Sandy Creek Stream Enhancement and Riparian Wetland Restoration/ Creation Project

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For

The North Carolina Wetlands Restoration Program
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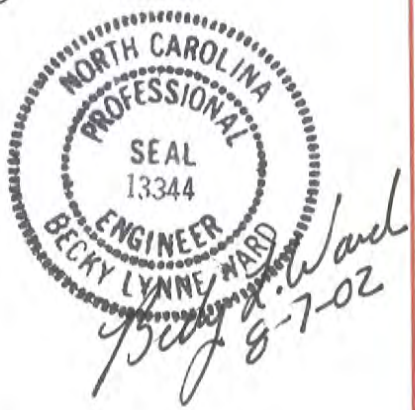

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Sandy Creek Stream Enhancement
&
Wetland Restoration / Creation

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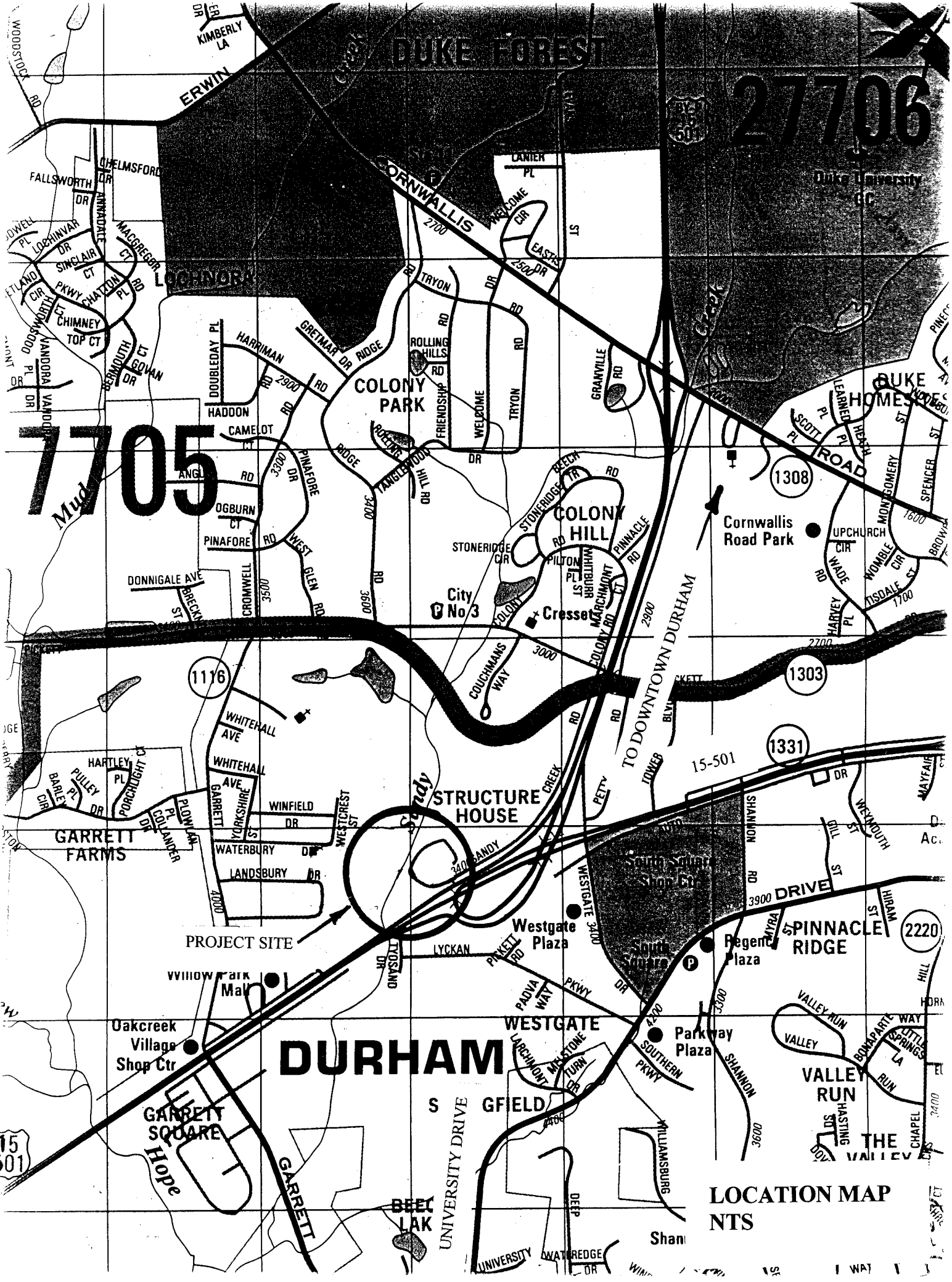
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&
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INTRODUCTION

The Sandy Creek Stream Enhancement and Wetland Restoration/ Creation project is a project funded by the State of North Carolina Wetland Restoration Program. The property which includes, an abandoned wastewater facility on Sandy Creek, was selected to mitigate impacts to Section 404 jurisdictional areas associated with the extension of the Martin Luther King, Jr. (MLK) Parkway between Cook Road and Hope Valley Road in Durham County North Carolina. The impacts of the MLK Roadway project on jurisdictional wetlands and non-wetland jurisdictional waters totaled 1.73 acres near Third Fork Creek. The Sandy Creek property will provide approximately 3.2 acres of wetland restoration/ creation as mitigation for the impacts during construction of the MLK Parkway. In addition to the wetlands designed for this project, Sandy Creek will be enhanced with the creation of pool features along the stream's length.

The City of Durham Parks and Recreation Department has plans to create an Environmental Center at the abandoned treatment plant on the property. The program for the Sandy creek life Long Learning Center will advance environmental awareness, knowledge and skill through education, research and demonstration. This site also acts as an entry point to the New Hope Trail Corridor Master Plan. The new Hope Corridor Master Plan is an " open space corridor linking the Eno River State Park, the New Hope Creek, Corps Lands and the growing communities of Durham and Chapel Hill for aesthetic, environmental, educational and recreational purposes, and as a means of shaping the urban form of the area." Currently Sandy Creek Trail Phase One, a walking/biking trail, is under construction from the abandoned treatment plant to Pickett Road.

The wetlands created in this project will be visited by many people using the Sandy Creek Environmental Center and the Sandy Creek Trail.

PROJECT LOCATION

The Sandy Creek Mitigation Site is located in Durham County approximately 1000 feet north of the intersection of Chapel Hill Boulevard (US Business 15/501) and Sandy Creek. The site is on an abandoned treatment plant facility owned by the City of Durham on Sandy Creek Road The area is located on the U.S. Geologic Service (USGS) Southwest Durham 7.5 minute topographic quadrangle at latitude 35°58'00" North and longitude 78°57'45" West. The site is in the Cape Fear River Basin in Cataloging Unit 03030002.

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PROBLEM STATEMENT

The land on the west side of Sandy Creek has been impacted with fill material used to construct sludge drying beds for the treatment plant. This project will include the removal of fill dirt and debris to a design elevation that will restore/ create wetlands that may have been found there naturally before the construction of the treatment plant.

Sandy Creek has a featureless bed. The only significant pools along the stream length are currently being formed by debris. The lack of features in the stream as well as large woody debris creates poor habitat.

GOALS AND OBJECTIVES

The goal of the project is to restore riparian wetlands and improve in-stream habitats in sandy Creek for the NCWRP. In so doing, it presents an opportunity to take an existing waste and spoil area that is overrun with nuisance weeds and trash and change it into a functioning wetland ecosystem that provides quality food and habitat for wildlife and improves water quality within the Sandy Creek drainage basin. Since the City of Durham is currently constructing areas adjacent to the mitigation site as a park and recreation center, the site offers a unique opportunity for the general public to view a wetland restoration project and learn the benefits of the wetland ecosystem.

The enhancement of Sandy Creek will provide additional bedform features to a currently uniform bed and introduce woody debris into the stream to create habitat and enhance water quality.

WATERSHED CONDITIONS SANDY CREEK

The Sandy Creek watershed extends from the southern most boundary of 15-501 north to Hillsborough Road. The watershed is approximately 6.4 square miles. The Sandy Creek watershed is currently almost completely developed with the predominate uses and approximate areas as follow:

Low density residential	(< 4 du/acre)	20% of the watershed
Medium density residential	(4 to 8 du/acre)	10% of the watershed
High Density residential	(> 8 du/acre)	5% of the watershed
Commercial/Office not including Duke University		10% of the watershed
Duke University Campus and Medical Center		25% of the watershed
Duke Golf Course and other permanent open space		25% of the watershed
Roads		5% of the watershed
		100%

Duke University Campus can be characterized as a suburban density development, with an average impervious surface of about 30%. The golf course and other open space areas have less than 5% impervious surface. See watershed drainage area and current land usage maps included with the exhibits ant the end of the report section.

The watershed has seen the few remaining undeveloped parcels build out over the past few years. That development has primarily consisted of medium to high-density residential development, infill construction of the Duke Campus, and re-development of some of the commercial centers to higher density uses.

The Future Land Use Maps (FLUM's) prepared by the City of Durham as a component of the 2025 Plan call for preservation of existing neighborhoods as well as higher intensity development in the existing commercial centers, particularly along the proposed Durham/Chapel Hill Transit Corridor. This will be concentrated in the Erwin Road/Duke Corridor, as well as in the South Square Mall area. However, as these areas are already developed to a fairly high land use impact, re-development will only have a minor impact on impervious surface amounts. Duke University will continue to expand at their Main Campus and Medical Center, probably increasing impervious surfaces by 5 to 10% in those areas.

EXISTING CONDITIONS SANDY CREEK

Sandy Creek classifies as a sand bed, "E" stream type . The D50 sediment in the channel is 0.50 mm. The bankfull width is approximately 27 feet and the mean bankfull depth is 2.76 feet. The bankfull cross sectional area is approximately 75 square feet. The width depth ratio of the stream is 9.9. The stream shows incision with a low bank height to maximum bankfull depth of 1.46. The stream is located in a well developed floodplain that extends from 280 ft. to 600 feet, making the average entrenchment ratio 17. The stream is a regulated FEMA stream with an approximate bankfull discharge determined from FEMA discharge data of 2,600 cfs. The morphological data collected for Sandy Creek is listed in the Morphological Table included with the exhibits at the end of the report section.

Sandy Creek throughout the project area has been assigned Index No. 16-41-1-11 by the North Carolina Division of Water Quality (NCDWQ) and has a Best Usage Classification of C NSW. Class C waters are suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. The supplemental classification NSW denotes Nutrient Sensitive Waters, which require additional nutrient management, because of their susceptibility to excessive growth of microscopic and macroscopic vegetation.

The stream banks are composed of mostly the same sandy soils found in the creek bed. The bank erosion potential ranged from moderate to high along the stream. A mature piedmont forest has developed on both sides of the stream. This forest provides root mass that has stabilized the stream banks.

STREAM BANK VEGETATION Three community types were identified along the section of Sandy Creek surveyed: piedmont levee forest, emergent (low elevation seep), and bottomland forest. The relative locations of these plant communities are identified on Existing Vegetation Map included with the exhibits at the end of the report section. Along the stream banks canopy trees have heavily shaded the ground below.

The dominant plant community identified adjacent to Sandy Creek was the piedmont levee forest. The canopy trees were composed of river birch (*Betula nigra*), box elder (*Acer negundo*), black willow (*Salix nigra*), green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar strraciflua*), sycamore (*Platanus occidentalis*) and red maple (*Acer rubrum*). Understory trees included American elm (*Ulmus americana*) and ironwood (*Carpinus caroliniana*). False indigo (*Amorpha fruticosa*), Chinese privet (*Ligustrum sinense*), box elder and red maple encompassed the shrub/sapling layer. Trees were growing to approximately 20 feet from the creek and tree crowns reached to 40 feet across. Many trees were mature with canopy heights reaching 40 to 50 feet. The most dominant species observed was box elder. This common maple was the dominant streambank species and grew as thickets in the understory as a shrub/sapling.

An emergent (low elevation seep?) area was encountered between the creek and the road near the former sewer plant site. No mature trees were in this emergent area. Red maple and sweetgum samplings were along the edge of the site. Standing water covered the lowest portion of the site. The herb layer included smartweed (*Polygonum* spp.), sedges, soft-rush (*Juncus effusus*), and false nettle (*Boehmeria clindrica*).

Adjacent to Sandy Creek a bottomland forest community is located near the southern terminus of the project. At this location the area appears to have been disturbed as tree canopy formation is scattered. This area offers the opportunity to establish a denser canopy layer by the addition of selected tree plantings. Presently, the canopy is composed primarily of green ash, sycamore, and red maple.

PAST STREAM IMPACTS Sandy Creek was straightened for the sewer line placement in the early 1970's from the City property line north. In the 1955 aerial photographs the stream was in the same alignment as it is currently on the City property. From the photographs confirmation of an alternative stream pattern before the construction of the treatment plant was not available. However the stream is very straight and uniform on the property and therefore it is likely that the stream was adjusted at the time of the treatment plant construction.

STREAM REFERENCE REACH SITE

The stream reference reach site used for this project is in the adjacent watershed of Mud Creek. The reference reach length studied is located in the Garrett Farms Subdivision on Cottonwood Drive off of Garrett Road. A schematic of the reference reach along with a vicinity map are included in Section C of this report. The watershed for Mud Creek is approximately 5.8 square miles. The Mud Creek watershed is largely undeveloped due to a large percentage of the land being owned by Duke University as Duke Forest, as well as the lack of public utilities in the western portion of the watershed. The predominate uses and approximate areas are as follow:

Duke Forest		40 % of the watershed
Undeveloped	(<1 du/acre)	30% of the watershed
Low density residential	(1 to 4 du/acre)	21% of the watershed
Medium density residential	(4 to 8 du/acre)	3% of the watershed
High Density residential	(> 8 du/acre)	2% of the watershed
Commercial/Office		1% of the watershed
Roads		3% of the watershed
		100%

The watershed has primarily seen low density single family development take place over the past few years. There have also been a few pockets of apartments and condominium construction along Garrett Road and in the northern portion of the watershed. Mud Creek watershed drainage area map and land usage map are included in Section C.

The Future Land Use Maps (FLUM's) prepared by the City of Durham as a component of the 2025 Plan call for preservation of existing neighborhoods, and a continuing pattern of low density residential growth in the un-developed areas as public water and sewer are extended. Few if any opportunities exist for higher density development patterns. Duke Forest is expected to remain as research forestland for the future.

Mud Creek is a sand bed "E type stream. The bankfull discharge predicted by the FEMA HEC-1 models for this stream is 1,600 cfs. This discharge is significantly lower than the discharge predicted for Sandy Creek although there is not a significant difference in the watershed size. This discharge is expected however because the watershed is significantly less developed than the Sandy Creek watershed. Maps of Mud Creek drainage area and land use are included in Section C of this report.

This stream was selected as a reference reach because it had fair pattern and it seemed to have pools that were correctly spaced and developed along the reach studied. Mud creek is starting to show some signs of incising however the data required for our stream enhancement reference regarding pool to pool spacing seemed stable. Mr. Todd St. John of the North Carolina Water Quality Division came to the reference site and reviewed it for an applicable reference reach for this study.

Mud Creek is an E5 stream with a bankfull width of approximately 17.5 feet, bankfull mean depth of 3.24 feet, width to depth ratio of 5.4, and bankfull cross sectional area of 57 square feet. The pool to pool spacing for the reference reach was 118 feet on average with a range to 91 to 154 feet. A complete listing of the Mud Creek stream data may be found in the Sandy Creek Stream Morphological Table, under the reference reach column, included with the exhibits at the end of the report section.

REFERENCE VEGETATION One community type was identified along the section of Mud Creek surveyed: piedmont levee forest. This plant community was identified along both sides of the creek. The dominant plant community identified adjacent to Mud Creek was the piedmont levee forest. The canopy trees were composed of river birch (*Betula nigra*), sweetgum (*Liquidambar strraciflua*), sycamore (*Platanus occidentalis*),

tulip poplar (*Liriodendron tulipifera*) and red maple (*Acer rubrum*). Understory trees included paw paw (*Asimina triloba*), American elm (*Ulmus americana*), dogwood (*Cornus amomum*), and ironwood (*Carpinus caroliniana*). Privet (*Ligustrum spp.*), red maple, and green ash (*Fraxinus pennsylvanica*), and paw paw encompassed the shrub/sapling layer. Trees were growing to approximately 20 feet from the creek to the east interrupted by a sewerline easement. To the west, tree cover was uninterrupted. Vegetation along the west side of the creek included Jack in the Pulpit (*Arisaema triphyllum*). Tree crowns reached to 50 feet across. Many trees were mature with canopy heights reaching 50 to 60 feet. The most dominant sub canopy species observed was paw paw. This species, of custard-apple family, is occasionally found along river bottoms and streams. Paw paw grew in thickets in the understory as a small tree and shrub/sapling.

The sewerline easement was maintained and vegetation grew to approximately 6-8" height. Shrub-sapling of red maple and sweetgum were observed. Also, the herbs Indian hemp (*Apocynum cannabinum*) and false nettle (*Boehmeria cylindrica*) were present. Microstegium (*Microstegium vimineum*) was the dominant grass along the sewerline easement.

To the east of the sewerline easement there was a narrow bottomland forest. Cherry bark oak (*Quercus pagoda*) and willow oak (*Quercus phellos*) were encountered. Sub-canopy trees included American elm and ironwood.

PROPOSED WETLAND SITE CONDITIONS

The area proposed for mitigation was once a wastewater treatment plant (WWTP) for the city of Durham. The WWTP, which was abandoned in 1984, consisted of an approximate 2.4-acre complex of eight sludge ponds separated by concrete berms and enclosed by a metal fence. During the construction of the WWTP in 1954 and as recently as Hurricane Fran in 1996, approximately 1.96 acres south of the WWTP has been utilized as a dump site for construction and storm debris. Both the 2.4-acre WWTP and the 1.96-acre fill site will be utilized for the wetland mitigation area. Sandy creek borders the mitigation site to the east and a wetland abuts the south and southwest boundary. North and northwest of the site is bounded by wooded uplands.

EXISTING VEGETATION The existing vegetation is described in detail in the Compensatory Wetland Mitigation Plan for martin Luther King, Jr. Parkway is as follows: "The site supports a variety of slightly mesophytic and wetland vegetation typical of piedmont floodplains, disturbed successional areas and man-dominated areas. The site proposed for mitigation is surrounded by open alluvial forest on three sides with small sloughs occurring to the west and small sloughs and levees found on the creek side. The eastern side of the mitigation area near the creek is dominated by species more tolerant of periods of flooding such as American sycamore, red maple, green ash, river birch, box elder (*Acer negundo*), Chinese privet, Nepal microstegium (*microstegium vimineum*), and various knotweeds. Scattered specimens of tulip poplar (*Lirionendron tulipfera*) are also found. The slightly higher elevations on the more mesic portions of

the floodplain to the north west and north of the mitigation area contain white oak (*Quercus alba*), loblolly pine (*Pinus taeda*), red maple and a sparse herb layer containing Japanese honeysuckle, Virginia creeper, and poison ivy. The south west edge of the mitigation site adjoins the upper fringe of a beaver impoundment and contains several small sloughs and depressions. The canopy is predominantly red maple and green ash with a few scattered sweetgum (*Liquidambar styraciflua*). The open herbaceous community south of the site is comprised of a collection of wetland and upland species common to disturbed areas. Plants found in this vicinity are red cedar (*Juniperus virginiana*), black willow, various bushclovers (*Lespedeza spp.*), rushes (*Juncus spp.*) grassed (*Panicum spp.*) Nepal microstegium, and sedges (*Carex spp.*). The wettest areas in the adjacent floodplain contain false stinging nettle (*Bohemeria cylindrica*), Jack in the Pulpit (*Arisaema triphyllum*), and slender spike grass (*Chasmanthium laxum*) among others." Areas of wetland vegetation can be found in the abandoned sludge drying beds where standing water collects at times.

EXISTING SOILS The soils in the wetland mitigation site are mapped as Chewacla and Wehadkee soils on the Durham County Soil Survey, which are typical of North Carolina piedmont floodplains. A soils map of the project site is included with the exhibits at the end of the report section. A portion of the land in the mitigation site is mapped as Urban Land on the Soil Survey in the area of the sludge drying beds. Some of the soil in the exsting wetland near the restoration area is comprised of the same fill material that is found throughout the restoration site. An attempt was made to hand auger below the fill material to reach the original soil. While this was successfully accomplished in some borings, usually the soil was disturbed beyond five feet, which was the length of the auger. In some cases, the separation between the fill material and the original soil surface was not always apparent. It appears that the original soil was either mixed in with the fill material or had been removed and simply replaced by the fill material. Further complicating the site was the presence of redoximorphic features in the fill material. Determining which of these features are relict and which have developed on-site was extremely difficult to impossible. Therefore, it was not possible to determine the hydric/non-hydric soil boundary. These soils would be classed as Udorthents under the current taxonomic criteria – manmade soils resulting from recent cut, fill, mixing, etc.

REFERENCE WETLAND ADJACENT TO THE PROPOSED RESTORATION/ CREATION SITE

The approximately 6-acre existing wetland lies mostly south of the mitigation site in the floodplain of Sandy Creek. The wetland was delineated by Ecological Consultants and verified by the U.S. Army Corps of Engineers in December 1997. The wetland is essentially a large depression along the floodplain that traps water within it. This process is aided by the presence of beavers that have built numerous dams in the low areas along the levee separating the wetland from Sandy Creek. These are relatively small, shallow dams that have filled in with soil debris over the years such that little, if any, maintenance is required from the beavers.

REFERENCE VEGETATION The forest is comprised of green ash, red maple, black gum, ironwood (*Carpinus caroliniana*) American elm, box elder, sweet gum , tulip poplar and hackberry (*Celtis laevigata*). The herbaceous layer is diverse in the marsh and includes cattails, smartweed, bull-rush, sedges, fox tail, soft-rush, and false nettle. Vegetation plants in created wetlands will include similar species as found in the forested and herbaceous layer of the adjacent marsh including cattails, bull-rush, sedges, fox tail, soft-rush, and false nettle.

EXISTING HYDROLOGY The hydrology of the wetland is principally derived from two sources, precipitation and overbank flooding from Sandy Creek. Precipitation and resulting storm runoff from the surrounding upland collects in the wetland. A storm which generates over 2800 cfs. of flow is required for Sandy Creek to breach the levee and flood the wetland. Such a storm has a greater than 1.5-year return interval. Once the wetland floods, the water becomes impounded and slowly recedes throughout the growing season until partially replenished by rain events or fully replenished by the next flooding event.

The hydrologic regimes described in Classification of Wetland and Deepwater Habitats of the United States (Cowardin, 1979) are appropriate to describe this wetland:

Permanently Flooded – Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes.

Intermittently Exposed – Surface water is present throughout the year except in years of extreme drought.

Semipermanently Flooded – Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

Seasonally Flooded – Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface.

Temporarily Flooded – Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plants that grow both in uplands and wetlands are characteristic of the temporarily flooded regime.

The majority of the wetland is permanently flooded with some trees and shrubs scattered on small islands and tussocks throughout. Near the edge of the pond, the wetland becomes less inundated, herbaceous vegetation becomes established, and the amount of woody vegetation increases. The transition between the hydrologic regimes from permanently flooded to seasonally flooded is not readily apparent. Therefore, it is more practicable to divide the wetland into three sections based on the more obvious and larger

hydrologic regimes: Permanently Flooded, Seasonally Flooded, and Temporarily Flooded.

REFERENCE WETLAND SOILS The soil throughout most of the wetland is an alluvial soil that has a low-chroma matrix of less than 2 well within the top 12 inches of the soil surface, clear evidence of hydric soils. This corresponds with the Wehadkee soil series, which is the typical hydric soil found on Piedmont floodplains. This assessment agrees with the Durham County Soil Survey (197-), which has mapped the area as a Chewacla/Wehadkee complex.

WETLAND INVESTIGATION

HYDROLOGIC MONITORING. Three open access groundwater monitoring gauges were placed on the site on April 21, 2002 and monitoring of these wells commenced on April 23, 2002. These were placed on the site in an effort to characterize groundwater / surface water relationship as early as possible in the growing season. These gauges were then supplemented with four Model #138 Infinities Water Level Data Loggers on June 11, 2002, as indicated in the exhibit labeled Sandy Creek Well Sample Data for Wetland Design included in this report.. Data Loggers 1 and 4 record water to an approximate depth of 3.7 feet, Data Logger 2 to a depth of 4.5 feet, and Data Logger 3 to a depth of 5.5 feet. Data Logger 4 was placed in the adjacent (reference) wetland while Loggers 1-3 were strategically placed around the restoration site. The Data Loggers are programmed to record water levels twice a day.

While the monitoring data collected from the original three open access gauges did not provide technical data of the level of detail that was anticipated, it was sufficient to describe the general groundwater / surface water relationship. This was imperative since due to the drought conditions, the water table had dropped below the level of the Data Loggers within a week after they were installed. The information from the gauges was then merged with field indicated water levels and a detailed topographic map of the site. This information was then utilized to ascertain an overall picture of the hydrologic regime that was used to design the mitigation site.

During the early part of the growing season, groundwater levels beyond the limits of standing water were higher than that of the pond, as is to be expected due to capillary action within the soil. As the growing season progressed, the difference between the pond elevation and that of the gauges lessened until the pond was higher than the groundwater, indicating the evapotranspiration within the vegetated regions exceeded that of the pond, or non-vegetated regions. Hence, the pond becomes a recharge area for the wetland until the end of the growing season. After significant rain events, this recharge function becomes even more evident as the pond level rises while the groundwater water elevations remains essentially unchanged. Therefore, the storage of runoff and floodwater within the ponded portion of the wetland is the key component to the hydrology of the existing wetland.

Considering the hydrologic forces that will drive the wetland mitigation area, it was not necessary to assess the hydraulic conductivity of the soil, but sufficient to understand the groundwater / surface water relationship. Accordingly, the water balance provided in Appendix D of Reference 2 was deemed sufficient for designing the wetland mitigation site. This appendix has been included in this report.

WETLAND RESTORATION PLAN

The objective of the mitigation project is to restore/create a wetland that acts as an extension of the existing wetland. Therefore, the wetland will also receive its hydrologic input from precipitation and overbank flooding from Sandy Creek. Similar to the reference wetland, the target wetland is designed to also have three basic hydrologic regimes. However, the permanently flooded regime of the reference wetland will be replaced with semipermanently flooded regime. This decision was predicated on the concept that less flooded areas with at least non-persistent herbaceous vegetation will provide more wetland functions and values, especially with respect to water quality, than permanently inundated areas devoid of vegetation. The wetland restoration preliminary construction plan is included in Section D.

HYDROLOGIC RESTORATION. As with the existing wetland, it is essential to allow a portion of the restoration area to retain runoff and floodwaters to provide hydrology to the remainder of the wetland. However, it is also important not to simply create an extension of the existing wetland that would also remain permanently flooded. To this goal, the site has been designed such that a broad levee set at the elevation of the seasonal high water table of the pond, 262.0 feet, will separate the site into two sections. The front section will tie into the grade of the existing wetland and slope gradually up to the levee. The site will then gradually slope down to the back section of the site. At the rear of the back section where the old sludge ponds will be removed, a ponded area will be built that is expected to store runoff and floodwaters well into the growing season. In the middle of the ponded area, an elevated wetland "island" will be constructed. This island is expected to allow for a different assemblage of vegetation.

Once the growing season commences and the pond level begins to recede, precipitation is expected to have little impact on the back section of the restoration area. This is to allow for the seasonal "drying out" of the wetland. The wetland "island" will aid in this process by increasing the evapotranspiration within this section of the wetland.

The total amount of wetland restoration/creation that is anticipated from this project is 3.2 acres. The wetland will have the following benefits:

- The site can retain enough of the floodwaters to provide hydrology to the site at the beginning of the growing season and after flooding events.
- The back portion of the site will not be dependent upon the beaver dams that are currently controlling the level of water in the existing wetland

- The levee provides a lane for constructing a boardwalk through the wetland that be incorporated into proposed park
- The site provides an ephemeral pool in the back section that should provide habitat and breeding opportunities to a number of different species

The excess spoil from the restoration area is expected to be partially disposed of on-site in order to keep construction costs within budget. A 2.3-acre wooded upland northwest of the restoration area has been targeted as the waste area. Trees removed from this upland will be utilized in the stream restoration activities.

HYDRIC SOIL REMEDIATION. The hydric soil remediation proposed at Sandy Creek is a passive process. Hydric soil development is already evident at the site. Grading of the site will create the hydrologic regime necessary to further promote and increase hydric soil development. The current fill material has a significant topsoil component that appears to be able support a variety of vegetation types. Therefore, no additional soil will be brought into the site. During the grading process, if areas of well developed topsoil are encountered, for example in the sludge pits, this soil will be stockpiled and spread back over the site to obtain final grades and provide a seed bank for rapid revegetation of the site.

VEGETATION RESTORATION / PLANTING PLAN. The objective of the revegetation plan is to plant a suite of native species that will maximize wetland functions. The target species will be based on the three target hydrologic regimes of the wetland as follows:

Planting Zone 1 – Semipermanently Flooded (0.9 ac)

Black Willow	*Salix nigra*	OBL
Tag Alder	*Alnus serrulata*	FACW+
Button Bush	*Cephalanthus occidentialis*	OBL
Overcup Oak	*Quercus lyrata*	OBL

Planting Zone 2 – Seasonally Flooded (1.8 ac)

Elderberry	*Sambucus Canadensis*	FACW-
Silky Dogwood	*Cornus amomum*	FACW+
Green Ash	*Fraxinus pennsylvanica*	FACW
Willow Oak	*Quercus phellos*	FACW+

Planting Zone 3 – Temporarily Flooded (1.9 ac)

Black Gum	*Nyssa sylvatica*	FAC
Tulip Poplar	*Liriodendron tulipifera*	FAC
River Birch	*Betula nigra*	FACW
Laural Oak	*Quercus laurifolia*	FACW-

In addition to the wetland restoration planting, there are areas that are also targeted for revegetation. Planting zone 4 entails the upland spoil area. Zones 5 – 7 include wetland areas that have been cut as a result of debris removal for the city park. Zone 6 will be located at the entrance of the bridge leading to the wetland trail and has therefore been targeted with a more aesthetic vegetation mix. Zone 8 will repair stream bank area that will be disturbed due to stream restoration activities.

Planting Zone 4 – Upland Spoil Area (2.3 ac)

White Oak	*Quercus alba*	FACU
Southern Red Oak	*Quercus falcata*	FACU-
Black Gum	*Nyssa sylvatica*	FAC
Tulip Poplar	*Liriodendron tulipifera*	FAC

Planting Zone 5 – Disturbed Seasonally Flooded Area (0.23 ac)

Elderberry	*Sambucus Canadensis*	FACW-
Silky Dogwood	*Cornus amomum*	FACW+
Wax Myrtle	*Myrica cerifera*	FAC+
Green Ash	*Fraxinus pennsylvanica*	FACW

Planting Zone 6 – Disturbed Temporarily Flooded Area (0.05 ac)

Wax Myrtle	*Myrica cerifera*	FAC+
American beautyberry	*Callicarpa americana*	FACU-
Red Chokeberry	*Aronia arbutifolia*	FACW
Laural Oak	*Quercus laurifolia*	FACW-

Planting Zone 7 – (0.03 ac)

Wax Myrtle	*Myrica cerifera*	FAC+
Spice bush	*Lindera benzoin*	FACW

Planting Zone 8 – Stream bank Reforestation (0.12 ac)

Buttonbush	Cephalanthus occidentalis
Elderberry	Sambucus canadensis
Carolina Willow	Salix caroliniana

All of the listed species in Planting Zones 1 – 3 and 5 - 8 are found in Piedmont palustrine forested floodplains and some are present in the reference wetland. The plants chosen for each planting zone were based on their facultative status, professional judgement, and the reference wetland. Plants chosen for the panting zone 4 are typical of a mesic mixed hardwood forest. Once established, these assemblages of plants are

expected to provide water storage, nutrient storage/transformation, sediment retention and bank stabilization, carbon storage, and habitat and food for a variety of wildlife.

Planting of seedlings should occur between December 1 and March 31 when trees are dormant. A total of 680 stems/acre of the appropriate species mix will be planted in each designated area on approximately 8 ft. by 8 ft. centers. The proposed planting plan assumes the availability of high quality planting stock at the time of planting. If quality seedlings of a particular species are not available at the time of planting, that species will be eliminated and an appropriate substitute found. The U.S. Army Corps of Engineers Compensatory Hardwood Mitigation Guidelines (1993) were utilized in developing the planting plan.

STREAM ENHANCEMENT PLAN

Log vane structures will be used along the creek to create bed form in the creek. During the longitudinal profile study of the existing creek, good pools were found only at debris locations in the creek. The goal with the stream enhancement will be to create pool features with log vane structures. Two rock cross vane/ W-type structures just upstream of the culverts under 15-501 and the treatment plant access bridge will be used to stabilize the grade of the stream and direct the water into and under the existing structures. The rock structures will be constructed from quarry stone.

One area of the stream just upstream of the culverts under 15-501 will be repaired by reparing and existing blowout and regrading adjacent banks. This area will also include the installation of two root wads to protect a newly constructed slope.

The placement of log vanes to create pools in sandy creek were spaced using the Mud Creek as a reference reach for our design. Mud creek watershed is adjacent to sandy Creek. Sandy Creek is a E5 stream with a watershed area of 6.4 square miles. Mud Creek is a E5 stream with a watershed area of 5.84 square miles. The Sandy Creek watershed is more developed and according to FEMA has a bankfull discharge of approximately 2,600 cfs. Mud Creek has a bankfull discharge of approximately 1,600 cfs. Mannings's "n" values were developed at the ripple sections for both streams based on the above discharges. Approximately the same Mannings "n" value was obtained confirming the reasonability of the FEMA discharges. The pool to pool spacing of average 180 ft., and range 140-240 feet was used in the proposed design of Sandy Creek. The stream enhancement design is shown on the preliminary construction drawings in section D.

