR MAXIMUM UTILIZATION BY ALL CONSTRUCTION VEHICLES.
4. ENTRANCE(S) MUST BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR DIRECT FLOW OF MUD ONTO ADJOINING ROADWAY. PERIODIC TOP DRESSING WITH STONE WILL BE NECESSARY. ANY MATERIAL WHICH STILL MAKES IT ONTO THE ROADWAY MUST BE CLEANED UP IMMEDIATELY. IF MUD CONTINUES TO BE TRACKED ONTO THE ADJOINING ROADWAY, THE GOVERNING AUTHORITY WILL CLEAN THE AREA AND INVOICE THE FINANCIALLY RESPONSIBLE PERSON AS INDICATED ON THE FINANCIAL RESPONSIBILITY FORM.
5. PLACE CONSTRUCTION ENTRANCE AT ALL POINTS OF INGRESS AND EGRESS UNTIL THE SITE IS STABILIZED. FREQUENT CHECKS OF THE DEVICE AND TIMELY MAINTENANCE MUST BE PROVIDED.

GRAVEL CONSTRUCTION ENTRANCE

NTS



CROSS-SECTION VIEW

NOTE:
1. UNDERCUT AND REPAIR/COMPACT ANY AREAS WHERE EXISTING GRADE IS SOFT ENOUGH TO PUMP UNDER EXPECTED DUMP TRUCK LOADING.
2. USE ONLY IN LOCATION AS DIRECTED BY ENGINEER.

CONSTRUCTION ACCESS ROAD

NTS

CHANNEL MAXIMUM BANKFULL SHEER STRESS BY REACH

REACH	SHEER STRESS (LB/S.F.)
BEAVER CREEK	0.198
FIFTH CREEK-U/S BEAVER CREEK	0.461
FIFTH CREEK-BEAVER CREEK TO SWANN ROAD	0.242
FIFTH CREEK-D/S SWANN ROAD	0.285
UT AT SWANN ROAD	0.139

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NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

DETAILS SHEET NO. D4

Date:<DATE>
Filename:<FILE>

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

NOTE: PROPERTY BOUNDARIES OBTAINED COURTESY OF IREDELL COUNTY GIS/MAPPING DEPARTMENT WEBSITE.

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NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 5

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

NOTE: PROPERTY BOUNDARIES OBTAINED COURTESY OF IREDELL COUNTY GIS/MAPPING DEPARTMENT WEBSITE.

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 6

NAD 83

APPROXIMATE VERNAL POOL LOCATION

WLB

45+00

50+00

MATCH LINE TO SHEET 6 STA. 43+50 -PRBVR-

MATCH LINE TO SHEET 8 STA. 54+50 -PRBVR-

EXIST. BEAVER CREEK

EXIST. BEAVER CREEK

PROPOSED CUT LINE

WLB PROPOSED WETLAND

BANK GRADING AREAS

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

NOTE: PROPERTY BOUNDARIES OBTAINED COURTESY OF IREDELL COUNTY GIS/MAPPING DEPARTMENT WEBSITE.

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FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 7

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

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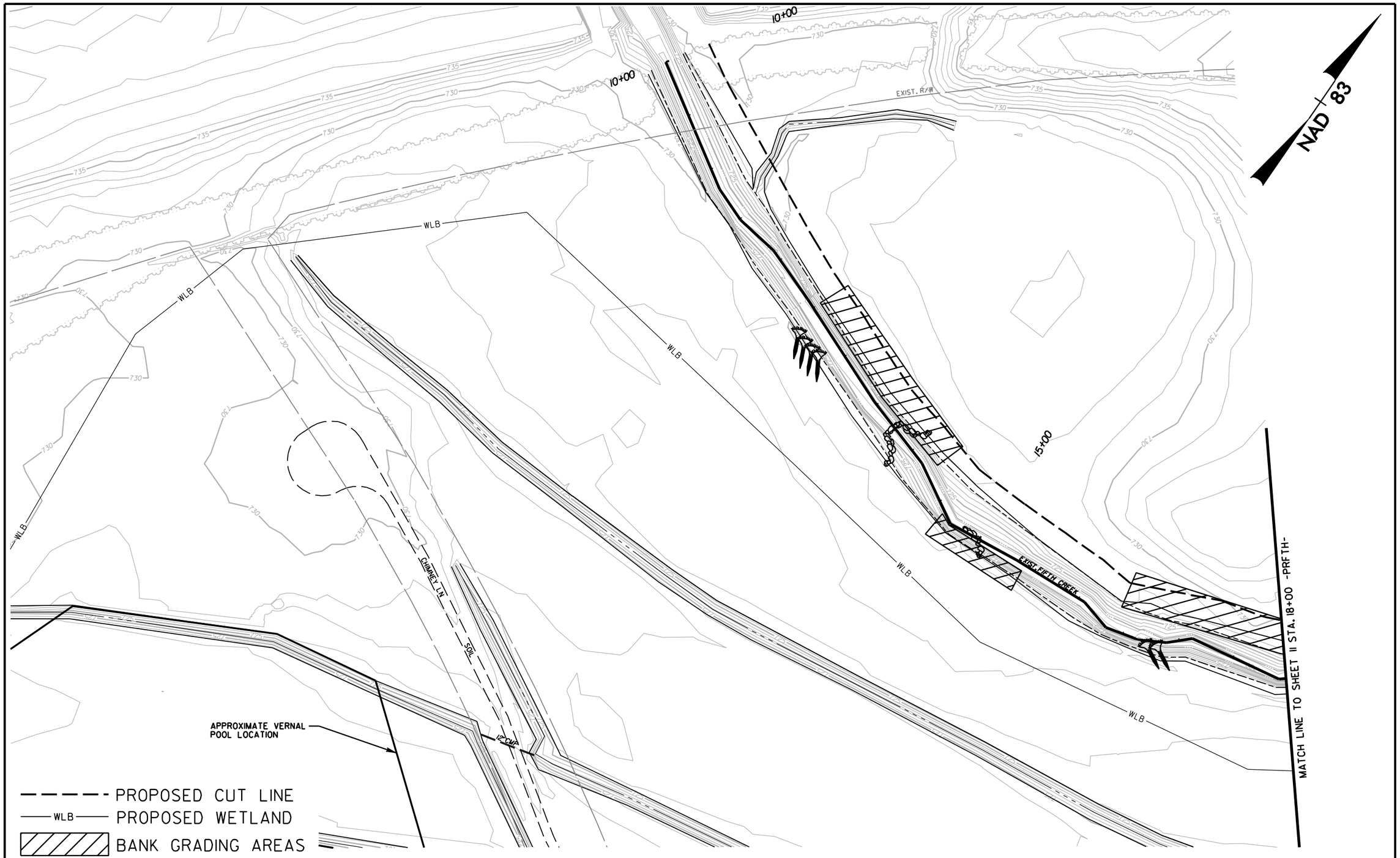
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH

IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 8



Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

NOTE: PROPERTY BOUNDARIES OBTAINED COURTESY OF IREDELL COUNTY GIS/MAPPING DEPARTMENT WEBSITE.

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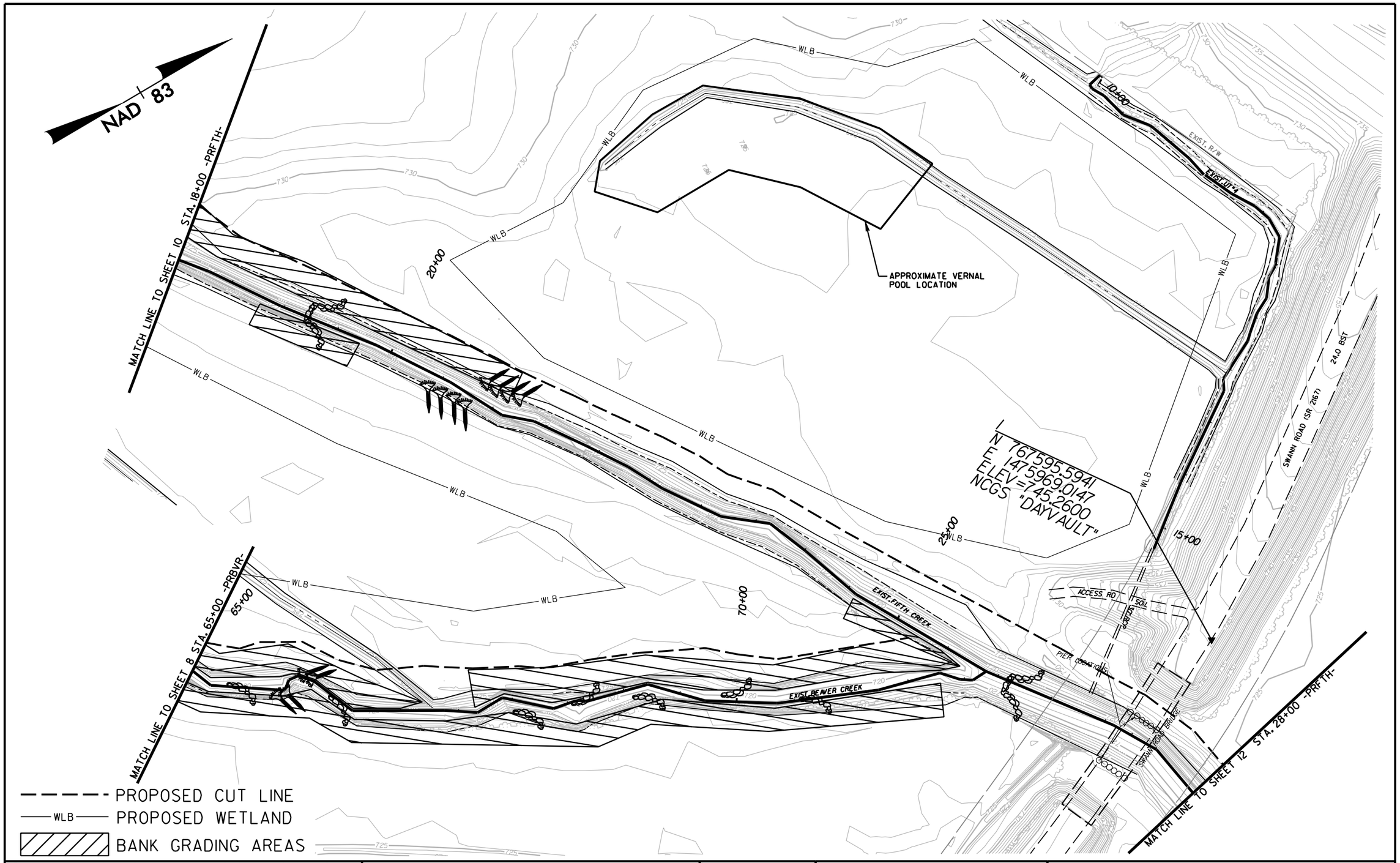
FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 9



Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

NOTE: PROPERTY BOUNDARIES OBTAINED COURTESY OF IREDELL COUNTY GIS/MAPPING DEPARTMENT WEBSITE.

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FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 10

NAD 83

EXIST. R/W

WLB

APPROXIMATE VERNAL POOL LOCATION

30+00

35+00

XSC '13

repair large wash out

EXIST. FIFTH CREEK

MATCH LINE TO SHEET II STA. 28+00 -PRFTH-

MATCH LINE TO SHEET 13 STA. 38+50 -PRFTH-

PROPOSED CUT LINE

WLB PROPOSED WETLAND

BANK GRADING AREAS

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

NOTE: PROPERTY BOUNDARIES OBTAINED COURTESY OF IREDELL COUNTY GIS/MAPPING DEPARTMENT WEBSITE.

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FIVE-MILE BRANCH

IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 11

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

NOTE: PROPERTY BOUNDARIES OBTAINED COURTESY OF IREDELL COUNTY GIS/MAPPING DEPARTMENT WEBSITE.

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FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 12

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

NOTE: PROPERTY BOUNDARIES OBTAINED COURTESY OF IREDELL COUNTY GIS/MAPPING DEPARTMENT WEBSITE.

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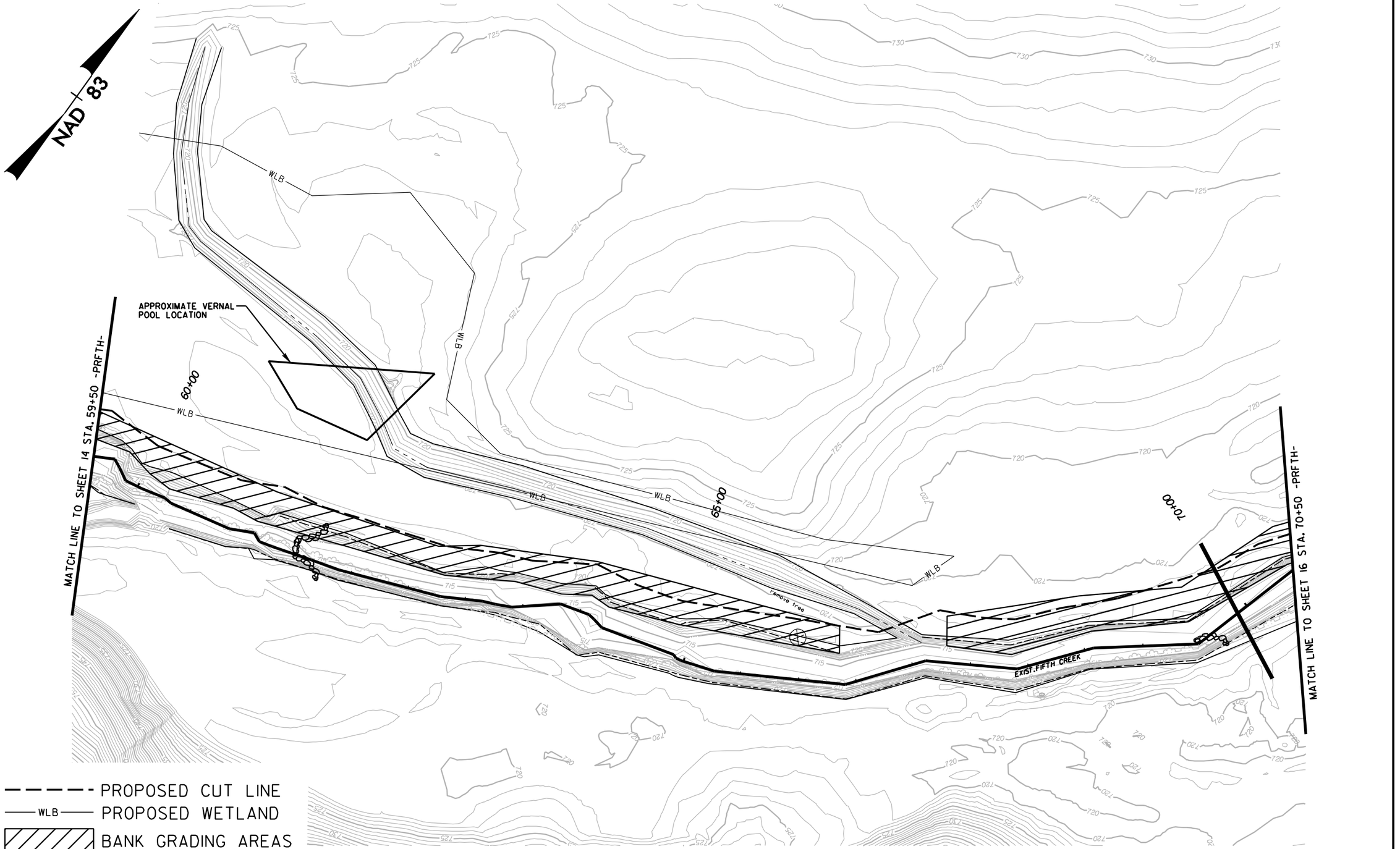
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 13



Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 14

NAD 83

APPROXIMATE VERNAL POOL LOCATION

75+00

10+00

remover cedar tree

MATCH LINE TO SHEET 15 STA. 70+50 -PRFTH-

PROPOSED CUT LINE

WLB PROPOSED WETLAND

BANK GRADING AREAS

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

20' 0 40'
SCALE

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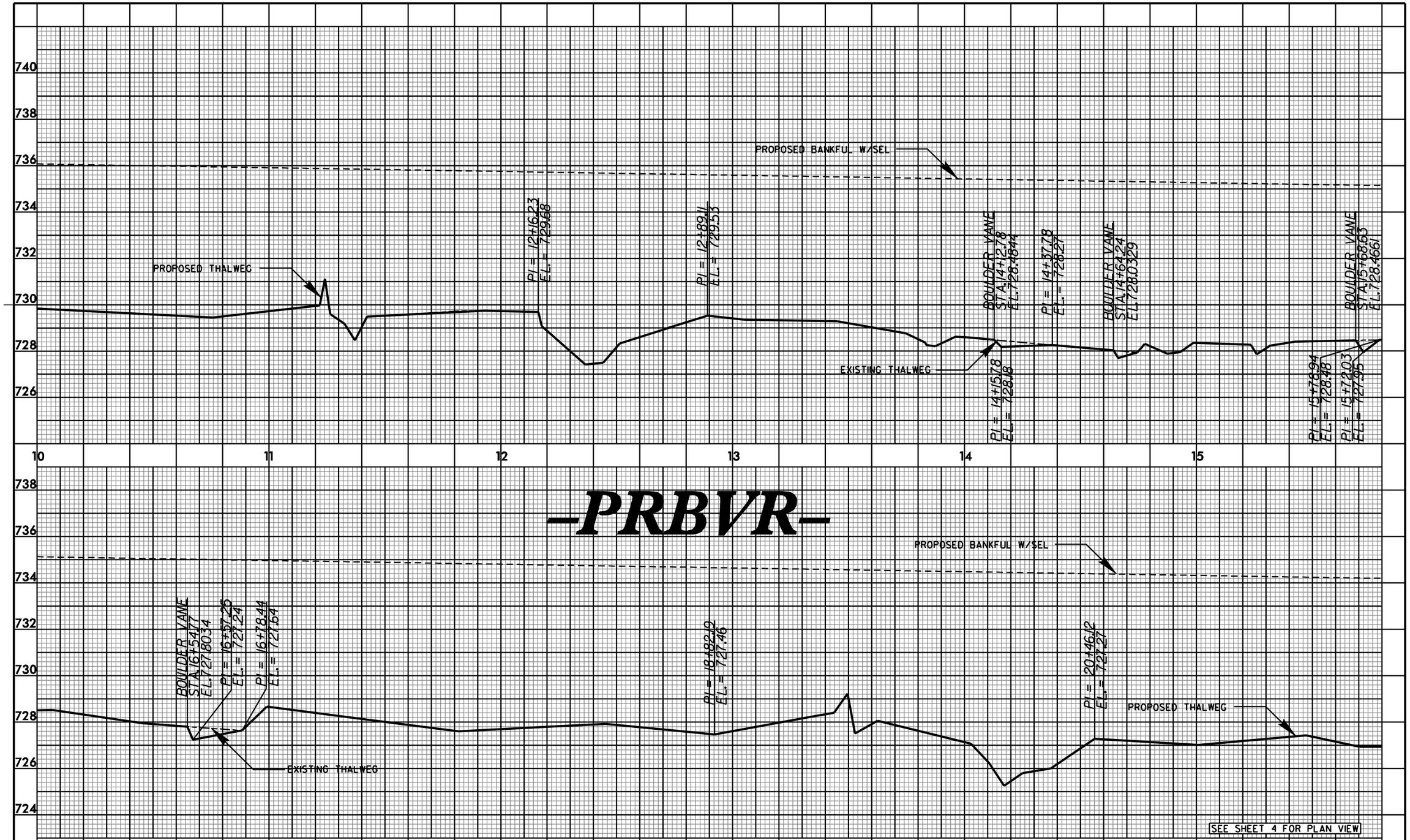
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLAN SHEET NO. 15



10' 0 20'
HORIZON. SCALE

1' 0 2'
VERTICAL SCALE

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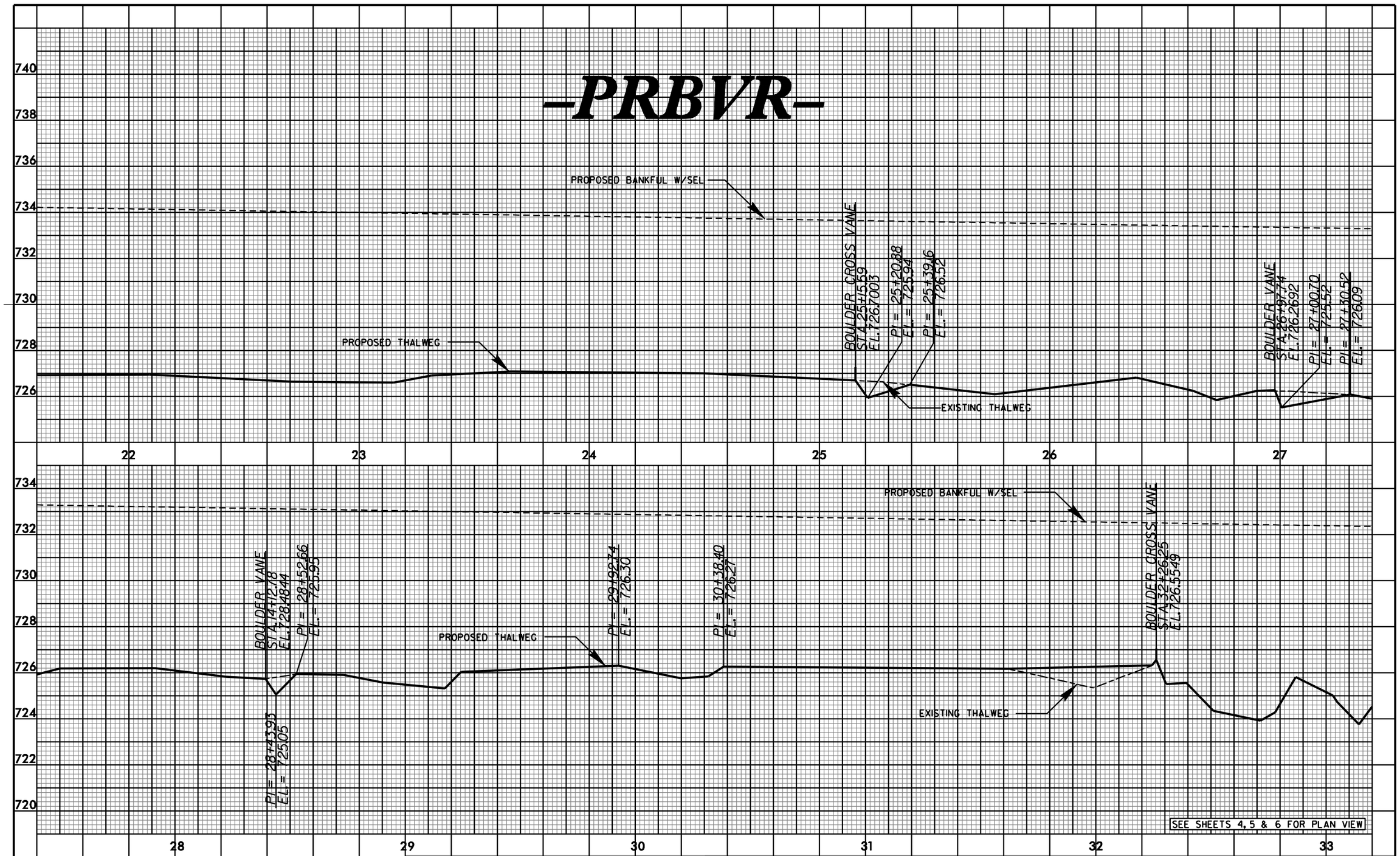
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

