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DATA SUMMARY REPORT FOR THE 1991 LANDFARM AREA SAMPLING AND COMPARISON OF 1990 AND 1991 SOIL AND GROUND-WATER DATA SOUTHERN WOOD PIEDMONT COMPANY WILMINGTON, NORTH CAROLINA

September 1993

Prepared for

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DATA SUMMARY REPORT FOR THE 1991 LANDFARM AREA SAMPLING AND COMPARISON OF 1990 AND 1991 SOIL AND GROUND-WATER DATA SOUTHERN WOOD PIEDMONT COMPANY WILMINGTON, NORTH CAROLINA

1.0 INTRODUCTION

Geraghty & Miller, Inc., was retained by the Southern Wood Piedmont Company (SWP) to conduct a study of current conditions in the two landfarm areas at the SWP Wilmington former wood-treatment facility. Soil samples were collected on October 15, 1991, from the same landfarm locations sampled in October 1990 (Geraghty & Miller, 1993a). The purpose of the sampling was to provide baseline data with which to conduct a risk assessment. This risk assessment was to evaluate whether a "concentration of residual pentachlorophenol (PCP) and major constituents of creosote is reached which will protect public-health and the environment," according to the terms of the Administrative Order of Consent Agreement (North Carolina Department of Human Resources, 1985), paragraph 10.

This report presents a brief history of the landfarming operations at the site, a discussion of the site environmental setting, the sampling and analysis methodologies used, and a discussion of the results. The analytical data for the 1990 and 1991 sampling events were also compared to evaluate changes in constituent levels attributable to physical, chemical, and biological degradation.

1395swp

2.0 SITE HISTORY AND ENVIRONMENTAL SETTING

This section gives of brief description of the history of the site and landfarming operations and a review of historical landfarm sampling data. Land use for the surrounding area and regional/local geology and hydrogeology are also discussed.

2.1 SITE HISTORY

SWP and its predecessors leased and operated a wood-treatment facility in Wilmington, North Carolina, from approximately 1932 to 1983. In 1932 the North State Company leased the property previously operated by Liberty Shipyards. The North State Company purchased and sold non-treated wood from 1932 to 1935. In 1935, the Taylor Colquitt Company leased the property to establish a wood-preserving facility to treat piling and poles with creosote. ITT, of which SWP is a subsidiary, acquired the company in 1969. SWP added chromated copper arsenate (CCA) to the wood-treatment process in the early 1970s and pentachlorophenol (PCP) in the late 1970s. Each of the three preservatives was stored on site in tanks adjacent to the respective treating facility. Additional creosote storage was in the southwestern property corner. In June 1983, the SWP facility ceased its wood-treatment operations and began closure procedures.

2.2 HISTORY OF LANDFARMING OPERATIONS AND PREVIOUS SAMPLING

In the northwest corner of the SWP property, a 5-acre area was bermed and ditched following the removal of rails and crossties and was divided into two landfarm areas: Landfarm 1 (LF1) and Landfarm 2 (LF2) (Figure 2-1). This area was formerly used as the treated wood storage area.

During the period July 1984 through April 1990, soil material originating from the spoil pile area was applied at regular intervals. Over the period, approximately 17 different soil amendments occurred for LF1 and 20 for LF2. Each amendment consisted of a 2-inch-thick layer of spoil pile material being added to the surface of the landfarm. During the landfarm operation, irrigation water, 10-10-10 fertilizer, and chicken and turkey manure were added to promote and enhance microbial growth and polycyclic aromatic hydrocarbon (PAH) degradation. The two landfarm areas were tilled to a depth of 6 inches weekly, promoting biological and photochemical treatment of residual chemicals.

Two composite sets of soil samples were taken by a SWP representative. A composite sample was taken for each of the following depths: 0 to 3 inches, 9 to 12 inches, and 21 to 24 inches. Soil from the four corners of each landfarm was mixed to make up the two composite samples for each depth. Each landfarm was sampled separately. The initial sampling began in September 1985 for LF2 and in November 1985 for LF1. Over the time period of operation, 59 sets of samples were taken from LF2 and 37 from LF1.

The samples were analyzed for total nitrogen, total phosphorus, chloride, total organic carbon, soil pH, PAH, PCP, phenol, and microbial counts by the Mississippi State Unviersity Forest Products Research Division Laboratory (MSUFPRD) in State College, Mississippi. A discussion of results of these sampling events is provided in the 1990 Data Summary Report (Geraghty & Miller, 1993a).

The quality of ground water in the two landfarmed areas was monitored during the landfarm operations. Four monitor wells were installed in September 1985 on the perimeter of the landfarm area. Ground-water samples from the upgradient (MW-6) and three downgradient (MW-7, -8, and -9) monitor wells initially were collected biannually and subsequently annually and analyzed for PCP and the major constituents of creosote. Composite soil samples were also taken directly from the spoil pile and analyzed for PAH constituents.

Cultivation and fertilization treatments were ended in May 1990. On October 9 and 10, 1990, the four monitor wells and the two landfarms, LF1 and LF2, were sampled by Geraghty & Miller for the MSUFPRD list of constituents to establish a baseline of current conditions (Table 2-1) (Geraghty & Miller, 1993a). The four monitor wells and two landfarms were resampled by Geraghty & Miller on October 14 and 15, 1991.

2.3 SURROUNDING LAND USE

The SWP facility, which measures approximately 1,000 feet east to west by 1,600 feet north to south, lies within an industrialized area of Wilmington, North Carolina. Industry in the vicinity includes the Hess Fuel Tank Farms separated from the SWP property by a ditch on the north side and the Poctank, Inc., plant separated by an undeveloped lot on the south side of the SWP property. The major roads in the vicinity of the plant are Greenfield and Surrey Street. Greenfield Street runs in an east-west direction and dead ends into the center of the facility. Surrey Street runs in a north-south direction and is situated east of the property. The Cape Fear River borders the property on the west.

2.4 REGIONAL AND SITE GEOLOGY AND HYDROLOGY

The Wilmington site is located in the Coastal Plain Physiographic Province of North Carolina, a region underlain by Cretaceous and Cenozoic marine and non-marine sedimentary sequences. Approximately 1500 feet of Coastal Plain sediments overlie pre-Mesozoic crystalline basement rock in the Wilmington area (NCGS, 1985). The site is directly underlain by the Cretaceous-age Pee Dee Formation (NCGS, 1985), which consists predominantly of unconsolidated, dark green to gray, clay-rich, marine sand and which may contain calcareous sandstone ledges (Sohl and Owens, 1991).

Five soil borings were advanced at the site to a maximum depth of approximately 50 feet by Soil and Material Engineers, Inc., during 1981 and an additional four borings (to a maximum

depth of 20 feet) were drilled by Law Environmental in 1985. Lithologic logs (presented in Soil and Material Engineers, 1981, and Law Environmental, 1985) indicate that a surficial layer of sandy fill material or sand is present at the site, which varies from less than 1 foot to 18 feet in thickness. This layer, which appears to be thickest in the northern part of the site, is described as consisting of fine to medium sand, with wood, roots, or other material occasionally found. Below this sandy material is a layer consisting of dark brown, organic-rich silt or peat, which may contain traces of fine sand, roots, and wood fragments. This layer ranges in thickness from 5 to 19 feet.in the soil boring locations, and apparently increases in thickness toward the Cape Fear River to the west. Fine to medium sands extend from below the organic rich layers to a depth of 42 to 45.5 feet, below which a gray marl is encountered (Soil and Material Engineers, Inc., 1981).

Based on their observations, Soil and Material Engineers (1981) concluded that the dominant direction of shallow ground-water flow at the site was to the south, parallel to the Cape Fear River. Water table maps prepared by Law Environmental (1985) indicate westward to southwestward flow (toward the river) near the Landfarm areas, and generally southward flow at the eastern part of the site. Tidal influences may cause temporary alterations or reversals in these flow directions. Hydraulic conductivities ranging from 3×10^{-5} centimeters/second (cm/sec) to 10^{-6} cm/sec were determined based on in-situ monitor well tests, and an average ground-water flow velocity of 0.10 feet/year was calculated (Law Environmental, 1985).

1395swp

3.0 INVESTIGATIVE METHODS

A soil and ground-water sampling program was conducted in October 1991 within the two landfarmed areas, LF1 and LF2, to provide data on current conditions. The soil sampling locations and depths were selected to assess the presence of PAHs, CCA, and nutrients within the landfarmed material. The samples were collected from the ten locations previously sampled in 1990 (Figure 3-1). The sampling depths, however, were modified to include only the upper and lower layers of landfarmed material. The landfarmed material center and underlying substrate were not sampled since the 1990 sampling program indicated the PAH concentrations in the landfarmed material to be consistent with depth and to be significantly lower in the underlying substrate (Geraghty & Miller, 1993).

The soil samples were collected in the landfarmed material in accordance with standard operating procedures presented in the Work Plan. Ground-water samples were collected from the four monitor wells bordering LF1 and LF2. All samples were analyzed by Savannah Laboratories and Environmental Services, Inc., Savannah, Georgia, for the expanded list of constituents presented in Table 2-1 in accordance with U.S. Environmental Protection Agency (USEPA) methodologies. All field records and analytical data were reviewed and validated by a Geraghty & Miller Quality Assurance/Quality Control Manager.

3.1 SOIL SAMPLING

Soil samples were collected on October 15, 1991, from the five locations sampled on October 10, 1990, within the two landfarmed areas as illustrated in Figure 3-1. At each location, two samples were collected within the landfarmed material and analyzed for pH and the expanded list of wood-preserving constituents and nutrients (Table 2-1).

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A small-diameter (<4-inch), stainless steel, hand-held bucket auger was used to determine the depth of the underlying substrate soil at each sampling location prior to collecting soil samples. Following this preliminary activity, the auger was decontaminated with a laboratory-grade soap solution and rinsed three times with distilled water. The depth of the landfarmed material in LF1 and LF2 ranged from 15 to 26 inches and 15 to 20.5 inches, respectively. These depths are on the average less than those recorded in 1990 (12 to 30 inches).

The two soil samples within the landfarmed material were collected at each sampling location by means of a hand-held bucket auger. Each borehole consisted of a sample taken at the surface and above the substrate layer. The upper and lower sections of the individual soil cores were removed and discarded to prevent potential contamination between subsequent samples. The landfarmed soil was black, friable, and had a moist consistency. Bricks and glass were encountered at the landfarmed material-substrate interface at several borehole locations. The samples were placed in stainless steel bowls and thoroughly mixed prior to being stored in sample containers on ice at 4°C. Following the collection of the samples and the removal of the intermediate soil layers, the bucket auger was decontaminated with a laboratory grade soap solution and rinsed three times with distilled water.

3.2 GROUND-WATER SAMPLING

The three downgradient (MW-7, MW-8, and MW-9) and upgradient (MW-6) monitor wells on the perimeter of LF1 and LF2 were sampled on October 14 and 15 for total suspended solids and for the expanded list of nutrients and wood-preserving constituents (Table 2-1). Plastic sheeting was placed around the wells to protect the sampling equipment from potential contamination prior to determining the well depth and water elevation using an electronic water-level meter. The wells were evacuated and sampled with disposable polyethylene bailers in accordance with standard operating procedures outlined in the Work Plan (Geraghty & Miller,

1990). The ground-water samples were placed in appropriate sample containers and stored on ice at 4°C. Ground-water sampling logs are included in Appendix A.

3.3 LABORATORY ANALYSES AND QUALITY ASSURANCE/QUALITY CONTROL PRACTICES

All soil and ground-water samples were analyzed by Savannah Laboratories and Environmental Services, Inc., Savannah, Georgia, for nutrients (total nitrogen, total phosphorus, total organic carbon, and chloride) and wood-preserving constituents in accordance with USEPA-approved methodologies. The 1991 list of constituents was expanded to include the PAHs and metals detected during the former treated and non-treated wood storage area sampling programs (Table 2-1). The 1990 analytical data for these additional PAHs were requested from Savannah Laboratories and Environmental Services, Inc., to permit a more comprehensive comparison between the two data sets. Several field quality control samples were collected during the ground-water and soil sampling programs to assess field techniques and laboratory performance. These samples included rinsate blanks (RB-1 and RB-2) and field blanks (FB-1 and FB-2). Sample RB-1was collected using a clean disposable polyethylene bailer whereas sample RB-2 was collected using the decontaminated bucket auger and stainless steel bowl following the collection of sample LF2ALS. Samples FB-1 and FB-2 were taken concurrently. The quality control samples were prepared in accordance with standard operating procedures.

3.4 CHAIN OF CUSTODY

Samples collected in the field remained in the presence of a project representative at all times until they were shipped to the analytical laboratory. The transfer for the samples to the laboratory was accomplished by means of chain-of-custody records. The placement of the custody seals ensured the integrity of the samples and prevented potential tampering. Chain-of-custody records are included in Appendix A.

3.5 DATA VALIDATION

The purpose of this section is to evaluate the field data for its adherence to the approved Work Plan (Geraghty & Miller, 1990) and to ensure the completion of required documentation. Additionally, the analytical laboratory data were reviewed for the completeness of the data package deliverables and the achievement of project-specific data quality objectives.

All field activities were appropriately documented. Field and rinsate blanks for nutrient and wood-preserving constituent analysis were taken at a frequency of 1 for every 20 samples collected using procedures described in the Work Plan (Geraghty & Miller, 1990). Blank sample results are presented in Table 3-1. Total organic carbon was detected at concentrations ranging from 1.8 to 2.4 milligrams per liter (mg/L) in samples RB-1, RB-2, FB-1, and FB-2. Nitrate-nitrite was detected at 0.10 mg/L in RB-2. This constituent was not found in FB-2.

The requested detection limits for the wood-preserving constituents analyzed in the soil samples were not achieved for the majority of the soil samples. The samples were diluted due to PAH concentrations above the calibration range of the gas chromatography/mass spectroscopy (GC/MS) detection system. These dilutions accounted for the absence of surrogate recoveries for sample LF1ALS. The remaining quality control (QC) data, however, were within established control limits. Matrix spike and matrix spike duplicate recoveries were not reported for many PAHs due to the abundance of a target constituent in this sample. Relative percent differences above established control limits were also reported for several PAHs, phenolic constituents, and arsenic. Estimated constituent concentrations (J qualified) were reported for levels below the practical quantitation limits (PQL) where applicable.

All soil, ground-water, and QC samples collected were analyzed within the required holding times. With the exception of the deviation reported herein, all QC samples were found to be within established control limits.

4.0 SAMPLING RESULTS

4.1 SOIL SAMPLE RESULTS

The wood-preserving constituent, pH, and nutrient results for soil samples collected from LF1 and LF2 in 1991 are presented in Tables 4-1 and 4-2, respectively. Sample results are identified with a unique sample ID consisting of the landfarm (LF1 or LF2), the location (A through E), and the sampling depth (US [upper sample] or LS [lower sample]). For example, sample LF2BUS was the upper sample collected from location B in LF2. Laboratory data reports are included in Appendix A.

A total of 20 semi-volatile organic compounds (semi-VOCs) were detected above their respective practical quantitation limits (PQLs) in the landfarm samples. Sixteen are PAHs: naphthalene; 2-methylnaphthalene; acenaphthene; acenaphthylene; fluorene; phenanthrene; anthracene; pyrene; benzo(a)anthracene; chrysene; benzo(a)pyrene; benzo(g,h,i)perylene; fluoranthene; benzo(b,k)fluoranthene (the laboratory could not resolve the two isomers and reported them together); indeno(1,2,3-cd)pyrene; and dibenzo(a,h)anthracene. Two of the constituents are heterocyclic organics: carbazole and dibenzofuran. Pentachlorophenol and 1,1-biphenyl were also detected. An additional 7 semi-VOCs were detected in the landfarm samples, but the concentrations were below the PQLs: 1,1-methylnaphthalene; phenol; 2,4-dimethylphenol; trichlorophenols; cresols (o, m, & p); and tetrachlorophenols. All except the first constituent are phenolic compounds. 1,1-Methylnaphthalene is a PAH. Compounds detected below PQLs are "J"-qualified on the data tables.

Pyrene, a 4-ring PAH, had the highest concentration of the semi-VOCs: 980 milligrams per kilogram (mg/kg) in the lower sample from location D in LF2. Fluoranthene occurred in the second-highest concentration: up to 500 mg/kg in the same sample. Generally, there was no observable trending in semi-VOC constituent concentrations between the upper and lower

samples from the landfarm areas. For example, chrysene (a 4-ring PAH) occurred in concentrations of 11 and 150 mg/kg for the upper and lower samples, respectively, from location D in LF2. However, anthracene (a 3-ring PAH) occurred in concentrations of 310 and 19 mg/kg for the upper and lower samples, respectively, from location B in LF2. Analyses of variance (ANOVA) performed on the data indicate no significant difference in constituent concentrations between the upper and lower samples.

Arsenic, chromium, and copper were detected in all of the landfarm samples, with maximum concentrations of 84, 100, and 150 mg/kg, respectively. The maximum arsenic and chromium concentrations occurred in the lower sample from location B in LF2 (copper occurred at a concentration of 140 mg/kg in this sample). The maximum concentration of copper occurred in the lower sample from location D in LF2. Chromium and copper levels are within naturally-occurring ranges for the eastern U.S. soils of up to 1,000 and 700 mg/kg, respectively (USGS, 1984). The maximum naturally-occurring concentration of arsenic has been reported to be 73 mg/kg (USGS, 1984).

4.2 GROUND-WATER SAMPLE RESULTS

The wood-preserving constituent, pH, suspended solids, and nutrient results for ground-water samples collected from monitor wells MW-6, MW-7, MW-8, and MW-9 are presented in Table 4-3. None of the wood-preserving constituents were detected in any of the ground-water samples.

5.0 ANALYSIS OF 1990 AND 1991 LANDFARM SAMPLING DATA

Data used in this assessment include 30 soil samples collected in 1990 and 20 soil samples collected in 1991 from LF1 and LF2 at the former SWP facility in Wilmington, North Carolina. Data for 1990 are presented in the 1990 Landfarm Data Summary Report (Geraghty & Miller, 1993a).

5.1 DATA REDUCTION

Data were reduced according to current USEPA guidelines (USEPA, 1989a). The frequency of detection, maximum detected value, mean, and 95 percent upper confidence limit (UCL) of the mean for soil samples were determined. If a constituent concentration was below the PQL, one-half the PQL was entered into the data to calculate the mean. Estimated (J qualified) values were also used to calculate the means.

PAHs were divided into two classes: carcinogenic (cPAHs) and total PAHs (tPAHs) for the risk assessment (Geraghty & Miller, 1993b). tPAH and cPAH data for 1990 are listed by sample number in Appendix B (Tables B-1 and B-2). tPAH and cPAH data for 1991 are listed in Tables B-3 and B-4, respectively. cPAH data were further reduced according to a toxicity equivalency factor (TEF) scheme (USEPA, 1989b). Because cancer slope factors (CSFs) required for quantitative cancer risk assessments were only available for benzo(a)pyrene and carbazole, all the other cPAHs were reduced to benzo(a)pyrene equivalents. Dibenzo(a)anthracene was considered equally potent compared to benzo(a)pyrene. 1-, and 2-Methylnaphthalene, benzo(a)anthracene, chrysene, benzo(b,k)fluoranthene, benzo(g,h,i)perylene, and indo(1,2,3-c,d)pyrene were considered to be one/one-hundredth (0.01) as potent as benzo(a)pyrene (USEPA, 1989b). Therefore, concentrations of the cPAHs were multiplied by TEFs (1 or 0.01) and summed together to derive the total benzo(a)pyrene equivalent cPAH

concentration. The tPAH concentration was calculated as the total of all PAH concentrations. TEF values were not used to derive tPAH concentrations.

The 1990 data indicated no statistical differences in constituent concentrations with sampling depth. Likewise, the 1991 data were examined for differences between the two sampling depths. The landfarms had not been tilled for about a year prior to the 1991 sampling event. The landfarm soils had settled and weeds were present. Mean tPAH concentrations were 531 milligrams per kilogram (mg/kg) in the lower zone and 385 mg/kg in the upper zone (Tables B-5 and B-6). Two sampling points were primarily responsible for the apparent higher concentrations in the lower zone. Sampling point LF2D had tPAH concentrations of 2,573 and 273 mg/kg in the lower and upper zones, respectively, and sampling point LF2E had tPAH concentrations of 1,146 and 273 mg/kg in the lower and upper zones, respectively. Conversely, sampling points LF1C, D, and E, and LF2B had much higher tPAH concentrations in the upper zone. Statistical comparisons of the data in the lower and upper zones did not indicate a significant difference.

5.2 DATA COMPARISON

The results from the 1991 soil sampling program are shown by sample number in Table B-7. Soil data for 1990 and 1991 are compared in Table 4-4. Because of the differences in the analyses requested for the two sets of data, temporal comparisons are limited to PCP and PAHs. The data were log-normally distributed; therefore, statistical comparisons were based on log transformations of the data. A non-parametric test (Mann-Whitney) was also used because the samples were not randomly selected. The sampling plan was not specifically designed to determine PAH degradation rates; therefore, results of these statistical tests are tentative.

PCP was detected in only 1 of 30 samples in 1990 because of the high PQL. A lower PQL was obtained for the 1991 samples, and PCP was detected in 16 of 20 samples, although most concentrations were estimated values which were lower than the PQL. The maximum PCP

concentration was 150 mg/kg in 1991. The UCL (which is used in risk calculations) increased from 19 mg/kg in 1990 to 29 mg/kg in 1991.

PAHs were detected in all samples collected in 1990 and 1991; however, all PAHs were not detected in all samples. Although the highest tPAH concentration (2,572 mg/kg) was detected in the 1991 data, the mean concentrations for both tPAHs and cPAHs showed a slight decrease. Mean tPAH concentrations declined from 527 mg/kg to 458 mg/kg; however, UCL concentrations were essentially the same (733 mg/kg in 1990 and 726 mg/kg in 1991) because of higher variability in the 1991 data. Both mean and UCL cPAH concentrations declined by about 24 percent (25.9 mg/kg to 19.8 mg/kg) and 16 percent (30.9 mg/kg to 25.7 mg/kg), respectively, between 1990 and 1991. However, statistical analyses of the data generally did not indicate that the concentrations reported in 1991 were significantly different than 1990 concentrations. A t-test of the log-transformed data for cPAHs indicated that 1991 concentrations were slightly lower ($P = 0.041$) than 1990 concentrations. The non-parametric test (Mann-Whitney) did not indicate a significant difference in cPAH concentrations. However, the sampling plan was not specifically designed to examine site-specific degradation rates; therefore, the statistical power of the tests was low. In other words, large differences would be necessary in order to detect a significant difference.

More detailed comparisons of the PAH data are shown in Tables 4-5 and 4-6. PAHs have variable degradation rates which are closely correlated with the number of rings in the chemical structure of the compound. PAHs with two or three rings are expected to degrade faster than those with four or more rings. The site data are consistent with this expectation (Table 4-5). Two- and three-ring PAHs decreased from 9 to 88 percent between 1990 and 1991. The average decrease was about 33 percent. Concentrations of four-, five-, and six-ring PAHs had a net average increase of 4.5 percent. However, the data for the PAHs with more than four rings was highly variable. For example, pyrene (four rings) had an increase of more than 40 percent while dibenzo(a)anthracene (five rings) and benzo(g,h,i)perylene (six rings) decreased by about 40 percent (Table 4-5).

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Relative degradation percentages were also examined for the cPAHs because they were more important to the risk assessment than tPAHs (Table 4-6). cPAH concentrations decreased by an average of 14.5 percent between 1990 and 1991. This was not significantly different from the 13.1 percent decline for tPAHs. Eliminating the methylnaphthalenes (the only two-ring PAHs with a TEF) resulted in a 10.8 percent average decrease in cPAH concentrations. Benzo(b)fluoranthene and benzo(k)fluoranthene were the only cPAHs which had higher concentrations in the 1991 data (Table 4-6). Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)anthracene, chrysene, and benzo(a)pyrene were the predominant cPAHs detected at the site and therefore control the risk. The average decrease was about 9.4 percent for these compounds. These degradation rates are consistent with the reported literature values; however, conclusive statements about the site-specific degradation rates cannot be made because of statistical limitations.

Using constituent-specific degradation half-life values from the literature, concentrations of organic wood-preserving constituents estimated to occur in landfarm soils after a period of 30 years were calculated. Most of the constituents will be degraded to less than 0.001 mg/kg, and the 4- and 5-ring PAHs will have concentrations of 2 mg/kg or less, based on these calculations (Geraghty & Miller, 1993b).

6.0 FINDINGS AND RECOMMENDATIONS

After reviewing the data, Geraghty & Miller makes the following findings: mean PAH concentrations showed an overall decrease between the 1990 and 1991 sampling events, especially PAHs having two and three rings in their structures. Although the overall decrease was not statistically significant, this does not necessarily mean that the PAHs are not degrading. Rather, the failure to detect a significant decrease in PAH concentrations was more likely related to the power of the statistical tests and analytical procedures.

Calculations of constituent degradation over a 30-year period show that most of the constituents will be degraded to less than 0.001 mg/kg after 30 years, based on constituent-specific half-lives from the literature (Geraghty & Miller, 1993b). Those constituents estimated to still occur after 30 years (all are four- and five-ring PAHs) have calculated concentrations of 2 mg/kg or less.

Geraghty & Miller recommends consideration of an anerobic approach to accelerate degradation of PAHs with four or more aromatic rings.

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Table 4-3. Analytical Results for Ground-Water Samples Collected in 1991 from the Upgradient Monitor Well (W-6) and Three Downgradient Monitor Wells (W-7, W-8, and W-9) Located on the Perimeter of Landfarms 1 and 2 at the Southern Wood Piedmont Site, Wilmington, North Carolina.

Sample Identification #	MW-6 9673	MW-7 9674	MW-8 9675	MW-9 9676
Constituents (mg/L)				
Semi-Volatile Organic Compounds (8270)				
Naphthalene	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND
1-Methylnaphthalene	ND	ND	ND	ND
1,1-Biphenyl	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND
Carbazole	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND
Benzo(a)Anthracene	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND
Phenol	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND
Trichlorophenols	ND	ND	ND	ND
Creosol (ortho)	ND	ND	ND	ND
Creosol m&p	ND	ND	ND	ND
P-chloro-m-cresol	ND	ND	ND	ND
Tetrachlorophenols	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND
Benzo(b,k)fluoranthene	ND	ND	ND	ND
Ideno(1,2,3-cd)pyrene	ND	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	ND	ND
Metals				
Arsenic (7060)	ND	ND	ND	ND
Chromium (6010)	ND	ND	ND	ND
Copper (6010)	ND	ND	ND	ND
Total Suspended Solids (160.2)	34	20	ND	ND
Nitrogen Series				
Total Kjeldahl Nitrogen-N	11	8.3	9.7	6.3
Nitrate + Nitrite-N	ND	ND	ND	ND
Total Nitrogen	11	8.3	9.7	6.3
Total Phosphorous	2.0	0.72	0.78	0.89
Total Organic Carbon	16	22	27	20
Chloride	310	200	130	120

ND Compound was not detected.

Table 4-5. Degradation of Polycyclic Aromatic Hydrocarbons Based on Ring Number, Landfarms 1 and 2, Southern Wood Piedmont Facility, Wilmington, North Carolina.

# Rings	Constituent		Mean Concentration (mg/kg) 1990	1991	1990-1991	% Change
2	1,1-Biphenyl		3.77	0.61	3.16	-83.82
2	1-Methylnaphthalene		4.3	0.51	3.79	-88.14
2	2-Methylnaphthalene		6.05	3.21	2.84	-46.94
2	Naphthalene		5.18	2.94	2.24	-43.24
3	Acenaphthene		6.72	6.1	0.62	-9.23
3	Acenaphthylene		3.77	2.9	0.87	-23.08
3	Anthracene		117.66	80.77	36.89	-31.35
3	Carbazole		43.19	30.08	13.11	-30.35
3	Dibenzofuran		7.16	4.71	2.45	-34.22
3	Fluorene		15.53	13.44	2.09	-13.46
3	Phenanthrene		37.53	23.74	13.79	-36.74
		Total	250.86	169.01	81.85	-32.63
		Mean	22.81	15.36	7.44	-32.63
4	Benzo(a)anthracene		23.57	22.05	1.52	-6.45
4	Chrysene		32.14	26.12	6.02	-18.73
4	Fluoranthene		71.45	72.52	-1.07	1.50
4	Pyrene		65.76	92.3	-26.54	40.36
5	Benzo(a)pyrene		20.32	16.06	4.26	-20.96
5	Benzo(b,k)fluoranthene		40.7	44.24	-3.54	8.70
5	Dibenzo(a,h)anthracene		4.37	2.62	1.75	-40.05
6	Benzo(g,h,i)perylene		8.96	5.43	3.53	-39.40
6	Indeno(1,2,3-c,d)pyrene		9.38	7.83	1.55	-16.52
		Total	276.65	289.17	-12.52	4.53
		Mean	30.74	32.13	-1.39	4.53

mg/kg Milligrams per kilogram.

Table 4-6. Data Comparison for Polycyclic Aromatic Hydrocarbons, Landfarms 1 and 2, Southern Wood Piedmont Facility, Wilmington, North Carolina.

# Rings	Constituent	Mean Concnetration (mg/kg) 1990	1991	1990-1991	% Change
2	1,1-Biphenyl	3.77	0.61	3.16	-83.82
2	Naphthalene	5.18	2.94	2.24	-43.24
3	Acenaphthene	6.72	6.1	0.62	-9.23
3	Acenaphthylene	3.77	2.9	0.87	-23.08
3	Anthracene	117.66	80.77	36.89	-31.35
3	Carbazole*	43.19	30.08	13.11	-30.35
3	Dibenzofuran	7.16	4.71	2.45	-34.22
3	Fluorene	15.53	13.44	2.09	-13.46
3	Phenanthrene	37.53	23.74	13.79	-36.74
4	Fluoranthene	71.45	72.52	-1.07	1.50
4	Pyrene	65.76	92.3	-26.54	40.36
	Subtotal	377.72	330.11	47.61	-12.60
	Mean	34.34	30.01	4.33	-12.60
	cPAHs				
2	1-Methylnaphthalene	4.3	0.51	3.79	-88.14
2	2-Methylnaphthalene	6.05	3.21	2.84	-46.94
4	Benzo(a)anthracene	23.57	22.05	1.52	-6.45
4	Chrysene	32.14	26.12	6.02	-18.73
5	Benzo(a)pyrene	20.32	16.06	4.26	-20.96
5	Benzo(b,k)fluoranthene	40.7	44.24	-3.54	8.70
5	Dibenzo(a,h)anthracene	4.37	2.62	1.75	-40.05
6	Benzo(g,h,i)perylene	8.96	5.43	3.53	-39.40
6	Indeno(1,2,3-c,d)pyrene	9.38	7.83	1.55	-16.52
	Total cPAHs	149.79	128.07	21.72	-14.50
	Mean	16.64	14.23	2.41	-14.50
	Without 2-ring PAHs	139.44	124.35	15.09	-10.82
	tPAHs	527.51	458.18	69.33	-13.14

* Carbazole is also a cPAH but was considered separately from the other cPAHs.
cPAHs Carcinogenic polycyclic aromatic hydrocarbons included in the TEF scheme.
mg/kg Milligrams per kilogram.
TEF Toxicity equivalency factor based on benzo(a)pyrene (USEPA, 1989b).
tPAHs Total of all polycyclic aromatic hydrocarbons.

APPENDIX A
1991 DATA SHEETS
SOUTHERN WOOD PIEDMONT FACILITY, WILMINGTON, NORTH CAROLINA

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-1	MW-6/9673	10-14-91
36568-2	MW-7/9674	10-14-91
36568-3	MW-8/9675	10-14-91

PARAMETER	36568-1	36568-2	36568-3
Semi-Volatiles (8270)			
Naphthalene, ug/l	<10	<10	<10
1-Methylnaphthalene, ug/l	<10	<10	<10
2-Methylnaphthalene, ug/l	<10	<10	<10
1,1-Biphenyl, ug/l	<10	<10	<10
Acenaphthylene, ug/l	<10	<10	<10
Acenaphthene, ug/l	<10	<10	<10
Dibenzofuran, ug/l	<10	<10	<10
Fluorene, ug/l	<10	<10	<10
Phenanthrene, ug/l	<10	<10	<10
Anthracene, ug/l	<10	<10	<10
Carbazole, ug/l	<10	<10	<10
Pyrene, ug/l	<10	<10	<10
Benzo(a)Anthracene, ug/l	<10	<10	<10
Chrysene, ug/l	<10	<10	<10
Benzo(a)pyrene, ug/l	<10	<10	<10
Benzo(g,h,i)perylene, ug/l	<10	<10	<10
Pentachlorophenol, ug/l	<50	<50	<50
Fluoranthene, ug/l	<10	<10	<10
2-Chlorophenol, ug/l	<10	<10	<10
Phenol, ug/l	<10	<10	<10
2,4-Dimethylphenol, ug/l	<10	<10	<10

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-1	MW-6/9673	10-14-91
36568-2	MW-7/9674	10-14-91
36568-3	MW-8/9675	10-14-91

PARAMETER	36568-1	36568-2	36568-3
Trichlorophenols, ug/l	<10	<10	<10
Cresol (ortho), ug/l	<10	<10	<10
Cresol m & p, ug/l	<10	<10	<10
p-Chloro-m-cresol, ug/l	<10	<10	<10
Tetrachlorophenols, ug/l	<10	<10	<10
2,4-Dinitrophenol, ug/l	<50	<50	<50
Benzo(b,k)fluoranthene, ug/l	<10	<10	<10
Indeno(1,2,3-cd)pyrene, ug/l	<10	<10	<10
Dibenzo(a,h)anthracene, ug/l	<10	<10	<10
Surrogate-2FP (CL 21-110)	46 %	38 %	50 %
Surrogate-PHL (CL 10-110)	38 %	30 %	43 %
Surrogate-NBZ (CL 35-114)	84 %	68 %	91 %
Surrogate-TBP (CL 10-123)	34 %	37 %	54 %
Surrogate-TPH (CL 33-141)	78 %	56 %	72 %
Surrogate-FBP (CL 43-116)	72 %	55 %	70 %
Date Extracted	10.18.91	10.18.91	10.18.91
Date Analyzed	10.23.91	10.24.91	10.24.91
Chloride (325.2)			
Chloride (325.2), mg/l	310	200	130
Date Analyzed	10.22.91	10.23.91	10.22.91

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Project: Wilmington, NC
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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-1	MW-6/9673	10-14-91
36568-2	MW-7/9674	10-14-91
36568-3	MW-8/9675	10-14-91

PARAMETER	36568-1	36568-2	36568-3
Nitrogen Series			
Total Kjeldahl Nitrogen-N, mg/l	11	8.3	9.7
Nitrate + Nitrite-N, mg/l	<0.050	<0.050	<0.050
Total Nitrogen, mg/l	11	8.3	9.7
Date Analyzed	10.23.91	10.23.91	10.23.91
Total Phosphorus (365.1)			
Total Phosphorus, mg/l	2.0	0.72	0.78
Date Analyzed	10.23.91	10.23.91	10.23.91
Total Organic Carbon (415.1)			
Total Organic Carbon , mg/l	16	22	27
Date Analyzed	10.15.91	10.15.91	10.15.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-4	MW-9/9676	10-14-91

PARAMETER	36568-4
Semi-Volatiles (8270)	
Naphthalene, ug/l	<10
1-Methylnaphthalene, ug/l	<10
2-Methylnaphthalene, ug/l	<10
1,1-Biphenyl, ug/l	<10
Acenaphthylene, ug/l	<10
Acenaphthene, ug/l	<10
Dibenzofuran, ug/l	<10
Fluorene, ug/l	<10
Phenanthrene, ug/l	<10
Anthracene, ug/l	<10
Carbazole, ug/l	<10
Pyrene, ug/l	<10
Benzo(a)Anthracene, ug/l	<10
Chrysene, ug/l	<10
Benzo(a)pyrene, ug/l	<10
Benzo(g,h,i)perylene, ug/l	<10
Pentachlorophenol, ug/l	<50
Fluoranthene, ug/l	<10
2-Chlorophenol, ug/l	<10
Phenol, ug/l	<10
2,4-Dimethylphenol, ug/l	<10
Trichlorophenols, ug/l	<10
Cresol (ortho), ug/l	<10

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-4	MW-9/9676	10-14-91

PARAMETER	36568-4
Cresol m & p, ug/l	<10
p-Chloro-m-cresol, ug/l	<10
Tetrachlorophenols, ug/l	<10
2,4-Dinitrophenol, ug/l	<50
Benzo(b,k)fluoranthene, ug/l	<10
Indeno(1,2,3-cd)pyrene, ug/l	<10
Dibenzo(a,h)anthracene, ug/l	<10
Surrogate-2FP (CL 21-110)	47 %
Surrogate-PHL (CL 10-110)	37 %
Surrogate-NBZ (CL 35-114)	86 %
Surrogate-TBP (CL 10-123)	50 %
Surrogate-TPH (CL 33-141)	68 %
Surrogate-FBP (CL 43-116)	69 %
Date Extracted	10.18.91
Date Analyzed	10.24.91
Suspended Solids (160.2)	
Suspended Solids, mg/l	<5.0
Date Analyzed	10.17.91
Chloride (325.2)	
Chloride (325.2), mg/l	120
Date Analyzed	10.22.91
Nitrogen Series	
Total Kjeldahl Nitrogen-N, mg/l	6.3
Nitrate + Nitrite-N, mg/l	<0.050
Total Nitrogen, mg/l	6.3
Date Analyzed	10.23.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-4	MW-9/9676	10-14-91

PARAMETER	36568-4
Total Phosphorus (365.1)	
Total Phosphorus, mg/l	0.89
Date Analyzed	10.23.91
Total Organic Carbon (415.1)	
Total Organic Carbon , mg/l	20
Date Analyzed	10.15.91
Copper (6010)	
Copper, mg/l	<0.025
Date Analyzed	10.23.91
Chromium (6010)	
Chromium, mg/l	<0.010
Date Analyzed	10.23.91
Arsenic (7060)	
Arsenic, mg/l	<0.010
Date Analyzed	10.30.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-5	RB-1	10-14-91
36568-6	FB-1	10-14-91

PARAMETER	36568-5	36568-6
Semi-Volatiles (8270)		
Naphthalene, ug/l	<10	<10
1-Methylnaphthalene, ug/l	<10	<10
2-Methylnaphthalene, ug/l	<10	<10
1,1-Biphenyl, ug/l	<10	<10
Acenaphthylene, ug/l	<10	<10
Acenaphthene, ug/l	<10	<10
Dibenzofuran, ug/l	<10	<10
Fluorene, ug/l	<10	<10
Phenanthrene, ug/l	<10	<10
Anthracene, ug/l	<10	<10
Carbazole, ug/l	<10	<10
Pyrene, ug/l	<10	<10
Benzo(a)Anthracene, ug/l	<10	<10
Chrysene, ug/l	<10	<10
Benzo(a)pyrene, ug/l	<10	<10
Benzo(g,h,i)perylene, ug/l	<10	<10
Pentachlorophenol, ug/l	<50	<50
Fluoranthene, ug/l	<10	<10
2-Chlorophenol, ug/l	<10	<10
Phenol, ug/l	<10	<10
2,4-Dimethylphenol, ug/l	<10	<10
Trichlorophenols, ug/l	<10	<10

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-5	RB-1	10-14-91
36568-6	FB-1	10-14-91

PARAMETER	36568-5	36568-6
Cresol (ortho), ug/l	<10	<10
Cresol m & p, ug/l	<10	<10
p-Chloro-m-cresol, ug/l	<10	<10
Tetrachlorophenols, ug/l	<10	<10
2,4-Dinitrophenol, ug/l	<50	<50
Benzo(b,k)fluoranthene, ug/l	<10	<10
Indeno(1,2,3-cd)pyrene, ug/l	<10	<10
Dibenzo(a,h)anthracene, ug/l	<10	<10
Surrogate-2FP (CL 21-110)	37 %	37 %
Surrogate-PHL (CL 10-110)	26 %	26 %
Surrogate-NBZ (CL 35-114)	79 %	81 %
Surrogate-TBP (CL 10-123)	74 %	76 %
Surrogate-TPH (CL 33-141)	82 %	76 %
Surrogate-FBP (CL 43-116)	77 %	78 %
Date Extracted	10.18.91	10.18.91
Date Analyzed	10.24.91	10.24.91
pH (150.1)		
pH, units	5.4	5.0
Date Analyzed	10.15.91	10.15.91
Chloride (325.2)		
Chloride (325.2), mg/l	<1.0	<1.0
Date Analyzed	10.22.91	10.22.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36568-5	RB-1	10-14-91
36568-6	FB-1	10-14-91

PARAMETER	36568-5	36568-6
Nitrogen Series		
Total Kjeldahl Nitrogen-N, mg/l	<0.10	<0.10
Nitrate + Nitrite-N, mg/l	<0.050	<0.050
Total Nitrogen, mg/l	<0.15	<0.15
Date Analyzed	10.24.91	10.24.91
Total Phosphorus (365.1)		
Total Phosphorus, mg/l	<0.10	<0.10
Date Analyzed	10.24.91	10.24.91
Total Organic Carbon (415.1)		
Total Organic Carbon , mg/l	1.8	2.3
Date Analyzed	10.15.91	10.15.91
Copper (6010)		
Copper, mg/l	<0.025	<0.025
Date Analyzed	10.23.91	10.23.91
Chromium (6010)		
Chromium, mg/l	<0.010	<0.010
Date Analyzed	10.23.91	10.23.91
Arsenic (7060)		
Arsenic, mg/l	<0.010	<0.010
Date Analyzed	10.30.91	10.30.91

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CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-7	Detection Limits
36568-8	Method Blank (MB) Results
36568-9	Lab Control Standard (LCS) Result
36568-10	LCS Expected Value
36568-11	LCS % Recovery

PARAMETER	36568-7	36568-8	36568-9	36568-10	36568-11
Semi-Volatiles (8270)					
Naphthalene, ug/l	10	<10	101	100	101 %
1-Methylnaphthalene, ug/l	10	<10	---	---	---
2-Methylnaphthalene, ug/l	10	<10	---	---	---
1,1-Biphenyl, ug/l	10	<10	---	---	---
Acenaphthylene, ug/l	10	<10	114	100	114 %
Acenaphthene, ug/l	10	<10	105	100	105 %
Dibenzofuran, ug/l	10	<10	---	---	---
Fluorene, ug/l	10	<10	---	---	---
Phenanthrene, ug/l	10	<10	92	100	92 %
Anthracene, ug/l	10	<10	96	100	96 %
Carbazole, ug/l	10	<10	---	---	---
Pyrene, ug/l	10	<10	---	---	---
Benzo(a)Anthracene, ug/l	10	<10	87	100	87 %
Chrysene, ug/l	10	<10	83	100	83 %
Benzo(a)pyrene, ug/l	10	<10	79	100	79 %
Benzo(g,h,i)perylene, ug/l	10	<10	---	---	---
Pentachlorophenol, ug/l	50	<50	69	100	69 %
Fluoranthene, ug/l	10	<10	98	100	98 %
2-Chlorophenol, ug/l	10	<10	92	100	92 %

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CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-7	Detection Limits
36568-8	Method Blank (MB) Results
36568-9	Lab Control Standard (LCS) Result
36568-10	LCS Expected Value
36568-11	LCS % Recovery

PARAMETER	36568-7	36568-8	36568-9	36568-10	36568-11
Phenol, ug/l	10	<10	36	100	36 %
2,4-Dimethylphenol, ug/l	10	<10	90	100	90 %
Trichlorophenols, ug/l	10	<10	83	100	83 %
Cresol (ortho), ug/l	10	<10	---	---	---
Cresol m & p, ug/l	10	<10	---	---	---
p-Chloro-m-cresol, ug/l	10	<10	90	100	90 %
Tetrachlorophenols, ug/l	10	<10	109	100	109 %
2,4-Dinitrophenol, ug/l	50	<50	52	100	52 %
Benzo(b,k)fluoranthene, ug/l	10	<10	82	100	82 %
Indeno(1,2,3-cd)pyrene, ug/l	10	<10	79	100	79 %
Dibenzo(a,h)anthracene, ug/l	10	<10	74	100	74 %
Surrogate-2FP (CL 21-110)	---	57 %	53 %	---	---
Surrogate-PHL (CL 10-110)	---	41 %	39 %	---	---
Surrogate-NBZ (CL 35-114)	---	106 %	99 %	---	---
Surrogate-TBP (CL 10-123)	---	69 %	64 %	---	---
Surrogate-TPH (CL 33-141)	---	101 %	93 %	---	---
Surrogate-FBP (CL 43-116)	---	94 %	89 %	---	---
Date Extracted	---	10.18.91	10.18.91	---	---
Date Analyzed	---	10.23.91	10.28.91	---	---
Suspended Solids (160.2)					
Suspended Solids, mg/l	5.0	<5.0	92	100	92 %
Date Analyzed	---	10.17.91	10.17.91	---	---

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-36568

Received: 15 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-7	Detection Limits
36568-8	Method Blank (MB) Results
36568-9	Lab Control Standard (LCS) Result
36568-10	LCS Expected Value
36568-11	LCS % Recovery

PARAMETER	36568-7	36568-8	36568-9	36568-10	36568-11
pH (150.1)					
pH, units	---	---	---	---	---
Chloride (325.2)					
Chloride (325.2), mg/l	1.0	<1.0	7.46	7.7	97 %
Date Analyzed	---	10.22.91	10.22.91	---	---
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	0.10	<0.10	0.43	0.50	86 %
Nitrate + Nitrite-N, mg/l	0.050	<0.050	0.397	0.375	106 %
Total Nitrogen, mg/l	0.15	<0.15	---	---	---
Date Analyzed	---	10.23.91	10.23.91	---	---
Total Phosphorus (365.1)					
Total Phosphorus, mg/l	0.10	<0.10	0.702	0.75	94 %
Date Analyzed	---	10.23.91	10.23.91	---	---
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/l	1.0	<1.0	22.4	23.0	97 %
Date Analyzed	---	10.15.91	10.15.91	---	---
Copper (6010)					
Copper, mg/l	0.025	<0.025	0.981	1.00	98 %
Date Analyzed	---	10.23.91	10.23.91	---	---
Chromium (6010)					
Chromium, mg/l	0.010	<0.010	0.993	1.01	98 %
Date Analyzed	---	10.23.91	10.23.91	---	---

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-7	Detection Limits
36568-8	Method Blank (MB) Results
36568-9	Lab Control Standard (LCS) Result
36568-10	LCS Expected Value
36568-11	LCS % Recovery

PARAMETER	36568-7	36568-8	36568-9	36568-10	36568-11
Arsenic (7060)					
Arsenic, mg/l	0.010	<0.010	0.051	50	102 %
Date Analyzed	---	10.30.91	10.30.91	---	---

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Project: Wilmington, NC
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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-12	LCS % Recovery Limits
36568-13	Matrix Spike (MS) Result/Duplicate
36568-14	MS Expected Value
36568-15	MS % Recovery/Duplicate
36568-16	MS % Recovery Limits

PARAMETER	36568-12	36568-13	36568-14	36568-15	36568-16
Semi-Volatiles (8270)					
Naphthalene, ug/l	21-133 %	100/100	100	100/100 %	21-133 %
Acenaphthylene, ug/l	33-145 %	108/108	100	108/108 %	33-145 %
Acenaphthene, ug/l	47-145 %	100/100	100	100/100 %	47-145 %
Phenanthrene, ug/l	54-120 %	92/92	100	92/92 %	54-120 %
Anthracene, ug/l	27-133 %	92/92	100	92/92 %	27-133 %
Benzo(a)Anthracene, ug/l	33-143 %	44/44	100	44/44 %	33-143 %
Chrysene, ug/l	17-168 %	80/80	100	80/80 %	17-168 %
Benzo(a)pyrene, ug/l	17-163 %	28/28	100	28/28 %	17-163 %
Pentachlorophenol, ug/l	14-176 %	31/29	100	31/29 %	14-176 %
Fluoranthene, ug/l	26-137 %	88/88	100	88/88 %	26-137 %
2-Chlorophenol, ug/l	23-134 %	32/36	100	32/36 %	23-134 %
Phenol, ug/l	5-112 %	18/11	100	18/11 %	5-112 %
2,4-Dimethylphenol, ug/l	32-119 %	60/48	100	60/48 %	32-119 %
Trichlorophenols, ug/l	37-144 %	128/112	100	128/112 %	37-144 %
p-Chloro-m-cresol, ug/l	22-147 %	56/44	100	56/44 %	22-147 %
Tetrachlorophenols, ug/l	10-130 %	15/19	100	15/19 %	10-130 %
2,4-Dinitrophenol, ug/l	10-191 %	11/10	100	11/10 %	10-191 %
Benzo(b,k)fluoranthene, ug/l	24-159 %	68/68	100	68/68 %	24-159 %
Indeno(1,2,3-cd)pyrene, ug/l	10-171 %	32/32	100	32/32 %	10-171 %

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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LOG NO: S1-36568

Received: 15 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-12	LCS % Recovery Limits
36568-13	Matrix Spike (MS) Result/Duplicate
36568-14	MS Expected Value
36568-15	MS % Recovery/Duplicate
36568-16	MS % Recovery Limits

PARAMETER	36568-12	36568-13	36568-14	36568-15	36568-16
Dibenzo(a,h)anthracene, ug/l	10-227 %	26/28	100	26/28 %	10-227 %
Surrogate-2FP (CL 21-110)	---	35/21	100	35/21 %	21-110 %
Surrogate-PHL (CL 10-110)	---	23/15	100	23/15 %	10-110 %
Surrogate-NBZ (CL 35-114)	---	51/50	50	102/100 %	35-114 %
Surrogate-TBP (CL 10-123)	---	57/56	100	57/56 %	35-114 %
Surrogate-TPH (CL 33-141)	---	43/44.5	50	86/89 %	33-141 %
Surrogate-FBP (CL 43-116)	---	45/44.5	50	90/89 %	43-116 %
Date Extracted	---	10.18.91	---	---	---
Date Analyzed	---	10.23.91	---	---	---
Suspended Solids (160.2)					
Suspended Solids, mg/l	75-125 %	---	---	---	---
Date Analyzed	---	---	---	---	---
pH (150.1)					
pH, units	---	---	---	---	---
Chloride (325.2)					
Chloride (325.2), mg/l	90-110 %	5.17/5.08	5.0	103/102 %	75-125 %
Date Analyzed	---	10.22.91	---	---	---
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	75-125 %	1.14/1.21	1.0	114/121 %	75-125 %
Nitrate + Nitrite-N, mg/l	90-110 %	.208/.204	0.20	104/102 %	75-125 %
Date Analyzed	---	10.23.91	---	---	---

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Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-12	LCS % Recovery Limits
36568-13	Matrix Spike (MS) Result/Duplicate
36568-14	MS Expected Value
36568-15	MS % Recovery/Duplicate
36568-16	MS % Recovery Limits

PARAMETER	36568-12	36568-13	36568-14	36568-15	36568-16
Total Phosphorus (365.1)					
Total Phosphorus, mg/l	60-140 %	0.89/0.92	1.0	89/92 %	60-140 %
Date Analyzed	---	10.23.91	---	---	---
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/l	60-140 %	103/105	100	103/105 %	60-140 %
Date Analyzed	---	10.15.91	---	---	---
Copper (6010)					
Copper, mg/l	75-125 %	.991/.947	1.00	99/95 %	75-125 %
Date Analyzed	---	10.23.91	---	---	---
Chromium (6010)					
Chromium, mg/l	75-125 %	.949/.995	1.01	95/99 %	75-125 %
Date Analyzed	---	10.23.91	---	---	---
Arsenic (7060)					
Arsenic, mg/l	75-125 %	51/51	50	102/102 %	75-125 %
Date Analyzed	---	10.30.91	---	---	---

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-17	ICVS/CCVS Control Limits
36568-18	ICVS/CCVS Source Lot
36568-19	ICVS/CCVS Expected Value
36568-20	ICVS Result
36568-21	ICVS % Recovery

PARAMETER	36568-17	36568-18	36568-19	36568-20	36568-21
Arsenic (7060)					
Arsenic, mg/l	90-110 %	3-87/SPEX	50.1	48.4	97 %
Date Analyzed	---	---	---	10.30.91	---
Chromium (6010)					
Chromium, mg/l	90-110 %	3-87/SPEX	1.01	0.971	96 %
Date Analyzed	---	---	---	10.23.91	---
Copper (6010)					
Copper, mg/l	90-110 %	3-87/SPEX	1.00	0.960	96 %
Date Analyzed	---	---	---	10.23.91	---

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Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-22	CCVS Result
36568-23	CCVS % Recovery

PARAMETER	36568-22	36568-23
Arsenic (7060)		
Arsenic, mg/l	48	96 %
Date Analyzed	10.30.91	---
Chromium (6010)		
Chromium, mg/l	0.989	98 %
Date Analyzed	10.23.91	---
Copper (6010)		
Copper, mg/l	0.969	97 %
Date Analyzed	10.23.91	---

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-24	CCVS Result
36568-25	CCVS % Recovery

PARAMETER	36568-24	36568-25
Arsenic (7060)		
Arsenic, mg/l	47.1	94 %
Date Analyzed	10.30.91	---
Chromium (6010)		
Chromium, mg/l	1.01	100 %
Date Analyzed	10.23.91	---
Copper (6010)		
Copper, mg/l	0.998	100 %
Date Analyzed	10.23.91	---

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Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-26	CCVS Result
36568-27	CCVS % Recovery
36568-28	CCVS Result
36568-29	CCVS % Recovery
36568-30	CCVS Result

PARAMETER	36568-26	36568-27	36568-28	36568-29	36568-30
Chromium (6010)					
Chromium, mg/l	1.02	101 %	0.991	98 %	0.966
Date Analyzed	10.23.91	---	10.23.91	---	10.23.91
Copper (6010)					
Copper, mg/l	1.00	100 %	0.977	98 %	0.957
Date Analyzed	10.23.91	---	10.23.91	---	10.23.91

Methods: EPA SW-846

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

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Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36568-31	CCVS % Recovery
36568-32	CCVS Result
36568-33	CCVS % Recovery

PARAMETER	36568-31	36568-32	36568-33
Chromium (6010)			
Chromium, mg/l	96 %	0.940	93 %
Date Analyzed	---	10.23.91	---
Copper (6010)			
Copper, mg/l	96 %	0.944	94 %
Date Analyzed	---	10.23.91	---

Methods: EPA SW-846

SL SAVANNAH LABORATORIES
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Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES

36568-34 MS % RPD (Limit)

PARAMETER	36568-34
Chloride (325.2)	
Chloride (325.2)	.97(<30) %
Nitrogen Series	
Total Kjeldahl Nitrogen-N	6.0(<30) %
Nitrate + Nitrite-N	1.9(<30) %
Total Phosphorus (365.1)	
Total Phosphorus	3.3(<40) %
Total Organic Carbon (415.1)	
Total Organic Carbon	1.9(<40) %
Copper (6010)	
Copper	4.1(<20) %
Chromium (6010)	
Chromium	4.1(<20) %
Arsenic (7060)	
Arsenic	0(<20) %

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Sampled By: Client

REPORT OF RESULTS

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES

36568-34 MS % RPD (Limit)

PARAMETER	36568-34
emi-Volatiles (8270)	
Naphthalene	0(<40) %
enaphthylene	0(<40) %
enaphthene	0(<31) %
enanthrene	0(<40) %
thracene	0(<40) %
zo(a)Anthracene	0(<40) %
ysene	0(<48) %
to(a)pyrene	0(<40) %
Pe achlorophenol	6.7(<50) %
Fluoranthene	0(<40) %
2-Chlorophenol	12(<40) %
Phenol	48(<42) %
2,4-Dimethylphenol	22(<40) %
Trichlorophenols	13(<50) %
p-Chloro-m-cresol	24(<40) %
Tetrachlorophenols	24(<50) %
2,4-Dinitrophenol	9.5(<50) %
Benzo(b,k)fluoranthene	0(<40) %
Indeno(1,2,3-cd)pyrene	0(<45) %
Dibenzo(a,h)anthracene	7.4(<70) %

J. W. Andrews

J. W. Andrews, Ph. D.

GERAGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Number NC09005

Project Location SWP Wilmington, NC

Laboratory SAVANNAH LABORATORIES

Sampler(s)/Affiliation M. RADECKE (G&M)
P. JACOBS (G&M)

SAMPLE BOTTLE / CONTAINER DESCRIPTION

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	1 liter amber glass Semi volatile Constituents (8270) 4°C	100 ml plastic TSS 4°C	100 ml plastic pH 4°C	100 ml plastic Cl⁻ 4°C	250 ml plastic TP TP 4°C H_2SO_4	125 ml amber glass TOC 4°C H_2SO_4	250 ml plastic Cu/Cr/As metals 4°C HNO_3			TOTAL
MW-6/9673	L	10-14-91 17:20		1	X MR		1	1	1				4
MW-7/9674	L	10-14-91 15:38		1			1	1	1				4
MW-8/9675	L	10-14-91 15:18		1			1	1	1				4
MW-9/9676	L	10-14-91 13:10		1	1		1	1	1	1			6
RB-1	L	10-14-91 16:50		1		1	1	1	1	1			6
FB-1	L	10-14-91 16:50		1		1	1	1	1	1			6

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 30

Relinquished by: Mark E Radecke Organization: Geraghty & Miller, Inc. 10-14-91 19:00
Received by: Organization: Date / / Time

Seal Intact? Yes No N/A

Relinquished by: Organization:
Received by: L. Johnson SL#36568 Organization: SAV LABS Date 10/15/91 Time 9:30

Seal Intact? (Yes) No N/A

Special Instructions/Remarks: MW-9/9676 constituents were sampled at 13:10 with the exception of TSS and Cu, Cr & As which were sampled at 16:10

Delivery Method: ☐ In Person ☒ Common Carrier FEDERAL EXPRESS (SPECIFY) ☐ Lab Courier ☐ Other (SPECIFY)

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G & M RALEIGH

LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
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P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-1	LF1AUS/9663A	10-15-91
36592-2	LF1ALS/9663B	10-15-91
36592-3	LF1DUS/9666A	10-15-91
36592-4	LF1DLS/9666B	10-15-91
36592-5	LF1CUS/9665A	10-15-91

PARAMETER	36592-1	36592-2	36592-3	36592-4	36592-5
Semi-Volatiles (8270)					
Naphthalene, mg/kg dw	2.8	0.56J	1.0	0.088J	3.4J
1-Methylnaphthalene, mg/kg dw	0.22J	0.17J	0.14J	0.070J	4.0J
2-Methylnaphthalene, mg/kg dw	2.7	0.29J	1.1	0.067J	6.4J
1,1-Biphenyl, mg/kg dw	0.42	0.092J	0.24J	0.022J	0.90J
Acenaphthylene, mg/kg dw	3.8	0.59J	1.4	0.13J	2.1J
Acenaphthene, mg/kg dw	0.95	1.9J	0.36	0.18J	0.62J
Dibenzofuran, mg/kg dw	2.7	0.89J	1.6	0.21J	5.6J
Fluorene, mg/kg dw	6.9	2.4J	4.9	0.21J	14
Phenanthrene, mg/kg dw	16	15	7.7	3.3	21
Anthracene, mg/kg dw	54	5.7	36	1.0	140
Carbazole, mg/kg dw	23	1.1J	8.2	0.98	38
Pyrene, mg/kg dw	20	69	28	5.7	34
Benzo(a)Anthracene, mg/kg dw	11	24	15	2.1	11
Chrysene, mg/kg dw	12	28	18	3.0	15
Benzo(a)pyrene, mg/kg dw	13	14	11	1.8	14
Benzo(g,h,i)perylene, mg/kg dw	7.4	6.5	2.1	0.70	6.4J
Pentachlorophenol, mg/kg dw	1.2	3.9J	0.79J	<1.8	<39
Fluoranthene, mg/kg dw	22	77	24	4.7	15
2-Chlorophenol, mg/kg dw	<0.38	<3.7	<0.36	<0.35	<7.8

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LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-1	LF1AUS/9663A	10-15-91
36592-2	LF1ALS/9663B	10-15-91
36592-3	LF1DUS/9666A	10-15-91
36592-4	LF1DLS/9666B	10-15-91
36592-5	LF1CUS/9665A	10-15-91

PARAMETER	36592-1	36592-2	36592-3	36592-4	36592-5
Phenol, mg/kg dw	<0.38	<3.7	<0.36	<0.35	<7.8
2,4-Dimethylphenol, mg/kg dw	0.06J	<3.7	0.028J	<0.35	0.86J
Trichlorophenols, mg/kg dw	<0.38	<3.7	<0.36	<0.35	<7.8
Cresol (ortho), mg/kg dw	<0.38	<3.7	<0.36	<0.35	0.023J
Cresol m & p, mg/kg dw	0.044J	<3.7	<0.36	<0.35	<7.8
p-Chloro-m-cresol, mg/kg dw	<0.38	<3.7	<0.36	<0.35	<7.8
Tetrachlorophenols, mg/kg dw	0.19J	<3.7	<0.36	<0.35	<7.8
2,4-Dinitrophenol, mg/kg dw	<1.9	<19	<1.8	<1.8	<39
Benzo(b,k)fluoranthene, mg/kg dw	30	36	32	3.4	43
Indeno(1,2,3-cd)pyrene, mg/kg dw	9.6	9.2	4.4	0.74	7.9
Dibenzo(a,h)anthracene, mg/kg dw	3.4	2.9J	1.1	0.26J	<7.8
Surrogate-2FP (CL 25-121)	66 %	*F33	60 %	72 %	64 %
Surrogate-PHL (CL 24-113)	59 %	*F33	54 %	75 %	78 %
Surrogate-NBZ (CL 23-120)	54 %	*F33	60 %	78 %	68 %
Surrogate-TBP (CL 19-122)	70 %	*F33	71 %	58 %	83 %
Surrogate-TPH (CL 18-137)	159 %	*F33	179 %	119 %	120 %
Surrogate-FBP (CL 30-115)	65 %	*F33	65 %	75 %	61 %
Date Extracted	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Date Analyzed	10.21-22	10.23-25	10.21-25	10.21-25	10.21-25
Arsenic (7060)					
Arsenic, mg/kg dw	6.5	23	4.9	15	2.5
Date Analyzed	10.29.91	10.30.91	10.29.91	10.30.91	10.29.91

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-1	LF1AUS/9663A	10-15-91
36592-2	LF1ALS/9663B	10-15-91
36592-3	LF1DUS/9666A	10-15-91
36592-4	LF1DLS/9666B	10-15-91
36592-5	LF1CUS/9665A	10-15-91

PARAMETER	36592-1	36592-2	36592-3	36592-4	36592-5
Chromium (6010)					
Chromium, mg/kg dw	6.2	14	5.5	1.9	12
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Copper (6010)					
Copper, mg/kg dw	37	70	22	12	39
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	1500	980	1200	290	1100
Nitrate + Nitrite-N, mg/kg dw	<5.8	<5.6	14	6.3	7.0
Total Nitrogen, mg/kg dw	1500	980	1200	300	1100
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Total Phosphorus (365.1)					
Total Phosphorus, mg/kg dw	730	980	700	240	1000
Date Analyzed	10.31.91	10.31.91	10.31.91	10.31.91	10.31.91
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/kg dw	33000	24000	21000	5000	35000
Date Analyzed	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Chloride (325.2)					
Chloride (325.2), mg/kg dw	<23	<22	<22	<22	<24
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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36592-3	LF1DUS/9666A	10-15-91
36592-4	LF1DLS/9666B	10-15-91
36592-5	LF1CUS/9665A	10-15-91

PARAMETER	36592-1	36592-2	36592-3	36592-4	36592-5
pH in Soil (9045)					
pH-soil (9045), units	6.3	6.9	6.3	6.7	6.6
Date Analyzed	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Percent Solids, %	86	89	92	94	84

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-6	LF1CLS/9665B	10-15-91
36592-7	LF1EUS/9667A	10-15-91
36592-8	LF1ELS/9667B	10-15-91
36592-9	LF1BUS/9664A	10-15-91
36592-10	LF1BLS/9664B	10-15-91

PARAMETER	36592-6	36592-7	36592-8	36592-9	36592-10
Semi-Volatiles (8270)					
Naphthalene, mg/kg dw	0.23J	4.7J	0.13J	1.1J	0.27J
1-Methylnaphthalene, mg/kg dw	0.097J	0.56J	0.063J	0.27J	0.11J
2-Methylnaphthalene, mg/kg dw	0.14J	7.7	0.11J	0.93J	0.18J
1,1-Biphenyl, mg/kg dw	0.040J	2.1J	0.028J	0.23J	0.066J
Acenaphthylene, mg/kg dw	0.58	1.4J	0.35	1.7J	4.1J
Acenaphthene, mg/kg dw	0.15J	0.78J	0.070J	0.52J	1.1J
Dibenzofuran, mg/kg dw	0.18J	9.3	0.14J	1.2J	0.31J
Fluorene, mg/kg dw	0.20J	25	0.18J	2.6J	1.1J
Phenanthrene, mg/kg dw	1.4	34	0.98	6.4	17
Anthracene, mg/kg dw	2.3	350	1.8	23	16
Carbazole, mg/kg dw	0.97	98	1.1	7.0	5.4J
Pyrene, mg/kg dw	10	25	4.2	18	62
Benzo(a)Anthracene, mg/kg dw	5.7	9.6	2.0	10	31
Chrysene, mg/kg dw	8.9	3.6J	2.9	13	36
Benzo(a)pyrene, mg/kg dw	4.1	11	1.5	11	21
Benzo(g,h,i)perylene, mg/kg dw	1.8	4.3J	0.60	4.6	9.1
Pentachlorophenol, mg/kg dw	1.3J	<37	0.70J	1.6J	4.3J
Fluoranthene, mg/kg dw	12	22	3.7	17	72
2-Chlorophenol, mg/kg dw	<0.36	<7.4	<0.35	<3.7	<7.4

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-36592

Received: 16 OCT 91

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Southern Wood Piedmont (WI)
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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-6	LF1CLS/9665B	10-15-91
36592-7	LF1EUS/9667A	10-15-91
36592-8	LF1ELS/9667B	10-15-91
36592-9	LF1BUS/9664A	10-15-91
36592-10	LF1BLS/9664B	10-15-91

PARAMETER	36592-6	36592-7	36592-8	36592-9	36592-10
Phenol, mg/kg dw	<0.36	<7.4	<0.35	<3.7	<7.4
2,4-Dimethylphenol, mg/kg dw	0.050J	0.14J	<0.35	<3.7	0.057J
Trichlorophenols, mg/kg dw	<0.36	<7.4	<0.35	<3.7	<7.4
Cresol (ortho), mg/kg dw	<0.36	<7.4	<0.35	<3.7	<7.4
Cresol m & p, mg/kg dw	<0.36	<7.4	<0.35	<3.7	0.047J
p-Chloro-m-cresol, mg/kg dw	<0.36	<7.4	<0.35	<3.7	<7.4
Tetrachlorophenols, mg/kg dw	0.13J	<7.4	0.045J	0.31J	0.44J
2,4-Dinitrophenol, mg/kg dw	<1.8	<37	<1.8	<19	<37
Benzo(b,k)fluoranthene, mg/kg dw	18	30	4.4	31	61
Indeno(1,2,3-cd)pyrene, mg/kg dw	1.9	5.3J	0.70	5.6	12
Dibenzo(a,h)anthracene, mg/kg dw	0.58	<7.4	<0.35	<3.7	2.3J
Surrogate-2FP (CL 25-121)	54 %	72 %	73 %	80 %	48 %
Surrogate-PHL (CL 24-113)	47 %	81 %	54 %	83 %	36 %
Surrogate-NBZ (CL 23-120)	56 %	76 %	66 %	80 %	36 %
Surrogate-TBP (CL 19-122)	64 %	168 %	77 %	99 %	50 %
Surrogate-TPH (CL 18-137)	93 %	127 %	111 %	156 %	137 %
Surrogate-FBP (CL 30-115)	60 %	71 %	87 %	84 %	46 %
Date Extracted	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Date Analyzed	10.22-23	10.22-25	10.22-25	10.22/25	10.21/22
Arsenic (7060)					
Arsenic, mg/kg dw	4.9	6.9	9.9	7.9	13
Date Analyzed	10.30.91	10.29.91	10.30.91	10.31.91	10.30.91

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

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LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-6	LF1CLS/9665B	10-15-91
36592-7	LF1EUS/9667A	10-15-91
36592-8	LF1ELS/9667B	10-15-91
36592-9	LF1BUS/9664A	10-15-91
36592-10	LF1BLS/9664B	10-15-91

PARAMETER	36592-6	36592-7	36592-8	36592-9	36592-10
Chromium (6010)					
Chromium, mg/kg dw	5.4	6.7	2.8	8.2	7.9
Date Analyzed	10.30.91	10.30.91	10.31.91	10.30.91	10.30.91
Copper (6010)					
Copper, mg/kg dw	38	44	17	30	35
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	1000	1600	300	5000	1000
Nitrate + Nitrite-N, mg/kg dw	<5.4	<5.7	<5.3	<5.7	<5.7
Total Nitrogen, mg/kg dw	1000	1600	300	5000	1000
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Total Phosphorus (365.1)					
Total Phosphorus, mg/kg dw	520	1300	270	920	460
Date Analyzed	10.31.91	10.31.91	10.31.91	10.31.91	10.31.91
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/kg dw	16000	31000	5900	27000	22000
Date Analyzed	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Chloride (325.2)					
Chloride (325.2), mg/kg dw	<22	<23	<21	29	<23
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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36592-7	LF1EUS/9667A	10-15-91
36592-8	LF1ELS/9667B	10-15-91
36592-9	LF1BUS/9664A	10-15-91
36592-10	LF1BLS/9664B	10-15-91

PARAMETER	36592-6	36592-7	36592-8	36592-9	36592-10
pH in Soil (9045)					
pH-soil (9045), units	7.6	7.0	7.4	7.1	7.4
Date Analyzed	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Percent Solids, %	92	88	95	88	88

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-11	LF2BLS/9669B	10-15-91
36592-12	LF2BUS/9669A	10-15-91
36592-13	LF2DUS/9671A	10-15-91
36592-14	LF2DLS/9671B	10-15-91
36592-15	LF2EUS/9672A	10-15-91

PARAMETER	36592-11	36592-12	36592-13	36592-14	36592-15
Semi-Volatiles (8270)					
Naphthalene, mg/kg dw	1.4J	11J	3.4J	14J	3.5J
1-Methylnaphthalene, mg/kg dw	0.29J	0.59J	0.26J	1.6J	0.26J
2-Methylnaphthalene, mg/kg dw	0.88J	16J	4.4J	8.0J	5.1
1,1-Biphenyl, mg/kg dw	0.18J	2.1J	0.64J	2.3J	0.66J
Acenaphthylene, mg/kg dw	2.4J	5.0J	3.7J	5.4J	3.8J
Acenaphthene, mg/kg dw	1.6J	2.5J	1.3J	92	1.0J
Dibenzofuran, mg/kg dw	1.7J	20	5.0J	21J	5.1
Fluorene, mg/kg dw	2.8J	62	14	59J	13
Phenanthrene, mg/kg dw	13	87	20	91	21
Anthracene, mg/kg dw	19	310	75	170	64
Carbazole, mg/kg dw	6.8	170	34	46J	37
Pyrene, mg/kg dw	25	64	17	980	19
Benzo(a)Anthracene, mg/kg dw	12	25	8.6	130	11
Chrysene, mg/kg dw	15	31	11	150	12
Benzo(a)pyrene, mg/kg dw	9.2	23	12	61J	12
Benzo(g,h,i)perylene, mg/kg dw	5.5	10J	7.0J	6.7J	5.1
Pentachlorophenol, mg/kg dw	10	<98	6.4J	150J	4.1J
Fluoranthene, mg/kg dw	30	78	19	520	20
2-Chlorophenol, mg/kg dw	<3.7	<20	<8.0	<82	<3.9

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36592-12	LF2BUS/9669A	10-15-91
36592-13	LF2DUS/9671A	10-15-91
36592-14	LF2DLS/9671B	10-15-91
36592-15	LF2EUS/9672A	10-15-91

PARAMETER	36592-11	36592-12	36592-13	36592-14	36592-15
Phenol, mg/kg dw	<3.7	<20	<8.0	2.2J	<3.9
2,4-Dimethylphenol, mg/kg dw	0.037J	<20	<8.0	<82	0.081J
Trichlorophenols, mg/kg dw	0.048J	<20	<8.0	<82	<3.9
Cresol (ortho), mg/kg dw	0.040J	<20	<8.0	<82	0.022J
Cresol m & p, mg/kg dw	<3.7	<20	<8.0	<82	0.087J
p-Chloro-m-cresol, mg/kg dw	<3.7	<20	<8.0	<82	<3.9
Tetrachlorophenols, mg/kg dw	0.52J	<20	0.34J	3.5J	0.47J
2,4-Dinitrophenol, mg/kg dw	<19	<98	<40	<410	<20
Benzo(b,k)fluoranthene, mg/kg dw	21	55	26	190	30
Indeno(1,2,3-cd)pyrene, mg/kg dw	6.8	13J	8.8	18J	7.3
Dibenzo(a,h)anthracene, mg/kg dw	2.6J	3.4J	2.0J	6.6J	2.5J
Surrogate-2FP (CL 25-121)	57 %	63 %	54 %	31 %	59 %
Surrogate-PHL (CL 24-113)	45 %	64 %	48 %	37 %	67 %
Surrogate-NBZ (CL 23-120)	44 %	60 %	50 %	34 %	57 %
Surrogate-TBP (CL 19-122)	59 %	104 %	65 %	164 %	51 %
Surrogate-TPH (CL 18-137)	142 %	210 %	140 %	84 %	127 %
Surrogate-FBP (CL 30-115)	57 %	64 %	56 %	58 %	59 %
Date Extracted	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Date Analyzed	10.21/22	10.21/22	10.21/22	10.23/25	10.21/25
Arsenic (7060)					
Arsenic, mg/kg dw	84	8.3	6.4	22	6.7
Date Analyzed	10.30.91	10.29.91	10.29.91	10.30.91	10.29.91

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36592-12	LF2BUS/9669A	10-15-91
36592-13	LF2DUS/9671A	10-15-91
36592-14	LF2DLS/9671B	10-15-91
36592-15	LF2EUS/9672A	10-15-91

