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343SERBSF10,619

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State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Solid Waste Management

James B. Hunt, Jr., Governor
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DEHNR

January 31, 1995

Ms. Cynthia Gurley
NC CERCLA Project Officer
EPA Region IV Waste Division
345 Courtland Street, NE
Atlanta, Georgia 30365

Subject: Site Inspection Prioritization
Southern Wood Piedmont Co.
Wilmington, New Hanover County, NC
NCD 058 517 467

Dear Ms. Gurley:

The enclosed document summarizes the results of a Site Inspection Prioritization (SIP) of the Southern Wood Piedmont Co. site in Wilmington, NC. This site, owned by the City of Wilmington and the NC State Ports Authority, was formerly used to treat and store wood products. Wood treating materials historically used at the site included creosote and, more recently, pentachlorophenol (PCP) and chromated copper arsenate (CCA). During the mid-to-late 1980s, SWP excavated and landfarmed creosote-contaminated soils from various on-site locations. CCA-contaminated soil either was stabilized onsite or was shipped to a hazardous waste landfill. The landfarming operation concluded in April 1990.

Results of previous investigations at the site indicate detectable soil and groundwater contamination throughout much of the site. The principal contaminants are semi-volatile organic compounds (SVOCs), with traces of volatile aromatic compounds, both of which are associated with creosote. Localized PCP and CCA contamination has also been detected. The areas of contamination include former creosote and CCA storage and treatment areas, outdoor wood storage areas, and a former drainage ditch. The visibly creosote-contaminated soils in these areas were landfarmed in the northern half of the site, where they currently remain as an additional contaminant source.

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Two sand units directly beneath the site are known to be contaminated by organic and (locally) inorganic wood preserving residuals. These overburden units not used as a drinking water source. The underlying sandy limestone bedrock is a principal confined aquifer in the area, and a second, semi-confined bedrock aquifer to the southeast has been used historically for drinking water, however, most groundwater use in the study area occurs more than 2 miles from the site.

SVOCs attributable to the site have contaminated sediment in an existing drainage ditch and in Greenfield Creek, which connects the ditch to the Cape Fear River. The contaminated sediment samples were located downstream of wetland frontage along the ditch. Surface water has not been sampled in the ditch or Greenfield Creek. To date, no surface water contaminants have been detected in Cape Fear River water, but semi-volatile contaminants were detected adjacent to the site when river sediment was last sampled in 1985. Two other possible sources of semi-volatile contaminants have been identified over 0.5 mile upstream of the site. The Greenfield Creek contaminants, however, are at least partially attributable to the site.

Because of extensive tidal flow reversal in the Cape Fear River and its tributaries, the surface water pathway theoretically extends 15 miles both upstream and downstream from the site. The potential for contaminant transport upstream from the site may be limited, however, by the net seaward transport of sediment in the estuary.

No drinking-water-supply intakes reportedly operate in the pathway, but the Cape Fear and the Northeast Cape Fear River systems are commercial and recreational fisheries. As defined in the SIP, the surface water pathway (including tidal tributaries) contains 170 miles of mapped wetland frontage. Wetlands adjacent to the site are within the downstream limits of detected SVOC contamination. Eleven rare animal and 9 rare plant species are identified within the pathway. Three of the animal species are listed as Endangered in NC and/or the US. One animal and 2 plant species are Threatened in NC and/or the US.

Landfarm soils contain residual creosote components, some exceeding their current health-based Cancer Risk Screening Concentrations for human soil exposure. Soil sampling in the former wood storage areas also detected organic and arsenic contamination at levels above Cancer Risk Screening Concentrations. The landfarm area soils also contained detectable polychlorinated dibenzodioxins and dibenzofurans, but soils outside the landfarming areas have not been tested for these two groups of compounds.

The site is accessible on foot or by boat, but has no residential or worker populations. The nearest residences are 400 feet east of the site. No schools or day care facilities are present within 0.2 mile of the site. A railroad grade and dense vegetation separate the site from a nearby recreational park. Surface soil at the site is currently stabilized by vegetation.

Under present circumstances, the site appears to pose a minimal health hazard via soil or by migration of contaminant through air. A Risk Assessment completed at the site concluded that contaminant levels at the site are low enough for future industrial use. Based on the Risk Assessment report, however, the NC Environmental Epidemiology Section has concluded that the site does not currently meet cleanup standards for future residential use, and may pose an increased cancer risk to future workers.

In summary, cumulative evidence indicates that creosote residuals attributable to the site have contaminated downstream wetlands, and possibly a fishery. Dioxins and halogenated dibenzofurans have been detected in the landfarmed soils, but the extent of contamination has not been determined for the remainder of the site. Based on this information, the Southern Wood Piedmont - Wilmington site is recommended as a high priority for an expanded Site Inspection under CERCLA. Additional testing of soil, surface water, and sediment for organic and inorganic wood preservative components, as well as for dioxins and halogenated dibenzofurans, is recommended to evaluate the site's likely impact on public health and the environment. If you have any questions, please contact me at (919) 733-2801

Sincerely,

Stuart F. Parker, Jr.
Hydrogeologist,
NC Superfund Section

STATE OF NORTH CAROLINA

Department of Environment, Health, and Natural Resources
Division of Solid Waste Management
Superfund Section

SITE INSPECTION PRIORITIZATION

Southern Wood Piedmont Company
NCD 058 517 467
Wilmington, New Hanover County, North Carolina
Reference No. 02821

January 1995

Stuart Parker, Hydrogeologist
Division of Solid Waste Management
Superfund Section

SITE INSPECTION PRIORITIZATION

Southern Wood Piedmont Company
NCD 058 517 467
Wilmington, New Hanover County, North Carolina

January 1995

Superfund Section
Division of Solid Waste Management
North Carolina Department of Environment, Health
and Natural Resources

Prepared by:

Stuart Parker
Hydrogeologist

Reviewed by:

Pat DeRosa
CERCLA Branch Head

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EXECUTIVE SUMMARY

The Southern Wood Piedmont, Wilmington site, owned by the City of Wilmington and the NC State Ports Authority, was used from 1935 to 1983 to treat and store wood products. Wood treating materials historically used at the site included creosote and, more recently, pentachlorophenol (PCP) and chromated copper arsenate (CCA).

During the mid-to-late 1980s SWP excavated and landfarmed large quantities of contaminated soils from various locations at the site. Much of the soil came from a buried, creosote-contaminated ditch in the southeast part of the site. Visibly discolored soils were stockpiled and then landfarmed on 5 acres of the northern half of the site. Based on arsenic content, CCA-contaminated soils were either stabilized onsite with cement or were shipped to a hazardous waste landfill. Sandy clay from offsite was used to backfill the excavated areas. Excavation and landfarming ended in April 1990.

Investigations completed on site between 1985 and 1993 have documented contamination of surface and subsurface soil and groundwater at the site by wood-treating compounds. Subsurface exploration has revealed both non-aqueous and aqueous phase semi-volatile organic compounds (SVOCs) in groundwater and soils beneath much of the site. Aqueous contaminants in a sandy water-table aquifer beneath the site have migrated through a peat layer and contaminated a deeper, semiconfined sand unit. PCP has not been detected in the groundwater, however, and elevated inorganics have been identified only in monitoring wells adjacent to a former CCA storage area. The contamination appears to have originated at the site's former wood treating areas and at a buried creosote-contaminated ditch at the site. Sampling results do not indicate that contaminants in the site's 5-acre landfarm have migrated to groundwater.

Neither of the contaminated sand units is used as a drinking water source. This overburden is separated from bedrock by a tight, apparently continuous clay layer over 2 feet thick. The sandy limestone formation beneath the clay is a principal aquifer in the region. No groundwater samples were collected from this aquifer, however, groundwater use is very limited within 2 miles of the site.

The site drains to the Cape Fear River directly and via a drainage ditch and Greenfield Creek. Sediment samples collected from the upper end of the ditch and the lower end of the creek contained most of the same SVOCs detected onsite. The detection of tetra- and pentacyclic SVOCs suggests that the contaminant is creosote rather than refined fuel. No surface water samples have been collected in this segment of the pathway. To date, no SVOCs from the site have been detected in Cape Fear River water, however, Cape Fear River sediment adjacent to the site was sampled in 1985 and found to be contaminated with creosote components. Additional potential sources for semi-volatiles exist within 0.7 mile upstream of the site, but the Greenfield Creek contamination is at least partially attributable to the site.

The Cape Fear River and its tributaries, including the Northeast Cape Fear River, undergo tidal flow reversal for more than 15 miles upstream of the site. No surface water intakes for public supply operate within 15 miles upstream or downstream of the site. Wilmington's municipal supply source is a surface water intake located several miles upstream of the pathway.

State Fisheries officials report that both the Cape Fear River and the Northeast Cape Fear River are commercial and sport fisheries. Marine Fisheries officials report that the Cape Fear River at Wilmington is a nursery for commercially harvested blue crab, eel, and shrimp.

An approximately 2300 foot frontage of wetland is mapped along the drainage ditch linking the site to Greenfield Creek. Sediment contamination detected in the creek extends beyond the wetland interval. The Cape Fear River system contains approximately 170 miles of additional mapped wetland frontage within 15 miles upstream and downstream of the site. The Natural Heritage Foundation has identified 10 rare animal and 8 rare plant species within the surface water pathway. Three of the animal species are listed as Endangered in NC and/or the US. One animal and 2 plant species are listed as Threatened.

Landfarm soil samples collected in 1990 and 1991 contained residual creosote contamination. In some samples, benzo(a)pyrene and PCP concentrations exceeded their current health-based Cancer Risk Screening Concentrations for human soil exposure. Various dioxins and chlorodibenzofurans were detected in the landfarm areas, also above their benchmarks, however there is some uncertainty in their quantitation. No other dioxin testing has been performed at the site or at any of the off-site sample locations .

Soil sampling in 1991 detected SVOCs in areas which were formerly used for outdoor storage of treated and non-treated wood (TWS, NTA, NTB), but which were never excavated or landfarmed. Benzo(a)pyrene exceeded its Cancer Risk Screening Concentration in these areas as well. All other SVOCs were below their respective benchmarks, but arsenic was detected at elevated levels which exceeded its soil exposure benchmark.

The site is currently uninhabited, but is secured only by a vehicle gate at the entrance, and is accessible by foot or by boat. The nearest residences are located approximately 400 feet east of the site. The nearest school is located 0.45 mile south of the site. The nearest day care facilities are on South 2nd Street, at least 0.2 mile east of the site. A sports field is located directly southeast of the site, but is separated from the site by a railroad grade, by thick vegetation, and by the existing on-site drainage ditch.

A Risk Assessment completed at the site indicated that contaminant levels and exposure levels at the site are low enough for future industrial land use. Based on the Risk Assessment report, however, the NC Environmental Epidemiology Section has indicated that the site does not currently meet cleanup standards for future residential use, and may pose a threat to future on-site employees.

In summary, extensive shallow groundwater contamination has occurred at the site, but does not appear to threaten any drinking water supplies. The likelihood of human exposure to contaminated on-site soil or to contaminants migrating through air is limited by current surface conditions and the lack of an on-site residential or worker population. Semi-volatile organic soil contaminants at the site have apparently migrated to a section of the adjacent surface water pathway containing mapped wetlands. Sampling performed in recent years is insufficient to determine whether sediment contamination has spread to the nearby Cape Fear River, which contains additional wetlands, several rare plant and animal species, fisheries, and a nursery for human food chain organisms. Dioxins and dibenzofurans have been detected in landfarmed soils at the site, but have not been tested elsewhere at the site.

1.0 INTRODUCTION

Under authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the North Carolina Superfund Section conducted a Site Inspection Prioritization (SIP) at the Southern Wood Piedmont site in Wilmington, New Hanover County, NC. The purpose of this investigation was to collect information concerning conditions at the Southern Wood Piedmont site sufficient to assess the threat posed to human health and the environment, and to determine the need for additional investigation under CERCLA or other authority.