The canopy is very good through out most of the stream bank top on the project and would need little if any supplemental plantings. The stream enhancement plan includes planting along the stream in areas in which disturbance will occur, such as at the box culverts and in areas where equipment needs to take access to the creek for construction. Other opportunities for plantings adjacent to the stream are as follows: Between the sewer line and the access road on the south side of the bridge across Sandy Creek (wetland area), on the north side of the bridge between the creek and the sanitary sewer easement, and at the north end of the property between the stream and the sanitary sewer. These areas are shown on the planting plan included in the preliminary construction drawings found in section D.

SEDIMENTATION & EROSION CONTROL

A sediment and erosion control plan will be developed for all work proposed for this project. The plan will have provisions detailed in all disturbed areas to contain any runoff sediment to the site and a stabilized construction entrance to the site. The wetland grading operation will include temporary sediment basins, diversion ditches, and silt fences as necessary to prevent the sediment from reaching Sandy Creek or the existing on site wetlands. Work preformed in the creek will involve bypass pumping around work areas and stabilization of slopes with biodegradable erosion control blankets. Disturbed areas will be seeded and vegetation established as soon as final grading is completed to stabilize the site. The project will include the protection of existing vegetation adjacent to work areas. The erosion control plan will be submitted to the State of North Carolina, Land Quality Division for approval and permits.

MONITORING PLAN AND SUCCESS CRITERIA

Following completion of the proposed restoration activities, the Sandy Creek Mitigation Site will be monitored for no less than five years to establish success of the vegetation and hydrologic criteria. If the site fails to meet success at any point during the five years, the reason for the failure must be established. If the failure is attributable to a flaw in design, remedial action will be considered in coordination with regulatory review agencies and additional monitoring initiated.

HYDROLOGIC MONTORING. Upon completion of the restoration activities, one automated Water Level Data Loggers will be installed at the top most elevation of each of the three target hydrologic regimes. Success at this elevation assumes success for entire regime. For the intermittently exposed and semipermanently flooded regions, (262.0 feet and less) hydrologic restoration will be considered successful if the soil is ponded, flooded, or saturated within 12-inches of the surface for at least 12.5% of the growing season during years with normal precipitation. For the temporarily flooded region (262.1 to 263.5 feet), hydrologic restoration will be considered successful if the soil is ponded, flooded, or saturated within 12-inches of the surface for at least 5% of the growing season during years with normal precipitation. In addition, a Data Logger will be installed in the reference wetland at the same elevation as the one installed in the temporarily flooded region. If the hydrology in the seasonally flooded region fails to meet the 5% criteria, success will still be assumed if the hydrology matches or exceeds that which is recorded in the reference wetland.

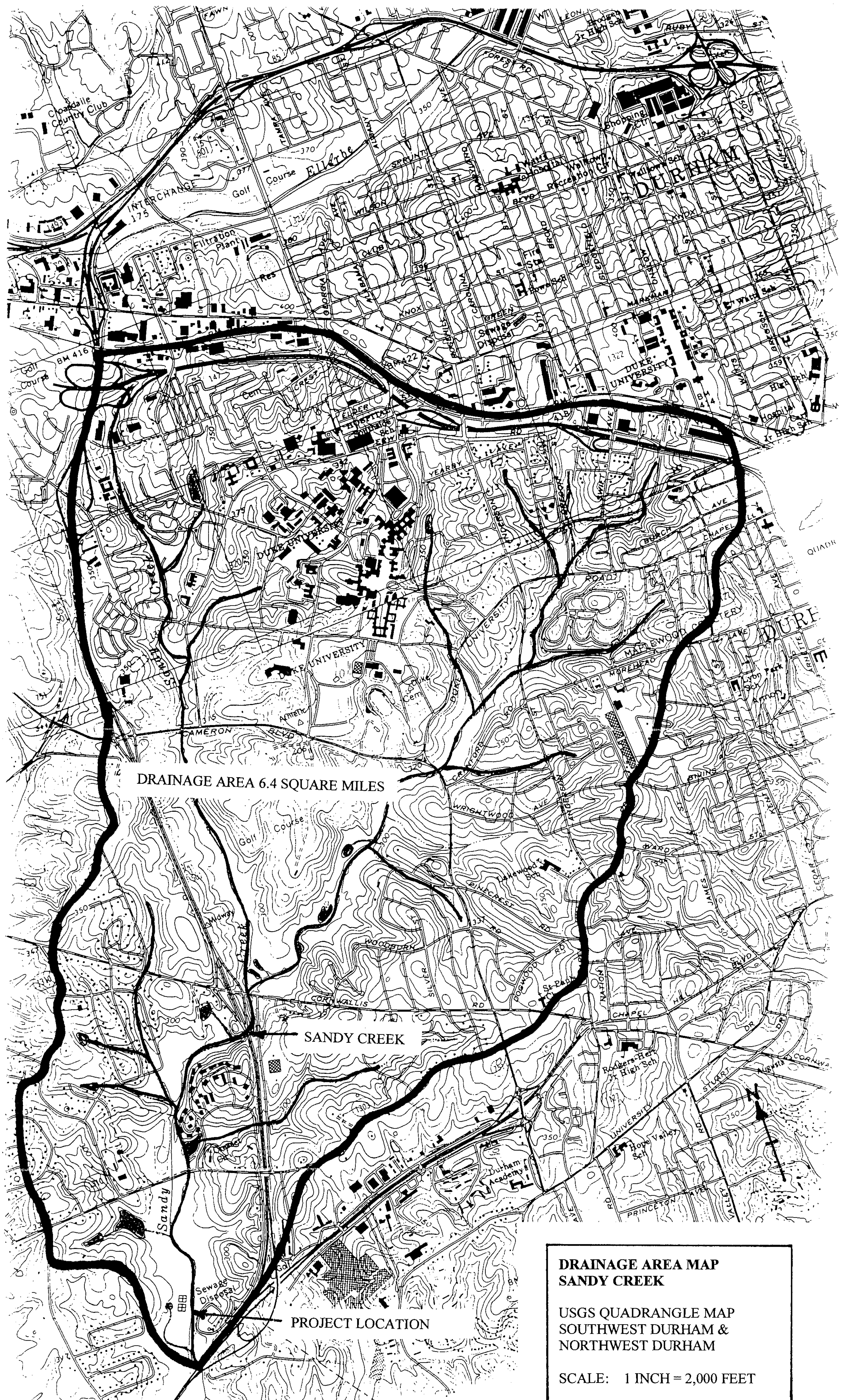
STREAM ENHANCEMENT MONITORING Permanent cross sections will be established at determined locations along the stream to evaluate the effectiveness of the in-stream structures in the creation of pool features. All constructed structures will be evaluated for stability and effectiveness yearly. The longitudinal profile of Sandy Creek will be monitored to determine the effects of the in-stream structures on the stream bed form. Vegetation monitoring for areas planted adjacent to the stream will conform to the monitoring proposed for the wetland vegetation as listed below. The stream and structures will be monitored for a period of five years.

VEGETATION MONITORING. Vegetation monitoring will be conducted within the wetland mitigation site only. The planting proposed on this project along the stream corridor is for aesthetics and bank stabilization. Therefore, only Planting Zones 1 through 3 will be monitored. Vegetation monitoring procedures are designed in accordance with EPA guidelines enumerated in Mitigation Site Type (MiST) documentation (1990) and USACE Compensatory Mitigation Guidelines (1993). After planting has been completed, the site will be inspected to verify that proper planting methods were used, including proper plant spacing, density, and species composition. Assuming successful planting, 0.05 acre vegetative plots will be established in representative locations across the site. Plot locations will be placed in proximity of water table monitoring gauge points where possible to help correlate data between vegetation and hydrology parameters. Quantitative sampling of vegetation will performed during each growing season for five years or until vegetative success criteria are met.

Vegetative success will be determined by the survival of target species within the sample plots. The required minimum survival rate is 320 stems/acre of target species at end of the fifth year. Included in the required survival criteria are planted seedlings and natural recruitment of the same species. At least six different representative species should be present on the entire site. If the vegetative success criteria are not met, the cause of failure will be determined and appropriate corrective action taken, if necessary.

REFERENCES

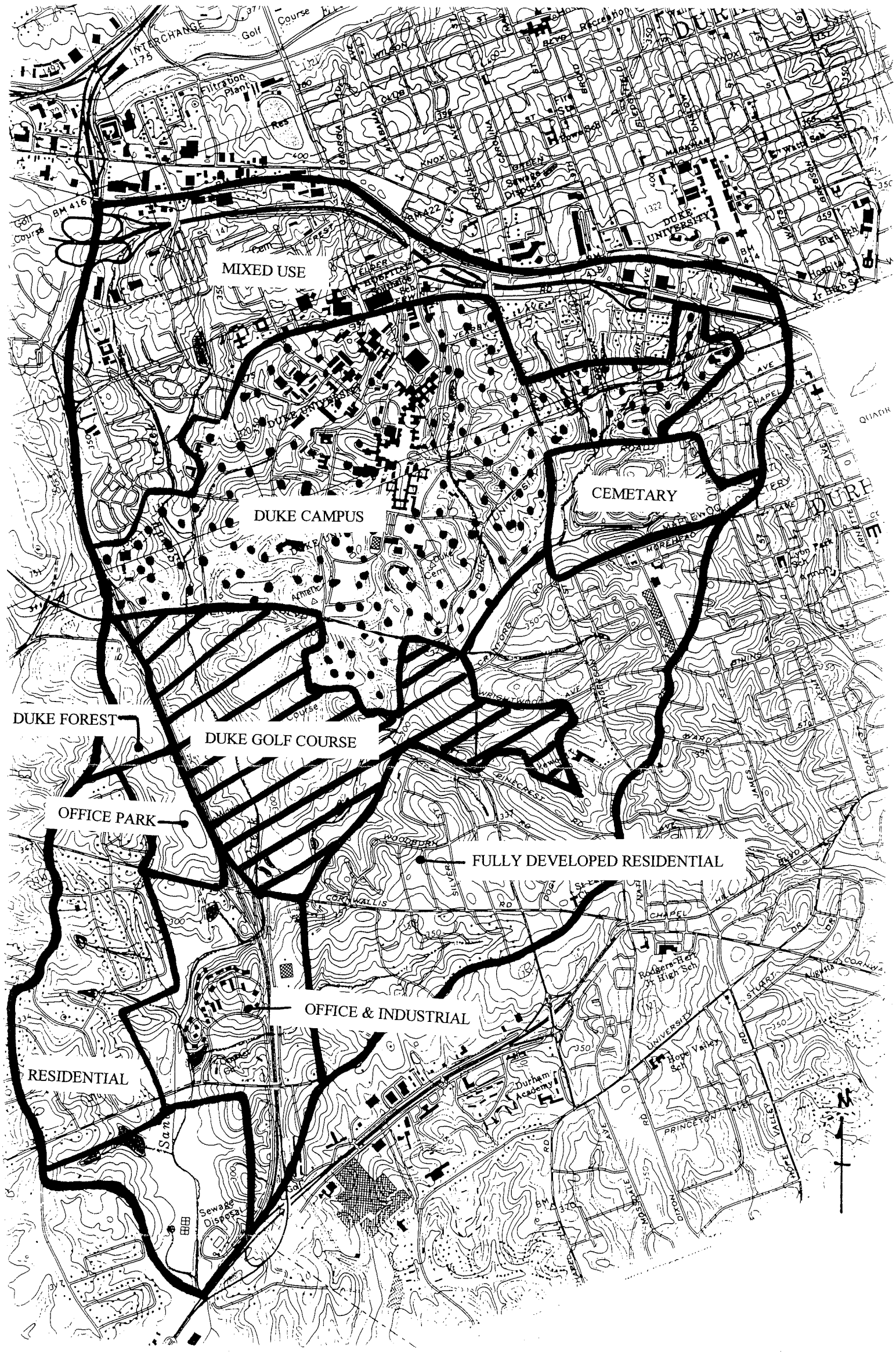
1. Soil Survey of Durham County, North Carolina United States Department of Agriculture Soil Conservation Service, 1971.
2. Compensatory Wetland Mitigation Plan for Martin Luther King, Jr. Parkway, DWQ Project No. 991177, Action ID No. 200020073 & 200020074, CZR Incorporated, September 2000.
3. North Carolina State Highway Commission Raleigh, North Carolina Hydrologic Department Culvert Survey & Hydrologic Design Report Project No. 9.8050591
4. Conceptual Master Plan for Sandy Creek Environmental Center for the City of Durham Parks & Recreation, Coulter Jewell, Thames PA., 1998
5. Environmental Assessment for the Sandy Creek Life Long Learning Center Sandy Creek Trail – Phase One Hayes, Seay, Mattern & Mattern, Inc. (HSMM), 2000
6. Base map prepared by HSMM for Sandy Creek Trail Phase One, August 2000
7. Flood Insurance Study Durham County, North Carolina & Incorporated Areas Effective Date February 2, 1996
8. Sandy Creek Conservation Easement Triangle Township, Durham County, North Carolina August, 2001.
9. "Wetland Delineation Survey, Sandy Creek Wastewater Treatment Facility" by Barbara H. Mulkey Engineering Inc. dated 12/1/1997, revised 12/5/1997, delineation by Ecological Consultants.
10. Project Narrative for Sandy Creek Environmental Center, HSMM, January 2000.
11. City of Durham Zoning Maps



DRAINAGE AREA MAP
SANDY CREEK

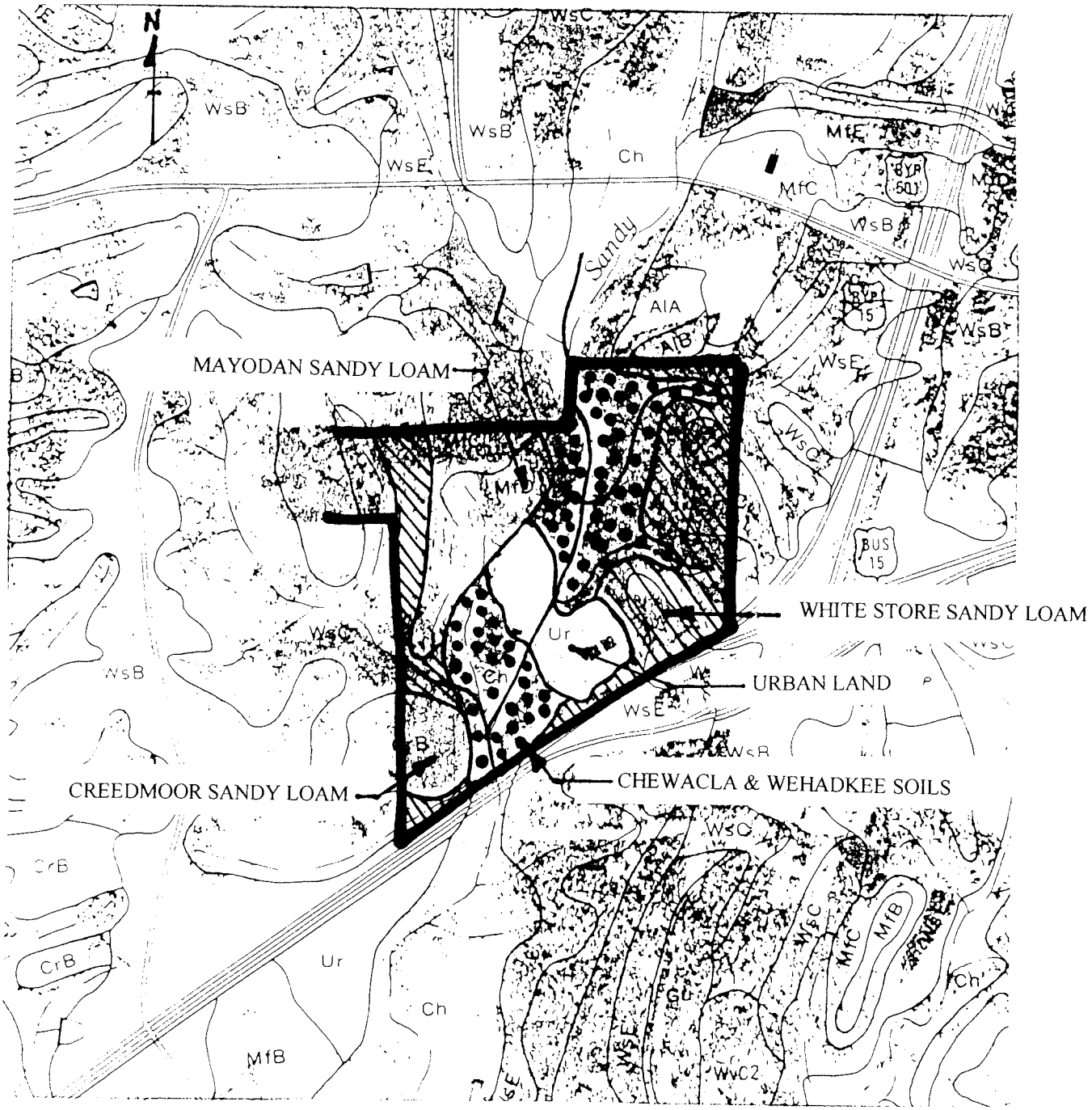
USGS QUADRANGLE MAP
SOUTHWEST DURHAM &
NORTHWEST DURHAM

SCALE: 1 INCH = 2,000 FEET



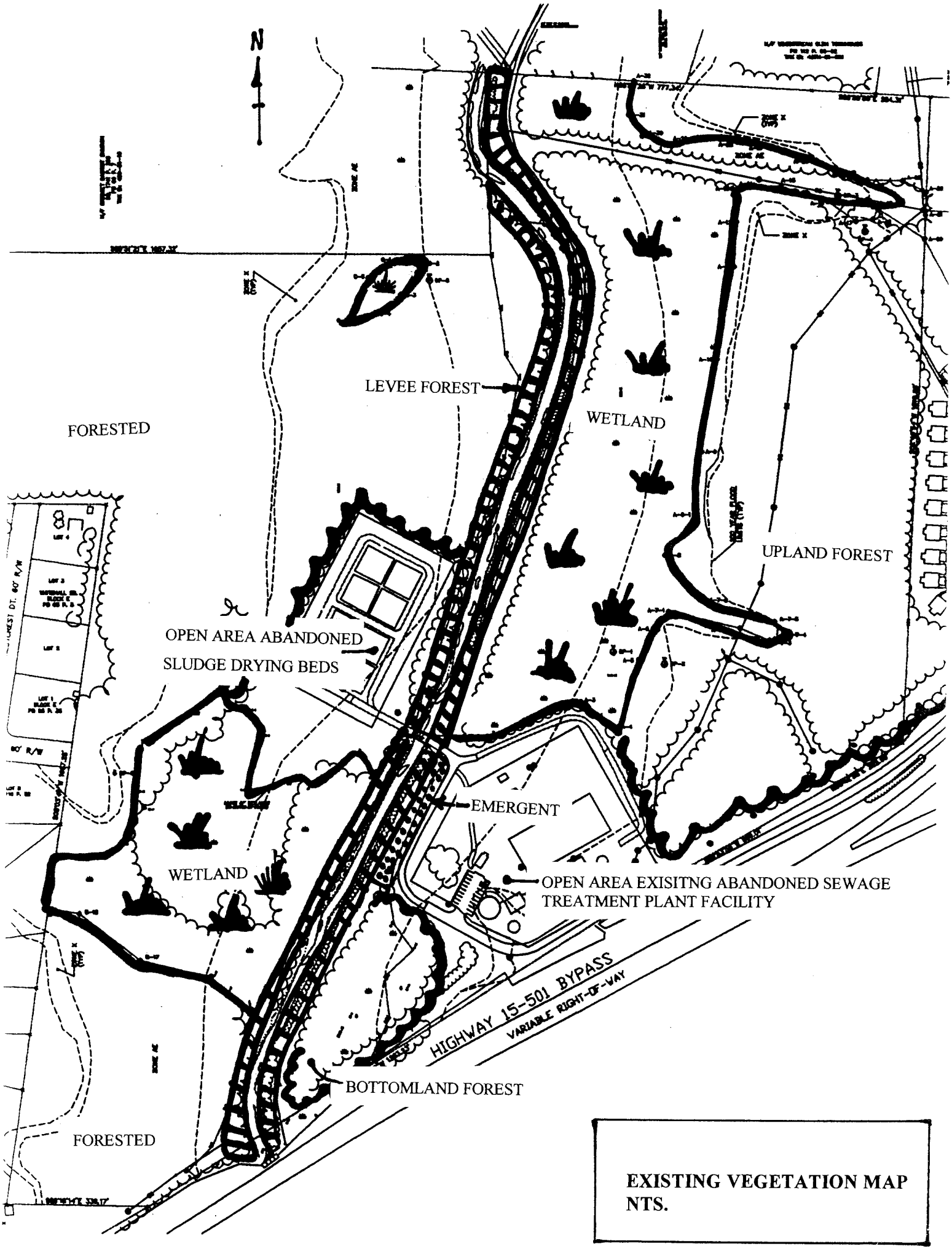
SANDY CREEK WATERSHED
CURRENT LAND USE

SCALE 1"= 2000 FEET



PROJECT SITE SOILS
SANDY CREEK

REFERENCE MAP
DURHAM COUNTY, NORTH CAROLINA
Not To Scale



EXISTING VEGETATION MAP
NTS.

Sandy Creek Durham County, North Carolina

May 2002

Proposed Wetland Site

Existing Wetlands to the South of the Proposed Mitigation Site

Sandy Creek Durham County, North Carolina

May 2002

Typical Ripple

Typical Pool

Sandy Creek Stream Enhancement
Durham, North Carolina

Variables	Existing Channel	Proposed Reach	Reference Reach
Stream type	E5	E5	E5
Drainage Area (Sq. Mile)	6.4	6.4	5.84
Bankfull width (Wbkf) Ft.	27.3 (27 – 27.7)	NC	17.55
Bankfull mean depth (dbkf) Ft.	2.76 (2.71 – 2.82)	NC	3.24
Width/depth ratio (Wbkf/dbkf)	9.9 (9.6 – 10.23)	NC	5.4
Bankfull Cross Sectional Area (Abkf) Sq. ft.	75.5 (75 – 76.1)	NC	57
Bankfull Mean Velocity (Vbkf) fps.	34	NC	28
Bankfull Discharge, cfs (Qbkf) Cfs.	2600 FEMA	NC	1600 FEMA
Bankfull Maximum depth (dmax) Ft.	3.19 (3.12 – 3.3)	NC	4.14
Max driff/dbkf ratio	1.16 (1.43-1.18)	NC	1.28
Low bank Height to max dbkf	1.46 (1.41 – 1.49)	NC	1.15
Width of flood prone area (Wfpa) Ft.	450 (280-600)	NC	400
Entrenchment ratio (Wfpa/Wbkf)	16.6 (10.4 – 22)	NC	400
Meander length (Lm) Ft.	2400	NC	93 (86- 147)
Ratio of meander length to bankfull width (Lm/Wbkf)	88	NC	5.3 (4.9 – 8.4)
Radius of Curvature (Rc) Ft.	240 (175 – 335)	NC	36.5 (17.5 – 75)
Ratio of radius of curvature to bankfull width (Rc/Wbkf)	8.8	NC	2.08 (1 – 4.3)

Belt width (Wblt) Ft.	120 – 400	NC	39 (25 – 59)
Meander width ratio (Wblt/Wbkf)	4.4 – 14.6	NC	2.2 (1.4 – 3.36)
Sinuosity (stream length /valley distance) (k)	1.08	NC	1.13
Valley slope (ft/ft)	.0018	NC	.0015
Average slope Savg= (Svalley /k)	.0017	NC	.0013
Pool Slope (Spool) Ft./ Ft.	.0005	NC	.0003
Ratio of pool slope to average slope (spool/Sbkf)	0.29	NC	0.23
Maximum pool depth (dpool) Ft.	4.2 (3.2 – 5.2)	To be increased with log vane placement	7.4 (6.2 – 8.1)
Ratio of pool depth to average bankfull depth (dpool/dbkf)	1.52 (1.15 – 1.9)	To be increased upwards towards 2.3 value w/ log vanes.	2.3 (1.9 – 2.5)
Pool width (Wpool) Ft.	27 (19 – 32)	NC	15.2
Ratio of pool width to bankfull width (Wpool/Wbkf)	0.99	NC	0.87
Ratio of pool area to bankfull area	1.17 (1.1 – 1.46)	Increase in Pool area with increased pool depth.	1.26
Pool to pool spacing (p-p) Ft.	130 (40 – 400)	180 (140 – 238)	118 (91.5 – 154)
Ration of p-p spacing to bankfull width (p-p/Wbkf)	4.8 (1.5 – 14.8)	6.7 (5.2 – 8.8)	6.7 (5.2 – 8.8)

Materials:	Existing	Proposed	Reference
Particle Size distribution of channel material			
D16	0.20 mm	NC	0.16 mm
D35	0.43 mm	NC	0.22 mm
D50	0.50 mm	NC	0.36 mm
D84	1.14 mm	NC	0.90 mm
D95	5.2 mm	NC	1.30 mm
Particle Size distribution of bar material			
D16			
D35			
D50			
D84			
D95			
Largest size particle at the toe (lower third) of bar			

Sediment Transport Validation (Based on Bankfull shear Stress)	Existing	Proposed
Calculated value		
Value from Shield Diagram (lb/sq.ft.)		
Critical dimensionless shear stress		
Miminum mean dbkf calculated using critical dimensionless shear stress equations		

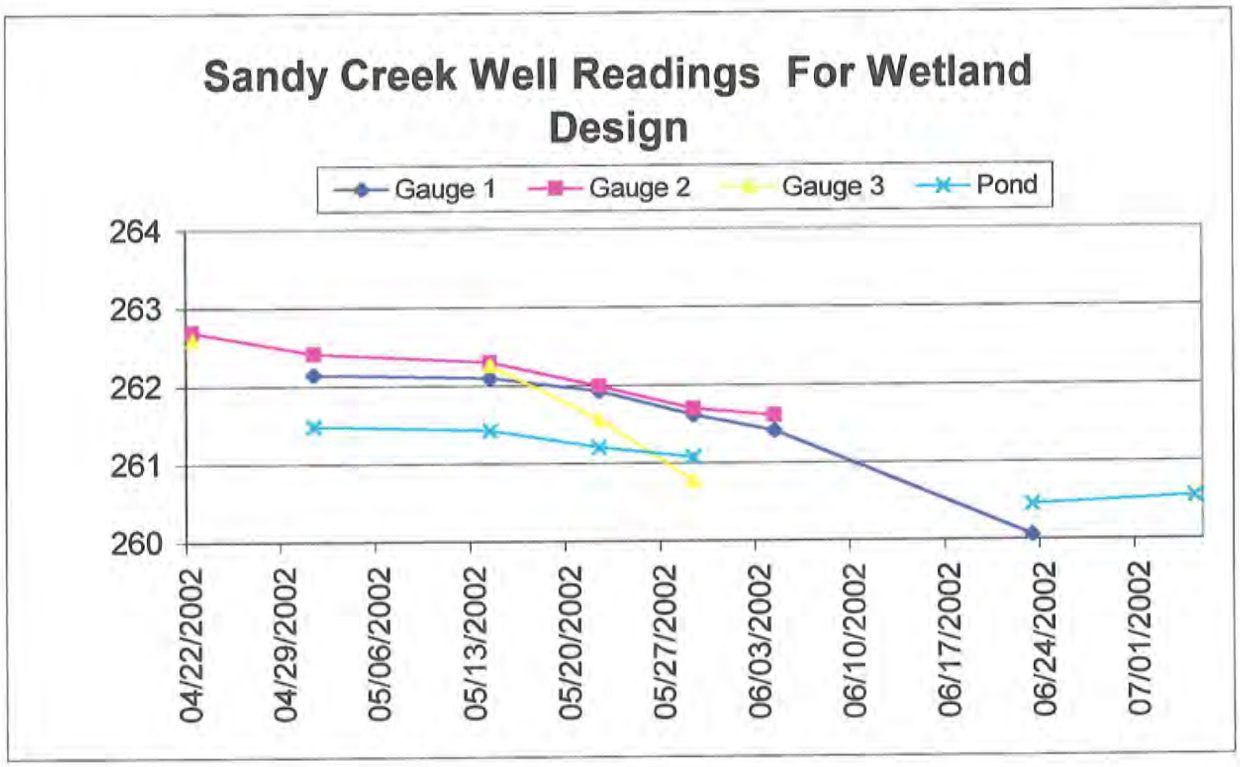
Note:

1. Sand bed stream "Rosgen" sediment transport methods not valid. Assumption made that all sediment will be transported through the system.
2. NC – No change in design from existing to proposed with this enhancement design.

Section A – Wetland Development Supporting Data

Sandy Creek Well Sample data for Wetland Design

Date	Gauge 1	Gauge 2	Gauge 3	Pond
04/22/2002		262.69	262.59	
05/01/2002	262.14	262.41		261.48
05/14/2002	262.09	262.3	262.26	261.42
05/22/2002	261.92	261.99	261.56	261.2
05/29/2002	261.61	261.69	260.77	261.07
06/04/2002	261.41	261.6		
06/23/2002	260.06			260.45
07/05/2002				260.55



APPENDIX D
WATER BUDGETS

As Prepared By
CZR Incorporated
September 2000

For The
Compensatory Wetland Mitigation Plan
Martin Luther King, Jr. Parkway
Extension Between Cook Road and Hope Valley Road
Durham County, North Carolina

Table D-3. Sandy Creek restoration mitigation site input water budget for average conditions without overbank flooding on a 4.36-acre site.

35.6-ACRE DRAINAGE BASIN INPUT				
	RAINFALL[a] (1970-1999)	PET[b]	NET (rainfall-PET)	TOTAL (basin factor x net)
January	4.39	0.24	4.15	33.9
February	3.74	0.4	3.34	27.3
March	4.76	1.1	3.66	29.9
April	3.3	2.29	1.01	8.3
May	4.85	3.64	1.21	9.9
June	3.87	5.22	-1.35	0
July	4.02	6.55	-2.53	0
August	4.34	5.9	-1.56	0
September	4.31	4.29	0.02	0.2
October	3.86	2.26	1.6	13.1
November	3.44	1.12	2.32	19.0
December	3.47	0.45	3.02	24.7

[a] Rainfall data was provided by the State Climate Office of NC State University and collected at the Durham County weather station and/or Raleigh-Durham Airport.

[b] Potential evapotranspiration (PET) was calculated using the Thornthwaite method.

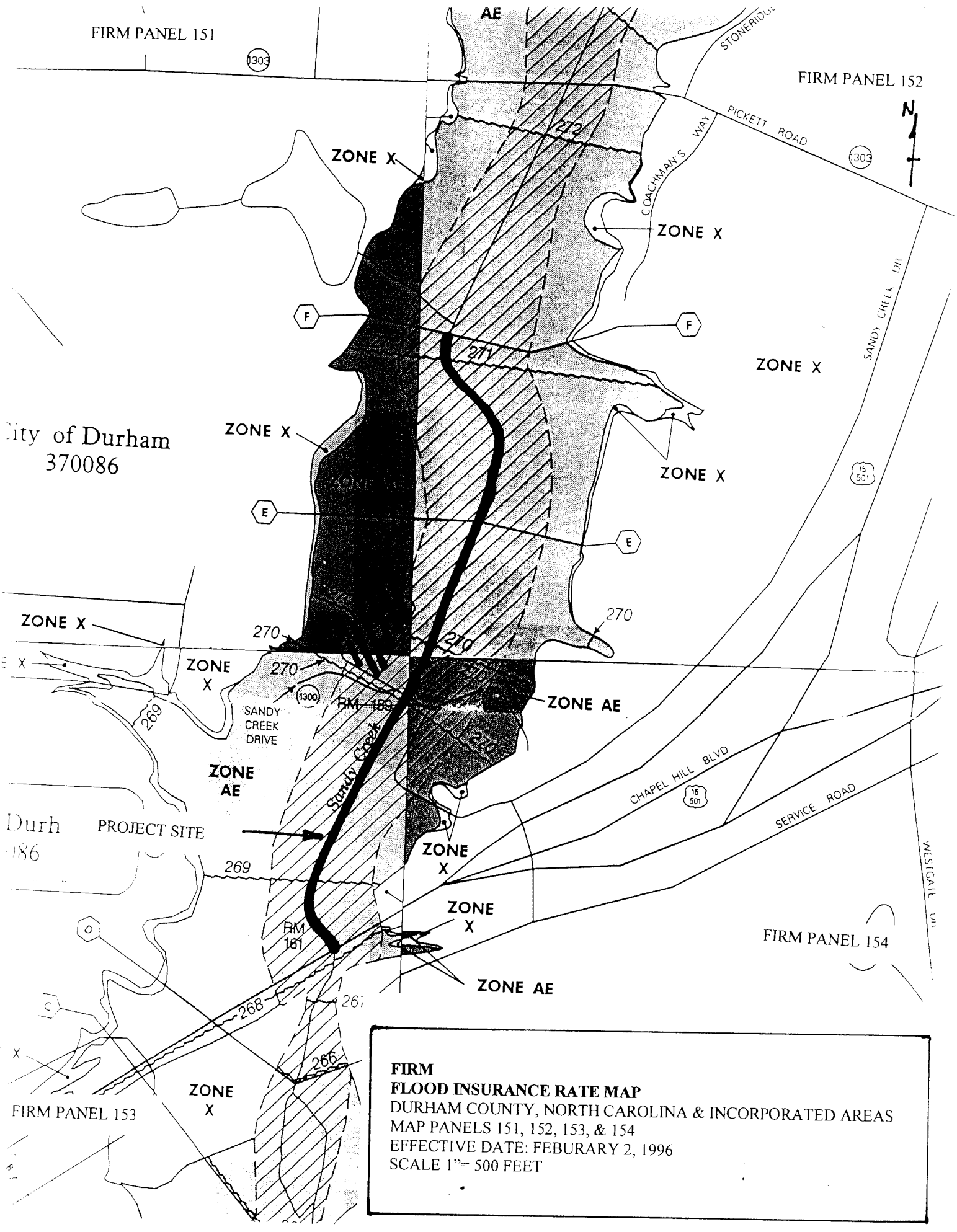
Table D-4. Sandy Creek mitigation site output water budget for average conditions without overbank flooding on a 4.36-acre site.