PARAMETER	36592-11	36592-12	36592-13	36592-14	36592-15
Chromium (6010)					
Chromium, mg/kg dw	100	11	7.1	21	7.8
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Copper (6010)					
Copper, mg/kg dw	140	44	35	150	39
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	840	1900	1200	4900	1700
Nitrate + Nitrite-N, mg/kg dw	12	<5.8	<6.0	<6.3	7.2
Total Nitrogen, mg/kg dw	850	1900	1200	4900	1700
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Total Phosphorus (365.1)					
Total Phosphorus, mg/kg dw	440	760	490	610	200
Date Analyzed	10.31.91	10.31.91	10.31.91	10.31.91	10.31.91
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/kg dw	21000	34000	32000	47000	32000
Date Analyzed	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Chloride (325.2)					
Chloride (325.2), mg/kg dw	<23	<23	46	100	<24
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-16	LF2ELS/9672B	10-15-91
36592-17	LF2AUS/9668A	10-15-91
36592-18	LF2ALS/9668B	10-15-91
36592-19	LF2CUS/9670A	10-15-91
36592-20	LF2CLS/9670B	10-15-91

PARAMETER	36592-16	36592-17	36592-18	36592-19	36592-20
Semi-Volatiles (8270)					
Naphthalene, mg/kg dw	2.5J	2.2J	0.36J	4.3J	1.9J
1-Methylnaphthalene, mg/kg dw	0.41J	0.22J	0.13J	0.46J	0.34J
2-Methylnaphthalene, mg/kg dw	2.4J	2.1J	0.22J	4.6J	0.85J
1,1-Biphenyl, mg/kg dw	0.59J	0.37J	0.078J	0.91J	0.27J
Acenaphthylene, mg/kg dw	5.0J	5.2	2.4J	4.7J	4.3J
Acenaphthene, mg/kg dw	8.1J	1.0J	0.62J	5.5J	1.7J
Dibenzofuran, mg/kg dw	5.6J	2.6J	0.49J	8.4	2.2J
Fluorene, mg/kg dw	19J	7.1	1.2J	26	7.2J
Phenanthrene, mg/kg dw	45	12	4.1	38	21
Anthracene, mg/kg dw	93	41	9.5	120	84
Carbazole, mg/kg dw	28J	18	3.1J	60	15
Pyrene, mg/kg dw	310	21	25	35	74
Benzo(a)Anthracene, mg/kg dw	63	13	12	17	28
Chrysene, mg/kg dw	69	15	18	20	41
Benzo(a)pyrene, mg/kg dw	29J	16	9.6	20	27
Benzo(g,h,i)perylene, mg/kg dw	8.3J	7.2	3.7J	6.0J	5.6J
Pentachlorophenol, mg/kg dw	19J	3.8J	2.8J	4.6J	22J
Fluoranthene, mg/kg dw	350	20	24	37	83
2-Chlorophenol, mg/kg dw	<37	<4.0	<4.1	<7.6	<9.3

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-16	LF2ELS/9672B	10-15-91
36592-17	LF2AUS/9668A	10-15-91
36592-18	LF2ALS/9668B	10-15-91
36592-19	LF2CUS/9670A	10-15-91
36592-20	LF2CLS/9670B	10-15-91

PARAMETER	36592-16	36592-17	36592-18	36592-19	36592-20
Phenol, mg/kg dw	<37	<4.0	<4.1	<7.6	<9.3
2,4-Dimethylphenol, mg/kg dw	<37	0.092J	0.082J	0.087J	0.12J
Trichlorophenols, mg/kg dw	<37	<4.0	<4.1	<7.6	<9.3
Cresol (ortho), mg/kg dw	<37	0.024J	<4.1	0.028J	0.026J
Cresol m & p, mg/kg dw	<37	0.10J	0.070J	<7.6	<9.3
p-Chloro-m-cresol, mg/kg dw	<37	<4.0	<4.1	<7.6	<9.3
Tetrachlorophenols, mg/kg dw	1.1J	0.48J	0.25J	<7.6	0.85J
2,4-Dinitrophenol, mg/kg dw	<190	<20	<21	<38	<46
Benzo(b,k)fluoranthene, mg/kg dw	90	34	32	37	81
Indeno(1,2,3-cd)pyrene, mg/kg dw	12J	9.2	5.2	9.1	9.8
Dibenzo(a,h)anthracene, mg/kg dw	5.1J	2.0J	1.2J	3.4J	4.0J
Surrogate-2FP (CL 25-121)	57 %	72 %	56 %	65 %	58 %
Surrogate-PHL (CL 24-113)	66 %	74 %	31 %	67 %	54 %
Surrogate-NBZ (CL 23-120)	53 %	65 %	52 %	60 %	60 %
Surrogate-TBP (CL 19-122)	173 %	81 %	57 %	112 %	86 %
Surrogate-TPH (CL 18-137)	199 %	211 %	137 %	195 %	189 %
Surrogate-FBP (CL 30-115)	67 %	79 %	61 %	68 %	62 %
Date Extracted	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Date Analyzed	10.21/23	10.21/25	10.21/25	10.21/25	10.21.91
Arsenic (7060)					
Arsenic, mg/kg dw	9.5	7.9	18	5.6	14
Date Analyzed	10.30.91	10.30.91	10.30.91	10.29.91	10.30.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE SAMPLED
36592-16	LF2ELS/9672B	10-15-91
36592-17	LF2AUS/9668A	10-15-91
36592-18	LF2ALS/9668B	10-15-91
36592-19	LF2CUS/9670A	10-15-91
36592-20	LF2CLS/9670B	10-15-91

PARAMETER	36592-16	36592-17	36592-18	36592-19	36592-20
Chromium (6010)					
Chromium, mg/kg dw	15	15	12	6.2	9.8
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Copper (6010)					
Copper, mg/kg dw	51	42	120	41	62
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	1300	1300	1900	1600	1100
Nitrate + Nitrite-N, mg/kg dw	<5.6	6.9	6.1	<5.8	<5.7
Total Nitrogen, mg/kg dw	1300	1300	1900	1600	1100
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91
Total Phosphorus (365.1)					
Total Phosphorus, mg/kg dw	200	580	470	580	280
Date Analyzed	10.31.91	10.31.91	10.31.91	10.31.91	10.31.91
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/kg dw	23000	26000	21000	26000	28000
Date Analyzed	10.17.91	10.17.91	10.17.91	10.18.91	10.18.91
Chloride (325.2)					
Chloride (325.2), mg/kg dw	<22	<24	<24	<23	<22
Date Analyzed	10.30.91	10.30.91	10.30.91	10.30.91	10.30.91

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36592-17	LF2AUS/9668A	10-15-91
36592-18	LF2ALS/9668B	10-15-91
36592-19	LF2CUS/9670A	10-15-91
36592-20	LF2CLS/9670B	10-15-91

PARAMETER	36592-16	36592-17	36592-18	36592-19	36592-20
pH in Soil (9045)					
pH-soil (9045), units	6.9	6.7	6.8	6.4	6.5
Date Analyzed	10.17.91	10.17.91	10.17.91	10.17.91	10.17.91
Percent Solids, %	89	83	82	86	88

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID
36592-21	Detection Limits
36592-22	Method Blank (MB) Result
36592-23	Lab Control Standard (LCS) Result
36592-24	LCS Expected Value
36592-25	LCS % Recovery

PARAMETER	36592-21	36592-22	36592-23	36592-24	36592-25
Semi-Volatiles (8270)					
Naphthalene, mg/kg dw	0.33	<0.33	2.51	3.30	76 %
1-Methylnaphthalene, mg/kg dw	0.33	<0.33	---	---	---
2-Methylnaphthalene, mg/kg dw	0.33	<0.33	---	---	---
1,1-Biphenyl, mg/kg dw	0.33	<0.33	---	---	---
Acenaphthylene, mg/kg dw	0.33	<0.33	2.87	3.30	87 %
Acenaphthene, mg/kg dw	0.33	<0.33	2.41	3.30	73 %
Dibenzofuran, mg/kg dw	0.33	<0.33	---	---	---
Fluorene, mg/kg dw	0.33	<0.33	---	---	---
Phenanthrene, mg/kg dw	0.33	<0.33	2.48	3.30	75 %
Anthracene, mg/kg dw	0.33	<0.33	2.64	3.30	80 %
Carbazole, mg/kg dw	0.33	<0.33	---	---	---
Pyrene, mg/kg dw	0.33	<0.33	---	---	---
Benzo(a)Anthracene, mg/kg dw	0.33	<0.33	2.57	3.30	78 %
Chrysene, mg/kg dw	0.33	<0.33	2.28	3.30	69 %
Benzo(a)pyrene, mg/kg dw	0.33	<0.33	2.77	3.30	84 %
Benzo(g,h,i)perylene, mg/kg dw	0.33	<0.33	---	---	---
Pentachlorophenol, mg/kg dw	1.7	<1.7	1.06	3.30	32 %
Fluoranthene, mg/kg dw	0.33	<0.33	2.41	3.30	73 %
2-Chlorophenol, mg/kg dw	0.33	<0.33	2.87	3.30	87 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID
36592-21	Detection Limits
36592-22	Method Blank (MB) Result
36592-23	Lab Control Standard (LCS) Result
36592-24	LCS Expected Value
36592-25	LCS % Recovery

PARAMETER	36592-21	36592-22	36592-23	36592-24	36592-25
Phenol, mg/kg dw	0.33	<0.33	3.27	3.30	99 %
2,4-Dimethylphenol, mg/kg dw	0.33	<0.33	2.77	3.30	84 %
Trichlorophenols, mg/kg dw	0.33	<0.33	2.11	3.30	64 %
Cresol (ortho), mg/kg dw	0.33	<0.33	---	---	---
Cresol m & p, mg/kg dw	0.33	<0.33	---	---	---
p-Chloro-m-cresol, mg/kg dw	0.33	<0.33	2.81	3.30	85 %
Tetrachlorophenols, mg/kg dw	0.33	<0.33	2.08	3.30	63 %
2,4-Dinitrophenol, mg/kg dw	1.7	<1.7	0.99	3.30	30 %
Benzo(b,k)fluoranthene, mg/kg dw	0.33	<0.33	2.64	3.30	80 %
Indeno(1,2,3-cd)pyrene, mg/kg dw	0.33	<0.33	3.23	3.30	98 %
Dibenzo(a,h)anthracene, mg/kg dw	0.33	<0.33	2.84	3.30	86 %
Surrogate-2FP (CL 25-121)	---	72 %	75 %	---	---
Surrogate-PHL (CL 24-113)	---	73 %	75 %	---	---
Surrogate-NBZ (CL 23-120)	---	63 %	64 %	---	---
Surrogate-TBP (CL 19-122)	---	64 %	62 %	---	---
Surrogate-TPH (CL 18-137)	---	74 %	70 %	---	---
Surrogate-FBP (CL 30-115)	---	64 %	68 %	---	---
Date Extracted	---	10.17.91	10.17.91	---	---
Date Analyzed	---	10.21/25	10.21.91	---	---
Arsenic (7060)					
Arsenic, mg/kg dw	1.0	<1.0	9.7	9.9	98 %
Date Analyzed	---	10.29.91	10.31.91	---	---

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID
36592-26	LCS % Recovery Limits
36592-27	Matrix Spike (MS) Result/Duplicate
36592-28	MS Expected Value
36592-29	MS % Recovery/Duplicate
36592-30	MS % Recovery Limits

PARAMETER	36592-26	36592-27	36592-28	36592-29	36592-30
Semi-Volatiles (8270)					
Naphthalene, mg/kg dw	21-133 %	2.08/2.74	3.30	63/83 %	21-133 %
Acenaphthylene, mg/kg dw	33-145 %	2.61/2.18	3.30	79/66 %	33-145 %
Acenaphthene, mg/kg dw	47-145 %	5.05/2.15	3.30	153/65 %	47-145 %
Phenanthrene, mg/kg dw	54-120 %	*F61	3.30	*F61	---
Anthracene, mg/kg dw	27-133 %	*F61	3.30	*F61	---
Benzo(a)Anthracene, mg/kg dw	33-143 %	*F61	3.30	*F61	---
Chrysene, mg/kg dw	17-168 %	*F61	3.30	*F61	---
Benzo(a)pyrene, mg/kg dw	17-163 %	*F61	3.30	*F61	---
Pentachlorophenol, mg/kg dw	14-176 %	3.60/1.52	3.30	109/46	14-176 %
Fluoranthene, mg/kg dw	26-137 %	*F61	3.30	*F61	---
2-Chlorophenol, mg/kg dw	23-134 %	2.24/2.34	3.30	68/71 %	23-134 %
Phenol, mg/kg dw	5-112 %	2.21/2.24	3.30	67/68 %	5-112 %
2,4-Dimethylphenol, mg/kg dw	32-119 %	2.11/2.34	3.30	64/71 %	32-119 %
Trichlorophenols, mg/kg dw	37-144 %	2.05/2.15	3.30	62/65 %	37-144 %
p-Chloro-m-cresol, mg/kg dw	22-147 %	2.08/2.34	3.30	63/71 %	22-147 %
Tetrachlorophenols, mg/kg dw	10-130 %	0.40/1.85	3.30	12/56 %	10-130 %
2,4-Dinitrophenol, mg/kg dw	10-191 %	0.79/0.33	3.30	24/10 %	10-191 %
Benzo(b,k)fluoranthene, mg/kg dw	24-159 %	*F61	3.30	*F61	---

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Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID
36592-26	LCS % Recovery Limits
36592-27	Matrix Spike (MS) Result/Duplicate
36592-28	MS Expected Value
36592-29	MS % Recovery/Duplicate
36592-30	MS % Recovery Limits

PARAMETER	36592-26	36592-27	36592-28	36592-29	36592-30
Indeno(1,2,3-cd)pyrene, mg/kg dw	10-171 %	5.12/2.90	3.30	155/88 %	10-171 %
Dibenzo(a,h)anthracene, mg/kg dw	10-227 %	1.98/1.75	3.30	60/53 %	10-227 %
Surrogate-2FP (CL 25-121)	---	69/69 %	---	---	---
Surrogate-PHL (CL 24-113)	---	70/70 %	---	---	---
Surrogate-NBZ (CL 23-120)	---	56/63 %	---	---	---
Surrogate-TBP (CL 19-122)	---	220/72 %	---	---	---
Surrogate-TPH (CL 18-137)	---	190/165 %	---	---	---
Surrogate-FBP (CL 30-115)	---	64/65 %	---	---	---
Date Extracted	---	10.17.91	---	---	---
Date Analyzed	---	10.21/25	---	---	---
Arsenic (7060)					
Arsenic, mg/kg dw	70-130 %	5.6/3.7	5.2	108/71 %	75-125 %
Date Analyzed	---	10.31.91	---	---	---
Copper (6010)					
Copper, mg/kg dw	70-130 %	115/112	110	105/102 %	75-125 %
Date Analyzed	---	10.30.91	---	---	---
Chromium (6010)					
Chromium, mg/kg dw	70-130 %	108/110	111	97/99 %	75-125 %
Date Analyzed	---	10.30.91	---	---	---

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID
36592-26	LCS % Recovery Limits
36592-27	Matrix Spike (MS) Result/Duplicate
36592-28	MS Expected Value
36592-29	MS % Recovery/Duplicate
36592-30	MS % Recovery Limits

PARAMETER	36592-26	36592-27	36592-28	36592-29	36592-30
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	75-125 %	151/103	250	60/41 %	75-125 %
Nitrate + Nitrite-N, mg/kg dw	90-110 %	25.5/25.0	20	128/125 %	75-125 %
Date Analyzed	---	10.30.91	---	---	---
Total Phosphorus (365.1)					
Total Phosphorus, mg/kg dw	60-140 %	142/95	250	57/38 %	75-125 %
Date Analyzed	---	10.31.91	---	---	---
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/kg dw	60-140 %	---	---	---	---
Date Analyzed	---	---	---	---	---
Chloride (325.2)					
Chloride (325.2), mg/kg dw	90-110 %	120/120	100	120/120 %	75-125 %
pH in Soil (9045)					
pH-soil (9045), units	---	---	---	---	---

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36592-31	MW-6/9673	10-15-91
36592-32	MW-7/9674	10-15-91
36592-33	MW-8/9675	10-15-91

PARAMETER	36592-31	36592-32	36592-33
Copper (6010)			
Copper, mg/l	<0.025	<0.025	<0.025
Date Analyzed	10.23.91	10.23.91	10.23.91
Chromium (6010)			
Chromium, mg/l	<0.010	<0.010	<0.010
Date Analyzed	10.23.91	10.23.91	10.23.91
Arsenic (7060)			
Arsenic, mg/l	<0.010	<0.010	<0.010
Date Analyzed	10.29.91	10.29.91	10.31.91
Suspended Solids (160.2)			
Suspended Solids, mg/l	34	20	<5.0
Date Analyzed	10.17.91	10.17.91	10.17.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36592-34	RB-2	10-15-91
36592-35	FB-2	10-15-91

PARAMETER	36592-34	36592-35
Chromium (6010)		
Chromium, mg/l	<0.010	<0.010
Date Analyzed	10.23.91	10.23.91
Copper (6010)		
Copper, mg/l	<0.025	<0.025
Date Analyzed	10.24.91	10.23.91
Arsenic (7060)		
Arsenic, mg/l	<0.010	<0.010
Date Analyzed	10.29.91	10.29.91

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LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36592-34	RB-2	10-15-91
36592-35	FB-2	10-15-91

PARAMETER	36592-34	36592-35
Semi-Volatiles (8270)		
Naphthalene, ug/l	<10	<10
1-Methylnaphthalene, ug/l	<10	<10
2-Methylnaphthalene, ug/l	<10	<10
1,1-Biphenyl, ug/l	<10	<10
Acenaphthylene, ug/l	<10	<10
Acenaphthene, ug/l	<10	<10
Dibenzofuran, ug/l	<10	<10
Fluorene, ug/l	<10	<10
Phenanthrene, ug/l	<10	<10
Anthracene, ug/l	<10	<10
Carbazole, ug/l	<10	<10
Pyrene, ug/l	<10	<10
Benzo(a)Anthracene, ug/l	<10	<10
Chrysene, ug/l	<10	<10
Benzo(a)pyrene, ug/l	<10	<10
Benzo(g,h,i)perylene, ug/l	<10	<10
Pentachlorophenol, ug/l	<50	<50
Fluoranthene, ug/l	<10	<10
2-Chlorophenol, ug/l	<10	<10
Phenol, ug/l	<10	<10
2,4-Dimethylphenol, ug/l	<10	<10
Trichlorophenols, ug/l	<10	<10

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36592-34	RB-2	10-15-91
36592-35	FB-2	10-15-91

PARAMETER	36592-34	36592-35
Cresol (ortho), ug/l	<10	<10
Cresol m & p, ug/l	<10	<10
p-Chloro-m-cresol, ug/l	<10	<10
Tetrachlorophenols, ug/l	<10	<10
2,4-Dinitrophenol, ug/l	<50	<50
Benzo(b,k)fluoranthene, ug/l	<10	<10
Indeno(1,2,3-cd)pyrene, ug/l	<10	<10
Dibenzo(a,h)anthracene, ug/l	<10	<10
Surrogate-2FP (CL 21-110)	49 %	48 %
Surrogate-PHL (CL 10-110)	39 %	39 %
Surrogate-NBZ (CL 35-114)	93 %	86 %
Surrogate-TBP (CL 10-123)	61 %	30 %
Surrogate-TPH (CL 33-141)	84 %	77 %
Surrogate-FBP (CL 43-116)	77 %	72 %
Date Extracted	10.22.91	10.22.91
Date Analyzed	10.23.91	10.23.91
Nitrogen Series		
Total Kjeldahl Nitrogen-N, mg/l	<0.10	<0.10
Nitrate + Nitrite-N, mg/l	0.10	<0.050
Total Nitrogen, mg/l	<0.20	<0.15
Date Analyzed	10.23.91	10.23.91
Total Phosphorus (365.1)		
Total Phosphorus, mg/l	<0.10	<0.10
Date Analyzed	10.23.91	10.23.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36592-34	RB-2	10-15-91
36592-35	FB-2	10-15-91

PARAMETER	36592-34	36592-35
Chloride (325.2)		
Chloride (325.2), mg/l	<1.0	<1.0
Date Analyzed	10.22.91	10.22.91
Total Organic Carbon (415.1)		
Total Organic Carbon , mg/l	2.4	2.1
Date Analyzed	10.16.91	10.16.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36592-36	9677	10-15-91

PARAMETER	36592-36
K001 (Method 8270)	
2-Chlorophenol, ug/l	<10
Phenol, ug/l	<10
2,4-Dimethylphenol, ug/l	<10
Trichlorophenols, ug/l	<10
p-Chloro-m-cresol, ug/l	<10
Tetrachlorophenols, ug/l	<10
2,4-Dinitrophenol, ug/l	<50
Pentachlorophenol, ug/l	<50
Naphthalene, ug/l	<10
Acenaphthene, ug/l	<10
Acenaphthylene, ug/l	<10
Phenanthrene, ug/l	<10
Anthracene, ug/l	<10
Fluoranthene, ug/l	<10
Chrysene, ug/l	<10
Benzo(a)Anthracene, ug/l	<10
Benzo(b,k)fluoranthene, ug/l	<10
Benzo(a)pyrene, ug/l	<10
Indeno(1,2,3-cd)pyrene, ug/l	<10
Dibenzo(a,h)anthracene, ug/l	<10
Carbazole, ug/l	<10
Surrogate-2FP (CL 21-110)	55 %
Surrogate-PHL (CL 10-110)	48 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
36592-36	9677	10-15-91

PARAMETER	36592-36
Surrogate-NBZ (CL 35-114)	90 %
Surrogate-TBP (CL 10-123)	81 %
Surrogate-TPH (CL 33-141)	79 %
Surrogate-FBP (CL 43-116)	70 %
Date Extracted	10.22.91
Date Analyzed	10.28.91

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-37	Detection Limits
36592-38	Method Blank (MB) Result
36592-39	Lab Control Standard (LCS) Result
36592-40	LCS Expected Value
36592-41	LCS % Recovery

PARAMETER	36592-37	36592-38	36592-39	36592-40	36592-41
Copper (6010)					
Copper, mg/l	0.025	<0.025	0.981	1.00	98 %
Date Analyzed	---	10.23.91	10.23.91	---	---
Chromium (6010)					
Chromium, mg/l	0.010	<0.010	0.993	1.01	98 %
Date Analyzed	---	10.23.91	10.23.91	---	---
Arsenic (7060)					
Arsenic, mg/l	0.010	<0.010	0.057	0.050	114 %
Date Analyzed	---	10.29.91	10.29.91	---	---
Suspended Solids (160.2)					
Suspended Solids, mg/l	5.0	<5.0	92	100	92 %
Date Analyzed	---	10.17.91	10.17.91	---	---

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-37	Detection Limits
36592-38	Method Blank (MB) Result
36592-39	Lab Control Standard (LCS) Result
36592-40	LCS Expected Value
36592-41	LCS % Recovery

PARAMETER	36592-37	36592-38	36592-39	36592-40	36592-41
Semi-Volatiles (8270)					
Naphthalene, ug/l	10	<10	101	100	101 %
1-Methylnaphthalene, ug/l	10	<10	---	---	---
2-Methylnaphthalene, ug/l	10	<10	---	---	---
1,1-Biphenyl, ug/l	10	<10	---	---	---
Acenaphthylene, ug/l	10	<10	114	100	114 %
Acenaphthene, ug/l	10	<10	105	100	105 %
Dibenzofuran, ug/l	10	<10	---	---	---
Fluorene, ug/l	10	<10	---	---	---
Phenanthrene, ug/l	10	<10	92	100	92 %
Anthracene, ug/l	10	<10	96	100	96 %
Carbazole, ug/l	10	<10	---	---	---
Pyrene, ug/l	10	<10	---	---	---
Benzo(a)Anthracene, ug/l	10	<10	87	100	87 %
Chrysene, ug/l	10	<10	83	100	83 %
Benzo(a)pyrene, ug/l	10	<10	79	100	79 %
Benzo(g,h,i)perylene, ug/l	10	<10	---	---	---
Pentachlorophenol, ug/l	50	<50	69	100	69 %
Fluoranthene, ug/l	10	<10	98	100	98 %
2-Chlorophenol, ug/l	10	<10	92	100	92 %

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36592-37	Detection Limits
36592-38	Method Blank (MB) Result
36592-39	Lab Control Standard (LCS) Result
36592-40	LCS Expected Value
36592-41	LCS % Recovery

PARAMETER	36592-37	36592-38	36592-39	36592-40	36592-41
Phenol, ug/l	10	<10	36	100	36 %
2,4-Dimethylphenol, ug/l	10	<10	90	100	90 %
Trichlorophenols, ug/l	10	<10	83	100	83 %
Cresol (ortho), ug/l	10	<10	---	---	---
Cresol m & p, ug/l	10	<10	---	---	---
p-Chloro-m-cresol, ug/l	10	<10	90	100	90 %
Tetrachlorophenols, ug/l	10	<10	109	100	109 %
2,4-Dinitrophenol, ug/l	50	<50	52	100	52 %
Benzo(b,k)fluoranthene, ug/l	10	<10	82	100	82 %
Indeno(1,2,3-cd)pyrene, ug/l	10	<10	79	100	79 %
Dibenzo(a,h)anthracene, ug/l	10	<10	74	100	74 %
Surrogate-2FP (CL 21-110)	---	57 %	53 %	---	---
Surrogate-PHL (CL 10-110)	---	41 %	39 %	---	---
Surrogate-NBZ (CL 35-114)	---	106 %	99 %	---	---
Surrogate-TBP (CL 10-123)	---	69 %	64 %	---	---
Surrogate-TPH (CL 33-141)	---	101 %	93 %	---	---
Surrogate-FBP (CL 43-116)	---	94 %	89 %	---	---
Date Extracted	---	10.22.91	10.22.91	---	---
Date Analyzed	---	10.23.91	10.28.91	---	---

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36592-37	Detection Limits
36592-38	Method Blank (MB) Result
36592-39	Lab Control Standard (LCS) Result
36592-40	LCS Expected Value
36592-41	LCS % Recovery

PARAMETER	36592-37	36592-38	36592-39	36592-40	36592-41
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	0.10	<0.10	0.43	0.50	86 %
Nitrate + Nitrite-N, mg/l	0.050	<0.050	0.397	0.375	106 %
Total Nitrogen, mg/l	0.15	<0.15	---	---	---
Date Analyzed	---	10.23.91	10.23.91	---	---
Total Phosphorus (365.1)					
Total Phosphorus, mg/l	0.10	<0.10	0.702	0.75	94 %
Date Analyzed	---	10.23.91	10.23.91	---	---
Chloride (325.2)					
Chloride (325.2), mg/l	1.0	<1.0	7.46	7.7	97 %
Date Analyzed	---	10.22.91	10.22.91	---	---
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/l	1.0	<1.0	23.2	23.0	101 %
Date Analyzed	---	10.16.91	10.16.91	---	---

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-42	LCS % Recovery Limits
36592-43	Matrix Spike (MS) Result/Duplicate
36592-44	MS Expected Value
36592-45	MS % Recovery/Duplicate
36592-46	MS % Recovery Limits

PARAMETER	36592-42	36592-43	36592-44	36592-45	36592-46
Copper (6010)					
Copper, mg/l	75-125 %	.991/.947	1.00	99/95 %	75-125 %
Date Analyzed	---	10.23.91	---	---	---
Chromium (6010)					
Chromium, mg/l	75-125 %	.995/.949	1.01	99/94 %	75-125 %
Date Analyzed	---	10.23.91	---	---	---
Arsenic (7060)					
Arsenic, mg/l	75-125 %	.058/.059	0.050	116/118 %	75-125 %
Date Analyzed	---	10.31.91	---	---	---
Suspended Solids (160.2)					
Suspended Solids, mg/l	75-125 %	---	---	---	---
Date Analyzed	---	---	---	---	---

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36592-42	LCS % Recovery Limits
36592-43	Matrix Spike (MS) Result/Duplicate
36592-44	MS Expected Value
36592-45	MS % Recovery/Duplicate
36592-46	MS % Recovery Limits

PARAMETER	36592-42	36592-43	36592-44	36592-45	36592-46
Semi-Volatiles (8270)					
Naphthalene, ug/l	21-133 %	100/100	100	100/100 %	21-133 %
Acenaphthylene, ug/l	33-145 %	108/108	100	108/108 %	33-145 %
Acenaphthene, ug/l	47-145 %	100/100	100	100/100 %	47-145 %
Phenanthrene, ug/l	54-120 %	92/92	100	92/92 %	54-120 %
Anthracene, ug/l	27-133 %	92/92	100	92/92 %	27-133 %
Benzo(a)Anthracene, ug/l	33-143 %	44/44	100	44/44 %	33-143 %
Chrysene, ug/l	17-168 %	80/80	100	80/80 %	17-168 %
Benzo(a)pyrene, ug/l	17-163 %	28/28	100	28/28 %	17-163 %
Pentachlorophenol, ug/l	14-176 %	31/29	100	31/29 %	14-176 %
Fluoranthene, ug/l	26-137 %	88/88	100	88/88 %	26-137 %
2-Chlorophenol, ug/l	23-134 %	32/36	100	32/36 %	23-134 %
Phenol, ug/l	5-112 %	18/11	100	18/11 %	5-112 %
2,4-Dimethylphenol, ug/l	32-119 %	60/48	100	60/48 %	32-119 %
Trichlorophenols, ug/l	37-144 %	128/112	100	128/112 %	37-144 %
p-Chloro-m-cresol, ug/l	22-147 %	56/44	100	56/44 %	22-147 %
Tetrachlorophenols, ug/l	10-130 %	15/19	100	15/19 %	10-130 %
2,4-Dinitrophenol, ug/l	10-191 %	11/10	100	11/10 %	10-191 %
Benzo(b,k)fluoranthene, ug/l	24-159 %	68/68	100	68/68 %	24-159 %
Indeno(1,2,3-cd)pyrene, ug/l	10-171 %	32/32	100	32/32 %	10-171 %

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REPORT OF RESULTS

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36592-42	LCS % Recovery Limits
36592-43	Matrix Spike (MS) Result/Duplicate
36592-44	MS Expected Value
36592-45	MS % Recovery/Duplicate
36592-46	MS % Recovery Limits

PARAMETER	36592-42	36592-43	36592-44	36592-45	36592-46
Dibenzo(a,h)anthracene, %	10-227 %	26/28	100	26/28 %	10-227 %
Surrogate-2FP (CL 21-110)	---	35/21	100	35/21 %	---
Surrogate-PHL (CL 10-110)	---	23/15	100	23/15 %	---
Surrogate-NBZ (CL 35-114)	---	51/50	50	102/100 %	---
Surrogate-TBP (CL 10-123)	---	57/56	100	57/56 %	---
Surrogate-TPH (CL 33-141)	---	43/44.5	50	86/89 %	---
Surrogate-FBP (CL 43-116)	---	45/44.5	50	90/89 %	---
Date Extracted	---	10.22.91	---	---	---
Date Analyzed	---	10.23.91	---	---	---
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	75-125 %	0.93/0.90	1.0	93/90 %	75-125 %
Nitrate + Nitrite-N, mg/l	90-110 %	.179/.183	0.20	90/92 %	75-125 %
Date Analyzed	---	10.23.91	---	---	---
Total Phosphorus (365.1)					
Total Phosphorus, mg/l	60-140 %	0.89/0.92	1.0	89/92 %	60-140 %
Date Analyzed	---	10.23.91	---	---	---
Chloride (325.2)					
Chloride (325.2), mg/l	90-110 %	5.17/5.08	5.0	103/102 %	75-125 %
Date Analyzed	---	10.23.91	---	---	---

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36592-42	LCS % Recovery Limits
36592-43	Matrix Spike (MS) Result/Duplicate
36592-44	MS Expected Value
36592-45	MS % Recovery/Duplicate
36592-46	MS % Recovery Limits

PARAMETER	36592-42	36592-43	36592-44	36592-45	36592-46
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/l	60-140 %	103/105	100	103/105 %	60-140 %
Date Analyzed	---	10.16.91	---	---	---

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-47	ICVS/CCVS Control Limits
36592-48	ICVS/CCVS Source Lot
36592-49	ICVS/CCVS Expected Value
36592-50	ICVS Result
36592-51	ICVS % Recovery

PARAMETER	36592-47	36592-48	36592-49	36592-50	36592-51
Arsenic (7060)					
Arsenic, mg/l	90-110 %	3-87/SPEX	0.0501	0.050	100 %
Date Analyzed	---	---	---	10.29.91	---
Chromium (6010)					
Chromium, mg/l	90-110 %	3-87/SPEX	1.01	1.02	101 %
Date Analyzed	---	---	---	10.23.91	---
Copper (6010)					
Copper, mg/l	90-110 %	3-87/SPEX	1.00	1.02	102 %
Date Analyzed	---	---	---	10.23.91	---

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-52	CCVS Result
36592-53	CCVS % Recovery

PARAMETER	36592-52	36592-53
Arsenic (7060)		
Arsenic, mg/l	0.0487	97 %
Date Analyzed	10.29.91	---
Chromium (6010)		
Chromium, mg/l	1.04	103 %
Date Analyzed	10.23.91	---
Copper (6010)		
Copper, mg/l	1.02	102 %
Date Analyzed	10.23.91	---

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Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-54	CCVS Result
36592-55	CCVS % Recovery
36592-56	CCVS Result
36592-57	CCVS % Recovery
36592-58	CCVS Result

PARAMETER	36592-54	36592-55	36592-56	36592-57	36592-58
Arsenic (7060)					
Arsenic, mg/l	0.0534	107 %	0.0539	108 %	0.0536
Date Analyzed	10.29.91	---	10.29.91	---	10.29.91
Chromium (6010)					
Chromium, mg/l	1.04	103 %	1.05	104 %	1.04
Date Analyzed	10.23.91	---	10.23.91	---	10.23.91
Copper (6010)					
Copper, mg/l	1.01	101 %	1.01	101 %	1.01
Date Analyzed	10.23.91	---	10.23.91	---	10.23.91

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Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-59	CCVS % Recovery
36592-60	CCVS Result
36592-61	CCVS % Recovery
36592-62	CCVS Result
36592-63	CCVS % Recovery

PARAMETER	36592-59	36592-60	36592-61	36592-62	36592-63
Arsenic (7060)					
Arsenic, mg/l	107 %	0.0491	98 %	0.0504	101 %
Date Analyzed	---	10.29.91	---	10.29.91	---
Chromium (6010)					
Chromium, mg/l	103 %	1.04	103 %	1.03	102 %
Date Analyzed	---	10.23.91	---	10.23.91	---
Copper (6010)					
Copper, mg/l	101 %	1.00	100 %	0.999	100 %
Date Analyzed	---	10.23.91	---	10.23.91	---

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-64	CCVS Result
36592-65	CCVS % Recovery
36592-66	CCVS Result
36592-67	CCVS % Recovery
36592-68	CCVS Result

PARAMETER	36592-64	36592-65	36592-66	36592-67	36592-68
Arsenic (7060)					
Arsenic, mg/l	0.0489	98 %	0.0484	97 %	0.0454
Date Analyzed	10.29.91	---	10.29.91	---	10.29.91
Chromium (6010)					
Chromium, mg/l	1.01	100 %	1.02	101 %	0.997
Date Analyzed	10.23.91	---	10.23.91	---	10.23.91
Copper (6010)					
Copper, mg/l	0.992	99 %	0.992	99 %	0.968
Date Analyzed	10.23.91	---	10.23.91	---	10.23.91

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-69	CCVS % Recovery

PARAMETER	36592-69
Arsenic (7060)	
Arsenic, mg/l	91 %
Chromium (6010)	
Chromium, mg/l	99 %
Copper (6010)	
Copper, mg/l	97 %

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-70	CCVS Result
36592-71	CCVS % Recovery
36592-72	CCVS Result
36592-73	CCVS % Recovery

PARAMETER	36592-70	36592-71	36592-72	36592-73
Arsenic (7060)				
Arsenic, mg/l	0.0542	108 %	0.0460	92 %
Date Analyzed	10.29.91	---	10.29.91	---

Methods: EPA SW-846

F33 - Surrogates were not reported due to sample dilution required prior to analysis.

F61 - MS/MSD were not recovered due to the abundance of a target analyte in the sample.

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
36592-74	MS % RPD (Limit) - Liquid

PARAMETER	36592-74
Copper (6010)	
Copper	4.1(<20) %
Chromium (6010)	
Chromium	5.2(<20) %
Arsenic (7060)	
Arsenic	1.7(<20) %

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES

36592-74 MS % RPD (Limit) - Liquid

PARAMETER	36592-74
Semi-Volatiles (8270)	
Naphthalene	0(<40) %
Acenaphthylene	0(<40) %
Acenaphthene	0(<31) %
Phenanthrene	0(<40) %
Anthracene	0(<40) %
Benzo(a)Anthracene	0(<40) %
Chrysene	0(<48) %
Benzo(a)pyrene	0(<40) %
Pentachlorophenol	6.6(<50) %
Fluoranthene	0(<40) %
2-Chlorophenol	12(<40) %
Phenol	48(<42) %
2,4-Dimethylphenol	22(<40) %
Trichlorophenols	13(<50) %
p-Chloro-m-cresol	24(<40) %
Tetrachlorophenols	24(<50) %
2,4-Dinitrophenol	9.5(<50) %
Benzo(b,k)fluoranthene	0(<40) %
Indeno(1,2,3-cd)pyrene	0(<45) %
Dibenzo(a,h)anthracene	7.4(<70) %
Nitrogen Series	
Total Kjeldahl Nitrogen-N	3.3(<30) %
Nitrate + Nitrite-N	2.2(<30) %
Total Phosphorus (365.1)	
Total Phosphorus	3.3(<40) %

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

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Doc No.: S1-35591

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES

36592-74 MS % RPD (Limit) - Liquid

PARAMETER	36592-74
Chloride (325.2)	
Chloride (325.2)	.97(<30) %
Total Organic Carbon (415.1)	
Total Organic Carbon , mg/l	1.9(<40) %

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Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID

36592-75 MS % RPD (Limit) - Soil

PARAMETER	36592-75
Semi-Volatiles (8270)	
Naphthalene	27(<40) %
Acenaphthylene	18(<40) %
Acenaphthene	80(<19) %
Phenanthrene	*F61
Anthracene	*F61
Benzo(a)Anthracene	*F61
Chrysene	*F61
Benzo(a)pyrene	*F61
Pentachlorophenol	81(<47) %
Fluoranthene	*F61
2-Chlorophenol	4.3(<50) %
Phenol	1.5(<35) %
2,4-Dimethylphenol	10(<26) %
Trichlorophenols	4.7(<40) %
p-Chloro-m-cresol	12(<40) %
Tetrachlorophenols	129(<50) %
2,4-Dinitrophenol	82(<50) %
Benzo(b,k)fluoranthene	*F61
Indeno(1,2,3-cd)pyrene	55(<45) %
Dibenzo(a,h)anthracene	12(<70) %
Arsenic (7060)	
Arsenic	41(<30) %
Copper (6010)	
Copper	5.1(<30) %

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID
36592-75	MS % RPD (Limit) - Soil

PARAMETER	36592-75
Chromium (6010)	
Chromium	2.0(<30) %
Nitrogen Series	
Total Kjeldahl Nitrogen-N	38(<30) %
Nitrate + Nitrite-N	2.4(<30) %
Total Phosphorus (365.1)	
Total Phosphorus	40(<40) %
Total Organic Carbon (415.1)	
Total Organic Carbon	---
Chloride (325.2)	
Chloride (325.2)	0(<30) %

J. W. Andrews

J. W. Andrews, Ph. D.

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

[redacted] & MILLER, INC.
Environmental Services

Laboratory Task Order No. N[redacted]

CHAIN-OF-CUSTODY RECORD

P[redacted] 1 of 1

Project Number NC0900S SWP

Project Location Wilmington, NC

Laboratory SAVANNAH LABORATORIES

Sampler(s)/Affiliation M. RADECKE (G&M)
P. JACKS (G&M)

SAMPLE BOTTLE / CONTAINER DESCRIPTION

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500ml w/m glass (G2a) Semi Volatile contaminants 4°C	1 liter w/m plastic pH, metals (Cu, Cr, As) TOC, TP, TN, Cl- 4°C								TOTAL
LFIAUS/9663A	S	10-15-91 10134		1	1								2
LFIALS/9663B	S	10-15-91 10141		1	1								2
LADUS/9666A	S	10-15-91 11118		1	1								2
LFIDLS/9666B	S	10-15-91 11121		1	1								2
LFICUS/9665A	S	10-15-91 12156		1	1								2
LFICLS/9665B	S	10-15-91 13101		1	1								2
LFIEUS/9667A	S	10-15-91 12118		1	1								2
LFIELS/9667A	S	10-15-91 12123		1	1								2

Sample Code: L = Liquid; S = Solid; A = Air

Temp: 5.0

Total No. of Bottles/Containers 16

Relinquished by: Mark E. Radecke	Organization: Geraghty & Miller, Inc.	10-15-91 19:00	Seal Intact? (Yes) No N/A
Received by: L. Bonds	Organization: SL 36592	Date 10/16/91 Time 10:00 am	
Relinquished by:	Organization:		Seal Intact? Yes No N/A
Received by:	Organization:	Date / / Time	

Special Instructions/Remarks:

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other _____ (SPECIFY)

G&M Form 09 1-90

Southpoint 90 0128

[redacted] & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Number NC09005

Project Location SWP WILMINGTON, NC

Laboratory SAVANNAH LABS

Sampler(s)/Affiliation M. RADECKE (G&M)
P. JACOBS (G&M)

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500 ml w/m Blue semi-volatile contaminants (327°C) 4°C	1 liter w/m plastic pH, TOC/TP, TP Cl-, metals (Cu, Cr, Ni) 4°C								TOTAL
LF1BUS/9664A	S	10-15-91 13:27		1	1								2
LF1BLS/9664B	S	10-15-91 13:32		1	1								2
LF2BW/9669B	S	10-15-91 14:45		1	1								2
LF2BUS/9669A	S	10-15-91 14:39		1	1								2
LF2DUS/9671A	S	10-15-91 15:28		1	1								2
LF2DLS/9671B	S	10-15-91 15:40		1	1								2
LF2EUS/9672A	S	10-15-91 15:05		1	1								2
LF2ELS/9672B	S	10-15-91 15:10		1	1								2

Sample Code: L = Liquid; S = Solid; A = Air

Temp 4.9

Total No. of Bottles/Containers 16

Relinquished by: [signature] Organization: Geraghty & Miller, Inc 10-15-91 19:00
Received by: [signature] Organization: SL 36592 Date 10/16/91 Time 10:00 am
Seal Intact? (Yes) No N/A

Relinquished by: Organization:
Received by: Organization: Date / / Time
Seal Intact? Yes No N/A

Special Instructions/Remarks:

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other (SPECIFY)

G&M Form 09 1-90

Southprint 90-0136

A-118

GEORGHIADIS & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Page ___ of ___

Project Number NC09005

Project Location SWP Wilmington, NC

Laboratory SAVANNAH LABORATORIES

Sampler(s)/Affiliation M. RADECKE (G&M)
P. JACOBS (G&M)

SAMPLE BOTTLE / CONTAINER DESCRIPTION

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	250ml plastic metals (Cu, Cr, As) 4°C H_2SO_3	100ml plastic TSS 4°C	1 liter amber glass semi-volatile compounds (8270) 4°C	1 liter amber glass pesticides (8080) 4°C	250ml m/m plastic pH NOT SAMPLED HERE	250ml m/m plastic TN, TP 4°C H_2SO_4	100ml plastic Cl⁻ 4°C	125ml amber glass TOC 4°C	1 liter amber glass KOOL compounds 4°C	TOTAL
MW-6/9673	L	10-15-91 9120		1	1								2
MW-7/9674	L	10-15-91 9110		1	1								2
MW-8/9675	L	10-15-91 8155		1	1								2
RB-2	L	10-15-91 16:35		1		1	* MR	1	1	1			MR ~~8~~ 5
FB-2	L	10-15-91 16135		1		1	* MR	1	1	1			MR ~~8~~ 5
9677	L	10-15-91 17:30									1		1

Sample Code: L = Liquid; S = Solid; A = Air

Temp. 4-5

Total No. of Bottles/Containers 17

Relinquished by: Mark E Radecke Organization: Georghiadis & Miller, Inc 10-15-91 19:00
Received by: Lab Onda Organization: SL 36592 Date 10/16/91 Time 10:01 am
Seal Intact? (Yes) No N/A

Relinquished by: ___ Organization: ___
Received by: ___ Organization: ___ Date / / Time ___
Seal Intact? Yes No N/A

Special Instructions/Remarks: ___

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other ___ (SPECIFY)

GSM Form 09 1.00 Southprint 90-0136

[redacted] & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Project Number NC09005

Project Location SWP Wilmington, NC

Laboratory SAVANNAH LABS

Sampler(s)/Affiliation M. RADECKE (G&M)
P. JACOBS (G&M)

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500 ml glass semi volatile contaminants (8270) 4°C	1 liter w/m plastic pH TOC, TSS, TP Cl, metal (Cu, Cr, Ni) 4°C								TOTAL
LF2AUS/9668A	S	10-15-91 16102		1	1								2
LF2ALS/9668B	S	10-15-91 16110		1	1								2
LF2CUS/9670A	S	10-15-91 16144		1	1								2
LF2CLS/9670B	S	10-15-91 16150		1	1								2

Sample Code: L = Liquid; S = Solid; A = Air

Temp. 9.0

Total No. of Bottles/Containers: 8

Relinquished by: Mark E. Radecke	Organization: Geraghty & Miller, Inc	10-15-91 19:00	Seal Intact? (Yes) No N/A
Received by: A. Blonds	Organization: SL 36592	Date 10/16/91 Time 10:00am	
Relinquished by:	Organization:		Seal Intact?
Received by:	Organization:	Date / / Time	Yes No N/A

Special Instructions/Remarks: Refer to other chain of custody forms submitted on 10-15-91 for complete list of semi volatile constituents

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other _____ (SPECIFY)

G&M Form 09 1-90

Southprint 90-0136

1990 ANALYTICAL DATA
SUPPLEMENTAL EXPANDED CONSTITUENT LIST
SOUTHERN WOOD PIEDMONT, WILMINGTON, NORTH CAROLINA

RECEIVED
DEC 16 1991
G & M RALEIGH

12822	-1	-2	-3	-4	-5
	9101C	9101A	9101B	9101D	9104D
2-Chlorophenol	<7.3	<7.4	<7.8	<0.35	<0.34
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-Chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<37	<7	<39	<1.8	<1.7
Benzo(b,k)fluoranthene	27J	43J	19J	<0.35	1.1J
Indeno(1,2,3-cd)pyrene	5.2J	10J	4.9J	↓	<0.34
Dibenzo(a,h)anthracene	2.3J	4.3J	2.7J	↓	↓
o-cresol	<7.3	<7.4	<7.8	↓	↓
m+p-cresol	↓	↓	↓	↓	↓

12822	-6	-7	-8	-9	-10
	9104B	9104C	9104A	9102A	9102B
2-Chlorophenol	<7.4	<7.2	<7.5	<9.4	<7.4
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-Chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<37	<36	<38	<47	<37
Benzo(b,k)Fluoranthene	120J	9.1J	29J	49J	14J
Indeno(1,2,3-cd)pyrene	14J	2.0J	8.1J	11J	3.3J
Dibenzo(a,h)anthracene	4.2J	0.76J	3.2J	5.0J	1.6J
o-cresol	<7.4	<7.4	<7.5	<9.4	<7.4
m+p-cresol	↓	↓	↓	↓	↓

12822	-11	-12	-13	-14	-15
	9102C	9102D	9100A	9100B	9100C
2-Chlorophenol	<7.5	<0.36	<8.0	<7.3	<7.3
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-Chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<38	<1.8	<40	<37	<37
Benzo(b,k)fluoranthene	68 J	<0.36	35 J	19 J	100 J
Indeno(1,2,3-cd)pyrene	9.3 J	↓	10 J	5.2 J	17 J
Dibenzo(a,h)anthracene	4.7 J	↓	4.2 J	2.2 J	7.5 J
o-cresol	<7.5	↓	<8.0	<7.3	<7.3
m+p-cresol	↓	↓	↓	↓	↓

12822	-16	-17	-18	-19	-20
	9100D	9106A	9106B	9106C	9106D
2-Chlorophenol	<0.35	<7.7	<7.8	<7.6	<0.37
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<1.8	<39	<39	<38	<1.9
Benzo(b,k)fluoranthene	<0.35	43 J	24 J	17 J	0.78 J
Indeno(1,2,3-cd)pyrene	↓	11 J	<7.8	<7.6	0.18 J
Dibenzo(a,h)anthracene	↓	<7.7	↓	↓	<0.37
o-cresol	↓	↓	↓	↓	↓
m+p-cresol	↓	↓	↓	↓	↓

12822	-21	-22	-23	-24	-25
	9109A	9109B	9109C	9109D	9105A
2-Chlorophenol	<7.4	<7.5	<4.1	<0.36	<7.8
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol					
Trichlorophenols					
p-chloro-m-cresol					
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<37	<38	<21	<1.8	<39
Benzo(b,k)Fluoranthene	35J	32J	31J	<0.36	33J
Indeno(1,2,3-cd)pyrene	9.6J	8.3J	9.4J	↓	8.6J
Dibenzo(a,h)anthracene	4.4J	3.2J	3.9J		3.9J
o-cresol	<7.4	<7.5	<4.1		<7.8
m+p-cresol	↓	↓	↓	↓	↓

12822	-26	-27	-28	-29	-30
	9105B	9105C	9105D	9107B	9107A
2-Chlorophenol	<8.3	<7.1	<0.45	<7.3	<7.6
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<42	<36	<2.3	<37	<38
Benzo(b,k)Fluoranthene	89J	6.2J	2.6J	5.7J	43J
Indeno(1,2,3-cd)pyrene	18J	1.1J	<0.45	14J	11J
Dibenzo(a,h)anthracene	<8.3	<7.1	↓	6.2J	5.3J
o-cresol	↓	↓	↓	<7.3	<7.6
m+p-cresol	↓	↓	↓	↓	↓

39

	-31	-32	-33	-34	-35
	9107C	9107D	9108D	9108A	9108C
2-Chlorophenol (128)	<7.5	<0.39	<0.42	<0.39	<8.5
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	1.2J
2,4-Dinitrophenol	<38	<2.0	<2.1	<2.0	<43
Benzo(b,k)Fluoranthene	38J	<0.39	2.3J	1.4J	99J
Indeno(1,2,3-cd)pyrene	23J	↓	0.53J	<0.39	19J
Dibenzo(a,h)anthracene	15J	↓	0.23J	↓	9.4J
o-cresol	<7.5	↓	<0.42	↓	<8.5
m+p-cresol	↓	↓	↓	↓	↓

12822	-36	-37	-38	-39	-40
	9108B	9108C	9103A	9103B	9103D
2-Chlorophenol	<7.8	<7.6	<7.6	<7.3	<7.6
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<39	<38	<38	<37	<38
Benzo(b,k)Fluoranthene	82J	52J	31J	14J	18J
Indeno(1,2,3-cd)pyrene	19J	8.7J	8.0J	4.9J	4.1J
Dibenzo(a,h)anthracene	8.0J	3.9J	4.3J	1.6J	1.8J
o-cresol	<7.8	<7.6	<7.6	<7.3	<7.6
m+p-cresol	↓	↓	↓	↓	↓

	-41	-42	-43
	RB1	FB1	TB2
2-Chlorophenol	<0.010	<0.010	<0.010
Phenol	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓
Trichlorophenols	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓
Tetrachlorophenols	↓	↓	↓
2,4-Dinitrophenol	<0.050	<0.050	<0.050
Benzo(b,k)Fluoranthene	<0.010	<0.010	<0.010
Indeno(1,2,3-cd)pyrene	↓	↓	↓
Dibenzo(a,h)anthracene	↓	↓	↓
o-cresol	↓	↓	↓
m+p-cresol	↓	↓	↓

GERAGHTY & MILLER, INC.
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WATER SAMPLING LOG

Project/No. SWP NC0900S Date 10-14-91

Site Location LF Areas SWP Wilmington, NC Site

Site/Well No. MW-6/9673 ~~Rep.~~/Field Blank No. RB-1 & FB-1 Collected prior to Sampling MW-6

Weather Cloudy, Cool & windy Sampling Began _____ Ended _____

Description of Measuring Point (MP) _____

MP Elevation _____ Water Level Elevation _____

Evacuation Data

Height of MP			
Depth of Well Below MP			21.40
Held _____ Depth to Water Below MP		-	2.62
Wet _____ Water Column in Well		=	18.78
Casing Diameter 2"	Gal./ft.	x	0.16
Gallons in Well		=	3.00
Evacuation Volume	x 3	=	9.00

Gallons	3.00	6.00	9.00		*	
pH	6.25	6.15	6.15		6.1	
Spec. Conductance µmhos	700	915	970		800	
Temperature (°C/°F)	20.0	21.0	21.0		21	
	17:05	17.20	17:25		9:20	

Sampling Data/Field Parameters

Color orange brown Odor vague sulfide odor Appearance slightly silty cloudy

Comments: _____

Spec. Cond. (umhos/cm) 1000 pH 6.30 T(°C/°F) 20.0 17:35

Sampling Method DISPOSABLE BAILER

Analyses	Container Type (Lab X G&M ___)	Preservative
TOC / TP, TN	125 ml amber glass / 250 ml m/m plastic	4°C H_2SO_4
TSS / Cl^-	100 ml plastic / 100 ml plastic	4°C
Cu, Cr, As	250 ml plastic	4°C HNO_3
SV	1 liter amber glass	4°C

Remarks: * Readings taken after TSS + metals on 10-15-91 9:20 slightly cloudy

Sampling Personnel: M. RADECKE, P. JACOBS (G&M)

GERAGHTY & MILLER, INC.
Environmental Services

WATER SAMPLING LOG

Project/No. SWP NC09005 Date 10-14-91
Site Location SWP LF areas, Wilmington, NC Site -
Site/Well No. MW-7/9674 Rep./Field Blank No. _____
Weather Sunny mid 70's windy Sampling Began _____ Ended _____
Description of Measuring Point (MP) _____
MP Elevation _____ Water Level Elevation _____

Evacuation Data

Height of MP			
Depth of Well Below MP			21.38
Held _____ Depth to Water Below MP		-	3.95
Wet _____ Water Column in Well		=	17.43
Casing Diameter 2"	Gal./ft.	x	0.16
Gallons in Well		=	2.79
Evacuation Volume	x 3	=	8.40

Gallons	2.80	5.60	8.40			
pH	6.20	6.35	6.40		6.3	
Spec. Conductance µmhos	780	830	830		760	
Temperature (°C/°F)	22.0	22.0	22.5		22	
	14:39	15:05	15:30		9:10	

Sampling Data/Field Parameters

Color Brown Odor Sulfides Appearance Silty
Comments: _____
Spec. Cond. (umhos/cm) 840 pH 6.45 T (°C/°F) 22.0 15:40
Sampling Method DISPOSABLE BAILER

Analyses	Container Type (Lab X G&M ___)	Preservative
TOC / TP, TN	125 ml amber glass / 250 ml m/m plastic	4°C H_2SO_4
TSS / Cl^-	100 ml plastic / 100 ml plastic	4°C
Cu, Cr, As	250 ml plastic	4°C HNO_3
SV	1 liter amber glass	4°C

Remarks: Well was slow to recharge
Readings were taken after TSS + metals on 10-15-91 slightly cloudy
Sampling Personnel: M. RADECKE P. JACOBS (G&M)

GERAGHTY & MILLER, INC.
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WATER SAMPLING LOG

Project/No. SWP NC09005 Date 10-14-91
Site Location LF Areas SWP Wilmington, NC Site
Site/Well No. MW-8/9675 Rep./Field Blank No. _____
Weather Sunny Mid 70's Sampling Began _____ Ended _____
Description of Measuring Point (MP) _____
MP Elevation _____ Water Level Elevation _____

Evacuation Data

Height of MP _____
Depth of Well Below MP 21.40
Held _____ Depth to Water Below MP - 4.40
Wet _____ Water Column in Well = 17
Casing Diameter 2" Gal./ft. x 0.16
Gallons in Well = 2.72
Evacuation Volume x 3 = 8.16

Gallons	2.75	5.50			* Slightly cloudy	
pH	6.00	6.05	6.15		5.7	
Spec. Conductance µmhos	510	510	495		480	
Temperature (°C/°F)	20.05	20.05	20.00		22.0	
	13:50	14:15	15:10		~~1628~~ MER 8:55	

Sampling Data/Field Parameters

Color brown Odor Silty Appearance Silty then clear
Comments: _____
Spec. Cond. (umhos/cm) 485 pH 6.10 T(°C/°F) 20.0 15:22
Sampling Method DISPOSABLE BAILER

Analyses	Container Type (Lab X G&M ___)	Preservative
TOC / TP, TN	125ml amber glass / 250ml m/m plastic	4°C H_2SO_4
TSS / Cl^-	100 ml plastic / 100 ml plastic	4°C
Cu, Cr, As	250 ml plastic	4°C HNO_3
SV	1 liter amber glass	4°C

Remarks: well was slow to recharge.
* Readings taken after TSS & Metals on 10-15-91 8:55 Sample collection
Sampling Personnel: M. RADECKE, P. JACOBS (G&M)

GERAGHTY & MILLER, INC.
Environmental Services

WATER SAMPLING LOG

Project/No. SWP NC09005 Date 10-14-91
Site Location LF areas SWP Wilmington, NC Site
Site/Well No. MW-9 / 9676 Rep./Field Blank No. N/A
Weather Sunny 70's Sampling Began 1305 Ended 1310
Description of Measuring Point (MP) _____
MP Elevation _____ Water Level Elevation _____

Evacuation Data

Height of MP _____
Depth of Well Below MP 21.40
Held _____ Depth to Water Below MP - 3.98
Wet _____ Water Column in Well = 17.42
Casing Diameter 2" Gal./ft. x 0.16
Gallons in Well = 2.78
Evacuation Volume x 3 = 8.36

Gallons	2.75	5.50	8.25		*	
pH	5.95	5.95	5.95		6.40	
Spec. Conductance µmhos	480	465	470		520	
Temperature (°C/°F)	22.0	20.0	20.0		22.0	
	12:36	12:43	13:00		16:10 clear	

Sampling Data/Field Parameters

Color Light-brown Odor Sulfides Appearance Silty - cloudy
Comments: _____
Spec. Cond. (umhos/cm) 530 pH 6.15 T(°C/°F) 21.0 13:12 Light brown/clear
Sampling Method DISPOSABLE BAILER

Analyses	Container Type (Lab X G&M ___)	Preservative
TOC/TP/TN	125ml amber glass / 250 ml m/m plastic	4°C H_2SO_4
TSS / Cl^-	100 ml plastic / 100ml plastic	4°C
Cu, Cr, As	250 ml plastic	4°C HNO_3
SV	1 liter amber glass	4°C

Remarks: well was slow to recharge
* readings were taken after TSS + metals on 10-14-91
Sampling Personnel: M. RADECKE P. JACOBS (G&M)

Ref. 14

DATA SUMMARY REPORT FOR THE TREATED AND NON-TREATED WOOD STORAGE AREAS SOIL INVESTIGATION SOUTHERN WOOD PIEDMONT COMPANY, WILMINGTON, NORTH CAROLINA

December 9, 1993

NC009006

Prepared for:

SOUTHERN WOOD PIEDMONT COMPANY
Spartanburg, South Carolina

Prepared by:

GERAGHTY & MILLER, INC.
Environmental Services
2840 Plaza Place - Suite 350
Raleigh, North Carolina 27612
(919) 571-1662

1623wp

1.0 INTRODUCTION

Geraghty & Miller, Inc., was retained by the Southern Wood Piedmont Company (SWP) to sample the soils in the former treated wood storage (TWS) and former non-treated wood storage areas (NTA, north of Greenfield Street, and NTB, south of Greenfield Street). aThe purpose of the sampling was to determine whether the surficial soils within these areas had been impacted by wood-treating constituents. A grid system on 100-foot (ft) centers was laid out over the areas to be sampled, and hand-augered soil samples collected from one-third of the grid points were submitted to Savannah Laboratories and Environmental Services, Inc., (SL) for chemical analysis. Two depths (0 to 6 inches and 12 to 18 inches) were sampled. The samples for laboratory analysis were selected using random number tables. Hand-augered borings also were advanced at all remaining grid points. The soils at these locations were examined visually for evidence of wood-treating constituents. All observations, including odor, were recorded.

3.0 INVESTIGATIVE METHODS

The soil sampling program was designed to determine whether the surficial soils within the treated and non-treated wood storage areas have been impacted by wood-treating constituents and to define the lateral and, to the extent possible, vertical extent of any impacts. Selected samples were analyzed by U.S. Environmental Protection Agency (USEPA) methodologies for wood-preserving constituents. All field records and analytical data were reviewed and validated by a Geraghty & Miller Quality Assurance Manager.

3.1 SOIL BORINGS AND SAMPLING PROGRAM

Hand-operated bucket auger soil borings were advanced at a total of 92 locations in the three former wood storage areas. A total of 48 samples were collected from 35 locations for laboratory analysis. Soils from the remaining 57 locations were examined visually.

- NTA - 9 shallow (0 to 6 inches) soil samples were collected for analysis from 9 boring locations, and visual observations only were recorded at 12 boring locations;

- NTB - 13 shallow (0 to 6 inches) soil samples were collected for analysis from 13 boring locations, and visual observations only were recorded at 21 boring locations; and

- TWS - 13 shallow (0 to 6 inches) and 13 deeper (12 to 18 inches) soil samples were collected for analysis from 13 boring locations for a total of 26 samples, and visual observations only were recorded at 24 boring locations.

The samples were collected based on a grid system on 100-ft centers laid out over the three former wood storage areas. Figure 3-1 shows the locations of the three areas. Soil samples

from only one depth (0 to 6 inches) were collected in the former non-treated wood storage areas (NTA and NTB). Samples from two depths were collected from the former TWS area to determine whether wood-preserving constituents have migrated vertically through the soil profile. Visual evidence of creosote in the form of staining and weathered material was observed on the soil surface in the TWS but not in the NTA or NTB.

The soil investigation was conducted as two separate sampling events. During the first event, conducted on February 26-28, 1991, hand-augered soil samples were collected for laboratory analysis from one-third of the grid points analysis. The results of this sampling event indicated that additional characterization was required. Therefore, on April 3, 1991, hand-augered soil borings were advanced at remaining grid points for visual assessment only. The borehole depths were identical to those of the first sampling event.

A small-diameter (<4-inch), stainless steel, hand-held bucket auger was used to collect soil samples. The samples were thoroughly mixed in a stainless steel bowl and stored in pre-cleaned sample containers on ice at 4°C. The auger and bowl were decontaminated between samples with a laboratory-grade soap solution and rinsed three times with distilled water.

3.2 CHAIN OF CUSTODY

Samples collected in the field remained in the presence of a project representative at all times until they were shipped to the analytical laboratory. The transfer of the samples to the laboratory was accomplished by means of chain-of-custody forms. Activity documentation logs completed during this investigation are presented in Appendix A, and chain-of-custody forms are included in Appendix B. The placement of the custody seals ensured the integrity of the samples and prevented potential tampering.

1623ewp

4.0 SAMPLING RESULTS

4.1 SOIL SAMPLE RESULTS

The wood-preserving constituent results for soil samples collected from NTA, NTB, and TWS are presented in Tables 4-1 through 4-3, respectively. Figures 4-1 through 4-3 show the analytical results for the organic wood-preserving constituents (summed and identified as K001) and inorganic constituents (arsenic, chromium, copper) plotted on maps for the NTA, NTB, and TWS areas.

4.1.1 Semi-Volatile Constituents

A total of 14 semi-volatile organic compounds (semi-VOCs) were detected above their respective practical quantitation limits (PQLs) in the samples. Twelve are PAHs: naphthalene, acenaphthene, acenaphthylene, phenanthrene, anthracene, benzo(a)anthracene, chrysene, benzo(a)pyrene, benzo(b,k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and fluoranthene. The PAHs are characteristic components of creosote. One constituent is a heterocyclic, nitrogen-containing organic (carbazole), and one is a phenolic compound (trichlorophenol isomers).

The semi-VOC concentrations were summed as total K001 compounds for comparison purposes. Semi-volatile wood-treating constituents were detected in 18 of 26 samples collected in the former TWS area. Soil samples collected from the TWS area generally had the highest concentrations of K001 compounds, with the maximum occurring in sample TWS-10. Samples from this boring, on the north side of area TWS near the Cape Fear River, had total K001 concentrations of 200 and 15,000 milligrams per kilogram dry weight (mg/kg dw) for 0- to 6-inch and 12- to 18-inch deep samples, respectively. Two other samples, the 0- to 6-inch sample from boring TWS-1 (110 mg/kg dw) and the 12- to 18-inch sample from boring TWS-13 (470

mg/kg dw) had total K001 concentrations exceeding 100 mg/kg dw. The rest of the samples from area TWS had total K001 concentrations below 100 mg/kg dw.

In 10 of 13 area TWS borings, total K001 concentrations decreased with increasing depth from the 0- to 6-inch interval to the 12- to 18-inch interval. Total K001 concentrations in the 12- to 18-inch samples from borings TWS-10 (15,000 mg/kg dw), TWS-12 (100 mg/kg dw), and TWS-3 (470 mg/kg dw) were higher than the corresponding 0- to 6-inch samples (200, ND, and 22 mg/kg dw, respectively). This vertical distribution indicates that downward migration of constituents originally released to the surficial soils has occurred. Natural biotic and abiotic degradation of the PAHs in the surficial soil (0- to 6-inch interval) may account for the differences in concentrations with depth. In each of these three borings, concentrations of PAHs having more than three aromatic rings in their molecular structures were proportionately greater in the 12- to 18-inch samples than in the 0- to 6-inch samples. PAHs with more than three rings are more resistant to aerobic biodegradation than those containing two or three rings (USEPA, 1990). Aerobic biodegradation occurs more rapidly in the 0- to 6-inch soil interval than at greater depths due to higher oxygen levels and higher daytime temperatures.

Semi-volatile wood-treating constituents were detected in 23 of 24 samples collected in the former non-treated wood storage areas (NTA and NTB). The maximum total K001 concentration for samples collected from areas NTA and NTB was 390 mg/kg dw, detected in the sample from boring NTB-4. The rest of the samples collected in areas NTA and NTB had less than 100 mg/kg total K001 compounds.

4.1.2 Inorganic Constituents

Arsenic, chromium, and copper were detected at a frequency of 20, 26, and 16 samples, respectively, from a total of 26 samples collected in area TWS. Maximum concentrations of arsenic, chromium, and copper in area TWS samples were 41, 29, and 100 mg/kg dw,

respectively. These maximum concentrations are within observed ranges for these elements in soils of the eastern United States (USGS, 1984).

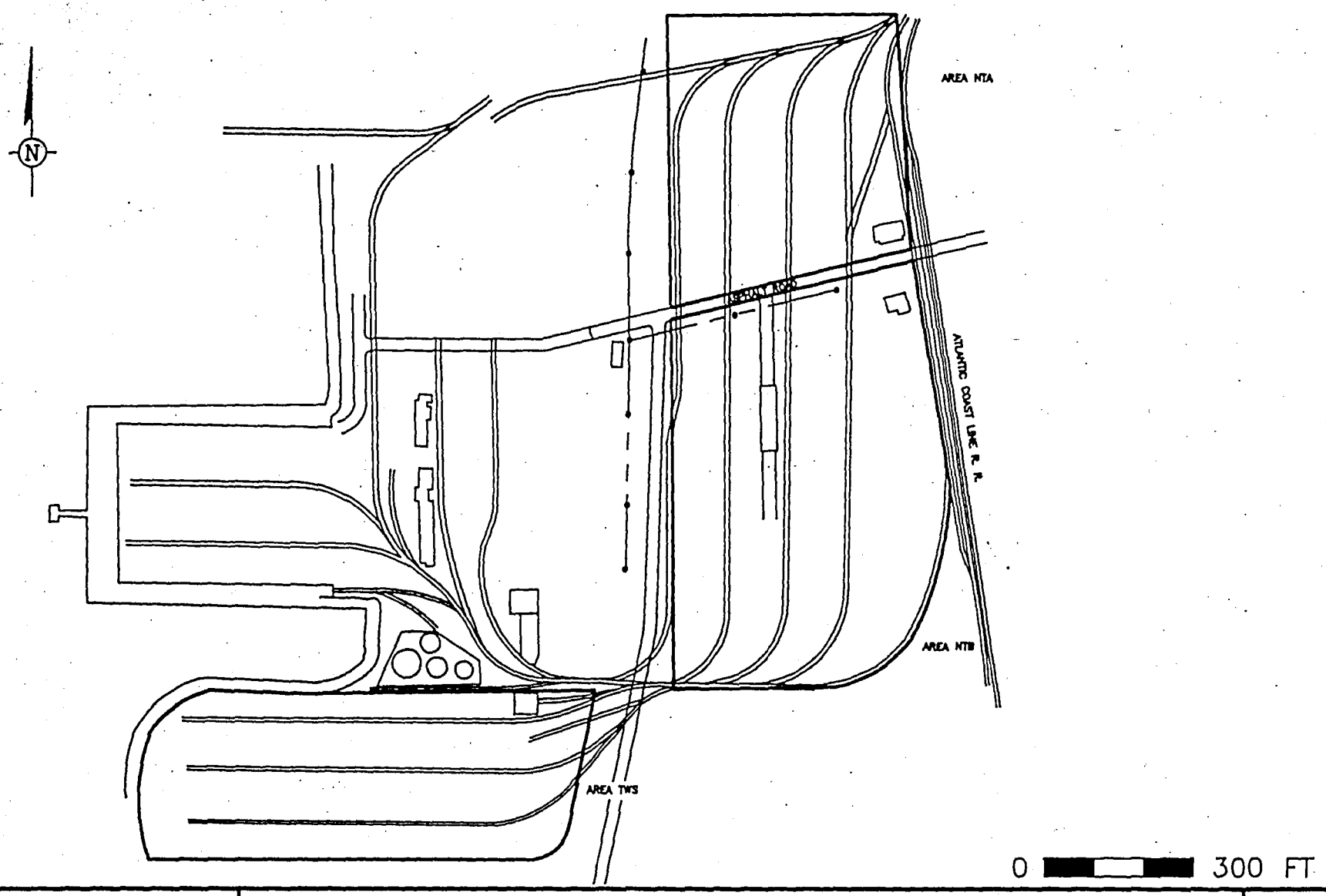
Frequencies of detection and concentrations of the metals were generally greater for samples collected in areas NTA and NTB than in area TWS. Arsenic, chromium, and copper were detected in all 9 samples collected in area NTA, and in 12, 13, and 12 samples, respectively, of a total of 13 samples collected in area NTB. Maximum concentrations of arsenic, chromium, and copper were 63, 15, and 300 mg/kg dw, respectively, in area NTA samples and 13, 22, and 130 mg/kg dw, respectively, in area NTB samples. These maximum concentrations are also within observed ranges for these elements in soils of the eastern United States (USGS, 1984).

4.2 VISUAL SOIL ASSESSMENT RESULTS

The results of the visual soil assessment for areas NTA, NTB, and TWS are shown on Figures 4-4 through 4-6, respectively. Odors and/or discolored soils were observed in 2 of 12 locations during the visual assessment at area NTA, on the northern edge of the area bordering an intermittent stream. Observations of odors and/or discolored soils were made at 6 of 21 locations during the assessment in area NTB, and these locations were distributed throughout the area (not concentrated near one location). In area TWS, observations of odors and/or discolored soils were made at 8 of 23 locations, and these observations also were distributed throughout the area.

