

4.0 NATURE AND EXTENT OF CONTAMINATION

Soil, surface water, sediment and ground water samples were collected to identify and characterize contaminants present at the Brunswick Wood Preserving Superfund site in Brunswick, Georgia. Samples were collected during two phases of investigation. Most of the samples were collected during Phase I, when extensive site characterization sampling occurred (February-March 1997). Additional soil and ground water samples were collected to complete the characterization in October 1997 during Phase II. This section of the report addresses the findings of the investigation.

4.1 Source Areas

4.1.1 Soil

Numerous source areas have been identified at the Brunswick Wood Preserving site, either through direct visual observation or through historical means, such as reviewing aerial photographic coverages. The term source area, as used in discussions in this section, refers to one of several obviously contaminated areas located across the site. Some of these areas earn this distinction based on the presence of significant concentrations of polynuclear aromatic hydrocarbons (PAHs), other areas are considered source areas based on the confirmed presence of oily contaminated soils, which may have volatile organic compounds such as benzene, toluene, ethyl benzene or xylene associated with the PAH compounds. These areas generally represent historical or current ponds or impoundments. Based particularly on the aerial photographic review, there are several areas, primarily stained soil areas, that were present in the past but which were removed during the EPA removal.

Five areas have been identified which are present today and are reflected in the analytical results reported for samples collected for the remedial investigation. These are described in this

section and are referred to frequently in discussions contained in the following text. The locations of the areas are shown on Figure 4-1.

Pentachlorophenol/creosote treating area - This area, located near the western corner of the site, is one of the more contaminated areas on site. In this area there were several oil/water impoundments, several historical spills of oil and treating compounds and generally heavy staining of the soil from the handling of material in this area. Significant in this area is the presence of a buried fiber optics telephone line. During the EPA removal, a large volume of heavily contaminated soil at the location of a former impoundment was left in place because of problems associated with working around the fiber optics line, which is still in service. This material remains today. This area is generally represented by remedial investigation grids 6, 7 and 8.

Treated Pole Storage Area - A large area in the vicinity of grids 13 and 15 was used for storage of treated poles. Dark soil staining is obvious in this area on aerial photographs. Other, nearby adjacent storage areas, although they were originally heavily stained, much like the area around grids 13 and 15, were apparently at least partially remediated by the EPA removal. Relatively low concentrations of PAHs have been detected in the soil from these areas following the removal.

Large Structure with Historical (now absent) Surface Impoundment - A very large area, located near the middle of the site, was previously occupied by a large structure with obvious heavy staining in the immediate area. There was also an adjacent surface impoundment with storage areas surrounding it. This area is represented by remedial investigation grids 42, 54, 56, 73, 74 and 75.

Treated Pole Storage Area - A fourth area, represented by grids 30 and 31, is located just east of the old main office building and was apparently used for treated product storage.

CCA Area - The fifth and smallest area, in the vicinity of grid 51, is located southeast of the CCA area and is relatively small, but contained high concentrations of a number of PAH compounds.

4.1.2 Surface Water and Sediment

Burnett Creek Culvert Discharge - A culvert is present on the east bank of Burnett Creek, between Perry Lane Road and the CSX railroad trestle. This culvert serves as a discharge point for what has been described as a buried pipe flume. This feature was apparently designed to convey storm water or other site-derived waters to the banks of the creek. Currently, after significant precipitation events, an oily material with a distinct creosote odor can be observed discharging into the creek. The buried pipe apparently recharges, through breaches in the pipe walls, with non-aqueous phase oily material and this flushes into the creek during rain events.

4.2 Soil

One-hundred and seventy-seven (177) soil samples were collected from ninety-four (94) on-site and off-site locations during both phases of the investigation. The samples are described in Table 2-1 in Section 2.0 of the report and their locations are shown in Figure 3-1, Soil Sample Locations. The analytical results have been summarized in analytical data summary tables. These tables contain only the results of detected compounds or constituents. If an element or compound was analyzed for but not detected in any of the samples found on a data summary table, that element or compound is not listed on that table. The first set of tables, Tables 4-1 through 4-30, summarize the organic compound analytical results, including volatile organic compounds, extractable organic compounds (including pesticides/PCBs) and dioxin/furan compounds. Tables 4-31 through 4-53 are a summary of the inorganic analytical results. The complete data set is located in Appendix C.

The old impoundment, IM-1, was not sampled during the investigation. Although some material had been removed from this pond during the EPA removal action, large amounts of creosote/penta oil was observed to still be present. This material could not be removed due to the presence of a fiber optics telephone line.

4.2.1 Background Soil

Numerous off-site locations were sampled to determine soil concentrations in areas not impacted by site operations. The grids from which these samples were collected surround the site in its entirety and were designated as the "Perimeter Grids" in the work plan for the investigation. Because they are generally not impacted by the site, they were also sampled to provide, at least to some degree, background quality. The concept of background, as it relates to these samples, needs to be discussed. With respect to most of the organic compounds detected in samples collected both from the perimeter grids and the on-site grids, none are what would be considered naturally occurring and their presence in perimeter grid samples is thought to be related to both direct impacts, of varying degree, from the site and, as was found during the investigation, direct impacts from human activity, such as dumping. There are no other nearby sources of these compounds, except for near and on-site contributions from cross-ties associated with the railroad tracks.

To this extent, a true background condition for the perimeter grids would be one in which no PAH and related compounds would be suspected to be naturally occurring. This is generally supported based on the number of grids for which little or no compounds were detected. Although samples from several grids were found to be contaminated, this contamination was found later to be related to cultural impacts, such as burn piles, and the bulk of the grids, therefore are considered to be indicative of background conditions. The following discussion of background locations, therefore, generally describes the conditions encountered in the perimeter grids, with respect to the presence of the non-naturally occurring organic compounds.

