

WETLAND MITIGATION PLAN

ONSLOW COUNTY MARSH MITIGATION SITE

CAMP LEJEUNE, ONSLOW COUNTY NORTH CAROLINA

The North Carolina Department of Transportation
Raleigh, North Carolina



September 1997

WETLAND MITIGATION PLAN

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CAMP LEJEUNE, ONSLOW COUNTY, NORTH CAROLINA**

Prepared for:

The North Carolina Department of Transportation
Raleigh, North Carolina

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SEPT 1997

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WETLAND MITIGATION PLAN

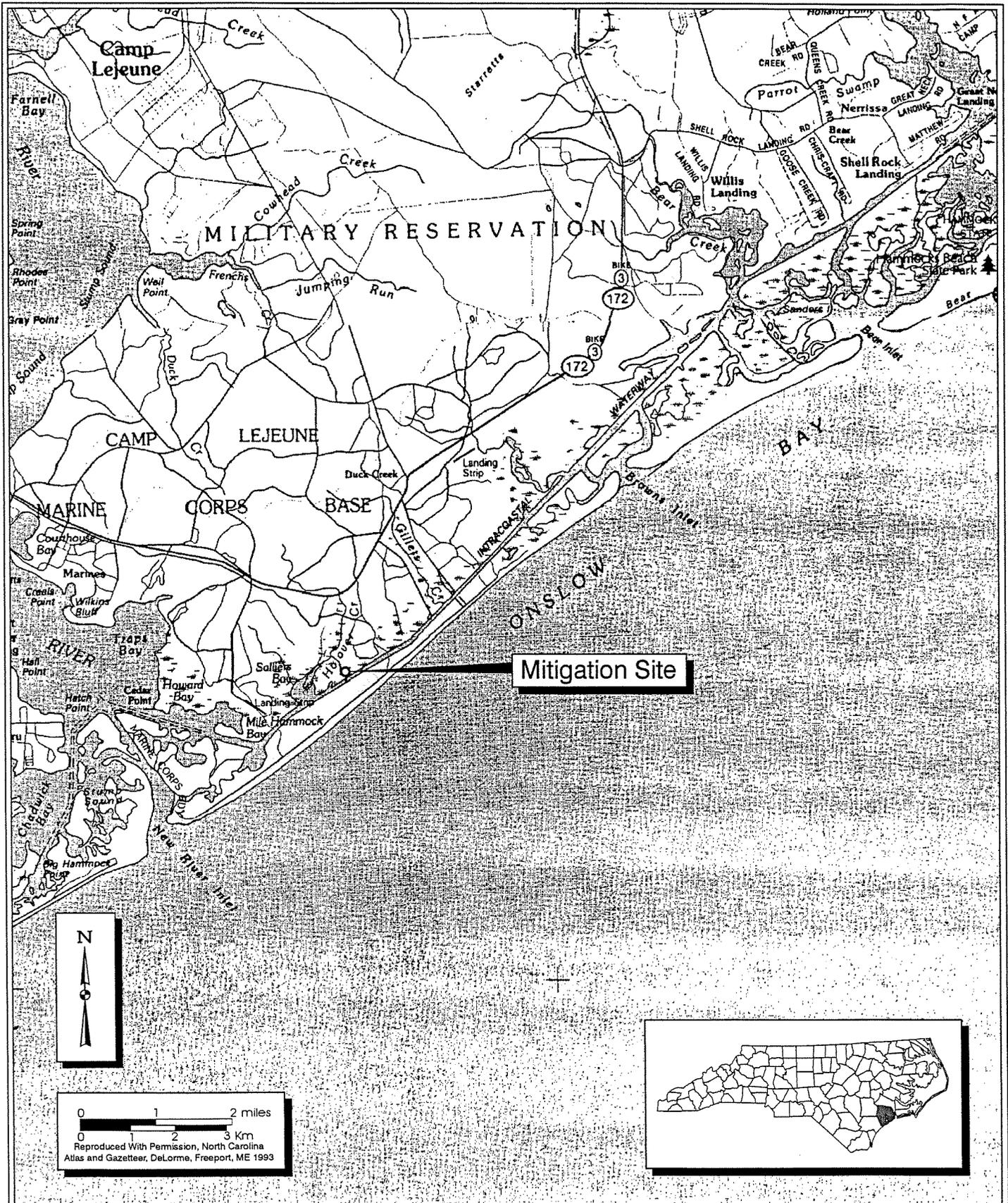
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION COASTAL MARSH MITIGATION SITE CAMP LEJEUNE, ONSLOW COUNTY

1.0 INTRODUCTION

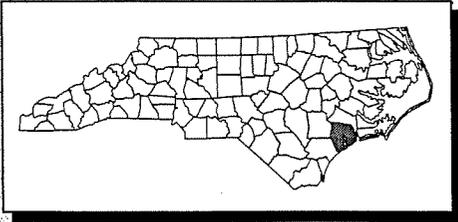
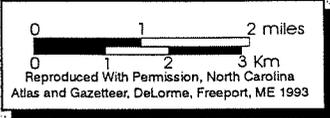
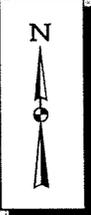
General Assembly House Bill 399, ratified in 1989, provides for the establishment of the North Carolina Highway Trust Fund. This fund was established to facilitate the development of free-flowing, safe, inter-city travel for motorists, and to support statewide growth and development objectives. In 1994, the State of North Carolina created a new transportation plan called Transportation 2001 that emphasizes, among other things, the acceleration of highway projects associated with key regions of economic development. As part of this effort, the N.C. Department of Transportation (NCDOT) is planning and constructing roadway improvement projects in the tidewater portion of the state. A priority corridor in this region is the US 17 Bypass of Jacksonville (R-2107).

NCDOT is endeavoring to establish mitigation as compensation for the projected loss of tidal salt marsh habitat due to construction of the US Route 17 Bypass around Jacksonville, North Carolina. NCDOT has identified a mitigation site adjacent to the Atlantic Intracoastal Waterway (AIWW) at the southern end of the Camp Lejeune Marine Corps Base in Onslow County (Figure 1), called the Onslow County Marsh Mitigation Site (hereafter the "Site"). The Site is composed of two parcels of filled land (Area A and Area B, Figure 2) totaling approximately 1.6-hectares (ha) (3.5-acres [ac]). After cursory hydrological evaluations, determination of depth of fill and evaluation of biotic communities, NCDOT determined the Site offers reasonable wetlands mitigation potential for inclusion in its wetland mitigation program.

The purpose of this document is to: (1) describe existing conditions at the Site; (2) present a mitigation plan for restoring tidal salt marsh wetlands; and (3) present a plan for monitoring and measuring success of restoration efforts.



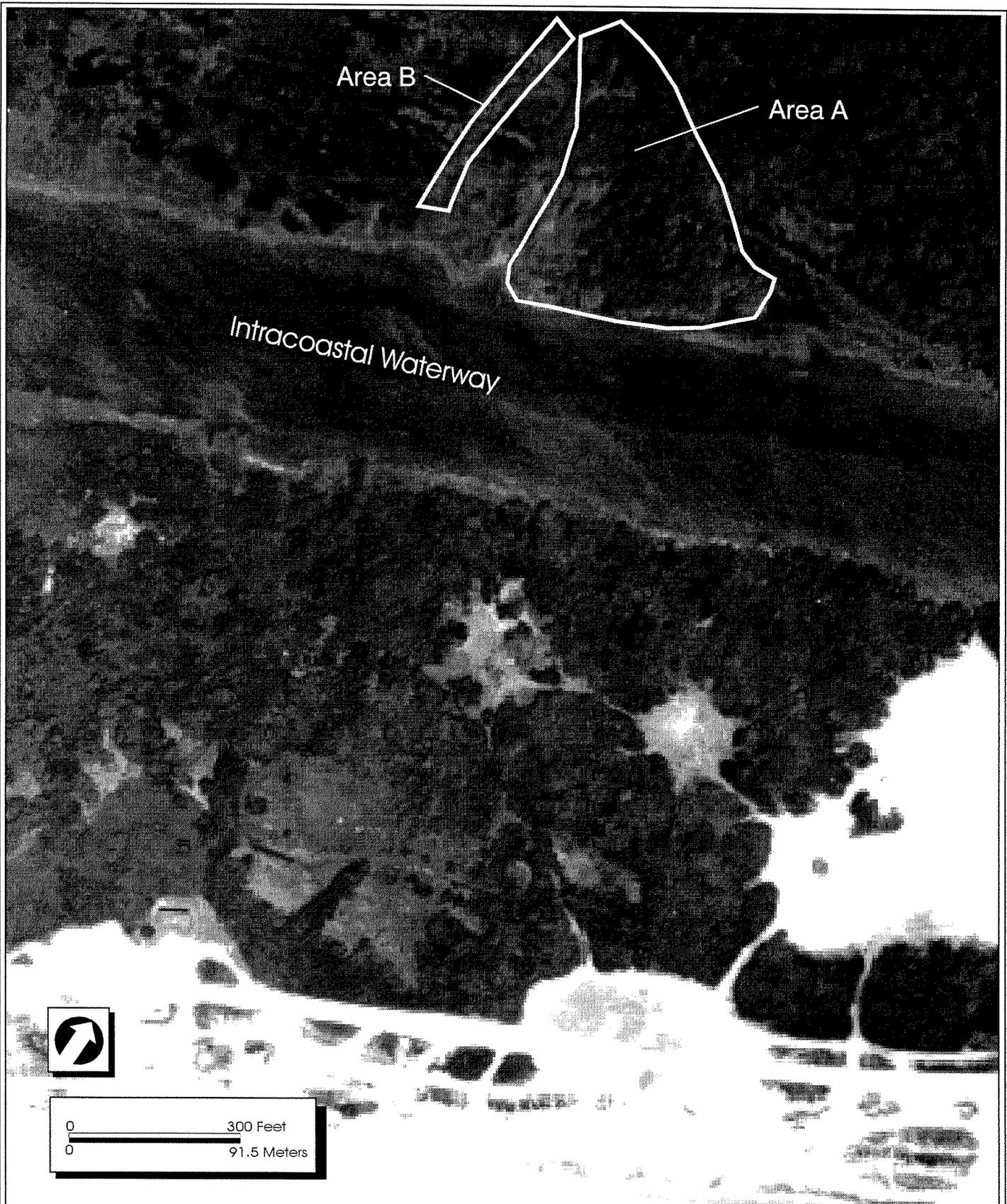
Mitigation Site



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Location Map
 Marsh Mitigation Site
 Onslow County, North Carolina

Figure:	1
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Site Vicinity
 Marsh Mitigation Site
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2.0 METHODOLOGY