BEAVER CREEK PROFILE SHEET NO. 16

-PRBVR-



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HORIZON. SCALE

1' 0 2'
VERTICAL SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

BEAVER CREEK PROFILE SHEET NO. 17

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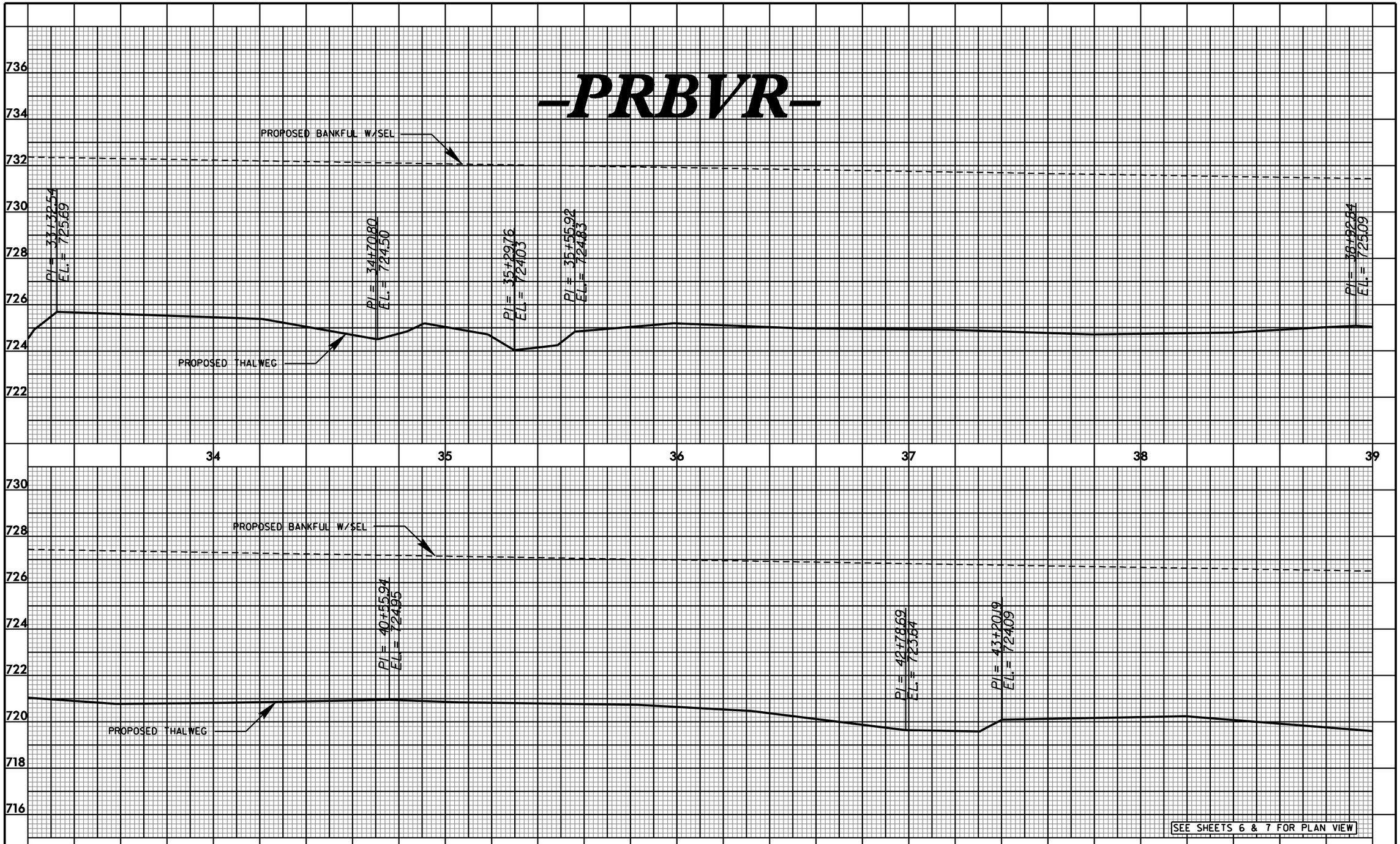

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HORIZON. SCALE

1' 0 2'
VERTICAL SCALE

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FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

BEAVER CREEK PROFILE SHEET NO. 18

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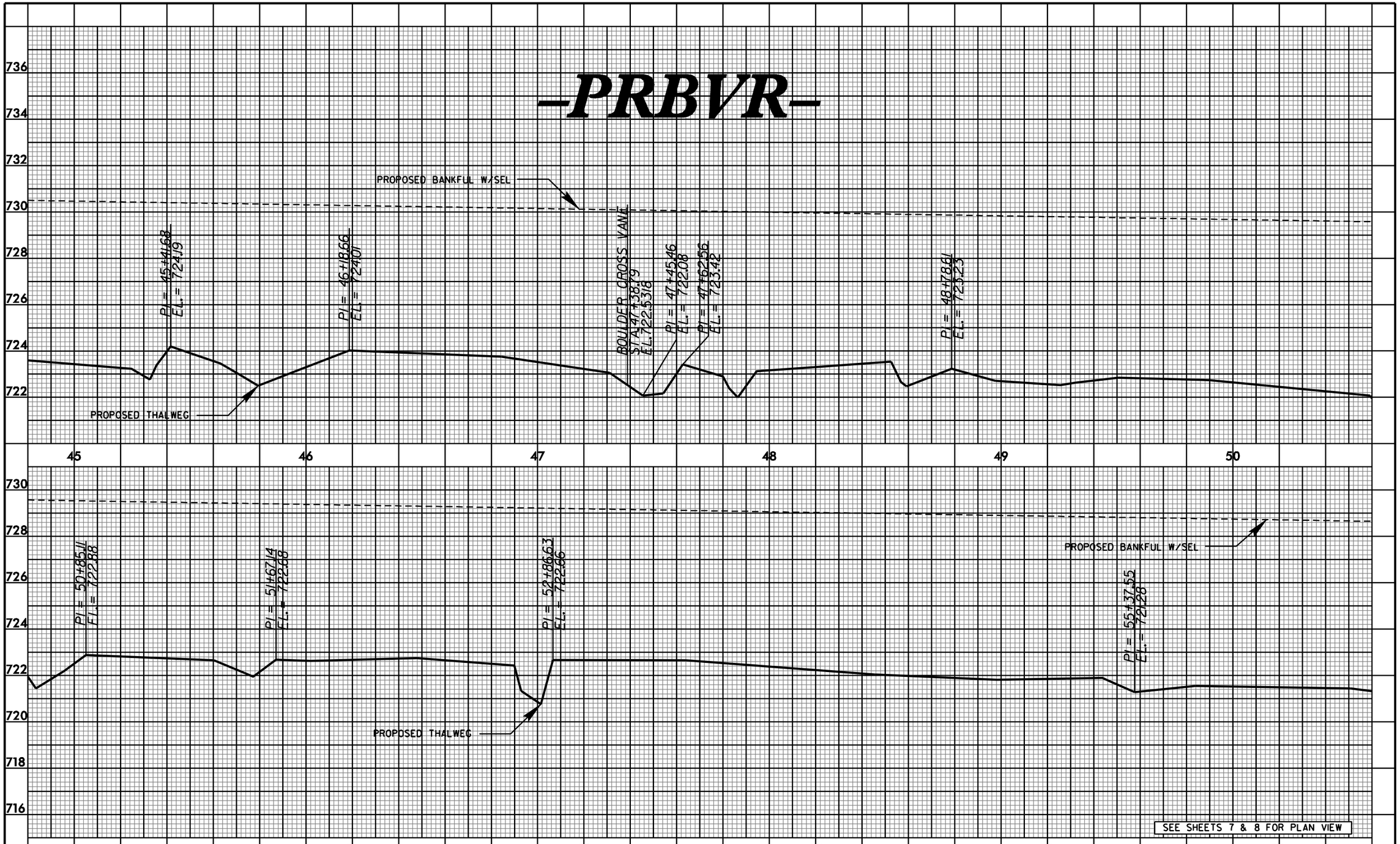

10' 0 20'
HORIZON. SCALE

1' 0 2'
VERTICAL SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

BEAVER CREEK PROFILE SHEET NO. 19

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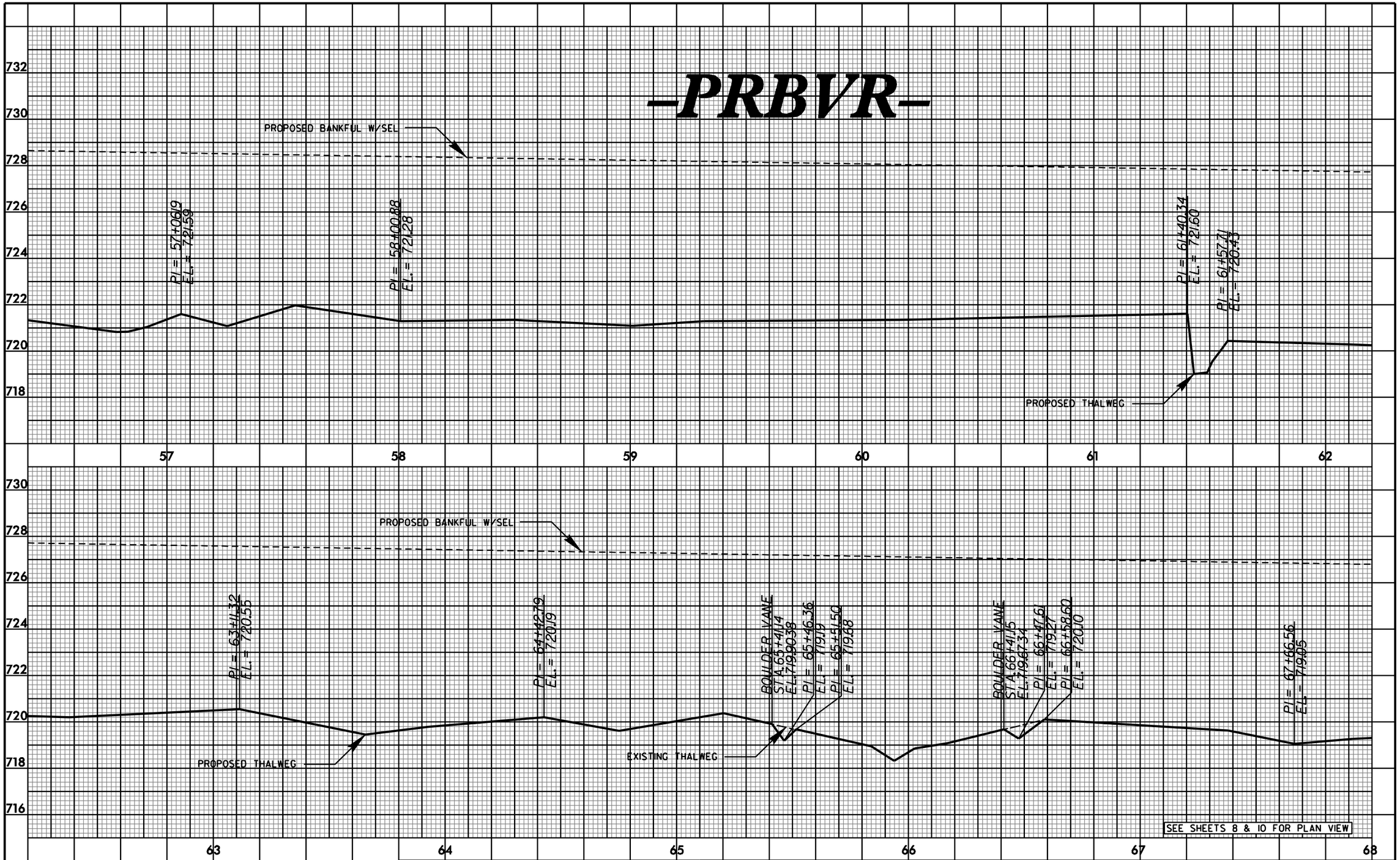

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HORIZON. SCALE

1' 0 2'
VERTICAL SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

BEAVER CREEK PROFILE SHEET NO. 20

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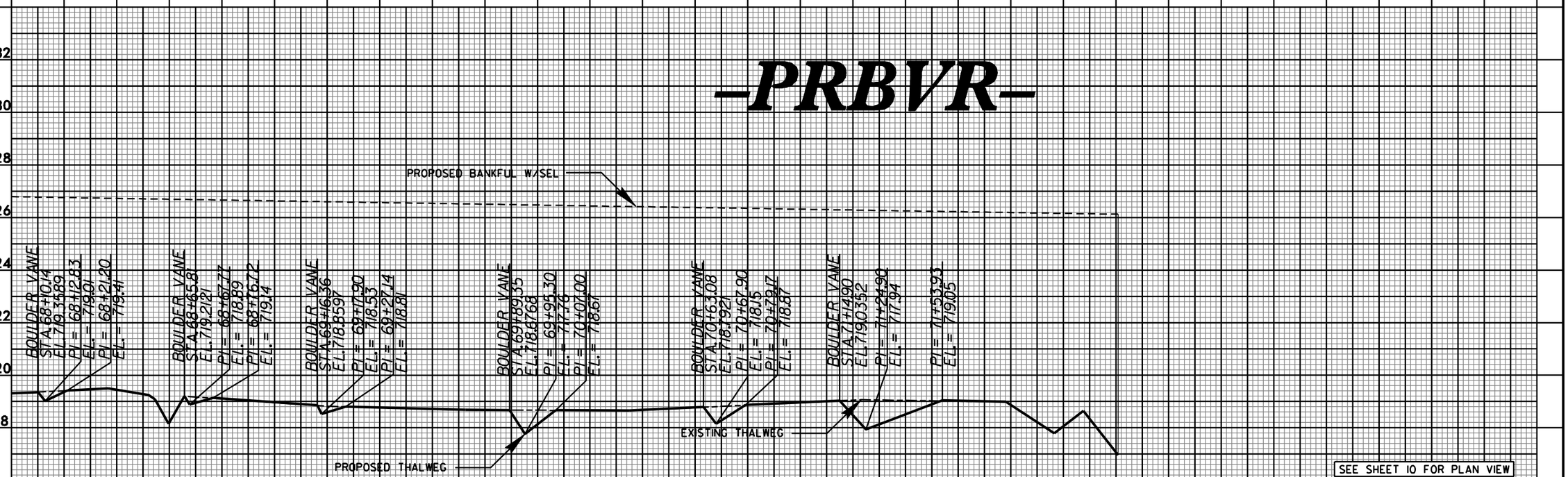

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HORIZON. SCALE

1' 0 2'
VERTICAL SCALE

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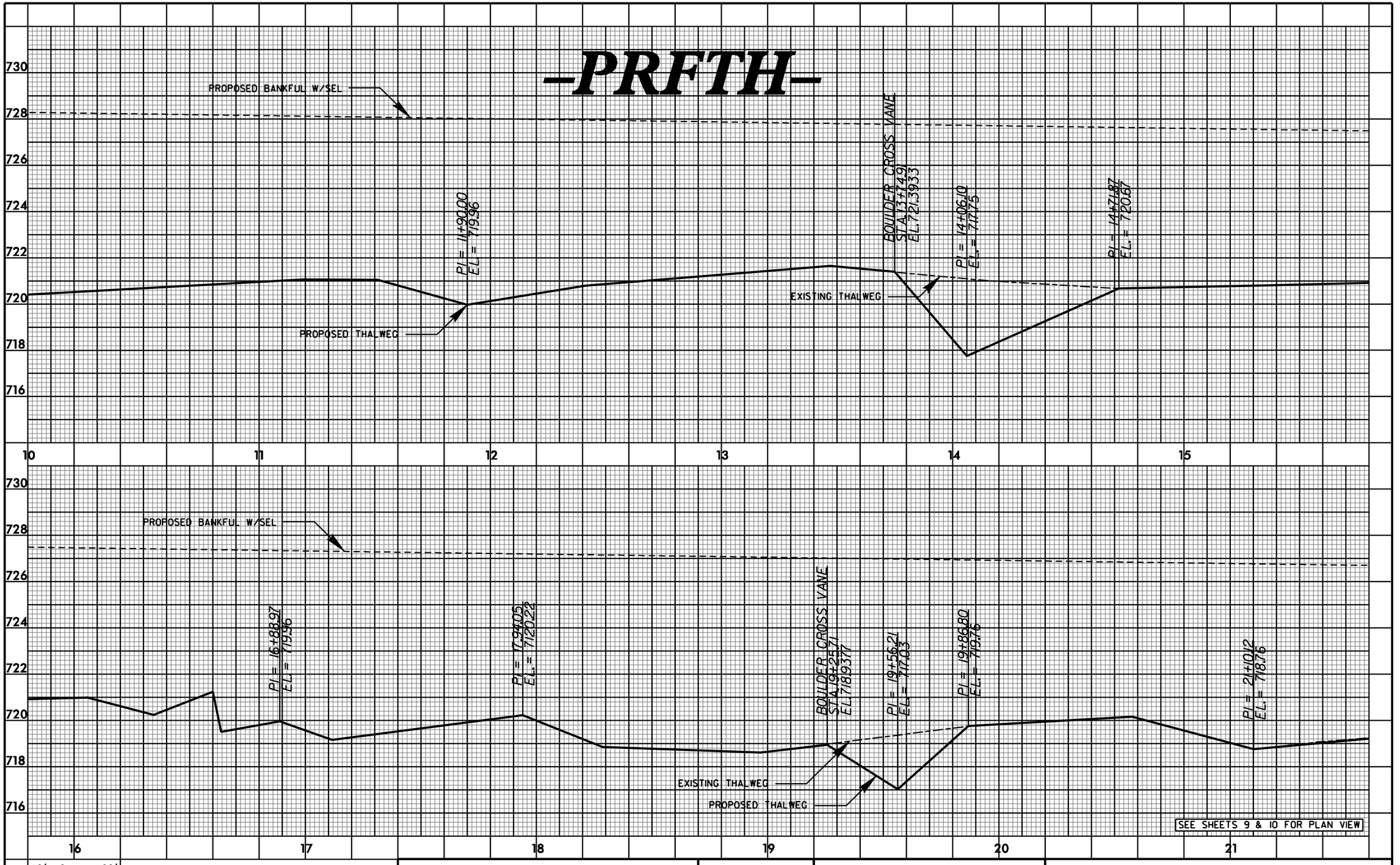
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

BEAVER CREEK PROFILE SHEET NO. 21

-PRFTH-



10' 0 20'
HORIZON. SCALE

1' 0 2'
VERTICAL SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

FIFTH CREEK PROFILE SHEET NO. 22

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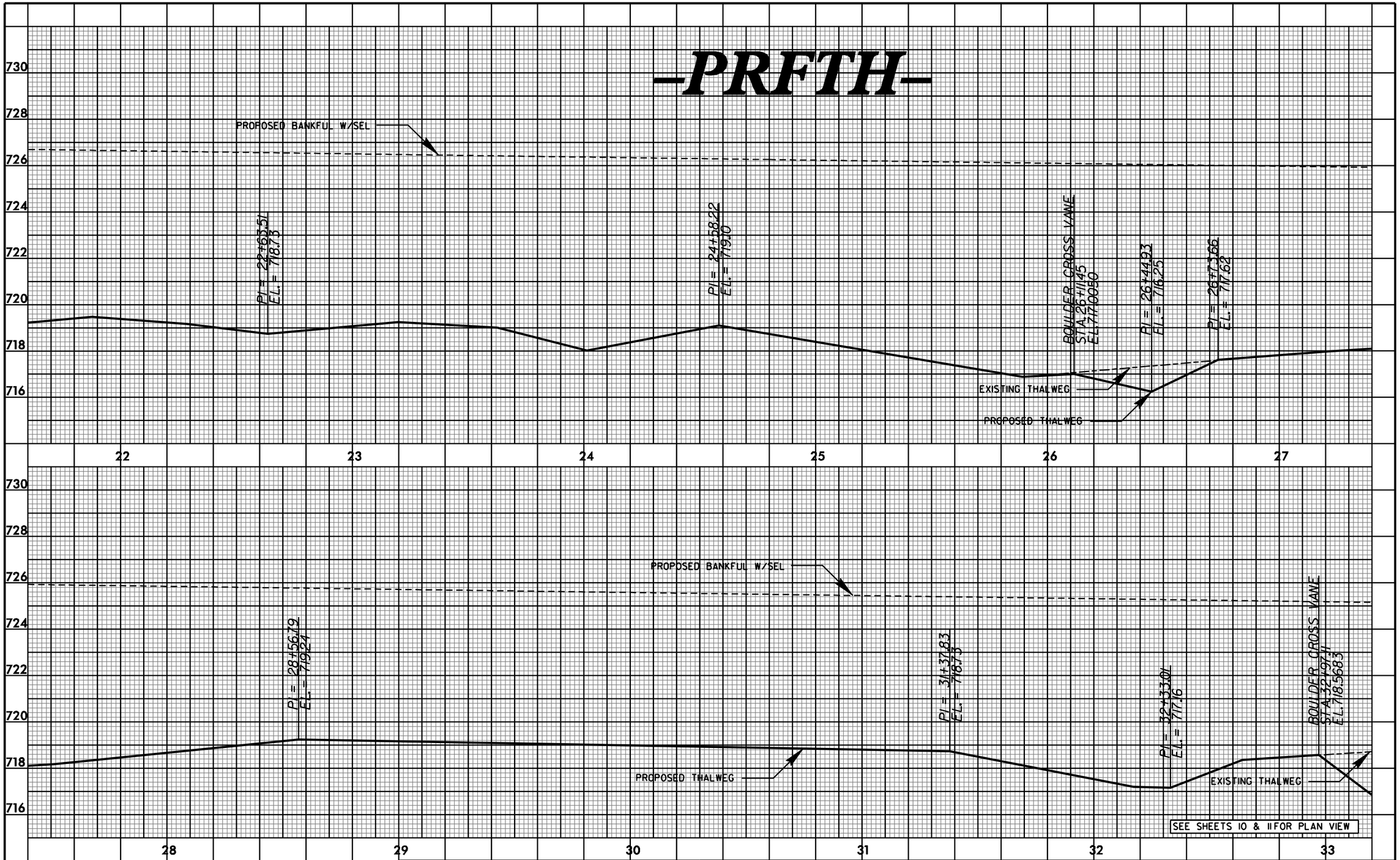