The metals concentrations reported for the perimeter grid locations are thought, as described later in this section, to be generally representative of background conditions. Because metals-related site activity was restricted to a small area where CCA treatment occurred, the opportunity for impacting off-site locations was small. Contrary to the organic compounds, all of the metals detected

are naturally occurring and there is greater reason to expect that they are more or less representative of natural conditions.

4.2.1.1 Extractable Organic Compounds, Primarily Polynuclear Aromatic Hydrocarbons (PAHs)

These compounds are the most common contaminants present at the site. They were detected at high concentrations (multiple compounds detected in excess of 1,000 ug/kg) in two of the perimeter grid samples, grids P05 and P29. During Phase II, these two grids were resampled.

During the resampling, it was determined that the grid center for P05 was located very near an old burn pile with some treated wood present. There was also numerous crossties and other treated material observed scattered throughout the wooded area. A different composite pattern was sampled during Phase II, resulting in the detection of much lower concentrations of PAHs. No compound exceeded 320 ug/kg and most were in the 100 to 200 ug/kg range. Similarly, grid P29 was resampled, concentrating on areas located away from the obvious construction debris areas. Only three PAH compounds were detected during this subsequent sampling, none exceeding 100 ug/kg. The high concentrations detected in grids P05 and P29 are probably attributable to the material identified within these grids and are not the result of direct impacts from the Brunswick Wood Preserving site, such as aerial deposition.

PAH compounds, primarily those associated with treated wood products, were also detected at trace to low concentrations in six other perimeter grids (P04, P06, P07, P09, P11 and P14). The concentrations detected in the sample from grid P04 is most likely due to the presence of existing cross-ties associated with the active rail line in the middle of the grid. The other listed grids are located along the old rail spur that was used to move treated wood product from the site. The low concentrations detected in the samples from these grids are most likely due to the earlier presence of crossties and contaminated soil associated with the storage and transport areas for the treated wood products along the southern extent of the site.

Other than the compounds detected in the sample from grid P29, previously discussed, there were little or no extractable organic compounds detected in the perimeter grids located along the north side of the site. It appears, therefore, that any compounds found on site are wholly attributable to site activities.

A variety of miscellaneous extractable organic compounds were also detected in many of the perimeter grids. The concentrations of these compounds are generally low and they have a wide distribution with no pattern of occurrence, beyond associations with other PAH compounds in the grids containing the highest overall organic compound concentrations.

4.2.1.2 Dioxin/Furans

For all samples analyzed for dioxin/furan congeners, TCDD Equivalents (TEQs) were calculated. The TEQ is based on the toxicity of each the dioxin/furan congeners, relative to 2,3,7,8-TCDD. A factor is assigned to each congener, based on its toxicity relative to 2,3,7,8-TCDD. The concentration of each congener is multiplied by the factor and, after all of the factors have been applied, they are totaled. The result is the TEQ. These TEQs were calculated based on guidance in EPA's 1-TEF/89 equivalence scheme, released in 1989 (Interim procedures for estimating risks associated with exposures to mixtures of chlorinated dibenzo-p-dioxins and dibenzofurans (CDDs, CDFs) and 1989 update, Risk Assessment Forum. EPA/625/3-89/016, NTIS, Springfield, VA; PB90-145756).

As the site is basically a triangle, for the perimeter grid samples, TEQ ranges were identified for the south, east and north groups. Along the south side of the site, at locations adjacent to the railroad tracks and the old spur, TEQs ranged from 4.7 ng/kg to 46 ng/kg. The TEQ value of 46 ng/kg, for the sample from grid P12, represents the highest TEQ value for a sample collected from the perimeter grids. The unit, ng/kg, stands for nanogram per kilogram and is equivalent to one part per trillion. Along the east side, also adjacent to railroad tracks, a single sample was analyzed for

dioxin/furans and a TEQ value of 7 ng/kg was reported for this location. Along the north side of the site, north of Perry Lane Road, the range was 0.5 ng/kg, at grid P31, to 12 ng/kg, at grid P23.

4.2.1.3 Pesticides/PCBs

Pesticide/PCB compounds are found throughout the perimeter grids. This group of compounds is represented by a large number of different compounds, detected at trace to generally very low concentrations. Detected concentrations were generally less than 5 ug/kg.

4.2.1.4 Volatile Organic Compounds

No significant occurrences of volatile organic compounds were detected in any samples collected from the perimeter grids. Carbon disulfide was detected in samples from four grids, the highest concentration, an estimated 22 ug/kg, detected in the sample from grid P02. All other volatile organic compound, including toluene, chloroform, p-isopropyltoluene and styrene, were detected at concentrations less than 10 ug/kg.

4.2.1.5 Metals

Eight metals were detected in all samples collected from the perimeter grids. These are aluminum, barium, calcium, chromium, iron, lead, magnesium and manganese. The concentrations detected appear to be indicative of the natural background range for soils in the area. Fourteen other metals were also detected in at least one of the perimeter grids. The concentrations reported for these metals are considered to also be within the natural range found in the area and can be used to evaluate the results of on-site sample results.

4.2.2 On-site Soil

4.2.2.1 Polynuclear Aromatic Hydrocarbons (PAHs), Surface Soil

As would be anticipated, a large variety of PAH compounds were detected at many of the sampling locations across the site. At many of the locations, the concentrations ranged into the tens of thousands of ug/kg. Concentrations in the hundreds to thousands of ug/kg for a variety of compounds are common over the western two-thirds of the site. In general, the contamination pattern for the PAH compounds reflects the areas of high concentrations discussed in Section 4.1, Source Areas.