	TOTAL INPUT (Rainfall and basin)	OUTPUT		NET
		PET[a]	Infiltration[b]	
January	38.3	0.24	18.6	19.5
February	31.0	0.4	16.8	13.8
March	34.7	1.1	18.6	15.0
April	11.6	2.29	18.0	-8.7
May	14.8	3.64	18.6	-7.5
June	3.9	5.22	18.0	-19.3
July	4.0	6.55	18.6	-21.1
August	4.3	5.9	18.6	-20.2
September	4.5	4.29	18.0	-17.8
October	17.0	2.26	18.6	-3.9
November	22.4	1.12	18.0	3.3
December	28.2	0.45	18.6	9.1

[a] Potential evapotranspiration (PET) was calculated using the Thornthwaite method.

[b] Infiltration rate used was the mid-point for Natural Resources Conservation Service hydrologic Group D soil.

Section B – Sandy Creek Supporting Data



FIRM
FLOOD INSURANCE RATE MAP
DURHAM COUNTY, NORTH CAROLINA & INCORPORATED AREAS
MAP PANELS 151, 152, 153, & 154
EFFECTIVE DATE: FEBURARY 2, 1996
SCALE 1"= 500 FEET

No. 5505 Engineer's Computation Pad
AMN

DETERMINE BANKFULL DISCHARGES:

Fema discharge data for 10, 50, 100, & 500 yr storm events plotted on Log/Log paper to determine a linear relationship. From this linear relationship 1.5 year storm event determined for Sandy & Mud Creek.

Sandy Creek DA = 6.4 sq. miles 2,600 cfs.

Mud Creek DA = 5.8 sq. miles 1,600 cfs.

Determine manning's "N" value with known information & FEMA Discharges for both creeks.

Manning's Equation:

$$N = \frac{1.486}{Q}(A)(R)^{2/3}(S)^{1/2}$$

Sandy Creek

$Q = 2{,}600$ cfs
$A = 75.5\ ft^2$
$R = 2.76\ ft$
$S = 0.0017\ ft/ft.$

$$N = \frac{1.486}{2{,}600}(75.5)(2.76)^{.67}(.0017)^{.5}$$

$N = 0.0035$

$$V = Q/A = \frac{2600}{75.6} = 34.4\ ft/s$$

Mud Creek

$Q = 1600$ cfs
$A = 57\ ft^2$
$R = 3.24\ ft$
$S = 0.0013\ ft/ft.$

$$N = \frac{1.486}{1600}(57)(3.24)^{.67}(.0013)^{.5}$$

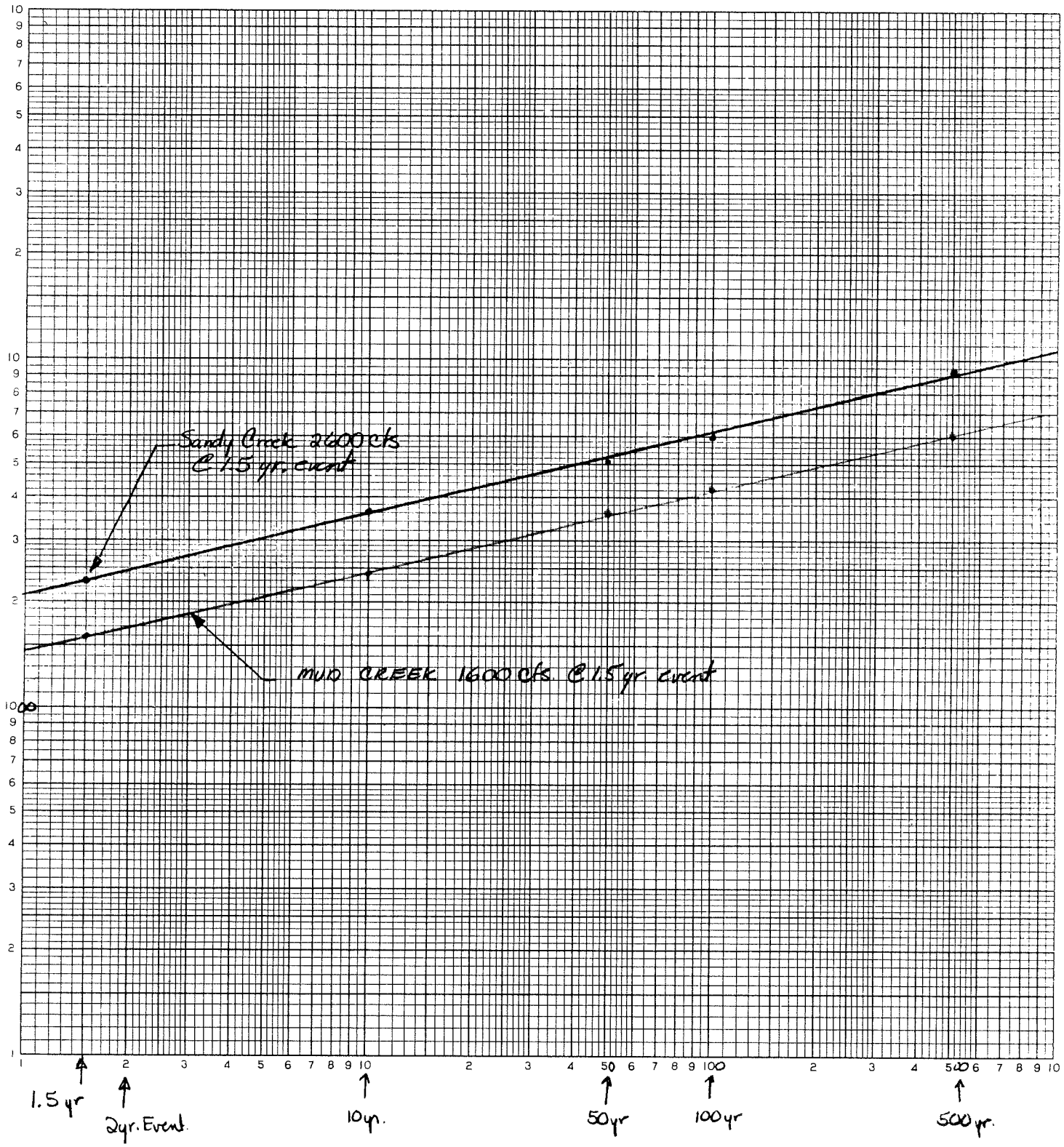
$N = 0.004$

$$V = Q/A = \frac{1600}{57} = 28\ ft/sec$$

N-values are very low however good correlation for sand bed stream between both streams.

NATIONAL
12-081
Made in U.S.A.

LOG/LOG PLOT OF FEMA DISCHARGE DATA



Full Logarithmic, 3 × 3 Cycles

TABLE 3 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
SANDY CREEK					
At confluence with New Hope Creek	6.83	3,538	5,019	5,778	8,013
At Bypass 15-501	6.50	3,624	5,155	5,941	8,260
At Pickett Road	5.32	3,671	5,209	5,997	8,318
At confluence of Sandy Creek Tributary D	2.00	2,067	2,911	3,343	4,610
At State Route 751	1.50	1,998	2,794	3,200	4,385
SANDY CREEK TRIBUTARY A					
At confluence with New Hope Creek	1.66	1,556	2,167	2,478	3,383
At Southern Parkway	1.16	1,473	2,040	2,327	3,159
SANDY CREEK TRIBUTARY D					
At confluence with Sandy Creek	2.66	1,932	2,741	3,155	4,374
At Cameron Boulevard	1.56	1,468	2,072	2,381	3,288
SEVENMILE CREEK					
At confluence with Eno River	2.72	1,754	2,858	3,448	5,331
At Inverness Drive	1.87	1,230	2,027	2,469	3,904
Approximately 1,100 feet upstream of Inverness Drive	0.59	420	705	858	1,354
SOUTH ELLERBE CREEK					
At confluence with Ellerbe Creek	2.89	3,446	4,872	5,602	7,747
At Interstate Route 85	1.46	1,252	1,764	2,025	2,790
At Guess Road	0.82	874	1,233	1,417	1,957
SOUTH ELLERBE CREEK TRIBUTARY					
At confluence with South Ellerbe Creek	1.32	2,325	3,271	3,754	5,169
Approximately 250 feet upstream of West Knox Street	0.84	1,795	2,521	2,892	3,978

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Rocky Creek								
A	833[1]	269	1,745	3.3	289.2	284.8[3]	284.8	0.0
B	2,379[1]	305	2,184	2.6	289.5	289.5	289.6	0.1
C	3,236[1]	360	2,288	2.5	292.1	292.1	292.3	0.2
D	5,196[1]	237	1,422	3.6	297.0	297.0	297.5	0.5
E	5,881[1]	216	1,796	2.9	299.0	299.0	299.7	0.7
F	7,278[1]	300	2,093	2.5	303.2	303.2	304.2	1.0
G	8,827[1]	158	1,497	2.8	307.8	307.8	308.8	1.0
H	9,731[1]	210	1,836	2.2	309.3	309.3	310.3	1.0
I	11,481[1]	152	1,066	2.9	314.1	314.1	314.9	0.8
J	12,382[1]	170	1,043	1.3	317.1	317.1	318.1	1.0
K	13,355[1]	70	182	7.4	320.5	320.5	320.9	0.4
Sandy Creek								
A	2,531[2]	685	6,042	1.0	258.7	258.7	259.7	1.0
B	3,316[2]	650	4,873	1.2	259.3	259.3	260.3	1.0
C	3,907[2]	300	1,739	3.3	260.5	260.5	261.4	0.9
D	4,636[2]	340	1,672	3.5	266.1	266.1	267.0	0.9
E	7,233[2]	520	4,455	1.3	270.6	270.6	271.6	1.0
F	8,104[2]	550	4,878	1.2	271.2	271.2	272.2	1.0
G	10,057[2]	380	2,472	2.4	273.5	273.5	274.4	0.9
H	10,589[2]	75	745	8.1	273.9	273.9	274.6	0.7
I	11,379[2]	355	2,972	2.0	276.8	276.8	277.5	0.7
J	12,186[2]	290	1,891	3.2	277.4	277.4	278.1	0.7
K	15,508[2]	307	3,948	0.8	292.4	292.4	293.4	1.0
L	16,485[2]	319	3,637	0.9	292.6	292.6	293.6	1.0
M	17,403[2]	204	1,775	1.9	292.9	292.9	293.9	1.0
N	20,653[2]	280	4,360	0.7	312.9	312.9	313.8	0.9
O	21,615[2]	305	3,810	0.8	313.0	313.0	313.9	0.9

[1]Feet above confluence with Third Fork Creek
[2]Feet above confluence with New Hope Creek
[3]Elevation computed without consideration of backwater effects from Third Fork Creek

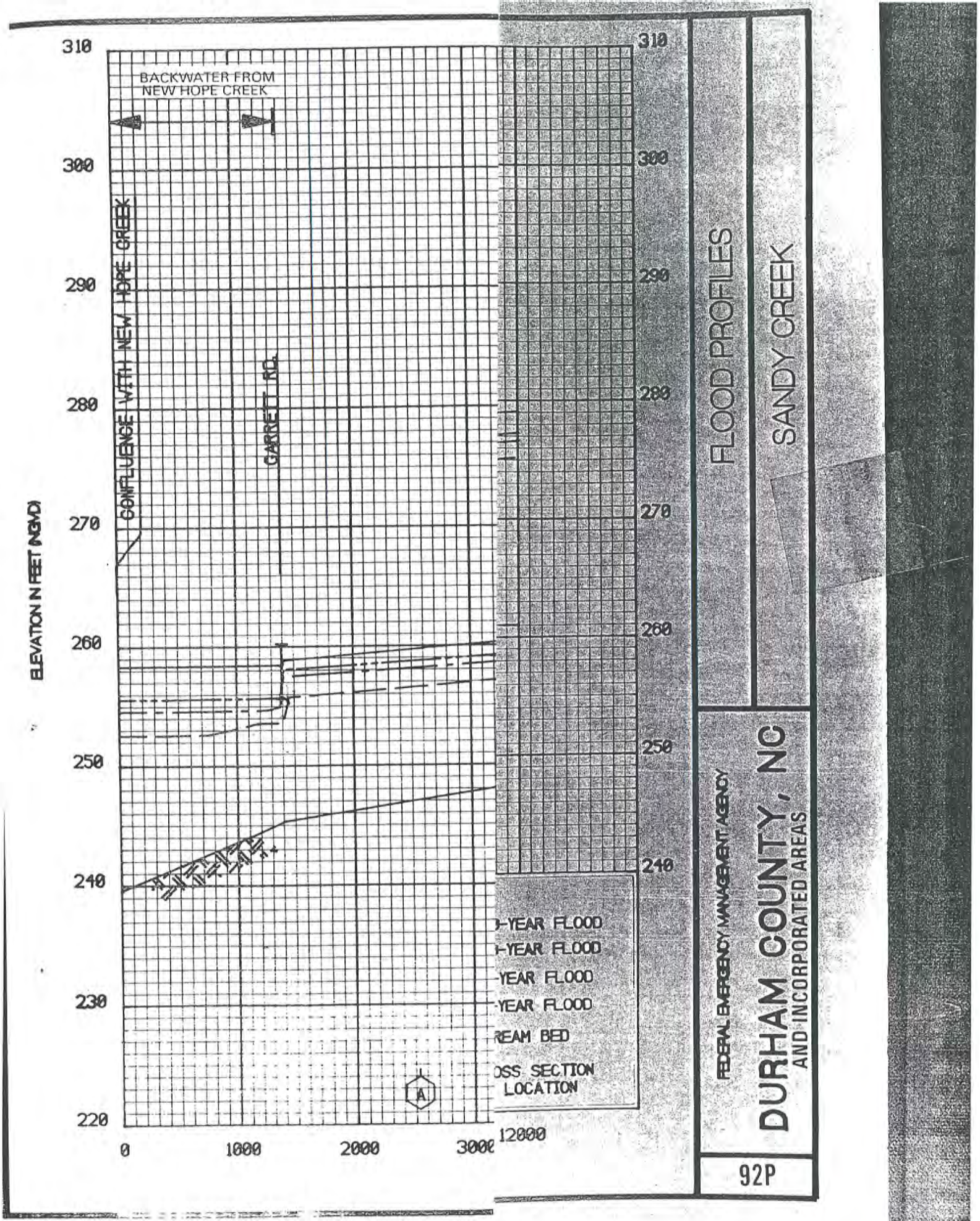
TABLE

FEDERAL EMERGENCY MANAGEMENT AGENCY

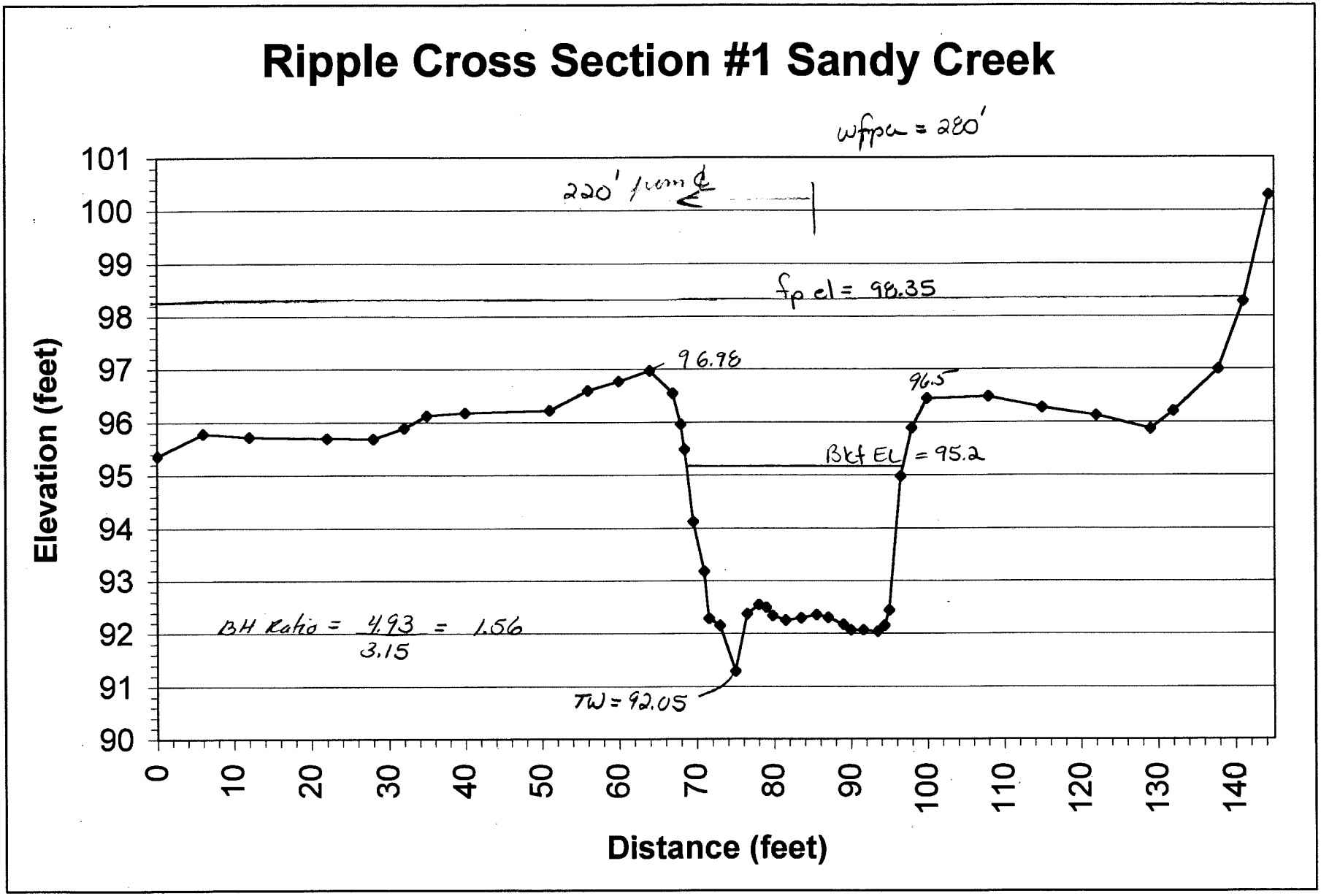
DURHAM COUNTY, NC
AND INCORPORATED AREAS

FLOODWAY DATA

ROCKY CREEK - SANDY CREEK


BACKWATER FROM NEW HOPE CREEK
CONFLUENCE WITH NEW HOPE CREEK
GARRETT RD.
ELEVATION IN FEET (NGVD)
310
300
290
280
270
260
250
240
230
220
0
1000
2000
3000
12000
-YEAR FLOOD
-YEAR FLOOD
-YEAR FLOOD
-YEAR FLOOD
REAM BED
OSS SECTION
LOCATION
A
FLOOD PROFILES
SANDY CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
DURHAM COUNTY, NC
AND INCORPORATED AREAS
92P

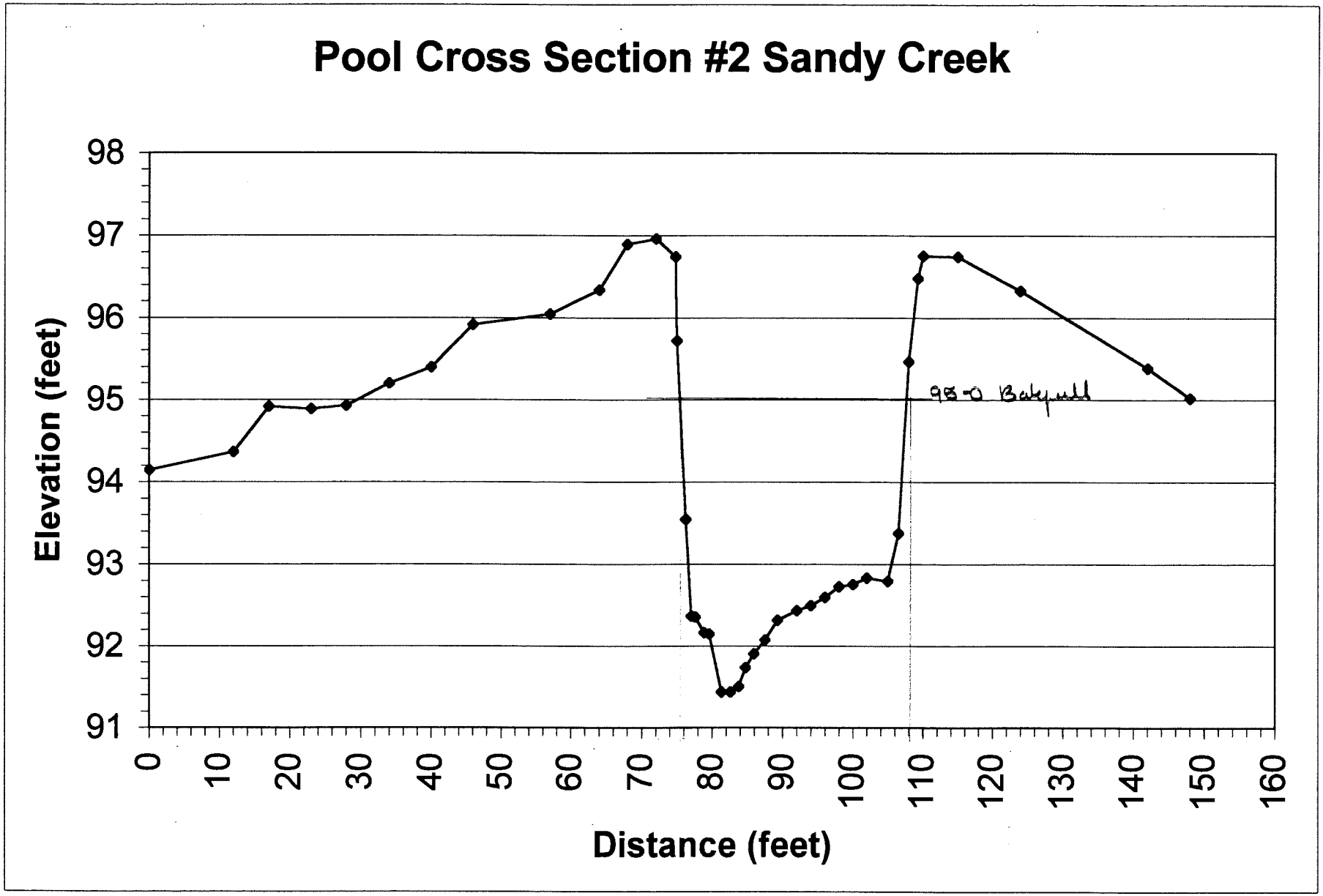
Ripple Cross Section #1 Sandy Creek



Cross Sectional Area Computations
Ripple Cross Section #1- Adjusted Bankfull Height
Bench Mark Elevation = 100 HI = 101.21
BS = 1.21
Bankfull Cross Section Bankfull Elevation 95.2

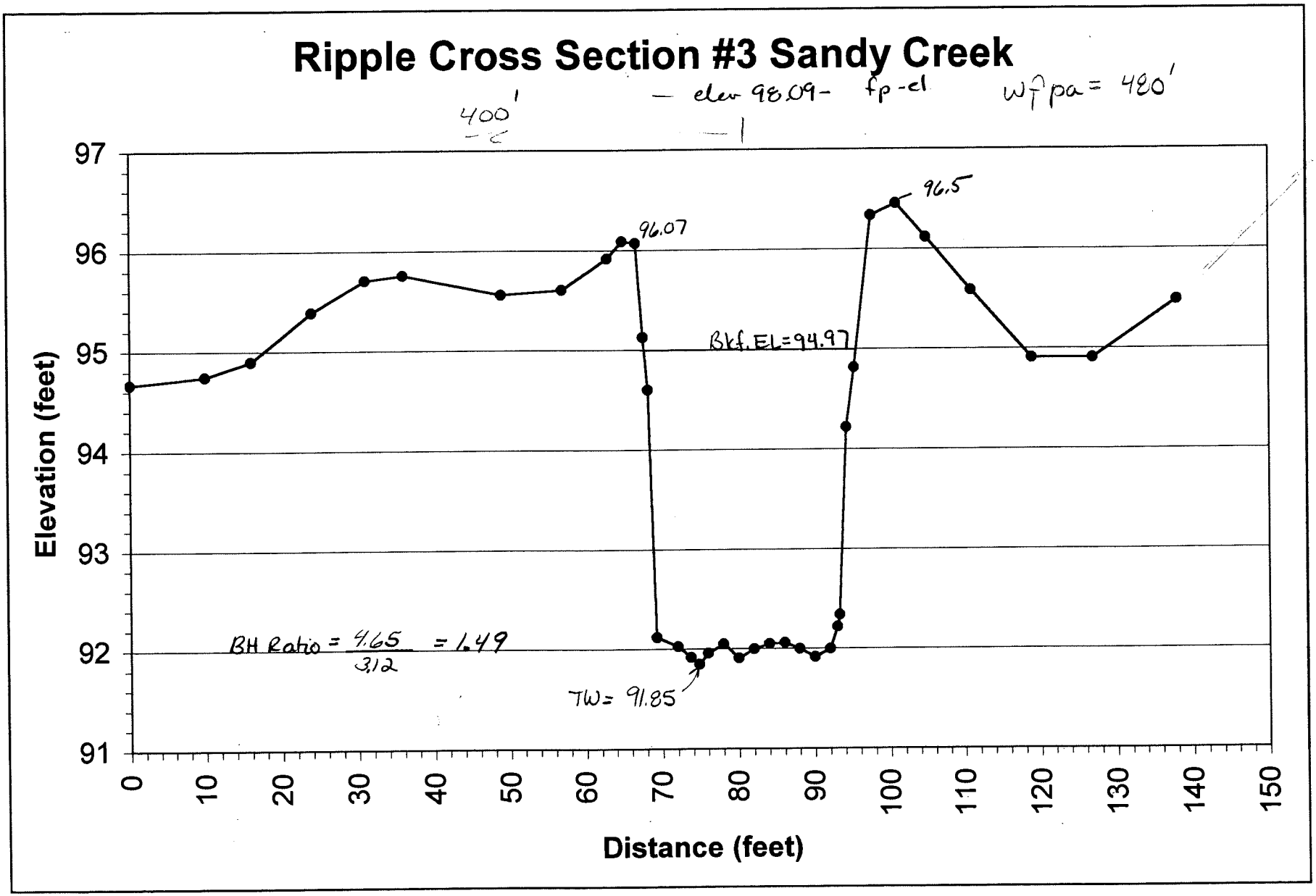
Station	FS	Elevation	Elevation from Bankfull	Incremental Avg.Height Ft.	Incremental Distance Ft.	Incremental Area Sq.Ft.
69	5.72	95.2	0			
				0.54	0.60	0.32
69.6	7.08	94.13	1.07			
				1.55	1.40	2.16
71	8.03	93.18	2.02			
				2.97	0.60	1.78
71.6	9.92	91.29	3.91			
				3.48	1.40	4.87
73	9.05	92.16	3.04			
				3.48	2.00	6.95
75	9.92	91.29	3.91			
				3.37	1.50	5.05
76.5	8.83	92.38	2.82			
				2.74	1.50	4.10
78	8.66	92.55	2.65			
				2.68	1.00	2.68
79	8.71	92.5	2.7			
				2.78	0.80	2.22
79.8	8.87	92.34	2.86			
				2.90	1.70	4.93
81.5	8.95	92.26	2.94			
				2.92	2.00	5.84
83.5	8.91	92.3	2.9			
				2.87	2.00	5.74
85.5	8.85	92.36	2.84			
				2.87	1.50	4.30
87	8.9	92.31	2.89			
				2.96	2.00	5.91
89	9.03	92.18	3.02			
				3.08	1.00	3.08
90	9.14	92.07	3.13			
				3.13	1.60	5.01
91.6	9.14	92.07	3.13			
				3.14	1.90	5.97
93.5	9.16	92.05	3.15			
				3.10	0.90	2.79
94.4	9.05	92.16	3.04			
				1.52	1.60	2.43
96	5.72	95.2	0			

flood prone el= 98.35 ft. Total Area 76.11 Sq. Feet
Wfpa = 280.00 ft. Wbkf = 27 ft
ER = 10.37 dbkf = 2.82 ft
D50 = 0.50 mm. W/d = 9.58
BH Ratio 1.56 dmbkf = 3.15 ft.


Pool Cross Section #2 Sandy Creek
Elevation (feet)
98
97
96
95
94
93
92
91
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Distance (feet)
95-0 Bankfull

Cross Section 2
BM Top of MH -A = 100

Station	BS	HI	FS	Elevation	Notes:
	1.09	101.09			BM top of MH-A
0			6.94	94.15	
12			6.72	94.37	
17			6.17	94.92	
23			6.2	94.89	
28			6.16	94.93	
34			5.89	95.2	
40			5.69	95.4	
46			5.17	95.92	
57			5.04	96.05	
64			4.75	96.34	
68			4.19	96.9	
72			4.12	96.97	
74.8			4.34	96.75	TOB-L
75			5.37	95.72	Bkf- L
76.3			7.54	93.55	
77.1			8.72	92.37	Toe
77.6			8.73	92.36	EOW WS
78.9			8.92	92.17	
79.6			8.94	92.15	
81.3			9.65	91.44	
82.6			9.65	91.44	
83.8			9.58	91.51	
84.7			9.35	91.74	
85.9			9.18	91.91	
87.5			9.01	92.08	
89.3			8.77	92.32	EOW WS
92			8.65	92.44	
94			8.59	92.5	
96			8.49	92.6	
98			8.36	92.73	
100			8.33	92.76	
102			8.25	92.84	
105			8.29	92.8	Toe- R
106.5			7.71	93.38	
108			5.62	95.47	Bkf- R
109.3			4.61	96.48	TOB
110			4.33	96.76	
115			4.34	96.75	
124			4.76	96.33	
142			5.7	95.39	
148			6.07	95.02	
158					Edge of Terrace

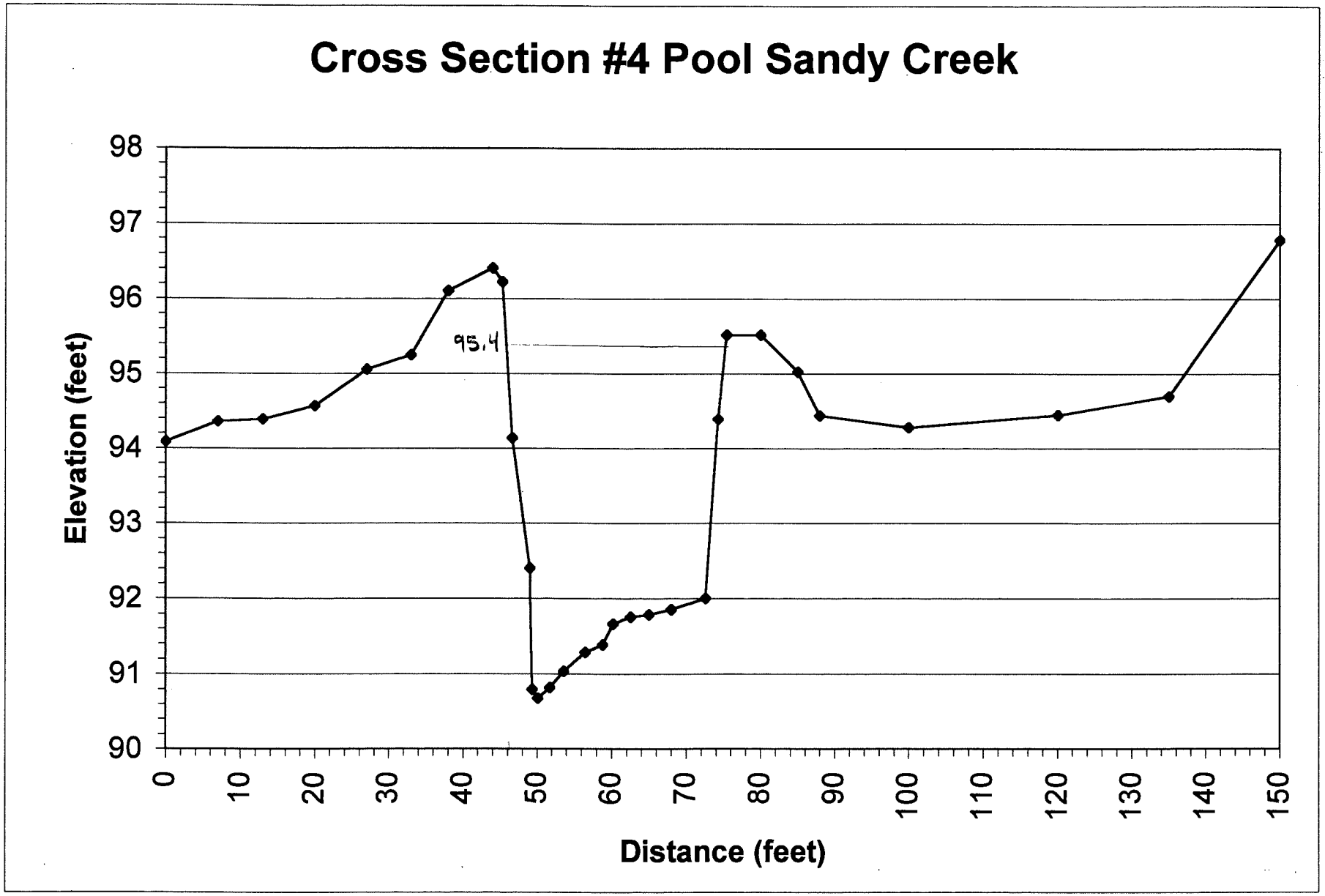

Ripple Cross Section #3 Sandy Creek
400'
elev 98.09 - fp-el
wfpa = 480'
Elevation (feet)
Distance (feet)
96.07
96.5
Bkf. EL=94.97
BH Ratio = 4.65 / 3.12 = 1.49
TW= 91.85

Cross Sectional Area Computations
Ripple Cross Section #3- Estimated Bankfull Height Field observations
Bench Mark Elevation (MH-A) = 100 HI = 100.34
BS = 0.34
Bankfull Cross Section Bankfull Elevation 94.97