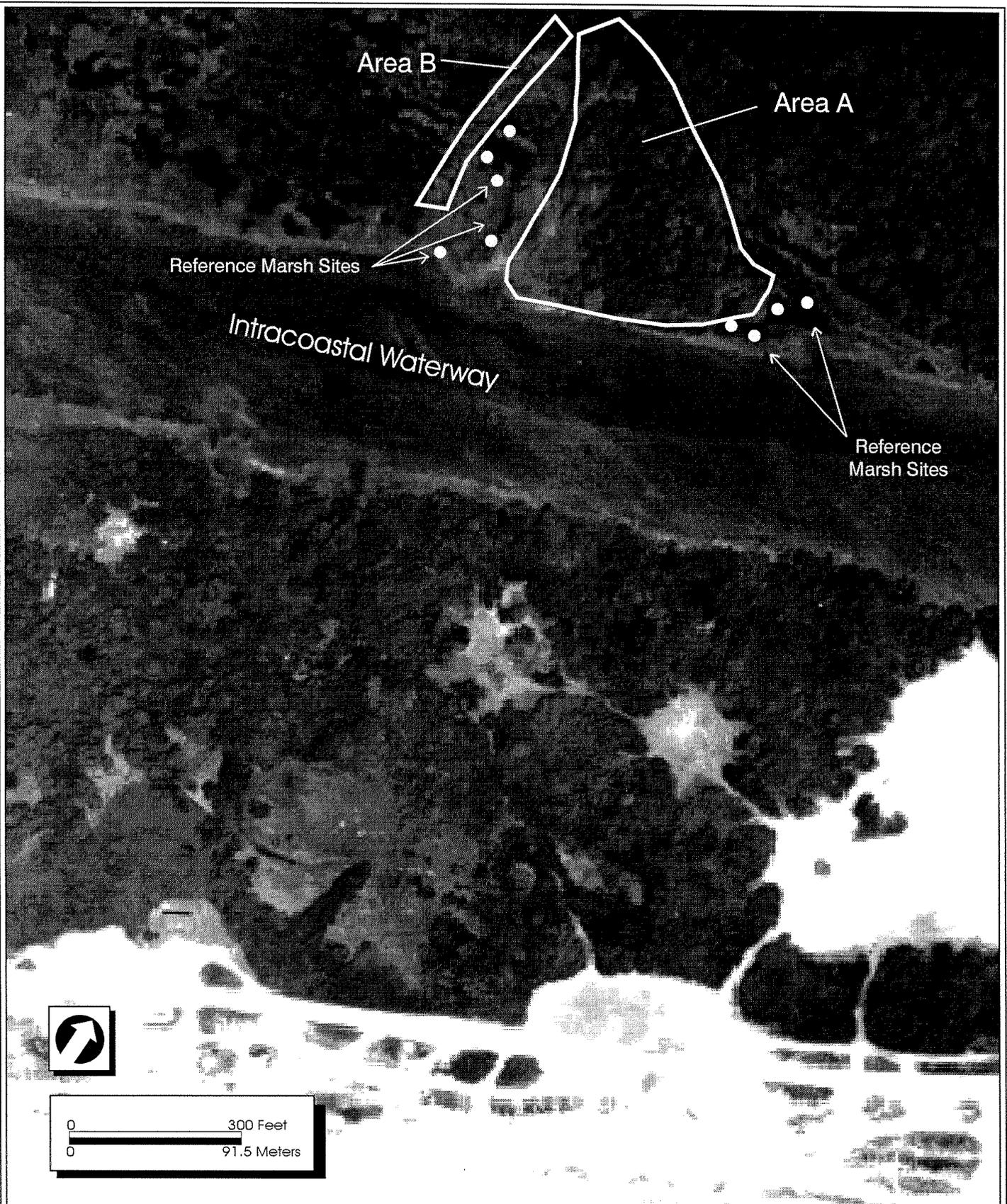
NCDOT provided aerial photography and defined the project limits of the Site. Existing information was evaluated through the use of: U.S. Geological Survey (USGS) topographic mapping; the Natural Resource Conservation Service (NRCS) soil survey for Onslow County (USDA 1992); and U.S. Fish and Wildlife Service (FWS) National Wetland Inventory (NWI) mapping.

Field surveys were undertaken on July 15-16, 1996 and February 27, 1997 to evaluate existing plant communities and determine existing site conditions. Plant species were identified by strata (canopy, shrub, herb). Soil samples were taken to characterize substrate conditions, and estimates of elevation gradient changes were noted.

The tidal salt marsh system adjacent to the Site was considered to be appropriate for reference marsh purposes. The natural marsh landform, soils, and hydrological characteristics will be emulated by restoration of the Site. In order to characterize the reference marsh, 10 1-meter square (m^2) (10.8-foot square [ft^2]) plots were randomly established for use in a determination of species composition and percent cover (Figure 3). Importance values (Brower *et al.* 1990) were calculated for encountered species (see Section 4.1). This information has been used in development of a conceptual planting plan Section 4.4.

Project geologists used a series of 23 exploratory soil borings to determine the depth of fill and to delineate the fill/native soil boundary within the Site. Four transects within Area A, paralleling the AIWW, were established for soil borings. Transects were spaced at 30-meter (m) (98-foot [ft]) intervals with the first transect located approximately 15 m (50 ft) inshore from the shoreline. A total of 14 soil borings were conducted within the boundaries of Area A. Nine soil borings were conducted within Area B. Using hand augers, soil borings were advanced to a depth where the presence of native soil was encountered. Transect and boring locations for Area A are presented in Figure 4, while Figure 5 presents boring locations within Area B. Soil boring locations and the limits of fill were flagged and surveyed for Area A. In addition, the ground surface elevation at each soil boring location was surveyed for vertical elevation to assist in determining depth of fill material. Soil boring locations and the limits of fill boundary were located and delineated using laser technology for Area B.

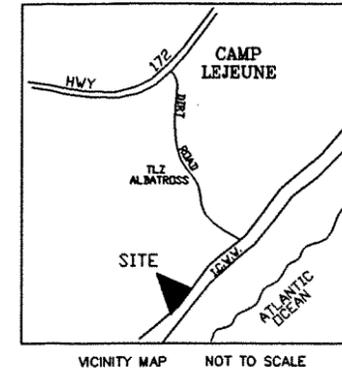
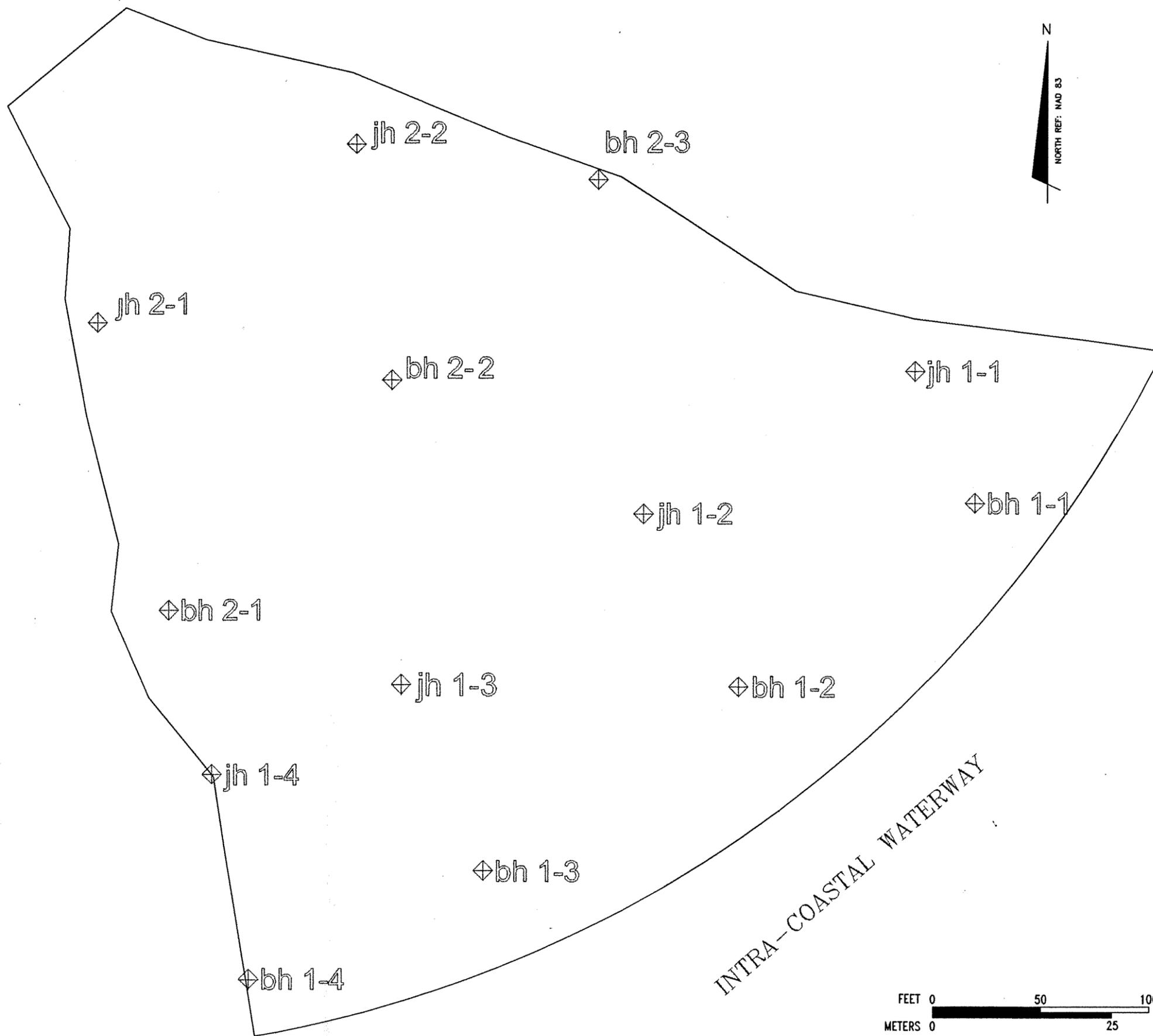
Topographic surfaces for the existing land surface and the probable historic surface were developed using SURFER (a surface mapping software package). A conceptual grading plan was developed by overlaying the two surfaces (existing land surface and historic marsh surface), and transect cross-sections were generated. These data were used to generate an estimation of the volume of material to be removed as part of Site restoration.



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Reference Marsh Site Locations
 Marsh Mitigation Site
 Onslow County, North Carolina

Figure:	3
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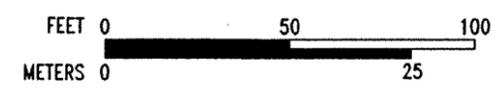


◊bh 1-1 Boring Location

BORE #	NORTH	EAST
JH 2-2	299573	2513834
JH 2-3	299645	2513902
JH 1-1	299470	2514093
BH 1-1	299410	2514121
BH 1-2	299326	2514011
BH 1-3	299242	2513893
BH 1-4	299192	2513784
JH 1-4	299286	2513767
BH 2-1	299361	2513747
JH 2-1	299492	2513714
BH 2-2	299468	2513850
JH 1-2	299405	2513967
JH 1-3	299327	2513855
BH 2-3	299557	2513946

NOTES:
 1. ELEVATIONS BASED ON U.S.M.C. MON "A 14", ELEVATION 14.14 FT. NGVD29 (NATIONAL GEODETIC VERTICAL DATUM 1929).
 2. HORIZONTAL DATUM BASED ON NAD83 (NORTH AMERICAN DATUM 1983).
 3. TBM = R/R SPIKE SET IN 30' PINE LOCATED IN THE NORTHEASTERN MOST CORNER OF SECONDARY LZ. ELEVATION 10.28

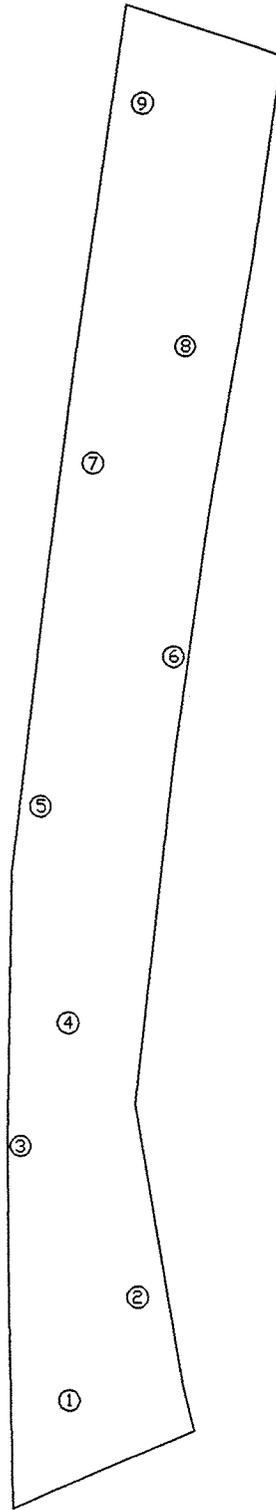
CERTIFICATE OF ACCURACY
 THE TRIMBLE PATHFINDER PRO XL AND EXTERNAL ANTENNA WERE USED FOR LOCATING THE BORE SITES AND THE PROJECT LIMITS ON THIS PROJECT. ONLY THE MANUAL 3-D POSITION FIX MODE WAS USED. POSITIONS WERE DIFFERENTIALLY CORRECTED WITH BASE FILES PROVIDED BY THE NORTH CAROLINA GEODETIC SURVEY (NCGS) BY USING THE POST-PROCESSING PROGRAM IN THE PRO XL'S SOFTWARE SUITE, PFINDER. THE NCGS BASE STATION AT WASHINGTON N.C. (LAT: 35-33-39.76910 N, LONG: 77-03-43.48870 W) WAS UTILIZED AND IS LESS THAN 110 KILOMETERS FROM THE SITE. ALL POINTS INCORPORATE AT LEAST 30 THREE DIMENSIONAL POSITION FIXES COLLECTED, AT 5 SECOND SYNCHRONOUS READINGS, WITH THE BASE STATION. THE HORIZONTAL ACCURACY FOR THE DIFFERENTIALLY CORRECTED DATA IS 1 METER OR LESS.