This discussion of soil contamination does not reflect the significant contamination present in the large ponds or lagoons in the eastern part of the site nor the contamination identified in the perimeter grids, which was discussed in Section 4.1. The lagoon results are reported in the surface water and sediment analytical results discussed in Section 4.4.2.1.

PAH compounds will be discussed in two separate sections. The first, Section 4.2.2.1.1, will discuss the carcinogenic PAHs, or CPAHs. Section 4.2.2.1.2 will then discuss selected non-carcinogenic PAHs, specifically pentachlorophenol and fluoranthene. The distribution patterns for these compounds are generally representative of the entire family of PAH compounds, both in terms of relative concentrations and distribution patterns. These compounds are generally found at their highest concentrations in the five source areas just described. Figures 4-2 through 4-9 show the areal contaminant patterns for these compounds. Refer to the data summary tables (Tables 4-1 through 4-30 for a complete list of PAH and other organic compounds and the concentrations at which they were detected.

4.2.2.1.1 CPAHs

Benzo(a)anthracene (Figure 4-2)

This compound was detected at about half of the locations at which most other PAH compounds were detected, and was detected at locations in four of the five source areas identified

previously in Section 4.1. The highest concentration, 7,200 ug/kg, was detected in the sample from grid 8, in the excavation south of the old office building.

Benzo(a)pyrene (Figure 4-3)

Although benzo(a)pyrene was detected in many of the grids sampled for the RI, it was detected at concentrations above 1,000 ug/kg at only two of the on-site grids. These grids correspond to the previous treating area (grid 8) and the small impoundment and storage area located in the north part of the site (grid 54). Concentrations ranging from 100 ug/kg to 1,000 ug/kg were detected at many of the grids comprising the western portion of the site.

Benzo(b and/or k)fluoranthene (Figure 4-4)

Benzo(b and/or k)fluoranthene was detected at concentrations exceeding 1,000 ug/kg at 13 grids located in each of the five areas previously described as potential source areas for contamination.

Chrysene (Figure 4-5)

Chrysene was also found at elevated concentrations at grids in the five main source areas. As with the previously discussed compounds, the highest concentrations were detected in samples collected from grids 7 and 8 at the previous treating area, where concentrations of 3,200 ug/kg and 6,600 ug/kg, respectively, were detected. The next highest concentration detected was 2,900 ug/kg at grid 15, located at the treated pole storage area.

Indeno(1,2,3-cd)pyrene (Figure 4-6)

Indeno(123-cd)pyrene was detected in 25 on-site surface soil samples. Concentrations in these samples ranged from 44ug/kg to 490 ug/kg. The highest concentrations were generally

detected in samples collected from the five “source” areas described in Section 4.1 and shown in Figure 4-1.

Dibenzo(ah)anthracene

Dibenzo(ah)anthracene was detected in only three samples collected from the on-site locations. Concentrations at these locations ranged from 43 ug/kg to 58 ug/kg.

Benzo(a)pyrene Equivalents (BAPEs) (Figure 4-7)

By applying toxicity equivalency factors to each of the carcinogenic PAHs, the total concentration of all of the CPAH compounds can be calculated to determine the equivalent concentration and toxicity of all of the CPAHs as benzo(a)pyrene. This number is the benzo(a)pyrene equivalent or BAPE. The BAPE worksheets for samples containing at least one of the CPAH compounds is included as Appendix D to this report. The worksheets provide a list of the CPAH compounds detected in samples collected for the investigation with the equivalency factors used to calculate the BAPE. BAPEs calculated for the source areas ranged from 501.69 ug/kg to 3,142.6 ug/kg.

4.2.2.1.2 Selected Non-carcinogenic PAHs

Pentachlorophenol (Figure 4-8)

Pentachlorophenol was detected at high concentrations at numerous locations across the site. In two locations, however, it was detected at concentrations exceeding 10,000 ug/kg, which greatly exceeded the concentrations detected at most other locations. At the penta treating area (grids 7 and 8), concentrations of 13,000 ug/kg and 150,000 ug/kg, respectively, were detected. At two other locations, grids 15 and 45, located near the center of the site, concentrations of 23,000 ug/kg and 15

ug/kg, respectively, were detected. Most of the other high concentration samples were located in grids that were either adjacent to these areas or were located in the area connecting the two areas.

One grid not located in one of the past active process areas of the site contained pentachlorophenol at high concentrations. A concentration of 2,000 ug/kg was detected in the sample from grid 68, located east of the large lagoons. A variability duplicate from the same grid did not contain any detectable pentachlorophenol. The pentachlorophenol that was detected could represent a small and isolated leak or other breach of the impoundment.

Fluoranthene (Figure 4-9)

Fluoranthene was detected in a large number of grids and at a wide range of concentrations across the site. As with many of the CPAHs, the highest concentrations were detected at the treating area and the treated pole storage area along the old siding. Other areas where high concentrations were detected generally correspond to the areas identified as historical source areas.

4.2.2.2 Polynuclear Aromatic Hydrocarbons (PAHs) , Subsurface Soil

In general, soil sampling results indicate that over much of the site, the high PAH concentrations observed in the surface soil samples are either absent or greatly diminished in the subsurface soils. At several grids, however, exceptions to this pattern can be seen.

At grids 9, 32, 36, 38 and 54, in particular, subsurface soil sample analytical results indicated that higher concentrations of PAH compounds were present in the subsurface interval when compared to the surface soil samples. During the Phase II work conducted in October 1997, additional subsurface soil sampling was either attempted or conducted at these locations to provide additional data on subsurface contamination. Samples were collected, where possible, from 48-inches to 54-inches below ground surface. Because of extensive debris in this interval at grid 9, a sample could not be collected.