Station	FS	Elevation	Elevation from Bankfull	Incremental Avg.Height Ft.	Incremental Distance Ft.	Incremental Area Sq.Ft.
67.7	5.21	94.97	0			
				0.18	0.60	0.11
68.3	5.74	94.6	0.37			
				1.61	1.00	1.61
69.3	8.22	92.12	2.85			
				2.90	2.70	7.82
72	8.31	92.03	2.94			
				3.00	1.70	5.09
73.7	8.42	91.92	3.05			
				3.08	1.10	3.39
74.8	8.49	91.85	3.12			
				3.06	1.20	3.68
76	8.38	91.96	3.01			
				2.96	2.00	5.93
78	8.29	92.05	2.92			
				2.99	2.00	5.98
80	8.43	91.91	3.06			
				3.02	2.00	6.03
82	8.34	92	2.97			
				2.94	2.00	5.89
84	8.29	92.05	2.92			
				2.91	2.00	5.83
86	8.28	92.06	2.91			
				2.94	2.00	5.88
88	8.34	92	2.97			
				3.01	2.00	6.02
90	8.42	91.92	3.05			
				3.01	2.00	6.02
92	8.34	92	2.97			
				2.80	1.30	3.64
93.3	8	92.34	2.63			
				1.69	1.00	1.69
94.3	6.12	94.22	0.75			
				0.38	1.10	0.41
95.4	5.52	94.97	0			

Total Area	75.02 Sq. Feet
Wbkf =	27.7 ft.
dbkf =	2.71 ft.
w/d =	10.23
dmbkf =	3.12 ft.
Fpa elev.=	98.09 ft.
Wfpa =	480.00 ft.
ER =	17.33

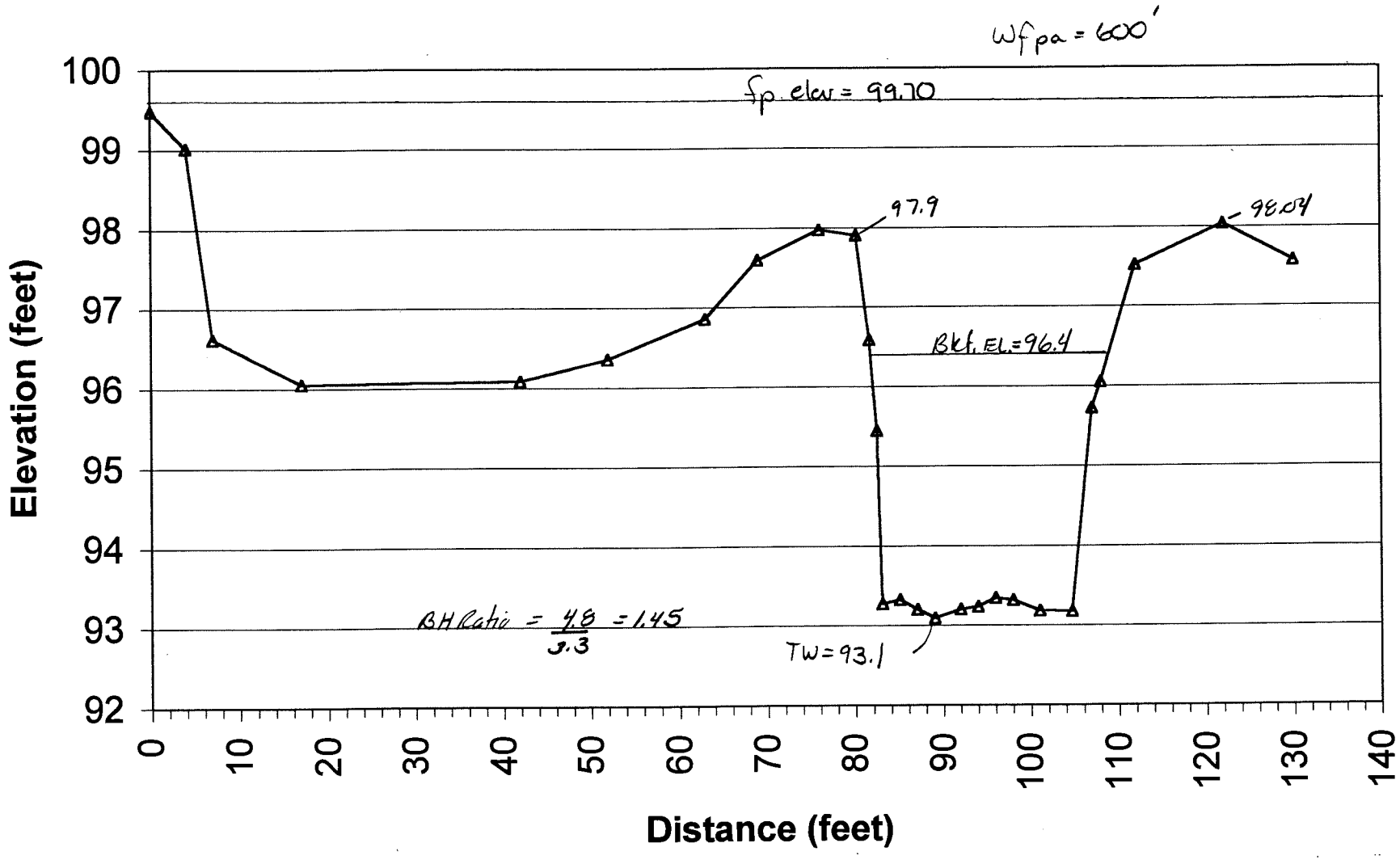
D50 =	0.50 mm.
BH Ratio	1.49


Cross Section #4 Pool Sandy Creek
Elevation (feet)
98
97
96
95
94
93
92
91
90
95.4
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Distance (feet)

Cross Section 4
BM Top of MH -B = 100

Station	BS	HI	FS	Elevation	Notes:
	0.05	100.05			BM top of MH-B
0			5.96	94.09	
7			5.69	94.36	
13			5.66	94.39	
20			5.48	94.57	
27			4.99	95.06	
33			4.8	95.25	
38			3.94	96.11	
44			3.64	96.41	
45.3			3.82	96.23	
46.6			5.91	94.14	
49			7.64	92.41	
49.3			9.25	90.8	
50.1			9.37	90.68	
51.7			9.23	90.82	
53.6			9.01	91.04	
56.5			8.76	91.29	
58.8			8.66	91.39	
60.2			8.38	91.67	
62.5			8.29	91.76	
65			8.26	91.79	
68			8.19	91.86	
72.6			8.04	92.01	
74.3			5.66	94.39	
75.4			4.53	95.52	
80			4.53	95.52	
85			5.02	95.03	
88			5.61	94.44	
100			5.77	94.28	
120			5.6	94.45	
135			5.35	94.7	
150			3.26	96.79	

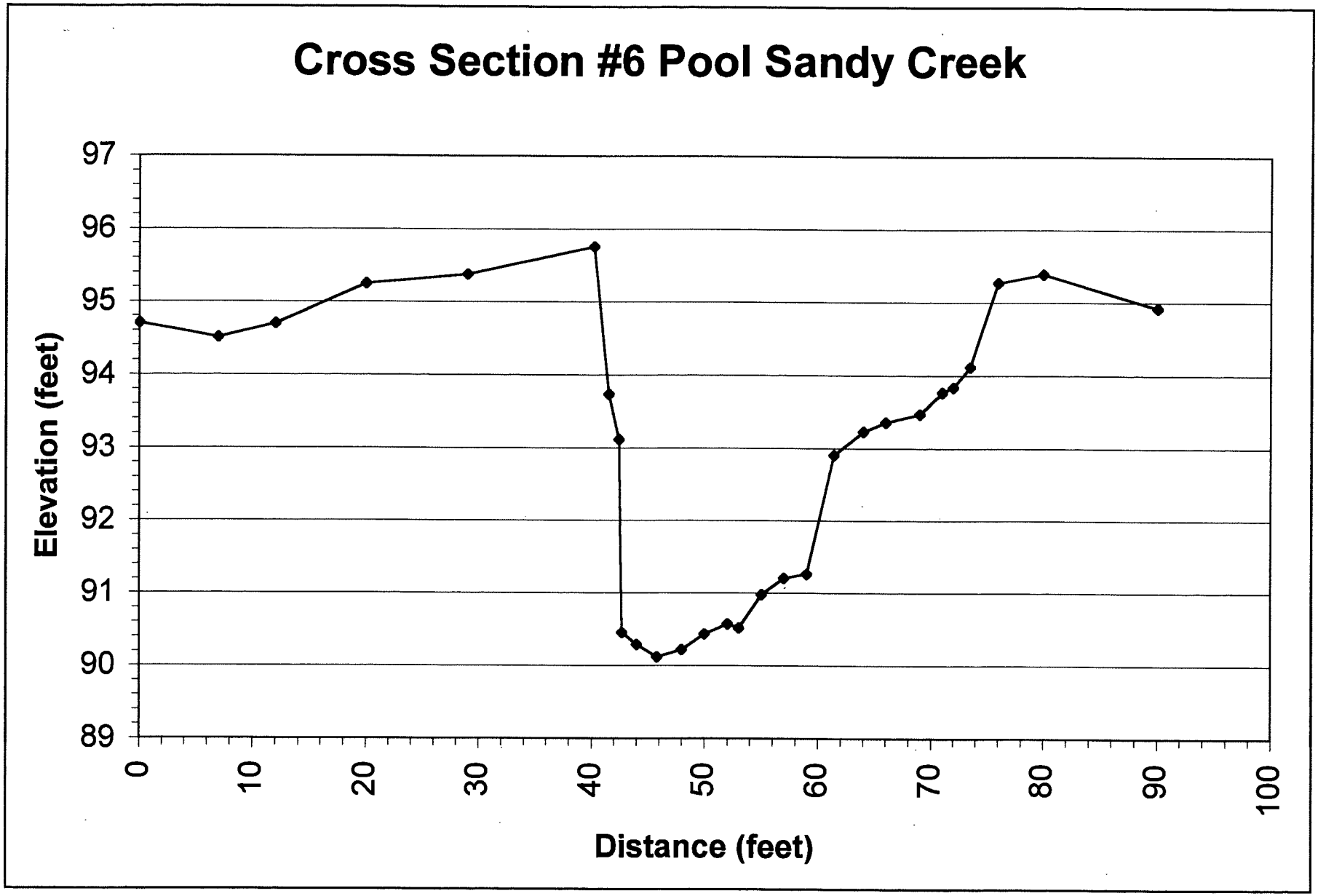
Ripple Cross Section #5 Sandy Creek



Cross Sectional Area Computations
Ripple Cross Section #5- Estimated Bankfull Height Field observations
Bench Mark Elevation (Wooden stake at Rd.) = 100 HI = 102.81
Width = 27.3 BS = 2.81
Bankfull Cross Section Bankfull Elevation 96.4

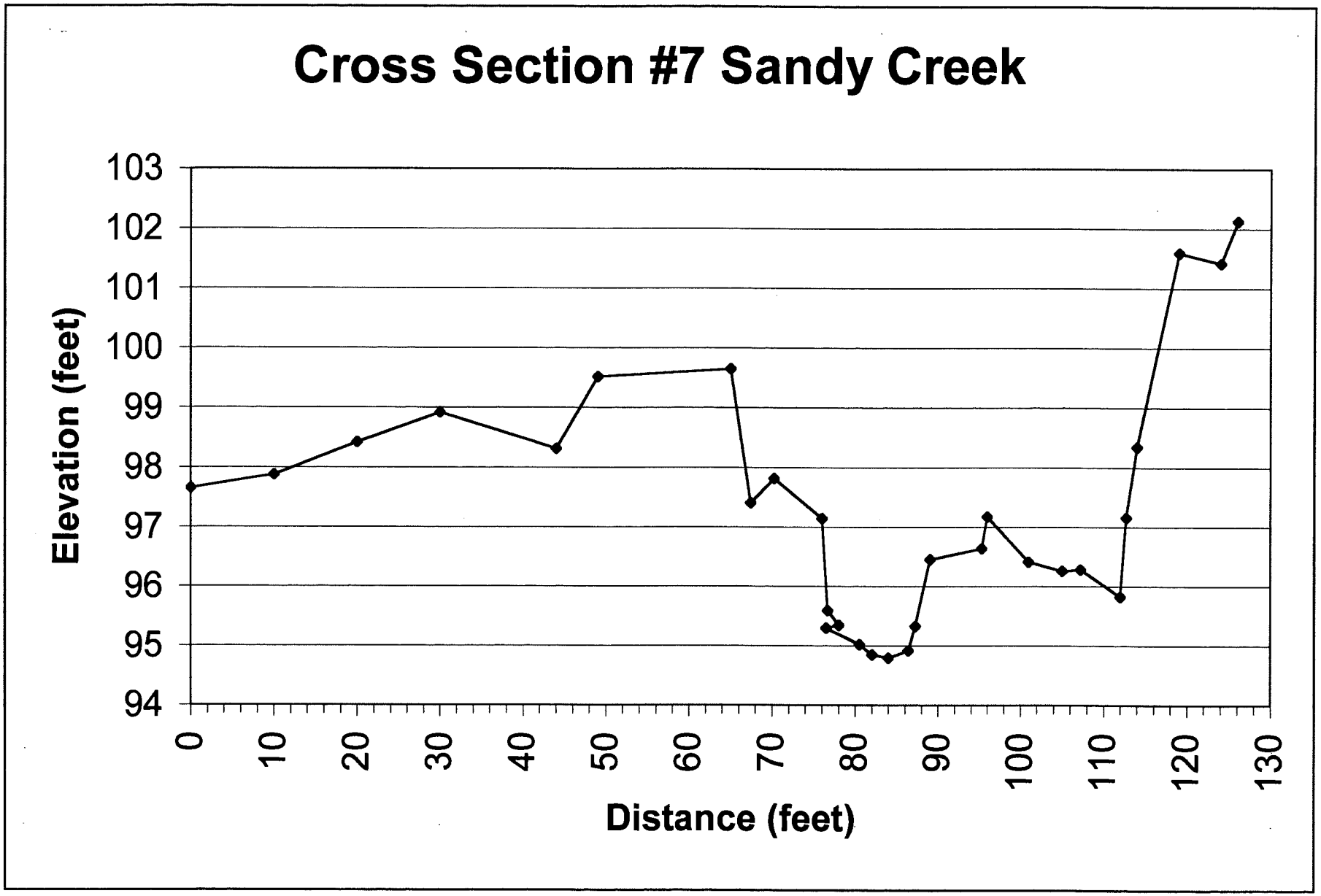
Station	FS	Elevation	Elevation from Bankfull	Incremental Avg.Height Ft.	Incremental Distance Ft.	Incremental Area Sq.Ft.
81.7	6.22	96.4	0			
				0.48	0.80	0.38
82.5	7.36	95.45	0.95			
				2.04	0.50	1.02
83	9.53	93.28	3.12			
				3.10	2.00	6.19
85	9.48	93.33	3.07			
				3.13	2.00	6.26
87	9.6	93.21	3.19			
				3.25	2.00	6.49
89	9.71	93.1	3.3			
				3.25	3.00	9.74
92	9.6	93.21	3.19			
				3.18	2.00	6.35
94	9.57	93.24	3.16			
				3.11	2.00	6.21
96	9.46	93.35	3.05			
				3.07	2.00	6.13
98	9.49	93.32	3.08			
				3.15	3.00	9.44
101	9.62	93.19	3.21			
				3.22	3.70	11.90
104.7	9.63	93.18	3.22			
				1.95	2.30	4.47
107	7.08	95.73	0.67			
				0.51	1.00	0.51
108	6.75	96.06	0.34			
				0.17	1.00	0.17
109		96.4	0			

Total Area	75.24	Sq. Feet
Wbkf =	27.30	ft.
dbkf =	2.76	ft.
W/d =	9.91	
dmbkf =	3.30	ft.
Fp elev =	99.70	ft.
Wfpa =	600.00	ft.
ER =	21.98	
D50 =	0.50	mm.
BH Ratio	1.45	


Cross Section #6 Pool Sandy Creek
Elevation (feet)
97
96
95
94
93
92
91
90
89
0
10
20
30
40
50
60
70
80
90
100
Distance (feet)

Cross Section 6
BM Top of MH -C = 100

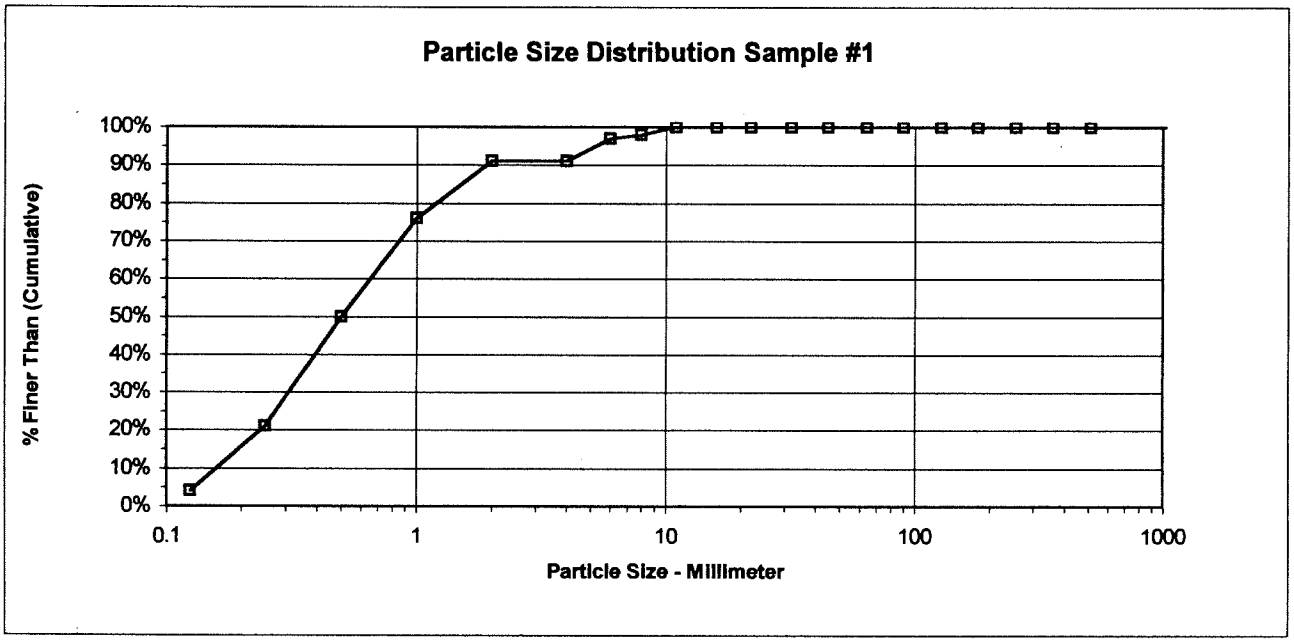
Station	BS	HI	FS	Elevation	Notes:
	0.61	100.61			BM top of MH-C
0			5.9	94.71	
7			6.1	94.51	
12			5.91	94.7	
20			5.36	95.25	
29			5.23	95.38	
40.2			4.85	95.76	TOB-L
41.5			6.87	93.74	
42.4			7.49	93.12	Bkf - L
42.7			10.15	90.46	Toe
44			10.32	90.29	
45.8			10.49	90.12	TW
48			10.39	90.22	
50			10.17	90.44	
52			10.03	90.58	
53			10.09	90.52	Eow - WS
55			9.63	90.98	
57			9.4	91.21	
59			9.34	91.27	Toe
61.4			7.7	92.91	TOB- R
64			7.38	93.23	
66			7.25	93.36	
69			7.14	93.47	Bkf - R
71			6.84	93.77	
72			6.77	93.84	
73.5			6.49	94.12	
76			5.34	95.27	TOB - R
80			5.22	95.39	
90			5.69	94.92	

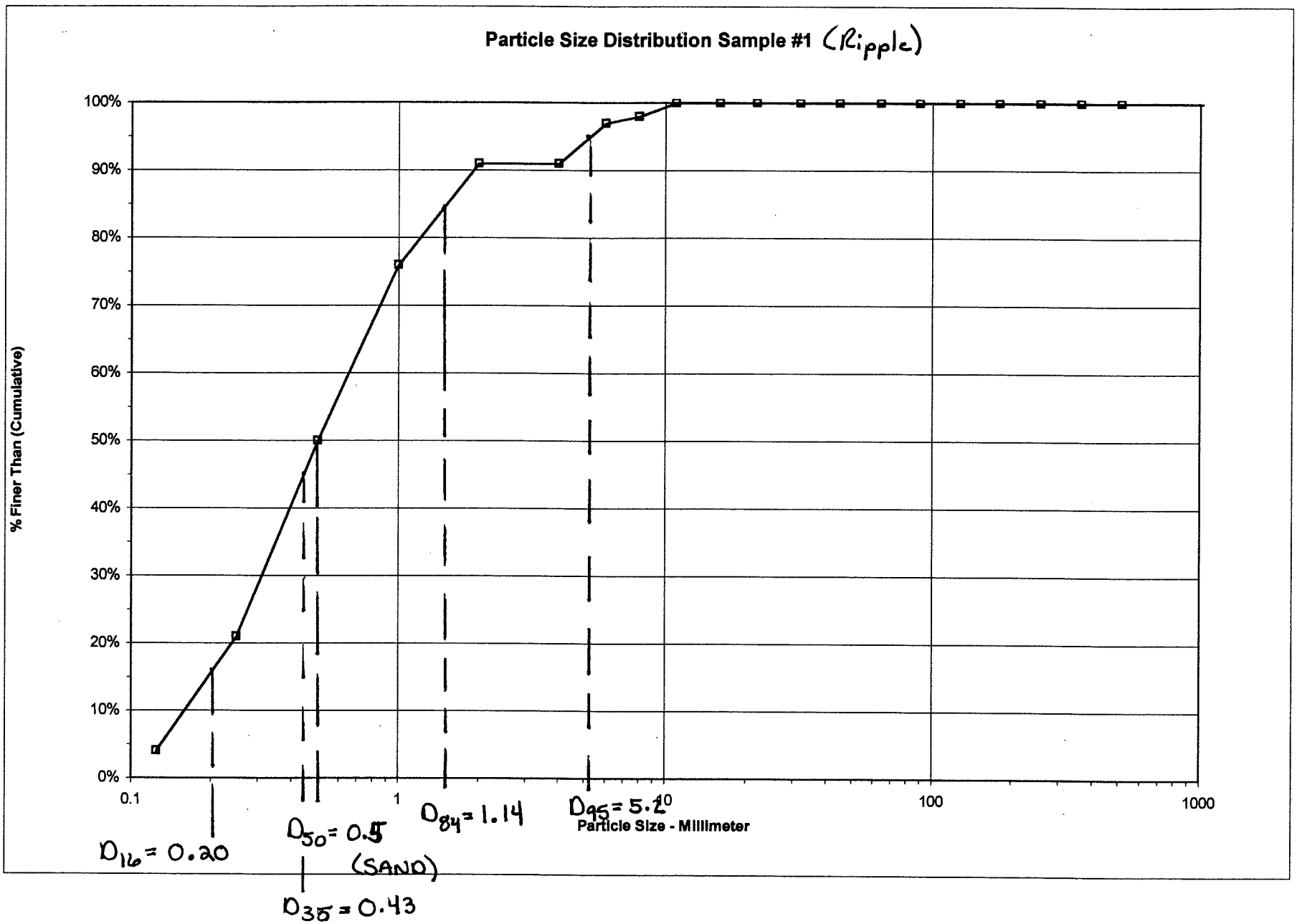

Cross Section #7 Sandy Creek
Elevation (feet)
103
102
101
100
99
98
97
96
95
94
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Distance (feet)

Cross Section 7
Top of hub at creek bank top = 100

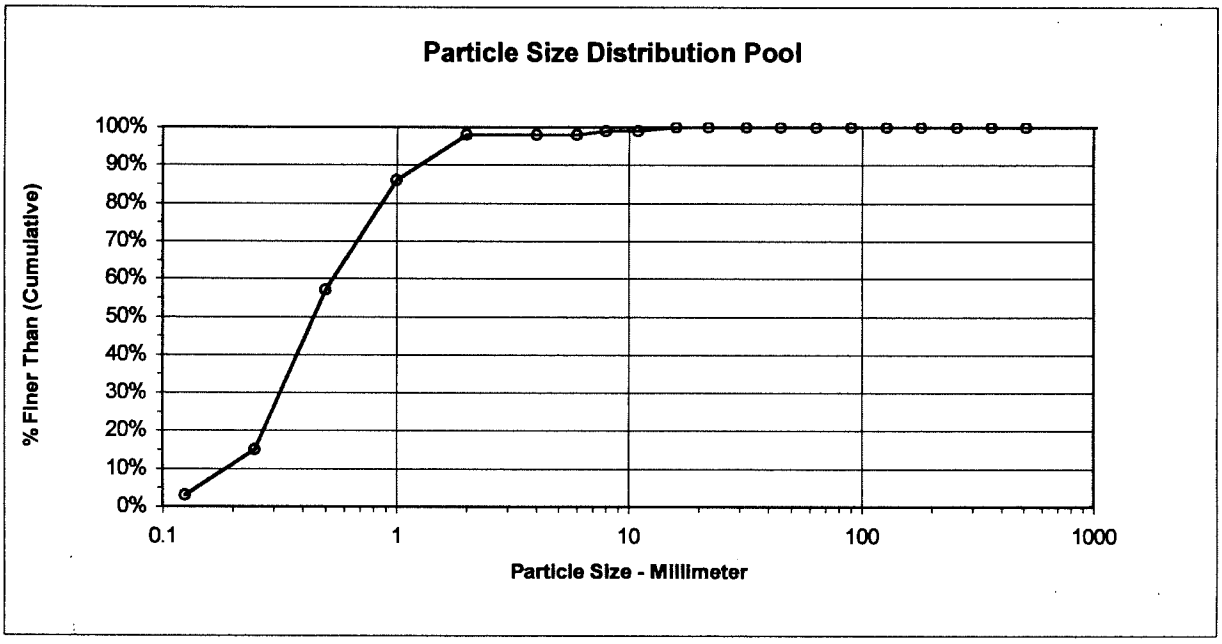
Station	BS	HI	FS	Elevation	Notes:
	3.45	103.45			BM hub set at top of bank
0			5.79	97.66	
10			5.57	97.88	
20			5.02	98.43	
30			4.53	98.92	
44			5.13	98.32	
49			3.93	99.52	
65			3.8	99.65	TOB -L
67.4			6.04	97.41	Toe
70.2			5.63	97.82	Bkf - L
76			6.3	97.15	Tob
76.7			7.85	95.6	Toe
78			8.1	95.35	
76.5			8.15	95.3	Eow - ws
80.5			8.43	95.02	
82			8.6	94.85	
84			8.65	94.8	TW
86.4			8.53	94.92	
87.2			8.12	95.33	Eow - ws
89			6.99	96.46	
95.3			6.81	96.64	
96			6.27	97.18	Bkf - R
101			7.03	96.42	
105			7.19	96.26	
107.2			7.16	96.29	
112			7.62	95.83	Toe
112.7			6.29	97.16	Bkf-R
114			5.1	98.35	
119			1.85	101.6	TOB -R
124			2.02	101.43	
126			1.32	102.13	

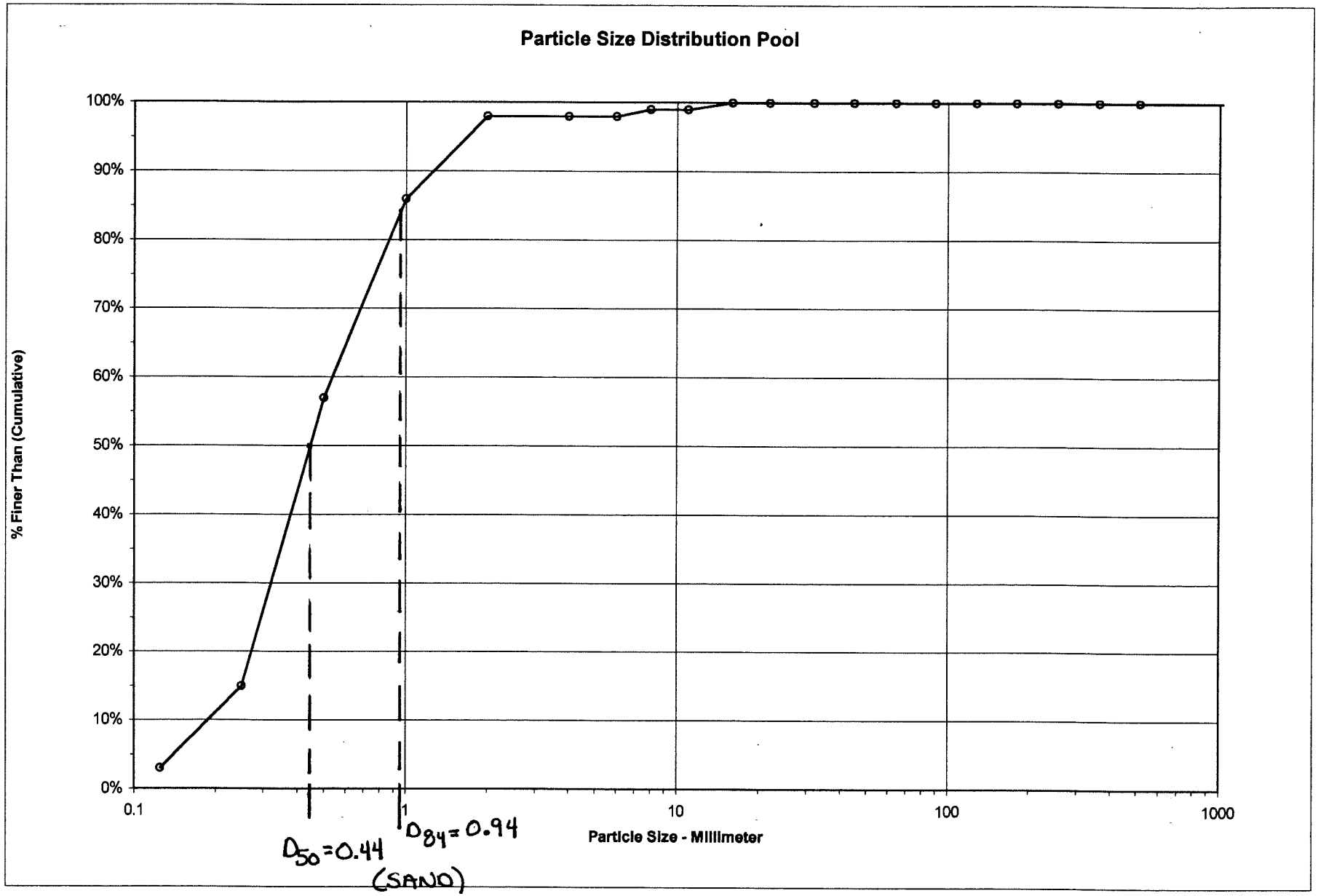
PEBBLE COUNT								
Project:	Sandy Creek					**Date:**	5/15/02	
Location:	At Cross Section #1							
				Particle Counts				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	0		0	0%	0%
	Very Fine	.062 - .125	S	4		4	4%	4%
	Fine	.125 - .25	A	17		17	17%	21%
	Medium	.25 - .50	N	29		29	29%	50%
	Coarse	.50 - 1.0	D	26		26	26%	76%
.04 -.08	Very Coarse	1.0 - 2.0	S	15		15	15%	91%
.08 - .16	Very Fine	2.0 - 4.0				0	0%	91%
.16 - .22	Fine	4.0 - 5.7	G	6		6	6%	97%
.22 - .31	Fine	5.7 - 8.0	R	1		1	1%	98%
.31 - .44	Medium	8.0 - 11.3	A	2		2	2%	100%
.44 - .63	Medium	11.3 - 16.0	V			0	0%	100%
.63 - .89	Coarse	16.0 - 22.6	E			0	0%	100%
.89 - 1.26	Coarse	22.6 - 32.0	L			0	0%	100%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S			0	0%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0				0	0%	100%
2.5 - 3.5	Small	64 - 90	C	0	0	0	0%	100%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%	100%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
			Totals	**100**	**0**	**100**	**100%**	**100%**



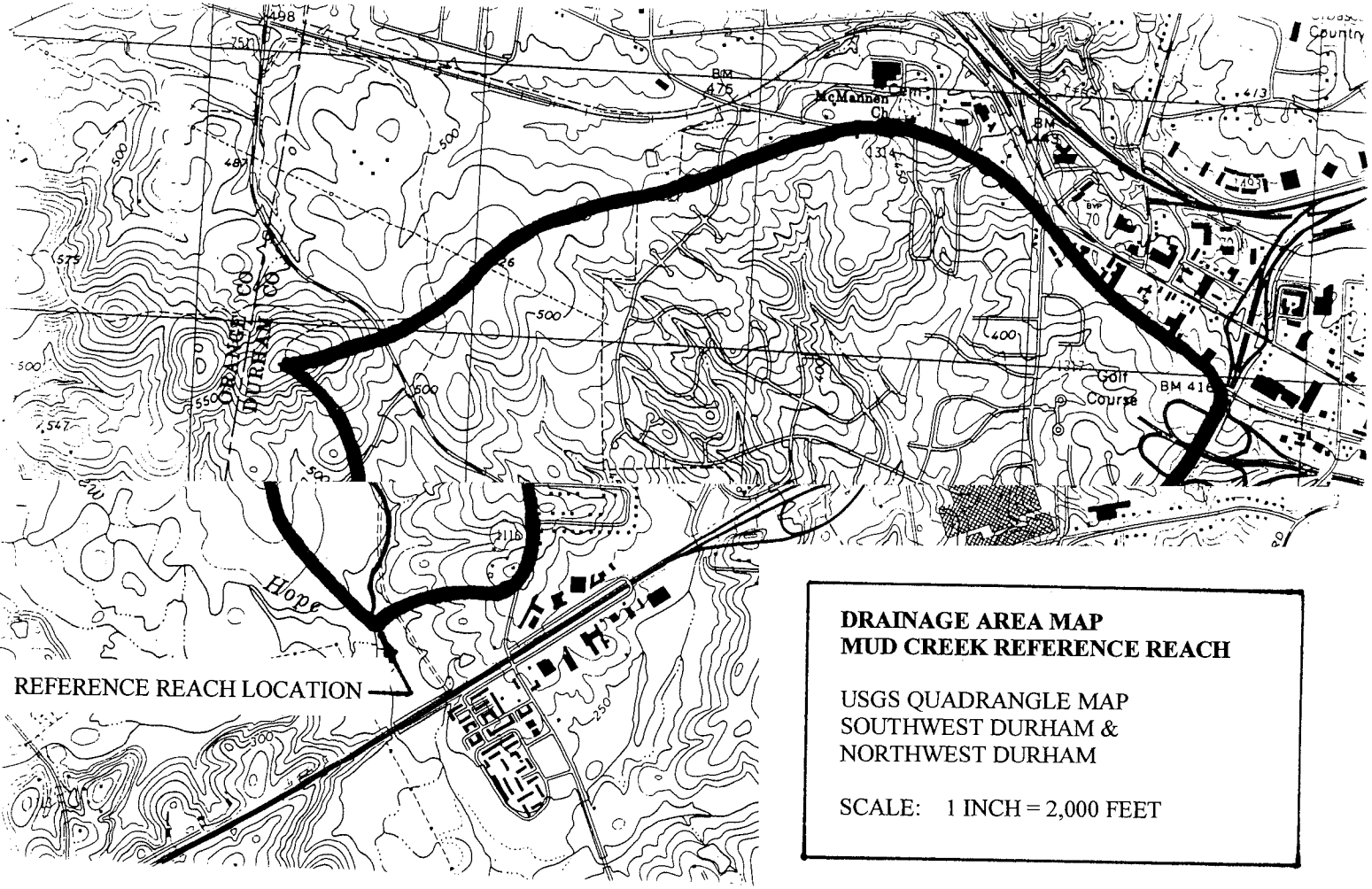

Particle Size Distribution Sample #1 (Ripple)
% Finer Than (Cumulative)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.1
1
10
100
1000
Particle Size - Millimeter
D16 = 0.20
D50 = 0.5
D84 = 1.14
D95 = 5.2
(SAND)
D35 = 0.43