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HORIZON. SCALE

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NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

FIFTH CREEK PROFILE SHEET NO. 23

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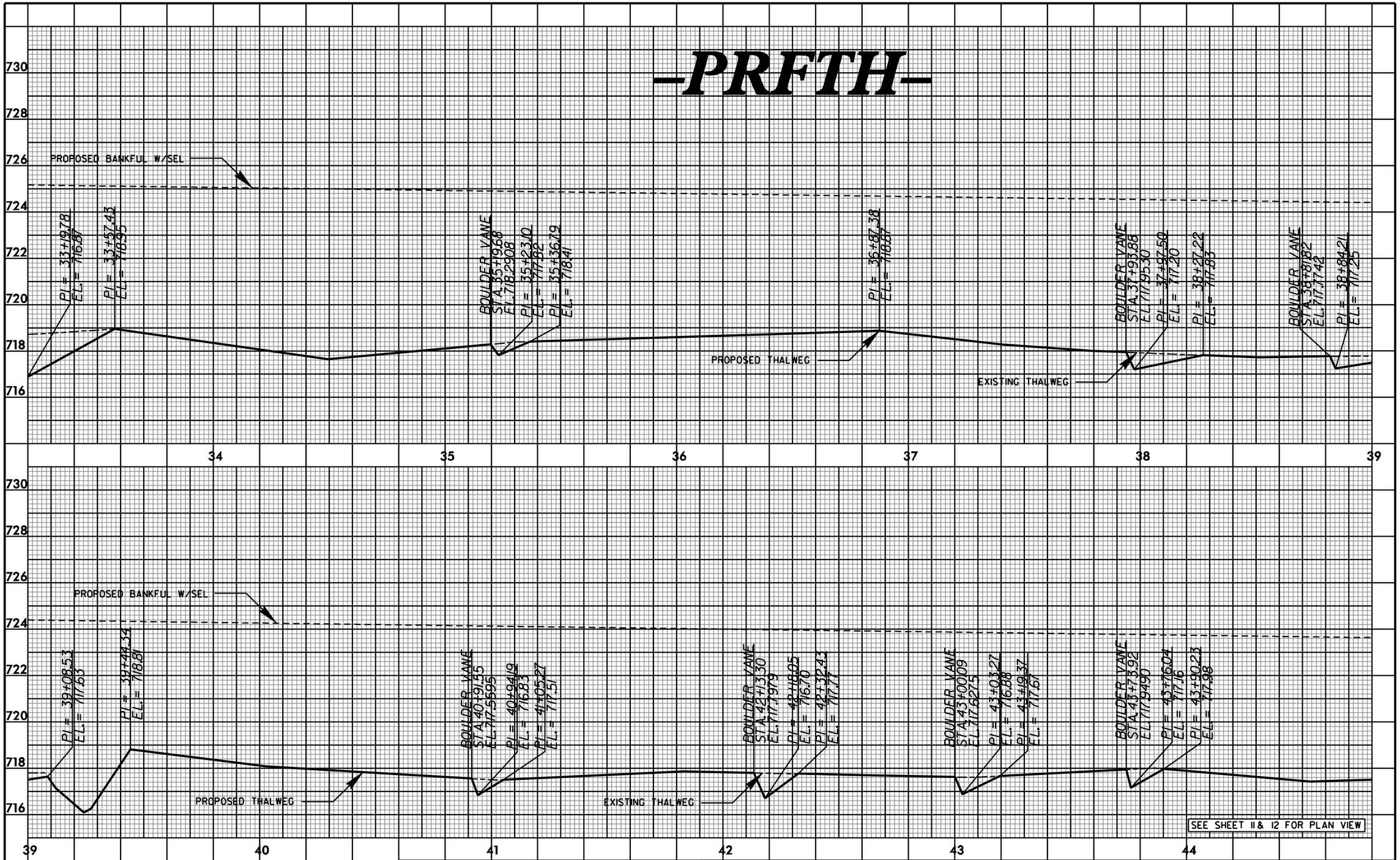

10' 0 20'
HORIZON. SCALE

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VERTICAL SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

FIFTH CREEK PROFILE SHEET NO. 24

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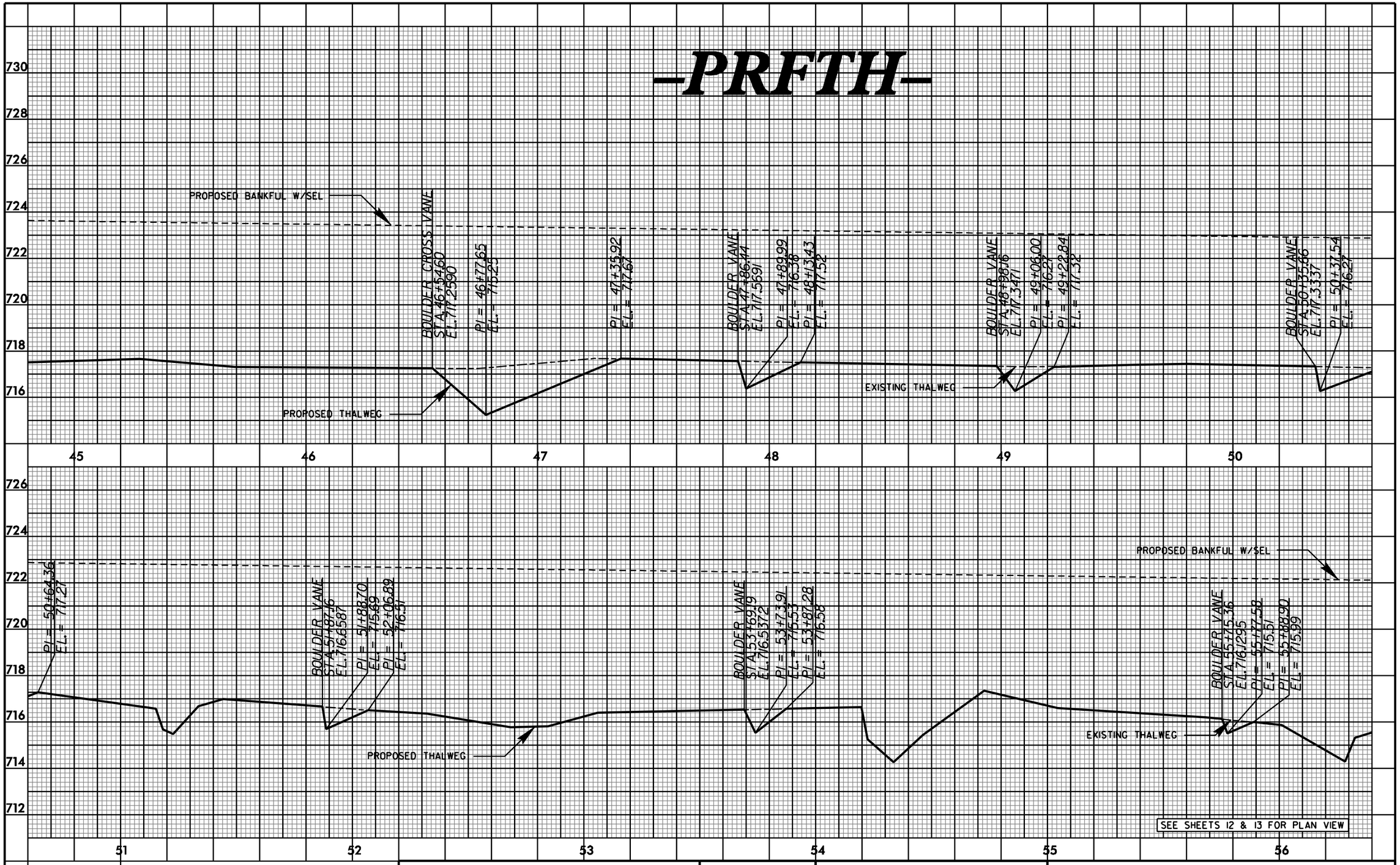

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HORIZON. SCALE

1' 0 2'
VERTICAL SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

FIFTH CREEK PROFILE SHEET NO. 25

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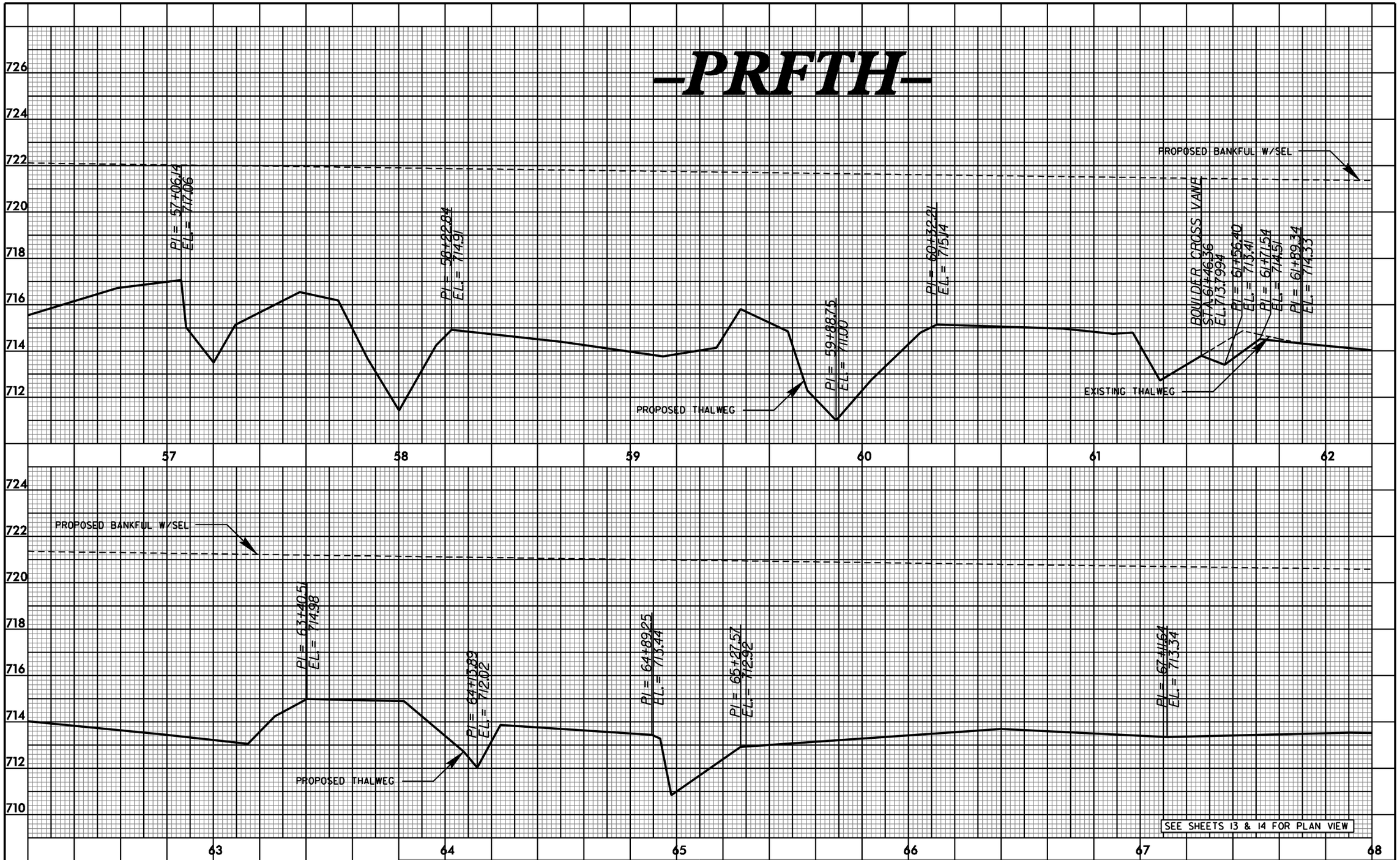

10' 0 20'
HORIZON. SCALE

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VERTICAL SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

FIFTH CREEK PROFILE SHEET NO. 26

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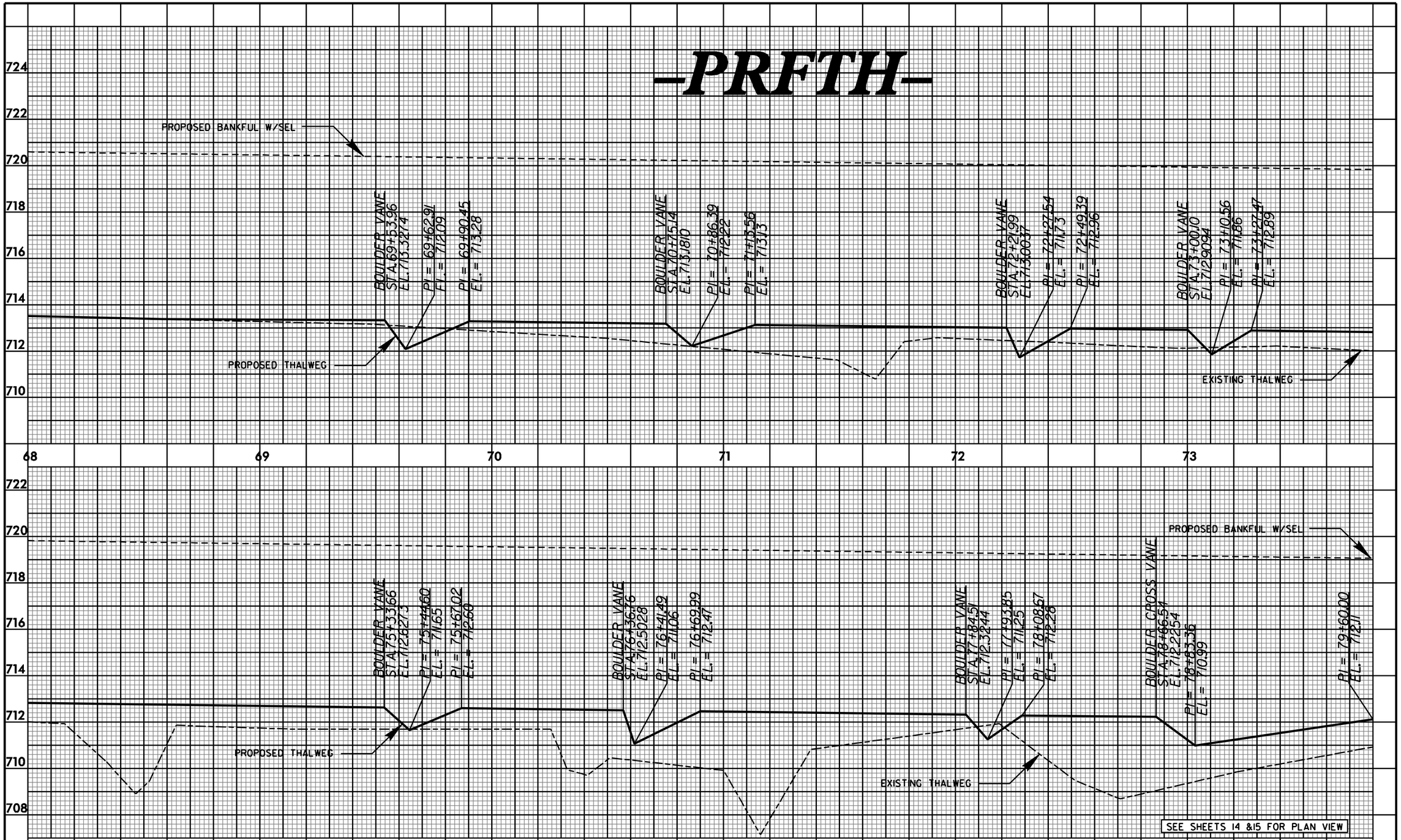

HORIZON. SCALE 10' 0 20'

VERTICAL SCALE 1' 0 2'

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

FIFTH CREEK PROFILE SHEET NO. 27

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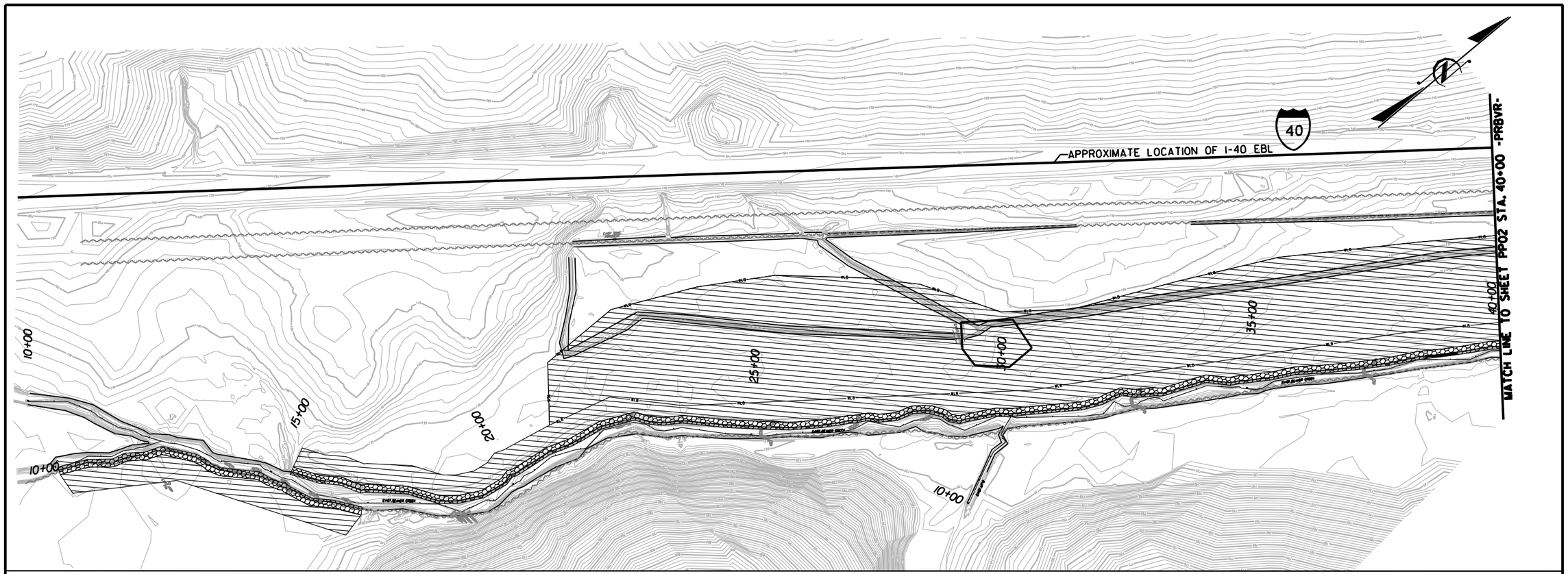

Stream Banks

Equal mixture of the three (3) shrubs and at least four (4) trees at 11 foot spacing

Shrub	
Tag alder	*Alnus serrulata*
Silky dogwood	*Cornus ammomum*
Elderberry	*Sambucus canadensis*
Trees	
Black willow	*Salix nigra*
River birch	*Betula nigra*
Green ash	*Fraxinus pennsylvanica*
Willow oak	*Quercus phellos*
Tulip poplar	*Liriodendron tulipifera*

Equal mixture of at least three (3) herbs and three (3) grass at 30 lbs/acre

Herbs	
Jewel weed	Impatiens capensis
Ironweed	Vernonia noveboracensis
Cardinal flower	Lobelia cardinalis
Beebalm	Monarda didyma
Joe-pye-weed	Eupatorium fistulosum
Gray's sedge	Carex grayi
Soft rush	Juncus effusus
Leathery rush	Juncus coriaceus
Grass	
River oats	Chasmanthium latifolium
Switchgrass	Panicum virgatum
Bottlebrush grass	Hystrix patula
Deer tongue	Panicum clandestinum

Floodplain/Wetland

Equal mixture of at least three (3) shrubs and six 6) trees(minimum two oaks) at 11 foot spacing

Shrub	
Pawpaw	*Asimina triloba*
Spice bush	*Lindera benzion*
Winterberry	*Ilex decidua*
Hazelnut	*Corylus americana*
Elderberry	*Sambucus canadensis*
Arrow-wood	*Viburnum dentatum*
Pinxterflower	*Rhododendron periclymenoides*
Trees	
Blackgum	*Nyssa sylvatica*
Swamp chestnut oak	*Quercus michauxii*
American elm	*Ulmus americana*
River birch	*Betula nigra*
Green ash	*Fraxinus pennsylvanica*
Sugarberry	*Celtis laevigata*
Black cherry	*Prunus serotina*
Black walnut	*Juglans nigra*
Willow oak	*Quercus phellos*
Flowering dogwood	*Cornus florida*
Sourwood	*Oxydendron arboreum*
Red mulberry	*Morus rubra*
Shortleaf pine	*Pinus echinata*
Tulip poplar	*Liriodendron tulipifera*

Equal mixture of at least three (3) forbes and three (3) grass at 30 lbs/acre

Forbe	
Blue lobelia	Lobelia siphilitica
Swamp milkweek	Asclepias incarnata
Jewel weed	Impatiens capensis
Ironweed	Vernonia noveboracensis
Tall coreopsis	Coreopsis tripteris
Tick-seed	Bidens aristosa
Blazing-star	Liatris spicata
Soft rush	Juncus effusus
Grass	
River oats	Chasmanthium latifolium
Deer tongue	Panicum clandestinum
Bottlebrush grass	Hystrix patula
Switchgrass	Panicum virgatum
Wild-rye	Elymus virginicus

Vernal Pools

Equal mixture of the following at 11 foot spacing

Shrub	
Possumhaw	*Viburnum nudum*
Tag alder	*Alnus serrulata*
Trees	
Black willow	*Salix nigra*
Overcup oak	*Quercus lyrata*

Temporary Seed Mixture

Fall, winter, and spring temporary seed mix (August 15 - May 01)

Cereal Rye	Secale cereal	120 lbs / acre
Orchard Grass	Dactylis glomerata	20 lbs / acre

Summer temporary seed mix (May 01 - August 15)

Sudangrass	Sorghum bicolor	35-45 lbs / acre
Browntop Millet	Panicum ramosum	30-40 lbs / acre

LEGEND

STREAM BANKS

FLOODPLAIN/ WETLAND

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

50' 0 100'

SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLANTING PLAN SHEET NO. PP1

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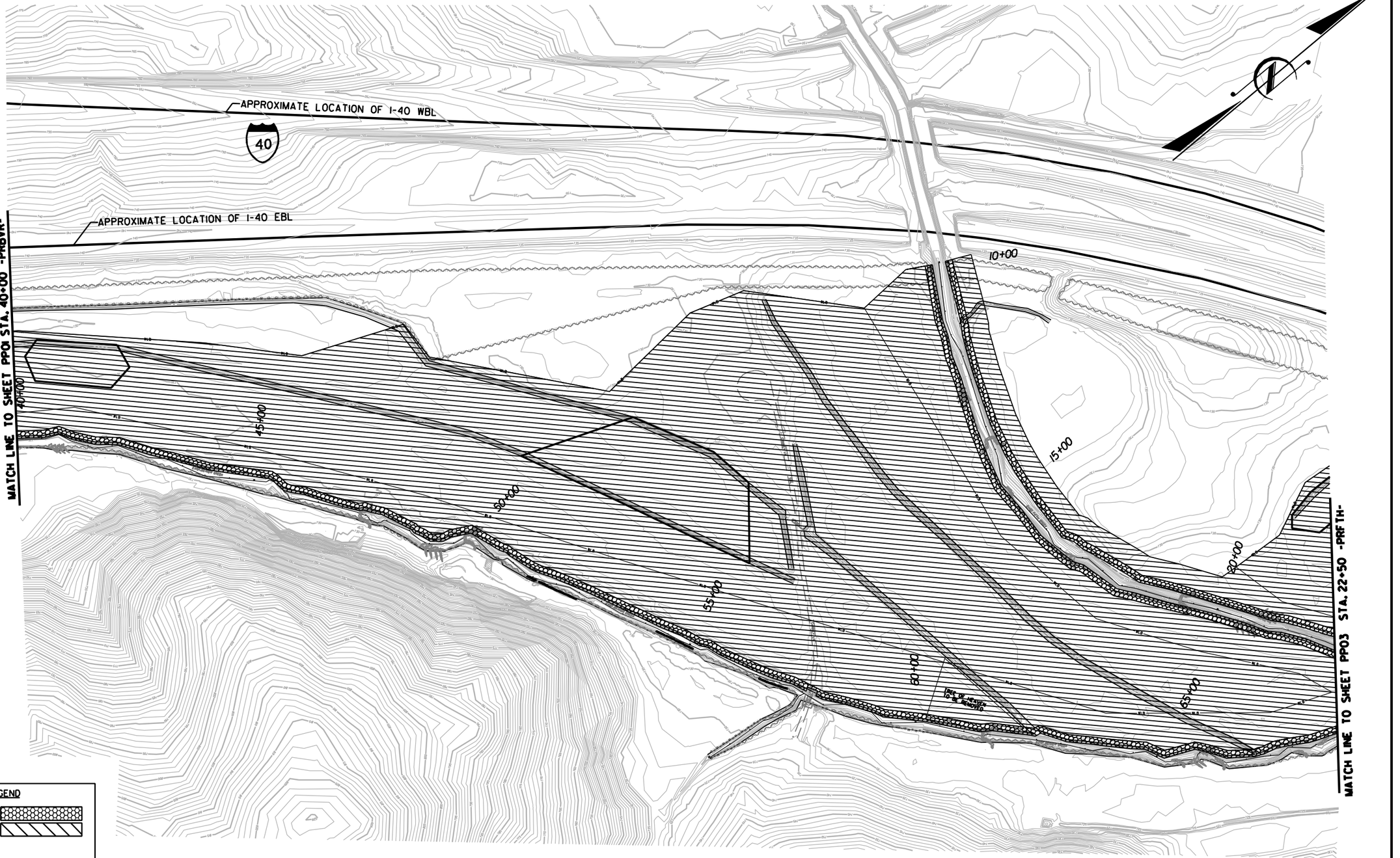

See specification and sheet PP1 for planting list.

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

50' 0 100'
SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLANTING PLAN SHEET NO. PP2

Dates&Date Filenames=FILES

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STREAM BANKS

FLOODPLAIN/ WETLAND

See specification and sheet PP1 for planting list.

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

50' 0 100'

SCALE

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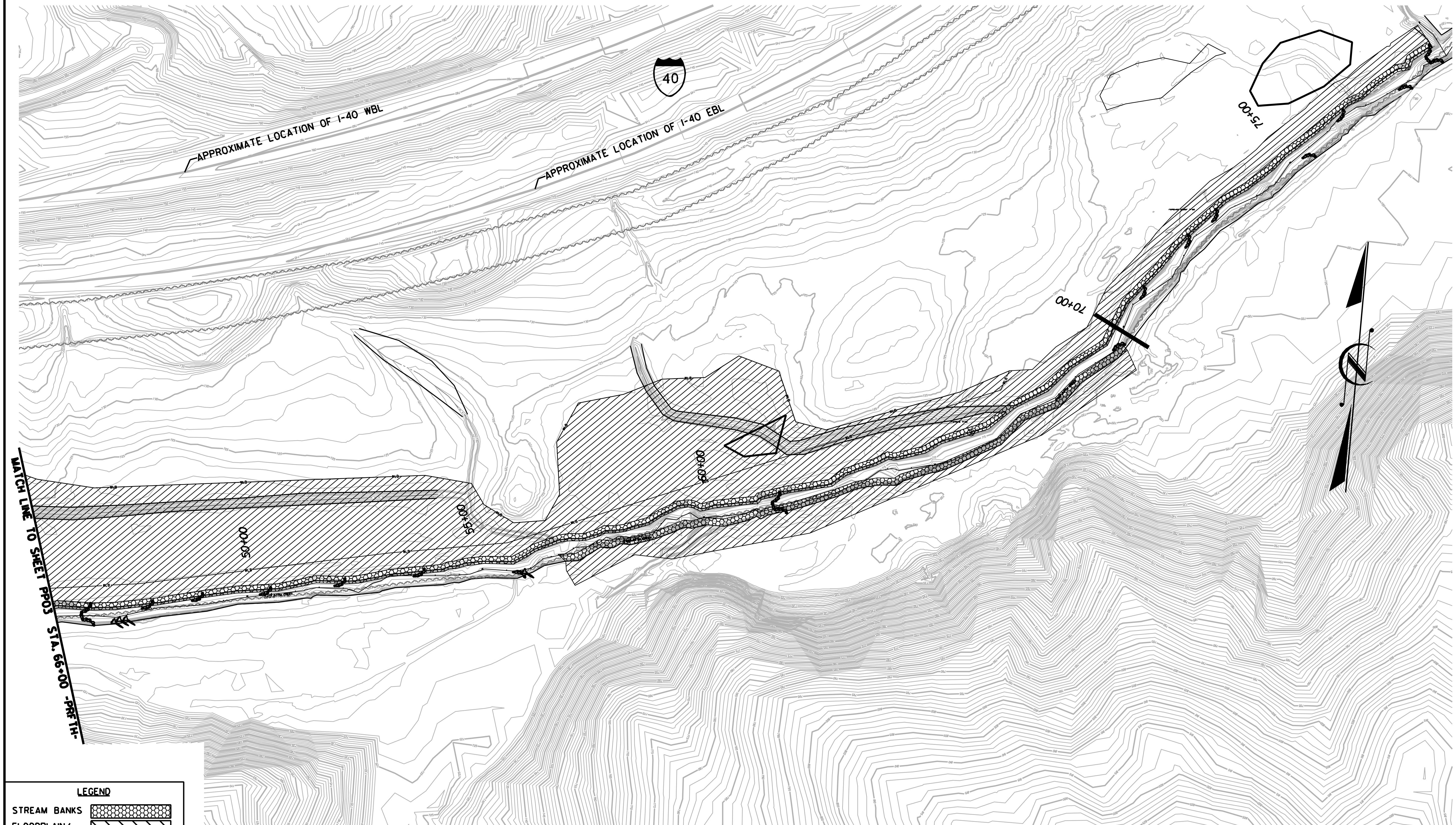
ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLANTING PLAN SHEET NO. PP3



LEGEND

STREAM BANKS

FLOODPLAIN/ WETLAND

See specification and sheet PP1 for planting list.

Development which will take place within the limits of the 100 year floodplain Zone A where base flood elevations have not been determined is designed in accordance with the requirements of Executive Order No.123 - Uniform Floodplain Management Policy.

50' 0 100'
SCALE

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ECOSYSTEM ENHANCEMENT PROGRAM

FIVE-MILE BRANCH
IREDELL COUNTY, NORTH CAROLINA

PLANTING PLAN

SHEET NO. PP4

Appendix 1

Restoration Site Photographs

Photo 1: Typical eroding bank on Beaver Creek

Photo 2: Typical debris jam on Beaver Creek

Photo 3: Eroding bank on Beaver Creek

Photo 4: Eroding bank On Beaver Creek

Photo 5: Log jam on Beaver Creek

Photo 6: Eroding bank On Beaver Creek.

Photo 7: Stable bank on Fifth Creek

Photo 8: Log jam on Fifth Creek

Photo 9: Eroding bank on Fifth Creek

Photo 10: Typical eroding bank on Fifth Creek and moderate right bank

Appendix 2

Restoration Site USACE Routine
Wetland Determination Data Forms

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual

Project/Site:	*Five Mile Branch Stream Restoration Project*	Date:	*15-Nov*
Applicant/Owner:	*NCDOT*	County:	*Iredell*
Investigator(s):	*Harold M. Brady / Bob Lepsic*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	Yes / No	Community ID:	*Upland*
Is the site significantly disturbed (Atypical Situation)?	Yes / No	Transect ID:	*A*
Is this area a potential Problem Area?	Yes / No	Plot ID:	*A16*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Cornus florida*	*tree*	*FACU*	9.	*Pinus taeda*	*tree*	*FAC*
2.	*Liquidambar styraciflua*	*tree*	*FAC*	10.	*Prunus serotina*	*tree*	*FACU*
3.	*Toxicodendron radicans*	*vine*	*FAC*	11.	*Vitis rotundifolia*	*vine*	*FAC*
4.	*Oxydendron arboreum*	*tree*	*FAC*	12.			
5.	*Acer rubrum*	*tree*	*FAC*	13.			
6.	*Fagus grandifolia*	*tree*	*FACU*	14.			
7.	*Juniperus virginiana*	*tree*	*FACU-*	15.			
8.	*Ulmus alata*	*tree*	*FACU+*	16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *65%*

Remarks *The majority of the vegetation is facultative.*

HYDROLOGY

___ Recorded Data (Describe in Remarks)
___ Stream, Lake, or tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)

Depth to Free Water in Pit: _____ (in.)

Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators
Primary Indicators:
___ Inundated
___ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks *6-10% slope*

SOILS

Map Unit Name
(Series and Phase): *Chewacla soils*

Drainage Class: *Somwhat poorly*

Taxonomy (Subgroup *Fluvaquentic Dystrudepts*

Field Observations
Confirm Mapped Type? Yes [No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2	*A*	*10YR 4/4*			*sandy clay loam*
2-10	*B1*	*10YR 5/4*			*clay loam, blocky*
10+	*B2*	*10YR 7/8*			*clay loam, sand inclusion*

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
___ Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks *Located on roadway embankment.*

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [Yes] No
Wetland Hydrology Present? Yes [No]
Hydric Soils Present? Yes [No]

Is this Sampling Point Within a Wetland? Yes [No]

Remarks *Plot was taken approximately 30 feet uphill from Plot A16*

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual

Project/Site:	*Five Mile Branch Stream Restoration Project*	Date:	*15-Nov*
Applicant/Owner:	*NCDOT*	County:	*Iredell*
Investigator(s):	*Harold M. Brady / Bob Lepsic*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	Yes / No	Community ID:	*Upland*
Is the site significantly disturbed (Atypical Situation)?	Yes / No	Transect ID:	*B*
Is this area a potential Problem Area?	Yes / No	Plot ID:	*B5*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Cornus florida*	*tree*	*FACU*	9.	*Pinus taeda*	*tree*	*FAC*
2.	*Liquidambar styraciflua*	*tree*	*FAC*	10.	*Prunus serotina*	*tree*	*FACU*
3.	*Toxicodendron radicans*	*vine*	*FAC*	11.	*Vitis rotundifolia*	*vine*	*FAC*
4.	*Oxydendron arboreum*	*tree*	*FAC*	12.			
5.	*Acer rubrum*	*tree*	*FAC*	13.			
6.	*Fagus grandifolia*	*tree*	*FACU*	14.			
7.	*Juniperus virginiana*	*tree*	*FACU-*	15.			
8.	*Ulmus alata*	*tree*	*FACU+*	16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *65%*

Remarks *The majority of the vegetation is facultative.*

HYDROLOGY

___ Recorded Data (Describe in Remarks)
___ Stream, Lake, or tide Gauge
___ Aerial Photographs
___ Other
__X__ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)

Depth to Free Water in Pit: _____ (in.)

Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators
Primary Indicators:
___ Inundated
___ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks *20-30% slope*

SOILS

Map Unit Name
(Series and Phase): *Cecil soils*

Drainage Class: *Well-drained*

Taxonomy (Subgroup *Typic Kanhapludults*

Field Observations
Confirm Mapped Type? [Yes] No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2	*A*	*10YR 4/4*			*sandy clay loam*
2-10	*B1*	*10YR 5/4*			*clay loam, blocky*
10+	*B2*	*10YR 7/8*			*clay loam, sand inclusion*

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
___ Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [Yes] No
Wetland Hydrology Present? Yes [No]
Hydric Soils Present? Yes [No]

Is this Sampling Point Within a Wetland? Yes [No]

Remarks *Plot was taken approximately 30 feet uphill from Plot B5*

Approved by HQUSACE 3/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual

Project/Site:	*Five Mile Branch Stream Restoration Project*	Date:	*15-Nov*
Applicant/Owner:	*NCDOT*	County:	*Iredell*
Investigator(s):	*Harold M. Brady / Bob Lepsic*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	Yes / No	Community ID:	*Upland*
Is the site significantly disturbed (Atypical Situation)?	Yes / No	Transect ID:	*C*
Is this area a potential Problem Area?	Yes / No	Plot ID:	*C10*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Cornus florida*	*tree*	*FACU*	9.			
2.	*Liquidambar styraciflua*	*tree*	*FAC*	10.			
3.	*Toxicodendron radicans*	*vine*	*FAC*	11.			
4.	*Oxydendron arboreum*	*tree*	*FAC*	12.			
5.	*Acer rubrum*	*tree*	*FAC*	13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *80%*

Remarks *The majority of the vegetation is facultative.*

HYDROLOGY

___ Recorded Data (Describe in Remarks)
___ Stream, Lake, or tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)

Depth to Free Water in Pit: _____ (in.)

Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators
Primary Indicators:
___ Inundated
___ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks *5-10% slope*

SOILS

Map Unit Name
(Series and Phase): *Altavista fine sandy loam*

Drainage Class: *Moderately well-drained*

Taxonomy (Subgroup *Aquic Hapludults*

Field Observations
Confirm Mapped Type? [Yes] No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2	*A*	*10YR 4/4*			*sandy clay loam*
2-10	*B1*	*10YR 5/4*			*clay loam, blocky*
10+	*B2*	*10YR 7/8*			*clay loam, sand inclusion*

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
___ Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [Yes] No
Wetland Hydrology Present? Yes [No]
Hydric Soils Present? Yes [No]

Is this Sampling Point Within a Wetland? Yes [No]

Remarks *Plot was taken approximately 30 feet uphill from Plot C10.*

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual

Project/Site:	*Five Mile Branch Stream Restoration Project*	Date:	*15-Nov*
Applicant/Owner:	*NCDOT*	County:	*Iredell*
Investigator(s):	*Harold M. Brady / Bob Lepsic*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	**Yes** / No	Community ID:	*PFO1*
Is the site significantly disturbed (Atypical Situation)?	Yes / **No**	Transect ID:	*A*
Is this area a potential Problem Area?	Yes / **No**	Plot ID:	*A16*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Arundinaria gigantea*	*grass*	*FACW*	9.			
2.	*Liquidambar styraciflua*	*tree*	*FAC*	10.			
3.	*Carex spp.*	*grass*	*FACW*	11.			
4.	*Nyssa sylvatica*	*tree*	*FAC*	12.			
5.	*Ulmus americana*	*tree*	*FAC*	13.			
6.	*Vitis rotundifolia*	*vine*	*FAC*	14.			
7.	*Smilax rotundifolia*	*tree*	*FAC*	15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *100%*

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks)
___ Stream, Lake, or tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: ____ (in.)

Depth to Free Water in Pit: **10** (in.)

Depth to Saturated Soil: **0** (in.)

Wetland Hydrology Indicators
Primary Indicators:
___ Inundated
X Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
X Sediment Deposits
X Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
X Oxidized Root Channels in Upper 12 Inches
X Water-Stained Leaves
___ Local Soil Survey Data
X FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks *Depression approximately 1.5 acres probably dug during the construction of Interstate 40 for borrow material.*

SOILS

Map Unit Name (Series and Phase): *Chewacla soils*

Drainage Class: *Somewhat poorly*

Taxonomy (Subgroup): *Fluvaquentic Dystrudepts*

Field Observations Confirm Mapped Type? Yes [No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2	*A*	*2.5YR 5/2*			*clay loam*
2+	*B*	*2.5YR 6/1*	*5Y 6/8*	*small*	*sandy clay loam*

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- X Sulfidic Odor
- X Aquic Moisture Regime
- X Reducing Conditions
- X Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks *This area is likely an inclusion of Wehadkee soils within an area mapped as Chewacla.*

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [Yes] No

Wetland Hydrology Present? [Yes] No

Hydric Soils Present? [Yes] No

Is this Sampling Point Within a Wetland? [Yes] No

Remarks *Plot taken approximately 10 feet downhill from A16.*

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual

Project/Site:	*Five Mile Branch Stream Restoration Project*	Date:	*15-Nov*
Applicant/Owner:	*NCDOT*	County:	*Iredell*
Investigator(s):	*Harold M. Brady / Bob Lepsic*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	**Yes** / No	Community ID:	*PFO1*
Is the site significantly disturbed (Atypical Situation)?	Yes / **No**	Transect ID:	*B*
Is this area a potential Problem Area?	Yes / **No**	Plot ID:	*B5*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Arundinaria gigantea*	*grass*	*FACW*	9.			
2.	*Liquidambar styraciflua*	*tree*	*FAC*	10.			
3.	*Carex spp.*	*grass*	*FACW*	11.			
4.	*Typha latifolia*	*grass*	*FACW+*	12.			
5.	*Ulmus americana*	*tree*	*FAC*	13.			
6.	*Vitis rotundifolia*	*vine*	*FAC*	14.			
7.	*Smilax rotundifolia*	*tree*	*FAC*	15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *100%*

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks)
___ Stream, Lake, or tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: ____ (in.)

Depth to Free Water in Pit: **4** (in.)

Depth to Saturated Soil: **0** (in.)

Wetland Hydrology Indicators
Primary Indicators:
___ Inundated
X Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
X Sediment Deposits
X Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
X Oxidized Root Channels in Upper 12 Inches
X Water-Stained Leaves
___ Local Soil Survey Data
X FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name (Series and Phase): *Chewacla soils*

Drainage Class: *Somewhat poorly*

Taxonomy (Subgroup): *Fluvaquentic Dystrudepts*

Field Observations Confirm Mapped Type? Yes [No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2	*A*	*2.5YR 5/2*			*clay loam*
2+	*B*	*2.5YR 6/1*	*5Y 6/8*	*small*	*sandy clay loam*

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- X Sulfidic Odor
- X Aquic Moisture Regime
- X Reducing Conditions
- X Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks *This area is likely an inclusion of Wehadkee soils within an area mapped as Chewacla.*

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [Yes] No

Wetland Hydrology Present? [Yes] No

Hydric Soils Present? [Yes] No

Is this Sampling Point Within a Wetland? [Yes] No

Remarks *Plot taken approximately 10 feet downhill from B5.*

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual

Project/Site:	*Five Mile Branch Stream Restoration Project*	Date:	*15-Nov*
Applicant/Owner:	*NCDOT*	County:	*Iredell*
Investigator(s):	*Harold M. Brady / Bob Lepsic*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	**Yes** / No	Community ID:	*PFO1*
Is the site significantly disturbed (Atypical Situation)?	Yes / **No**	Transect ID:	*C*
Is this area a potential Problem Area? (If needed, explain on reverse)	Yes / **No**	Plot ID:	*C10*

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Arundinaria gigantea*	*grass*	*FACW*	9.			
2.	*Liquidambar styraciflua*	*tree*	*FAC*	10.			
3.	*Carex spp.*	*grass*	*FACW*	11.			
4.	*Typha latifolia*	*grass*	*FACW+*	12.			
5.	*Ulmus americana*	*tree*	*FAC*	13.			
6.	*Vitis rotundifolia*	*vine*	*FAC*	14.			
7.	*Smilax rotundifolia*	*tree*	*FAC*	15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *100%*

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks)
___ Stream, Lake, or tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: ____ (in.)

Depth to Free Water in Pit: **4** (in.)

Depth to Saturated Soil: **0** (in.)