1623wp

DATE: 12 OCT 93 | PRJCT NO.: NC0090.006 | FILE NO.: SWP-WILM | DRAWING: NC09003A | CHECKED: C. LOVDAHL | APPROVED: C. LOVDAHL | DRAFTER: N. JOHNSON



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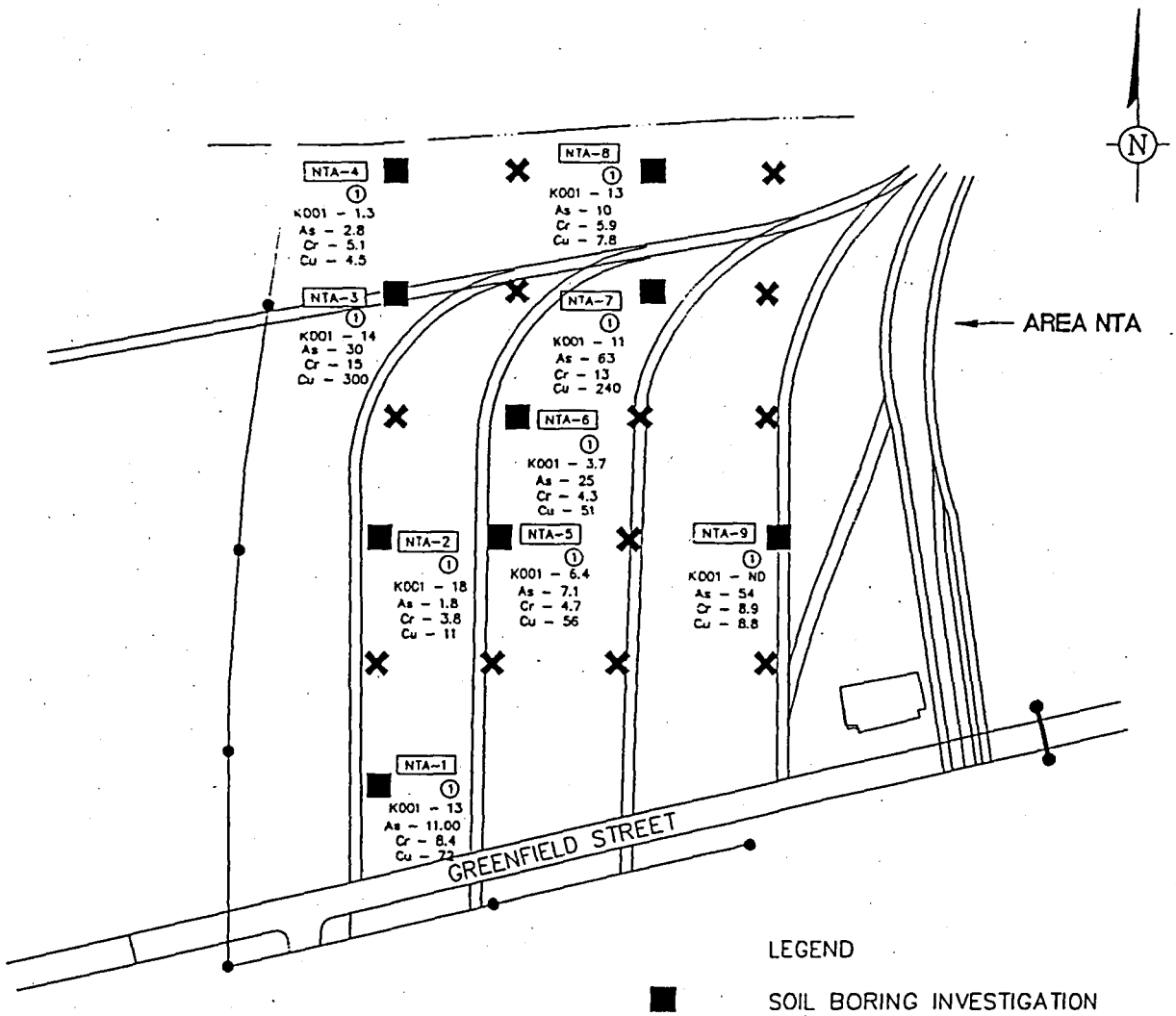
LOCATIONS OF THE FORMER TREATED (TWS) AND NON-TREATED (NTA AND NTB) WOOD STORAGE AREAS

SOUTHERN WOOD PIEDMONT COMPANY
WILMINGTON, NORTH CAROLINA

FIGURE 3-1



LEGEND

■ SOIL BORING INVESTIGATION

THE FOLLOWING DESIGNATIONS APPLY FOR ALL NTA SAMPLING LOCATIONS:

(1) DENOTES DEPTH AT 0"–6"

K001 – TOTAL DETECTABLE K001 (mg/kg dw)
As – TOTAL ARSENIC (mg/kg dw)
Cr – TOTAL CHROMIUM (mg/kg dw)
Cu – TOTAL COPPER (mg/kg dw)
ND – NOT DETECTED

✕ SOIL BORING INVESTIGATION LOCATION (NOT SAMPLED FOR CHEMICAL ANALYSIS)

—●— OVERHEAD ELEC. AND POLE

—·—·— DRAINAGE DITCH

0 ▬▬▬ 150 FT

GERAGHTY & MILLER, INC.
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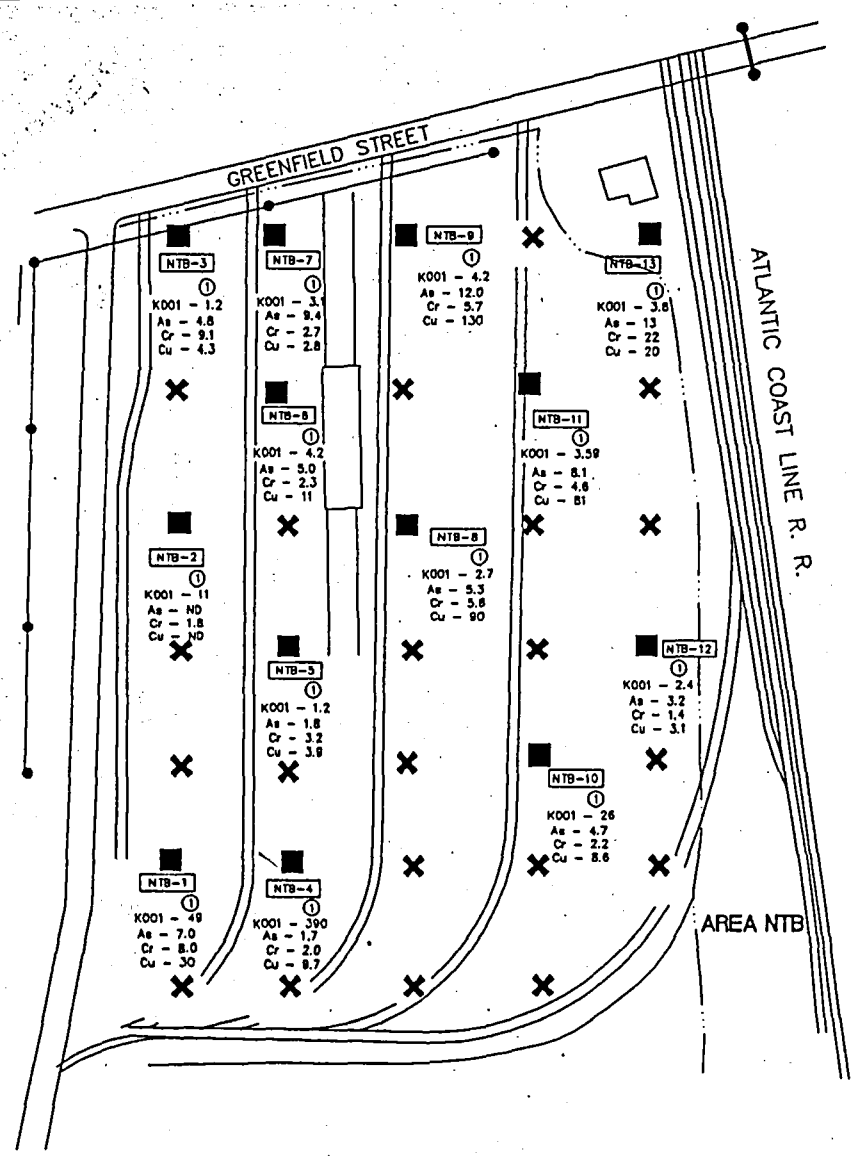
TOTAL DETECTED K001, ARSENIC, CHROMIUM, AND COPPER MEASURED IN SOIL SAMPLES COLLECTED IN THE FORMER NON-TREATED WOOD STORAGE AREA NTA

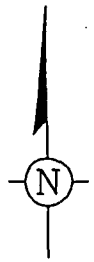
SOUTHERN WOOD PIEDMONT COMPANY
WILMINGTON, NORTH CAROLINA

FIGURE 4-1

DRAFTER: N. JOHNSON | APPROVED: C. LOVDAHL | CHECKED: C. LOVDAHL | DRAWING: NC09003J | FILE NO.: SWP-WILM | PRJCT NO.: NC009.006 | DWG DATE: 11 OCT 93

DWG DATE: 12 OCT 93	PRJCT NO.: NC0090.006	FILE NO.: SWP-WILM	DRAWING: NC09003D	CHECKED: C. LOVEDAHL	APPROVED: C. LOVEDAHL	DRAFTER: N. JOHNSON





LEGEND

■ SOIL SAMPLING LOCATION

THE FOLLOWING DESIGNATIONS APPLY FOR ALL NTB SAMPLING LOCATIONS:

(1) DENOTES DEPTH AT 0"–6"

K001 – TOTAL DETECTABLE K001 (mg/kg dw)
As – TOTAL ARSENIC (mg/kg dw)
Cr – TOTAL CHROMIUM (mg/kg dw)
Cu – TOTAL COPPER (mg/kg dw)

✕ SOIL BORING INVESTIGATION LOCATION (NOT SAMPLED FOR CHEMICAL ANALYSIS)

ND – NOT DETECTED

—— —— DRAINAGE DITCH

——•—— OVERHEAD ELEC. AND POLE

0 175 FT

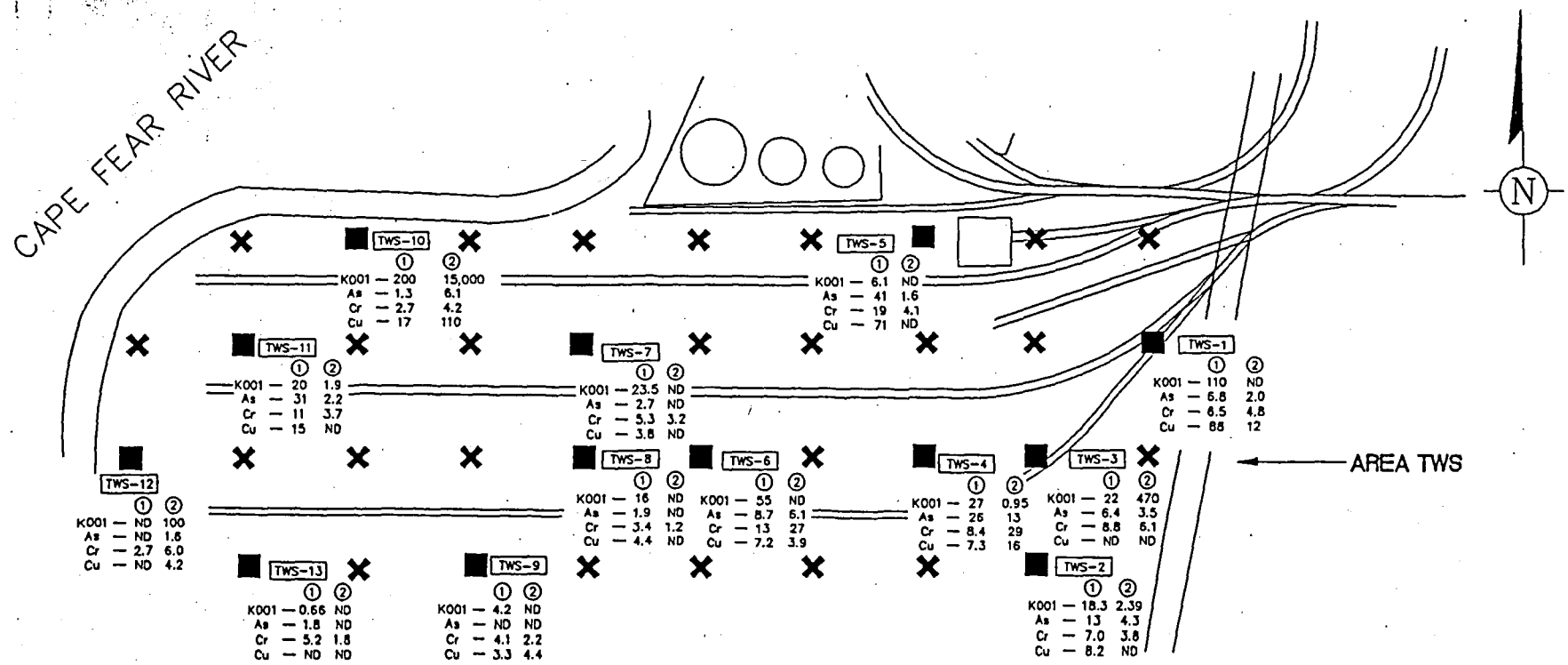
GERAGHTY & MILLER, INC.
Environmental Services

TOTAL DETECTED K001, ARSENIC, CHROMIUM, AND COPPER MEASURED IN SOIL SAMPLES COLLECTED IN THE FORMER NON-TREATED WOOD STORAGE AREA NTB

SOUTHERN WOOD PIEDMONT COMPANY
WILMINGTON, NORTH CAROLINA

FIGURE 4-2

DWG DATE: 12 OCT 93	PRJCT NO.: NC0090.006	FILE NO.: SWP-WILM	DRAWING: NC09003E	CHECKED: C. LOVDAHL	APPROVED: C. LOVDAHL	DRAFTER: N. JOHNSON



LEGEND

■ SOIL SAMPLING LOCATION

THE FOLLOWING DESIGNATIONS APPLY FOR ALL TWS SAMPLING LOCATIONS

① DENOTES DEPTH AT 0"–6"

② DENOTES DEPTH AT 12"–18"

K001 – TOTAL DETECTABLE K001 (mg/kg dw)
As – TOTAL ARSENIC (mg/kg dw)
Cr – TOTAL CHROMIUM (mg/kg dw)
Cu – TOTAL COPPER (mg/kg dw)
ND – NOT DETECTED
✕ – SOIL BORING INVESTIGATION LOCATION (NOT SAMPLED FOR CHEMICAL ANALYSIS)

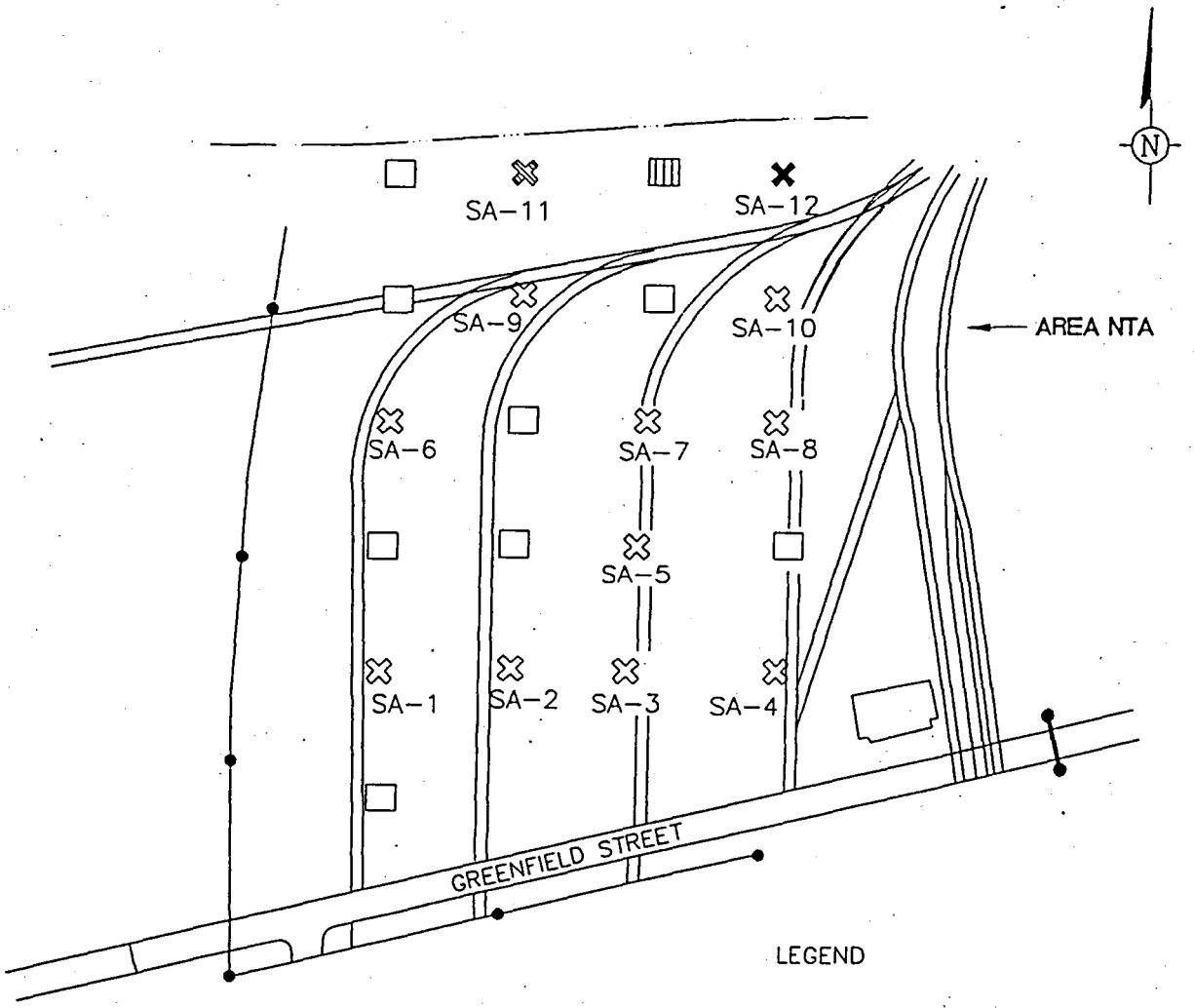
0 150 FT

GERAGHTY & MILLER, INC.
Environmental Services

TOTAL DETECTED K001, ARSENIC, CHROMIUM, AND COPPER MEASURED IN SOIL SAMPLES COLLECTED IN THE FORMER TREATED WOOD STORAGE AREA TWS

SOUTHERN WOOD PIEDMONT COMPANY
WILMINGTON, NORTH CAROLINA

FIGURE
4-3



LEGEND

SOIL BORING INVESTIGATION

- NO ODOR
- FAINT ODOR
- DISCOLORED SOIL, ODOR

SOIL SAMPLING LOCATION

- NO ODOR
- FAINT ODOR
- DISCOLORED SOIL, ODOR

- OVERHEAD ELEC. AND POLE
- DRAINAGE DITCH

0 150 FT

GERAGHTY & MILLER, INC.
Environmental Services

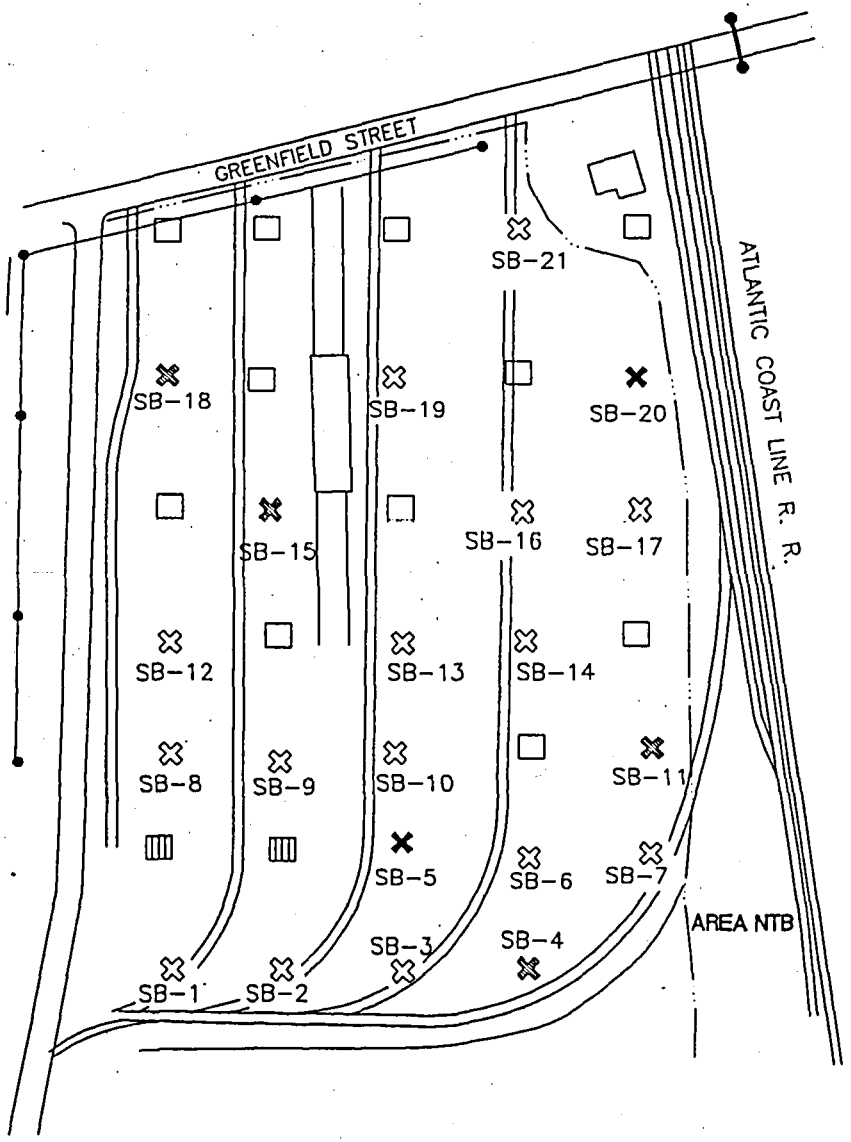
SOIL BORING INVESTIGATION OBSERVATIONS FOR THE FORMER NON-TREATED WOOD STORAGE AREA NTA

SOUTHERN WOOD PIEDMONT COMPANY
WILMINGTON, NORTH CAROLINA

FIGURE 4-4

DRAFTER: N. JOHNSON | APPROVED: C. LOVDAHL | CHECKED: C. LOVDAHL | DRAWING: NC09003C | FILE NO.: SWP-WILM | PRJCT NO.: NC0090.006 | DWG DATE: 15 JUN 92

DWG DATE: 12 OCT 93	PRJCT NO.: NC0090.006	FILE NO.: SWP-WILM	DRAWING: NC09003G	CHECKED: C. LOVDAHL	APPROVED: C. LOVDAHL	DRAFTER: N. JOHNSON



LEGEND

SOIL BORING INVESTIGATION

- NO ODOR
- FAINT ODOR
- DISCOLORED SOIL, ODOR

SOIL SAMPLING LOCATION

- NO ODOR
- FAINT ODOR
- DISCOLORED SOIL, ODOR

- OVERHEAD ELEC. AND POLE
- DRAINAGE DITCH

0 175 FT

GERAGHTY & MILLER, INC.
Environmental Services

SOIL BORING INVESTIGATION OBSERVATIONS FOR THE FORMER NON-TREATED WOOD STORAGE AREA NTB

SOUTHERN WOOD PIEDMONT COMPANY
WILMINGTON, NORTH CAROLINA

FIGURE 4-5

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

mark

RECEIVED
MAR 14 1991
G & M RALEIGH

LOG NO: S1-30896

Received: 27 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

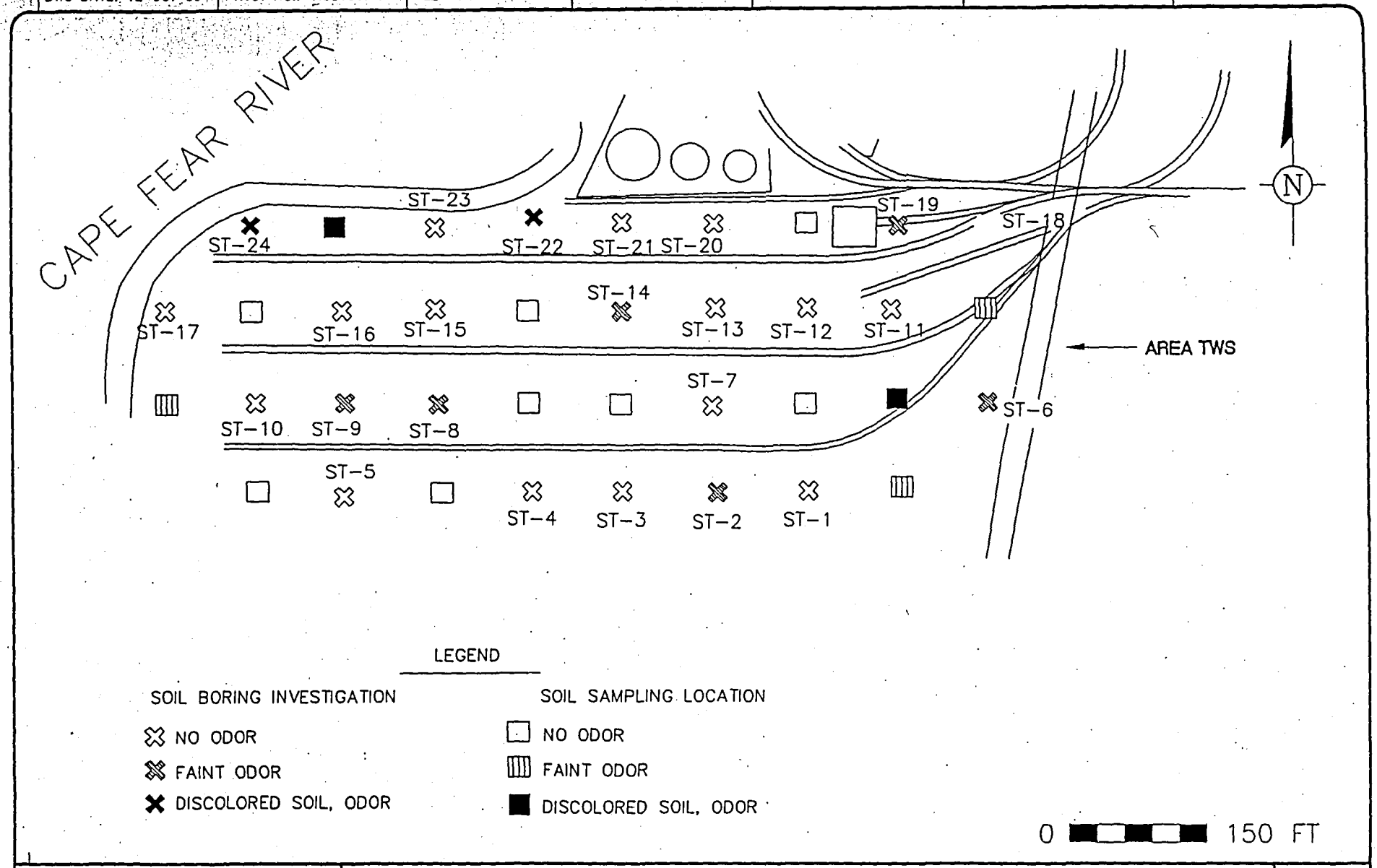
Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30896-1	NTA-1 (# 9329) 2-26-91	Client
30896-2	NTA-2 (# 9330) 2-26-91	
30896-3	NTA-3 (# 9331) 2-26-91	
30896-4	NTA-4 (# 9332) 2-26-91	
30896-5	NTA-5 (# 9333) 2-26-91	

PARAMETER	30896-1	30896-2	30896-3	30896-4	30896-5
001 (Method 8270)					
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	ND	0.66	ND	ND
Acenaphthene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthylene, mg/kg dw	ND	ND	ND	ND	ND
Phenanthrene, mg/kg dw	0.82	ND	1.0	ND	0.42
Anthracene, mg/kg dw	0.77	ND	0.79	ND	0.36
Fluoranthene, mg/kg dw	2.5	4.0	2.4	0.52	1.5
Chrysene, mg/kg dw	1.7	2.7	1.7	ND	0.93
Benzo(a)Anthracene, mg/kg dw	1.2	1.6	1.1	ND	0.57
Benzo(b,k)fluoranthene, mg/kg dw	4.1	5.9	4.1	0.80	2.2
Benzo(a)pyrene, mg/kg dw	1.0	1.1	1.0	ND	0.41
Indeno(1,2,3-cd)pyrene, mg/kg dw	0.68	0.66	0.85	ND	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	ND	ND	ND	ND
Carbazole, mg/kg dw	ND	0.54	0.49	ND	ND
Dilution factor	1	1	1	1	1

DWG DATE: 12 OCT 93	PRJCT NO.: NC0090.006	FILE NO.: SWP-WILM	DRAWING: NC09003H	CHECKED: C. LOVDAHL	APPROVED: C. LOVDAHL	DRAFTER: N. JOHNSON



GERAGHTY & MILLER, INC.
Environmental Services

SOIL BORING INVESTIGATION OBSERVATIONS FOR THE FORMER TREATED WOOD STORAGE AREA TWS

SOUTHERN WOOD PIEDMONT COMPANY
WILMINGTON, NORTH CAROLINA

FIGURE 4-6

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

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LOG NO: S1-30896

Received: 27 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30896-1	NTA-1 (# 9329) 2-26-91	Client
30896-2	NTA-2 (# 9330) 2-26-91	
30896-3	NTA-3 (# 9331) 2-26-91	
30896-4	NTA-4 (# 9332) 2-26-91	
30896-5	NTA-5 (# 9333) 2-26-91	

PARAMETER	30896-1	30896-2	30896-3	30896-4	30896-5
Arsenic, mg/kg dw	11	1.8	30	2.8	7.1
Chromium, mg/kg dw	8.4	3.8	15	5.1	4.7
Copper, mg/kg dw	72	11	300	4.5	56
Percent Solids, %	73	75	76	83	82

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& ENVIRONMENTAL SERVICES, INC.

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LOG NO: S1-30896

Received: 27 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30896-6	NTA-6 (# 9334) 2-26-91	Client
30896-7	NTA-7 (# 9335) 2-26-91	
30896-8	NTA-8 (# 9336) 2-26-91	
30896-9	NTA-9 (# 9337) 2-26-91	

PARAMETER	30896-6	30896-7	30896-8	30896-9
K001 (Method 8270)				
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	0.99	ND	ND
Acenaphthene, mg/kg dw	ND	ND	ND	ND
Acenaphthylene, mg/kg dw	ND	ND	0.48	ND
Phenanthrene, mg/kg dw	0.44	1.1	0.47	ND
Anthracene, mg/kg dw	0.55	1.1	0.95	ND
Fluoranthene, mg/kg dw	1.3	1.7	2.0	ND
Chrysene, mg/kg dw	0.93	1.5	1.7	ND
Benzo(a)Anthracene, mg/kg dw	0.47	0.97	1.5	ND
Benzo(b,k)fluoranthene, mg/kg dw	ND	1.7	2.9	ND
Benzo(a)pyrene, mg/kg dw	ND	0.77	1.3	ND
Indeno(1,2,3-cd)pyrene, mg/kg dw	ND	ND	0.58	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	ND	ND	ND
Carbazole, mg/kg dw	ND	1.1	1.0	ND
Dilution factor	1	1	1	1

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& ENVIRONMENTAL SERVICES, INC.

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30896-6	NTA-6 (# 9334) 2-26-91	Client
30896-7	NTA-7 (# 9335) 2-26-91	
30896-8	NTA-8 (# 9336) 2-26-91	
30896-9	NTA-9 (# 9337) 2-26-91	

PARAMETER	30896-6	30896-7	30896-8	30896-9
Arsenic, mg/kg dw	25	63	10	54
Chromium, mg/kg dw	4.3	13	5.9	8.9
Copper, mg/kg dw	51	240	7.8	8.8
Percent Solids, %	82	62	78	82

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LOG NO: S1-30896

Received: 27 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
30896-10	Rinse Blank (2-26-91)	Client
30896-11	Field Blank (2-26-91)	

PARAMETER	30896-10	30896-11
Copper, mg/l	ND	ND

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LOG NO: S1-30896

Received: 27 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
30896-12	Detection Limits - Soil	Client
30896-13	Accuracy (mean % recovery) - Soil	
30896-14	Precision (% RPD) - Soil	

PARAMETER	30896-12	30896-13	30896-14
K001 (Method 8270)			
2-Chlorophenol, mg/kg dw	0.33	87 %	15 %
Phenol, mg/kg dw	0.33	86 %	14 %
2,4-Dimethylphenol, mg/kg dw	0.33	91 %	19 %
Trichlorophenols, mg/kg dw	0.33	91 %	18 %
p-Chloro-m-cresol, mg/kg dw	0.33	91 %	19 %
Tetrachlorophenols, mg/kg dw	0.33	102 %	15 %
2,4-Dinitrophenol, mg/kg dw	1.7	43 %	12 %
Pentachlorophenol, mg/kg dw	1.7	67 %	7.5 %
Naphthalene, mg/kg dw	0.33	87 %	15 %
Acenaphthene, mg/kg dw	0.33	76 %	16 %
Acenaphthylene, mg/kg dw	0.33	85 %	15 %
Phenanthrene, mg/kg dw	0.33	80 %	13 %
Anthracene, mg/kg dw	0.33	80 %	13 %
Fluoranthene, mg/kg dw	0.33	89 %	17 %
Chrysene, mg/kg dw	0.33	70 %	11 %
Benzo(a)Anthracene, mg/kg dw	0.33	75 %	13 %
Benzo(b,k)fluoranthene, mg/kg dw	0.33	77 %	18 %
Benzo(a)pyrene, mg/kg dw	0.33	85 %	19 %
Indeno(1,2,3-cd)pyrene, mg/kg dw	0.33	102 %	15 %
Dibenzo(a,h)anthracene, mg/kg dw	0.33	106 %	17 %
Carbazole, mg/kg dw	0.33	115 %	17 %
Arsenic, mg/kg dw	1.0	106 %	1.9 %
Chromium, mg/kg dw	1.0	82 %	2.4 %

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LOG NO: S1-30896

Received: 27 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
30896-12	Detection Limits - Soil	Client
30896-13	Accuracy (mean % recovery) - Soil	
30896-14	Precision (% RPD) - Soil	

PARAMETER	30896-12	30896-13	30896-14
Copper, mg/kg dw	2.5	85 %	2.4 %

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LOG NO: S1-30896

Received: 27 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
30896-15	Detection Limits	Client

PARAMETER	30896-15
K001 (Method 8270)	
2-Chlorophenol, mg/l	0.010
Phenol, mg/l	0.010
2,4-Dimethylphenol, mg/l	0.010
Trichlorophenols, mg/l	0.010
p-Chloro-m-cresol, mg/l	0.010
Tetrachlorophenols, mg/l	0.010
2,4-Dinitrophenol, mg/l	0.050
Pentachlorophenol, mg/l	0.050
Naphthalene, mg/l	0.010
Acenaphthene, mg/l	0.010
Acenaphthylene, mg/l	0.010
Phenanthrene, mg/l	0.010
Anthracene, mg/l	0.010
Fluoranthene, mg/l	0.010
Chrysene, mg/l	0.010
Benzo(a)Anthracene, mg/l	0.010
Benzo(b,k)fluoranthene, mg/l	0.010
Benzo(a)pyrene, mg/l	0.010
Indeno(1,2,3-cd)pyrene, mg/l	0.010
Dibenzo(a,h)anthracene, mg/l	0.010
Carbazole, mg/l	0.010

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-30896

Received: 27 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
30896-16	Report Completion Date	Client

PARAMETER	30896-16
Date Reported	03.08.91

Methods: EPA SW-846
ND = Not Detected

J. W. Andrews, Ph. D.

GERAGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Project Number NC09003

Project Location Wilmington, NC

Laboratory Savannah Laboratories

Sampler(s)/Affiliation P. JACOBS (G&M)
M. RADECKE (G&M)

SAMPLE BOTTLE / CONTAINER DESCRIPTION

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500ml w/m glass K001 4°C	500ml w/m plastic metals Cu, Cr, As 4°C	1 liter amber glass K001 4°C	500ml plastic metals Cu, Cr, As 4°C HNO3						TOTAL
NTA-1/9329	S	2-26-91 13:40		1	1								2
NTA-2/9330	S	2-26-91 13:50		1	1								2
NTA-3/9331	S	2-26-91 14:35		1	1								2
NTA-4/9332	S	2-26-91 14:40		1	1								2
NTA-5/9333	S	2-26-91 15:10		1	1								2
NTA-6/9334	S	2-26-91 15:10		1	1								2
NTA-7/9335	S	2-26-91 16:05		1	1								2
NTA-8/9336	S	2-26-91 16:05		1	1								2
NTA-9/9337	S	2-26-91 16:35		1	1								2
RB-1	L	2-26-91 15:45				1	1						2
FB-1	L	2-26-91 15:45				1	1						2
30896													
												Total No. of Bottles/ Containers	22

Sample Code: L = Liquid; S = Solid; A = Air

Relinquished by: Mark E. Radecke	Organization: Geraghty & Miller, Inc.	2-26-91 19:00	Seal Intact?
Received by: Sandra Johnson	Organization: SAVANNAH LABS	Date 2/27/91 Time 9:30	(Yes) No N/A
Relinquished by:	Organization:		Seal Intact?
Received by:	Organization:	Date / / Time	Yes No N/A

Special Instructions/Remarks:

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express ☐ Lab Courier ☐ Other

APPENDIX B

Analytical Laboratory Reports and Chain-of-Custody Forms

1623rwp

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

RECEIVED MAR 13 1991 GEMS

LOG NO: S1-30925

Received: 28 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30925-1	TWS-9B (# 9349) 2-27-91	Client
30925-2	TWS-9A (# 9348) 2-27-91	
30925-3	TWS-8B (# 9347) 2-27-91	
30925-4	TWS-8A (# 9346) 2-27-91	
30925-5	TWS-7B (# 9351) 2-27-91	

PARAMETER	30925-1	30925-2	30925-3	30925-4	30925-5
K001 (Method 8270)					
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthylene, mg/kg dw	ND	ND	ND	ND	ND
Phenanthrene, mg/kg dw	ND	ND	ND	0.74	ND
Anthracene, mg/kg dw	ND	ND	ND	1.2	ND
Fluoranthene, mg/kg dw	ND	1.3	ND	3.6	ND
Chrysene, mg/kg dw	ND	0.89	ND	2.5	ND
Benzo(a)Anthracene, mg/kg dw	ND	ND	ND	1.2	ND
Benzo(b,k)fluoranthene, mg/kg dw	ND	2.0	ND	4.9	ND
Benzo(a)pyrene, mg/kg dw	ND	ND	ND	0.89	ND
Indeno(1,2,3-cd)pyrene, mg/kg dw	ND	ND	ND	0.64	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	ND	ND	ND	ND
Carbazole, mg/kg dw	ND	ND	ND	0.74	ND
Dilution factor	1	1	1	1	1

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-30925

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P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30925-1	TWS-9B (# 9349) 2-27-91	Client
30925-2	TWS-9A (# 9348) 2-27-91	
30925-3	TWS-8B (# 9347) 2-27-91	
30925-4	TWS-8A (# 9346) 2-27-91	
30925-5	TWS-7B (# 9351) 2-27-91	

PARAMETER	30925-1	30925-2	30925-3	30925-4	30925-5
Arsenic, mg/kg dw	ND	ND	ND	1.9	ND
Chromium, mg/kg dw	2.2	4.1	1.2	3.4	3.2
Copper, mg/kg dw	4.4	3.3	ND	4.4	ND
Percent Solids, %	80	80	85	79	77

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-30925

Received: 28 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30925-6	TWS-7A (# 9350) 2-27-91	Client
30925-7	TWS-10A (# 9344) 2-27-91	
30925-8	TWS-10B (# 9345) 2-27-91	
30925-9	TWS-11A (# 9342) 2-27-91	
30925-10	TWS-11B (# 9343) 2-27-91	

PARAMETER	30925-6	30925-7	30925-8	30925-9	30925-10
K001 (Method 8270)					
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	2.8	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	0.87	ND	ND	ND
Acenaphthene, mg/kg dw	ND	0.93	2000	ND	ND
Acenaphthylene, mg/kg dw	0.50	2.5	ND	0.46	ND
Phenanthrene, mg/kg dw	0.73	4.2	4000	0.43	ND
Anthracene, mg/kg dw	1.2	14	2200	1.2	ND
Fluoranthene, mg/kg dw	4.2	33	3700	4.9	0.43
Chrysene, mg/kg dw	3.6	27	740	4.0	0.49
Benzo(a)Anthracene, mg/kg dw	2.4	23	800	2.9	ND
Benzo(b,k)fluoranthene, mg/kg dw	7.4	60	690	2.7	1.0
Benzo(a)pyrene, mg/kg dw	1.6	17	290	1.6	ND
Indeno(1,2,3-cd)pyrene, mg/kg dw	1.0	7.2	88	0.68	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	2.4	ND	ND	ND
Carbazole, mg/kg dw	0.90	3.4	390	0.93	ND
Dilution factor	1	5	200	1	1

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LOG NO: S1-30925

Received: 28 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30925-6	TWS-7A (# 9350) 2-27-91	Client
30925-7	TWS-10A (# 9344) 2-27-91	
30925-8	TWS-10B (# 9345) 2-27-91	
30925-9	TWS-11A (# 9342) 2-27-91	
30925-10	TWS-11B (# 9343) 2-27-91	

PARAMETER	30925-6	30925-7	30925-8	30925-9	30925-10
Arsenic, mg/kg dw	2.7	1.3	6.1	31	2.2
Chromium, mg/kg dw	5.3	2.7	4.2	11	3.7
Copper, mg/kg dw	3.8	17	110	15	ND
Percent Solids, %	75	80	50	78	79

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Received: 28 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30925-11	TWS-12A (# 9338) 2-27-91	Client
30925-12	TWS-12B (# 9339) 2-27-91	
30925-13	TWS-13A (# 9340) 2-27-91	
30925-14	TWS-13B (# 9341) 2-27-91	

PARAMETER	30925-11	30925-12	30925-13	30925-14
K001 (Method 8270)				
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	ND	ND	ND
Acenaphthene, mg/kg dw	ND	ND	ND	ND
Acenaphthylene, mg/kg dw	ND	ND	ND	ND
Phenanthrene, mg/kg dw	ND	ND	ND	ND
Anthracene, mg/kg dw	ND	ND	ND	ND
Fluoranthene, mg/kg dw	ND	42	0.66	ND
Chrysene, mg/kg dw	ND	19	ND	ND
Benzo(a)Anthracene, mg/kg dw	ND	12	ND	ND
Benzo(b,k)fluoranthene, mg/kg dw	ND	30	ND	ND
Benzo(a)pyrene, mg/kg dw	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene, mg/kg dw	ND	ND	ND	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	ND	ND	ND
Carbazole, mg/kg dw	ND	ND	ND	ND
Dilution factor	1	1	1	1

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30925-11	TWS-12A (# 9338) 2-27-91	Client
30925-12	TWS-12B (# 9339) 2-27-91	
30925-13	TWS-13A (# 9340) 2-27-91	
30925-14	TWS-13B (# 9341) 2-27-91	

PARAMETER	30925-11	30925-12	30925-13	30925-14
Arsenic, mg/kg dw	ND	1.6	1.8	ND
Chromium, mg/kg dw	2.7	6.0	5.2	1.8
Copper, mg/kg dw	ND	4.2	ND	ND
Percent Solids, %	92	87	77	81

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Received: 28 FEB 91

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
30925-15	Rinse Blank (2-27-91)	Client
30925-16	Field Blank (2-27-91)	

PARAMETER	30925-15	30925-16
K001 (Method 8270)		
2-Chlorophenol, mg/l	ND	ND
Phenol, mg/l	ND	ND
2,4-Dimethylphenol, mg/l	ND	ND
Trichlorophenols, mg/l	ND	ND
p-Chloro-m-cresol, mg/l	ND	ND
Tetrachlorophenols, mg/l	ND	ND
2,4-Dinitrophenol, mg/l	ND	ND
Pentachlorophenol, mg/l	ND	ND
Naphthalene, mg/l	ND	ND
Acenaphthene, mg/l	ND	ND
Acenaphthylene, mg/l	ND	ND
Phenanthrene, mg/l	ND	ND
Anthracene, mg/l	ND	ND
Fluoranthene, mg/l	ND	ND
Chrysene, mg/l	ND	ND
Benzo(a)Anthracene, mg/l	ND	ND
Benzo(b,k)fluoranthene, mg/l	ND	ND
Benzo(a)pyrene, mg/l	ND	ND
Indeno(1,2,3-cd)pyrene, mg/l	ND	ND
Dibenzo(a,h)anthracene, mg/l	ND	ND
Carbazole, mg/l	ND	ND
Dilution factor	1	1
Arsenic, mg/l	ND	ND
Chromium, mg/l	ND	ND

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
30925-15	Rinse Blank (2-27-91)	Client
30925-16	Field Blank (2-27-91)	

PARAMETER	30925-15	30925-16
Copper, mg/l	ND	ND

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
30925-17	Detection Limits - Soil	Client
30925-18	Accuracy (mean % recovery) - Soil	
30925-19	Precision (% RPD) - Soil	

PARAMETER	30925-17	30925-18	30925-19
K001 (Method 8270)			
2-Chlorophenol, mg/kg dw	0.33	94 %	4.3 %
Phenol, mg/kg dw	0.33	89 %	5.1 %
2,4-Dimethylphenol, mg/kg dw	0.33	81 %	11 %
Trichlorophenols, mg/kg dw	0.33	87 %	4.6 %
p-Chloro-m-cresol, mg/kg dw	0.33	101 %	2.0 %
Tetrachlorophenols, mg/kg dw	0.33	111 %	0.9 %
2,4-Dinitrophenol, mg/kg dw	1.7	78 %	1.3 %
Pentachlorophenol, mg/kg dw	1.7	26 %	7.7 %
Naphthalene, mg/kg dw	0.33	92 %	1.1 %
Acenaphthene, mg/kg dw	0.33	79 %	0 %
Acenaphthylene, mg/kg dw	0.33	88 %	1.1 %
Phenanthrene, mg/kg dw	0.33	87 %	2.3 %
Anthracene, mg/kg dw	0.33	86 %	2.3 %
Fluoranthene, mg/kg dw	0.33	98 %	0 %
Chrysene, mg/kg dw	0.33	78 %	1.3 %
Benzo(a)Anthracene, mg/kg dw	0.33	81 %	0 %
Benzo(b,k)fluoranthene, mg/kg dw	0.33	85 %	2.4 %
Benzo(a)pyrene, mg/kg dw	0.33	90 %	4.4 %
Indeno(1,2,3-cd)pyrene, mg/kg dw	0.33	111 %	4.5 %
Dibenzo(a,h)anthracene, mg/kg dw	0.33	113 %	3.5 %
Carbazole, mg/kg dw	0.33	123 %	0.8 %
Arsenic, mg/kg dw	1.0	124 %	8.5 %
Chromium, mg/kg dw	1.0	101 %	13 %

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Received: 28 FEB 91

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
30925-17	Detection Limits - Soil	Client
30925-18	Accuracy (mean % recovery) - Soil	
30925-19	Precision (% RPD) - Soil	

PARAMETER	30925-17	30925-18	30925-19
Copper, mg/kg dw	2.5	86 %	7.0

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LOG NO: S1-30925

Received: 28 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
30925-20	Detection Limits	Client

PARAMETER	30925-20
K001 (Method 8270)	
2-Chlorophenol, mg/l	0.010
Phenol, mg/l	0.010
2,4-Dimethylphenol, mg/l	0.010
Trichlorophenols, mg/l	0.010
-Chloro-m-cresol, mg/l	0.010
Tetrachlorophenols, mg/l	0.010
2,4-Dinitrophenol, mg/l	0.050
Pentachlorophenol, mg/l	0.050
Naphthalene, mg/l	0.010
Acenaphthene, mg/l	0.010
Acenaphthylene, mg/l	0.010
Phenanthrene, mg/l	0.010
Anthracene, mg/l	0.010
Fluoranthene, mg/l	0.010
Chrysene, mg/l	0.010
Benzo(a)Anthracene, mg/l	0.010
Benzo(b,k)fluoranthene, mg/l	0.010
Benzo(a)pyrene, mg/l	0.010
Indeno(1,2,3-cd)pyrene, mg/l	0.010
Dibenzo(a,h)anthracene, mg/l	0.010
Carbazole, mg/l	0.010

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LOG NO: S1-30925

Received: 28 FEB 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
30925-21	Report Completion Date	Client

PARAMETER	30925-21
Date Reported	03.07.91

Methods: EPA SW-846
ND = Not Detected

J. W. Andrews

J. W. Andrews, Ph. D.

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-36592

Received: 16 OCT 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID
36592-21	Detection Limits
36592-22	Method Blank (MB) Result
36592-23	Lab Control Standard (LCS) Result
36592-24	LCS Expected Value
36592-25	LCS % Recovery

PARAMETER	36592-21	36592-22	36592-23	36592-24	36592-25
Copper (6010)					
Copper, mg/kg dw	2.5	<2.5	15.0	15.2	99 %
Date Analyzed	---	10.30.91	10.30.91	---	---
Chromium (6010)					
Chromium, mg/kg dw	1.0	<1.0	29.6	31.5	94 %
Date Analyzed	---	10.30.91	10.30.91	---	---
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	25	<25	1262	1375	92 %
Nitrate + Nitrite-N, mg/kg dw	5.0	<5.0	21.6	20	108 %
Total Nitrogen, mg/kg dw	30	<30	---	---	---
Date Analyzed	---	10.30.91	10.30.91	---	---
Total Phosphorus (365.1)					
Total Phosphorus, mg/kg dw	25	<25	485	569	85 %
Date Analyzed	---	10.31.91	10.31.91	---	---
Total Organic Carbon (415.1)					
Total Organic Carbon , mg/kg dw	50	<50	284760	226000	126 %
Date Analyzed	---	10.18.91	10.18.91	---	---
Chloride (325.2)					
Chloride (325.2), mg/kg dw	20	<20	99.6	100	100 %
Date Analyzed	---	10.30.91	10.30.91	---	---
pH in Soil (9045)					
pH-soil (9045), units	---	---	---	---	---

Laboratory locations in Savannah, GA • Tallahassee, FL • Mobile, AL • Deerfield Beach, FL • Tampa, FL

GERAGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Project Number NC09003

Project Location Wilmington, N.C.

Laboratory Savannah Labs

Sampler(s)/Affiliation P. Jacobs (G&M)
M. Radecke (G&M)

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500ml w/m plastic metals (Cu, Cr, As) 4°C	500ml w/m glass Kool 4°C	500ml Plastic metals (Cu, Cr, As) HNO3 4°C	1 L Amber glass Kool 4°C						TOTAL
TWS-10A/9344	S	2-27-91 13:45		1	1								2
TWS-10B/9345	S	2-27-91 13:55		1	1								2
TWS-11A/9342	S	2-27-91 12:25		1	1								2
TWS-11B/9343	S	2-27-91 12:30		1	1								2
TWS-12A/9338	S	2-27-91 11:00		1	1								2
TWS-12B/9339	S	2-27-91 11:10		1	1								2
TWS-13A/9340	S	2-27-91 11:30		1	1								2
TWS-13B/9341	S	2-27-91 11:35		1	1								2
FB-2	L	2-27-91 15:30				1	1						2
RB-2	L	2-27-91 15:25				1	1						2
30925													

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 20

Relinquished by: P. Jacobs	Organization: Geraghty & Miller, Inc.	2-27-91 19:00	Seal Intact? Yes No N/A
Received by: Janice Johnson	Organization: SAVH J-LABS	Date 2/28/91 Time 9:45	
Relinquished by:	Organization:		Seal Intact? Yes No N/A
Received by:	Organization:	Date / / Time	

Special Instructions/Remarks:

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express ☐ Lab Courier ☐ Other

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RECEIVED
MAR 15 1991
G & M RALEIGH

LOG NO: S1-30948

Received: 01 MAR 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30948-1	TWS-6A (# 9352) 2-28-91	Client
30948-2	TWS-6B (# 9353) 2-28-91	
30948-3	TWS-5A (# 9354) 2-28-91	
30948-4	TWS-5B (# 9355) 2-28-91	
30948-5	TWS-4A (# 9356) 2-28-91	

PARAMETER	30948-1	30948-2	30948-3	30948-4	30948-5
001 (Method 8270)					
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthylene, mg/kg dw	0.66	ND	ND	ND	0.48
Phenanthrene, mg/kg dw	2.4	ND	0.64	ND	0.75
Anthracene, mg/kg dw	2.3	ND	1.1	ND	1.4
Fluoranthene, mg/kg dw	16	ND	1.2	ND	5.9
Chrysene, mg/kg dw	8.1	ND	0.95	ND	4.8
Benzo(a)Anthracene, mg/kg dw	5.0	ND	0.88	ND	2.6
Benzo(b,k)fluoranthene, mg/kg dw	13	ND	0.73	ND	8.2
Benzo(a)pyrene, mg/kg dw	3.5	ND	0.58	ND	1.4
Indeno(1,2,3-cd)pyrene, mg/kg dw	1.9	ND	ND	ND	0.63
Dibenzo(a,h)anthracene, mg/kg dw	0.49	ND	ND	ND	ND
Carbazole, mg/kg dw	1.8	ND	ND	ND	1.0
Dilution factor	1	1	1	1	1

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LOG NO: S1-30948

Received: 01 MAR 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30948-1	TWS-6A (# 9352) 2-28-91	Client
30948-2	TWS-6B (# 9353) 2-28-91	
30948-3	TWS-5A (# 9354) 2-28-91	
30948-4	TWS-5B (# 9355) 2-28-91	
30948-5	TWS-4A (# 9356) 2-28-91	

PARAMETER	30948-1	30948-2	30948-3	30948-4	30948-5
Arsenic, mg/kg dw	8.7	6.1	41	1.6	26
Chromium, mg/kg dw	13	27	19	4.1	8.4
Copper, mg/kg dw	7.2	3.9	71	ND	7.3
Percent Solids, %	83	55	70	79	74

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& ENVIRONMENTAL SERVICES, INC.

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LOG NO: S1-30948

Received: 01 MAR 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30948-6	TWS-4B (# 9357) 2-28-91	Client
30948-7	TWS-3A (# 9358) 2-28-91	
30948-8	TWS-3B (# 9359) 2-28-91	
30948-9	TWS-2A (# 9360) 2-28-91	
30948-10	TWS-2B (# 9361) 2-28-91	

PARAMETER	30948-6	30948-7	30948-8	30948-9	30948-10
K001 (Method 8270)					
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthene, mg/kg dw	ND	ND	47	ND	ND
Acenaphthylene, mg/kg dw	ND	0.60	ND	ND	ND
Phenanthrene, mg/kg dw	ND	0.75	220	ND	ND
Anthracene, mg/kg dw	ND	1.7	51	0.68	ND
Fluoranthene, mg/kg dw	0.95	3.9	150	3.4	1.0
Chrysene, mg/kg dw	ND	3.2	13	3.5	0.73
Benzo(a)Anthracene, mg/kg dw	ND	1.7	17	2.2	0.66
Benzo(b,k)fluoranthene, mg/kg dw	ND	7.0	20	6.7	ND
Benzo(a)pyrene, mg/kg dw	ND	1.4	ND	1.3	ND
Indeno(1,2,3-cd)pyrene, mg/kg dw	ND	0.84	ND	0.53	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	ND	ND	ND	ND
Carbazole, mg/kg dw	ND	0.77	ND	ND	ND
Dilution factor	1	1	10	1	1

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LOG NO: S1-30948

Received: 01 MAR 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30948-6	TWS-4B (# 9357) 2-28-91	Client
30948-7	TWS-3A (# 9358) 2-28-91	
30948-8	TWS-3B (# 9359) 2-28-91	
30948-9	TWS-2A (# 9360) 2-28-91	
30948-10	TWS-2B (# 9361) 2-28-91	

PARAMETER	30948-6	30948-7	30948-8	30948-9	30948-10
Arsenic, mg/kg dw	13	13	4.3	6.4	3.5
Chromium, mg/kg dw	29	7.0	3.8	8.8	6.1
Copper, mg/kg dw	16	8.2	ND	ND	ND
Percent Solids, %	56	72	72	71	55

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& ENVIRONMENTAL SERVICES, INC.

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LOG NO: S1-30948

Received: 01 MAR 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30948-11	TWS-1A (# 9362) 2-28-91	Client
30948-12	TWS-1B (# 9363) 2-28-91	
30948-13	NTB-3 (# 9364) 2-28-91	
30948-14	NTB-6 (# 9365) 2-28-91	
30948-15	NTB-7 (# 9366) 2-28-91	

PARAMETER	30948-11	30948-12	30948-13	30948-14	30948-15
K001 (Method 8270)					
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthylene, mg/kg dw	ND	ND	ND	ND	ND
Phenanthrene, mg/kg dw	13	ND	ND	ND	ND
Anthracene, mg/kg dw	36	ND	ND	ND	ND
Fluoranthene, mg/kg dw	25	ND	0.39	0.91	0.83
Chrysene, mg/kg dw	8.0	ND	0.40	0.82	0.75
Benzo(a)Anthracene, mg/kg dw	6.2	ND	ND	0.38	ND
Benzo(b,k)fluoranthene, mg/kg dw	12	ND	0.45	1.7	1.5
Benzo(a)pyrene, mg/kg dw	5.1	ND	ND	0.39	ND
Indeno(1,2,3-cd)pyrene, mg/kg dw	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	ND	ND	ND	ND
Carbazole, mg/kg dw	7.1	ND	ND	ND	ND
Dilution factor	10	1	1	1	1

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LOG NO: S1-30948

Received: 01 MAR 91

Ms. Sandra Watson
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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30948-11	TWS-1A (# 9362) 2-28-91	Client
30948-12	TWS-1B (# 9363) 2-28-91	
30948-13	NTB-3 (# 9364) 2-28-91	
30948-14	NTB-6 (# 9365) 2-28-91	
30948-15	NTB-7 (# 9366) 2-28-91	

PARAMETER	30948-11	30948-12	30948-13	30948-14	30948-15
Arsenic, mg/kg dw	6.8	2.0	4.8	5.0	9.4
Chromium, mg/kg dw	6.5	4.8	9.1	2.3	2.7
Copper, mg/kg dw	88	12	4.3	11	2.8
Percent Solids, %	89	79	88	87	79

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
30948-16	Rinse Blank (2-28-91)	Client
30948-17	Field Blank (2-28-91)	

PARAMETER	30948-16	30948-17
K001 (Method 8270)		
2-Chlorophenol, mg/l	ND	ND
Phenol, mg/l	ND	ND
2,4-Dimethylphenol, mg/l	ND	ND
Trichlorophenols, mg/l	ND	ND
p-Chloro-m-cresol, mg/l	ND	ND
Tetrachlorophenols, mg/l	ND	ND
2,4-Dinitrophenol, mg/l	ND	ND
Pentachlorophenol, mg/l	ND	ND
Naphthalene, mg/l	ND	ND
Acenaphthene, mg/l	ND	ND
Acenaphthylene, mg/l	ND	ND
Phenanthrene, mg/l	ND	ND
Anthracene, mg/l	ND	ND
Fluoranthene, mg/l	ND	ND
Chrysene, mg/l	ND	ND
Benzo(a)Anthracene, mg/l	ND	ND
Benzo(b,k)fluoranthene, mg/l	ND	ND
Benzo(a)pyrene, mg/l	ND	ND
Indeno(1,2,3-cd)pyrene, mg/l	ND	ND
Dibenzo(a,h)anthracene, mg/l	ND	ND
Carbazole, mg/l	ND	ND
Dilution factor	1	1
Arsenic, mg/l	ND	ND
Chromium, mg/l	ND	ND

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CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
30948-16	Rinse Blank (2-28-91)	Client
30948-17	Field Blank (2-28-91)	

PARAMETER	30948-16	30948-17
Copper, mg/l	ND	ND

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CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
30948-18	Detection Limits - Soil	Client
30948-19	Accuracy (mean % recovery) - Soil	
30948-20	Precision (% RPD) - Soil	

PARAMETER	30948-18	30948-19	30948-20
K001 (Method 8270)			
2-Chlorophenol, mg/kg dw	0.33	101 %	1.0 %
Phenol, mg/kg dw	0.33	85 %	5.2 %
2,4-Dimethylphenol, mg/kg dw	0.33	57 %	18 %
Trichlorophenols, mg/kg dw	0.33	64 %	7.8 %
p-Chloro-m-cresol, mg/kg dw	0.33	88 %	2.3 %
Tetrachlorophenols, mg/kg dw	0.33	76 %	7.9 %
2,4-Dinitrophenol, mg/kg dw	1.7	79 %	10 %
Pentachlorophenol, mg/kg dw	1.7	93 %	14 %
Naphthalene, mg/kg dw	0.33	91 %	1.1 %
Acenaphthene, mg/kg dw	0.33	89 %	2.2 %
Acenaphthylene, mg/kg dw	0.33	107 %	1.9 %
Phenanthrene, mg/kg dw	0.33	89 %	2.2 %
Anthracene, mg/kg dw	0.33	84 %	7.1 %
Fluoranthene, mg/kg dw	0.33	89 %	4.5 %
Chrysene, mg/kg dw	0.33	72 %	1.4 %
Benzo(a)Anthracene, mg/kg dw	0.33	80 %	3.8 %
Benzo(b,k)fluoranthene, mg/kg dw	0.33	76 %	3.9 %
Benzo(a)pyrene, mg/kg dw	0.33	84 %	1.2 %
Indeno(1,2,3-cd)pyrene, mg/kg dw	0.33	90 %	1.1 %
Dibenzo(a,h)anthracene, mg/kg dw	0.33	84 %	13 %
Carbazole, mg/kg dw	0.33	93 %	7.2 %
Arsenic, mg/kg dw	1.0	111 %	5.4 %
Chromium, mg/kg dw	1.0	119 %	0.84 %

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LOG NO: S1-30948

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P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
30948-18	Detection Limits - Soil	Client
30948-19	Accuracy (mean % recovery) - Soil	
30948-20	Precision (% RPD) - Soil	

PARAMETER	30948-18	30948-19	30948-20
Copper, mg/kg dw	2.5	117 %	2.6 %

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
30948-21	Detection Limits - Liquid	Client

PARAMETER	30948-21
K001 (Method 8270)	
2-Chlorophenol, mg/l	0.010
Phenol, mg/l	0.010
2,4-Dimethylphenol, mg/l	0.010
Trichlorophenols, mg/l	0.010
p-Chloro-m-cresol, mg/l	0.010
Tetrachlorophenols, mg/l	0.010
2,4-Dinitrophenol, mg/l	0.050
Pentachlorophenol, mg/l	0.050
Naphthalene, mg/l	0.010
Acenaphthene, mg/l	0.010
Acenaphthylene, mg/l	0.010
Phenanthrene, mg/l	0.010
Anthracene, mg/l	0.010
Fluoranthene, mg/l	0.010
Chrysene, mg/l	0.010
Benzo(a)Anthracene, mg/l	0.010
Benzo(b,k)fluoranthene, mg/l	0.010
Benzo(a)pyrene, mg/l	0.010
Indeno(1,2,3-cd)pyrene, mg/l	0.010
Dibenzo(a,h)anthracene, mg/l	0.010
Carbazole, mg/l	0.010
Arsenic, mg/l	0.010
Chromium, mg/l	0.010
Copper, mg/l	0.025

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
30948-22	Report Completion Date	Client

PARAMETER	30948-22
Date Reported	03.13.91

Methods: EPA SW-846
ND - Not Detected

J. W. Andrews, Ph. D.

GERAGHTY & MILLER, INC. Laboratory Task Order No. 10777 CHAIN-OF-CUSTODY RECORD Page 1 of 1

Project Number NC 09003

Project Location Wilmington, NC

Laboratory Savannah Labs

Sampler(s)/Affiliation P. Jacobs (G&M)
M. Radecke (G&M)

SAMPLE BOTTLE / CONTAINER DESCRIPTION

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500 ml w/m plastic metals Cu, Cr, As 4°C	500 ml w/m glass K001 4°C								TOTAL
TWS-6A/9352	S	2-28-91 8:35		1	1								2
TWS-6B/9353	S	2-28-91 8:45		1	1								2
TWS-5A/9354	S	2-28-91 9:15		1	1								2
TWS-5B/9355	S	2-28-91 9:20		1	1								2
TWS-4A/9356	S	2-28-91 10:10		1	1								2
TWS-4B/9357	S	2-28-91 10:15		1	1								2
TWS-3A/9358	S	2-28-91 11:10		1	1								2
TWS-3B/9359	S	2-28-91 11:15		1	1								2
TWS-2A/9360	S	2-28-91 12:15		1	1								2
TWS-2B/9361	S	2-28-91 12:25		1	1								2
TWS-1A/9362	S	2-28-91 13:05		1	1								2
TWS-1B/9363	S	2-28-91 13:15		1	1								2
30948													

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 24

Relinquished by: P. Jacobs	Organization: Geraghty + Miller, Inc.	2-28-91 19:00	Seal Intact? Yes No N/A
Received by: Lanara Johnson	Organization: SAVH LABS	Date 3/1/91 Time 9:45	
Relinquished by:	Organization:		Seal Intact? Yes No N/A
Received by:	Organization:	Date / / Time	

Special Instructions/Remarks: Log in under Southern Wood Piedmont

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other (SPECIFY)

G&M Form 09.1.90 Southwind 90.0126

[redacted] Laboratory Task Order No. [illegible] [redacted] CHAIN-OF-CUSTODY [redacted] Page [redacted]

Project Number NC09003

Project Location Wilmington, NC

Laboratory Savannah Labs

Sampler(s)/Affiliation P. Jacobs (G+M)
M. Rodecke (G+M)

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500ml w/m plastic metals Cu,Cr,As 4°C	500ml w/m glass Kool 4°C	500ml plastic metals Cu,Cr,As HNO3 4°C	1L Amber glass Kool 4°C						TOTAL
NTB-3/9364	S	2-28-91 17:10		1	1								2
NTB-6/9365	S	2-28-91 17:30		1	1								2
NTB-7/9366	S	2-28-91 17:30		1	1								2
FB-3	L	2-28-91 16:50				1	1						2
RB-3	L	2-28-91 16:48				1	1						2
30948													

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 10

Relinquished by: P. Jacobs	Organization: Geraghty + Miller, Inc.	2-28-91 19:00	Seal Intact? Yes No N/A
Received by: Tamara Johnson	Organization: SAVH LABS	Date 3/1/91 Time 9:45	
Relinquished by:	Organization:		Seal Intact? Yes No N/A
Received by:	Organization:	Date / / Time 9	

Special Instructions/Remarks:
Log in under Southern Wood Piedmont

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other _____ (SPECIFY)

G&M Form 09 1-90 Southprint 90-0136

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& ENVIRONMENTAL SERVICES, INC.

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Mark

RECEIVED
MAR 21 1991
G & M

LOG NO: S1-30966

Received: 02 MAR 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09003 Wilmington

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30966-1	NTB-2 (# 9367) 3-1-91	Client
30966-2	NTB-5 (# 9368) 3-1-91	
30966-3	NTB-1 (# 9370) 3-1-91	
30966-4	NTB-4 (# 9369) 3-1-91	
30966-5	NTB-8 (# 9371) 3-1-91	

PARAMETER	30966-1	30966-2	30966-3	30966-4	30966-5
K001 (Method 8270)					
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	ND	0.93	ND	ND
Acenaphthene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthylene, mg/kg dw	ND	ND	1.6	ND	ND
Phenanthrene, mg/kg dw	1.0	ND	2.0	54	ND
Anthracene, mg/kg dw	3.7	ND	7.6	84	ND
Fluoranthene, mg/kg dw	1.3	0.70	7.5	97	0.68
Chrysene, mg/kg dw	0.74	0.49	4.6	52	0.79
Benzo(a)Anthracene, mg/kg dw	0.56	ND	3.1	25	ND
Benzo(b,k)fluoranthene, mg/kg dw	1.0	ND	11	50	1.2
Benzo(a)pyrene, mg/kg dw	ND	ND	4.3	17	ND
Indeno(1,2,3-cd)pyrene, mg/kg dw	ND	ND	3.8	ND	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	ND	1.3	ND	ND
Carbazole, mg/kg dw	2.2	ND	1.6	11	ND
Dilution factor	1	1	1	20	1

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LOG NO: S1-30966

Received: 02 MAR 91

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Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09003 Wilmington

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30966-1	NTB-2 (# 9367) 3-1-91	Client
30966-2	NTB-5 (# 9368) 3-1-91	
30966-3	NTB-1 (# 9370) 3-1-91	
30966-4	NTB-4 (# 9369) 3-1-91	
30966-5	NTB-8 (# 9371) 3-1-91	

PARAMETER	30966-1	30966-2	30966-3	30966-4	30966-5
Arsenic, mg/kg dw	ND	1.8	7.0	1.7	5.3
Chromium, mg/kg dw	1.8	3.2	8.0	2.9	5.6
Copper, mg/kg dw	ND	3.9	30	9.7	90
Percent Solids, %	91	78	68	87	78

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LOG NO: S1-30966

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Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09003 Wilmington

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30966-6	NTB-9 (# 9372) 3-1-91	Client
30966-7	NTB-10 (# 9374) 3-1-91	
30966-8	NTB-11 (# 9373) 3-1-91	
30966-9	NTB-12 (# 9375) 3-1-91	
30966-10	NTB-13 (# 9376) 3-1-91	

PARAMETER	30966-6	30966-7	30966-8	30966-9	30966-10
Arsenic, mg/kg dw	12	4.7	8.1	3.2	13
Chromium, mg/kg dw	5.7	2.2	4.6	1.4	22
Copper, mg/kg dw	130	8.6	81	3.1	20
Percent Solids, %	71	71	89	72	51

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S1-30966

Received: 02 MAR 91

Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09003 Wilmington

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
30966-6	NTB-9 (# 9372) 3-1-91	Client
30966-7	NTB-10 (# 9374) 3-1-91	
30966-8	NTB-11 (# 9373) 3-1-91	
30966-9	NTB-12 (# 9375) 3-1-91	
30966-10	NTB-13 (# 9376) 3-1-91	

PARAMETER	30966-6	30966-7	30966-8	30966-9	30966-10
K001 (Method 8270)					
2-Chlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Phenol, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dimethylphenol, mg/kg dw	ND	ND	ND	ND	ND
Trichlorophenols, mg/kg dw	ND	ND	ND	ND	ND
p-Chloro-m-cresol, mg/kg dw	ND	ND	ND	ND	ND
Tetrachlorophenols, mg/kg dw	ND	ND	ND	ND	ND
2,4-Dinitrophenol, mg/kg dw	ND	ND	ND	ND	ND
Pentachlorophenol, mg/kg dw	ND	ND	ND	ND	ND
Naphthalene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthene, mg/kg dw	ND	ND	ND	ND	ND
Acenaphthylene, mg/kg dw	ND	ND	ND	ND	ND
Phenanthrene, mg/kg dw	ND	3.0	ND	ND	ND
Anthracene, mg/kg dw	ND	1.3	ND	ND	ND
Fluoranthene, mg/kg dw	1.0	5.8	0.63	0.58	0.86
Chrysene, mg/kg dw	1.2	4.5	0.76	0.59	0.93
Benzo(a)Anthracene, mg/kg dw	ND	3.1	0.50	ND	0.69
Benzo(b,k)fluoranthene, mg/kg dw	2.0	5.5	1.7	1.2	1.3
Benzo(a)pyrene, mg/kg dw	ND	1.2	ND	ND	ND
Indeno(1,2,3-cd)pyrene, mg/kg dw	ND	0.57	ND	ND	ND
Dibenzo(a,h)anthracene, mg/kg dw	ND	ND	ND	ND	ND
Carbazole, mg/kg dw	ND	0.51	ND	ND	ND
Dilution factor	1	1	1	1	1

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Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09003 Wilmington

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
30966-11	Detection Limits	Client
30966-12	Accuracy (mean % recovery)	
30966-13	Precision (% RPD)	

PARAMETER	30966-11	30966-12	30966-13
K001 (Method 8270)			
2-Chlorophenol, mg/kg dw	0.33	98 %	1.0 %
Phenol, mg/kg dw	0.33	98 %	5.1 %
2,4-Dimethylphenol, mg/kg dw	0.33	88 %	2.3 %
Trichlorophenols, mg/kg dw	0.33	75 %	8.0 %
p-Chloro-m-cresol, mg/kg dw	0.33	82 %	2.4 %
Tetrachlorophenols, mg/kg dw	0.33	76 %	12 %
2,4-Dinitrophenol, mg/kg dw	1.7	33 %	42 %
Pentachlorophenol, mg/kg dw	1.7	41 %	47 %
Naphthalene, mg/kg dw	0.33	84 %	4.8 %
Acenaphthene, mg/kg dw	0.33	83 %	2.4 %
Acenaphthylene, mg/kg dw	0.33	93 %	4.3 %
Phenanthrene, mg/kg dw	0.33	89 %	3.4 %
Anthracene, mg/kg dw	0.33	82 %	11 %
Fluoranthene, mg/kg dw	0.33	83 %	8.5 %
Chrysene, mg/kg dw	0.33	87 %	5.8 %
Benzo(a)Anthracene, mg/kg dw	0.33	87 %	6.9 %
Benzo(b,k)fluoranthene, mg/kg dw	0.33	83 %	6.1 %
Benzo(a)pyrene, mg/kg dw	0.33	86 %	3.5 %
Indeno(1,2,3-cd)pyrene, mg/kg dw	0.33	90 %	1.1 %
Dibenzo(a,h)anthracene, mg/kg dw	0.33	89 %	1.1 %
Carbazole, mg/kg dw	0.33	110 %	5.5 %
Arsenic, mg/kg dw	1.0	111 %	10 %
Chromium, mg/kg dw	1.0	98 %	4.1 %

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& ENVIRONMENTAL SERVICES, INC.

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Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09003 Wilmington

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
30966-11	Detection Limits	Client
30966-12	Accuracy (mean % recovery)	
30966-13	Precision (% RPD)	

PARAMETER	30966-11	30966-12	30966-13
Copper, mg/kg dw	2.5	95 %	11 %

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Ms. Sandra Watson
Southern Wood Piedmont (WI)
P.O. Box 5477, I-85 and Sigsbee Rd.
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09003 Wilmington

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
30966-14	Report Completion Date	Client

PARAMETER	30966-14
Date Reported	03.20.91

Methods: EPA SW-846
ND = Not Detected

J. W. Andrews

J. W. Andrews, Ph. D.

GERAGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Project Number: NC 09003

Project Location: Wilmington, NC

Laboratory: Savannah Labs

Sampler(s)/Affiliation: P. Jacobs (G&M)
M. Radecke (G&M)

SAMPLE BOTTLE / CONTAINER DESCRIPTION

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500ml w/m plastic metals Cu, Cr, As 4°C	500ml w/m glass KOH 4°C	500ml w/m plastic metals Cu, Cr, As 4°C							TOTAL
NTB-2/9367	S	3-1-91 9:15		1	1								2
NTB-5/9368	S	3-1-91 9:15		1	1								2
NTB-1/9370	S	3-1-91 9:40		1	1								2
NTB-4/9369	S	3-1-91 9:35		1	1								2
NTB-8/9371	S	3-1-91 10:15		1	1								2
NTB-9/9372	S	3-1-91 10:15		1	1								2
NTB-10/9374	S	3-1-91 10:45			1	1							2
NTB-11/9373	S	3-1-91 10:50			1	1							2
NTB-12/9375	S	3-1-91 11:15			1	1							2
NTB-13/9376	S	3-1-91 11:40			1	1							2
30966													

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers: 20

Relinquished by: P. Jacobs	Organization: Geraghty & Miller, Inc.	Date 3-1-91	Time 17:30	Seal Intact? (Yes) No N/A
Received by: L. Bond	Organization: Savh. Labs	Date 3/2/91	Time 11:40am	
Relinquished by:	Organization:			Seal Intact? Yes No N/A
Received by:	Organization:	Date / /	Time	

Special Instructions/Remarks:
Log in under Southern Wood Piedmont

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express ☐ Lab Courier ☐ Other _____

Ref. 15

RISK ASSESSMENT REPORT FOR LANDFARM AREAS, SOUTHERN WOOD PIEDMONT COMPANY WILMINGTON, NORTH CAROLINA

December 1993

Prepared for:

SOUTHERN WOOD PIEDMONT COMPANY
281 Creosote Road
Inman, South Carolina 29349

Prepared by:

GERAGHTY & MILLER, INC.
Risk Evaluation Group
2840 Plaza Place - Suite 350
Raleigh, North Carolina 27612
(919) 571-1662

JAN 1994
Received
Hazardous Waste Section

RISK ASSESSMENT REPORT
FOR LANDFARM AREAS,
SOUTHERN WOOD PIEDMONT COMPANY
WILMINGTON, NORTH CAROLINA

December 1993

Geraghty & Miller, Inc., is submitting this report to Southern Wood Piedmont Company for work performed at the landfarms in Wilmington, North Carolina. The report was prepared in conformance with Geraghty & Miller's strict quality assurance/quality control procedures to ensure that the report meets the highest standards in terms of the methods used and the information presented. If you have any questions or comments concerning this report, please contact one of the individuals listed below.

Respectfully submitted,

GERAGHTY & MILLER, INC.

Stanley T. Atwood

Stanley T. Atwood, DABT
Senior Scientist

Christopher W. Lovdahl
Project Scientist/Project Manager

William H. Doucette

William H. Doucette, Jr., Ph.D.
Project Director/Associate

EXECUTIVE SUMMARY

A risk assessment was conducted for the two landfarm areas at the former wood treating facility operated by Southern Wood Piedmont Company (SWP) in Wilmington, North Carolina. The land farms were operated and maintained by SWP between July 1984 and April 1990 to remediate soils containing pentachlorophenol (PCP) and creosote. The purpose of this risk assessment was to evaluate whether concentrations of PCP and components of creosote (primarily polycyclic aromatic hydrocarbons [PAHs]) remaining in the landfarms posed a potential risk to public health and the environment pursuant to the terms of the Administrative Order on Consent (AOC) Agreement (May 22, 1985) between SWP and the State of North Carolina. Once the terms of the AOC have been met, the property will be returned to the City of Wilmington for development. It was assumed that the site would be used for low intensity industrial purposes such as a loading dock and storage area. Therefore, this risk assessment examined potential risk associated with future industrial development of the site.