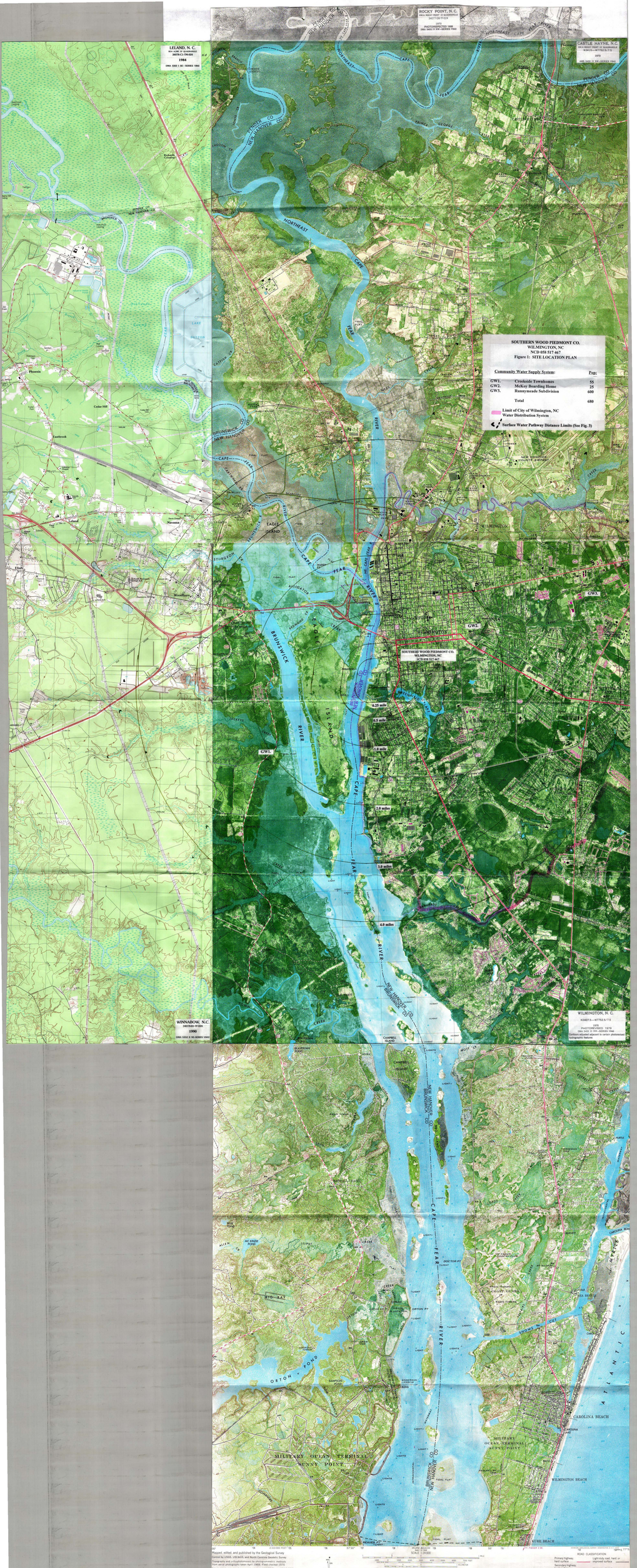
This investigation supplements a Preliminary Assessment (PA) and the Screening Site Investigation (SSI), completed in July 1984 and April 1986, respectively. The scope of this investigation included a file review, and the examination of available analytical data. Waste and environmental media sampling was conducted by Geraghty & Miller in 1990 and 1991, and groundwater, surface water, soil and sediment sampling was conducted by ETE/Virogroup between 1992 and 1994. This report summarizes the findings of the previously completed studies, and updates information on offsite conditions and resource use, in order to satisfy present Hazard Ranking System (HRS) requirements, to test previous conclusions regarding the site, and to document Hazard Ranking System (HRS) factor values and scoring.

2.0 SITE DESCRIPTION

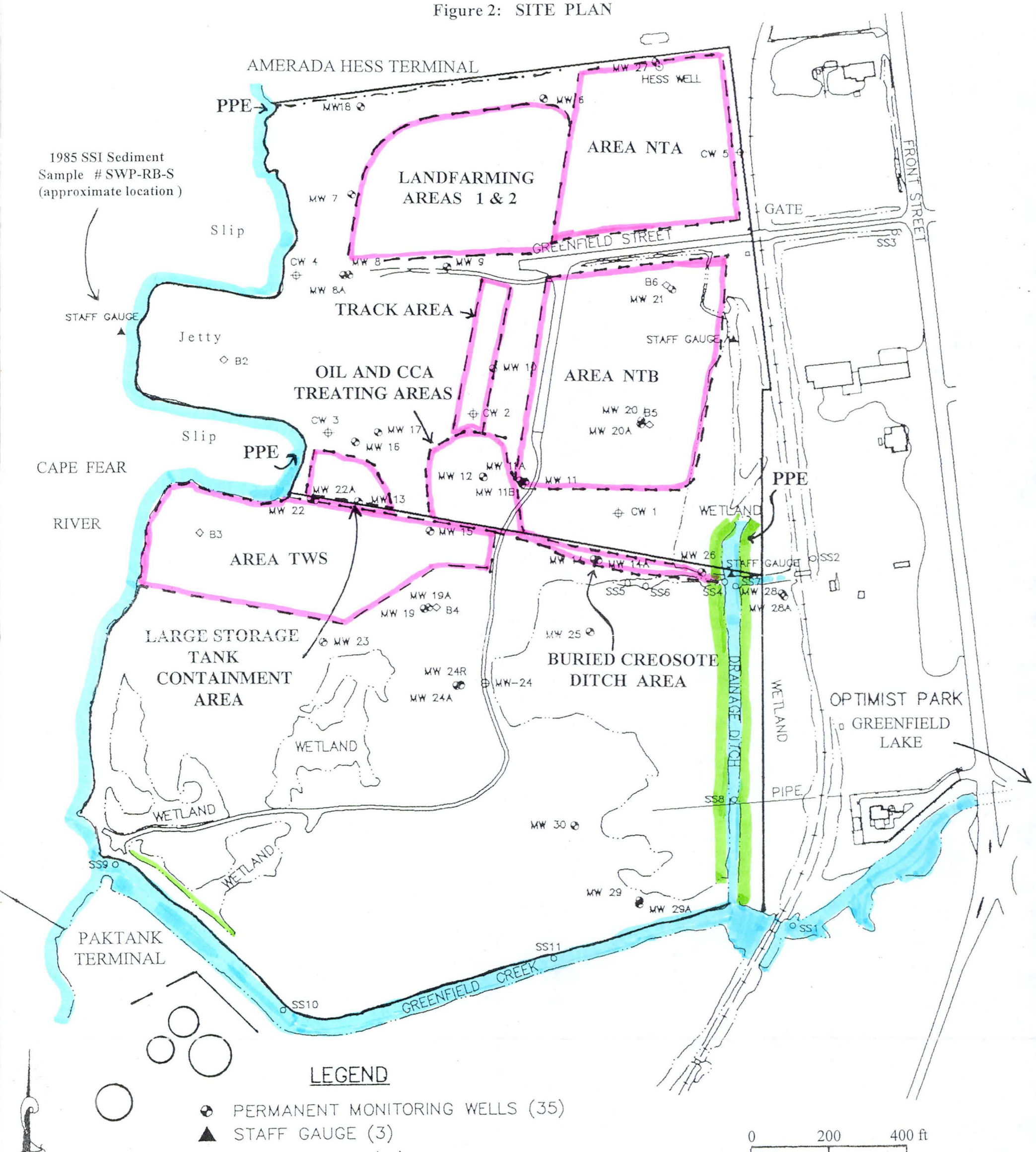
2.1 Site Location

The Southern Wood Piedmont, Wilmington site is located on Greenfield Street in downtown Wilmington, New Hanover County, North Carolina (Ref. 1; Fig. 1). The geographic coordinates of the site are 34° 12' 55" N latitude and 77° 57' 1.5" W longitude (Ref. 2). To access the site from Raleigh, NC, travel southeast on I-40 to US 117. Follow 117 south to 3rd Street and continue south approximately 2 miles. The site is located on the Cape Fear River waterfront at the end of Greenfield Street, 4 blocks west of 3rd Street. (Figs. 1-2).

The climate in the Wilmington area is classified as subtropical and is influenced by proximity to the ocean. Winters are mild, with an average January temperature in excess of 48 F. . Summers are hot and humid with an average July temperature in excess of 80 F (Ref. 3, p. 94, p. 98). Mean annual precipitation is 51 inches and mean annual lake evaporation is 42 inches, therefore, net precipitation for the area is 9 inches per year (Ref. 4). The 2-year, 24-hour rainfall in the study area is 5.0 inches (Ref. 55).


ROCKY POINT, N.C.
34077-G8-TF-024
1970
PHOTOREVISED 1978
DMA 6652 II SW—SERIES V882
LELAND, N.C.
34078-C1-TM-024
1984
DMA 6552 I SE—SERIES V882
CASTLE HAYNE, N.C.
34077-G7-TF-024
1970
PHOTOREVISED 1978
DMA 6652 II SW—SERIES V882
WINNABOW, N.C.
34077-B8-TF-024
1990
DMA 6552 II NE—SERIES V882
WILMINGTON, N.C.
34077-A8-TF-024
1970
PHOTOREVISED 1979
DMA 6652 II SW—SERIES V882
Contours adjusted adjacent to certain photomapped hydrographic features
SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC
NCD 058 517 467
Figure 1: SITE LOCATION PLAN
Community Water Supply System: Pop:
GW1. Creekside Townhomes 55
GW2. McKoy Boarding Home 25
GW3. Runnymeade Subdivision 600
Total 680
Limit of City of Wilmington, NC Water Distribution System
Surface Water Pathway Distance Limits (See Fig. 3)
SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC
NCD 058 517 467
0.25 mile
0.5 mile
1.0 mile
2.0 mile
3.0 mile
4.0 mile
GW1.
GW2.
GW3.
CAPE FEAR RIVER
BRUNSWICK RIVER
EAGLE ISLAND
CAMPBELL ISLAND
MILITARY OCEAN TERMINAL SUNNY POINT
ORTON POND
CAROLINA BEACH
WILMINGTON BEACH
KURE BEACH
ATLANTIC OCEAN
NEW HANOVER CO.
BRUNSWICK CO.
Mapped, edited, and published by the Geological Survey
Control by USGS, USC&GS, and North Carolina Geodetic Survey
Topography and orthophotomosaic by photogrammetric methods from aerial photographs taken April 1969. Field checked 1970
Selected hydrographic data compiled from USC&GS Charts 826 (1970), 829 (1967) and 2108 (1969). This information is not intended for navigational purposes
Horizontal control datum 1927 North American datum
10,000-foot grid based on North Carolina coordinate system
1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue
SCALE 1:24 000
CONTOUR INTERVAL 5 FEET
DOTTED LINES REPRESENT 1-FOOT CONTOURS
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
Primary highway, hard surface
Light-duty road, hard or improved surface
Secondary highway, hard surface
Unimproved road
Trails
Interstate Route
U. S. Route
State Route
CAROLINA BEACH, N.C.
34077-A8-TF-024
1970
ARS 5652 II SW-SERIES V882

SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC
NCD 058 517 467
Figure 2: SITE PLAN



1. This figure was adapted from Figs. 3 & 4 of Virogroup,s Report on Phase III Groundwater Quality, Assessment, SWP Wilmington (Ref. 7).

2. No sampling was conducted during the NC Superfund Section's Site Inspection Prioritization.

2.2 Site Description

The Southern Wood Piedmont (SWP) Wilmington site consists of 52 acres of vacant land on the Cape Fear River waterfront. Thirty-five acres in the northern and central portion of the site are owned by the City of Wilmington, and the remaining 17 acres are owned by the NC State Ports Authority (Ref. 5, p. 1). Features surrounding the site include 2 petroleum storage facilities on the north and south, and a residential area and the Cape Fear River on the east and west, respectively (Ref. 1; Ref. 7, p. 1; Photos 5-6, 12-14).

The southern portion of the site abuts an undeveloped portion of the State Ports Authority property (Ref. 18). A drainage ditch extends approximately 850 feet south across this area from the site, joining Greenfield Creek. The creek flows westward another 1900 feet, passing the north edge of the Paktank petroleum terminal and a tidal control gate, before emptying into the Cape Fear River (Ref. 1; Ref. 7, Fig. 2; Fig. 2). The river, creek, and drainage ditch are all tidally influenced, undergoing flow reversal during normal tidal cycles (Ref. 6, p. 4; Ref. 8; Photos 15-16).

The site has been cleared of surface structures, storage tanks, and railroad sidings, and is currently vacant. Remaining features visible at the site include an entrance gate, sections of paved and unpaved roadway, scattered concrete foundation slabs, partially buried railroad ties, and drainage ditches (Photos 1-2, 7-8). The Cape Fear riverfront onsite consists of 2 broad slips, which contain the remnants of wooden cribbing and piers (Photos 13-14). The north central portion of the site includes a 5-acre landfarming area surrounded by an earth berm averaging about a foot in height (Photos 9-10) . Most of the land surface at the site is presently covered with short grass (Photos 1-2, 5-11). The site is relatively flat, the ground surface standing approximately 2 to 6 feet above the Cape Fear River at high tide (Ref. 6, pp.2-3).

2.3 Operational History and Waste Characteristics

The site was first developed to construct concrete barges and ships during World War I. The site operated as a wood-treating facility beginning in the early 1930s. Southern Wood Preserving Company (now Southern Wood Piedmont) operated the facility beginning in 1964. Creosote was the only wood preservative reportedly used prior to 1972, when SWP also began using chromated copper arsenate (CCA). In 1980, part of the facility was modified to use pentachlorophenol (PCP) as well. SWP began its first closure procedures at the site in 1975, when the facility reportedly obtained a permit to bury a drainage ditch on the State Ports Authority section. The ditch, which contained creosote sludges, was covered with fill. Wood treatment operations ceased in May of 1983, and removal of plant equipment began at that time (Ref. 9, p. 1) .