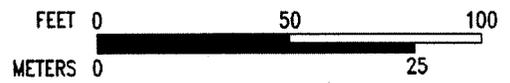
AREA A BORING LOCATIONS
 ONSLOW COUNTY MARSH SITE
 ONSLOW COUNTY, NORTH CAROLINA
 NCDOT



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② Boring Location



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Area B Boring Locations
Marsh Mitigation Site
Onslow County, North Carolina

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3.0 EXISTING CONDITIONS

The Site is located in the tidewater region of the outer Coastal Plain physiographic province of North Carolina, approximately 1.2 kilometers (0.7 miles) northeast of the confluence of Holover Creek/Salliers Bay and the AIWW (Figure 1). The approximately 1.6-ha (3.5-ac) Site is composed of two parcels generally shaped like a funnel (Area A) with a separate stem (Area B) off the west side of the apex (Figure 2). Site boundaries are generally identified by maritime forest along the northwestern boundary, tidal salt marsh along the northeastern boundary and the AIWW along the southeastern boundary.

3.1 Physiography, Site History, and Land Use

The landscape consists of a slightly undulating, table-like mound of fill that rises approximately 0.6 to 0.9 m (2 to 3 ft) above adjacent salt marshes in Area A. The surface of the table undulates with a variation in elevation of approximately 0.5 m (1.5 ft). Area B consists of a remnant causeway ranging from 9 to 12 m (30 ft to 40 ft) wide and approximately 122 m (400 ft) long. The adjacent salt marsh appears to be a flat, depositional surface with drainage channels and pools of undetermined depth.

In response to needs brought on by World War II, approximately 34,845 ha (86,100 ac) (16 percent of Onslow County) was established as the Camp Lejeune Marine Corps Base. Today the base is approximately 62,100 ha (153,440 ac) and is used to train naval and marine personnel in infantry maneuvers, amphibious assaults, and weapons systems. While Base lands are managed under a natural resource plan, base activities have modified the surrounding landscape.

Historically, the Site appears to have supported a high salt marsh (upper marsh) grading to an intertidal salt marsh along the AIWW. Approximately 20 years ago, the elevation was artificially raised by placing fill material on a wedge-shaped area approximately 1.3 ha (3.2 ac) in size (Area A). An adjacent, raised causeway, approximately 0.1 ha (0.3 ac) in size (Area B), was established by the placement of fill in a linear arrangement extending in a north-south direction, passably as part of a relic air field landing or roadway system. With the change in elevation, the Site no longer experiences tidal flooding, allowing colonization by upland plant communities dominated by loblolly pine (*Pinus taeda*) and a variety of shrubs and grasses.

3.2 Geology

The Coastal Plain is composed of sediments deposited since the Cretaceous Period, 138 million years before present (m.y.B.P.) by a series of transgressions and regression of the Atlantic Ocean. In North Carolina, Coastal Plain sediments generally dip to the east or southeast, and the sediment thickness increases from west to east (Stuckey 1958). The underlying geologic

unit at the Site is Surficial Deposits originating in the Pleistocene Epoch of the Quaternary Period (1.6 m.y.B.P) (NCGS 1985). This geologic unit is composed of sand, gravel, clay, and peat deposits in active marine fluvial environments.

3.3 Hydrology

The Site is located within the Cape Fear River Basin in Hydrologic Unit #0303001 (USGS 1974). Primary sources of hydrology for the Site are diurnal tides and local rainfall. At the time of the initial site visit (July 15-16), groundwater elevations ranged from the surface to 0.5 m (1.5 ft) below surface; standing water was observed in shallow, on-site depressions. It is assumed these conditions were due to several days of heavy rainfall associated with the passage of Hurricane Bertha, four days prior to the site visit. Under normal conditions, the groundwater table is expected to be 0.5 to 0.6 m (1.5 to 2 ft) below the surface (USDA 1992).

The relative elevation of the Site, the lack of a confining layer, natural forestation by loblolly pine, and proximity of adjacent salt marshes suggest that a fresh groundwater lens, floating on denser saline groundwater with some tidally-influenced fluctuations of the water table, represents the current hydrological conditions of the Site. This is typical for shallow, unconfined groundwater in coastal areas (Fetter 1980). The fresh groundwater lens is likely influenced by groundwater inputs from the adjacent maritime forest. It is expected that the fresh groundwater is flowing towards the AIWW, as well as seeping into the adjacent salt marsh.

3.4 Water Quality

The portion of the AIWW (DWQ index # 19-41-[0.5]) adjacent to the Site from New River to northeast mouth of Goose Creek, has a best usage classification of **SA**. Class **SA** uses include shellfishing for market purposes and aquatic life propagation and survival, fishing, wildlife, and secondary recreation activities associated with tidal salt water. Secondary recreation refers to activities involving human body contact with water on an infrequent or incidental basis (DEM 1993). The Benthic Macroinvertebrate Ambient Network (BMAN) is a State established network of fixed stations for monitoring biological, chemical, physical, and hydrological characteristics of stream systems. No rated BMAN stations occur within the vicinity of the Site.

3.5 Soils

Based upon the Onslow County soil survey (USDA 1992), Area A is primarily underlain by the non-hydric soil series Pactolus (*Aquic Quartzipsammets*), and is bounded on the southwest by the hydric soil series Bohicket (*Typic Sulfaquents*). Area B appears to be a linear extension

of the Pactolus map unit associated with Area A, although most of Area B is mapped as Bohicket (Figure 6).

The Pactolus series typically consists of moderately well drained and somewhat poorly drained soils on uplands and stream terraces. These soils form in coarse-textured sediments with slopes ranging from 1 to 3 percent. However, soils encountered on-site are finer than the Pactolus description. Fill material is estimated to have been placed in the marsh some time in the mid to late 1970s resulting in extension of the Pactolus map unit to the AIWW by NRCS.

The Bohicket series is characterized as very poorly drained soils in tidal marshes that are less than 0.9 m (3 ft) above sea level. These soils form in silty and clayey sediments washed from the drainage areas of freshwater streams and have slopes less than 1 percent.

Soil borings indicate that the thickness of fill ranges from 1.4 m (4.5 ft) to less than 0.3 m (1 ft), decreasing in thickness back into the maritime forest area that forms the inland boundary of the Site. The fill material is composed of slightly clayey to silty, very fine to fine sandy soils. This material is similar to the underlying sediments and soils of the adjacent maritime forest located northwest of Area A. Soils underlying the fill material appear to consist of intergrades of the Bohicket map unit.

3.6 Plant Communities

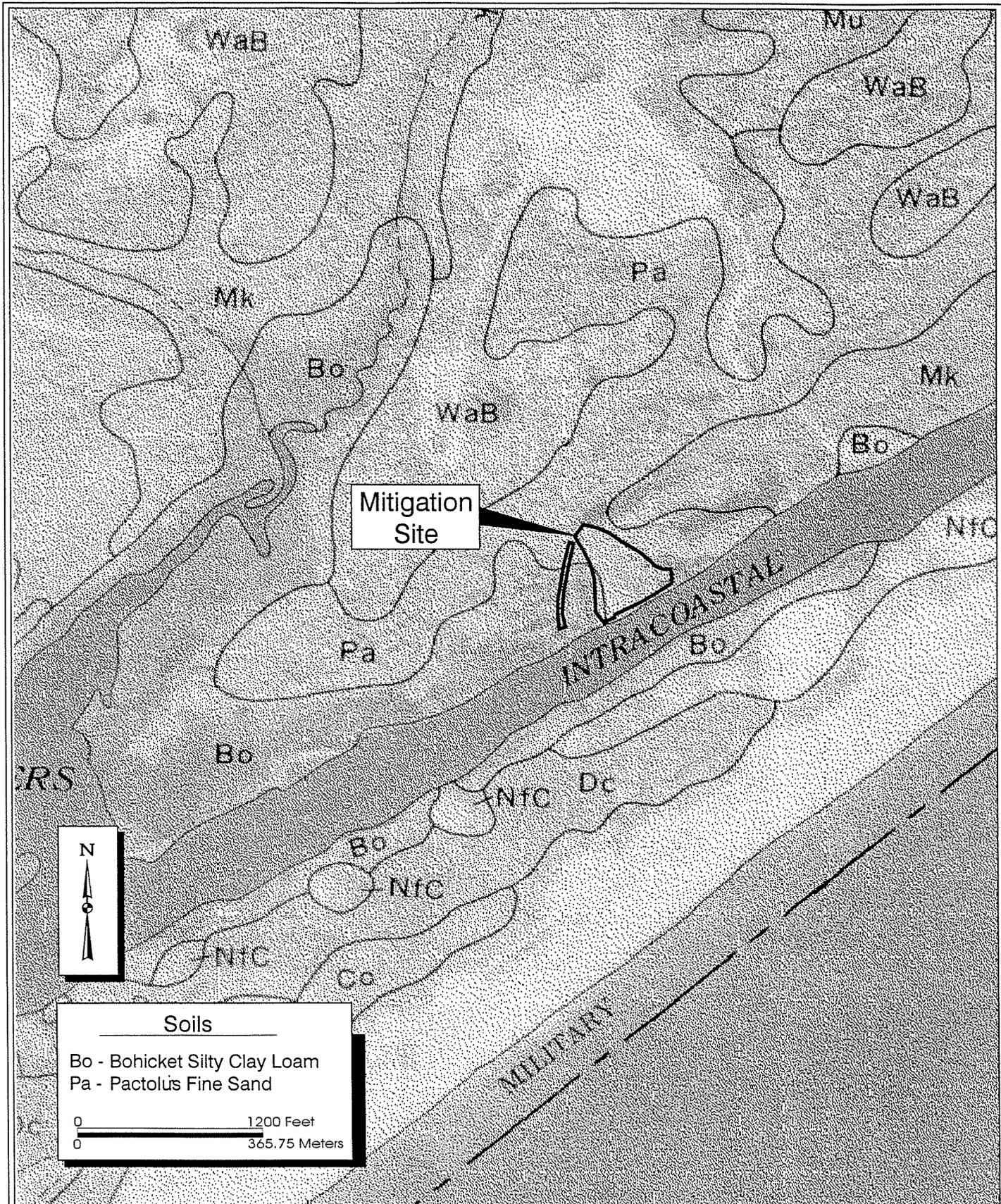
Distribution and composition of plant communities within the Site reflects past disturbance to topography, soils, and hydrology. The primary factor affecting vegetation structure is the placement of 0.3 to 1.4 m (1 to 4.5 ft) of fill material on the historic salt marsh. The existing vegetative cover is a mosaic of shrub and forested areas. Two communities have been identified at the Site: pine forest and coastal shrub assemblage. Vascular plant names follow nomenclature in Radford *et al.* (1968).

Pine Forest

This community occurs on the approximately 1.3 ha (3.2 ac) of fill material within Area A. The absence of tidal flow has allowed for the establishment of a mixed-age pine forest that occurs as a monotypic stand of loblolly pine. Sparse shrub and herbaceous layers include wax myrtle (*Myrica cerifera*), silverling (*Baccharis halimifolia*), and broomsedge (*Andropogon* sp.).

Coastal Shrub Assemblage

This community occurs on the approximately 0.1 ha (0.3 ac) of fill material within Area B. The absence of tidal flow has allowed for the establishment of a coastal shrub assemblage consisting of wax myrtle, silverling and broomsedge.



Soils

Bo - Bohicket Silty Clay Loam
 Pa - Pactolus Fine Sand

0 1200 Feet
 0 365.75 Meters



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Soils Map
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 Onslow County, North Carolina

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3.7 Wildlife

3.7.1 Terrestrial

Site communities are expected to support wildlife species adapted maritime forest-marsh ecotones. Food, protective cover, water, and nesting sites for many species are available within the Site.