Soil samples within the landfarms were collected periodically throughout the active maintenance and operational period (September 1985 to April 1990). Samples were analyzed for soil nutrients, PCP, PAHs, phenol, and microbial counts throughout this period. These samples indicated that the landfarms were effective and that constituents of concern (COCs) were not leaching into the substrate soils or ground water beneath the landfarms. Geraghty & Miller, Inc. subsequently collected soil samples from the landfarms in October 1990 and October 1991. This risk assessment is based on the results of the samples collected by Geraghty & Miller, Inc.

COCs included in the risk assessment were PAHs, phenol, dimethylphenol, trichlorophenol, tetrachlorophenol, PCP, arsenic, chromium, and copper. Fifty samples were analyzed for PAHs and PCP; 20 samples were analyzed for phenol, dimethylphenol, trichlorophenol, pentachlorophenol, arsenic, chromium, and copper.

Because toxicity values (reference doses [RfD] and cancer slope factors [CSFs]) were not available for many of the PAHs, surrogate toxicity values were used. For example, the RfD for pyrene was used to represent non-carcinogenic PAHs which did not have an RfD and a toxicity

equivalency factor (TEF) scheme developed by U.S. Environmental Protection Agency (USEPA) Region IV was used to evaluate carcinogenic PAHs. The TEF approach allows for all carcinogenic PAHs to be expressed in terms of benzo(a)pyrene equivalent concentrations.

It is assumed that several feet of fill and/or concrete pavement will cover the landfarm area following development; therefore, exposure to constituents remaining in the landfarm soils would be eliminated. During the construction period, or subsequent excavation projects to install foundations or utility lines, site workers could contact landfarm soils. Off-site transport of soils via windblown dust could result in some exposure to downwind residents; however, such exposure would be minimal compared to a site construction worker. Therefore, this risk assessment evaluated potential exposures of a site construction worker. Professional judgment and standard USEPA exposure assumptions were used to calculate constituent intakes via incidental soil ingestion, dermal contact, and inhalation of dust. An exposure period of 13 weeks, 6 days per week, and 8 hours per day was assumed. Thirteen weeks was selected as a reasonable maximum period required for grading, filling, and paving the site.

Risk estimates for the site construction worker were compared to USEPA target risk criteria to determine if the terms of the AOC had been met. The USEPA currently uses a target excess lifetime cancer risk (ELCR) range of 1×10^{-4} to 1×10^{-6} and a hazard index (HI) of 1 to indicate if remediation is required. The total ELCR for the construction worker is 6×10^{-6} and is within the target risk range; the HI is 0.5 and is below the target value of 1. Benzo(a)pyrene was responsible for more than half of the ELCR. Ecological impacts from the site were judged to be limited because of the small size of the site, limited migration of the COCs, and planned use of the site as industrial property. These results indicate, that the proposed development of the site could proceed without posing a significant risk to human health and the environment.

CONTENTS

Page

1.0 INTRODUCTION 1-1

2.0 SITE CHARACTERIZATION 2-1
- 2.1 Site Location and Demographics 2-1
- 2.2 Site History 2-2
- 2.3 Regional and Site Geology and Hydrology 2-3
- 2.4 Landfarm Activities 2-4

3.0 CONSTITUENT CHARACTERIZATION 3-1
- 3.1 Data Reduction 3-1
- 3.2 Soil 3-1
- 3.3 Ground Water 3-2
- 3.4 Physical and Chemical Properties 3-3
- 3.5 Constituents of Concern (COCs) 3-4

4.0 ENVIRONMENTAL FATE AND TRANSPORT 4-1
- 4.1 Landfarming Environment 4-1
- 4.2 Creosote 4-2
- 4.3 Polycyclic Aromatic Hydrocarbons (PAHS) 4-2
- 4.4 Phenolic Compounds 4-4

5.0 HAZARD CHARACTERIZATION 5-1
- 5.1 Carcinogenic Effects 5-1
- 5.2 Non-Carcinogenic Effects 5-1
- 5.3 Toxicity Values 5-2

6.0 EXPOSURE CHARACTERIZATION 6-1
- 6.1 Release Source Analysis 6-1
- 6.2 Exposure Pathways and Receptors 6-1
- 6.3 Exposure Point Concentrations (EPCs) 6-2
- 6.4 Exposure Dose Calculations 6-3

7.0 RISK CHARACTERIZATION 7-1
- 7.1 Site Worker 7-2
- 7.2 Ecological Assessment 7-2
  - 7.2.1 General Concepts 7-3
  - 7.2.2 Community Description 7-5
  - 7.2.3 Community Effects 7-7
  - 7.2.4 Ecological Summary 7-11

8.0 UNCERTAINTIES 8-1

9.0 FINDINGS AND CONCLUSIONS 9-1

10.0 REFERENCES 10-1

TABLES

3-1. Polychlorinated Dibenzodioxin and Dibenzofuran Data For Composite Soil Samples Collected from Landfarms 1 and 2, October 1990, Southern Wood Piedmont, Wilmington, North Carolina.

3-2. Data Summary for Soil Samples, Southern Wood Piedmont, Wilmington, North Carolina.

3-3. Physical and Chemical Properties of Organic Constituents of Concern, Southern Wood Piedmont, Wilmington, North Carolina.

5-1. Reference Doses, Target Sites, and Confidence Levels for Constituents of Concern, Southern Wood Piedmont, Wilmington, North Carolina.

5-2. Cancer Slope Factors, Tumor Sites, and USEPA Cancer Classifications for Constituents of Concern, Southern Wood Piedmont, Wilmington, North Carolina.

5-3. Toxicity Summaries for Constituents of Concern, Southern Wood Piedmont, Wilmington, North Carolina.

5-4. Dermal and Oral Absorption Efficiencies for Constituents of Concern, Southern Wood Piedmont, Wilmington, North Carolina.

5-5. Adjusted Toxicity Values Used to Assess Dermal Exposure for Constituents of Concern, Southern Wood Piedmont, Wilmington, North Carolina.

5-6. Calculated Benzo(a)pyrene Equivalents for Carcinogenic Polycyclic Aromatic Hydrocarbons, Southern Wood Piedmont, Wilmington, North Carolina.

6-1. Exposure Parameters Used to Assess Risk to Receptors, Southern Wood Piedmont, Wilmington, North Carolina.

6-2. Equations and Sample Calculations for Incidental Ingestion of Soil, Southern Wood Piedmont, Wilmington, North Carolina.

6-3. Equations and Sample Calculations for Dermal Contact with Soil, Southern Wood Piedmont, Wilmington, North Carolina.

6-4. Equations and Sample Calculations for Inhalation of Fugitive Dust, Southern Wood Piedmont, Wilmington, North Carolina.

6-5. Site Construction Worker Exposure and Risk Estimates, Incidental Ingestion of Soil Based on Current Concentrations, Southern Wood Piedmont, Wilmington, North Carolina.

6-6. Site Construction Worker Exposure and Risk Estimates, Dermal Contact with Soil Based on Current Concentrations, Southern Wood Piedmont, Wilmington, North Carolina.

6-7. Site Construction Worker Exposure and Risk Estimates, Inhalation of Dust Based on Current Concentrations, Southern Wood Piedmont, Wilmington, North Carolina.

7-1. Total Site Risks, Future Construction Worker, Southern Wood Piedmont, Wilmington, North Carolina.

FIGURES

2-1. Regional Map of Southern Wood Piedmont Site, Wilmington, North Carolina.

2-2. Generalized Site Map, Southern Wood Piedmont, Wilmington, North Carolina.

2-3. Soil Sampling Locations within the Landfarm Areas at Southern Piedmont's Former Wood Treatment Facility - Wilmington, North Carolina.

APPENDICES

A. Particulate Emission Factor Calculations.

B. Threatened and Endangered Species, Wilmington, North Carolina.

DRAFT
RISK ASSESSMENT REPORT FOR LANDFARM AREAS, SOUTHERN WOOD PIEDMONT COMPANY WILMINGTON, NORTH CAROLINA

1.0 INTRODUCTION

Geraghty & Miller, Inc., (Geraghty & Miller) was retained by the Southern Wood Piedmont Company (SWP) to prepare a post-remediation residual risk assessment for the Wilmington, North Carolina, landfarm areas. The purpose of the landfarms was to remediate soils which contained wood-treating chemicals, particularly creosote and pentachlorophenol (PCP). This risk assessment was performed to evaluate whether a "concentration of residual PCP and major constituents of creosote is reached which will protect public-health and the environment," according to the terms of the Administrative Order on Consent (AOC) Agreement (May 22, 1985), paragraph 10. Once remediation is in agreement with the AOC, use of the property will be returned to the City of Wilmington. The future site use proposed by the City of Wilmington and the North Carolina Ports Authority is for low intensity industrial use. The report evaluates potential exposure and risk for future construction activities within the landfarm areas. Chronic exposure to landfarm soils following development is not evaluated because it is assumed that several feet of fill and concrete will be placed over the landfarm area during development.

This risk assessment follows U.S. Environmental Protection Agency (USEPA) guidance for risk assessments (USEPA, 1991a; 1989a,b,c) and is further based on the firm's professional judgment developed from preparing several hundred site-specific risk assessments. This risk assessment is a companion document to two other reports: "Data Summary Report for the 1990 Landfarm Area Sampling" (Geraghty & Miller, 1993a) and "Comparison of 1990 and 1991 Soil and Ground-Water Data" (Geraghty & Miller, 1993b). The report is organized according to the following outline:

- Site Characterization,
- Constituent Characterization,
- Environmental Fate and Transport,
- Hazard Characterization,
- Exposure Characterization,
- Risk Characterization,
- Uncertainties, and
- Findings and Conclusions.

The Site Characterization section (Section 2.0) refers to the site location and demographics, site history, regional and site geology and hydrology, and landfarm activities associated with the site. This information is utilized in other sections of the risk assessment.

The Constituent Characterization section (Section 3.0) discusses the data summary of samples collected at the site. Soil and ground-water data results and sampling procedures are discussed in detail.

The Environmental Fate and Transport section (Section 4.0) discusses the chemical and physical properties and the mobility and persistence of the constituents detected at the site. The landfarm bioremediation environment and biodegradation and half-life of organic constituents also are mentioned in this section.

The Hazard Characterization section (Section 5.0) discusses the potential carcinogenic and non-carcinogenic effects associated with constituents detected at the site. Toxicity values used for calculating risks are identified in this section.

The Exposure Characterization section (Section 6.0) addresses release sources, exposure pathways, exposure point concentrations, and exposure dose calculations. Assumptions used in the exposure calculations are presented.

The Risk Characterization section (Section 7.0) utilizes information provided in the previous sections to provide qualitative and quantitative risk estimates. Risks to both humans and ecological receptors are evaluated.

The Uncertainties section (Section 8.0) recognizes and explains the uncertainties associated with a risk assessment, and key Findings and Conclusions are provided in Section 9.0.

2.0 SITE CHARACTERIZATION

This section provides an overview of the site setting. Included are discussions of the site location and demographics, site history, geology and hydrology, and landfarm activities. Analytical data used in this report are summarized in Section 3.0 and discussed in detail in two companion reports (Geraghty & Miller, 1993a,b).

2.1 SITE LOCATION AND DEMOGRAPHICS

The former SWP facility measured approximately 1,000 feet (east to west) by 1,600 feet (north to south) and occupied an industrialized area along the Cape Fear River in Wilmington, North Carolina (Figures 2-1 and 2-2). Industry in the vicinity includes the Hess Fuel Tank Farms separated from the site by a ditch on the north side and the Poctank, Inc., plant separated by an undeveloped lot on the south side of the site. The North Carolina Ports Authority owns and operates property along the Cape Fear River south of the site. The major roads in the vicinity of the SWP facility are Greenfield and Surry Streets. Greenfield Street runs in an east-west direction and dead ends into the center of the facility. Surry Street runs in a north-south direction and is east of the property. The Cape Fear River borders the property on the west.

Residential areas, separated by a buffer zone of trees and commercial property (Figure 2-1), are east of the site. The residential areas include Dry Pond, a residential area which consists of multi-family housing units on the east side of Surry Street. According to the 1980 census (1990 census data are not yet available), approximately 1,600 people live in the area and approximately 12.5 percent were 0 to 5 years old; 12.5 percent were 5 to 15 years old; 61 percent were 15 to 65; and 14 percent were over 65 years old. Of the individuals 5 years old and older, approximately 54 percent lived in a different geographical location 5 years earlier. The 1980 census showed that of the 663 housing units in Dry Pond occupied year-round, 31.2 percent were occupied by owners and 68.2 percent were occupied by renters. There were 106 vacant housing units in this neighborhood, with a rental vacancy ratio of 6.2 percent and a homeowner vacancy rate of 7.6 percent (Wilmington Housing Authority, 1980). The statistics

for this neighborhood indicate that 22.5 percent of all homeowners in Dry Pond had lived in their housing units 10 years or more. Census data also indicated that 11.9 percent of the owners and 23.3 percent of the renters had moved into their units in the 15 months preceding the census. Dry Pond households are connected to City water. No evidence of active private water wells was observed in the immediate area during site visits in 1990 and 1991.

Geographically, the more distant residential areas to the east are North Lakeside and Southside. The combined 1980 population in those areas accounted for approximately 5,200 people. These areas also are connected to city water. Use of private water wells was not evident. School zones and day care centers were not observed in the vicinity of the site. Recreational facilities identified in the immediate area included Greenfield Lake and baseball fields directly adjacent to the southeast facility boundary.

2.2 SITE HISTORY

SWP and its predecessors leased and operated a wood-treatment facility in Wilmington, North Carolina, from approximately 1932 to 1983. In 1932, the North State Company leased the property previously operated by Liberty Shipyards. The North State Company purchased and sold non-treated wood from 1932 to 1935. In 1935, the Taylor Colquitt Company purchased the property to establish a wood-preserving facility to treat piling and poles with creosote. In 1964, the company name was changed to Taylor Piedmont, and the site remained a wood-treatment facility. When International Telephone & Telegraph (ITT) purchased Taylor Piedmont in 1968-1969, the company name and processes were maintained. On January 1, 1971, the company name was changed to SWP. SWP added chromated copper arsenate (CCA) to the wood-treatment process in the early 1970s. Until the facility was closed, raw and dressed lumber was delivered, debarked, kiln dried, and treated at the site. Wood-preserving chemicals were stored on-site in aboveground storage tanks. Additional creosote storage was in the southwestern property corner. In June 1983, the SWP facility ceased its wood-treatment operations and began closure procedures.

3.0 CONSTITUENT CHARACTERIZATION

The soil and ground-water sampling programs used as the basis of this risk assessment are described in detail in the two data summary reports (Geraghty & Miller, 1993a,b). This section discusses how the data were reduced for the risk assessment, summarizes the sampling results, discusses the physical and chemical properties of the constituents, and identifies constituents of potential concern (COCs).

3.1 DATA REDUCTION

The data were reduced according to guidelines provided by the USEPA (1989a) to identify COCs and exposure point concentrations (EPCs) for use in the exposure assessment (Section 4.0). The data summary tables list the frequency and range of detected values, the arithmetic mean, and the 95 percent upper confidence limit (UCL) on the mean. Constituents that were not detected in a specific medium were not included in the data summary tables. However, if a constituent was detected in at least one sample, the mean concentration was based on one-half the reported sample quantitation (SQL) for the non-detects, unless half the SQL exceeded the maximum detected value. When this occurred, the maximum detected value was used instead of half the SQL.

3.2 SOIL

Soil samples were collected from five locations within each landfarm (Figure 2-3) in October 1990 and October 1991 and were analyzed for constituents associated with wood-preserving chemicals used at the site: creosote, PCP, and CCA.

Thirty soil samples collected from LF1 and LF2 were analyzed for PAHs and PCP in 1990. Three samples were collected at each sampling point to represent the upper, middle, and lower portions of the landfarm soil (Figure 2-3). An additional 10 soil samples were collected from the substrate beneath LF1 and LF2 and demonstrated minimal migration of COCs from the

landfarm soils (Geraghty & Miller, 1993a). Two composite soil samples (one from each landfarm) also were analyzed in 1990 for polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). In October 1991, 20 soil samples were collected from LF1 and LF2 and were analyzed for PAHs, phenols (including PCP) and cresols, and three inorganics (arsenic, chromium, and copper). Only two samples were collected at each sampling point (upper and lower portions of the landfarm soil).

PAHs detected at the highest concentrations were anthracene (900 milligrams per kilogram [mg/kg]), fluoranthene (520 mg/kg), and pyrene (980 mg/kg). Five phenols (2,4-dimethylphenol, PCP, phenol, tetrachlorophenol, and trichlorophenol) were detected. PCP was detected at a maximum concentration of 150 mg/kg. The other phenols were detected at lower concentrations ranging from less than 1 to 3.5 mg/kg. Two cresols (o-cresol and m,p-cresol) were detected in 1991 in 6 and 5 out of 20 samples, respectively. The highest concentration for cresol was m,p-cresol at 0.10 mg/kg. Arsenic, chromium, and copper were detected in each sample collected in 1991. The maximum detected concentrations for arsenic, chromium, and copper were 84 mg/kg, 100 mg/kg, and 150 mg/kg, respectively. Soil data are summarized in Table 3-1.

PCDD and PCDF data were reduced using a toxicity equivalency factor (TEF) scheme developed by the USEPA (1989d). The end result is a concentration expressed as a 2,3,7,8-tetrachlorodibenzodioxin (TCDD) equivalent concentration. Using this scheme, TCDD equivalent concentrations of about 0.002 mg/kg and 0.003 mg/kg were detected in LF1 and LF2, respectively (Table 3-2).

3.3 GROUND WATER

Each of the four existing monitoring wells (MW-6, MW-7, MW-8, and MW-9) surrounding the landfarms were sampled in October 1990 (Figure 2-2). None of the wood-preserving COCs identified in soil were detected in ground-water samples from these monitoring wells. Therefore, ground water is not considered further in this risk assessment.

3.4 PHYSICAL AND CHEMICAL PROPERTIES

Physical and chemical properties affect the fate and transport of constituents. Table 3-3 summarizes several important properties of the organic COCs identified at the site. The physical and chemical properties considered in this report include water solubility, specific gravity, vapor pressure, Henry's Law Constant, organic carbon distribution coefficient (K_{oc}), octanol-water partition coefficient (K_{ow}), fish bioconcentration factor (BCF), and half-life.

These physical and chemical properties generally are not available for inorganic constituents because they are highly variable, depending on the particular form of the inorganic molecule. The chemical variables which are primarily responsible for controlling metal speciation (the form of the molecule or ion in solution) are the electrode potential (Eh) and pH (Stumm and Morgan, 1981). Eh is a measure of the electrochemical potential of ions present in soil or water and determines the oxidation state of the metal; pH is a measure of acidity or alkalinity of the medium and also influences the form of the metal and its mobility and bioavailability.

Water solubility is the maximum or saturated concentration of a chemical in pure water at a specific temperature. Specific gravity is the ratio of the density of a chemical to the density of water at a specific temperature. Vapor pressure is a property of a chemical in its pure state and indicates the volatility of a chemical. Henry's Law Constant is the air-water partition coefficient which relates a chemical's concentration in the gas phase to its concentration in the water phase and indicates the rate of evaporation of a chemical from water. K_{oc} is a measure of the tendency for organic chemicals to be adsorbed by soil and sediment; K_{ow} is an indicator of water solubility, mobility, adsorption, and bioconcentration. Generally, a high K_{ow} indicates that a chemical has low water solubility and mobility and a high potential to adsorb to soil or bioaccummulate. BCF is a measure of the tendency for a chemical in water to concentrate in fish tissue. The half-life ($T_{1/2}$) is the time required for the constituent concentration to be reduced by a factor of two.

3.5 CONSTITUENTS OF CONCERN (COCs)

All constituents detected at the site were selected as COCs; however, the PCDD and PCDF data are not included in the quantitative risk assessment. The USEPA currently is reviewing PCDD and PCDF toxicity and likely will have new recommendations regarding sensitive toxic endpoints and toxicity values. Nevertheless, the total TCDD equivalent concentrations detected (0.002 to 0.003 mg/kg) are only slightly above the 0.001 mg/kg recommendation for residential soil by the Centers for Disease Control (USEPA, 1989e). Cleanup values for industrial soil typically have been higher than those detected at the site. Furthermore, PCDDs and PCDFs are not mobile in soil, and bioconcentration is limited. Therefore, the concentrations of PCDDs and PCDFs detected at the site were considered to be acceptable. Pending outcome of USEPA's reassessment, these data can be reevaluated.

2.3 REGIONAL AND SITE GEOLOGY AND HYDROLOGY

The site is in the Coastal Plain Physiographic Province of North Carolina, a region underlain by Cretaceous and Cenozoic marine and non-marine sedimentary sequences. Approximately 1,500 feet of Coastal Plain sediments overlie pre-Mesozoic crystalline basement rock in the Wilmington area (North Carolina Geological Survey [NCGS], 1985). The site is underlain directly by the Cretaceous-age Pee Dee Formation (NCGS, 1985), which consists predominantly of unconsolidated, dark green to gray, clay-rich, marine sand and which may contain calcareous sandstone ledges (Sohl and Owens, 1991).

Five soil borings were advanced at the site to a maximum depth of approximately 50 feet by Soil and Material Engineers, Inc., (SME) during 1981, and an additional four borings (to a maximum depth of 20 feet) were drilled by Law Environmental (Law) in 1985. Lithologic logs (presented in SME [1981] and Law [1985]) indicate that a surficial layer of sandy fill material or sand, which varies from less than 1 foot to 18 feet in thickness, is present at the site. This layer, which appears to be thickest in the northern part of the site, is described as consisting of fine to medium sand, with wood, roots, or other material occasionally found. Below this sandy material is a layer consisting of dark brown, organic-rich silt or peat, which may contain traces of fine sand, roots, and wood fragments. This layer ranges in thickness from 5 to 19 feet in the soil boring locations and apparently increases in thickness toward the Cape Fear River to the west. Fine to medium sands extend from below the organic-rich layers to a depth of 42 to 45.5 feet, below which a gray marl is encountered (SME, 1981).

Based on their observations, SME (1981) concluded that the dominant direction of shallow ground-water flow at the site was to the south, parallel to the Cape Fear River. Water-table maps prepared by Law (1985) indicate westward to southwestward flow (toward the river) near the landfarm areas and generally southward flow at the eastern part of the site. Tidal influences may cause temporary alterations or reversals in these flow directions. Hydraulic conductivities ranging from 3×10^{-5} centimeters per second (cm/sec) to 10^{-6} cm/sec were

determined based on in-situ monitor-well tests; an average ground-water flow velocity of 0.10 feet/year was calculated (Law, 1985).

2.4 LANDFARM ACTIVITIES

At the northwest boundary of the site, a 5-acre area was bermed and ditched following the removal of existing rails and crossties and divided into two landfarm areas: Landfarm 1 (LF1) is closest to the river, and Landfarm (LF2) is closest to the SWP office (Figure 2-2). This area formerly was used as the wood-treatment storage area.

During the period July 1984 through April 1990, soil material originating from the spoil pile area was applied at regular intervals. Over this period, approximately 17 different soil amendments occurred for LF1 and 20 for LF2. Each amendment consisted of a 2-inch-thick layer of spoil pile material being added to the surface of the landfarm. During the landfarm operation, irrigation water, 10-10-10 fertilizer, and chicken and turkey manure were added to promote and enhance microbial growth and polycyclic aromatic hydrocarbon (PAH) degradation. The two landfarm areas were tilled to a depth of 6 inches weekly, promoting biological and photochemical degradation of residual chemicals.

Two composite sets of soil samples were collected periodically by a SWP representative. A composite sample was taken for each of the following depths: 0 to 3 inches, 9 to 12 inches, and 21 to 24 inches. Soil from the four corners of each landfarm was mixed to make up the two composite samples for each depth. Each landfarm was sampled separately. The initial sampling began in September 1985 for LF2 and in November 1985 for LF1. Over the period of operation, 59 sets of soil samples were collected from LF2 and 37 from LF1.

The samples were analyzed for total nitrogen, total phosphorus, chloride, total organic carbon, soil pH, PAHs, PCP, phenol, and microbial counts by the Mississippi State University Forest Products Research Division (MSUFPRD) Laboratory in State College, Mississippi.

The quality of the ground water in the two landfarmed areas was monitored during the landfarm operations. Four monitor wells were installed by Law between September 5 and 10, 1985, on the perimeter of the landfarm area. Ground-water samples from the upgradient (MW-6) and three downgradient (MW-7, MW-8, and MW-9) monitor wells were collected by Environmental Technology Engineering (ETE) and analyzed by Savannah Laboratories. Composite soil samples also were taken by SWP's site manager directly from the spoil pile and were analyzed for PAH constituents by MSUFPRD.

4.0 ENVIRONMENTAL FATE AND TRANSPORT

Environmental fate and transport processes for the COCs at the SWP Wilmington site are dependent on the physical and chemical properties of the constituents and the characteristics of the surrounding environment. Soils at the site underwent active bioremediation up to 1990. This section will describe the landfarm environment and the primary environmental fate and transport processes for the organic constituents.

4.1 LANDFARMING ENVIRONMENT

The basic principle of landfarming bioremediation is to exploit the ability of microorganisms to catabolize a wide range of organic compounds. When successful, landfarming bioremediation results in detoxification (the conversion of a toxic chemical to nontoxic materials).

As might be expected, there are potential limitations which must be addressed if in-situ bioremediation is to be successful. The chemical compound in question must be in a chemical state conducive to microbial utilization. A chemical compound must be in an aqueous phase to enter a microbial cell and to be biologically degraded (although some compounds may be transformed by extracellular enzymes). Typically, many persistent compounds are only slightly soluble in water. Insoluble compounds tend to persist in nature adsorbed to inert matrices.

The addition of large amounts of organic carbon may result in the rapid consumption of oxygen and essential inorganic nutrients (nitrogen, phosphorus, sulfur, and potassium), thereby resulting in an anoxic and nutrient-limiting environment. Although a microbial population may exist with the potential to degrade the chemical compound, the newly developed environment restricts its activity. Hence, on-going aeration and nutrient supplementation are essential elements of the landfarm operation. The environmental fate and transport of wood-treating chemicals and constituents associated with wood-treating chemicals are discussed in the following sections.

4.2 CREOSOTE

Creosote is a complex mixture of chemical constituents encompassing diverse chemical structures. Coal tar creosote is composed of approximately 85 percent PAHs, 10 percent phenolic compounds, and 5 percent nitrogen (N), sulfur (S), and oxygen (O)-heterocyclics. Of the approximately 150 to 200 chemicals in creosote, only a few are present in amounts of 1 percent or more (Mueller et al., 1989).

Although coal tar creosote generally is considered to be environmentally persistent, losses of creosote constituents occur with time. Losses may occur through biological processes and a variety of chemical-physical processes such as volatilization, leaching, and photodegradation (USEPA, 1988). Because biodegradation represents the primary route through which creosote is removed from the environment, exploitation of this naturally-occurring process could yield an efficient means of remediating such sites.

For creosote to be degraded biologically under field conditions, basic criteria must be met. First, an appropriate microbial community must be present. The ability to degrade unique carbon sources often is associated with prior exposure of microbial communities to the chemical or to similar chemicals (Mueller et al., 1989). Second, bioavailability of the potential substrate must be considered along with the requirement for organism-substrate interaction. Finally, environmental parameters such as temperature, redox potential, oxygen and nutrient availability, and moisture must be conducive to growth of the requisite organisms.

4.3 POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)

PAHs, the major constituents of creosote, generally tend to sorb strongly to soil particles and have low aqueous solubilities and mobility (Hickock et al., 1982). However, nitrogenous bases present in creosote (e.g., xylidines, aniline, and toluidines) are relatively soluble and mobile (Pereira et al., 1983).

In general, as molecular weight of a PAH increases, its water solubility tends to decrease. For example, phenanthrene is more soluble in water than pyrene (Table 3-3). PAHs dissolved in ground water would remain relatively intact due to slow degradation rates and limited volatilization. Upon release to surface water, PAHs will undergo rapid photolysis. Biodegradation and biotransformation are the ultimate fate processes for PAHs in soils and sediment.

Mueller et al. (1989) reviewed the available literature that outline enzymatic processes and describe microbial oxidation of PAHs and concluded the following:

1. In the presence of appropriate organisms, biodegradation of lower molecular weight PAHs, such as naphthalene, is relatively rapid.

2. Biological transformation of 3-ring PAHs, such as acenaphthene, anthracene, and phenanthrene, usually is slower than 2-ring PAHs.

3. Organisms are capable of transforming higher molecular weight PAHs, such as benzo(a)anthracene, benzo(a)pyrene, fluoranthene, and pyrene. In general, degradation of these compounds usually requires populations of several microbial species (co-metabolism). Pure microbial cultures have not been identified which are capable of mineralizing these compounds.

A variety of microorganisms have been found to possess the ability to degrade PAHs: bacteria from the genera *Aeromonas, Alcaligenes, Beijerinkia, Cyanobacter, Flavobacterium, Micrococcus, Mycobacterium, Nocardia, Pseudomonas, Vibrio*, and the fungus *Phanerochaete chrysosporium*. In addition to pure-culture studies, biodegradation of creosote PAHs by mixed microbial communities has been demonstrated by many researchers (Mueller et al., 1989).

Park et al. (1990) studied the fate of 14 PAHs in two soils and found volatilization to account for 30 and 20 percent loss of naphthalene and 1-methylnaphthalene; for the remaining

12 PAHs, volatilization was negligible. They also found that chemical reactions alone reduced concentrations of 2- and 3-ring PAHs by 2 to 20 percent; no reduction was observed for PAHs containing greater than 3 aromatic rings. Half-life values in the two soils increased from 2 to 60 days for 2-, 3-, and 4-ring PAHs, and to more than 300 days for 5-ring PAHs. Biodegradation rates can vary widely depending on such soil conditions as oxygen availability (aerobic vs. anaerobic), pH, nutrient level, moisture content, temperature, and the resident microbial community.

PAHs are readily bioconcentrated; however, they also are rapidly metabolized and excreted (Niimi and Palazzo, 1986), such that bioaccumulation is not a long-term situation. The available evidence indicates that clearance rates for most PAHs are rapid, with half-lives of 9 days or less (Niimi and Dookhran, 1989). The dominant transport process for PAHs is associated with sorption to soil particles, suspended particulates, and sediments; once sorbed to soil particles and sediments, transport of PAHs would be limited.

4.4 PHENOLIC COMPOUNDS

Bacteria capable of degrading phenolic compounds have been isolated from soil and water, and a variety of microorganisms--bacteria, yeast, and fungi--have been isolated for their ability to degrade phenol and substituted phenols. The primary phenol at the site is PCP.

PCP is quite stable; it does not decompose when heated at temperatures up to its boiling point for extended periods. Pure PCP is considered to be chemically inert (Bevenue and Beckman, 1967). The chlorinated ring structure tends to impart stability, but the polar hydroxyl group facilitates biological degradation (Renberg, 1974). PCP is not subject to the easy oxidative coupling or electrophilic substitution reactions common to most phenols. Monovalent alkali metal salts of PCP are very soluble in water, but the protonated (phenolic) form is virtually insoluble. Hence, transport of PCP in water depends largely on the pH of the environment.

PCP is volatile enough to be steam distilled. Relative to other chlorinated organic compounds with low vapor pressures, volatility may cause significant losses of PCP from soils (Briggs, 1975). Even though PCP's vapor pressure is low, a finite amount will vaporize.

In the aquatic environment, PCP may be present in a dissolved form, associated with suspended matter or bottom sediments, or absorbed by organisms. Metal salts of the compound have a much greater water solubility and therefore would exist primarily in the dissolved form. The tendency of PCP to ionize depends on the pH of the system. It is nonionized in aqueous solutions with a pH less than 5. There is limited evidence of microbiological degradation of PCP in aquatic environments. Photodecomposition and volatilization from water also may occur.

In the soil, PCP is affected by many complex factors; many details of its behavior are unknown or have not been verified (Bevenue and Beckman, 1967). Hilton and Yuen (1963) reported relatively high adsorption of PCP in agricultural soils of Hawaii. Choi and Aomine (1974) studied adsorption of PCP in 13 soil samples which had various clay mineral species, organic matter content, and pH. Seven different concentrations of PCP, ranging from 12.5 to 500 milligrams per liter (mg/L), were studied. They concluded that adsorption behavior depends primarily on the pH of the system; the more acidic the soil is, the more complete the adsorption of PCP. Organic matter content of the soil is important to adsorption of PCP at all pH values. At different pH values, comparisons of untreated soil and soil oxidized with hydrogen peroxide (H_20_2) to remove organic matter showed that humus-containing soil always adsorbed more PCP than H_2O_2-treated soil. Adsorption of PCP by humus is important when the concentration of PCP is low. At higher concentrations of PCP, the inorganic fractions become more important.

5.0 HAZARD CHARACTERIZATION

The risk associated with exposure to any constituent is a function of the inherent toxicity (hazard) and the exposure dose. Two general categories of toxic effects (carcinogenic and non-carcinogenic) and toxicity values (reference doses [RfDs] and cancer slope factors [CSFs]) used to calculate risk estimates are discussed in this section.

5.1 CARCINOGENIC EFFECTS

Identification of constituents which are regulated as carcinogens is based on a USEPA classification scheme in which chemicals are systematically evaluated for their ability to cause cancer in mammalian species. This classification scheme contains six categories based on the weight of available evidence: A (human carcinogen), B1 (probably human carcinogen -- limited evidence in humans), B2 (probable human carcinogen -- sufficient evidence in animals and inadequate data in humans), C (possible human carcinogen -- limited evidence in animals), D (inadequate evidence to classify), and E (no evidence of carcinogenicity). Categories A, B1, B2, and C are included in this assessment as potential human carcinogens. The USEPA uses a linearized multistage model to derive a 95 percent upperbound estimate of cancer incidence at a given dose. The slope of the extrapolated dose-response curve, called the CSF, is used to calculate the probability of cancer associated with the exposure dose.

5.2 NON-CARCINOGENIC EFFECTS

A finite dose (threshold), below which adverse effects will not occur, is believed to exist for non-carcinogenic chemicals. A single compound might elicit several adverse effects depending on the dose, the route, and the duration of exposure. For a given chemical, the dose which elicits no effect when evaluating the most sensitive response (the no observed effect level [NOEL]) in the most sensitive species is used to establish a reference dose (RfD) for non-carcinogenic effects. The RfD is defined as "an estimate" (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including

sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a "lifetime" (USEPA, 1989a). Typically the NOEL is divided by uncertainty factors of 10 to 10,000, depending on the type and quality of the study, to derive the RfD. RfDs are established by USEPA for subchronic exposure (2 weeks to 7 years) and chronic exposure (>7 years) and route of exposure (ingestion and inhalation) and are reported in milligrams per kilogram per day (mg/kg/day). Reference concentrations (RfCs), reported in milligrams per cubic meter (mg/m^3), also may be used to assess inhalation exposure.

5.3 TOXICITY VALUES

In general, CSFs, cancer classifications, and RFDs for oral and inhalation exposures are taken from USEPA's Integrated Risk Information System (IRIS, 1993) or the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1992a). RfDs and CSFs used in this report are listed in Tables 5-1 and 5-2, respectively. Brief toxicity summaries are provided in Table 5-3.

Whenever possible, route-specific toxicity values are used to assess risk. However, RfDs and CSFs have not been developed for dermal exposure. Therefore, oral RfDs are adjusted, as recommended by the USEPA (1989a), by multiplying by the oral absorption efficiency to assess dermal exposure. CSFs are adjusted by dividing by the oral absorption efficiency. The rationale for these adjustments is as follows: most toxicity values are based on administered doses and dermal exposures are calculated as absorbed doses. Therefore, the toxicity value is adjusted to an absorbed dose value prior to evaluating dermal exposures. Constituent-specific dermal and oral absorption efficiencies are shown in Table 5-4. The adjusted toxicity values used to assess dermal exposure are shown in Table 5-5. It is noted that oral CSFs for carcinogenic PAHs were not adjusted for dermal exposure. Carcinogenic PAHs have been associated with skin cancer through a local effect. Therefore, it is inappropriate to use the oral CSF for constituents that cause skin cancer through a local rather than a systemic effect (USEPA, 1989a).

Toxicity values are not available for several PAHs. The RfD for pyrene was used as a surrogate for non-carcinogenic PAHs not having RfDs (acenaphthylene, benzo[g,h,i]perylene, carbazole, 1-methylnaphthalene, 2-methylnaphthalene, and phenanthrene) and dibenzofuran. Benzo(a)pyrene is the only carcinogenic PAH (cPAH) with CSFs. USEPA Region IV has developed a toxicity equivalency factor (TEF) scheme based on structure activity relationships and the toxicity literature to convert all cPAHs to benzo(a)pyrene equivalents (USEPA, 1992b). This TEF approach is used in this report, and benzo(a)pyrene equivalents are shown in Table 5-6.

Isomers of tetrachlorophenols and trichlorophenol were not specified in the data summary. Therefore, 2,3,4,6-tetrachlorophenol was used to represent tetrachlorophenols, and two isomers of trichlorophenol (2,4,5-trichlorophenol and 2,4,6-trichlorophenol) were chosen to represent trichlorophenols. An RfD is available for 2,4,5-trichlorophenol, and CSFs are available for 2,4,6-trichlorophenol.

6.0 EXPOSURE CHARACTERIZATION

This section addresses the potential for on-site exposure to constituents released from the landfarm area during construction activities. Exposure occurs only when a potential receptor comes in contact with constituents released to the environment. In the absence of exposure, there is no risk or hazard; therefore, exposure assessment is one of the key components of risk assessment.

6.1 RELEASE SOURCE ANALYSIS

As a result of past operations as a wood-treating facility, PCP, PAHs, and CCAs were released to site soils. In accordance with an Administrative Order on Consent with the State of North Carolina, signed on May 20, 1985, SWP constructed and operated a landfarm to remediate soils containing PCP and various PAHs associated with creosote. Details of the landfarm operation are provided in Section 4.1. The available data indicate that biodegradation of PCP and PAHs has occurred; however, residual levels of PAHs and PCP remain in the landfarm soil. Leaching from the landfarm area has not occurred, as evidenced by ground-water and subsurface soil analyses. Soil berms control run-on and runoff; therefore, release of constituents from the landfarm to surface water is not known or believed to have occurred. Past fugitive dust emissions during tilling and landfarm maintenance activities may have resulted in minimal off-site transport of COCs. Vegetation currently limits dust emissions. Future dust emissions will be eliminated completely by fill and pavement.

6.2 EXPOSURE PATHWAYS AND RECEPTORS

Potential exposure pathways considered in this report include incidental soil ingestion, dermal (skin) contact with soil, and inhalation of dust on site during future construction activities.

It is assumed that future land use will remain industrial/commercial. A potential use for the site is as a loading dock and storage area for containerized cargo by the State Ports Authority. It is assumed that the site will be covered with fill and/or paved with concrete. Construction of buildings over the landfarm, paving, or additional soil cover should eliminate exposure. However, exposure could occur during a short-term construction period required to develop the property or from future excavations through the fill into the landfarm soils to install utility lines or building foundations. Therefore, this report evaluates exposure of a future site worker during construction and/or excavation within the landfarm area.

6.3 EXPOSURE POINT CONCENTRATIONS (EPCs)

Soil EPCs were selected as the lower of the UCL or maximum concentration from Table 3-2. EPCs for cPAHS (benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, and indeno[1,2,3-c,d]pyrene) were multiplied by TEFs to derive benzo(a)pyrene-equivalent EPCs (Table 5-6). Current PAH concentrations were assumed to be representative of future concentrations.

Inhalation exposure was based on fugitive dust emissions from the site, and assumed constituent concentrations in airborne dusts were equal to concentrations in the landfarm soils. Dust emissions were calculated using a model developed by Cowherd et al. (1985). This model assumes that the soil is characterized by bare surfaces of finely divided material with an unlimited reservoir of erodible particles. This model was selected by USEPA (1991b) to calculate risk-based preliminary soil remediation goals (Appendix A). Default parameters (as listed in USEPA, 1991b) were used with the following exceptions: the width of the contaminated area perpendicular to the prevailing wind direction (northeast) was estimated at about 220 meters (m), and the total landfarm area was estimated at about 22,300 m^2. A particulate emission factor of 2.0×10^9 m^3/kg was calculated (Appendix A, Table A-1).

6.4 EXPOSURE DOSE CALCULATIONS

Average daily intakes (ADIs) for non-carcinogenic effects and lifetime average daily intakes (LADIs) for carcinogenic effects were calculated using standard assumptions, risk assessment guidance, site data, and professional judgment. The primary receptor identified was a future site construction worker. Standard USEPA exposure assumptions (USEPA, 1991a; 1989a) considered for use in this report are listed in Table 6-1 and are discussed below. The exposure dose equations and sample calculations for oral, dermal, and inhalation exposures are shown in Tables 6-2, 6-3, and 6-4, respectively.

Future site workers involved with site construction/excavation were selected to represent the reasonably maximally exposed individuals. During construction, workers may be exposed to soil via ingestion, inhalation of dust generated from affected soil, and dermal contact. It was assumed that the construction period would last for 13 weeks (approximately 3 months) and that workers would be on the job 6 days per week and 8 hours per day. Standard USEPA factors for soil ingestion, dermal contact, and inhalation rates for construction workers were used (USEPA, 1991a). The ADIs and LADIs (assuming constant COC concentrations) from ingestion, dermal contact, and inhalation of dust are shown in Tables 6-5, 6-6, and 6-7, respectively.

7.0 RISK CHARACTERIZATION

This section discusses potential risk to future site workers involved in construction/excavation activities at the landfarms. A distinction is made between carcinogenic and non-carcinogenic effects, and two general criteria are used to describe risk: excess lifetime cancer risk (ELCR) (for Class A, B, or C carcinogens) and the hazard quotient (HQ) for non-carcinogenic effects. This section presents the results of the quantitative human risk estimates and provides a qualitative discussion of potential risk to the environment.

The ELCR is an estimate of the increased risk, or probability, of developing cancer, and is an indication of the increased risk which may result from site worker exposure to constituents in landfarm soil. The ELCR is an upperbound estimate; therefore, it is likely that the true risk is less than that predicted by the model. Current regulatory methodology assumes that ELCRs can be summed across routes and media of exposure and COCs to derive a "Total Site Risk" (USEPA, 1989a). ELCRs in the target range of 10^{-4} to 10^{-6} generally do not require remediation (USEPA, 1991c).

The HQ is the ratio of the estimated exposure dose and the RfD. If the HQ exceeds 1, there may be concern for potential non-carcinogenic effects. However, the HQ does not provide the probability of an adverse effect as does the ELCR. An HQ greater than 1 indicates that the estimated exposure dose for that constituent exceeds the RfD, but it does not necessarily imply that adverse health effects will occur because RfDs typically are set an order of magnitude or more below the NOEL as discussed in Section 5. Furthermore, the level of concern does not increase linearly with increasing HQs because RfDs have different levels of confidence, are based on different toxic effects, and do not consider the slope of the dose-response curve. HQs are summed to derive the hazard index (HI). Current regulatory methodology (USEPA, 1989a) advises summing HIs across exposure routes for all media to derive a "Total Site HI." However, if the HI exceeds 1, constituents may be grouped according to critical toxic effects, and HIs may be calculated separately for each effect.

7.1 SITE WORKER

Risks estimates for a future site construction worker are provided in Tables 6-5, 6-6, and 6-7 for ingestion, dermal contact, and inhalation exposures, respectively. ELCRs were calculated to be 6×10^{-6} (ingestion), 2×10^{-7} (dermal contact), and 1×10^{-9} (inhalation). Benzo(a)pyrene was responsible for more than half of the ELCR. Benzo(a)anthracene, benzo(b)- and benzo(k)fluoranthene, dibenzo(a,h)anthracene, and arsenic accounted for about a third of the ELCR. HIs were calculated to be 0.4 (ingestion) and 0.1 (dermal). An HI could not be calculated for the inhalation pathway because appropriate toxicity values were not available; however, the HI from the inhalation pathway is expected to be insignificant compared to the other exposure routes based on the low ADIs. All risk values were within or below the regulatory target values.

Total site risks are shown in Table 7-1. The total ELCR and HI for a hypothetical future site worker (obtained by adding risk from each exposure route) are 6×10^{-6} and 0.5. Ingestion was the predominant exposure route.

These estimates are conservative because of the assumed high frequency of contact with affected soil. Actual exposures may be controlled by site safety plans during construction and deed restrictions following initial construction. Nevertheless, the risk calculations indicate that risks to construction workers are within acceptable regulatory ranges.

7.2 ECOLOGICAL ASSESSMENT

The objective of this ecological assessment is to determine if constituents detected at the site have the potential to adversely affect the ecosystems at and/or surrounding the site. Currently, the USEPA has no guidance for quantifying potential impacts to ecological receptors but has developed a qualitative approach generally used for ecological evaluation (USEPA, 1989b). The qualitative approach recommends the comparison of ambient environmental media concentrations to relevant criteria (e.g., water-quality criteria) to determine if any of the

constituents that ecological receptors may potentially contact exceed these criteria. COCs were detected only in soil samples at the site. Currently, there are no established state or federal soil quality criteria for the protection of terrestrial organisms. Therefore, this section discusses some general concepts of environmental toxicology, provides a brief description of the ecological community, and assesses potential impacts from available toxicity data and likelihood of exposure. This discussion is applicable for current conditions at the site. Future development of the property also will prevent exposure of environmental receptors to constituents in the landfarm soil.

7.2.1 General Concepts

Environmental toxicology or ecotoxicology combines the sciences of ecology and toxicology to study the ecological effects of environmental pollutants. Pollutants are defined as environmental contaminants that occur at high enough concentrations to cause deleterious biological effects (Moriarty, 1988). Toxicology has focused largely on studying the effects of single compounds on individual organisms. In ecotoxicology, this must be extended to include effects of multiple contaminants on the ecosystem. An ecosystem is composed of both abiotic and biological components. The organization of biological components are species, populations, and communities. The abiotic component is called the habitat. A population is composed of individuals of a species that occur within a defined area, and a community is a collection of all populations (plant, animal, bacteria, and fungi) that live in a defined area and interact with one another. In practice, it is not always easy to set the boundaries for populations and communities. The community plus its habitat is an ecosystem (Moriarty, 1988).

The prediction of ecotoxicological effects from chemical constituents released to the environment is complicated. To begin with, ecosystems are not static; the biological components experience constant fluctuations both in population numbers and relative composition. Abiotic factors (temperature, precipitation, nutrient availability, etc.) also are changing constantly. The stability of an ecosystem therefore is determined to a great extent by the ability to respond to "normal" stresses. Unfortunately, the normal or baseline conditions are not well understood or

defined for any ecosystem. Therefore, it is difficult to determine whether changes in ecological parameters are associated with pollutants or merely reflect normal fluctuations.

It is possible that effects on individual organisms or even populations may not affect the ecosystem at all. If a prey species is affected, predators may be able to shift to feeding on other species; losses of predators may be compensated for by other predators or by immigration of another predator population. Recognizing when an adverse effect has occurred, or is occurring, is difficult. Unless there is a mass killing within a population or community, effects may go unnoticed. Sublethal effects such as behavioral changes, reduced reproductive success, enzyme level changes, effects on microorganisms, etc., likely will have more of an ecological impact than lethal effects. When effects are measured, it may be difficult to determine the cause.

Predictive abilities also are limited by the amount of available data relevant to environmental conditions. Most of the toxicological database is derived from carefully controlled studies of single compounds on inbred populations of laboratory animals. This is in sharp contrast to environmental exposures, which generally involve multiple contaminants interacting within a complex ecosystem. Furthermore, metabolites and degradation products of contaminants may be of more toxicological significance than the parent compounds. The distribution of environmental contaminants is not uniform, and although there are numerous data on occurrence of contaminants in biological tissues, there are few data on rates of absorption, metabolism, and excretion; therefore, dose estimations are difficult.

To summarize, although the effects of contaminants on populations of organisms are a concern (some perhaps more than others), it is difficult to predict if observed effects on individual populations will result in any real damage to the ecosystem. The science of ecotoxicology is in its infancy and the ability to predict ecological effects is rudimentary at best. Populations are dynamic; therefore, baseline knowledge of the normal range of variability needs to be improved. Sublethal effects, which may be very important to overall ecosystem health, are very difficult to detect. Contaminants at low concentrations may not kill organisms directly but may greatly diminish their ability to survive and reproduce. Finally, it is important to

remember that chemical contamination is not the only way humans impact ecosystems. Habitat destruction from development, agriculture, recreation, forestry, etc., is likely the major way humans exert ecological impacts (Moriarty, 1988).

It is extremely difficult to predict ecological effects of a single chemical released to the environment, let alone multiple chemicals such as detected at the SWP landfarm site. The following discussion will present and evaluate the results obtained from sampling of the ground water and soil at the landfarm site and evaluate the potential for environmental effects.

7.2.2 Community Description

The former SWP site was an active industrial facility for more than 60 years. Prior to initial development, during World War I, the site was a coastal forest. Forest and a small swamp currently border the site to the south. Drainage canals along the northern and western borders also indicate that the property was at least partially a wetland prior to development. Loblolly pine (*Pinus taeda*), oaks (*Quercus* sp.), sycamore (*Platanus occidentalis*), hickory (*Carya* sp.), maple (*Acer* sp.), sweet gum (*Liquidambar styraciflua*), and bald cypress (*Taxodium distichum*) were the primary canopy species; red bay (*Persea borbonia*), wax myrtle (*Murica cerifera*), and holly (*Ilex* sp.) were the primary understory species observed.

The Cape Fear River borders the site to the west. A petroleum tank farm is immediately north, and residential/commercial/recreational areas are east of the site. The landfarm areas cover approximately 5 acres in the northwestern corner of the facility. After the facility was closed, native grasses, shrubs, and herbaceous plants have grown on much of the land which was previously used as a log/lumber stockpile. While landfarms were active, vegetation was limited to the bermed sections between the tilled areas of the landfarm. Vegetation has now grown over the landfill areas.

Wildlife have free access to the site. Herons (*Ardeidae*), sea gulls (*Laridae*), doves (*Columbidae*), fish crows (*Corvus ossifraquis*), warblers (*Parulidae*), sparrows (*Fringillidae*),

and finches (*Fringillidae*) were observed during a brief site visit. Evidence of small mammals such as marsh rabbits (*Sylvilaque palustris*), field mice (*Peromyscus* sp.), and moles (*Talpidae*) also were observed. The adjacent Cape Fear River supports a diverse aquatic community; however, berms surrounding the landfarm areas restrict runoff from the site and hence exposure. No critical habitats of endangered species have been identified in the area.

The North Carolina Heritage Program was requested to search its database for the occurrence of rare species and communities in the vicinity of the site (Appendix B). The Heritage Program identified one priority natural area, Brunswick River-Cape Fear Marshes, northwest of the site. This area is significant for its extensive tidal freshwater marshes and for the habitat it provides to fish and other species. The Brunswick River-Cape Fear Marshes area is approximately 0.6 mile from the site. The Cape Fear River lies between the site and this area.

The Heritage Program also identified records of several rare species within approximately 1 mile of the site. These species include: the state significantly rare cypress knee sedge (*Carex decomposita*); the state threatened Carolina grasswort (*Liliaeopsis carolinensis*); the state candidate Carolina bishopweed (*Ptiliumnium* sp.); the state and federal threatened American alligator (*Alligator mississippiensis*); the state and federal endangered shortnose sturgeon (*Acipenser brevirostrum*); the state special concern species least killfish (*Heterandria formosa*); the state endangered barrel floater (*Anodonta couperiana*); the state endanged magnificent ramshorn (*Planorbella magnifica*); and the extirpated Greenfield ramshorn snail (*Helisoma eucosmium*). The Heritage Program indicated that some of these species have not been seen in the area in recent years; however, they did not indicate which species.

An expanded list of rare species potentially occurring within the Wilmington area was included by the Heritage Program (Appendix B). These species include: the state and federal endangered shortnose sturgeon and red cockaded woodpecker (*Picoides borealis*); the state endangered barrel floater and magnificent ramshorn; the state threatened American alligator, Carolina grasswort, and snowy orchid (*Platanthera nivea*); the extirpated greenfield ramshorn

snail; significantly rare and/or candidate species least killfish, black-necked stilt (*Himantopus mexicanus*), Eastern coral snake (*micrurus fulvius*), mimic glass lizard (*Ophisaurus mimicus*), Carolina gopher frog (*Rana capito capito*), Brazillian free-tailed bat (*Tadarida brasiliensis*), rare skipper (*Problema bulenta*), cypress knee sedge, swamp lily (*Crinum americanum*), Leconte's flatsedge (*Cyperus lecontei*), venus flytrap (*Dionaea muscipula*), blackfruit spikerush (*Eleocharis melanocarpa*), pondspice (*Litsea aestivalis*), ribbed bishop's-weed (*Ptilimnium costatum*), Carolina bishopweed, feather-bristle beakrush (*Rhynchospora oligantha*), and coastal beakrush (*Rhynchospora pleiantha*).

Based on the habitat preferences of these species, none of these species is expected to inhabit the industrial landfarm site. It is not known whether these species existed in this area prior to industrialization of the property.

7.2.3 Community Effects

Constituent concentrations detected in soil samples collected during the 1990 and 1991 sampling are presented in Table 3-2. PAHs were detected in both sampling rounds. PAHs, phenolics, arsenic, chromium, and copper were identified. PAHs detected at the highest concentrations were anthracene (900 mg/kg), fluoranthene (520 mg/kg), and pyrene (980 mg/kg). PCP, arsenic, chromium, and copper were detected at maximum concentrations of 150 mg/kg, 84 mg/kg, 100 mg/kg, and 150 mg/kg, respectively.

PAHs occur in the terrestrial environment both (1) naturally from forest fires, volcanoes, and synthesis by plants and micro-organisms, and (2) from anthropogenic sources such as the burning of fossil fuels, fuel exhausts, and waste products from industry in localized areas, as in this case. Endogenous soil concentrations range from 1 to 10 micrograms per kilogram (μg/kg) and in plants from 10 to 20 μg/kg (Edwards, 1983), and reported background concentrations of total PAHs in urban soils range from 100 mg/kg to 175 mg/kg (USEPA, 1980).

Eventually, much of the PAHs in the environment reaches the soil either by direct accumulation or following deposition on vegetation. Plants are capable of uptake, translocation, metabolism, and degradation. However, in areas with high concentrations of PAHs, assimilation can exceed metabolism and degradation. This can result in accumulation within plant tissues. PAHs accumulate highest in plant peels and oils. Wang and Meresz (1982) compared the levels of 17 PAHs measured in cultivated soil with levels in tomatoes, beets, and onions. The site soil concentration in their study was 1.1 mg/kg PAHs, of which up to 18 percent of this (0.2 mg/kg dry weight) was measured in plant tissues. Phytotoxic effects of PAHs on germination, growth, and development of plants are not well known; however, the presence of plants along the landfarm berms and within the landfarms indicate that some if not all species can adapt to the current site concentrations.

Microorganisms and animals can metabolize PAHs (Edwards, 1983). In fact, high PAH concentrations in soil can lead to increased populations of microorganisms capable of degrading the PAHs (Edwards, 1983).

PAHs may accumulate in terrestrial animals through the food chain or by ingestion of soil; however, they show little tendency to biomagnify in food chains (Eisler, 1987). Although PAHs may accumulate in plants and animals, most are metabolized rapidly or their levels are regulated by homeostatic mechanisms in higher organisms. Invertebrates, small mammals, or birds living in or foraging at the landfarm areas would be exposed to PAHs. Gile et al. (1982) studied the environmental fate of creosote tar distillate (9 percent acenaphthene and 21 percent phenanthrene and dieldrin) in a terrestrial microcosm. The environment contained soil, rye grass, insects, snails, and earthworms. Two voles were added 54 days after the experiment began for ±20 days. Daily average surficial soil concentrations were 1.19 mg/kg acenaphthene and 0.6 mg/kg phenanthrene; various levels of these compounds were detected in all parts of the system. Levels measured in voles exceeded average soil concentrations, but toxic effects were not reported. However, exposure to creosote apparently reduced cricket predation by voles. The concentrations of PAHs in this study are much lower than those detected at the SWP site.

In soils, phenol and trichlorophenols are expected to biodegrade rapidly; however, this process may be hindered or precluded by the presence of excessively high concentrations of these constituents or lack of nutrients or microorganisms capable of degrading the constituents (Agency for Toxic Substances and Disease Registry [ATSDR], 1988; 1989a). There is evidence that cresols biodegrade in soils; however, information on the biodegradation rate is not available (Howard, 1989). Plants can metabolize phenol rapidly; therefore, exposure to phenol by consumption of plant foods is minimal (ATSDR 1988). Based on bioconcentration factors (BCFs) for cresols (approximately 20 Liters per kilogram [L/kg], phenol (approximately 200 L/kg), and trichlorophenols (approximately 300 L/kg) (Howard, 1989), these compounds are not expected to significantly bioconcentrate in organisms. There is no good information in the literature on the bioconcentration of the COCs by terrestrial life. Although BCFs are determined using aquatic species, they can serve as a general indication of a constituent's potential for bioconcentration in other species.

It is not known if the arsenic, chromium, and copper detected at the site are in forms that are bioavailable to potential receptors. The bioavailability of metals to animals at higher trophic levels generally is determined by transfer from water and food organisms rather than soils (Connell and Miller, 1984).

Arsenic can be relatively toxic to plants; however, its toxicity depends on the concentration of soluble, rather than total, arsenic in soils. Above 2 milligrams of soluble arsenic per kilogram of soil, marked damage to plants is known to occur (Vandecaveye et al., 1936). Arsenic poisoning has been reported in some cattle in pastures contaminated by very high levels of arsenic in soil; however, Eisler (1988) reports that episodes of terrestrial wildlife poisoning by arsenic are infrequent. Concentrations causing death in 50 percent of test animals (LD_{50}s) of 40.4 mg/kg body weight have been reported in wild rabbits and hares following acute oral exposure (National Research Council of Canada [NRCC], 1978). Although arsenic can bioaccumulate in terrestrial species, the available data indicate that biomagnification does not occur (Andren et al., 1988; National Academy of Science [NAS], 1977).

Chromium is moderately to severely toxic to plants depending on its form. Chromates have been found to be the most toxic to plants. It is likely that soluble, hexavalent chromium may be responsible for the toxic effects reported for soil-based plants. Symptoms of chromium toxicity in plants generally appears as chlorosis in young leaves, brownish-red coloration of leaves, wilting of tops, and root injury (Kabata-Pendias and Pendias, 1984) at levels as low as 1.37 mg/kg (Mertz, 1967).

Chromium is considered to be an essential trace element for animals. It is biologically non-toxic to animals as chromium III. Chromium VI may be up to 100 times more toxic to animals. Chromium VI causes toxicity to experimental animals at concentrations of 5 mg/kg in feed; chromium III is toxic at 260 mg/kg in feed (Sax and Lewis, 1989).

Copper tolerance in animals varies widely partly because of differences in dietary levels of other trace elements such as iron, molybdenum, selenium, sulfur, and zinc (NAS, 1980). NAS suggested the following tolerable levels for dietary copper: 25 mg/kg for sheep, 100 mg/kg for cattle, 200 mg/kg for rabbits, 250 mg/kg for swine, 300 mg/kg for turkeys and chickens, and 800 mg/kg for horses (NAS, 1980). Furr et al. (1976) and Dowdy and Larson (1975) conducted studies on plant growth in soils amended with sludge. They reported that soil/sludge copper concentrations of 395 mg/kg and 245 mg/kg had no effect on plant growth and physiology, respectively. However, Kabata-Pendias and Pendias (1992) reported that copper levels in soil as low as 60 mg/kg can be phytotoxic to some plants.

Bioaccumulation of the COCs would be most significant for those COCs which have a moderate to high potential for uptake by plants and animals serving as food sources at the site. Arsenic and copper have a moderate potential for uptake into plants (Kabata-Pendias and Pendias, 1992); however, they are not a biomagnification concern and will not be passed on to higher foodchain organisms.

7.2.4 Ecological Summary

Insects, small mammals, birds, and plants potentially have been exposed to PAHs, phenols, creosols, and inorganics at the site; however, it is not known if toxicity has occurred. Toxic effects, if any, would be limited in scope because of the small size of the site and past maintenance activities. In addition, COCs at the site are unlikely to pose a biomagnification hazard to potential receptors. Therefore, the potential for adverse environmental effects (beyond the impact from past and future development and industrial use) are believed to be minimal.

8.0 UNCERTAINTIES

The risk assessment represents conservative estimates of the potential risks associated with constituents at the wood-treatment plant operated by SWP. However, it is important to recognize that considerable uncertainty is inherent in the risk assessment process. There are three basic components of a risk assessment, each of which contributes uncertainties: monitoring data, exposure scenarios, and toxicity values. These components are discussed below.

This risk assessment is founded on the assumption that the monitoring data adequately describe constituent concentrations at the site. It was assumed that the landfill environment would be relatively homogeneous; therefore, a systematic sampling design (points at each corner and one in the middle) was used. The data indicate that the concentrations were relatively evenly distributed. All PAHs and inorganics were detected in each sample, and maximum concentrations were generally less than an order of magnitude greater than the mean.

Uncertainty associated with analysis of samples can be minimized by using appropriate analytical methods and equipment, documenting chain of custody of samples, and implementing strict laboratory data validation and quality assurance procedures. It is also critical that sample detection limits be lower than the standards or other criteria used to evaluate health risk. The sample quantitation limits were adequate for the risk assessment.

Exposure scenarios also are characterized by uncertainty. Because the specific nature and extent of actual exposures are often unknown, it is necessary to use standard assumptions and professional judgment to construct possible scenarios. The scenario presented in this report represents a conservative approach based on the available information concerning probable future site use and was intended to overestimate actual exposure.

The toxicity values and other toxicologic (health effects) information used in this report are associated with uncertainty but are based on the most recent information available. In some cases, particularly for inhalation exposures, toxicity values were not available. The impact of

missing toxicity values on the risk assessment is probably low because inhalation appears to be the least important exposure route.

The use of surrogate toxicity values to evaluate risk also adds to uncertainty. Benzo(a)pyrene TEFs (USEPA, 1992b) were used to calculate ELCRs for cPAHs, and the RfD for pyrene was used to represent PAHs which did not have an RfD. Potential carcinogenic effects of dermal exposure to PAHs could not be evaluated. However, local skin tumors resulting from PAH exposure require high doses over a long exposure period. Normal hygiene practices should eliminate the risk of skin tumors from exposure to PAHs at the site.

It generally is acknowledged that there also is considerable uncertainty associated with the toxicity of mixtures. For the most part, data about the toxicity of chemical mixtures are unavailable. Rather, toxicity studies generally are performed using a single chemical. Chemicals present in a mixture can interact to yield a new compound, or one of the compounds could interfere with absorption, distribution, metabolism, or excretion of another. Chemicals also may act by the same target organ or can act completely independently. This risk assessment assumes that toxicity is additive; the HIs were summed across constituents. This procedure assumes that the mixture of constituents present at the site have neither synergistic nor antagonistic interactions.

Because of the inherent uncertainty associated with risk assessment, current methods are designed to compensate by using conservative toxicity and exposure estimates. Therefore, the risk estimates in this report likely do not underestimate actual risks for the COCs evaluated but may overestimate risks by an order of magnitude or more.

9.0 FINDINGS AND CONCLUSIONS

A risk assessment was conducted for potential exposure during future site construction and development to landfarm soils at the former SWP site in Wilmington, North Carolina. Potential risks were evaluated by considering direct contact with affected soils (ingestion and dermal contact) and inhalation of fugitive dusts by a site construction worker. Actual future exposure likely will be limited to a short construction period (assumed to be 3 months), following which the landfarm areas will likely be covered by fill and pavement. Total risks were compared to the USEPA (1991c) guidelines of 10^{-4} to 10^{-6} for ELCRs and an HI of 1.0 for non-carcinogenic effects. Findings and conclusions are summarized below:

- Based on data from the available monitoring wells, release of constituents from the landfarmed soils to ground water has not occurred. Run-on/runoff controls at the landfarm presumably prevent release to nearby surface water and sediments. Thus, current or foreseeable future exposure to these media were not identified as pathways of concern associated with landfarming operation.

- The potential exists for exposure (ingestion, dermal contact, and inhalation of fugitive dust) to surficial soils at the site during future construction activities.

- The total ELCR calculated for a future site construction worker was 6×10^{-6} and is within the target risk range of 10^{-4} to 10^{-6}. Potential ingestion of benzo(a)pyrene in soil accounted for most of the risk.

- The total HI was 0.5 and is below the target value of 1.0.

- Ecological impacts of the landfarms are limited by their relatively small size and surrounding development. Invertebrates, small mammals, and birds would have the greatest potential to be exposed to COCs at the site. The potential for

threatened or endangered species to be impacted by the site appears to be remote. Future development will prevent exposure to ecological receptors.

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Ronald H. Levine, M.D., M.P.H.
STATE HEALTH DIRECTOR

DIVISION OF HEALTH SERVICES
EASTERN REGIONAL OFFICE
404 St. Andrews Street
Greenville, N.C. 27834
(919) 756-1343

RECEIVED
AUG 3 1982
SOLID & HAZARDOUS WASTE MANAGEMENT BRANCH

Ref. 16

August 2, 1982

Mr. Ed Gibbs, Environmental Manager
Southern Wood Piedmont
P.O. Box 5447
Spartanburg, SC 29304

file under Wilmington

Dear Mr. Gibbs:

As per our conversation of July 30, 1982 I am enclosing a copy of analyses run on soil samples obtained from the treating track area of your Wilmington, North Carolina facility.

It is apparent from these analyses that the major contamination is found in the upper few inches of soil along the treating track drip area and at greater depths nearer the treating vessels.

Please contact me as soon as you have received your analyses on the split samples in order that they may be compared.

If you have any questions regarding this matter please call me at (919) 799-9078 or contact me by mail at 805 Spring Branch Road, Wilmington, NC 28405.

Very truly yours,

Ray Church
Solid & Hazardous Waste Management Branch
Environmental Health Section

sle

Enclosure

cc: Terry Dover
William Paige

DEPARTMENT OF HUMAN RESOURCES - DIVISION OF HEALTH SERVICES
LABORATORY SECTION
OCCUPATIONAL HEALTH

G C REPORT SHEET

COMPANY: Southern Wood Piedmont

DATE OF ANALYSIS: 5/06/82 - 5/21/82

SAMPLE #	Pentachlorophenol	Napthalene	Acenaphthylene	Anthracene	Pyrene	Chrysene	Benzo(K) Fluoranthene			
					PPM [a]					
1447	3000+	8	300	1000+	1000+	400	500			
1448	ND	100	70	200	81	ND	ND			
1449	2000+	2	16	200	500	120	90			
1450	ND	ND	ND	ND	ND	ND	ND			

Other compounds identified:

1447 Sub. decane, hexadecane, phenathrene, other hydrocarbons.

1448 Methyl napthalene, sub. decane, sub. octane, sub. decane.

1449 sub. hydrocarbons.

1450 ND

[a] Result based on GC/MS autoquantitation program, using EPA mixed standard with d10 Anthracene as internal standard. 0.5 grams of soil analyzed [Sample bias present.]

DHS Form 2123 11-74
Laboratory

STATE LABORATORY OF PUBLIC HEALTH
DIVISION OF HEALTH SERVICES
N.C. DEPARTMENT OF HUMAN RESOURCES
P.O. BOX 28047 - 306 N. WILMINGTON ST., RALEIGH 27611

RECEIVED
MAY 24 1982
SOLID & HAZARDOUS WASTE MANAGEMENT BRANCH

CHEMICAL ANALYSES - SOLID AND HAZARDOUS WASTE

Source: Southern Wood Piedmont
Address: Greenfield St
Wilmington Zip
County: New Hanover
Report To: Wm Paige - Ray Church
Address: Solid & Hazardous Waste
Raleigh Zip
Telephone Number: (919) 733 -2178
Collected By: Ray Church
Date Collected: 4-30-82 Time 12:00 AM PM
Location of Sampling Point: 10'-Track #1 Surface

Remarks: #1 - Surface
10' from treatment vessels

Retain sample for further analysis

Extractable Metals / Total Metals	Results Total	Results Extract.	Results expressed in ppm unless otherwise indicated.	Total	Extractable
Arsenic			Zinc		
Barium			Ignitability		
Cadmium			Corrosivity		
Chloride			Reactivity		
Chromium			Spec. Conductivity		
Color			Chlorinated Hydrocarbons		
Copper			Endrin		
Flammability			Lindane		
Fluoride			Methoxychlor		
Iron			Toxaphene		
Lead			2,4-D		
Manganese			2,4,5-TP		
Mercury			Creosote		
Nitrate			Pentachlorophenol		
pH					
Selenium					
Silver					

Date Received _____ Date Reported 5/21/82 Reported By John Neal

Laboratory Number 04447

STATE LABORATORY OF PUBLIC HEALTH
DIVISION OF HEALTH SERVICES
N.C. DEPARTMENT OF HUMAN RESOURCES
P.O. BOX 28047 – 306 N. WILMINGTON ST., RALEIGH 27611

CHEMICAL ANALYSES – SOLID AND HAZARDOUS WASTE

Source: Southern Wood Piedmont
Address: Greenfield St.
Wilmington Zip
County: New Hanover
Report To: Wm Paige - Ray Chmel
Address: Solid & Hazardous Waste
Raleigh Zip
Telephone Number: (919) 733 -2178
Collected By: Ray Chmel
Date Collected: 4-30-82 Time 2:00 AM PM
Location of Sampling Point: #2 Subsurface 4" deep 10' from vessel

Remarks: #2
Subsurface 14" deep
10' from treatment vessel

Retain sample for further analysis

) Extractable Metals) Total Metals	Results Total	Results Extract.	Results expressed in ppm unless otherwise indicated.	Total	Extractable
Arsenic			Zinc		
Barium			Ignitability		
Cadmium			Corrosivity		
Chloride			Reactivity		
Chromium			Spec. Conductivity		
Color			Chlorinated Hydrocarbons		
Copper			Endrin		
Flammability			Lindane		
Fluoride			Methoxychlor		
Iron			Toxaphene		
Lead			2,4-D		
Manganese			2,4,5-TP		
Mercury			✓ Creosote		
Nitrate			✓ Pentachlorophenol		
pH					
Selenium					
Silver					

Date Received _____ Date Reported 5/21/82 Reported John Neal

Laboratory Number 14448

STATE LABORATORY OF PUBLIC HEALTH
DIVISION OF HEALTH SERVICES
N.C. DEPARTMENT OF HUMAN RESOURCES
P.O. BOX 28047 - 306 N. WILMINGTON ST., RALEIGH 27611

CHEMICAL ANALYSES - SOLID AND HAZARDOUS WASTE

Source: Southern Wood Piedmont
Address: Greenfield St.
Wilmington Zip
County: New Hanover.
Report To: Wm. Paige - Ray Church
Address: Solid & Hazardous Waste
Raleigh Zip
Telephone Number: (919) 733 - 2178
Collected By: Ray Church
Date Collected: 4-30-82 Time 12:00 AM PM
Location of Sampling Point: #3 see above

Remarks: #3 Surface
125' from vessel
Retain sample for further analysis

) Extractable Metals) Total Metals	Results Total	Results Extract.	Results expressed in ppm unless otherwise indicated.	Total	Extractable
Arsenic			Zinc		
Barium			Ignitability		
Cadmium			Corrosivity		
Chloride			Reactivity		
Chromium			Spec. Conductivity		
Color			Chlorinated Hydrocarbons		
Copper			Endrin		
Flammability			Lindane		
Fluoride			Methoxychlor		
Iron			Toxaphene		
Lead			2,4-D		
Manganese			2,4,5-TP		
Mercury			✓ Creosote		
Nitrate			✓ Pentachlorophenol		
pH					
Selenium					
Silver					

Date Received
Date Reported 5/21/82 Reported by John Hearl
Laboratory Number 04449

STATE LABORATORY OF PUBLIC HEALTH
DIVISION OF HEALTH SERVICES
N.C. DEPARTMENT OF HUMAN RESOURCES
P.O. BOX 28047 - 306 N. WILMINGTON ST., RALEIGH 27611

CHEMICAL ANALYSES - SOLID AND HAZARDOUS WASTE

Source: Southern Wood Piedmont
Address: Greenfield St
Zip
County: New Hanover.
Report To: Wm Paige - Ray Church
Address: Solid & Hazardous Waste
Raleigh Zip
Telephone Number: (919) 733 -2178
Collected By: Ray Church
Date Collected: 4-30-82 Time 1230 AM PM
Location of Sampling Point: Truck
see Remarks

Remarks: #4 Subsurface
14" depth 125° from vessel

Retain Sample for further analysis

Extractable Metals / Total Metals	Results Total	Results Extract.	Results expressed in ppm unless otherwise indicated;	Total	Extractable
Arsenic			Zinc		
Barium			Ignitability		
Cadmium			Corrosivity		
Chloride			Reactivity		
Chromium			Spec. Conductivity		
Color			Chlorinated Hydrocarbons		
Copper			Endrin		
Flammability			Lindane		
Fluoride			Methoxychlor		
Iron			Toxaphene		
Lead			2,4-D		
Manganese			2,4,5-TP		
Mercury			✓ Creosote		
Nitrate			Pentachlorophenol		
pH					
Selenium					
Silver					

Date Received
Date Reported 5/21/82 Reported by John Neal
Laboratory Number 01450

P. O. Box 5447
Spartanburg, S. C. 29304

Phone 803/576-7660

Ref. 17

Southern Wood Piedmont Company

11-M-1.10.7

August 20, 1982

Mr. Ray Church
805 Spring Branch Road
Wilmington, North Carolina 28405

Dear Mr. Church:

Enclosed is a copy of the analyses for the four (4) soil samples from the treating tank area of our Wilmington facility. Our analyses closely follow yours.

If you need to discuss this data, please give me a call at 803/576-7660.

Sincerely,

SOUTHERN WOOD PIEDMONT COMPANY

Edward L. Gibbs

Edward L. Gibbs
Environmental Manager

ELG:kwm

cc: Mr. C. A. Burdell (w/o Enc.)

Enclosure

RECEIVED

ENVIRONMENTAL AFFAIRS

TECHNICAL SERVICES, INC.

ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
OFFICE 2471 SWAN ST. — P.O. BOX 52329
LABORATORIES 103-107 STOCKTON STREET
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 46479

August 5, 1982

Sample of SOIL

Date Received May 17, 1982

For SOUTHERN WOOD PIEDMONT COMPANY, P.O. Box 5447, Spartenburg, S. C. 29301 ATTN: Charles Burdell

Marks: Sample No. 1, from Wilmington, N. C.