During the Preliminary Assessment, completed in July 1984, representatives of the NC Department of Human Resources observed evidence of soil and groundwater contamination at the site. Visible soil staining was observed in the main production areas in the south central portion of the site, around a cluster of creosote storage tanks to the west, and in the vicinity of the buried creosote ditch. Oily sheens were noted on groundwater from 1.5 feet beneath the ground surface, and on surface water at several locations onsite. Disposal of trash, tars and creosote sludge was also reported in earth berms at the 2 slips on the Cape Fear River (Ref. 10, Part 2, pp. 3-5)

On May 20, 1985, SWP signed an Administrative Order of Consent with the State (Ref. 11), in which the company agreed to treat and/or dispose creosote and CCA contaminated soils at wood treating and chemical storage areas at the site. Under the provisions of the Consent Order,, 4 onsite areas of contamination were designated to be treated by excavation and landfarming. These areas included: (1) the buried Creosote Drainage Ditch (a.k.a. Superfund Area I); (2) the Track Area, directly north of the facility's wood treatment areas; (3) the Oil Treating (main production) Area; (4) the Large Storage Tank (creosote) Containment Area, west of the treatment areas. Visibly discolored soils were excavated from these areas (Ref. 11, pp. 3-4). The excavations were backfilled with sandy clay obtained from a borrow pit 10 to 15 miles away (Ref. 57).

The stained soils were applied in a designated landfarm area in the northern part of the site. Application was limited to lifts of 2 inches or less, and land treatment was limited to the uppermost 6 inches of soil. During active landfarming, the area , which was bermed to prevent runoff, was irrigated, fertilized, and tilled weekly to promote degradation of contaminants. Lysimeters were installed to monitor soil moisture, and 1 upgradient and 3 downgradient monitoring wells were installed to monitor for groundwater contamination (Ref. 11, p. 5). Additionally, the former treated wood storage areas outside the landfarm were tilled in place. In accordance with the Consent Order, SWP conducted periodic monitoring of landfarm soil contamination, as well as biannual water quality monitoring on the Cape Fear River (Ref. 11, pp. 5-6).

From mid-1984 through mid-1990, SWP actively landfarmed the excavated soils. The landfarming areas, LF-1 and LF-2, consisted of 2 adjacent bermed areas in the north central portion of the site, with a combined area of 5 acres (Ref. 12, p. 2-1; Ref. 19, p. 2). Based on the reported number of 2-inch lifts emplaced in each of the landfarm areas (17 applications at LF-1 and 20 at LF-2) and assuming uniform coverage by each lift, an estimated 672,000 cubic feet (15.4 acre-feet) of material was landfarmed.

In the CCA area, the Consent Order specified excavation of soils containing 0.5 ppm or more of arsenic, as determined by EP Toxicity testing. Excavation was limited to depths of 5 feet or less. Excavated soils in excess of 5 ppm arsenic were reportedly transported and disposed at the former CSX hazardous waste landfill in Pinewood, South Carolina (Ref. 57). SWP reported that a net 98 cubic yard volume of soil was designated for such removal. Soils with less than 5 ppm arsenic were to be diluted to less than 0.5 ppm EP Toxicity by mixing with Portland cement, then buried onsite. SWP reported that a 93 cubic yard volume was disposed onsite in this manner (Ref. 11, p. 4; Ref. 20, pp. 3-10).

During the landfarming period, SWP collected and submitted 59 composite soil samples from LF-1 and 37 samples from LF-2. Each composite was analyzed for phosphorus, chloride, total organic carbon, soil pH, polynuclear aromatic hydrocarbons (PAH), PCP, phenol, and microbial content. Samples were analyzed by the Mississippi State University Forest Products Research Division Laboratory (MSUFPRD) (Ref. 12, p. 2-2). SWP also contracted Law Environmental Services to install 4 monitoring wells around the perimeter of the landfarming areas in September 1985, and periodically sampled these wells for PCP and semi-volatile organics between 1985 and 1990 (Ref. 13, p. 2-2, p. 7-1).

Several environmental investigations have been completed at the site since wood-treatment operations ceased in 1983. In 1981, prior to shutdown, the City of Wilmington contracted Soil & Materials Engineering to install and sample five monitoring wells (CW-1 through CW-5) around the inner perimeter of the site (Ref. 13, pp. 2-3 to 2-4). Four of the wells were screened in a shallow water table unit, but CW-5 was screened in a deeper sand unit (See Section 4.1) (Ref. 7, p. 3)

NUS Corporation, the US EPA's Field Investigative Team (FIT), performed a Screening Site Investigation (SSI) at the site in January 1985. The FIT resampled 4 of the 5 city monitoring wells, and sampled 1 "artesian" well at Greenfield Lake, approximately 0.5 mile southeast of the site (Ref. 5, pp. 4-7) The FIT collected soil samples in the landfarming areas and on the jetty area adjacent to the Cape Fear River. The FIT also collected 1 surface water and 1 sediment sample adjacent to the site on the Cape Fear River, and collected background samples from the outlet of Greenfield Lake (Ref. 5, pp. 7-12). In 1985, Law Environmental Inc. installed four 20-foot monitoring wells (MW-6 through MW-9) to monitor conditions at the periphery of the landfarming areas (Ref. 7, p. 4; Ref. 13, pp. 2-3 - 2-4).

In 1991, Geraghty & Miller, Inc., completed soils investigations of the 3 outdoor wood storage areas. Soil in these areas was not excavated for landfarming. G & M collected 48 shallow soil samples in the 2 Non-treated Wood Storage areas (NTA, NTB) and in the Treated Wood Storage area (TWS) (Ref. 14, p. 3-1, Figs. 4-1 to 4-3).

G&M reviewed SWP's landfarm sampling results, focussing on data from sequential sampling events which occurred between soil applications. The 4 - 6 month periods which were evaluated for each landfarm area began on June 1986, November 1987, and June 1988. G&M concluded from the analytical data that significant biodegradation of semi-volatile organic compounds (SVOCs) had occurred in the landfarmed soil between applications. Results, however, indicated that some SVOCs broke down at slower rates than others. Most species essentially degraded to non-detect levels after 2 to 4 months, but anthracene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, and chrysene persisted beyond 6 months (Ref. 12, pp. 2-3 to 2-6, App. A). The most rapid degradation generally occurred during the warmest months of the year.

G&M conducted 2 sampling events at the landfarming areas, collecting soil composites from 5 borings at each landfarming area in October 1990 and again in October 1991 (Ref. 12, p. 3-1; Ref. 13, p. 3-1). Twice, G&M also sampled MW-6 through MW-9 at the landfarm These landfarm investigations were completed and used in preparation of G & M's December 1993 Risk Assessment report (Ref. 15).

Beginning in February 1992, ETE/Virogroup, of Lexington, SC, conducted a 3-phase groundwater investigation of the site. ETE initially installed and sampled 5 temporary wells (B-2 through B-6) and 8 permanent monitoring wells (MW-10 through MW-17) into the site's water table groundwater unit (Ref. 7, pp. 5-7).

The Phase II investigation in September-October 1992 began with abandonment of the temporary wells and the installation of 9 additional permanent monitoring wells in the water table unit (MW-18 through MW-26) and 3 wells in a deeper, semi-confined groundwater unit (MW-8A, MW-11A, MW-19A) (See Section 4.1). In December 1992, ETE collected soil and sediment samples (SS-1 through SS-11) along surface drainage south from the site, including the on-site drainage ditch and Greenfield Creek (Ref. 7, pp. 8-13).

During ETE's Phase III investigation, which began in October 1993, one monitoring well (MW-24) was relocated and 11 more wells (MW-27 through MW-30, MW-11B, MW-14A, MW-20A, MW-22A, MW-24A, MW-28A, MW-29A) were installed in the 2 sand units (Ref. 7, pp. 13-29). ETE sampled most of the new and existing monitoring wells (including the landfarm wells) during each work phase (Ref. 7, pp. 7, 12, 25) and monitored groundwater elevations in the wells to determine flow direction in the 2 unconsolidated sand units (Ref. 7, pp. 8, 19, 29-30).

3.0 WASTE/SOURCE SAMPLING

3.1 Sample Locations

In 1982, SWP and the NC Division of Health Services collected 4 split soil samples along the Oil Treating and Track areas (Refs 16-17). No other analytical samples apparently were collected directly from the former main production areas or tank storage areas at the site, where contamination was visually identified during excavation. Soils analyzed after landfarming were from multiple source areas at the site.

ETE/Virogroup sampled soils at the former Creosote Ditch area in December 1992 (Ref. 7, p. 11, Fig. 3). In the CCA Area, soil sampling for arsenic EP toxicity was performed by SWP to pre-screen selected areas for soil excavation and disposal (Ref. 20, pp. 4-10).

During the period of active landfarming, SWP collected a total of 96 composite samples of landfarm area soils. In 1985 the EPA FIT collected soil composites from the 2 landfarming plots and a soil stockpile to be landfarmed (Ref. 5, p. 4, p. 8-10, Table I). G&M also sampled the landfarm area soils in 1990 and in 1991 (Refs. 12-13).

In 1985 the EPA FIT collected a composite soil sample from the jetty at the site (near TWS). In February and April, 1991, Geraghty & Miller sampled soil along 100-foot grid patterns in each of the NTW and TWS storage areas (Ref. 14, pp. 3-1, 3-2).

3.2 Analytical Results

Organic compounds: Soil samples collected by Geraghty & Miller and ETE/Virogroup from Landfarms 1 and 2 and from the former Creosote Ditch area contained several semi-volatile organic compounds commonly associated with creosote. Residual creosote contaminants were also detected in soil beneath the former treated and untreated wood storage areas, but at generally lower concentrations than above (Ref. 5. p. 2; Ref. 14, pp. 4-1 - 4-2). Detected compounds included the following:

Acenaphthene	Chrysene
Acenaphthylene	Dibenzo(a,h)anthracene
Benzo(a)anthracene	Fluoranthene (Benzo(j,k)fluorene)
Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene
Benzo(bk)fluoranthene	Phenanthrene

The former Track and Oil Treating (main production) Area and the Large Storage Tank (creosote) Containment Area all contained visible creosote spills at the time operations ceased, indicating extensive source area contamination. Creosote sludges are also reported to have been deposited during filling adjacent to the north and south slips at the Cape Fear River (Ref. 5, p. 2). Based on sampling results from the lower portion of Greenfield Creek, it appears that the same semi-volatile creosote components have migrated downstream from the southeast corner of the site (Ref. 7; Att. A).

In accordance with the EPA's Interim Final SI Guidance, the creosote source areas, despite having been excavated, are still considered sources because 1) their excavated soils were not physically removed from the site, and 2) results of the above investigations indicate release of contaminants from these areas to groundwater and to the surface water environment (See Sections 4.4, 5.4). Additional creosote residues are anticipated to be present in the unexcavated soils within the source areas, as was the case at the Creosote Ditch area. Together, the main source areas and the other areas of known contamination cover over half of the site (Ref. 7, Fig. 4; Ref. 14, Figs. 3-1, 4-1, 4-2, 4-3).

Inorganics: Testing of soils in the CCA area detected arsenic EP Toxicity concentrations in excess of 5 mg/kg (Ref. 19, p. 6). Testing of soils in the NTA, NTB, and TWS areas detected maximum arsenic concentrations of 63 mg/kg, 13 mg/kg, and 41 mg/kg, respectively. Maximum chromium concentrations for the three areas were 15 mg/kg, 22 mg/kg, and 11 mg/kg, respectively. Maximum copper concentrations were 300 mg/kg, 130 mg/kg, and 110 mg/kg, respectively (Ref. 14, Tables 4-1 - 4-3).

ETE/Virogroup sample SS-2, an offsite soil/sediment sample collected from a drainage ditch on the property east of the railroad grade and the site, contained arsenic, chromium and copper concentrations of 5.2 mg/kg, 14 mg/kg, and 46 mg/kg, respectively (Ref. 7, Att. A, p. 7). If SS-2 is considered a background sample, these results indicate that areas NTA and TWS contain arsenic in excess of 3 times the background level, and that area NTA contains copper in excess of 3 times background level. None of the samples contained chromium in excess of 3 times background concentration. The minimum health-based benchmark concentrations for human soil exposure are 0.33 mg/kg for arsenic and 2900 mg/kg for chromium. No such benchmark presently exists for copper (Ref. 20). These results therefore indicate that maximum arsenic levels at the site are in excess of the benchmark level.1

The source areas and contaminants at the site can be summarized as follows:

<u>Track & Treating Areas</u>: est. 13,861 cu. yd; Semi-volatile organics (PAH).