Mammal sightings or evidence (scat, tracks, burrows) observed on and around the Site were limited to a single raccoon (*Procyon lotor*). Other mammals likely to occur include least shrew (*Cryptotis parva*), red bat (*Lasiurus borealis*), seminole bat (*Lasiurus seminolus*), marsh rabbit (*Sylvilagus palustris*), gray squirrel (*Sciurus carolinensis*), marsh rice rat (*Oryzomys palustris*), cotton mouse (*Peromyscus gossypinus*), golden mouse (*Ochrotomys nuttalli*), muskrat (*Ondatra zibethicus*), nutria (*Myocastor coypus*), and mink (*Mustela vison*) (Webster *et al.* 1985).

Birds sighted during field investigations include osprey (*Pandion haliaetus*), red-tailed hawk (*Buteo jamaicensis*), American coot (*Fulica americana*), double-crested cormorant (*Phalacrocorax auritus*), ring-billed gull (*Larus delawarensis*), laughing gull (*Larus atricilla*), killdeer (*Charadrius vociferus*), American crow (*Corvus brachyrhynchos*), rock dove (*Columba livia*), morning dove (*Zenaida macroura*), belted kingfisher (*Ceryle alcyon*), house finch (*Carpodacus mexicanus*), long-billed marsh wren (*Cistothorus platensis*), clapper rail (*Rallus longirostris*), red-winged blackbird (*Agelaius phoeniceus*), northern cardinal (*Cardinalis cardinalis*), and American robin (*Turdus migratorius*). Other birds likely to occur on Site include great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), great egret (*Casmerodius alba*), common tern (*Sterna hirundo*), northern mockingbird (*Mimus polyglottos*), common yellowthroat (*Geothlypis trichas*), sharp-tailed sparrow (*Ammodramus caudacutus*), and common grackle (*Quiscalus quiscula*) (Potter *et al.* 1980).

Likely reptiles residents of the marsh-upland ecotones of the Site and adjacent tidal salt marsh include American alligator (*Alligator mississippiensis*), diamondback terrapin (*Malaclemys terrapin*), five-lined skink (*Eumeces fasciatus*), southeastern five-lined skink (*Eumeces inexpectatus*), six-lined racerunner (*Cnemidophorus sexlineatus*), eastern glass lizard (*Ophisaurus ventralis*), eastern coachwhip (*Masticophis flagellum*), and the yellow rat snake (*Elaphe obsoleta quadrivittata*) (Palmer and Braswell 1995).

3.7.2 Aquatic

A widely accepted function of tidal salt marshes is their role as nursery areas for marine and estuarine fishes. However, few fish are permanent residents of the marsh. Most feed along marsh edges and in shallow marsh pools, moving up into the marsh on high tide. Fishes expected adjacent to the Site include spotfin killifish (*Fundulus luciae*), Atlantic croaker (*Micropogon undulatus*), Atlantic menhaden (*Brevoortia tyrannus*), sheepshead minnow

(*Cyprinodon variegatus*), mummichog (*fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), and striped bass (*Morone saxatilis*). Primary nursery utilizers include striped mullet (*Mugil cephalus*), pinfish (*Lagodon rhomboides*), and spot (*Leiostomus xanthurus*) (Fish 1968; Peterson and Peterson 1979; Rohde *et al.* 1994; Stout 1984; and Wiegert and Freeman 1990).

Dead and decaying plant material on adjacent tidal salt marsh surfaces provide important benthic habitat for invertebrates. These organisms browse on the sediment surface, ingesting algae and detritus. Invertebrates expected on and adjacent to the Site include the periwinkle snail (*Littorina irrorata*), mud snail (*Ilyanassa obsoleta*), mud fiddler crab (*Uca pugnax*) sand fiddle crab (*U. pugilator*) (Mitsch and Gosslink 1993; Peterson and Peterson 1978).

3.8 Protected Species

Federal Species

Species with the federal classification of Endangered (E) or Threatened (T) are protected under the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq.*). The following federal-protected species are listed for Onslow County as of 2 May 1997:

Species	Status		Potential Habitat
	Fed.	State	
American Alligator (<i>Alligator mississippiensis</i>)	T(S/A) ^a	T	Yes
Loggerhead sea turtle (<i>Caretta caretta</i>)	T	T	No
Piping plover (<i>Charadrius melodus</i>)	T	T	No
Green sea turtle (<i>Chelonia mydas</i>)	T	T	No
Leatherback sea turtle (<i>Dermochelys coriacea</i>)	E	E	No
Eastern cougar (<i>Felis concolor cougar</i>)	E	E	No
Red-cockaded woodpecker (<i>Picoides borealis</i>)	E	E	No
Seabeach amaranth (<i>Amaranthus pumilus</i>)	T	T	No
Rough-leaved loosestrife (<i>Lysimachia asperulaefolia</i>)	E	E	No
Cooley's meadowrue (<i>Thalictrum cooleyi</i>)	E	E	No

^a T (S/A) - Threatened due to similarity of appearance

A brief description of these species follows.

American Alligator - The American alligator is listed as threatened based on the similarity in appearance to other federal-listed crocodylians; however, there are no other crocodylians within North Carolina. This species is not biologically endangered or threatened. American alligators can be found in a variety of freshwater to estuarine habitats including swamp forests,

marshes, large streams and canals, and ponds and lakes. Marginal habitat for American alligator exists on the Site. However, past land use activities would probably discourage their use of the Site. No negative impact to the American alligator is anticipated as a result of this project.

Loggerhead sea turtle - The loggerhead is the most common sea turtle on the coast of the Carolinas. This species averages 79 to 120 centimeters (cm) (31 to 47 inches [in]) in length and weighs from 77 to 227 kilograms (kg) (170 to 500 pounds [lb]) (Martof *et al.* 1980). The loggerhead is basically temperate or subtropical in nature, and is primarily oceanic, but it may also be found in fresh water bays, sounds, and large rivers. This species occurs along the coast of North Carolina from late April to October. Preferred nesting habitat is ocean beaches, generally south of Cape Lookout. Traditionally, the largest concentration of loggerhead nests each year is on Smith Island, at the mouth of the Cape Fear River in Brunswick County (Palmer and Braswell 1995). This species is not expected to occur within the Site, and there are no documented sightings of this species near the Site. No negative impact to the Loggerhead sea turtle is expected as a result of this project.

Piping plover - This small shorebird occur along ocean beaches above the high tide line, sand flats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, and washover areas cut into or between dunes (Dyer *et al.* 1987). Nests are most often on open, wide sandy stretches of beach similar to those associated with inlets and capes. Due to a lack of habitat this species is not expected to occur on the Site, and there are no documented sightings of this species near the Site. No negative impact to the Piping plover is expected as a result of this project.

Eastern Cougar - The eastern cougar is a possibly extinct eastern subspecies of the widespread mountain lion species. This species was possibly extirpated from North Carolina by the late 1800s although recent sporadic sightings have been reported from remote areas of the mountains and Coastal Plain (Lee 1987). Mountain lions are large, long-tailed cats; adult males may measure 2.1 to 2.7 m (7 to 9 ft) total length with females averaging 30 to 40 percent smaller (Handley 1991). Recent specimens of mountain lion taken in North Carolina and elsewhere in mid-Atlantic states have proved to be individuals of other subspecies that have escaped or been released from captivity (Lee 1987; Handley 1991). The eastern cougar requires large tracts of relatively undisturbed habitat that support populations of white-tailed deer (Webster *et al.* 1985). Habitat for this species does not occur on Site. No negative impact to the Eastern Cougar are expected as a result of this project.

Red-cockaded Woodpecker (RCW) - The RCW is a colonial species found in pine forests of the southeastern United States. Primary habitat is southern pine forests consisting of long-leaf

(*Pinus palustris*), slash (*P. elliotii*), pond (*P. serotina*), and loblolly pine species. Traditionally, fire-maintained pine flatwoods or long-leaf pine-dominated savannas have served as nesting and foraging sites. Habitat for this species is lacking on the Site and in the vicinity; and there are no documented RCW colonies on or near the Site. No negative impact to the RCW is anticipated as a result of this project.

Green sea turtle - The green sea turtle is a medium to large turtle 76 to 152 cm (30 to 60 in) long, 100 to 295 kg (220 to 650 lb) in weight with a smooth, heart-shaped shell (Martof *et al.* 1980). It is most commonly found in the Caribbean where it breeds, although individuals, usually immature, are occasionally found along the North Carolina coast. Green sea turtles are omnivorous, primarily eating jellyfish and seaweeds. Preferred nesting habitat is ocean-fronting beaches (Palmer and Braswell 1996). This species is not expected to occur within the Site, and there are no documented sightings of this species near the Site. No negative impact to the green sea turtle is expected as a result of this project.

Leatherback Sea Turtle - The leatherback is a large, heavy turtle with a soft shell and leathery skin. This species is primarily tropical in nature, and occasionally moves into shallow bays, estuaries, and river mouths. Its preferred food is jellyfish, although the diet includes other sea animals and seaweed. The leatherback generally nests on sandy, tropical beaches (Palmer and Braswell 1996). This species is not expected to occur within the Site, and there are no documented sightings of this species near the Site. No negative impact to the leatherback sea turtle is expected as a result of this project.

Seabeach Amaranth - The seabeach amaranth is an annual that grows from seeds germinating from April through July. The plant is sprawling or trailing, and may reach 0.6 m (2 ft) in length. Its leaves are succulent, rounded with an indented tip, and are clustered near the ends of the stem (USFWS 1993). Inconspicuous flowers and fruits are produced in the leaf axil beginning in July and continuing until frost. This species occurs on ocean beaches where its primary habitat consists of overwash flats at accreting ends of islands and lower foredunes and upper strands of non-eroding beaches. Seabeach amaranth appears to be intolerant of competition and does not occur on well-vegetated sites. No negative impacts to Seabeach amaranth are expected as a result of this project.

Rough-leaved Loosestrife - The rough-leaved loosestrife is a rhizomatous perennial herb that often reaches the height of 0.6 m (2 ft). Plants are dormant in the winter, with the first leaves appearing in late March or early April. The triangular leaves typically occur in whorls of 3 or 4. Leaves are typically sessile, entire, 8-10 millimeter (mm) (0.3-0.4 in) wide, broadest at the base, and have three prominent principal veins (Godfrey and Wooten 1981). Five-lobed yellow flowers, approximately 1.5 cm (0.6 in) across, are produced on a loose terminal raceme 3-10

cm (1-4 in) long (Godfrey and Wooten 1981). The rough-leaved loosestrife is endemic to Coastal Plain and Sandhill regions of the Carolinas. Typical habitat of the rough-leaved loosestrife consists of the wet ecotone between longleaf pine savannas and wet, shrubby areas, where lack of canopy vegetation allows abundant sunlight into the herb layer. This species is fire maintained. No populations of loosestrife have been documented near the Site (NHP records), and none were observed during field investigations. No negative impacts to rough-leaved loosestrife are expected as a result of this project.

Cooley's meadowrue - Cooley's meadowrue is a rhizomatous, perennial herb that flowers in June with the fruits maturing in August and September. This species is endemic to the Southeastern U.S. Coastal Plain. Cooley's meadowrue presently is thought to survive only at 11 sites in North Carolina and one site in Florida (FWS 1994). Cooley's meadowrue historically occurred in moist bogs and savannas where fire maintained the habitat at early secondary successional stages. Cooley's meadowrue is now found along utility corridors, roadside margins, or other savanna-like maintained habitats containing suitable hydrology and circumneutral soils. No populations of Cooley's meadowrue have been documented near the Site (NHP records), and none were observed during field investigations. No negative impacts to rough-leaved loosestrife are expected as a result of this project.

Federal Species of Concern (FSC) listed for Onslow County (list date 2 May 1997), their North Carolina status, and an indication of whether potential habitat for each species exists on the Site are listed below.