PEBBLE COUNT								
Project:						**Date:**	5/15/02	
Location: At Cross Section #2 - Pool								
				Particle Counts				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	0		0	0%	0%
	Very Fine	.062 - .125	S		3	3	3%	3%
	Fine	.125 - .25	A		12	12	12%	15%
	Medium	.25 - .50	N		42	42	42%	57%
	Coarse	.50 - 1.0	D		29	29	29%	86%
.04 -.08	Very Coarse	1.0 - 2.0	S		12	12	12%	98%
.08 - .16	Very Fine	2.0 - 4.0				0	0%	98%
.16 - .22	Fine	4.0 - 5.7	G			0	0%	98%
.22 - .31	Fine	5.7 - 8.0	R		1	1	1%	99%
.31 - .44	Medium	8.0 - 11.3	A			0	0%	99%
.44 - .63	Medium	11.3 - 16.0	V		1	1	1%	100%
.63 - .89	Coarse	16.0 - 22.6	E			0	0%	100%
.89 - 1.26	Coarse	22.6 - 32.0	L			0	0%	100%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S			0	0%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0				0	0%	100%
2.5 - 3.5	Small	64 - 90	C	0	0	0	0%	100%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%	100%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Lrg- Very Lr	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
			Totals	**0**	**100**	**100**	**100%**	**100%**




Particle Size Distribution Pool
% Finer Than (Cumulative)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.1
1
10
100
1000
Particle Size - Millimeter
D50=0.44
D84=0.94
(SAND)

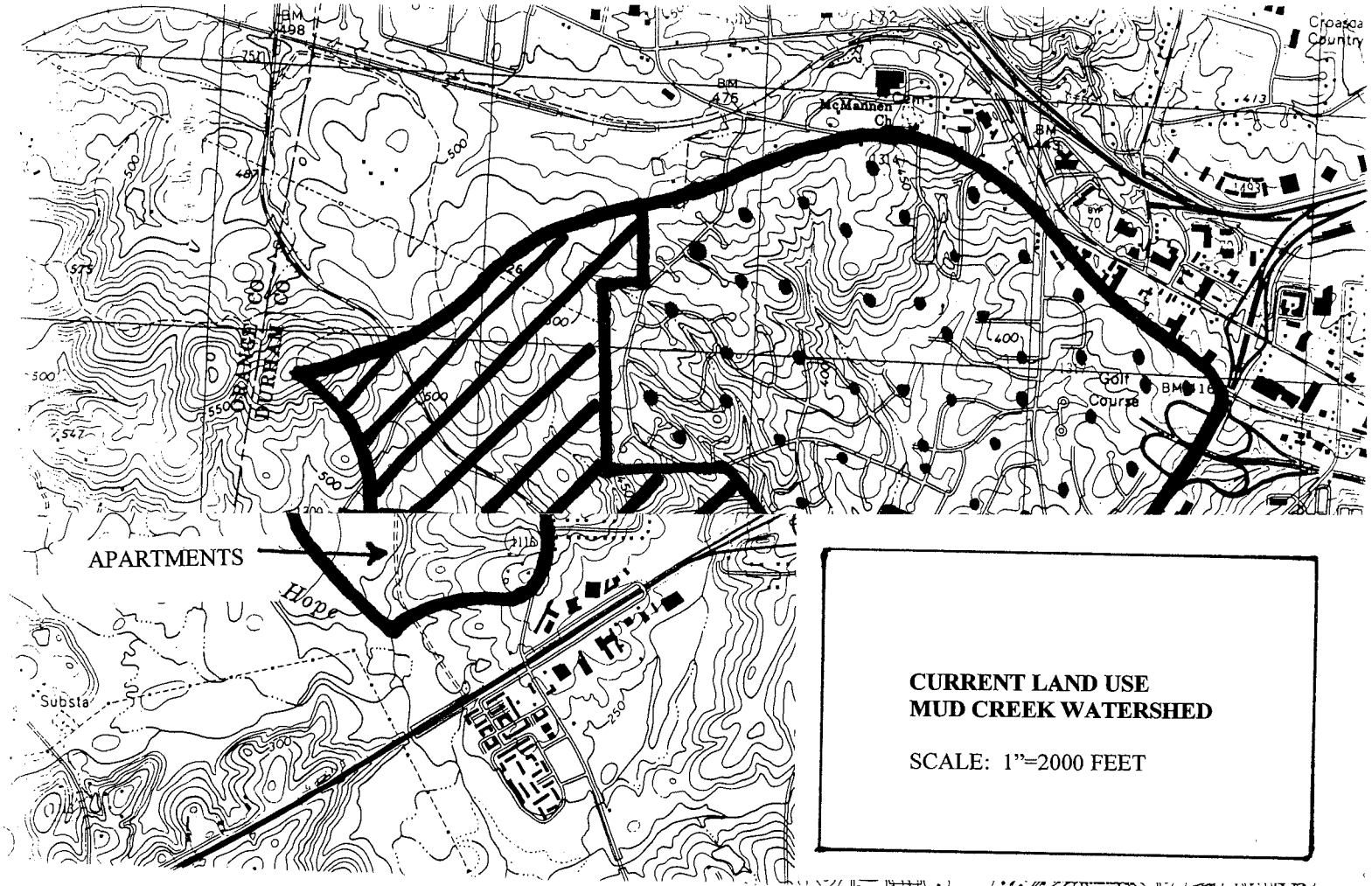
Section C - Mud Creek Stream Reference Reach Data



DRAINAGE AREA MAP
MUD CREEK REFERENCE REACH

USGS QUADRANGLE MAP
SOUTHWEST DURHAM &
NORTHWEST DURHAM

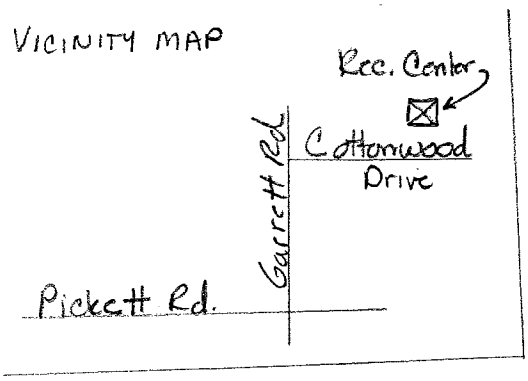
SCALE: 1 INCH = 2,000 FEET

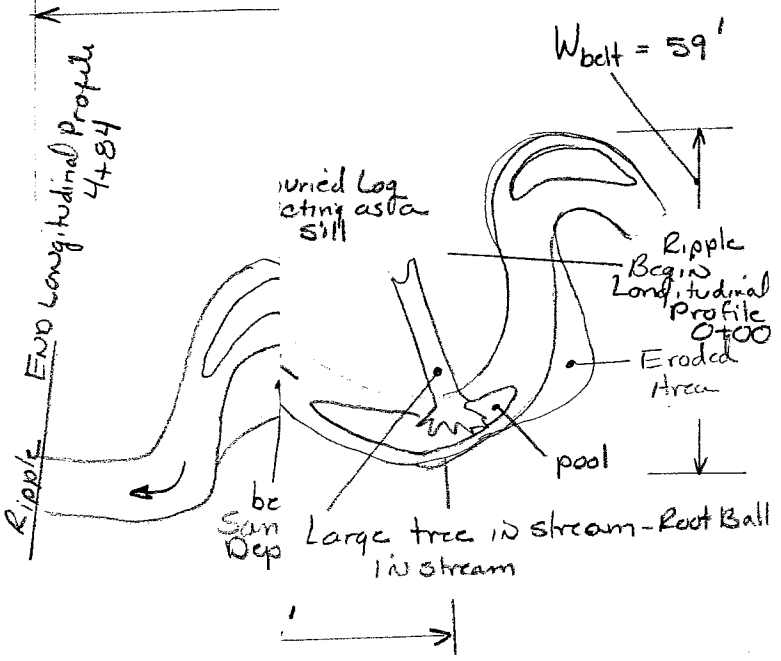


CURRENT LAND USE
MUD CREEK WATERSHED

SCALE: 1"=2000 FEET

VICINITY MAP





Note: Creek Dry day of Surve
Water in pools

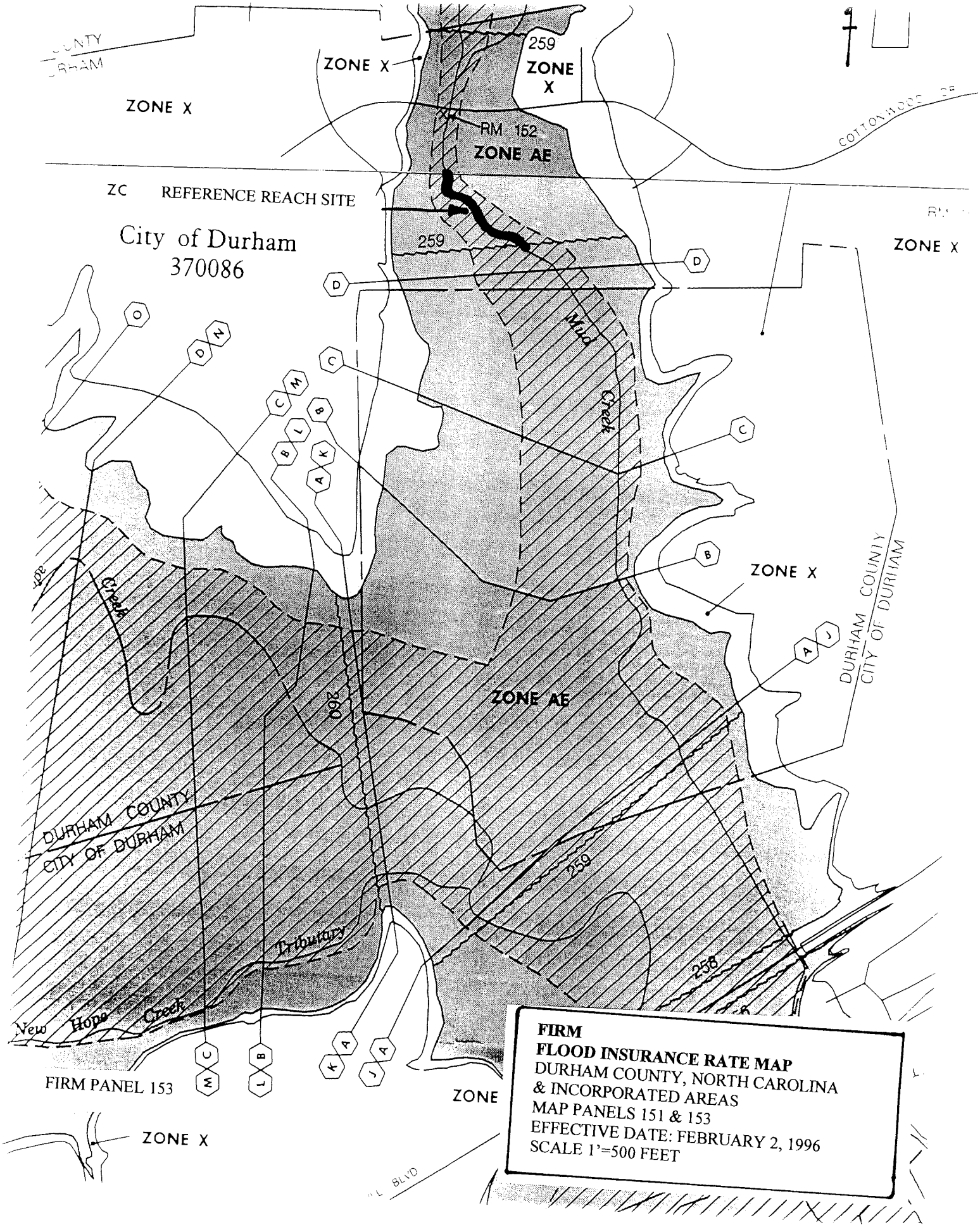
Drainage Area = 5.

Valley length = 4:

Stream length =

Sinuosity = 1.13

MUD CREEK
DURHAM, NC
LONGITUDINAL PROFILE
SKETCH 6/15/02
B. WARD
(NTS)

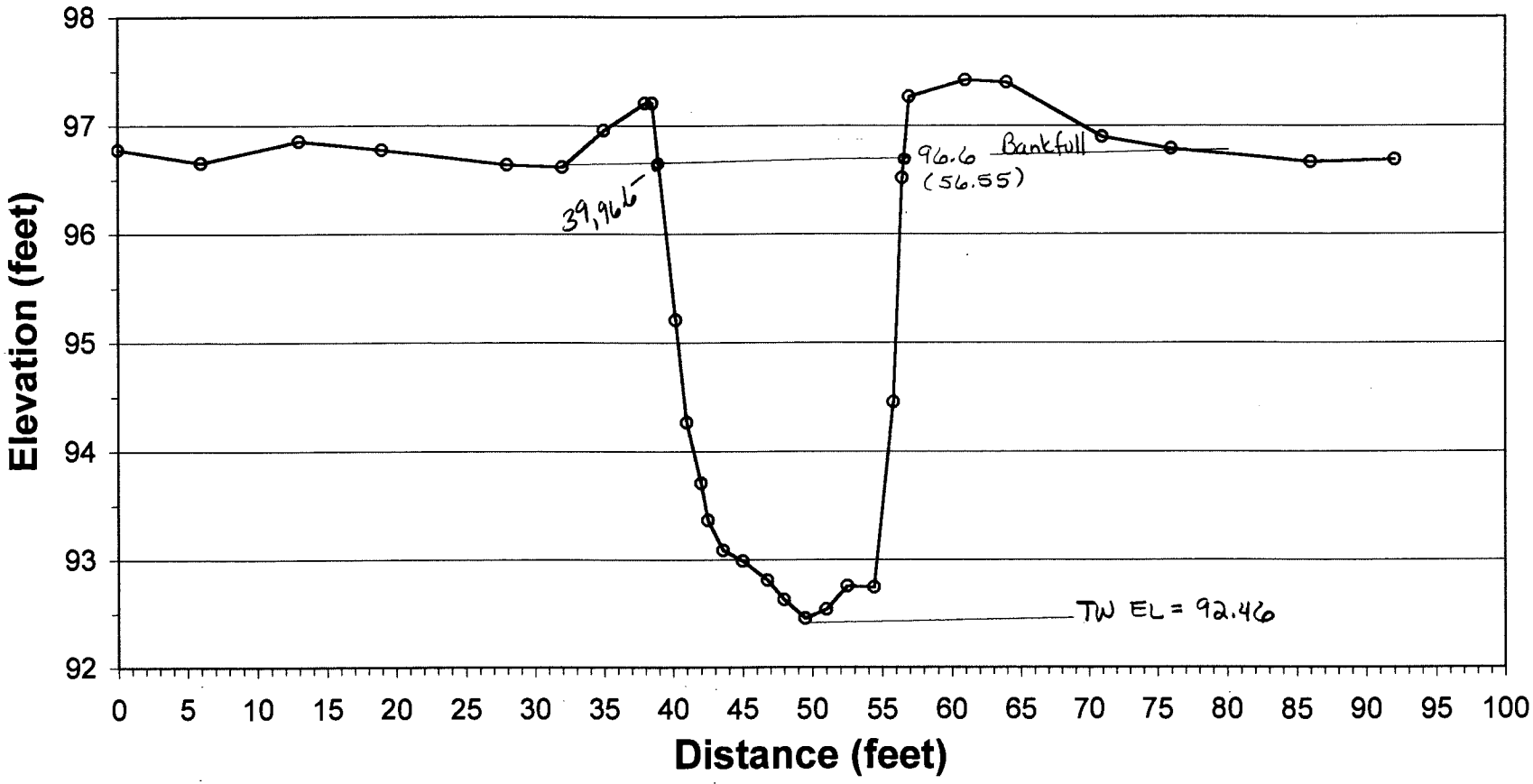


FIRM
FLOOD INSURANCE RATE MAP
DURHAM COUNTY, NORTH CAROLINA
& INCORPORATED AREAS
MAP PANELS 151 & 153
EFFECTIVE DATE: FEBRUARY 2, 1996
SCALE 1'=500 FEET

TABLE 3 - SUMMARY OF DISCHARGES - continued

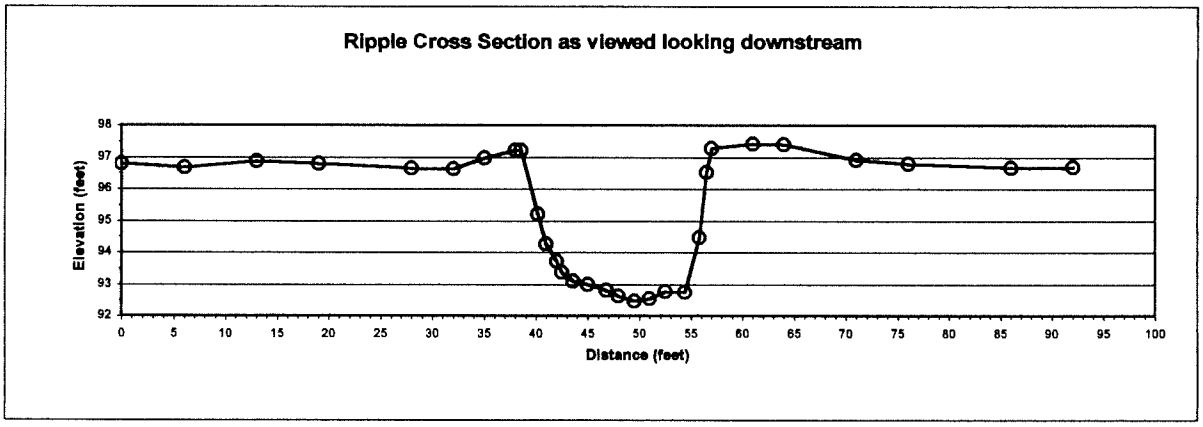
FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
LITTLE RIVER TRIBUTARY 1					
At confluence with Little River	3.78	1,401	2,245	2,600	3,658
Approximately 3,600 feet upstream of State Route 1003	3.25	1,249	2,029	2,364	3,356
LITTLE RIVER NORTH FORK					
At confluence with Little River	40.37	5,644	8,022	8,743	11,418
Approximately 2,300 feet upstream of State Route 1461	38.72	5,468	7,800	8,516	11,150
LITTLE RIVER NORTH FORK TRIBUTARY 1					
At confluence with Little River North Fork	2.59	1,054	1,746	2,053	2,953
Approximately 0.9 mile upstream of State Route 1461	0.79	427	788	972	1,501
LITTLE RIVER SOUTH FORK					
Approximately 500 feet upstream of confluence with Little River	33.28	4,893	7,070	7,763	10,250
Approximately 1,100 feet upstream of State Route 1003	29.46	4,460	6,516	7,189	9,562
MUD CREEK					
At confluence with New Hope Creek	5.94	2,389	3,585	4,210	6,115
At Pickett Road	5.33	2,498	3,746	4,398	6,384
Approximately 500 feet upstream of Pickett Road	4.11	2,254	3,392	3,987	5,803
At State Route 1308	3.38	2,327	3,503	4,118	5,995
At State Route 1306	2.54	1,832	2,786	3,287	4,826
At State Route 751	1.39	1,151	1,720	2,016	2,915
NEW HOPE CREEK					
At Chapel Hill Road	52.01	8,566	12,739	14,945	21,656
At confluence of Sandy Creek Tributary A	49.40	8,401	12,525	14,706	21,350
At confluence of Sandy Creek	42.46	5,419	8,440	10,068	15,165
At confluence of Mud Creek	36.37	5,116	8,022	9,575	14,442
At confluence of New Hope Creek Tributary 1	33.81	5,041	7,924	9,465	14,300

Ripple Cross Section as viewed looking downstream



Project: Mud Creek Reference Reach for Sandy Creek Enhancement Project
Date: 06/18/2002 Elevation
Benchmark: Manhole = 100
Section #1Location: Ripple cross Section for Classification At bend even with MH

Station	BS	HI	FS	Elevation	Comments
0	1.88	101.88	5.1	96.78	
6			5.22	96.66	
13			5.02	96.86	
19			5.1	96.78	
28			5.24	96.64	
32			5.26	96.62	
35			4.92	96.96	
38			4.67	97.21	
38.5			4.67	97.21	Tobl Bkfl
40.2			6.67	95.21	
41			7.61	94.27	
42			8.17	93.71	
42.5			8.51	93.37	Toe
43.6			8.79	93.09	
45			8.89	92.99	
46.8			9.07	92.81	
48			9.25	92.63	
49.5			9.42	92.46	
51			9.34	92.54	
52.5			9.12	92.76	
54.4			9.13	92.75	Toe
55.8			7.42	94.46	
56.5			5.36	96.52	Bkfl
57			4.61	97.27	Tobr- bkfl?
61			4.46	97.42	
64			4.48	97.4	
71			4.98	96.9	
76			5.09	96.79	
86			5.21	96.67	
92			5.19	96.69	



Cross Section #1

Bankfull Cross Section

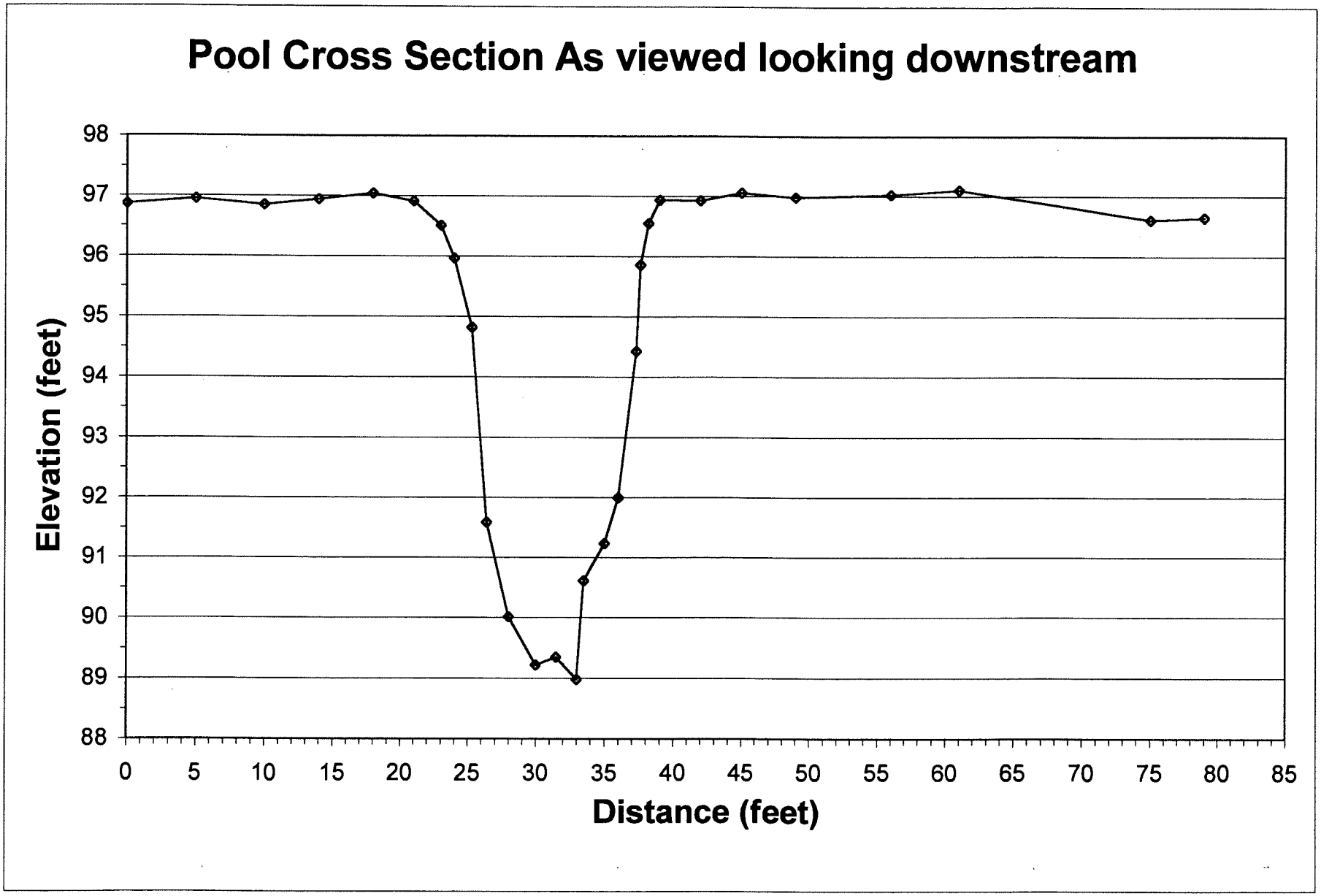
Width= 17.55

Bankfull Elevation 96.6

Station	Elevation	Elevation from Bankfull	Incremental Avg.Height Ft.	Incremental Distance Ft.	Incremental Area Sq.Ft.
39	96.6	0			
			0.70	1.20	0.83
40.2	95.21	1.39			
			1.86	0.80	1.49
41	94.27	2.33			
			2.61	1.00	2.61
42	93.71	2.89			
			3.06	0.50	1.53
42.5	93.37	3.23			
			3.37	1.10	3.71
43.6	93.09	3.51			
			3.56	1.40	4.98
45	92.99	3.61			
			3.70	1.80	6.66
46.8	92.81	3.79			
			3.88	1.20	4.66
48	92.63	3.97			
			4.06	1.50	6.08
49.5	92.46	4.14			
			4.10	1.50	6.15
51	92.54	4.06			
			3.95	1.50	5.92
52.5	92.76	3.84			
			3.84	1.90	7.31
54.4	92.75	3.85			
			3.00	1.40	4.19
55.8	94.46	2.14			
			1.07	0.75	0.80
56.55	96.6	0			

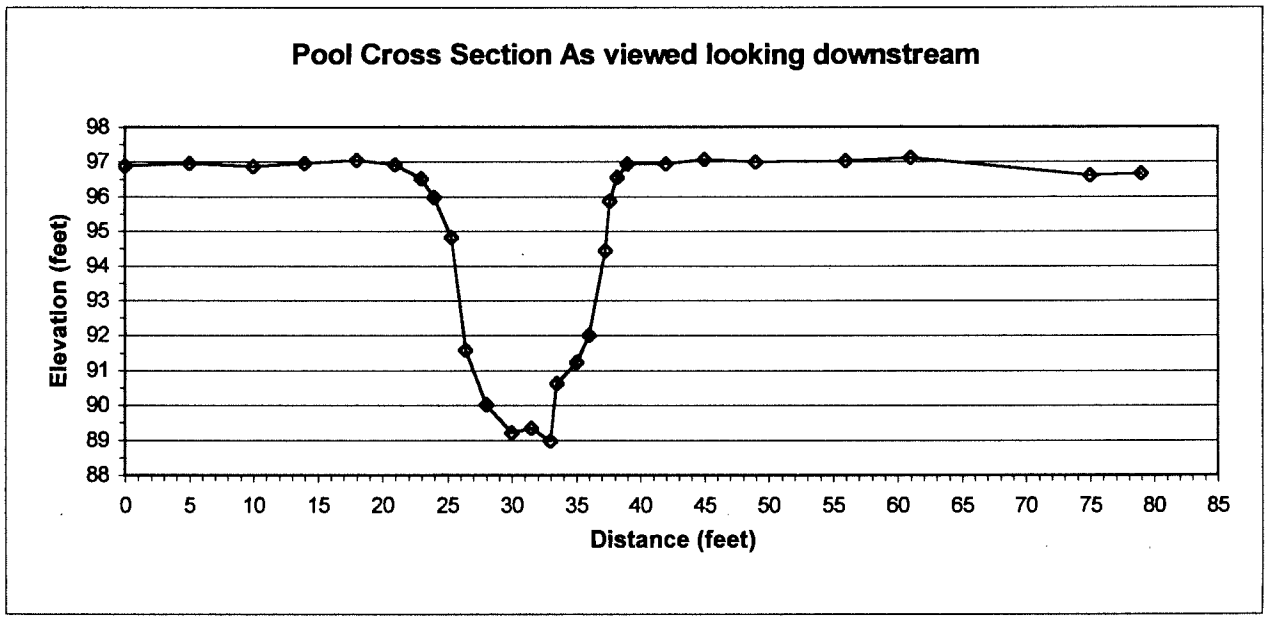
Total Area 56.93 Sq. Feet

Dbkf = 3.24 feet


Pool Cross Section As viewed looking downstream
Elevation (feet)
98
97
96
95
94
93
92
91
90
89
88
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Distance (feet)

Cross Section # 2 Pool section just downstream of Ripple cross section

Station	BS	HI	FS	Elevation	Comments
0		101.88	5.01	96.87	
5			4.92	96.96	
10			5.02	96.86	
14			4.93	96.95	
18			4.83	97.05	
21			4.96	96.92	
23			5.37	96.51	TOBL
24			5.91	95.97	Bkfl
25.3			7.06	94.82	
26.4			10.29	91.59	
28			11.86	90.02	
30			12.66	89.22	
31.5			12.53	89.35	
33			12.9	88.98	
33.5			11.26	90.62	
35			10.64	91.24	EOW ws
36			9.88	92	Toe
37.3			7.45	94.43	
37.6			6.02	95.86	Bkfl
38.2			5.33	96.55	TobR
39			4.94	96.94	
42			4.95	96.93	
45			4.82	97.06	
49			4.89	96.99	
56			4.85	97.03	
61			4.77	97.11	
75			5.27	96.61	
79			5.23	96.65	