In addition to the follow-up sampling at these locations, additional subsurface characterization was conducted at six new locations (BW070 through BW075). These locations could not be sampled during the initial phase of the investigation because of the presence of three encapsulated waste cells. These have since been removed, allowing access to the locations. The surface soil results were incorporated into the previous discussion of surface soil.

Based on the combined results from the follow-up sampling and the waste cell area sampling, the only significant contamination in the 48-inch to 54-inch interval appears to be at grid locations 38, 71 and 74. Results from these locations indicated that, in some areas, contamination may extend further into the subsurface and may actually be present at higher concentrations.

4.2.2.3 Dioxin/Furans

Dioxin/furan compounds were detected in 23 samples collected on-site (all but one sample were surface soil). These samples were generally five-point composites, except for stations that were located beneath concrete slabs. These were grabs from holes cored at the grid center. At 16 of the locations, TEQs of greater than 100 ng/kg were detected. TEQs greater than 1,000 ng/kg were detected in four samples, from grids 13, 15, 29 and 31. The highest TEQ was detected in the sample from grid 31, where a TEQ of 13,000 ng/kg was calculated.

The locations where high TEQs were calculated are generally the locations where the previously described high concentrations of PAH contaminations were found. The locations where dioxin/furan samples were collected were selected prior to sampling based on anticipated findings. Several locations were sampled where higher than anticipated PAH results were detected. These locations may also contain soils which exhibit high dioxin/furan and TEQ results.

These results show that dioxin/furan compounds are widespread across the site, probably over a greater area than currently characterized. Further high dioxin/furan concentrations can be anticipated at other locations, when sampled.

Additionally, 2,3,7,8-TCDD was detected in six of the samples. The highest concentrations detected was 12 ng/kg.

4.2.2.4 Pesticide/PCBs

Numerous pesticide compounds were detected in 27 of the samples collected for the investigation. Most of the detected pesticide compounds were found in surface samples and all were detected at concentrations less than 5 ug/kg. No PCBs were detected in any of the samples.

4.2.2.5 Volatile Organic Compounds

Volatile organic compounds were detected in over 20 soil samples, most of which were subsurface samples. Toluene and other BTEX constituents (xylene, ethyl benzene and other related compounds) comprise most of the compounds detected, however they were generally not detected at high or significant concentrations. They were detected primarily in samples from the 30, 40 and 50 series grids in the central and eastern part of the site

4.2.2.6 Metals

Surface Soil

In evaluating the on-site surface soils for metals, the analytical results were compared to the concentrations detected in the perimeter grids, which generally reflect background concentrations for surface soil. When this comparison was made, on-site concentrations were found to be significantly higher at many of the on-site locations. Most of these metals, however, are those that are commonly found in the native mineralogy making up the sediments and lithologies found at the site. The higher concentrations that are found on-site are most likely due to variations in lithology and are not directly attributable to site activities. The fact that the on-site area was sampled much more densely, with a greater number of samples, provides a greater potential to sample any of the geologic variations that

might exist. The exceptions to this discussion are copper, chromium and arsenic, and are discussed below.

Barium, aluminum, calcium, iron, magnesium and manganese are all common constituents in the sands, clays and shelly material found in the site soil. The higher concentrations found on-site have no real pattern that would attribute their presence to site activities and probably have their source, as proposed, in a variety of types of geological materials found over the site. Simple variations in the amount of silt or clay would cause noticeable changes in the concentrations of these constituents in samples.

Three metals, copper, chromium and arsenic, however, warrant further evaluation. Although each of the three metals are generally found over the entire sampled area (perimeter grids and on-site grids), they are each present at unusually high concentrations in one location on site, and are present at somewhat high concentrations at other locations. The high concentration location, generally comprised by the area defined by grids 19, 44, 45, 46, 47, 48 and 50, represents the area immediately to the west, south and east of the old chromated copper arsenate (CCA) wood treating process area in the eastern portion of the site.

Chromium, which ranged up to approximately 20 mg/kg in the perimeter/background sample locations, was detected at concentrations ranging from 59 mg/kg to 200 mg/kg in the CCA area. In addition, there were several other areas where chromium was present consistently at concentrations above 20 mg/kg but less than the high concentrations detected in the immediate CCA area. One of these areas is adjacent to and west-southwest of the high concentration area and appears to be related to the higher concentrations identified around the source area. The pattern of contamination/occurrence for chromium is shown in Figure 4-10.

The arsenic and copper patterns are very similar. Both metals were found at their highest concentrations in the same area as the high chromium concentrations. In this area, arsenic ranges from 27 mg/kg to 60 mg/kg and copper ranges from 13 mg/kg to 82 mg/kg. The area of somewhat

high concentrations generally extends off of the high concentration area towards the west as a thin strip of contamination and terminates in the area just east of the old main office building. Historical photographs indicate that this area was stained and probably was used for treated wood product storage. Figures 4-11 and 4-12 show the contaminant patterns for arsenic and copper, respectively.

Subsurface Soil

At most of the on-site sampling locations, subsurface samples were collected at a depth of 24 inches to 30 inches below ground surface (actual depth varied, depending on conditions encountered at sampling location). Figure 4-13 shows the pattern of chromium, where detected at concentrations of 20 mg/kg or higher. In the subsurface interval, the pattern of highest chromium concentrations present in the surface soil is absent but the 20 mg/kg pattern is much larger and is characterized by many smaller patterns, located over the entire site. This is highly suggestive of naturally occurring concentrations of chromium and suggest that there may be some degree of concentrating of inorganics occurring in the subsurface interval, perhaps in the clay that is present over much of the site. A review of the other metals data shows this phenomenon to be fairly common, particularly with respect to metals such as aluminum, calcium and iron.