Species	State	Habitat
Bachman's sparrow (<i>Aimophila aestivalis</i>)	SC	No
Henslow's sparrow (<i>Ammodramus henslowii</i>)	SR	No
Southern hognose snake (<i>Heterodon simus</i>)	SR	No
Black rail (<i>Laterallus jamaicensis</i>)	SR	No
Mimic glass lizard (<i>Ophisaurus mimicus</i>)	SC	No
Eastern painted bunting (<i>Passerina ciris ciris</i>)	SR	Yes
Carolina gopher frog (<i>Rana capito capito</i>)	SC	No
Croatan crayfish (<i>Procambarus plumimanus</i>)	SR	No
Carolina spleenwort (<i>Asplenium heteroresiliens</i>)	E	No
Chapman's sedge (<i>Carex chapmanii</i>)	WL	No
Hirst's panic grass (<i>Dichanthelium</i> sp.)	C/PE	No
Venus flytrap (<i>Dionaea muscipula</i>)	C/SC	No
Pondspice (<i>Litsea aestivalis</i>)	C	No
Boykin's lobelia (<i>Lobelia boykinii</i>)	C	No
Loose watermilfoil (<i>Myriophyllum laxum</i>)	T	No
Savanna cowbane (<i>Oxypolis ternata</i>)	WL	No
Carolina ggrass-of-parnassus (<i>Parnassia caroliniana</i>)	E	No
Awnead meadowbeauty (<i>Rhexia aristosa</i>)	SR	No
Thorn's beaksedge (<i>Rhynchospora thornei</i>)	C/PE	No
Carolina goldenrod (<i>Solidago verna</i>)	E/PT	No
Spring-flowering goldenrod (<i>Solidago verna</i>)	E/PT	No
Carolina asphodel (<i>Tofieldia glabra</i>)	C	No

E - Endangered

SC - Special Concern

WL - Watch List

T - Threatened

C - Candidate

P_ - Proposed _

FSC - Federal Species of Concern

SR - Significantly Rare

State Species

Species of mammals, birds, reptiles, amphibians, and plants with the North Carolina status of Endangered (E), Threatened (T), Special Concern (SC) receive limited protection under the North Carolina Endangered Species Act (G.S. 113-331 *et seq.*) and the North Carolina Plant Protection Act of 1979 (G.S. 106-202.12 *et seq.*). A review of NHP records indicates that no state-listed species are found on the Site.

3.9 Wetlands

Jurisdictional wetland limits are regulated under Section 404 of the Clean Water Act by the COE and under the Coastal Area Management Act (CAMA) by the N.C. Division of Coastal Management (DCM). As stipulated in the 1987 COE wetland delineation manual, the presence of three defined parameters (hydrophytic vegetation, hydric soils, and evidence of wetland hydrology) are required for a wetland jurisdictional determination (DOA 1987). CAMA coastal wetlands are generally defined as marshes subject to diurnal flooding that support specific vegetation.

Field observations indicate sediments comprising the fill are well sorted and relatively uniform-sized sand, suggesting that porosity and hydraulic conductivity are relatively high with conductivity values ranging from 10^{-5} cm/sec to 1^{-1} cm/sec (Fetter, 1980). No evidence of flooding or development of hydric conditions were present in overburden soils. Based upon these observations, it appears that the overburden soils behave like typical, well-sorted sands and drain rapidly. Therefore, it is unlikely wetland hydrology is achieved within the overburden soils. Current conditions indicate that Areas A and B do not support jurisdictional wetlands.

4.0 MITIGATION PLAN

Salt marshes along the coast of North Carolina flourish where the accumulation of sediments is equal to or greater than the rate of land subsidence and there is protection from the destructive energy of waves and storms. Vegetation of these marshes, mainly halophytic grasses and rushes, develops in zones due to physical and chemical variables such as tidal flooding frequency, flooding duration, and soil salinity.

Tidal energy represents the main force in salt marsh ecology which influences a wide range of physiographic, chemical, and biological processes. These processes, in turn, influence the species that occur on the marsh and their productivity (Mitsch and Gosselink 1986). The lower and upper limits of the marsh are set, in part, by tidal amplitude. The lower limit is determined by the depth and duration of flooding (Chapman 1960). The upper limits of the salt marsh usually extend to the limit of flooding on extreme high tides; between mean high water and extreme high water of spring tides (Beefink 1977).

The successful restoration of degraded or obliterated salt marshes will be dependent upon: 1) the restoration of a marsh surface elevation conducive to salt marsh plant survival and the ability to restore wetland hydrology; and 2) the reintroduction of natural emergent vegetation.

The Site presently includes approximately 1.6 ha (3.5 ac) of disturbed land that now supports secondary-growth on fill material. This plan proposes to replacing the pine forest uplands with salt marsh and a salt shrub buffer.

4.1 Reference Marsh Ecosystem

A reference marsh ecosystem (RME) was used to determine vegetation and hydrologic patterns appropriate for on-site restoration of a salt marsh complex. The mitigation area should emulate the RME in soils, hydrology, and vegetation. Relatively undisturbed salt marshes adjacent to the northeast and southwest sections of the Site were selected for reference characterization. Chapman (1960) found that a high marsh is flooded irregularly and has a minimum of at least 10 days of continuous exposure to the atmosphere; an intertidal marsh is flooded daily and has a maximum of nine days of continuous exposure.

The RMEs are characterized as diurnally flooded flats extending from the AIWW shoreline landward to the maritime forest. While the RMEs do not exhibit an obvious gradient, plant species composition indicate high (*Juncus roemareianus*) and intertidal (*Spartina alterniflora*) salt marsh zones with interlacing tidal creeks. Soils of the RMEs are mapped as the Bohicket series which are typical salt marsh soils of the region.

As previously mention, 10 1-m² (10.8-ft²) plots were randomly established for use in determining species composition and percent cover (Figure 3). Importance values (IV) were calculated for encountered species and are presented in Table 1. Importance values are based on a scale of 0-100 percent(%); higher values indicate greater importance to the community. RMEs are dominated by smooth cordgrass (*Spartina alterniflora*, IV = 38%), salt grass (*Distichlis spicata*, IV = 28%), and black needlerush (*Juncus roemerianus*, IV = 27%). Sea oxeve (*Borrchia frutescens*, IV = 4%) occurs in slightly elevated areas and glasswort (*Salicornia europaea*, IV = 5%) is present in shallow, sandy depressions.

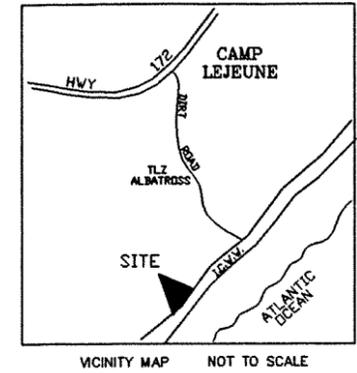
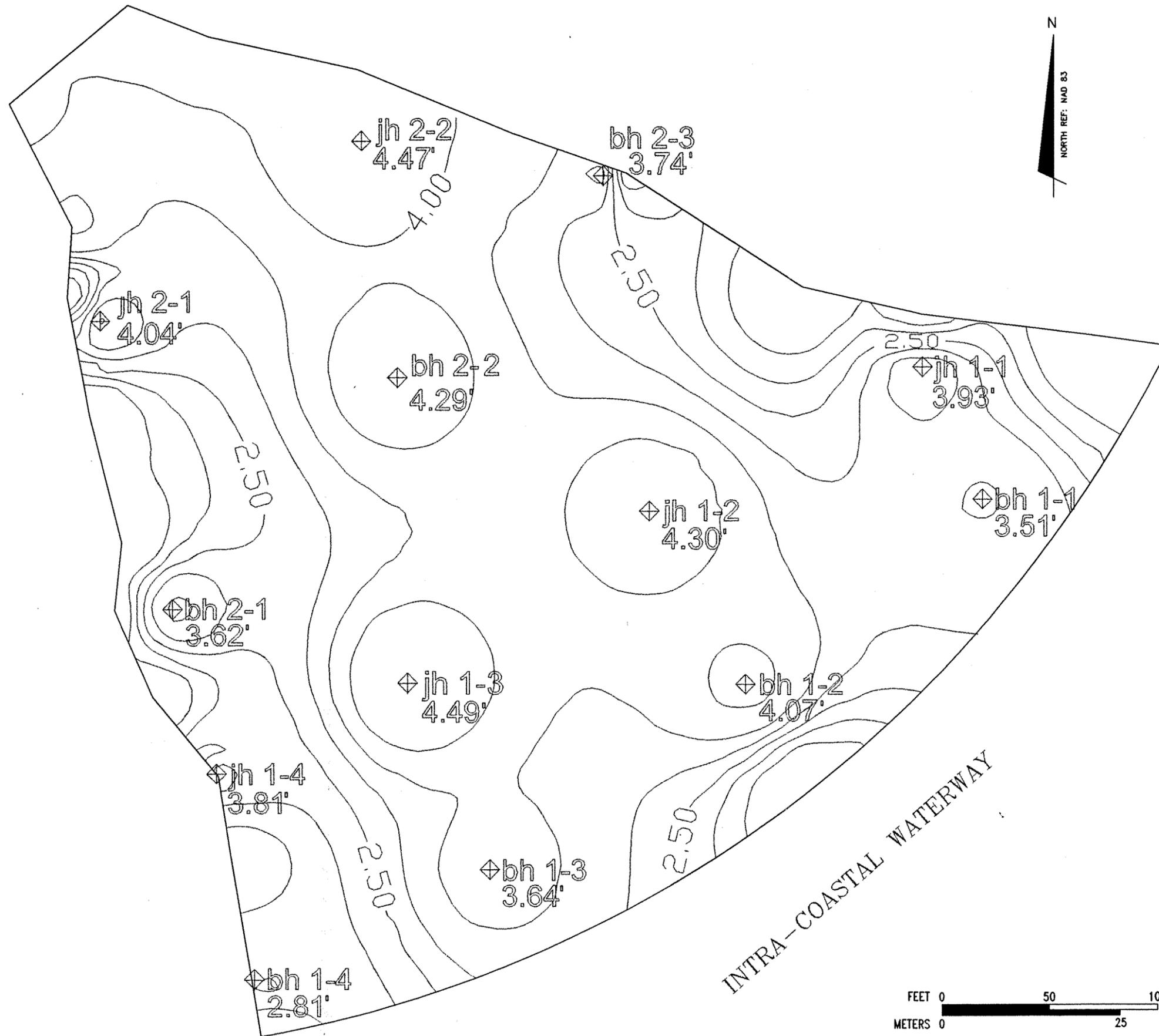
Table 1. Reference Tidal Salt Marsh Vegetation

Species	Frequency	Relative Frequency	Coverage	Relative Coverage	Importance Value (IV) %
<i>Spartina alterniflora</i>	0.6	0.33	34.0	0.43	38
<i>Distichlis spicata</i>	0.5	0.28	22.5	0.28	28
<i>Juncus roemaerianus</i>	0.5	0.28	22.0	0.25	27
<i>Salicornia europaea</i>	0.1	0.06	2.5	0.03	5
<i>Borrchia frutescens</i>	0.1	0.6	0.5	0.01	4

4.2 Hydrology Restoration

Tidal hydrology influences the biological, chemical and physical processes which occur in salt marshes. These processes, in turn, influence the species that occur on the marsh. The lower and upper limits of the marsh are set by tidal range and surface elevation. The lower limit is set by the depth and duration of flooding with the upper limit extending to the limit of flooding on extreme tides.