<u>Large Storage Tank (Creosote) Containment Area</u>: est. 800 cu. yd; (same).

<u>Creosote Ditch Area</u>: est. 2315 cu. yd.; (same).

Landfarm Areas 1 & 2: est. 5 acres; (same).

Areas NTA & NTB (Non-treated wood storage): est. 17,708 cu. yd (PAH, Arsenic (NTA)).

Area TWS (Treated wood storage): est. 15,000 cu. yd. (PAH, Arsenic).

Chromated Copper Arsenate (CCA) area: est. 191 cu. yd. (Metals (Arsenic)).

4.0 GROUNDWATER PATHWAY

4.1 Hydrogeologic Setting

The Wilmington area lies within the Coastal Plain Physiographic Province (Ref. 21, p. 3). Bedrock formations in this province consist of a crystalline basement complex, overlain by a thick wedge consisting of a layered series of sedimentary bedrock formations. The sedimentary formations are sands, clays, and limestones, most of which date from the Cretaceous Period. The sedimentary wedge, which contains all the significant potable aquifers in the region, thickens toward the Atlantic coast, measuring 1100 feet in Wilmington (Ref. 21, p. 8). Overlying the sedimentary bedrock formations are unconsolidated surficial units of sediment deposited some time between the Cretaceous Period and the present.

Historically, geologic reports have disagreed on the identity of the bedrock unit beneath the clay. Most sources (Refs. 21-23) place bedrock around the site within the upper Cretaceous Pee Dee Formation, while some (Refs. 26-27) map the area within the younger Tertiary (Eocene) Castle Hayne Formation. The 3 deepest test borings completed at the site encountered "a very dense, light gray, sandy shell-mold limestone", which was interpreted to be the Scotts Hill Member of the upper middle Pee Dee Formation (Ref. 7, p. 17; Ref. 23, pp. 212-215).

At the top of the limestone, ETE's deepest borings encountered a layer of dense, dry, olive-gray clay which measured 2.5 to 4 feet thick. The measured depth to the base of the clay ranged from 43 to 48 feet onsite (Ref. 7, Att. D). Regionally, the upper surface of the clay undulates because of channeling and erosion (Ref. 21, p. 13), and the layer has eroded away completely in areas north and west of the site (Ref. 21, pp. 10, 14). The layer averages 25 feet thick (Ref. 27, pp. 30), but thickens from only 2.5 feet at the site to as much as 60 feet in areas southeast of the site (Ref. 21, p. 14; Ref. 27, p. 30). No clay layer was reported during S&ME's 1982 subsurface exploration program (Ref. 5, p. 3), however, it was encountered in all 9 of ETE's deep borings (Ref. 21, pp. 9-10, p. 13), suggesting that it is continuous beneath the site. The clay layer's hydraulic conductivity is anticipated to be on the order of 10^{-8} cm/sec (Ref. 25, p. 51601).

To the south, east, and northeast of the site, the Pee Dee Formation is overlain by the limestone beds of the Castle Hayne Formation. Like the Pee Dee Formation, the Castle Hayne generally thickens toward the coast. Its thickness varies considerably, however, because of post-depositional solution and erosion at the top of the formation, and because of the irregular surface of the underlying clay (Ref. 21, pp. 15-16).

Between the top of the clay layer and the ground surface at the site, the unconsolidated, post-Cretaceous overburden consist of 2 sand units, separated by a semi-permeable peat layer. The upper unit is 7-16 feet thick and generally consists of loose, light brown sand, locally discolored by creosote. The peat layer is 13 - 16 feet thick and contains varying amounts of clay, wood and root fragments. The lower unit consists of loose, darker brown sand, 14 to 18 feet thick. The upper unit has been excavated in places to depths of several feet, and backfilled with sandy clay soil from offsite(Ref. 57).

Surface soil throughout most of the site is mapped as Urban land, wherein the original soil profile has been disturbed by cutting, filling, and grading to the extent that identification is no longer possible (Ref. 24, p. 6). Although the underlying material is described as sand, ponding of rainwater (possibly due to introduction and compaction of sandy clay fill) occurs on the ground surface over portions of the site (Ref. 6, p. 2; Ref. 51; Photo 11).

The southeast corner of the site, including the existing drainage ditch, is underlain by Dorovan Series soil, characteristic of bays, tidal plains and floodplains. This organic-rich soil typically consists of a 4-inch surface layer of black muck, underlain by 5 feet of dark gray or black muck. This soil type is subject to frequent and prolonged flooding , and the seasonal high water table is very close to the ground surface (Ref. 24, pp. 7, 25). The typical hydraulic conductivity for this type of soil is on the order of 10^{-8} cm/sec (Ref. 25, p. 51601).

Potable groundwater in the Pee Dee Formation is found in the sandy limestone stratum encountered onsite. This aquifer unit is the uppermost of 4 confined water-bearing strata within the formation., The sandy strata are separated from one another by thicker silty clay units. Groundwater in the deeper sand units ranges from brackish to saline, so only the uppermost unit in the Pee Dee is used for drinking.

Historical well records indicate that groundwater wells in Wilmington began penetrating the limestones of the Castle Hayne Formation along a broad, NE-SW trending strip that approaches to within 1 mile south and east of the site. Several of the wells in this zone drew groundwater from both the Castle Hayne and the deeper Pee Dee Formation (Ref. 21, p. 26, pp. 62-71, Fig. 3). In the northern part of the county, the Castle Hayne Formation is locally unconfined. Closer to the coast, the aquifer thickens and becomes confined by Miocene silts (Ref. 21, pp. 18, 26).

Recharge in unconfined units tends to occur in upland or interstream areas, as precipitation percolates downward to the water table. The groundwater eventually discharges to perennial surface water bodies, where the water table approaches the surface (Ref. 26, p. 41). Due to the site's low elevation and proximity to surface water, the water table in the upper sand unit approaches to within 2 feet of the ground surface during high tide (Ref. 7, Atts. D-E).

Measured groundwater elevations indicate the presence of a groundwater mound centered beneath the site in the upper sand unit. Groundwater there is anticipated to flow radially southeast south and west, discharging to the existing drainage ditch, to Greenfield Creek, and to the Cape Fear River. The data indicate that the existing drainage ditch acts as a discharge boundary to southeastward groundwater flow in the upper sand unit (Ref. 7, Figs. 6-9). For this reason, contaminants in the water-table sand unit are not anticipated to migrate beyond the east or south drainage system toward Wilmington, but are more likely to discharge to surface water (Ref. 7, pp. 29-31, Figs. 18-19).

Groundwater flow in the lower sand unit is influenced by the level of the Cape Fear River, to which the unit has apparently been hydraulically connected as a result of dredging in the riverbed. A groundwater mound with a radial flow pattern occurs in this unit during low tide, however, the overall flow direction shifts increasingly to the southeast as the river level rises (Ref. 7, p. 19). Whether groundwater contaminants in the lower sand unit can migrate laterally toward the unconfined areas of the Castle Hayne aquifer is not presently known.

At most of the monitoring well clusters completed on and adjacent to the site, groundwater elevation monitoring has indicated an upward hydraulic gradient across the peat formation which separates the 2 sand units. These upward hydraulic gradients persisted throughout the tidal cycle and indicate that the lower sand unit is partially confined by the peat. No apparent vertical gradient was evident at one south-central cluster. Near the south property line (and away from surface water), groundwater levels indicated a downward hydraulic gradient at 2 clusters (Ref. 7, Att. A, Fig. 3). ETE/Virogroup has indicated that the upward hydraulic gradients tend to persist throughout the tidal cycle near the drainage ditches, but that gradients tend to fluctuate closer to the Cape Fear River (Ref. 7, pp. 21-22). Whether contaminants in the fluctuating areas have migrated vertically to the Pee Dee aquifer is not known.

4.2 Groundwater Targets

No municipal water supply wells are located within 4 miles of the site (Ref. 28). The City of Wilmington's active water source consists of surface water intakes over 15 miles upstream of the site on the Cape Fear River (Refs. 28-29).

The 1994 community well database indicates that 3 community wells supply approximately 680 residents within a 4-mile radius of the site (Ref. 28; Refs. 30-31). Two of the wells, supplying 625 people, are located 1.7 and 3.8 miles east-northeast of the site, in areas where potable wells have historically tapped both the Castle Hayne and the Pee Dee aquifers. The other 55 community -well users are located 1.6 miles west of the site and probably utilize the Pee Dee aquifer (Ref. 21, pp. 62-74, Fig. 3). A house count indicates that approximately 1449 people are supplied by individual domestic wells within a 4-mile radius, the nearest estimated to be 1.6 miles west of the site (Refs. 31-32). All of the domestic wells identified in New Hanover County are located north of Smith Creek, so it is likely that all the domestic wells within 4 miles of the site tap the Pee Dee aquifer (Ref. 1; Ref. 21, pp. 62-74, Fig. 3). The total groundwater population within 4 miles of the site is estimated to be 2129 people (Refs. 31-32; Table 1).

The nearest groundwater supplies to the site are springs which supply outdoor faucets in Greenfield Park, approximately 0.25-0.5 miles southeast of the site. These springs are classified as noncommunity, transient supplies (Ref. 28). The nearest other known groundwater supplies are the community and domestic wells located 1.6 miles west of the site, and the community well located 1.7 miles east of the site (Ref. 1; Refs. 30-31; Fig. 1). No wellhead protection areas (WHPAs) are designated in NC (Ref. 33).

4.3 Sample Locations

No groundwater sampling was conducted at the site by the NC Superfund Section during the SIP. Analytical data from samples collected onsite during recent hydrogeologic evaluations were sufficient to characterize subsurface soil and groundwater conditions beneath the site.

During the January 1985 FIT Screening Site Investigation (SSI), a groundwater sample was collected at one of the non-perennial springs in Greenfield Park, approximately 0.5 mile southeast of the site (Ref. 5). Because this is a non-perennial transient supply, it was not resampled during the SIP.

The FIT performed early sampling at 4 of the original 5 monitoring wells installed at the site. The FIT sampled monitoring wells MW-1 (CW-1, near the Creosote Ditch), MW-2 (CW-2, near the Treatment Areas), MW-4 (CW-4, near the north slip fill area), and MW-5 (CW-5, northeast corner of the site) (Ref. 5, pp. 5-7, Fig. 2).

Geraghty & Miller sampled landfarm monitoring wells MW-6 through MW-9 in October 1990 and again in October 1991 to determine whether the landfarm area had contaminated the upper sand unit at the site. Both G&M sample sets were tested for the semi-volatiles associated with creosote, and the 1991 samples were also tested for copper, chromium, and arsenic (Ref. 12, pp. 3-2 - 3-4, Table 4-4; Ref. 13, p. 3-2 - 3-3, Table 4-3).

TABLE 1
SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC.
NCD 058 517 467
GROUNDWATER POPULATION COUNT

Radial Distance (mi.):	Domestic wells		Domestic Well Population		Community Well Population		Total Well Population
	N Han. Co.	Brun. Co.	N Han. Co.	Brun. Co.	N Han. Co.	Brun. Co.	
0.0-0.25	0	0	0	0	0	0	0
0.25-0.5	0	0	0	0	0	0	0
0.5-1.0	0	0	0	0	0	0	0
10.-2.0	0	27	0	73	25	55	153
2.0-3.0	10	60	27	161	0	0	188
3.0-4.0	189	253	507	681	600	0	1788
		Subtotals:	534	915	625	55	2129

1. House count completed by S. F. Parker, NC Superfund Section, using current USGS 7-1/2 minute photoquadrangles. and available information on current water main distribution.
2. Domestic population based on 1990 Census mean household populations for Leland and Wrightsboro, NC (Ref. 32).
3. Approximately 50 % of houses in Brunswick Co. section of study area are reported to use wells (Ref. 31).

Figure 2, adapted from ETE/Virogroup's most recent hydrogeologic report (Ref. 7, Fig. 4), indicates the locations of monitoring wells and monitoring well clusters in relation to the primary contaminant source areas at the site. ETE/Virogroup performed their Phase I, II and III Groundwater Quality Assessments during February 1992, October-November 1992, and October- November 1993, respectively. During Phase I, 5 temporary wells (B2, B3, B4, B5, and B6) and 8 permanent monitoring wells (MW-10 through MW-17) were installed in the upper sand unit and at the top of the underlying peat layer (Ref. 7, p. 6). Monitoring wells MW-10 and MW-13 through MW-17 were sampled in March 1992, along with the 5 temporary wells. Four monitoring wells (MW-6 through MW-9) which had been installed in 1985 by Law Environmental, Inc., were also sampled (Ref. 7, p. 4, Att. A).

During Phase II, 9 additional monitoring wells (MW-18 through MW-26) were installed in the upper sand unit, 3 monitoring wells (MW-8A, MW-11A, and MW-19A) were completed in the lower sand unit, and the 5 temporary wells were abandoned by grouting. In October 1992, a total of 21 groundwater samples were collected from existing wells MW-6 through MW-9, from Phase I wells MW-10 and MW-13 through MW-17, from Phase II shallow wells MW-18 through MW-25, and from Phase II deep wells MW-8A, MW-11A and MW-19A (Ref. 7, pp. 8, 12, Att. A).