Wetland Hydrology Indicators
Primary Indicators:
___ Inundated
X Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
X Sediment Deposits
X Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
X Oxidized Root Channels in Upper 12 Inches
X Water-Stained Leaves
___ Local Soil Survey Data
X FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name (Series and Phase): *Chewacla soils*

Drainage Class: *Somewhat poorly*

Taxonomy (Subgroup): *Fluvaquentic Dystrudepts*

Field Observations
Confirm Mapped Type? Yes [No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2	*A*	*2.5YR 5/2*			*clay loam*
2+	*B*	*2.5YR 6/1*	*5Y 6/8*	*small*	*sandy clay loam*

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- X Sulfidic Odor
- X Aquic Moisture Regime
- X Reducing Conditions
- X Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks *This area is likely an inclusion of Wehadkee soils within an area mapped as Chewacla.*

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [Yes] No

Wetland Hydrology Present? [Yes] No

Hydric Soils Present? [Yes] No

Is this Sampling Point Within a Wetland? [Yes] No

Remarks *Plot taken approximately 10 feet downhill from C10.*

Appendix 3

Restoration Site NCDWQ Stream Classification Form

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

Date: 3/11/09	Project: 5 mile Branch	Latitude:
Evaluator: RSL	Site: Beaver Creek	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 49.5	County: Iredell	Other Statesville East *e.g. Quad Name:*

A. Geomorphology (Subtotal = 27)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	(3)
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	2	(3)
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	1	2	(3)
9[a] Natural levees	0	1	(2)	3
10. Headcuts	(0)	1	2	3
11. Grade controls	0	0.5	1	(1.5)
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		(Yes = 3)	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10.5)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season	0	1	2	(3)
16. Leaflitter	(1.5)	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	(1.5)
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	(1.5)
19. Hydric soils (redoximorphic features) present?	(No = 0)		Yes = 1.5	

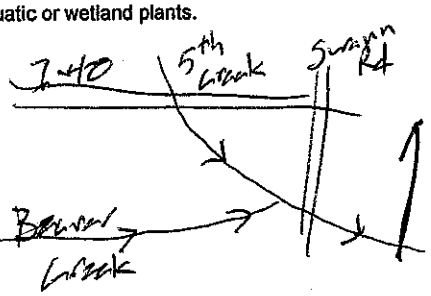
C. Biology (Subtotal = 12)				
20[b]. Fibrous roots in channel	(3)	2	1	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	0.5	1	(1.5)
23. Bivalves	(0)	1	2	3
24. Fish	0	0.5	1	(1.5)
25. Amphibians	0	0.5	1	(1.5)
26. Macrobenthos (note diversity and abundance)	0	0.5	1	(1.5)
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Stream 20-30' wide @ TOB. 6-8' deep @ TOB
Low flow < 1' on average. Sand bed.
Numerous logjams. Evidence of overbank flow. Severe bank erosion

Sketch:



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

Date: 3/11/09	**Project:** 5 Mile Branch	**Latitude:**
Evaluator: RSL	**Site:** Fifth Creek	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 49.5	**County:** Iredell	**Other** Statesville East *e.g. Quad Name:*

A. Geomorphology (Subtotal = 27)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	(3)
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	2	(3)
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	1	2	(3)
9[a] Natural levees	0	1	(2)	3
10. Headcuts	(0)	1	2	3
11. Grade controls	0	0.5	1	(1.5)
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		(Yes = 3)	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10.5)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season	0	1	2	(3)
16. Leaflitter	(1.5)	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	(1.5)
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	(1.5)
19. Hydric soils (redoximorphic features) present?	(No = 0)		Yes = 1.5	

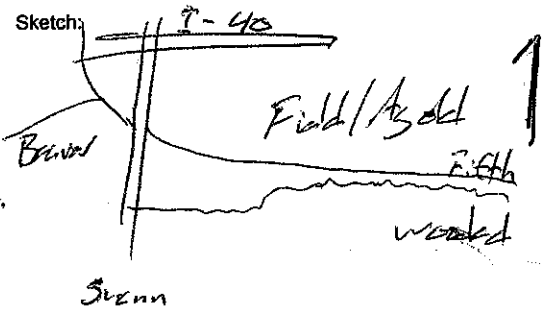
C. Biology (Subtotal = 12)				
20[b]. Fibrous roots in channel	(3)	2	1	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	0.5	1	(1.5)
23. Bivalves	(0)	1	2	3
24. Fish	0	0.5	1	(1.5)
25. Amphibians	0	0.5	1	(1.5)
26. Macrobenthos (note diversity and abundance)	0	0.5	1	(1.5)
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

30' wide x 6-8' deep @ TOB. Scrd Bed. Severe bank erosion. Frogs, fish, macros+ crayfish. Numerous log jams. Low slope. Evidence of floodplain flow.

Sketch:



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

Date: 3/11/09	**Project:** 5 mile	**Latitude:**
Evaluator: RE	**Site:** UT to Beaver	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 29.5	**County:** Iredell	**Other** Statesville East *e.g. Quad Name:*

A. Geomorphology (Subtotal = 19.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	1	(2)	3
3. In-channel structure: riffle-pool sequence	0	1	(2)	3
4. Soil texture or stream substrate sorting	0	1	(2)	3
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	(2)	3
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	(1)	2	3
9[a] Natural levees	0	(1)	2	3
10. Headcuts	0	(1)	2	3
11. Grade controls	0	0.5	(1)	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 2.5)				
14. Groundwater flow/discharge	0	1	(2)	3
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	(2)	3
16. Leaflitter	1.5	1	(0.5)	0
17. Sediment on plants or debris	0	0.5	(1)	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	(1.5)
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

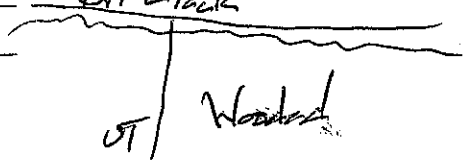
C. Biology (Subtotal = 2.5)				
20[b]. Fibrous roots in channel	3	(2)	1	0
21[b]. Rooted plants in channel	3	(2)	1	0
22. Crayfish	(0)	0.5	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	(0)	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	(0.5)	1	1.5
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	(FAC = 0.5); FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Flows through mature woods. Spoil piles adjacent ±3' wide 1-2' deep @ TOB. Only bugs found. Mixed substrate.

Sketch: 40



1

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

Date: 3/11/09	Project: 5 Mile	Latitude:
Evaluator: RL	Site: UT @ Chimney	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 35.5	County: Iredell	Other *e.g. Quad Name:* Statesville East

A. Geomorphology (Subtotal = 23.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	1	2	(3)
3. In-channel structure: riffle-pool sequence	0	1	2	(3)
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	(0)	1	(2)	3
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	1	(2)	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	0	1	(2)	3
11. Grade controls	0	0.5	(1)	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	1	(0.5)	0
17. Sediment on plants or debris	0	0.5	(1)	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	(1)	1.5
19. Hydric soils (redoximorphic features) present?	(No = 0)		Yes = 1.5	

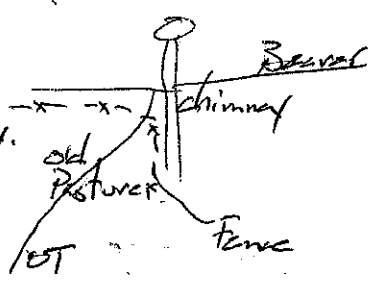
C. Biology (Subtotal = 4)				
20[b]. Fibrous roots in channel	3	2	(1)	0
21[b]. Rooted plants in channel	3	2	(1)	0
22. Crayfish	(0)	0.5	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	0	(0.5)	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	(1)	1.5
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	(FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

3-4' wide 1-2' deep @ TOB. Flow through old pasture. Sparse understory. Bugs only found. Evidence of overbank flow. Substrate mixed sand & gravel

Sketch: 40



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

Date: 3/11/05	Project: 5 Mile	Latitude:
Evaluator: RL	Site: UT to Swann	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 27.5	County: Iredell	Other Statesville East e.g. Quad Name:

A. Geomorphology (Subtotal = 15)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	(1)	2	3
4. Soil texture or stream substrate sorting	0	(1)	2	3
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	0	(1)	2	3
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	1	(2)	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	(0)	1	2	3
11. Grade controls	0	0.5	1	(1.5)
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	1	(0.5)	0
17. Sediment on plants or debris	0	0.5	(1)	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	(1)	1.5
19. Hydric soils (redoximorphic features) present?	(No = 0)		Yes = 1.5	

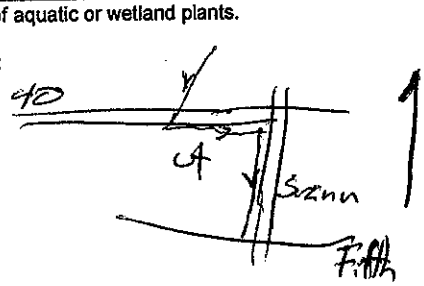
C. Biology (Subtotal = 4)				
20[b]. Fibrous roots in channel	3	2	(1)	0
21[b]. Rooted plants in channel	3	2	(1)	0
22. Crayfish	(0)	0.5	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	0	(0.5)	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	(1)	1.5
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	(FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Enters site under 40 in box culvert. Straightened in past. Flows adjacent to 40 then Swann. Sand bed. Evidence of flooding. Bugs + frogs found. Enters 5th through culvert

Sketch:



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

Date: 3/11/09	**Project:** Smith	**Latitude:**
Evaluator: RS	**Site:** UT to Smith	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 35.5	**County:** Iredell	**Other** *e.g. Quad Name:* Statesville East

A. Geomorphology (Subtotal = 23.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	1	2	(3)
3. In-channel structure: riffle-pool sequence	0	1	(2)	3
4. Soil texture or stream substrate sorting	0	1	(2)	3
5. Active/relic floodplain	0	1	(2)	3
6. Depositional bars or benches	0	1	(2)	3
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	1	(2)	3
9[a] Natural levees	0	(1)	2	3
10. Headcuts	0	(1)	2	3
11. Grade controls	0	0.5	(1)	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		(Yes = 3)	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	1	(0.5)	0
17. Sediment on plants or debris	0	0.5	(1)	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	(1)	1.5
19. Hydric soils (redoximorphic features) present?	(No = 0)		Yes = 1.5	

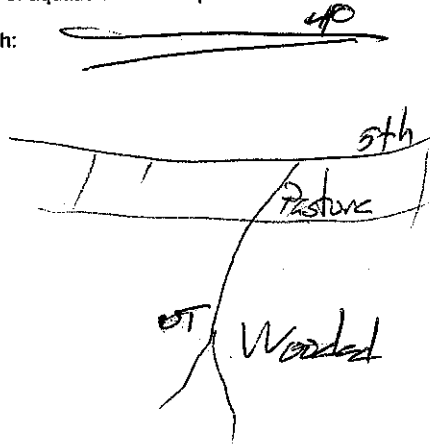
C. Biology (Subtotal = 3.5)				
20[b]. Fibrous roots in channel	3	2	(1)	0
21[b]. Rooted plants in channel	3	2	(1)	0
22. Crayfish	(0)	0.5	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	(0)	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	(1)	1.5
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Lower section flows through pasture. 5-6' wide & 2-3' deep @ TOB. Upper bank located in mature trees. Bugs found. Evidence of overbank flow

Sketch:



Appendix 4

Reference Site Photographs

Photo 1: Reference Wetland

Photo 2: Reference Wetland

Appendix 5

Reference Site USACE Routine
Wetland Determination Data Forms

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: *Five Mile Branch*
Applicant/Owner: *NCDOT*
Investigator(s): *Harold Brady and Layna Thrush*

Date: *12/4/2002*
County: *Iredell*
State: *North Carolina*

Do Normal Circumstances exist on the site?	[Yes]	No
Is the site significantly disturbed (Atypical Situation)?	Yes	[No]
Is this area a potential Problem Area? (If needed, explain on reverse)	Yes	[No]

Community ID: *Wetland*
Transect ID:
Plot ID:

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Quercus michauxii*	*canopy*	*FACW-*	9.	*Liquidambar styraciflua*	*canopy*	*FAC+*
2.	*Cornus amomum*	*understory*	*FACW+*	10.	*Quercus phellos*	*canopy*	*FACW-*
3.	*Acer rubrum*	*canopy*	*FAC*	11.	*Smilax rotundifolia*	*vine*	*FAC*
4.	*Quercus falcata*	*canopy*	*FACU*	12.	*Viburnum dentatum*	*understory*	*FAC*
5.	*Nyssa sylvatica*	*understory*	*FAC*	13.			
6.	*Juncus effusus*	*herb*	*FACW+*	14.			
7.	*Platanus occidentalis*	*canopy*	*FACW-*	15.			
8.	*Osmunda regalis*	*herb*	*OBL*	16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *92%*

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks)
___ Stream, Lake, or tide Gauge
___ Aerial Photographs
___ Other
_x_ No Recorded Data Available

Field Observations:

Depth of Surface Water: _1_ (in.)
Depth to Free Water in Pit: ___ (in.)
Depth to Saturated Soil: ___ (in.)

Wetland Hydrology Indicators:
Primary Indicators:
_x_ Inundated
_x_ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
_x_ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
_x_ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name (Series and Phase): *Wehadkee silt loam*

Drainage Class: *Aquic*

Field Observations

Taxonomy (Subgroup) *Fine-loamy, mixed, nonacid, thermic Typic Fluvaquent*

Confirm Mapped Type? [Yes] No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0 to 1/2	*OA*	*2.5YR 3/1*			*Silty Clay Loam*
1/2 to 3	*A*	*5YR 5/3*			*Silty Clay Loam*
3 to 16	*B*	*2.5Y 6/1*	*10YR 6/6*	*Common/Distinct*	*Silty Clay Loam*
			10YR 6/4	*Common/Distinct*	
16+	*Bh*	*2.5Y 2.5/1*			*Sandy Loam*

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- x Aquic Moisture Regime
- x Reducing Conditions
- x Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- x Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [Yes] No

Wetland Hydrology Present? [Yes] No

Hydric Soils Present? [Yes] No

Is this Sampling Point Within a Wetland? [Yes] No

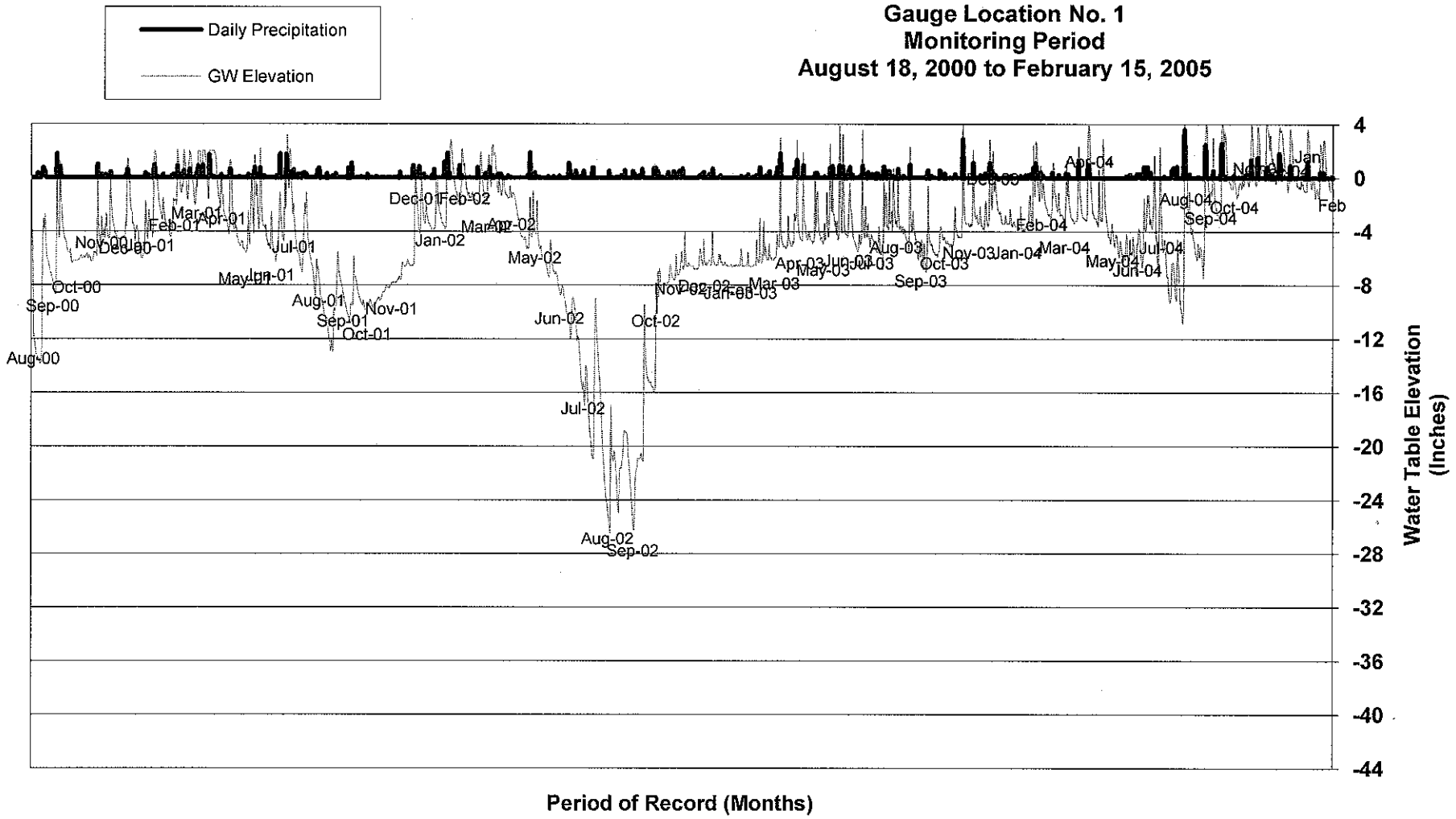
Remarks:

Appendix 6

Hydrologic Gauge Data Summary,
Groundwater and Rainfall Information

Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

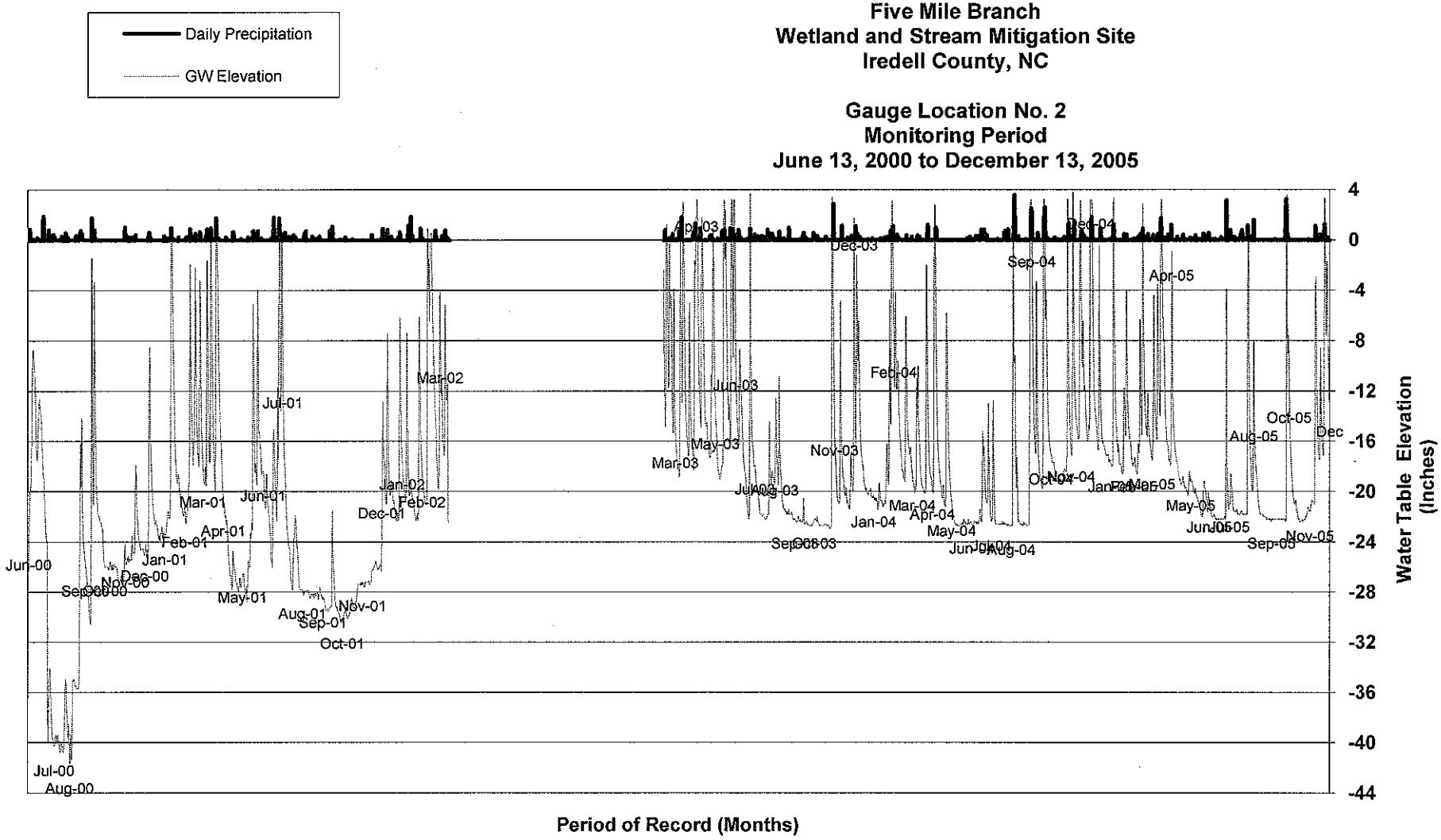
Gauge Location No. 1
Monitoring Period
August 18, 2000 to February 15, 2005



Period of Record (Months)

Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

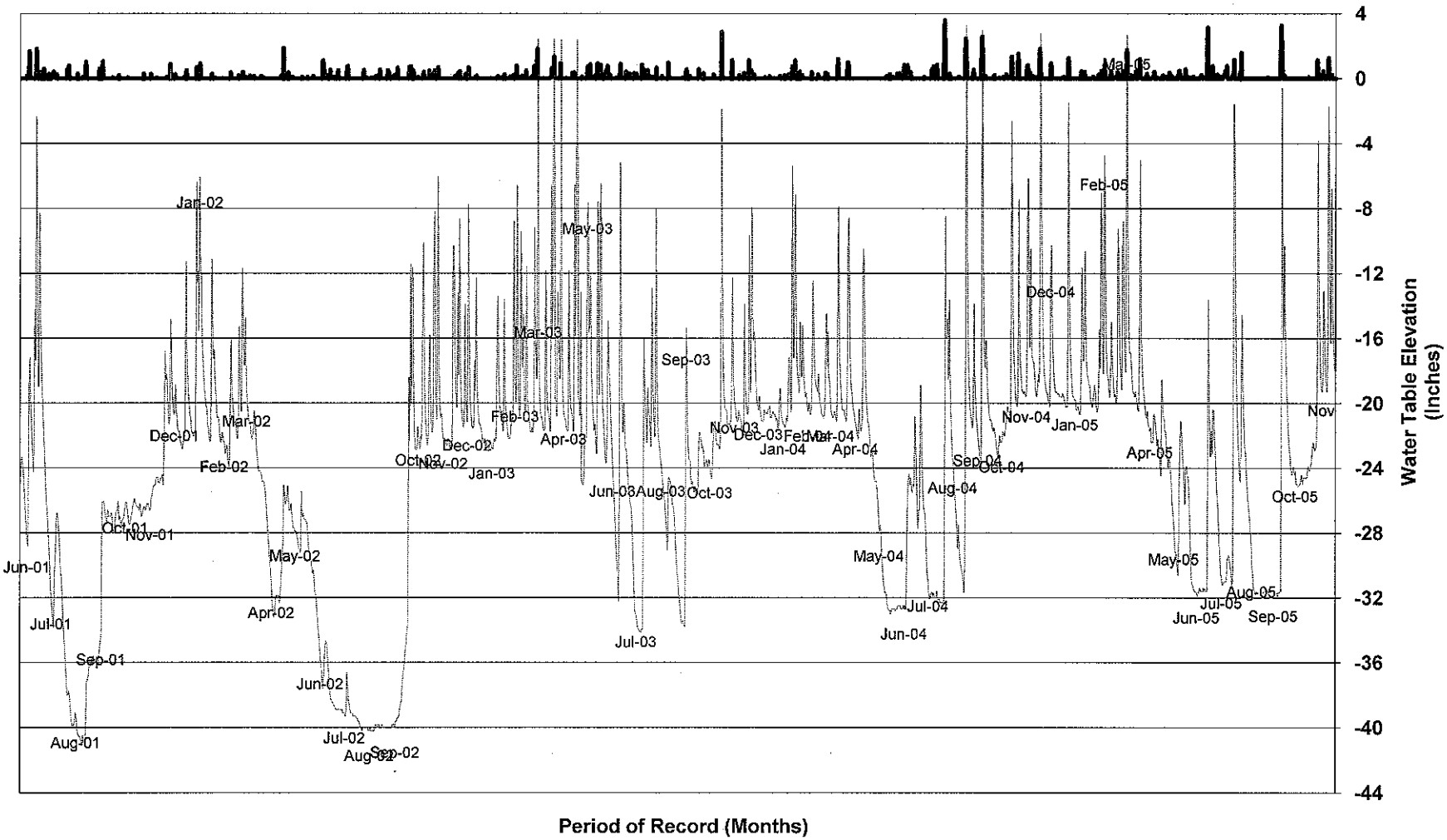
Gauge Location No. 2
Monitoring Period
June 13, 2000 to December 13, 2005