Approximately 20 years before present, fill material was placed on the Site. The volume of fill was sufficient to prevent tidal flooding of the Site, thereby, transforming the Site from salt marsh to upland. Therefore, in order to restore the Site to historic conditions, tidal hydrology will be re-established through the removal of fill material and surface grading to appropriate contours. The Site will be graded to elevations determined through the use of the adjacent RME. Using data from the soil borings survey, a topographic surface map representing the existing surface and the estimated historical surface of Area A was prepared using SURFER software (Figures 7 and 8). At present, surface elevation averages 2.5 ft above mean sea level (MSL) with hummocks up to 4.3 ft MSL (Figure 7). Historic surface elevation averaged 1.5 ft MSL with an increase to 3.5 ft MSL in the northwest section of the Site at the marsh-maritime forest interface (Figure 8). Figure 9 presents the two surfaces overlain to show the difference in elevations. Based on the difference between the existing ground surface and

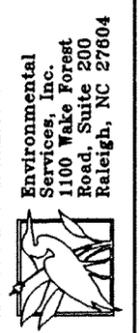
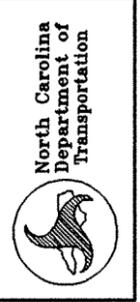
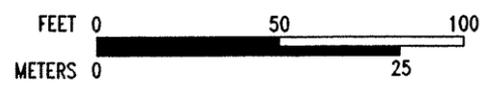


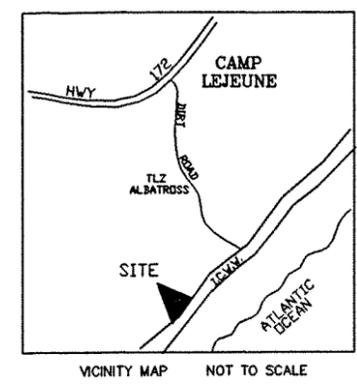
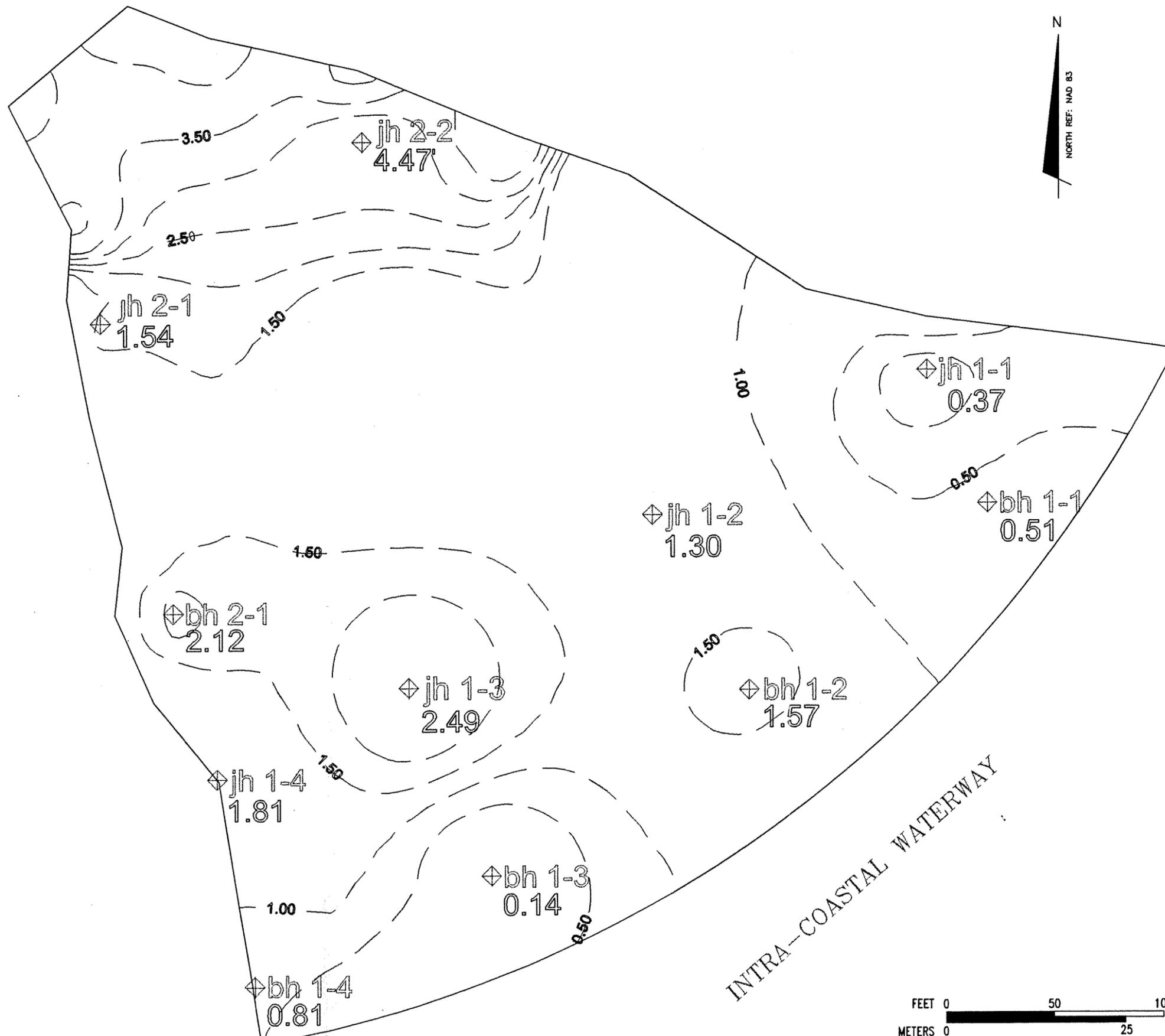
2.50 — Current Surface
 +bh 1-1 3.51 Elevation of Current Surface at Boring Locations

BORE #	NORTH	EAST
JH 2-2	299573	2513834
JH 2-3	299645	2513902
JH 1-1	299470	2514093
BH 1-1	299410	2514121
BH 1-2	299326	2514011
BH 1-3	299242	2513893
BH 1-4	299192	2513784
JH 1-4	299286	2513767
BH 2-1	299361	2513747
JH 2-1	299492	2513714
BH 2-2	299468	2513850
JH 1-2	299405	2513967
JH 1-3	299327	2513855
BH 2-3	299557	2513946

NOTES:
 1. ELEVATIONS BASED ON U.S.M.C. MON "A 14", ELEVATION 14.14 FT. NGVD29 (NATIONAL GEODETIC VERTICAL DATUM 1929)
 2. HORIZONTAL DATUM BASED ON NAD83 (NORTH AMERICAN DATUM 1983).
 3. TBW = R/R SPIKE SET IN 30° PINE LOCATED IN THE NORTHEASTERN MOST CORNER OF SECONDARY LZ. ELEVATION 10.28

CERTIFICATE OF ACCURACY
 THE TRIMBLE PATHFINDER PRO XL AND EXTERNAL ANTENNA WERE USED FOR LOCATING THE BORE SITES AND THE PROJECT LIMITS ON THIS PROJECT. ONLY THE MANUAL 3-D POSITION FIX MODE WAS USED. POSITIONS WERE DIFFERENTIALLY CORRECTED WITH BASE FILES PROVIDED BY THE NORTH CAROLINA GEODETIC SURVEY (NCGS) BY USING THE POST-PROCESSING PROGRAM IN THE PRO XL'S SOFTWARE SUITE. PRINDER, THE NCGS BASE STATION AT WASHINGTON N.C. (LAT: 35-33-39.76910 N, LONG: 77-03-43.46870 W) WAS UTILIZED AND IS LESS THAN 110 KILOMETERS FROM THE SITE. ALL POINTS INCORPORATE AT LEAST 30 THREE DIMENSIONAL POSITION FIXES COLLECTED AT 5 SECOND SYNCHRONOUS READINGS. WITH THE BASE STATION, THE HORIZONTAL ACCURACY FOR THE DIFFERENTIALLY CORRECTED DATA IS 1 METER OR LESS.





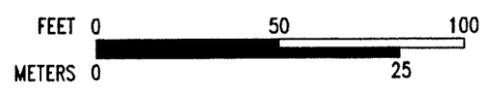
1.00 — Apparent Historical Surface Based Upon Field Data

+bh 1-1 0.51' Elevation of Proposed Surface at Boring Locations

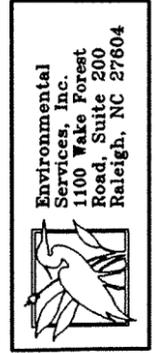
BORE #	NORTH	EAST
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JH 2-3	299645	2513902
JH 1-1	299470	2514093
BH 1-1	299410	2514121
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BH 1-3	299242	2513893
BH 1-4	299192	2513784
JH 1-4	299286	2513767
BH 2-1	299361	2513747
JH 2-1	299492	2513714
BH 2-2	299468	2513850
JH 1-2	299405	2513967
JH 1-3	299327	2513855
BH 2-3	299557	2513946

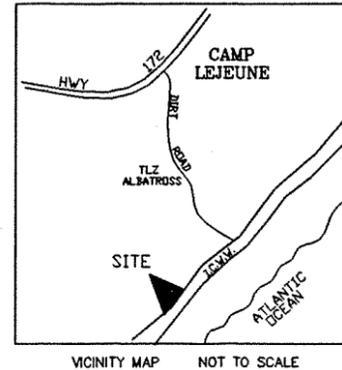
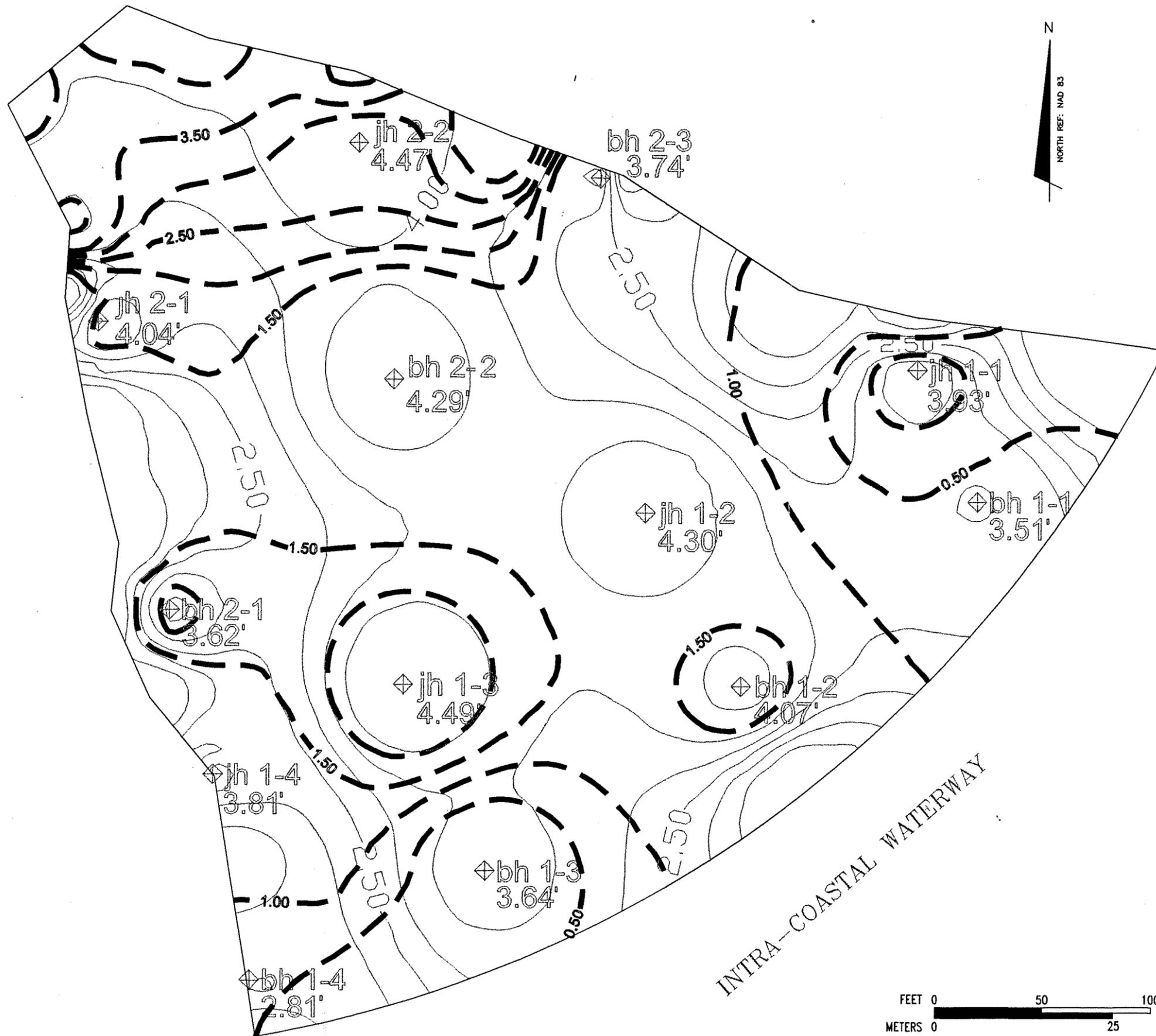
NOTES:
 1. ELEVATIONS BASED ON U.S.M.C. MON "A 14", ELEVATION 14.14 FT. NGVD29 (NATIONAL GEODETIC VERTICAL DATUM 1929).
 2. HORIZONTAL DATUM BASED ON NAD83 (NORTH AMERICAN DATUM 1983).
 3. TBM = R/R SPIKE SET IN 30" PINE LOCATED IN THE NORTHEASTERN MOST CORNER OF SECONDARY LZ. ELEVATION 10.28

CERTIFICATE OF ACCURACY
 THE TRIMBLE PATHFINDER PRO XL AND EXTERNAL ANTENNA WERE USED FOR LOCATING THE BORE SITES AND THE PROJECT LIMITS ON THIS PROJECT. ONLY THE MANUAL 3-D POSITION FIX MODE WAS USED. POSITIONS WERE DIFFERENTIALLY CORRECTED WITH BASE FILES PROVIDED BY THE NORTH CAROLINA GEODETIC SURVEY (NCGS) BY USING THE POST-PROCESSING PROGRAM IN THE PRO XL'S SOFTWARE SUITE, PRINDER. THE NCGS BASE STATION AT WASHINGTON N.C. (LAT: 35-33-39.76910 N, LONG: 77-03-43.46870 W) WAS UTILIZED AND IS LESS THAN 110 KILOMETERS FROM THE SITE. ALL POINTS INCORPORATE AT LEAST 30 THREE DIMENSIONAL POSITION FIXES COLLECTED, AT 5 SECOND SYNCHRONOUS READINGS, WITH THE BASE STATION. THE HORIZONTAL ACCURACY FOR THE DIFFERENTIALLY CORRECTED DATA IS 1 METER OR LESS.