Two shallow monitoring wells, MW-27, and MW-28, were installed at the northeast and southeast corners of the site, respectively. MW-29 and MW-30 were completed adjacent to wetlands, in the southeast corner of the NC Ports Authority property south of the site. MW-24 was replaced with MW-24R in response to vandalism. Seven additional deep monitoring wells (MW- 11B, MW-14A, MW-20A, MW-22A, MW-24A, MW-28A, and MW-29A) were completed in the lower sand at their respective cluster locations.

In November 1993, ETE/Virogroup collected 31 groundwater samples from the new and existing monitoring wells. Wells MW-11 and MW-12 were sampled, in addition to those wells previously sampled. Four monitoring wells (MW-11, MW-14, MW-22, and MW-26) were omitted because of the presence of dense nonaqueous-phase product in each well.

4.4 Analytical Results

The 1985 EPA FIT samples from MW-1, MW-2, MW-4 and MW-5 (CW-1, CW-2, CW-4 and CW-5) varied in composition. Contaminants detected in various combinations included benzene, ethyl benzene, and methyl butyl ketone (MW-1 and MW-2), naphthalene, dibenzofuran, and 2-methyl naphthalene (MW-2), arsenic, lead, toluene, acetone, acenaphthene, fluorene, and phenanthrene (MW-2 and MW-4), acenaphthylene, anthracene, fluoranthene, and pyrene (MW-4), chromium (MW-2 and MW-5). Methyl butyl ketone and propene were also detected at MW-5, indicating a possible offsite source for these 2 compounds (Ref. 5, pp. 5-7, Figure 2, Tables 2-3). The results were generally consistent with those of the subsequent Virogroup assessments.

No copper, chromium, arsenic, or semi-volatile organic compounds were detected in Geraghty & Miller's 1990 and 1991 landfarm area groundwater samples. (Ref. 12, p. 4-2, Table 4-4, App D; Ref. 13, p. 4-2, Table 4-3, App. A). The results indicate that the presence of these substances in the landfarm area has not impacted groundwater at the site.

Analytical results from each phase of the Virogroup groundwater investigation are documented and tabulated in Ref. 7, Attachments A and G. Maximum detected concentrations are summarized in Table 2. Several of the groundwater samples collected onsite contained detectable concentrations of volatile aromatic and semi-volatile organic compounds, as well as arsenic, cadmium, chromium, and lead. The semi-volatiles included many polynuclear aromatic hydrocarbons characteristic of creosote, some of which are listed carcinogens (Refs. 34-36; Ref. 44).

Table 2 includes a list of the detected volatile, semivolatile, and inorganic parameters, their maximum detected concentrations, and minimum health-based benchmark concentrations for groundwater. Of the detected contaminants, the maximum detected concentrations for benzene, benzo(a)pyrene, and arsenic exceeded their respective EPA Cancer Risk Screening Concentrations. Acenaphthene and fluoranthene (benzo(j,k)fluorene) exceeded their Reference Dose Screening Concentrations, and the metals chromium and lead exceeded their Maximum Contaminant Level/Maximum Contaminant Level Goals (MCL/MCLG) for groundwater (Ref. 7, Att. A, Att. G; Ref. 20).

The sampling results indicated that a plume of contaminated groundwater exists beneath the site, extending between the Large Storage Tank Area, the CCA and Creosote Treatment Areas, the former Buried Creosote Ditch Area, and the existing onsite drainage ditch. Within each of the principal source areas, Virogroup personnel detected dense, non-aqueous phase creosote in 1 or more of the upper sand unit monitoring wells. Within the upper sand unit, the aqueous contaminant plume extended up to 400 feet north of the source areas (MW-17, MW-20), and was detected to the southeast near the junction of the existing drainage ditch and Greenfield Creek (MW-30). The southern limit of the plume was not precisely defined. The lower sand unit also contained aqueous contaminants, but no apparent free product. Based on Virogroup's interpretation, the deeper plume was centered beneath the path of the former creosote and existing drainage ditch. (Ref. 7, pp 29-31, Figs. 15-16, Atts. A, D, G).

Analysis of the offsite groundwater sample collected by the EPA FIT in 1985 detected several volatile organic compounds, including methylene chloride (37 ug/l), chloroform (63 ug/l), bromoform (tribromomethane, 14 ug/l), carbon tetrachloride (38 ug/l), bromodichloromethane (60 ug/l), dibromochloromethane (38 ug/l), 1,1-dichloroethene (6.6 ug/l), 1,2-dichloroethane (55 ug/l), 1,1,1-trichloroethane (14 ug/l), trichloroethene (15 ug/l), tetrachloroethene (81 ug/l), and toluene (26 ug/l) (Ref. 5, p. 7, Table 3). All of the compounds except 1,1,1-trichloroethane and toluene were in excess of their respective Cancer Risk Screen Concentrations for groundwater (Ref. 20). However, none of the compounds except toluene were detected in groundwater at the site, so it is likely that these contaminants were from another source.

TABLE 2
SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC
NCD 058 517 467
PHASE I - III GROUNDWATER QUALITY ASSESSMENT
GROUNDWATER CONTAMINANT SUMMARY

Contaminant:	Maximum Detected Concentration (mg/l):	Lowest Health-based Benchmark:	Monitoring Well (Location):
Volatile Organic Compounds:			
Benzene	0.073	1.2 E-3 (C)	MW-13 (Large Storage Tank Area)
Ethyl benzene	0.11	0.7 (M)	B-4 (300 ft S of Treatment Area)
Toluene	0.046	1.0 (M)	MW-14
M/P - Xylene	0.078	10 (M)	"
O - Xylene	0.038	10 (M)	"
Semi-volatile Organic Compounds:			
Acenaphthene	3	2.1 (R)	B-4 (300 ft S of Treatment Area)
Anthracene	0.94	11 (R)	"
Benzo(a)anthracene	0.42	* (M)	"
Benzo(a)pyrene	0.11	4.8 E-6 (C)	"
Benzo(b)fluoranthene (Benzofluoranthene 3-4)	0.21	- -	"
Benzo(k)flouranthene	0.056	* (M)	"
Chrysene	0.34	* (M)	"
Dibenzo(a,h)anthracene	0.011	* (M)	"
2,4-Dimethyl phenol	0.37	0.7 (R)	"
Fluoranthene (Benzo(j,k)fluorene)	2.7	1.4 (R)	B-4 (300 ft S of Treatment Area)
Indeno(1,2,3-cd)pyrene	0.035	* (M)	"
Naphthalene	14	* (R)	"
Phenanthrene	5.8	- -	"
Inorganic Parameters:			
Arsenic	0.14	2 E-5 (C)	MW-17 (150 ft WNW of CCA Treatment Area)
Chromium	0.19 (1)	0.1 (M)	B-4 (300 ft S of Treatment Area)
Copper	0.4	1.3 (M)	MW-17 (150 ft WNW of CCA Treatment Area)
Lead	0.39	0.015 (M)	MW-17 (150 ft WNW of CCA Treatment Area)

Health-based Benchmark Values (1994) from Superfund Chemical Data Matrix, Appendix B:
(C) = Cancer Risk Screening Concentration.
(M) = MCL/MCLG.
(R) = Reference Dose Screening Concentration.

(*) Indicates Benchmark Concentration currently under review by USEPA.
(- -) Indicates No Established Benchmark Concentration.

1. MW-18 (North edge of site) contained 4.6 mg/l Chromium.
2. Concentrations in excess of applicable Health-based Benchmarks for groundwater are shaded.
3. Data obtained from Virogroup (ETE Division) report on Phase III Groundwater Quality Assessment, Wilmington, North Carolina Facility, prepared for Southern Wood Piedmont Company, 1994.

4.5 Groundwater Conclusions

Use and storage of wood-preserving chemicals at the Southern Wood Piedmont Co. site has resulted in extensive groundwater contamination both on site and on the additional State Ports Authority to the southeast. Subsurface exploration and sampling have revealed the presence of both aqueous and nonaqueous organic contaminants in the upper sand unit at the site. The lower sand unit has also been contaminated, apparently by vertical migration of aqueous contaminants through the semi-confining peat layer between the units.

Analytical and hydrogeologic data indicate that lateral migration in both units is influenced by proximity to the on-site drainage ditch, which apparently acts as a discharge boundary to eastward groundwater flow. To the south and west of the site, Greenfield Creek and the Cape Fear River may also act as discharge boundaries to contaminant migration in the unconsolidated sediments.

No groundwater samples have been collected from the Pee Dee Formation beneath the site. The formation is separated from the overlying contaminated groundwater units by a continuous, tight, dry clay layer 2.5 to 4 feet thick. This clay is reported to cap the entire formation, which serves as the regional aquifer northwest of the site. The Castle Hayne Formation, the regional aquifer south and east of the site, is reported to be only partially confined, and receives recharge through overburden units east of the site.

The nearest known domestic or community wells are located 1.5 to 2 miles from the site. An artesian spring used by the public and located less than a mile southeast of the site was reportedly contaminated by toluene and 11 halogenated organic solvents. Because only one of the compounds (toluene) was detected in the SWP groundwater samples, however, the contamination is not considered attributable to the site. Based on the above information, the presence of subsurface contamination at the site is not believed to be a likely threat to any drinking water supplies.

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

Based on surface topography (Ref. 18), runoff from most of the site is anticipated to flow in a general south-southeasterly direction, toward the wetlands and the existing drainage ditch at the eastern edge of the site. The drainage ditch begins on site, receiving runoff via shallower ditches along the entry road within the site (Photos 3-4, 15-16. The system drains to the Cape Fear River via Greenfield Creek. The main ditch is tidal and is therefore considered perennial. The upper end of the main ditch is one of multiple probable points of entry (PPEs) to the surface water pathway, but it is the primary one, draining the majority of the site (Figs. 2-3).

Greenfield Creek conveys runoff from the main PPE to the Cape Fear River. The Creek flows from freshwater Greenfield Lake, at a dam located approximately 700 feet upstream of where the main drainage ditch enters the creek. Based on topography, the entire creek below the dam may be tidally influenced (Ref. 1; Ref. 18).

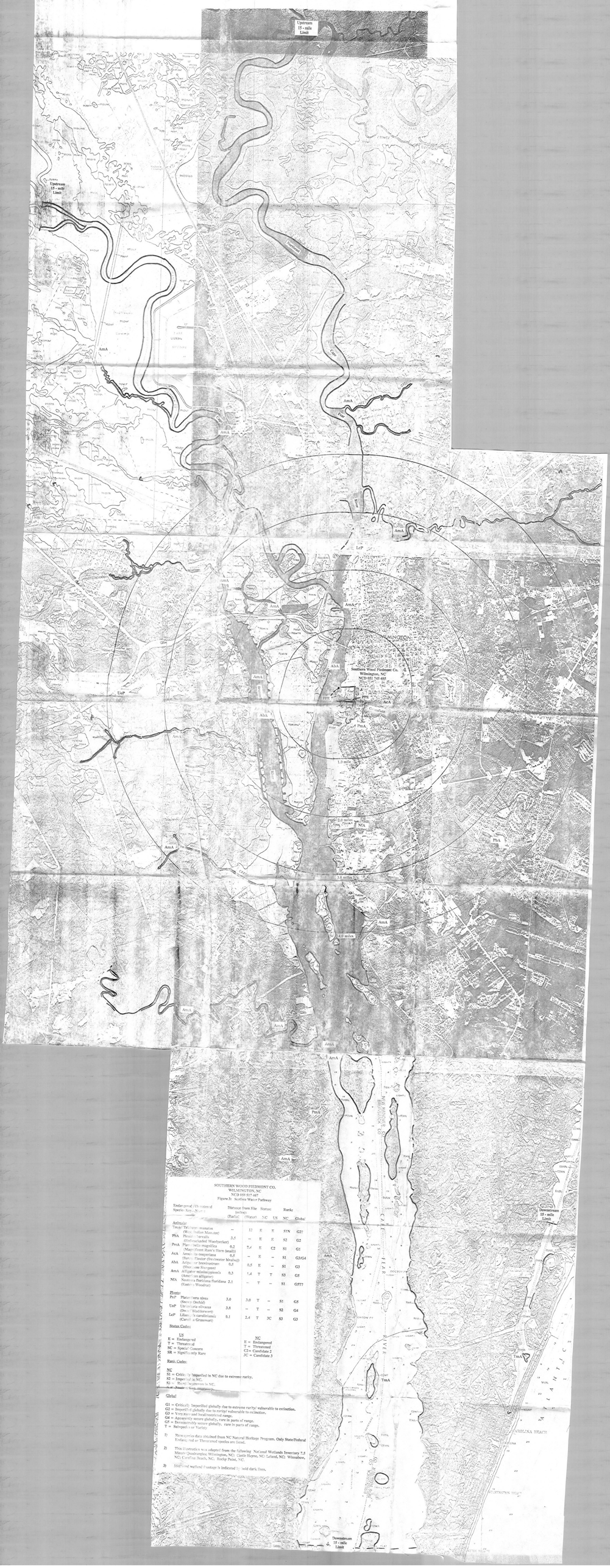
Runoff from the jetty area and from most of the on-site Area TWS is expected to flow directly to the Cape Fear River via a second PPE at the southern of the site's 2 former boat slips. A third, minor PPE exists where an intermittent ditch at the site's northern edge directs runoff from the northernmost areas of the site (Ref. 7, Figs. 2-3). Because of the site's history of equipment removal, excavation, and filling, however, its present topography and surface drainage may not be representative of the period in which wood treating occurred.