Period of Record (Months)

Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

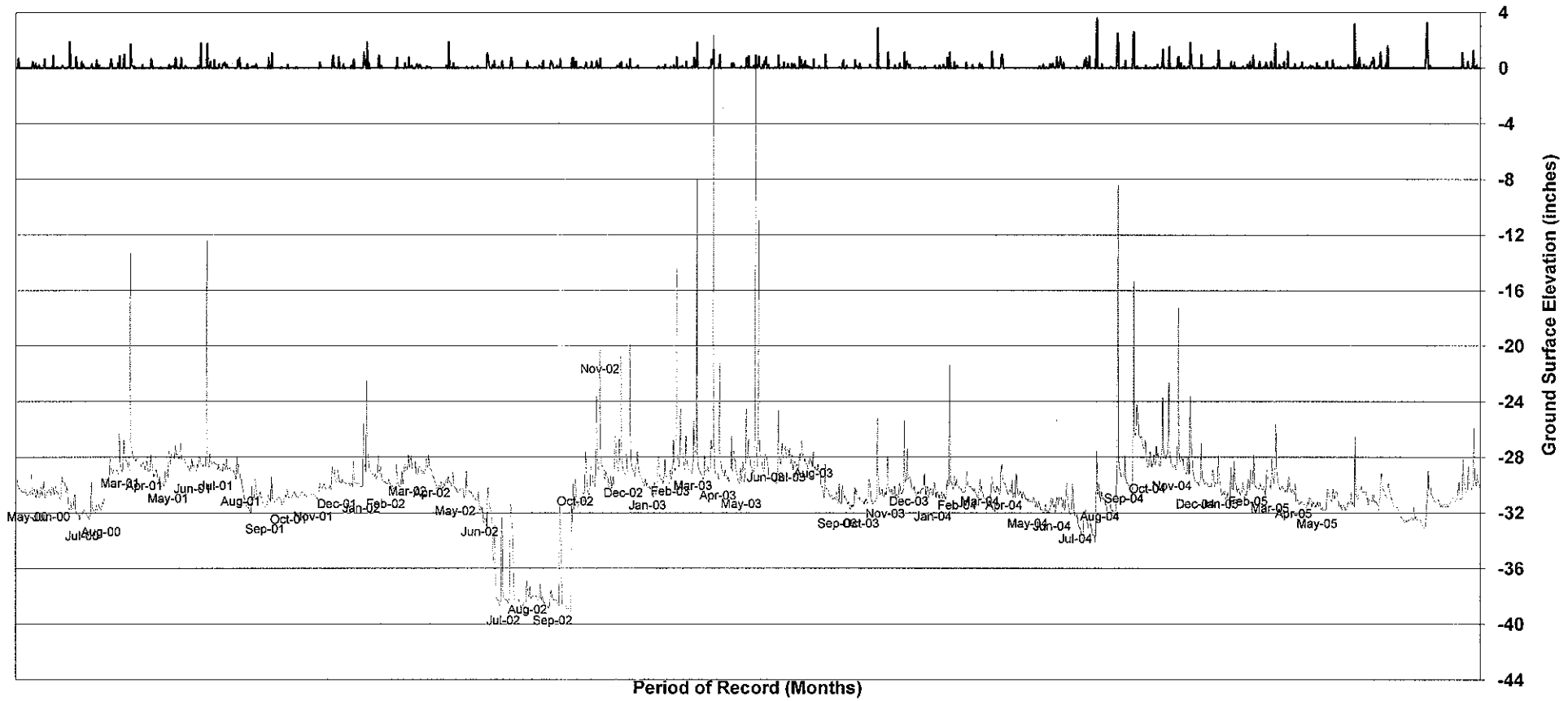
Gauge Location No. 3
Monitoring Period
June 14, 2001 to December 14, 2005



Period of Record (Months)

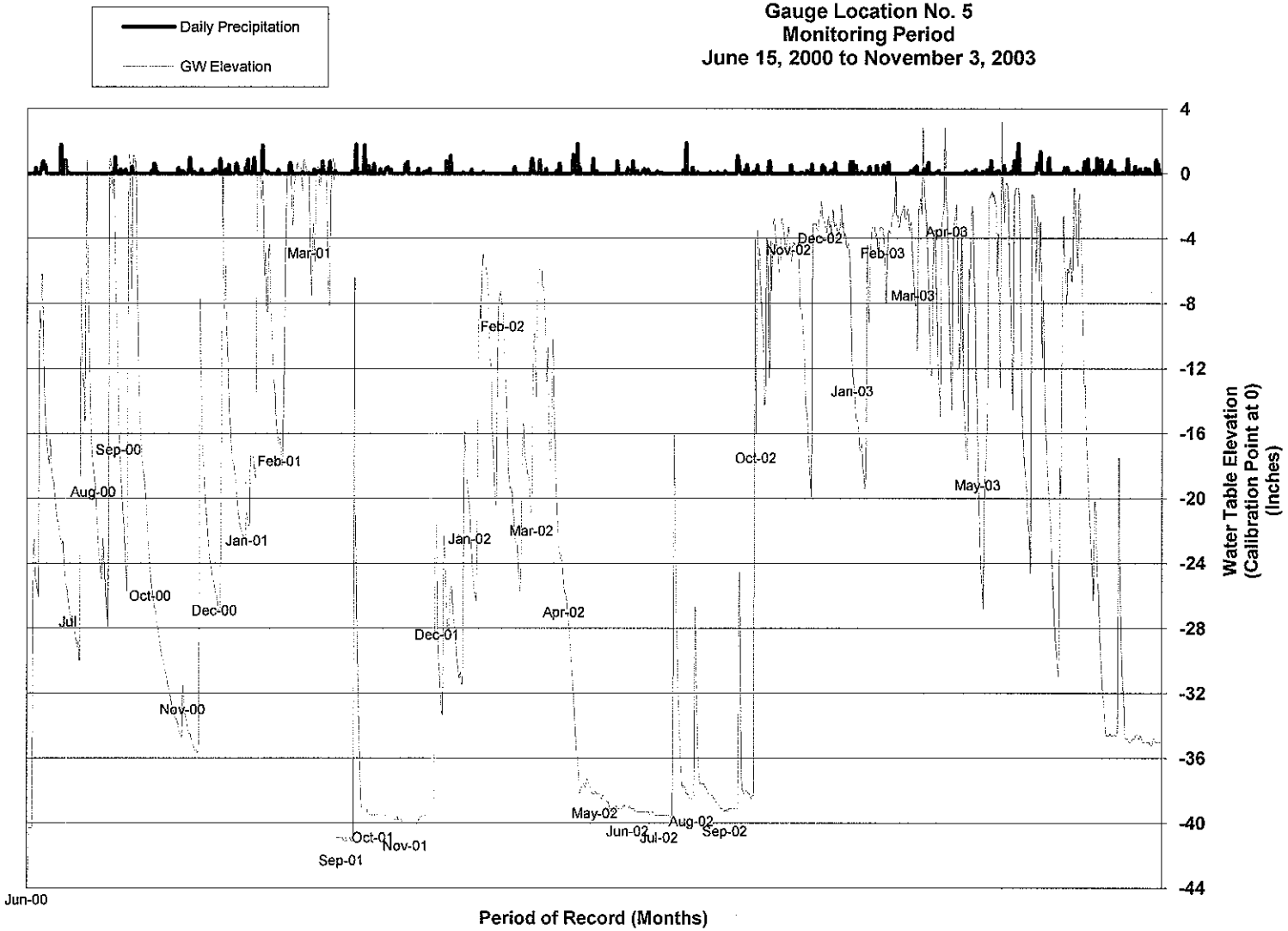
Five Mile Branch Wetland and Stream Mitigation Site Iredell County, NC

Gauge Location No. 4
April 30, 2000 to December 13, 2005



Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

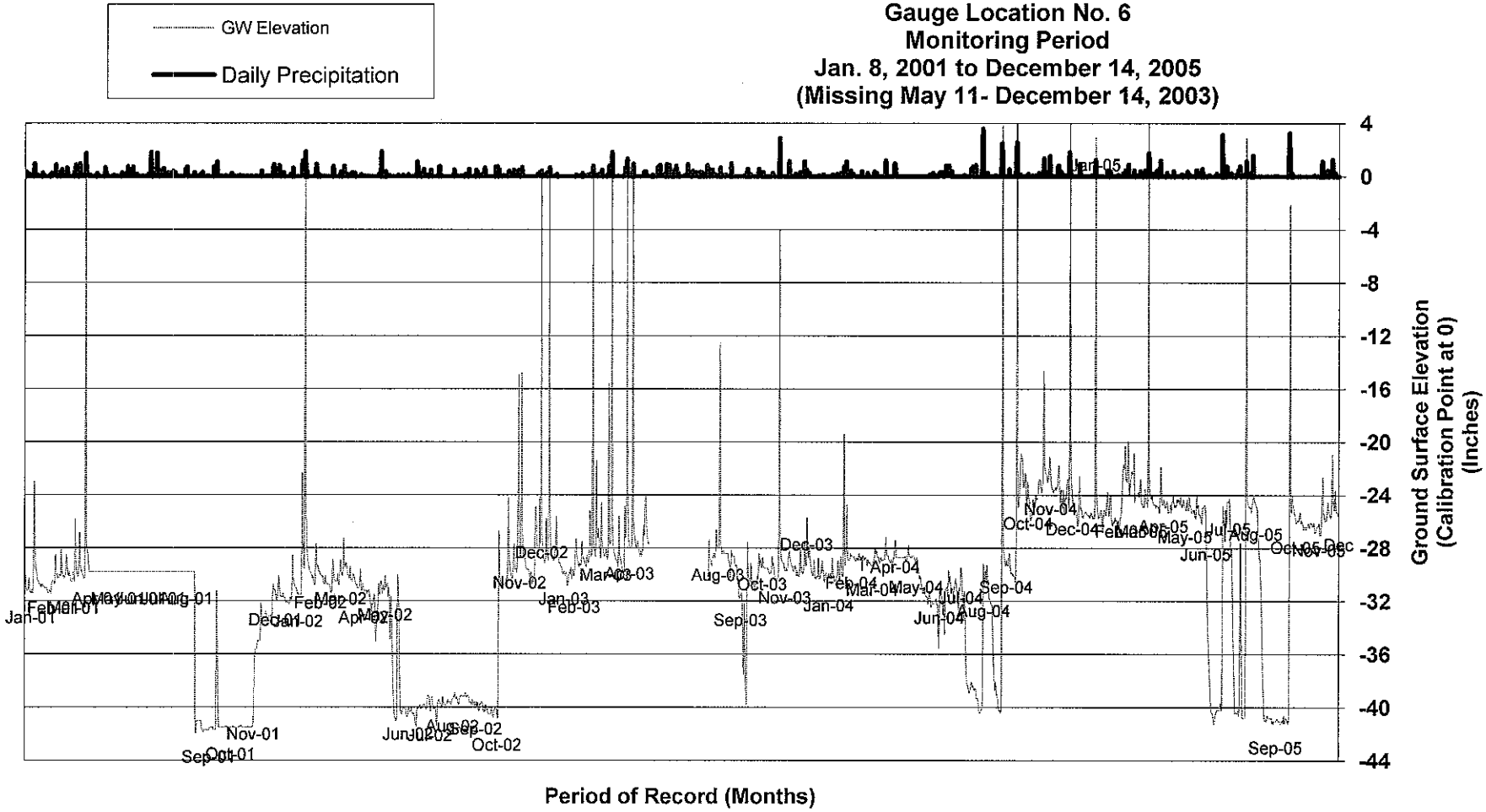
Gauge Location No. 5
Monitoring Period
June 15, 2000 to November 3, 2003



Tra\601017_FiveMile2\Well Data\Well Data Sheets\All_Well_Data.xls

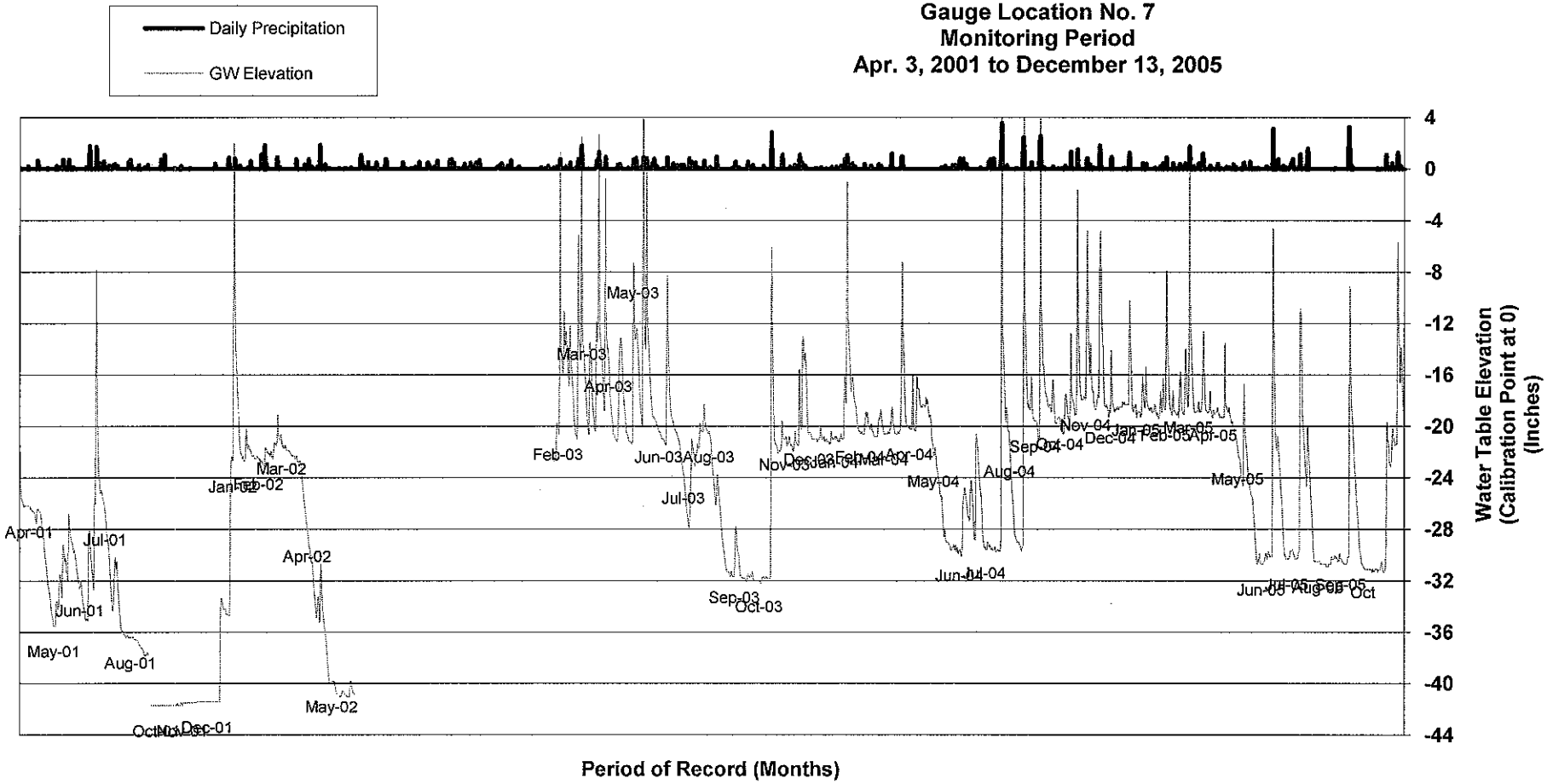
Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 6
Monitoring Period
Jan. 8, 2001 to December 14, 2005
(Missing May 11- December 14, 2003)



Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

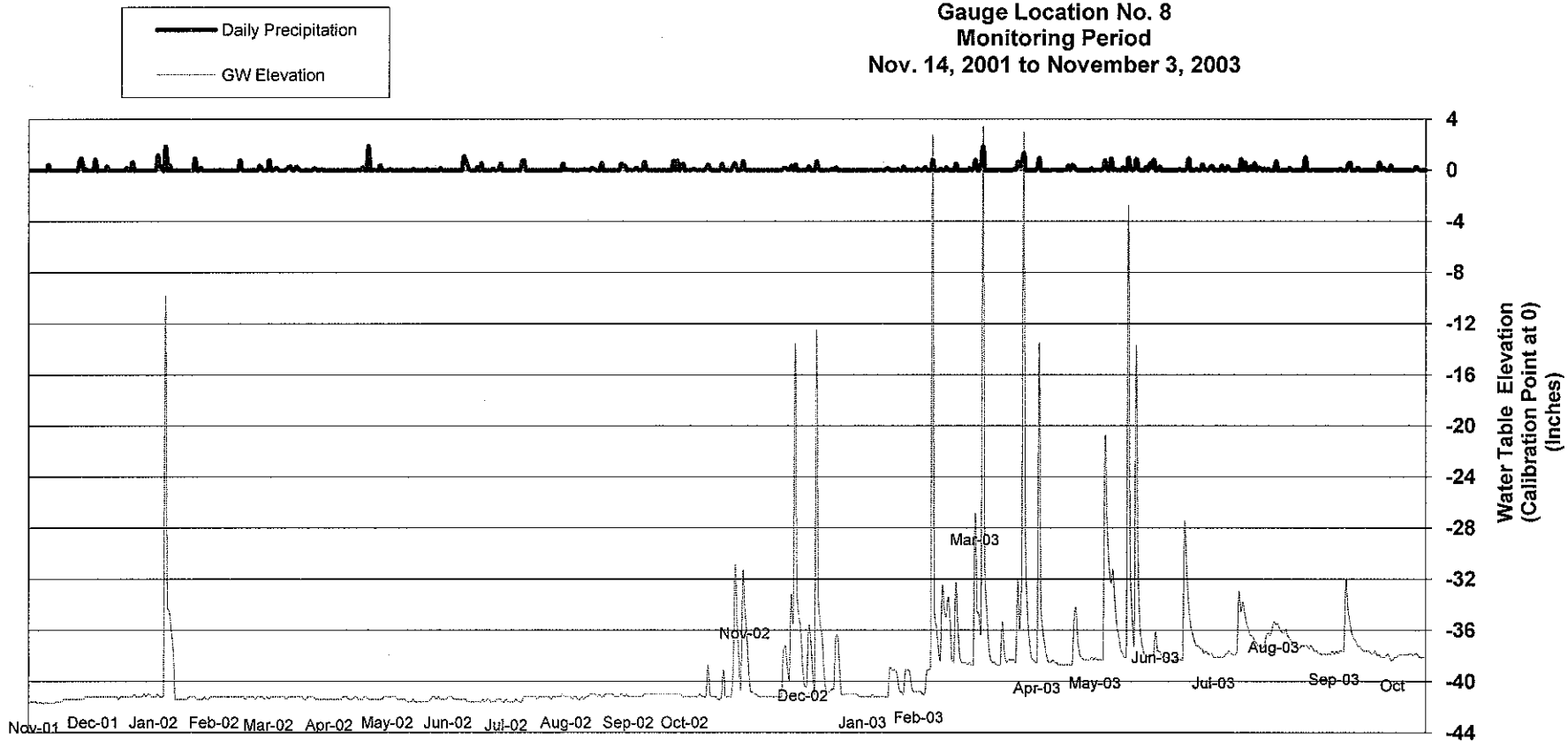
Gauge Location No. 7
Monitoring Period
Apr. 3, 2001 to December 13, 2005



Period of Record (Months)