HISTORIC SURFACE TOPOGRAPHY AT AREA A
 ONSLOW COUNTY MARSH SITE
 ONSLOW COUNTY, NORTH CAROLINA
 NCDOT



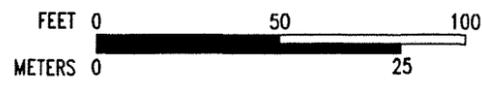


2.50 — Current Surface
 1.00 - - - Proposed Restored Historical Surface

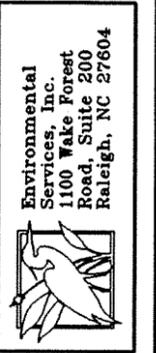
BORE #	NORTH	EAST
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JH 1-3	299327	2513855
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NOTES:
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 2. HORIZONTAL DATUM BASED ON NAD83 (NORTH AMERICAN DATUM 1983).
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CONCEPTUALIZED GRADING PLAN AT AREA A
 ONSLOW COUNTY MARSH SITE
 ONSLOW COUNTY, NORTH CAROLINA
 NCDOT



historical surface, the expected volume of soil to be removed from Area A is approximately 5734 cubic meters (m³) (7,500 cubic yards [CY]).

Soil boring data obtained at Area B were used to prepare a topographic map of the estimated historical land surface (Figure 10). Based upon soil boring data, the expected volume of soil to be removed is approximately 535 m³ (700 CY). Data sheets documenting calculations of the volume of fill to be removed at both Area A and B are included in Appendix A.

Site grading should be conducted in a pattern parallel to the AIWW shoreline to reduce the tendency of erosion channel formation. Grading the Site surface to RME elevations will allow restoration of characteristic tidal salt marsh hydrology. Site hydrology will be dominated by diurnal tides, and to a lesser extent by direct precipitation, runoff from adjacent uplands, and groundwater seepage.

4.3 Soils Modification

A characteristic of tidal salt marsh systems is high silt and organic content in the substrate. Removal of approximately 5869 m³ (8200 CY) of fill material from Areas A and B is expected to expose historic salt marsh sediments that have a higher percentage of silt and organic content. The establishment on Site of a productive emergent vegetation community will insure high seasonal inputs of surface organics.

4.4 Vegetation Restoration

A planting plan is proposed to stabilize the surface with desired tidal salt marsh species after removal of fill material and re-contouring. RME data, on-site observations, and review of available literature, were used to develop the planting plan. Species selected for planting will depend upon the availability of local seed sources at the time of planting. The plan consists of: 1) acquisition of available wetland species; 2) implementation of proposed surface topography improvements; and 3) planting of selected species.

Suggested plant species are listed below:

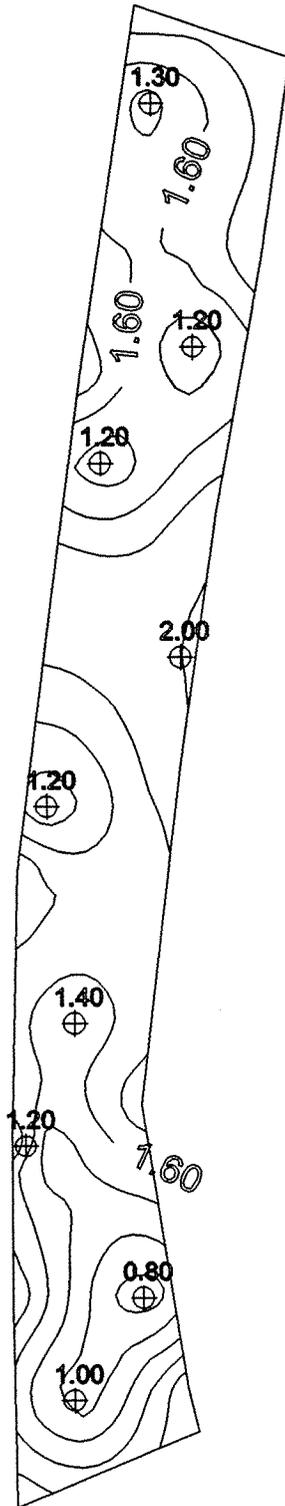
Tidal Salt Marsh

A. Shrub-Marsh Complex

1. False Willow (*Baccharis angustifolia*)
2. Marsh Elder (*Iva frutescens*)
3. Wax Myrtle (*Myrica cerifera*)

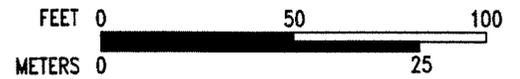
B. High Marsh

1. Black Needlerush (*Juncus roemerianus*)



1.00 Depth to Historical Surface

⊕ Boring Location



Environmental Services, Inc.
1100 Wake Forest Road, Suite 200
Raleigh, NC 27604

Thickness of Fill Material and Proposed Restored Surface - Area B
Marsh Mitigation Site
Onslow County, North Carolina

Figure: 10

Project: ER96021.12

Date: July 1997

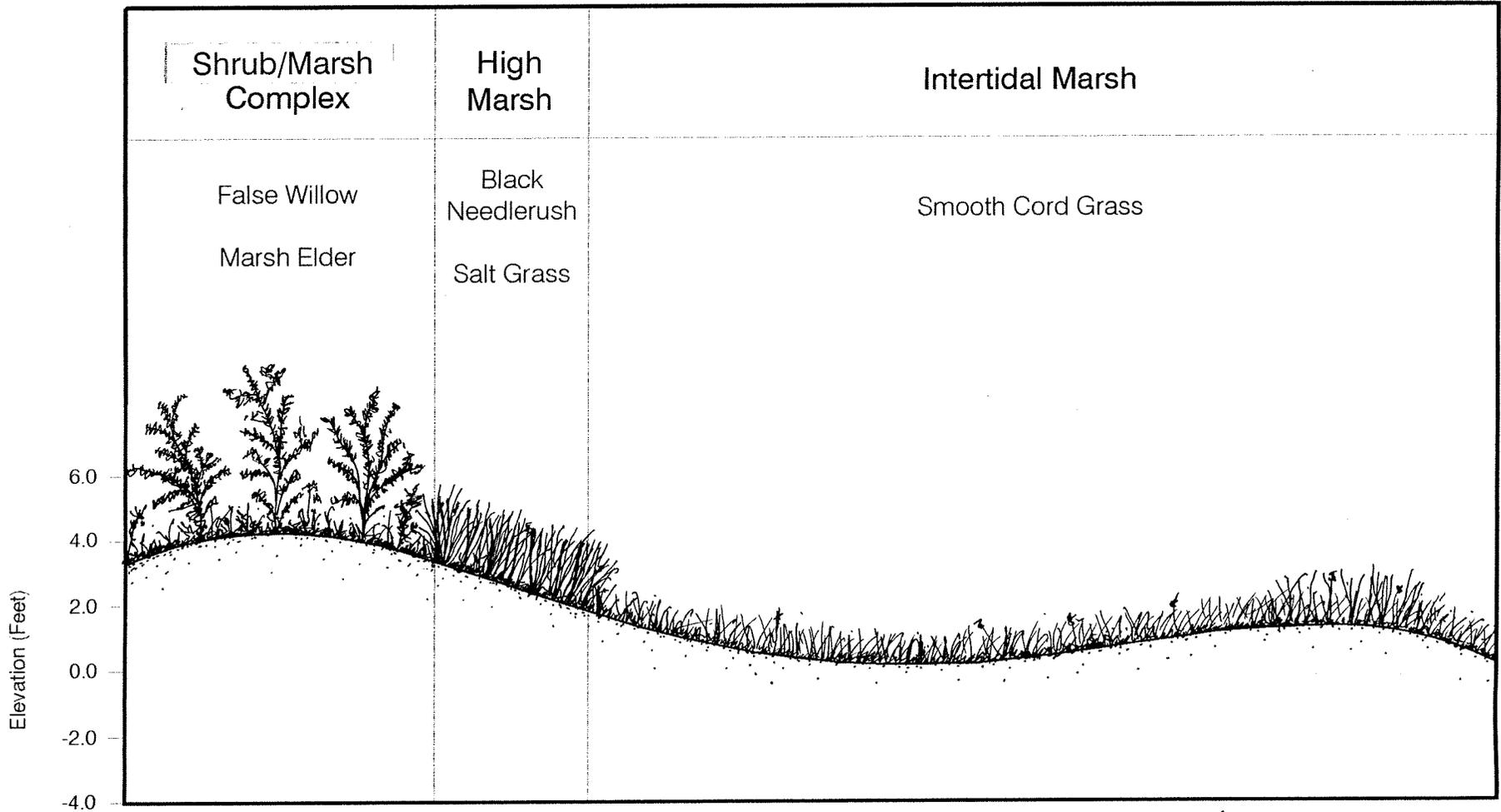
C. Intertidal Marsh

1. Smooth Cordgrass (*Spartina alterniflora*)

It is suggested that bare root or 1-gallon containers of shrub species be planted on 1.5-m (5-ft) centers (705 stem/ha [1,742 stem/ac]) above the 1.0 m (3.5-ft) contour elevation.

Tuber/rhizomes of high marsh species will be planted on 0.9-m (3-ft) centers (1959 stem/ha [4840 stems/acre]) between the 0.6 to 1.0 m (2.0 to 3.5-ft) contour elevations. Intertidal marsh species should be planted as tuber/rhizomes on 0.9-m (3-ft) centers (1959 stems/ha [4840 stem/ac]) below the 0.6-m (2.0-ft) contour (Figure 11). Planting should occur between 1 April and 15 June to avoid adverse climatological conditions of the late winter and early spring and provide seedlings with an entire growing season for establishment.

Wetland Planting Communities



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Raleigh, NC 27604

Planting Plan
Onslow County Marsh Site
Onslow County, North Carolina

Figure: 11

Project: ER96021.12

Date: July 1997

5.0 MONITORING PLAN

Monitoring of wetland restoration efforts will be performed until success criteria are fulfilled. Monitoring is proposed for two wetland components: hydrology and vegetation.

5.1 Hydrology

A surficial hydrology monitoring network of wells will be installed at the conclusion of Site hydrological modifications. The monitoring wells will be designed and placed in accordance with specifications in the COE's *Installing Monitoring Wells/Peizometers in Wetlands* (WRP Technical Note HY-IA-3.1, August 1993). The network will utilize RDS WL-80 continuous monitoring wells. These wells can continuously record water levels along a 2.0-m (80-inch) vertical gradient. Two wells are proposed for Area A, two wells are proposed for Area B, and three comparable wells are proposed for the RME (Figure 12).

RDS WL-80 wells will be installed to a depth no greater than 0.5 m (20 inches) below the ground surface. These wells will record water levels from a depth of 0.5 m (20 inches) below the ground surface to an elevation of approximately 1.5 m (60 inches) above the ground surface. These wells will be supported by 4 in x 4 in wooden posts for protection from floating debris and wave energy. "Tall" wells have been proposed in anticipation of significant surface water levels on a periodic basis; inundation of the top of these wells may result in malfunction and data loss.