Storet No.	Parameter	Concentration
	1,3-Dichlorobenzene	
	1,4-Dichlorobenzene	
	1,2-Dichlorobenzene	
34396	Hexachloroethane	
34273	bis(2-Chloroethyl) ether	
34283	bis(2-Chloroisopropyl)ether	
34428	N-Nitrosodi-n-propylamine	
34408	Isophorone	
34447	Nitrobenzene	
39702	Hexachlorobutadiene	
	1,2,4-Trichlorobenzene	
34696	Naphthalene	ND
34278	bis(2-Chloroethoxy) methane	
34386	Hexachlorocyclopentadiene	
	2-Chloronaphthalene	
34200	Acenaphthylene	ND
81533	2,6-Dinitrotoluene	
34205	Acenaphthene	490 PPM
34341	Dimethylphthalate	
34381	Fluorene	ND
	4-Chlorophenyl phenyl ether	
81533	2,4-Dinitrotoluene	
	1,2-Diphenylhydrazine	

Storet No.	Parameter	Concentration
34336	Diethylphthalate	
34433	N-Nitrosodiphenylamine	
39700	Hexachlorobenzene	
77794	4-Bromophenyl phenyl ether	
34461	Phenanthrene	2200 PPM
34220	Anthracene	190
39110	Di-n-butylphthalate	
34376	Fluoranthene	1800
34469	Pyrene	1090
39120	Benzidine	
	Butylbenzylphthalate	
39100	bis-(2-Ethylhexyl) phthalate	
34320	Chrysene	240
34526	Benzo(a)anthracene	ND
34230	Benzo(b)fluoranthene	ND
34242	Benzo(k)fluoranthene	ND
	3.3'-Dichlorobenzidine	
34596	Di-n-octylphthalate	
34247	Benzo(a)pyrene	TRACE <10
34403	Indeno(1,2,3-cd) pyrene	ND
	Dibenzo(a,h) anthracene	380
34521	Benzo(g,h,i)perylene	ND
	Nitrosodimethylamine	

Pentachlorophenol, mg/kg 1300

ND = NOT DETECTED

TECHNICAL SERVICES, INC.

BY Harvey C. Gray, Jr.

EL G

TECHNICAL SERVICES, INC.

ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
OFFICE 2471 SWAN ST. — P.O. BOX 52329
LABORATORIES 103-107 STOCKTON STREET
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 46479 August 5, 1982

Sample of SOIL

Date Received May 17, 1982

For SOUTHERN WOOD PIEDMONT COMPANY, P.O. Box 5447, Spartenburg, S. C. 29301 ATTN: Charles Burdell

Marks: Sample No. 2 from Wilmington, N. C.

CERTIFICATE OF ANALYSIS OR TESTS

Storet No.	Parameter	Concentration
	1,3-Dichlorobenzene	
	1,4-Dichlorobenzene	
	1,2-Dichlorobenzene	
34396	Hexachloroethane	
34273	bis(2-Chloroethyl) ether	
34283	bis(2-Chloroisopropyl)ether	
34428	N-Nitrosodi-n-propylamine	
34408	Isophorone	
34447	Nitrobenzene	
39702	Hexachlorobutadiene	
	1,2,4-Trichlorobenzene	
34696	Naphthalene	ND
34278	bis(2-Chloroethoxy) methane	
34386	Hexachlorocyclopentadiene	
	2-Chloronaphthalene	
34200	Acenaphthylene	ND
81533	2,6-Dinitrotoluene	
34205	Acenaphthene	72 PPM
34341	Dimethylphthalate	
34381	Fluorene	ND
	4-Chlorophenyl phenyl ether	
81533	2,4-Dinitrotoluene	
	1,2-Diphenylhydrazine	

Storet No.	Parameter	Concentration
34336	Diethylphthalate	
34433	N-Nitrosodiphenylamine	
39700	Hexachlorobenzene	
77794	4-Bromophenyl phenyl ether	
34461	Phenanthrene	ND
34220	Anthracene	190 PPM
39110	Di-n-butylphthalate	
34376	Fluoranthene	130
34469	Pyrene	94
39120	Benzidine	
	Butylbenzylphthalate	
39100	bis-(2-Ethylhexyl) phthalate	
34320	Chrysene	< 30
34526	Benzo(a)anthracene	ND
34230	Benzo(b)fluoranthene	ND
34242	Benzo(k)fluoranthene	ND
	3.3'-Dichlorobenzidine	
34596	Di-n-octylphthalate	
34247	Benzo(a)pyrene	ND
34403	Indeno(1,2,3-cd) pyrene	ND
	Dibenzo(a,h) anthracene	ND
34521	Benzo(g,h,i)perylene	ND
	Nitrosodimethylamine	

Pentachlorophenol, mg/ kg 250

ND = NOT DETECTED

TECHNICAL SERVICES, INC.

BY Harvey C. Gray, Jr.

TECHNICAL SERVICES, INC.

ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
OFFICE 2471 SWAN ST. — P.O. BOX 52329
LABORATORIES 103-107 STOCKTON STREET
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 46479

August 5, 1982

Sample of Soil

Date Received May 17, 1982

For Southern Wood Piedmont Company, P.O. Box 5447, Spartenburg, S. C. 29301 ATTN: Charles Burdell

Marks: Sample No. 3 from Wilmington, N. C.

CERTIFICATE OF ANALYSIS OR TESTS

Storet No.	Parameter	Concentration
	1,3-Dichlorobenzene	
	1,4-Dichlorobenzene	
	1,2-Dichlorobenzene	
34396	Hexachloroethane	
34273	bis(2-Chloroethyl) ether	
34283	bis(2-Chloroiso-propyl)ether	
34428	N-Nitrosodi-n-propylamine	
34408	Isophorone	
34447	Nitrobenzene	
39702	Hexachlorobutadiene	
	1,2,4-Trichloro-benzene	
34696	Naphthalene	ND
34278	bis(2-Chloroethoxy) methane	
34386	Hexachlorocyclo-pentadiene	
	2-Chloronaphthalene	
34200	Acenaphthylene	ND
81533	2,6-Dinitrotoluene	
34205	Acenaphthene	50 PPM
34341	Dimethylphthalate	
34381	Fluorene	ND
	4-Chlorophenyl phenyl ether	
81533	2,4-Dinitrotoluene	
	1,2-Diphenylhydra-zine	

Storet No.	Parameter	Concentration
34336	Diethylphthalate	
34433	N-Nitrosodiphenyla-mine	
39700	Hexachlorobenzene	
77794	4-Bromophenyl phenyl ether	
34461	Phenanthrene	100 PPM
34220	Anthracene	<20
39110	Di-n-butylphthalate	
34376	Fluoranthene	970
34469	Pyrene	640
39120	Benzidine	
	Butylbenzylphthalate	
39100	bis-(2-Ethylhexyl) phthalate	
34320	Chrysene	200
34526	Benzo(a)anthracene	ND
34230	Benzo(b)fluoranthene	ND
34242	Benzo(k)fluoranthene	ND
	3.3'-Dichloroben-zidine	
34596	Di-n-octylphthalate	
34247	Benzo(a)pyrene	ND
34403	Indeno(1,2,3-cd) pyrene	ND
	Dibenzo(a,h) anthracene	190
34521	Benzo(g,h,i)perylene	ND
	Nitrosodimethylamine	

ntachlorophenol, mg/kg 1000

ND = NOT DETECTED

TECHNICAL SERVICES, INC.

By Harvey C. Gray, Jr.

TECHNICAL SERVICES, INC.

ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
OFFICE 2471 SWAN ST. — P.O. BOX 52329
LABORATORIES 103-107 STOCKTON STREET
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 46479 August 5, 19 82

Sample of SOIL

Date Received May 17, 1982

For SOUTHERN WOOD PIEDMONT COMPANY, P.O. Box 5447, Spartenburg, S.C.

Marks: Sample No. 4 from Wilmington, N. C.

CERTIFICATE OF ANALYSIS OR TESTS

Storet No.	Parameter	Concentration
	1,3-Dichlorobenzene	
	1,4-Dichlorobenzene	
	1,2-Dichlorobenzene	
34396	Hexachloroethane	
34273	bis(2-Chloroethyl) ether	
34283	bis(2-Chloroisopropyl)ether	
34428	N-Nitrosodi-n-propylamine	
34408	Isophorone	
34447	Nitrobenzene	
39702	Hexachlorobutadiene	
	1,2,4-Trichlorobenzene	
34696	Naphthalene	ND
34278	bis(2-Chloroethoxy) methane	
34386	Hexachlorocyclopentadiene	
	2-Chloronaphthalene	
34200	Acenaphthylene	ND
81533	2,6-Dinitrotoluene	
34205	Acenaphthene	<10 PPM
34341	Dimethylphthalate	
34381	Fluorene	ND
	4-Chlorophenyl phenyl ether	
81533	2,4-Dinitrotoluene	
	1,2-Diphenylhydrazine	

Storet No.	Parameter	Concentration
34336	Diethylphthalate	
34433	N-Nitrosodiphenylamine	
39700	Hexachlorobenzene	
77794	4-Bromophenyl phenyl ether	
34461	Phenanthrene	ND
34220	Anthracene	17 PPM
39110	Di-n-butylphthalate	
34376	Fluoranthene	28
34469	Pyrene	21
39120	Benzidine	
	Butylbenzylphthalate	
39100	bis-(2-Ethylhexyl) phthalate	
34320	Chrysene	11
34526	Benzo(a)anthracene	ND
34230	Benzo(b)fluoranthene	ND
34242	Benzo(k)fluoranthene	ND
	3.3'-Dichlorobenzidine	
34596	Di-n-octylphthalate	
34247	Benzo(a)pyrene	14
34403	Indeno(1,2,3-cd) pyrene	ND
	Dibenzo(a,h) anthracene	ND
34521	Benzo(g,h,i)perylene	ND
	Nitrosodimethylamine	

Pentachlorophenol, mg/kg ND

ND = NOT DETECTED

TECHNICAL SERVICES, INC.

BY Harvey C. Gray, Jr.

Ref. 18

NORTH CAROLINA STATE PORTS AUTHORITY
2202 BURNETT BLVD.
P. O. BOX 9002

TEL: 919/763-1621
FAX: 919/763-6440
TELEX: 510-937-0351

TELECOPIER COVER LETTER

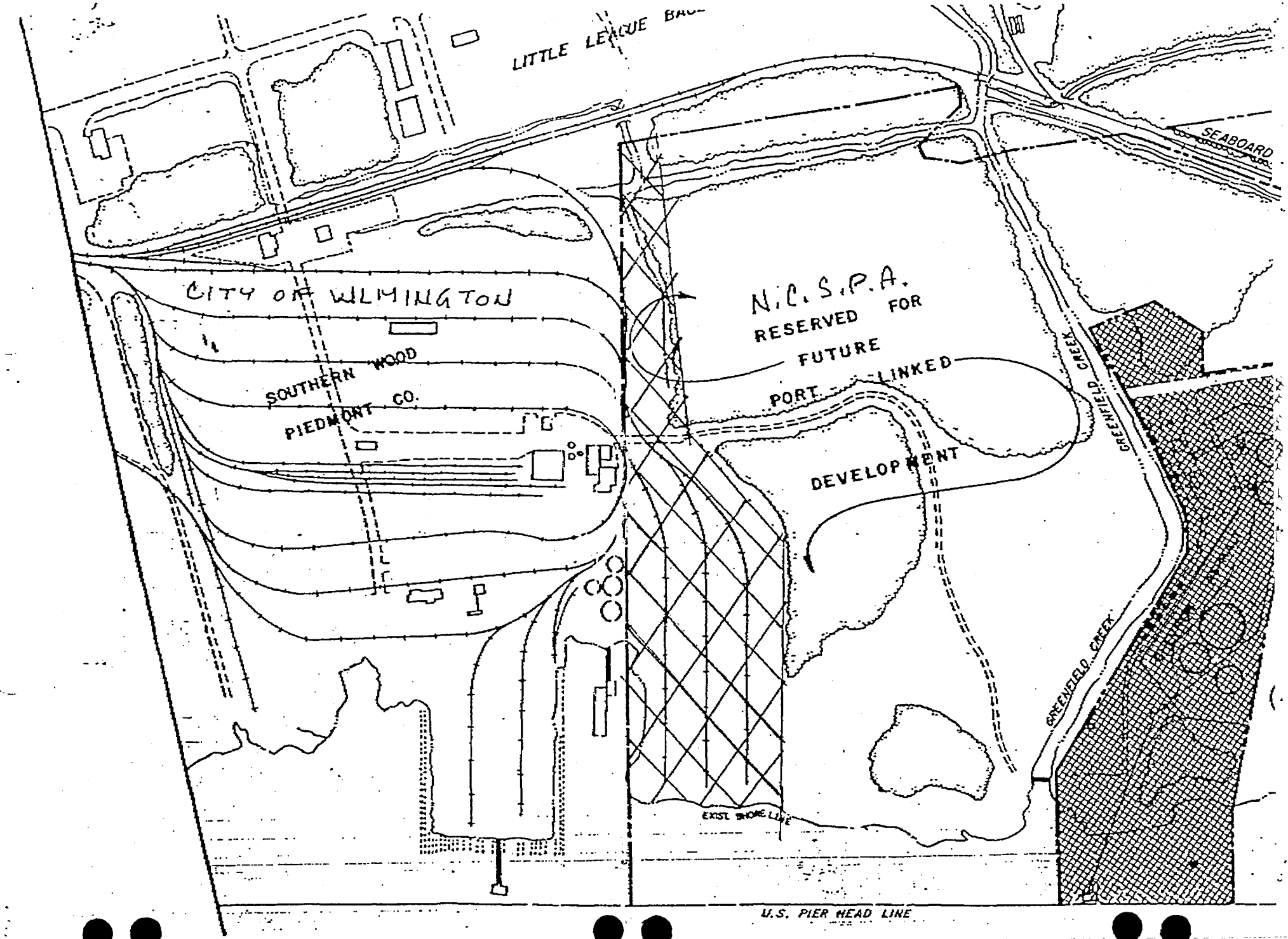
DATE: 3-14-90

PLEASE DELIVER THE FOLLOWING TO:

NAME: Pat DeRosa
COMPANY: Super Fund
FROM: Bonnie Allritton
NC State Ports

WE ARE TRANSMITTING 2 PAGE(S), INCLUDING THIS COVER LETTER.
IF YOU DO NOT RECEIVE ALL PAGES, PLEASE CALL BACK AS SOON AS POSSIBLE.

Attached shows Southern Wood Piedmont (City of Wilmington) and South of that property is the Ports property that was leased to Southern Wood Piedmont. It is identified by large hatching and shows the three rail spurs. Hopefully this will help you identify our concern.


LITTLE LEAGUE BAS
SEABOARD
CITY OF WILMINGTON
SOUTHERN WOOD
PIEDMONT CO.
N.C.S.P.A.
RESERVED FOR
FUTURE
PORT LINKED
DEVELOPMENT
GREENFIELD CREEK
GREENFIELD CREEK
EXIST SHORE LINE
U.S. PIER HEAD LINE

P.O. Box 5447
Spartanburg, S.C. 29304
Phone: (803) 599-1070
FAX: (803) 599-1087

Ref. 19

17

Southern Wood Piedmont Company

January 3, 1994

North Carolina Dept. of Environment, Health &
Natural Resources
Division of Solid Waste Management
401 Oberlin Road
Raleigh, NC 27605

JAN 1994

Attn: Doug Holyfield

Re: Completion Letter
Southern Wood Piedmont Company
Administrative Order # NCD 058517467
Wilmington, NC

Dear Mr. Holyfield:

Southern Wood Piedmont Company is submitting this letter to provide notice that we have fully completed all actions agreed to by the Department and Southern Wood Piedmont Company contained within the above referenced Administrative Order. Paragraph 9, found on page 5, indicates that "land treatment shall continue until residual concentrations are determined not to have a significant impact on the public health and the environment." You will find enclosed, a report entitled "Risk Assessment Report for Land Farmed Areas, Southern Wood Piedmont Company, Wilmington, N. C." This report has been prepared and submitted to provide the Department with an analyses of Risk that will indicate that we have fully met the letter of the Administrative Order. SWP believes that we have treated the soils to a level that is "Protective of Human Health and the Environment."

To provide further information on the landfarming operation and other points contained within the Administrative Order, the following discussion is provided:

LAND FARMING:

Southern Wood Piedmont Company (SWP) excavated and treated in the approved landfarms, discolored soils from the following areas of the closed plant site.

- Superfund Area I
- Superfund Area III
- Superfund Area IV
- Track Area
- Oil Treating Areas
- Large Storage Tank Containment Area
- Diesel Fueling Area

The Wilmington land farming (LF) project was started in June 1984 after 16 months of negotiations with the State of North Carolina. The Compliance Order provided that the ongoing LF remedial action would be continued as modified in the Administrative Order of Consent. The final signed document was received May 22, 1985 (attached). As noted above, residual soils from the cylinder track, treating tank, storage tank and the old drainage ditch area were land treated as approved. The entire plant, after removal and cleaning of any solid materials, was tilled several times to encourage biological activity. The LF was set up on about 5 acres of the former treated pole storage area. The normal bacteria and fungus present in the soil was given food (preservatives in soil), air, sun, water and fertilizer to breakdown the preservatives to their basic component of carbon, hydrogen, oxygen and chlorine. Confirmation of this has been made with soil and water analysis of polyneculararomatics (creosote) and chlorinated hydrocarbon (penta), (see enclosures for data).

1) Landfarms were located on a 5 acre site of the treated pole storage in the northwest corner of the plant. All rail track within the area was removed. The area was cleaned of solid residuals and divided into two sections (river area about 3 acres and office area about 2 acres).

2) The perimeter of the entire area was ditched and bermed to prevent run off and on of rainwater.

3) Shallow wells (MW-6, MW-7, MW-8, MW-9) were installed. The three monitoring wells downgradient and the one upgradient were installed to monitor ground-water quality.

4) Fertilizer was spread to bring the carbon-nitrogen ratio to 20:1. Lime was spread to adjust the soil pH to about 6.5.

5) Contaminated soil was added to maxing depth of 2" or 5% max. creosote content, whichever is the lesser. Two inches of soil on an acre is 7260 cu. ft. or 269 cu. yds. This gives the LF area a capacity of about 1300 cubic yards. A standard farm manure spreader without the distributor disc was purchased to apply the contaminated soil. The discharge gate on the spreader is adjustable for uniform depth application. A multidisc harrow for tilling was pulled by a medium powered farm tractor.

6) An irrigation system was installed to provide a means for controlling soil moisture.

Plant personnel operated the LF mainly installing the irrigation system, tilling and sampling soil and groundwater. Soil samples were collected approximately at two months intervals, or right after a new soil application. Monitoring wells were sampled regularly. Temperature and rain data was recorded. River samples at four locations were taken twice a year. Mississippi State University analyzed the soil for nutrients, bacteria and PNA, and penta concentrations every two months. Savannah Labs analyzed water samples for PNA, penta and sometimes metals.

Two documents are enclosed which will outline the data from a historical perspective. As you are well aware, SWP regularly submitted reports to Mr. William Paige of your staff outlining progress, current conditions and analytical data. Graphic presentations were also included which indicated breakdown of contaminants and ranges of constituent loading.

RIVER SAMPLING:

SWP also submitted data from semi-annual river samples and the four monitoring wells (shallow) surrounding the landfarms. Both the river samples and data from the shallow wells indicate no detectable levels of wood treating constituents.

CCA AREAS:

You will also find two memos which outline how the CCA contaminated soils were handled. On October 9, 1985, SWP provided William Paige with the scenario to be followed. Soils greater than 5.0 ppm arsenic will be excavated and disposed of off-site, at an approved disposal facility. This was accomplished. Soils with arsenic levels with levels of between .5 ppm and 5.0 ppm will be mixed with concrete and placed on site. This was accomplished with the use of a concrete mixer. A November 27, 1985 memo, addressed to you, outlined the grid system. These figures (figures attached), outline results of sampling and how each area was handled.

It is the belief of SWP that all terms and conditions of the Consent Order have now been met. As discussed, I will be happy to meet with you and your staff should you have any further questions. You may reach me at the address above or call me at (803) 599-1075 at your convenience.

Sincerely,

T. M. Davis
Manager, Environmental Affairs

6805bw

CC: T. H. Brannon
M. D. Pruett
J. L. Shroads
W. P. Arrants
H. O. Phillips w/enclosures
Glenn Dunn - Poyner & Spruill w/enclosures
Bonnie Albritton - NC Ports Authority w/enclosures
Thomas Pollard - City Attorney, Wilmington w/enclosures

P. O. Box 5447
Spartanburg, S. C. 29304

Phone 803/576-7660

Southern Wood Piedmont Company

(9)

November 27, 1985

Mr. R. Douglas Holyfield
Division of Health Services
Solid & Hazardous Waste Management Branch
P. O. Box 4484
Wilmington, NC 28406

Dear Doug,

Enclosed you will find a copy of the grid system used to determine the areas for soil removal and encapsulation at Southern Wood Piedmont's (SWP) Wilmington site.

I trust this is sufficient, however, if there are any questions, please do not hesitate to call.

Sincerely,
Southern Wood Piedmont

Doug

Douglas E. Latham, P.E.
Assistant Environmental Manager

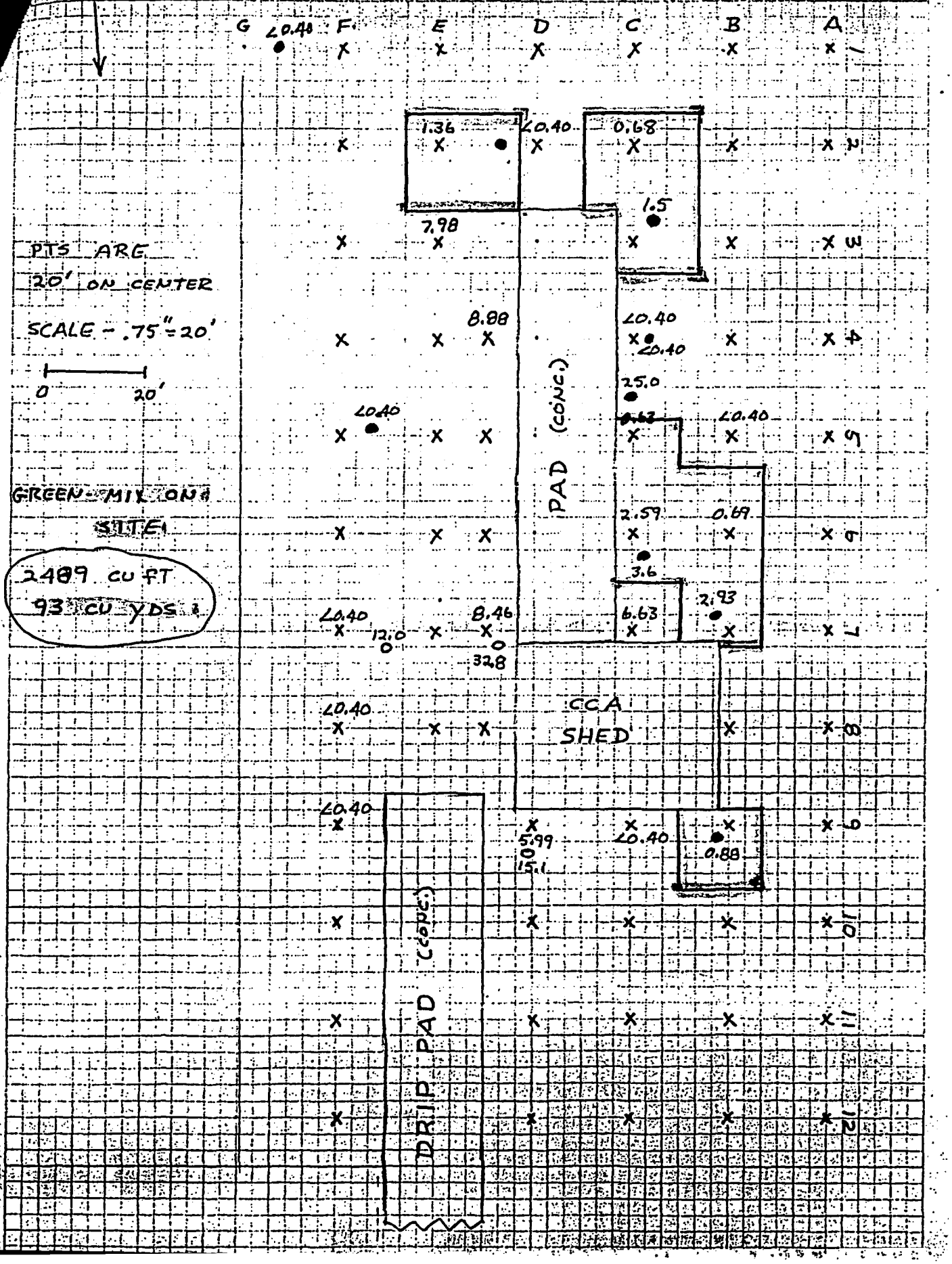
2173T/ms

cc: T. M. Davis - Baldwin
H. O. Phillips - Wilmington

SUBJECT WILMINGTON, N.C. BY DATE

0-3" ARSENIC CONCENTRATIONS SHEET NO. of

PROJECT NO. G.P. EXTRACTIONS



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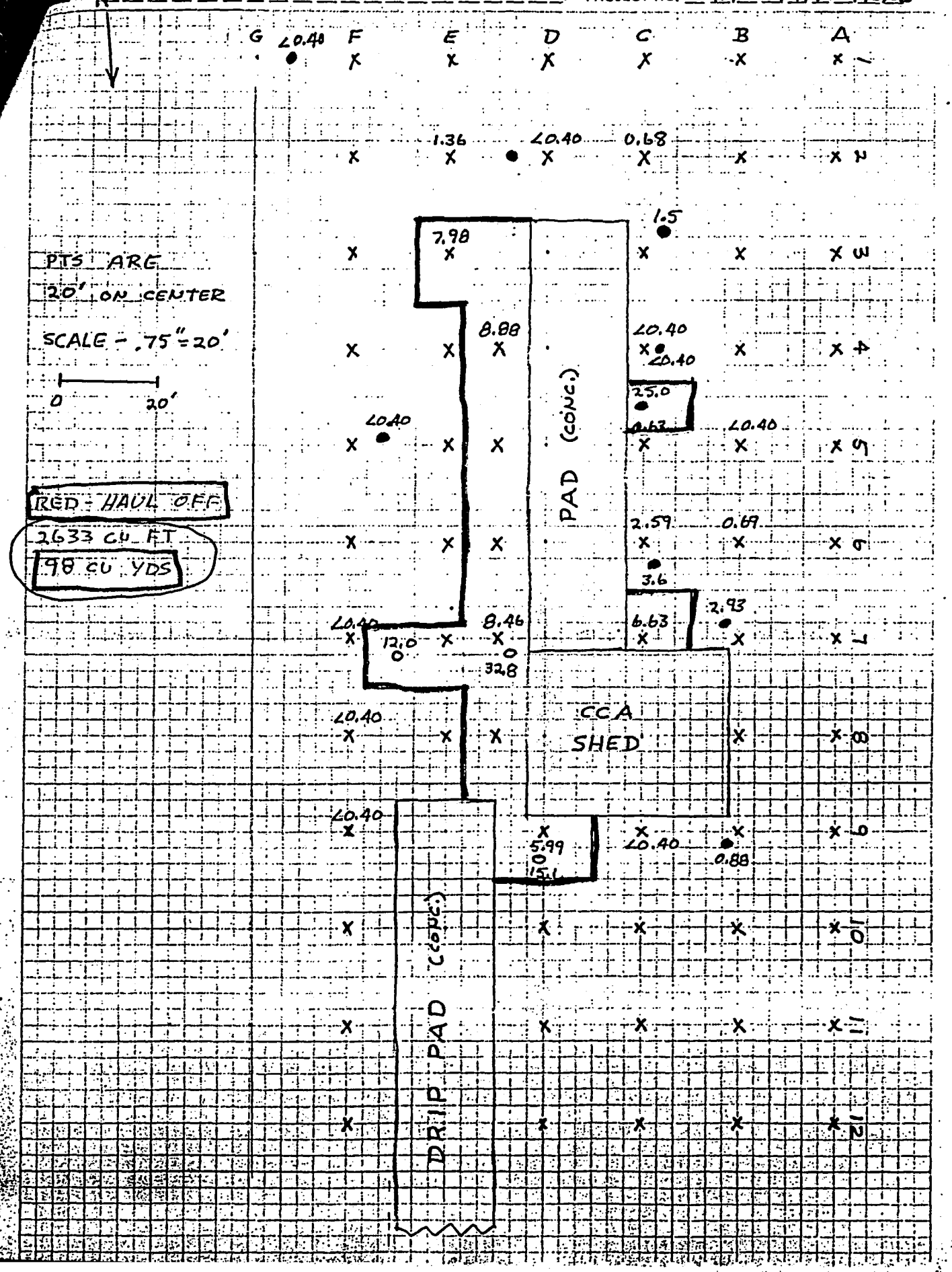

SUBJECT WILMINGTON, N.C. BY DATE
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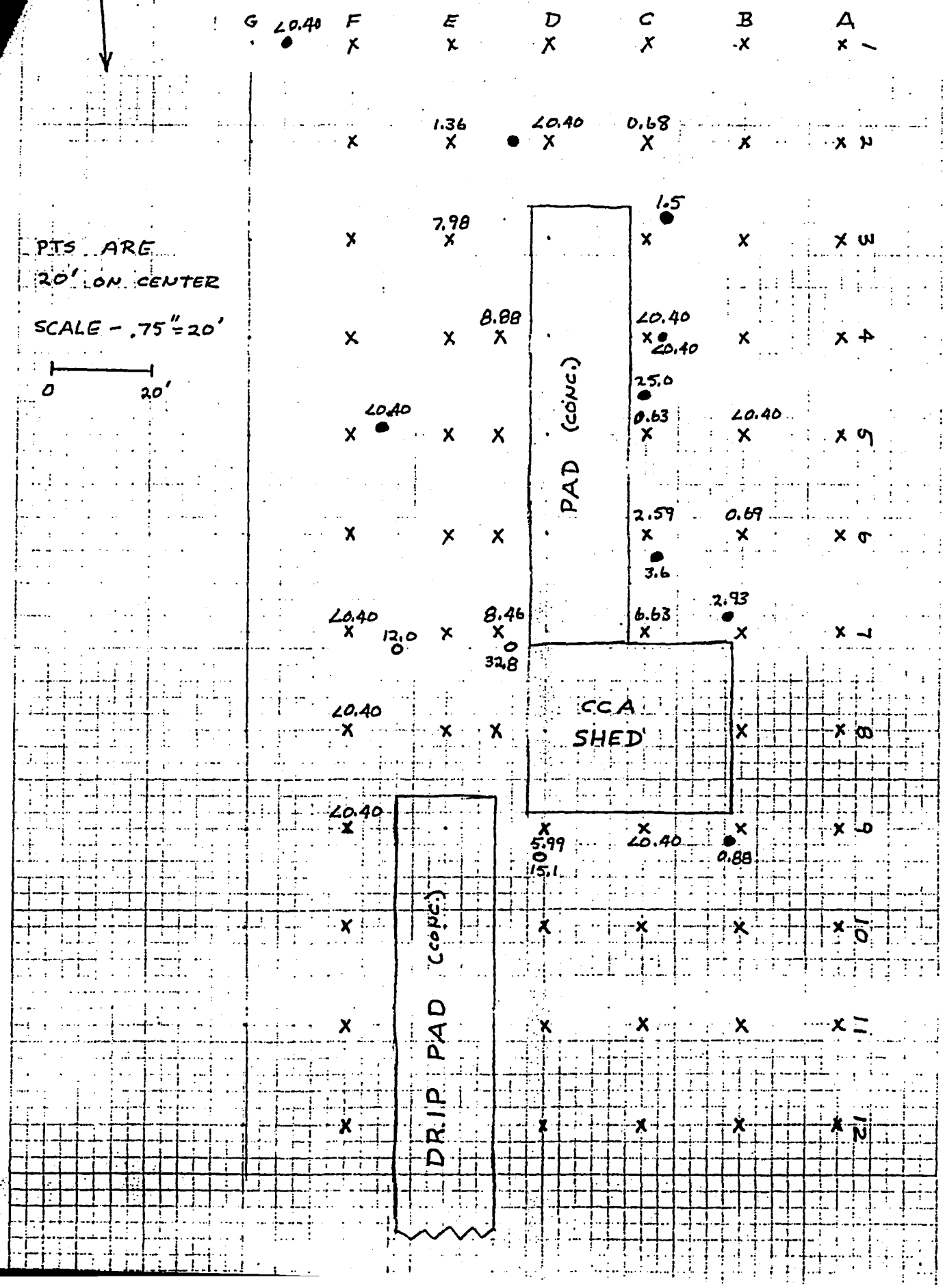
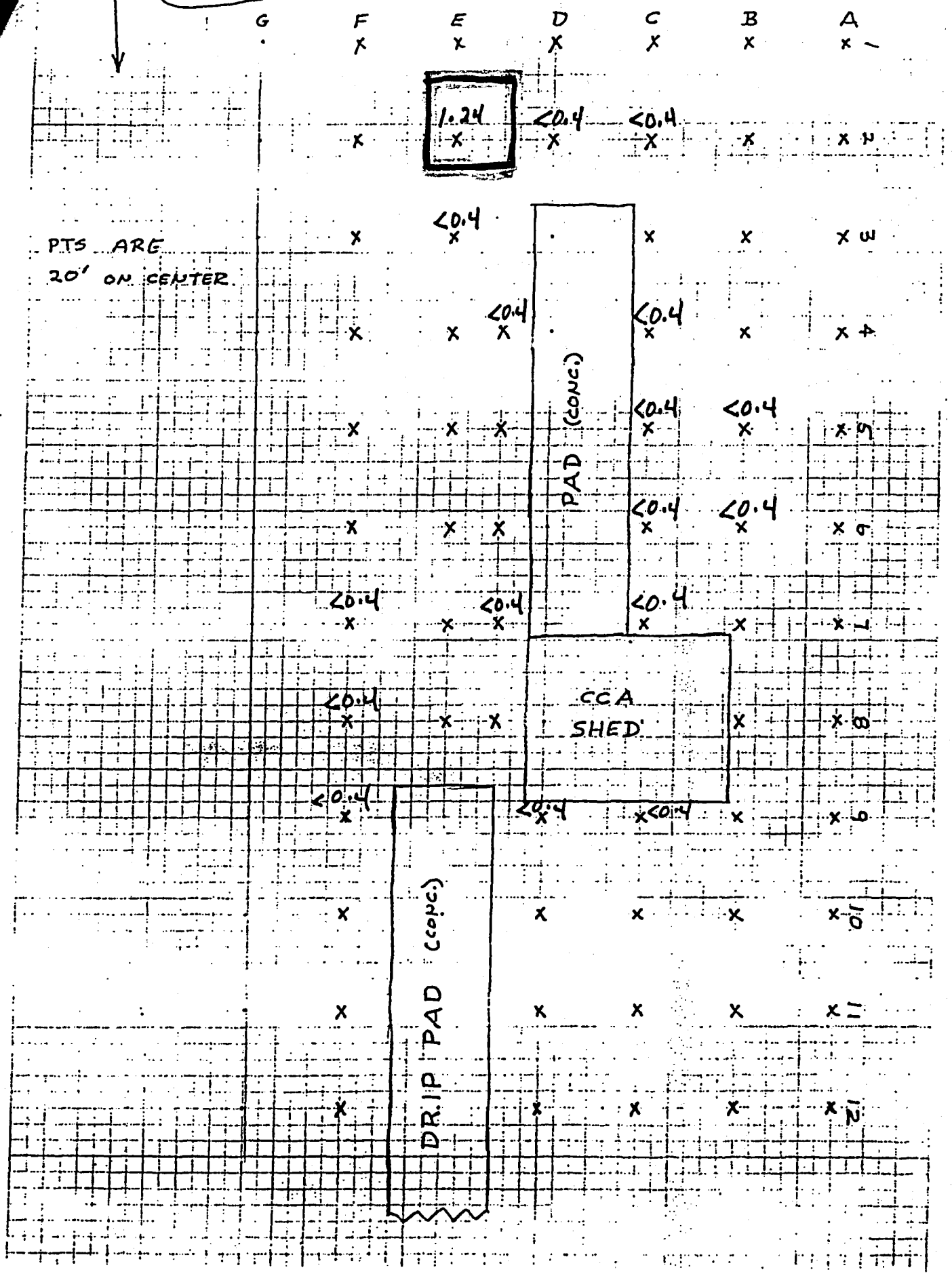


SUBJECT Wilmington 3rd Depth Arsenic Concentrations

DATE 9-12-85

SHEET NO. 2 of

~~PROJECT~~ NO. E.P. extractions

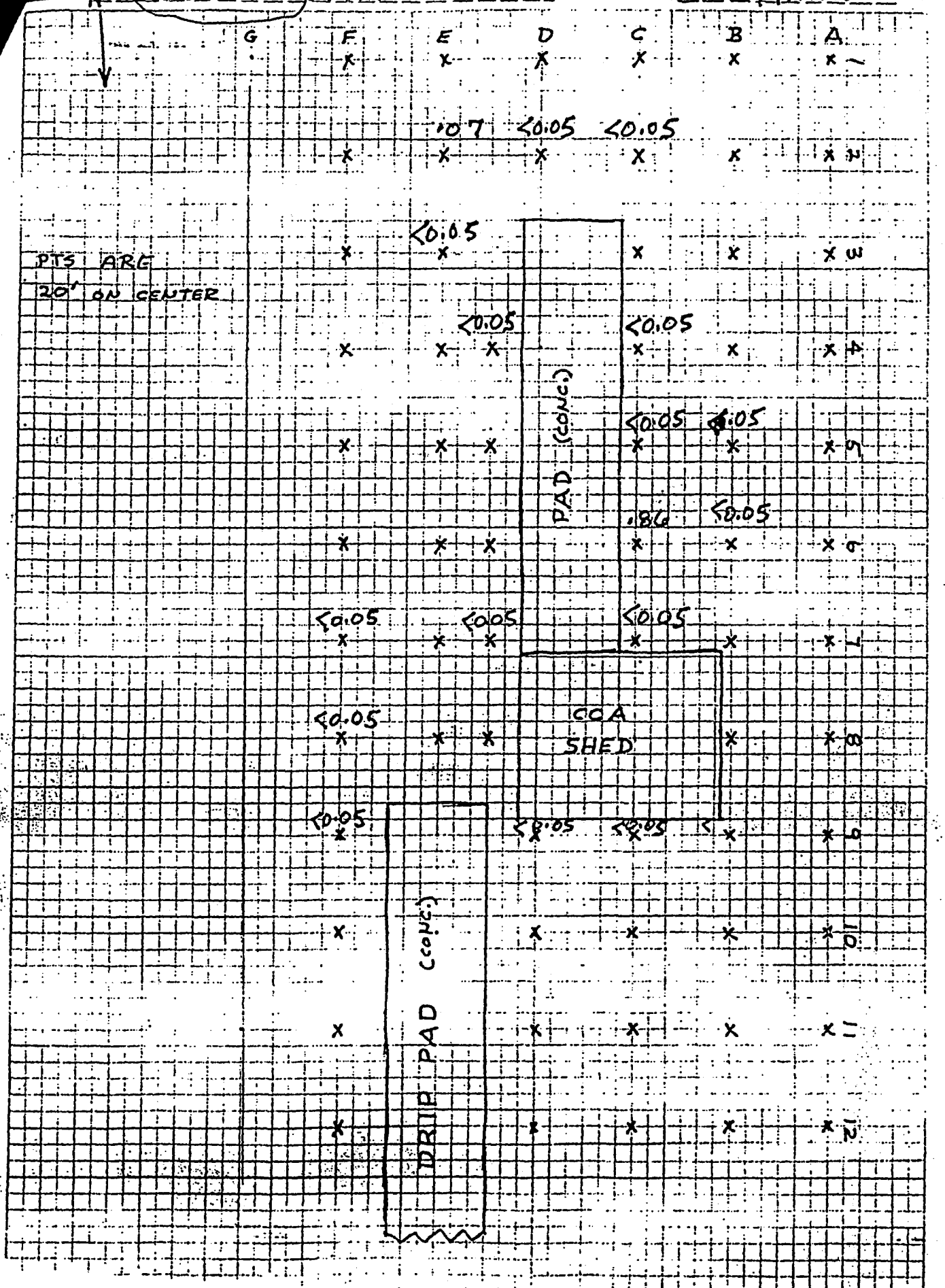


SUBJECT Wilmington 4' depth Chromium Concentrations

BY [illegible] DATE 7-17-85

SHEET NO. 6 of

PROJECT NO. EP Extracts



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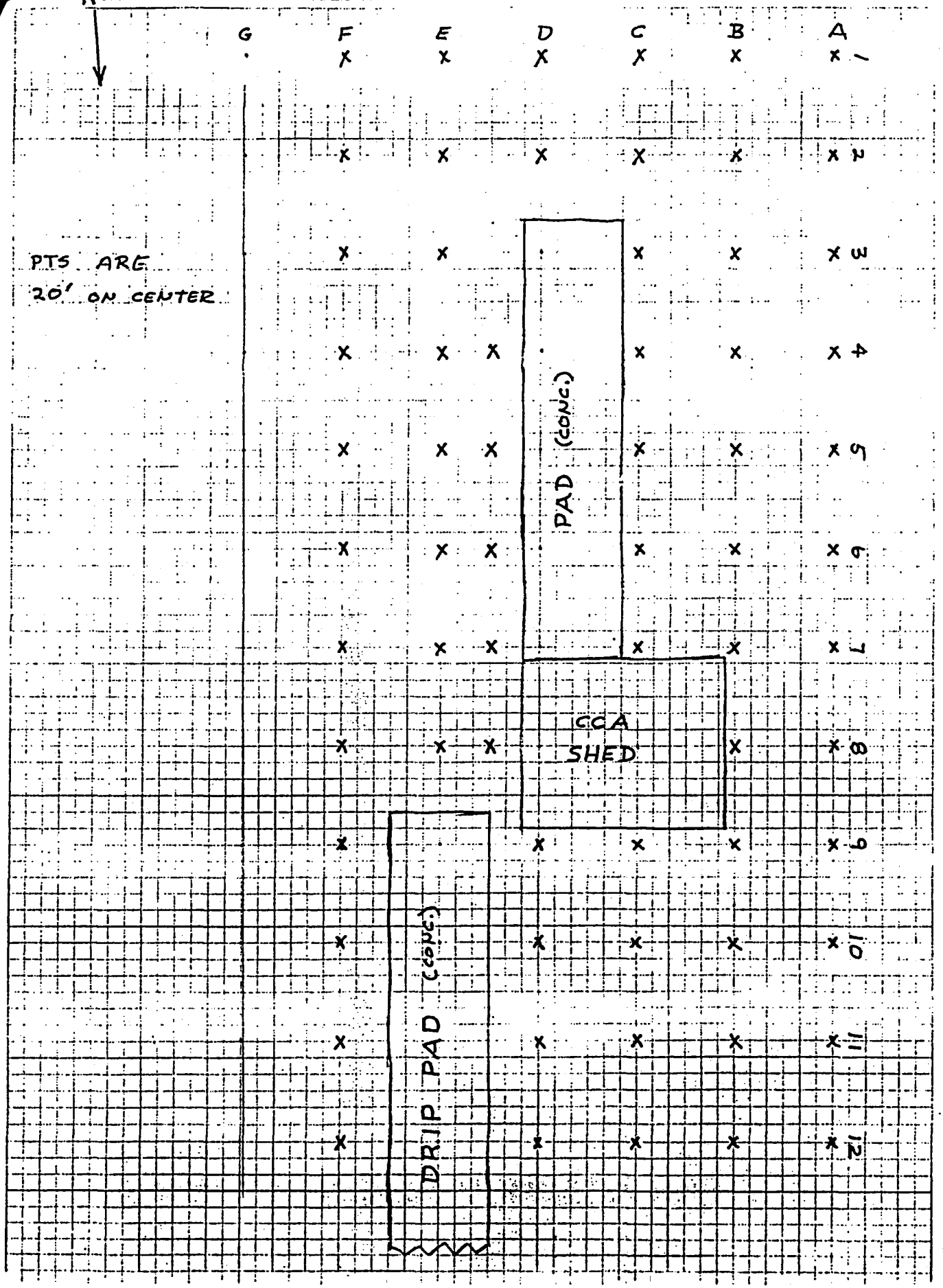

Ref. 20

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

- 4 1994

Ms. Pat DeRosa
North Carolina Department of Environment,
Health and Natural Resources
P.O.Box 27687
Raleigh, North Carolina 27611-7687

Subject: Superfund Chemical Data Matrix (SCDM)

Dear Ms. DeRosa:

Attached is the revised Superfund Chemical Data Matrix (SCDM) These tables, which replace the March 1993 version of SCDM, are to be used when evaluating sites with the Hazard Ranking System (HRS) . Changes from the previous version have been marked with an asterisk in the tables. Also enclosed is a separate list of the values which have been changed.

There is one change of specific importance. In the June 1994 SCDM, a benchmark has been included for lead in drinking water. Since the former MCL of 50 ug/l was rescinded in November 1992, the action level of 15 ug/l, which is the standard used by the drinking water program to monitor water quality at the tap, was included.

Please contact me at 404/347-5069, ext. 6160 or Trish Gowland at 703/603-9017 if you have any questions.

Sincerely

Deborah A. Vaughn-Wright

Deborah A. Vaughn-Wright
Region 4 NPL Coordinator

Enclosure

Printed on Recycled Paper

SUPERFUND CHEMICAL DATA MATRIX

APPENDIX B TABLES

June 1994

TABLE OF CONTENTS

SECTION Page

1. INTRODUCTION 1
1.1 DEFINITIONS 1

2. SUPERFUND CHEMICAL DATA MATRIX DATA SOURCES 1
2.1 HAZARDOUS SUBSTANCE IDENTITIES 2
2.2 DATA COMPILATION METHODOLOGY 3
2.2.1 Toxicity Information 3
2.2.1.1 LD_{50}—Oral, Dermal 3
2.2.1.2 LC_{50}—Inhalation 4
2.2.1.3 Reference Dose (RfD)—Oral, Inhalation 4
2.2.2 Carcinogenicity Information 5
2.2.2.1 Cancer Potency Factor and Weight-of-Evidence—Oral, Inhalation 5
2.2.2.2 ED_{10} and Weight-of-Evidence—Oral, Inhalation 6
2.2.3 Mobility Information 6
2.2.3.1 Vapor Pressure 6
2.2.3.2 Henry's Law Constant 7
2.2.3.3 Water Solubility—Non-metallic Compounds 8
2.2.3.4 Water Solubility—Metals and Metalloids 8
2.2.3.5 Distribution Coefficient (K_d) 9
2.2.4 Persistence Information 9
2.2.4.1 Hydrolysis, Biodegradation, and Photolysis Half-Lives 9
2.2.4.2 Radioactive Half-Life 9
2.2.5 Bioaccumulation Potential Information 10
2.2.5.1 Bioconcentration Factor—Freshwater, Salt Water 10
2.2.5.2 Partition Coefficient (Log K_{ow}) 11
2.2.6 Ecotoxicity Parameters 11
2.2.6.1 Acute and Chronic Freshwater Criteria 11
2.2.6.2 Acute and Chronic Salt Water Criteria 11
2.2.6.3 LC_{50}—Freshwater, Salt Water 11
2.2.7 Benchmarks 12
2.2.7.1 National Ambient Air Quality Standards (NAAQS) 12
2.2.7.2 National Emissions Standards for Hazardous Air Pollutants (NESHAPS) 12
2.2.7.3 Maximum Contaminant Levels (MCLs) 12
2.2.7.4 Maximum Contaminant Level Goals (MCLGs) 12
2.2.7.5 FDA Action Level 13
2.2.7.6 Uranium Mill Tailings Radiation Control Act (UMTRCA) Standards 13
2.2.7.7 Ecological-Based Benchmarks 13
2.3 CALCULATIONS IN SUPERFUND CHEMICAL DATA MATRIX 13
2.3.1 Volatilization Half-Life 13
2.3.1.1 Volatilization Half-Life for Rivers, Oceans, Coastal Tidal Waters, and the Great Lakes 14
2.3.1.2 Volatilization Half-Life for Lakes 15
2.3.2 Distribution Coefficient (K_d) 15
2.3.3 Benchmarks 15

2.3.3.1 Screening Concentrations for the Ground Water Pathway and the Surface Water Pathway Drinking Water Threat 16
2.3.3.2 Screening Concentrations for the Surface Water Pathway Human Food Chain Threat 18
2.3.3.3 Screening Concentrations for the Soil Exposure Pathway 19
2.3.3.4 Screening Concentrations for the Air Pathway 21

3. CHEMICAL DATA, FACTOR VALUES, AND BENCHMARKS FOR HAZARDOUS SUBSTANCES 22

LIST OF REFERENCES 23

APPENDIX B-1 TABLES FOR NON-RADIOACTIVE HAZARDOUS SUBSTANCES B-1

APPENDIX B-2 TABLES FOR RADIONUCLIDES B-73

APPENDIX C SYNONYMS C-1

CERCLA

Ref. 21

GEOLOGY AND GROUND-WATER RESOURCES OF NEW HANOVER COUNTY, NORTH CAROLINA

By

George L. Bain

Geologist, U. S. Geological Survey

Prepared by the

United States Geological Survey

in cooperation with the

New Hanover County Board of Commissioners

and the

North Carolina Department of Water Resources

GROUND-WATER BULLETIN NUMBER 17

Raleigh, North Carolina

1970

GEOLOGY AND GROUND-WATER RESOURCES OF NEW HANOVER COUNTY, NORTH CAROLINA

By

George L. Bain

Geologist, U. S. Geological Survey

ABSTRACT

This report describes the ground-water resources of New Hanover County in southeastern North Carolina. The county is a part of the Atlantic Coastal Plain Province and occupies a peninsula between the Atlantic Ocean and the Cape Fear and Northeast Cape Fear Rivers. New Hanover County is a relatively flat sandy plain, few points in the county being more than 50 feet above sea level. The climate is humid; the average annual precipitation is about 50 inches.

Ground water occurs in a system of slightly inclined formations underlying the Coastal Plain. Although individual formations dip and thicken in various directions, they in aggregate, thicken in wedge-like fashion toward the coast, reaching a maximum thickness in New Hanover County of slightly more than 1,500 feet. Most of the formations are composed of unconsolidated sands and clays containing a few beds of limestone and calcareous sandstone. A veneer of sand and sandy clay of probable Pleistocene age tends to conceal the underlying sequence of rock materials of Tertiary and Cretaceous age.

The volume of water stored in the Coastal Plain formations in New Hanover County is large; however, water in all but the shallow formations is too salty for most uses.

Three major aquifers, or water-bearing beds, furnish water to wells, at least two of them being available for use in most parts of the county. They include a sandstone bed in the Peedee Formation of Late Cretaceous age, the Castle Hayne Limestone of Eocene age, and the shallow surface sands.

The sandstone aquifer in the Peedee Formation averages about 35 feet in thickness, sloping from sea level in the northwestern part of the county to about 190 feet below sea level at Wrightsville Beach. Where data are available, the aquifer is known to contain fresh water and is separated from underlying beds containing salty water by 100 to 150 feet of relatively impermeable clay. Except along the Cape Fear River and the Atlantic coast, ground water in the Peedee sandstone is under sufficient pressure to rise above sea level, and it rises to more than 30 feet above sea level in the center of the county. Some wells tapping this aquifer yield more than 400 gallons per minute, and the specific capacity in part of the county is more than 30 gallons per minute per foot of drawdown.

The Castle Hayne Limestone is irregular in thickness and areal distribution, being thicker and more extensive under the northeastern and southern parts of the county. It lies within about 30 feet of the land surface except along the coastal margin where it is somewhat deeper. The Castle Hayne has easy access for replenishment, and much water enters the limestone in the center of the county. Some wells tapping this aquifer yield more than 400 gallons per minute, and the specific capacity ranges from 3 to 80 gallons per minute per foot of drawdown.

Sand, clay, and marl of Pleistocene and Miocene age cover the land surface in all of the county. The sands comprise the uppermost aquifer in the county--that is, the water-table aquifer, except in a few places where the Castle Hayne Limestone and Peedee Formation are near the land surface. The water table commonly lies within 10 feet of the land surface and is easily reached by the common type of drive-point well.

Water of acceptable chemical quality for most purposes is available throughout the county, but a wide range in quality of water within the aquifers is common. Water in the Peedee sandstone is hard in most places, and the iron content exceeds 1 milligram per liter in the central and north-central parts. Water in the Castle Hayne Limestone is a calcium bicarbonate type ranging from moderately hard to very hard. The iron content ranges from 0.01 to more than 12 milligrams per liter. Water in the surficial sands is soft but almost everywhere is corrosive.

The current withdrawal of ground water is only a small part of the available supply, but the availability of water varies considerably from one part of the county to another. The aquifers are susceptible to salt-water encroachment because of aquifers containing salty water underlying the Peedee sandstone aquifer and because of the bordering Atlantic Ocean and brackish Cape Fear River. The present position of the interface between salty and fresh water in the ground is maintained by the volume and hydrostatic head of the fresh water. Thus, a substantial reduction in rainfall or changes in ground-water conditions created by man's activities, such as withdrawal of water through pumping, swamp drainage, or dredging which reduces the fresh-water hydrostatic head, may cause a corresponding encroachment of salt water. Salt-water encroachment may be controlled at least partially by well-field design and management. Proper practices include pumping more wells at lower rates and the use of multiple well points and infiltration galleries in shallow aquifers.

GEOLOGY

OUTLINE OF GEOLOGY

The present-day quality, occurrence, and availability of ground water in New Hanover County depend upon the physical and chemical character of the sediments beneath the county. Such characteristics as: kind of sediment, lithology, thickness, and attitude have been predetermined by the county's geologic history. When any area is inundated through a general rise in sea level or localized subsidence of the earth's crust, accumulation of marine sediment begins and erosion ceases. The kind and character of the sediment being deposited at any one place, whether limestone, sandstone, clay, shale, or sand, whether coarse or fine, or whether cemented or unconsolidated depends on many complex variables. Some variables include the kind of source material and degree of weathering, distance of sediment transport, and rate of accumulation of the shells of marine organisms.

Crustal movements along the axis of the geologic structure known as the Cape Fear Arch had a profound effect upon the type, thickness, and inclination (dip) of the sedimentary formations beneath New Hanover County and thus, ultimately have influenced the ground water. The Cape Fear Arch is now a broad gentle uplift roughly paralleling the Cape Fear River and trending southeastward through New Hanover County. Crustal movements along this axis are responsible for the lack of deposition of Lower Cretaceous sediments in part of the county, the deposition of a thick sequence of Upper Cretaceous sediments, and thin to nondeposition of the more recent Tertiary formations.

Sediment accumulation on the crystalline basement floor ranges in thickness from about 1,100 feet at Wilmington to 1,500 feet at Fort Fisher. Nearly 90 percent of the sediments accumulated during Cretaceous time when the county was on the flank of a depositional basin. These deposits, ranging in age from Cretaceous through Tertiary, are divided from oldest to youngest into the Black Creek, Peedee, Castle Hayne, and undifferentiated deposits of Oligocene(?) and Miocene age. They are overlain at the surface by sands, clays, and marls deposited during the comparatively recent geologic past.

BASEMENT ROCK

The submerged erosional surface upon which the Upper Cretaceous sediments were deposited consists of schist, gneiss, granite, and metamorphosed volcanic rocks typical of rocks which are exposed in the Piedmont Province of North Carolina. Granite occurs at a depth of 1,109 feet in well 202, which was drilled as a municipal water well for Wilmington in 1899. A well drilled during 1905-07 at Fort Caswell, across the Cape Fear River from the southern tip of the county, penetrated basement rock at 1,540 feet (Clark and others, 1912, p. 194-196). The ages of the basement rocks are unknown but may range from Precambrian(?) to Mississippian(?).

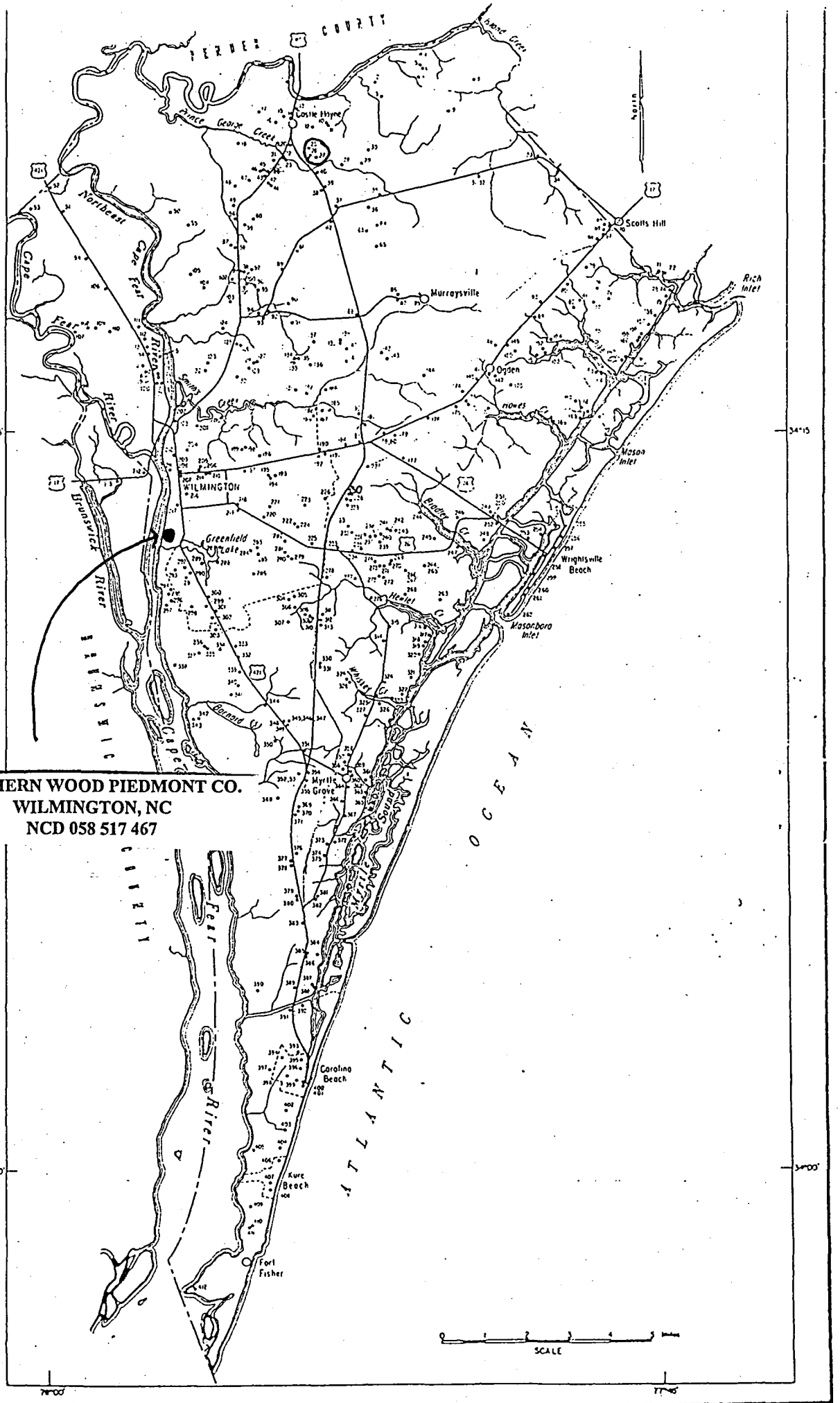

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FIGURE 3

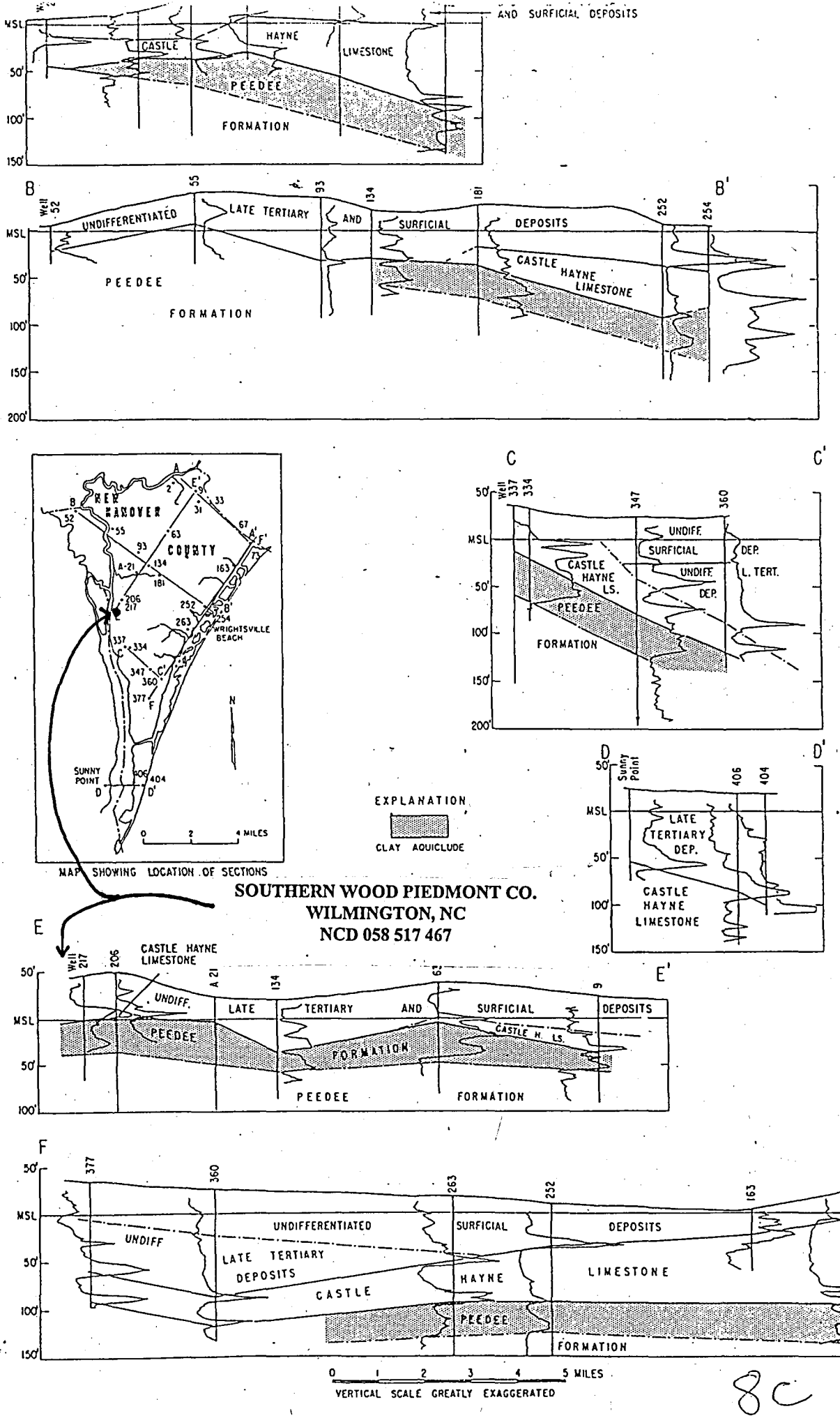

Figure 4.--Sections showing correlation of formations by gamma-ray logs.

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CRETACEOUS SYSTEM

BLACK CREEK FORMATION

The Black Creek Formation of Late Cretaceous age rests unconformably upon the basement rocks at Wilmington. Lower Cretaceous sediments and the Tuscaloosa Formation, prominent in other parts of the Coastal Plain, are not known to be present beneath New Hanover County (Brown, 1959a).

The Black Creek Formation is approximately 380 feet thick in New Hanover County. The upper and lower contacts were placed at 711 and 1,100 feet below sea level, respectively, in the Hilton Park well (well 202, see fig. 3), by T. W. Stanton (Clark and others, 1912). The top of the Black Creek was penetrated at 673 feet below mean sea level in the Murraysville test well (well 87) but was not reached in the Edwards test hole (well 347), which was drilled to a depth of 610 feet below sea level.

The Black Creek Formation is assumed to contain saline water everywhere beneath New Hanover County. Highly saline water was found in the Hilton Park well in all zones below 370 feet and in a well at Fort Caswell, Brunswick County, below 354 feet (Clark and others, 1912).

PEEDEE FORMATION

The Peedee Formation conformably overlies the Black Creek Formation in New Hanover County. It typically consists of unconsolidated greenish-gray to dark-gray silt, olive-green to gray sand, and massive black clay interbedded with consolidated calcareous sandstone and impure limestone. Glauconite gives the Peedee Formation its characteristic salt and pepper appearance. There appears to be an increase in sand and lime and a decrease in clay toward the top of the formation in New Hanover County.

The Peedee Formation in New Hanover County is 710 feet thick at well 202 and 645 feet thick at well 87, and contains four water-bearing beds of sand. The uppermost sand contains fresh water and the lower three contain brackish to saline water throughout the county. The general relationship of the Peedee Formation to the other formations in the county is illustrated in figures 4, 5, and 6. Figure 6 is a structure contour map of the top of the uppermost salt-water bearing sand. The top of the sand strikes N. 25° E. and dips toward the southeast at the rate of 10 feet per mile.

Figure 7 is a structure contour map of the top of a calcareous sandstone, the topmost sandstone in the Peedee Formation and the principal fresh-water aquifer in New Hanover County. It is discussed in a later section as the sandstone aquifer.

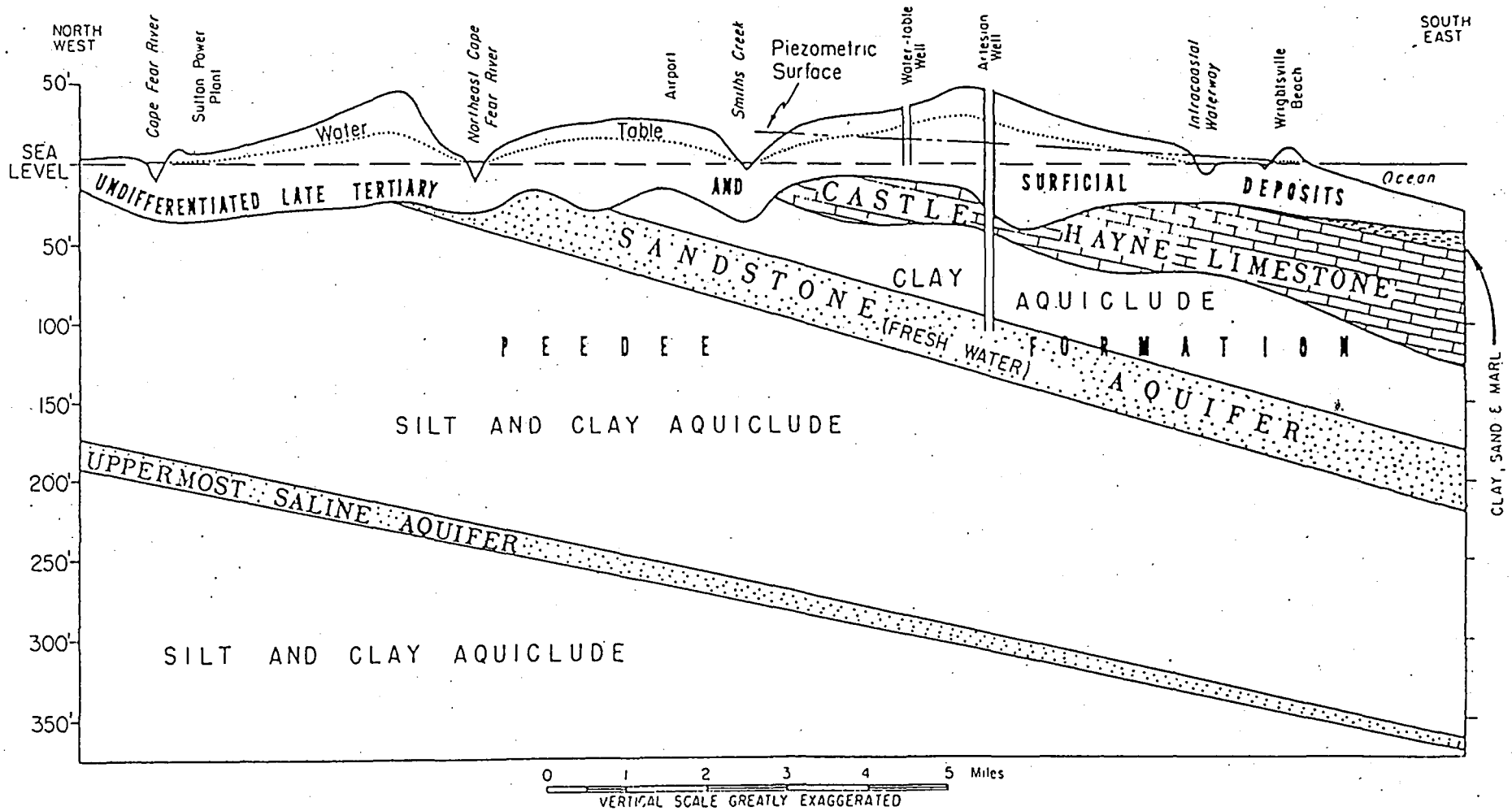

Figure 5.--Generalized diagram showing the relation of geologic conditions to the occurrence of fresh ground water.

All water below the altitudes shown on figure 6 is saline. All water in and above the sandstone shown in figure 7 is known to be fresh except th south of Myrtle Grove, where there are no data. Fresh water of unknown but probably limited extent and quantity was detected in well 87 in fine unconsolidated sand below the sandstone aquifer.

Figure 8 is an isopach map showing the distribution and thickness of t massive clay aquiclude lying between the calcareous sandstone and the top o the Peedee Formation. In effect, this figure shows the thickness of the im permeable beds lying between the sandstone aquifer and the Castle Hayne Lim stone, the next higher aquifer.

TERTIARY SYSTEM

CASTLE HAYNE LIMESTONE

The Castle Hayne Limestone of middle and late Eocene age (LeGrand and Brown, 1955) was first described by Miller (Clark and others, 1912) at a qu near the intersection of Prince George Creek and U. S. Highway 421 at the town of Castle Hayne. Rocks of Paleocene age were not deposited in the cour because of erosion or nondeposition upon the elevated Cape Fear Arch. Thus, the Castle Hayne Limestone unconformably overlies the channeled and eroded upper surface of the Peedee Formation.

The Castle Hayne Limestone is quite variable lithologically, consisting of shell, marl, sand, and limestone. A complete geologic section in New Hanover County includes:

A. A basal sandy shell conglomerate containing much reworked material from the Peedee Formation. It is discontinuous in occurrence because it was deposited in channels on the top of the Peedee Formation. It is approximately 30 feet thick in the Superior Stone quarry near the town of Castle Hayne.

B. Above the basal shell-conglomerate is a glauconitic shell limestone. It is light-gray toward the top and yellow and dolomitic toward the bottom. In places it contains interbedded sand. Where the lower unit is missing the shell limestone facies rests unconformably upon the Peedee Formation. The glauconitic shell limestone thickens from a featheredge along its up-dip extremities to about 40 feet at the town of Wrightsville Beach and to more than 80 feet at the town of Carolina Beach.

C. The shell facies is overlain by a dense, chalk-white siliceous limestone that contains phosphate at its base. This limestone, called "cap rock," by local well drillers averages about 3 feet in thickness throughout the county.

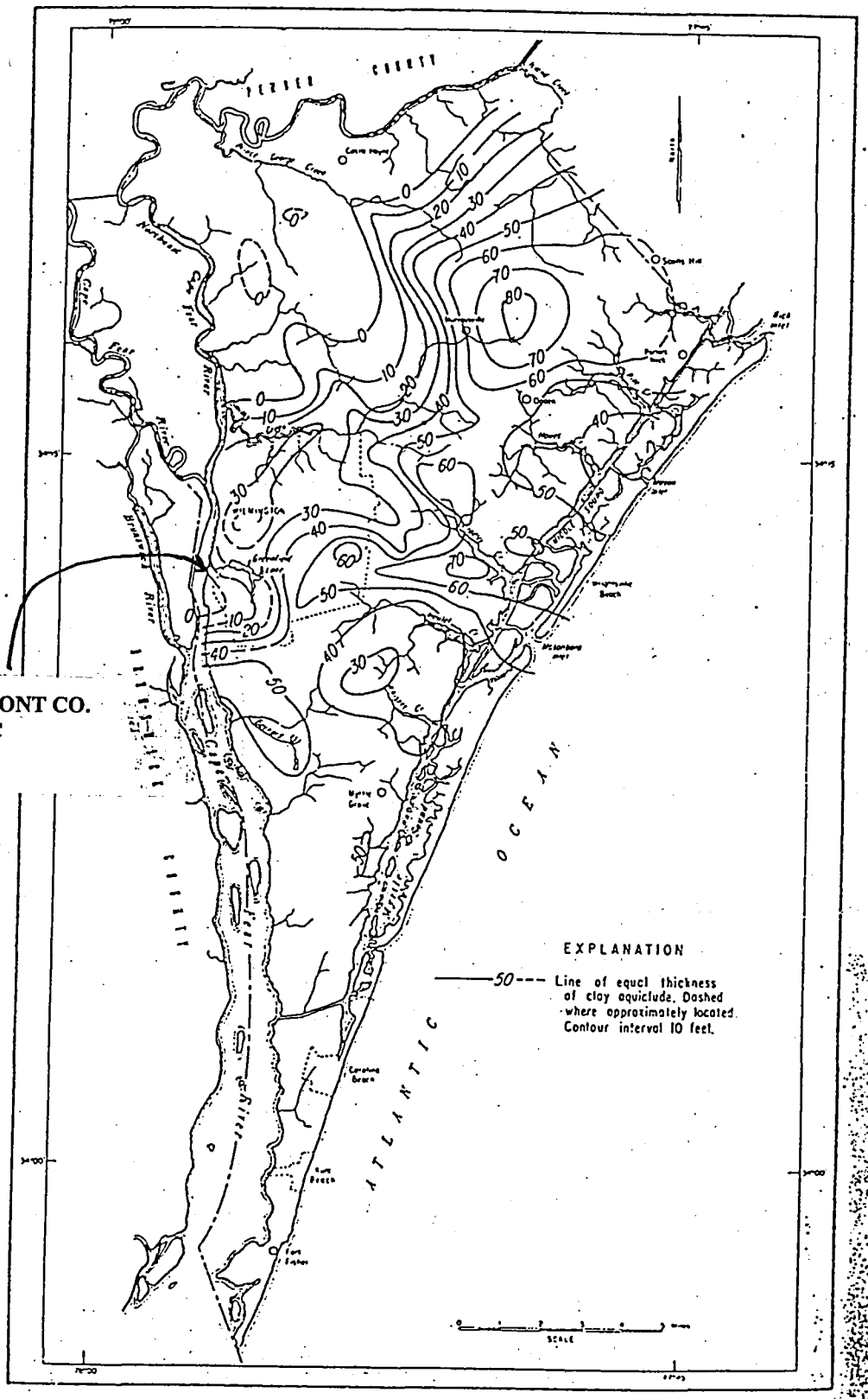

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Figure 8.--Map showing thickness of the clay aquiclude in the Peedee Formation.