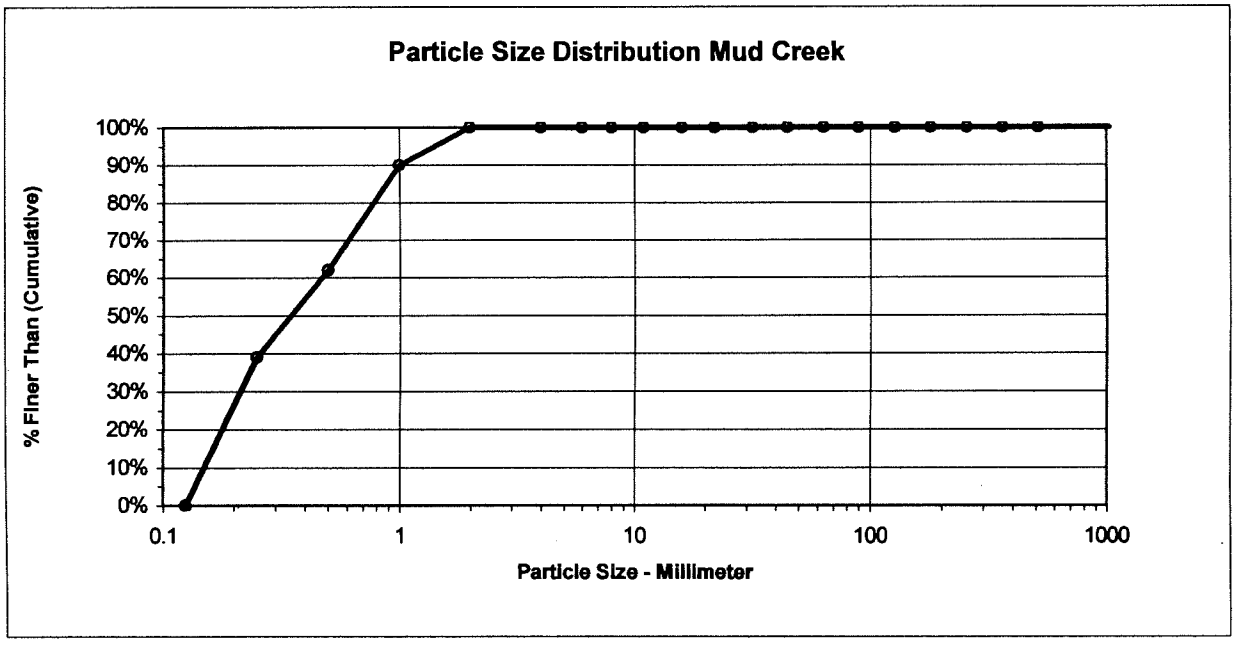


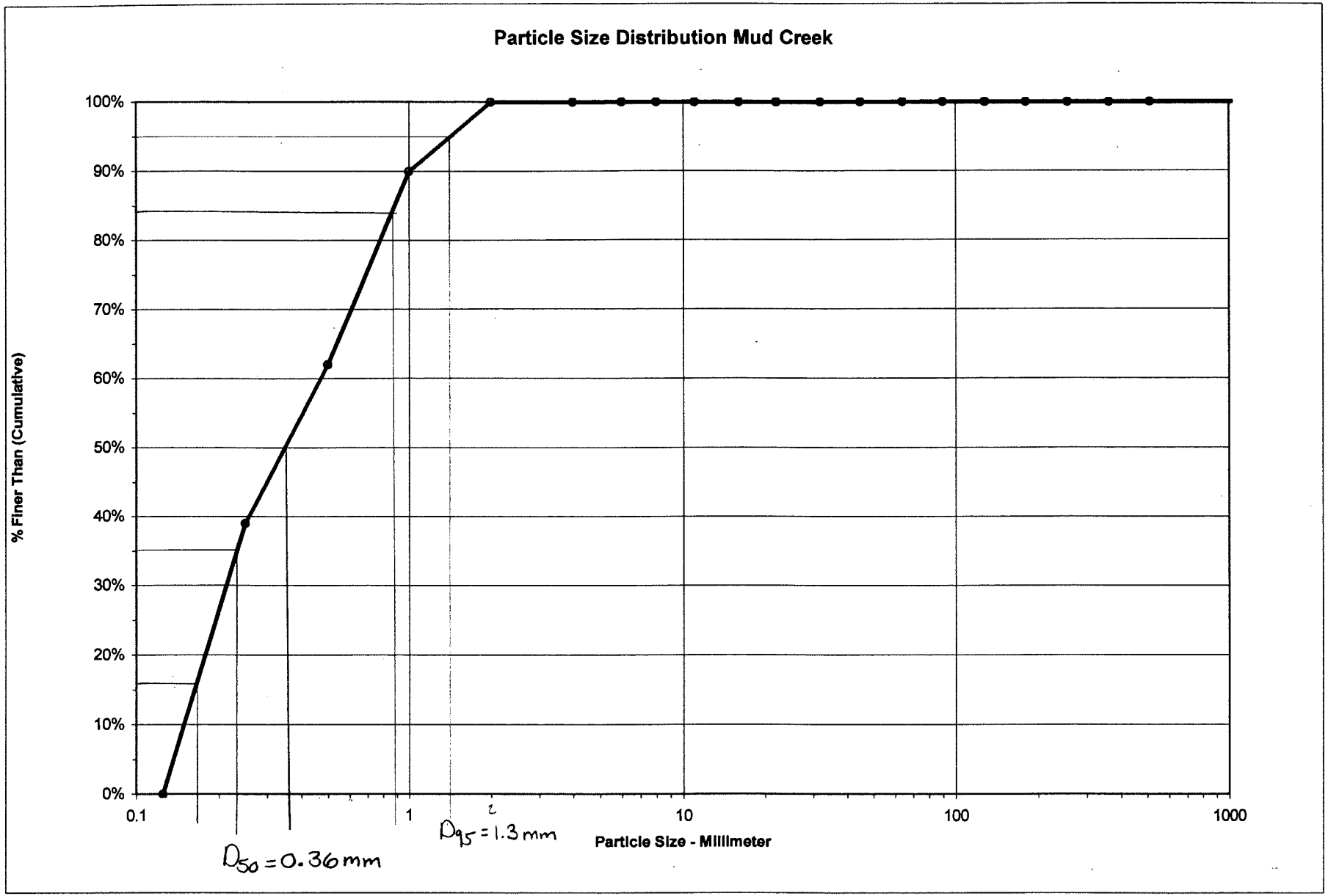
Cross Section #2

Bankfull Cross Section			Bankfull Elevation		96.55
Station	Elevation	Elevation from Bankful	Incremental Avg.Height Ft.	Incremental Distance Ft.	Incremental Area Sq.Ft.
23	96.55	0			
			0.29	1.00	0.29
24	95.97	0.58			
			1.16	1.30	1.50
25.3	94.82	1.73			
			3.35	1.10	3.68
26.4	91.59	4.96			
			5.75	1.60	9.19
28	90.02	6.53			
			6.93	2.00	13.86
30	89.22	7.33			
			7.27	1.50	10.90
31.5	89.35	7.2			
			7.39	1.50	11.08
33	88.98	7.57			
			6.75	0.50	3.38
33.5	90.62	5.93			
			5.62	1.50	8.43
35	91.24	5.31			
			4.93	1.00	4.93
36	92	4.55			
			3.33	1.30	4.34
37.3	94.43	2.12			
			1.38	0.30	0.42
37.6	95.9	0.65			
			0.32	0.60	0.19
38.2	96.55	0			

Total Area	71.69	Sq. Feet
Width	15.20	Feet

PEBBLE COUNT								
Project: Mud Creek						**Date:** 06/18/02		
Location: At Ripple location at bend near manhole for classification								
				Particle Counts				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	0		0	0%	0%
	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	39	0	39	39%	39%
	Medium	.25 - .50	N	23	0	23	23%	62%
	Coarse	.50 - 1.0	D	28	0	28	28%	90%
.04 -.08	Very Coarse	1.0 - 2.0	S	10	0	10	10%	100%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	100%
.16 - .22	Fine	4.0 - 5.7	G	0	0	0	0%	100%
.22 - .31	Fine	5.7 - 8.0	R	0	0	0	0%	100%
.31 - .44	Medium	8.0 - 11.3	A	0	0	0	0%	100%
.44 - .63	Medium	11.3 - 16.0	V	0	0	0	0%	100%
.63 - .89	Coarse	16.0 - 22.6	E	0	0	0	0%	100%
.89 - 1.26	Coarse	22.6 - 32.0	L	0	0	0	0%	100%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	0	0	0	0%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0		0	0	0	0%	100%
2.5 - 3.5	Small	64 - 90	C	0	0	0	0%	100%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%	100%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
			Totals	**100**	**0**	**100**	**100%**	**100%**




Particle Size Distribution Mud Creek
% Finer Than (Cumulative)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.1
1
10
100
1000
Particle Size - Millimeter
$D_{50} = 0.36\,mm$
$D_{95} = 1.3\,mm$

No. 5505 Engineer's Computation Pad AWW

MUD CREEK PATTERN MEASUREMENTS:

Meander Wavelength (Lm)

100
147
86

Avg = 93 ft
Range (86 - 147)

Radius of Curvature (Rc)

$R_c = (c^2/8m) + m/2$

Field Measurements

c	m	Rc
50'	4.3'	74.8
21'	3.5'	17.5
26'	6'	27.1
32'	5.5'	26.0

Average = 36.5 ft
Range (17.5 - 75)

Belt Width
Field Measured

39'
34'
25'
59'

Average = 39 ft
Range = (25 - 59)

Maximum pool depth from Bankfull (d pool)

7.56' (just in front of large root ball debris in channel)
8.08' (just after debris log still in channel)
6.15' no debris - in bend
7.79' at bend - some debris directly upstream

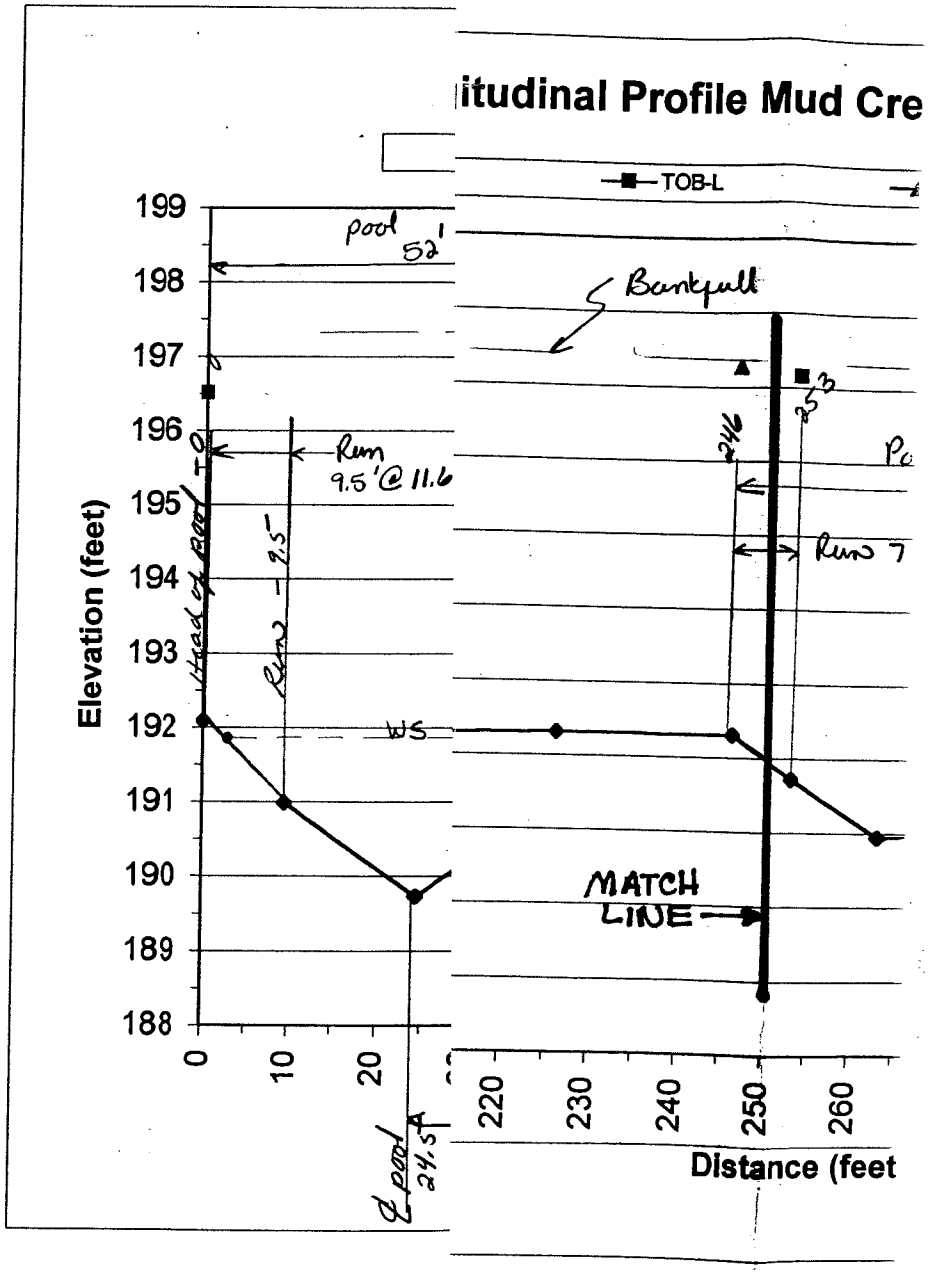
Overall Average = 7.4
Range = (6.2 - 8.1)

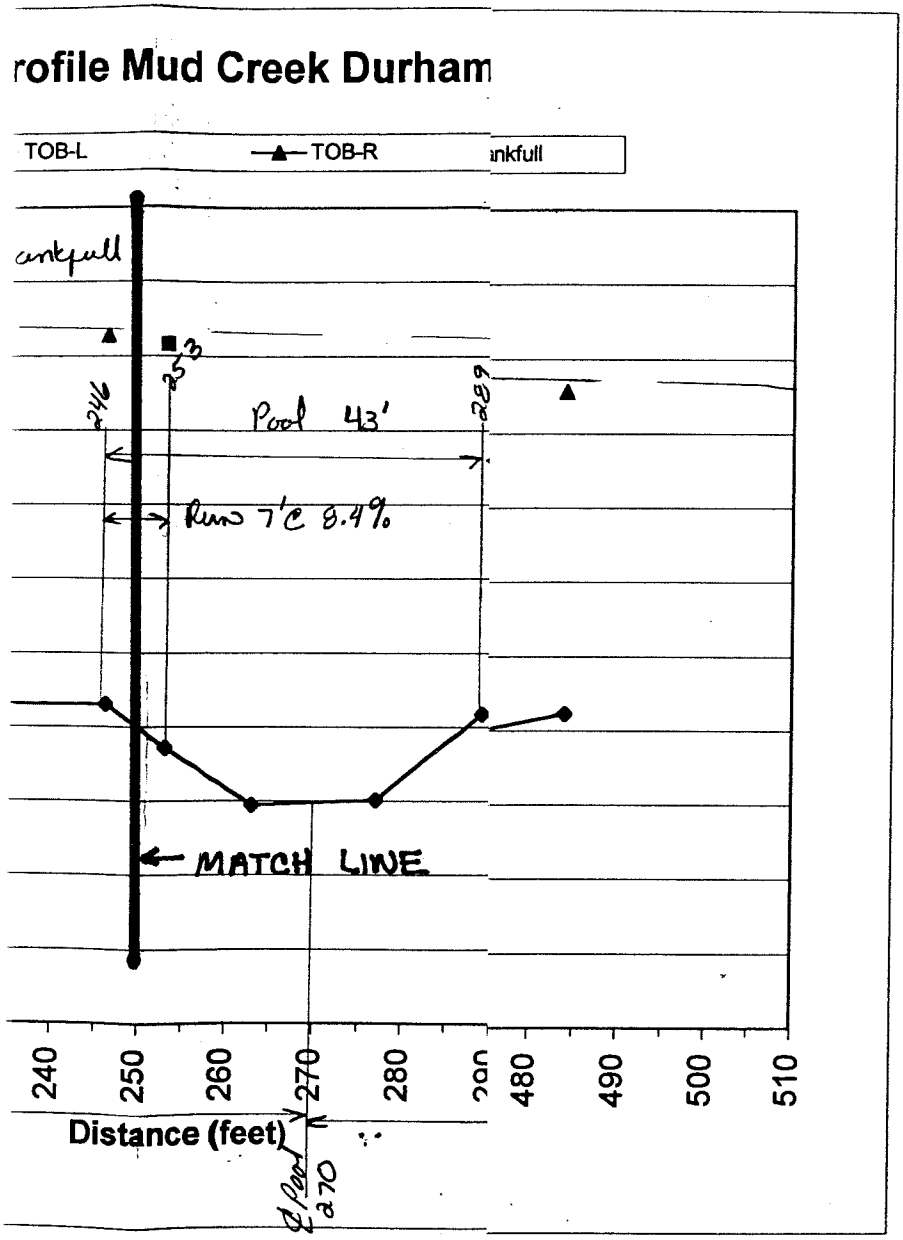
Pools effected by debris

Average = 7.8
Range = (7.6 - 8.1)

Pools in Bends

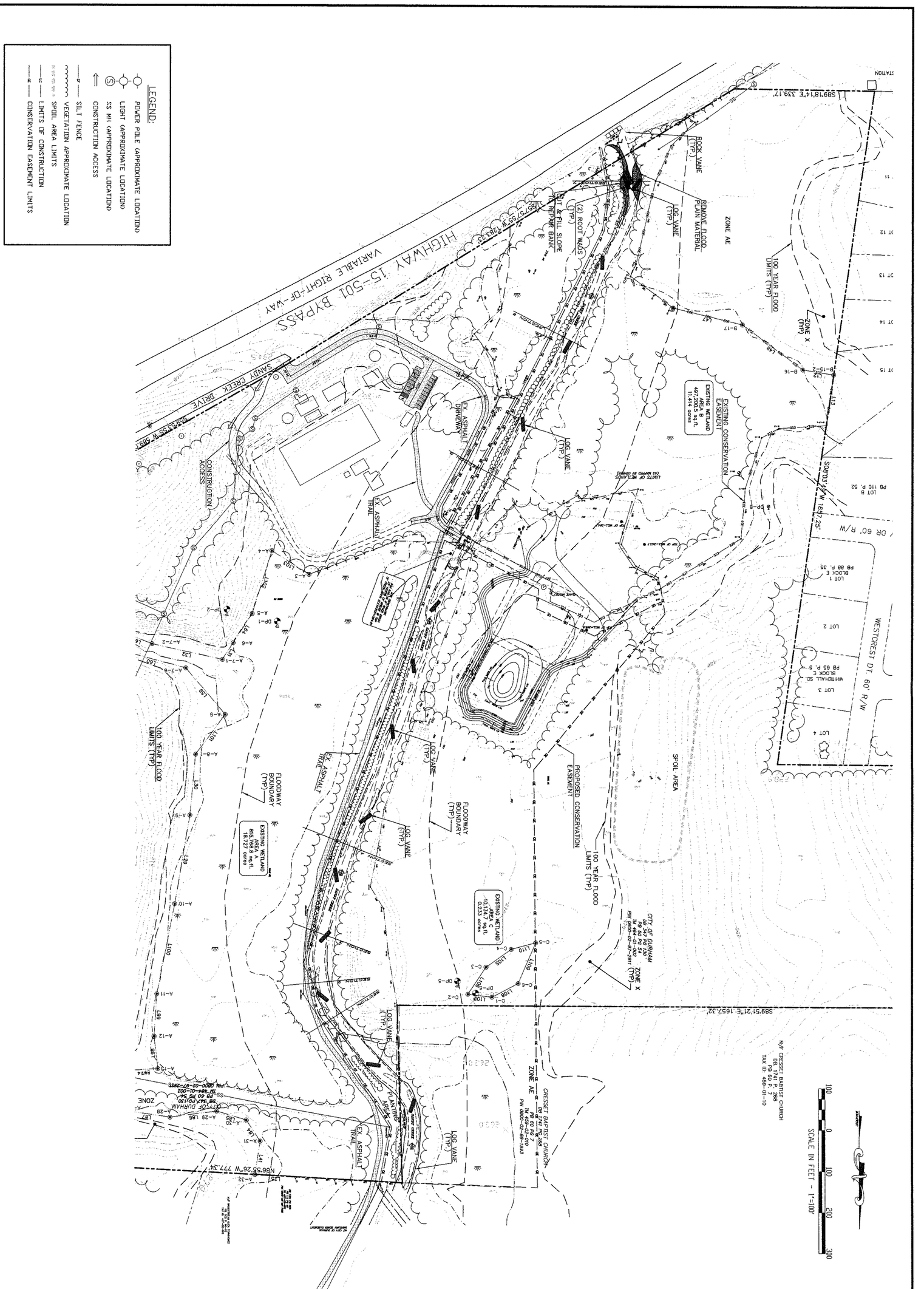
Average = 6.97
Range = (6.2 - 7.8)


itudinal Profile Mud Cre
TOB-L
Bankfull
pool
52'
Run
9.5'@ 11.6
Run 2 - 9.5'
WS
MATCH
LINE
Run 7
Elevation (feet)
199
198
197
196
195
194
193
192
191
190
189
188
0
10
20
220
230
240
250
260
Distance (feet


rofile Mud Creek Durham
TOB-L
TOB-R
ankfull
ankfull
246
253
289
Pool 43'
Run 71' 8.4%
MATCH LINE
240
250
260
270
280
480
490
500
510
Distance (feet)
@ pool
@ 270

Section D – Preliminary Construction Plans

H:\Becky Ward\Sandy Creek\c-full-site.dwg Wed Jul 31 10:01:41 2002



SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

OVERALL PLAN

SEAL:

NORTH CAROLINA PROFESSIONAL SEAL 13344 ENGINEER BECKY LYNNE WARD

SEAL:

Becky Ward Consulting
Storm Water Management Engineering
1512 Eglantyne Court (919) 870-0526
Raleigh, NC 27613 FAX (919) 870-5359

WETLANDS DESIGNED BY:
THE CATENA GROUP
303 POND LILY COURT
HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

DATE: 08-02-02
REVISIONS:

PROJECT NAME: SANDY CREEK
DWG NAME: c-full-site
SCALE: 1" = 100'
SHEET NO. 2 OF 12

30 0 30 60 90

SCALE IN FEET - 1"=30'

LEGEND:

- POWER POLE (APPROXIMATE LOCATION)
- LIGHT (APPROXIMATE LOCATION)
- SS MH (APPROXIMATE LOCATION)
- CONSTRUCTION ACCESS
- SILT FENCE
- VEGETATION APPROXIMATE LOCATION
- SPOIL AREA LIMITS
- LIMITS OF CONSTRUCTION
- CONSERVATION EASEMENT LIMITS

Becky Ward Consulting
Storm Water Management Engineering
1512 Eglantyne Court (919) 870-0526
Raleigh, NC 27613 FAX (919) 870-5359

THE CATENA GROUP
308 POND LILY COURT
HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

WETLANDS DESIGNED BY:

SEAL

NORTH CAROLINA REGISTERED PROFESSIONAL SEAL 13344 ENGINEER BECKY L. WARD

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLAN AND PROFILE 0+00 TO 9+00

DATE: 08-02-02

REVISIONS:

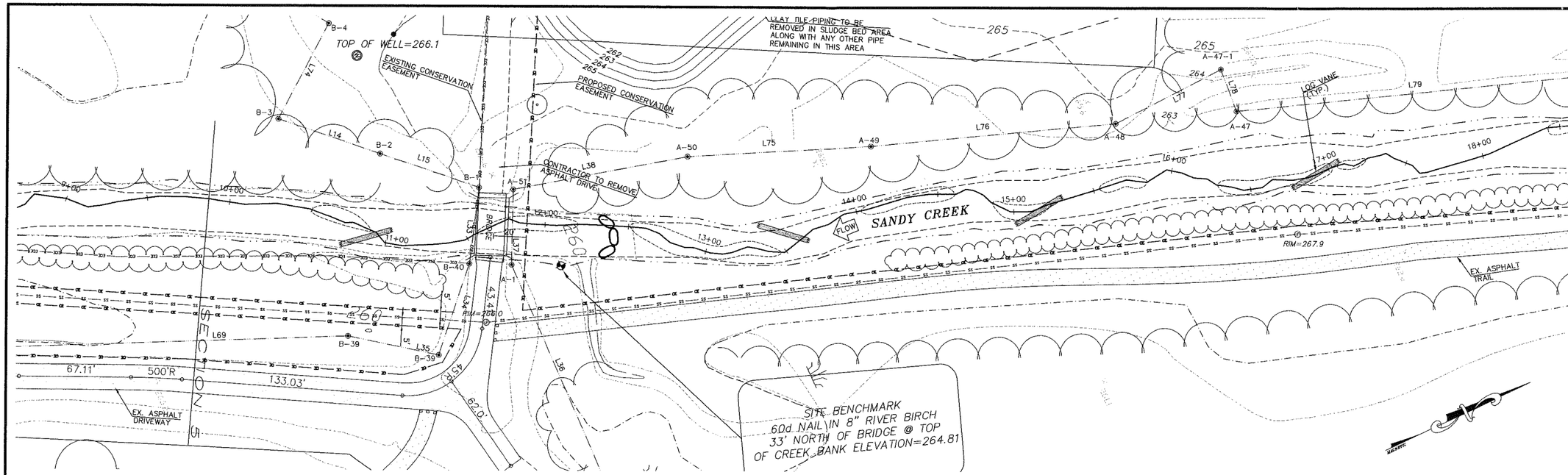
PROJECT NAME: SANDY CREEK

DWG NAME: pp-creek1

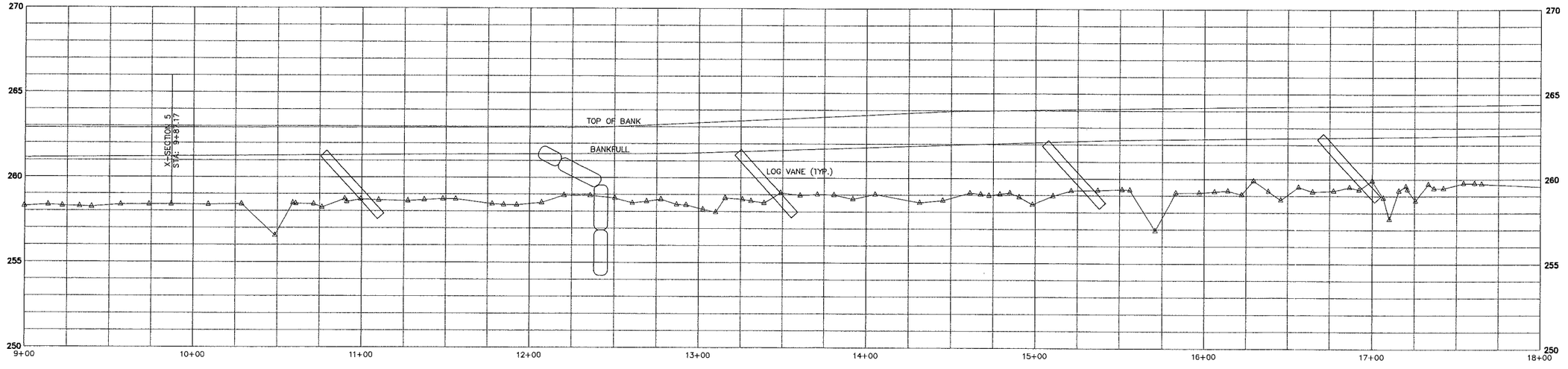
SCALE: 1" = 30'

SHEET NO. 3 OF 12

H:\Becky Ward\Sandy Creek\pp-creek1.dwg Wed Jul 31 10:06:54 2002



30 0 30 60 90
SCALE IN FEET - 1"=30'



LEGEND:

- POWER POLE (APPROXIMATE LOCATION)
- LIGHT (APPROXIMATE LOCATION)
- SS MH (APPROXIMATE LOCATION)
- CONSTRUCTION ACCESS
- SILT FENCE
- VEGETATION APPROXIMATE LOCATION
- SPOIL AREA LIMITS
- LIMITS OF CONSTRUCTION
- CONSERVATION EASEMENT LIMITS

Becky Ward Consulting
Storm Water Management Engineering
1512 Eglantyne Court
Raleigh, NC 27613
(919) 870-0526
FAX (919) 870-5359

WETLANDS DESIGNED BY:
THE CATENA GROUP
303 POND LILY COURT
HILLSBOROUGH, NC 27278
(919) 732-9300 FAX (919) 732-1303

SEAL:

NORTH CAROLINA PROFESSIONAL SEAL 1344 ENGINEER BECKY A. WARD

SEAL:

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLAN AND PROFILE 9+00 TO 18+00

DATE: 08-02-02
REVISIONS:
PROJECT NAME: SANDY CREEK
DWG NAME: pp-creek2
SCALE: 1" = 30'
SHEET NO. 4 OF 12

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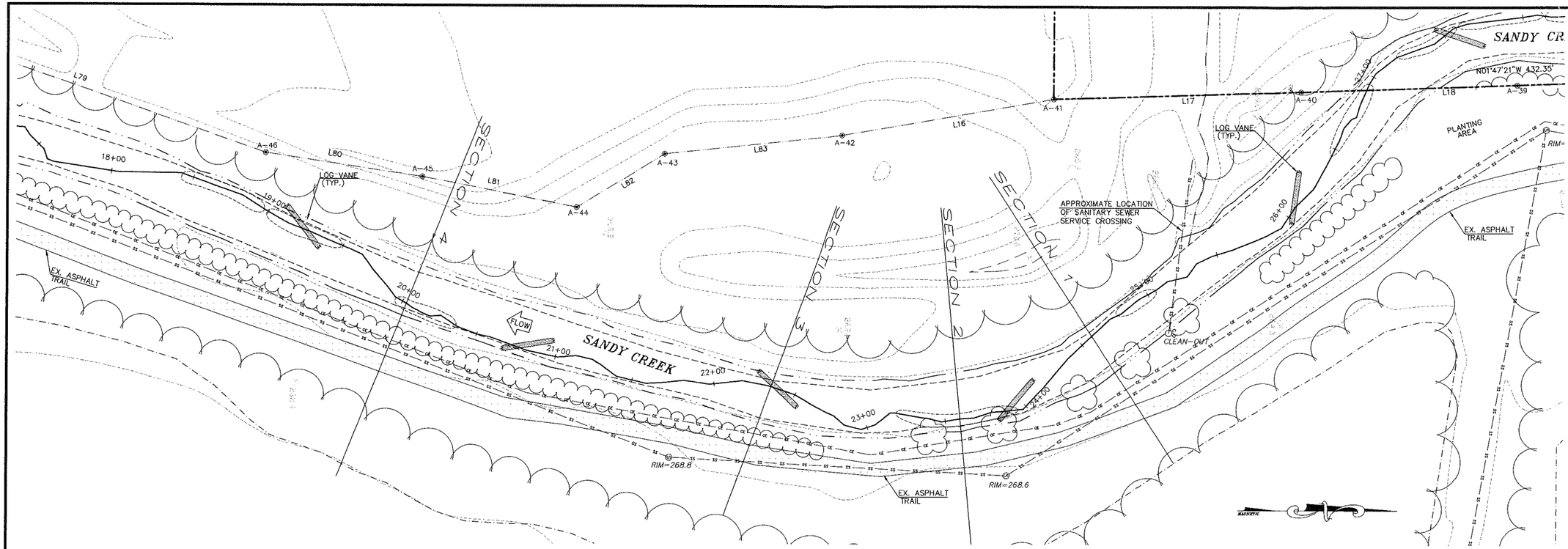

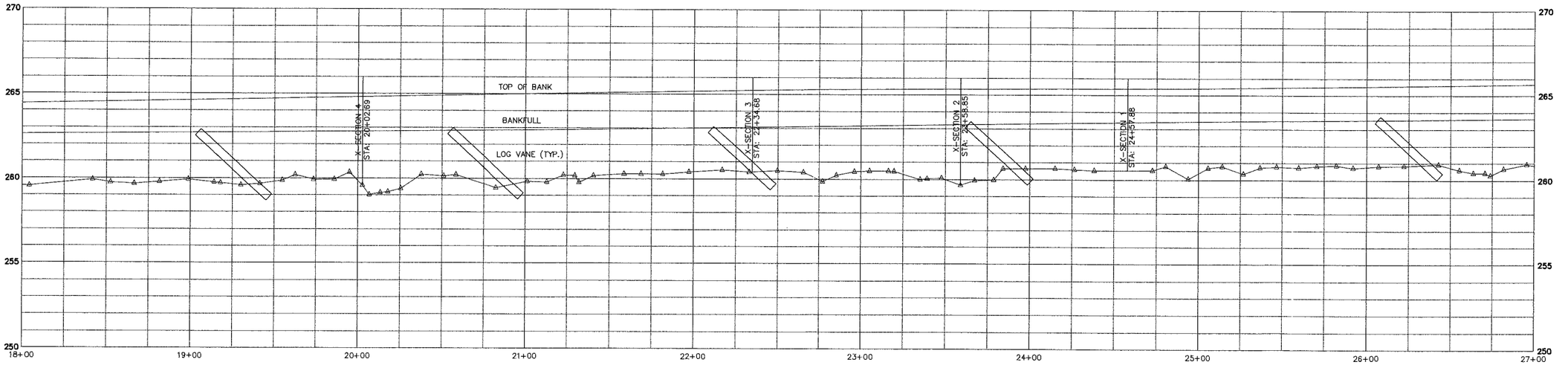

LEGEND:

- POWER POLE (APPROXIMATE LOCATION)
- LIGHT (APPROXIMATE LOCATION)
- SS MH (APPROXIMATE LOCATION)
- CONSTRUCTION ACCESS
- SF — SILT FENCE
- VEGETATION APPROXIMATE LOCATION
- SPOIL AREA LIMITS
- LC — LIMITS OF CONSTRUCTION
- CE — CONSERVATION EASEMENT LIMITS

Becky Ward Consulting
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1512 Eglantyne Court (919) 870-0526
Raleigh, NC 27613 FAX (919) 870-5359

WETLANDS DESIGNED BY:

THE CATENA GROUP
303 POND LILY COURT
HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

SEAL:

SEAL:

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 13344 BECKY T. WARD

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLAN AND PROFILE 18+00 TO 27+00

DATE: 08-02-02

REVISIONS:

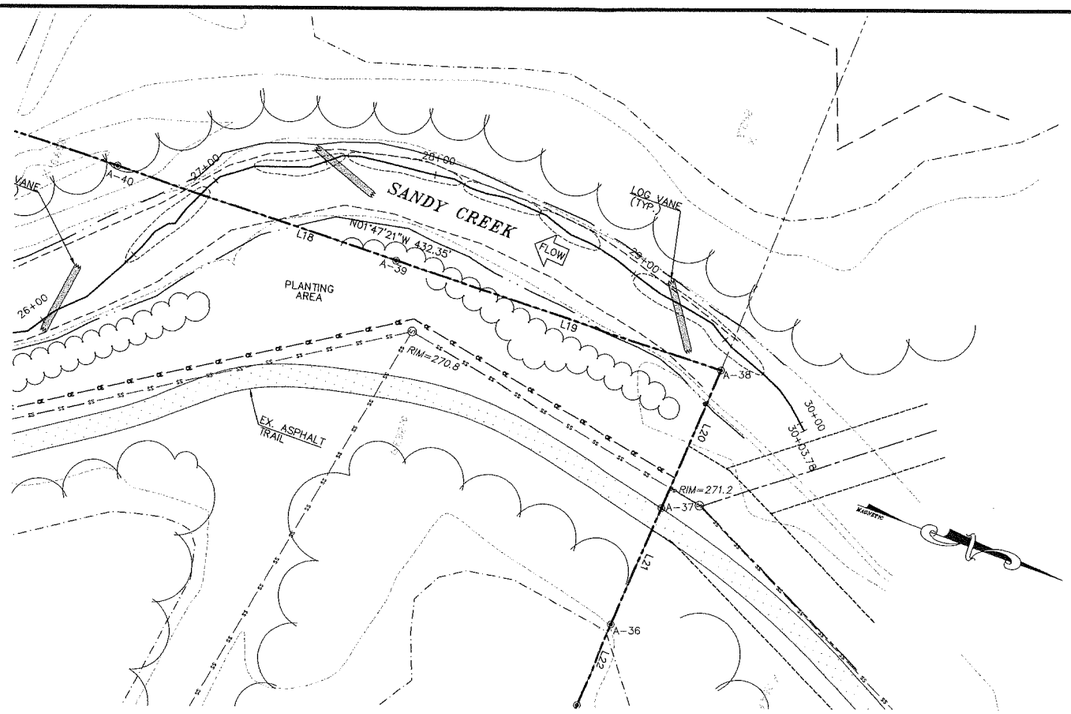
PROJECT NAME: SANDY CREEK

DWG NAME: PP-creek3

SCALE: 1" = 30'