Copper and arsenic were evaluated in much the same manner as chromium. In the subsurface, the higher concentration areas for both metals are non-existent and the areas where concentrations of 10 mg/kg were detected are much smaller and scattered across the site.

4.3 Ground Water

Ground water samples were collected during two phases of the remedial investigation. During Phase I, samples were collected from temporary and potable wells to provide an indication of the degree of contamination that is present at the site. After the analytical results were evaluated, Phase II of the ground water investigation, consisting of several direct push approaches (electric cone

penetrometer testing (ECPT), Hydrocone® sampling and piezometer installation) was conducted to better define the extent of contamination. The following sections describe the findings of both phases.

4.3.1 Phase I Ground Water Sampling

During Phase I in February and March of 1997, samples were collected from 15 temporary monitoring wells installed over much of the site and three on-site and off-site potable wells. The locations of these wells are shown on Figure 4-14, Phase I Ground Water Sampling Locations.

Samples were collected using a variable speed peristaltic pump, using slow purge techniques, at the temporary well locations. Samples from the potable wells were collected directly out of the spigots. The most significant contamination was detected in samples from wells MW-6S, MW-6D, MW-7S and MW-11S. At each of the locations, the contamination was characterized by a mix of PAH compounds, primarily naphthalene and dichlorophenol, and BTEX (benzene, toluene, ethylbenzene and xylene) compounds.

At location MW-6, contamination was identified in both the shallow and deep wells, however, the highest contamination was found in samples from the deep well. At the other two locations, MW-7 and MW-11, the greatest contamination was found in the shallow wells. Naphthalene, detected at 110 ug/l, was the PAH compound found at the highest concentration in the sample from MW-7S, and dichlorophenol, also detected at 110 ug/l, was the compound found at the highest concentration in the sample from MW-11S. The BTEX compounds were found at the highest concentrations in the sample from MW-11S, where total xylenes were detected at 11.1 ug/l, benzene was detected at 3.7 ug/l and ethyl benzene was detected at 23 ug/l. Based on these detections and presumed ground water flow directions, a ground water contamination scenario was hypothesized. This presumed pattern of ground water contamination is shown in Figure 4-15, Phase I Presumed Contaminant Plume Boundaries. This figure does not distinguish between depths of observed contamination, which is described in this section, but simply shows the areal extent of contamination that was further investigated during Phase II activities, the results of which are described below.

4.3.2 Phase II Ground Water Investigation

Based on the presumed ground water contamination scenario developed using the Phase I data, Phase II of the investigation was planned and implemented in October 1997. After conducting direct push investigations to provide a geological and stratigraphic characterization of the site, ground water samples were collected using two devices, the Hydrocone® ground water sampler and the Hydroprobe® ground water sampler. Both of these devices were directly pushed to the desired sampling depths, opened and the sample was obtained. Figure 4-16 shows the locations sampled with these devices during Phase II of the remedial investigation.

4.3.2.1 Ground Water Sampling Methodology

The Hydrocone® device is a sophisticated sampling device which allows for not only ground water sample collection but also provides the ability of determining approximate hydraulic conductivity using computer generated fill rate curves, developed during filling of the sample device. The Hydrocone® is pushed to the desired depth with the screen contained inside the device with an O-ring to keep ground water out until the sample is collected. In addition to the O-ring, argon gas is used to pressurize the sample device to maintain it in an empty state until sample collection is desired.

When the sample depth is reached, the push rods are pulled back approximately 18 inches and argon is applied, through an umbilical, to the device. This pushes the screen out of the bottom of the device. The argon gas is then slowly reduced until a slow and steady fill is achieved. This fill is observed as a graphical representation on a computer screen to monitor the rate of fill and the volume of sample collected. When an adequate sample volume has been collected, argon gas is again applied to the device and this seats a ball check in the device, stops any additional filling and captures the sample, under pressure, until the device can be pulled back to the surface. At the surface, the screen is removed, the gas pressure is removed and the sample is taken from the bottom by pushing a Teflon tube past the ball check and draining the sample from the device.

At locations where the Hydrocone® was not used to collect ground water samples, the Hydroprobe® was used. The Hydroprobe® is a strictly mechanical device with no electronic monitoring. It is pushed in a sealed and closed condition to the desired sample depth. The push rods are slowly and partially pulled back, exposing a portion of the screen, which is a laser-slotted hollow steel tube in the middle of the device. After allowing adequate time for filling of the sample device, the push rods are pulled and the sample device retrieved to the surface. As the screen is fully extended below the push rod during this action, multiple O-rings seat and seal the sample device, preventing any more ground water from entering the device. At the surface, the Hydroprobe® is unscrewed from the screen and the sample is poured from the device into the sampling vials.

During the investigation, SESD maintained a mobile lab on property adjacent to the site. The lab contained a Scentograph® GC which was used to provide analytical results on the samples immediately after they were collected. Additional sample volume was sent to the SESD laboratory in Athens, Georgia for confirmatory bench analysis.

Based on the site stratigraphy and water bearing characteristics identified during the electric cone penetrometer investigation, it was determined that there were three intervals that should be sampled to provide a reasonable vertical characterization of the contamination, though it would not be necessary to sample each interval at all locations. The shallowest interval was generally sampled at a depth of 10 feet to 17 feet below ground surface, representing the shallow surficial zone and roughly coinciding with the screened interval of the shallow temporary wells installed in February. The next interval was sampled at a depth of 20 feet to 27 feet, which was more representative of the upper portion of the zone sampled by the deep temporary wells. The deepest samples were collected at a depth of approximately 40 feet below ground surface from beneath a clay unit that was generally found beneath the entire site. This zone represented ground water that was separated from and probably not impacted by the zone immediately above the clay.