D. Overlying the "cap rock" is a cream to light-green, glauconitic, bryozoan-bearing "shell hash" (a coarse, braided mixture of shell fragments). This unit is generally confined to the northeastern section of the county north of a line connecting the city of Wilmington and Wrightsville Beach. South of this line the unit, if deposited, has apparently been removed by erosion. At the Ideal Cement Company quarry in the northern part of the county, where this unit is approximately 10 feet thick, it is mined for the manufacturing of cement. At Porters Neck crossroad it ranges from 55 to 80 feet thick.

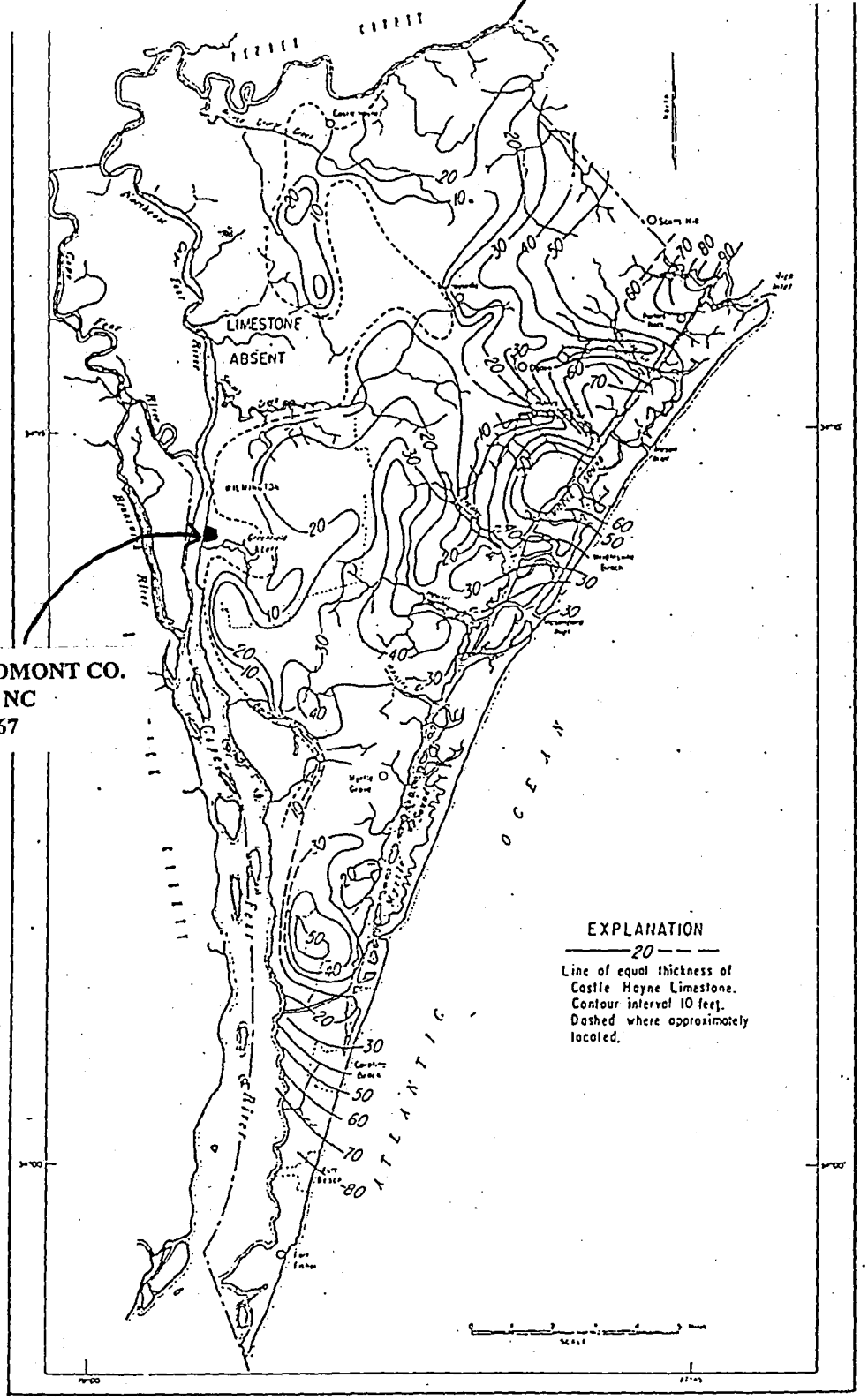
The irregular distribution and thickness of the Castle Hayne Limestone (figs. 9 and 10) results from its deposition on an eroded surface of the Peedee Formation and from subsequent erosion and solution of the upper surface of the Castle Hayne. Areas in which the Castle Hayne Limestone is missing or spotty are also shown in figure 9.

The sandy, shell part of the Castle Hayne Limestone is generally a productive aquifer. Yields of individual wells in the county depend largely upon the degree to which the porosity and permeability have been increased by solution.

UNDIFFERENTIATED DEPOSITS OF LATE TERTIARY AGE

Overlying the Castle Hayne Limestone in the southern part of the county are sediments that probably range in age from late Oligocene through late Miocene. Most of the sediments in this late Tertiary sequence are phosphatic sands, silts and clays, and phosphatic limestones similar to materials in the Pungo River Formation described by Kimrey (1964) in Beaufort County, North Carolina. The upper part of the Pungo River Formation is equivalent in age to the Calvert Formation of Maryland (Brown, 1958b, p. 89) (Gibson, 1967, p. 636), which the U. S. Geological Survey currently recognizes as middle Miocene. The possibility that the lower part of the Pungo River is of early Miocene or late Oligocene has not been discounted (Brown, 1958b, p. 90) (Gibson, 1967, p. 637). According to Gibson (written communication, July 1, 1968), the sediments in southern New Hanover County "are in part facies equivalents of the phosphatic sands, limes, and diatomites of the Pungo River, but whether they belong lithologically and genetically is another question." Thus, the name Pungo River should not be applied to the deposits in New Hanover County although they are probably facies equivalents.

In the Carolina Beach area the above deposits consist chiefly of marl interbedded with light-green to dark-gray silty clay containing thin shell beds. The silty phase is replaced to the northwest by light-gray sand and sandy coquina overlain by olive-green sand. The sandy coquina, present in wells 368 and 381, is possibly of late Miocene age. Phosphate is present but is not known to be in sufficient quantities to warrant economic



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WILMINGTON, NC
NCD 058 517 467

Figure 9.--Map showing thickness of the Castle Hayne Limestone.

development. The lower silty part of the unit thickens southward from about 10 feet at Wrightsville Beach to 75 feet at well 394 at Carolina Beach and dips to the south-southeast and southeast at 10 to 25 feet per mile. It is overlain in the southeastern part of the county by 20 to 30 feet of fine- to medium-grained sand containing dark-gray to chocolate-brown clay beds that change southward to light-gray to olive-green clay and shell beds. This late Miocene unit is as much as 10 feet above sea level. In the north-central and northeastern sections of the county--10 to 20 feet of fine- to medium-grained sand containing a dark-gray to blue-gray clay is overlain by 5 to 20 feet of blue or gray dense clay of late Miocene age. The late Miocene clay occurs in a zone as much as 25 feet above sea level.

The silty part of the unit functions as a hydraulic barrier (aquiclude) between the overlying water-table aquifer and the underlying Castle Hayne aquifer near the seacoast.

Small to moderate water supplies are available from the sandy coquina, but only small supplies are available from the shallow sands and from the thin shell beds of this formation.

QUATERNARY SYSTEM

UNDIFFERENTIATED SURFACE DEPOSITS

Overlying the channeled surfaces of the formations previously described are deposits of clay, sand, and marl. Their age, thickness, and origin vary from one place to another. As used in this report the deposits include all of the sediments between land surface and the undifferentiated deposits of late Tertiary age. Thus, they include terraced and barrier-beach deposits, sandy coquinas (DuBar and Johnson, 1964), fossil sand dunes, stream channel deposits, and possibly thin and scattered remnants of the underlying formation. These sediments are absent in the towns of Castle Hayne and Wilmington, where the underlying limestone is exposed, but are as much as 70 feet deep near the Cape Fear River west of Myrtle Grove.

Eastward from a line connecting Fort Fisher, Myrtle Grove, and Wrightsville Beach, the base of these surficial sediments rests upon silt, clay, and shell beds of the underlying deposits of late Tertiary age. In the northwest one-third of the county they rest upon the Peedee Formation where the Castle Hayne Limestone is missing as shown in figure 10. Between the above areas they rest upon the Castle Hayne Limestone.

The surficial sediments may be divided into the following oversimplified or generalized categories:

1. In the central and western parts of the county, 0 to 35 feet of coarse, clean, nonfossiliferous quartz sand generally from 0 to 30 feet below sea level. Reference to figures 10 and 11 shows that the coarse sand occurs where the Castle Hayne is missing, or more specifically, in

HYDROLOGY

GENERAL STATEMENT

The earth's vast but fixed supply of water is kept in endless circulation by energy supplied from the sun. Water evaporates from the oceans, lakes, streams, and land surfaces and is carried in the atmosphere as water vapor until it condenses and falls as precipitation. Part of the precipitation flows overland as surface runoff, a part is returned directly to the atmosphere by evaporation, a part is transpired by plants, and the remaining part enters the ground from which it eventually discharges to streams or to the coast.

Ground water occurs in the spaces between the rock particles in the zone of saturation. Where the spaces are interconnected and large enough to permit flow through them the rocks will yield water to wells. Rock units that yield water to wells are called aquifers. In New Hanover County two types of spaces that transmit and store water are: (1) the openings between the sand grains; and (2) the larger interconnected openings, created by solution of some of the calcareous cement and shell material from the limestone and shell beds. Interbedded clay sediments contain numerous pore spaces, but the pores are extremely small and the yield to wells is so small that they are not considered to be aquifers.

Ground water not evaporated to the atmosphere or transpired by vegetation is eventually discharged to the streams or to the ocean. The discharge of ground water is facilitated where streams have incised their channels into, or below, the water table. The discharge of water as springs or seeps in such topographically low places creates a significant difference in hydrostatic head between the water level in the interstream and stream areas. New Hanover County is essentially a peninsula; thus the Northeast Cape Fear and the Cape Fear Rivers serve as diffuse discharge lines along the west boundary and the coast serves the same purpose along the east boundary. The upward movement through the confining beds occurs over large areas, and through the geologic ages it has been sufficient to cause partial flushing of the original connate sea water from the aquifers.

The uppermost water-bearing unit includes the surface sand that covers most of the county to depths of 50 feet or more in places. The lower part of the surface material is saturated with water; in the upper part the water is moving downward in response to gravity. The upper surface of the saturated zone is called the water table.

All of the sediments below the water table are saturated, not only in the surface sand, but also in the underlying limestone, clay, and sand. Where beds of clay and silt (aquicludes) are impermeable enough to retard the movement of water, the water in the underlying beds of limestone and sand is confined under hydraulic pressure and is called artesian water. The height to which artesian water will rise in wells forms an imaginary surface called the piezometric surface.

Artesian water moves to discharge areas in many places along the major streams and the coast. The rate of water movement from areas of recharge to areas of discharge ranges from a few feet to as much as a few hundred feet per year.

The aquifers in New Hanover County are recharged by local rainfall. Areas of significant recharge are identified on the maps showing the piezometric surfaces as the areas having higher water levels, and on the water quality maps as the areas of lower chloride and of higher iron and hardness values. These are in the interstream areas where the topography is relatively high. Conditions for recharge are excellent in New Hanover County because most of the areas are underlain by sand.

AQUIFER CHARACTERISTICS

The quantity of water that an aquifer can hold in storage is governed by its porosity. Porosity is the ratio of volume of pore space or interstices to the total volume of the rock material and is usually expressed as a percentage. Clean, well-sorted sand may have an initial porosity as high as 40 percent, but during its transformation into a sandstone the porosity may be reduced by compaction and cementation to less than 10 percent. Clay may have a porosity of 50 percent, but because of the minute size of its pores, a large percentage of the water stored in clay is retained by molecular attraction. Consequently, clays and clayey sediments act as aquicludes and tend to retard water movement.

The permeability of an aquifer is a measure of its ability to transmit water in response to gravity or to differences in hydrostatic pressure. It is governed by the size and shape of pore spaces and the degree to which these spaces are interconnected. A rock unit that is nonporous is also impermeable. However, water may be yielded freely from rocks of low porosity if the pores are interconnected and are large enough to freely transmit water. In New Hanover County, the removal of cementing material from the calcareous sandstones and limestones by solution has increased the effective porosity and permeability of these rocks, thus increasing their water-bearing potential.

The water level in an unpumped well is referred to as the "static" water level. Withdrawal of water from a well creates a difference in head between the water in the well and that in the surrounding aquifer with the result that water flows toward the well. The surface of the water around the well assumes the shape of an inverted cone (cone of depression) whose apex is at the well. (See fig. 12.) The vertical distance between the static water level and the pumping level is called the drawdown. The area in which water levels are lowered by the pumping of a well is termed the area of influence.

The coefficient of transmissibility is the quantity of water, in gallons per day, that will move through a vertical section of an aquifer 1-foot wide and extending to its full saturated thickness under a hydraulic gradient of 1 foot per foot at the prevailing water temperature. The coefficient of storage is a measure of the volume of water that an aquifer releases from or takes into storage under a unit surface area by a unit change in head.

The shape, size, and rate of growth of the cone of depression (and th the yield of the well) are controlled by the transmissibility and storage coefficients of the aquifer and the rate and duration of pumping.

The specific capacity of a well is the quantity of water in gallons per minute (gpm) that a well yields for each foot of drawdown in water level after a given period of continuous pumping. The theoretical specific capacity can be calculated from the transmissibility and storage coefficients of the aquifer. The actual specific capacity is found by dividing the yield in gallons per minute by the number of feet of drawdown. Comparison of the theoretical and actual specific capacities is useful in determining the efficiency of a well.

AQUIFERS CONTAINING FRESH WATER

The deposits underlying New Hanover County may be grouped according to their ability to transmit water. The productive zones are termed aquifers, and the relatively nonproductive zones are termed aquicludes. One objective of the study was to identify and map the productive zones.

The chief fresh-water-bearing zones or aquifers in New Hanover County are: an indurated calcareous sand in the upper part of the Peedee Formation, a sandy limestone in the Castle Hayne Limestone, and beds of sand and some coquina in deposits younger than the Castle Hayne at the land surface.

Peedee Formation

The lowermost productive zone is a bed of sand in the upper part of the Peedee Formation (see fig. 7). This zone is about 35 feet thick in most of the county except where it has been partly or entirely removed by erosion; it dips to the southeast at about 14 feet per mile. It consists of quartz sand which is usually indurated with calcareous cement and is underlain by an aquiclude about 150 feet thick consisting of very fine sand and clay. Water in this zone is under artesian pressure throughout most of the county. The permeability of this sand has been increased by solution of its calcareous cement in an area that lies generally northwest of U. S. Route 17. The specific capacities of wells in this area range from 20 to 75 gpm per foot of drawdown, whereas they range from 1 to 7 gpm per foot in the eastern part of the county.

Many of the wells that tap this productive zone in the Peedee Formation are of the open-hole type, the casing being set in sandstone or on the overlying limestone. These wells are developed by using compressed air to remove loose sand, silt, and clay.

The zone is generally 10 to 25 feet below land surface in the northwestern part of the county but is more than 150 feet below land surface along the Atlantic coast. It is overlain by a clay bed that ranges in thickness from only a few feet to more than 50 feet in places. The clay bed retards the movement of water both into and out of the sand. The piezometric surface (fig. 13) is highest in the interstream areas in the central part of the county. These are the areas in which the sandstone aquifer is recharged.

This recharge occurs as water moves downward from the overlying beds. The natural discharge from the sandstone aquifer is in the major stream valleys and upward through the overlying beds along the coast.

The quality of the water from the sand in the Peedee Formation is acceptable for most uses. The hardness ranges from less than 60 mg/l (milligrams per liter) to more than 200 mg/l (fig. 14), the higher values being in the northern half of the county where the sandstone aquifer shows the greatest degree of calcium carbonate concentration. Figure 15 shows that the chloride content generally ranges from 5 to about 200 mg/l. Note that the chloride map roughly outlines the areas of recharge and discharge. The area surrounded by the 20 mg/l chloride contour approximates the area in which the Peedee sandstone aquifer is receiving recharge, and the area outside of this contour is approximately the area of discharge. The iron content in samples analyzed ranges from 0.01 mg/l to 3.0 mg/l in areas of effective recharge (fig. 16).

Castle Hayne Limestone

The Castle Hayne Limestone overlies the Peedee Formation and is a productive aquifer in much of the county. The limestone is absent in an area west and northwest of Wilmington but in other parts of the county it thickens toward the southeast. It is predominantly a sandy shell limestone, but in some places it is a hard limestone. The Castle Hayne is readily identified from well-cuttings, as it is an indurated light-colored fossiliferous limestone. Although it contains some relatively impermeable beds of marl or dense limestone, much of it is highly permeable; the permeability resulting from solution of the rock by circulating ground water (LeGrand, 1960, p. 17-18) (Mundorff, 1945, p. 50).

In the southern part of the county beds of sandy coquina and clay, probably of Miocene age, overlie the Castle Hayne Limestone. The sandy coquina yields some water to wells and probably forms a single hydrologic unit with the Castle Hayne.

Where the Castle Hayne Limestone is present in the northern part of the county, it lies near the land surface, but is more than 100 feet deep in the southern part. The thickness of the Castle Hayne varies greatly from one place to another, being generally less than 50 feet in much of the county and more than 100 feet in the southern part (fig. 9).

The water-bearing characteristics of the Castle Hayne are variable from place to place, depending on the thickness and permeability. The specific capacities of wells tested range from 4 to more than 50 gpm per foot of drawdown. The highest yields obtained from the Castle Hayne Limestone are in the area between U. S. Highway 17 and Wrightsville Beach. The water in the Castle Hayne occurs under water-table conditions in the northern part of the county. Elsewhere, however, the water may be confined beneath clay beds. Wells generally tap only the Castle Hayne in the southern part of the county where the limestone is thickest, but in the northern part, where it is thinner, the wells also generally tap both the Castle Hayne and the sand in the Peedee Formation.

The amount of ground-water discharge that can be salvaged as potable water depends upon future well-field design and development, the degree to which the area is left unpaved, and the manner of disposal of industrial wastes. The moderate coefficient of transmissibility and high coefficient of storage indicate that the coarse sand deposits can be developed using infiltration galleries, open ponds, multiple well points or large-diameter gravel-packed wells.

The data from the sand hills area northwest of Wilmington indicate that yields from wells 8-inches in diameter, gravel packed to a nominal 16-inch diameter with 20 feet of screen, and spaced at least 500 feet apart will be at least 250 gpm. Similar yields should be expected from such well-field designs in the sand-dune area south of Wilmington where underlain by coarse sand. Larger yields may be obtainable as a result of induced infiltration in areas where the sands are hydraulically connected with the rivers, such as at the Carolina Power and Light Company's Sutton Plant and along the Northeast Cape Fear River below Castle Hayne. Care must be exercised, however to prevent infiltration from the rivers where they contain brackish water. Brackish water extends upstream in the Cape Fear River as much as 10 miles above Wilmington during periods of low flow. This fluctuation in quality of water from time to time requires careful planning of ground-water development near the river.

Elsewhere the specific capacity of a properly designed and developed well generally is found to be at least 3 gpm per foot of drawdown throughout the county (fig. 19). Minimum yields of 150 to 250 gpm of potable water may be developed almost anywhere in the county.

The specific capacity of wells in the watershed of Smiths Creek north of Wilmington is greater than 20 gpm per foot of drawdown. Here, the sandstone aquifer, containing some calcareous material, has undergone solution and channels (fig. 19) in its upper surface contain up to 30 feet of coarse sand. Solution in the aquifer may account in part for the abnormally high specific capacity of well 112. Wells having exceptionally high specific capacities also are found in the limestone aquifer at Porters Neck (well 82) and near Wrightsville Beach (well 251). However, high specific capacities of wells in the limestone is much more sporadic than in the other aquifers.

The prohibitive cost of drilling test wells and the limited time available made it necessary to collect most of the data from existing privately owned wells. Thus, the available hydrologic data from remote and unpopulated areas are less than desired. Specifically, the position of the salt-water interface and information on the water-bearing characteristics of the sandstone aquifer are unavailable in the southern tip of the county. In areas where the geology is known but the hydrologic data are deficient, the aquifer characteristics are estimated by projecting known data from similar geologic situations.

The information presented in this section does not preclude the necessity of drilling exploratory wells when the desired quality of water is critical or when the needed quantity of water approaches the limits indicated in this report.

DISSOLVED SOLIDS

Total dissolved solids are the residue after a given volume of water has en evaporated and dried at a definite temperature (180°C by the U. S. Geo- gical Survey methods). Computed dissolved solids are equal to approximately e-half the bicarbonate plus the sum of the other chemical constituents in rams per liter. Computed dissolved solids are used in the report, un- ss stated otherwise.

The U. S. Public Health Service recommends that dissolved solids in public ter supplies not exceed 500 mg/l. Except in cases of chloride contamination, ssolved solids are less than 500 mg/l in ground water in New Hanover County.

HARDNESS

Hardness of water is usually recognized by the increased amount of soap cessary to form and maintain a lather. Hard water is objectionable not only cause of its soap-consuming properties, but also because it forms scale in ilers and, to a lesser degree, encrustations in cooking utensils. The incipal ions that produce hardness in ground water are calcium and magnesium, ich have been discussed in a previous section. The following classification water hardness is used by the U. S. Geological Survey.

Hardness as $CaCO_3$ (mg/l)	Classification
0 - 60	Soft water
61 - 120	Moderately hard water
121 - 200	Hard water
More than 200	Very hard water

g 14 shows the areal distribution of the hardness in the sandstone aquifer. t of the water in the county with the exception of that from the water-table ifer would be classed as hard to very hard water of the calcium-bicarbonate pe.

Hardness in excess of that equivalent to the carbonate and bicarbonate esent in the water is referred to as noncarbonate hardness.

OCCURRENCE OF SALTY WATER AND ITS POSSIBLE ENCROACHMENT

In New Hanover County it is important to know where the salty water occurs the ground as well as in the major rivers so that fresh water can be devel- ed without encroachment of salty water. The county is underlain by aquifers taining brackish to highly saline sea water. The overlying reservoir of sh water exists in dynamic equilibrium with the underlying and surrounding lt water.

Table 5.--Records of wells in New Hanover County, N. C.

Ownership: C-County; F-Federal Government; M-Municipal; N-Corporation or Company; P-Private; S-State agency; Use: A-Air Conditioning; C-Commercial; H-Domestic; I-Irrigation; N-Industrial; P-Public supply; S-Stock supply; T-Institutional; U-Unused. Type of QW analysis available: P-Partial; C-Complete. Log data available: D-Driller's log; E-Electric log; G-Geologist log; J-Gamma-ray log. Well finish: G-Gravel with screen; S-Screen; T-Sand point; X-Open hole. Quality of water: Iron, pH, Chloride, Hardness, and Specific conductance are coded according to range in concentration. Explanation of code given on last page of tables. Aquifer: Kpd-Peedee; Tch-Castle Hayne; TQ-Undifferentiated late Tertiary and Quaternary sands.

Well No.	Well location		Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water					Water-bearing unit	Remarks
	Lat	Long															Iron	pH	Cl	Hardness	Sp. Cond.		
1	342216N	0775403	1	USGS	F	U	P	G	29	30	2	T	5				5	7	1	4	2	Kpd	Temp. 65°F.
2	342205N	0775154	1	SUPERIOR STONE	N	U		J	50		2	X	5	5					2			Tch	
3	342147N	0775145	1	LEWIS NIXON	P	H	P		60		1	X	25	23								Tch	
4	342239N	0775048	1	IDEAL CEMENT	N	N	C	D	160	23	24	G		15	322	30						Tch-Kpd	
5	342225N	0775049	1	IDEAL CEMENT	N	N	C	D	164		24	G	27	19	325	20						Tch-Kpd	
6	342222N	0775045	1	IDEAL CEMENT	N	U			75		7	X										Tch-Kpd	Obs. well
7	342211N	0775051	1	IDEAL CEMENT	N	N	C	D	160		24	G		18	329	29						Tch-Kpd	
8	342209N	0774930	1	HARLEY SMITH	P	H			40		1	X	23	7			7		0	5	3	Tch	
9	342130N	0775008	1	J B WILCOX	P	I	P	J	117	54	6	X	26	29	125		8		0	6	3	Tch-Kpd	
10	342115N	0775309	1	E NIXON	P	H			50	21	2	X	24	12								Tch-Kpd	
11	342112N	0775306	1	W A PENDER SR	P	H			35		1	X	23	12								Tch-Kpd	
12	342111N	0775329	1	NEGRO BAPT CH	P	T			26		1	X	23	10								Tch	
13	342133N	0775353	1	QUEEN TIRE SER	P	C			50	30	2	X	19	9	90		2		1	6	3	Kpd	
14	342116N	0775402	1	RAINBOW END MOT	P	C			50	36	2	X	19	11			3		1	6	3	Kpd	
15	342123N	0775414	1	JOHN LOREK	P	I			30	12	3	X	13	8	80							Tch-Kpd	
16	342127N	0775427	1	JOHN LOREK	P	I	P		21		4	X	14	8	100		5		1	6	4	Tch-Kpd	
17	342129N	0775448	1	JOHN LOREK	P	H			18		1	X										Tch-Kpd	
18	342051N	0775529	1	W H JONES	P	H			37		2	X	15	7			2		0	5	2	Kpd	

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
19	342045N	0775404	1	SMITH BARBER	P	H	P		40		1	X					6		0	6	3	Kpd	
20	342043N	0775402	1	MELLO ICE CREAM	N	C	P		10		30	X					0	7	0	5	3		Spring flow 10 gpm
21	342030N	0775427	1	ST STANISLAUS	P	T	P		180		2	X					4		0	5	3	Kpd	
22	342033N	0775413	1	WILM PACKING	N	C	C		68		4	X	18		80+		3	6'	1	5	3	Kpd	
23	342033N	0775409	1	WILM PACKING	N	A	C		21		6	X	*15	9			4		2	6	4	Tch	
24	342033N	0775326	1	REASOR CHEMICAL	N	N		DJ	150	30	10	G	22	9	400	75			2			Tch-Kpd	3 screens between 30'-120'
25	342045N	0775336	1	REASOR CHEMICAL	N	N		D	148	34	10	G		8	300	20						Tch-Kpd	Screened 33'-148'
26	342034N	0775323	1	REASOR CHEMICAL	N	U		D	212	14	6	X	22	11								Tch-Kpd	Stratigraphic test
27	342035N	0775324	1	REASOR CHEMICAL	N	N		D	150	33	6	G		4	200	12	5		2	6	4	Tch-Kpd	Screened 33'-133'
28	342025N	0775245	1	HENRY BAND	P	I			69	26	2	X	16	1			6		2	4	3	Tch-Kpd	
29	342028N	0775216	1	R D TARDUGNO	P	H	C	G	60	20	2	X	29	11	*30		5	6'	1	6	3	Tch-Kpd	Temp. 65°F.
30	342043N	0775207	1	A H PARKER	P	H			60	20	2	X	29		*40		7		1	6	4	Tch-Kpd	
31	342012N	0774925	1	USGS	F	U		J	94	92	1	T	33	7								Kpd	Auger hole No. 6
32	342012N	0774925	2	USGS	F	U		J	42	40	1	T	33	4								Tch	Auger hole No. 6
33	342036N	0774755	1	USGS	F	U		J	75	73	1	T	22	0								Kpd	Auger hole No. 45
34	342019N	0774727	1	JOSEPH WENEUT	P	H	C		42		2	X	40	9			5	6'	1	5	3	Tch	Temp. 66°F.
35	341948N	0775147	1	C LITTLEJOHN JR	P	H			50		2	X					5		0	5	3	Tch	Much iron reported
36	341933N	0775205	1	RAEFORD TRASK	P	I			87		6	X	39	12								Kpd	
37	341934N	0775253	1	ARTHUR KAUFMAN	P	U			29		1	X	28	4								Tch	
38	341954N	0775316	1	K E KORNEGAY	P	H	C		58	52	2	X		-			5	7'	1	6	3	Kpd	
39	341959N	0775312	1	MR HILL	P	H			52	24	2	X		9	*100							Tch-Kpd	
40	342015N	0775323	1	H A BRANCH JR	P	H	P		40		2	X					5		1	6	3		
41	342001N	0775431	1	S C STRICKLAND	P	U	P		24		1	X	21	7			7					Tch	
42	342003N	0775434	1	S C STRICKLAND	P	H			90	81	2	X	21	6	45							Kpd	

* Estimated. ' pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
43	342010N	0775441	1	J W SAVAGE	P	H	P		44		2	X	* 21	5	*60		6		1	4	2	Tch-Kpd	
44	342017N	0775436	1	J S CAMERON	P	U			40		4	X		8								Kpd	
45	342018N	0775441	1	J S CAMERON	P	U			179		4	X		8			3	7	5			Kpd	
46	342018N	0775445	1	J S CAMERON	P	H			55		1	X					3	7	1	6		Kpd	
47	342007N	0775504	1	HUGH OOSTERWYK	P	I			71		3	X	21	6								Kpd	
48	342000N	0775524	1	HUGH OOSTERWYK	P	I	P		74		8	X	21				5		2	6	4	Kpd	
49	341936N	0775527	1	S J SZCZERBIAK	P	H			100		1	X	25	1			4		2	6	3	Kpd	
50	341926N	0775658	1	USGS	F	U	C	GJ	54	52	2	T	34				4	7[1]	0	4	2	Kpd	Obs., Temp. 69°F, Auger #32
51	341928N	0775939	1	USGS	F	U	C	GJ	48	46	1	T	18	15			0		0	0	0	TQ	Obs., Auger #8
52	341957N	0775957	1	USGS	F	U		J	38	36	2	T	7									TQ	
53	341932N	0780127	1	USGS	F	U	C	G	20	18	2	T	3	1									Auger #41
54	341832N	0775904	1	USGS	F	U		GJ	65	62	2	T	17									TQ	
55	341910N	0775634	1	USGS	F	U		GJ	75	73	2	T	39									Kpd	Obs., Auger #25
56	341919N	0775526	1	JOHN G OWENS	P	H			40		1	X	25	7								Kpd-Tch	
57	341847N	0775531	1	MAGGIE L ALLEN	P	H			46		1	X		8								Kpd	
58	341844N	0775524	1	ST JAMES AME CH	P	T	P		54		2	X	36	10			5		1	6	3	Kpd	
59	341912N	0775510	1	US DEPT OF AGRI	F	I			45	35	3	X		5	100		6		0	5	3	Tch	
60	341920N	0775458	1	US DEPT OF AGRI	F	U		J	31		3	X	35	5								TQ	Observation well
61	341839N	0775352	1	RAEFORD TRASK	P	U			27		1	T	35	5								TQ	
62	341918N	0775303	1	PAULINE CORE	P	H			72		2	X	28	6								Kpd	
63	341904N	0775208	1	RAEFORD TRASK	P	I		J	119		4	X	38	11								Kpd	
64	341912N	0775153	1	RAEFORD TRASK	P	I			64		4	X	40	4	*100							Kpd	
65	341845N	0775153	1	RAEFORD TRASK	P	I		J	98	84	6	X	38	8	250							Kpd	
66	341856N	0774628	1	E C BRINKLEY	P	H	P		14		36	X	48	11			1	6	2	3		TQ	

* Estimated.

[1]pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
67	341902N	0774617	1	USGS	F	U		GJ	74	72	1	T	48									Tch	Obs. well, Auger #47
68	341905N	0774618	1	J C WELLS	P	H	C		70	60	1	X	50	26			5	6'	1	6	4	Tch	Temp. 66°F.
69	341913N	0774615	1	J F SWAN SR	P	H			100		2	X	50	28			8		1	6	3	Tch	
70	341911N	0774611	1	J F SWAN JR	P	H	C		172	130	2	X	46				6	6'	1	6		Kpd	
71	341816N	0774458	1	RALPH MOORE	P	H			30	22	2	X	24	11	15							Tch	Temp. 66°F.
72	341819N	0774450	1	HARRY L. SMITH	P	H			20	18	1	T	20	9			0		2	5	3	TQ	Cl 2280 at 60'.
73	341754N	0774440	1	MR ORNESBY	P	H		JD	165	159	2	X	18	9			3	7				Kpd	
74	341753N	0774441	1	R G JOHNSTON	P	H	P		60		2	X					1	7	4	7		Tch	
75	341747N	0774444	1	E E CASTEEN	P	H	P		47	27	2	X		17			1	7	5	7		Tch	
76	341743N	0774611	1	COR-DAVIS HOME	N	T	P		181	131	6	X	25	10	*450			7'	3			Kpd	
77	341738N	0774634	1	JOHN F MURRAY	P	H	P				1	X	23	12			1	7	1	4		Tch	
78	341755N	0774628	1	C E RIVENBARK	P	I	P		75		6	X		17	450		1		0	4	2	Tch	
79	341820N	0774646	1	C E RIVENBARK	P	I		J	60	38	2	X	40	12								Tch	
80	341800N	0774714	1	R D DREW JR	P	H			55		2	X	42	21			5		0	5	3	Tch	
81	341741N	0774655	1	W J WILSON	P	H	P		21	19	1	T	24	15			7		0	2	2	TQ	
82	341731N	0774704	1	W J WILSON	P	I			81	32	6	X	29	18	275	23	6		1	5	3	Tch	
83	341738N	0774752	1	A L SOUTHERLAND	P	H			56	52	1	X	36	12			5		1	6	3	Tch	
84	341722N	0774803	1	G P WILSON	P	U			41		1	X	37	20								Tch	
85	341746N	0775048	1	JOHN D MURRAY	P	H	P		123		2	X	42	16			5		0	7	3	Kpd	
86	341745N	0775123	1	JOHN D OLSEN	P	H	C		120	105	2	X	34	13			4	7'	1	6	3	Kpd	
87	341741N	0775123	1	USGS	F	U	C		740	120	4	X	32									Kpd	Test well
88	341722N	0775223	1	ALEXENDER WEIDE	P	H			109	78	2	X	42	17						5		Kpd	
89	341817N	0775414	1	USGS	F	U		GJ	55	53	1	T	38									Tch	Obs. well
90	341734N	0775406	1	RAEFORD TRASK	P	I		J	83		6	X	31									Kpd	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
91	341711N	0775401	1	RAEFORD TRASK	P	I		J	90		8	X	28		300		4	7'	2	6	3	Kpd	Temp. 65°F.
92	341724N	0775436	1	CORNELIUS MOORE	P	C			21	19	1	T	34	12								TQ	
93	341720N	0775443	1	USGS	F	U		GJ	130	128	1	T	34	11								Kpd	
94	341722N	0775448	1	J C LONG	P	H		G	55	51	2	S	35	13	*20		1		1	2	1	TQ	
95	341751N	0775451	1	J L SMITH	P	H		J	62		2	X	34	13								Tch-Kpd	
96	341758N	0775456	1	REED SMITH SR	P	H	P		55	42	2	X	30	9				7'				Kpd	
97	341818N	0775459	1	SWART SONS INC	N	U	P		367	309	8	X	35	1	*30			9	8			Kpd	Temp. 67°F., Br 22 ppm
98	341815N	0775512	1	A D COX	P	I			63		4	X	28	13	*50							Kpd	
99	341816N	0775516	1	A D COX	P	H			45		1	T	33	14								TQ	
100	341759N	0775507	1	G PLOTT	P	H			70	52	2	X	30	9								Kpd	
101	341754N	0775512	1	TINGA NURSERY	P	I			80	35	4	X	32		100+		6		1	5	3	Kpd	
102	341806N	0775530	1	E M STANLEY	P	H	P		67		2	X	*20	8	*100		7		1	6	4	Kpd	
103	341738N	0775532	1	C R WATTS	P	U			29	27	1	T	23	12								TQ	
104	341755N	0775612	1	ROY BROWN	P	H			26	24	1	T	26	20								TQ	High Fe content rept.
105	341811N	0775630	1	E H TINGA	P	U			28	26	1	T	26	10								TQ	
106	341753N	0775836	1	USGS	F	U		GJ	57	47	2	S	14									TQ	
107	341700N	0775921	1	USGS	F	U		GJ	50	47	2	T	11									TQ	
108	341705N	0775902	1	CAROLINA POWER	N	N	C	D	53	33	10	G	8	9	480	7		5'				Kpd-TQ	Temp. 67°F.
109	341706N	0775849	1	CAROLINA POWER	N	N			55		10	G	12									Kpd-TQ	
110	341701N	0775831	1	USGS	F	U		GJ	57	54	2	T	18									TQ	
111	341706N	0775748	1	USGS	F	U	C	G	56	53	2	T	20				1	7	0	0	0	Kpd-TQ	
112	341651N	0775738	1	CAROLINA NITRO	N	N		D	84	56	8	G	44		280							Kpd-TQ	
113	341642N	0775734	1	CAROLINA NITRO	N	N	P	J	65	30	8	G	33	27	200	18						Kpd-TQ	
114	341634N	0775732	1	CAROLINA NITRO	N	N		D	60	40	8	G	24	23	200	13						Kpd-TQ	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
115	341631N	0775721	1	CAROLINA NITRO	N	N	C	D	72	47	8	G	24	23	80	20						Kpd	
116	341619N	0775741	1	JOHNNY MALPASS	P	H	P		25	23	1	T	12	5			5		0	1	1	TQ	
117	341619N	0775727	1	SWIFT AGRI CHEM	N	N			55	35	8	G		6	*100							Kpd	
118	341609N	0775719	1	ROBERTSON CHEM	N	H			21	18	2	T		4				5[1]	1			TQ	Reported high Fe
119	341605N	0775718	1	ROBERTSON CHEM	N	U			47		4	X	5	3			5		0	1	0	Kpd	
120	341558N	0775719	1	HORTON IRON MET	N	H			20	15	2	T	6									TQ	
121	341558N	0775713	1	HORTON IRON MET	N	N			40		4	X	5	2	*50		8		1	4	2	Kpd	
122	341613N	0775609	1	GROVER SCOTT	P	H			60	42	2	X		14								Kpd	
123	341623N	0775604	1	FRED TOWNSEND	P	H	C		60	42	2	X	24	17	*100		6	6[1]	1	4	3	Kpd	Temp. 66°F.
124	341706N	0775544	1	W F INGOLD	P	U			20	18	1	T	25	9								TQ	
125	341646N	0775524	1	EDGAR MCKOY	P	H		D	75	72	2	X			*50							Kpd	
126	341644N	0775517	1	M K MALPASS	P	H			78	70	2	X	28	12	*100							Kpd	
127	341624N	0775452	1	NEW HAN AIRPORT	M	U	P	DJ	89		8	X	29	15								Kpd	Specific cap. 34 gpm/ft.
128	341623N	0775455	1	NEW HAN AIRPORT	M	P			105	65	8	X		15	211	9						Kpd	
129	341616N	0775505	1	NEW HAN AIRPORT	M	P			102	93	8	X		17	300	8						Kpd	
130	341605N	0775523	1	PILOT FRGT INC	N	C			75	51	2	X	25	12								Kpd ?	
131	341550N	0775355	1	ADC DIS COMPLEX	F	P	C				8	X		8	425	13						Kpd	12" in 5x6 orifice
132	341545N	0775339	1	ADC DIS COMPLEX	F	P			96	74	8	X		1	445	8	5		2	5	3	Kpd	13" in 5x6 orifice
133	341623N	0775357	1	S H FEENSTRA	P	H	P		20	17	1	T	21	5			6		1	0	1	TQ	H_2S
134	341628N	0775357	1	S H FEENSTRA	P	I	C		113		8	X	20	0			5	7[1]	1	6	3	Kpd	Temp. 64°F.
135	341629N	0775351	1	S H FEENSTRA	P	I		J			4	X		2								Kpd	H_2S
136	341622N	0775332	1	FRED A JORDAN	P	U			25	23	1	T	21	6			5		1	2	1	TQ	H_2S
137	341649N	0775329	1	DOROTHY PEOPLES	P	H	P		22	20	1	T	24	4			7		1	2	1	TQ	H_2S
138	341652N	0775248	1	J N CORBETT	P	U			36	34	1	T	40	9								TQ	

* Estimated. [1]pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
139	341649N	0775249	1	E E LEWIS	P	H	C		121	90	2	X	41	5	*130		3	7	0	5	3	Kpd	Temp. 66°F.
140	341641N	0775240	1	G W SHEARON	P	H	P		115	110	2	X					5		0	5	3	Kpd	
141	341626N	0775241	1	HARRELLS BLDG	N	I		J	87		6	X	29	3			6	7'	0	5		Tch-Kpd ?	Temp. 65°F.
142	341635N	0775147	1	HERBERT NEWTON	P	H					2	X	38	19			5	8	0	5	4	Kpd ?	
143	341629N	0775139	1	RAYMOND MCKOY	P	H	P		20	17	1	T	45	5								TQ	
144	341610N	0775045	1	E F PRIDGEN	P	P		D	146	92	2	X	41	21			5		0	5	3	Kpd	
145	341608N	0774923	1	NEGRO CHURCH	P	T		J	87		4	X	46	6								Tch	
146	341616N	0774907	1	J W COVIL	P	C	P		75		2	X		18	*60		6		1	6	3	Tch	High Fe
147	341613N	0774857	1	CHRISTIAN CH	P	T	C		65	50	2	X	45	12				7'				Tch	Temp. 68°F.
148	341646N	0774858	1	FRANK PARKER	P	H		J	155	60	2	X	47									Tch-Kpd	
149	341646N	0774842	1	BAYSHORE EST	N	U		J	68		2	X	44	9								Tch	
150	341639N	0774830	1	E K CARTER JR	P	H	P				1		31				4		0	4	2		
151	341634N	0774758	1	M L HONEYCUTT	P	H		G	80	40	2	X	16	12								Tch	
152	341641N	0774750	1	M P RAINES	P	H		G	90		2	X	20	13	*30		5		1	5	3	Tch	
153	341637N	0774747	1	D P HERBERT	P	H			50	41	2	X		15	*20							Tch	
154	341654N	0774739	1	M MARSHBURN	P	H	C		150	110	2	X	23					7'				Kpd	Tem. 66°F., much H_2S
155	341648N	0774642	1	W J ROBINSON	P	H	C		60	55	1	X	10				2	7'	2	5	3	Tch	Temp. 66°F.
156	341723N	0774503	1	C M DAVIS	P	H	P		85			X					0		3	4	3	Tch	
157	341712N	0774510	1	M H BELL	P	H	P		120		2	X					0	8	2	5		Tch	
158	341659N	0774522	1	G A RYALS	P	H			180	126	2	X	20	15	*50		5		2	6	4	Kpd	
159	341654N	0774525	1	J N MCCARTNEY	P	H	P		42	40	1	X					0	8	5	7		Tch	
160	341652N	0774526	1	G D FARMER	P	H	C		180	127	2	X	20	15				7'				Kpd	Temp. 66°F.
161	341631N	0774548	1	CAMERON - TRASK	P	H	P		38		1	T					1		1	5	3	TQ	
162	341629N	0774552	1	CAROLINA POWER	N	H	P		70		2	X					0		1	4	2	Tch ?	

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
187	341525N	0775315	1	ALLENDALE DEV	P	U			29		1	T	21	11								TQ	
188	341526N	0775325	1	E C AKERS	P	H			70	43	2	X	15									Kpd	Flows
189	341519N	0775328	1	H C JOHNSTON	P	H			92		2	X	28	15								Kpd	
190	341438N	0775321	1	LEON SULLIVAN	P	P			129	42	3	X	38	16	100+							Tch-Kpd	
191	341432N	0775313	1	SANDRE - BASS	P	H			151	57	2	X	40	22								Tch-Kpd	
192	341431N	0775320	1	BECKERS BLDS	N	C	C		150	105	2	X	42		*40		5	7'	1	6	3	Kpd	Temp. 67°F.
193	341405N	0775426	1	D L SNEEDEN	P	S			130	35	2	X	36	10								Tch-Kpd	
194	341402N	0775434	1	JOS FREEDLAND	P	A		D	89	72	4	X		12	*100							Tch-Kpd	
195	341405N	0775435	1	B W NEWKIRK	P	H		D	87	40		X		19	*60							Tch-Kpd	
196	341430N	0775448	1	BNAI ISR SYNAG	P	A		D	94	15		X	35	8	100	14						Tch-Kpd	
197	341411N	0775512	1	RUDOLPH KONIG	P	H		D	75	27	4	X					1		1	6	3	Tch-Kpd	
198	341441N	0775511	1	J FRED MURRAY	P	I		D	97	75	4	X	28	25	*100		5		1	5	3	Kpd	
199	341438N	0775515	1	R L DAVIS	P	I		G	90	34	2	X	28	24								Tch-Kpd	
200	341517N	0775544	1	SOUTHERN BOX	N	N	P		85		6	X	21	20	185				2	5		Kpd	
201	341507N	0775621	1	BOYLE ICE CO	N	C			65		8	X			650				2			Kpd	
202	341530N	0775651	1	HILTON PARK CO	M	U	P	G	1330		6	X	9		*50		5	8	8	5	8	Kpd ?	Temp. 70°F., Br 31 ppm
203	341512N	0775653	1	HILTON PARK CO	N	U			80		10	X	10	6	400							Kpd	
204	341437N	0775636	1	INDEPENDENT ICE	N	U			120	75	12	X			325	6			2	6		Kpd	
205	341417N	0775616	1	COCA COLA BOTT	N	C	P		180		4	X	44	19	*80		2		1	5	3	Kpd	
206	341413N	0775618	1	WARDS FUNERAL	N	U		J	82		4	X	53									Tch-Kpd	
207	341407N	0775644	1	PEOPLES SAVINGS	N	A			86		6	X	38	31	100	12						Kpd	Fe bacteria rptd.
208	341407N	0775644	2	PEOPLES SAVINGS	N	A		D	122	108	8	G	38	44	96		2	8	2	4	3	Kpd	
209	341407N	0775644	3	PEOPLES SAVINGS	N	A	C	D	133	110	8	G	36	41	97	13						Kpd	
210	341430N	0775655	1	WILM COLD STOR	N	C		J	104		10	X	21	26								Kpd	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

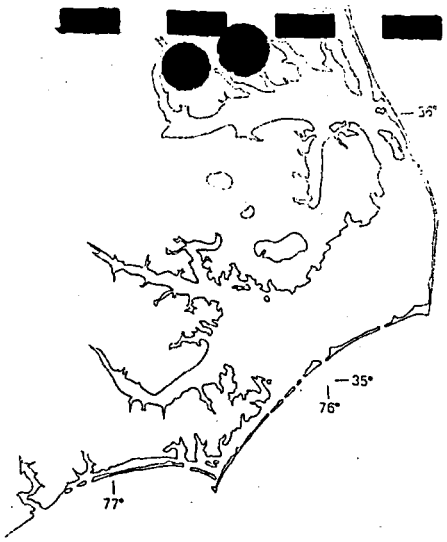
Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
211	341412N	0775702	1	WACHOVIA BANK	N	U			80		6	X							3			Kpd	Test well
212	341409N	0775738	1	USGS	F	U	P	G	93	91	1	T	4				5	7	3	6		Kpd	Auger hole #40
213	341403N	0775818	1	TERMINAL CITY	N	C			63		3	S	4	8	*6							Kpd	
214	341407N	0775609	1	ROSE ICE CO	N	C			96		6	X										Tch-Kpd	Cl rept. 62 ppm in 1942
215	341407N	0775605	1	NEW HAN HIGH SC	C	P		D	122	50	6	X		18	165							Kpd	
216	341349N	0775637	1	5TH AVE BAPT CH	P	T		D	90	58	6	X	45	18	*35							Kpd	
217	341331N	0775646	1	BRIGADE BOYS CL	P	T		J	115	40	4	X	47	42								Kpd	
218	341330N	0775522	1	PEPSI COLA BOTT	N	C		D	75	41	8	X	37	11	220	20	5		0	5	3	Tch-Kpd	
219	341324N	0775521	1	WHITEBROOK FARM	N	C					8	X	38		150							Tch-Kpd	Rept. Cl 62 ppm, Hard. 210
220	341314N	0775442	1	ALBERT PERRY	P	I	P		163	58	3	X	35		*80		5		0	5	3	Tch-Kpd	
221	341327N	0775434	1	L B FINBERG	P	I			135		4	X			*100							Tch-Kpd	
222	341306N	0775356	1	R A YOPP	P	H		G	135	100	4	X	40	2								Kpd	
223	341329N	0775341	1	J D PRIDGEN	P	H			25	21	1	T	28	7	*10							TQ	
224	341302N	0775352	1	D E JOHNSON	P	H	P	G	140	50	2	X	38	9	*40		4		1	6	3	Tch-Kpd	
225	341243N	0775331	1	W S ARTHURS	P	H			98	58	2	X	42	10								Tch	
226	341307N	0775312	1	L J MINTZ	P	H		D	140	86	4	X	38	28	165		5		1	6	3	Kpd	
227	341416N	0775206	1	W D MCKEE	P	H		J	135	60	2	X	41									Tch-Kpd	
228	341337N	0775239	1	WILM COLLEGE	S	A	P	D	165	80	10	G		12	340	80	2	8	2	6	3	Tch-Kpd	Temp. 66°F.
229	341330N	0775236	1	WILM COLLEGE	S	U		J	84		4	X	42									Tch	
230	341336N	0775232	1	WILM COLLEGE	S	A	P	D	180	80	10	G		7	360	50						Tch-Kpd	
231	341303N	0775236	1	M J PIERCE	P	H	P	D	170	80	2	X	42		*60		4		0	5	3	Tch-Kpd	
232	341255N	0775231	1	MRS EARL BIGGS	P	H			35	31	1	T	40	13			4		1	1	1	TQ	
233	341237N	0775252	1	ANDY MASON	P	H		G	159	76	2	X	*42									Tch-Kpd	
234	341233N	0775231	1	E R WILSON	P	H		D	163	82	4	X	41	30			3		1	5	3	Kpd	

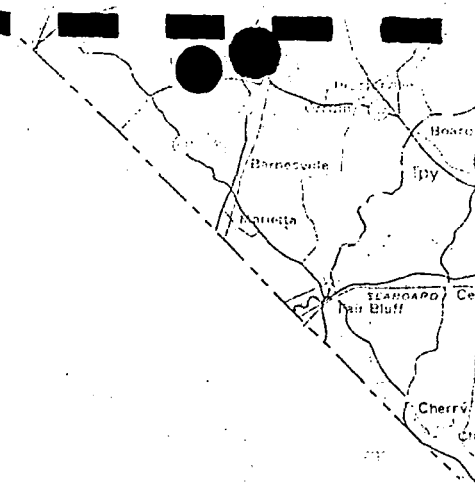
* Estimated.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
283	341238N	0775452	1	DR S V ALLEN	P	I	P		19	16	1	T			*15		7		2	2	2	TQ	
284	341234N	0775502	1	W B BEERY III	P	I			155		6	X	33									Kpd	
285	341230N	0775450	1	MR STALLWORTH	P	H			158	66	3	X	45	29	*100							Kpd	
286	341206N	0775457	1	C R BRINDELL	P	H			160	60	2	X	55	46	*20							Tch-Kpd	
287	341238N	0775547	1	GEORGE LAMICA	P	H	C		30	24	2	X	22				2	7[1]	0	4	2	Tch	
288	341220N	0775553	1	JOHN W DIXON JR	P	H	C		110	90	2	X	*7	1			1	8[1]	0	4	2	Kpd	Temp. 67°F., H_2S odor
289	341220N	0775613	1	LEE E MORROW	P	H			26	22	1	T	10	3								TQ	
290	341207N	0775630	1	SUNSET PK METH	P	T		D	82		8	X	19	15								Kpd	
291	341202N	0775638	1	SUNSET CO 3	N	U	P		140		6	G			132				2	3		Kpd	Rept. HCO_3 133 ppm
292	341214N	0775639	1	SUNSET CO 4	N	U			140		6	G			150	18						Kpd	
293	341210N	0775654	1	BILL CANNON	P	U			20	16	1	T	23	11								TQ	
294	341146N	0775703	1	WILM SHIPYARD	F	C		D	123	70	10	G		20	275	58						Kpd	
295	341141N	0775703	1	WILM SHIPYARD	F	U	P							13								Kpd	
296	341132N	0775702	1	WILM SHIPYARD	F	A	P		103	81	10	G		28	300	48	1	8	1	3	2	Kpd	
297	341126N	0775708	1	SHELL OIL CO	N	C	P		76	36	8	X		6	*325	6	7	7	2	4		Kpd	
298	341125N	0775630	1	WECT TV	N	A			133	55	4	X	52	26	100+							Tch-Kpd	
299	341127N	0775609	1	MOFFIT VILLAGE	N	P		G	175		10		43	9	140	37						Tch-Kpd ?	
300	341138N	0775606	1	L W CARROLL	P	H			57	44	4	X	*30	14			7		0	4	2	Tch	
301	341120N	0775555	1	NATL YOUTH ASSN	P	U		D			6		56	24								Tch-Kpd	
302	341112N	0775559	1	HANOVER MILLS	N	N			157	79	8	X	57	30	*100	17		8	1			Tch-Kpd	
303	341058N	0775555	1	H B LUDLUM	P	H		G	140	76	2	X	56	17								Tch-Kpd	
304	341134N	0775406	1	J R KUTRON	P	H	P		160	60	2	X	40		*40		5		0	5	3	Tch-Kpd	
305	341139N	0775357	1	H M DANIELS	P	H	P		160		4	X	48		100+		6		0	6	3	Tch-Kpd	
306	341124N	0775357	1	FRED CONNER	P	H	P		160	60	3	X	50	19			5		0	6	3	Tch-Kpd	

* Estimated. [1]pH measured in field.





GEOLOGIC MAP OF NORTH CAROLINA

1985

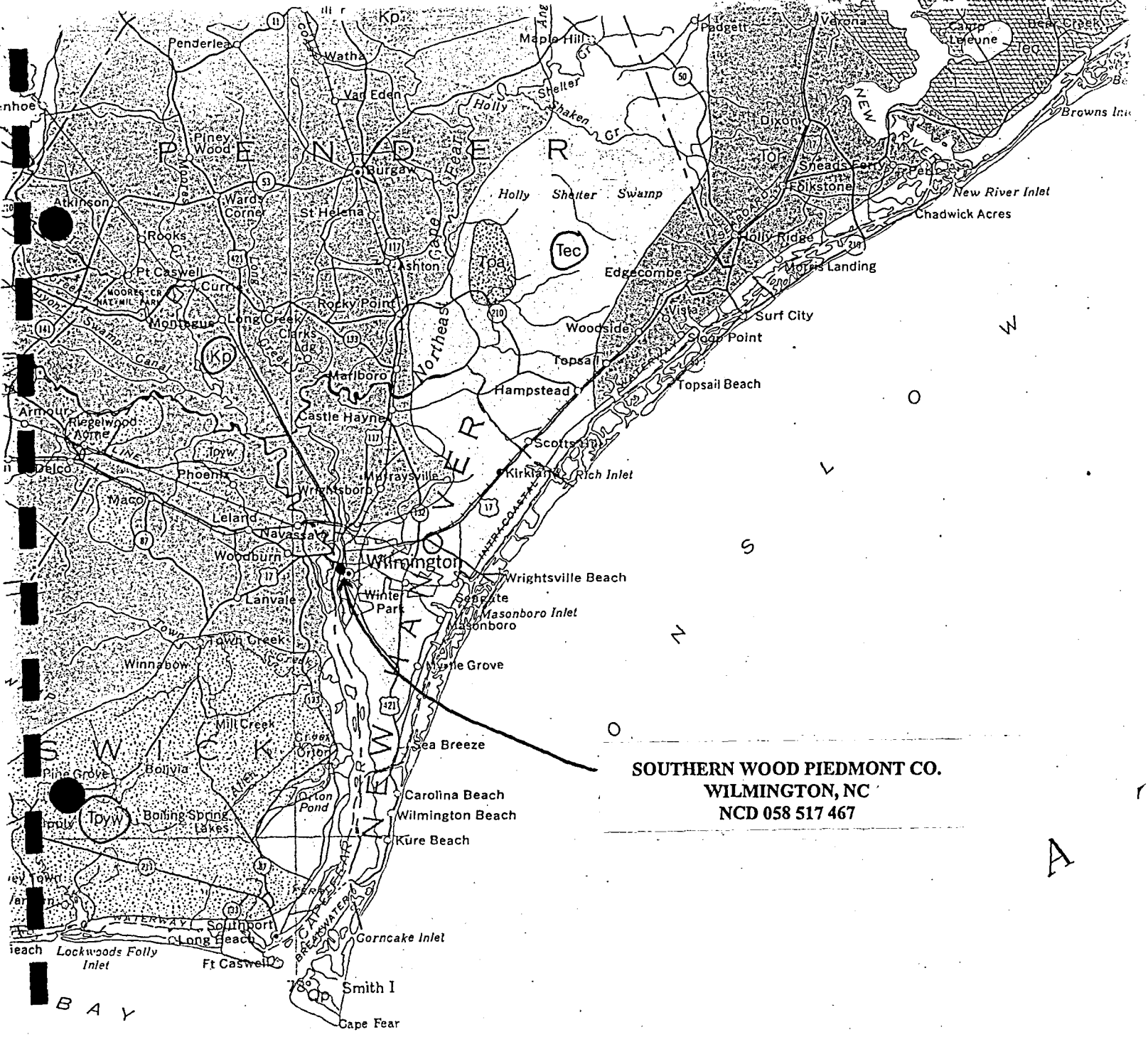
Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometres

Ref. 22



SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC
NCD 058 517 467

COASTAL PLAIN

QUATERNARY

Qp — SURFICIAL DEPOSITS, UNDIVIDED — Sand, clay, gravel, and peat deposited in marine, fluvial, eolian, and lacustrine environments. Quaternary deposits not shown at altitudes greater than approximately 25 feet above mean sea level (Suffolk Scarp, in part)

TERTIARY

Tp — PINEHURST FORMATION — Sand, medium- to coarse-grained, cross-bedding and rhythmic bands of clayey sand common, unconsolidated

Tt — TERRACE DEPOSITS AND UPLAND SEDIMENT — Gravel, clayey sand, and sand, minor iron-oxide cemented sandstone

Tpyw — WACCAMAW FORMATION — Fossiliferous sand with silt and clay, bluish-gray to tan, loosely consolidated. Straddles Pleistocene-Pliocene boundary

Tpy — YORKTOWN FORMATION AND DUPLIN FORMATION, UNDIVIDED

Yorktown Formation: Fossiliferous clay with varying amounts of fine-grained sand, bluish gray, shell material commonly concentrated in lenses; mainly in area north of Neuse River

Duplin Formation: Shelly, medium- to coarse-grained sand, sandy marl, and limestone, bluish gray; mainly in area south of Neuse River

Tob — BELGRADE FORMATION, UNDIVIDED

Pollocksville Member: Oyster-shell mounds in tan to orange sand matrix, indurated locally

Haywood Landing Member: Fossiliferous clayey sand, gray to brown. Members grade into each other laterally

Tor — RIVER BEND FORMATION — Limestone, calcarenite overlain by and intercalated with indurated, sandy, molluscan-mold limestone

CASTLE HAYNE FORMATION

Tecs — Spring Garden Member: Molluscan-mold limestone, indurated, very sandy. Grades downward into a calcareous sand and laterally into Comfort Member

Tec — Comfort Member and New Hanover Member, undivided

Comfort Member: Bryozoan-echinoid skeletal limestone, locally dolomitized, solution cavities common

New Hanover Member: Phosphate-pebble conglomerate, micritic, thin; restricted to basal part of Castle Hayne Formation in southeastern counties

Tpa — BEAUFORT FORMATION, UNDIVIDED

Unnamed upper member: Sand and silty clay, glauconitic, fossiliferous, and locally calcareous

Jericho Run Member: Siliceous mudstone with sandstone lenses, thin bedded; basal phosphatic pebble conglomerate

CRETACEOUS

Kp — PEEDEE FORMATION — Sand, clayey sand, and clay, greenish gray to olive black, massive, glauconitic, locally fossiliferous and calcareous. Patches of sandy molluscan-mold limestone in upper part

Kb — BLACK CREEK FORMATION — Clay, gray to black, lignitic; contains thin beds and laminae of fine-grained micaceous sand and thick lenses of cross-bedded sand. Glauconitic, fossiliferous clayey sand lenses in upper part

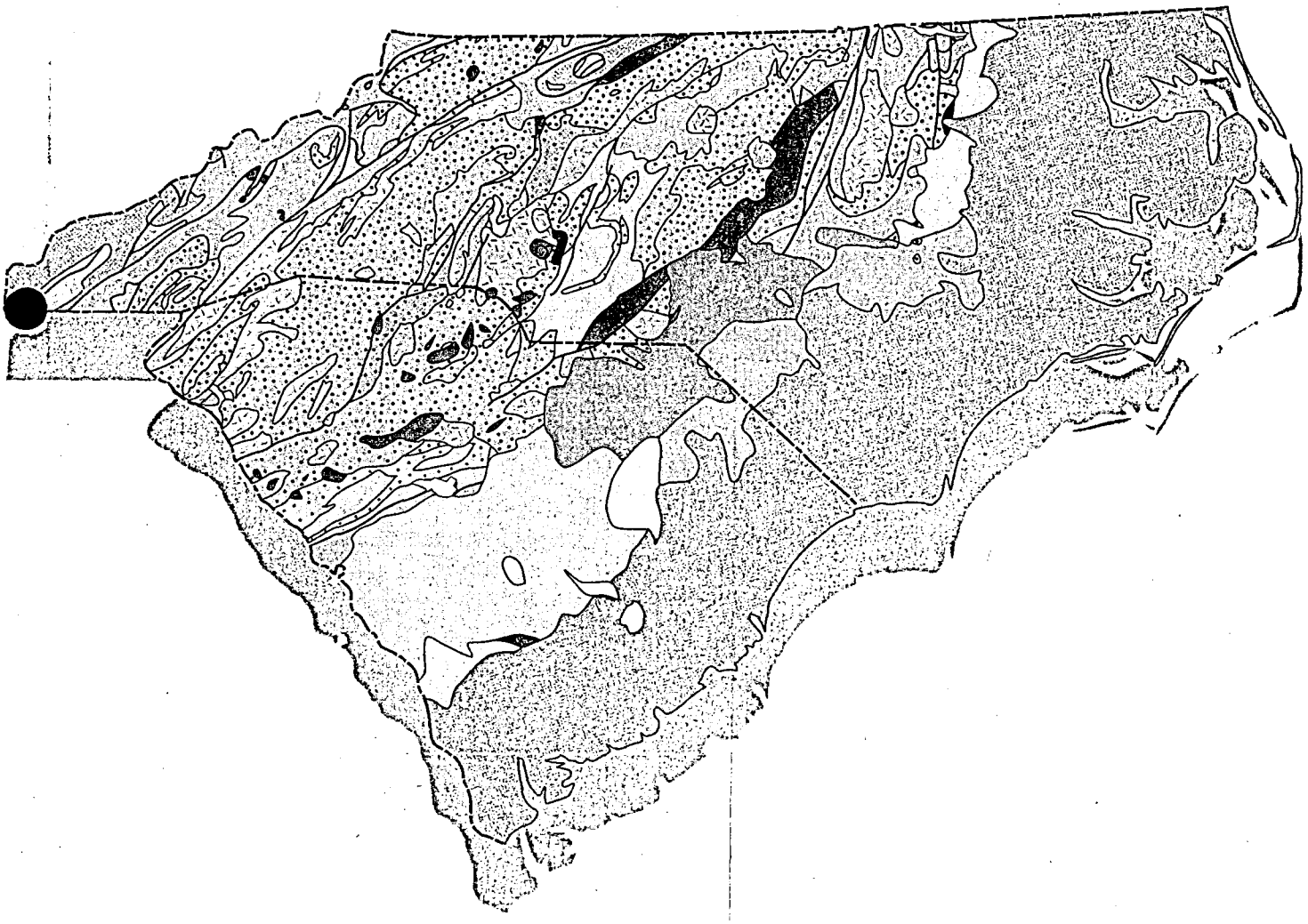
Km — MIDDENDORF FORMATION — Sand, sandstone, and mudstone, gray to pale gray with an orange cast, mottled; clay balls and iron-cemented concretions common, beds laterally discontinous, cross-bedding common

Kc — CAPE FEAR FORMATION — Sandstone and sandy mudstone, yellowish gray to bluish gray, mottled red to yellowish orange, indurated, graded and laterally continuous bedding, blocky clay, faint cross-bedding, feldspar and mica common

Ref. 23

The Geology of the Carolinas

Carolina Geological Society Fiftieth Anniversary Volume



Edited by J. Wright Horton, Jr., and Victor A. Zullo

The Geology of the Carolinas

Carolina Geological Society Fiftieth Anniversary Volume

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The University of Tennessee Press KNOXVILLE

11. Cretaceous Stratigraphy of the Carolina Coastal Plain

Norman F. Sohl and James P. Owens

Introduction

Studies of the Cretaceous outcropping rocks in the Carolinas are largely confined to major river valleys of the region. Unweathered beds of Cretaceous age are best exposed in the river valleys between the Peedee River in South Carolina on the south and the Roanoke River in central North Carolina on the north. Beyond these limits the unweathered Cretaceous beds have been overlapped by younger units. Cretaceous beds are also exposed in areas of higher elevation in the inner Coastal Plain, but very deep weathering there has made lithic separation of the formations very difficult. Because of the relatively small areas of outcrop of unweathered beds, a provincial stratigraphy evolved in the Carolinas that differed significantly from that of other areas of unweathered Cretaceous outcrop in the Atlantic Coastal Plain, such as the Salisbury embayment to the north, and in western Georgia to the south (Fig. 11-1).

Study of the stratigraphic relations of Cretaceous rocks in the Carolinas has a long and complicated history (Fig. 11-2). For outcropping rocks, in recent years, authors such as Brett and Wheeler (1961) and Swift and Heron (1961) have accepted a stratigraphic column consisting of four formations as follows, from oldest to youngest: Cape Fear, Middendorf, Black Creek, and Peedee. As seen in Fig. 11-2, the older three formations have been assigned to a variety of ages. This instability arose primarily because of the lack of distinctive calcareous faunas that would establish definitive age relationships. Obviously, this instability has led to many miscorrelations of these units with those of other areas. Only the Peedee Formation has had a relatively stable history in both nomenclature and correlation. This stability arose from its comparative uniform lithology throughout its outcrop belt and its biostratigraphically distinctive calcareous fauna. As discussed below in the sections dealing with the individual formations, Stephenson (1912a and 1923) provided much potentially valuable biostratigraphic information that, if properly analyzed, would have alleviated some of the correlation problems for the Black Creek interval. However, this information subsequently has either been ignored, misinterpreted, or not upgraded in the light of more precise knowledge currently available.

Units such as the Cape Fear and Middendorf Formations and, to some degree, parts of the Black Creek Formation, are nonmarine in origin, but all can be related to deltaic systems of sedimentation (Owens and Gohn, 1985). In other Coastal Plain areas, similar coeval nonmarine deposits have proven amenable to biostratigraphic zonation by the study of contained pollen. For example, Brenner (1963) provided a zonation of the Potomac Group of the Salisbury embayment. Utilizing this pollen based biostratigraphic zonation, Owens and others (1977) traced the distribution of the major Lower Cretaceous deltaic lobes in that region. Subsequently, Wolfe (1976) erected a pollen zonation for the Upper Cretaceous of the northern Atlantic Coastal Plain. Although refined by later workers, it is Wolfe's pioneering zonation that has provided a firm basis for relating nonmarine to marginal marine units in our studies of the Carolina Coastal Plain. In addition to these biostratigraphic studies, work directed toward integrating the pollen zonation with the available calcareous faunas is exemplified by the study of the Black Creek-Peedee Formation boundary on the Cape Fear River by Sohl and Christopher (1983). Much of their additional work on the other Carolina river sections remains unpublished but has been utilized in the following synthesis.

Lithostratigraphic studies in the outcrop by Owens (1988) and regional surface to subsurface synthesis by Owens and Gohn (1985) suggest that the Cretaceous units of the Carolinas fit well into a deltaic-to-shelf model of sedimentation. Within such systems, lithofacies changes are rapid, and interpretation of their spatial distribution must be done within a chrono- and biostratigraphic framework to avoid gross correlation errors. In particular, correlation from marine to nonmarine facies is imperative. The stratigraphic tools needed to accomplish such an end are available and are applied herein. Thus, our interpretations disagree with previously advanced models such as that in which the Middendorf, Black Creek, and Peedee were interpreted as time-transgressive units representing a single cycle of marine transgression that encompassed the Eaglefordian (late Cenomanian-Turonian) through Navarroan (Maastrichtian) (Heron and Wheeler, 1964, p. 7; Swift and Heron, 1969). In this paper, we propose that a number of cycles of sedimentation can be recognized within the Cretaceous section. Generally, these cycles are separated by disconformities, some of which are limited to the Carolinas, but others appear to extend as far

nates the sand fraction with feldspar, mostly potassium feldspar, usually present in amounts of less than 10 percent. Detrital glauconite is sparingly present, becoming abundant only in the upper part of the formation in the valley of Contentnea Creek.

Age

The Donoho Creek Formation is virtually coeval with the *Exogyra cancellata* Zone as proposed by Stephenson (1914, 1933). Because the unit is disconformity bounded, one cannot definitely state that the Donoho Creek deposits represents the full time interval of the zone, but it does appear to fall within its range. This zone is now accepted as being lower Maastrichtian, and both planktonic foraminifers and nannofossils of this age have been identified from this formation along the Cape Fear River (C.A. Smith, written communication, June, 1980).

From the outcrop of the formation along the rivers in North Carolina, the massive shelfal sands have yielded macrofossil assemblages that are dominated by epifaunal pelecypods. Most common are *Exogyra*, various other ostreids, and anomids. Most important from a biostratigraphic standpoint are *Exogyra cancellata* Stephenson and *Anomia tellenoides* Morton. Stephenson (1923) reported these species from a number of localities in North Carolina but maintained that they were not to be found south of Lake Waccamaw. This led him to conclude that beds of this age were absent at the outcrop in South Carolina. Subsequent authors, such as Cooke (1936), Dorf (1952), Heron (1958a), and others (Fig. 11–2), have perpetuated this view. This interpretation has led to a number of papers dealing with the Burches Ferry section on the Pee Dee River. Opposing views have been expressed on the issue of a long versus short interval of erosion that preceded Peedee Formation deposition (Swift, 1966; Benson, 1969; and Swift, 1969). These arguments are now moot, because beds assignable to the *Exogyra cancellata* Zone are present at Burches Ferry. Sohl and Owens (1980, p. 229) found a previously unrecorded fauna at Burches Ferry, during a time of low water, some 2.4 to 2.7 meters below the contact with the Peedee Formation. Among other molluscs, specimens of both *Exogyra costata* and *Anomia tellenoides* were recovered. Owens and Gohn (1985, Fig. 2–20) show the relationships for this interval, as now understood, between the Pee Dee River and the Cape Fear River. Fig. 11–6 lists a number of molluscan species characteristic of the underlying Bladen and overlying Peedee that serve to biostratigraphically differentiate the units.

Origin

The Donoho Creek Formation is principally a delta front–prodelta to shelf deposit with the bulk of the outcrop being shelfal. The delta front to prodelta facies are mainly found in the Pee Dee River valley and to the west in South Carolina. Downdip of the Pee Dee River into the subsurface, mainly shallow shelf conditions prevailed. The source of the Donoho Creek sediments appears to be from an igneous to metamorphic terrane, if one considers the nonopaque mineral suite. However, the low feldspar content is an anomaly, but suggests two possible explanations: (1) feldspar may not have survived or been transported beyond the swash zone, and thus is not to be seen in appreciable amounts in these shelfal facies; (2) the deposits of the formation were derived by reworking from older units during which the feldspar was destroyed. The first explanation seems the more likely to us.

If the Donoho Creek Formation was deposited in a delta-shelf similar to that we have outlined for the other formations of the Black Creek Group, then it is obvious that much of the unit's former extent is now missing. It therefore seems likely that much of the Donoho Creek deltaic facies has been stripped from the Cape Fear arch area and probably from much of the upper Coastal Plain of South Carolina. This episode of stripping probably occurred during the deposition of the Tertiary units or perhaps later.

Peedee Formation

Surface, Exposures

Exposures of the Peedee Formation occur along all of the major Coastal Plain streams from Contentnea Creek in the north to the Pee Dee River basin in the south. Only the lower parts of the formation are exposed along the northern rivers, but outcrops of both the older and the younger beds of the Peedee are visible along the Cape Fear and Pee Dee Rivers (Fig. 11–13).

The base of the unit rests with disconformity upon the Donoho Creek Formation. This relationship is well exposed at its type section at Burches Ferry (milepost 87.75) along the Pee Dee River in South Carolina (Sloan, 1907a; Stephenson, 1923; Fig. 11–14, this volume). It may also be seen at Black Rock Landing (milepost 38) on the Cape Fear River and just upstream of Edwards bridge (milepost 13.4) on Contentnea Creek in North Carolina. In these exposures the basal unit incorporates reworked phosphatic clasts consisting of bored subrounded cobbles and internal molds of molluscs and teeth and bone materials. Coarse grains of quartz sand to pebbles may also contribute to the coarser fraction. When shells are incorporated in this unit their orientation is chaotic and many may be fragmented or worn. Cobbles are commonly encrusted by epizoans. Lawrence and Hall (1987) provide faunal lists of the basal beds at Burches Ferry.