SHEET NO. 5 OF 12

H:\Becky Ward\Sandy Creek\pp-creek3.dwg Wed Jul 31 10:19:01 2002



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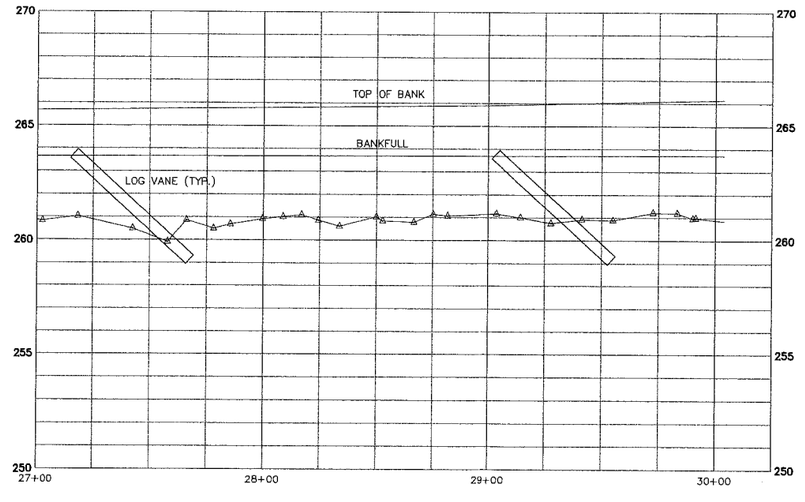
SCALE IN FEET - 1"=30'



LEGEND:

- POWER POLE (APPROXIMATE LOCATION)
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- CONSTRUCTION ACCESS
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HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

SEAL:

NORTH CAROLINA PROFESSIONAL SEAL 13344 ENGINEER BECKY WARD

SEAL:

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLAN AND PROFILE 27+00 TO 30+03.78

DATE: 08-02-02

REVISIONS:

PROJECT NAME: SANDY CREEK

DWG NAME: pp-creek4

SCALE: 1" = 30'

SHEET NO. 6 OF 12

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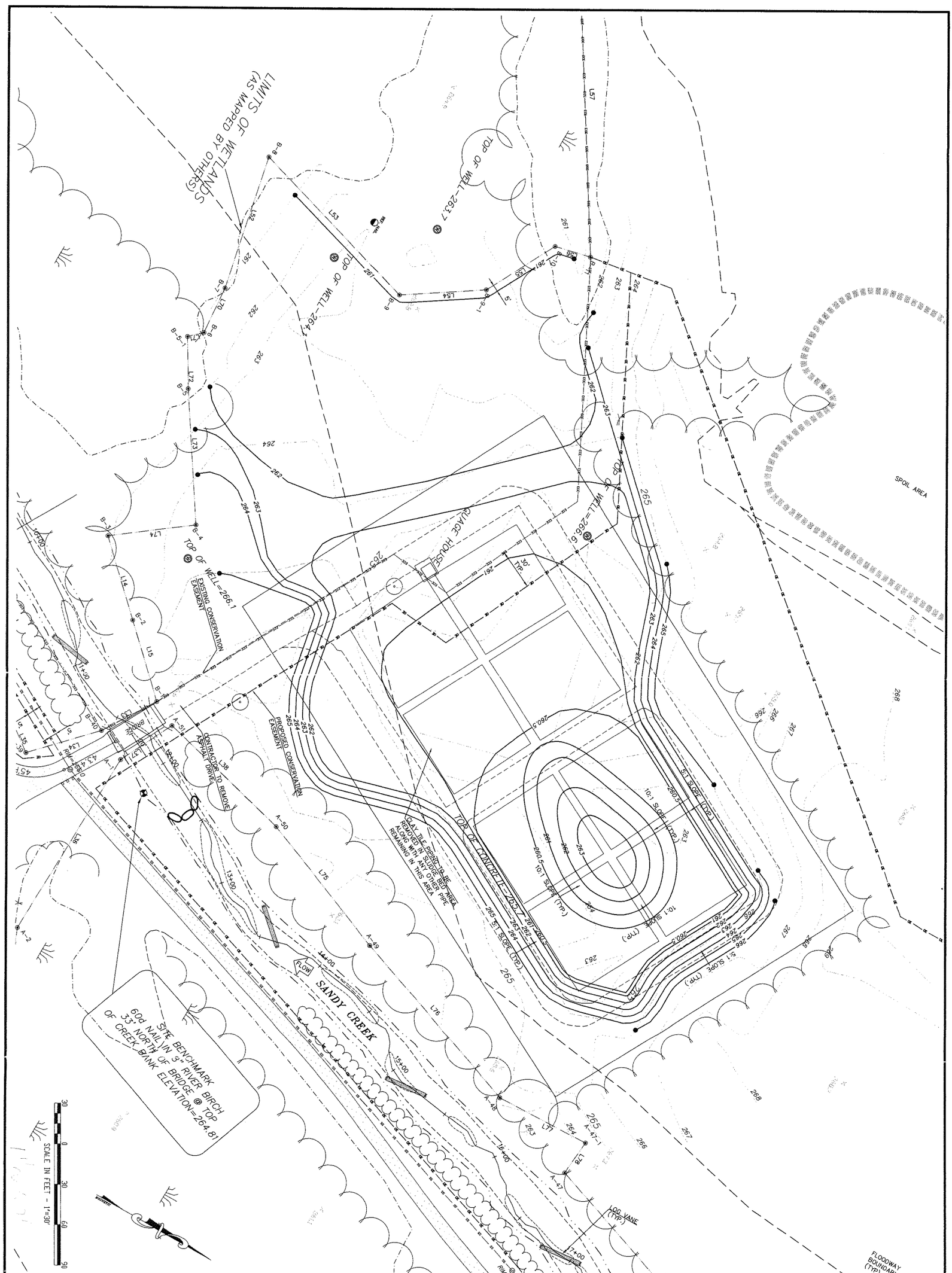
M:\Becky Ward\Sandy Creek\c-wetland.dwg Wed Jul 31 10:56:10 2002



SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

WETLAND PLAN PRELIMINARY DESIGN

SHEET NO. 7 OF 12

SCALE: 1" = 30'

DWG NAME: c-wetland

PROJECT NAME: SANDY CREEK

REVISIONS:

DATE: 08-02-02

SEAL:

NORTH CAROLINA PROFESSIONAL SEAL 13344 ENGINEER BECKY LYNNE WARD

SEAL:

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Storm Water Management Engineering
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WETLANDS DESIGNED BY:
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HILLSBOROUGH, NC 27278
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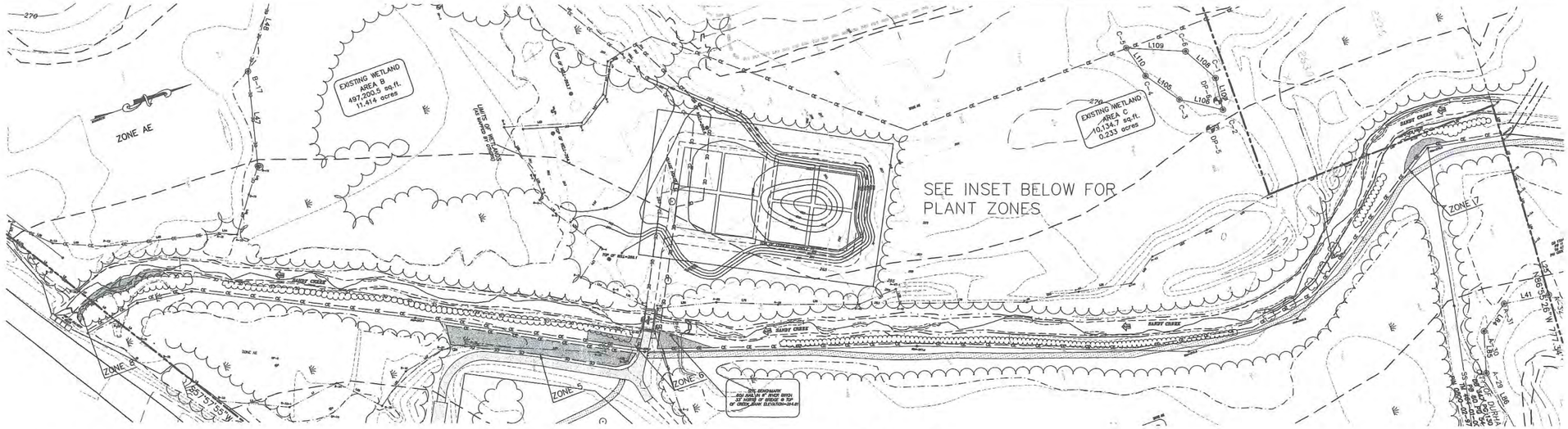

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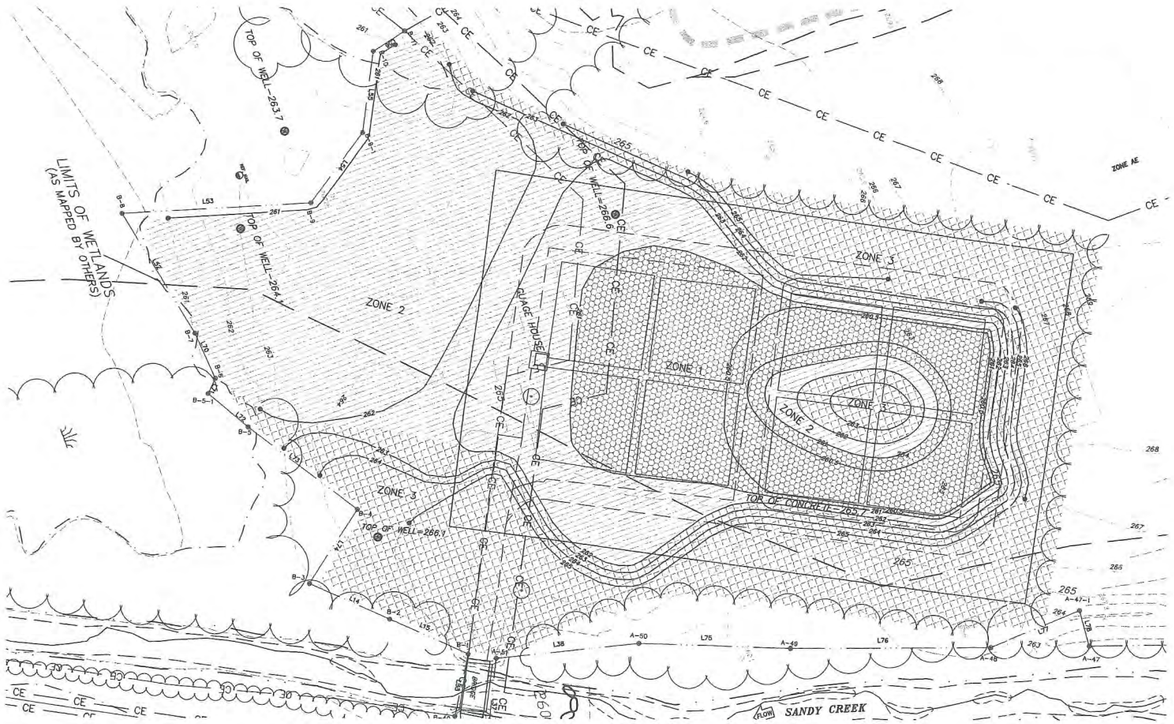
SCALE IN FEET - 1"=100'

SANDY CREEK PLANT ZONES



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SCALE IN FEET - 1"=50'

WETLAND PLANT ZONES

SUMMARY OF PLANT QUANTITIES		
Quantity	Genus/Species	Common Name
Planting Zone 1 – Semipermanently Flooded (0.9 ac)		
144	Salix nigra	Black Willow
144	Alnus serrulata	Tag Alder
144	Cephalanthus occidentalis	Button Bush
144	Quercus lyrata	Overcup Oak
Planting Zone 2 – Seasonally Flooded (1.8 ac)		
306	Sambucus Canadensis	Elderberry
306	Cornus amomum	Silky Dogwood
306	Fraxinus pennsylvanica	Green Ash
306	Quercus phellos	Willow Oak
Planting Zone 3 – Temporarily Flooded (1.9 ac)		
323	Nyssa sylvatica	Black Gum
323	Liriodendron tulipifera	Tulip Poplar
323	Betula nigra	River Birch
323	Quercus laurifolia	Laurel Oak
Planting Zone 4 – Upland Spoil (2.3 ac)		
391	Quercus alba	White Oak
391	Quercus falcate	Southern Red Oak
391	Nyssa sylvatica	Black Gum
391	Liriodendron tulipifera	Tulip Poplar
Planting Zone 5 – Seasonally Flooded (0.2? ac)		
39	Sambucus canadensis	Elderberry
39	Cornus amomum	Silky Dogwood
39	Myrica cerifera	Wax Myrtle
40	Fraxinus pennsylvanica	Green Ash
Planting Zone 6 – Temporarily Flooded (0.05 ac)		
8	Myrica cerifera	Wax Myrtle
9	Callicarpa americana	American Beautyberry
9	Aronia arbutifolia	Red Chokeberry
8	Quercus laurifolia	Laurel Oak
Planting Zone 7 – Temporarily Flooded (0.03 ac)		
11	Myrica cerifera	Wax Myrtle
13	Lindera benzoin	Spice bush
Planting Zone 8 – Streambank Live stakes (0.12 ac)		
500	Cephalanthus occidentalis	Buttonbush
500	Sambucus canadensis	Elderberry
500	Salix caroliniana	Carolina Willow

Planting Zone 1: 260.5 feet – 261.0
Planting Zone 2: 261.0 feet – 262.0
Planting Zone 3: 262.0 feet plus

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HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

SEAL:

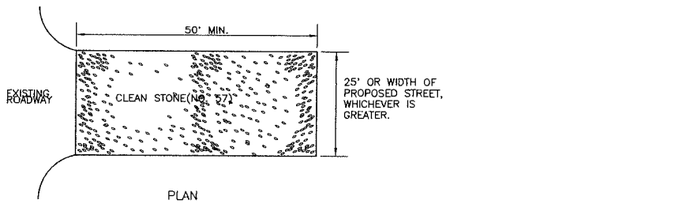
SEAL: NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 13344 BECKY T. WARD

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLANTING PLAN
PRELIMINARY DESIGN

DATE: 08-02-02
REVISIONS:
PROJECT NAME: SANDY CREEK
DWG NAME: c-plant-plan
SCALE: AS SHOWN
SHEET NO. 8 OF 12

C:\Projects\...\c-plant-plan.dwg Thu Aug 01 09:50:17 2002



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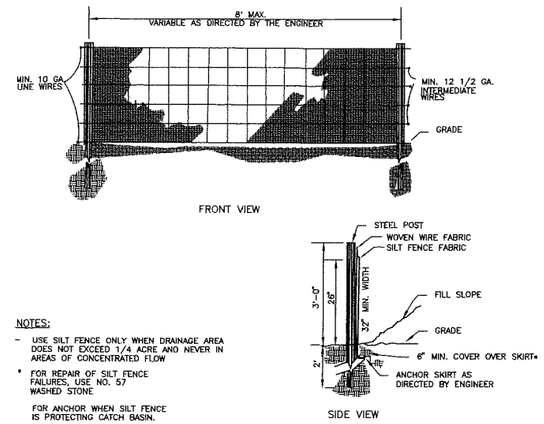
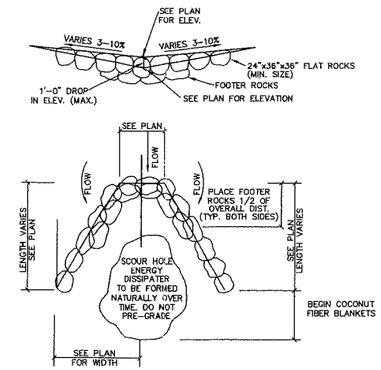
SCALE: NOT TO SCALE



2 STANDARD TEMPORARY SILT FENCE

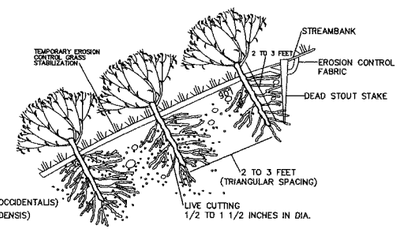
SCALE: NOT TO SCALE



3 TYPICAL ROCK GRADE CONTROL STRUCTURE

SCALE: NOT TO SCALE

LIVE, DORMANT MATERIALS BETWEEN 0.5 IN (13mm) AND 1 IN (25mm) IN DIAMETER AND 2–3 FT (0.6– 0.9m) LONG. REMOVE SIDE BRANCHES, BEING CAREFUL NOT TO DAMAGE THE BARK. CUT BASAL ENDS AT AN ANGLE FOR EASIER PENETRATION INTO SOIL, AND CUT TOPS SQUARE TO MAKE A SUITABLE POUNDING SURFACE. MATERIALS SHOULD BE INSTALLED THE SAME DAY THEY ARE PREPARED. BE CERTAIN THAT THE BUDS WILL BE POINTED UP WHEN PLANTED. CUTTINGS MUST BE INSTALLED WHEN DORMANT, USUALLY SEPTEMBER TO MARCH. A MIXTURE OF PLANT SPECIES SHALL BE SELECTED FOR THE PROJECT SITE. POUND LIVE STAKES AT RIGHT ANGLES TO SLOPE FACE USING ONLY DEAD BLOW HAMMERS. (HAMMER HEAD FILLED WITH SHOT OR SAND). FOUR–FIFTHS OF THE LENGTH OF THE LIVE STAKE SHOULD BE INSTALLED, INTO THE GROUND, AND SOIL SHOULD BE FIRMLY PACKED AROUND IT AFTER INSTALLATION. WATER THOROUGHLY TO REMOVE ANY AIR POCKETS. MAKE PILOT HOLES WITH AN IRON BAR WHEN NECESSARY. DISCARD ANY STAKES THAT SPLIT DURING PLANTING. SPACE IN A RANDOM CONFIGURATION OF CLUSTERS WITH AN OVERALL AVERAGE DENSITY OF 2 TO 4 STAKES PER SQUARE YARD (SQUARE METER).

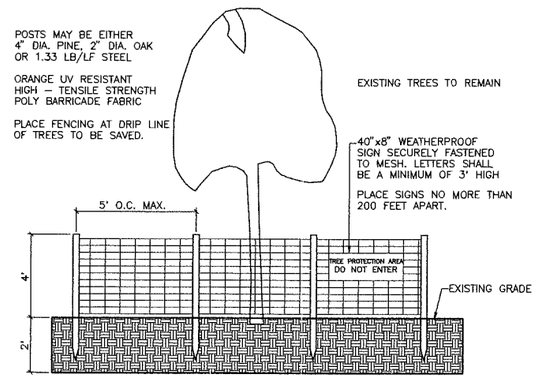


SPECIES LIST
BUTTONBUSH – (CEPHALANTHUS OCCIDENTALIS)
ELDERBERRY – (SAMBUCUS CANADENSIS)
BLACK WILLOW – (SALIX NIGRA)
CAROLINA WILLOW (SALIX CARDINIANA)
SILKY DOGWOOD – (CORNUS AMOMUM)
(SPECIES MIX AND PLANTING PLAN TO BE APPROVED BY ENGINEER PRIOR TO INSTALLATION)

NOTE:
ROOTED/LEAFED CONDITION OF THE LIVING PLANT MATERIAL IS NOT REPRESENTATIVE OF THE TIME OF INSTALLATION.

4 TYPICAL LIVE STAKE DETAIL

SCALE: NOT TO SCALE



5 TREE PROTECTION FENCE

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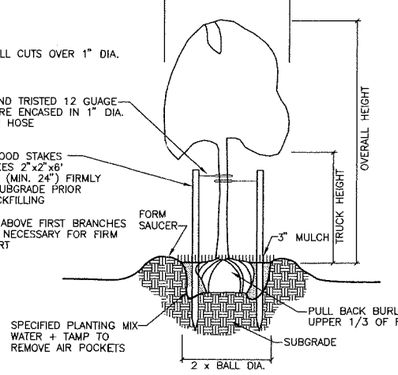
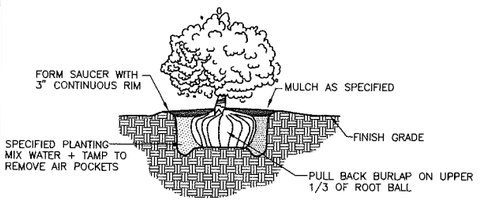


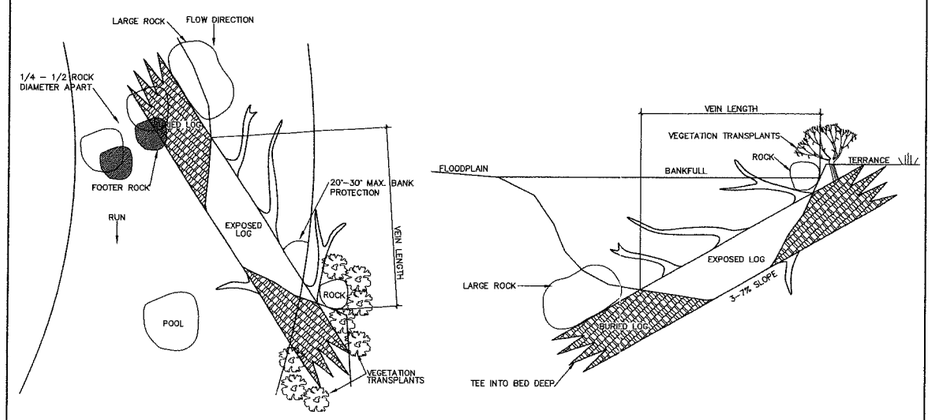
6 TREE PLANTING DETAIL

SCALE: NOT TO SCALE



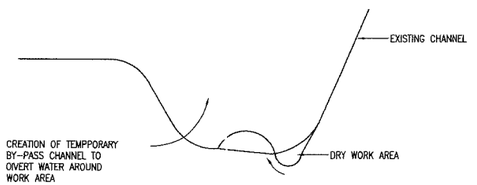
7 TREE PLANTING DETAIL

SCALE: NOT TO SCALE



8 BANK LOG (VANE) STRUCTURE

SCALE: NOT TO SCALE



NOTE: THIS IS FOR DAILY WORK ALONG THE CHANNEL TOE ONLY

DETAIL FOR TEMPORARY CHANNEL CREATION
FOR WORK ALONG THE EXISTING TOE
NTS

9 TEMPORARY CHANNEL CREATION

SCALE: NOT TO SCALE

Becky Ward Consulting
Storm Water Management Engineering
1512 Eglantyne Court (919) 870-0526
Raleigh, NC 27613 FAX (919) 870-5359

WETLANDS DESIGNED BY:

THE CATENA GROUP
303 POND LILY COURT
HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

SEAL:

SEAL:

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

DETAILS

DATE: 08--02--02

REVISIONS:

PROJECT NAME: SANDY CREEK

DWG NAME: c-detail1

SCALE: NTS

SHEET NO. 9 OF 12

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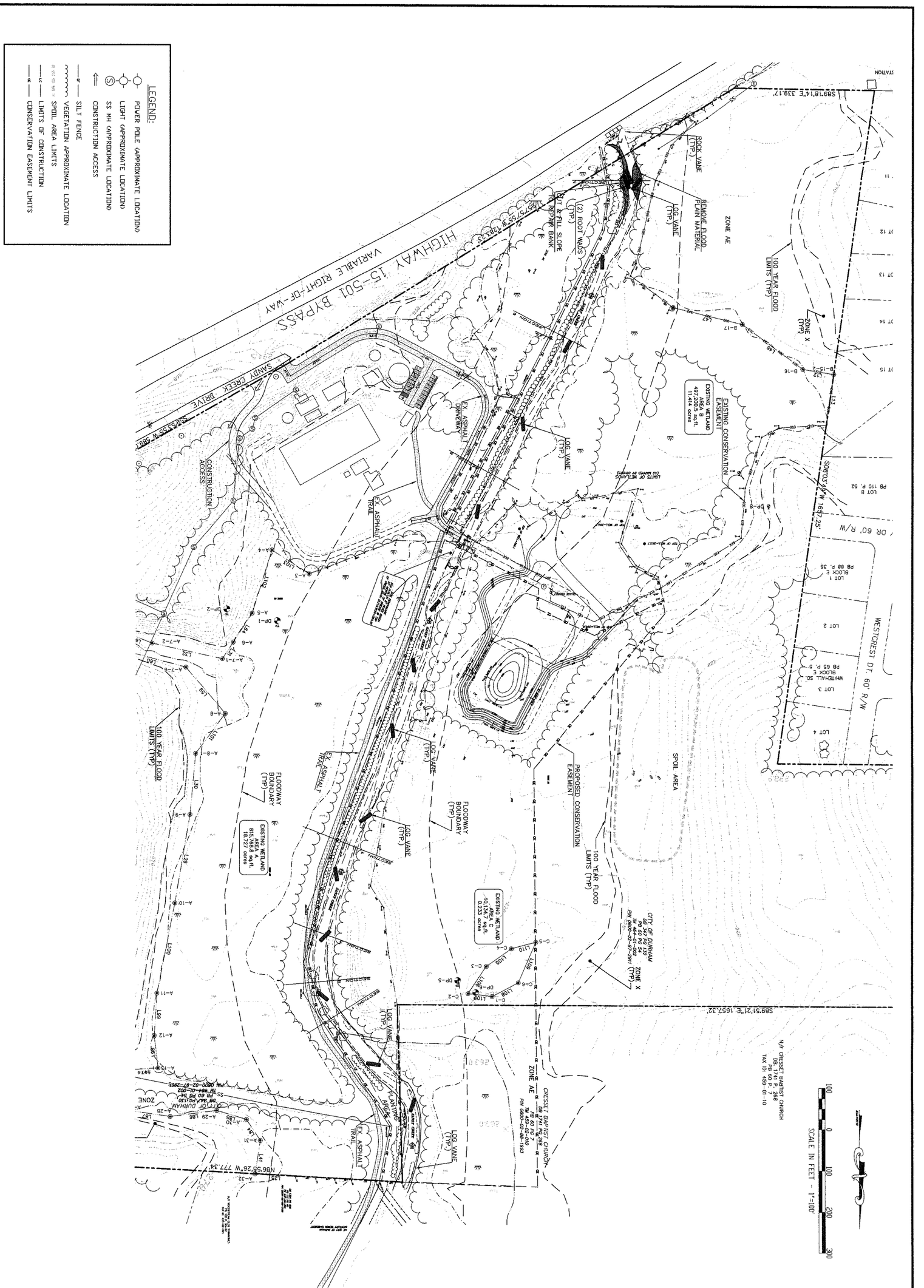

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

OVERALL PLAN

SEAL:

NORTH CAROLINA PROFESSIONAL SEAL 0344 ENGINEER BECKY LYNNE WARD

SEAL:

Becky Ward Consulting
Storm Water Management Engineering
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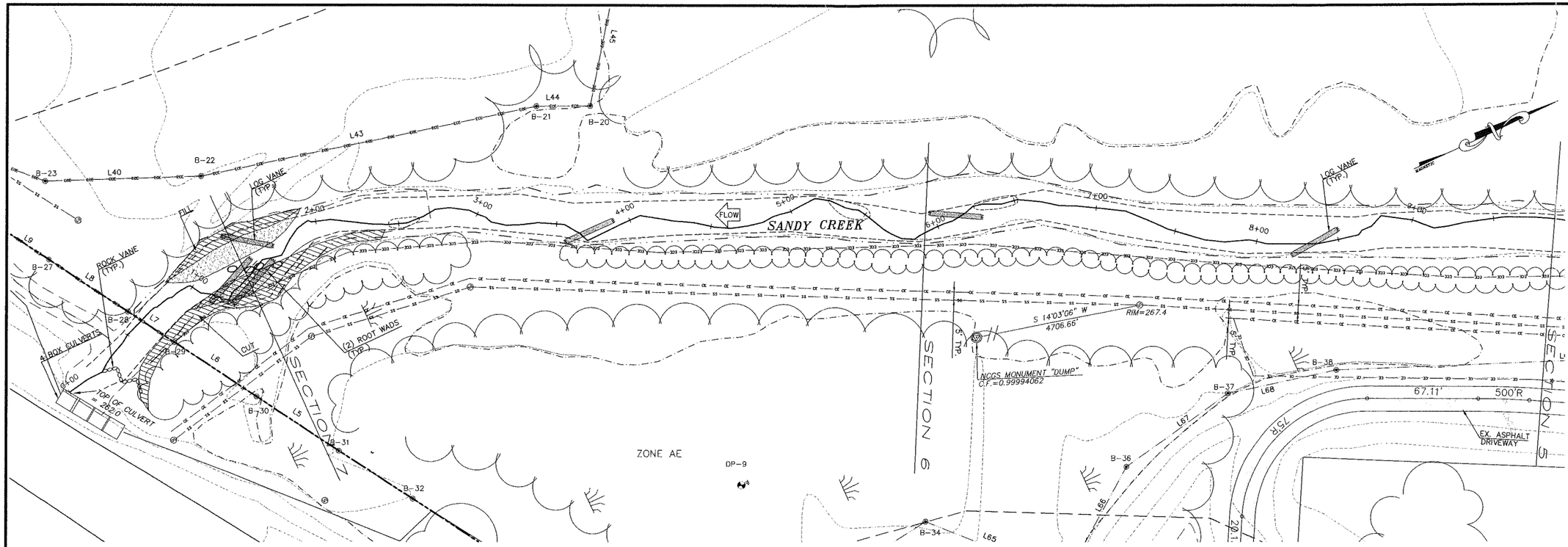
303 POND LILY COURT
HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

DATE: 08-02-02
REVISIONS:

PROJECT MANAGER: SANDY CREEK
DWG NAME: c-full-site
SCALE: 1" = 100'
SHEET NO. 2 OF 12



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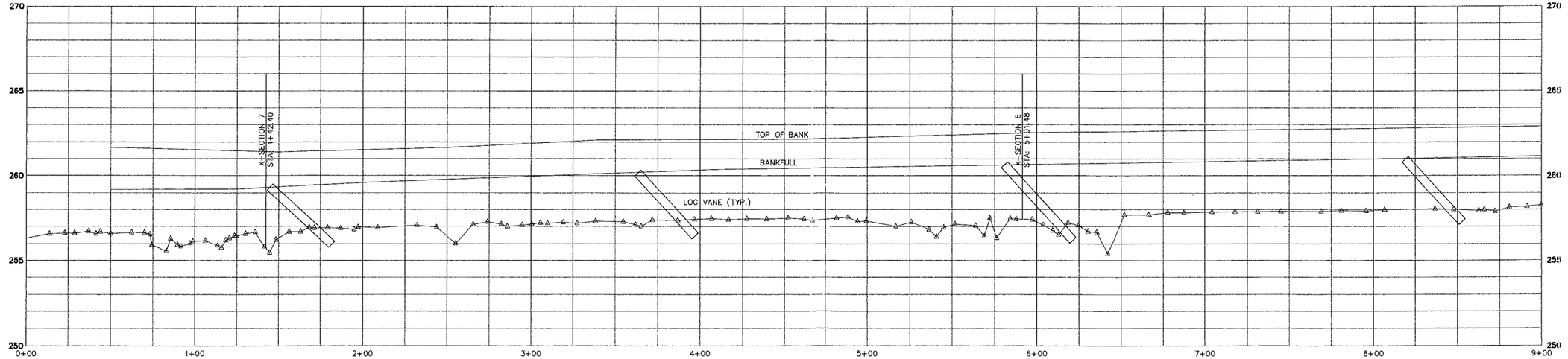

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FAX (919) 870-5559

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THE CATENA GROUP
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SEAL

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 13344 ENGINEER BECKY WARD

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLAN AND PROFILE 0+00 TO 9+00

DATE: 08-02-02

REVISIONS:

PROJECT NAME: SANDY CREEK

DWG NAME: pp-creek1

SCALE: 1" = 30'

SHEET NO. 3 OF 12

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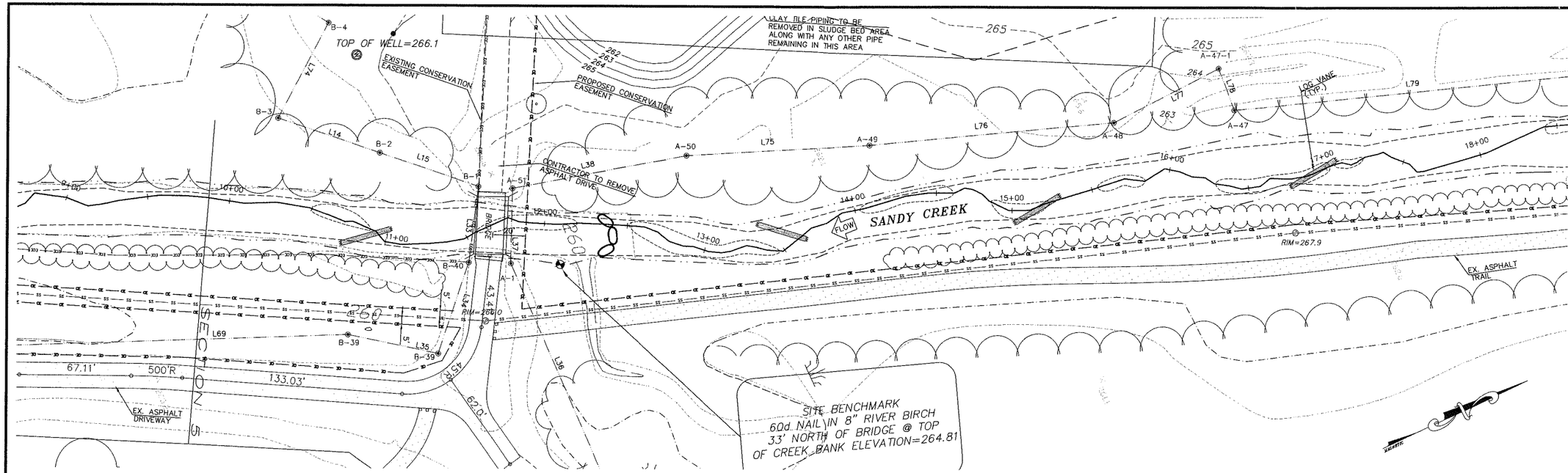
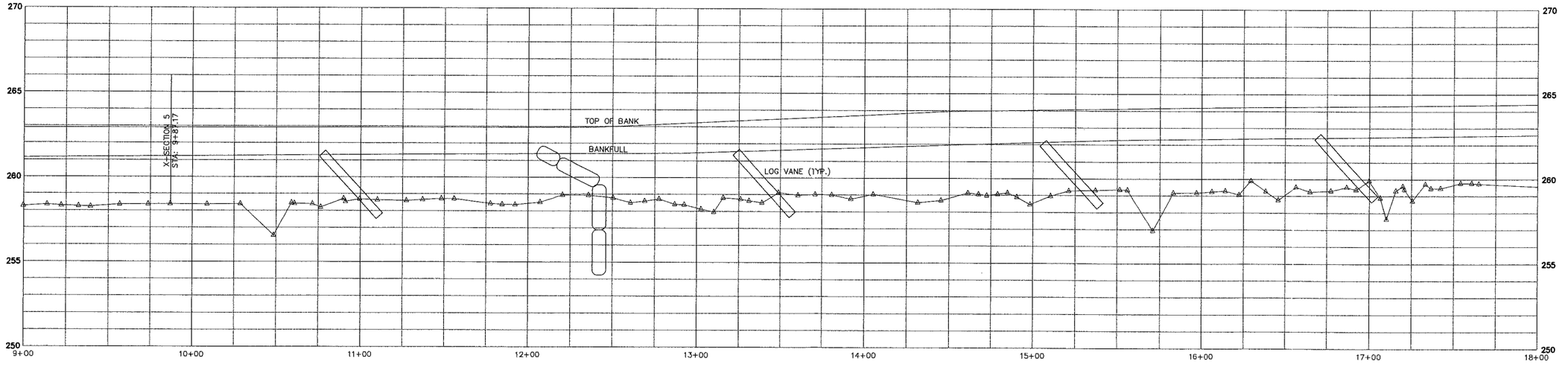