5.1.1 Monitoring

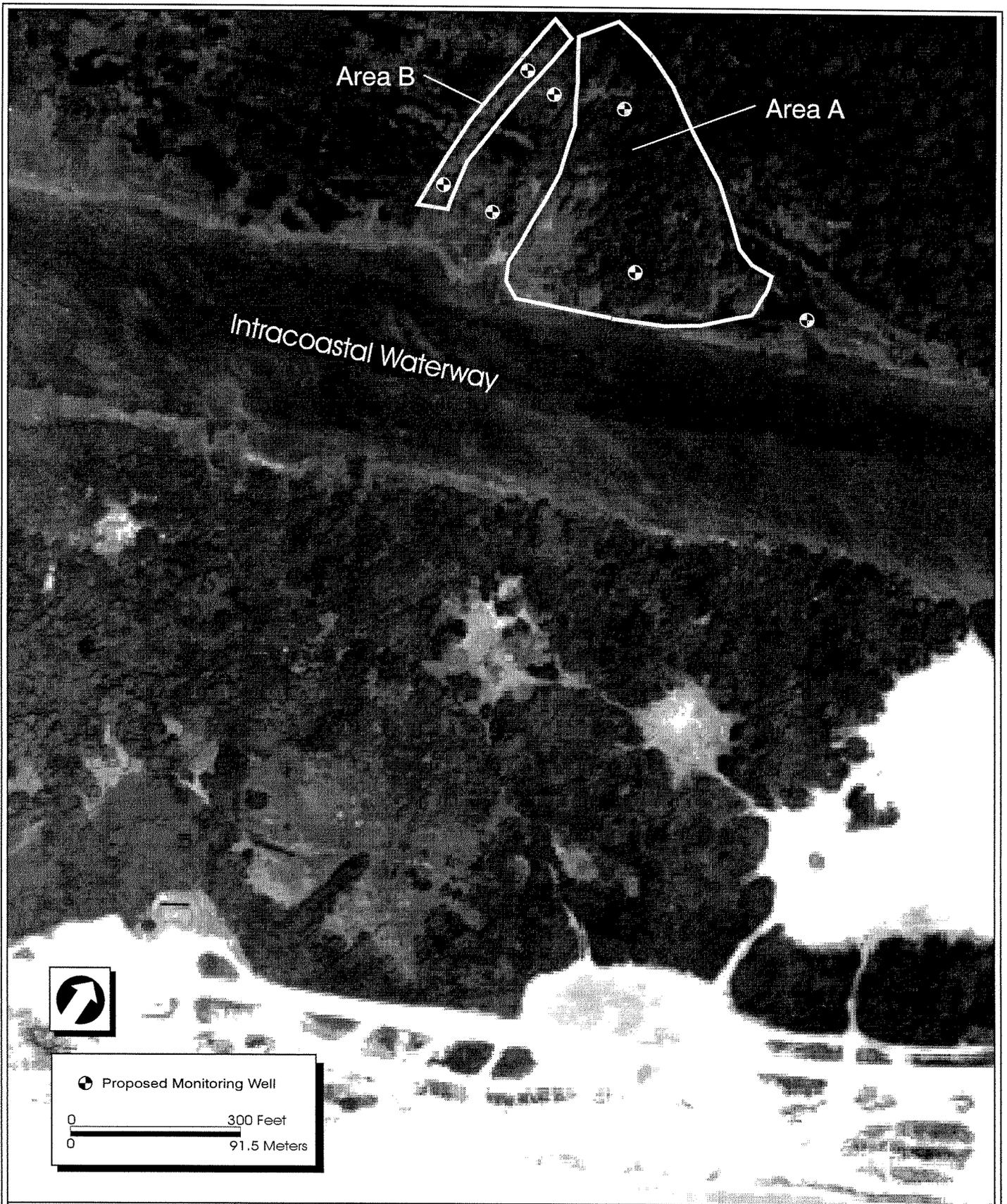
Continuous monitoring wells will be adjusted to record water levels at 6-hour intervals. The continuous monitoring wells will be in operation throughout the year, and data will be downloaded at intervals (1) sufficient to insure proper operation and maintenance of the hardware and (2) necessary to satisfy the established hydrology success criteria (EPA 1990).

5.1.2 Success Criteria

Hydrological success criteria will include the recorded presence of similar water-level elevations and flood durations within the mitigation area as compared with the RME. Recorded hydrological data will be analyzed at the end of the first growing season; if success is in doubt, corrective measures such as grading may be necessary.

5.2 Vegetation

Restoration monitoring procedures for vegetation are designed in accordance with EPA guidelines enumerated in Mitigation Site Type (MiST) documentation (EPA 1990). A general discussion of the restoration monitoring plan is provided.



 Proposed Monitoring Well

0 ————— 300 Feet
 0 ————— 91.5 Meters



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 Services, Inc.
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 Road, Suite 200
 Raleigh, NC 27604

Proposed Monitoring Well Locations
 Marsh Mitigation Site
 Onslow County, North Carolina

Figure:	12
Project:	ER96021.12
Date:	July 1997

5.2.1 Monitoring

After planting has been completed, an initial evaluation will be performed to verify planting methods and to determine initial species composition and density. Supplemental planting and additional site modification will be implemented, if necessary. Permanent photography stations will be established at selected vantage points to provide a visual record of vegetation development over time.

During the first year, beginning approximately 4 to 6 weeks after planting, the Site will receive cursory visual evaluation to ascertain the extent of mortality of transplanted species and the presence of nuisance species. Subsequently, quantitative sampling of vegetation will be performed between August 1 and September 30 after each growing season until vegetation success criteria is achieved.

During quantitative vegetation sampling in the early fall of the first year 1.0 meter square (10.8 feet square) quadrants will be established and permanently located within the mitigation area and the RME. The monitoring plots will be located to provide representative samples of the restoration area and RME. Vegetation monitoring plots will be correlated with hydrological monitoring sites to allow for point-source data of hydrologic and vegetation parameters.

5.2.2 Success Criteria

Success criteria have been established to verify that the mitigation areas support vegetation necessary for a jurisdictional determination. Additional success criteria are dependent upon the density and growth of characteristic species. The percent cover characteristic of the RME must be surviving for at least 3 years after initial planting. Characteristic species are those elements enumerated in the planting plan along with natural recruitment. Supplemental plantings will be undertaken as needed to achieve the vegetation success criteria within the mitigation areas.

5.3 Report Submittal

An "as built" report will be generated after completion of planting that includes: a plan view of the Site, final elevations, photographs, monitoring well locations, vegetation monitoring quadrant locations, and a description of initial plantings by quadrat. A discussion of the planting design, including species planted, species densities, and number of stems planted will be included. The report will be provided within 90 days of completion of planting and monitoring well installation.

Mitigation status reports will be submitted annually to appropriate permitting agencies following each assessment. Submitted reports will include: sample plot data, well data (if applicable), and a discussion of problems and proposed solutions. The duration of wetland

hydrology during the growing season will also be calculated at each monitoring well location and extrapolated to the entire Site. Mortality and density of planted stock will be reported.

5.4 Contingency

In the event that vegetation or hydrology success criteria are not fulfilled, a mechanism for contingency will be implemented. For the vegetation contingency, additional planting and extended monitoring periods will be implemented if community restoration does not fulfill minimum species density and distribution requirements.

Hydrological contingency will require consultation with hydrologists in the event that wetland hydrology restoration is not achieved during the monitoring period. Recommendations for contingency to establish wetland hydrology will be implemented and monitored until the Hydrology Success Criteria are achieved.

6.0 DISPENSATION OF PROPERTY

NCDOT will be responsible for ensuring that all mitigation activities are completed and the Site is determined successful. It is anticipated that the U.S. Department of Defense will protect and manage the Site in perpetuity.

7.0 MITIGATION VALUE

The proposed mitigation Site consists of 1.6 ha (3.5 ac) of filled land which presently support a monotypic mixed-age pine forest and coastal shrub community. Fill material exist to a depth of 1.4 m (4.5 ft) and consists of slightly clayey to silty, very fine to fine sand. The fill material has eliminated the influence of tidal flow across the sites.

7.1 Pre-Mitigation Wetland Functions

The Site currently contains no jurisdictional wetlands due to fill material being placed on historic tidal salt marsh. Under existing land uses, no wetland functions occur on the Site.

The floral and fauna populations characteristic of the tidal salt marsh landscape setting have been replaced on Site with a monotypic stand of loblolly pine and invasive species. Currently the Site acts as an upland obstacle to many mobile aquatic and semi-aquatic fauna.

7.2 Post-Mitigation Wetland Functions

Wetland mitigation plans have been designed to restore on-site tidal salt marsh wetland features and functions. After implementation, the Site is expected to support approximately 1.6 ha (3.5 ac) of diurnal-flooded salt marsh wetlands.

Proposed alterations are expected to result in near-surface and above-surface hydrodynamics throughout the Site. The transformation from fill land to tidal salt marsh wetlands will restore wetland biochemical functions such as biological fixing of carbon, export of organic sediments to the estuary, retention of particulates, removal of elements and compounds, and nutrient cycling. The restoration of a tidal salt marsh adjacent to the AIWW will increase the capacity of area wetlands to support characteristic floral and faunal communities, and will enhance and protect water quality.

Biotic functions potentially restored within the Site include maintenance of habitat for certain aquatic and semi-aquatic wildlife guilds, as well as bird species that nest in marsh environments. These wetland interactions are considerably absent within the Site due to the presence of fill material. An increase in area of marsh along this shoreline due to restoration will provide more opportunities in terms of aquatic nursery areas than are presently unavailable.

Based on model results, the removal of 6269 m³ 8200 CY of fill material will restore historic surface contours consistent with the contours of the adjoining RME. The historic surface will provide a soil and hydrological environment conducive to salt marsh restoration. Re-vegetation

of the mitigation site with plant species identified within the RME will facilitate development of a typical tidal salt marsh community.

Restoration of this Site will promote local tidal salt marsh diversity through the re-establishment of lost physical, chemical, and biological wetland functions.

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APPENDIX

VOLUME COMPUTATIONS for Site A

UPPER SURFACE

Grid File: C:/EXCEL/LEJUNE.GRD
Rows: 0 to 32766
Cols: 0 to 32766
Grid size as read: 50 cols by 45 rows
Delta X: 11.0204
Delta Y: 10.8864
X-Range: 2.51367E+006 to 2.51421E+006
Y-Range: 299166 to 299645
Z-Range: 1.00138 to 4.4894

LOWER SURFACE

Grid File: C:/EXCEL/OLDSURF.GRD
Rows: 0 to 32766
Cols: 0 to 32766
Grid size as read: 50 cols by 45 rows
Delta X: 11.0204
Delta Y: 10.8864
X-Range: 2.51367E+006 to 2.51421E+006
Y-Range: 299166 to 299645
Z-Range: -0.360531 to 4.1

VOLUMES

Approximated Volume by
Trapezoidal Rule: 206333
Simpson's Rule: 206039
Simpson's 3/8 Rule: 206626

CUT & FILL VOLUMES

Positive Volume [Cuts]: 206333
Negative Volume [Fills]: 0
Cuts minus Fills: 206333 (7642 c.y.)

AREAS

Positive Planar Area
(Upper above Lower): 117753
Negative Planar Area
(Lower above Upper): 0
Blanked Planar Area: 140907
Total Planar Area: 258660

Positive Surface Area
(Upper above Lower): 117832
Negative Surface Area
(Lower above Upper): 0

VOLUME COMPUTATIONS for site B

UPPER SURFACE

Level Surface defined by $Z = 0$

LOWER SURFACE

Grid File: C:/EXCEL/ONSLOW/CAUSWY2.GRD

Rows: 0 to 32766

Cols: 0 to 32766

Grid size as read: 7 cols by 50 rows

Delta X: 7.4646

Delta Y: 6.86741

X-Range: -86.8656 to -42.078

Y-Range: -205.961 to 130.542

Z-Range: -1.96979 to -0.808773

VOLUMES

Approximated Volume by

Trapezoidal Rule: 19342.8

Simpson's Rule: 19341

Simpson's 3/8 Rule: 19340.9

CUT & FILL VOLUMES

Positive Volume [Cuts]: 19342.1

Negative Volume [Fills]: 0

Cuts minus Fills: 19342.1 (716.4 c.y.)

AREAS

Positive Planar Area

(Upper above Lower): 15071.2

Negative Planar Area

(Lower above Upper): 0

Blanked Planar Area: 0

Total Planar Area: 15071.2

Positive Surface Area

(Upper above Lower): 15071.7

Negative Surface Area

(Lower above Upper): 0