4.3.2.2 Phase II Ground Water Investigation Results, Shallow Zone

The shallow saturated zone at sixteen locations was sampled with either the Hydrocone® or Hydroprobe® sampler. Elevated concentrations of PAHs and BTEX compounds (as well as other fuel-related VOCs) were detected at two stations, HC7 and HC18. 1,2,4-trimethylbenzene was detected at the highest concentration of any VOC in these samples and was reported at concentrations of 260 ug/l and 91 ug/l, respectively, in the shallow sample at each location. Xylene (86 ug/l, estimated), toluene (93 ug/l, estimated) and benzene (63 ug/l, estimated) were also reported at location 7. 1,3,5-trimethylbenzene and isopropylbenzene were both detected at estimated concentrations of 14 ug/l in the shallow sample from location 18. Trace concentrations of these compounds were detected at five other locations across the western portion of the site. These samples also contained elevated PAHs, particularly naphthalene. It was detected at concentrations of 6,200 ug/l and 1,600 ug/l, respectively, in samples from locations HC7 and HC18. These compounds appear to be directly related to source areas at the old pond locations, IM-1 and IM-2. The trace concentration locations are apparently related to ground water in contact with contaminated soil in deeply stained areas and are not related to a plume of contamination with a well defined non-aqueous phase liquid (NAPL) source area. The estimated plume boundary for PAH and BTEX contamination in the shallow interval is shown in Figure 4-17.

4.3.2.3 Phase II Ground Water Investigation Results, Intermediate Zone

The intermediate saturated zone was sampled at nineteen locations with either the Hydrocone® or Hydroprobe® sampler. Trace and elevated concentrations of PAH compounds and BTEX and other fuel related VOCs compounds were detected at nine of the sixteen locations. The locations of these samples can be used to begin defining an intermediate depth plume at the Brunswick Wood Preserving site. The sample with the highest concentrations was collected at location HC7, located in the small plume associated with the source area at historical impoundments IM-1 and IM-2. 1,2,4-trimethylbenzene was present at a concentration of 260 ug/l, along with 120 ug/l each of benzene and toluene. Xylene was present at an estimated concentration of 99 ug/l;

ethylbenzene was present at an estimated concentration of 60 ug/l. The next highest bulk concentrations were associated with the plume emanating from the IM-3/IM-4 source area to the east. Most of the BTEX compounds are represented in the sampling results for these locations, however, the highest concentrations detected were 60 ug/l ethylbenzene from location HC1, 18 ug/l isopropylbenzene from location HC3 and 13 ug/l ethylbenzene from location HC5.

Naphthalene was also detected at considerably elevated concentrations in several of the samples, generally located in the core of the plumes. The highest concentrations, in the thousands of ug/l range, were detected in two downgradient sampling locations associated with the smaller plume associated with ponds IM-1 and IM-2. Several locations, two in the larger plume and one in the smaller plume, yielded samples with naphthalene concentrations in the hundreds of ug/l.

These results were evaluated and when considered along with the established ground water flow pattern and known source areas, two contaminant plumes, with probable NAPL or heavy contamination associations, were found to be present in the intermediate zone.

The two plumes, as identified by the intermediate zone sampling, are shown in Figure 4-18. The plume associated with the eastern source area, old ponds IM-4 and IM-5, is restricted to the zone immediately above the continuous clay unit present across much of the site. The extent has not been fully identified. Based on the Phase II sampling results, it appears that the plume extends at least to Perry Lane Road, and probably, to some extent, beyond the road in the direction of Burnett Creek. The area north of Perry Lane Road, however, was inaccessible and could not be sampled to provide plume boundary data for this area of the plume. These results will have to be evaluated to determine if sufficient risk exist to continue the characterization beyond Perry Lane Road. The contamination associated with the western source area, old ponds IM-1 and IM-2, is a vertical continuation of the shallow contamination identified in the shallower zone at this location.

4.3.2.4 Phase II Ground Water Investigation Results, Deep Zone

The deep saturated zone was sampled at eleven locations with either the Hydrocone® or Hydroprobe® sampler. Elevated concentrations of PAH compounds and BTEX (and other fuel-related VOCs) compounds were detected at one of the eleven locations, HC7, and trace to low concentrations of PAH compounds only were detected at three additional locations, HC1, HC8 and HC18. 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene were detected at concentrations of 430 ug/l and 120 ug/l, respectively, in the sample from location HC7. Xylene compounds were detected at a total concentration of 71 ug/l in the sample, as well as 7,700 ug/l of naphthalene.

Among the findings from the deep sampling results are that there is virtually no significant contamination of any kind beneath the continuous clay layer where it is present across the site. Trace concentrations of PAH compounds are present at HC-1, located just downgradient of the large ponds located in the eastern part of the site. These concentrations probably represent low concentrations of PAH compounds that have migrated through the clay layer in the immediate vicinity of the ponds.

The deep sampling results also indicate that contamination is present virtually throughout the entire saturated zone immediately west of the old ponds IM-1 and IM-2. This is because the clay unit is not present in this area and the contamination is able to migrate unrestricted vertically. The lower boundary of contamination in this area was not identified but is known to be present, based on sampling results, to a depth of at least 40 feet below ground surface. The contaminated portion of the deep sampled zone is shown in Figure 4-19.