The site is located in the east bank of the Cape Fear River estuary, approximately 25 miles upstream of the open Atlantic Ocean (Ref. 1; Ref. 37, Fig. 2.3; Photos 12-14)). Within the study area, the river system includes several tributaries, most notably the Northeast Cape Fear River, which joins the Cape Fear River 1.5 miles upstream of the site. Further upstream, flow of the Cape Fear River divides around Eagle Island, which lies westward across the main channel from the site. The alternate channel, known as the Brunswick River, rejoins the Cape Fear River approximately 2 miles downstream of the site (Ref. 1; Fig. 1).

Flow within the Cape Fear estuary is significantly affected by ocean tides. Flow rates are affected several tens of miles upstream on both the Cape Fear and the Northeast Cape Fear rivers. Tidal flow reversal on the Cape Fear River has been documented as far inland as Phoenix, NC, over 14 miles upstream of the site (Ref. 1; Ref. 37, p. 23 (Fig. 2.3)). On the Northeast Cape Fear River, salt water intrusion occurs up to the east-west river section north of Castle Hayne, at least 15 miles upstream from the site (Ref. 37, Plate 1).

Based on this information, the surface water pathway can be characterized to include 1) a 15-mile section of the lower Cape Fear River, 2) a 15-mile upstream section that includes the Cape Fear (and Brunswick) River, and 3) a 15-mile upstream path containing 1.5 miles of the Cape Fear River, and 13.5 miles of the Northeast Cape Fear River. Each also includes the tidally-reversing portions of any tributary streams that fall within the distance limit (Ref. 1; Ref. 8; Fig. 1; Fig. 3).

The peak flow rates of the various pathway segments during tidal reversal are not known. The seaward flow rates of the various pathway segments can be estimated based on their drainage areas and on annual runoff statistics for the region. The existing on-site drainage ditch has a limited drainage area, and is estimated to flow at less than 1 cfs. Based on the data, Greenfield Creek is estimated to flow at 6 cfs. The lower Cape Fear estuary from the Northeast Cape Fear River to 15 miles below the site has a calculated mean flow rate of 16,128 cfs. Further upstream, the Cape Fear River was calculated to flow at 11,778 cfs. Within the distance limit, the calculated mean flow of the Northeast Cape Fear River is 2531 cfs (Refs. 38-39).



SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC
NCD 057 517 467
Figure 3: Surface Water Pathway

Endangered/Threatened Species Key: Name	Distance from Site (miles) (Radial)	(Water)	Status: NC	US	Ranks: NC	Global
Animals:						
Trout: Brook (Salvelinus fontinalis) (Wild Indian Mountain)	--	12	E	E	S1N	G2?
PhA Phoxinus tennesseensis (Tennessee Minnow)	3.0	--	E	E	S2	G2
PmA Picoides borealis (Red-cockaded Woodpecker)	0.2	7.4	E	C2	S1	G1
AcA Acipenser oxyrinchus (Atlantic Sturgeon)	0.6	--	E	--	S1	G3/G4
AbA Alligator mississippiensis (American alligator)	0.6	0.5	E	--	S1	G3
AmA Alligator mississippiensis (American alligator)	0.3	1.4	T	T	S3	G5
NIA Neonectura floridana floridana (Eastern Woodrat)	2.1	--	T	--	S1	G5T?
Plants:						
PrP Platanthera nivea (Snowy Orchid)	3.0	3.0	T	--	S1	G5
UsP Utricularia olivacea (Dwarf Bladderwort)	3.8	--	T	--	S2	G4
LeP Lilaeopsis carolinensis (Carolina Grasswort)	0.1	2.4	T	3C	S3	G3

Status Codes:

US	NC
E = Endangered	E = Endangered
T = Threatened	T = Threatened
SC = Special Concern	C2= Candidate 2
SR = Significantly Rare	3C = Candidate 3

Rank Codes:

NC

S1 = Critically Imperiled in NC due to extreme rarity.
S2 = Imperiled in NC.
S3 = Rare or uncommon in NC.
S4 = Apparently secure in NC.

Global

G1 = Critically Imperiled globally due to extreme rarity/ vulnerable to extinction.
G2 = Imperiled globally due to rarity/ vulnerable to extinction.
G3 = Very rare and local/restricted range.
G4 = Apparently secure globally, rare in parts of range.
G5 = Demonstrably secure globally, rare in parts of range.
T = Subspecies or Variety

1) Rare species data obtained from NC Natural Heritage Program. **Only State/Federal** Endangered and Threatened species are listed.

2) This illustration was adapted from the following National Wetlands Inventory 7.5 Minute Quadrangles: Wilmington, NC; Castle Hayne, NC; Leland, NC; Winnabow, NC; Carolina Beach, NC; Rocky Point, NC.

3) Surface water flowpath is indicated by bold dark lines.

Water quality classifications of the various pathway sections differ because of salinity. Upstream of the mouth of Toomers Creek (at the north end of Eagle Island (Ref. 1, Fig. 1)) the Cape Fear River is designated Class "C Sw", meaning that the water is suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation and agriculture. The Sw modifier indicates low velocity (as in swamps), as the river meanders through wetland . The Northeast Cape Fear River, from Ness Creek upstream to the 15-mile limit, has the same classification. For the remainder of the pathway both rivers are designated "SC", the tidal salt water equivalent of class "C" (Ref. 41). The entire site is mapped within the 100-year floodplain of the Cape Fear River and Greenfield Creek (Ref. 42)

5.2 Surface Water Targets

Two inactive surface water intakes for the City of Wilmington were listed within the 15-mile distance limits from the site. One is located at Toomers Creek and the other is on Smith Creek, both approximately 4 miles upstream of the site during normal flow. Because of salinity problems related to historical droughts, neither intake has been used for several decades except for emergencies. The city's active intake is located at Riegelwood, more than 15 miles upstream of the site on the Cape Fear River. No primary or standby municipal intakes currently operate within 15 miles upstream or downstream of the site (Ref. 21, p. 59; Refs. 28-29).

State fishery biologists report that both the Cape Fear River and the Northeast Cape Fear River support a seasonal commercial fishery. In the Wilmington area, transient american shad, hickory shad, and herring are taken for human consumption. Sport and subsistence fishing also yield resident largemouth and striped bass, flathead and blue catfish, and redbreast sunfish. Marine Fisheries officials report that the Cape Fear River at Wilmington is a nursery for blue crab, eel, and shrimp, which are commercially harvested within 15 miles downstream of the site (Ref. 43). At least 1 species of small crab was observed onsite during the SIP reconnaissance (Ref. 6, p. 2). Fish and wildlife enforcement personnel maintain that any accessible locations on Greenfield Creek or Greenfield Lake would be fished as well.

The site lies directly north, and upgradient, of a mapped wetland area which fronts the main drainage ditch between the main PPE and Greenfield Creek. This wetland frontage totals approximately 0.45 mile. Because of the low topographic relief and tides, wetlands are widespread within the study area. Most of the main Cape Fear and Northeast Cape Fear River channels are lined with mapped wetland frontage. In addition, several of the river systems' small tidal tributaries meander through large wetland areas. In particular, the lower portions of Indian, Sturgeon, Jackeys, Mallory, and Town creeks undergo tidal reversal and contain several miles of frontage. Within intervals subject to tidal reversal, a total of approximately 170 miles of frontage are mapped within 15 miles upstream and downstream of the site (Ref. 8; Ref. 40).

Ten rare animal species and 8 rare plant species have been reported within the surface water pathway. Of these, 4 animal and 2 plant species are listed as endangered or threatened in NC or the US (Fig. 3). These species are summarized in Table 3 (Ref. 45). The nearest (NC) Endangered animal species to the site, Acipensor brevirostrum (Shortnose Sturgeon), was identified 0.5 mile upstream on the Cape Fear River. The (NC and US) Threatened species Alligator mississippiensis (American Alligator) has been identified at 16 locations along the Cape Fear River, Brunswick River, and Northeast Cape Fear River. The (NC) Endangered snail species Planorbella magnifica (Magnificent Ram's Horn) and the (NC and US) Endangered mammal Trichecus manatus (West Indian Manatee) are reported in the Cape Fear estuary, 7.4 and 12 miles downstream of the site, respectively (Refs. 45-46). The (NC) Threatened plant species Lilaeopsis caroliniansis (Carolina Grasswort) and Platanthera nivea (Snowy Orchid) were identified on a tidal flat at locations 2.4 and 3.0 water miles downriver from the site, respectively (Ref. 45; Ref. 47).

5.3 Sample Locations

On 14 occasions between December 1985 and July 1993, SWP personnel collected surface water samples at 4 designated locations along the east bank of the Cape Fear River. The 4 locations included the US Route 74 Bridge, one of the 2 old boat slips west of the site, the mouth of Greenfield Creek, and the State Ports Authority waterfront, locations ranging from approximately 3500 feet upstream to 3500 feet downstream of the site (Ref. 7, Fig. 22; Ref. 49). The samples were tested for semi-volatile organic compounds and metals. Concurrent sediment sampling was not performed at these locations, not having been specified in the Administrative Order of Consent (Ref. 11, p. 6). ETE/Virogroup resampled surface water at these same locations on January 18, 1994 (Ref. 7, p. 29).

The last known sampling and testing of Cape Fear River sediment occurred during the January 1985 SSI. At that time, sediment sample SWP-RB-S was collected from the end of the jetty on the Cape Fear River (Fig. 2). This location lies between the 2 waterfront PPEs. Sediment sample SWP-BK-S1 was collected from Greenfield Creek below Greenfield Lake for comparison (Ref. 5, p. 8, Table 1, Table 5).

In December 1992, during Phase II of their assessment, ETE/Virogroup collected 11 soil and sediment samples both on and offsite, along the existing drainage ditch and the north bank of Greenfield Creek. The samples, numbered SS-1 through SS-11, were collected from 2-foot-deep borings and analyzed for volatile and semi-volatile compounds and inorganic parameters. No surface water sampling was conducted at these locations (Ref. 7, p. 21, Att. A).

Table 3
Southern Wood Piedmont Co.
Wilmington, NC
NCD 058 517 467
Surface Water Pathway - Endangered/Threatened Species

Species Name:	Distance from Site (Downstream)	Status NC	Status US	Rank NC	Rank Global
Animals:					
Trichecus manatus (West Indian Manatee)	12	E	E	S1N	G2?
Planorbella magnifica (Magnificent Ram's Horn (snail))	7.4	E	C2	S1	G1
Acipensor brevirostrum (Shortnose Sturgeon)	0.5	E	--	S1	G3
Alligator mississippiensis (American alligator)	1.4	T	T	S3	G5
Plants:					
Platanthera nivea (Snowy Orchid)	3.0	T	--	S1	G5
Lilaeopsis caroliniansis (Carolina Grasswort)	2.4	T	3C	S3	G3

Status Codes:

US
E = Endangered
T = Threatened

NC
E = Endangered
T = Threatened
C2= Candidate 2
3C = Candidate 3

Rank Codes:

NC
S1 = Critically Imperiled in NC due to extreme rarity.
S3 = Rare/Uncommon in NC.
N = Nonbreeding, migratory.

5.4 Analytical Results

SWP's Cape Fear water quality results were summarized by ETE/Virogroup in their Phase III report. Some of the analytical lab reports from 1990-1991 were also available from the files of the NC Hazardous Waste Section (Ref. 49). In general, no organic or inorganic parameters were detected in the samples. During June 1989, naphthalene was detected at 0.05 mg/l in a surface water sample from the mouth of Greenfield Creek, but the compound was not detected in a follow-up sample collected the following month. A July 1990 sample from the same location contained chromium at 0.046 mg/l and copper at 0.052 mg/l, but no detected arsenic (Ref. 7, p. 13, Att. A; Ref. 49). The concurrent sample at the old boat slip contained 0.011 mg/l chromium (Ref. 49).