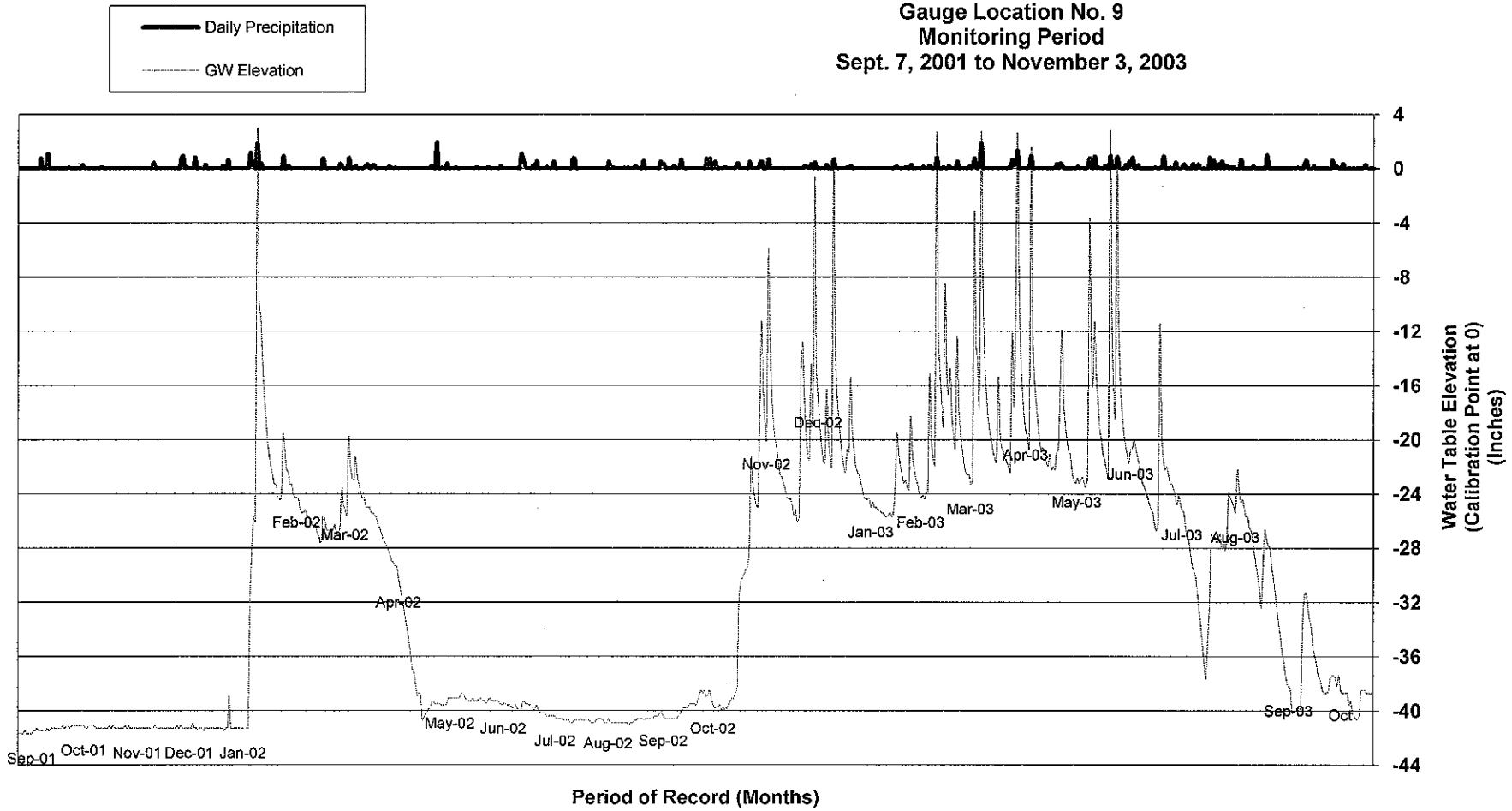
Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 8
Monitoring Period
Nov. 14, 2001 to November 3, 2003



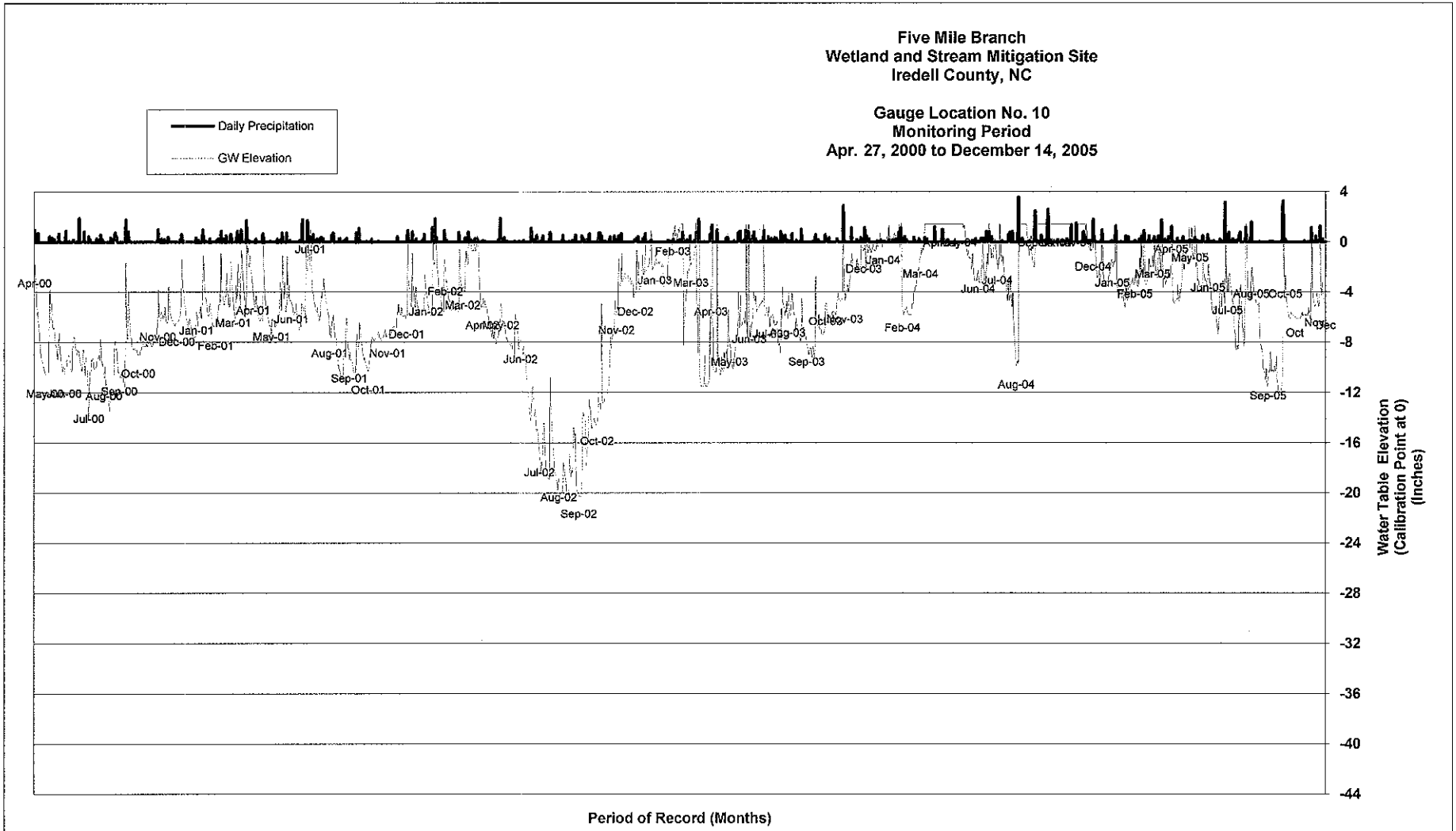
Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 9
Monitoring Period
Sept. 7, 2001 to November 3, 2003



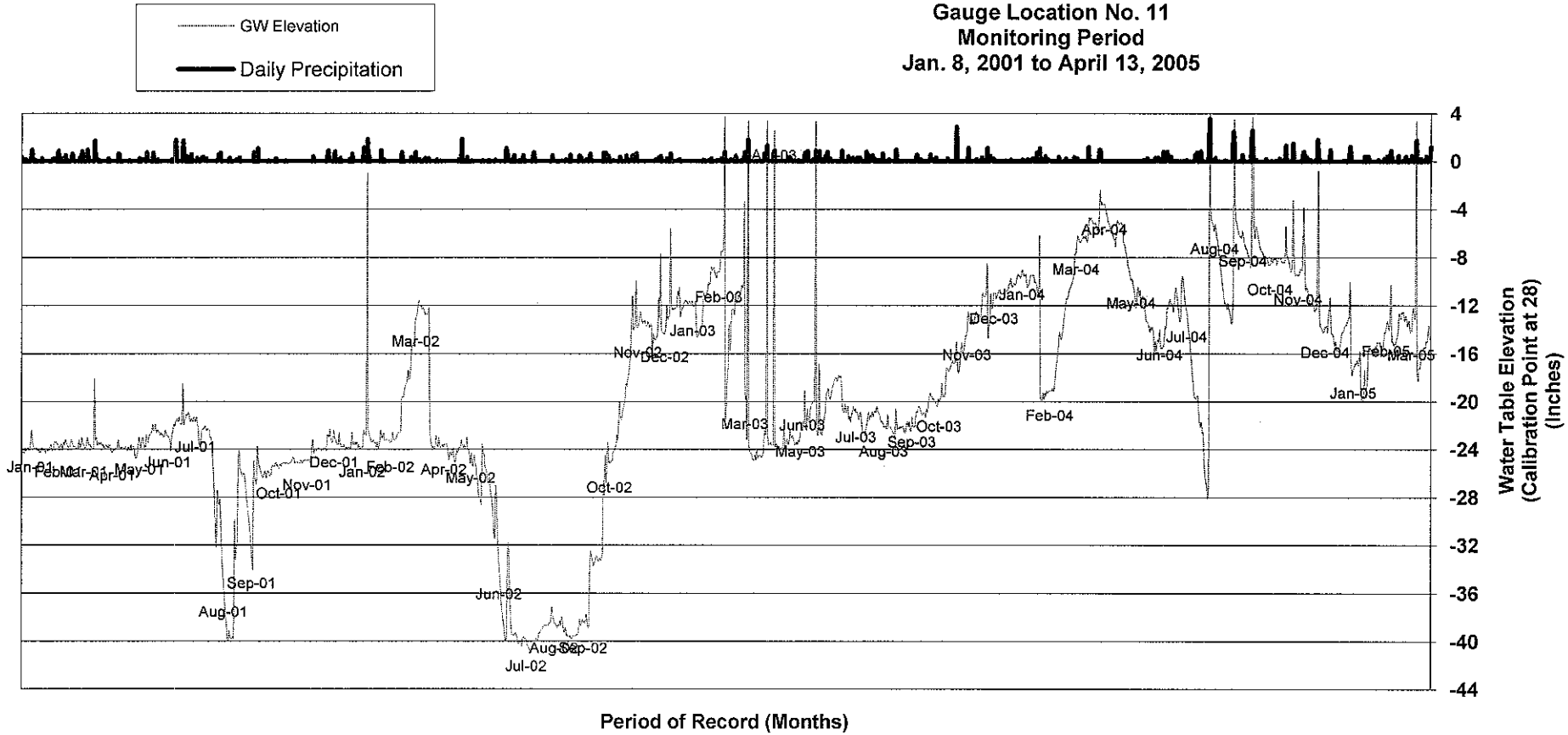
Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 10
Monitoring Period
Apr. 27, 2000 to December 14, 2005

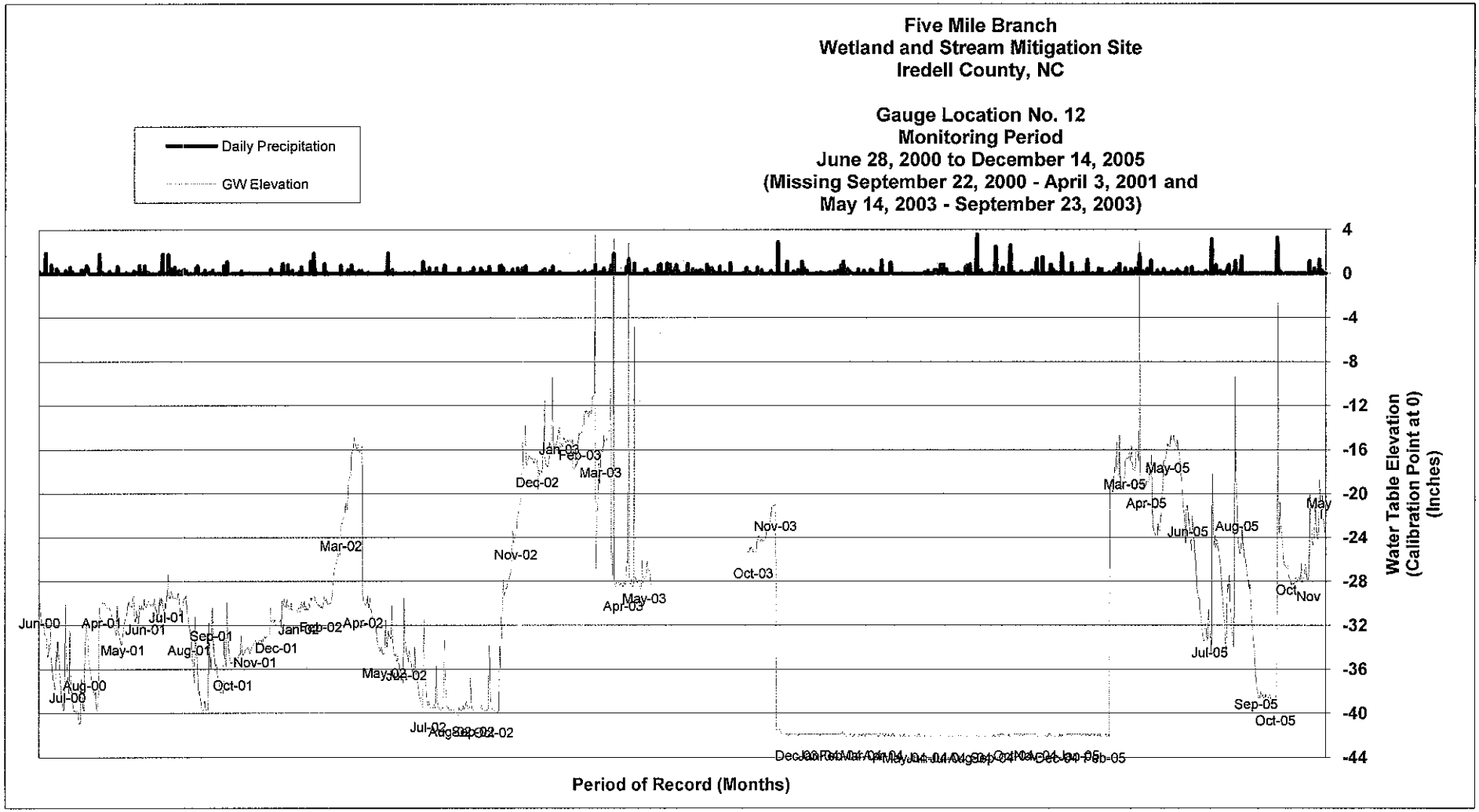


Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 11
Monitoring Period
Jan. 8, 2001 to April 13, 2005

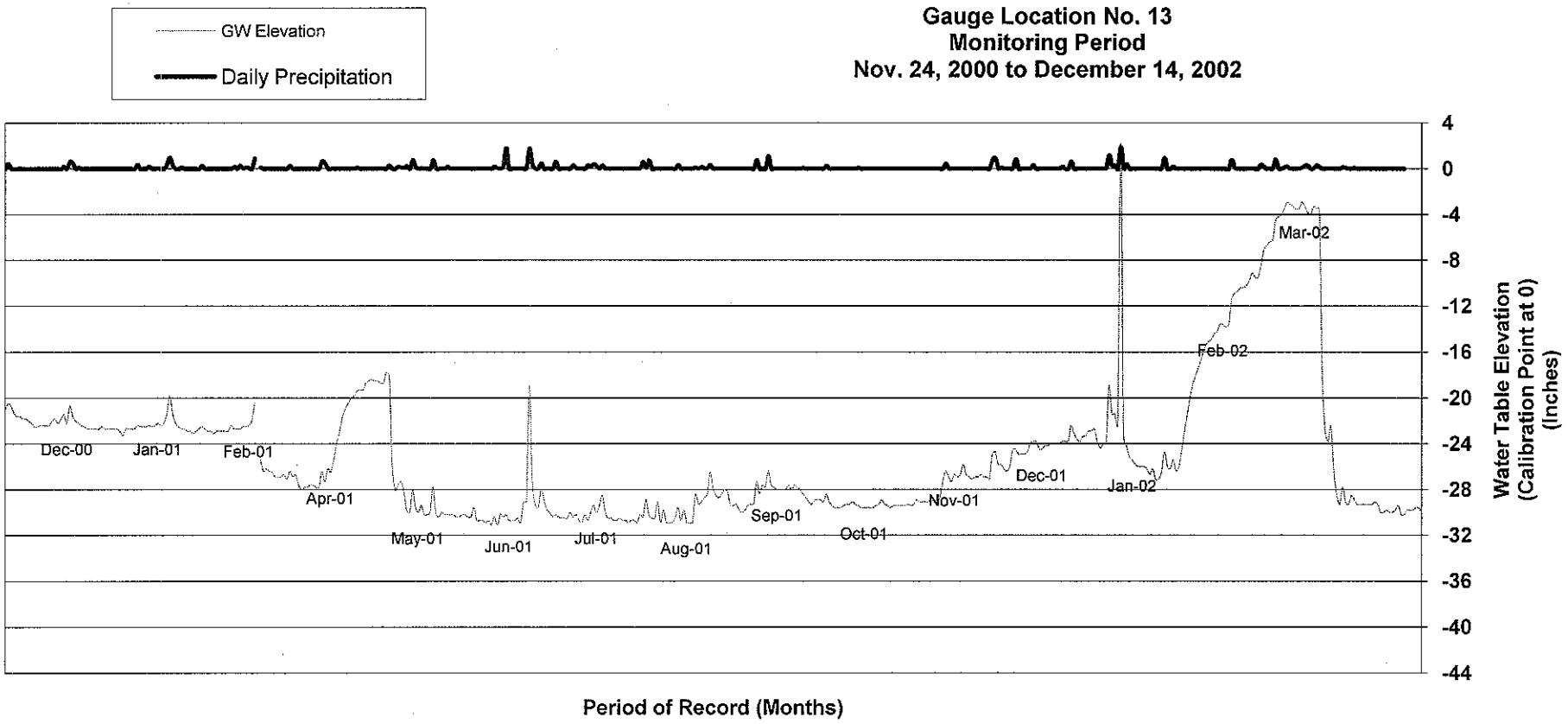


Period of Record (Months)


Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC
Gauge Location No. 12
Monitoring Period
June 28, 2000 to December 14, 2005
(Missing September 22, 2000 - April 3, 2001 and
May 14, 2003 - September 23, 2003)
Daily Precipitation
GW Elevation
4
0
-4
-8
-12
-16
-20
-24
-28
-32
-36
-40
-44
Water Table Elevation
(Calibration Point at 0)
(Inches)
Jun-00
Apr-01
Jul-01
Jun-01
May-01
Aug-01
Sep-01
Nov-01
Dec-01
Oct-01
Aug-00
Jul-00
Jan-02
Feb-02
Apr-02
Mar-02
May-02
Jun-02
Jul-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Oct-03
Nov-03
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov
May
Period of Record (Months)

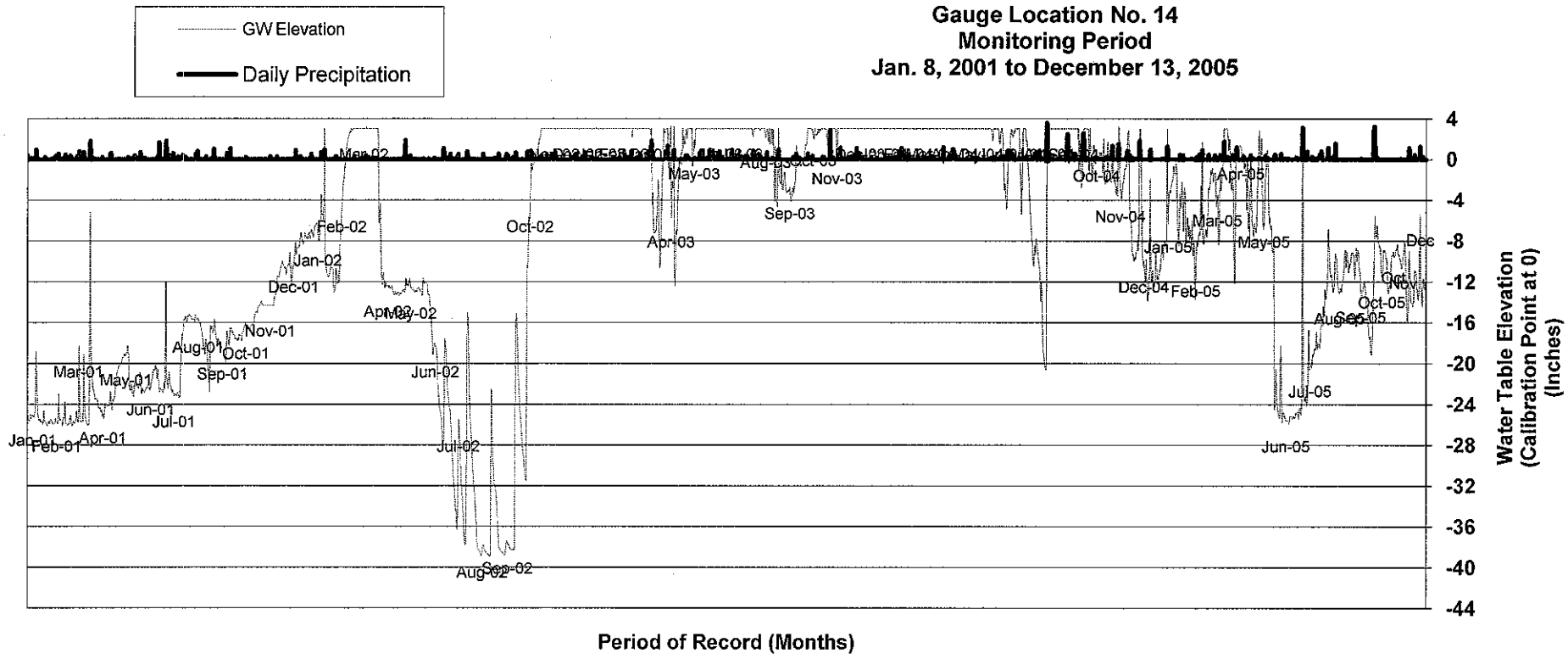
Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 13
Monitoring Period
Nov. 24, 2000 to December 14, 2002



Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

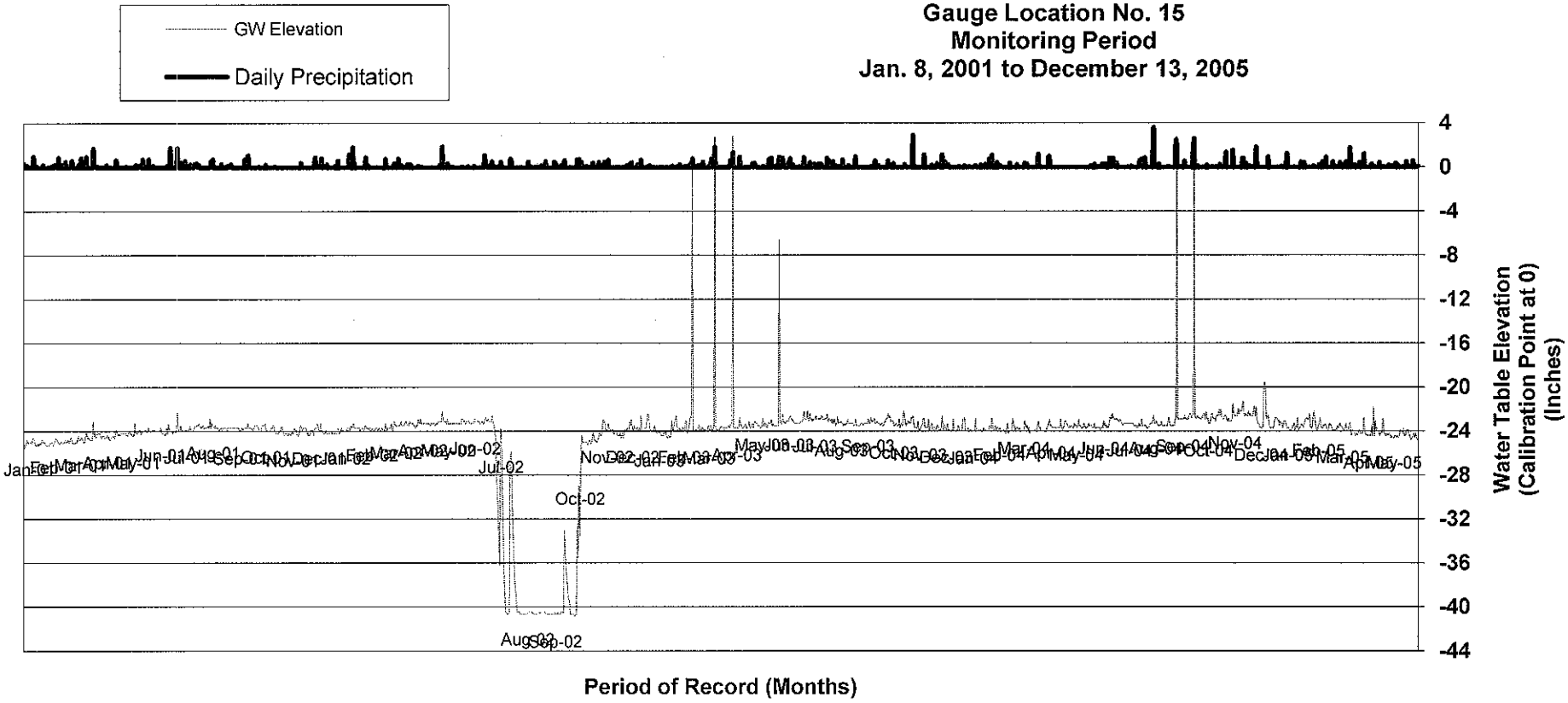
Gauge Location No. 14
Monitoring Period
Jan. 8, 2001 to December 13, 2005



Period of Record (Months)

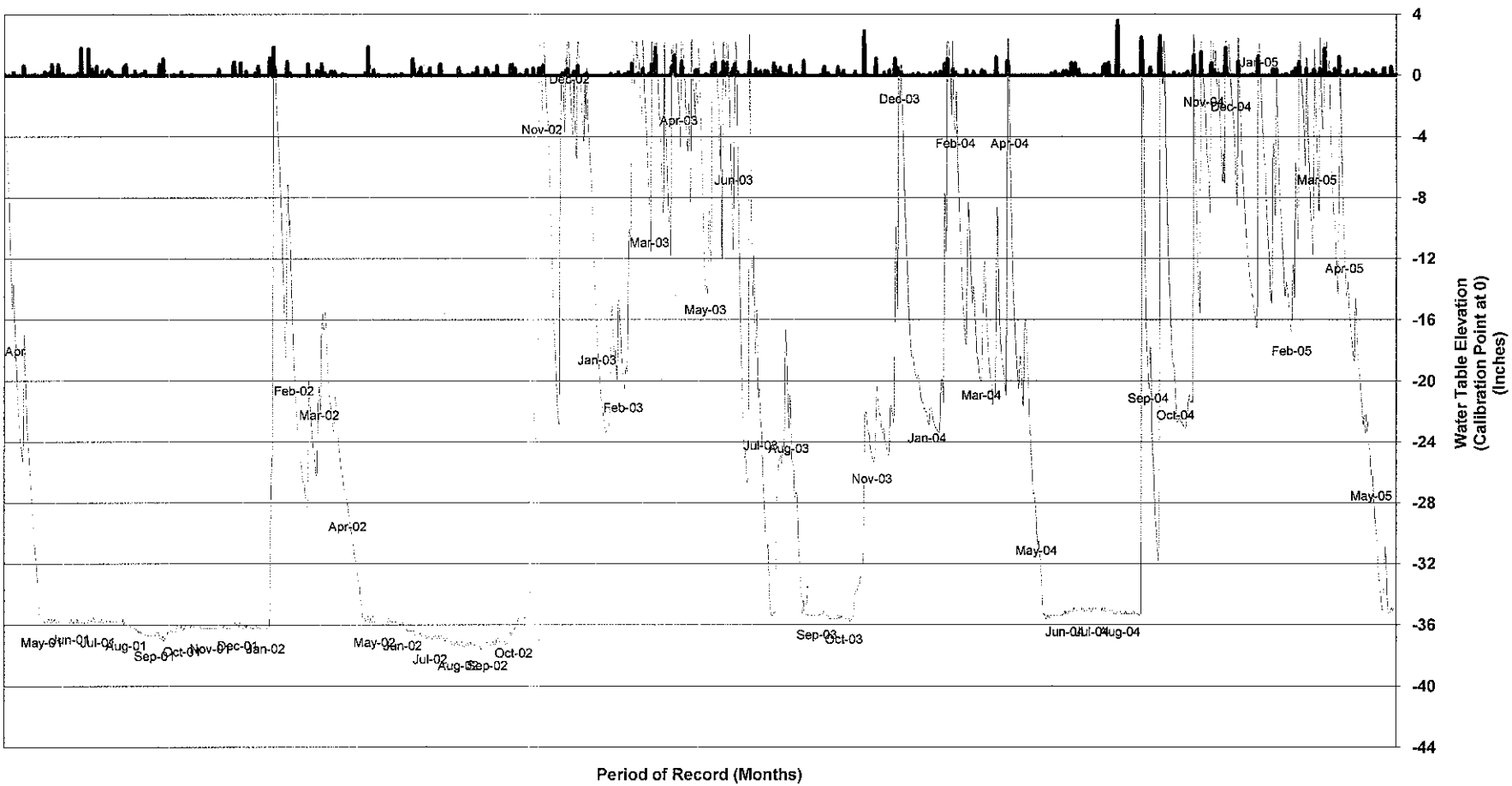
Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 15
Monitoring Period
Jan. 8, 2001 to December 13, 2005



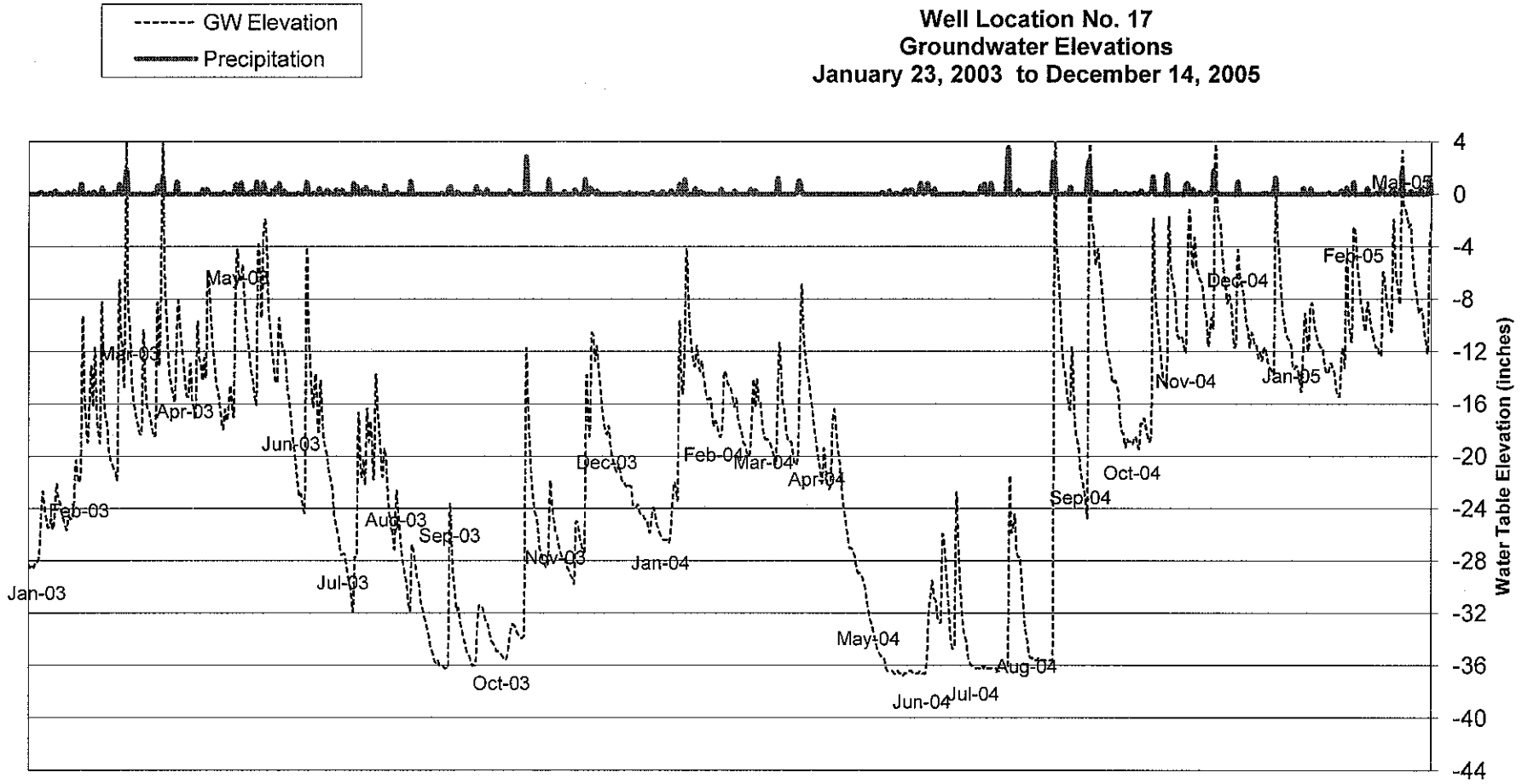
Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 16
Monitoring Period
April 3, 2001 to December 13, 2005



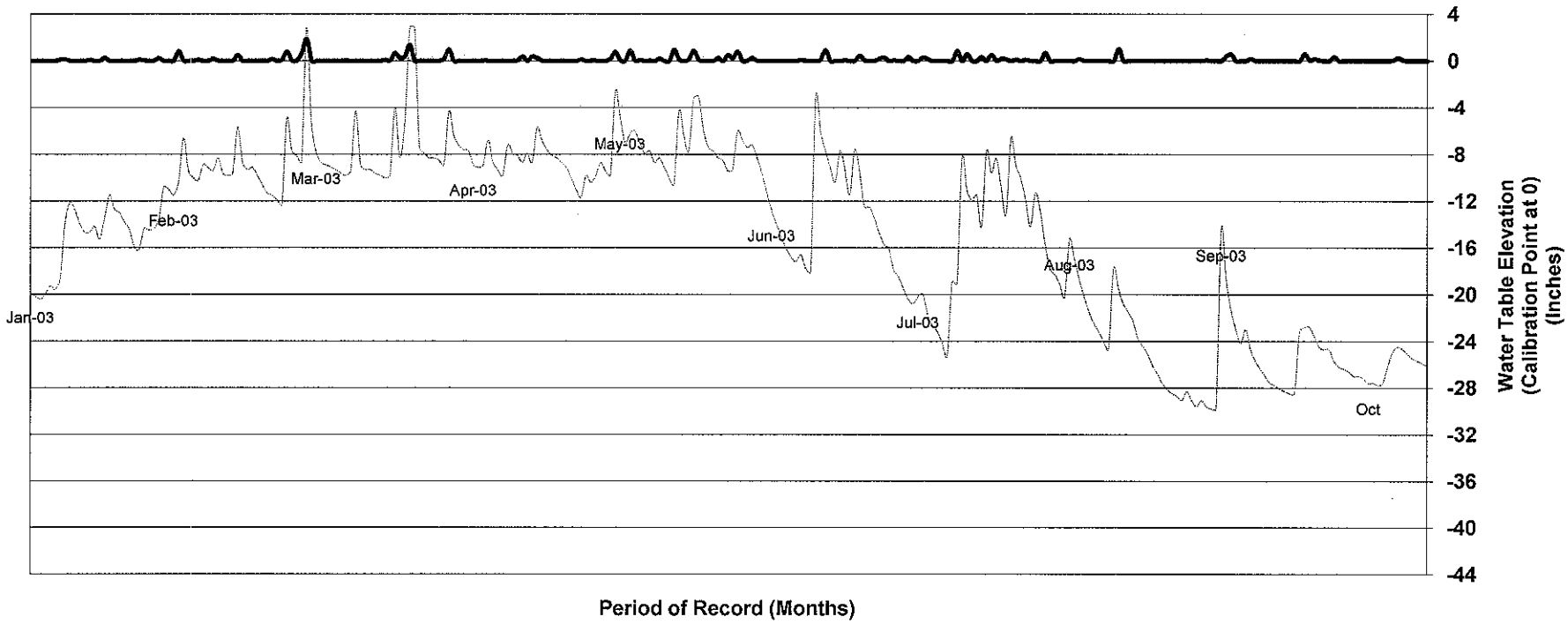
Five-Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Well Location No. 17
Groundwater Elevations
January 23, 2003 to December 14, 2005



Five Mile Branch
Wetland and Stream Mitigation Site
Iredell County, NC

Gauge Location No. 18
Monitoring Period
January 23, 2003 to November 3, 2003



Appendix 7

HEC-RAS Analysis

HEC-RAS Plan: Duplicate Eff River: Fifth Creek Reach: Reach-1 Profile: 100-year

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	15856	100-year	5728.00	710.39	724.66	719.71	724.71	0.000363	3.12	5892.58	845.52	0.15
Reach-1	16500	100-year	5728.00	710.53	724.86		725.22	0.001396	6.14	2819.92	563.38	0.29
Reach-1	17000	100-year	5728.00	712.61	725.62		725.98	0.001669	6.29	2687.05	698.22	0.31
Reach-1	17616	100-year	5589.00	714.50	726.72		727.11	0.001991	6.58	2465.64	629.65	0.33
Reach-1	18053	100-year	5589.00	715.12	727.53		727.62	0.000703	3.95	4295.66	757.69	0.20
Reach-1	18500	100-year	5589.00	715.82	727.86		727.98	0.000872	4.31	3772.70	663.11	0.22
Reach-1	19000	100-year	5589.00	715.92	728.31		728.48	0.001087	4.91	2897.20	443.55	0.25
Reach-1	19456	100-year	5589.00	716.39	728.79	724.39	728.88	0.000707	3.96	3828.05	911.43	0.20
Reach-1	19915	100-year	5589.00	717.26	729.14	725.50	729.25	0.000882	4.29	3815.73	896.28	0.22
Reach-1	20451	100-year	5589.00	718.75	729.58	727.42	730.60	0.004308	9.08	1040.89	859.20	0.52
Reach-1	20528		Bridge									
Reach-1	20608	100-year	5589.00	719.00	731.11	728.24	732.04	0.003188	8.50	1099.81	835.84	0.45
Reach-1	21077	100-year	3890.00	719.34	732.65		732.68	0.000265	2.73	6567.50	1092.52	0.13
Reach-1	21922	100-year	3830.00	720.04	732.86		732.88	0.000220	2.42	7568.30	1233.84	0.12
Reach-1	22240	100-year	3754.00	720.75	732.54	729.01	733.57	0.004569	8.80	680.05	897.91	0.47
Reach-1	22329		Bridge									
Reach-1	22395	100-year	3754.00	721.00	734.56	729.75	735.17	0.002387	7.02	890.46	743.79	0.35
Reach-1	22425	100-year	3754.00	721.55	734.76	730.00	735.27	0.001999	6.29	925.68	587.05	0.33
Reach-1	22502		Bridge									
Reach-1	22596	100-year	3754.00	721.80	735.51	729.54	735.86	0.001296	5.41	1116.14	689.56	0.27
Reach-1	22631	100-year	3754.00	721.15	735.41	730.72	736.08	0.002689	7.44	893.85	722.95	0.38

HEC-RAS Plan: Duplicate Eff River: Beaver Creek Reach: Reach-1 Profile: 100-year

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	956	100-year	3267.00	719.38	730.04	727.69	730.06	0.000401	2.55	4440.33	1241.41	0.14
Reach-1	1335	100-year	3267.00	719.55	730.19	727.41	730.21	0.000396	2.37	3968.83	1029.49	0.13
Reach-1	1418		Bridge									
Reach-1	1503	100-year	3267.00	719.80	730.51	728.22	730.58	0.001098	3.96	2785.52	981.38	0.22
Reach-1	2000	100-year	3267.00	720.03	731.14		731.35	0.001846	5.83	1958.30	711.42	0.30
Reach-1	2631	100-year	3267.00	722.06	732.08		732.19	0.001336	4.47	2110.11	547.12	0.25
Reach-1	3000	100-year	3267.00	722.67	732.76		732.91	0.001723	5.10	1919.65	510.74	0.29
Reach-1	3500	100-year	3267.00	723.00	733.66		733.89	0.002133	5.89	1813.79	547.78	0.32
Reach-1	4000	100-year	3212.00	724.06	734.83		735.54	0.004601	8.68	1054.44	360.61	0.47
Reach-1	4500	100-year	3212.00	724.18	736.43		736.55	0.001040	4.51	2017.41	453.94	0.23
Reach-1	5000	100-year	3212.00	725.17	737.00		737.45	0.002758	7.17	1097.19	256.66	0.37
Reach-1	5527	100-year	3212.00	727.02	738.53		739.03	0.003188	7.56	1414.28	441.83	0.40
Reach-1	6184	100-year	2367.00	728.44	740.48		740.74	0.001995	5.95	1952.76	592.65	0.31
Reach-1	6768	100-year	2367.00	731.00	741.50		741.56	0.000998	3.83	2702.36	600.53	0.21
Reach-1	7364	100-year	2367.00	729.85	742.11	736.07	742.69	0.002344	6.37	460.89	410.96	0.32
Reach-1	7453		Culvert									
Reach-1	7547	100-year	2367.00	730.40	743.60	736.55	744.06	0.001656	5.69	506.76	114.36	0.28
Reach-1	7600	100-year	2367.00	730.86	743.65	736.98	744.20	0.002007	6.22	471.20	104.52	0.30
Reach-1	7682		Culvert									
Reach-1	7762	100-year	2367.00	731.20	744.62	737.64	745.10	0.001734	5.90	511.09	259.04	0.28
Reach-1	8023	100-year	2367.00	731.70	745.13	737.53	745.55	0.001570	5.41	530.53	210.65	0.26
Reach-1	8120		Culvert									
Reach-1	8224	100-year	2367.00	732.20	745.86	738.01	746.27	0.001484	5.32	539.66	286.75	0.25
Reach-1	8544	100-year	2292.00	732.90	746.57		746.81	0.000425	2.98	2896.67	511.00	0.14
Reach-1	9025	100-year	2292.00	735.19	746.76		746.81	0.000410	2.91	2335.33	376.56	0.15
Reach-1	9475	100-year	2292.00	735.72	746.89		747.30	0.002544	7.07	1310.40	444.06	0.38
Reach-1	10079	100-year	2292.00	737.55	748.70		749.45	0.004754	8.69	737.65	218.55	0.46
Reach-1	10587	100-year	2292.00	740.15	750.74		750.89	0.001754	5.09	1507.61	333.60	0.28
Reach-1	11000	100-year	2292.00	740.33	751.49	750.04	752.06	0.003932	7.90	811.76	790.91	0.42
Reach-1	11500	100-year	2292.00	740.93	752.86		752.94	0.000924	4.01	2096.07	485.46	0.21
Reach-1	12000	100-year	2292.00	741.77	753.32		753.39	0.000848	3.76	2319.42	512.52	0.20
Reach-1	12448	100-year	2173.00	742.50	753.68		753.73	0.000671	3.25	2921.84	788.18	0.17
Reach-1	12883	100-year	2173.00	744.28	753.97		754.51	0.005179	8.18	1039.65	445.11	0.47
Reach-1	13302	100-year	2173.00	745.87	755.99		756.41	0.003949	7.36	1024.99	348.96	0.41
Reach-1	14000	100-year	2173.00	745.82	757.99		758.22	0.001790	5.62	1425.39	370.32	0.29
Reach-1	14500	100-year	2173.00	749.06	759.10		759.41	0.003176	6.57	1179.94	344.13	0.37
Reach-1	15107	100-year	1671.00	751.68	761.06		761.21	0.002687	5.40	1083.46	310.73	0.32
Reach-1	15635	100-year	1613.00	752.53	762.33		762.44	0.002025	4.77	1110.02	340.62	0.28
Reach-1	16000	100-year	1613.00	752.61	763.07		763.21	0.002147	5.14	1211.23	481.16	0.29
Reach-1	16477	100-year	1613.00	754.61	763.58		766.46	0.023834	15.37	203.48	55.80	0.93
Reach-1	16987	100-year	1613.00	757.47	770.20		770.80	0.004010	8.05	531.24	107.64	0.41
Reach-1	17291	100-year	1613.00	758.78	771.46		771.68	0.001998	5.67	1044.24	271.36	0.29

Appendix 8

NCEEP Floodplain Requirements

EEP Floodplain Requirements Checklist

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

Project Location

Name of project:	Five Mile Branch Stream and Wetland Restoration
Name if stream or feature:	Beaver Creek and Fifth Creek
County:	Iredell
Name of river basin:	Yadkin – Pee Dee
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Iredell County
DFIRM panel number for entire site:	3710476600J
Consultant name:	ARCADIS G&M of N.C. Inc.
Phone number:	919-854-9812
Address:	801 Corporate Center Drive Suite 300 Raleigh, NC 27607

Design Information

The project involves grading banks and removing a dredge spoil berm adjacent to Beaver creek and Fifth Creek. Banks will be regarded in areas that are eroding. A 50 foot wide buffer will be reestablished within the floodplain.

Example

Reach	Length	Priority
Beaver Creek	*6220 lf*	*Enhancement I*
Fifth Creek	*6962*	*Enhancement I*

Floodplain Information

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

☑ Yes ☐ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☑ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☑ AE Zone

- ◉ Floodway
- ○ Non-Encroachment
- ○ None

☐ A Zone

- ○ Local Setbacks Required
- ○ No Local Setbacks Required

If local setbacks are required, list how many feet:

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

○ Yes ◉ No

Land Acquisition (Check)

☑ State owned (fee simple)

☑ Conservation easment (Design Bid Build)

☐ Conservation Easement (Full Delivery Project)

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

Is community/county participating in the NFIP program?

◉ Yes ○ No

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

Name of Local Floodplain Administrator:
Phone Number:

Floodplain Requirements

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

☐ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision

☐ Other Requirements

List other requirements:

Comments:
LFPA not yet contacted.

Name: _____ Signature: _____

Title: _____ Date: _____