4.4 Surface Water and Sediment

4.4.1 Surface Water

Surface water samples were collected at twenty-two on-site and off-site locations (see Figures 2-4 and 2-5). Nine locations were sampled in the major ponded water areas, including IM-4 and IM-

5, the CCA area pond and the excavated areas south of the old office building. Burnett Creek and its tributaries, including the ditch north of Perry Lane Road, were sampled at nine locations and three samples were collected from ditches along the north and east boundaries of the site proper. A background sample was collected from Dillard Creek, located west of the site and upstream on the Turtle River.

4.4.1.1 PAH Compounds

PAH contamination detected in surface water samples was generally insignificant. Fluoranthene and pentachlorophenol were detected in samples collected at four locations, including the southeast end of pond IM-5 (BW-206-SW), the ditch draining the IM-4/IM-5 pond area prior to discharge to the ditch south of Perry Lane Road (BW-209-SW), the water sample collected from the flooded removal excavation south of the old office building (BW-230-SW) and the area immediately surrounding the Burnett Creek culvert discharge, which empties into Burnett Creek between the trestle and Perry Lane Road, at the west end of the site (BW-225-SW).

The highest concentration of pentachlorophenol, 78 ug/l, was detected in the sample from station BW-225-SW, at the Burnett Creek culvert discharge. Other concentrations ranged from 7 ug/l to 32 ug/l. Fluoranthene concentrations were all below 10 ug/l.

4.4.1.2 Pesticides/PCBs

Only one surface water sample contained pesticides at detectable concentrations. Beta-BHC was presumed to be present at an estimated concentration of 0.16 ug/kg in the sample from location BW-211-SW, located in the flowing ditch across Perry Lane Road from the site.

4.4.1.3 VOCs

Trace levels of several BTEX and other fuel-related compounds were detected in the surface

water sample collected at location BW-225-SW, at the Burnett Creek Culvert Discharge. An obvious oily emulsion was visible, discharging from the culvert into Burnett Creek during sampling.

4.4.1.4 Metals

The metals results for surface water samples were generally unremarkable. With the exception of copper, chromium and arsenic, no metals appeared to be present at levels above what would be considered background in any of the ditch sampling locations or locations in Burnett Creek or its tributaries. Although many values were somewhat greater than the corresponding value from the background location, BW-228-SW, this is thought to be due more to differences in the amount of suspended sediment and detritus rather than the impacts from the site.

Copper, chromium and arsenic, which are associated with the CCA process, were detected only in surface water samples collected from the ponds located in the general vicinity of the old CCA treating area. Arsenic was detected in all six of the pond sample locations and ranged in concentration from 18 ug/l to 96 ug/l. Copper was detected in samples from four of the six locations and ranged from 5.6 ug/l to 9.1 ug/l. Chromium was detected in samples from two of the locations at concentrations of 5.5 ug/l and 6.1 ug/l.

4.4.2 Sediment

Sediment samples were collected at 29 off-site and on-site locations (See Figures 2-4 and 2-5). These samples were collected to reflect sediment quality in on-site ditches, on-site ponds, and off-site ditches and creeks. Dillard Creek, located several miles west of the site, was sampled, at location BW-228-SD, to provide background and reference data. Figure 4-20 shows the locations of sediment samples collected for the investigation and the range of concentrations characteristic for each location (see discussion immediately below).

4.4.2.1 PAHs

PAH compounds were detected in many of the sediment samples collected for the investigation, frequently at relatively high concentrations. Specific details regarding detected compounds and their concentrations can be found in the data summary tables. However, for the purposes of this discussion, five ranges of concentration will be used in an effort to present the results to the reader effectively. High concentration samples generally describe samples characterized by large numbers of compounds, many of which were detected at concentrations ranging from the tens of thousands of ug/kg to percent concentrations. Moderately contaminated sediments are those which also contain many different compounds but which exhibit a lower range of concentrations, generally between 1,000 ug/kg and 10,000 ug/kg. Sediments described as having low concentrations of PAH compounds are those in which most or all of the compounds were detected at concentrations of less than 1,000 ug/kg and the numbers of compounds present are generally fewer than in the other, higher concentration samples. Trace concentration samples are those samples in which there are few compounds identified and in which most of the concentrations are less than 100 ug/kg. PAH-free samples, for purposes of this discussion, are those in which there were either no compounds identified/detected, or which contain only one or two compounds detected at very low and insignificant levels, which will be considered PAH-free samples, again, for the purposes of this discussion only.

High PAH concentration areas are limited to two general locations. The large pond complex (ponds IM-4 and IM-5), which includes stations BW-202-SD through BW-206-SD, had the highest sediment levels of PAHs recorded during this investigation, with percent level concentrations of several PAH compounds. Station BW-0225-SD, at the Burnett Creek culvert discharge, is also contaminated with high concentrations of PAH compounds, though not to the degree identified in the pond sediments. Moderately contaminated sediments were identified at two stations; BW-209-SD, located between the large ponds and Perry Lane Road, and at BW-217-SD, located near the southwest corner of the site adjacent to the railroad tracks.

Low concentrations were found in samples from nine other locations, most of which were located in ditches bordering the site. Two of these locations, however, were located in Burnett Creek, immediately upstream and downstream of the storm drain discharge point. Contamination at these locations appears to be the result of migration of PAH compounds from the depositional area around the storm drain. The upstream contamination immediately above the discharge culvert is apparently the result of migration with incoming tides. Samples from stations located further upstream, both in Burnett Creek and in a tributary to Burnett Creek, still exhibit contamination with PAH compounds, however, the levels are considerably lower, measurable only in trace concentrations

Both samples collected from the creek in the ditch on the north side of Perry Lane Road were free, or virtually free, of PAH contamination. Further, no PAH compounds were detected in the sample from the upstream (control) station in Burnett Creek, located above the point at which the creek in the Perry Lane Road ditch discharges into Burnett Creek.