The 1985 sediment sample SWP-RB-S from the Cape Fear River contained several semi-volatile organic compounds, including isophorone, 2-chloronaphthalene, acenaphthylene, phenanthrene, anthracene, fluoranthene (benzo(j,k)fluorene), pyrene, benzo-a-anthracene, chrysene, benzo(b) fluoranthene (benzofluoranthene -3,4), benzo(k)fluoranthene, and benzo-a-pyrene. Sediment sample SWP-BK-S1 from below Greenfield Lake contained isophorone, 2-chloronaphthalene, fluoranthene, and pyrene in similar concentrations , but not the remaining contaminants (Ref. 5, p. 8, Table 5, App. A). Both samples contained lead (6 - 15 mg/kg) and cyanide (0.225 - 0.430 mg/kg), but no detected copper, chromium, or arsenic (Ref. 5, p. 8, Table 4, App. A).

Except for the lack of detected naphthalene, and the presence of some additional components (isophorone, 2-chloronaphthalene, acenaphthylene, and pyrene - the latter 2 being coal tar derivatives), the contaminant composition of the Cape Fear River sediment resembled that of the creosote waste encountered at the site (Ref. 7, Att. A, Att. G; Ref. 34; Ref. 50).

Contaminants were also detected in several of the soil and sediment samples collected from the existing drainage ditch and Greenfield Creek in 1992. Detected volatile organics included 1,2 - dichloropropane, toluene, ethyl benzene, and xylenes. Several semi-volatile organic compounds, including polynuclear aromatic hydrocarbons, were detected in the samples (Ref. 7, p. 11, Att. A; Ref. 50; Table 4). The organic contaminants closely match the composition of the organics encountered at the site (Ref. 7, Att. A, Att. G). SS-7, located within the mapped wetland interval in the ditch, contained elevated semi-volatiles, especially naphthalene and phenanthrene. Contaminants were detected in samples SS-4, SS-5, and SS-6 at the site, and in samples SS-9 and SS-10, near the mouth of Greenfield Creek (Fig. 2). The organic compositions of samples at both locations included a number of compounds associated with creosote and coal tar (Refs. 34-36).

TABLE 4
SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC.
NCD 058 517 467
SOIL & SEDIMENT CONTAMINANT SUMMARY

Contaminant:	Soil Sampling Results: Maximum Detected Contaminant Levels					Sediment Sampling: Maximum Results		Lowest Health-based Benchmark Concentration (Soil Exposure)
	Wood Storage Areas			Landfarm Areas		Drainage Ditch SS-7	Greenfield Creek SS-9	
Volatile Organic Compounds (ug/kg):	TWS	NTA	NTB	LF-1	LF-2			
Dichloromethane	Soil samples not analyzed for volatile organic compounds.					0.059	0.02	(No applicable sediment benchmarks)
(Methylene chloride)							--	
Benzene						--	--	
Ethyl benzene						0.15	--	
Toluene						0.016	--	
M/P - Xylene						0.084	0.0071	
O - Xylene						0.069	0.0075	
Semi-volatile Organic Compounds (ug/kg):								
Acenaphthene	2000	--	--	1.9 J	92	4.4	32	3500 R
Acenaphthylene	2.5	0.48	1.6	4.1 J	5.4 J	NA	NA	**
Anthracene	2200	1.1	84	350	900	45	49	170000 R
Benzo(a)anthracene	800	1.6	25	42	130	7.4	26	**
Benzo(a)pyrene	290	1.1	17	32	65	3.2	9	0.08 C
Benzo(b)fluoranthene						0.75	15	**
(Benzofluoranthene 3-4)	690	5.9	50	120 J	190			
Benzo(k)flouranthene						4.9	--	**
Benzo(g.h.i)perylene	--	--	--	16	34	NA	NA	**
1,1 - biphenyl	--	--	--	1.1 J	2.3 J	--	--	29000 R
Chrysene	740	2.7	52	59	150	5.5	22	**
Cresol	--	--	--	0.07	50 J	NA	NA	2900
Dibenzo(a,h)anthracene	2.4	--	1.3	7.5 J	15 J	3.7	0.94	**
Dibenzofuran	--	--	--	9.3	26	NA	NA	**
2,4-dimethyl phenol	--	--	--	0.86	0.12	--	--	12000 R
Fluoranthene	3700	4	97	140	520	52	130	23000 R
(Benzo(j,k)fluorene)								
Indeno(1,2,3-cd)pyrene	88	0.85	3.8	17 J	980	2	3.4	**
1-methyl naphthalene	--	--	--	4.0 J	20	NA	NA	**
2-methyl naphthalene	--	--	--	15	41	NA	NA	**
Naphthalene	0.87	0.99	0.93	4.8	30	1.8	--	*
Pentachlorophenol	--	--	--	4.3 J	150 J	--	--	4.9 C
Phenanthrene	4000	1.1	54	130	200	42	70	**
Pyrene	--	--	--	150	500	NA	NA	17000
Trichlorophenol	--	--	--	--	0.048 J	--	--	53 C(4)
Tetrachlorophenol	--	--	--	0.044 J	3.5	--	--	17000 R
TCDD (total)	NA	NA	NA	0.00014	0.00017	NA	NA	0.0000039 C
Inorganic Parameters (mg/kg):								
Arsenic	31	63	13	23	84	3.6	--	0.33 C
Chromium	11	15	22	14	100	11	4.1	2900 R
Copper	110	300	130	70	150	14	4.4	**
Lead	NA	NA	NA	NA	NA	25	6.9	**

Health-based Benchmark Values (1994) from Superfund Chemical Data Matrix, Appendix B:
(C) = Cancer Risk Screening Concentration.
(R) = Reference Dose Screening Concentration.

NA Indicates sample not analyzed for parameter.
(*) Indicates Benchmark Concentration currently under review by USEPA.
(**) Indicates No Established Benchmark Concentration.

1. Concentrations in excess of applicable Health-based Benchmarks for human soil exposure are shaded.
2. Soil contaminant data obtained by Geraghty and Miller, Inc. (Refs. 12 - 15).
   Sediment contaminant data obtained by ETE/Virogroup, Inc. (Ref. 7).
3. SCDM benchmark for 2,4,6 trichlorophenol.

Samples SS-8 and SS-11, located at intermediate positions on the ditch and creek, contained no detected organic compounds other than dichloromethane. SS-8, like SS-7, was within the mapped wetland interval. SS-1, located at an apparent upstream (background) position on Greenfield Creek, contained several of the compounds detected downstream and onsite (Ref. 7, Fig. 2; Ref. 50). However, contaminants might have been transported to this location from downstream during tidal flow reversal. Because of the high semi-volatile concentrations detected in SS-10 (total: 6,110 mg/kg), the location was resampled on November 19, 1993 as SS-10A. This follow-up sample contained a much lower but still detectable concentration of semi-volatiles (total: 45.3 mg/kg) (Ref. 7, p. 11, pp.-24-25, Att. F).

Arsenic was detected in sediment samples SS-1, SS-2, SS-4, SS-5, and SS-7, at a maximum concentration of 5.2 mg/kg. SS-1 was the only lower ditch or creek sample in which arsenic was found. Chromium concentrations in the 11 samples ranged from 1.3 mg/kg to 14.0 mg/kg. Copper concentrations ranged from 1 to 46 mg/kg, and lead ranged from 1.9 to 290 mg/kg. Sample SS-2, located east of the main drainage ditch, contained the highest detected concentrations of all 4 metals. This sample's location, a small ditch connected to the main ditch, appears to be subject to tidal flooding, but may also receive drainage from the adjacent railroad grade (Ref. 7, Fig. 3; Ref. 51).

5.5 Surface Water Conclusions

Sediment sampling results indicate historical release of the site's organic wood-preserving compounds to the surface water pathway. The data indicate the presence of volatile and semi-volatile aromatic compounds in Greenfield Creek sediments, and in the Cape Fear River bed west of the site. Although past investigators have indicated the possibility that nearby petroleum terminals are also potential sources (Ref. 7, p. 13) the presence of tetracyclic and pentacyclic semi-volatiles in the samples indicates creosote or coal tar rather than refined petroleum (Refs. 35-37; Ref. 44). The site's history, and the overall similarity between lower Greenfield Creek contaminants and the organic content of on-site soils, points to the site as a likely source.

Although net sediment transport is toward the Atlantic Ocean, tidal flow reversal occurs as far as 15 miles inland from the site, potentially transporting contaminants for measurable distances upstream from the site as well as downstream. Because of the amount of regional development and the physical complexity of the river system, contamination detected at a significant distance up- or downriver would be more difficult to attribute to the site.

The brackishness of the Cape Fear estuary and lack of active intakes minimizes the surface drinking water threat posed by the site. The river system is a significant commercial and recreational fishery, however, and Greenfield Creek is probably fished as well. Therefore contaminant release to the surface water pathway may have affected fisheries in both surface water pathway segments. Extensive wetland frontage, and several Threatened, Endangered, and other rare species have been identified upstream and downstream of the site in the Cape Fear River system and its tributaries.

Because of the amount of regional development and the physical complexity of the river system, contamination detected at a significant distance would be difficult to attribute to the site. Locally, however, the evidence indicates that creosote contamination has migrated from the site to an adjacent wetland and to the adjacent Cape Fear River bed. The evidence for inorganic contamination at these locations is less conclusive.

6.0 SOIL AND AIR PATHWAYS

6.1 Physical Conditions

The site is currently inactive and vacant of SWP or other employees. All above-grade structures have been removed. Unpaved areas of the site are vegetated with grass. The landfarm areas, which are no longer being actively worked, are bermed to prevent runoff and are also vegetated (Ref. 6, p. 1). Surface soils at the site that were visibly contaminated with creosote were excavated and treated in the landfarming areas. Soils contaminated by chromated copper arsenate in excess of 500 ug/kg were excavated and either disposed offsite or stabilized onsite using concrete. The various excavations were backfilled with soil from an offsite location. In their December 1993 report, Geraghty &Miller reported some creosote staining in the northern part of area NTA, in area NTB and in area TWS (Ref. 14, p. 4-3, Figs. 4-4 to 4-6; Fig. 2).

6.2 Soil and Air Targets

No residents or workers are present at the site (Ref. 6, p. 1). The property is secured only by a vehicle gate at the entrance, and is accessible to local pedestrians or to boaters on the Cape Fear River. During the SIP reconnaissance, no evidence of trespassing was observed, however, vandalism has occurred at a monitoring well accessible via the site (Ref. 7, p. 13) . The nearest residences are located approximately 400 feet east of the site (Ref. 1; Ref. 51). The total population residing within 0.25 mile of the site is estimated at 527. A total of 51,914 people live within 4 miles of the site (Ref. 56; Table 5) .

The nearest workers are anticipated to be at the Hess terminal north of the site and at the Greenfield Transmission Co. and the Locke Industries facilities, located directly east of the site (Ref. 51). The nearest school is located 0.45 mile south of the site (Ref. 1; Refs. 51-52). The nearest day care facilities are on South 2nd, South 3rd, South 4th, and Meares Streets, a minimum distance of 0.2 mile east of the site (Ref. 52-53). A recreational park is located less than 0.25 mile southeast of the site, but is separated from the site by a railroad grade, by vegetation, and by the ditch that drains the site (Ref. 51).

Table 5
Southern Wood Piedmont
Wilmington, NC
Population Distribution

Distance (mi.):	Population:	Cumulative Population:
0.0 - 0.25	527	527
0.25 - 0.5	828	1,355
0.5 - 1.0	7,206	8,561
1.0 - 2.0	16,147	24,708
2.0 - 3.0	12,212	36,920
3.0 - 4.0	14,994	51,914

6.3 Soil Sample Locations

In 1982, prior to any soils excavation or treatment, SWP and the NC Division of Health Services collected 4 split soil sample sets along the Oil Treating and Track areas (Refs 16-17; Fig. 2). In the CCA Area, soil sampling for arsenic EP toxicity was used as a screening tool to guide soil excavation and disposal (Ref. 20, pp. 4-10).

In February and April, 1991, Geraghty & Miller collected 48 soil samples from 35 borings in the NTA, NTB, and TWS areas of the site. Sample depth ranges were 0-6 inches in the 2 Non-treated Wood (NTW) areas, and 0-6 inches and 12-18 inches in the Treated Wood Storage (TWS) area (Ref. 14, p. 3-1, Figs. 4-1 to 4-3).). Soil in these areas had been tilled, but not treated.

G&M conducted 2 sampling events at the landfarming areas, collecting soil composites from 5 borings at each landfarming area in October 1990 and again in October 1991 (Ref. 12, p. 3-1; Ref. 13, p. 3-1). Each sample fraction was a composite from 3 depths within the landfarmed material and 1 depth within the underlying substrate. These samples were tested for pH, various nutrients, and PAH compounds. The 1990 samples were also tested for dioxins and furans. These landfarm investigations were completed in preparation for G & M's December 1993 Risk Assessment report (Ref. 15).