SCALE IN FEET - 1"=30'



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FAX (919) 870-5359

WETLANDS DESIGNED BY:
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SEAL:

NORTH CAROLINA PROFESSIONAL SEAL 13344 ENGINEER BECKY T. WARD

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLAN AND PROFILE 9+00 TO 18+00

DATE: 08-02-02
REVISIONS:
PROJECT NAME: SANDY CREEK
DWG NAME: pp-creek2
SCALE: 1" = 30'
SHEET NO. 4 OF 12

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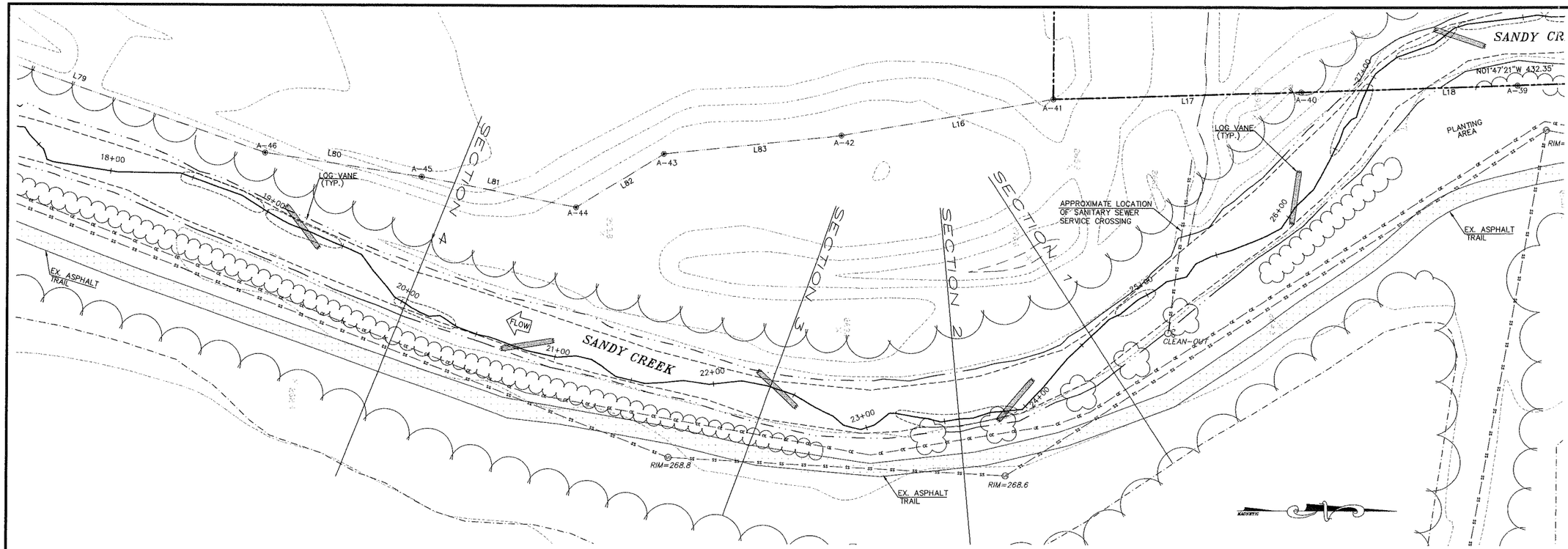

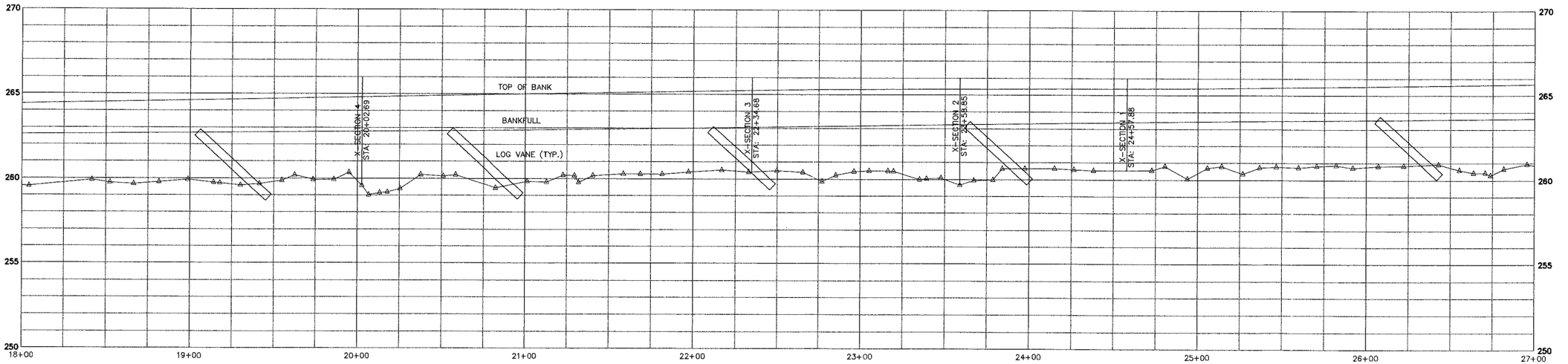

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(919) 732-1300 FAX (919) 732-1303

WETLANDS DESIGNED BY:

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 13144 ENGINEER BECKY T. WARD

SEAL

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLAN AND PROFILE 18+00 TO 27+00

DATE: 08-02-02

REVISIONS:

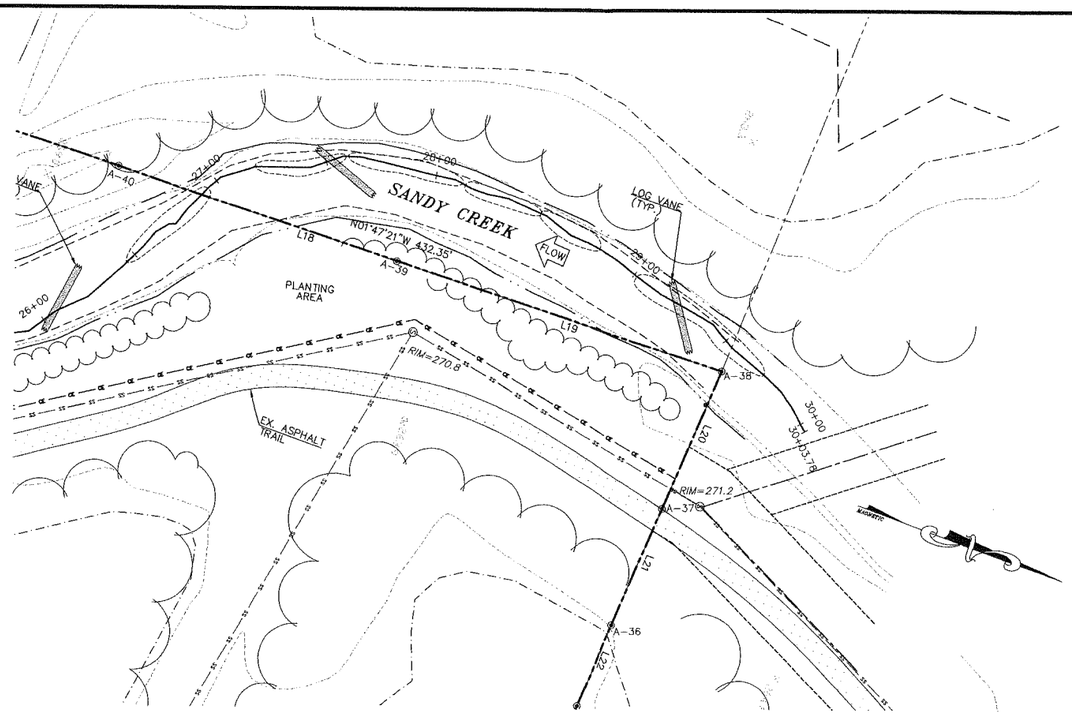
PROJECT NAME: SANDY CREEK

DWG NAME: PP-creek3

SCALE: 1" = 30'

SHEET NO. 5 OF 12

M:\Becky Ward\Sandy Creek\pp-creek3.dwg Wed Jul 31 10:19:01 2002



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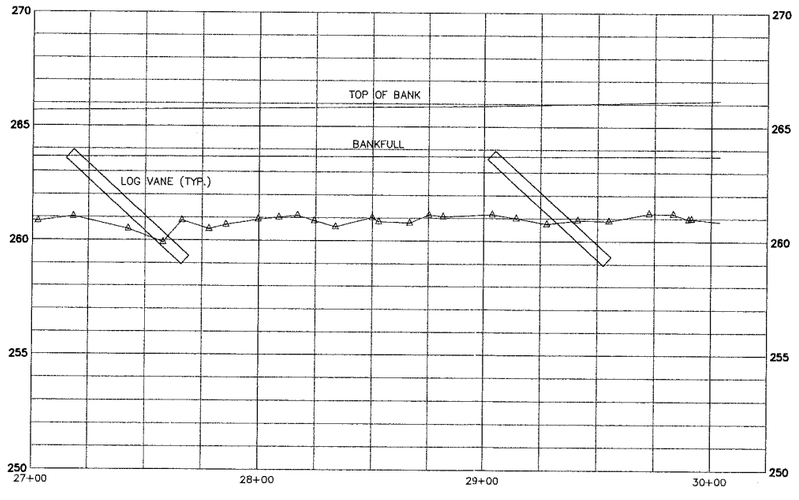

LEGEND:

- POWER POLE (APPROXIMATE LOCATION)
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WETLANDS DESIGNED BY:

THE CATENA GROUP
303 POND LILY COURT
HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

SEAL:

NORTH CAROLINA PROFESSIONAL SEAL 17344 ENGINEER BECKY L. WARD

SEAL:

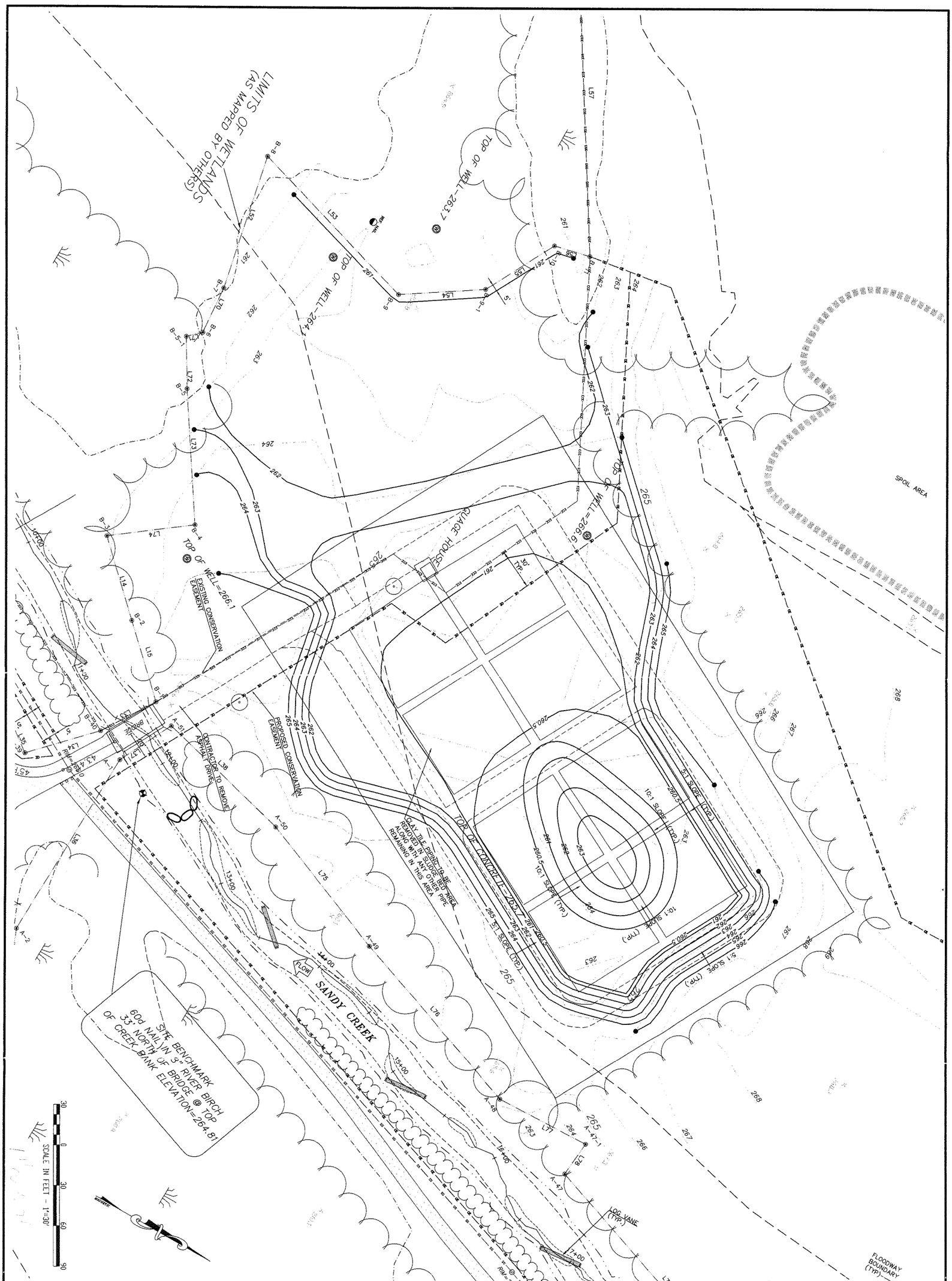
SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

PLAN AND PROFILE 27+00 TO 30+03.78

DATE: 08-02-02
REVISIONS:
PROJECT NAME: SANDY CREEK
DWG NAME: PP-creek4
SCALE: 1" = 30'
SHEET NO.
6 OF 12

R:\Becky Ward\Sandy Creek\pp-creek4.dwg Wed Jul 31 10:41:15 2002

H:\Becky Ward\Sandy Creek\c-wetland.dwg Wed Jul 31 10:56:10 2002



SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION

WETLAND PLAN PRELIMINARY DESIGN

SEAL:

NORTH CAROLINA PROFESSIONAL SEAL 13344 ENGINEER BECKY LYNNE WARD

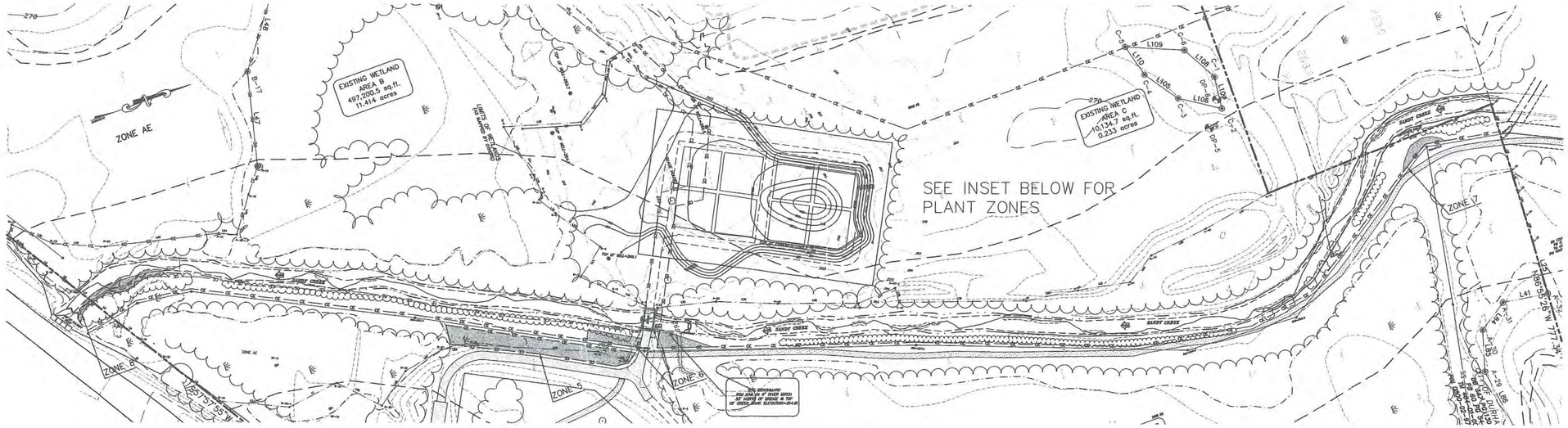
SEAL:

Becky Ward Consulting
Storm Water Management Engineering
1512 Eglantyne Court (919) 870-0526
Raleigh, NC 27613 FAX (919) 870-5359

WETLANDS DESIGNED BY:
THE CATENA GROUP
303 POND LILY COURT
HILLSBOROUGH, NC 27278
(919) 732-1300 FAX (919) 732-1303

DATE: 08-02-02
REVISIONS:

PROJECT NAME: SANDY CREEK
DWG NAME: c-wetland
SCALE: 1" = 30'
SHEET NO. 7 OF 12



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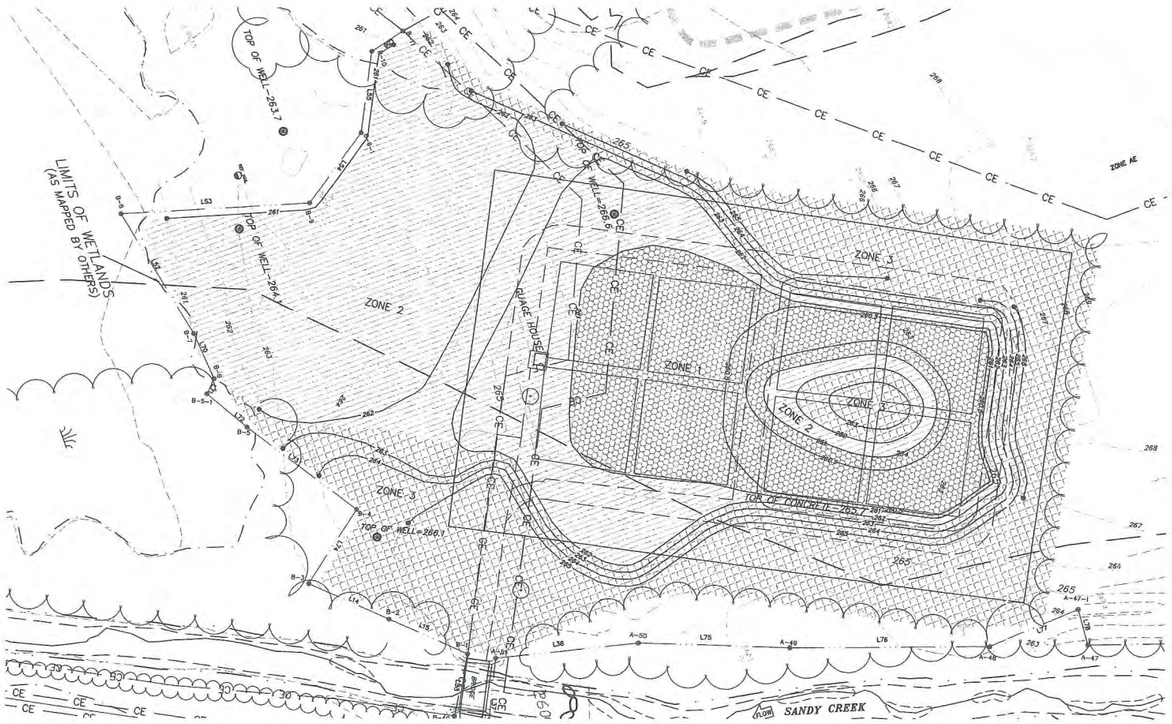
SCALE IN FEET - 1"=100'

SANDY CREEK PLANT ZONES



50 0 50 100 150
SCALE IN FEET - 1"=50'

WETLAND PLANT ZONES

SUMMARY OF PLANT QUANTITIES		
Quantity	Genus/Species	Common Name
Planting Zone 1 – Semipermanently Flooded (0.9 ac)		
144	Salix nigra	Black Willow
144	Alnus serrulata	Tag Alder
144	Cephalanthus occidentalis	Button Bush
144	Quercus lyrata	Overcup Oak
Planting Zone 2 – Seasonally Flooded (1.8 ac)		
306	Sambucus Canadensis	Elderberry
306	Cornus amomum	Silky Dogwood
306	Fraxinus pennsylvanica	Green Ash
306	Quercus phellos	Willow Oak
Planting Zone 3 – Temporarily Flooded (1.9 ac)		
323	Nyssa sylvatica	Black Gum
323	Liriodendron tulipifera	Tulip Poplar
323	Betula nigra	River Birch
323	Quercus laurifolia	Laurel Oak
Planting Zone 4 – Upland Spoil (2.3 ac)		
391	Quercus alba	White Oak
391	Quercus falcate	Southern Red Oak
391	Nyssa sylvatica	Black Gum
391	Liriodendron tulipifera	Tulip Poplar
Planting Zone 5 – Seasonally Flooded (0.2[illegible] ac)		
39	Sambucus canadensis	Elderberry
39	Cornus amomum	Silky Dogwood
39	Myrica cerifera	Wax Myrtle
40	Fraxinus pennsylvanica	Green Ash
Planting Zone 6 – Temporarily Flooded (0.C5 ac)		
8	Myrica cerifera	Wax Myrtle
9	Callicarpa americana	American Beautyberry
9	Aronia arbutifolia	Red Chokeberry
8	Quercus laurifolia	Laurel Oak
Planting Zone 7 – Temporarily Flooded (0.C3 ac)		
11	Myrica cerifera	Wax Myrtle
13	Lindera benzoin	Spice bush
Planting Zone 8 – Streambank Live stakes (0.12 ac)		
500	Cephalanthus occidentalis	Buttonbush
500	Sambucus canadensis	Elderberry
500	Salix caroliniana	Carolina Willow

Planting Zone 1: 260.5 feet – 261.0
Planting Zone 2: 261.0 feet – 262.0
Planting Zone 3: 262.0 feet plus

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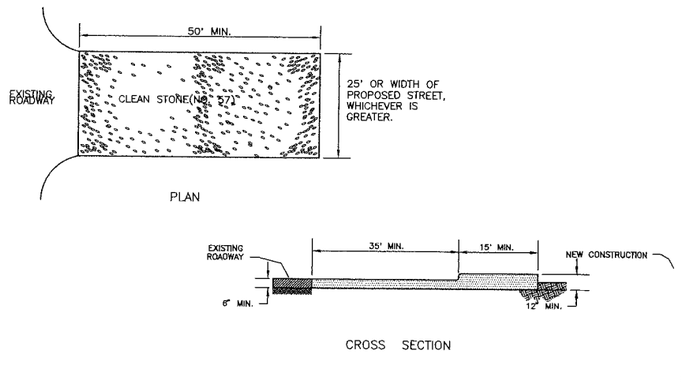
SEAL:

SEAL:

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION
PLANTING PLAN
PRELIMINARY DESIGN

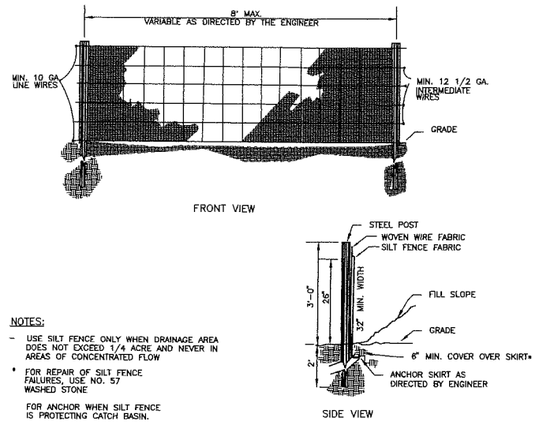
DATE: 08-02-02
REVISIONS:
PROJECT NAME: SANDY CREEK
DWG NAME: c-plant-plan
SCALE: AS SHOWN
SHEET NO. 8 OF 12

u:\Sandy Creek\Sandy Creek Preliminary Design\c-plant-plan.dwg Thu Aug 01 08:50:17 2002



1 CONSTRUCTION ENTRANCE

SCALE: NOT TO SCALE



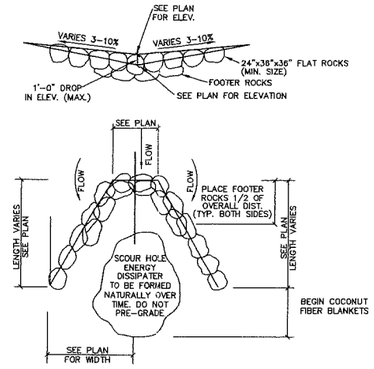
NOTES:

- USE SILT FENCE ONLY WHEN DRAINAGE AREA DOES NOT EXCEED 1/4 ACRE AND NEVER IN AREAS OF CONCENTRATED FLOW
- * FOR REPAIR OF SILT FENCE FAILURES, USE NO. 57 WASHED STONE

FOR ANCHOR WHEN SILT FENCE IS PROTECTING CATCH BASIN.

2 STANDARD TEMPORARY SILT FENCE

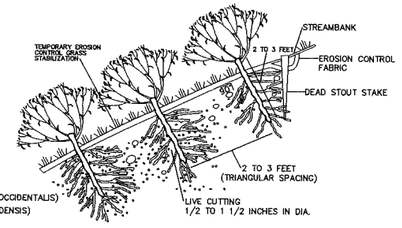
SCALE: NOT TO SCALE



3 TYPICAL ROCK GRADE CONTROL STRUCTURE

SCALE: NOT TO SCALE

LIVE, DORMANT MATERIALS BETWEEN 0.5 IN (13mm) AND 1 IN (25mm) IN DIAMETER AND 2–3 FT (0.6– 0.9m) LONG. REMOVE SIDE BRANCHES, BEING CAREFUL NOT TO DAMAGE THE BARK. CUT BASAL ENDS AT AN ANGLE FOR EASIER PENETRATION INTO SOIL, AND CUT TOPS SQUARE TO MAKE A SUITABLE POUNDING SURFACE. MATERIALS SHOULD BE INSTALLED THE SAME DAY THEY ARE PREPARED. BE CERTAIN THAT THE BUDS WILL BE POINTED UP WHEN PLANTED. CUTTINGS MUST BE INSTALLED WHEN DORMANT, USUALLY SEPTEMBER TO MARCH. A MIXTURE OF PLANT SPECIES SHALL BE SELECTED FOR THE PROJECT SITE. POUND LIVE STAKES AT RIGHT ANGLES TO SLOPE FACE USING ONLY DEAD BLOW HAMMERS. (HAMMER HEAD FILLED WITH SHOT OR SAND). FOUR-FIFTHS OF THE LENGTH OF THE LIVE STAKE SHOULD BE INSTALLED, INTO THE GROUND, AND SOIL SHOULD BE FIRMLY PACKED AROUND IT AFTER INSTALLATION. WATER THOROUGHLY TO REMOVE ANY AIR POCKETS. MAKE PILOT HOLES WITH AN IRON BAR WHEN NECESSARY. DISCARD ANY STAKES THAT SPLIT DURING PLANTING. SPACE IN A RANDOM CONFIGURATION OF CLUSTERS WITH AN OVERALL AVERAGE DENSITY OF 2 TO 4 STAKES PER SQUARE YARD (SQUARE METER).



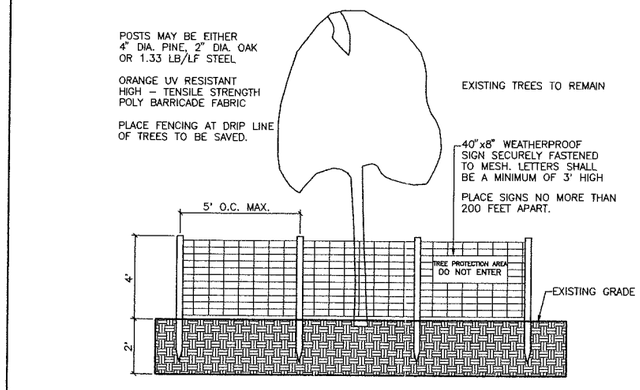
SPECIES LIST

BUTTONBUSH – (CEPHALANTHUS OCCIDENTALIS)
ELDERBERRY – (SAMBUCUS CANADENSIS)
BLACK WILLOW – (SALIX NIGRA)
CAROLINA WILLOW (SALIX CAROINIANA)
SILKY DOGWOOD – (CORNUS AMOMUM)
(SPECIES MIX AND PLANTING PLAN TO BE APPROVED BY ENGINEER PRIOR TO INSTALLATION)

NOTE:
ROOTED/LEAFED CONDITION OF THE LIVING PLANT MATERIAL IS NOT REPRESENTATIVE OF THE TIME OF INSTALLATION.

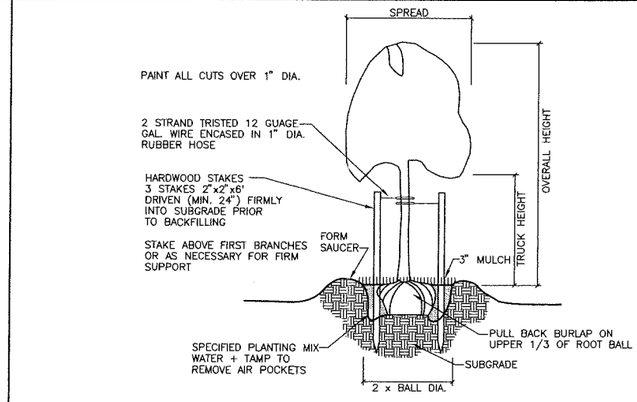
4 TYPICAL LIVE STAKE DETAIL

SCALE: NOT TO SCALE



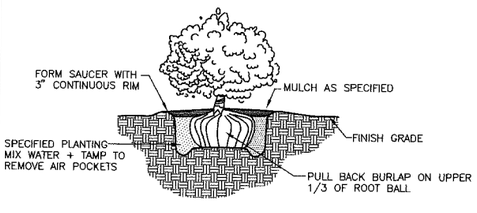
5 TREE PROTECTION FENCE

SCALE: NOT TO SCALE



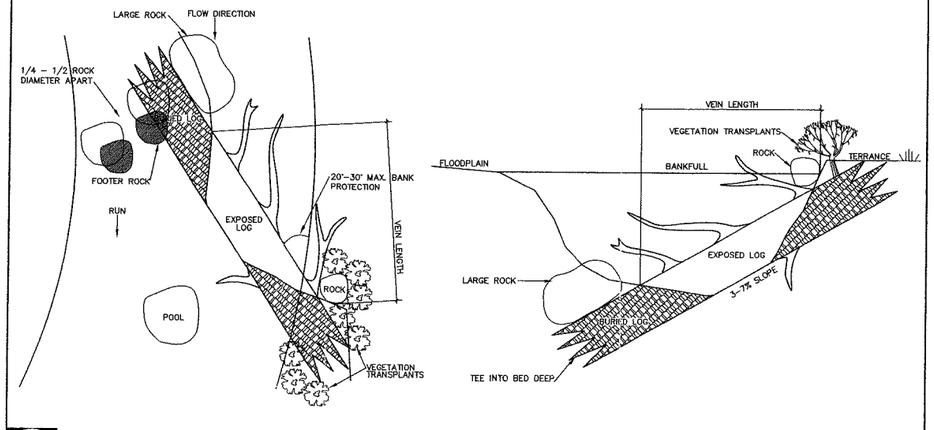
6 TREE PLANTING DETAIL

SCALE: NOT TO SCALE



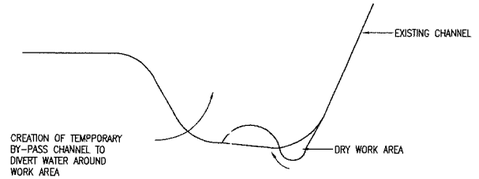
7 TREE PLANTING DETAIL

SCALE: NOT TO SCALE



8 BANK LOG (VANE) STRUCTURE

SCALE: NOT TO SCALE



NOTE: THIS IS FOR DAILY WORK ALONG THE CHANNEL TOE ONLY

DETAIL FOR TEMPORARY CHANNEL CREATION FOR WORK ALONG THE EXISTING TOE

NTS

9 TEMPORARY CHANNEL CREATION

SCALE: NOT TO SCALE

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SEAL:

SEAL:

SEAL:

SANDY CREEK STREAM ENHANCEMENT & WETLAND RESTORATION/CREATION DETAILS

DATE: 08-02-02

REVISIONS:

PROJECT NAME: SANDY CREEK

DWG NAME: c-detail1

SCALE: NTS

SHEET NO. 9 OF 12

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