The formation is dominantly a dark-greenish to grey, sparingly micaceaous and glauconitic, argillaceous sand that commonly appears to be massive. Calcareous cemented concretions occur both sporadically or aligned at a uniform stratigraphic level. Dark marine clays are decidedly subordinate, although locally, as at Davis Landing (milepost 72) on the Pee Dee River, they may be up to 2 meters thick. Calcareous sandstone ledges occur at many stratigraphic levels interbedded with the firm, but noncemented sands. These beds may range up to 0.6 meters in thickness. Sandy limestones (biomicrudite) occur near the

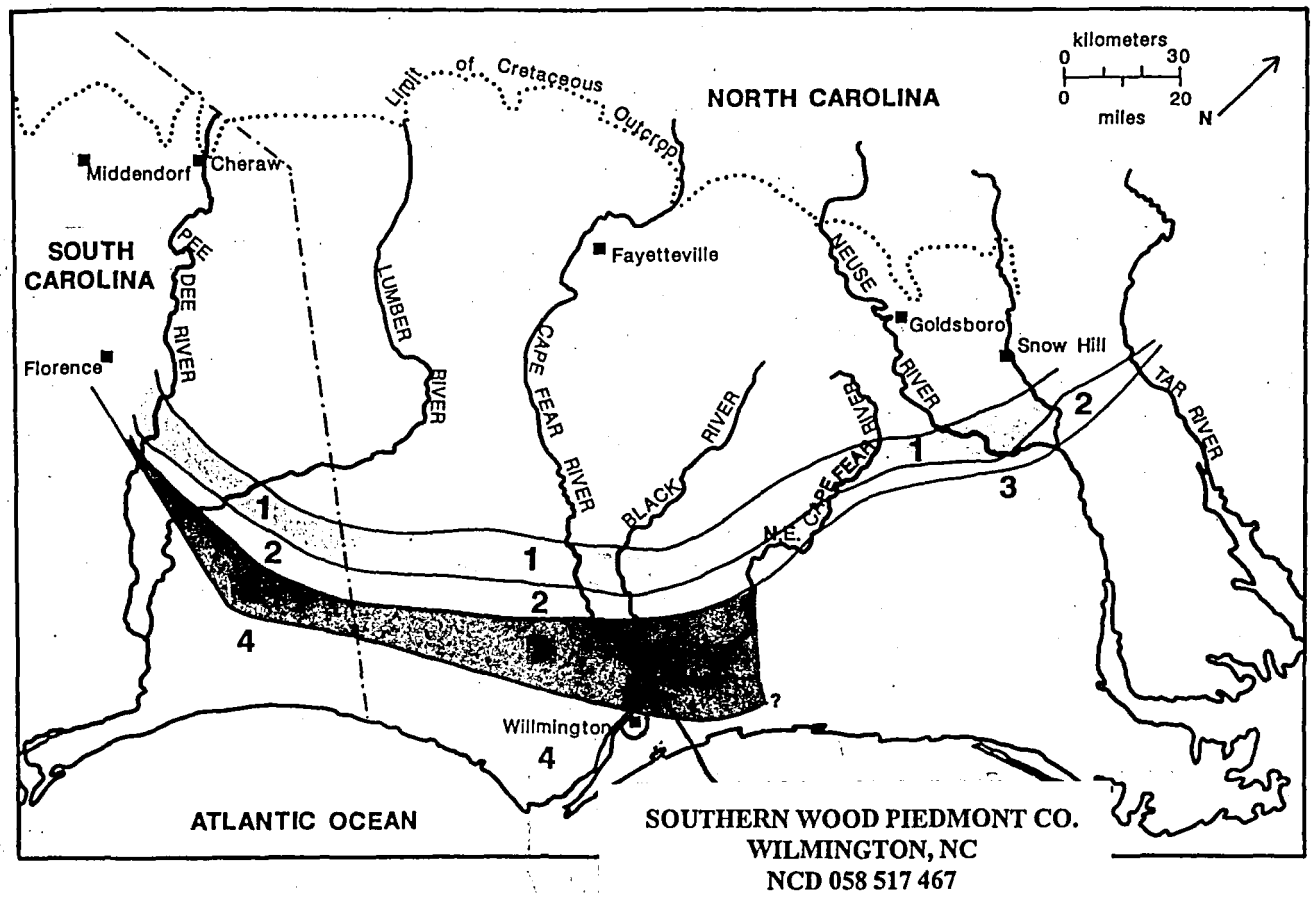


Fig. 11-13. Areal distribution of the biozones in the Donoho Creek and Peedee Formations: 1) *Exogyra cancellata* Zone; 2) *Belemnitella americana* Range Zone; 3) *Flemingostrea subspatulata*, normal form, Range Zone; 4) *Haustator bilira* Assemblage Zone.

top of the Peedee along the Cape Fear River and in the Castle Hayne area (Pender County, North Carolina), where they have been named the Scotts Hill Member, which replaces the preempted name "Rocky Point Member," of Wheeler and Curran (1979), and in the Pee Dee River sequence at Allisons Landing (milepost 67.5). These sandy limestones contain a large fauna that is usually dominated by pelecypods. In these limestones, the aragonitic shelled molluscs have either been replaced by calcite or, when dissolved, occur as external molds.

Burrows are common to almost all parts of the formation, with much of the massive character of the sand probably resulting from homogenization by bioturbation. Individual burrows may have clays concentrated in the burrow linings and, upon weathering, provide a mottled pattern to outcrop faces of the river bluffs.

Minor diastemic breaks occur within the section, but represent little time. One of the most easily observed diastems is that along the Northeast Cape Fear River below the bridge near Chinquapin, Duplin County, North Carolina. Here the hummocky upper surface of a Peedee sandstone bed is exposed. The sandstone evidently underwent rapid post-depositional lithification. Subsequently, this bed was sublitorally exposed and boring organisms penetrated the surface. The surface was then eroded somewhat to the point that only the lower part of the borings remains. The surface was then recovered by normal Peedee shelfal sands. In contrast to the disconformity at the base of the formation, which can be traced regionally, such intraformational hiatuses as that at Chinquapin appear to be of minor lateral extent.

Subsurface

The Peedee is widespread in the subsurface of the Carolinas. It is used here in the sense of Owens and Gohn's (1985) depositional Unit 6—that is, as equivalent to middle to upper Maastrichtian deposits. So construed, it forms only the upper part of what previous authors have considered Navarroan units in their discussions of various corehole sections. The main body of the Peedee Formation in the subsurface, as in outcrop, consists of calcareous muddy sand and calcareous muds. Less clayey sands are to be found locally, as in the Scotts Hill Member (Rocky Point), in

southeastern North Carolina (Harris and others, 1986), and at the top of the Peedee (depositional Unit 6) of the Charleston corehole (Owens and Gohn, 1985, p. 77).

Biostratigraphic data suggest that some variance in thickness from well to well may be the result of post-Cretaceous erosion of the top of the Peedee. This is especially likely in the more updip wells. In others, such as the Fripp Island well, Beaufort County, South Carolina, the presence of such species as *Micula murus* and *Trinitella scotti* indicates the presence of quite late Maastrichtian beds, and little section appears to be lost (Valentine, 1982). In this general area, downdip thickening of the Peedee may also be seen between the 26 meters of the unit in the Charleston corehole, and the increase to about 43 meters in the Fripp Island well. A similar trend may be seen for the total Maastrichtian (Valentine, 1982) and for Unit 6 of Gohn and others (1978). The Charleston corehole has probably been more extensively studied than any other Carolina well, with both macrofossil and microfossil data developed (Hazel and others, 1977; Hattner and Wise, 1979; Valentine, 1982). In addition, some of the macrofossil intervals of the outcrop, such as the *Belemnitella americana* and *Exogyra costata* Range Zones, can be recognized.

Petrology

Our examination of the sand and clay mineralogy of the outcropping Peedee Formation was centered largely on the exposures in the Pee Dee and Cape Fear River valleys, where the most complete sections are exposed. Random samples from a few other rivers were examined to determine if there were any significant geographic variations. Samples from the three major coreholes in South Carolina provided control on downdip changes.

As one might predict, because the Peedee Formation is a shelfal deposit, few changes from place to place are to be found. Among the samples the nonopaque heavy mineral fraction is most commonly marked by a dominance of staurolite, zircon, garnet, kyanite, tourmaline, and chloritoid. The presence of chloritoid in some abundance follows the same pattern of specific gravity segregation found in the shelfal deposits of the older formations.

Feldspar content in the Peedee is rather constant and ranges between 10 and 20 percent of the sand fraction. The Peedee compositionally may therefore be classed as protoquartzite.

The clay minerals also show no significant variation from surface to subsurface exposures. Kaolinite and I/S are the dominant forms, although illite occurs in most samples in amounts ranging from 10 to 15 percent.

The mineral composition indicates that the Peedee Formation was derived from an igneous to metamorphic terrane similar to that for the other underlying Cretaceous formations.

Age

At both Black Rock Landing on the Cape Fear River and at Burches Ferry on the Pee Dee River, the first appearance datum of the planktonic foraminifer *Gansserina gansseri* occurs in the Peedee (personal communication, W.A. Bryant and C.C. Smith, 1981). The lower few feet of the formation may be lower Maastrichtian, but the remainder of the formation is assignable to the middle to upper Maastrichtian, if a three-part division is accepted for the stage, or to the upper Maastrichtian, if only a two-fold division is used. The basal disconformity marks the uppermost limit of occurrence of *Exogyra cancellata*. Thus, the Peedee falls within that part of the *E. costata* Zone above the *E. cancellata* Subzone. In terms of the pollen zonation, it falls within zone CA6/MAI of Wolfe (1976).

Utilizing the Mollusca, the Peedee is susceptible of division into three parts. The lower two divisions fall within the range zone of *Flemingostrea subspatulata* (Forbes), normal form (see Sohl and Smith, 1980; Sohl and Koch, 1986, Fig. 4), and the upper one equates with the *Haustator bilira* Assemblage Zone (Sohl, 1977a). The lower part of the *F. subspatulata* (normal form) Range Zone, at least in the Carolinas, may be differentiated by the occurrence of *Belemnitella americana* (Morton) (2 on Fig. 11–13).

The surface occurrence of these biostratigraphic subdivisions are plotted areally on Fig. 11–13 and diagrammatically on Fig. 11–15. Several features are very apparent from these figures. The concentric bands representing the successive zones on Fig. 11–13 follow an arcuate pattern from the Tar River in North Carolina southwestward to the Pee Dee River in South Carolina. The path of this arc broadly outlines the Cape Fear arch. The breadth of the area encompassed between the lines for the lower two Peedee zones (2 and 3 on Fig. 11–13) maintains a relatively uniform width across North Carolina, but becomes compressed in the Pee Dee River area. No evidence exists for suggesting this is caused by increased amounts of dip in these intervals. The cause of this phenomenon is presently unclear, but it may represent differential rates of sedimentation. Fig. 11–15 shows that the sections exposed on the outcrop along the northern rivers of North Carolina are missing the upper part of the formation where the Cretaceous is overlapped by Tertiary deposits. Southward, progressively younger exposures are seen. Only the lowest part of the formation has been recorded from borrow pits in the vicinity of Greenville, North Carolina (Conrad, 1871), but no Peedee exposures are known on the Tar River itself. On Contentnea Creek and the Neuse River, Peedee exposures range upward only into the lower part of the upper *F. subspatulata* Zone. On the Northeast Cape Fear, almost all of the upper part of the *F. subspatulata* Zone is represented. On the Cape Fear River the basal part of the *Haustator bilira* Zone is found at Wilmington, at the base of the bluffs at Hilton Park. On the Pee Dee River, beds of the *H. bilira* Zone are encountered from DeWitts Bluff (milepost 82) to milepost 50.3.

In the Cape Fear River area, the general contention has been

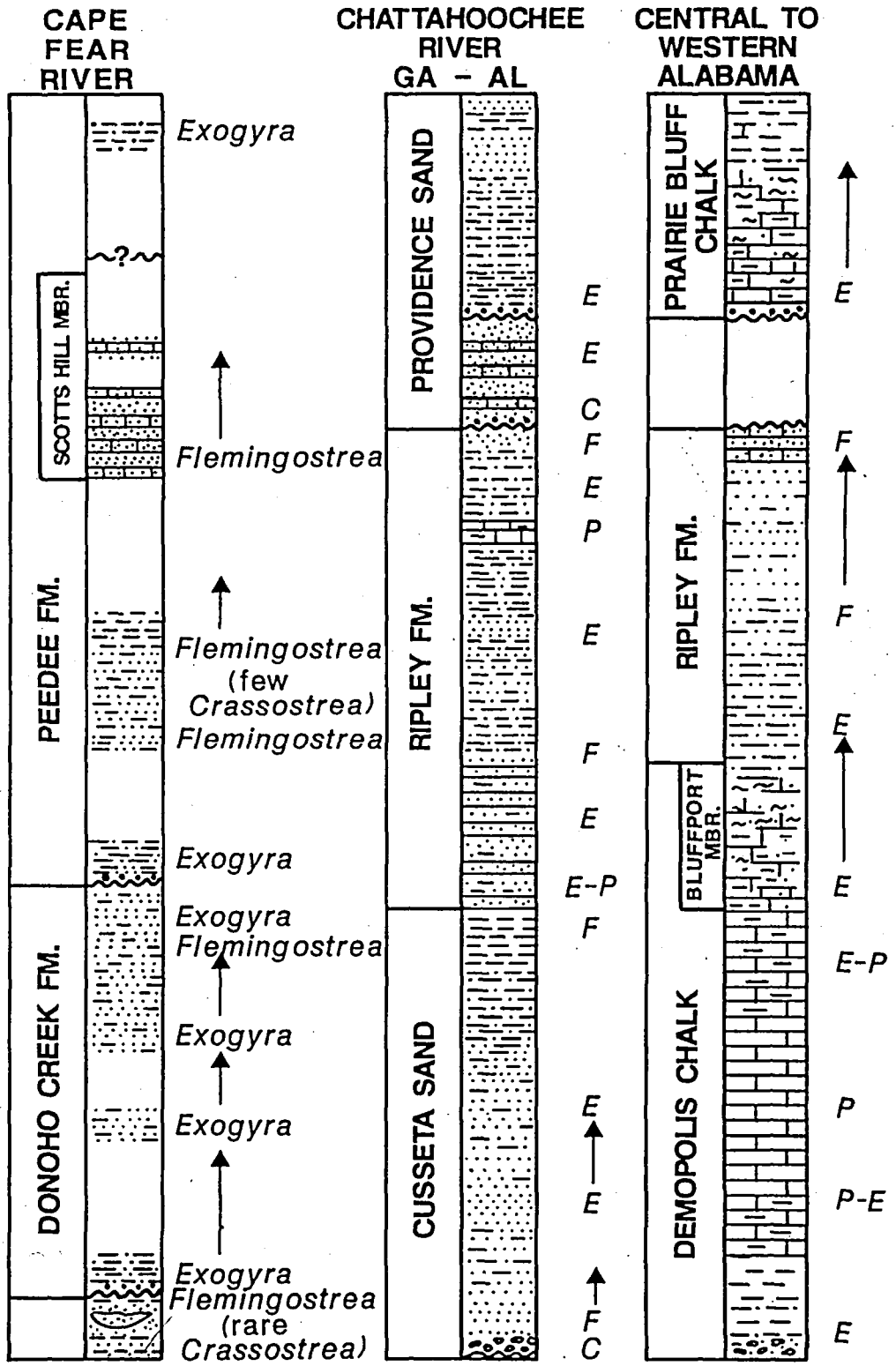


Fig. 11-16. Comparison of succession of dominant ostreid pelecypods among three Upper Cretaceous (Campanian-Maastrichtian) sections in the Atlantic and Gulf Coastal Plains. *Crassostrea* is dominant in marginal marine environments but ranges to shallow near shore marine situations. *Flemingostrea* occurs in shallow, fully marine, shoreface to inner shelf zones; *Exogyra* is dominant in the next inner shelf zone. *Pycnodonte (Phrygea)* dominates farthest offshore. Levels of codominance reflect gradational character of boundary between zones. Pattern of dominant occurrence follows the transgressive-regressive curve. Lithologic symbols same as for Fig. 11-4.

for use on Soil Potential Study

1977

Ref. 24

SOIL SURVEY OF

New Hanover County, North Carolina

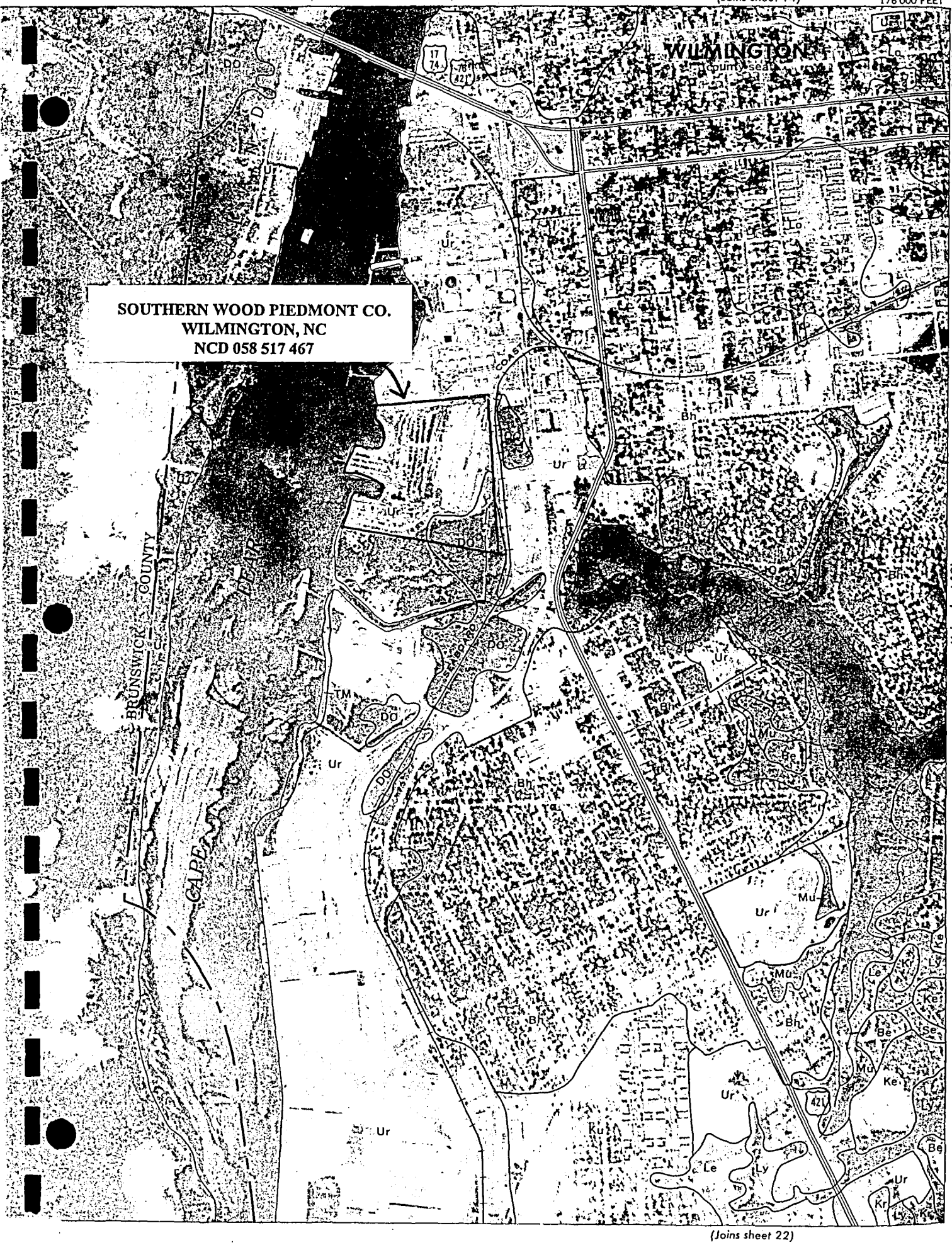
United States Department of Agriculture
Soil Conservation Service

In cooperation with
North Carolina Agricultural Experiment Station
and the
New Hanover County Board of Commissioners

(Joins sheet 14)

176 000 FEET

2 323 000 FEET



(Joins sheet 19)

(Joins sheet 22)

This area is mapped on 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

dustrial sites, and the rest is forested. The dominant vegetation is longleaf pine, turkey oak, bluejack oak, post oak, dwarf waxmyrtle, dwarf huckleberry, and pineland three-awn. This vegetation increases in density on the lower slopes along with additional species, such as hickory, American holly, red oak, black oak, and bracken.

Typically, the surface layer is dark gray fine sand 3 inches thick. The subsurface layer is fine sand 33 inches thick. It is light gray in the upper part and very pale brown in the lower part. The subsoil is 22 inches thick. It is strong brown fine sandy loam in the upper part and strong brown loamy fine sand in the lower part. The underlying layer, to a depth of 78 inches, is mottled white and very pale brown fine sand in the upper part and very pale brown fine sand and loamy fine sand in the lower part.

Included with this soil in mapping are a few small areas of Norfolk, Kenansville, Seagate, and Wakulla soils.

The organic-matter content of the surface layer is very low. Permeability is moderately rapid, available water capacity is very low, and shrink-swell potential is low. Reaction is strongly acid to slightly acid throughout, unless the soil is limed. The seasonal high water table is at a depth of more than 4 feet.

Very low available water capacity, moderately rapid permeability, leaching of plant nutrients, droughtiness, and soil blowing are the main limitations in the use and management of this soil. If supplemental irrigation is not used, available moisture capacity in this soil is generally inadequate for the establishment and maintenance of most lawn grasses, shrubs, and trees. Soil conditioners may also be needed. Capability subclass IIIs; woodland group 3s.

Bh—Baymeade-Urban land complex, 1 to 6 percent slopes. This mapping unit is on the flats and low ridges of the upland and in small areas that are along the drainageways but are not subject to flooding. It consists of Baymeade soils and Urban land that are in areas so small and so intermingled that is was not practical to map them separately. About 35 to 45 percent of this mapping unit is Baymeade soils, and 30 to 50 percent is Urban land. The percentage of Urban land in the mapped areas is greater near the towns.

Typically, the surface layer of a Baymeade soil is dark gray fine sand 3 inches thick. The subsurface layer is fine sand 33 inches thick. It is light gray in the upper part and very pale brown in the lower part. The subsoil is 22 inches thick. It is strong brown fine sandy loam in the upper part and strong brown loamy fine sand in the lower part. The underlying layer, to a depth of 78 inches, is mottled white and very pale brown fine sand in the upper part and very pale brown fine sand and loamy fine sand in the lower part.

The Urban land part of this unit consists of areas where the original soils have been cut, filled, graded, or paved so that most soil properties have been altered to the extent that the soils cannot be identified. These areas are used for shopping centers, factories, municipal buildings, apartment complexes, or parking lots, or for other purposes where buildings are closely spaced or the soil is covered with pavement. Slope is generally modified to fit the site needs, and it generally ranges from 0 to 6 percent. The extent of site modification varies greatly. Many areas are relatively undisturbed, but other areas have been cut and filled.

Included with these soils in mapping are small areas of Kureb, Leon, Seagate, Rimini, Lakeland, Murville, Lynn Haven, and Torhunta soils.

The runoff of the Urban land is greater than that of the Baymeade soils because of the impervious cover of buildings, streets, and parking lots.

Very low available water capacity, moderately rapid permeability, leaching of plant nutrients, droughtiness, and soil blowing are the main limitations in the use and management of these soils. If supplemental irrigation is not used, available water capacity in this soil is generally inadequate for the establishment and maintenance of most lawn grasses, shrubs, and trees. Soil conditioners may be needed. Capability subclass not assigned; Baymeade part in woodland group 3s, Urban land part not placed in a woodland group.

Bp—Borrow pits. Borrow pits consists of small areas where the soil has been removed and is used as a fill material around bridges, industrial sites, and other structures. Areas range in size from about 2 to 15 acres, but most areas are less than 5 acres. Most areas have not been reclaimed, and areas that are revegetated were done so by volunteer stands of grasses and trees. Capability subclass and woodland group not assigned.

Cr—Craven fine sandy loam, 1 to 4 percent slopes. This moderately well drained soil is on broad, smooth flats on the uplands and on short side slopes along drainageways. Areas are small in size and irregular in shape. Most of the acreage is used for residential or industrial sites. The rest is used for pasture or is forested. The native vegetation is American holly, various oaks, hickory, loblolly pine, sweetgum, sweetleaf, sweet pepperbush, waxmyrtle, and gallberry.

Typically, the surface layer is dark gray fine sandy loam 8 inches thick. The subsoil is 48 inches thick. The upper part is mottled yellowish brown clay loam, the middle part is mottled light brownish gray clay loam, and the lower part is mottled light gray clay. The underlying layer, to a depth of 64 inches, is mottled light gray sandy clay loam.

Included with this soil in mapping are a few areas of soils that have a sandy loam and loamy fine sand surface layer. Also included are small areas of soils that have a sandy surface layer, and a few small areas of Norfolk, Onslow, and Wrightsboro soils.

The organic-matter content of the surface layer is low. Permeability is slow, available water capacity is medium, and shrink-swell potential is moderate. The seasonal high water table is at a depth of 2 to 3 feet.

The clayey texture of the lower part of the subsoil, erosion, seasonal wetness, and slow permeability are the

main limitations in the use and management of this soil. If drained, this soil is suited to most locally grown crops. The main crops are corn, soybeans, tobacco, and peanuts. Minimum tillage and crop residue management aid in maintaining organic-matter content. This soil has good tilth and can be worked over a wide range of moisture content, but tillage is delayed during wet seasons. Drainage is needed for most uses. Capability subclass IIIe; woodland group 3w.

DO—Dorovan soils. These nearly level, very poorly drained soils are in bays and in long, broad areas of tidal and stream flood plains. All of the acreage is used for woodland and as wildlife habitat. The native vegetation is red maple, willow, tupelo, cypress, sweetgum, ash, American cyrilla, and greenbrier.

Typically the surface layer is black muck 4 inches thick. The underlying layer, to a depth of 64 inches, is black or very dark gray muck.

Included with these soils in mapping are small areas of Johnston soils and Tidal marsh. A few small areas of soils that have thin, continuous mineral layers are also included.

The organic-matter content in the surface layer is very high. Permeability is very slow, available water capacity is very high, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless the soils are limed. The seasonal high water table is at or near the surface. These soils are frequently flooded for very long periods.

Flooding and high organic-matter content are the main limitations in the use and management of these soils. If these soils are drained and tilled, the organic matter decomposes and the soil subsides. Capability subclass VIIIw; woodland group 4w.

JO—Johnston soils. These nearly level, very poorly drained soils are on flood plains of the major streams. Areas are commonly long and narrow. Most of the acreage is forested, and some small areas have been filled and used for industrial and residential sites. The native vegetation consists of pond pine, tupelo-gum, ash, water oak, cypress, red maple, sweetgum, American cyrilla, waxmyrtle, and gallberry.

Typically, the surface layer is 42 inches thick. It is black loam in the upper part and black sandy loam in the lower part. The underlying layer, to a depth of about 64 inches, is light gray sand.

Included with these soils in mapping are small areas of Pamlico, Dorovan, and Murville soils. A few small areas of soils that are less acid than these Johnston soils are also included.

The organic-matter content of the surface layer is high. Permeability is moderately rapid, available water capacity is high, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless these soils are limed. The seasonal high water table is at or near the surface. These soils are frequently flooded for long periods.

A seasonal high water table and flooding are the main limitations in the use and management of these soils. These soils subside if drained and tilled. Capability subclasses VIIw, where undrained, and IVw, where drained; woodland group 1w.

Ke—Kenansville fine sand, 0 to 3 percent slopes. This well drained soil is on broad smooth flats on the uplands. Areas are commonly large in size and irregular in shape. Most of the acreage is cultivated. The rest is forested or is used for residential or industrial sites. The native vegetation consists of longleaf and loblolly pines; white, red, black, turkey, water, and bluejack oaks; hickory; dogwood; holly; and sassafras.

Typically, the surface layer is grayish brown fine sand 3 inches thick. The subsurface layer is fine sand 30 inches thick. It is is pale brown in the upper part and mottled very pale brown in the lower part. The subsoil is fine sandy loam 17 inches thick. It is strong brown in the upper part and reddish yellow in the lower part. The underlying layer, to a depth of 80 inches, is yellow loamy fine sand.

Included with this soil in mapping are a few small areas of Norfolk and Lakeland soils. Some small areas of soils that are less acid throughout are also included.

The organic-matter content of the surface layer is very low. Permeability is moderately rapid, available water capacity is low, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless this soil is limed. The seasonal high water table is at a depth of more than 6 feet.

Leaching of plant nutrients, moderately rapid permeability, droughtiness, low available water capacity, and soil blowing are the main limitations in the use and management of this soil. This soil is well suited to most locally grown crops. The main crops are corn, soybeans, peanuts, tobacco, and truck crops, such as squash, lettuce, cucumbers, cabbage, snapbeans, and corn. Winter cover crops, minimum tillage, and crop residue management aid in maintaining organic-matter content and conserving moisture. Soil blowing is a concern in the management of this soil. The blowing sand often causes damage to young plants. This soil is droughty during periods of low rainfall. Some supplemental irrigation, soil conditioners, and fertilizers are needed for lawn grasses, shrubs, and trees. Capability subclass IIs; woodland group 3s.

Kr—Kureb sand, 1 to 8 percent slopes. This excessively drained soil is on long, broad ridges on the uplands. Areas are generally broad and long. Most of the acreage is forested. The rest is used for residential and industrial sites. The sparse native vegetation on the higher elevations is turkey oak, scattered longleaf pine, a few bluejack oaks, and scattered dwarf myrtle and huckleberry. Much of the area is barren of any vegetation, except for mosses and lichens. On the lower slopes, the vegetation increases in density and includes various oaks, scattered hickory, holly, and brackenfern.

Typically, the surface layer is dark gray sand 3 inches thick. The subsurface layer is light gray sand 23 inches

B2t—36 to 49 inches, strong brown (7.5YR 5/6) fine sandy loam; weak coarse subangular blocky structure; very friable; many fine and medium roots; medium acid; gradual wavy boundary.

B3—49 to 58 inches, strong brown (7.5YR 5/6) loamy fine sand; weak fine granular structure; very friable; few fine roots; medium acid; gradual wavy boundary.

C1—58 to 75 inches, mottled white (10YR 8/1) and very pale brown (10YR 7/4) fine sand; single grained; loose; medium acid; gradual wavy boundary.

C2—75 to 78 inches, very pale brown (10YR 8/3) fine sand and loamy fine sand; single grained; loose; medium acid.

The A1 horizon is dark gray or gray and has some clean white sand grains. The A2 horizon is light gray or white. The Bh part of the A2&Bh horizon is very pale brown, brown, dark brown, very dark brown, or black and has organic coatings. The B2t horizon is strong brown, brown, reddish yellow, or light olive brown fine sandy loam or sandy clay loam. In some pedons this horizon occurs as lamellae of fine sand and fine sandy loam with a composite thickness of more than 6 inches. The B3 horizon is strong brown, reddish yellow, brownish yellow, or olive yellow. The C horizon is white, very pale brown, yellow, light gray, or brownish yellow fine sand or loamy fine sand. Some pedons have thin discontinuous Bh bodies in the C horizon.

Craven series

The Craven series consists of moderately well drained, slowly and very slowly permeable, nearly level and gently sloping soils that formed on flats and side slopes on uplands. Slopes are 1 to 4 percent.

Typical pedon of Craven fine sandy loam, 1 to 4 percent slopes, 0.6 mile northwest from Masonboro on State Road 1515, and about 600 feet north of State Road 1515 on farm road, 100 feet east of farm road:

Ap—0 to 8 inches, dark gray (10YR 4/1) fine sandy loam; weak medium granular structure; very friable; common medium and large roots; strongly acid; abrupt smooth boundary.

B21t—8 to 20 inches, yellowish brown (10YR 5/6) clay loam; few medium distinct reddish yellow (7.5YR 6/8) mottles; moderate coarse angular blocky structure; very firm, very sticky, very plastic; continuous silt and clay coating on faces of peds; common medium and large roots; strongly acid; gradual wavy boundary.

B22t—20 to 28 inches, yellowish brown (10YR 5/6) clay loam; many medium distinct yellowish red (5YR 5/8) and strong brown (7.5YR 5/8) mottles, and common medium faint light brownish gray (10YR 6/2) mottles; moderate coarse angular blocky structure; very firm, very sticky, very plastic; continuous clay films on faces of peds; few medium and large roots; very strongly acid; gradual wavy boundary.

B23tg—28 to 44 inches, light brownish gray (10YR 6/2) clay loam; common medium prominent red (2.5YR 5/8) and common medium distinct strong brown (7.5YR 5/8) mottles; moderate fine and medium angular blocky structure; very firm, very sticky, very plastic; prominent clay films on faces of peds; very strongly acid; abrupt smooth boundary.

IIB24tg—44 to 56 inches, light gray (10YR 7/1) clay; common medium prominent red (2.5YR 4/8) and common medium distinct strong brown (7.5YR 5/8) mottles; massive and weak medium angular blocky structure; very firm, very sticky, very plastic; few fine roots; very strongly acid; gradual wavy boundary.

IICg—56 to 64 inches, light gray (10YR 7/1) sandy clay loam with pockets of sandy loam; few medium distinct yellowish red (5YR 5/8) and strong brown (7.5YR 5/8) mottles; massive; friable; very strongly acid.

The A1 or Ap horizon is gray, dark gray, or dark grayish brown fine sandy loam or loam. If present, the A2 horizon is pale brown or very pale brown loamy fine sand or fine sandy loam. The B21t and B22t horizons are brownish yellow, yellowish brown, or light yellowish brown clay loam, clay, and silty clay. The B23tg horizon is brownish yellow, strong brown, yellowish red, light brownish gray, or light gray clay loam and clay. The B24tg horizon is light gray or very pale brown clay, clay loam, or sandy clay loam. The C horizon is light gray or gray sandy clay loam, sandy loam, or sand.

Craven soils in New Hanover County have slightly less clay in the upper part of the B2t horizon than is defined as within the range for the series. This difference, however, does not significantly alter their usefulness or behavior.

Dorovan series

The Dorovan series consists of very poorly drained, very slowly permeable, nearly level soils that formed on tidal and stream flood plains and in bays. Slopes are less than 1 percent.

Typical pedon of Dorovan muck in an area of Dorovan soils west of Wilmington from north bridge along U.S. Highway 421 north to railroad crossing, about 100 feet west of U.S. Highway 421 and 50 feet north of railroad:

Oe—0 to 4 inches, black (10YR 2/1) hemic material (muck); massive; about 50 percent fiber after rubbing; very strongly acid; clear smooth boundary.

Oa1—4 to 36 inches, black (10YR 2/1) sapric material; about 25 percent fiber, about 10 percent after rubbing; massive; nonsticky; few to common roots, partially decomposed limbs and logs; very strongly acid; diffuse smooth boundary.

Oa2—36 to 55 inches, very dark gray (10 YR 3/1) saphic material; about 25 percent fiber, about 10 percent after rubbing; massive; few roots; partially decomposed limbs and twigs and occasional logs; very strongly acid; diffuse smooth boundary.

Oe—55 to 64 inches, black (10YR 2/1) hemic material; about 50 percent fiber, about 20 percent after rubbing; massive; decomposed limbs and twigs and occasional logs; very strongly acid.

The Oe horizon is black or very dark grayish brown. Fiber content is 50 to 90 percent unrubbed and 20 to 50 percent rubbed. The Oa horizon is black or very dark gray. Fiber content is 15 to 35 percent unrubbed and 5 to 20 percent rubbed. Many logs, limbs, and other woody fragments are in the middle and lower parts of the organic layer.

Johnston series

The Johnston series consists of very poorly drained, moderately rapidly permeable soils that formed on the flood plains of the major streams. Slopes are less than 2 percent.

Typical pedon of Johnston loam, in an area of Johnston soils about 4 miles south of Wilmington, 300 yards west of U.S. Highway 421, 0.2 mile southwest of entrance to dairy farm, in wooded area along stream:

A11—0 to 20 inches, black (10YR 2/1) loam; weak medium granular structure; very friable; many medium and fine roots; strongly acid; gradual wavy boundary.

A12—20 to 36 inches, black (10YR 2/1) loam; weak medium granular structure; friable; few medium and large roots; strongly acid; gradual wavy boundary.

A13—36 to 42 inches, black (10YR 2/1) sandy loam; weak medium granular structure; very friable; strongly acid; gradual wavy boundary.

C1—42 to 64 inches, light gray (10YR 7/1) sand; single grained; loose, compact in places; strongly acid.

The A horizon is black or very dark gray loam, sandy loam, or fine sandy loam. The AC horizon, if present, is dark gray or dark grayish brown loamy fine sand or loamy sand. The C horizon is light gray, light brownish gray, or dark gray sand, fine sandy loam, sandy loam, or loamy sand.

PARKER

Ref. 25

Federal Register

Friday
December 14, 1990

Part II

Environmental Protection Agency

40 CFR Part 300
Hazard Ranking System; Final Rule

12-14-90
Vol. 55 No. 241

federal register

Friday
December 14, 1990

Book 2

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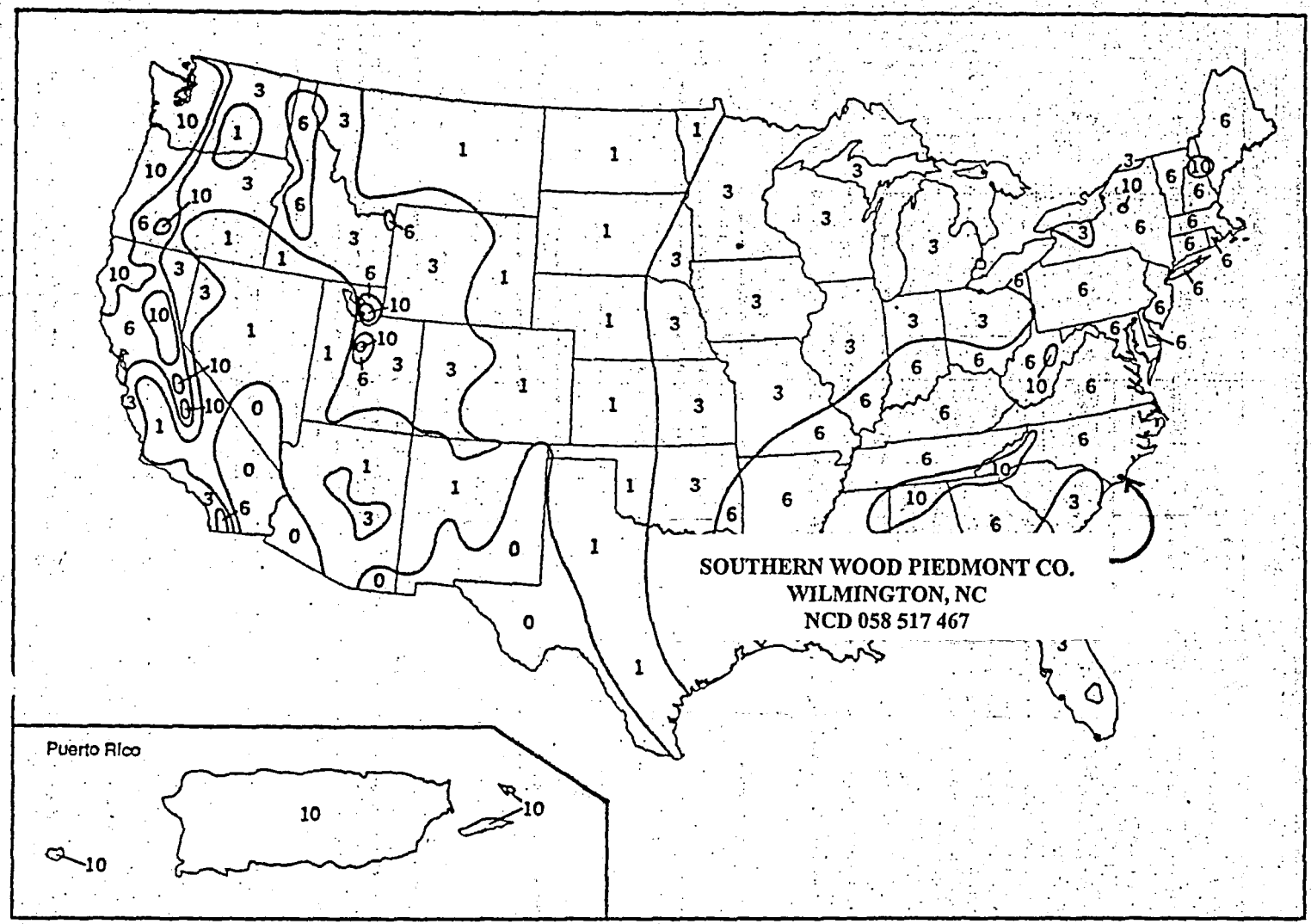


FIGURE 3-2
NET PRECIPITATION FACTOR VALUES

TABLE 3-6.—HYDRAULIC CONDUCTIVITY OF GEOLOGIC MATERIALS

Type of material	Assigned hydraulic conductivity [a] (cm/sec)
Clay; low permeability till (compact unfractured till); shale; unfractured metamorphic and igneous rocks	10^{-8}
Silt; loesses; silty clays; sediments that are predominantly silts; moderately permeable till (fine-grained, unconsolidated till, or compact till with some fractures); low permeability limestones and dolomites (no karst); low permeability sandstone; low permeability fractured igneous and metamorphic rocks	10^{-6}
Sands; sandy silts; sediments that are predominantly sand; highly permeable till (coarse-grained, unconsolidated or compact and highly fractured); peat; moderately permeable limestones and dolomites (no karst); moderately permeable sandstone; moderately permeable fractured igneous and metamorphic rocks	10^{-4}
Gravel; clean sand; highly permeable fractured igneous and metamorphic rocks; permeable basalt; karst limestones and dolomites	10^{-2}

[a] Do not round to nearest integer.

TABLE 3-7.—TRAVEL TIME FACTOR VALUES [a]

Hydraulic conductivity (cm/sec)	Thickness of lowest hydraulic conductivity layer(s) [b] (feet)			
	Greater than 3 to 5	Greater than 5 to 100	Greater than 100 to 500	Greater than 500
Greater than or equal to 10^{-3}	35	35	35	25
Less than 10^{-3} to 10^{-4}	35	25	15	15
Less than 10^{-5} to 10^{-7}	15	15	5	5
Less than 10^{-7}	5	5	1	1

[a] If depth to aquifer is 10 feet or less or if, for the interval being evaluated, all layers that underlie a portion of the sources at the site are karst, assign a value of 35.

[b] Consider only layers at least 3 feet thick. Do not consider layers or portions of layers within the first 10 feet of the depth to the aquifer.

Determine travel time only at locations within 2 miles of the sources at the site, except: if observed ground water contamination attributable to sources at the site extends more than 2 miles beyond these sources, use any location within the limits of observed ground water contamination when evaluating the travel time factor for any aquifer that does not have an observed release. If the necessary subsurface geologic information is available at multiple locations, evaluate the travel time factor at each location. Use the location having the highest travel time factor value to assign the factor value for the aquifer. Enter this value in Table 3-1.

3.1.2.5 *Calculation of potential to release factor value.* Sum the factor values for net precipitation, depth to aquifer, and travel time, and multiply this sum by the factor value for containment. Assign this product as the potential to release factor value for the aquifer. Enter this value in Table 3-1.

3.1.3 *Calculation of likelihood of release factor category value.* If an observed release is established for an aquifer, assign the observed release factor value of 550 as the likelihood of release factor category value for that aquifer. Otherwise, assign the potential to release factor value for that aquifer as the likelihood of release value. Enter the value assigned in Table 3-1.

3.2 *Waste characteristics.* Evaluate the waste characteristics factor category for an aquifer based on two factors: toxicity/mobility and hazardous waste quantity. Evaluate only those hazardous substances available to migrate from the sources at the site to ground water. Such hazardous substances include:

- Hazardous substances that meet the criteria for an observed release to ground water.
- All hazardous substances associated with a source that has a ground water containment factor value greater than 0 (see sections 2.2.2, 2.2.3, and 3.1.2.1).

3.2.1 *Toxicity/mobility.* For each hazardous substance, assign a toxicity factor value, a mobility factor value, and a combined toxicity/mobility factor value as specified in the following sections. Select the toxicity/mobility factor value for the aquifer being evaluated as specified in section 3.2.1.3.

3.2.1.1 *Toxicity.* Assign a toxicity factor value to each hazardous substance as specified in Section 2.4.1.1.

3.2.1.2 *Mobility.* Assign a mobility factor value to each hazardous substance for the aquifer being evaluated as follows:

- For any hazardous substance that meets the criteria for an observed release by chemical analysis to one or more aquifers underlying the sources at the site, regardless of the aquifer being evaluated, assign a mobility factor value of 1.
- For any hazardous substance that does not meet the criteria for an observed release by chemical analysis to at least one of the aquifers, assign that hazardous substance a mobility factor value from Table 3-8 for the aquifer being evaluated, based on its water solubility and distribution coefficient (K_d).
- If the hazardous substance cannot be assigned a mobility factor value because data on its water solubility or distribution coefficient are not available, use other hazardous substances for which information is available in evaluating the pathway.

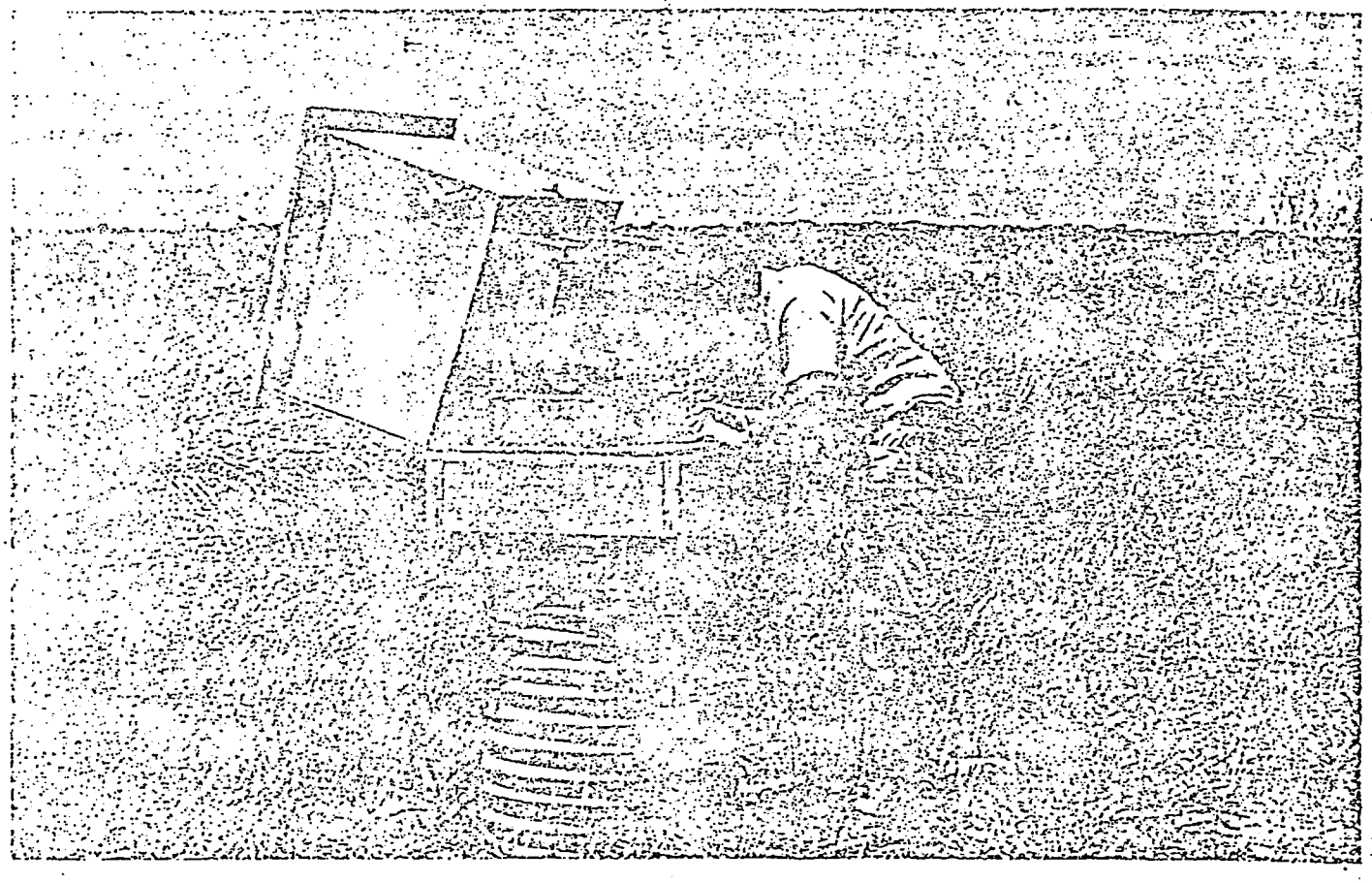
TABLE 3-8.—GROUND WATER MOBILITY FACTOR VALUES [a]

Water solubility (mg/l)	Distribution coefficient (K_d) (ml/g)			
	Karst [c]	≤10	>10 to 1,000	>1,000
Present as liquid [b]	1	1	0.01	0.0001
Greater than 100	1	1	0.01	0.0001
Greater than 1 to 100	0.2	0.2	0.002	2×10^{-5}
Greater than 0.01 to 1	0.002	0.002	2×10^{-5}	2×10^{-7}
Less than or equal to 0.01	2×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-9}

[a] Do not round to nearest integer.
[b] Use if the hazardous substance is present or deposited as a liquid.
[c] Use if the entire interval from the source to the aquifer being evaluated is karst.

Ref. 26

Basic Elements of Ground-Water Hydrology with Reference to Conditions in North Carolina



U.S. GEOLOGICAL SURVEY
WATER RESOURCES INVESTIGATIONS
OPEN-FILE REPORT 80-44

Prepared in cooperation with the
North Carolina Department of Natural
Resources and Community Development

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Basic Elements of Ground-Water Hydrology With Reference to Conditions in North Carolina

By Ralph C. Heath

U.S. Geological Survey
Water-Resources Investigations
Open-File Report 80-44

Prepared in cooperation with the
North Carolina Department of Natural
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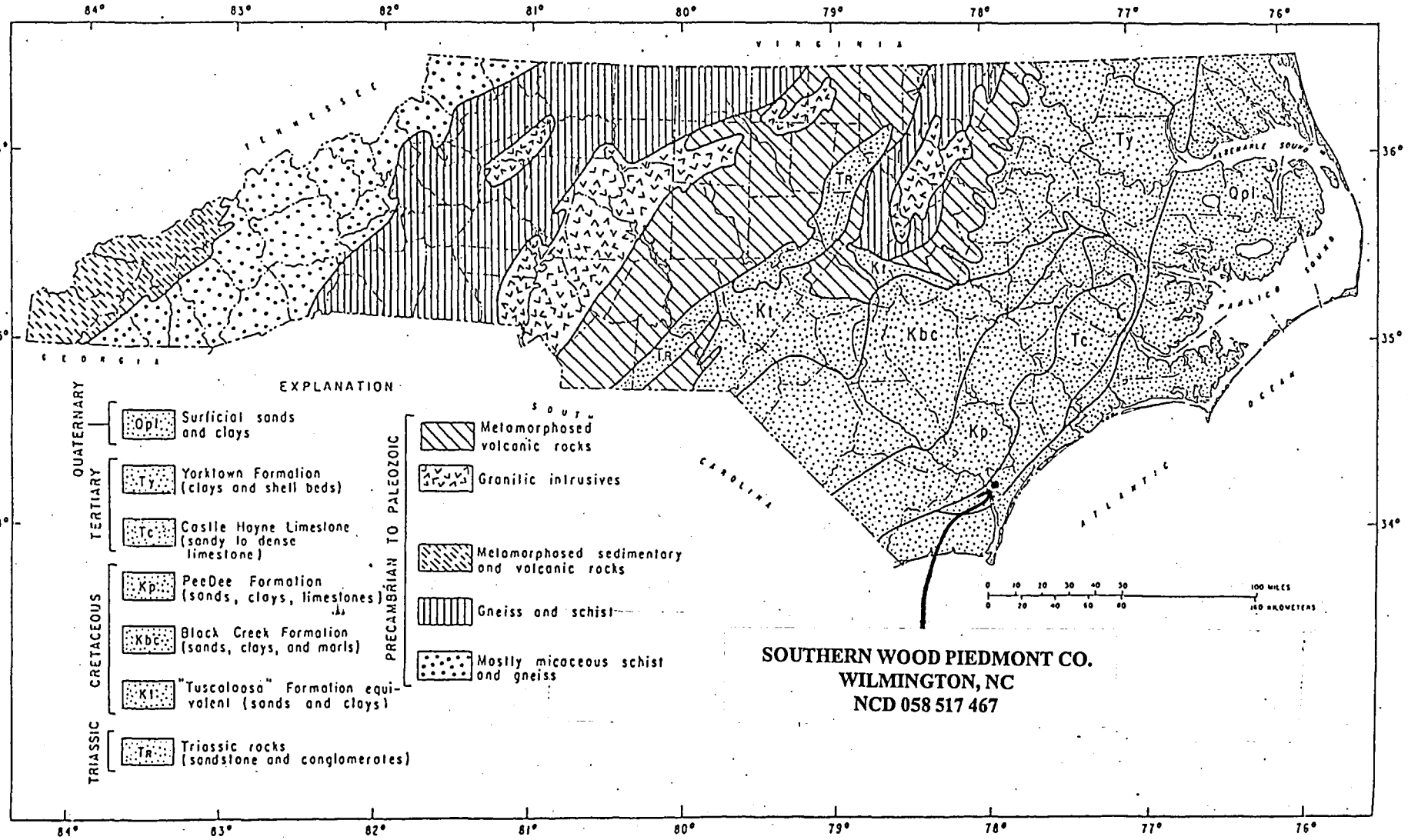
Raleigh, North Carolina
1980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83°
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81°
80°
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78°
77°
76°
36°
35°
34°
VIRGINIA
TENNESSEE
GEORGIA
SOUTH CAROLINA
ATLANTIC OCEAN
ALBEMARLE SOUND
PAMLICO SOUND
Ty
Opl
Tc
Kbc
Kp
Kl
TR
EXPLANATION
QUATERNARY
Opl Surficial sands and clays
TERTIARY
Ty Yorktown Formation (clays and shell beds)
Tc Castle Hayne Limestone (sandy to dense limestone)
CRETACEOUS
Kp PeeDee Formation (sands, clays, limestones)
Kbc Black Creek Formation (sands, clays, and marls)
Kl "Tuscaloosa" Formation equivalent (sands and clays)
TRIASSIC
TR Triassic rocks (sandstone and conglomerates)
PRECAMBRIAN TO PALEOZOIC
Metamorphosed volcanic rocks
Granitic intrusives
Metamorphosed sedimentary and volcanic rocks
Gneiss and schist
Mostly micaceous schist and gneiss
0 10 20 30 40 50 100 MILES
0 20 40 60 80 160 KILOMETERS
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Rock Units and Aquifers in the Coastal Plain

The Coastal Plain of North Carolina is underlain by sedimentary rocks that were deposited in water in several different layers which geologists refer to as formations. Formations are commonly given names for places near which they are exposed at the land surface, for ease in referring to them in geologic literature.

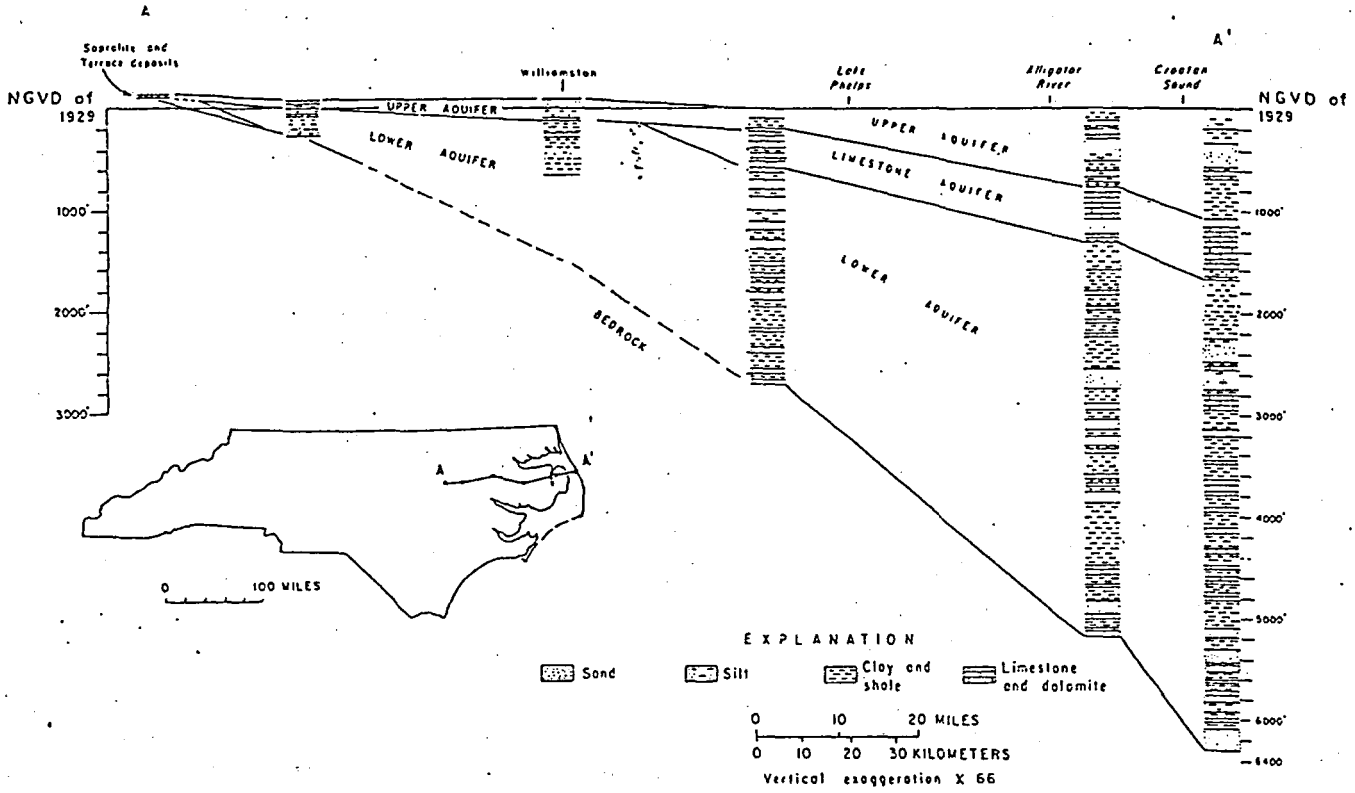
Rock layers are normally given names by geologists if they have a distinct composition or, if of variable composition, include materials deposited during a particular segment of geologic time. Named rock units may or may not coincide with hydrologic units so that in ground-water reports some aquifers may be referred to by the formal geologic names used by geologists, such as the Castle Hayne Limestone and Yorktown Formation, and others may be given more informal names, such as the "Upper aquifer", "Surficial aquifer" or "post-Miocene deposits." The name "Surficial aquifer" indicates the aquifer in any area that is closest to land surface and thus is clearly identifiable, regardless of any other names that may have been assigned to that rock unit.

Non-geologists concerned both with ground-water problems and with ground-water studies in the Coastal Plain are probably confused by the different named applied to the different hydrologic units. The following chart was prepared in an effort to eliminate some of this confusion. We should note, however, that in preparing the chart we have neither tried to include all formation names nor been overly concerned with the relative geologic age of the formations. The names used in the last two columns can be confusing to the extent that all units are referred to as "aquifers." Confining beds composed of clay occur in all of the formations and in the formations of Cretaceous age clay comprises about half of the total thickness.

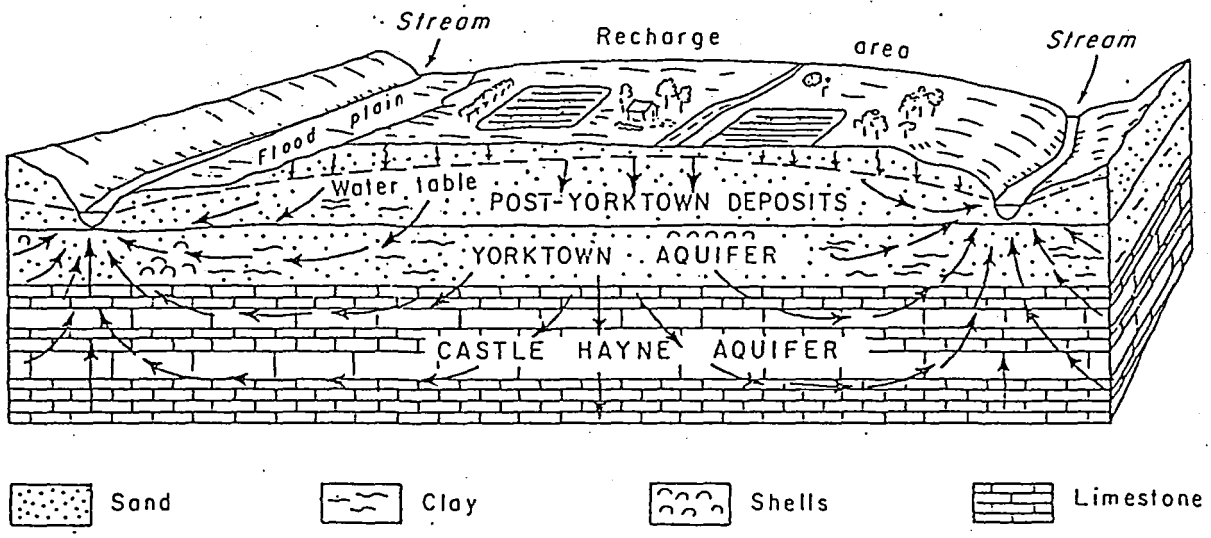
The two most important aquifers in the Coastal Plain are the upper aquifer and the limestone aquifer. Recharge of the ground-water system is from precipitation on the land surface. Therefore, the surficial aquifer has the largest yield in terms of rate per unit area (for example, gallons per minute per square mile). The upper aquifer is also most subject to pollution from land-surface waste disposal. The limestone aquifer is the most productive aquifer in North Carolina in terms of yields of individual wells. Wells capable of yielding more than 1000 gal/min can readily be developed in this aquifer.

Geologic age	Formation or geologic name	Names used in some ground-water reports	Simpliest useful hydrologic names
Pleistocene	Pleistocene deposits	Post-Miocene deposits	Upper aquifer
	Croatan Formation		
Pliocene	Yorktown Formation	Yorktown aquifer	
Miocene	Pungo River Formation		
	Belgrade Formation		
Oligocene	River Bend Formation	Castle Hayne aquifer	Limestone aquifer
Eocene	Castle Hayne Limestone		
Paleocene	Beaufort Formation	Beaufort aquifer	Lower aquifer
Cretaceous	Peedee Formation	Cretaceous aquifer	
	Black Creek Formation		
	"Tuscaloosa" Formation		

The complex interlaying of the sediments underlying the Coastal Plain is shown in the following cross section. It will also be observed from the cross section that the rock layers (and formations) underlying the Coastal Plain dip toward the coast at a rate of about 15 ft./mi. As a result, each formation occurs at a greater depth below land surface toward the coast.



Ground-Water Situation in the Coastal Plain



Recharge of the ground-water system in the Coastal Plain occurs in the "upland" areas above the flood plains of perennial streams. Water reaching the saturated zone moves downward and laterally through the system to discharge areas.

Ground-water discharge occurs by seepage through the bottoms and sides of streams and drainage ditches and also through evaporation from the top of the capillary fringe in flood plains and other areas in which the water table is within several feet of the land surface During the growing season, ground water is also used by plants whose roots reach the capillary fringe or saturated zone. In the area adjacent to the coast, ground water also discharges by seepage into the sides and bottoms of estuaries and the ocean.

The presence of clay layers in the Coastal Plain formations hampers recharge to the deeper aquifers, so that most of the recharge tends to move laterally to discharge areas through the shallowest aquifers. Recharge to the deepest aquifers occurs only in the central part of the interstream recharge areas. This is an important point relative to waste disposal, in that if pollution of the deeper aquifers is to be avoided, waste disposal sites should be located as close as possible to perennial streams.

Prior to the construction of drainage ditches into the central part of the interstream areas, the water table reached the land surface in these areas during the fall, winter, and early spring recharge season. As a result, water was ponded on the surface for periods of several months each year in high-level swamps referred to as *pocosins*.

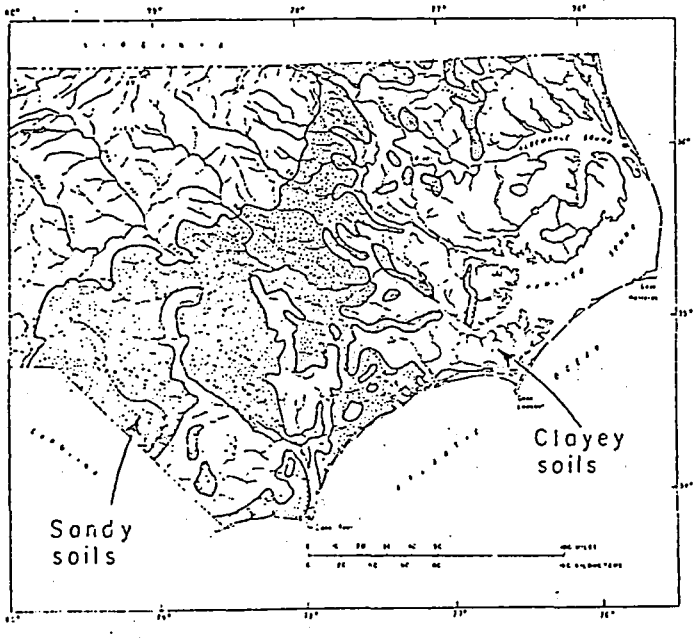
Two regional aspects of the Coastal Plain are of primary importance from the standpoint of ground-water occurrence and availability. The first is the nature of the surficial materials, which controls the recharge to the ground-water system. The second is the geologic conditions that control the occurrence of aquifers and confining beds.

The materials forming the surface of the Coastal Plain can usefully be divided into sandy and clayey soils on the basis of their effect on ground-water recharge. Recharge in the areas underlain by sandy soils is much more effective than in the areas underlain by clayey soils. One of the consequences of this is a much larger sustained base flow of streams in these areas.

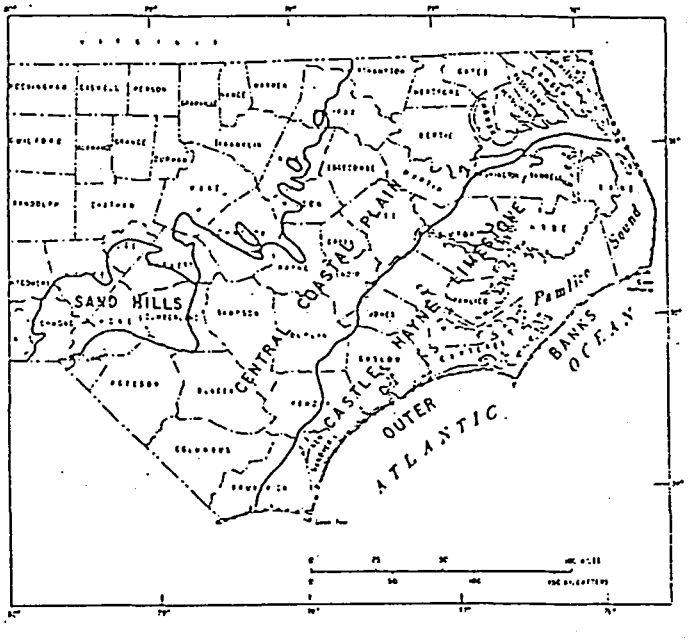
The geologic conditions in the area of about 25,000 mi² occupied by the Coastal Plain differ significantly from one part of the region to another. These differences affect both the occurrence and the availability of ground water. As an aid to understanding the Coastal Plain ground-water system, it is useful to divide the region into four hydrologic areas. Information on these is summarized in the following table in which the areas are listed in order from the simpliest to the most complex.

Hydrologic area	Geohydrologic characteristics	Yield of the most productive wells (gal/min)	Remarks
Sand Hills	Productive water-bearing sand at the land surface and overlying, for the most part, much less-productive material.	50-250	Water obtained from both bored wells and from screened drilled and driven wells. Water only slightly mineralized.
Outer Banks	Productive water-bearing sand at the land surface containing fresh water in contact with sea water.	25-100	Water obtained from both shallow, vertical, screened wells, and from horizontal collectors. Fresh-water zone subject to salt-water encroachment both from above and below.
Castle Hayne Limestone	Productive limestone overlain and underlain by less-productive sand interbedded with clay.	more than 1000	Drilled open-hole wells. Water moderately hard. Aquifer is confined and large withdrawals affect a large area.
Central Coastal Plain	Numerous thin layers of water-bearing sand complexly interbedded with clay.	250-1000	Sediments of Cretaceous age comprise most productive zones and is tapped by multiple-screened drilled wells. Water of excellent quality and, in places, naturally softened. Surficial sand aquifer also widely used for domestic supplies.

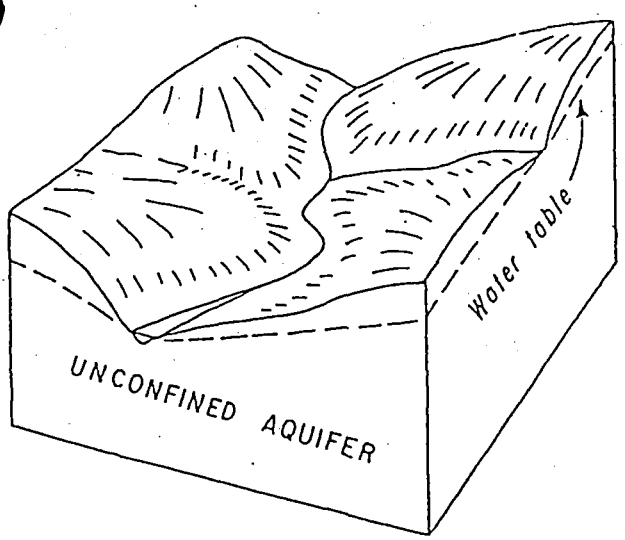
SOILS

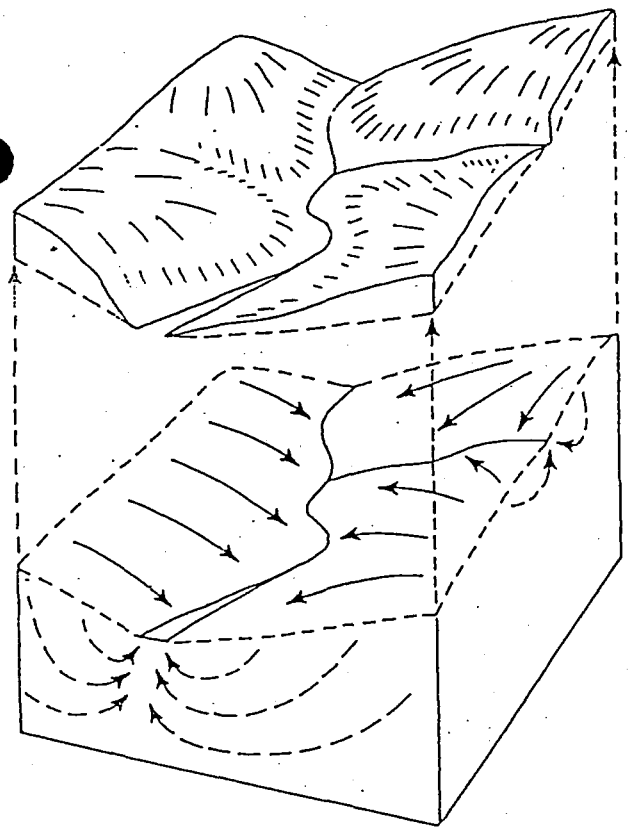


HYDROLOGIC AREAS



Ground-Water Movement And Topography





Arrows show direction of ground-water movement.

It is desirable, wherever possible, to determine the position of the water table and the direction of ground-water movement by measuring the depth of water level in shallow wells. However, in humid areas like North Carolina, general, but very valuable, conclusions about the direction of ground-water movement can be derived from observations of land-surface topography.

We know that gravity is the dominant driving force in ground-water movement and that under natural conditions ground water moves "downhill" until, in the course of its movement, it reaches the land surface at a spring or through a seep along the side or bottom of a stream channel or an estuary.

Thus, ground water in the shallowest part of the saturated zone moves from interstream areas toward streams or the coast. If we ignore minor surface irregularities, we find that the land surface also slopes in these directions. The depth to the water table is greatest along the divide between streams and least beneath the floodplain. In effect, *the water table is a subdued replica of the land surface.*

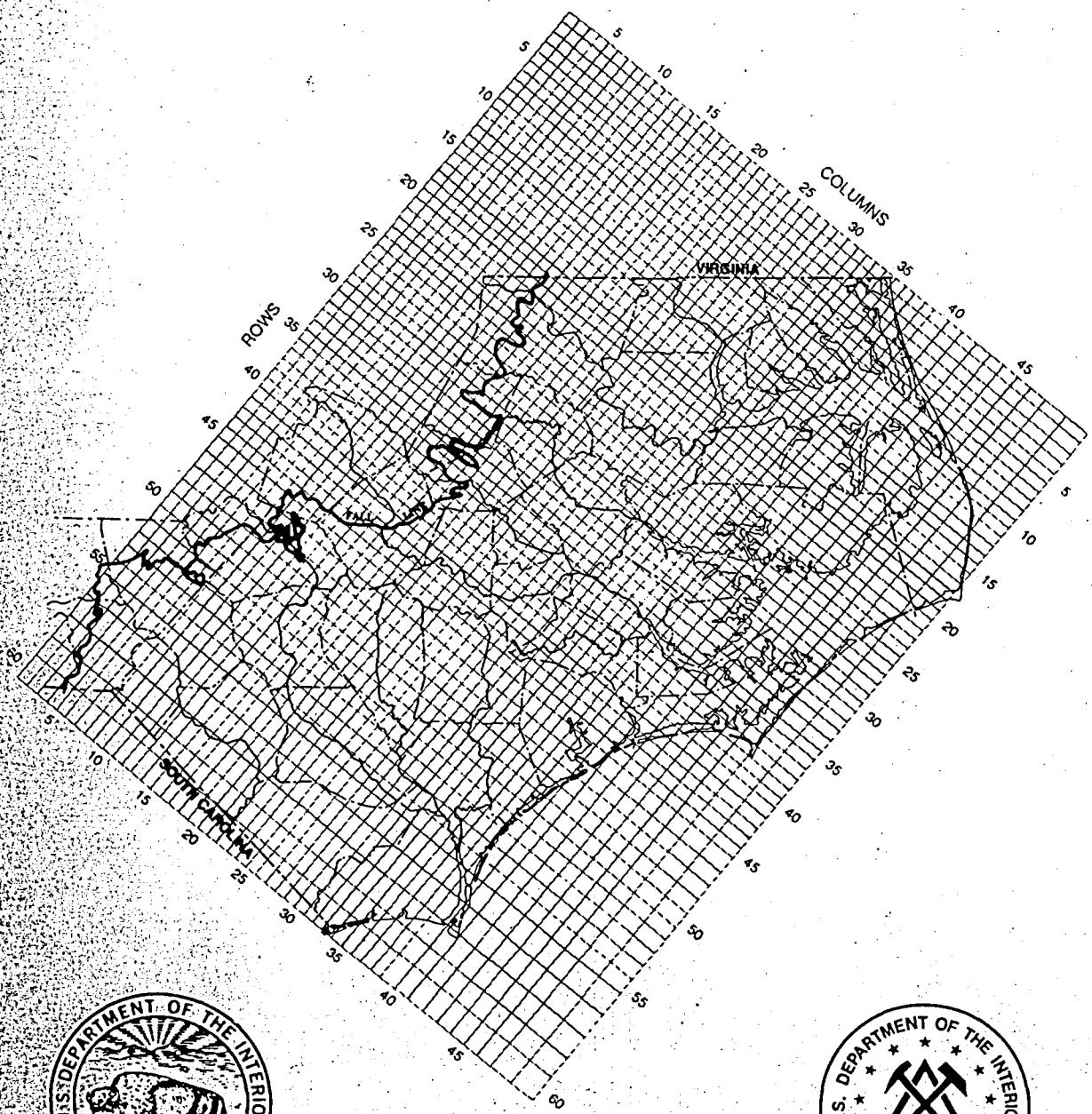
In areas where ground water is used for domestic and other needs requiring good-quality water, septic tanks, sanitary landfills, waste ponds, and other waste disposal sites should not be located uphill from supply wells.