Benzo(a)pyrene equivalent (BAPE) toxicities were calculated for all of the sediment stations containing BAPE compounds. The worksheets for these calculations are included in Appendix C of this report. The highest BAPes, as would be expected, correspond to the locations where the highest concentrations of PAHs were detected. BAPes at the large impoundment sampling locations ranged from 992.2 ug/kg, at station BW-205-SD, to 99,830 ug/kg, at station BW-206-SD.

4.4.2.2 Dioxin/Furans

Samples from seven sediment locations, including locations in Burnett Creek, the ditch feeding Burnett Creek, the IM-4/IM-5 pond complex and the ditch draining the site to the east, were analyzed for dioxin/furan compounds. The two samples collected from the large ponds, BW-203-SD and BW-204-SD, reflected the highest dioxin/furan results. TEQs of 2,700 ng/kg and 12,000 ng/kg, respectively, were calculated for these samples. Both samples also contained 2,3,7,8-TCDD, at concentrations of 13 ng/kg (estimated) and 130 ng/kg, respectively.

The next highest concentrations were detected in the two Burnett Creek locations downstream of the site. The location immediately downstream of the storm drain, BW-222-SD, had a calculated TEQ estimated at 5.2 ng/kg. Further downstream at the Highway 341 location, BW-224-SD, the TEQ was estimated at 4.3 ng/kg.

The TEQs calculated at the remaining sediment sampling locations were all less than 1.0 ng/kg and none of the samples contained 2,3,7,8-TCDD.

4.4.2.3 Pesticides/PCBs

Endrin, endrin ketone and endrin aldehyde were the pesticide compounds detected at the highest concentrations in sediment samples. Endrin was detected at a concentration of 200 ug/kg in the sample from BW-204-SD, located in the large pond. Endrin ketone and endrin aldehyde were detected at concentrations of 240 ug/kg (presumptive evidence) and estimated 330 ug/kg in a sample from the dry ditch on the southwest side of the site, near the end of Floraville Rd. The remaining pesticides detected in sediment samples were represented by a variety of compounds, all generally found at concentrations less than 50 ug/kg.

4.4.2.4 VOCs

VOCs were detected in sediment samples from six locations, all located in either the large pond complex (IM-4/IM-5) or in Burnett Creek at the stormwater discharge location. The highest concentrations were found in the samples from the large ponds.

The sample from BW-203-SD contained few compounds, primarily BTEX compounds, but the concentrations of these compounds were relatively high. Total xylene was estimated to be present at a concentration of 960 ug/kg, ethyl benzene was present at an estimated concentration of 150 ug/kg and toluene was detected at an estimated concentration of 89 ug/kg. The sample from BW-202-SD contained many BTEX and fuel related compounds, six of which were present at concentrations

exceeding 100 ug/kg. The sample from BW-205-SD contained trace BTEX but acetone was detected at an estimated concentration of 290 ug/kg.

The samples from BW-204-SD and BW-206-SD, also located in the pond complex, contained few VOC compounds, all present at concentrations below 25 ug/kg. The storm water discharge sample from BW-225-SD contained primarily acetone, at an estimated concentration of 380 ug/kg, and trace levels of BTEX and other fuel-related compounds.

4.4.2.5 Metals

The metals data for sediment samples were evaluated using the same criteria used for evaluating surface soil sampling results. Using these same criteria, which were generally 1.5 to 2.0 times the highest detected concentrations in the perimeter grids, copper, chromium and arsenic all appear to be elevated above background conditions at several on-site locations. No samples located on the opposite sides of the railroad tracks or Perry Lane Road contained any of the three metals at concentrations exceeding these criteria.

Two or more of the three metals were detected at elevated concentrations in all six of samples collected from the three ponds located at the eastern end of the site (CCA pond and IM-4/IM-5). One or more of the three were detected at elevated concentrations at six of the eight ditch sampling locations bordering the site.

4.4.3 Surface Water/Sediment Summary

High concentrations of several metals and numerous PAH compounds, including several of the CPAH compound, were detected in samples collected for the investigation. The highest concentrations, however, were detected at stations located within the site proper and, for the most part, were associated with the large pond complex near the eastern extent of the site. Although some contaminants, primarily PAH compounds, were detected in surface water, their concentrations were

generally detected in the trace to low range and diminished quickly with distance from the site. The only exception to the low concentrations detected in Burnett Creek was the surface water and sediment samples collected at the Burnett Creek culvert discharge, located at the western edge of the site. As indicated, however, impacts from this appear to diminish quickly. While the large pond complex and the Burnett Creek culvert discharge appear to present a problem, with regard to high PAH/CPAH concentrations, the site, as a whole, does not appear to be greatly affecting off-site surface water and sediment.

4.5 Fish Tissue

Four fish tissue samples were analyzed for dioxin/furan compounds. These locations are shown on Figure 4-21. Samples consisted of processed whole body forage fish (see Section 2.1.4 for a full description). Based on the fish tissue analytical results, the site is apparently impacting stream biota in the immediate vicinity of the ditch outfall and the Burnett Creek culvert discharge.

The two samples with the lowest TEQs and lowest numbers of dioxin/furan compounds were those collected upstream of the outfall into the Perry Land Road ditch and from the reference stream location, Dillard Creek. The TEQs at these locations were 0.01 ng/kg and 0.02 ng/kg, respectively.

The next highest concentration, 0.1 ng/kg, was detected in the sample collected downstream of the ditch outfall. This sample also contained more compounds than detected in the upstream and reference stream locations. The sample collected from Burnett Creek, near the culvert discharge, however, contained by far the largest number of dioxin/furan compounds and had the highest TEQ, 0.8 ng/kg.