ETE/Virogroup sampled soils at the former Creosote Ditch area in December 1992. These samples were collected from within 2 feet of the ground surface at 3 locations (SS-4 through SS-6) along the former course of the ditch. The samples were tested for volatile and semi-volatile organics and for inorganics (Ref. 7, p. 11, Fig. 3).

6.4 Soil Analytical Results

Soil sample analytical results are outlined in Table 4. Samples of landfarmed soils collected by G&M in 1990 and 1991 contained 24 semi-volatile organic compounds. Several of the detected semi-volatiles are commonly associated with creosote. Pentachlorophenol was among the analytes detected (Ref. 12, pp. 2-3 - 2-6, pp. 4-1 - 4-2, Tables 4-1 - 4-2, App. D).

Polychlorinated dibenzodioxins and polychlorinated dibenzofurans were detected in the landfarm soils. Totals for these compounds, including tetrachlorodibenzodioxins (TCDD), exceeded health-based benchmarks for human soil exposure (Ref. 12, pp. 3-5 - 3-6, Table 4-3, App. D; Ref. 20). One dioxin and 1 furan isomer were detected in the laboratory blank, however, and quantitative interferences for several isomers were reported in the blank and the LF-1 and LF-2 samples, leading G & M to conclude that concentrations of the affected analytes may be considered qualitative (Ref. 12, p. 3-6). These compounds have not been tested for in other soil or sediment samples.

G & M's samples from the former outdoor treated and untreated wood storage areas contained 12 of the same semi-volatile compounds detected in the landfarmed soils. One sample from the TWS area contained 2000 mg/kg acenaphthene, 4000 mg/kg phenanthrene, 2200 mg/kg anthracene, and 3700 mg/kg fluoranthene (benzo(jk)fluorene). Maximum detected semi-volatile concentrations at the NTW areas were considerably less than those in the TWS area (Ref. 14, Table 4). Additional products detected included carbazole and trichlorophenol isomers, which are not included in the Superfund Chemical Data Matrix (Ref. 14, p. 4-1, App. B; Ref. 20).

Some of the compounds detected at the above locations were not tested for during analysis of ETE's soil and sediment samples from the former Creosote Ditch area and Greenfield Creek. The majority of creosote-associated semi-volatiles that were tested, however, were detected in the samples (Ref. 7, p. 11, Att. A; Ref. 50, Att. E; Table 4).

Testing of soils in the CCA area detected arsenic EP Toxicity concentrations in excess of 5 mg/kg (Ref. 19, p. 6). Testing of soils in the NTA, NTB, and TWS areas detected maximum concentrations for total arsenic of 63 mg/kg, 13 mg/kg, and 41 mg/kg, respectively. Maximum total chromium concentrations for these 3 areas were 15 mg/kg, 22 mg/kg, and 11 mg/kg, respectively. Maximum total copper concentrations were 300 mg/kg, 130 mg/kg, and 110 mg/kg, respectively (Ref. 14 , Tables 4-1 - 4-3).

ETE/Virogroup sample SS-2, an offsite soil/sediment sample collected from a drainage ditch on the property east of the railroad grade and the site, contained arsenic, chromium and copper concentrations of 5.2 mg/kg, 14 mg/kg, and 46 mg/kg, respectively (Ref. 7, Att. A, p. 7). If SS-2 is considered a background sample, these results indicate that areas NTA and TWS contain arsenic in excess of 3 times the background level, and that area NTA contains copper in excess of 3 times background level. None of the samples contained chromium in excess of 3 times background concentration. The minimum health-based benchmark concentrations for human soil exposure are 0.33 mg/kg for arsenic and 2900 mg/kg for chromium. No such benchmark presently exists for copper (Ref. 20). The results therefore indicate that arsenic levels at the site are in excess of the EPA benchmark level for soil exposure.

6.5 Air Monitoring

No formal air monitoring was conducted onsite during the SIP reconnaissance. Historical air monitoring has apparently occurred only during active contractor subsurface explorations at the site, when recovered soil samples were screened in the field for the presence of volatile organic compounds (Ref. 7, Att D). Elevated volatiles were detected in the subsurface materials during the explorations. At present, however, the site is vegetated, and no odors, or visual evidence of wood-preserving materials or blowing particulates was detected at the site during the 1994 site reconnaissance.

6.6 Soil and Air Pathway Conclusions

The site is located in an urban industrial area close to residential areas in Wilmington, where it is potentially accessible to the public. Soils at the site contain residual amounts of hazardous wood-preserving materials. Currently, however, the site is vegetated and has no on-site resident or worker populations, limiting the potential for human exposure. Historical vandalism has occurred onsite, however, no evidence of trespassing was seen during the reconnaissance. The predominantly non-volatile nature of the wood-preserving materials, and the present surface conditions at the site, do not indicate a significant vapor or particulate respiratory hazard to individuals on or near the site.

A risk assessment of the landfarm areas of the site was completed by Geraghty & Miller, Inc., in 1993 . The assessment indicated that small mammals, birds and invertebrates at the site might be affected by exposure to soil contaminants at the site, but that little risk to humans or rare species would be incurred by future site development, particularly in the event of additional filling and paving at the site (Ref. 15).

NC DEHNR Environmental Epidemiology Section reviewed the Risk Assessment Report, and noted that the assessment had not addressed all potential future uses of the site, but had instead assumed future industrial, nonresidential use. EES concluded that future site usage would have to be specified, and cited acceptable levels in uncovered industrial soils for pentachlorophenol 6 other PAH species, and TCDD equivalents. Additionally, the NC Hazardous Waste Section, Waste Management Branch listed recommended remediation levels for the same parameters (Ref. 54).

At one or more onsite locations, the maximum soil concentrations of each of the 7 semi-volatile parameters detected exceeded the acceptable levels quoted by EES (Ref. 7; Refs. 12-15; Ref. 54; Table 4). In particular, the maximum concentrations of benzo(a)pyrene exceeded the EES limits in all 3 of the treated and untreated wood storage areas, in both landfarm areas, the drainage ditch, and the mouth of Greenfield Creek. TCDD in the landfarm soils also exceeded the provided TCDD equivalent limits (Ref. 12, pp. 3-5 - 3-6, Table 4-3, App. D).

The above results indicate that the potential remains for human soil exposure to carcinogenic waste materials from wood-treating activities at the site. The potential for exposure may increase in the event of future development of the site, particularly if soil excavation or other construction activity unearths contaminated soil. Under present conditions, however, the threat of human exposure to soil or air contamination at the site appears to be minimal.

7.0 SUMMARY AND CONCLUSIONS

The Southern Wood Piedmont, Wilmington site was used from 1935 to 1983 to treat and store wood products. Wood treating materials used at the site included creosote, pentachlorophenol (PCP) and chromated copper arsenate (CCA). SWP excavated large quantities of creosote contaminated soils from various locations at the site in the 1980s and landfarmed them onsite. Arsenic-contaminated soils were transported to a hazardous waste landfill or were stabilized with cement and reburied in their excavation. Clean fill from offsite was reportedly used to backfill the excavated areas. Excavation and landfarming ended in April 1990.

Investigations completed on site between 1985 and 1993 have documented creosote contamination of surface and subsurface soil and groundwater at the site. Subsurface exploration has revealed both non-aqueous and aqueous phase semi-volatile organic compounds (SVOCs) in groundwater and soils beneath much of the site. Aqueous contaminants in the sandy subsoil have migrated through a peat layer and contaminated a deeper, semiconfined sand unit. PCP has not been detected in the groundwater, and elevated inorganics in groundwater have been identified only in monitoring wells adjacent to a former CCA storage area. Sampling results do not indicate that contaminants have migrated from the 5-acre landfarm to groundwater.

Neither of the contaminated overburden units is used as a drinking water source. The overburden is separated from bedrock by a tight, apparently continuous clay layer 2 feet thick. The sandy limestone formation beneath the clay is a principal aquifer in the region. No groundwater samples were collected from this aquifer, however, groundwater use is very limited within 2 miles of the site, and no municipal groundwater supply wells are located in the study area.

The site drains to the Cape Fear River by direct runoff and via a drainage ditch and Greenfield Creek. Sediment samples collected from the upper ditch and the lower creek contained most of the same SVOCs detected onsite. The detection of tetra- and pentacyclic SVOCs suggests that the contaminant is creosote rather than fuel. No surface water samples have been collected in this segment of the pathway. To date, no SVOCs from the site have been detected in water samples collected from the Cape Fear River, however, Cape Fear River sediment sampled adjacent to the site was found to be contaminated with creosote components. The Cape Fear River and its tributaries undergo tidal flow reversal for more than 15 miles upstream of the site. The amount of upstream migration of contaminated sediment is unknown.

No surface water intakes for public supply operate within 15 miles upstream or downstream of the site. However, the Cape Fear River system is a commercial and sport fishery, and the Cape Fear River at Wilmington is a nursery for commercially harvested blue crab, eel, and shrimp. Greenfield Creek, where sediment sampling has detected SVOC contamination at multiple locations, is reportedly fished as well.

Approximately 2000 feet of wetland frontage is mapped along the drainage ditch linking the site to Greenfield Creek. Detected sediment contamination in the creek extends beyond the wetland interval. The Cape Fear River system contains approximately 170 miles of additional mapped wetland frontage within 15 miles upstream and downstream of the site. The Natural Heritage Foundation has identified 10 rare animal and 8 rare plant species within the surface water pathway. Four of the animal species are listed as Endangered in NC and/or the US. One animal and 2 plant species are listed as Threatened.

Landfarm soil samples collected in 1990 and 1991 contained residual creosote contamination. In some samples, benzo(a)pyrene and PCP concentrations exceeded their current health-based Cancer Risk Screening Concentrations for human soil exposure. Various dioxins and chlorodibenzofurans were also detected above their benchmarks in the landfarm areas , however there is some uncertainty in their quantifications. No other dioxin testing has been performed at the site or at any of the off-site sample locations.

Soil sampling in 1991 detected SVOCs in areas TWS, NTA and NTB, which were formerly used for outdoor storage of treated and non-treated wood, but were never excavated or landfarmed. Benzo(a)pyrene detection in some locations exceeded its Cancer Risk Screening Concentration for human soil exposure. All other SVOCs were below their respective benchmarks. Arsenic was detected above its soil exposure benchmark in all of the landfarm and wood storage areas.

The site is currently uninhabited, but is accessible on foot or by boat. The nearest residences are located approximately 400 feet east of the site. The nearest school is located 0.45 mile south of the site, and the nearest day care facilities are at least 0.2 mile from the site. A sports field is located directly southeast of the site, but is separated from the site by a railroad grade, by thick vegetation, and by the existing on-site drainage ditch.

A Risk Assessment completed at the site in 1993 indicated that contaminant levels at the site are low enough for future industrial land use. However, based on the Risk Assessment report, the NC Environmental Epidemiology Section has indicated that the site does not currently meet cleanup standards for future residential use. Future site development might also expose workers to unacceptably high carcinogen levels.

In summary, extensive groundwater contamination has occurred at the site, but does not appear to threaten any drinking water supplies. The threat of human soil or respiratory exposure to on-site contaminants is limited by current surface conditions and the lack of an on-site residential or worker population, but could increase with future site development. Semi-volatile organic soil contaminants at the site have historically migrated to sections of the surface water pathway containing mapped wetlands and fisheries. Sampling performed since the mid-1980s is insufficient to determine the full extent of sediment contamination in the surface water pathway. Elevated polychlorinated dibenzodioxin and dibenzofuran concentrations have been detected in landfarmed soils at the site, but current analytical data are insufficient to evaluate the full extent and significance of contamination. Based on the above results and information, the NC Superfund Section recommends the SWP-Wilmington site for an Expanded Site Inspection (ESI) under CERCLA.

Southern Wood Piedmont Co. - Wilmington
NCD 058 517 467
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PHOTOGRAPHS

Photos 1-2: Views SE and ~~SW~~ NW across site from site entrance. Note surface vegetation, and small drainage ditch (top photo).

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Photos 3-4: Detail of vegetation and recently ponded rainwater in small drainage ditch.

Photos 5-6: Views N and NW toward Hess terminal and Cape Fear River, respectively. Landfarming Areas are in foreground. SWP personnel report that landfarm is no longer actively irrigated.

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Photo 7: Ground surface detail at edge of Landfarming Area. Berm is at lower right.

Photo 8: Ground surface detail of unexcavated area NW of former Main Production Area. Note railroad ties still in place.

Photos 9-10: W and N berms of former Landfarming Areas, bordered by uncut vegetation. Note apparent surface slopes to S and E.

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Photo 11: View E from waterfront showing ponding of rainwater on ground surface in former Treated Wood Storage (TWS) Area.

Photo 12: View SSW from waterfront, south of former boat slips, showing Cape Fear River estuary.

Photos 13-14: Southern and northern former boat slips, respectively, viewed from jetty area.

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Photos 15-16: On-site portion of Existing Drainage Ditch (which flows south to Greenfield Creek), viewed during (approximate) high tide.