The potentiometric surface of confined aquifers, like the water table, also slopes from recharge areas to discharge areas. Shallow confined aquifers, which are relatively common along the Atlantic Coastal Plain, share both recharge and discharge areas with the surficial unconfined aquifer. This may not be the case with the deeper confined aquifers. The principal recharge areas for these are probably in their outcrop areas near the western border of the Coastal Plain. Their discharge areas are probably near the heads of the estuaries along the major streams. Thus, movement of water through these aquifers is in a general west to east direction, where it has not been modified by withdrawals.

Ref. 27

SIMULATION OF GROUND-WATER FLOW IN THE COASTAL PLAIN AQUIFER SYSTEM OF NORTH CAROLINA

U.S. GEOLOGICAL SURVEY
Open-File Report 90-372



SIMULATION OF GROUND-WATER FLOW IN THE COASTAL PLAIN AQUIFER SYSTEM OF NORTH CAROLINA

By G.L. Giese, J.L. Eimers, and R.W. Coble

U.S. GEOLOGICAL SURVEY

Open-File Report 90-372

Raleigh, North Carolina

1991

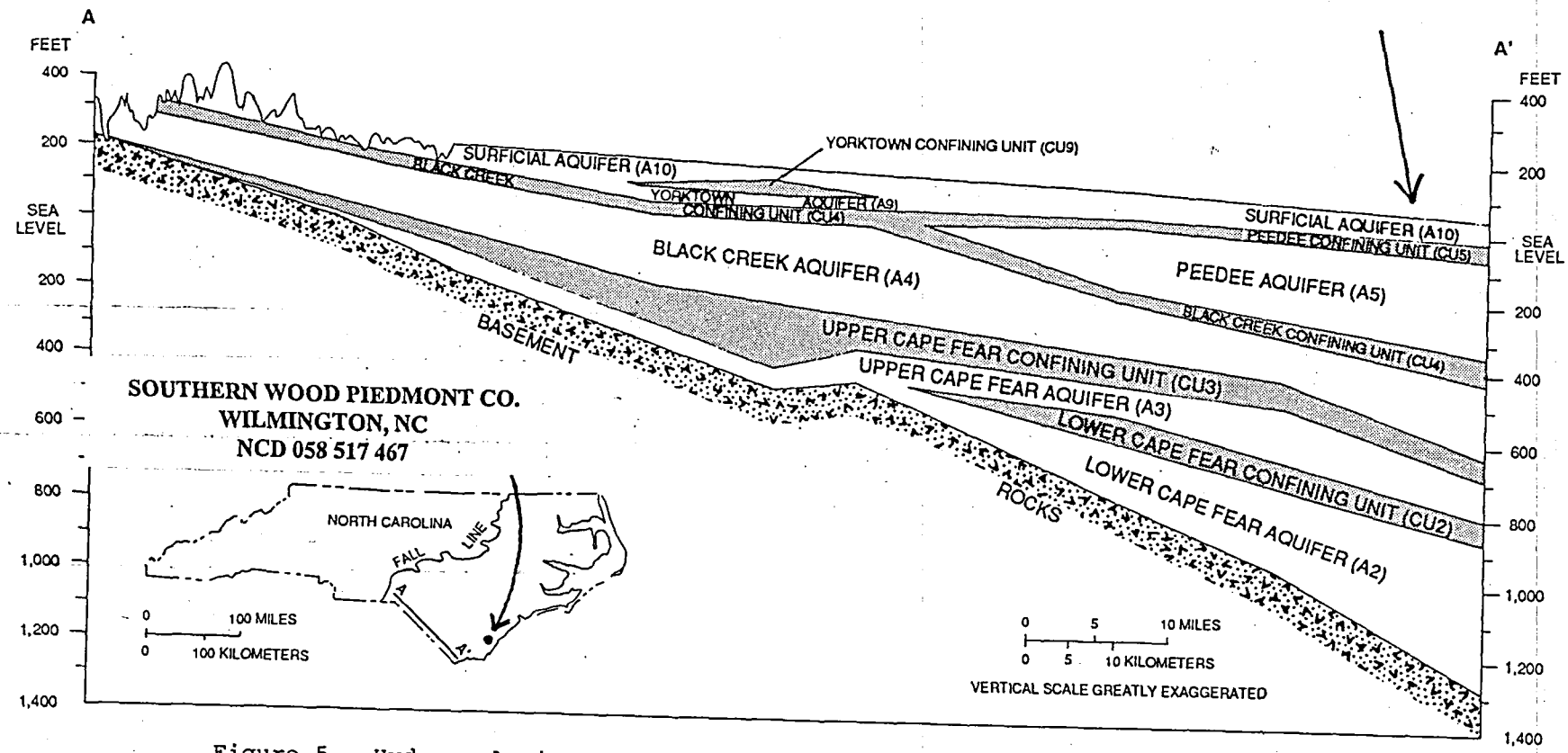


Figure 5.--Hydrogeologic section A-A′ from Richmond County to Brunswick County (modified from Winner and Coble, 1989).

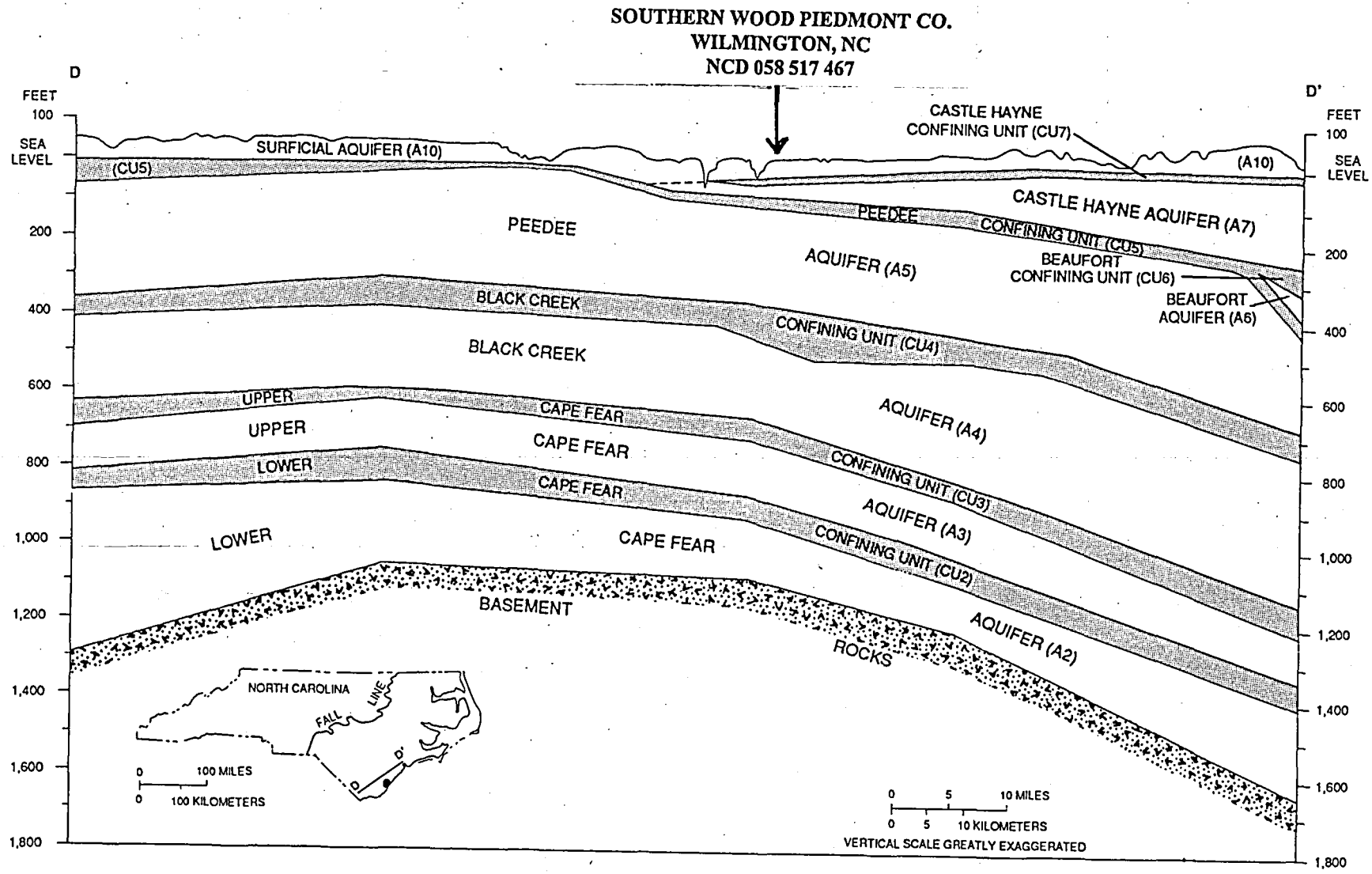


Figure 8.--Hydrogeologic section D-D′ from Brunswick County to Onslow County (modified from Winner and Coble, 1989).

Pungo River Aquifer (A8) and Overlying Confining Unit (CU8)

The Pungo River aquifer (A8) consists of the permeable part of the Pungo River Formation of lower and middle Miocene age, described in detail by Kimrey (1965). The Pungo River aquifer is composed of fine to medium marine sands with considerable phosphate content. Average estimated horizontal hydraulic conductivity based on analysis of geophysical logs is 33 ft/d, according to Winner and Coble (1989). Shells and other fossils are present throughout the aquifer; occasionally, beds of limestone and coarse sand are found.

The Pungo River aquifer (A8) is thinnest near its western and northern limits, where its thickness averages about 15 ft. The aquifer dips eastward and thickens to more than 200 ft in the vicinity of the Outer Banks where the top is more than 700 ft below sea level. The aquifer is overlain everywhere by aquifers A9 or A10 (fig. 11), except where it is exposed in an open-pit phosphate mine in Beaufort County. The Pungo River aquifer is underlain everywhere by the Castle Hayne aquifer (A7).

The Pungo River confining unit (CU8) is formed by the upper clay beds of the Pungo River Formation and contiguous clays of the lowermost Yorktown Formation. The confining unit ranges in thickness from less than 10 ft near the western margin to about 150 ft beneath Currituck County, with an average thickness of nearly 55 ft. For most of the area, the confining unit is composed of nearly uniform clay containing less than 10 percent sand.

Castle Hayne Aquifer (A7) and Overlying Confining Unit (CU7)

The Castle Hayne aquifer (A7) is delineated as those calcareous sediments of Eocene age that are equated with the Castle Hayne Limestone and the Trent Formation of former usage of Clark and others (1912). Also included in this aquifer are rocks of Oligocene age, now designated River Bend Formation, overlying the Castle Hayne (Brown and others, 1972), which are lithologically identical and hydraulically connected to the Castle Hayne Limestone. The basal part of the aquifer may include older contiguous permeable units in local areas. The areal extent of this aquifer is shown in figure 12, which also shows the extent of overlying aquifers.

The Castle Hayne aquifer (A7) is composed of limestone, sand, and minor amounts of clay deposited under marine conditions. Limestone may occur as shell limestone, dolomitic limestone, and sandy limestone ranging from loosely consolidated to hard and recrystallized. Along the western margin, the aquifer occurs near land surface from New Hanover County to Craven County. Eastward, the aquifer thickens to more than 950 ft in Carteret County and to nearly 1,200 ft beneath Cape Hatteras (Brown, 1958, fig. 4). In the area north of Albemarle Sound, limestone beds are thin to nonexistent, and the sediments contain more clay. The thickness of the unit averages about 50 ft between Bertie and Currituck Counties but reaches a maximum of 115 ft in Currituck County.

The Castle Hayne aquifer (A7) is the most productive aquifer in North Carolina due to its thickness and high percentage of permeable limestone and sand. On the basis of aquifer tests and lithologic and geophysical log data, the hydraulic conductivity of the Castle Hayne aquifer ranges from about 15 ft/d, where it is composed of fine sand, to about 200 ft/d where the bulk of the aquifer is porous limestone.

The thickness of the Castle Hayne confining unit (CU7) averages only about 10 ft; it exceeds 25 ft only in Gates County along the Virginia border, in eastern Pamlico and Carteret Counties, and in two small areas along the western limit of the Castle Hayne aquifer (A7). The confining unit is composed of beds of clay, sandy clay, and clay with sandy streaks that are part of the Pungo River Formation, the Yorktown Formation, or younger clays. The confining unit is missing in several stream valleys south of Craven County and in two areas in the northeastern Coastal Plain. In addition to being thinner than most of the other confining units, the Castle Hayne confining unit contains more sand; thus, it is relatively permeable and allows significant vertical leakage between the Castle Hayne and overlying aquifers.

The Castle Hayne aquifer (A7) and confining unit (CU7) are directly overlain by the Pungo River aquifer (A8) throughout most of its northern and eastern area (fig. 12), whereas to the south, the Castle Hayne is overlain by the Yorktown and surficial aquifers (A9 and A10). The Castle Hayne is directly underlain by the Beaufort aquifer (A6) and confining unit (CU6) northeast of Jones and Onslow Counties and by the Peedee aquifer (A5) and confining unit (CU5) south of these counties (fig. 13).

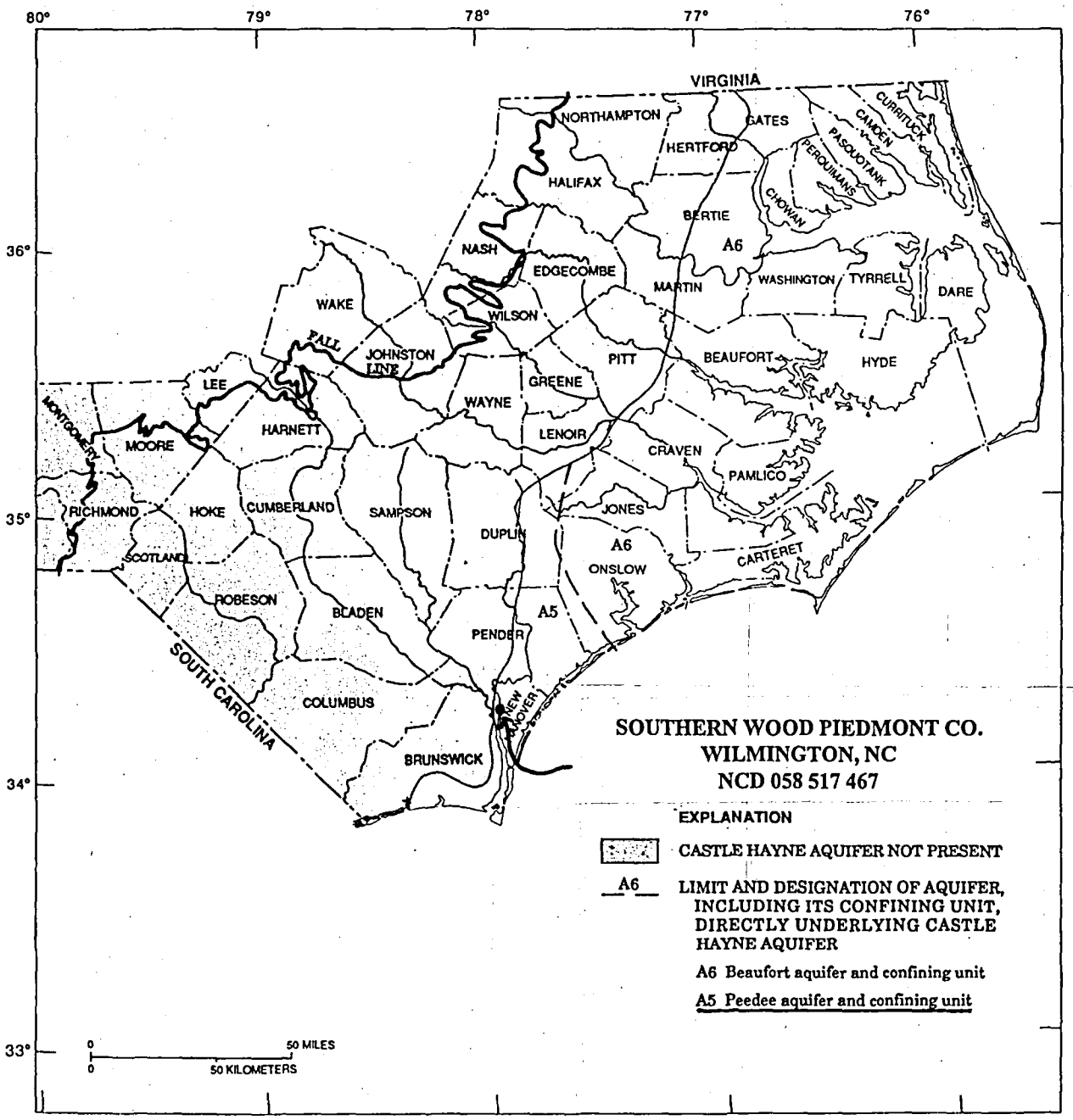


Figure 13.--Areal extent of the Castle Hayne aquifer (A7) and underlying aquifers (modified from Winner and Coble, 1989).

Peedee Aquifer (A5) and Overlying Confining Unit (CU5)

The Peedee aquifer (A5) is named for the Upper Cretaceous Peedee Sand of Clark and others (1912, p. 145) and the Peedee Formation of Stephenson and Rathbun (1923, p. 11), of which the aquifer is largely composed. The areal extent of the Peedee aquifer and overlying units is shown in figure 16.

The Peedee aquifer (A5) is composed of fine to medium-grained sands interbedded with clays and silts. Thin beds of consolidated calcareous sandstone and impure limestone are interlayered among the sands in some places, particularly in the southeastern Coastal Plain area. Shells are common throughout the unit. The top of the Peedee aquifer dips eastward at an average rate of about 24 ft/mi (feet per mile), but the dip is variable from about 10 ft/mi in the western part to over 32 ft/mi in the more deeply buried part along the coast. The aquifer thickness ranges from zero along its western limit to more than 300 ft along the coast from southern Onslow County to the South Carolina border. Northeast of Onslow County, the maximum thickness of the aquifer is less than 200 ft and the unit contains saltwater. The average horizontal hydraulic conductivity of the Peedee aquifer was estimated from geophysical logs to be about 33 ft/d by Winner and Coble (1989).

The Peedee confining unit (CU5) is composed of clay, silty clay, and sandy clay. Winner and Coble (1989) did not identify the confining unit with a particular geologic unit, but the unit is composed primarily of sediments at the Cenozoic-Mesozoic boundary. The average thickness of the Peedee confining unit is about 25 ft. In the eastern part of the confining unit, thickness may reach 60 ft but commonly does not exceed 30 to 35 ft.

Black Creek Aquifer (A4) and Overlying Confining Unit (CU4)

The Black Creek aquifer (A4) (Winner and Coble, 1989) includes Upper Cretaceous sediments of both the Black Creek and underlying Middendorf Formations (fig. 17). The Black Creek Formation consists mainly of thinly-laminated gray to black clay, interbedded with gray to tan sands. Outcrops also exhibit sand or clay-dominated lenses. The Middendorf Formation

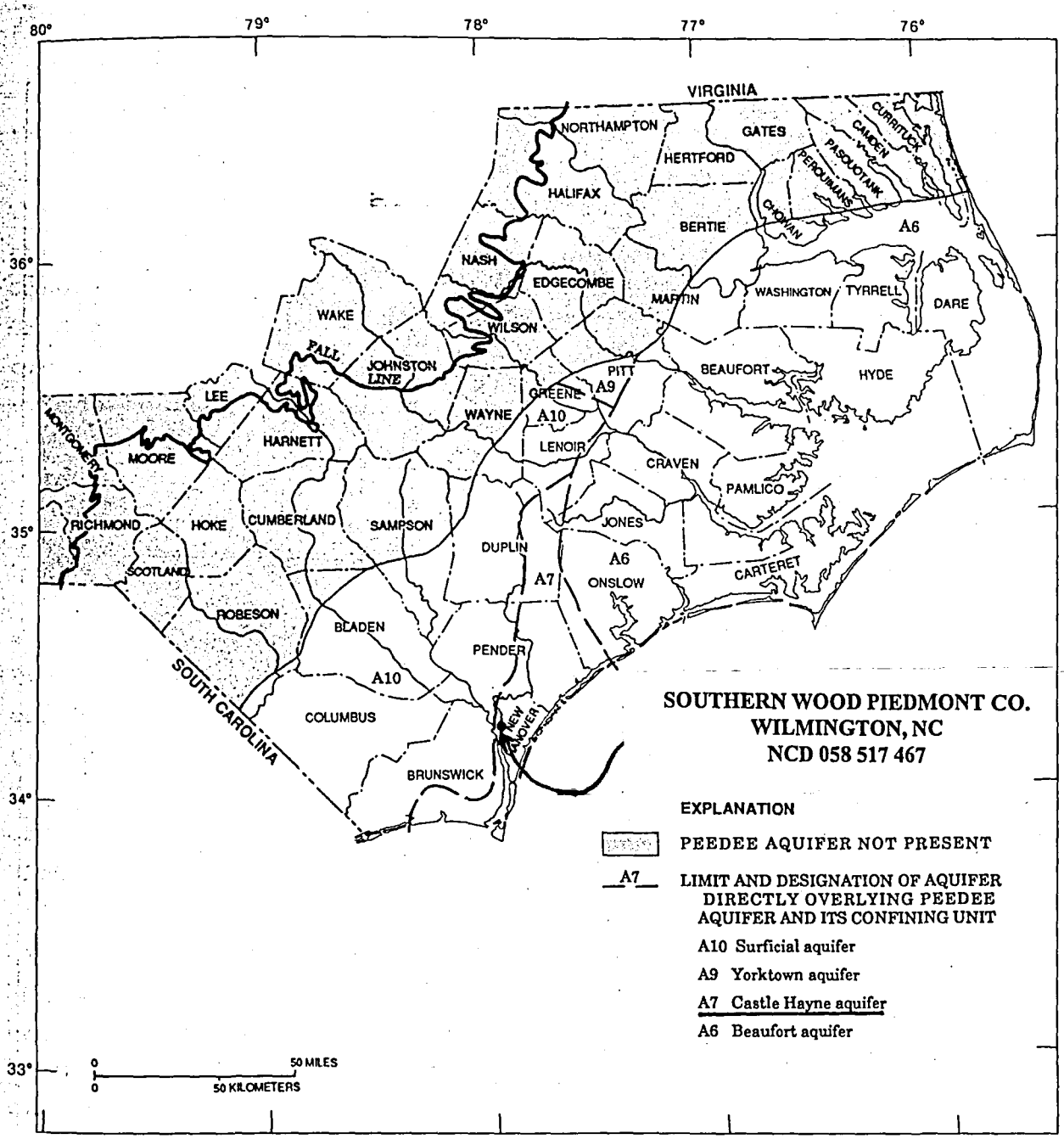


Figure 16.--Areal extent of the Peedee aquifer (A5) and overlying aquifers (modified from Winner and Coble, 1989).

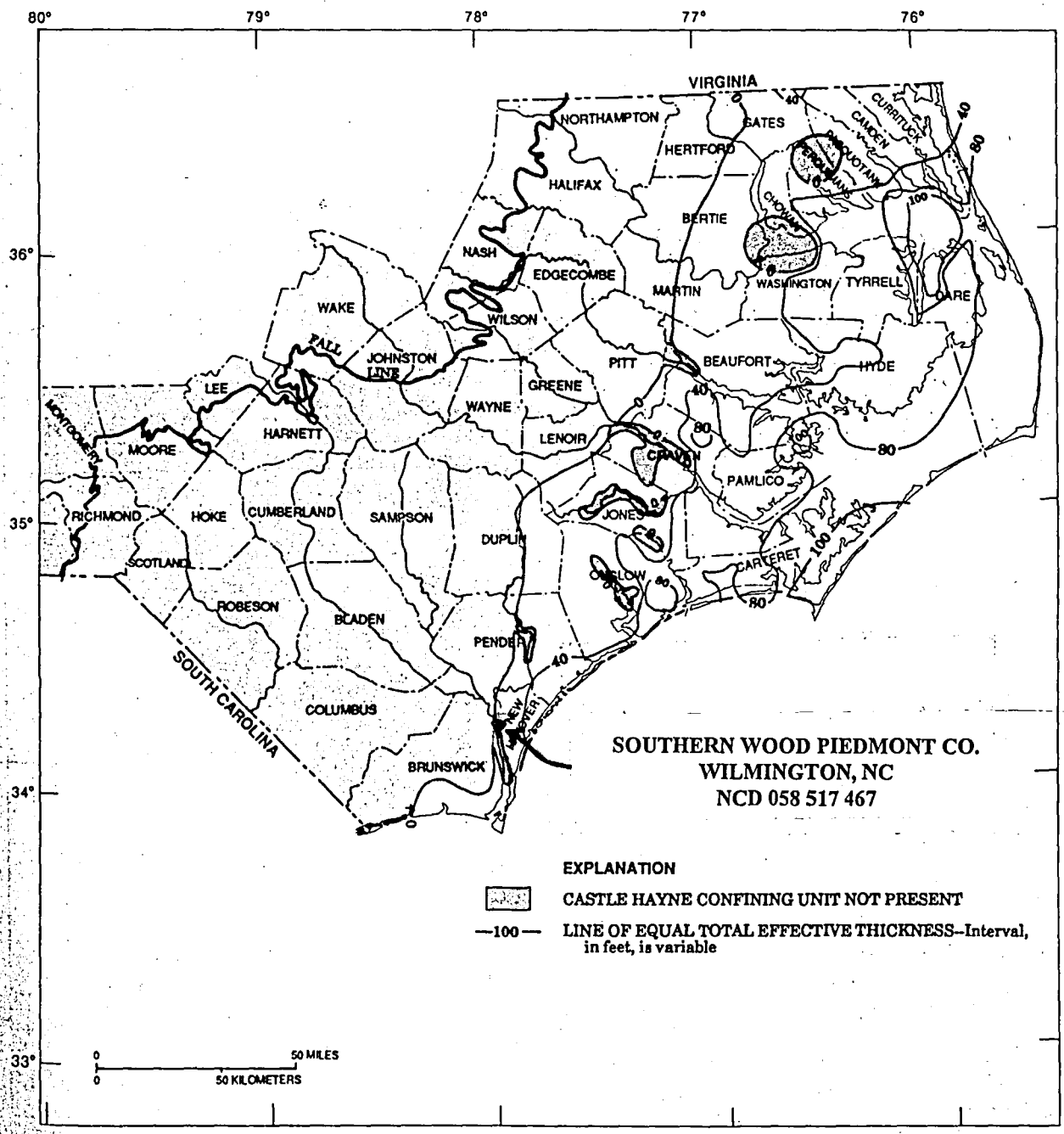


Figure 37.--Effective thickness of the Castle Hayne confining unit (CU7).

MEMORANDUM

To: File
From: Stuart F. Parker, Jr., Hydrogeologist
Date: December 12, 1994
Re: Southern Wood Piedmont Co, Wilmington
NCD 058 517 467
Municipal Drinking Water Supplies
within the Wilmington Area.

SFP contacted personnel at the City of Wilmington Water Department and at the DEHNR Wilmington Regional Office to determine the locations and status of municipal drinking water sources within the study area, which (due to tides) includes 15-mile distances both upstream and downstream of the site on the Cape Fear and Northeast Cape Fear Rivers.

SFP telephoned J D Monroe of the NC DEHNR Water Supply Branch in Wilmington (910-486-1191) on 7/20/94. Monroe checked his listings of intakes for the region. According to his data, the primary intake is located on the Cape Fear River at approximately latitude 34°24'30", longitude 78°17'50". Two other intakes, one for Brunswick County and the other for Riegelwood Co., are also located there. This location is at least 30 miles upstream of Wilmington on the Cape Fear River.

A second municipal intake is located on Toomers Creek, a channel located in a tidal flat north of Eagle Island, 4 miles NW of downtown Wilmington. This intake was used as a standby. A third Wilmington intake is listed on Northeast Cape Fear River, at latitude 34°15'30", longitude 77°57'00", just downstream of Smith Creek.

SFP telephoned Chuck Davis, City of Wilmington Water Department (910-341-4683) on 7/25/94 and on 12/12/94 for additional information on the system. He confirmed that the main intake is more than 30 miles NW of Wilmington on the Cape Fear River. He was not familiar with any intake on the Northeast Cape Fear River (The indicated supply coordinates coincide with the location of the city's filtration plant). He reported that the Toomers Creek intake has not been used for several years (decades) because of high salinity due to tidal influence. He reported that no wells are used by the City, and that no other municipal supply systems operate in the County.

Maps of the Wilmington system's distribution lines are available at the City Engineering Department. According to Davis, the system's northern limit is presently at Division Drive, located directly north of Smith Creek off US Route 117. The service area includes the entire area within Wilmington's mapped city boundary.

SFP telephoned J Fred Hill, Water Supply Consultant at DEHNR's Washington, NC Regional Office (919-946-6481) on 7/19/94. Hill reported that the only active intakes in the Wilmington/Castle Hayne area are the ones located at Riegelwood. He reported that the intake at Smith Creek, like the Toomers Creek intake, is used only for emergencies because of high salinity.

SFP telephoned Ralph Harper, Environmental Engineer at the Wilmington Regional Office, Public Water Supply (910-395-3900) on 7/25/94 for information on local wells. Harper reported that Castle Hayne has no municipal system, but that community and private wells supply the population. Transient springs supply some water to taps at Greenwood Lake (a non-perennial, non-community supply).

SFP telephoned the Town of Leland on 8/9/94, where a purchase water supply is indicated on public water supply database (910-371-9949. Ms.Jean Steight, Administrator, reported that the water is purchased from Brunswick County/Cape Fear Water and Sewer Authority. There are no municipal wells. From Leland to the east edge of the county (at the Cape Fear River, approximately 50 % of residences are hooked up. The rest are on private wells.

NEW HANOVER

DIVISION OF HEALTH SERVICES - ENVIRONMENTAL HEALTH SECTION - WATER SUPPLY BRANCH

* * * PUBLIC WATER SUPPLY DATA SHEET * * *ONLY SURFACE SOURCE

DATE OF RUN 05/16/90

PWSI-ID W0410S

NC INVENTORY DOCUMENT (PWSI.410) AS OF MAY 90

RE-CO-SEQ	DATA LINE CODE			
04-65-010	03	NAME OF PUBLIC WATER SYSTEM WILMINGTON, CITY OF	RESPONSIBLE PERSON ADDRESS PO BOX 1810	
	04	RESPONSIBLE PERSON CITY WILMINGTON	STATE NC	ZIP CODE 28403	PHONE- AREA CODE/NUMBER 919-343-3690
	17	RESPONSIBLE PERSON NAME A G SURRATT OR MANAGER NOW	LOCATION OF PUBLIC WATER SUPPLY 407 HILTON ST.	UPDATE CODE C
	01	OWNERS NAME CITY OF WILMINGTON	OWNERS STREET ADDRESS DIR BOX 1810	
	02	OWNERS CITY WILMINGTON	STATE NC	ZIP CODE 28402	OWNER TYPE C

05 CITY OR COMMUNITY SERVED — SERVICE AREA CHARACTERISTICS

CITY OR COMMUNITY SERVED	COUNTY CODE	IND RES	RES	COT	REC	MOH	INS	SCH	MOT	RET	SST	CAG	PIC	LOG	MRR	SKI	BAT	VIS	HWY	AIR	OTHER
WILMINGTON	065	000	1																		

06

NO. CONSECUTIVE PURCHASING	INTERSTATE CARRIERS	PWS TYPE	POPULATION SERVED	NO. SERVICE CONNECTIONS	NUMBER METERS	CONSECUTIVE INDICATOR
00	N	C	000057301	0018500	0018500	0

07

AVERAGE PRODUCTION GAL/DAY	DESIGN GAL/DAY	EMERGENCY GAL/DAY	STORAGE CAPACITY/GALS.	MAXIMUM PRODUCTION GAL/DAY
0008750000	0015000000	0015000000	0020500000	0013400000

08

PWS BEGIN	LAST SURVEY DATE	BACTI AND TURBIDITY COMPLIANCE CYCLE	ACTIVITY INDICATOR	DEACTIVATION DATE	REASON	ACTIVITY DATE
06/77	05/06/88	01	A	00/00/00		050688

09

POST CODE	REG BY	STATE REG	STATE DIS	BACTI FLAG	MONTHLY MONITOR	NUMBER SAMPLES	SEASON BEGIN	SEASON END	DAILY CHECKS	SAMPLE FREQ	MCL CK SAMPLE	CHLORINE P P M	TURBIDITY FLAG	TURBIDITY UNITS
NC	B	04		L	Y	065	00/00	00/00	1	000	2	00	L	1.4

16 - - - - - - - - - SOURCE - - - - - - - -

NO.	NAME	CODE	NUMBER WELLS	AVL	RIVER BASIN	LATITUDE DEG	MIN	SEC	LONGITUDE DEG	MIN	SEC	PWSI-ID OF SELLER	WATER TREATMENTS 6 7 8 9 0 1 2 3 4 5 6 7 8
01	CAPE FEAR RIVER	S	00	P	0002	034	24	15	078	17	08	- -	B S R D C Y G
02	TOOMERS CREEK	S		R	0002	034	15	43	077	59	02	- -	
03	N E CAPE FEAR	S		E	0002	034	15	29	077	56	52	- -	
04	L CAPE FEAR W&S	S	00	E								- -	

Ref. 29

Stuart Parker

PMMGRID STATE N.C. PUBLIC WATER SUPPLY SYSTEM 07/28/94
ACTIVE SYSTEMS
GRID LATITUDE: 340900 / 341630, LONGITUDE: 0775230 / 0780130

	PWS ID	SYSTEM NAME	TYPE	POPULATION	RES.PERSON WORK PHONE	SOURCE NAME	SOURCE TYPE	SOURCE AVAIL.	LATITUDE	LONGITUDE	
OUT	410070	LELAND SANITARY DISTRICT	C	3483	9103719949	BRUNSWICK CO	P	P	341350	780015	NOT SOURCE LOCATION
	410131	~~CAMELIA RESTAURANT & MOTEL~~	~~N~~	85	9103716318	WELL	G	P	341345	775950	
1	410139	CREEKSIDE TOWNHOMES	C	55	9107541609	WELL #1	G	P	341200	775900	
2	410149	MCKOY BOARDING HOME	C	25	9103712339	WELL N	G	P	341345	775523	
	410426	~~SANDPIPER - SEAFOOD HOUSE~~	~~N~~	200	9103719262	WELL	G	P	341445	780055	
	410436	~~LELAND SHOPPING CENTER~~	~~N~~	1000	9192917635	WELLS	G	P	341415	780045	
	410437	~~TOWN AND COUNTRY MOTEL~~	~~N~~	33	9103712289	WELL	G	P	341250	775945	
	410462	MCDONALDS 5668	N	62	9103713112	WELL	G	P	341400	780000	
	410464	SHIRLEY'S BURGER HOUSE	N	40	9103712890	WELL	G	P	341330	780000	
	410468	WILSON'S #8	N	500	9103712696	WELL	G	P	341345	780000	
	410481	FEEDING SITE FOR ELDERLY	N	35	9102534391	WELL	G	P	341430	780030	
	410490	MCGEES MINI MART	N	100	9103712495	WELL	G	P	341430	780030	
	410510	H & LEE OIL COMPANY	N	50	9103716631	WELL	G	P	341410	780045	
	410511	SECURITY SAVINGS AND LOAN	N	35	9103716444	WELL	G	P	341438	775940	
	410512	FAMILY DOLLAR STORE	N	35	9103712431	WELL	G	P	341425	775935	
	410513	LELAND PROFESSIONAL CENTER	N	100	9103716386	WELL	G	P	341430	775925	
	410534	SCOTCHMAN #115	N	200	9103955300	WELL	G	P	341425	775940	
	~~465010~~	~~WILMINGTON WATER SYSTEM~~	~~C~~	~~57242~~	~~9103433690~~	~~CAPE FEAR RIVER~~	~~S~~	~~E~~	~~341545~~	~~775920~~	
OUT	465105	BROOKFIELD S/D	C	500	9107990433	WELL #1	G	P	341617	775245	
		~~BROOKFIELD S/D~~	~~C~~	~~500~~	9107990433	WELL #2	G	P	341618	775231	
OUT	465129	KINGS GRANT WATER CO	C	5000	9107629997	WELL #3	G	P	341610	775305	
	465137	PALMS MHP	C	75	9107620944	WELL #1	G	P	341630	775530	
	465153	TOWN & COUNTRY MHP #1	C	140	9103950697	WELL #1	G	P	341530	775300	
	465163	ADJ-TOWN & COUNTRY MHP #2	A	25	9103950697	WELL #2	G	P	341530	775257	
3	465190	RUNNYMEADE S/D	C	600	9103417139	WELL #1	G	P	341414	775314	
		RUNNYMEADE S/D	C	600	9103417139	WELL #2	G	P	341414	775314	
	465410	DR JEWELLS DENTISTRY OFFICE	N	25	9107912401	WELL	G	P	341241	775241	
	465411	STUCKEY AUTO PARTS	N	25	9107995550	WELL	G	P	341241	775240	
	465427	WINTER PARK PENTECOSTAL HOLINE	N	150	9103716646	WELL	G	P	341250	775250	
	465436	CENTER PIER REST	N	500	9104599411	WELL	G	P	341118	775330	
	465437	CONVENANT FOOD MART	N	25	9107994200	WELL	G	P	340909	775403	
	465443	THE DUG OUT	N	100	9103927029	WELL	G	P	341110	775530	
	465454	CAPE FEAR ACADEMY	P	300	9107910287	WELL	G	P	340925	775310	
OUT		CAPE FEAR ACADEMY	P	300	9107910287	WELL	G	P	340925	775310	
	465467	HERITAGE BAPTIST CHURCH	N	250	9103924475	WELL	G	P	341000	775300	
	465473	UNITED ADVENT CHRISTIAN CHURCH	N	200	9107916383	WELL	G	P	340908	775415	
	465476	SOUTHSIDE BAPTIST CHURCH	N	350	9107994751	WELL	G	P	341030	775312	
	465482	TRAVELERS STATION	N	25	9197792086	WELL	G	P	341245	775242	
	465484	FIRST ASSEMBLY OF GOD	N	130	9107913671	WELL	G	P	341247	775253	
	465497	ARBYS UNIT 336	N	150	9107919892	WELL	G	P	341250	775245	
	465518	HUGH MCRAE PARK	N	300	9103417198	WELLS	G	P	341109	775314	
		HUGH MCRAE PARK	N	300	9103417198	WELLS	G	P	341109	775314	
		HUGH MCRAE PARK	N	300	9103417198	WELLS	G	P	341109	775314	
		HUGH MCRAE PARK	N	300	9103417198	WELLS	G	P	341109	775314	
	465521	USCG LORSTA	N	25	9107910501	WELL	G	P	341330	775500	
	465528	FAST FARE	N	25	9107916301	WELL	G	P	341210	775308	
	465541	HARDEE'S CASTLE HAYNE ROAD	N	400	9107910185	WELL	G	P	341620	775602	
	465543	MIKES BAR-B-Q	N	45	9107621332	WELL	G	P	341615	775610	
	465544	NASHVILLE EAST	N	300	9106262653	WELL	G	P	341615	775610	

PMMGRID STATE N.C. PUBLIC WATER SUPPLY SYSTEM 07/28/94
ACTIVE SYSTEMS
GRID LATITUDE: 340900 / 341630, LONGITUDE: 0775230 / 0780130

	PWS ID	SYSTEM NAME	TYPE	POPULATION	RES.PERSON WORK PHONE	SOURCE NAME	SOURCE TYPE	SOURCE AVAIL.	LATITUDE	LONGITUDE
OUT	465561	NC NATIONAL GUARD WATER SYSTEM	P	50	9102517183	WELL #1	G	P	341350	775350

Ref. 30

DIVISION OF HEALTH SERVICES - ENVIRONMENTAL HEALTH SECTION - WATER SUPPLY BRANCH — DATE OF RUN 05/16/90

* * * PUBLIC WATER SUPPLY DATA SHEET * * *ONLY SURFACE SOURCE

NC INVENTORY DOCUMENT (PWSI.410) AS OF MAY 90

PWSI-ID W0410S
RE-CO-SEQ DATA LINE CODE

04-10-045

03 NAME OF PUBLIC WATER SYSTEM: BRUNSWICK CO WATER SYSTEM
RESPONSIBLE PERSON ADDRESS: PO BOX 249

04 RESPONSIBLE PERSON CITY: BOLIVIA
STATE: NC
ZIP CODE: 28422
PHONE- AREA CODE/NUMBER: 919-457-9183

17 RESPONSIBLE PERSON NAME: O KENNETH HEWITT OR MGR NOW
LOCATION OF PUBLIC WATER SUPPLY: HWY 211 W SOUTHPORT
UPDATE CODE: C

01 OWNERS NAME: BRUNSWICK COUNTY
OWNERS STREET ADDRESS: PO BOX 249

02 OWNERS CITY: BOLIVIA
STATE: NC
ZIP CODE: 28422
OWNER TYPE: N

05 CITY OR COMMUNITY SERVED: BRUNSWICK CO
COUNTY CODE: 010
IND RES: 000

RES	COT	REC	MOH	INS	SCH	MOT	RET	SST	CAG	PIC	LOG	MRR	SKI	BAT	VIS	HWY	AIR	OTHER
1																		1

06

NO. CONSECUTIVE PURCHASING	INTERSTATE CARRIERS	PWS TYPE	POPULATION SERVED	NO. SERVICE CONNECTIONS	NUMBER METERS	CONSECUTIVE INDICATOR
00	N	C	000001905	0000635	0000635	0

07

AVERAGE PRODUCTION GAL/DAY	DESIGN GAL/DAY	EMERGENCY GAL/DAY	STORAGE CAPACITY/GALS.	MAXIMUM PRODUCTION GAL/DAY
0008300000	0031500000	0007000000	0013950000	0006800000

08

PWS BEGIN	LAST SURVEY DATE	BACTI AND TURBIDITY COMPLIANCE CYCLE	ACTIVITY INDICATOR	DEACTIVATION DATE	DEACTIVATION REASON	ACTIVITY DATE
06/77	05/27/88	01	A	00/00/00		052788

09

POST CODE	REG BY	STATE REG	STATE DIS	BACTI FLAG	MONTHLY MONITOR	NUMBER SAMPLES	SEASON BEGIN	SEASON END	DAILY CHECKS	SAMPLE FREQ	MCL CK SAMPLE	CHLORINE P P M	TURBIDITY FLAG	TURBIDITY UNITS
NC	B	04		L	Y	002	00/00	00/00	1	000	2	00	L	0.0

16 - - - - - - - - - SOURCE - - - - - - - -

NO.	NAME	CODE	NUMBER WELLS	AVL	RIVER BASIN	LATITUDE DEG	MIN	SEC	LONGITUDE DEG	MIN	SEC	PWSI-ID OF SELLER	WATER TREATMENTS 6 7 8 9 0 1 2 3 4 5 6 7 8
01	CAPE FEAR RIVER	S	00	P	0002	034	24	30	078	17	47	- -	
02	211 WELL #1	G	01	P	0002	033	58	23	078	05	17	- -	Y C O M A L C G
03	211 WELL #2	G	01	P	0002	033	58	42	078	04	54	- -	
04	211 WELL #3	G	01	P	0002	033	58	05	078	04	51	- -	
05	211 WELL #5	G	01	P	0002	033	57	25	078	04	52	- -	
06	211 WELL #6	G	01	P	0002	033	56	51	078	04	55	- -	
07	211 WELL #7	G	01	P	0002	033	56	50	078	05	25	- -	
08	211 WELL #8	G	01	P	0002	033	56	57	078	04	49	- -	
09	211 WELL #11	G	01	P	0002	033	56	44	078	04	26	- -	
10	211 WELL #12	G	01	P	0002	033	57	10	078	04	28	- -	
11	211 WELL #12-A	G	01	P	0002	033	57	22	078	04	34	- -	
12	211 WELL #15	G	01	P	0002	033	56	11	078	04	25	- -	
13	211 WELL #16	G	01	P	0002	033	58	59	078	04	52	- -	
14	211 WELL #17	G	01	P	0002	033	56	11	078	02	55	- -	
15	211 WELL #18	G	01	P	0002	033	58	42	078	03	51	- -	

MEMORANDUM

To: File
From: Stuart F. Parker, Jr., Hydrogeologist
Date: December 1, 1994
Re: Southern Wood Piedmont Co., Wilmington
NCD ~~986~~ 058 ~~228~~ 517 ~~054~~ 467
Radial House Count

SFP completed a house count within radial distance increments from the site using current US Geological Survey quadrangles (Ref 1). The data are summarized in Table 1.

No residents or workers are present at the site. The City of Wilmington's municipal water system serves most of the population within a 4-mile radius, particularly east of the Cape Fear River. The distribution system covers the entire area within city limits with a few extensions to the south, north, and east.

Of the population using private domestic wells within the study area, all of those in New Hanover Co. reside north of Smith Creek. All those in Brunswick Co. are located west of Eagle Island and the Brunswick River, over 1.5 miles from the site. Approximately half of these Brunswick residences are served by the Leland public water system, which, like the Wilmington system, originates outside the study area.

The results of the house count indicate that approximately 539 houses within a 4-mile radius use private groundwater wells. Multiplying by 2.68 persons per household in (Wrightsboro) New Hanover County and by 2.69 persons per household in (Leland) Brunswick County (Ref. 32), the resulting private well population numbers 1449. An additional 680 individuals are estimated to obtain water from 3 community wells within the 4-mile radius (Ref. 30). The resulting population count for groundwater use within 4.0 mi. of the site is therefore 2129 persons.

(next page)

Radial Distance (mi.):	House Count (Domestic Wells)		Population (Domestic Wells)		Population (Community Wells)	Total Well Population
	N Han. Co.	Brun. Co.	N Han. Co.	Brun. Co.		
0.0-0.25	0	0	0	0	0	0
0.25-0.5	0	0	0	0	0	0
0.5-1.0	0	0	0	0	0	0
10.-2.0	0	27	0	73	80	153
2.0-3.0	10	60	27	161	0	188
3.0-4.0	189	253	507	681	600	1788
		Total Subpop.	534	915	680	2129

U.S. Department of Commerce
Economics and Statistics Administration
BUREAU OF THE CENSUS

1990 CPH-1-35

CENSUS '90

1990 Census of Population and Housing

Summary Population and Housing Characteristics

North Carolina

Ref. 32

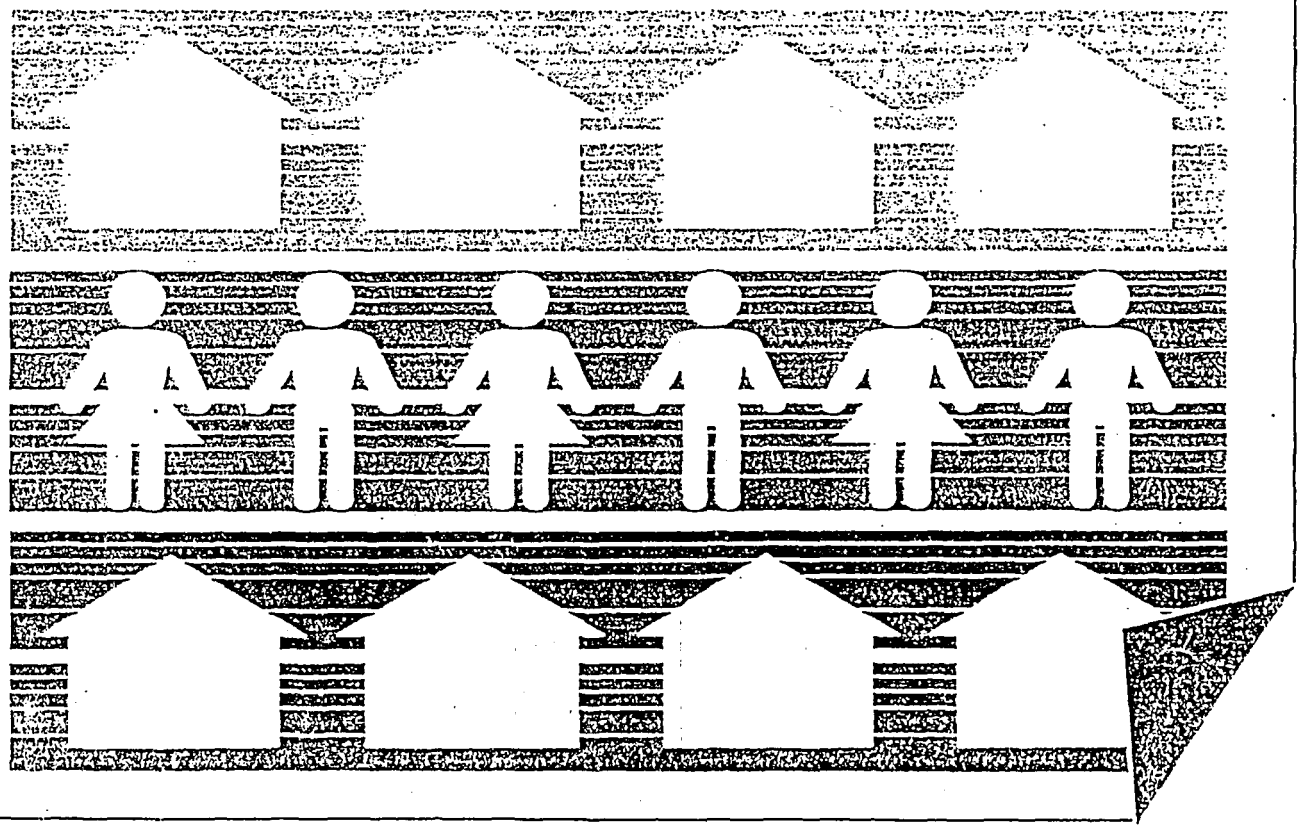


Table 5. Household, Family, and Group Quarters Characteristics: 1990—Con

[For definitions of terms and meanings of symbols, see text]

State County County Subdivision Place	Persons in households	All households	Family households: Total	Family households: Married-couple family	Family households: Female householder, no husband present	Nonfamily households: Total	Nonfamily households: Householder living alone: Total	Nonfamily households: Householder living alone: 65 years and over: Total	Nonfamily households: Householder living alone: 65 years and over: Female	Persons per—: Household	Persons per—: Family	Persons in group quarters: Total	Persons in group quarters: Institutionalized persons	Persons in group quarters: Other persons in group quarters
Brunswick County—Con.														
Leland township—Con.														
Southport city	2 274	981	650	493	133	331	305	166	136	2.32	[illegible]	95	95	-
Yaupon Beach town	734	342	233	205	20	109	102	40	28	2.15	[illegible]	-	-	-
Town Creek township	9 175	3 394	2 677	2 152	410	717	620	238	180	2.70	[illegible]	85	34	51
Belville town (pt.)	66	28	12	7	5	16	11	4	2	2.36	[illegible]	-	-	-
Boiling Spring Lakes city	1 650	666	523	447	53	143	122	54	38	2.48	[illegible]	-	-	-
Sandy town	228	87	64	50	12	23	21	15	13	2.62	[illegible]	-	-	-
Leland town (pt.)	242	90	63	41	17	27	26	6	5	2.69	[illegible]	-	-	-
Woodlawn township	2 260	856	643	528	87	213	192	91	74	2.64	[illegible]	-	-	-
Buncombe County	169 715	70 802	49 335	39 637	7 684	21 467	18 868	8 174	6 642	2.40	[illegible]	5 108	2 966	2 142
Asheville township	68 864	30 497	19 091	14 023	4 201	11 406	9 988	4 327	3 546	2.26	[illegible]	2 383	1 371	1 012
Asheville city (pt.)	53 343	24 106	14 506	10 295	3 524	9 600	8 433	3 757	3 093	2.21	[illegible]	2 246	1 234	1 012
Biltmore Forest town (pt.)	690	291	213	193	17	78	77	49	40	2.37	[illegible]	-	-	-
Woodfin town (pt.)	2 661	1 166	760	565	155	406	360	180	142	2.28	[illegible]	-	-	-
Avery Creek township	4 653	1 748	1 368	1 179	140	380	337	126	91	2.66	[illegible]	-	-	-
Asheville city (pt.)	6	2	2	2	-	-	-	-	-	3.00	[illegible]	-	-	-
Avery Creek CDP	1 144	408	341	304	27	67	60	15	11	2.80	[illegible]	-	-	-
Bent Creek CDP	1 487	532	452	397	45	80	71	27	15	2.80	[illegible]	-	-	-
Black Mountain township	9 873	4 219	2 921	2 398	424	1 298	1 164	619	503	2.34	[illegible]	967	565	402
Black Mountain town	5 032	2 256	1 462	1 168	241	794	722	441	366	2.22	[illegible]	386	331	55
Montreat town	394	181	131	117	12	50	43	14	13	2.18	[illegible]	299	-	299
Swannanoa CDP (pt.)	398	165	118	91	23	47	41	18	12	2.41	[illegible]	151	130	21
Broad River township	1 070	405	332	299	23	73	66	27	21	2.64	[illegible]	-	-	-
Fairview township	6 437	2 416	1 947	1 711	164	469	406	162	122	2.66	[illegible]	107	98	9
Fairview CDP	1 830	682	559	485	53	123	104	38	31	2.68	[illegible]	-	-	-
Flat Creek township	3 374	1 246	1 017	876	99	229	208	112	87	2.71	[illegible]	228	-	228
French Broad township	3 571	1 333	1 090	967	97	243	198	76	63	2.68	[illegible]	369	369	-
Woodfin town (pt.)	75	31	24	22	2	7	5	2	1	2.42	[illegible]	-	-	-
Ivy Township	2 757	1 057	783	675	67	274	249	125	84	2.61	[illegible]	-	-	-
Leicester township	11 442	4 292	3 466	2 969	364	826	723	319	244	2.67	[illegible]	3	3	-
Asheville city (pt.)	4	1	1	-	1	-	-	-	-	4.00	[illegible]	-	-	-
Limestone township	15 901	6 778	4 723	3 983	574	2 055	1 834	734	622	2.35	[illegible]	106	89	17
Asheville city (pt.)	4 431	2 228	1 273	1 081	152	955	871	410	360	1.99	[illegible]	35	35	-
Biltmore Forest town (pt.)	637	249	207	194	9	42	39	23	19	2.56	[illegible]	-	-	-
Royal Pines CDP	4 414	1 688	1 323	1 184	108	365	314	67	57	2.61	[illegible]	4	4	-
Lower Hominy township	8 619	3 492	2 636	2 219	304	856	754	329	291	2.47	[illegible]	141	118	23
Asheville city (pt.)	245	109	78	71	4	31	27	11	10	2.25	[illegible]	-	-	-
Reems Creek township	9 458	3 758	2 847	2 422	339	901	795	327	252	2.51	[illegible]	-	-	-
Weaverville town	2 107	882	606	492	95	276	252	86	65	2.39	[illegible]	-	-	-
Sandy Mush township	1 003	364	293	249	31	71	65	39	29	2.76	[illegible]	-	-	-
Swannanoa township	12 026	4 995	3 559	2 928	485	1 436	1 248	503	401	2.41	[illegible]	640	210	430
Asheville city (pt.)	1 293	581	358	268	78	223	180	55	46	2.23	[illegible]	4	-	4
Swannanoa CDP (pt.)	2 949	1 212	859	675	133	353	315	172	146	2.43	[illegible]	40	-	40
Upper Hominy township	10 665	4 192	3 242	2 739	372	950	833	349	286	2.54	[illegible]	164	143	21
Burke County	73 281	29 184	21 711	17 462	3 148	7 473	6 589	2 706	2 228	2.51	[illegible]	2 463	2 410	53
Drexel township	6 016	2 416	1 814	1 490	238	602	528	220	179	2.49	[illegible]	115	115	-
Drexel town	1 631	696	488	372	91	208	189	95	77	2.34	[illegible]	115	115	-
Valdese town (pt.)	36	13	11	10	1	2	2	1	1	2.77	[illegible]	-	-	-
Glen Alpine township	14 010	5 337	4 199	3 471	509	1 138	984	403	321	2.63	[illegible]	50	50	-
Connelly Springs town (pt.)	261	107	82	68	9	25	22	9	8	2.44	[illegible]	-	-	-
Hickory city (pt.)	40	15	14	12	-	1	1	1	1	2.67	[illegible]	39	39	-
Hildebran town	790	328	242	192	32	85	80	51	41	2.41	[illegible]	-	-	-
Icard CDP	2 547	997	740	612	91	257	226	80	66	2.55	[illegible]	6	6	-
Long View town (pt.)	358	150	113	90	14	37	34	15	14	2.39	[illegible]	-	-	-
Rhodhiss town (pt.)	226	88	64	50	10	24	21	10	7	2.57	[illegible]	-	-	-
Jacks Ridge township	606	238	175	156	9	63	58	31	20	2.55	[illegible]	53	53	-
Linville township	1 098	424	327	263	45	97	80	34	26	2.59	[illegible]	33	33	-
Lovelady township	8 005	3 334	2 382	1 910	357	952	870	411	362	2.40	[illegible]	-	-	-
Connelly Springs town (pt.)	1 088	426	322	255	41	104	92	40	37	2.55	[illegible]	-	-	-
Rutherford College town	1 126	468	339	279	46	129	123	59	50	2.41	[illegible]	-	-	-
Valdese town (pt.)	3 878	1 679	1 155	890	208	524	480	256	234	2.31	[illegible]	-	-	-
Lower Creek township	2 011	763	582	460	81	181	154	58	46	2.64	[illegible]	68	68	-
Lower Fork township	2 364	870	698	586	67	172	143	52	38	2.72	[illegible]	-	-	-
Morganton township	22 698	9 702	6 708	5 155	1 239	2 994	2 667	1 068	898	2.34	[illegible]	2 032	1 979	53
Morganton city (pt.)	12 148	5 493	3 500	2 536	803	1 993	1 783	764	639	2.21	[illegible]	1 475	1 422	53
Salem CDP	2 271	903	699	560	96	204	180	61	55	2.51	[illegible]	-	-	-
Quaker Meadow township	5 298	2 162	1 735	1 426	230	427	369	143	125	2.68	[illegible]	29	29	-
Morganton city (pt.)	1 163	436	369	311	50	67	54	20	18	2.67	[illegible]	-	-	-
Silver Creek township	8 164	3 003	2 351	1 922	299	652	572	223	162	2.72	[illegible]	64	64	-
Glen Alpine town	557	224	155	132	18	69	62	36	31	2.49	[illegible]	6	6	-
Morganton city (pt.)	299	119	87	71	13	32	28	9	9	2.51	[illegible]	-	-	-
Smoky Creek township	665	238	200	169	21	38	29	14	9	2.79	[illegible]	-	-	-
Upper Creek township	1 005	373	281	237	30	92	79	29	25	2.69	[illegible]	9	9	-
Upper Fork township	841	324	259	217	23	65	56	20	17	2.60	[illegible]	10	10	-
Cabarrus County	97 255	37 515	26 367	23 279	3 972	9 148	8 038	3 599	2 971	2.59	[illegible]	1 680	1 223	457
Township 1, Harrisburg	8 110	2 889	2 420	2 165	183	469	404	120	100	2.81	[illegible]	-	-	-
Harrisburg town	1 625	614	511	447	44	103	93	37	34	2.65	[illegible]	-	-	-
Township 2, Poplar Tent	10 994	3 975	3 216	2 789	293	759	653	212	158	2.77	[illegible]	114	114	-
Concord city (pt.)	855	317	229	169	43	88	79	40	33	2.70	[illegible]	114	114	-
Poplar Tent CDP (pt.)	3 086	1 141	918	779	102	223	197	78	61	2.70	[illegible]	-	-	-
Township 3, Odell	2 956	1 026	882	780	69	144	124	52	40	2.88	[illegible]	45	45	-
Township 4, Kannapolis	30 327	12 307	8 739	6 762	1 609	3 568	3 158	1 466	1 224	2.46	[illegible]	332	269	63
Concord city (pt.)	2 608	1 193	684	490	145	509	442	122	107	2.19	[illegible]	135	133	2
Kannapolis city (pt.)	21 084	8 632	6 109	4 641	1 221	2 523	2 238	1 138	961	2.44	[illegible]	136	75	61
Poplar Tent CDP (pt.)	786	273	220	201	16	53	47	12	11	2.88	[illegible]	-	-	-
Township 5, New Gilead	3 365	1 204	1 025	916	63	179	163	74	55	2.79	[illegible]	-	-	-
Concord city (pt.)	182	56	55	52	1	1	1	-	-	3.25	[illegible]	-	-	-
Township 6, Rimertown	1 743	632	529	478	40	103	90	30	26	2.76	[illegible]	-	-	-
Township 7, Gold Hill	991	365	298	267	22	67	60	31	26	2.72	[illegible]	-	-	-
Township 8, Mount Pleasant	4 543	1 671	1 335	1 166	118	336	299	144	122	2.72	[illegible]	190	190	-
Mount Pleasant town	1 027	420	301	242	45	119	109	56	53	2.45	[illegible]	-	-	-
Township 9, Georgeville	2 158	760	623	555	49	137	114	47	36	2.84	[illegible]	20	-	20
Township 10, Midland	4 114	1 516	1 219	1 085	84	297	256	100	83	2.71	[illegible]	9	9	-
Township 11, Central Cabarrus	11 692	4 413	3 522	2 972	431	891	765	332	276	2.65	[illegible]	230	230	-
Concord city (pt.)	6 434	2 484	1 924	1 566	288	560	485	223	189	2.59	[illegible]	17	17	-
Township 12, Concord	16 262	6 757	4 559	3 344	1 011	2 198	1 952	991	825	2.41	[illegible]	740	366	374
Concord city (pt.)	16 262	6 757	4 559	3 344	1 011	2 198	1 952	991	825	2.41	[illegible]	740	366	374

Table 5. Household, Family, and Group Quarters Characteristics: 1990—Con.

[For definitions of terms and meanings of symbols, see text]

State County County Subdivision Place	Persons in households	All households	Family households: Total	Family households: Married-couple family	Family households: Female householder, no husband present	Nonfamily households: Total	Nonfamily households: Householder living alone: Total	Nonfamily households: Householder living alone: 65 years and over: Total	Nonfamily households: Householder living alone: 65 years and over: Female	Persons per— Household	Persons per— Family	Persons in group quarters: Total	Persons in group quarters: Institutionalized persons	Persons in group quarters: Other
Moore County—Con.														
Township 7, McNeill	13 323	5 881	3 910	3 154	612	1 971	1 757	854	704	2.27	2.79	332	332	
Pinehurst town (pt.)	17	7	6	5	1	1	1	1	1	2.43	2.67	–	–	
Southern Pines town (pt.)	6 328	2 930	1 720	1 266	390	1 210	1 083	542	461	2.16	2.83	332	332	
Voss town	670	252	197	145	40	55	47	25	22	2.66	3.01	–	–	
Whispering Pines village	1 243	649	510	498	11	139	136	104	80	1.92	2.15	–	–	
Township 8, Sand Hill	12 775	5 028	3 711	2 803	749	1 317	1 152	488	401	2.54	3.00	109	76	
Aberdeen town	2 679	1 154	773	587	150	381	336	188	162	2.32	2.87	21	–	
Foxfire village (pt.)	–	–	–	–	–	–	–	–	–	–	–	–	–	
Pinebluff town	876	342	256	214	34	86	81	39	36	2.56	3.02	–	–	
Pinehurst town (pt.)	291	140	109	101	6	31	28	21	14	2.08	2.36	–	–	
Southern Pines town (pt.)	2 444	1 016	696	431	244	320	282	84	69	2.41	2.95	–	–	
Township 9, Mineral Springs	12 178	5 374	4 164	3 771	296	1 210	1 083	597	469	2.27	2.58	211	211	
Foxfire village (pt.)	334	164	135	134	1	29	29	22	16	2.04	2.25	–	–	
Pinehurst town (pt.)	4 642	2 318	1 726	1 648	57	592	533	310	240	2.00	2.30	153	153	
Seven Lakes CDP	1 991	869	771	741	23	98	88	50	43	2.29	2.43	58	58	
Southern Pines town (pt.)	25	7	7	7	–	–	–	–	–	3.57	3.57	–	–	
Taylortown town	543	206	141	81	50	65	57	25	19	2.64	3.30	–	–	
Township 10, Little River	1 887	728	571	468	79	157	132	46	30	2.59	2.93	–	–	
Nash County	75 450	29 041	21 224	16 322	3 968	7 817	6 926	2 880	2 316	2.60	3.09	1 227	807	
Bailey township	2 810	1 109	801	656	107	308	277	144	110	2.53	3.04	12	–	
Bailey town	553	245	151	118	26	94	89	55	42	2.26	2.97	–	–	
Castalia township	1 385	491	368	285	61	123	113	63	44	2.82	3.31	–	–	
Castalia town	261	98	74	53	17	24	23	15	11	2.66	3.12	–	–	
Coopers township	2 327	892	703	616	65	189	171	80	58	2.61	3.00	36	–	
Dry Wells township	2 507	978	704	541	128	274	252	126	110	2.56	3.06	35	32	
Middlesex town	730	294	206	143	53	88	78	50	47	2.48	2.95	–	–	
Ferrells township	1 881	687	536	424	83	151	135	69	53	2.74	3.14	28	26	
Griffins township	2 412	767	613	429	148	154	133	54	35	3.14	3.58	–	–	
Jackson township	1 972	732	550	431	94	182	165	68	55	2.69	3.19	55	–	
Mannings township	4 944	1 862	1 417	1 105	247	445	409	204	160	2.66	3.11	–	–	
Spring Hope town	1 221	522	360	255	85	162	148	89	75	2.34	2.86	–	–	
Nashville township	6 632	2 491	1 886	1 441	359	605	552	249	199	2.66	3.12	349	349	
Nashville town	3 351	1 281	937	702	197	344	318	155	126	2.62	3.14	266	266	
North Whitakers township	2 254	776	589	393	153	187	167	84	61	2.90	3.41	–	–	
Whitakers town (pt.)	396	163	106	69	32	57	55	27	23	2.43	3.15	–	–	
Oak Level township	3 912	1 434	1 123	881	186	361	305	98	67	2.64	3.05	–	–	
Rocky Mount city (pt.)	916	352	246	151	84	106	88	27	21	2.60	3.13	–	–	
Red Oak township	2 351	822	680	572	81	142	125	46	37	2.86	3.18	–	–	
Dortches town (pt.)	180	66	56	45	10	10	8	3	2	2.73	2.93	–	–	
Red Oak town	280	107	75	59	12	32	30	14	12	2.62	3.23	–	–	
Rocky Mount township	18 367	7 540	5 025	3 326	1 439	2 515	2 240	1 069	877	2.44	3.02	132	112	
Rocky Mount city (pt.)	14 392	5 969	3 876	2 397	1 262	2 093	1 877	963	790	2.41	3.02	132	112	
Sharpsburg town (pt.)	1 054	421	295	222	62	126	103	25	20	2.50	3.00	–	–	
South Whitakers township	1 953	716	522	358	127	194	164	49	35	2.73	3.22	290	–	
Battleboro town (pt.)	167	76	54	48	4	22	21	14	13	2.20	2.67	–	–	
Dortches town (pt.)	4	1	1	1	–	–	–	–	–	4.00	4.00	–	–	
Rocky Mount city (pt.)	353	134	93	58	25	41	31	1	–	2.63	3.12	–	–	
Stony Creek township	19 743	7 694	5 707	4 864	690	1 987	1 718	485	415	2.57	3.03	290	288	
Dortches town (pt.)	656	242	189	159	24	53	47	30	29	2.71	3.14	–	–	
Rocky Mount city (pt.)	15 947	6 292	4 592	3 946	531	1 700	1 464	399	342	2.53	3.02	200	198	
New Hanover County	115 999	48 139	32 400	24 723	6 383	15 739	12 434	4 372	3 512	2.43	2.95	3 285	1 321	1
Cape Fear township	12 274	4 514	3 567	2 919	498	947	793	230	181	2.72	3.09	296	296	
Castle Hayne CDP	1 178	444	342	256	66	102	87	24	20	2.65	3.02	4	4	
Smith Creek CDP (pt.)	1 379	506	404	343	48	102	82	21	16	2.73	3.06	–	–	
Wrightsboro CDP (pt.)	4 537	1 692	1 327	1 081	191	365	314	107	88	2.68	3.06	208	208	
Federal Point township	10 345	4 266	2 980	2 454	401	1 286	1 031	254	204	2.42	2.88	68	61	
Carolina Beach town	3 574	1 605	1 004	835	133	601	478	125	55	2.23	2.77	56	55	
Kure Beach town	619	282	199	178	19	83	75	31	18	2.20	2.59	–	–	
Myrtle Grove CDP (pt.)	2 101	829	630	548	65	199	156	49	36	2.53	2.89	–	–	
Silver Lake CDP (pt.)	438	164	123	93	19	41	33	8	3	2.67	3.08	–	–	
Harnett township	28 521	11 239	8 187	7 010	903	3 052	2 236	615	482	2.54	2.94	700	317	
Bayshore CDP	1 661	605	517	471	30	88	80	26	22	2.75	3.00	–	–	
Ogden CDP	3 228	1 216	964	827	106	252	197	46	32	2.65	2.99	–	–	
Seagate CDP	5 394	2 101	1 579	1 348	174	522	405	134	108	2.57	2.95	50	50	
Smith Creek CDP (pt.)	6 082	2 154	1 769	1 502	218	385	284	69	52	2.82	3.11	–	–	
Wilmington city (pt.)	267	84	75	60	14	9	9	2	4	3.18	3.39	–	–	
Windemere CDP	4 231	1 672	1 224	1 069	114	449	339	105	86	2.53	2.96	373	–	
Wrightsboro CDP (pt.)	7	5	2	–	–	3	3	–	–	1.40	2.00	–	–	
Wrightsville Beach town	2 934	1 401	673	559	71	728	432	75	57	2.09	2.57	3	–	
Masonboro township	12 797	4 642	3 833	3 365	358	809	647	161	127	2.76	3.04	–	–	
Masonboro CDP (pt.)	6 990	2 519	2 145	1 936	165	374	311	78	63	2.77	3.03	–	–	
Myrtle Grove CDP (pt.)	2 174	852	662	579	67	190	157	44	34	2.55	2.90	–	–	
Silver Lake CDP (pt.)	3 633	1 271	1 026	850	126	245	179	39	30	2.86	3.17	–	–	
Wilmington township	53 062	23 478	13 833	8 975	4 223	9 645	7 727	3 069	2 518	2.26	2.91	2 221	647	1
Masonboro CDP (pt.)	20	5	5	4	1	–	–	–	–	4.00	4.00	–	–	
Wilmington city (pt.)	53 042	23 473	13 828	8 971	4 222	9 645	7 727	3 069	2 518	2.26	2.91	2 221	647	1
Northampton County	20 055	7 591	5 644	3 958	1 436	1 947	1 816	968	704	2.64	3.13	743	742	
Gaston township	4 594	1 752	1 328	928	354	424	378	177	122	2.62	3.06	1	–	
Gaston town	1 003	413	308	214	83	105	93	56	49	2.43	2.78	–	–	
Jackson township	940	376	258	185	57	118	113	61	48	2.50	3.13	16	16	
Jackson town (pt.)	576	236	159	123	26	77	75	39	32	2.44	3.08	16	16	
Kirby township	3 470	1 315	1 012	781	184	303	289	173	124	2.64	3.08	–	–	
Conway town	759	316	231	160	62	85	82	51	42	2.40	2.85	–	–	
Severn town	260	107	75	57	14	32	31	23	18	2.43	2.97	–	–	
Oconeechee township	2 192	804	581	324	224	223	211	102	69	2.73	3.30	–	–	
Garysburg town	1 057	378	277	137	123	101	94	41	30	2.80	3.35	–	–	
Pleasant Hill township	469	171	126	102	18	45	41	22	14	2.74	3.32	64	64	
Rich Square township	3 422	1 277	946	646	257	331	313	173	130	2.68	3.18	94	94	
Rich Square town	964	395	284	207	67	111	107	64	52	2.44	2.94	94	94	
Woodland town	760	272	208	137	64	64	61	39	30	2.79	3.24	–	–	
Roanoke township	1 322	511	373	273	88	138	131	72	52	2.59	3.10	568	568	
Lasker town	139	62	42	36	6	20	20	13	11	2.24	2.79	–	–	
Seaboard township	1 818	667	492	312	156	175	158	82	62	2.73	3.23	–	–	
Jackson town (pt.)	–	–	–	–	–	–	–	–	–	–	–	–	–	
Seaboard town	791	296	211	115	86	85	76	45	37	2.67	3.24	–	–	
Wiccacanee township	1 828	718	528	407	98	190	182	106	83	2.55	3.06	–	–	
Onslow County	115 274	40 658	32 971	28 037	3 843	7 687	6 271	1 752	1 384	2.84	3.16	34 564	954	3

MEMO

TO: Superfund Section Staff

FROM: Jeanette Stanley
Environmental Chemist
NC Superfund Section

DATE: January 10, 1994

SUBJECT: Update on Status of Well Head Protection Programs in N.C.

I spoke with Carl Bailey, Groundwater Planning Branch Section Chief at (919) 733-3221. I asked him about Well Head Protection Areas (WHPAs) in North Carolina. Mr. Bailey said that Wally Venrick, Public Water Supply Section Chief, would be the most knowledgeable person on this subject.

I called Mr. Venrick at (919) 715-3232. He said that North Carolina has extended an invitation to communities to establish WHPAs, but none have been established. The cost to the community of establishing a WHPA exceeds the savings realized from waivers for certain analytical requirements. He does not anticipate that any WHPAs will be established prior to 1996.

Mr. Venrick said that there are minimum allowable distances between wells and certain structures (e.g. 100 feet between septic tanks and wells), but distances are arbitrary and vary depending on the structure.